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Chapter 1 Introduction

The mobile communication system has experienced the first generation (analog system) and the second generation (digital system). As one of the main development trends of the second generation, the CDMA2000 1X technology, advocated by the 3rd Generation Partnership Project 2 (3GPP2), has been widely used for commercial purpose.

The CDMA2000 1X technology complies with IS-95A and IS-95B standards. The capacity of CDMA2000 1X system has increased substantially since it adopts technologies such as reverse pilot, fast power control and transmit diversity.

This chapter first introduces the network solution of Huawei CDMA2000 1X mobile communication system, and then the market position of Huawei outdoor BTS3612A.

1.1 Huawei CDMA2000 1X System Network Solution

The Huawei CDMA2000 1X mobile communication system comprises the Base Station Subsystem (BSS) and the Core Network (CN). The operation and maintenance of the system are implemented via an integrated mobile network management system.

Figure 1-1 shows the network of CDMA2000 1X system. This manual aims to introduce the BTS product of the BSS part. Therefore, this figure details the network structure of BSS.

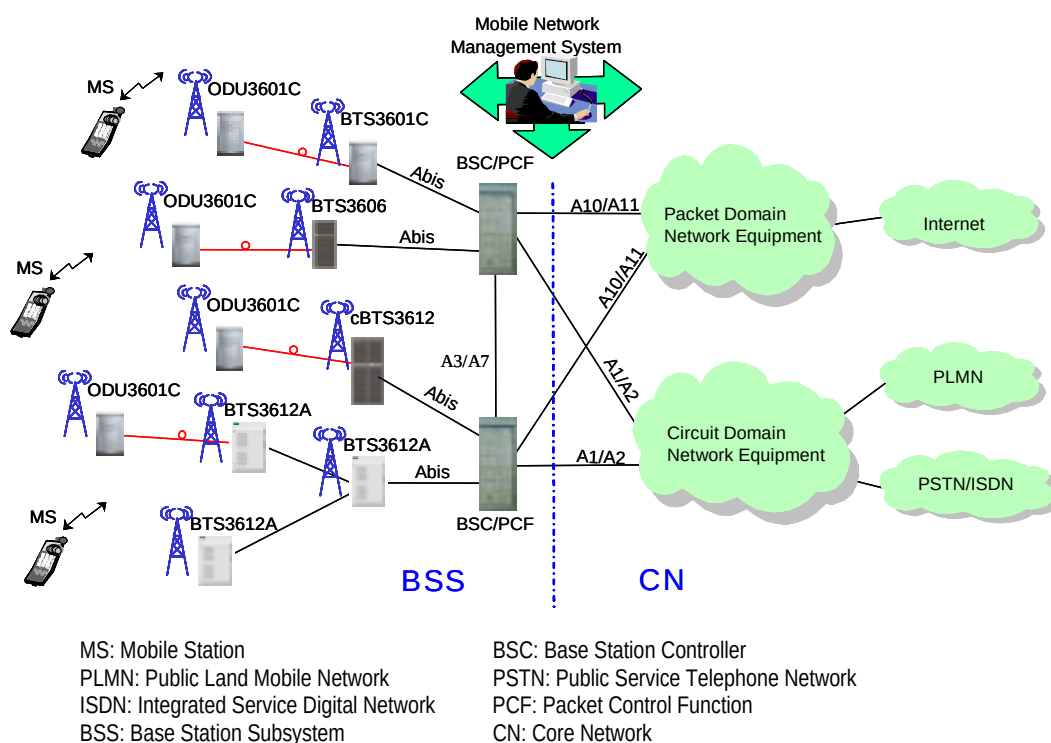


Figure 1-1 Network structure of Huawei CDMA2000 1X system

1.1.1 BSS Brief

The BSS comprises the Base Transceiver Station (BTS), Base Station Controller (BSC), and Packet Control Function (PCF), which is usually integrated with the BSC.

I. BTS

The BTS is mainly responsible for transmitting and receiving radio signals to achieve the communication between the radio network and the Mobile Station (MS).

Huawei provides a series of BTS products, including:

- **BTS3612A:** Outdoor BTS equipment developed based on the cBTS3612. The maximum capacity of a single cabinet is 2 carriers 3 sectors.
- **BTS3606:** Indoor BTS equipment. The maximum capacity of a single cabinet is 2 carriers 3 sectors.
- **cBTS3612:** Indoor BTS equipment. The maximum capacity of a single cabinet is 4 carriers 3 sectors or 2 carriers 6 sectors.
- **BTS3601C:** Outdoor one-carrier BTS equipment.
- **ODU3601C:** Outdoor one-carrier BTS. It shares the baseband processing resource of its upper-level BTS. It implements radio signal transmission and reception together with the upper-level BTS.

II. BSC/PCF

The BSC performs the following functions:

- BTS control and management.
- Call connection and disconnection.
- Mobility management.
- Power control.
- Radio resource management.
- The BSC provides stable and reliable radio connections for the upper-level services through soft or hard handoff.

The PCF is used for the management of Radio-Packet (R-P) connection. As radio resources are limited, they should be released when subscribers are not sending or receiving information, but the Peer-Peer Protocol (PPP) connection must be maintained. PCF isolates the radio mobility from the upper-level services through the handoff function.

III. MS

The MS is the equipment used by the mobile subscriber. It can originate and receive calls, and can communicate with the BTS.

1.1.2 CN Brief

The CN comprises the packet domain network and circuit domain network.

I. Equipments of packet domain network

Equipments of packet domain network include Packet Data Service Node (PDSN), Mobile Internet Protocol Home Agent (MIP HA), Authorization, Authentication and Accounting (AAA) and so on.

These equipments interwork with the Internet.

II. Equipments of circuit domain network

Equipments of circuit domain network include Mobile Switching Center (MSC), Home Location Register (HLR), Gateway Mobile-services Switching Center (GMSC) and so on.

These equipments interwork with the conventional Public Land Mobile Network (PLMN) and Public Switched Telephone Network/Integrated Services Digital Network (PSTN/ISDN).

1.2 Position of BTS3612A in the Network

The BTS3612A is located between the BSC and the MS in the CDMA2000 1X mobile communication system.

Under the control of the BSC, the BTS3612A serves as the radio transceiver equipment of one cell or multiple logical sectors. By connecting to the BSC via the Abis interface, it assists the BSC in managing the radio resource, radio parameter and interface resource. It also implements, via the Um interface, the radio transmission between the BTS and the MS as well as related control functions.

The outdoor BTS3612A can accommodate to various climates and complex electromagnetic environments. It features low cost, fast installation and flexible environment adaptability. As an essential part of Huawei CDMA BTS series, it allows the radio network to achieve seamless coverage more easily.

Chapter 2 Product Feature

The BTS3612A is designed with considerations of customers' requirements for service, capacity, coverage, transmission, power supply, installation and maintenance.

2.1 Technical Feature

The BTS3612A has the following technical features:

The advanced hierarchical structure allows the smooth upgrade to CDMA2000 1X EV.

The operational mode of Channel Element (CE) pool improves the availability of the hardware resources, and the error tolerance capability of the system.

The digital intermediate frequency technology enhances the signal processing capability.

The BTS3612A supports bands of 450MHz, 800MHz and 1900MHz.

The BTS3612A can be cascaded with the ODU3601C to flexibly expand the coverage area of radio network

2.2 Easy Upgrade and Expansion

I. Compatibility design

The BTS3612A is compatible with IS-95A/B and CDMA2000 1X, and can be upgraded to CDMA2000 1X EV smoothly. Huawei BTS3612A saves the operator's investment when the network is upgraded from IS-95 to CDMA2000 1X, or from CDMA2000 1X to CDMA2000 1X EV.

II. Flexible configuration

It supports the configurations of omni cell, 3 sectors and 6 sectors. The full configuration per cabinet is 2 carriers 3 sectors. The capacity of 4 carriers 3 sectors or 2 carriers 6 sectors can be configured as required by combining the cabinets.

III. Smooth expansion

The modular structure allows BTS3612A to be expanded simply by adding the modules. The cabinets can be combined to achieve the capacity of more than 6 carriers.

2.3 Powerful Environment Adaptability

The BTS3612A is protected against wind, sand, rain, sun shine and theft. It features excellent environment adaptability, which minimizes its environmental requirements.

I. Fully-enclosed integrated structure

The BTS3612A complies with the IP55 (IEC 60529: Degrees of protection provided by enclosure) in respect of waterproof and dustproof. It is up to the Class 1 protection standard (3 classes) against moisture air, mould and salt atmosphere.

II. Wide operating temperature range

The BTS3612A is equipped with a temperature control system. Its operating temperature ranges from -40°C through +55°C (Air conditioner type) or from -40°C through +45°C (Heat exchanger type).

In the case of high temperature, BTS3612A dissipates heat through the temperature control unit. In the case of low temperature, the built-in heater is started to ensure the internal components to operate in a reliable temperature range.

III. Robust power distribution function

The BTS3612A supports 220V, 230V and 240V power supplies and single-phase or three-phase input. The voltage ranges between 176 and 264V and frequency between 47 and 63Hz. It provides over-voltage protection upon 290V voltage.

The system is also compatible with 110, 115 and 127 AC power and single-phase or three-phase input. The voltage ranges between 90 and 135V and frequency between 47 and 63Hz. It provides over-voltage protection upon 85V.

The built-in storage battery provides power supply in the case of AC power failure, so as to ensure the normal operation of BTS3612A for a period of time.

The optional outdoor battery rack allows a one carrier 3 sectors system to operate for more than 8 hours when the AC power BTS fails.

With hierarchical power supply function, the BTS3612A can promise the transmission function of lower-level BTS in the absence of mains support.

IV. Sound lightning protection and monitoring function

The BTS3612A is equipped with reliable lightning protection facilities such as built-in lightning protection board and external lightning protection box.

It is also furnished with comprehensive environment monitoring system that allows remote monitoring.

2.4 Convenient Operation and Maintenance

The Local Maintenance Terminal (LMT) and the integrated maintenance console of the M2000 implement the operation and maintenance function to the BTS3612A. The following lists the maintenance functions:

I. System status monitoring

This function provides the indication for the system running status and resource status, the configuration of local cell and logical cell, and their status indication.

II. Data configuration

The BTS3612A adopts dynamic data configuration mode, and the configured data takes effect without resetting BTS. It also provides data backup function, batch processing of data configuration, and the function of configuring common data for multiple network elements.

III. Alarm handling

This function provides a series of alarm handling methods: Alarm collection, alarm clearing, alarm querying, alarm shielding, alarm filtering and so on.

IV. Security management

The security management covers the following functions: user login authentication, command authority restriction, confirmation of crucial operation, user group management, timeout locking, etc.

V. Test

The BTS3612A supports both offline and online tests. The test items include board loopback test, self-test, trunk loopback test, etc.

VI. Site monitoring

Data transmission channels are provided for monitoring devices so as to realize centralized monitoring.

VII. Upgrade

System upgrade can be implemented through remote loading. The upgrade process is retrievable, that is, the system can fall back to the original one when the upgrade fails.

VIII. Equipment operation

BTS3612A supports front operation (operations can be conducted on the facade of the cabinet), and hot swappable baseband boards. This facilitates the maintenance, upgrade and capacity expansion.

IX. Auto restart function

In the case of whole BTS service interruption due to power failure or transmission faults, the BTS3612A system can restart automatically right after the faults are cleared.

X. Simulation of BSC for testing purpose

The BTS3612A can simulate the BSC for testing purpose. Call tests and system debugging can be performed without BSC connected.

XI. Reverse maintenance function

With the reverse maintenance function, users can, from the LMT, log in to the BAM through the network port on the BCKM to perform operation, maintenance and management to the whole BSS.

2.5 Flexible Networking Mode

I. Transmission mode

In the BTS3612A cabinet, the standard clearance is reserved for transmission equipment, such as microwave, High-bit-rate Digital Subscriber Link (HDSL) or Synchronous Digital Hierarchy (SDH) system. It supports various transmission modes.

The BTS3612A supports the networking by using E1 and T1 links, and the interfaces of Inverse Multiplexing on ATM (IMA) and User Network Interface (UNI). The multiplexing rate on the Abis interface is greatly increased.

II. Networking mode

The BTS3612A supports networking modes in chain, star and tree topologies. It can also share the transmission network with other Network Elements (NEs) over the Fractional ATM.

III. Clock source

The BTS3612A supports the Global Position System (GPS) clock, the Global Navigation Satellite System (GLONASS) clock and other external clock sources. Thus, it can adapt to various networking situations.

In case of the loss of external clock source signal, the BTS3612A can still keep clock synchronization for 24 hours.

2.6 Serial Products for Seamless Coverage

Huawei provides a series of BTS products to enable a seamless coverage for urban, suburb, and rural area, high way and hot area. Table 2-1 shows the application of various BTS products.

Table 2-1 Application comparison between serial BTS products

Product	Max. sector carrier per cabinet	Capacity	Application	Type
cBTS3612	12	Large	Highly populated area and city.	Indoor
BTS3606	6	Medium	Medium and small cities, towns. Low requirement for equipment room.	Indoor
BTS3612A	6	Medium	Outdoor, heavy traffic and limited equipment room space	Outdoor
BTS3601C	1	Small	Indoor, underground, highway and railroad.	Outdoor (also applicable to the indoor condition)
ODU3601C	1	Small	Indoor, underground, highway and railroad.	Outdoor (also applicable to the indoor condition)

Chapter 3 Product Architecture

3.1 Cabinet Profile and Configuration

3.1.1 Cabinet Profile

I. Cabinet appearance

The BTS3612A cabinet conforms to the IEC297 standard. The external dimensions are: 1700mm×1200mm×1000mm (Height×Width×Depth). Its appearance is as shown in Figure 3-1.



Figure 3-1 BTS3612A cabinet

II. Cabinet feature

The BTS3612A cabinet features:

Fully-enclosed integrated structure and powerful environment adaptability

Light weight owing to its aluminum alloy materials.

Excellent electrical conductivity and shielding effect.

Good ventilation effect owing to the well-designed air ducts.

Convenient installation and maintenance.

Nice appearance.

3.1.2 Cabinet Configuration

The BTS3612A cabinet is show in Figure 3-2.

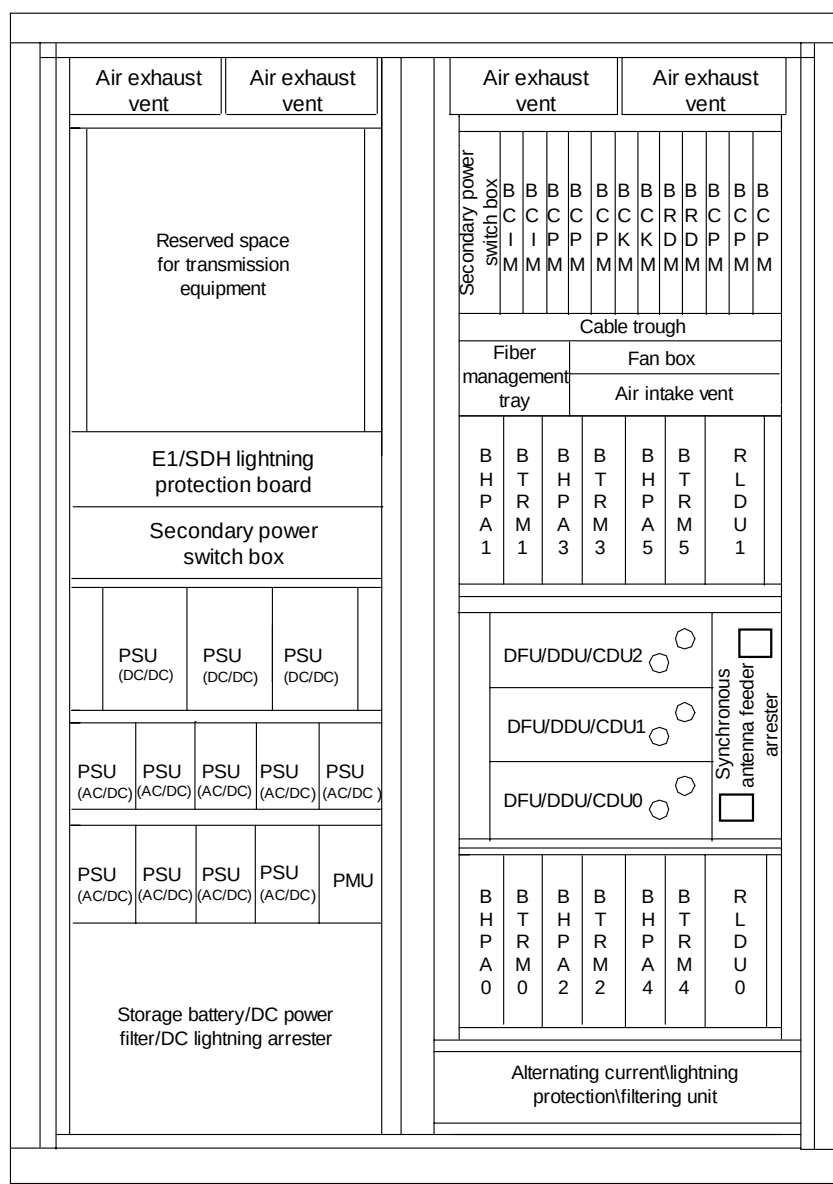


Figure 3-2 Full configuration of the BTS3612A cabinet

The boards and modules of BTS3612A are listed in Table 3-1.

Table 3-1 Boards and modules of the BTS3612A

Acronyms	Full name
BCIM	BTS Control Interface Module
BCKM	BTS Control & Clock Module
BCPM	BTS Channel Processing Module
BESP	BTS E1 Surge Protector

Acronyms	Full name
BRDM	BTS Resource Distribution Module
CDU	Combiner and Duplexer Unit
DDU	BTS Dual Duplexer Unit
DFU	Duplexer and Filter Unit
BHPA	BTS High Power Amplifier
BTRM	BTS Transceiver Module
PSU _{AC/DC}	AC/DC Power Supply Unit
PSU _{DC/DC}	DC/DC Power Supply Unit
PMU	Power Management Unit
RLDU	Receive LNA Distribution Unit

3.2 System Structure

This section highlights the main equipment of BTS3612A, which is composed of baseband subsystem, Radio Frequency (RF) subsystem, antenna & feeder subsystem, and power & environment monitor subsystem, as shown in Figure 3-3.

Standard space is reserved in the cabinet to accommodate transmission equipment such as microwave and SDH, so as to support different networking modes.

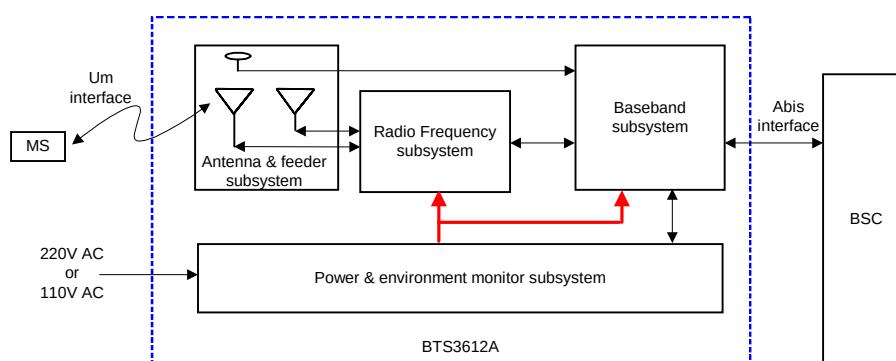


Figure 3-3 BTS3612A system structure

3.2.1 Baseband Subsystem

Composed of the BCKM, BCIM, BRDM, BCPM, etc, the baseband subsystem can

- Provide Abis interface and complete the related processing of Abis protocol.

- Provide a fiber interface to the RF subsystem, and complete the processing of Um physical layer and Common Channel (CCH) MAC layer protocols.
- Implement the modulation/demodulation of baseband data and the coding/decoding of CDMA channels.
- Provide synchronization clock signal to the BTS.

The baseband subsystem also implements system resource management, operation and maintenance, and environment monitoring.

3.2.2 Radio Frequency Subsystem

The RF subsystem is composed of the BTRM, BHPA, CDU/DFU/DDU, RLDU, etc. Its functions can be grouped in forward and reverse directions.

- In forward direction

The subsystem completes the power-adjustable up-conversion and linear power amplification to the modulated transmission signals, filtering of signals, and multi-carrier combination (optional) before sending the signal to the antenna & feeder subsystem.

- In reverse direction

The subsystem filters the signals received by the antenna to suppress the outband interference, and performs low-noise amplification, multi-carrier division, noise factor-adjustable down-conversion, and channel-selective filtering before sending the signals to the baseband subsystem.

3.2.3 Antenna and Feeder Subsystem

The antenna and feeder subsystem of BTS3612A includes two parts: the RF part and the GPS/GLONASS synchronization part.

- RF antenna and feeder

This part is composed of the transmitting and receiving antennae, feeders, tower amplifier (optional), etc. It transmits and receives signals on the air interface.

- GPS/GLONASS synchronization antenna and feeder

This part is composed of the satellite signal receiving antenna, feeder, lightning protector, etc. It receives synchronization signals from the satellites (GPS or GLONASS) to provide precise clock source for the BTS. .

3.2.4 Power and Environment Monitoring Subsystem

The power and environment monitoring subsystem includes the power supply and environment monitor (including the temperature controller).

- Power supply

The power supply contains the AC distribution unit, DC distribution unit, Power Supply Units (PSUs, including PSU_{AC/DC} and PSU_{DC/DC}), PMU, battery group and its management unit.

The PSUs work in N+1 redundancy mode. If any PSU fails, an alarm will be reported. The PSUs support online insertion and removal.

- Environment monitor

The environment monitor includes the PMU and sensors. The PMU collects the environment variables of temperature, humidity, smoke, water and access control from the sensors, and reports them to the BCKM of the BTS. The BTS performs the preset operations and reports the information to the OMC.

- Temperature control device

The temperature controller may be an air conditioner or a heat exchanger, which can ensure the normal operation of the BTS in the following ambient-temperature ranges:

- Air conditioner: -40°C–55°C
- Heat exchanger: -40°C–45°C

3.3 External Physical Interface

The BTS3612A provides the following main external physical interfaces listed in Table 3-2.

Table 3-2 Main external physical interfaces on the BTS3612A

Interface name	Type	Quantity	Function
Abis interface	E1/T1 (One of the two)	8	Connecting to transmission system and the BSC equipment. Supporting IMA/UNI and cascading. Providing 75Ω and 120Ω loading interfaces for E1, 100Ω loading interfaces for T1. Providing the Fractional Asynchronous Transfer Mode (ATM) function. Realizing transmission on timeslots different from those used by other network elements.

Interface name	Type	Quantity	Function
Cabinet combining interface		6	When cabinets are combined, the extension cabinet and the main cabinet share one baseband subrack. Optical fiber is used for the connection between cabinets.
		4	Four RF connection cables are provided to connect the RLDU and BTRM in different cabinets.
ODU3601C cascading interface	Optical fiber	6	When the combined cabinet is fully configured with 12 sectors/carriers, six more external ODU3601Cs can be attached to the combined cabinet.
Clock interface	GPS/GLO NASS	2	Connecting the satellite signal receiver and the satellite antenna to provide long-term and stable clock signal for the BTS.
	External synchronous clock input	1	Providing high-precision clock.
Maintenance interface	Ethernet interface	1	Providing near-end maintenance path.
Clock test interface	Clock source interface	1	Outputting 10MHz signal for testing.
	Sync test interface	1	Outputting 2S signal for testing.
Power supply and grounding	Power supply	4	A, B, and C phase lines and zero line
	Protection grounding (PGND)	3	One PGND is led out to the grounding cable. When cabinets are combined, one PGND is connected to the extension cabinet. One PGND is connected to the auxiliary equipment.
	DC power supply	2	Providing -48 DC power for the recharge of batteries
Feeder interface	RF signal	6	Corresponding to 3 sectors. Each sector corresponds to 2 DIN connectors, which can be used for both transmitting and receiving.

Chapter 4 Main Functions

4.1 Basic Function

The Um interface of the BTS3612A supports the TIA/EIA IS-2000 Rel.A standard, and is compatible with the TIA/EIA-95-A/B standard. The minimum performance satisfies TIA/EIA-97-D requirements.

The Abis interface complies with the 3GPP2 A.R0003 standard.

The BTS3612A supports:

- The 90~290V AC input.
- The GPS/GLONASS synchronization interface and external synchronization interface to achieve long-term clock synchronization.
- Cascading of ODU3601Cs.
- Soft and softer handoffs.
- Slotted mode paging and fast paging modes.
- Channel management function.
- Channel Element (CE) pool operational mode to dynamically allocate resources.
- Resource status management.
- High power and wide coverage (When operate at 450MHz band, the max power output is 25W).
- Multiple power controls.
- The 75Ω unbalanced interface (E1, coaxial cable), 120Ω balanced interface (E1, twisted pair) and the 100Ω unbalanced interface (T1, twisted pair) on the Abis interface.
- Timeslot cross function on the Abis interface.

4.2 Radio Network Function

4.2.1 Power Control

The CDMA system is a self-jamming system, in which every subscriber is an interference source to other subscribers. Power control directly affects the system capacity and the service quality. If it is possible to ensure that every MS transmits the minimum power it needs, the whole system capacity can be the largest.

Power control can be divided into forward power control and reverse power control. The forward power control is used to control BTS's transmit power while the reverse power control aims to control MS's transmit power.

I. Forward power control

Forward power control has various methods, whose applications are subject to the MS protocol version and the system parameters.

- Power control based on PMRM

When the MS adopts power control based on Power Measurement Report Message (PMRM), it will determine the method and frequency of reporting PMRM in accordance with the received control message of the system parameter message.

- Power control based on EIB

When the MS adopts power control based on Erasure Indicator Bit (EIB), it will detect forward frame quality, and feed back the information to the BTS via EIB. The BTS will adjust the transmit power according to EIB information.

- Forward fast power control

The MS will adjust BTS power according to power control bit (the maximum speed can reach 800bit/s). In the CDMA2000 1X system, high speed data service is supported. Therefore, the requirement on forward power control is increasingly strict. The forward fast power control method can control forward channel transmit power accurately, so as to reduce interference and improve the capacity.

II. Reverse power control

Reverse power control includes open-loop power control and close-loop power control. The close-loop power control can be further divided into inner loop power control and outer loop power control.

- Open-loop power control

The MS will determine the transmit power to access the BTS according to the received pilot signal strength.

- Close-loop power control

The BTS issues power control command to the MS, and performs the adjustment according to MS feedback. The principle of close-loop power control is shown in the following figure.

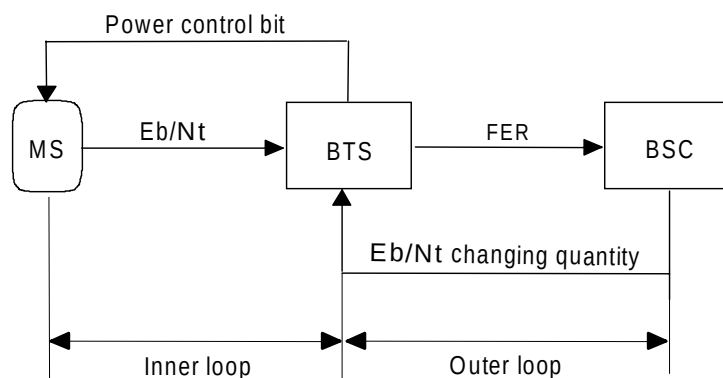


Figure 4-1 Close-loop power control

In inner loop power control mode, the BTS will issue power control bit according to the received E_b/N_t value.

In outer power control mode, the BSC will adjust preset E_b/N_t value according to the Frame Error Rate (FER) of the received reverse signal. Then the BTS will use the newly set E_b/N_t value to issue power control bit. In this way, the transmit power of MS can be controlled.

4.2.2 Handoff

When the MS is moving out of the coverage of current cell/sector or the conversation quality deteriorates to an unbearable degree, the MS will be handed off to another cell/sector to maintain the ongoing conversation.

If the MS handoff helps to improve conversation quality and network performance, handoff procedure may also be triggered.

I. Soft handoff

The soft handoff happens between adjacent cells which serve on the same frequency and belong to different BTSs. The two different BTSs can belong to the same BSC, or two different BSCs connected with A3/A7 interface.

In soft handoff procedure, the MS will maintain the connection with the previous cell until it establishes the communication with the new cell. During handoff procedure, the MS can establish radio links with multiple cells, select and combine data received from these links so as to improve conversation quality and reduce call drops.

II. Softer handoff

The softer handoff happens between adjacent cells that serve on the same frequency and belong to the same BTS. In fact, it is a special case of soft handoff. Since the MS establishes radio links with multiple sectors under the same BTS, the BTS can combine the diversity signals received by its sectors from the MS. Therefore, the conversation quality during softer handoff is better than that of soft handoff.

III. Hard handoff

In hard handoff procedure, the MS will firstly interrupt the connection with the previous cell, and then set up the connection with the new cell. There is a chance of call drop.

Hard handoff includes:

- Intra-frequency hard handoff: Handoff between the BSCs with no A3/A7 interface in-between.
- Inter-frequency hard handoff: Handoff between cells of different frequencies.

4.2.3 Radio Configuration

The Um interface of BTS3612A supports CDMA2000 1X, and is compatible with IS-95A/B. The spreading rate is 1.2288Mcps.

The CDMA2000 1X physical layer supports multiple Radio Configurations (RC). Each radio configuration supports the frames of the different rate sets, and possesses different channel configuration and spreading spectrum structure.

The transmission combinations supported by BTS3612A include:

- Forward RC1, and reverse RC1.
- Forward RC2, and reverse RC2.
- Forward RC3 or RC4, and reverse RC3.
- Forward RC5, and reverse RC4.

Each RC supports different traffic channel data rate. With different RC, the CDMA2000 1X can present different capabilities. RC1 and RC2 are compatible with IS-95A/B.

4.2.4 Channel Configuration

A series of physical channels have been defined on the Um interface. These physical channels are divided into different types according to the channel features. Different RCs support different channels.

I. Forward channel

- Forward Common Channel

Forward Pilot Channel (F-PICH): Provides the MSs in the BTS coverage with synchronization signals. Different from other channels, the F-PICH is a spread spectrum signal which is not modulated and is transmitting continuously.

Forward Sync Channel (F-SYNCH): Provides the MSs in the BTS coverage with initial synchronization information.

Forward Paging Channel (F-PCH): Sends overhead message and MS-specific message to the MSs in the BTS coverage. Each frequency in a sector supports seven paging channels at most.

Forward Quick Paging Channel (F-QPCH): Used to send paging order and the system configuration changing order to MSs working in slotted mode, instructing them to receive the paging messages. Thus the MS battery energy can be saved.

- Forward Dedicated Channel

Forward Dedicated Control Channel (F-DCCH): Bears traffic information and signaling information between the MS and the BTS.

Forward Fundamental Channel (F-FCH): Bears traffic information between the MS and the BTS.

Forward Supplemental Channel (F-SCH): Bears traffic information between the MS and the BTS. It is applicable to RC3, RC4 and RC5 only.

II. Reverse channel

- Reverse common channel

Reverse Access Channel (R-ACH): Used by the MS to initiate the communication with the BTS, and respond to paging channel message. MS uses random access protocol to *initiate* access procedure. Regarding each paging channel supported, maximum 32 access channels can be supported.

- Reverse dedicated channel

Reverse Fundamental Channel (R-FCH): Bears traffic information between the MS and the BTS.

Reverse Common Control Channel (R-DCCH): Bears traffic information and signaling information between the MS and the BTS.

Reverse Supplemental Channel (R-SCH): Bears traffic information between the MS and the BTS. It is applicable to RC3 and RC4 only.

4.2.5 Receiving Diversity

The BTS3612A supports receiving diversity function. The function is realized through two sets of independent equipment, including antenna, feeder, CDU/DDU/DFU and main/diversity receiving channels.

The two sets of receiving equipment demodulate the received signals. Then the baseband processing unit decodes the signals using diversity combining algorithm, which is expected to provide some diversity gain.

The receiving diversity increases the anti-attenuation capability of the BTS and ensures the receiving quality of the BTS under complicated radio environment.

4.2.6 Cell Breathing

The BTS3612A can control the coverage of a cell and balance system load by adjusting the transmit power. This function has great significance for the CDMA system. The transmit power of BTS3612A ranges from "1dB" to "24dB", which can be adjusted at a step of "0.5dB".

Chapter 5 Reliability Design

5.1 System Reliability

I. De-rating design

To delay performance degeneration and prolong the service life of high-power components and heat-generating components, less stress (electrical stress and temperature stress) is to be borne during operation by these components than their designed capabilities.

II. Quality control of components

The category, specifications and manufacturers of the components are carefully selected and examined according to the requirements of the product reliability and maintainability. The replaceability and normalization of components is one of the main factors for the decision. Strict quality control is implemented on hardware assembling procedures to ensure high reliability and stability in long run.

III. Thermal design

The heat design primarily concerns the component selection, circuit design, mechanical design and heat dissipation design so that the impact of temperature changes upon product performance is minimized. The thermal design of BTS3612A ensures that it can work reliably in a wide range of temperatures.

IV. EMC design

The design ensures that the BTS3612A will not degrade to an unacceptable level due to the electromagnetic interference (EMI) from other equipment in the same electromagnetic environment. At the same time, the BTS3612A will not cause other equipment in the same electromagnetic environment to degrade to an unacceptable level due to the EMI from it.

V. Redundancy design

For the purpose of reliability, the system is designed with several sets of units performing the same function. The system will not fail unless the specified sets of units fail.

VI. Reliability design for input voltage

The system is protected against reverse connection of power supply.

The input voltage of the -48V power supply is checked and alarm signal will be generated when the voltage is too low or too high.

The system is protected again sharp voltage drop and lightning strikes.

The system provides protection for program and data in the case of power failure.

VII. Maintainability design

The reasonable internal wiring of the BTS facilitates boards replacement. To replace a faulty board, only the cable of this board is required to be removed. The board can be pulled out from the front side of the cabinet.

Board indicators are provided to help users identify board status.

VIII. Fault monitoring and handling

The BTS3612A is equipped with the functions of self-detection and fault diagnosis. It can record, output and print various fault information. It can also collect environment condition information and generate alarms if there is any problem.

The hardware fault detection procedures include fault locating, isolating the faulty components and automatic switchover to active components. The system will make a final confirmation on a hardware fault through repeated detection, thus avoiding the system reconfiguration or QoS deterioration due to contingent faults.

When faults occur to software, certain automatic error-correction function will be executed, including restarting and reloading. Critical faults will be recorded, output or printed, and notified to users through network management system.

5.2 Hardware Reliability

I. Protection against wrong insertion of boards

When a board is plugged in the slot of another board by mistake, the special pins will prevent the board from touching the backplane. This avoids the possible damage to the equipment due to wrong insertion.

II. Active-standby switchover of BCKM

The active BCKM will back up the file data to the standby one periodically. Once critical faults occur to the active BCKM, it will trigger active-standby switchover to secure normal operation of the BTS.

III. CE pool design of CCPM

The CCPM adopts CE pool design to enhance the system's reliability.

IV. Status monitoring and alarm report

The BCKM has the capability of monitoring the status of other boards or modules, and reporting alarms to ensure timely fault location.

V. Distributed power supply

The system internally adopts distributed power supply. The DC/DC power supply module (PSU_{DC/DC}) works in the N+1 redundancy mode. When an error occurs to a module, it will send the alarm to the BAM. It also supports online insertion and removal of boards.

5.3 Software Reliability

I. Periodic check of key resources

This function aims to check software resource which has been occupied for a long time. If certain resource becomes unavailable due to software error, the check mechanism will release that resource and output logs and alarm.

II. Process monitoring

Process monitoring provides channel for outputting various software and hardware faults while the software is running. It can monitor the status of a specific task or system running, and report the information to the outside.

III. Data check

Data check functions include:

- The consistency check for data of different processing boards, restore of data consistency and output of log files and alarms.
- The consistency check for the data input by the user to ensure correct reference relation among data.
- The rollback function. If the modification of some data fails at certain point, the data will be restored to the initial status so as to ensure data consistency.

IV. Fault isolation

The BTS3612A has the feature of isolating module software faults. When a fault occurs to one module, other modules will not be affected. In addition, the software has the

capability of fault tolerance and correction. The normal faults will not trigger system reset or reboot.

V. Software fallback

The system provides the function of program and data restoration. When the upgrade fails, the function help restore to the original program and data configuration.

VI. Log function

The Operation & Maintenance software will automatically record user's operations in a period of time and save them into a log file. When an unknown error occurs to the system, log files can help to trace back to the normal condition for fault location or data restoration.

Chapter 6 Operation and Maintenance System

The Operation and Maintenance (O&M) system includes the local O&M system and the M2000 Mobile Network Management System.

In this chapter, the local O&M system is described in the aspect of the local end and the remote end respectively. The M2000 system is not explained in details except its basic structure and functions. The details are available in the related manual of M2000.

6.1 Structure of the O&M System

6.1.1 Local O&M System

Figure 6-1 shows the structure of BSS local O&M system.

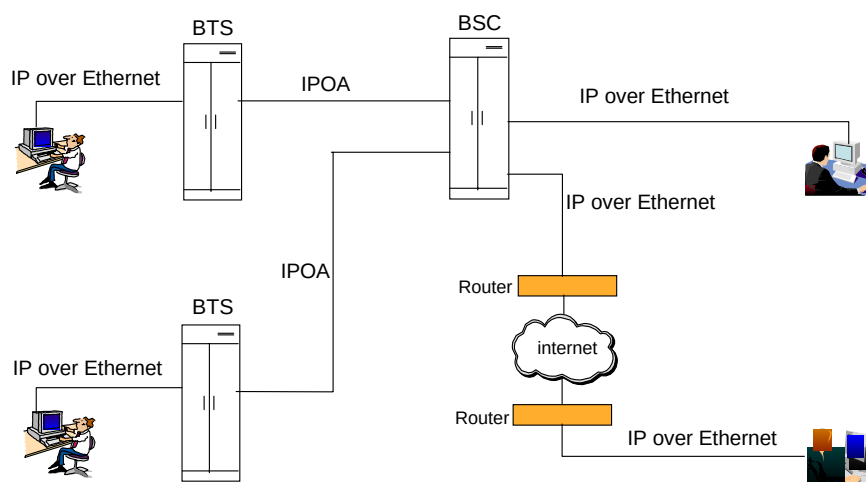


Figure 6-1 BSS local O&M system

I. Remote maintenance

The local OMC of the BSS is designed in the Client/Server (C/S) structure. The user inputs operation commands through the LMT (Client). As the server, the BAM processes commands from different Clients and sends these commands to the foreground (BSC or BTS). The BAM records the operation results (such as success, failure, timeout, or abnormality) and sends the results to the LMT in a specified format.

Through the OMC, the user can perform remote maintenance and can monitor all the BTSs. Meanwhile, information from these BTSs can be collected for network planning and optimization.

II. Local maintenance

Local maintenance is implemented by logging in to the BTS through Telnet Client or FTP mode from the LMT. In local maintenance mode, users can perform various operations and maintenance (including data configuration) on the BTS using the MML commands.

In addition, through the reverse maintenance function, users can maintain the whole BSS from the LMT of the BTS.

6.1.2 M2000 Mobile Network Management System

The M2000 mobile network management system implements the centralized O&M function. In this system, the M2000 server is the core, and various mobile network elements (such as BSC, MSC, HLR, and so on) are connected to the system via Local Area Network (LAN) or Wide Area Network (WAN).

The BSC is connected to the M2000 mobile network management system via the BAM.

Figure 6-2 shows the typical networking of the M2000 mobile integrated network management system.

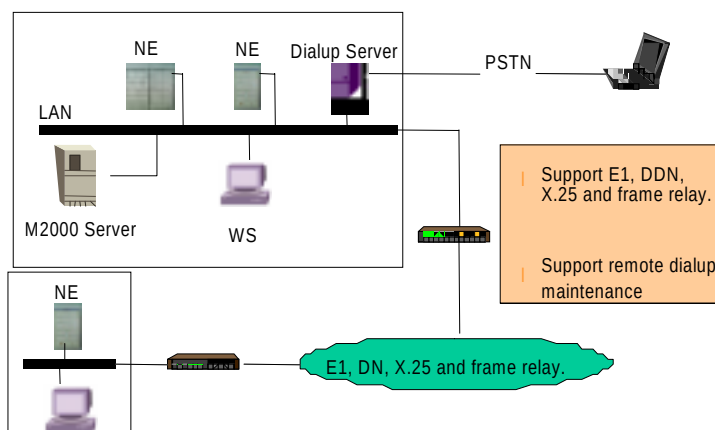


Figure 6-2 Networking of M2000 mobile integrated network management system

The M2000 mobile network management system performs configuration management, performance management and fault management.

- Configuration management function: Collecting, storing, querying and modifying the NE equipment data within the network system.

- Performance management function: The user can register the traffic measurement tasks of the NEs from the network Client, and can view the ask results.
- Fault management function: The user can set combined conditions to get the required alarm data of the network from the Alarm Client, and can view the results and perform related operations.

6.2 Operation and Maintenance Function

To meet user's requirement, the BTS3612A provides powerful operation and maintenance capability, including security management, alarm management, loading management, configuration management, equipment management, test management, tracing management, etc.

I. Security management

The security management based on the user authority mainly includes the user login/logout, user adding/deleting, password changing, and authority changing.

To prevent illegal operation, the system provides powerful security management function to control user's operation and equipment running.

The user will be authenticated before he can log in to and operate the BTS3612A. The system provides multi-level authority mechanism so that only the authorized user can perform the operation of specified command sets. In addition, the timeout locking function is provided. When a user has not operated the system for a specified period, the system will automatically lock the screen.

Before the execution of important commands, the system will prompt the user for confirmation.

II. Alarm management

The system performs centralized management over the alarms of the BSC and the BTS. The BSS Maintenance Console provides real-time alarm management function: alarm collecting, clearing, querying, handling, saving, interpretation, notification, shielding, filtering, acknowledging, analyzing, etc.

In addition, the alarm management system provides online help information and leveled filtering to help locate faults.

While reporting alarms, the BTS3612A will drive related devices (such as status indicators and alarm box) to give audible and visible alarms.

III. Loading management

The loading management implements the loading of software and configuration data. Software loading includes the downloading and activation of the Central Processing Unit (CPU) software and Field Programmable Gate Array (FPGA) logic. Configuration data loading includes downloading and uploading of the data.

IV. Configuration management

The configuration management is to configure BTS equipment and radio resources. Users can also query the configuration data and check data consistency.

Both online and offline configuration functions are provided together with batch processing function for data configuration.

V. Equipment management

The equipment management provides monitoring and querying of the board's and system's status. It also provides user operation log and system running log to facilitate fault location and shooting.

The equipment management function includes: version querying, status querying, electronic label querying, log management, equipment reset, resource blocking/unblocking, power supply management, etc.

VI. Test management

The test management facilitates fault location and the optimization of system performance. It includes board loopback, self-detection, Abis link test, etc.

VII. Tracing management

The tracing management is implemented for the purpose of fault location and performance measurement analysis. The traced objects include various interfaces and BTS resources.

The tracing results of some resources (such as CPU resource and cell resource) can be displayed in graphics in real-time for the purpose of monitoring.

Chapter 7 Technical Indices

7.1 Structure and Environment Indices

Item		Index
Cabinet dimensions (Height×Width×Depth)		1700mm x 1200mm x1000mm
Power supply		220/230/240V AC: Single-phase/three-phase input Voltage range: 176~264V Frequency range: 47~63Hz Over-voltage protection when the voltage reaches 290V.
		110/115/127V AC: Single-phase/three-phase input Voltage range: 90~135V Frequency range: 47~63Hz Under-voltage protection when the voltage reaches 85V.
Weight		650kg (excluding the batteries and the built-in transmission equipment)
Power consumption (in full configuration)	Air conditioner	Power consumption of integrated equipment (with air conditioner in cooling function and without battery cabinet): 6100W Power consumption of integrated equipment (with air conditioner in cooling function and with battery cabinet): 11000W Power consumption of integrated equipment (with air conditioner in heating function, and without battery recharging considered): 6000W
	Heat exchanger	4500W (without battery cabinet) 9500W (with battery cabinet) 6000W (heating, without recharging)
Operational environment temperature	Air conditioner	-40°C ~ 55°C
	Heat exchanger	-40°C ~ 45°C
Relative humidity		5% ~ 100%
Noise		≤ 65dBA (The noise varies with the ambient temperature)

Item	Index
Reliability	A: $\geq 99.999\%$
	MTBF: $\geq 100000\text{h}$
	MTTR: $\leq 1\text{h}$ (excluding the time spent on the journey)
	MTTR: $\leq 3\text{h}$ (including the time spent on the journey)

7.2 Capacity Indices

Full configuration of single cabinet	6 sectors/carriers
Full configuration of combined cabinet	12 sectors/carriers

7.3 Transmitter and Receiver Indices at 450MHz Band

I. Transmitter indices

Item	Index
Working band	460 ~ 467MHz
Channel bandwidth	1.23MHz
Channel precision	25kHz
Frequency tolerance	$\leq \pm 0.05\text{ppm}$
Transmit power	25W (the maximum value measured at the cabinet feeder port)

II. Receiver indices

Item	Index
Working band	450 ~ 457MHz
Channel bandwidth	1.23MHz
Channel precision	25kHz
Sensitivity of signal receiver	Better than -127 (RC3, main and diversity receiving)

7.4 Transmitter and Receiver Indices at 800MHz Band

I. Transmitter indices

Item	Index
Working band	869 ~894MHz
Channel bandwidth	1.23MHz
Channel precision	30kHz
Frequency tolerance	$\leq \pm 0.05\text{ppm}$
Transmit power	20W (the maximum value measured at the cabinet feeder port)

II. Receiver indices

Item	Index
Working band	824 ~ 849MHz
Channel bandwidth	1.23MHz
Channel precision	30kHz
Sensitivity of signal receiver	Better than -127dBm (RC3, main and diversity receiving)

7.5 Transmitter and Receiver Indices at 1900MHz Band

I. Transmitter indices

Working frequency	1930~1990MHz
Channel bandwidth	1.23MHz
Channel precision	50kHz
Frequency tolerance	$\leq \pm 0.05\text{ppm}$
Transmit power	20W (the maximum value measured at the cabinet feeder port)

II. Receiver indices

Working frequency	1850~1910MHz
Channel bandwidth	1.23MHz
Channel precision	50kHz
Sensitivity of signal receiver	Better than -126dBm (RC3, main and diversity receiving)

7.6 ODU3601C Cascading

Item	Index
Max. distance of single cascading	10km or 70km (depending on the optical interface module used)
Max. number cascaded ODU3601Cs	3
Max. distance of all cascading	90km

Appendix A Standard Compliance

A.1 General Technical Specification

TIA/EIA-97-D: Recommended minimum performance standards for base stations supporting dual-mode spread spectrum mobile stations

General Technical Requirements: Federal IMT-MC (CDMA2000) cellular mobile system operating in band 450MHz

A.2 Um Interface

I. Physical layer

TIA/EIA IS-2000-2-A: Physical layer standard for CDMA2000 spread spectrum systems

II. MAC layer

TIA/EIA IS-2000-3-A: Medium Access Control (MAC) standard for CDMA2000 spread spectrum systems

III. Service capability

TSB2000: Capabilities requirements mapping for CDMA2000 standards

A.3 Abis Interface

I. Physical layer

- E1 interface

E1 physical interface specification, september 1996

- SDH STM-1

ANSI T1.101: Synchronization interface standard

ITU-T G.707: (3/96) Network node interface for the synchronous digital hierarchy (SDH)

ITU-T G.703: (10/98) Physical/electrical characteristics of hierarchical digital interfaces

ITU-T G.957: Optical interface for equipment and systems relating to the synchronous digital hierarchy

ITU-T G.958: Digital line systems based on the synchronous digital hierarchy for use on optical fiber cables

- ATM

AF-PHY-0086.001: Inverse Multiplexing for ATM (IMA) specification version 1.1

ATM Forum af-phy-0064.000

ATM Forum af-phy-0130.000

STR-PHY-FN64-01.00: ATM on fractional E1/T1, October 1999

II. ATM layer

ANSI T1.627-1993: Telecommunications broadband ISDN-ATM layer functionality and specification

III. ATM adaptation layer

ITU-T recommendation I.366.2: B-ISDN ATM adaptation layer type 2 specification

ITU-T I.363.5: B-ISDN ATM adaptation layer 5 specification: Type 5 AAL

IV. TCP/IP

RFC791: Internet protocol

RFC793: Transport control protocol

V. Abis interface high layer protocol

3GPP2 A.R0003: Abis interface technical report for CDMA2000 1X spread spectrum system

VI. Self-defined standard

CDMA2000 1X Abis interface high layer protocol

A.4 Lightning Protection

IEC 61312-1(1995) Protection against lightning electromagnetic impulse part I: General principles

IEC 61643-1(1998) Surge protective devices connected to low-voltage power distribution systems

ITU-T K.11 (1993) Principles of protection against over-voltage and over-current.

ITU-T K.27 (1996) Bonding configurations and earthing inside a telecommunication building

ETS 300 253(1995) Equipment engineering; earthing and bonding of telecommunication equipment in telecommunication centers

A.5 Safety

IEC60950 Safety of information technology equipment including electrical business equipment

IEC60215 Safety requirement for radio transmitting equipment

CAN/CSA-C22.2 No 1-M94 Audio, video and similar electronic equipment

CAN/CSA-C22.2 No 950-95 Safety of information technology equipment including electrical business equipment.

UL 1419 Standard for professional video and audio equipment

73/23/EEC Low voltage directive

UL 1950 Safety of information technology equipment including electrical business equipment

IEC60529 Classification of degrees of protection provided by enclosure (IP Code).

GOST 30631-99. General Requirements to machines, instruments and other industrial articles on stability to external mechanical impacts while operating;

GOST R 50829-95. Safety of radio stations, radio electronic equipment using transceivers and their components. The general requirements and test methods;

GOST 12.2.007.0-75. Electrotechnical devices. The general safety requirements.

A.6 EMC

TS 25.105; 3rd Generation Partnership Project; TSG RAN WG4; UTRA (BS) TDD; Radio transmission and reception
89/336/EEC EMC directive Council directive of 3 May 1989 on approximation of laws of the Member States relating to electromagnetic compatibility;

CISPR 22 (1997): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment";

IEC 61000-6-1: 1997; "Electromagnetic compatibility (EMC) * Part 6: Generic standards * Section 1: Immunity for residential, commercial and light-industrial environments";

IEC 61000-6-3: 1996; "Electromagnetic compatibility (EMC) * Part 6: Generic standards * Section 3: mission standard for residential, commercial and light industrial environments";

IEC 61000-3-2 (1995): "Electromagnetic compatibility (EMC) - Part 3: Limits * Section 2: Limits for harmonic current emissions (equipment input current = 16 A) ";

IEC 61000-3-3 (1995): "Electromagnetic compatibility (EMC) - Part 3: Limits * Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current = 16 A"

IEC 61000-4-2 (1995): " Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques * Section 2: Electrostatic discharge immunity test";

IEC 61000-4-3 (1995): " Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques * Section 3: Radiated, radio-frequency electromagnetic field immunity test";

IEC 61000-4-4 (1995): " Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques * Section 4: Electrical fast transient/burst immunity test";

IEC 61000-4-5 (1995): " Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques * Section 5: Surge immunity test";

IEC 61000-4-6 (1996): " Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques * Section 6: Immunity to contacted disturbances, induced by radio frequency fields";

IEC 61000-4-11 (1994): " Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques * Section 11: Voltage dips, short interruptions and voltage variations. Immunity tests";

ITU-T Recommendation K.20, Resistibility of Telecommunication Switching Equipment to Overvoltages and Overcurrents;

CFR 47, FCC Part 15-Radio Frequency Device;

TS 25.113v3.1.0, 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; Base station EMC;

ITU-R Rec. SM.329-7: "Spurious emissions";

GOST R 51318.22-99: Electromagnetic compatibility of technical equipment. Man-made noise from informational equipment. Limits and test methods;

GOST 30429-96. "Electromagnetic compatibility of technical equipment. Man-made noise from equipment and apparatus used together with service receiver systems of civil application. Limits and Test methods.

A.7 Environment

IEC 60529 "Degrees of protection provided by enclosure (IP code)"

IEC 60721-3-1 "Classification of environmental conditions- Part3: Classification of groups of environmental parameters and their severities-Section 1: Storage";

IEC 60721-3-2 "Classification of environmental conditions- Part3: Classification of groups of environmental parameters and their severities-Section 2: Transportation";

IEC 60721-3-3 (1994) "Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 3: Stationary use at weather protected locations";

IEC 60721-3-4 (1995): "Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 4: Stationary use at non-weather protected locations";

ETS 300 019-2-1 "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part2-1, Specification of environmental tests Storage";

ETS 300 019-2-2 "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part2-2, Specification of environmental tests Transportation";

ETS 300 019-2-3 "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part2-3, Specification of environmental tests Transportation Stationary use at weather-protected locations";

ETS 300 019-2-3 "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part2-3, Specification of environmental tests Transportation Stationary use at non-weather-protected locations";

IEC 60068-2-1 (1990): "Environmental testing - Part 2: Tests. Tests A: Cold";

IEC 60068-2-2 (1974): "Environmental testing - Part 2: Tests. Tests B: Dry heat";

IEC 60068-2-6 (1995): "Environmental testing - Part 2: Tests - Test Fc: Vibration (sinusoidal)".

GOST 15150-69: Machines, instruments and other industrial articles. Applications for different climatic regions. Categories, operating, storage and transportation conditions in compliance with the environmental factors";

GOST 23088-80. "Electronic equipment. Requirements to packing and transportation and test methods".

Appendix B Abbreviations and Acronyms

A

ATM Asynchronous Transfer Mode

B

BCIM BTS Control Interface Module

BCKM BTS Control & Clock Module

BCPM BTS Channel Process Module

BESP BTS E1 Surge Protector

BHPA BTS High power Amplifier

BRDM BTS Resource Distribution Module

BSC Base Station Controller

BSS Base Station Subsystem

BTRM BTS Intermediate Frequency Module

C

CDU Combiner and Duplexer Unit

CN Core Network

CPU Central Processing Unit

D

DC Direct Current

DDU BTS Dual Duplexer Unit

DFU Duplexer and Filter Unit

E

EIA Electronics Industry Association

EIB Erasure Indicator Bit

F

F-DCCH Forward Dedicated Control Channel

F-FCH Forward Fundamental Channel

F-PCH Forward Paging Channel

FPGA Field Programmable Gate Array

F-PICH Forward Pilot Channel

F-QPCH Forward Quick Paging Channel

F-SCH Forward Supplemental Channel

F-SYNCH Forward Sync Channel

FTP	File Transfer Protocol
G	
GLONASS	Global Navigation Satellite System
GPS	Global Position System
GSM	Global System for Mobile Communication
H	
HDSL	High-speed Digital Subscriber Line
HLR	Home Location Register
I	
IMA	Inverse Multiplexing for ATM
ISDN	Integrated Services Digital Network
L	
LMT	Local Maintenance Terminal
M	
MAC	Medium Access Control
MML	Man-Machine Language
MS	Mobile Station
MSC	Mobile Switching Center
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
P	
PCF	Packet Control Function
PLMN	Public Land Mobile Network
PMRM	Power Measurement Report Message
PMU	Power Management Unit
PPP	Peer-to-Peer Protocol
PSTN	Public Switched Telephone Network
PSU (AC/DC)	AC/DC Power Supply Unit
PSU (DC/DC)	DC/DC Power Supply Unit
R	
R-ACH	Reverse Access Channel
RC	Radio Configuration
R-DCCH	Reverse Dedicated Control Channel
R-FCH	Reverse Fundamental Channel
RLDU	Receive LNA Distribution Unit
R-P	Radio-Packet

R-SCH	Reverse Supplemental Channel
S	
SDH	Synchronous Digital Hierarchy
T	
TIA	Telecommunications Industry Association
U	
UNI	User Network Interface