

GTI Research Report on 5G Handheld Device for Vertical Industry



GTI

GTI Research Report on 5G

Handheld Device for Vertical

Industry



Version:	V1.0.0
Deliverable Type	<input type="checkbox"/> Procedural Document <input checked="" type="checkbox"/> Working Document
Confidential Level	<input type="checkbox"/> Open to GTI Operator Members <input type="checkbox"/> Open to GTI Partners

	<input checked="" type="checkbox"/> Open to Public
Working Group	ENS WG
Task	Task-T-PM3-PJ2-1: Universal Capabilities of 5G Device
Source members	China mobile research institute Dingqiao communication technology co. LTD Hytera Communications Corporation Limited Datang terminal technology co. LTD
Support members	China mobile research institute Dingqiao communication technology co. LTD Hytera Communications Corporation Limited Datang terminal technology co. LTD
Editor	WangGuiying RuanHang ZhaoLuyang WangXize MaShuai Xiaoshanpeng LiXiangrong ZhangQiang YanRui PiKun LiJie
Last Edit Date	11-11-2020
Approval Date	DD-MM-YYYY

Confidentiality: This document may contain information that is confidential and access to this document is restricted to the persons listed in the Confidential Level. This document may not be used, disclosed or reproduced, in whole or in part, without the prior written authorization of GTI, and those so authorized may only use this document for the purpose consistent with the authorization. GTI disclaims any liability for the accuracy or completeness or timeliness of the information contained in this document. The information contained in this document may be subject to change without prior notice.

Document History

Date	Meeting #	Version #	Revision Contents
2020.11.11	GTI 29th	V1.0.0	

Contents

1 Status of Professional Portable Terminals	11
1.1 Core Concepts.....	11
1.1.1 Portable Terminals on Private Network	11
1.1.2 Portable Terminals on Public Network.....	12
1.1.3 Hybrid Portable Terminals on Private-Public Network	12
1.2 Visions	13
2 Performance of 5G Professional Portable Terminals.....	16
2.1 Large bandwidth	16
2.2 High reliability and low latency	17
2.3 Cloud-based office	17
2.4 Trunking services	18
2.5 Classification of 5G Industrial Handheld Terminals	19
3 Ability demanded 5G Professional Portable Terminals.....	21
3.1 Basic cellular communication capability.....	21
3.1.1 mode and frequency band	21

3.1.2 Network access capability.....	22
3.1.3 antenna	23
3.1.4 Transmitting power.....	24
3.1.5 Reception sensitivity	24
3.1.6 rate	25
3.1.7 The time delay.....	27
3.1.8 Text messages.....	28
3.1.9 Slice.....	28
3.2 Hardware and reliability requirements	28
3.2.1 Processor	28
3.2.2 Built-in storage	29
3.2.3 Electromagnetic compatibility	29
3.2.4 SIM/USIM card.....	29
3.2.5 USB	29
3.2.6 Memory card	29
3.2.7 Upgrade function.....	30
3.2.8 WLAN function	30

3.2.9 Positioning ability	30
3.3. Enhanced Functions.....	30
3.3.1 NFC	31
3.3.2 Trunking functions.....	31
3.3.3 Three Preventions.....	32
3.3.4 Explosion Protection	33
3.3.5 Security Functions.....	33
4. Applications and Tests on 5G Industrial Handheld Terminals	33
4.1 5G Industrial Handheld Terminals and Their Applications.....	33
4.1.1 Standard 5G Industrial Handheld Terminals	33
4.1.2 Professional 5G Industrial Handheld Terminals	36
4.2 Test Requirements of 5G Industrial Handheld Terminals.....	42
4.2.1 Communication capability testing requirements	43
4.2.2 Test Requirements on Service Capability.....	45
5 Appendix	51
5.1 Appendix 1 Adaptability Test in Mechanical Environment.....	51

Preface

The world economy has entered the information age. Both carrier cellular networks, which serve the public, and industry private networks, which offer customized solutions for a variety of industrial applications, are growing rapidly. In particular, the traditional private network adopts simulation system and cluster communication. With the social progress, the demand of private network users gradually changes from voice service and short message service to data broadband service such as picture transmission and video transmission. The broadband private network communication that can provide diversified services has a broad development prospect. 5G network has the capabilities and advantages of high speed, low delay, large connection and slicing, and the public network of operators will also be able to meet the business needs of some industries in the future. The combination of 5G and private network will further meet the customization needs of various vertical industries and bring better use experience to industry customers.

In industrial applications, handheld terminals are indispensable. This research report puts forward the industry-oriented concept of 5G handheld terminals, and discusses the technical specifications and industrial applications of corresponding handheld terminals in

public security, industrial and enterprise fields.

1 Status of Professional Portable Terminals

1.1 Core Concepts

The professional portable terminal is a handheld data-processing device incorporating an operating system, memory, CPU, graphics card, battery, and screen. This portable and easy-to-use terminal provides functions such as instant communication, real-time data collection, automatic data storage, real-time data display and feedback, and automatic transmission. In general, the professional portable terminal includes personal digital assistant (PDA), portable scanner, portable radio, body worn camera and more. They constantly change the form and flow of people's daily work, and are widely used in industry verticals such as government public utilities, financial management, ticketing, traceability, logistics, retails, e-commerce payment and many other industries. To meet communication needs in 2G/3G/4G era, some industries turn to carrier networks, while others choose to build their own private networks by using the licensed or non-licensed frequency band, such as professional digital trunking (PDT) network, or B-Trunc broadband trunking network, or other private local area networks. Based on these types of network, the professional portable terminals on the market are classified into three categories: portable terminals on private network, portable terminals on public network, and hybrid portable terminals on private-public network.

1.1.1 Portable Terminals on Private Network

The portable terminal on private network can only work on private network which is built

by using the licensed or non-licensed frequency band, for example, the professional digital trunking (PDT) network, GSM-R railway network, or other local area networks. Such terminal includes single-mode, multi-mode, and hybrid terminals which are capable of accessing the WLAN, B-Trunc, TETRA, PDT, DMR, or GSM-R network.

1.1.2 Portable Terminals on Public Network

The portable terminal on public network uses the carrier network to provide communication services for industrial users. There are two kinds of portable terminals. One is the commercial portable terminal that is refitted to provide mobile communication services. The other is the customized terminal to meet specific needs of industrial users, for example, the push-to-talk over cellular (PoC) radio and body worn camera for police officers, handheld scanning terminals used in the logistics industry, and payment PDAs used in the financial industry.

1.1.3 Hybrid Portable Terminals on Private-Public Network

The hybrid portable terminal on private-public network is a hybrid or multi-mode terminal that can access both the public and private networks. In general, the private networks have limited network coverage and service bearing capacity. For example, due to the limits of technology and bandwidth, the police trunking system cannot support high-speed data transmission. As a result, the officers cannot interrogate databases or send image and video in the field. Meanwhile, there are many blind spots in the private networks. In this case, if the hybrid terminal is adopted, it can automatically access the public network to ensure service mobility and continuity when the private network is out of service

temporarily.

1.2 Visions

As the world economy has entered the era of informationization, this is a general consensus for all countries in the world to accelerate the informationization and network construction. Network informationization includes the cellular network which provides public services, and the private network which is customized to meet specific requirements of customers in different industries.

Compared with the carrier network, the private network is tailored for specific industries, specific sectors, and specific groups to meet their diverse communication needs. Such users have stringent requirements on performance, data security, and a high degree of customization. At present, the private network is utilized in dozens of industries such as municipal management, industrial parks, public safety, highway, airports, ports, etc., among which public safety and transportation are the biggest market.

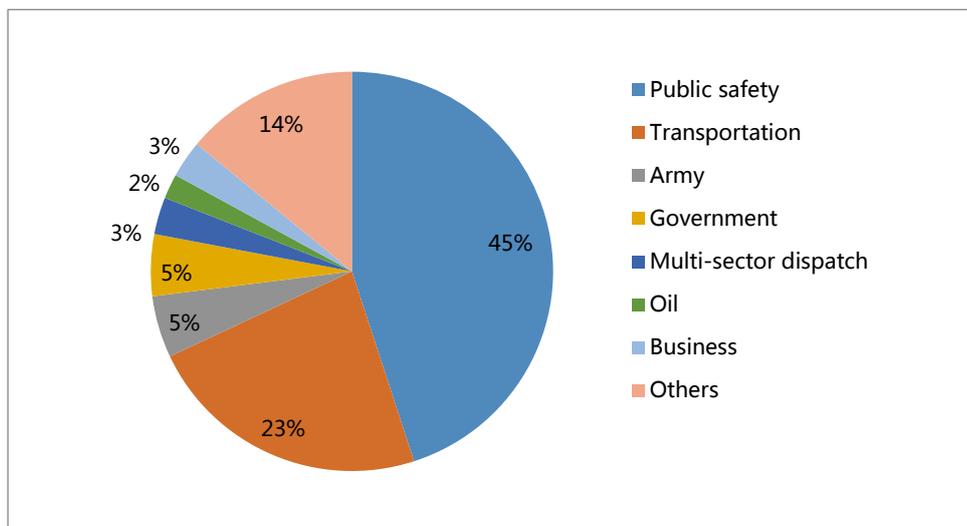


Figure 1-1 Global Private Network Customer

The global market of the private network is on the rise. Since 2015, the market size of the annual growth rate increased from 5% to 10%. It is estimated to exceed 190 billion yuan in 2023. In china, as the government puts more emphasis on public safety and more major events are held thanks to rapid economic development, the market size has been also accelerated. Considering the historical data of the PMR industry and development of downstream demands, it is expected that the market size will maintain a growth rate of about 15%, reaching 27.3 billion yuan by 2020.

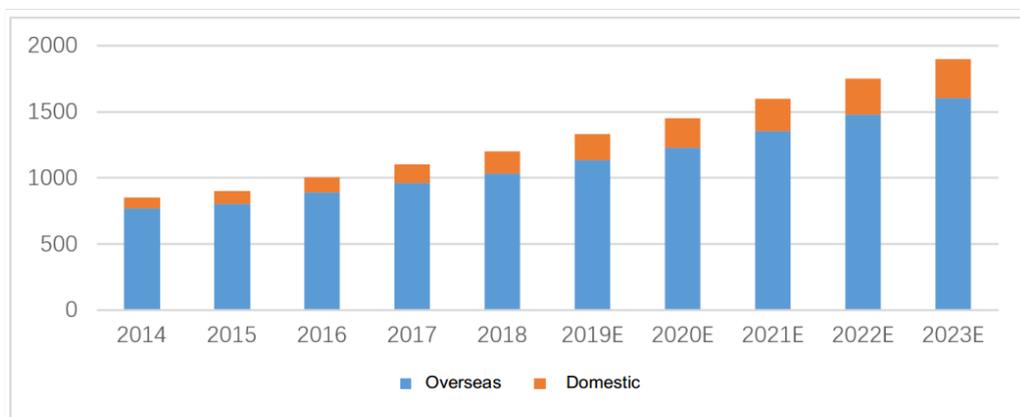


Figure 1-2 Global Private Network Market Size (billion Yuan)

Traditionally, the private network provides analog trunking communication services. With social development, the needs of the private network users are gradually shifting from voice call and text message to broadband data services such as image and video transmission. However, the traditional private trunking system can provide only voice services. So this brings more opportunities to the broadband private network capable of providing diversified services in the future.

As the commercial fifth-generation (5G) is on, communication is evolved from

machine-to-human to machine-to-machine. In this background, applications in the industry verticals have also been pushed to the foreground, which becomes a major theme of 5G applications. The private network market has become an important part because of its specificity and customized services. Therefore, the concept of 5G private network has been born. The 5G private network is the customized mobile cellular network that the carrier uses 4G or 5G technology and licensed spectrum to serve the special customers based on the exclusive network resources within the exclusive network coverage. The exclusive network resource includes the dedicated frequency, base station, and core network. With the advantages of 5G large-bandwidth licensed spectrum and strong operation and maintenance capabilities, the carrier can provide high-quality 5G private network services to meet the customized needs of various industry verticals and bring better experience to customers. According to SNS Research, the LTE and 5G private network infrastructure construction in the global will bring a compound annual revenue growth rate of 30% for communications industry from 2018 to 2021, and the market size will reach \$ 5 billion by 2021. In the future, most of professional portable terminals can provide the same communication services as smartphones. As the 5G smartphones become more popular, the professional 5G portable terminal on private and public network will continue to mature. And the hybrid terminal will also join the 5G era.

2 Performance of 5G Professional Portable Terminals

The ITU defines three major application scenarios for 5G: enhanced mobile broadband (eMBB), massive machine type communication (mMTC), and ultra-reliable low-latency communication (uRLLC). The eMBB mainly enhances the communication experience of personal consumption services such as people-centered entertainment and social activities. It is suitable for high-speed and high-bandwidth mobile broadband services. The mMTC and uRLLC focus on thing-to-thing connection. The mMTC mainly provides connectivity to a large number of devices (IoT). It is ideal for sensing and data acquisition scenarios. The uRLLC features ultra-low latency and high reliability, which can meet special communication needs in industry verticals. Combining the 5G characteristics with typical application scenarios of the professional portable terminals, the 5G professional portable terminal has the following features including large bandwidth, high reliability and low latency, cloud-based office, and trunking services.

2.1 Large bandwidth

In earlier times, the professional portable terminal can only provide voice or low-speed rate data services due to limits of bandwidth and capacity of the private network. High reliability, large bandwidth, and large capacity of the 5G network make it possible for the professional portable terminal to develop new services. Over the 5G network, the high-definition videos and photos can be transmitted and downloaded in real time. For example, the body worn camera can send the on-site video and photos to the data center

or cloud platform, enhancing transparency in the law enforcement.

2.2 High reliability and low latency

Emergency communication organizations such as TCCA believe that in the future, mission-critical communications will be gradually migrated to 5G broadband network, and the enhanced commercial carrier network will provide most of the emergency communication services. In the area of critical communications, the following use cases families have been identified, including high reliability and lower latency, higher reliability, higher availability and lower latency, very low latency, higher accuracy positioning, higher availability, and mission critical services. The mission critical services include prioritised communications, isolated communications, protected communications, guaranteed communications, optimised communications, and supported communications. The 5G professional portable terminal will meet the needs of ultra-reliable communications (police, fire, public safety) and high availability (auxiliary connectivity, disaster and emergency response, natural disasters and emergencies, and communications without ground coverage). It will also provide guaranteed communication (high success rate of communication) and supported communication (communication guarantee when system resources are limited).

2.3 Cloud-based office

With the development of telecommunication and Internet technologies, the form of terminals in the office has been changed. The 5G professional portable terminal is one such example. In the future, all work data will be stored in the cloud. Through ubiquitous

cellular connections, work can be done anytime, anywhere. The commercial smart terminals can be refitted to achieve mobile work and mobile office.

2.4 Trunking services

The Trunking services refer to communication services such as command and dispatch for users in multiple departments and units, using technologies such as channel sharing and dynamic allocation. It ensures communication in major events, facilitates dispatch and command services in daily operation, and provides emergency communications in response to natural disasters. As the traditional private network is narrowband network, its user capacity is limited. With the development of society and economy, more and more professional users in the industry utilize trunking service to improve productivity and management efficiencies. These users expect to achieve voice dispatch and command through carrier network.

The trunking service is classified into the following types:

- (1) Private trunking: As the private network is built to meet specific communication needs, the service performance is great. But the disadvantage is that the cost of network construction is too high and the network coverage is limited. However, because there is no better alternative, it is still the first choice for professional users in the industry.
- (2) Public trunking: As the push-to-talk service is delivered over the carrier network, the network construction cost is low and the network coverage is wider than the private trunking network. But the disadvantage is that the voice quality and latency cannot

meet the requirements of the professional users. The main technology is push-to-talk over cellular (PoC).

(3) OTT: Internet companies provide free push-to-talk service integrating multiple entertainment features through virtual operators, and this attracts a certain number of users. A typical example is WeChat.

(4) In 4G era, the PoC technology cannot fully meet the needs of professional and quasi-professional users due to the limitation of carrier network. However, with the advent of the 5G era, the mobile bandwidth has been greatly enhanced, and the ultra-reliable and low-latency performance have been met. Thus, the public trunking application will gain the popularity among professional users.

2.5 Classification of 5G Industrial Handheld Terminals

5G industrial handheld terminals can be classified into standard and professional terminals by product type.

A standard 5G industrial terminal is transformed from a commercial smart terminal and is used for mobile operation and office purposes.

A professional 5G industrial terminal is specially developed to satisfy operation requirements of industry customers. Based on trunking requirements, professional industrial terminals are further classified into trunking terminals and data terminals.

Trunking industrial terminals appear in two types:

Highly-reliable voice terminals: dust-proof, water-proof, and shock-proof, small screen,

keyboard available. Suitable for front-line personnel with only voice requirements.

Highly-reliable multimedia terminals: dust-proof, water-proof, and shock-proof, HD large screen, ability to process data, voice, and video communication services. Suitable for industry practitioners involved in services such as video, information import, and inquiry.

Data terminals are developed to support industry services, such as video and image collection, import, and inquiry. Data terminals also come in with two types:

Highly-reliable data terminals: Enhanced dust-proof, water-proof, and shock-proof. Suitable for industry practitioners involved in services such as video and image collection, information import, and inquiry. Such terminals include body-worn cameras and monitoring terminals.

Lightweight and thin data terminals: HD large screen. Suitable for industry practitioners involved in services such as video and image collection, information import, and inquiry. Such terminals include ward-round PDAs used in hospitals and handheld image upload accessories.

Figure 2-1 Handheld industrial terminals



voice terminal	multimedia terminal	Monitoring terminal	
----------------	---------------------	---------------------	--

3 Ability demanded 5G Professional Portable Terminals

3.1 Basic cellular communication capability

This section defines 5G Professional Portable Terminals of Basic cellular communication capability ,Except for special instructions ,. It is suitable of this report covers all of them5G 5G Professional Portable Terminals.

3.1.1 mode and frequency band

5G industry handheld terminals should support 5G/4G dual- mode and support the frequency bands listed in the table below.

Table3-1 5G industry handheld terminals support working frequency band

Network mode	Working frequency band	Up (terminal)	Down (terminal)
5G	n41	2496MHz-2690MHz	2496MHz-2690MHz
	n79	4400MHz-5000MHz	4400MHz-5000MHz

TD-LTE	Band 34	2010-2025MHz	2010-2025MHz
	Band 39	1880-1920MHz	1880-1920MHz
	Band 40	2300-2400MHz	2300-2400MHz
	Band 41	2496-2690MHz	2496-2690MHz
LTE FDD	Band 3	1710-1785MHz	1805-1880MHz
	Band 8	880-915MHz	925-960MHz

3.1.2 Network access capability

5G industry handheld terminals should support access and service capabilities in NSA mode and SA mode. NSA mode should support Option 3x, SA mode should support Option 2, support single-carrier up to 100MHz cell bandwidth, and support the following BWP configuration.

Table3-2. 5G industry handheld terminals support BWP configuration

BWPconfiguration	describe
BWPconfiguration1	Uplink /downlink supports configuration1 BWP and supports BWP activation via RRC signaling
BWPconfiguration2	Uplink /downlink supports maximum

	configuration2 BWP with the same numerology for each BWP and supports activation of BWP by RRC/DCI signaling
BWPconfiguration3	Uplink /downlink supports a maximum of 4 BWPS with the same numerology, and supports activation of BWP by RRC/DCI signaling

3.1.3 antenna

The maximum antenna and MIMO streams supported by the 5G industry handheld terminals are shown in the table below.

Table3-3. The 5G industry handheld terminals support antenna and MIMO streams

networking mode	antennas	Maximum MIMO streams
SA	NR : down 4 antenna, up 2 antenna	NR : downlink 4 flow, uplink 2 flow
NSA	LTE :down 2 antenna, up 1 antenna NR : down 4 antenna, up 1 antenna	LTE : downlink 2 flow, uplink 1 flow NR : downlink 4 flow, uplink 1 flow

3.1.4 Transmitting power

The 5G industry handheld terminal shall support the Power Class 2 of the total transmission Power of the terminal.

3.1.5 Reception sensitivity

The reference sensitivity is defined as a down power value with a receiving bit error rate of 5%. The reference sensitivity limit corresponding to the required frequency band should be met for the handheld terminals in 5G industry, please refer to section 7.3 in 3GPP TS 38.101-1 for details. For 5G industry handheld terminals with four antenna receivers, the sensitivity shall be based on up as required in section 7.3 of 3GPP TS 38.101-1, and the limits shall be tightened as shown in the following table.

Table3-4 5G industry handset receiver sensitivity $\Delta R_{IB,4R}$

NR spectrum	limit $\Delta R_{IB,4R}$ (dB)
n41	- 2.7
n77, n78, n79	- 2.2
Note: this reduction shall be subsequently consistent with the 3GPP definition.	

3.1.6 rate

Peak user rates of handheld terminals in the 5G industry should meet the requirements listed in the table below.

Table3-5 5G SA single user peak rate (n41 spectrum, 5ms frame structure, DL/UL subframe ratio: 7:1:2)

entry	describe
down peakrate(broadband100MHz ,downlink 4 flow , 256QAM)	single user peakrate : 1.5Gbps
up peakrate (broadband100MHz , uplink 2 flow , 256QAM)	single user peakrate : 250Mbps

Table3-6 5G SA single user peak rate (n79 spectrum, 2.5ms single-cycle frame structure, DL/UL subframe ratio: 1D:3U)

entry	describe
down peakrate(broadband100MHz ,downlink 4 flow , 256QAM)	single user peakrate : 0.7Gbps
up peakrate (broadband100MHz , uplink 2 flow ,	single user peakrate :

256QAM)	0.7G bps
----------	----------

Table3-7 5G SA single user peak rate (n79 spectrum, 2.5ms double-cycle frame structure, DL/UL subframe ratio: 7D:3U)

entry	describe
down peakrate(broadband100MHz ,downlink 4 flow , 256QAM)	single user peakrate : 1.35Gbps
up peakrate (broadband100MHz , uplink 2 flow , 256QAM)	single user peakrate : 350Mbps

Table3-8 5G NSA single user peakrate (B3+n41)

entry	describe
down peakrate (B3+n41)	NR downlink : 1.5Gbps
NR (n41): broadband100MHz , downlink 4 flow , 256QAM , DL/UL ratio of subframe : 7:1:2	LTE FDD downlink : 170Mbps
LTE(LTE FDD Band3) :broadband20MHz ,downlink 2 flow , 256QAM	
up peakrate (B3+n41)	NR uplink : 112.5Mbps
NR (n41): broadband100MHz , uplink 1 flow ,	LTE FDD uplink :

256QAM , DL/UL ratio of subframe : 7:1:2	67.5Mbps
LTE (LTE FDD Band3) : broadband20MHz , uplink 1 flow , 64QAM	

Table3-9 5G NSA single user peakrate (B39+n41)

entry	describe
down peakrate (B39+n41)	NR downlink : 1.5Gbps
NR (n41) : broadband100MHz , downlink 4 flow , 256QAM , DL/UL ratio of subframe : 7:1:2	TD-LTE downlink : 135Mbps
LTE (LTE FDD Band39) : broadband20MHz , down2flow , 256QAM	
up peakrate (B39+n41)	NR uplink : 112.5Mbps
NR (n41) : broadband100MHz , uplink 1 flow , 256QAM , DL/UL ratio of subframe : 7:1:2	TD-LTE uplink : 13.5Mbps
LTE (LTE FDD Band39) : broadband20MHz , up 1 flow , 64QAM	

3.1.7 The time delay

Handheld terminals in 5G industry shall meet the following delay requirements:

SA mode , NR Control surface idle convert toconnected , the delay is within 100ms , idle or inactive convert toconnected the delay is within 20ms ;

NR the end-to-end delay of the user surface is within 10ms when there is pre-scheduling, and 15ms when there is no pre-scheduling.

3.1.8 Text messages

Handheld terminals in 5G industry shall support SMS over IP (IMS) and SMS over NAS, and SMS over IP (IMS) shall be preferred for short message transmission.

Note: no requirement for pure data terminal

3.1.9 Slice

5G handset industry should support section function, including slice based on different business choose to access the corresponding network type, able to carry in the signaling message network slice identification (S - NSSAI) and passed to the network, support stored and updated network section related logo, and can simultaneously access multiple (same type section number greater than or equal to 2) network section.

3.2 Hardware and reliability requirements

In this chapter, hardware and reliability requirements of 5G industry handheld terminals are supported by all 5G industry handheld terminals covered in this study, except for special instructions.

3.2.1 Processor

Handheld terminals in 5G industry can use RISC(ARM, MIPS) or X86 CPU platform, with the main frequency recommended to be higher than 800MHz, and support above 200MIPS.

3.2.2 Built-in storage

The RAM used in 5G industry handheld terminals should be no less than 512MByte, and FLASH should be no less than 512MByte.

3.2.3 Electromagnetic compatibility

The electromagnetic compatibility characteristics of handheld terminals in 5G industry should meet the requirements of YD/T 1965-2009 and GB17626.

3.2.4 SIM/USIM card

5G industry handheld terminals should support two 3.3v / 1.8v compatible SIM/USIM card holders, which can be inserted into two SIM CARDS at the same time, and one SIM card can be used according to the configuration to realize up link redundancy and enhance the reliability of network connection. SIM/USIM interface shall meet the requirements of China mobile user card hardware specification. If aerial card writing is supported, it shall meet the technical specification of card writing for China mobile Internet of things private network.

3.2.5 USB

5G industry handheld terminals should support at least one standard or extended USB interface, conform to USB2.0 and up protocol, and support external computer devices.

3.2.6 Memory card

5G industry handheld terminals should support a 1-way Micro SD interface for inserting Micro SD CARDS and extending flash to store local data.

3.2.7 Upgrade function

5G industry handheld terminals should support local or OTA firmware upgrades and have upgrade exception alerts. During the upgrade process, there will be no abnormal situations such as machine crash and business failure, and fault-tolerant protection will be provided for downloading the upgrade package, decompression of the upgrade package, network outage and power loss during the incremental and full upgrade, so that the terminal can automatically resume normal operation.

3.2.8 WLAN function

For converting 5G wireless signals to WiFi signals, IEEE 802.11b /g/n 2.4ghz spectrum and IEEE 802.11ac 5GHz spectrum are supported. Support for IEEE 802.11ax 2.4g spectrum and 5GHz spectrum is recommended.

WiFi 2*2 antenna is supported. When the terminal starts the WiFi hotspot function, when the NR network adopts a single carrier at 100MHz and a DL/UL 7:1:2 time slot ratio, the WiFi peakrate should reach at least a single downlink 600Mbps.

3.2.9 Positioning ability

Support GNSS and a-gnss positioning capabilities according to application scenario requirements; Support the ability to obtain cell-id information to support up layer applications to obtain base station location information; It is recommended to support WiFi/ bluetooth /UWB/ infrared positioning.

3.3. Enhanced Functions

This section describes enhanced functions of 5G handheld industrial terminals. These functions are optionally configured for the terminals based on actual application scenarios and service requirements.

3.3.1 NFC

The NFC function is supported based on the application scenario requirements. Products that support NFC must use the GSMA-compliant NFC-SWP solution.

3.3.2 Trunking functions

Trunking services include trunking voice, multimedia, data, and supplementary services.

Trunking voice

Full-duplex voice calls between two terminals; half-duplex voice calls from one terminal to multiple terminals; half-duplex voice calls between two terminals

Trunking multimedia

Two-way video calls can be set up between two terminals. During a video call, the calling and called parties can hear each other and view each other in video. The terminal supports group call services, including voice and video media streams.

Trunking data

Two terminals can exchange short messages with each other. The receive end needs to respond with an acknowledgement message upon receiving a short message. However, the receive ends do not need to respond with an acknowledgement message if the short

message is sent from a terminal to a group. Status messages defined by industry users can be exchanged between terminals.

Trunking supplementary services

Emergency call: A user can press the emergency call key to initiate an emergency call.

The terminal automatically dials the emergency call number.

Remote disable/block: After being remotely blocked, the terminal must send an acknowledgment message to the network. Except for such services as attach, registration, authentication, enabling/remote disabling, and positioning, the terminal cannot apply for or receive any network services. After the terminal is remotely disabled, all its operation functions become unavailable and it cannot be enabled through messages generated over the air interface.

Ambience listening/monitoring: The terminal is unaware of the initiation or termination of ambience listening/monitoring or ongoing ambience listening/monitoring. Ambience listening/monitoring does not affect terminal operations or services.

3.3.3 Three Preventions

Three preventions refer to water-proof, dust-proof, and shock-proof. Superb water-proof, dust-proof, and shock-proof performance is required by industry users in rugged scenarios or harsh environments.

In terms of water-proof and dust-proof protection, a highly-reliable terminal must deliver IP68 protection while a lightweight terminal must deliver IP67 protection.

For details about the shock-proof requirements, see 5.1 Appendix 1 Adaptability Test in Mechanical Environment.

3.3.4 Explosion Protection

A handheld industrial terminal providing the explosion protection function must meet requirements in "Explosive atmospheres-Part 1: Equipment-General requirements" (GB3836.1) and "Explosive atmospheres -Part4: Equipment protection by intrinsic safety 'i'" (GB3836.4).

3.3.5 Security Functions

Handheld industrial terminals providing security functions must meet the requirements in "Information security technology—Technical requirements of security design for classified protection of cybersecurity" (GB/T 25070 -2019).

4. Applications and Tests on 5G Industrial Handheld Terminals

4.1 5G Industrial Handheld Terminals and Their Applications

This section describes typical 5G industrial handheld terminals and their application scenarios.

4.1.1 Standard 5G Industrial Handheld Terminals

A standard 5G industrial terminal is transformed from a commercial smart terminal and is

used for mobile office. Such terminals will also be the first 5G terminals applied in vertical industries.

Mobile office emerges with the integration of rapidly-developing communications technologies and the IT industry. In the industry, many employees cannot work in fixed offices for a long time due to their work characteristics, such as police officers, maintenance engineers, airport guard handlers, and financial practitioners. Mobile office makes work easy and convenient. With mobile phones, users can work efficiently and quickly in any emergency, facilitating emergency handling and emergency deployment. Security is the primary issue in the use and promotion of mobile office. One solution is to improve the security level of handheld terminals. The following figure shows the terminal security model. According to requirements on the operating system (OS), communication protocols, and cryptographic facilities, security requirements in six dimensions are specified: hardware security, OS security, application security, data security, peripheral management and control, and communication encryption.

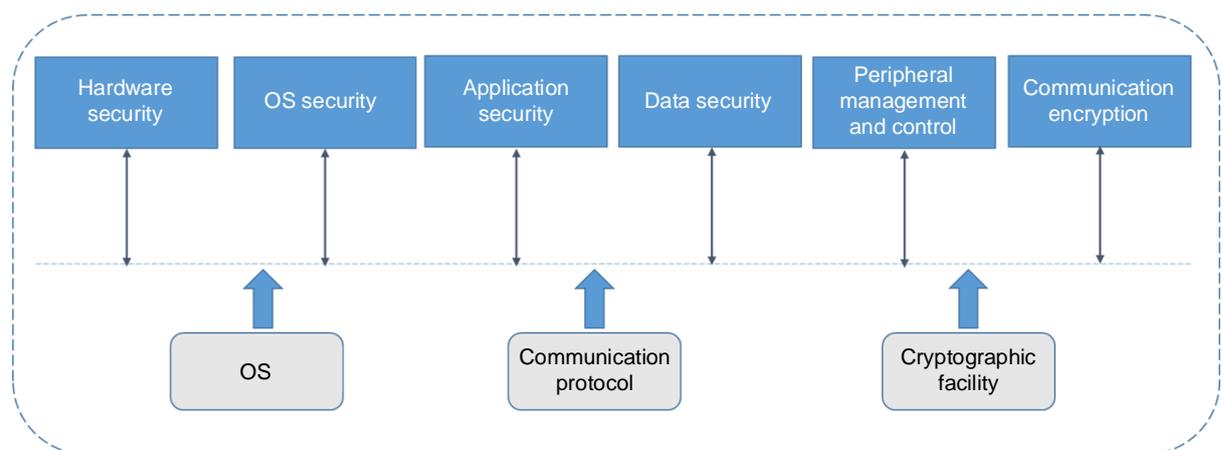


figure 4-1 terminal security model

Hardware security

- 1) The hardware circuit of the entire system is secure and controllable, and there is no component or module with unknown functions.
- 2) Static measurement is performed on executable entities involved in terminal startup based on a trusted root. The executable entities include at least the boot program, system image, system kernel, and key applications. If the measured object is tampered with, the startup is automatically terminated.

OS security

- 1) Illegal acquisition of rights of the super administrator is prohibited.
- 2) No known high-risk system vulnerabilities exist.
- 3) The OS is able to detect and resist virus intrusion.
- 4) Network connection status is displayed.
- 5) Network data transmission status is displayed.
- 6) Sending personal information to unknown or unauthorized servers is prohibited. The personal information includes but is not limited to keyboard-input or handwritten information, user location information, MAC or IP address, and hardware label information.
- 7) Password protection during startup and locking is supported.
- 8) Passwords are not stored or transmitted in plaintext and are not displayed in plaintext during input.
- 9) Device locking upon timeout and manual locking are supported.
- 10) Key codes can be independently controlled. Such codes include but are not limited to the graphics, multimedia, telephone, application management, security, and device subsystems as well as system core services.
- 11) Trusted dynamic measurement is performed on the OS.

Application layer security

- 1) Source and integrity check is performed on application installation packages or update packages.
- 2) No applications irrelevant to services are installed.
- 3) Applications started automatically upon system startup are monitored and can be configured.

- 4) Static measurement of applications: Application integrity check starts based on the reference value upon application start-up. If the integrity of the application is damaged, the application is prevented from running.

Network connection security

- 1) The WLAN can be used only to collect hotspot information. Connecting to the WLAN, enabling the hotspot, or directly connecting to each other are prohibited.
- 2) Users are not allowed to manually disable the data network connection. This ensures that the system is always under background monitoring.
- 3) IP address access policies can be pre-configured to specify network addresses accessible to users.

Peripheral interface security

Peripheral interfaces include but are not limited to Bluetooth, USB, and NFC interfaces. The peripheral interfaces must meet the following security technical requirements:

- 1) NFC can be enabled or disabled through the management and control interface, and the corresponding status is displayed to users.
- 2) Bluetooth connection policies or management and control interface settings can be pre-configured to specify devices that can be connected via Bluetooth and display corresponding status to users.
- 3) The USB interface policy or management and control interface settings can be pre-configured to allow the USB interface for charging only and display corresponding status to users.

User data security

- 1) User data cannot be queried, modified, or deleted by unauthorized users.
- 2) User data can be deleted permanently and deleted data cannot be restored.
- 3) Data on body-worn cameras can be locked, relocated, or destroyed remotely.
- 4) Authorized access to file-based user data is supported. Unauthorized applications are not allowed to access any protected user data files without user consent.

4.1.2 Professional 5G Industrial Handheld Terminals

Professional handheld terminals are customized and developed based on the operation

requirements of industry customers.

4.1.2.1 Trunking Terminals

Trunking terminals are widely used in industries such as public security, emergency communication, smart city, subway, mining area, port, and smart power network to meet voice and data transmission requirements. Trunking terminals enable unified management, dispatching, and commanding of employees, achieving scientific management. In case of emergencies, the trunking terminals can respond quickly, execute effectively, and connect the chief commander and subordinate levels. For example, trunking terminals are applicable to office/vehicle on-duty users, such as police officers, commanders, traffic police officers, or airport ground/aircraft dispatchers. They are also applicable to outdoor users, such as traffic police, patrol police, airport maintenance engineers, and ground handlers.

Trunking terminals must support trunking functions described in "3.3.2 Trunking functions" and the three preventions described in "3.3.3 Three Preventions." In addition, trunking terminals must support the following supplementary features based on actual applications: high volume, PTT button, and removable battery. The DMO function is optional to trunking terminals.

- (1) High volume: To guarantee trunking voice communication of handheld terminals in noisy environments, the terminals must be equipped with high-power speakers to deliver high volume.
- (2) PTT button: The PTT button allows industry users to quickly initiate trunking services during work. Normal smartphones' buttons cannot meet the requirements of trunking

services in terms of durability and comfort. Therefore, professional and reliable PTT buttons are necessary for industrial terminals.

- (3) Removable battery: Removable batteries are required on trunking terminals. The battery can be placed on the desktop charger for separate charging.
- (4) DMO: Trunking terminals can directly communicate with each other when wireless network is disconnected. Specifically, DMO is implemented by using the direct communication functions as Wi-Fi and Bluetooth or other direct communication functions in DMO.

Public and private trunking terminals must support one or more frequency bands besides broadband and narrowband networks. In addition, such terminals must support compatibility, interworking, and convergence between the public and private networks to implement communication between trunking terminals of multiple industries. Enterprise networks include WLAN, B-TrunC, Tetra, PDT, DMR, and GSM-R networks. The public-private network interworking and convergence function provides data channels for both public and private networks. This ensures reliable mission critical communication, video surveillance, and other application services. Public-private network interworking and convergence functions are as follows:

- (5) Terminal interworking: Terminals voice and video communication between different types of terminals.
- (6) Network coverage extension: Terminals can communicate with each other through public network by using the PoC function to cover the private network's coverage holes and extend the network coverage.
- (7) In addition, terminals support the ability to manually or automatically stay on the public or private network.
- (8) Manual network selection: Terminal users can manually switch between public and private networks based on network conditions to communicate with other terminals.
- (9) Automatic network selection: Terminals can automatically switch between networks based on the current registration status, achieving seamless communication without user awareness or requiring operations.

4.1.2.2 Data Terminals

In industry applications, there are various types of data handheld terminals. The following describes two types of terminals that are urgently required by vertical industries: HD video recorder and handheld PDA.

(1) HD video recorder

The large bandwidth and high rate of 5G allow real-time upload of videos and images by using HD video recorders. HD video recorders are widely used among industry customers. They can be body-worn and integrate functions such as real-time audio and video recording, photographing, and recording. They provide customers with services such as law enforcement evidence collection and working environment monitoring. HD video recorders are widely used in various industries and scenarios, such as stability maintenance, counter-terrorism, events, social security, traffic maintenance, court evidence collection, urban management law enforcement, industry and commerce management, station services, customs anti-smuggling, drug/food supervision, and energy. Detailed application scenarios are as follows:

- (1) Digitally records and uploads dynamic and static onsite information during law enforcement and routine security management, and provides effective onsite video materials for command, investigation, and procuratorial organs to collect evidence or provide work records.
- (2) Identifies suspects in real time. When law enforcement personnel record videos, the system automatically extracts face images, compares them with the blacklist library in real time, and quickly generates alarms. The extracted face images can be uploaded to the public security intelligence platform through 5G for storage and analysis.

- (3) Enables inspection and maintenance on the production environments such as mines and oil and gas transmission pipelines. By checking and recording on site, you can find potential security risks or perform irregular supervision. For example, in the petroleum industry, HD video recorders can be used to inspect oil wells, pipelines, and stations to check and record leakage as well as the integrity of key parts, identify pipeline damage and risks, and inspect the metering room (oil gathering valve room), transfer station, and joint station (including water injection station and processing station).

An HD video recorder must meet the following performance specifications:

- (1) Protection level: IP67, as required by GB/T 4208-2017
- (2) External environment adaptability: Environment adaptability requirements in 5.1"Appendix 1 Adaptability Test in Mechanical Environment."
- (3) Removable battery: Required. The battery can be placed on the charger base for separate charging.
- (4) Field of view (FoV): The horizontal FOV of the recorder must be greater than or equal to 90 degrees under all declared resolutions.
- (5) Geometrical distortion: The geometrical distortion of the recorder must be less than or equal to 20% when the horizontal FOV satisfies all product resolutions.
- (6) Video image quality: When the recorder is displaying or playing back videos, the video image must have no obvious defects, and the edge of an image showing a moving object must have no serration, burrs, cracking, or mosaics.
- (7) Maximum recording interval: In segment recording, the maximum recording interval between two adjacent video segments must be less than or equal to 0.1s.
- (8) Battery operating duration: class A: The battery should support continuous recording for 8 hours; class B: The battery should support continuous recording for 4 hours.
- (9) Night vision: The recorder should have the night vision function. After this function is enabled, the effective shooting distance should be no less than 3 m, and the facial features of a person must be clear at the effective shooting distance. A recorder with the infrared light compensation function must be able to cover more than 70% of the video image at 3 m.
- (10) Color reproduction: When the ambient illumination is greater than or equal to 800 lux, the color of the displayed and revisited images should not have obvious color casts.
- (11) Power-on time: The time from pressing the power button to entering the viewfinder mode should not be longer than 30s.

- (12) Audio and video synchronization recording: Assume that the recorder is used for recording for 4 hours. Randomly select at least five time points (including the start and end time of the file) in the recording file to play back. The out-of-synchronization time of audio and video signals must be less than or equal to 1s.

Handheld PDA

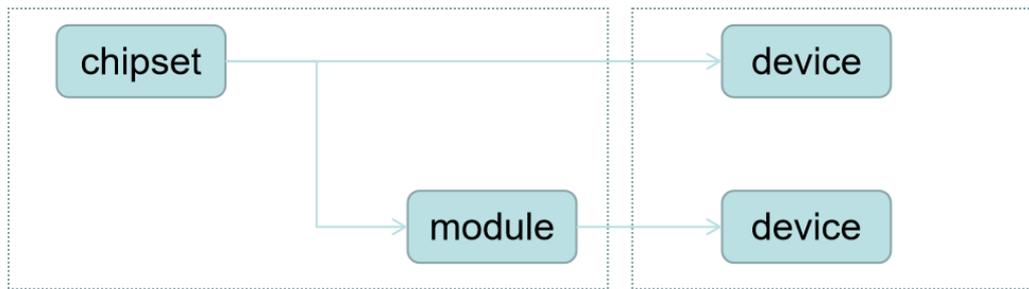
- (1) Handheld PDA integrates the advantages of PDA and mobile phone, and integrates data collection, data processing, wireless transmission and other functions, which are widely used in the industry. Typical application scenarios are described as follows:
- (2) The pharmaceutical industry can help the pharmaceutical industry to carry out inventory and data tracing, and can realize automatic checking of patients, doctor's orders and drugs, so as to prevent the occurrence of wrong drugs and ensure drug safety;
- (3) can be used for mobile operation, handheld PDA patient rounds by doctors and nurses can quickly query the patient medical records, the doctor's advice, inspection sheet and inspection reports, such as single, special nursing diagnosis and treatment temperature data, can also be a picture of the patient clinical, talking with the patient to the recording, etc., to provide basis for improve the diagnosis and treatment plan, greatly reduce the medical cost, simplify the medical work flow process, improve the working efficiency, let the doctor to better service for patients.
- (4) logistics and transportation industry realize real-time management in transportation management and product tracking. The staff can directly complete the warehousing/outbound/inventory management on the job site through handheld PDA. In the basic/system information management, data statistical analysis and other links, the order processing and information recording can be fully automated business operation process.
- (5) Using handheld PDA, can more timely and effective express query, emergency cargo real-time scheduling, to achieve zero delay processing;
- (6) The geographic location of dispatchers can be obtained in real time, and the whole process can be transparently tracked and located, making management easier and transparent;
- (7) check the order on site through PDA, automatically produce the signature statement and print the bill, transmit the updated data in real time up, and make the payment more safe and reliable.

- (8) Handheld PDA must support positioning and NFC functions, and according to the use of the scenario to support the corresponding three levels of protection and explosion protection functions, and should meet the following functions:
- (9) detachable battery: detachable battery shall be supported and terminals or batteries shall be placed to charge up separately;
- (10) support 1-d and 2-d scanning functions: able to accurately and quickly read all kinds of 1-d and 2-d bar codes;
- (11) UHF/ UHF/HP RFID reading and writing based on practical application scenarios, support UHF single-label and multi-label reading; Or it can support UHF/ UHF/HP RFID reading and writing through an extended back clamp.
- (12) support super sensitive touch, support wearing gloves, dry and wet hand touch ;
- (13) secondary development interface can be provided to meet the special needs of different industries

4.2 Test Requirements of 5G Industrial Handheld Terminals

There are many types and shapes of handheld terminals in 5G industry. According to different application scenarios, there are also differences in their business functions and performance requirements. For example, the cluster terminal for high volume, optional support for off-network pass-through function; Hd video recording instrument for night vision function, video audio recording function. Therefore, it is difficult to have a universal test scheme for handheld terminals in different 5G industries. However, despite the great differences in the business applications of the up layer, the test scheme for 5G communication capability is still universal.

Therefore, for the test of handheld terminals in 5G industry, the test can be conducted for the underlying communication capability and the up layer service capability. To improve the test efficiency and reduce the test cost, the test of communication ability can be conducted based on the module or chip integrated with the handheld terminal. Conduct a customized test on the business capability of the up layer. Since the business capability is closely related to the terminal shape, the test should be conducted based on the terminal. The following sections will study the communication capability test demand and business capability test demand of the 5G industry handheld terminals.



universal 5G communication capability test customized service capability test

figure4-2 5G industry handheld test scheme

4.2.1 Communication capability testing requirements

4.2.1.1 Instrument based conformance testing

Conformance test is a global standardized test method for wireless communication capability. Due to its basic and comprehensive test contents, it is usually used to test whether the basic protocol functions and performance indicators of 5G terminals meet the core standards of 3GPP. In the actual test, the instrument can simulate different scenarios by simulating the network environment, so as to ensure the stability of test cases, reproducibility of test results, and high efficiency of test execution.

The basic protocol function, rf performance and wireless resource management capability of the handheld terminal can be tested through protocol consistency, rf consistency and wireless resource management capability consistency test. Protocol conformance test is used to verify the correctness of protocol stack implementation of 5G terminal wireless communication layer. Rf consistency is used to investigate 5G terminal

transmitter/receiver performance and demodulation performance; Wireless resource management capability is used to investigate the performance of terminals in wireless link management, measurement accuracy, timing accuracy, etc.

4.2.1.2 Interoperability testing with 5G networks

In order to ensure the good performance of handheld terminals in different networks, it is necessary to verify the interoperability between 5G handheld terminals and real network devices.

Interop testing includes laboratory testing and field testing. In terms of laboratory testing, specific test scenarios can be built through test equipment and test tools to verify the performance of handheld terminal network access success rate, rate throughput, delay, etc.

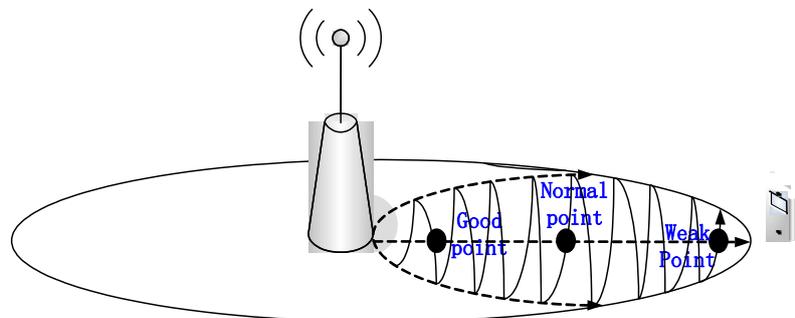


Figure4-3 Test point selection in field testing

As mentioned above, the field test is mainly used to verify the communication capability of the handheld terminal in the real network environment. For example, test points are selected according to the usage scenarios of handheld terminals, and fixed-point tests are conducted on functions and performance such as throughput and service success rate

under the actual network. For the handheld terminals used in the mobile scene, it is possible to select the traffic road that can cover the main use scene through the field running test, and test the functions and performance of the terminals in the mobile scene.

4.2.1.3 Performance and special scenario testing

In order to verify the function and performance of the industry terminal, and to complement the conformance test, a test requirement including performance test and special scenario test was proposed for the handheld terminal of different industries. In terms of function and performance testing, the basic functions, mobility, power consumption and throughput of the terminal are investigated, so as to ensure the data transmission capacity of the handheld terminal under different scenarios, the duration of battery life, and the absolute power consumption under standby and data transmission, etc. On the other hand, for the application characteristics of different handheld terminals, such as the application of handheld PDA to the material flow transportation industry, it is necessary to test the throughput of handheld PDA and the continuity of audio and video services in high-speed railway scenarios, and investigate the demodulation performance of terminals at 350km/h and higher mobile speeds.

Figure 4-1 Test solution of 5G industrial handheld terminals

4.2.2 Test Requirements on Service Capability

As described above, besides the communication capability, service capability of the handheld terminal also needs to be verified. Service functions vary with the categories of

handheld terminals. The following exemplifies the test requirements with trunking terminals and video terminals.

4.2.2.1 Test Requirements of Trunking Terminals

Trunking terminals are mainly used in public security, emergency communication, and noisy environments with poor network coverage, such as mines and ports. Therefore, it is recommended that the voice capability of trunking terminals be tested as follows based on application scenarios and features:

Table 4-1 Items for testing the voice performance of trunking terminals

Test Item	Test Method
Howling distance	<ol style="list-style-type: none"> 1. Configure the trunking services of two handheld terminals in the same group. 2. Enable one terminal to initiate a group call with the other terminal as the listener. 3. Test the maximum distance when howling generates both indoors and outdoors.
Noise reduction	Initiate a group call in 80 dB (standard environment) and 90 dB (noisy environment) noise settings respectively.

Test Item	Test Method
Group call echo	<ol style="list-style-type: none"> 1. Configure two terminals in the same group. 2. Enable the speaker of the listener. 3. Speak at a normal volume on the calling phone.
Sound pickup distance	Speak at a normal volume with the sound pickup distance greater than or equal to 30 cm (The sound pressure level is about 80 dB when the sound pressure meter is 10 cm away from the mouth.)
Loudness	<ol style="list-style-type: none"> 1. Use the standard sound source +6 dB for the uplink. The sound pickup distance is 10 cm. Perform an SLR test. 2. Perform a receive loudness rating (RLR) test with the standard distance of 60 cm in the downlink.

4.2.2.2 Test Requirements of Video Terminals

Video terminals, such as HD video recorders, can be used to maintain public security, provide powerful evidence for law enforcement personnel, and effectively monitor emergencies. According to the application scenarios of these terminals, the following service tests are recommended:

- 04-2 lists the video performance specifications.

Table4-2 Video performance specifications

Level	Video Resolution	Video Frame Rate
1	≥ 3840 x 2160	≥ 25 FPS
2	≥ 1920 x 1080	≥ 25 FPS
3	≥ 1280 x 720	≥ 25 FPS
4	≥ 720 x 480	≥ 25 FPS

- 0 lists the items for testing video quality.

Table4-3Test requirements for video quality

Item	Requirement
FOV	The horizontal FOV must be greater than or equal to 90 degrees under all declared resolutions.
Geometrical distortion	The geometrical distortion must be less than or equal to 20% when the horizontal FOV satisfies all product resolutions.
Video image quality	During display, playback, and object movement, the edge of an image must have no serration, burrs, cracking, or mosaics.
Night vision	The effective shooting distance should be no less than 3 m, and the facial features of a person must be clear at the effective shooting distance.

Item	Requirement
Infrared light compensation	A recorder with the infrared light compensation function must be able to cover more than 70% of the video image at 3 m.
Color reproduction	When the ambient illumination is greater than or equal to 800 lux, the color of the displayed and revisited images should not have obvious color casts.

5 Appendix

5.1 Appendix 1 Adaptability Test in Mechanical Environment

Test Item	Test Parameter	Test Parameter Value
Sinusoidal vibration (work status)	Frequency (Hz)	10–55–10
	Displacement amplitude (mm)	0.35
	Number of axial directions	3
	Frequency-scanning rate (oct/min)	1
	Duration in each axial direction (min)	30
Impact test (work status)	Impulse waveform	Half sine wave
	Pulse duration (ms)	11
	Acceleration amplitude	30g
	Number of impact axial directions	3
	Number of pulses in each axial direction	3
Free fall	Height (mm)	1200

Test Item	Test Parameter	Test Parameter Value
(work status)	Quantity of geometric surfaces	4
	Drop times on each surface	1