
China United Network Communications Co., Ltd.

Digital Repeater Test Specification

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target Second-rate

1 Range	2
2 Normative references	5

China Unicom Digital Repeater Test Specification

1 scope

This specification specifies the test methods for the application function, RF performance, power supply adaptability and environmental adaptability of digital repeaters.

This specification is applicable to the test of multi-system digital repeaters supporting GSM, WCDMA, NB-IoT, FDD-LTE, etc.

2 normative references

The terms in the following documents become terms of this specification by reference in this specification. For dated references, all subsequent amendments (excluding errata content) or revisions do not apply to this specification. However, parties to agreements based on this specification are encouraged to study whether the latest versions of these documents can be used. . For undated references, the latest edition applies to this specification.

[1]) YD/T 1337-2005 "900MHz/1800MHz TDMA Digital Cellular Mobile Communication Network Repeater Technical Requirements and Test Methods";

[2] YD/T 1554-2007 "2GHz WCDMA Digital Cellular Mobile Communication Network Repeater Technical Requirements and Test Methods";

[3] YD/T 2355-2011 "900MHz/1800MHz TDMA Digital Cellular Mobile Communication Network Digital Repeater Technical Requirements and Test Methods";

[4] YD/T 2573-2013 "Technical Requirements for Base Station Equipment of LTE FDD Digital Cellular Mobile Communication Network" (Phase 1);

[5] YD/T 2225-2011 "900/1800MHz TDMA digital cellular mobile communication network analog repeater equipment network management interface technical requirements";

[6] QB/CU 272 (2018) "China Unicom FDD-LTE Digital Cellular Mobile Communication Network Repeater Technical Requirements and Test Specification V1.0";

[7] GB 4943.1-2011 "Information Technology Equipment Safety Part 1: General Requirements";

[8] GB/T 17626.5-2008 "Surge (Shock) Immunity Test";

[9] 3GPP TS 25.143 UTRA repeater conformance testing;

[10] 3GPP TS 36.143 Evolved Universal Terrestrial Radio Access (E-UTRA); FDD repeater conformance testing.

3 Definitions and Abbreviations

3.1 definition

3.1.1 digital repeater

Digital repeater is divided into digital optical fiber repeater and digital wireless repeater. The coupling mode with the source includes wired coupling and wireless coupling. The digital optical fiber repeater adopts the wired coupling mode, and the digital wireless repeater adopts the wireless coupling mode .

3.1.2 Digital Fiber Repeater

Digital optical fiber repeater means that the digital repeater uses wired coupling to access the source.

3.1.3 digital wireless repeater

Digital wireless repeater means that the digital repeater uses wireless coupling to access the source .

3.1.4 RF performance test block diagram of digital repeater

shortest link digital repeater single-item RF index test block diagram is composed: the digital optical fiber repeater includes 1 RF access unit and 1 high-power remote unit , and the digital wireless repeater is a stand-alone unit .



图1 The shortest link digital repeater single-item RF index test block diagram

3.1.5 Block diagram of network capability test of digital repeater

digital optical repeater consists of 1 radio frequency access unit and 3 high-power remote units . In order to verify the maximum networking capability, the number of high-power remote units can be increased as appropriate according to the actual networking capability of the device .

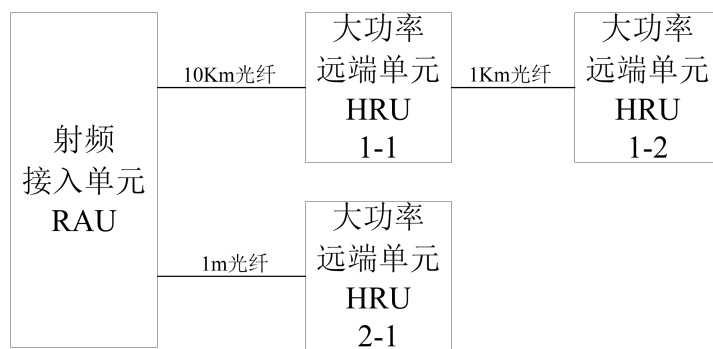


图2 Digital repeater network index test block diagram

3.2 abbreviation

The following abbreviations apply to this specification.

abbreviati on	English	Chinese
64QAM	64 Quadrature Amplitude Modulation	64th order quadrature amplitude modulation
ALC	Automatic Level Control	automatic level control
CW	Continuous Wave	continuous wave
EVM	Error Vector Magnitude	vector magnitude error
GSM	Global System for Mobile Communication	Global System for Mobile Communications
GPRS	General Packet Radio Service	General Packet Radio Service
LTE	Long Term Evolution	long term evolution technology
MIMO	Multiple-Input Multiple-Output-put	Multiple Input Multiple Output
PCDE	Peak Code Domain Error	Peak code domain error
POE	Power over Ethernet	Power over Ethernet
RAU	RF Access Unit	radio access unit
HRU	High Power Remote Unit	High Power Remote Unit
WCDMA	Wideband Code Division Multiple Access	Wideband Code Division Multiple Access
NB-IoT	Narrow Band Internet of Things	Cellular-based NB-IoT

4 System application function test

4.1 Networking Ability Test

4.1.1 Test configuration diagram

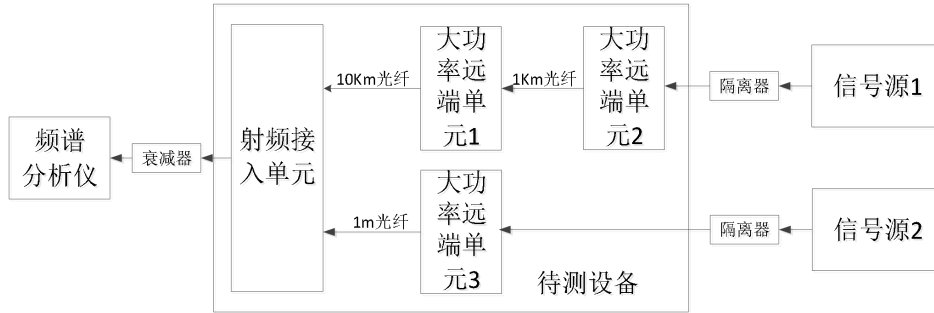


图3 Upstream test configuration diagram of longest and shortest tributary network

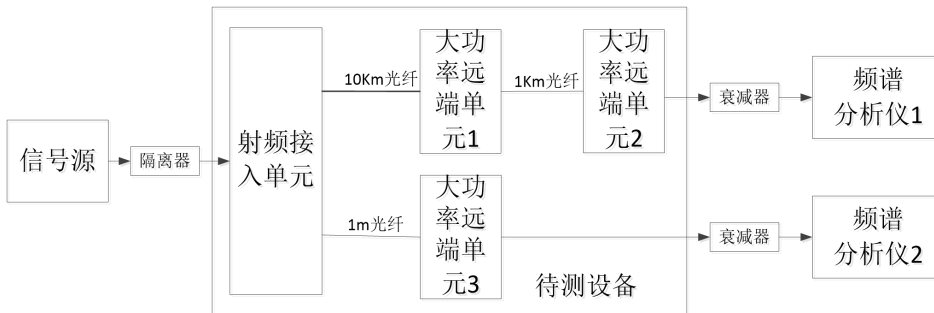


图4 Downlink test configuration diagram of longest and shortest tributary network

4.1.2 Networking Ability Test

test number	4.1.2
Test items	System application function test
test child	Networking Ability Test
Testing purposes	Verify the maximum networking capability of the digital optical fiber repeater
test instrument	N/ G/W/L signal source, spectrum analyzer , attenuator, isolator
Preconditions	1) Connect the test instrument and the digital fiber repeater for uplink testing according to Figure 3 ; 2) Connect the test instrument and the digital optical fiber repeater for downlink testing according to Figure 4 .
test steps	1) The signal source generates a modulated signal, and the output power is the maximum output power of a single remote unit of the digital optical fiber repeater , backed by 5dB. 2) Set the digital repeater gain to maximum . 3) For the longest branch: test system gain, maximum output power, and EVM, which must meet the corresponding index requirements. 4) For the shortest branch: test system gain, maximum output power, and EVM, which

	must meet the corresponding index requirements.
Test Data	1) Record digital fiber repeater gain, noise figure, maximum output power, EVM , maximum gain error. 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_S^2}$, where EVM_S is the EVM of the signal waveform file itself.
expected outcome	1) indicators meet the corresponding requirements , refer to "China Unicom Digital Repeater Technical Specifications"

4.1.3 Transmission Delay Test

4.1.3.1 Delay correction compensation range

test number	4.1.3.1
Test items	System application function test
test child	Delay Correction Compensation Range Test
Testing purposes	Verifying Transmission Delay of Digital Fiber Repeater
test instrument	Isolators, Attenuators, Signal Sources, Spectrum Analyzers
Preconditions	1) Connect the test instrument and the digital fiber repeater for uplink testing according to Figure 3 ; 2) Connect the test instrument and the digital optical fiber repeater for downlink testing according to Figure 4 .
test steps	1) Set the signal source to generate the corresponding standard signal (LTE: E-TM3.1) , and adjust the operating frequency to the center frequency of the digital repeater under test in turn ; 2) First test the carrier delay of the meter pass-through; 3) Connect the signal source and spectrum analyzer to the device under test; 4) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 5) Set the digital fiber repeater gain to the maximum; 6) Adjust the input signal level so that the output signal of the digital repeater reaches the manufacturer's nominal maximum value; 7) Turn off the automatic delay correction function ; 8) carrier delay from the signal analyzer and record it; 9) Turn on automatic delay calibration; 10) Repeat step 8.
Test Data	1) the transmission delay of each remote unit when the automatic delay correction function of the digital optical fiber repeater is turned off and on. 2) The delay adjustment range is the difference between the shortest branch delay with automatic delay adjustment turned off and the shortest branch delay with automatic delay adjustment turned on.
expected	1) Time delay correction compensation range $\geq 50 \mu s$.

outcome	
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4.1.3.2 Delay Correction Compensation Accuracy

test number	4.1.3.2
Test items	System application function test
test child	Time Delay Correction Compensation Accuracy Test
Testing purposes	Verification of Transmission Delay Correction and Compensation Accuracy of Digital Fiber Repeater
test instrument	Signal source, attenuator, spectrum analyzer, isolator
Preconditions	1) Connect the digital optical fiber repeater according to Figure 3 ; 2) Connect the test instrument and the device under test as shown in Figure 4 .
test steps	1) Set the signal source to generate the corresponding standard signal (LTE: E-TM3.1) , and adjust the operating frequency to the center frequency of the digital optical fiber repeater under test in turn ; 2) Connect according to the dotted line in Figure 5, first test the carrier delay of the meter pass-through; 3) Connect the signal source and spectrum analyzer to the device under test according to the solid line connection in Figure 5; 4) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 5) Set the digital fiber repeater gain to the maximum; 6) Adjust the input signal level so that the output signal of the digital repeater reaches the manufacturer's nominal maximum value; 7) Turn on the automatic delay correction function ; 8) Compare the delay measured by the farthest remote unit with that of other remote units , and take the largest difference as the delay correction compensation accuracy.
Test Data	1) Record digital repeater delay correction compensation accuracy.
expected outcome	1) time delay correction compensation accuracy is within the range of $\pm 1.5 \mu s$.

4.2 Channel Capability—Upstream Diversity Function

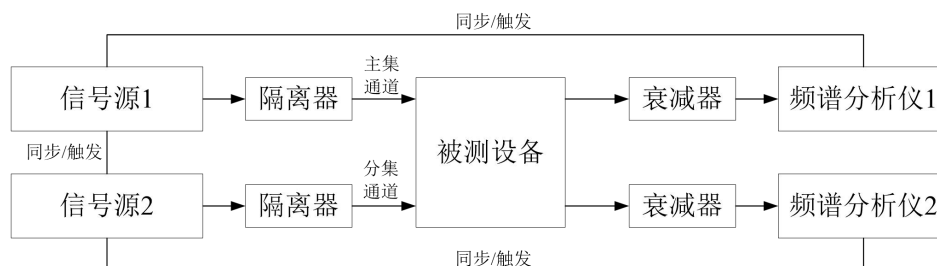


图5 Functional test configuration diagram

test number	4.3
Test items	System application function test
test child	Upstream Diversity Functional Test
Testing purposes	the capability of the upstream diversity function of the digital repeater
test instrument	Signal sources, isolators, spectrum analyzers , attenuators
Preconditions	1) Connect the digital repeater as shown in Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 5.
test steps	1) Set the gain of the device under test to the maximum gain; 2) Set the signal source 1 of the main channel to the center frequency within the operating frequency range of the device under test, and generate a modulated signal (LTE: E-TM3.1) ; set the signal source 2 corresponding to the diversity channel to the operating frequency range of the device under test the center frequency within and generate a modulated signal (LTE: E-TM1.1) as an interfering signal; 3) Adjust the levels of signal source 1 and signal source 2 until the upstream output power of the diversity channel of the device under test reaches the maximum linear output power; 4) Measure the uplink maximum output power and EVM index of the main channel, and meet the corresponding index requirements; 5) Adjust the level of signal source 1 to reduce 5dB; measure the maximum gain index of the main channel upstream, and meet the corresponding index requirements; 6) 2 of the diversity channel to the center frequency within the operating frequency range of the device under test, and generate a modulated signal (LTE: E-TM3.1) ; set the signal source 1 corresponding to the main channel to the operating frequency range of the device under test the center frequency within and generate a modulated signal (LTE: E-TM1.1) as an interfering signal; 7) Adjust the level of signal source 1 and signal source 2 until the upstream output power of the main channel of the device under test reaches the maximum linear output power; 8) Measure the uplink maximum output power and EVM index of the diversity channel , and meet the corresponding index requirements; 9) Adjust the level of signal source 2 to reduce 5dB; measure the upstream maximum gain index of the diversity channel, and meet the corresponding index requirements;
Test Data	1) maximum output power , EVM and gain of the digital repeater . 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.
expected outcome	1) Maximum output power , EVM and gain meet the requirements .

4.3 Transceiver isolation rejection ratio

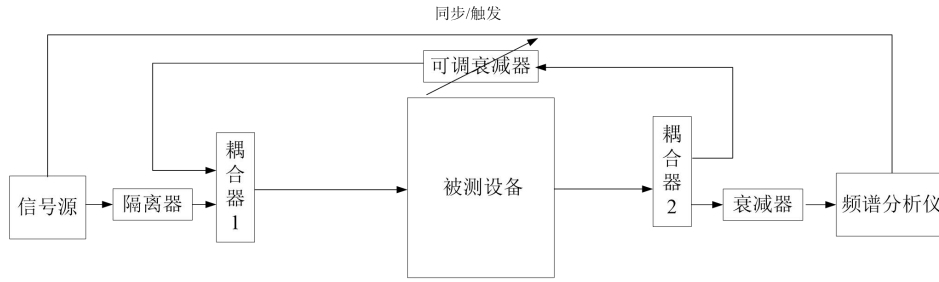


图6 Transceiver isolation rejection ratio functional test configuration diagram

test number	4.4
Test items	System application function test
test child	Transceiver isolation rejection ratio functional test
Testing purposes	The ability to verify the transceiver isolation rejection ratio of digital wireless repeater
test instrument	Signal sources, isolators, spectrum analyzers , attenuators
Preconditions	1) Connect the digital wireless repeater as shown in Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 6.
test steps	<ol style="list-style-type: none"> 1) Set the gain of the device under test to the maximum gain, and turn off the automatic gain adjustment function; 2) First test the attenuation error of the feedback link (two couplers + adjustable attenuator), the error should meet $\pm 1\text{dB}$, and the recorded attenuation values are "system maximum gain +20dB ", "system maximum gain", "system maximum gain -10dB " " corresponding adjustable attenuator adjustment value; 3) Turn on the interference cancellation function ICS; 4) Adjust the adjustable attenuator to adjust the link isolation (two coupler insertion loss + adjustable attenuator attenuation value) to " system maximum gain + 20 dB" ; 5) Signal source 1 generates the corresponding multi-carrier modulation signal according to the requirements in Appendix E; 6) Adjust the level of the signal source until the output power of the device under test reaches the maximum linear output power; 7) Test the EVM and GMSK modulation accuracy of the output signal of the device under test; 8) attenuation value of the adjustable attenuator in 1 dB steps until the isolation (two couplers insertion loss + attenuation value of the adjustable attenuator) is equal to the maximum gain of the system;

	<p>9) Test the actual gain of the device under test and meet the requirements of the maximum gain index;</p> <p>10) EVM and GMSK modulation accuracy of the output signal, and record the test results;</p> <p>11) attenuation value of the adjustable attenuator in steps of 1 dB until the isolation (two couplers insertion loss + attenuation value of the adjustable attenuator) is equal to the maximum gain of the system -10dB ;</p> <p>12) Test the EVM and GMSK modulation accuracy of the output signal of the device under test, and record the test results.</p>
Test Data	<p>1) , GMSK modulation accuracy and gain of digital repeater .</p> <p>2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.</p>
expected outcome	1) EVM , GMSK modulation accuracy and gain meet the requirements .

4.4 Overall efficiency

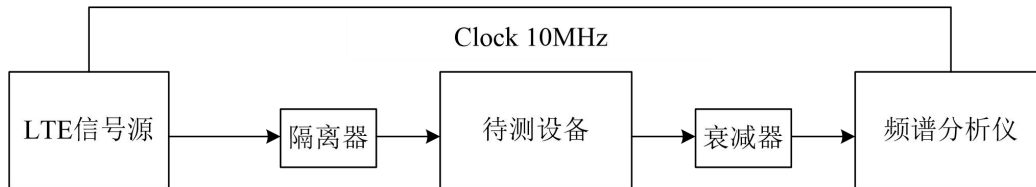


图7 The overall efficiency function test configuration diagram

test number	4.5
Test items	System application function test
test child	Machine efficiency function test
Testing purposes	Ability to verify the overall efficiency of a digital repeater
test instrument	Signal sources, isolators, spectrum analyzers , attenuators
Preconditions	<p>1) Connect the digital repeater as shown in Figure 1 ;</p> <p>2) Connect the test instrument and the device under test as shown in Figure 7.</p>
test steps	<p>1) Set the gain of the device under test to the maximum gain;</p> <p>2) Set the signal generator to the center carrier frequency in the working frequency band of the device under test, and generate a modulated signal (LTE: E-TM3.1) ;</p> <p>3) Adjust the level of the signal source until the output power of each downstream channel of the device under test reaches the ALC start control point ;</p> <p>4) Test the maximum linear output power of the downlink and record it;</p>

	<p>5) Measure the power supply voltage and current at the same time, and calculate the corresponding power consumption value of the whole machine;</p> <p>6) Overall machine efficiency = downlink maximum linear output power / overall machine power consumption.</p>
Test Data	1) downlink linear output power and power consumption of the digital repeater .
expected outcome	1) The overall efficiency of the remote unit meets the requirements .

4.5 Automatic gain adjustment function

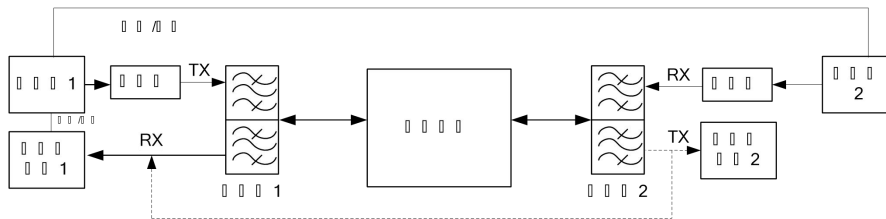


Figure 8 Automatic gain adjustment function test configuration diagram

test number	4.2
Test items	System application function test
test child	Automatic gain adjustment function test
Testing purposes	automatic gain adjustment capability of the digital repeater
test instrument	2 signal sources, isolators, duplexers, 2 spectrum analyzers , attenuators
Preconditions	<p>1) Connect the digital repeater as shown in Figure 1 ;</p> <p>2) Connect the test instrument and the device under test as shown in Figure 8.</p>
test steps	<p>1) Set the device under test to enable the automatic gain adjustment function; set the uplink and downlink gain difference $\Delta G = 5\text{dB}$;</p> <p>2) Signal source 1 generates the corresponding multi-carrier modulation signal according to the requirements in Appendix E; Signal source 2 is set to the center carrier frequency in the working frequency band of the device under test, and generates the modulation signal {LTE: E-TM3.1} ;</p> <p>3) When the PSS power of the downlink input signal is more than 5dB lower than the rated power of the downlink input PSS :</p> <p>a) Adjust the level of signal source 1 until the output power of the device under test reaches the downlink maximum linear output power and reduce it by 20 dB;</p> <p>b) Measure the power at the downstream output of the device under test, and calculate the actual downstream gain of the device under test;</p>

	<p>c) Keep signal source 1 turned on , and adjust the level of signal source 2 until the output power of the device under test reaches the maximum linear output power of the uplink, and meets the requirements of the nominal maximum linear output power of the uplink;</p> <p>d) Adjust the input power level of signal source 2 to reduce 5dB;</p> <p>e) Measure the power of the upstream output of the device under test, and calculate the actual upstream gain of the device under test;</p> <p>f) Read the PSS power value detected by the device and calculate the error.</p> <p>4) When the PSS power of the downstream input signal is 0dB higher than the rated power of the downstream input PSS :</p> <p>a) Adjust the level of signal source 1 until the output power of the device under test reaches the downlink maximum linear output power;</p> <p>b) Then add 10 dB in steps of 1 dB;</p> <p>c) Measure the maximum power of the downlink output of the device under test, and calculate the actual downlink gain of the device under test;</p> <p>d) Keep signal source 1 turned on , and adjust the level of signal source 2 until the rated upstream input power of the device under test is reduced by 5dB;</p> <p>e) Measure the uplink output power of the device under test, and calculate the actual uplink gain of the device under test;</p> <p>5) Read the PSS power value detected by the device and calculate the error.</p>
Test Data	1) PSS power value, upstream maximum output power and gain of the digital repeater .
expected outcome	1) The PSS power value, uplink maximum output power and gain of the digital repeater meet the requirements .

5 RF performance testing

5.1 Test Conditions and Judgment Basis

5.1.1 General Test Conditions

Unless otherwise specified, all tests shall be performed under the following normal conditions:

- Temperature: +15 °C ~+35 °C
- Relative humidity: 45 to 75%

5.1.2 Test Equipment Requirements

See Appendix A (normative) for test equipment requirements.

5.1.3 Test uncertainty

Table 1 shows the requirements for the uncertainty of the test system, and the uncertainty of the test system should be evaluated regularly.

表1 Uncertainty Requirements for Test Systems

Test items	allowable range (The unit is the same as that of the previous parameter)	Remark
Spurious Radiation (dBm)	1.5	
Output Intermodulation (dBm)	1.5	

5.1.4 Test Judgment Basis

The judgment basis of the test conclusion is to consider the situation when the uncertainty of the test system is not zero. Table 2 shows the relationship between the test judgment specification and the index requirements.

表2 Test judgment specification (different from index requirements)

Test items	UTS	The relationship between test judgment specifications and index requirements
maximum output power	0	Test Judgment Specification = Index Requirements
ALC	0	Test Judgment Specification = Index Requirements
gain	0	Test Judgment Specification = Index Requirements
In-band fluctuation	0	Test Judgment Specification = Index Requirements
frequency error	0	Test Judgment Specification = Index Requirements
transmission delay	0	Test Judgment Specification = Index Requirements
input Output VSWR	0	Test Judgment Specification = Index Requirements
Noise Figure	0	Test Judgment Specification = Index Requirements
out-of-band gain	0	Test Judgment Specification = Index Requirements
Spectrum emission mask	0	Test Judgment Specification = Index Requirements
stray radiation	1.5dB	Test Judgment Specification = Index Requirements + UTS
EVM	0	Test Judgment Specification = Index Requirements
PCDE	0	Test Judgment Specification = Index Requirements

input intermodulation	0	Test Judgment Specification = Index Requirements
output intermodulation	1.5dB	According to different test frequency bands, according to the test judgment specification of spectrum emission mask and spurious radiation
ACRR	0	Test Judgment Specification = Index Requirements

5.2 Multi-system coexistence RF performance

5.2.1 Multi-system interference protection (downlink reflection intermodulation)

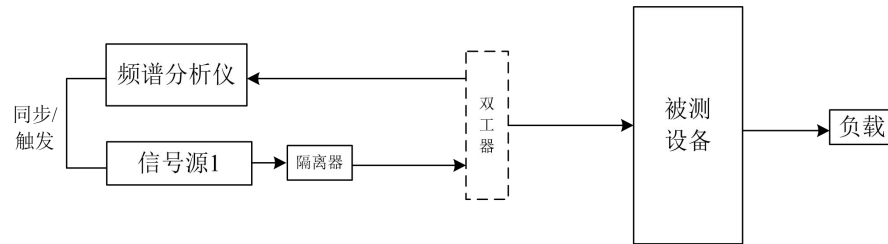


图9 Multi-system interference protection test

test number	5.2.1 _ _
Test items	System application function test
test child	Multi-system interference protection
Testing purposes	digital repeater in the case of multi-system integration Inter-system interference problem
test instrument	Signal sources, attenuators, spectrum analyzers , isolators, duplexers, loads
Preconditions	1) Connect the digital repeater as shown in Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 9 .
test steps	1) A duplexer is added to the downlink input port of the channel under test, so that the uplink output can be tested while the downlink channel is loaded; 2) Set the digital repeater gain to the maximum gain; 3) in accordance with Appendix E multi-carrier configuration ; 4) Adjust the power of each standard entering the device to be equal, and adjust the signal source to push the downlink power to the maximum output; 5) The spectrum analyzer sets the RBW to 1MHz, measures and records the uplink noise floor of the measured channels of each system of the digital repeater at this time ;
Test Data	1) the uplink noise floor of each system when multiple systems input signals at the same time ;

expected outcome	1) The test results should meet the requirements of "China Unicom Digital Repeater Technical Specifications".
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5.2.2 Common RF performance test

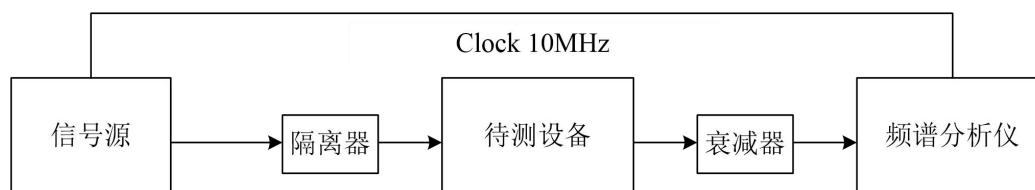


图 10 Common RF performance test configuration diagram

test number	5.2.2 _ _
Test items	System application function test
test child	Common RF performance test
Testing purposes	Verifying common RF performance of digital repeaters
test instrument	N / G / W / L Signal Source, Isolator, Attenuator, N / G / W / L Spectrum Analyzer
Preconditions	1) Connect the digital repeater as shown in Figure 1 . 2) connection is shown in Figure 10 ;
test steps	1) Set the gain of the digital repeater to be tested to the maximum, and disable the automatic carrier tracking function ; 2) signal source generates the corresponding multi-carrier modulation signal waveform 1 according to the requirements in Appendix E ; 3) Adjust the level of the signal source until the output power of the device under test reaches the ALC enable control point . 4) Test the multi-carrier total power and EVM of the output signal of each downstream channel; 5) signal source generates the corresponding multi-carrier modulation signal waveform 2 according to the requirements in Appendix E , and repeats steps 3 to 4;
Test Data	1) Record the total multi-carrier power and EVM metrics of the device under test. 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.
expected outcome	1) The test results all meet the corresponding standard output difference and EVM index requirements.

5.2.3 effective operating band

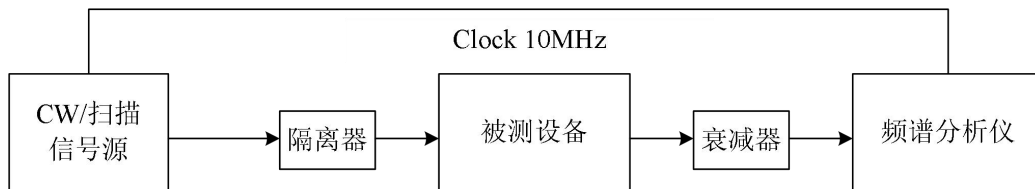


图 11 In-band fluctuation test connection diagram

test number	5.3.8 _ _ _ _ _
Test items	System Common RF Test
test child	valid operating band
Testing purposes	Verify in-band fluctuations in digital repeaters
test instrument	Signal sources, isolators, attenuators, spectrum analyzers
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test according to Figure 11 .
test steps	<ol style="list-style-type: none"> 1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) the signal source and spectrum analyzer within the effective working bandwidth of the digital repeater; 3) Adjust the gain of the digital repeater to the maximum , close the automatic gain adjustment function, the automatic carrier tracking function and the interference elimination function ICS ; if it is a product with DPD technology, close the DPD function; 4) Set the output level of the signal source to the input level when the maximum output power of the digital repeater is set back by 5dB; 5) For the 900 frequency band, the signal source adopts the CW frequency sweep method to test the difference between the maximum and minimum levels in the effective working frequency band of the digital repeater under test , which is the in -band fluctuation ; 6) For the 1800 frequency band, the signal source adopts the CW frequency sweep method to test the fluctuation in the effective working frequency band of the carrier defined in the appendix, and the worst recorded value is the fluctuation in the effective working band of each carrier; then the signal source generates a modulated signal (GSM: full-time Slot GMSK ; FDD-LTE: E-TM3.1 in the appendix) , test the gain of the GSM center carrier at the first 10 MHz, test the gain of the LTE center carrier frequency at the last 20 MHz, and record the gain difference between the carriers as the fluctuation within the effective working frequency band ; 7) For the 2100 frequency band, the signal source adopts the CW frequency sweep method to test the fluctuation of the high, medium and low carriers in the working frequency band (the effective working bandwidth of the LTE carrier is 18.18MHz, and the effective working bandwidth of the WCDMA carrier

	is 3.84MHz), and the worst record is recorded. The value is the fluctuation in the effective working band of each carrier; then generate the E-TM3 modulation signal from the signal source, test the gain of the high, medium and low carriers in the working band, and record the gain difference between the carriers as the fluctuation in the effective working band.
Test Data	1) the maximum and minimum levels within the effective working frequency band of each channel of the digital repeater ; 2) maximum and minimum levels in the effective working band of each carrier in the LTE format of the digital repeater ;
expected outcome	1) The fluctuation within the effective working band is less than or equal to 3dB (peak-to-peak) ; 2) Effective working band fluctuation of each carrier: WCDMA ≤ 2 dB (3.84MHz peak-to-peak), LTE ≤ 3 dB (18.18MHz peak-to-peak).

5.2.4 out-of-band spurs

test number	5.2.3 _ _
Test items	RF performance testing
test child	Out-of-Band Spurious Emissions Testing
Testing purposes	Verifying Out-of-Band Spurious Emissions from Digital Repeaters
test instrument	Signal sources, isolators, power attenuators, band-stop filters, spectrum analyzers
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device to be tested according to Figure 22 ;
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the gain of the digital repeater to be tested to the maximum; 3) signal generator generates multi-carrier modulation signals according to the requirements of Appendix E ; 4) Turn on all channels of the device under test, adjust the level of the signal source until the output power of each channel of the device under test reaches the ALC start control point (spurious in the working frequency band, no need to open the signal test) ; 5) Set the measurement bandwidth of the spectrum analyzer according to the requirements of the index, and adopt the RMS detection method and the Average (10 times) hold method ; 6) According to the requirements of the index, use a spectrum analyzer to read out the spurious emission power levels in each frequency band ; Note: 1) For some special frequency bands, when the spurious emission requirements are higher, it is necessary to cooperate with a notch filter for

	testing; 2) No out-of-band spurious emission requirements in special frequency bands are required for the uplink directly coupled to the base station; 3) For multi-standard products, the special frequency band where the working frequency band is located does not require special frequency band spurious.
Test Data	1) the spurious emission power levels in each frequency band of each downstream channel of the digital repeater .
expected outcome	1) Meet the out-of-band spurious index requirements.

5.3 GSM RF performance test

5.3.1 Nominal Maximum Linear Output Power Error

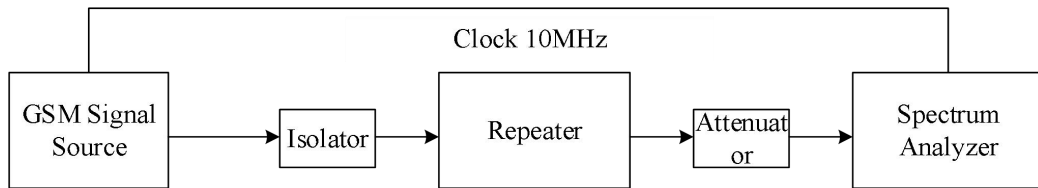


图 12 Nominal Maximum Linear Output Power Test Connection Diagram

test number	5.3.1 _ _
Test items	GSM RF performance test
test child	Nominal Maximum Linear Output Power Test
Testing purposes	Verify the maximum output power of the digital repeater
test instrument	GSM signal source, isolator, attenuator, spectrum analyzer
Preconditions	Connect the test instrument and the device under test according to Figure .
test steps	<ol style="list-style-type: none"> 1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 1) Set the GSM signal source to the center frequency point within the operating frequency range, and generate a full time slot GMSK signal ; 2) Set the digital repeater gain to the maximum gain; 3) Adjust the level of the GSM signal source until the ALC start control point, the carrier time slot power displayed on the spectrum analyzer should meet the tolerance range of the maximum output rated power declared by the manufacturer; 4) carrier time slot output level of the digital repeater ;
Test Data	<ol style="list-style-type: none"> 1) Recording equipment nominal maximum output power ; 2) Record carrier time slot output level and other information ; 3) Calculate the sum of the output levels of each carrier, that is, the total output

	power of the digital repeater .
expected outcome	1) error of each carrier is within $\pm 1.5\text{dB}$; 2) The total output power error of the digital repeater is within $\pm 1.5\text{dB}$.

5.3.2 Automatic Level Control (ALC)

test number	5.3.2 _ _
Test items	GSM RF performance test
test child	Automatic Level Control (ALC) Testing
Testing purposes	Verify the automatic level control range of the digital repeater
test instrument	GSM signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test according to Figure 12 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the GSM signal source to the center frequency point within the operating frequency range, and generate a GMSK signal with a time slot of 50% (interval time slot) ; 3) Set the digital repeater gain to the maximum gain; 4) Adjust the level of the GSM signal source until the output power of the digital repeater is the nominal maximum output power test value; 5) Record digital repeater carrier time slot output power; 6) Increase the output signal level of the GSM signal source in steps of 1dB until it increases to 10dB, use a spectrum analyzer to test the output power of the digital repeater, start from ALC until the maximum input power increases to 10dB , and record the digital direct The output power of the carrier time slot of the station ; 7) the output signal level of the signal source in steps of 1dB until it increases to 20dB or to the maximum non - damaged input power . Use a spectrum analyzer to test the carrier time slot output power of the digital repeater and record.
Test Data	1) Record the digital repeater carrier time slot output power.
expected outcome	1) When the input signal level increases less than 10dB (including 10dB), the output power should be kept within $\pm 2.0\text{ dB}$ of the maximum output power; 2) When the input signal level increases by more than 10dB (less than 20dB), the output power should be kept within $\pm 2.0\text{ dB}$ of the maximum output power or turned off.

5.3.3 Maximum gain and error

test number	5.3.3 _ _
Test	GSM RF performance test

items	
test child	Maximum Gain and Error Test
Testing purposes	Verify the maximum gain and error of the digital repeater
test instrument	GSM signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test according to Figure 12.
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the GSM signal source to the center frequency within the working frequency range of the digital repeater , and generate a GMSK signal with a time slot of 50% (interval time slot) ; 3) Set the digital repeater gain to the maximum; 4) Sequentially adjust the level of the GSM signal source until the output power of the digital repeater is at the nominal maximum output power and back off by 5 dB 5) The maximum gain is the ratio of the output power to the input power of the digital repeater; 6) The maximum gain error is the difference between the measured maximum gain value and the rated gain value declared by the manufacturer, and the maximum deviation value is taken.
Test Data	1) Record the rated gain value declared by the manufacturer; 2) Recording system digital repeater output power and input power ; 3) Calculate the maximum gain value and the maximum gain error.
expected outcome	1) The nominal maximum gain of digital optical fiber repeater: within $55\pm 3\text{dB}$; 2) Nominal maximum gain of digital wireless repeater: within $95\pm 3\text{dB}$;

5.3.4 Gain adjustment range

test number	5.3.4 _ _
Test items	GSM RF performance test
test child	Gain Adjustment Range Test
Testing purposes	Verify the gain adjustment range of the digital repeater
test instrument	GSM signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test according to Figure 12.
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the GSM signal source to the center frequency within the working frequency

	<p>range of the digital repeater, and generate a GMSK modulated signal with a time slot of 50% (interval time slot);</p> <ol style="list-style-type: none"> 3) Set the digital repeater gain to the maximum; 4) Adjust the level of the GSM signal source so that the output power of the digital repeater is the maximum output power declared by the manufacturer, back 1dB; 5) Measure the output power of the digital repeater at this time, and record the maximum gain as the ratio of the output power of the digital repeater to the input power at this time; 6) Set the digital repeater gain to the minimum; 7) Measure the output power of the digital repeater at the RF output port at this time, and record the minimum gain as the ratio of the output power to the input power of the digital repeater at this time; 8) The difference between the maximum gain and the minimum gain is the gain adjustment range of the device.
Test Data	<ol style="list-style-type: none"> 1) Record the nominal maximum output power of the digital repeater; 2) Record the input power of the digital repeater during the test; 3) Record the output power when the digital repeater gain is the maximum and minimum; the maximum gain is the ratio of the digital repeater output power to the input power; 4) The minimum gain is the ratio of the output power to the input power of the digital repeater with the minimum system gain; 5) The difference between the maximum gain and the minimum gain is the gain adjustment range of the device.
expected outcome	<ol style="list-style-type: none"> 1) Digital fiber repeater $\geq 20\text{dB}$; 2) Digital wireless repeater $\geq 30\text{dB}$;

5.3.5 Gain adjustment step size and error

test number	5.3.5 _ _ _
Test items	GSM RF Test
test child	Gain adjustment step size and step size error test
Testing purposes	Verify the gain adjustment step size and step size error of the digital repeater
test instrument	GSM signal source, isolator, attenuator, spectrum analyzer
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test according to Figure 12 .
test steps	<ol style="list-style-type: none"> 1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the GSM signal source to the center frequency within the working frequency range of the digital repeater, and generate a GMSK modulated signal with a time slot of 50% (interval time slot); 3) Set the digital repeater gain to the maximum; 4) Adjust the gain adjustment step size to reduce the gain of the digital repeater

	<p>under test , measure and record the power level when the actual gain of the digital repeater under test decreases by each step length through the spectrum analyzer , until the gain is the minimum;</p> <p>5) The actual gain adjustment step is the difference between each adjacent measured power level;</p> <p>6) The step error is the difference between the declared gain adjustment step and the actual gain adjustment step;</p> <p>7) Calculates the total gain adjustment accumulated error over the gain adjustment range .</p>
Test Data	<p>1) Record the power level when the actual gain of the system decreases by each step until the gain is the smallest; the actual gain adjustment step is the difference between each adjacent measured power level;</p> <p>2) The step error is the difference between the declared gain adjustment step and the actual gain adjustment step;</p> <p>3) Calculates the total gain adjustment accumulated error over the gain adjustment range .</p>
expected outcome	<p>1) Gain adjustment step size $\leq 1\text{dB}$;</p> <p>2) The gain adjustment step error should not exceed $\pm 1\text{dB}/\text{step}$;</p> <p>3) The total gain adjustment accumulated error within the gain adjustment range should be within $\pm 1\text{dB}$.</p>

5.3.6 frequency error

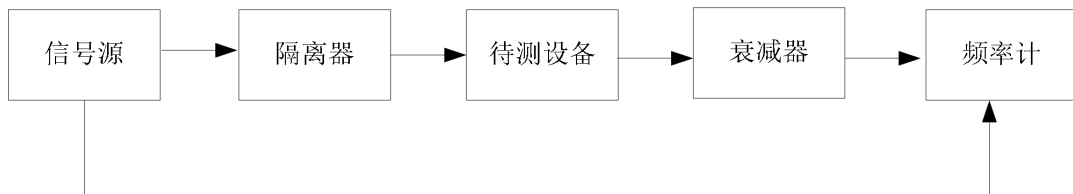


图 13 Frequency Error Test Configuration Diagram

test number	5.3.6 _ _ _
Test items	GSM RF Test
test child	Frequency Error Test
Testing purposes	Verify frequency error of digital repeater
test instrument	Signal sources, isolators, attenuators, frequency meters
Preconditions	<p>1) Connect the digital repeater according to Figure 1 ;</p> <p>2) Connect the test instrument and the device under test as shown in Figure 13 .</p>
test steps	<p>1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power);</p> <p>2) The GSM signal source is output as a full time slot 8PSK modulated signal, and its operating frequency is adjusted to the center frequency of the digital</p>

	repeater under test; 3) Set the digital repeater gain to the maximum; 4) When the output level of the signal source is set to the maximum output power, the input level is backed by 5dB; 5) In the working frequency range of the digital repeater, the frequency error of the center frequency point is measured respectively.
Test Data	1) Record the frequency error at the center frequency of the system.
expected outcome	1) The frequency error should be less than or equal to the input frequency $\pm 0.05\text{ppm}$.

5.3.7 Error Vector Magnitude (EVM) and GMSK Modulation Accuracy

test number	5.3.7 _ _ _
Test items	GSM RF performance test
test child	Vector Magnitude Error and GMSK Modulation Accuracy Test
Testing purposes	Verification of Vector Magnitude Error and GMSK Modulation Accuracy of Digital Repeater
test instrument	GSM signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1; 2) Connect the test instrument and the device under test as shown in Figure 12.
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) center frequency of the digital repeater under test in turn; 3) Set the digital repeater gain to the maximum; 4) Set the output level of the signal source to the input level at the maximum output power; 5) Read the rms EVM from the signal analyzer; 6) The output level of the signal source is increased by 10dB; 7) Repeat step 5; 8) center frequency of the digital repeater under test in turn; and set the output level of the signal source to the input level at the maximum output power; 9) peak values of the phase error from the signal analyzer. 10) The output level of the signal source is increased by 10dB; 11) Repeat step 9;
Test Data	1) Record EVM of GSM 8PSK signal; 2) Record the phase error RMS value and peak value of the GSM GMSK signal.
expected outcome	1) $EVM \leq 8\%$ (rms); 2) Accuracy is no greater than 7° RMS and 28° peak. 3) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.

5.3.8 RF Input Dynamic Range

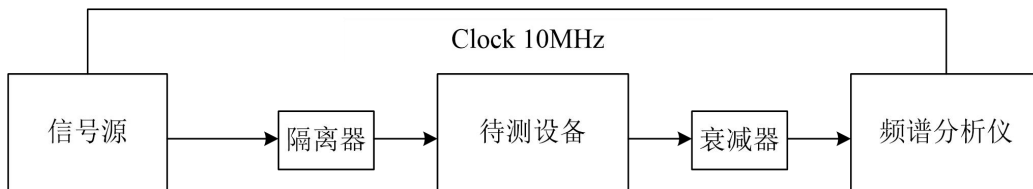


图 14 RF Input Dynamic Range Test Configuration Diagram

test number	5.3.9 _ _ _ _ _
Test items	GSM RF performance test
test child	RF Input Dynamic Range Test
Testing purposes	Verifying the RF Input Dynamic Range of a Digital Repeater
test instrument	Signal source, isolator, 5MHz filter, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 14 .
test steps	1) Set the start-up threshold of the noise suppression function to the lowest value. When the start-up threshold cannot be adjusted, the suppression function can be turned off; 2) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 3) Set the full time slot 8PSK modulated signal output by the signal source as the center frequency point within the working frequency range of the digital repeater; 4) Set the digital repeater gain to the maximum gain; 5) Adjust the output level of the signal source to the maximum rated input level and increase 5dB, and test the EVM value at this time; 6) Wired coupling downlink: the output level of the signal source is 20dB lower than the maximum rated input level , and the EVM value at this time is recorded ; 7) output level of the signal source is reduced to -8 7 dBm, record the EVM value at this time.
Test Data	1) EVM values of the upstream and downstream digital repeaters respectively. 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.
expected outcome	1) Wired coupled downlink : within the range from the maximum rated input power +5dB to the maximum rated input power -20dB, the EVM is not more than 6% ; 2) Uplink and wirelessly coupled downlink : EVM is not greater than 6% within the range of +5dB to ≤ -87 dBm from the maximum rated input power.

5.3.9 Intermodulation attenuation



图 15 Input Intermodulation Test Pattern

test number	5.3.10 _ _ _ _ _
Test items	GSM RF performance test
test child	Intermodulation Attenuation Test
Testing purposes	Verifying Intermodulation Attenuation in Digital Repeaters
test instrument	CW signal source, combiner, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 15 .
test steps	1) Adjust the signal source 1 to CW signal, the frequency is the center frequency of the digital repeater, and set the signal input level to the maximum output power specified by each carrier of the digital repeater; 2) Adjust the signal source 2 to be a CW signal, the frequency f2 and the frequency f1 of the signal source 1 are separated by 0.6MHz, and the output level is equal to f1; 3) Read the minimum difference between frequencies f1 and f2 and 2f1-f2 and 2f2-f1 on the spectrum analyzer, which is the third-order intermodulation; 4) Read out the minimum difference between frequencies f1 and f2 and 3f1-2f2 and 3f2-2f1 on the spectrum analyzer, which is the fifth-order intermodulation; 5) Read out-of-band intermodulation product levels in the range of 9kHz to 12.75GHz.
Test Data	1) Record the minimum difference between the frequencies f1 and f2 of the digital repeater and 2f1-f2 and 2f2-f1; 2) Record the minimum difference between the frequencies f1 and f2 of the digital repeater and 3f1-2f2 and 3f2-2f1; 3) Record out-of-band intermodulation product levels in the range of 9kHz to 12.75GHz.
expected outcome	1) In working band : intermodulation product $\leq -45\text{dBc}/30\text{KHz}$; 2) Working out of band: 9kHz~1GHz: $\leq -36\text{dBm}/100\text{kHz}$; 1GHz~12.75GHz: $\leq -30\text{dBm}/1\text{MHz}$.

5.3.10 Noise Figure

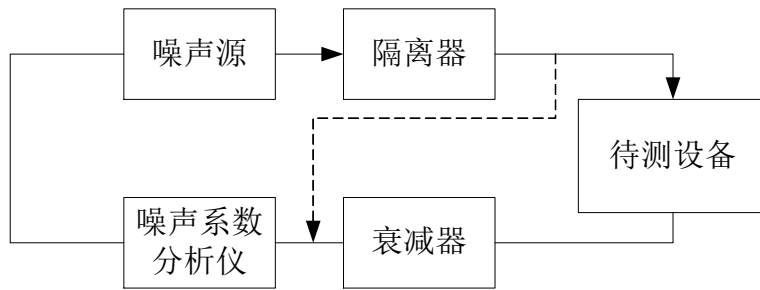


图 16 Noise Figure Test Chart

test number	5.3.11 _ _ _ _
Test items	GSM RF performance test
test child	Noise Figure Test
Testing purposes	Verifying the Noise Figure of a Digital Repeater
test instrument	Noise Sources, Isolators, Attenuators, Noise Figure Analyzers
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test according to Figure 16 .
test steps	1) by the dotted line in Figure 21 , and calibrate the noise figure tester; 2) Connect the test system as shown by the solid line in Figure 21 ; 3) Turn off the downlink and turn off the noise suppression function of the device under test; 4) Adjust the gain of the digital repeater under test to the maximum gain ; 5) Set the RBW of the noise analyzer to 1MHz; 6) the noise figure of the high , medium and low frequency points in the working frequency band of the digital repeater ;
Test Data	1) Record the system noise figure of the digital repeater; 2) Record the noise figure of the high, medium and low points in the working frequency band of the digital repeater.
expected outcome	1) Uplink noise figure in the state of minimum system maximum gain: $NF \leq 5dB$; Remarks: The minimum system of the digital optical fiber repeater is 1 RF access unit + 1 high-power remote unit; the minimum system of the digital wireless repeater is a single unit.

5.3.11 Spectrum emission mask

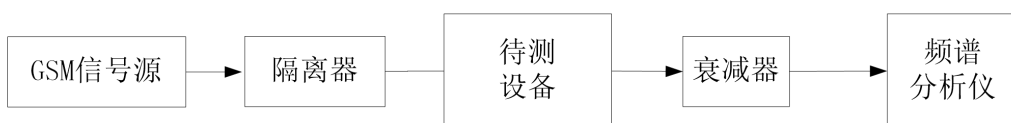


图 17 Spectrum emission mask test chart

test number	5.3.12 _ _ _ _
Test items	GSM RF performance test
test child	Spectrum emission mask test
Testing purposes	Spectrum Emission Masks for Digital Repeaters
test instrument	GSM signal source, isolator, attenuator , spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test according to Figure 17.
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Output 1 8PSK modulated carrier signal from the GSM signal source , and set it at the center frequency of the effective working frequency band; 3) Set the digital repeater gain to the maximum; 4) Set the output level of the GSM signal source to the input level at the maximum output power; 5) Set the measurement bandwidth of the spectrum analyzer to 30kHz, and the detection method to peak detection; 6) According to the requirements of the index, use a spectrum analyzer to read out the spurious emission power levels in each frequency band.
Test Data	1) Record the power level of spurious emissions in each frequency band of the digital repeater.
expected outcome	1) Meet the requirements of the spectrum emission mask index.

5.3.12 block

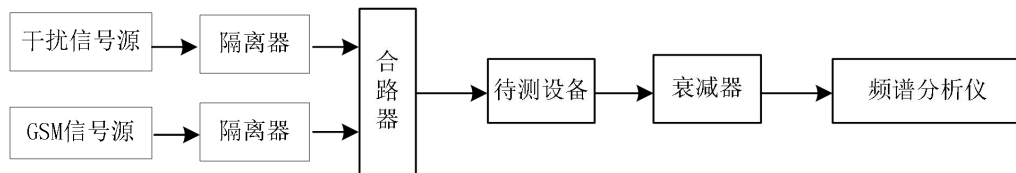


图 18 Blocking Test Block Diagram

test number	5.3.13 _ _ _ _
Test items	GSM RF performance test
test	blocking test

child	
Testing purposes	Test the effect of interfering signals on device gain
test instrument	GSM signal source , interference signal source , attenuator, isolator, combiner, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 18 .
test steps	1) Set the gain of the device under test to the maximum gain; 2) Set the output signal level of the main signal source so that the useful signal output of the device under test is the maximum output power, and record the gain at this time; 3) Turn on the interference signal source , and scan the frequency according to the frequency band and level required by the index; 4) and EVM with a spectrum analyzer .
Test Data	1) the main signal gain and EVM before and after turning on the interference signal source ; 2) the gain difference of the main signal before and after turning on the interfering signal source . 3) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_S^2}$, where EVM_S is the EVM of the signal waveform file itself.
expected outcome	1) The gain difference does not exceed 6dB ; 2) $EVM \leq 8\%$.

5.3.13 out-of-band suppression

test number	5.3.14 _ _ _ _
Test items	GSM RF performance test
test child	Out-of-Band Suppression Test
Testing purposes	Verifying Out-of-Band Suppression for Digital Repeaters
test instrument	CW/Scanning Signal Sources, Isolators , Attenuators, Spectrum Analyzers
Preconditions	1) Digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test according to Figure 12 .
test steps	1) Turn on the center carrier of the digital repeater, and turn off all other carriers ; 2) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 3) Set the signal source to CW signal, and set the output level to the input level of the digital repeater when the maximum output power is set back by 1 dB; 4) Set up the signal sources according to the requirements of the indicators, use the spectrum analyzer to test the output power of the corresponding frequency

	band of the digital repeater, and calculate the difference between the output power of the desired signal in the band as the out-of-band suppression value.
Test Data	1) Record the output power of the corresponding frequency band of the digital repeater ; 2) out-of-band suppression value of each frequency band is the ratio of the output power of the frequency band to the output power of the desired signal in the band.
expected outcome	1) The out-of-band suppression value meets the index requirements.

5.3.14 transmission delay

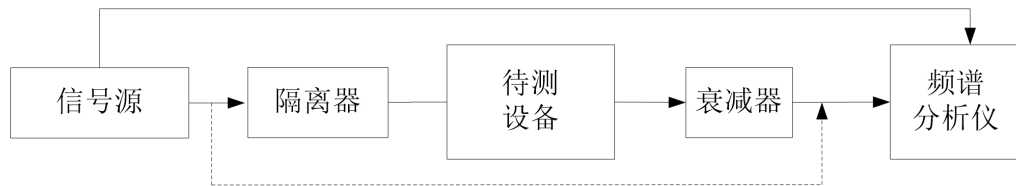


图 19 Delay test chart

test number	5.3.15 _ _ _ _
Test items	GSM RF performance test
test child	Transmission Delay Test
Testing purposes	Verifying the Transmission Delay of a Digital Repeater
test instrument	Attenuators, Isolators, Signal Sources, Spectrum Analyzers
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 19 .
test steps	1) Set the signal source to output GSM full time slot 8PSK modulation signal, and adjust the working frequency to the center frequency of the digital repeater under test in turn ; 2) according to the dotted line in Figure 19 , first test the carrier delay of the meter pass-through; 3) Connect the signal source and spectrum analyzer to the device under test according to the solid line connection in Figure 19 ; 4) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 5) Set the digital repeater gain to the minimum ; 6) Adjust the input signal level so that the output signal of the digital repeater reaches the manufacturer's nominal maximum value; 7) carrier delay from the signal analyzer ;
Test Data	1) Record the test delay of the digital repeater and the test delay of the meter

	pass-through . 2) The equipment delay of the digital repeater = the test delay of the equipment - the test delay of the meter pass-through;
expected outcome	1) Broadband devices $\leq 10\mu s$.

5.3.15 I/O VSWR



图 20 Input /Output VSWR Test Configuration Diagram

test number	5.3.16 _ _ _ _
Test items	GSM RF performance test
test child	Input /Output VSWR Test
Testing purposes	Verify the input VSWR of the digital repeater
test instrument	Matching loads, vector network analyzers
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 20 .
test steps	1) Turn off the uplink (measure the downlink input standing wave) or turn off the downlink (measure the uplink input power standing wave); 2) Set the frequency band of the vector network analyzer as the working frequency band of the digital repeater, and the output level is -30dBm; 3) Set as measurement after open circuit, short circuit and load calibration at the test port of the network analyzer; 4) Set the gain of the digital repeater to the minimum gain, connect the input (or output) port of the device under test to the test port, the output (or input) port to the load, and read the operating frequency band of the digital repeater under test from the vector network analyzer The maximum voltage standing wave ratio within.
Test Data	1) Record the maximum voltage standing wave ratio within the operating frequency band of the digital repeater.
expected outcome	1) Meet the input/output voltage standing wave ratio index requirements

5.3.16 Maximum allowable input level

test	5.3.17 _ _ _ _
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number	
Test items	GSM RF performance test
test child	Maximum allowable input level test
Testing purposes	Verify the maximum allowable input level of the digital repeater
test instrument	GSM signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 12 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) The GSM signal source outputs a full time slot 8PSK modulation signal, and its working frequency is adjusted to the center frequency point of the digital repeater under test; 3) Adjust the level to the maximum allowable input level for lmin; 4) Repeat the test of the maximum output power, maximum gain and automatic level control index items , and the measured values should be within the specified range of the index.
Test Data	1) The maximum allowable input level of uplink and downlink ; 2) Record test data for nominal maximum output power and gain index terms.
expected outcome	1) Uplink RF Input Ports: The maximum allowable input level is $\geq -10\text{dBm}$, the equipment can work normally without damage; 2) Downlink RF Input Ports: The maximum allowable input level of the optical fiber repeater is $\geq 10\text{dBm}$, and the equipment can work normally without damage; The maximum allowable input level of the wireless repeater is $\geq -10\text{dBm}$, and the equipment can work normally without damage.

5.3.17 Downstream reflection intermodulation

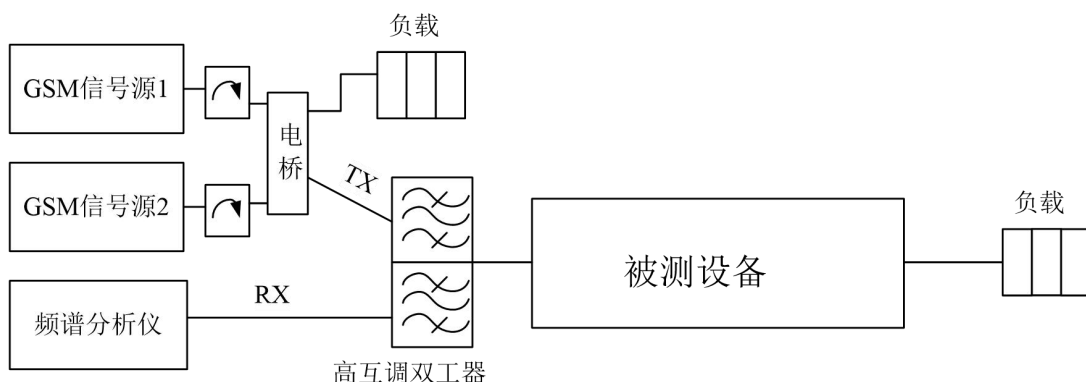


图 21 GSM downlink reflection intermodulation test configuration diagram

test	5.3.19 _ _ _ _
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number	
Test items	GSM RF performance test
test child	Downstream reflection intermodulation test
Testing purposes	Downlink Reflection Intermodulation of GSM Channel of Digital Repeater
test instrument	GSM signal source, bridge , high intermodulation load, high intermodulation duplexer, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 21 .
test steps	1) according to Figure 21 ; in order to solve the problem of signal source matching, the output port of the signal source must be connected to an isolator; a high intermodulation bridge is used for combining, and a high intermodulation load is used for port matching; the combined signal is passed through a high intermodulation Input from the TX port of the duplexer ; after the signal is output through the device, it is matched by a high intermodulation and high power load (the 5th -order passive intermodulation product needs to be satisfied $\leq -15 \text{ dBc}@ 30 \text{ dBm/CH}$, it is recommended to use the test provided by the instrument manufacturer load); spectrum analyzer RBW=100K , RMS detection. 2) Set the uplink and downlink gain of the digital repeater to the maximum nominal value (the maximum uplink gain is G), set signal source 1 to output 2 GMSK carrier signals, set signal source 2 to output 2 GMSK carrier signals with an interval of 600KHz , adjust The two signal sources make the power of the four GMSK carriers equal and the output power of the device under test reaches the nominal maximum power (in the 1800MHz frequency band , the four frequency points are 1830.2MHz , 1830.8MHz , and 1839.2MHz respectively) . , 1839.8MHz ; in the 900MHz frequency band , the four frequency points are 949.2MHz , 949.8MHz , 959.2MHz, 959.8MHz ;) ; for frequency selection equipment, it is necessary to Open the channel where the 4 GMSK carriers are located; 3) P0 of the intermodulation products in the upstream operating frequency band (1735-1745MHz or 904 -915MHz) in the spectrum analyzer ; for frequency selection equipment, all the channels where the intermodulation products are located should be turned on during the test. , the maximum value of the intermodulation product is P0 . 4) On the basis of step 2, the frequency point of signal source 2 remains unchanged, the frequency point of signal source 1 is increased in steps of 1MHz, and step 3 is repeated; until the carrier interval is less than 1MHz; 5) On the basis of step 2, the frequency point of signal source 1 remains unchanged, the frequency band of signal source 2 is decreased in steps of 1MHz, and step 3 is repeated; until the carrier interval is less than 1MHz;
Test Data	1) Record the maximum power value P0 of the intermodulation product falling into the upstream frequency band at the RX port of the high intermodulation duplexer at the donor end by recording the spectrum analyzer.
expected	1) The power of the downstream reflected intermodulation product at the upstream

outcome	RF output port should be lower than -110dBm/ 100KHz +upstream maximum gain;
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5.4 WCDMA RF performance test

5.4.1 Nominal Maximum Linear Output Power Error

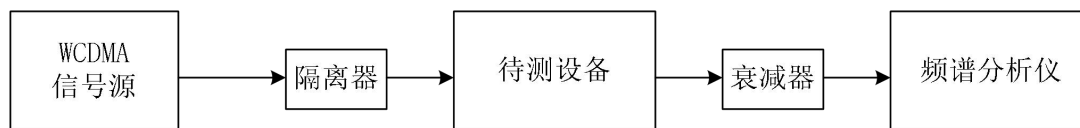


图 22 Maximum output power test configuration diagram

test number	5.4.1 _ _ _
Test items	WCDMA RF performance test
test child	Nominal Maximum Output Power Test
Testing purposes	Verify the maximum output power error of the digital repeater
test instrument	WCDMA signal source , isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 22 .
test steps	1) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 2) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, and make it generate the test mode 1B signal; 3) Set the digital repeater gain to the maximum gain; 4) the level of the WCDMA signal source until the ALC start control point, the power displayed on the spectrum analyzer should meet the tolerance range of the maximum output rated power declared by the manufacturer ; 5) output power of the carrier is measured separately by the spectrum analyzer .
Test Data	1) Recording equipment nominal maximum output power ; 2) output power of the digital repeater carrier ;
expected outcome	1) output power error of each carrier is within $\pm 1.5\text{dB}$; 2) The sum of the 3 carrier output powers is within $1.5\text{dB} \pm$ of the nominal maximum linear output power .

5.4.2 Automatic Level Control (ALC)

test number	5.4.2 _ _ _
Test items	WCDMA RF performance test
test child	Automatic Level Control (ALC) Testing

Testing purposes	Verification of Automatic Level Control (ALC) for digital repeaters
test instrument	WCDMA signal source , isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 22 .
test steps	1) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 2) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, and make it generate the test mode 1B modulated signal according to Appendix B; 3) Set the digital repeater gain to the maximum; 4) Adjust the level of the WCDMA signal source until the output power of the digital repeater is the maximum output power declared by the manufacturer; 5) Increase the output signal level of the WCDMA signal source by 10dB in steps of 1dB, and observe the change of the reading on the spectrum analyzer ; 6) the output signal level of the signal source in 1dB steps until it reaches 20dB or to the maximum non-destructive input power , and use a spectrum analyzer to test the output power respectively.
Test Data	1) Recording equipment nominal maximum output power ; 2) the output power on the digital repeater spectrum analyzer .
expected outcome	1) When the input signal level increases less than 10dB (including 10dB), the output power should be kept within ± 2.0 dB of the maximum output power; 2) When the input signal level increases by more than 10dB (less than 20dB), the output power should be kept within ± 2.0 dB of the maximum output power or turned off.

5.4.3 Maximum gain and error

test number	5.4.3 _ _ _
Test items	WCDMA RF performance test
test child	Maximum Gain and Error Test
Testing purposes	Verify the maximum gain and error of the digital repeater
test instrument	WCDMA signal source , isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 22 .
test steps	1) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 2) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, and make it generate the test mode 1B modulated signal according to Appendix B;

	<ol style="list-style-type: none"> 3) Set the digital repeater gain to the maximum; 4) Adjust the level of the WCDMA signal source in turn until the output power of the digital repeater reaches the nominal maximum output power and backs up by 5dB; 5) The maximum gain is the ratio of the output power to the input power of the digital repeater; 6) The maximum gain error is the difference between the measured maximum gain value and the rated gain value declared by the manufacturer, and the maximum deviation value is taken.
Test Data	<ol style="list-style-type: none"> 1) Record the rated gain value declared by the manufacturer; 2) Recording system digital repeater output power and input power ; 3) Calculate the maximum gain value and the maximum gain error.
expected outcome	<ol style="list-style-type: none"> 1) The nominal maximum gain of digital optical fiber repeater: within $55\pm 3\text{dB}$; 2) Nominal maximum gain of digital wireless repeater: within $95\pm 3\text{dB}$;

5.4.4 Gain adjustment range

test number	5.4.4 _ _ _ _
Test items	WCDMA RF performance test
test child	Gain Adjustment Range Test
Testing purposes	Verify the gain adjustment range of the digital repeater
test instrument	WCDMA signal source , attenuator, spectrum analyzer
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 22.
test steps	<ol style="list-style-type: none"> 1) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 2) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, and make it generate the test mode 1B modulated signal according to Appendix B; 3) Set the digital repeater gain to maximum: 4) Adjust the level of the WCDMA signal source until the output power of the digital repeater is the maximum output power declared by the manufacturer, back 1dB; 5) To measure the output power of the digital repeater, the maximum gain is the ratio of the output power of the digital repeater to the input power: 6) Set the digital repeater gain to the minimum; 7) To measure the output power of the digital repeater, the minimum gain is the ratio of the output power of the digital repeater to the input power; 8) The gain adjustment range is the difference between the maximum gain and the minimum gain.
Test Data	<ol style="list-style-type: none"> 1) Record the output power under the maximum gain and minimum gain of the digital repeater.
expected	<ol style="list-style-type: none"> 1) Digital fiber repeater $\geq 20\text{dB}$;

outcome	2) Digital wireless repeater $\geq 30\text{dB}$;
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5.4.5 Gain adjustment step size and error

test number	5.4.5 _ _ _ _
Test items	WCDMA RF performance test
test child	Gain adjustment step size and error test
Testing purposes	Verify the gain adjustment step size and error of the digital repeater
test instrument	WCDMA signal source , attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1; 2) Connect the test instrument and the device under test as shown in Figure 22 .
test steps	1) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 2) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, and make it generate the test mode 1B modulated signal according to Appendix B; 3) Calculate the nominal value of the output power of the digital repeater when the gain is reduced by one step; 4) Set the digital repeater gain to the maximum; 5) Adjust the level of the WCDMA signal source until the output power of the digital repeater is the maximum output power declared by the manufacturer; 6) Measure the output power of digital repeater; 7) Decrease the gain of the digital repeater by adjusting the step length, measure the output power of the digital repeater for each step down and record it until the gain of the digital repeater is the minimum; 8) The gain adjustment step error is the difference between the output power of the digital repeater recorded in step 6 and the nominal output power of the digital repeater calculated in step 5; 9) Calculates the total gain adjustment accumulated error over the gain adjustment range .
Test Data	1) Record the output power of the digital repeater for each step down.
Expected results	1) Gain adjustment step size $\leq 1\text{dB}$; 2) The gain adjustment step error should not exceed $\pm 1\text{dB}/\text{step}$; 3) The total gain adjustment accumulated error within the gain adjustment range should be within $\pm 1\text{dB}$.

5.4.6 frequency error

test number	5.4.6 _ _ _ _
Test items	WCDMA RF performance test

test child	Frequency error and frequency step value test
Testing purposes	Verify frequency error of digital repeater
test instrument	Signal sources , isolators, attenuators, frequency meters
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 13 .
test steps	1) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 2) Set the WCDMA signal source to 1B signal, the frequency is the center frequency within the working frequency range of the digital repeater, and connect the signal source to the input port of the digital repeater; 3) Set the digital repeater gain to the maximum; 4) When the output level of the signal source is set to the maximum output power, the input level is backed by 5dB; 5) Measure the frequency deviation of the center frequency point .
Test Data	1) Record digital repeater frequency error .
expected outcome	1) The frequency error should be less than or equal to the input frequency ± 0.05 ppm .

5.4.7 Error in vector magnitude (EVM)

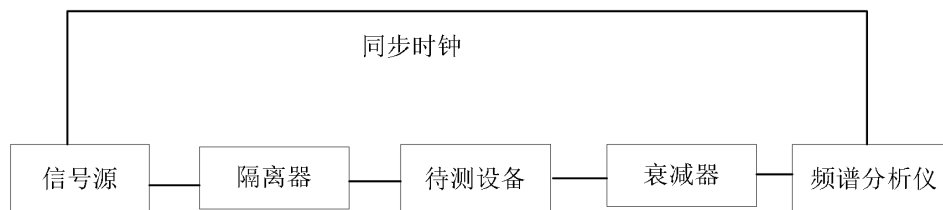


图 23 Vector Magnitude Error Test Configuration Diagram

test number	5.4.7 _ _ _ _
Test items	WCDMA RF performance test
test child	Error Vector Magnitude (EVM) Test
Testing purposes	Verifying Error Vector Magnitude (EVM) for Digital Repeaters
test instrument	Signal sources, isolators, attenuators, spectrum analyzers
Preconditions	1) Connect the digital repeater according to Figure 1; 2) Connect the test instrument and the device under test as shown in Figure 23 .
test steps	1) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, so that it can generate the signal of test mode 1B;

	<ol style="list-style-type: none"> 2) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 3) Set the gain of the digital repeater to the maximum; 4) Adjust the input signal level so that the output signal of the digital repeater reaches the manufacturer's nominal maximum value; 5) Test the vector magnitude error value at the output. 6) The output level of the signal source is increased by 10dB ; 7) Repeat step 5;
Test Data	<ol style="list-style-type: none"> 1) Record the vector magnitude error value of the digital repeater. 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.
expected outcome	<ol style="list-style-type: none"> 1) $\leq 12.5\%$(rms) .

5.4.8 Peak Code Domain Error (PCDE)

test number	5.4.8 _ _ _ _
Test items	WCDMA RF performance test
test child	Peak Code Domain Error (PCDE) Test
Testing purposes	Verify Peak Code Domain Error (PCDE) for Digital Repeaters
test instrument	Signal sources, isolators, attenuators, spectrum analyzers
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 23 .
test steps	<ol style="list-style-type: none"> 1) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, so that it can generate the signal of test mode 2 of Appendix B (spreading factor is 256); 2) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 3) Set the gain of the digital repeater to the maximum; 4) Adjust the input signal level so that the output signal of the digital repeater reaches the manufacturer's nominal maximum value; 5) Test the peak code domain error value at the output; 6) Increase the input signal level by 10dB and repeat step 5.
Test Data	<ol style="list-style-type: none"> 1) Record the peak code domain error value of the digital repeater.
expected outcome	<ol style="list-style-type: none"> 1) $\leq -35\text{dB}$.

5.4.9 RF Input Dynamic Range

test number	5.4.10 _ _ _ _
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Test items	WCDMA RF performance test
test child	RF Input Dynamic Range Test
Testing purposes	Verifying the RF Input Dynamic Range of a Digital Repeater
test instrument	Signal sources, isolators, attenuators, spectrum analyzers
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Figure 23 Connect the test instrument and the device under test.
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, so that it can generate the signal of test mode 1B; 3) Set the digital repeater gain to the maximum gain; 4) Adjust the output level of the signal source to the maximum rated input level and increase 5dB, and test the EVM value at this time; 5) Wired coupled downlink: The output level of the signal source is 20dB lower than the maximum rated input level , and the EVM value at this time is recorded ; 6) Uplink and wirelessly coupled downlink: When the output level of the signal source drops to -80 dBm, record the EVM value at this time.
Test Data	1) EVM values of the upstream and downstream digital repeaters respectively. 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.
expected outcome	1) Wired coupled downlink : within the range from the maximum rated input power +5dB to the maximum rated input power -20dB, the EVM is not greater than 1 2.5 %; 2) Uplink and wirelessly coupled downlink : From the maximum rated input power +5dB to ≤ -80 dBm, EVM is not greater than 1 2.5%.

5.4.10 Noise Figure

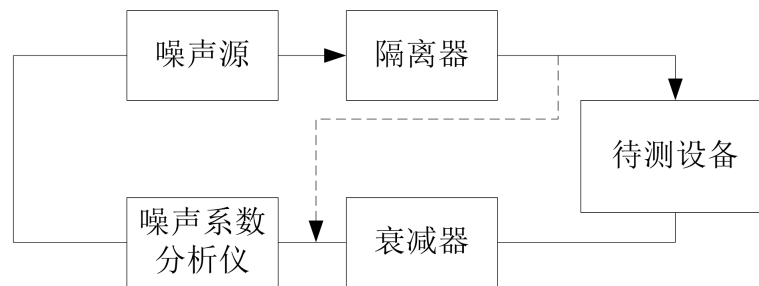


图 24 Noise Figure Test Configuration Diagram

test number	5.4.13 _ _ _ _
Test items	WCDMA RF performance test

test child	Noise Figure Test
Testing purposes	Verifying the Noise Figure of a Digital Repeater
test instrument	Noise Sources, Isolators, Attenuators, Noise Figure Analyzers
Preconditions	1) Connect the digital repeater according to Figure 1; 2) Connect the test instrument and the device under test as shown in Figure 24 .
test steps	1) Calibrate the noise measurement system as shown by the dotted line in Figure 26; 2) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 3) Adjust the digital repeater gain to the maximum gain ; 4) Set the RBW of the noise analyzer to 1MHz; 5) Use a noise figure meter to test the noise figure of the digital repeater at high, medium and low carrier frequencies .
Test Data	1) Record the noise figure of the digital repeater.
expected outcome	1) Uplink noise figure in the state of minimum system maximum gain: $NF \leq 5\text{dB}$; Remarks: The minimum system of the digital optical fiber repeater is 1 RF access unit + 1 high-power remote unit; the minimum system of the digital wireless repeater is a single unit.

5.4.11 Spectrum emission mask

test number	5.4.14 _ _ _ _
Test items	WCDMA RF performance test
test child	Spectrum emission mask test
Testing purposes	Validating Spectrum Emission Masks for Digital Repeaters
test instrument	GSM signal source , WCDMA signal source, LTE signal source, power attenuator, bandpass filter, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 22 .
test steps	1) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 2) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, so that it can generate the signal of test mode 1B in Appendix B; 3) Set the digital repeater gain to the manufacturer's nominal maximum value; 4) Adjust the input level to maximize the output power of the digital repeater ; 5) Test spurs within the frequency band range shown in the specification requirements; 6) The output level of the WCDMA signal source is increased by 10dB ;

	7) Repeat step 5;
Test Data	1) Record the spurs of the digital repeater.
expected outcome	1) Meet the requirements of the spectrum emission mask index.

5.4.12 block

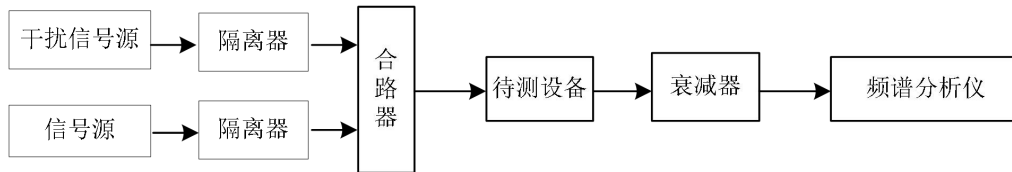


图 25 Blocking test configuration diagram

test number	5.4.15 _ _ _ _
Test items	WCDMA RF performance test
test child	blocking test
Testing purposes	Verify Blocking of Digital Repeater
test instrument	Signal sources , isolators, combiners, attenuators, spectrum analyzers
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 25 .
test steps	1) Set the carrier frequency of the WCDMA signal source to the center frequency of the effective working frequency band, and adjust the output level of the signal source to make the output of the digital repeater the maximum output power; measure the output level of the digital repeater, and calculate its gain value ; 2) Turn on the interference signal source, and set it according to the frequency band and level in the indicator requirements; 3) Measure the output level of the digital repeater, and calculate its gain value and gain change difference.
Test Data	1) Record the output level, gain, gain variation difference , and EVM of the digital repeater . 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_S^2}$, where EVM_S is the EVM of the signal waveform file itself.
expected outcome	1) The gain difference does not exceed 6dB ; 2) $EVM \leq 12.5\%$.

5.4.13 out-of-band suppression

test number	5.4.16 _ _ _ _
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Test items	WCDMA RF performance test
test child	Out-of-Band Suppression Test
Testing purposes	Suppression for Digital Repeaters
test instrument	Signal sources, isolators, attenuators , spectrum analyzers
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 22 .
test steps	1) Set the digital repeater gain to the manufacturer's nominal maximum value; 2) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 3) Set the RF signal source to CW signal, and adjust the output level of the RF signal source to (Linmax-5dB) to ensure that the digital repeater works in the linear region; 4) Set up the signal sources according to the requirements of the indicators, use the spectrum analyzer to test the output power of the corresponding frequency band of the digital repeater, and calculate the difference between the output power of the desired signal in the band as the out-of-band suppression value.
Test Data	1) output power of the corresponding frequency band of the digital repeater ; 2) out-of-band suppression value of each frequency band is calculated as the ratio of the output power of the frequency band to the output power of the desired signal in the band .
expected outcome	1) The out-of-band suppression meets the specification requirements.

5.4.14 transmission delay

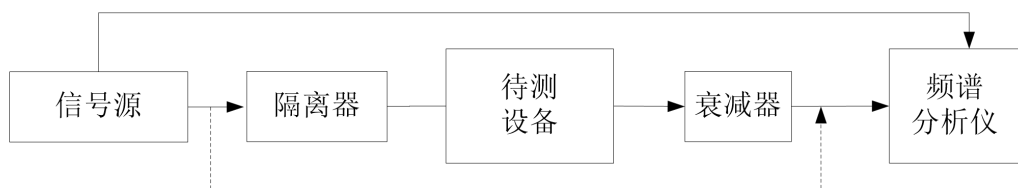


图 26 Transmission Delay Test Configuration Diagram

test number	5.4.17 _ _ _ _
Test items	WCDMA RF performance test
test child	Transmission Delay Test
Testing purposes	Verifying the Transmission Delay of a Digital Repeater
test	Isolators, Attenuators, Signal Sources, Spectrum Analyzers

instrument	
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 26 .
test steps	<ol style="list-style-type: none"> 1) Set the signal source to output the WCDMA test mode 1 B modulation signal, and adjust the operating frequency to the center frequency of the digital repeater under test in turn ; 2) according to the dotted line in Figure 26 , first test the carrier delay of the meter pass-through; 3) according to the solid line connection in Figure 26 ; 4) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 5) Set the digital repeater gain to the minimum ; 6) Adjust the input signal level so that the output signal of the digital repeater reaches the manufacturer's nominal maximum value; 7) carrier delay from the signal analyzer ;
Test Data	<ol style="list-style-type: none"> 1) Record the test delay of the digital repeater and the test delay of the meter pass-through . 2) The equipment delay of the digital repeater = the test delay of the equipment - the test delay of the meter pass-through;
expected outcome	1) Broadband devices $\leq 10\mu s$.

5. 4. 15 Input / Output VSWR

test number	5. 4. 18 _ _ _ _
Test items	WCDMA RF performance test
test child	Input /Output VSWR Test
Testing purposes	Verify the input VSWR of the digital repeater
test instrument	Matching loads, vector network analyzers
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 20 .
test steps	<ol style="list-style-type: none"> 1) Turn off uplink (measure downlink metrics) or turn off downlink (measure uplink metrics); 2) Set the frequency band of the vector network analyzer as the working frequency band of the digital repeater, and the output level is -30dBm; 3) Set as measurement after open circuit, short circuit and load calibration at the test port of the network analyzer; 4) Set the gain of the digital repeater to the minimum gain, connect the input (or output) port of the device under test to the test port, the output (or input) port to the load, and read the working frequency band of the digital repeater under test from the vector network analyzer The maximum voltage standing wave

	ratio within.
Test Data	1) Record the maximum value of the VSWR in the working frequency band of the digital repeater.
expected outcome	1) Meet the input/output voltage standing wave ratio index requirements

5.4.16 Maximum allowable input level

test number	5.4.19 _ _ _ _
Test items	WCDMA RF performance test
test child	Maximum allowable input level test
Testing purposes	Verify the maximum allowable input level of the digital repeater
test instrument	WCDMA signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 22 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the WCDMA signal source to the center frequency within the working frequency range of the digital repeater, so that it can generate the signal of Appendix B test mode 1B; 3) Adjust the level to the maximum allowable input level for lmin; 4) Repeat the test of the nominal maximum output power and gain index items, and the measured values should be within the specified range of the index.
Test Data	1) record the maximum allowable input level of the digital repeater; 2) Record test data for nominal maximum output power and gain index terms.
expected outcome	1) Uplink RF Input Ports: The maximum allowable input level is $\geq -10\text{dBm}$, the equipment can work normally without damage; 2) Downlink RF Input Ports: The maximum allowable input level of the optical fiber repeater is $\geq 10\text{dBm}$, and the equipment can work normally without damage; The maximum allowable input level of the wireless repeater is $\geq -10\text{dBm}$, and the equipment can work normally without damage.

5.5 LTE RF performance test

5.5.1 Nominal Maximum Linear Output Power Error

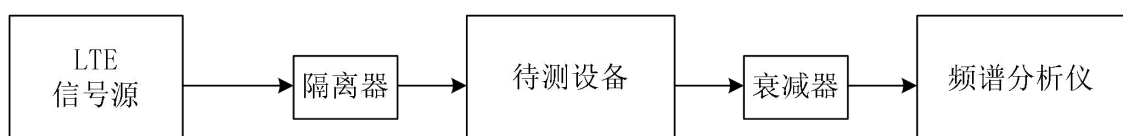


图 27 Nominal Maximum Linear Output Power Test Connection Diagram

test number	5.5.1 _ _ _ _
Test items	LTE RF Test
test child	Nominal Maximum Output Power Test
Testing purposes	Verify the maximum output power of the digital repeater
test instrument	LTE signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 27 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the LTE signal source to the center frequency within the working frequency range of the digital repeater, and send the E-TM1.1 modulated signal; 3) Set the digital repeater gain to the maximum gain; 4) Adjust the level of the LTE signal source until the ALC control point, back off by 1dB, and increase the power in steps of 0.2 dB to the maximum linear power; 5) spectrum analyzer shall meet the tolerance range of the maximum output rated power declared by the manufacturer; 6) Record the output level and input power level of the digital repeater.
Test Data	1) Recording equipment nominal maximum output power ; 2) Record the output level and input power level.
expected outcome	1) error of the digital repeater is within $\pm 1.5\text{dB}$.

5.5.2 Automatic Level Control (ALC)

test number	5.5.2 _ _ _ _ _
Test items	LTE RF Test
test child	Automatic Level Control (ALC) Testing
Testing purposes	Verify the automatic level control range of the digital repeater
test instrument	LTE signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 27 .
test	1) Turn off the uplink (measure the downlink output power) or turn off the

steps	<p>downlink (measure the uplink output power);</p> <ol style="list-style-type: none"> 2) Set the LTE signal source to the center frequency point within the working frequency range, and set it to the E-TM1.1 modulation signal; 3) Set the digital repeater gain to the maximum gain, and set the digital repeater ALC adjustment threshold to the factory rated power threshold; 4) Adjust the level of the LTE signal source until the output power of the digital repeater is the nominal maximum output power test value; 5) Record digital repeater output power; 6) Increase the output signal level of the LTE signal source in steps of 1dB until it increases to 10dB, use a spectrum analyzer to test the output power of the digital repeater respectively, from ALC control until the maximum input power increases to 10dB, record the carrier output power value; 7) Increase the output signal level of the signal source in steps of 1dB until it increases to 20dB or to the maximum non - destructive input power , and use a spectrum analyzer to test the output power respectively ;
Test Data	1) Record the digital repeater output power.
expected outcome	<ol style="list-style-type: none"> 1) When the input signal level increases less than 10dB (including 10dB), the output power should be kept within ± 2.0 dB of the maximum output power; 2) When the input signal level increases by more than 10dB (20dB), the output power should be kept within ± 2.0 dB of the maximum output power or turned off.

5.5.3 Maximum gain and error

test number	5.5.3 _ _ _ _ _
Test items	LTE RF Test
test child	Maximum Gain and Error Test
Testing purposes	Verify the maximum gain and error of the digital repeater
test instrument	LTE signal source, isolator, attenuator, spectrum analyzer
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 27.
test steps	<ol style="list-style-type: none"> 1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the LTE signal source to the center frequency point within the working frequency range, and set it to the E-TM1.1 modulation signal; 3) Set the digital repeater gain to the maximum; 4) Adjust the level of the LTE signal source in turn until the output power of the digital repeater is back to the nominal maximum output power by 5dB;

	<ol style="list-style-type: none"> 5) The maximum gain is the ratio of the output power to the input power of the digital repeater; 6) The maximum gain error is the difference between the measured maximum gain value and the rated gain value declared by the manufacturer, and the maximum deviation value is taken.
Test Data	<ol style="list-style-type: none"> 1) Record the rated gain value declared by the manufacturer; 2) Recording system digital repeater output power and input power ; 3) Calculate the maximum gain value and the maximum gain error.
expected outcome	<ol style="list-style-type: none"> 1) The nominal maximum gain of digital optical fiber repeater: within $55 \pm 3\text{dB}$; 2) Nominal maximum gain of digital wireless repeater: within $95 \pm 3\text{dB}$;

5.5.4 Gain adjustment range

test number	5.5.4 _ _ _ _
Test items	LTE RF Test
test child	Maximum Gain and Error Test
Testing purposes	Verify the maximum gain and error of the digital repeater
test instrument	LTE signal source, isolator, attenuator, spectrum analyzer
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 27 .
test steps	<ol style="list-style-type: none"> 1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the LTE signal source to the center frequency point within the working frequency range, and set it to the E-TM1.1 modulation signal; 3) Set the digital repeater gain to the maximum; 4) Adjust the level of the LTE signal source until the output power of the digital repeater is back to the maximum output power declared by the manufacturer by 1dB; 5) Measure the output power of the digital repeater, the maximum gain is the ratio of the output power of the digital repeater to the input power, and record the gain data; 6) Set the digital repeater gain to the minimum; 7) Measure the output power of the digital repeater, the minimum gain is the ratio of the output power of the digital repeater to the input power, and record the gain data; 8) The gain adjustment range is the difference between the maximum gain and the minimum gain, and the adjustment range data is recorded.
Test Data	1) Record the maximum gain and minimum gain of the digital repeater.
expected outcome	<ol style="list-style-type: none"> 1) Digital fiber repeater $\geq 20\text{dB}$; 2) Digital wireless repeater $\geq 30\text{dB}$;

5.5.5 Gain adjustment step size and error

test number	5.5.5 _ _ _ _
Test items	LTE RF Test
test child	Gain adjustment step size and step size error test
Testing purposes	Verify the gain adjustment step size and step size error of the digital repeater
test instrument	LTE signal source, isolator, attenuator, spectrum analyzer
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 27 .
test steps	<ol style="list-style-type: none"> 1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the LTE signal source to the center frequency within the working frequency range of the digital repeater, and set it to the E-TM1.1 modulation signal; 3) Set the digital repeater gain to the maximum; 4) digital repeater with the gain adjustment step , measure the power level when the actual gain of the digital repeater decreases by each step from the signal analyzer and record it until the gain is the minimum; 5) The actual gain adjustment step is the difference between each adjacent measured power level; 6) The step error is the difference between the declared gain adjustment step and the actual gain adjustment step; 7) Calculates the total gain adjustment accumulated error over the gain adjustment range .
Test Data	<ol style="list-style-type: none"> 1) Record the power level when the actual gain of the system decreases by each step, until the gain is the smallest , and the actual gain adjustment step is the difference between each adjacent measured power level; 2) The step error is the difference between the declared gain adjustment step and the actual gain adjustment step; 3) Calculates the total gain adjustment accumulated error over the gain adjustment range .
expected outcome	<ol style="list-style-type: none"> 1) Gain adjustment step size $\leq 1\text{dB}$; 2) The gain adjustment step error should not exceed $\pm 1\text{dB}/\text{step}$; 3) The total gain adjustment accumulated error within the gain adjustment range should be within $\pm 1\text{dB}$.

5.5.6 frequency error

test number	5.5.6 _ _ _
Test	LTE RF Test

items	
test child	Frequency Error Test
Testing purposes	Verify frequency error of digital repeater
test instrument	LTE signal source, isolator, attenuator, frequency meter
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 13 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the LTE signal source to the center frequency within the working frequency range of the digital repeater, and set it to the E-TM3.1 modulation signal; 3) Set the digital repeater gain to the maximum; 4) When the output level of the LTE signal source is set to the maximum output power, the input level is backed by 5dB; 5) Measure the frequency error of the midpoint within the operating frequency range of the digital repeater .
Test Data	1) error of the digital repeater .
expected outcome	1) The frequency error should be less than or equal to the input frequency ± 0.01 ppm .

5.5.7 Error in vector magnitude (EVM)

test number	5.5.7 _ _ _ _
Test items	LTE RF Test
test child	Vector Magnitude Error Test
Testing purposes	Verifying Vector Magnitude Errors of Digital Repeaters
test instrument	LTE signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 27 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the LTE signal source to the center frequency within the working frequency range of the digital repeater, and set it to the E-TM3.1 modulation signal; 3) Set the digital repeater gain to the maximum; 4) Set the output level of the LTE signal source to the input level at the

	<p>maximum output power;</p> <p>5) from an LTE spectrum analyzer .</p> <p>6) The output level of the signal source is increased by 10dB ;</p> <p>7) Repeat step 5;</p>
Test Data	<p>1) Record the vector magnitude error of the digital repeater .</p> <p>2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.</p>
expected outcome	<p>1) optical fiber repeater is $\leq 6\%$, and the vector magnitude error of the wireless repeater is $\leq 8\%$.</p>

5.5.8 RF Input Dynamic Range

test number	5.5.8 _ _ _
Test items	LTE RF performance test
test child	RF Input Dynamic Range Test
Testing purposes	LTE signal source, isolator, attenuator, spectrum analyzer
test instrument	Signal source, isolator, attenuator, spectrum analyzer
Preconditions	<p>1) Connect the digital repeater according to Figure 1 ;</p> <p>2) Connect the test instrument and the device under test as shown in Figure 27 .</p>
test steps	<p>1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power);</p> <p>2) Set the LTE signal source to the center frequency within the working frequency range of the digital repeater to generate E-TM3.1 modulation signal;</p> <p>3) Set the digital repeater gain to the maximum gain;</p> <p>4) Adjust the output level of the signal source to the maximum rated input level and increase 5dB, and test the EVM value at this time;</p> <p>5) Wired coupling downlink: The LTE signal is switched to the E-TM2.0 modulated signal, and the output level of the signal source is 20dB lower than the maximum rated input level , and the EVM value at this time is recorded ;</p> <p>6) Uplink and wirelessly coupled downlink: When the output level of the signal source is reduced to -6 7 dBm, record the EVM value at this time.</p>
Test Data	<p>1) EVM values of the upstream and downstream digital repeaters respectively.</p> <p>2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.</p>
expected outcome	<p>1) Wired coupled downlink : within the range from the maximum rated input power +5dB to the maximum rated input power -20dB, the EVM of the optical fiber repeater is not more than 6% , and the EVM of the wireless repeater is not more than 8%;</p> <p>2) Uplink and wireless coupling downlink : From the maximum rated input power +5dB to ≤ -67dBm, the EVM of the fiber optic repeater is not more than 6% , and the</p>

EVM of the wireless repeater is not more than 8% .

5.5.9 Noise Figure

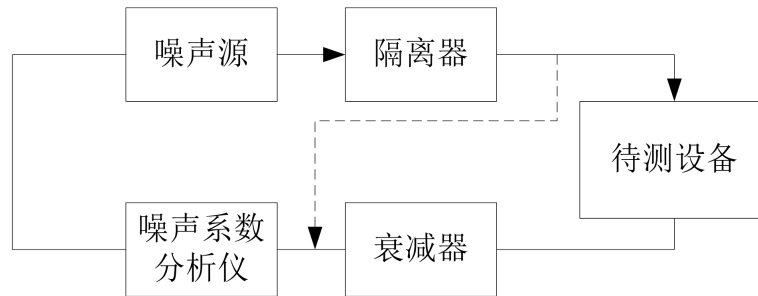


图 28 Noise Figure Test Chart

test number	5.5.10 _ _ _
Test items	LTE RF performance test
test child	Noise Figure Test
Testing purposes	Verifying the LTE Noise Figure of a Digital Repeater
test instrument	Noise Sources, Isolators, Attenuators, Noise Figure Analyzers
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 28 .
test steps	1) Calibrate the noise measurement system as shown by the dotted line in Figure 28 ; 2) turn off the downlink (measure the uplink metrics); 3) Adjust the digital repeater gain to the maximum gain ; 4) Set the RBW of the noise analyzer to 1MHz; 5) Use a noise figure meter to test the noise figure of the digital repeater at high, medium and low carrier frequencies .
Test Data	1) Record the noise figure of the digital repeater.
expected outcome	1) Uplink noise figure in the state of minimum system maximum gain: $NF \leq 5\text{dB}$; Remarks: The minimum system of the digital optical fiber repeater is 1 RF access unit + 1 high-power remote unit; the minimum system of the digital wireless repeater is a single unit.

5.5.10 Spectrum emission mask

test number	5.5.11 _ _ _
Test items	LTE RF Test
test child	Spectrum emission mask test

Testing purposes	Validating Spectrum Emission Masks for Digital Repeaters
test instrument	LTE signal source, isolator, attenuator, LTE signal analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 22 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the LTE signal source to the center frequency within the working frequency range of the digital repeater, and set it to the E-TM1.1 modulation signal; 3) Set the digital repeater gain to the maximum; 4) Set the output level of the LTE signal source to the input level at the maximum output power; 5) Measure the spurious emission power with a signal analyzer; 6) Increase the power of the LTE signal source by 10dB and repeat step 5.
Test Data	1) Record the power level of spurious emissions in each frequency band of the digital repeater.
expected outcome	1) Meet the LTE spectrum emission mask index requirements.

5.5.11 block

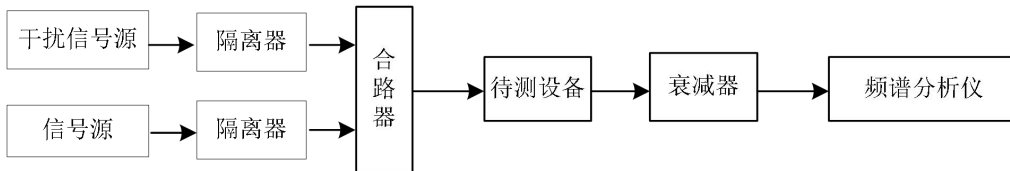


图 29 Blocking test configuration diagram

test number	5.5.12 _ _ _
Test items	LTE RF performance test
test child	blocking test
Testing purposes	Verify Blocking of Digital Repeater
test instrument	LTE signal source , interference signal source , combiner, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 29 .

test steps	<ol style="list-style-type: none"> 1) Set the carrier frequency of the LTE signal source to the center frequency of the effective working frequency band, adjust the output level of the signal source so that the output of the digital repeater is the maximum output power , measure the output level of the digital repeater, and calculate its gain value. 2) Turn on the interference signal source , and set it according to the frequency band and level in the indicator requirements; 3) Measure the output level of the digital repeater, and calculate its gain value and gain change difference.
Test Data	<ol style="list-style-type: none"> 1) Record the output level, gain, gain variation difference , and EVM of the digital repeater . 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.
expected outcome	<ol style="list-style-type: none"> 1) The gain difference does not exceed 6dB ; 2) Fiber repeater EVM $\leq 6\%$, wireless repeater EVM $\leq 8\%$.

5.5.12 out-of-band suppression

test number	5.5.13 _ _ _
Test items	LTE RF Test
test child	Out-of-Band Suppression Test
Testing purposes	Suppression for Digital Repeaters
test instrument	LTE signal source, isolator, attenuator, spectrum analyzer
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 27 .
test steps	<ol style="list-style-type: none"> 1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Adjust the gain of the digital repeater to the maximum gain; 3) Set the signal source to CW signal and adjust its output level to (Linmax-5dB); 4) Set the signal source according to the frequency required by the LTE radio frequency characteristics, and use the spectrum analyzer to test the output power of the relative frequency band of the digital repeater.
Test Data	<ol style="list-style-type: none"> 1) output power of the corresponding frequency band of the digital repeater ; 2) out-of-band suppression value of each frequency band is calculated as the ratio of the output power of the frequency band to the output power of the desired signal in the band .
expected outcome	<ol style="list-style-type: none"> 1) The out-of-band suppression meets the specification requirements.

5.5.13 transmission delay

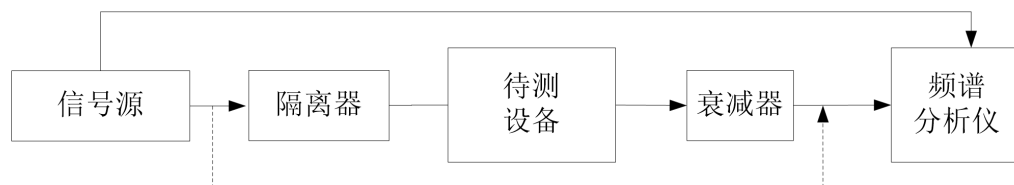


图 30 Transmission Delay Test Configuration Diagram

test number	5.5.14 _ _ _ _
Test items	LTE RF Test
test child	Transmission Delay Test
Testing purposes	Verifying the Transmission Delay of a Digital Repeater
test instrument	Signal source , spectrum analyzer, isolator, attenuator
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 30 .
test steps	1) Set the signal source to output the LTE E-TM3.1 modulated signal, and adjust the operating frequency to the center frequency of the digital repeater under test in turn ; 2) according to the dotted line in Figure 30 , first test the carrier delay of the meter pass-through; 3) Connect the signal source and spectrum analyzer to the device under test according to the solid line connection in Figure 30 ; 4) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 5) Set the digital repeater gain to the minimum ; 6) Adjust the input signal level so that the output signal of the digital repeater reaches the manufacturer's nominal maximum value; 7) Read carrier delay from spectrum analyzer;
Test Data	1) Record the test delay of the digital repeater and the test delay of the meter pass-through . 2) The equipment delay of the digital repeater = the test delay of the equipment - the test delay of the meter pass-through;
expected outcome	1) Transmission delay $\leq 10 \mu s$.

5.5.14 I/O VSWR

test number	5.5.15 _ _ _ _
Test	LTE RF Test

items	
test child	Input VSWR Test
Testing purposes	Verify the input VSWR of the digital repeater
test instrument	vector network analyzer , matching load
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 20 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the frequency band of the vector network analyzer as the working frequency band of the digital repeater, and the output level is -30dBm; 3) The network analyzer test port is set to measurement after open circuit, short circuit and load calibration; 4) Set the gain of the digital repeater to the minimum gain, connect the input (or output) port of the device under test to the test port, the output (or input) port to the load, and read the operating frequency band of the digital repeater under test from the vector network analyzer The maximum voltage standing wave ratio within.
Test Data	1) Record the maximum voltage standing wave ratio within the operating frequency band of the digital repeater .
expected outcome	1) Meet the input/output voltage standing wave ratio index requirements

5.5.15 Maximum allowable input level

test number	5.5.16 _ _ _
Test items	LTE RF performance test
test child	Maximum allowable input level test
Testing purposes	Verify the maximum allowable input level of the digital repeater
test instrument	LTE signal source , isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 27 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the LTE signal source to the center frequency within the working frequency range of the digital repeater, and set it to the E-TM1.1 modulation signal;

	3) Set the digital repeater gain to the maximum; 4) Adjust the level to the maximum allowable input level for lmin; 5) Repeat the test of the nominal maximum output power and gain index items, and the measured values should be within the specified range of the index.
Test Data	1) record the maximum allowable input level of the distribution system; 2) Record test data for nominal maximum output power and gain index terms.
expected outcome	1) Uplink RF Input Ports: The maximum allowable input level is $\geq -10\text{dBm}$, the equipment can work normally without damage; 2) Downlink RF Input Ports: The maximum allowable input level of the optical fiber repeater is $\geq 10\text{dBm}$, and the equipment can work normally without damage; The maximum allowable input level of the wireless repeater is $\geq -10\text{dBm}$, and the equipment can work normally without damage.

5.6 NB-IoT RF performance test

5.6.1 Nominal Maximum Linear Output Power Error

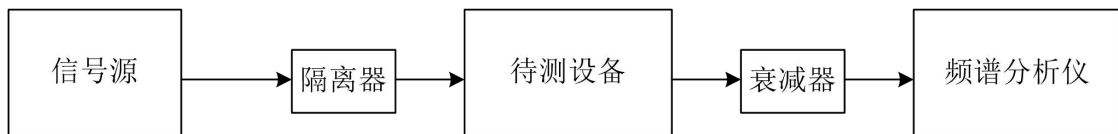


图 31 Nominal Maximum Linear Output Power Test Connection Diagram

test number	5.6.1 _
Test items	NB-IOT RF Test
test child	Nominal Maximum Output Power Test
Testing purposes	Verify the maximum output power of the digital repeater
test instrument	NB-IOT signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 31 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the NB-IOT signal source to the center frequency within the working frequency range of the digital repeater, and send the modulated signal { NB-IoT: N-TM 1 in the appendix is used for the downlink , and N-TM A.14-2 } ; 3) Set the digital repeater gain to the maximum gain; 4) Adjust the level of the NB-IOT signal source until the ALC start control point, and the power displayed on the spectrum analyzer should meet the

	tolerance range of the maximum output rated power declared by the manufacturer; 5) Record the output level and input power level of the digital repeater.
Test Data	1) Recording equipment nominal maximum output power ; 2) Record the output level and input power level.
expected outcome	1) error of the digital repeater is within $\pm 1.5\text{dB}$.

5.6.2 Automatic Level Control (ALC)

test number	5.6.2 _ _ _
Test items	NB-IOT RF Test
test child	Automatic Level Control (ALC) Testing
Testing purposes	Verify the automatic level control range of the digital repeater
test instrument	NB-IOT signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 31 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the NB-IOT signal source to the center frequency point within the working frequency range, and set the modulation signal { NB-IoT: N-TM 1 in the appendix is used for downlink , and N-TM A.14-2 in the appendix is used for uplink } ; 3) Set the digital repeater gain to the maximum gain, and set the digital repeater ALC adjustment threshold to the factory rated power threshold; 4) Adjust the level of the NB-IOT signal source until the output power of the digital repeater is the nominal maximum output power test value; 5) Record digital repeater output power; 6) Increase the output signal level of the NB-IOT signal source in steps of 1dB until it increases to 10dB, use a spectrum analyzer to test the output power of the digital repeater respectively, start the control from ALC until the maximum input power increases to 10dB, and record Carrier output power value; 7) Increase the output signal level of the signal source in steps of 1dB until it increases to 20dB or to the maximum non - destructive input power , and use a spectrum analyzer to test the output power respectively ;
Test Data	1) Record the digital repeater output power.
expected outcome	1) When the input signal level increases less than 10dB (including 10dB), the output power should be kept within ± 2.0 dB of the maximum output power; 2) When the input signal level increases by more than 10dB (20dB), the output

	power should be kept within ± 2.0 dB of the maximum output power or turned off.
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5.6.3 Maximum gain and error

test number	5.6.3 _ _
Test items	NB-IOT RF Test
test child	Maximum Gain and Error Test
Testing purposes	Verify the maximum gain and error of the digital repeater
test instrument	NB-IOT signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 31 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the NB-IOT signal source to the center frequency point within the working frequency range, and set the modulation signal { NB-IoT: N-TM 1 in the appendix is used for downlink , and N-TM A.14-2 in the appendix is used for uplink } ; 3) Set the digital repeater gain to the maximum; 4) Adjust the level of the NB-IOT signal source in turn until the output power of the digital repeater is back to the nominal maximum output power by 5dB; 5) The maximum gain is the ratio of the output power to the input power of the digital repeater; 6) The maximum gain error is the difference between the measured maximum gain value and the rated gain value declared by the manufacturer, and the maximum deviation value is taken.
Test Data	1) Record the rated gain value declared by the manufacturer; 2) Recording system digital repeater output power and input power ; 3) Calculate the maximum gain value and the maximum gain error.
expected outcome	1) The nominal maximum gain of digital optical fiber repeater: within 55 ± 3 dB; 2) Nominal maximum gain of digital wireless repeater: within 95 ± 3 dB;

5.6.4 Gain adjustment range

test number	5.6.4 _ _
Test items	NB-IOT RF Test
test child	Maximum Gain and Error Test

Testing purposes	Verify the maximum gain and error of the digital repeater
test instrument	NB-IOT signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 31 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the NB-IOT signal source to the center frequency point within the operating frequency range, and set the modulation signal { NB-IoT: N-TM 1 in the appendix is used for downlink , and N-TM A.14-2 in the appendix is used for uplink } ; 3) Set the digital repeater gain to the maximum; 4) Adjust the level of the NB-IOT signal source until the output power of the digital repeater is the maximum output power declared by the manufacturer, back 1dB; 5) Measure the output power of the digital repeater, the maximum gain is the ratio of the output power of the digital repeater to the input power, and record the gain data; 6) Set the digital repeater gain to the minimum; 7) Measure the output power of the digital repeater, the minimum gain is the ratio of the output power of the digital repeater to the input power, and record the gain data; 8) The gain adjustment range is the difference between the maximum gain and the minimum gain, and the adjustment range data is recorded.
Test Data	1) Record the maximum gain and minimum gain of the digital repeater.
expected outcome	1) Digital fiber repeater $\geq 20\text{dB}$; 2) Digital wireless repeater $\geq 30\text{dB}$;

5.6.5 Gain adjustment step size and error

test number	5.6.5 _ _
Test items	NB-IOT RF Test
test child	Gain adjustment step size and step size error test
Testing purposes	Verify the gain adjustment step size and step size error of the digital repeater
test instrument	NB-IOT signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 31 .
test	1) Turn off the uplink (measure the downlink output power) or turn off the

steps	<p>downlink (measure the uplink output power);</p> <p>2) Set the NB-IOT signal source to the center frequency within the working frequency range of the digital repeater, and set the modulation signal { NB-IoT: N-TM 1 in the appendix is used for downlink , and N-TM A.14 in the appendix is used for uplink -2 } ;</p> <p>3) Set the digital repeater gain to the maximum;</p> <p>4) digital repeater with the gain adjustment step , measure the power level when the actual gain of the digital repeater decreases by each step from the signal analyzer and record it until the gain is the minimum;</p> <p>5) The actual gain adjustment step is the difference between each adjacent measured power level;</p> <p>6) The step error is the difference between the declared gain adjustment step and the actual gain adjustment step;</p> <p>7) Calculates the total gain adjustment accumulated error over the gain adjustment range .</p>
Test Data	<p>1) Record the power level when the actual gain of the system decreases by each step, until the gain is the smallest , and the actual gain adjustment step is the difference between each adjacent measured power level;</p> <p>2) The step error is the difference between the declared gain adjustment step and the actual gain adjustment step;</p> <p>3) Calculates the total gain adjustment accumulated error over the gain adjustment range .</p>
expected outcome	<p>1) Gain adjustment step size ≤ 1dB;</p> <p>2) The gain adjustment step error should not exceed ± 1dB/step ;</p> <p>3) The total gain adjustment accumulated error within the gain adjustment range should be within ± 1dB .</p>

5.6.6 frequency error

test number	5.6.6 _
Test items	NB-IOT RF Test
test child	Frequency Error Test
Testing purposes	Verify frequency error of digital repeater
test instrument	NB-IOT signal source, isolator, attenuator, frequency meter
Preconditions	<p>3) Connect the digital repeater according to Figure 1 ;</p> <p>4) Connect the test instrument and the device under test as shown in Figure 13 .</p>
test steps	<p>6) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power);</p> <p>7) Set the NB-IOT signal source to the center frequency within the working frequency range of the digital repeater, and set the modulation signal { NB-IoT: N-TM 1 in the appendix is used for downlink , and N-TM A.14 in</p>

	<p>the appendix is used for uplink -2 } ;</p> <p>8) Set the digital repeater gain to the maximum;</p> <p>9) When the output level of the NB-IOT signal source is set to the maximum output power, the input level is backed by 5dB;</p> <p>10) Measure the frequency error of the midpoint within the operating frequency range of the digital repeater .</p>
Test Data	2) error of the digital repeater .
expected outcome	2) The frequency error should be less than or equal to the input frequency ± 0.01 ppm .

5.6.7 Error in vector magnitude (EVM)

test number	5.6.7 _
Test items	NB-IOT RF Test
test child	Vector Magnitude Error Test
Testing purposes	Verifying Vector Magnitude Errors of Digital Repeaters
test instrument	NB-IOT signal source, isolator, attenuator, spectrum analyzer
Preconditions	<p>1) Connect the digital repeater according to Figure 1 ;</p> <p>2) Connect the test instrument and the device under test as shown in Figure 31 .</p>
test steps	<p>1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power);</p> <p>2) Set the NB-IOT signal source to the center frequency within the working frequency range of the digital repeater, and set the modulation signal { NB-IoT: N-TM 1 in the appendix is used for downlink , and N-TM A.14 in the appendix is used for uplink -2 } ;</p> <p>3) Set the digital repeater gain to the maximum;</p> <p>4) Set the output level of the NB-IOT signal source to the input level at the maximum output power;</p> <p>5) from the NB-IOT spectrum analyzer .</p> <p>6) The output level of the signal source is increased by 10dB ;</p> <p>7) Repeat step 5;</p>
Test Data	<p>1) Record the vector magnitude error of the digital repeater .</p> <p>2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.</p>
expected outcome	1) Vector magnitude error $\leq 17.5\%$.

5.6.8 RF Input Dynamic Range

test	5.6.8 _
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number	
Test items	NB-IOT RF performance test
test child	RF Input Dynamic Range Test
Testing purposes	NB-IOT signal source, isolator, attenuator, spectrum analyzer
test instrument	Signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 31 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the NB-IOT signal source to the center frequency within the working frequency range of the digital repeater, and set the modulation signal { NB-IoT: N-TM 1 in the appendix is used for downlink , and N-TM A.14 in the appendix is used for uplink -2 } ; 3) Set the digital repeater gain to the maximum gain; 4) Adjust the output level of the signal source to the maximum rated input level and increase 5dB, and test the EVM value at this time; 5) Wired coupling downlink: NB-IOT signal is switched to E-TM2.0 modulation signal, and the output level of the signal source is 20dB lower than the maximum rated input level , and the EVM value at this time is recorded ; 6) Uplink and wirelessly coupled downlink: When the output level of the signal source drops to -87 dBm, record the EVM value at this time.
Test Data	1) EVM values of the upstream and downstream digital repeaters respectively. 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.
expected outcome	1) Wired coupled downlink : within the range from the maximum rated input power +5dB to the maximum rated input power -20dB, the EVM is not greater than 17.5 %; 2) Uplink and wirelessly coupled downlink : From the maximum rated input power +5dB to ≤ -87 dBm, EVM is not greater than 17.5%.

5.6.9 Noise Figure

test number	5.6.10 _
Test items	NB-IOT RF performance test
test child	Noise Figure Test
Testing purposes	Verifying NB-IOT Noise Figure of Digital Repeater
test	Noise Sources, Isolators, Attenuators, Noise Figure Analyzers

instrument	
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 28 .
test steps	1) Calibrate the noise measurement system as shown by the dotted line in Figure 28 ; 2) turn off the downlink (measure the uplink metrics); 3) Adjust the digital repeater gain to the maximum gain ; 4) Set the RBW of the noise analyzer to 1MHz; 5) Use the noise figure measuring instrument to test the noise figure of the high, medium and low carrier frequency points of the digital repeater ;
Test Data	1) Record the noise figure of the digital repeater.
expected outcome	1) Uplink noise figure in the state of minimum system maximum gain: $NF \leq 5dB$; Remarks: The minimum system of the digital optical fiber repeater is 1 RF access unit + 1 high-power remote unit; the minimum system of the digital wireless repeater is a single unit.

5.6.10 Spectrum emission mask

test number	5.6.11 _
Test items	NB-IOT RF Test
test child	Spectrum emission mask test
Testing purposes	Validating Spectrum Emission Masks for Digital Repeaters
test instrument	NB-IOT signal source, isolator, attenuator, NB-IOT signal analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 22 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the NB-IoT signal source to the center frequency within the working frequency range of the digital repeater, and set the modulation signal { NB-IoT: N-TM 2} ; 3) Set the digital repeater gain to the maximum; 4) Set the output level of the NB-IOT signal source to the input level at the maximum output power; 5) Measure the spurious emission power with a signal analyzer; 6) Increase the power of the NB-IOT signal source by 10dB and repeat step 5.
Test Data	1) Record the power level of spurious emissions in each frequency band of

	the digital repeater.
expected outcome	1) Meet the NB-IOT spectrum emission mask index requirements.

5.6.11 block

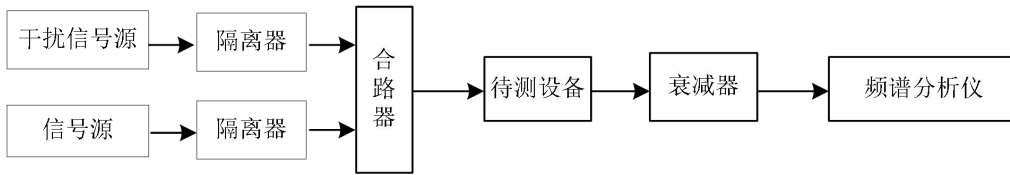


图 32 Blocking test configuration diagram

test number	5.6.12 _
Test items	NB-IOT RF performance test
test child	blocking test
Testing purposes	Verify Blocking of Digital Repeater
test instrument	NB-IOT signal source , interference signal source , combiner, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 32 .
test steps	1) Set the carrier frequency of the NB-IOT signal source to the center frequency of the effective working frequency band, adjust the output level of the signal source so that the output of the digital repeater is the maximum output power , measure the output level of the digital repeater, and calculate its gain value . 2) Turn on the interference signal source , and set it according to the frequency band and level in the indicator requirements; 3) Measure the output level of the digital repeater, and calculate its gain value and gain change difference.
Test Data	1) Record the output level, gain, gain variation difference , and EVM of the digital repeater . 2) Bring the measured EVM into the formula $EVM = \sqrt{EVM_{DAT}^2 - EVM_s^2}$, where EVM_s is the EVM of the signal waveform file itself.
expected outcome	1) The gain difference does not exceed 6dB ; 2) $EVM \leq 17.5\%$.

5.6.12 out-of-band suppression

test number	5.6.13 _
Test items	NB-IOT RF Test

test child	Out-of-Band Suppression Test
Testing purposes	Suppression for Digital Repeaters
test instrument	NB-IOT signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) according to 3) Figure 31 Connect the test instrument and the device under test.
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Adjust the gain of the digital repeater to the maximum gain; 3) Set the signal source to CW signal and adjust its output level to (Linmax-5dB); 4) Set the signal source according to the frequency required by the NB-IOT radio frequency characteristics, and use the spectrum analyzer to test the output power of the relative frequency band of the digital repeater.
Test Data	1) output power of the corresponding frequency band of the digital repeater ; 2) out-of-band suppression value of each frequency band is calculated as the ratio of the output power of the frequency band to the output power of the desired signal in the band .
expected outcome	1) The out-of-band suppression meets the specification requirements.

5.6.13 transmission delay

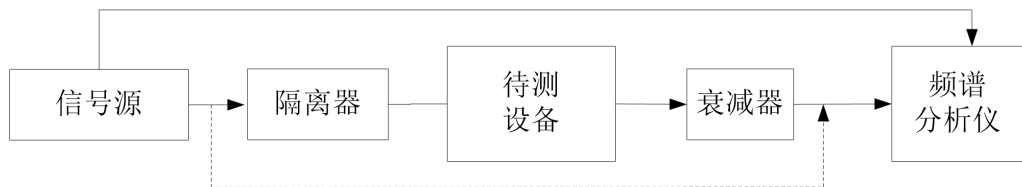


图 33 Transmission Delay Test Configuration Diagram

test number	5.6.14 _
Test items	NB-IOT RF Test
test child	Transmission Delay Test
Testing purposes	Verifying the Transmission Delay of a Digital Repeater
test instrument	Signal source , spectrum analyzer, isolator, attenuator
Precondi	1) Connect the digital repeater according to Figure 1 ;

tions	2) Connect the test instrument and the device under test as shown in Figure 33 .
test steps	<ol style="list-style-type: none"> 1) center frequency of the digital repeater under test in turn , and set the modulation signal { NB-IoT: N-TM 1 in the appendix is used for the downlink , and N-TM A in the appendix is used for the uplink. 14-2 } ; 2) according to the dotted line in Figure 33 , first test the carrier delay of the meter pass-through; 3) according to the solid line connection in Figure 33 ; 4) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 5) Set the digital repeater gain to the minimum ; 6) Adjust the input signal level so that the output signal of the digital repeater reaches the manufacturer's nominal maximum value; 7) Read carrier delay from spectrum analyzer;
Test Data	<ol style="list-style-type: none"> 1) Record the test delay of the digital repeater and the test delay of the meter pass-through . 2) The equipment delay of the digital repeater = the test delay of the equipment - the test delay of the meter pass-through;
expected outcome	1) Transmission delay $\leq 10 \mu s$.

5. 6. 14 I/O VSWR

test number	5. 6. 15 _
Test items	NB-IOT RF Test
test child	Input VSWR Test
Testing purposes	Verify the input VSWR of the digital repeater
test instrument	vector network analyzer , matching load
Preconditions	<ol style="list-style-type: none"> 1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 20 .
test steps	<ol style="list-style-type: none"> 1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the frequency band of the vector network analyzer as the working frequency band of the digital repeater, and the output level is -30dBm; 3) The network analyzer test port is set to measurement after open circuit, short circuit and load calibration; 4) Set the gain of the digital repeater to the minimum gain, connect the input (or output) port of the device under test to the test port, the output (or input) port to the load, and read the working frequency band of the digital repeater under test from the vector network analyzer The maximum voltage standing wave ratio within.

Test Data	1) Record the maximum voltage standing wave ratio within the operating frequency band of the digital repeater .
expected outcome	1) Meet the input/output voltage standing wave ratio index requirements

5.6.15 Maximum allowable input level

test number	5.6.16 _
Test items	NB-IOT RF performance test
test child	Maximum allowable input level test
Testing purposes	Verify the maximum allowable input level of the digital repeater
test instrument	NB-IOT signal source, isolator, attenuator, spectrum analyzer
Preconditions	1) Connect the digital repeater according to Figure 1 ; 2) Connect the test instrument and the device under test as shown in Figure 31 .
test steps	1) Turn off the uplink (measure the downlink output power) or turn off the downlink (measure the uplink output power); 2) Set the NB-IOT signal source to the center frequency within the working frequency range of the digital repeater, and set the modulation signal { NB-IoT: N-TM 1 in the appendix is used for downlink , and N-TM A.14 in the appendix is used for uplink -2 } ; 3) Set the digital repeater gain to the maximum; 4) Adjust the level to the maximum allowable input level for 1min; 5) Repeat the test of the nominal maximum output power and gain index items, and the measured values should be within the specified range of the index.
Test Data	1) record the maximum allowable input level of the distribution system; 2) Record test data for nominal maximum output power and gain index terms.
expected outcome	1) Uplink RF Input Ports: The maximum allowable input level is $\geq -10\text{dBm}$, the equipment can work normally without damage; 2) Downlink RF Input Ports: The maximum allowable input level of the optical fiber repeater is $\geq 10\text{dBm}$, and the equipment can work normally without damage; 3) The maximum allowable input level of the wireless repeater is $\geq -10\text{dBm}$, and the equipment can work normally without damage.

6 Power suitability test

6.1 Power supply voltage increase test

When the power supply voltage is AC264V or DC-57.6V, the nominal maximum linear output

power, frequency error, EVM, and noise figure of the measurement system should all meet the technical requirements.

6.2 Power supply voltage drop test

When the power supply voltage is AC176V or DC-38.4V, the nominal maximum linear output power, frequency error, EVM, and noise figure of the measurement system should all meet the technical requirements.

7 Environmental suitability test

7.1 low temperature test

1) The digital repeater with normal configuration is placed in the environmental test room to cool down at a rate of 1 ° C/min until -10 ° C (indoor equipment), -40 ° C (Class I outdoor equipment), -25 ° C (Class II outdoor equipment) equipment), keep the temperature stable for 2h, power on the system, and measure: nominal maximum linear output power, frequency error, EVM , noise figure.

2) After returning to normal temperature and stabilizing for 2 hours, check the index recovery of the same item again.

7.2 High temperature test

1) The digital repeater with normal configuration is placed in the environmental test room and heated at a rate of 1 ° C /min until +40 ° C (indoor equipment), +55 ° C (outdoor equipment), after the temperature is stable, keep it for 2 hours, power on the system, Separate measurements: nominal maximum linear output power, frequency error, EVM , noise figure.

2) After returning to normal temperature and stabilizing for 2 hours, check the recovery of the indicators of the same item.

7.3 Constant Damp Heat Test

1) The digital repeater with normal configuration is placed in the environmental test room and heated at a rate of 1 ° C /min until $+40\pm 2$ ° C (indoor equipment) or $+55\pm 2$ ° C (outdoor equipment), and then humidified to 95 ± 2 %, keep for 2h after stabilization, power on the system, and measure respectively: nominal maximum linear output power, frequency error, EVM, noise figure .

2) After returning to normal temperature and stabilizing for 2 hours, check the recovery of the indicators of the same item.

8 Electricity Safety Test

8.1 Ground conductor resistance and connection resistance

GB 4943.1-2011 "Information Technology Equipment" for the requirements and test methods of grounding conductor resistance and connection resistance. Safety Part 1 : General Requirements, Section 2.6.

If the current rating of the circuit under test is less than or equal to 16A, the test current, test voltage and test time shall be determined as follows:

The test current is twice the rated current of the circuit under test;

The test voltage should not exceed 12V;

The test time is 2min.

The calculated resistance of the protective bonding conductor from the voltage drop shall not exceed 0.1Ω .

If the current rating of the circuit under test exceeds 16A, the test current and test time shall be determined as follows:

2 times the circuit current rating for 120s or longer (depending on the protection current rating); or

Equipment powered by DC is specified by the manufacturer.

The voltage drop across the protective connecting conductor should not exceed 2.5V.

8.2 Dielectric strength

8.2.1 Dielectric strength of power circuit

The requirements and test methods for the electric strength of power circuits are specified in Section 5.2 of GB 4943.1-2011 " Information Technology Equipment Safety Part 1: General Requirements ".

The test voltage is determined as follows:

The working voltage peak or DC value of the equipment under test is $\leq 184V$, and the test voltage of the equipment under test with grounding protection is AC 1000V (50Hz), or the test voltage of the equipment under test without grounding protection is AC 2000V (50Hz);

The peak or DC value of the equipment under test is 184V to 354V (including 354V), the test voltage for the equipment under test with ground protection is AC 1500V (50Hz), or the test voltage for the equipment under test without ground protection is AC 3000V (50Hz);

During the test, the insulation of the equipment under test shall not break down.

The test voltage application point is selected according to the following applicable situations:

Between the primary circuit and the fuselage;

between the primary circuit and the secondary circuit;

between components of a primary circuit.

8.2.2 Dielectric strength of communication port

The requirements and test methods for the electrical strength of communication ports are specified in Section 6 of GB 4943.1-2011 " Information Technology Equipment Safety Part 1: General Requirements ".

For steady state test the test voltage and test application point are determined as follows:

In normal use, for ungrounded conductive parts and non-conductive parts (such as telephone receivers or keyboards) that need to be grasped or touched on the equipment, AC 1500V (50Hz) should be applied between these parts and the communication port. the test voltage;

For other parts and circuits and interfaces connected with other equipment, an AC 1000V (50Hz) test voltage should be applied between these parts, interfaces and communication ports.

During the test, the insulation of the equipment under test shall not break down.

8.3 touch current

8.3.1 Touch current of power circuit

GB 4943.1-2011 " Information Technology Equipment Safety Part 1: General Requirements " Section 5.1 for requirements and test methods for touch current of power circuits .

The maximum contact current should be less than or equal to 3.5mA (rms).

8.3.2 Touch current of communication port

GB 4943.1-2011 "Information Technology Equipment Safety Part 1: General Requirements" for the requirements and test methods for the contact current of the communication port, Section 5.1.

The maximum contact current between each communication port and other components should be less than or equal to 0.25mA (rms).

9 Lightning protection test

Carry out the system lightning protection test according to the test method in GB/T 17626.5-2008 "Surge (Shock) Immunity Test".

Appendix A Test Equipment Requirements

A.1 signal source

- Frequency range: 0.1 GHz - 3 GHz
- Frequency accuracy: $\pm 1 \times 10^{-8}$
- Output range: -120dBm to 10dBm or off
- Output level accuracy: ± 1 dB

A.2 RF signal source

The RF signal source should meet the following minimum performance requirements:

- Output frequency range: tunable within the application range of RF, and has frequency sweep function
- Frequency accuracy: $\pm 1 \times 10^{-8}$
- Frequency Resolution: 1kHz
- Output range: -50dBm to -10dBm or off
- Output Accuracy: ± 1.0 dB over the above output range or frequency
- Amplitude resolution: 0.1dB

A.3 Spectrum Analyzer

The spectrum analyzer shall provide the following functions:

- Measurements in the general frequency domain
- Power measurement of the integrating channel (power spectral density at 5MHz)

The spectrum analyzer should meet the following minimum performance requirements:

- Frequency range: Tunable in RF range
- Frequency step: 1kHz
- Frequency accuracy: $\pm 2 \times 10^{-7}$
- Dynamic range: 70dB
- Display logarithmic scale fidelity: ± 1 dB over the dynamic range shown above
- Amplitude measurement range from 10MHz to 12.75GHz signal:

1) Power measured with RBW 30kHz: -90 to +20dBm

2) Integrated 5MHz channel power: -70 to +40dBm

3) Noise floor: -140dBm/Hz

4) To meet the high power end of the power range, an external attenuator can be used and

can be considered an integral part of the device.

- Absolute amplitude accuracy in WCDMA transmit and receive bands (for integrated channel power measurements)

- 1) -40dBm to +20dBm: ± 1 dB

- 2) -70dBm to +20dBm: ± 1.3 dB

- Relative flatness: ± 1.5 dB from 10MHz to 2.6GHz

- Resolution Bandwidth Filter: Synchronous tuned or Gaussian (at least 3 poles) with 3dB selectable bandwidths of 1MHz, 300kHz, 100kHz and 30kHz.

- Post-detection video filter: selectable from 100Hz at least to 1MHz in decimal steps.

- Detection method: selectable peak or sample.

- RF input impedance: nominal 50 Ω

The spectrum analyzer can also provide the time domain (zero block) measurement function of true average power judgment. If this function is provided, the spectrum analyzer should meet the following additional performance requirements:

- Time domain scan time: selectable from 50 μ S to 100ms

- Delayed sweep trigger: selectable from 5 μ S to 40ms

- External scan trigger

- Sufficient bandwidth for time domain measurements

A.4 Average power meter

The power meter shall provide the following functions:

- Average power measurement

- Correct rms detection for sinusoidal and non-sinusoidal signals

- Absolute power in linear units (W) and logarithmic units (dBm)

- relative (offset) power in dB and percent

- Automatic calibration and zeroing

- Average of multiple readings

The power meter shall meet the following minimum performance requirements:

- Frequency range: 10MHz to 3GHz

- Power range: -70dBm(100pW) to +40dBm(10W)

Different sensors may be required to provide this power range. External attenuators can be used to meet the high power end of the power range and can be considered part of the device.

- Absolute and relative power accuracy: ± 0.2 dB (5%)

Excludes sensor and source mismatch (VSWR) errors, zeroing errors (significant at the bottom of the sensor range), and power linearity errors (significant at the top of the sensor range).

- Power measurement resolution: selectable between 0.1 or 0.01dB

- Sensor Standing Wave Ratio (VSWR): $\leq 1.15:1$

A.5 Vector Network Analyzer

- Frequency range: 1MHz to 3GHz

- Test impedance: 50 Ω

A.6 Noise Figure Meter

- Frequency range: 10Hz to 3GHz

- Noise figure measurement range: 0 to 30dB, error ± 0.3 dB

A.7 Attenuators, Couplers

- Frequency range: DC to 3GHz
- Standing wave ratio (VSWR): $\leq 1.2:1$

Appendix B WCDMA test mode

B.1 test mode 1

Test mode 1A signal:

This mode specifies that 64 DPCH channels of 30kbps (SF=128) are randomly distributed in the code domain. The power level of each DPCH is random, and the timing offset is also random. It is used to simulate a high peak-to-average power ratio (peak-to-average ratio). PAR=7dB actual business situation. Since not all base stations support 64 DPCHs, this mode also allows for 32 or 16 DPCHs. During the test, one of the maximum number of DPCHs that the base station can support should be selected from the three options of 64, 32, and 16 DPCHs. The power of each channel in Table B.1 is measured from the transmit antenna port.

Table B.1 Active channel for test mode 1

Type	number of channels	Percentage of power (%)	Level setting (dB)	channel code	Timing Bias (x256Tchip)
P-CCPCH+SCH	1	10	-10	1	0
P-CPICH	1	10	-10	0	0
PICH	1	1.6	-18	16	120
S-CCPCH with PCH (SF=256)	1	1.6	-18	3	0
DPCH (SF=128)	16/32/64	A total of 76.8	See Table B.1.2	See Table B.1.2	See Table B.1.2

The spreading code, timing offset and level setting of test mode 1 DPCH are shown in Table B.2

Table B.2 Spreading code, timing offset and level setting for test mode 1DPCH

code	timing offset (x256Tchip)	Level setting (dB) (16 yards)	Level setting (dB) (32 yards)	Level setting (dB) (64 yards)
2	86	-10	-13	-16
11	134	-12	-13	-16
17	52	-12	-14	-16
23	45	-14	-15	-17
31	143	-11	-17	-18
38	112	-13	-14	-20
47	59	-17	-16	-16
55	23	-16	-18	-17
62	1	-13	-16	-16
69	88	-15	-19	-19
78	30	-14	-17	-22
85	18	-18	-15	-20
94	30	-19	-17	-16
102	61	-17	-22	-17
113	128	-15	-20	-19
119	143	-9	-24	-21
7	83		-20	-19
13	25		-18	-21

code	timing offset (x256Tchip)	Level setting (dB) (16 yards)	Level setting (dB) (32 yards)	Level setting (dB) (64 yards)
20	103		-14	-18
27	97		-14	-20
35	56		-16	-24
41	104		-19	-24
51	51		-18	-22
58	26		-17	-21
64	137		-22	-18
74	65		-19	-20
82	37		-19	-17
88	125		-16	-18
97	149		-18	-19
108	123		-15	-23
117	83		-17	-22
125	5		-12	-21
4	91			-17
9	7			-18
12	32			-20
14	21			-17
19	29			-19
22	59			-21
26	22			-19
28	138			-23
34	31			-22
36	17			-19
40	9			-24
44	69			-23
49	49			-22
53	20			-19
56	57			-22
61	121			-21
63	127			-18
66	114			-19
71	100			-22
76	76			-21
80	141			-19
84	82			-21
87	64			-19
91	149			-twenty one
95	87			-20
99	98			-25
105	46			-25
110	37			-25
116	87			-twenty four
118	149			-twenty two
122	85			-20
126	69			-15

Test mode 1B signal:

Peak clipping is performed on the basis of the test mode 1A signal, and the peak-to-average ratio is 7dB.

Test mode 1C signal:

Three test mode 1A signals with the same power, the center frequency interval is 5MHz, and the combined peak-to-average ratio is 7dB.

B.2 Test Mode 2

Table B.3 Active channel for test mode 2

type	number of channels	Percentage of power (%)	Setting (dB)	channel code	Timing Bias (x256Tchip)
P-CCPCH+SCH	1	12.6/7.9	-9/-11	1	0
P-CPICH	1	12.6/7.9	-9/-11	0	0
PICH	1	5/1.6	-13/-18	16	120
S-CCPCH containing PCH (SF=256)	1	5/1.6	-13/-18	3	0
DPCH (SF=256)	16/32	Total 63.7/80.4	See Table B.2	See Table	See Table B.2

For test mode 2 DPCH spreading code, timing offset and level settings see B.4 .

Table B.4 Spreading Code, Timing Offset and Level Settings for Test Mode 2 DPCH

code	timing offset	Level Setting (dB) (16 codes)	Level Setting (dB) (32 codes)
64	86	-14	-16
69	134	-14	-16
74	52	-14	-16
78	45	-14	-16
83	143	-14	-16
89	112	-14	-16
93	59	-14	-16
96	twenty three	-14	-16
100	1	-14	-16
105	88	-14	-16
109	30	-14	-16
111	18	-14	-16
115	30	-14	-16
118	61	-14	-16
122	128	-14	-16
125	143	-14	-16
67	83	-14	-16
71	25		-16
76	103		-16
81	97		-16
86	56		-16
90	104		-16
95	51		-16
98	26		-16
103	137		-16
108	65		-16
110	37		-16
112	125		-16
117	149		-16
119	123		-16

123	83		-16
126	5		-16

Appendix C LTE test mode

C.1 E-TM1.1 test mode

Table C.1 E-TM1.1 test mode physical channel configuration

Parameter	1.4MHz	3 MHz	5MHz	10MHz	15MHz	20MHz
Reference, Synchronisation Signals						
RS boosting, $P_B = E_p/E_A$	1	1	1	1	1	1
Synchronisation signal EPRE / E_{RS} [dB]	0.000	0.000	0.000	0.000	0.000	0.000
Reserved EPRE / E_{RS} [dB]	-inf	-inf	-inf	-inf	-inf	-inf
PBCH						
PBCH EPRE / E_{RS} [dB]	0.000	0.000	0.000	0.000	0.000	0.000
Reserved EPRE / E_{RS} [dB]	-inf	-inf	-inf	-inf	-inf	-inf
PCFICH						
# of symbols used for control channels	2	1	1	1	1	1
PCFICH EPRE / E_{RS} [dB]	3.222	0	0	0	0	0
PHICH						
# of PHICH groups	1	1	1	2	2	3
# of PHICH per group	2	2	2	2	2	2
PHICH BPSK symbol power / E_{RS} [dB]	-3.010	-3.010	-3.010	-3.010	-3.010	-3.010
PHICH group EPRE / E_{RS} [dB]	0	0	0	0	0	0
PDCCH						
# of available REGs	23	23	43	90	140	187
# of PDCCH	2	2	2	5	7	10
# of CCEs per PDCCH	1	1	2	2	2	2
# of REGs per CCE	9	9	9	9	9	9
# of REGs allocated to PDCCH	18	18	36	90	126	180
# of <NIL> REGs added for padding	5	5	7	0	14	7
PDCCH REG EPRE / E_{RS} [dB]	0.792	2.290	1.880	1.065	1.488	1.195
<NIL> REG EPRE / E_{RS} [dB]	-inf	-inf	-inf	-inf	-inf	-inf
PDSCH						
# of QPSK PDSCH PRBs which are boosted	6	15	25	50	75	100
PRB $P_A = E_A / E_{RS}$ [dB]	0	0	0	0	0	0
# of QPSK PDSCH PRBs which are de-boosted	0	0	0	0	0	0
PRB $P_A = E_A / E_{RS}$ [dB]	and	and	and	and	and	na

Remarks: E-TM 1.1 peak-to-average ratio is 7dB

C.2 E-TM2 Test Mode

Table C.2 E-TM2 test mode physical channel configuration

Parameter	1.4MHz	3 MHz	5MHz	10MHz	15MHz	20MHz
Reference, Synchronisation Signals						
RS boosting, $P_B = E_B/E_A$	1	1	1	1	1	1
Synchronisation signal EPRE / E_{RS} [dB]	0.000	0.000	0.000	0.000	0.000	0.000
Reserved EPRE / E_{RS} [dB]	-inf	-inf	-inf	-inf	-inf	-inf
PBCH						
PBCH EPRE / E_{RS} [dB]	0.000	0.000	0.000	0.000	0.000	0.000
Reserved EPRE / E_{RS} [dB]	-inf	-inf	-inf	-inf	-inf	-inf
PCFICH						
# of symbols used for control channels	2	1	1	1	1	1
PCFICH EPRE / E_{RS} [dB]	0	0	0	0	0	0
PHICH						
# of PHICH groups	1	1	1	2	2	3
# of PHICH per group	2	2	2	2	2	2
PHICH BPSK symbol power / E_{RS} [dB]	-3.010	-3.010	-3.010	-3.010	-3.010	-3.010
PHICH group EPRE / E_{RS} [dB]	0	0	0	0	0	0
PDCCH						
# of available REGs	23	23	43	90	140	187
# of PDCCH	1	1	1	1	1	1
# of CCEs per PDCCH	1	1	2	2	2	2
# of REGs per CCE	9	9	9	9	9	9
# of REGs allocated to PDCCH	9	9	18	18	18	18
# of <NIL> REGs added for padding	14	14	25	72	122	169
PDCCH REG EPRE / E_{RS} [dB]	0	0	0	0	0	0
<NIL> REG EPRE / E_{RS} [dB]	-inf	-inf	-inf	-inf	-inf	-inf
PDSCH						
# of 64QAM PDSCH PRBs within a slot for which EVM is measured	1	1	1	1	1	1
PRB $P_A = E_A/E_{RS}$ [dB]	0	0	0	0	0	0
# of PDSCH PRBs which are not allocated	5	14	twenty four	49	74	99
PRB $P_A = E_A/E_{RS}$ [dB]	-inf	-inf	-inf	-inf	-inf	-inf

C.3 E-TM3.1 test mode

Table C.3 E-TM3.1 test mode physical channel configuration

Parameter	1.4MHz	3 MHz	5MHz	10MHz	15MHz	20MHz
Reference, Synchronisation Signals						
RS boosting, $P_B = E_B/E_A$	1	1	1	1	1	1
Synchronisation signal EPRE / E_{RS} [dB]	0.000	0.000	0.000	0.000	0.000	0.000
Reserved EPRE / E_{RS} [dB]	-inf	-inf	-inf	-inf	-inf	-inf
PBCH						
PBCH EPRE / E_{RS} [dB]	0.000	0.000	0.000	0.000	0.000	0.000
Reserved EPRE / E_{RS} [dB]	-inf	-inf	-inf	-inf	-inf	-inf
PCFICH						

# of symbols used for control channels	2	1	1	1	1	1
PCFICH EPRE / E_{RS} [dB]	3.222	0	0	0	0	0
PHICH						
# of PHICH groups	1	1	1	2	2	3
# of PHICH per group	2	2	2	2	2	2
PHICH BPSK symbol power / E_{RS} [dB]	-3.010	-3.010	-3.010	-3.010	-3.010	-3.010
PHICH group EPRE / E_{RS} [dB]	0	0	0	0	0	0
PDCCH						
# of available REGs	23	23	43	90	140	187
# of PDCCH	2	2	2	5	7	10
# of CCEs per PDCCH	1	1	2	2	2	2
# of REGs per CCE	9	9	9	9	9	9
# of REGs allocated to PDCCH	18	18	36	90	126	180
# of <NIL> REGs added for padding	5	5	7	0	14	7
PDCCH REG EPRE / E_{RS} [dB]	0.792	2.290	1.880	1.065	1.488	1.195
<NIL> REG EPRE / E_{RS} [dB]	-inf	-inf	-inf	-inf	-inf	-inf
PDSCH						
# of 64QAM PDSCH PRBs within a slot for which EVM is measured	6	15	25	50	75	100
PRB $P_A = E_A/E_{RS}$ [dB]	0	0	0	0	0	0
# of PDSCH PRBs within a slot for which EVM is not measured (used for power balancing only)	0	0	0	0	0	0
PRB $P_A = E_A/E_{RS}$ [dB]	na	na	na	na	na	na

Note: E-TM 3.1 peak-to-average ratio is 7dB

Appendix D NB-IoT Standard Test Mode Settings

N -TM 1 Test Mode

Table F -1 N-TM1 Test Modes

General parameters	The test models are defined for a single antenna port (using $p = 1000$);
	Duration is 10 subframes (10 ms)
	Normal CP
Physical channel parameters	The ratio of synchronisation signal EPRE and NRS EPRE is 0 dB
	NPDCCH format 1

Note: N-TM 1 peak-to-average ratio is 7dB

N –TM2 Test Mode

On the basis of the N-TM1 test mode, the near-sideband filtering is strengthened, so that the signal itself meets the requirements of the spectrum emission template index, and the peak-to-average ratio is 7dB

N –TM A14-2 Test Mode

Table F-2 N-TM A14-2 Test Mode

Reference channel	A14-2
Sub-carrier spacing (kHz)	3.75
Number of tone	1
Diversity	No
Modulation	$\pi/2$ BPSK
Frequency offset	0
Channel estimation length (ms)Notel	16
Number of NPUSCH repetition	1
IMCS / TBS	0 / 0
Payload size (bits)	32
Allocated resource unit	2
Code rate (target)	1/3
Code rate (effective)	0.29
Transport block CRC (bits)	24
Code block CRC size (bits)	0
Number of code blocks C	1
Total number of bits per resource unit	96
Total symbols per resource unit	96
Tx time (ms)	64
Reference channel	

Appendix E Test Carrier Signal Configuration

E. _ 1 Definition of effective working frequency

Table E.1 Effective operating frequencies

frequency band		Working frequency band (MHz)	Effective operating frequency (MHz)	Continuous instantaneous effective operating bandwidth (MHz)	Network standards supported by this frequency band	Remark
Working Band 1	up	904-915 __	904-915 __	11	GSM900,	

(Unicom 900MHz)	down	9 49-960 _	9 49-960 _	11	NB-IOT 900 , WCDMA 900 and LTE FDD 900
Working Band 2 (Unicom 1800MHz)	up	1735-1765	1735-1765	10+18.18	GSM1800 and LTE1800
	down	1830-1860 _ --	1830-1860 _ _ _	10+18.18	
Working Band 3 (Unicom 2100MHz)	up	1940-1 980 _	1940.5 -1 979.5	18.9+18.18	Unicom WCDMA and LTE2100
	down	2130 - 2170	2130.5 - 2169.5	18.9+18.18	

E. _ 2 full load working state signal loading configuration

Table E.2 Signal Loading Configuration for Full Load Operation

frequency band		Working frequency band (MHz)	Signal System, bandwidth	carrier spacing	Center frequency point (MHz)	Number of carriers	Combined peak-to-average ratio
Working Band 1 (Unicom 900MHz)	up	90 4 - 905	GSM 8PSK: 200KHz	400kHz	90 4.4	2	8dB
	down	9 49 -95 0			9 49.4		
	up	90 4 - 905	NB-IoT: N-TM1	/	9 05	1	
	down	9 49 -95 0			9 50		
	up	9 05-910	WCDMA Test Mode 1: 5MHz	/	9 07.5	1	
	down	9 50-955			9 52.5		
	up	910-915	LTE E-TM3.1: 5MHz	/	912.5	1	
down	955-960	957.5					
Working Band 2 (Unicom 1800MHz)	up	1735-1745	GSM 8PSK: 200KHz	2.4MHz	1740	4	8dB
	down	1830-184 0 --			1835		
	up	17 45 -17 65	LTE E-TM3.1: 20MHz	/	1755	1	
	down	18 40 -18 60			1850		
Working Band 3 (Unicom 2100MHz)	up	1940-1 960	WCDMA Test Mode 1: 5MHz	5MHz	1952.6	3	8dB
	down	2130 - 2150			2142.6		
	up	1 960 -1 980	LTE E-TM3.1: 20MHz	/	1970	1	
	down	2150 - 2170			2160		

For devices that only support Unicom frequency bands, select working frequency bands 1, 2, and 3 for testing according to the supported frequency bands;

frequency band		Working frequency band (MHz)	Signal System, bandwidth	carrier spacing	Center frequency point (MHz)	Number of carriers	Combined peak-to-average ratio
Unicom 900MHz (Waveform Configuration 1)	up	90 4 - 905	GSM 8PSK: 200KHz	400kHz _	90 4.4	2	8dB
	down	9 49 -95 0			9 49.4		
	up	90 4 - 905	NB-IoT: N-TM1	/	9 05	1	
	down	9 49 -95 0			9 50		
	up	9 05-910	WCDMA Test Mode 1: 5MHz	/	9 07.5	1	
	down	9 50-955			9 52.5		
	up	910-915	LTE E-TM3.1: 5MHz	/	912.5	1	
down	955-960	957.5					
Unicom 900MHz (Waveform configuration 2)	up	90 4 - 90 9	LTE E-TM3.1: 5MHz	/	906.5	2	8dB
	down	9 49 -954			951.5 _ _		
	up	909- 9 14	WCDMA Test Mode 1: 5MHz	/	911.5	1	
	down	954-959			9 5 2.5		
	up	914 -9 15	NB-IoT: N-TM1	/	914	1	
	down	9 5 9 -9 60			959		
	up	914 -9 15	LTE E-TM3.1: 5MHz	/	914.6	1	
down	9 5 9 -9 60	959.6					
Unicom 1800MHz (Waveform Configuration 1)	up	1735-1745	GSM 8PSK: 200KHz	2.4MHz	1740	4	8dB
	down	1830-184 0 _			1835		
	up	17 45 -17 65	LTE E-TM3.1: 20MHz	/	1755	1	
	down	18 40 -18 60			1850		
Unicom 1800MHz (Waveform configuration 2)	up	1735-1745	LTE E-TM3.1: 10MHz	/	1740	4	8dB
	down	1830-184 0 _			1835		
	up	17 45 -17 65	LTE E-TM3.1: 20MHz	/	1755	1	
	down	18 40 -18 60			1850		
Unicom 2100MHz (Waveform Configuration 1)	up	1940-1 960 _	WCDMA Test Mode 1: 5MHz	5MHz	1952.6	3	8dB
	down	2130 - 2150			2142.6		
	up	1 960 -1 980	LTE E-TM3.1: 20MHz	/	1970	1	
	down	2150 - 2170			2160		
Unicom 2100MHz (Waveform configuration 2)	up	1940-1 960 _	LTE E-TM3.1: 20MHz	/	1950	3	8dB
	down	2130 - 2150			2140		
	up	1 960 -1 980	LTE E-TM3.1: 20MHz	/	1970	1	
	down	2150 - 2170			2160		

For devices that only support the Unicom frequency band, select the corresponding frequency band waveform for testing according to the frequency band supported by the device;

Appendix F The high, medium and low frequency points corresponding to the frequency band system

The high, middle and low frequency points corresponding to the product frequency band system:

frequency band	Working	Low	Center frequency	High
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		frequency band (MHz)	frequency point (MHz)	point (MHz)	frequency point (MHz)
Unicom 900 band	up	904-915 __	9 06 .5	9 09.4	912.5
	down	9 49-960 _	95 1 .5	9 54.4	957.5
Unicom 1800 frequency band	up	1735-17 65	17 37.5	1755	1762.5
	down	1830-1860 _ _ _	183 2.5	1850	1857.5
Unicom 2100 frequency band	up	1940-1 9 80 _	1942. 5	1970	19 77.5
	down	2130 - 21 70	2132.5 _	2160	21 67.5