ZXG10-BTS

Base Transceiver Station

Technical Manual

Version 2.9

ZTE CORPORATION
ZTE Plaza, Keji Road South,
Hi-Tech Industrial Park,
Nanshan District, Shenzhen,
P. R. China
518057
Tel: (86) 755 26771900 800-9830-9830
Fax: (86) 755 26772236
URL: http: //support.zte.com.cn
E-mail: doc@zte.com.cn

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About this Technical Manual

The ZXG10 is a proprietary GSM mobile communication system of ZTE Corporation. It consists of the ZXG10-MSS Mobile Switching Subsystem and the ZXG10-BSS Base Station Subsystem. The ZXG10-BSS Base Station Subsystem provides and manages radio transmission in GSM, and it is composed of the ZXG10-BSC Base Station Controller and the ZXG10-BTS Base Transceiver Station.

The ZXG10-BTS (V2.9) is ZTE's second generation product upgraded from the ZXG10-BTS (V2.3). As an indoor BTS, it features large capacity, compactness, high reliability, high cost performance ratio, comprehensive functions, and powerful service support capability.

Purpose of this Technical Manual

The *ZXG10-BTS (V2.9) Base Transceiver Station Technical Manual* introduces the working principles, functions and technical features of the ZXG10-BTS (V2.9), and gives users a comprehensive idea about the technical features of the ZXG10-BTS (V2.9).

The complete set of manuals is listed as follows:

ZXG10-BTS (V2.9) Base Transceiver Station Guide to Documentation

ZXG10-BTS (V2.9) Base Transceiver Station Technical Manual

ZXG10-BTS (V2.9) Base Transceiver Station Hardware Manual

ZXG10-BTS (V2.9) Base Transceiver Station Installation Manual

ZXG10-BTS (V2.9) Base Transceiver Station System Test Manual

ZXG10-BTS (V2.9) Base Transceiver Station Maintenance Manual Routine Maintenance

ZXG10-BTS (V2.9) Base Transceiver Station Maintenance Manual Emergency Maintenance

ZXG10-BTS (V2.9) Base Transceiver Station Maintenance Manual Troubleshooting

This manual comprises the following five chapters:

Chapter 1, System Architecture, describes the background, the standards followed, major functions and the general structure of both the software and hardware of the ZXG10-BTS (V2.9). Thus users may have a general idea about the system.

Chapter 2, Technical Indices, describes the performance indices of the ZXG10-BTS (V2.9).

Chapter 3, Interfaces and Communications, describes the external interfaces and major interface protocols of the ZXG10-BTS (V2.9).

Chapter 4, System Functions, describes the system functions of the ZXG10-BTS (V2.9).

Chapter 5, Networking and System Configuration, details various networking modes, connections and configurations of the ZXG10-BTS (V2.9).

Appendix A, Normative References, introduces the normative references used in this manual.

Appendix B, Abbreviations, lists all the abbreviations used in the manual for users' reference.

Appendix C, Method for CDU TX Input Crossing Combiner, describes how to deal with CDU TX input crossing a combiner.

Appendix D, FCC STATEMENT.

Appendix E, CE STATEMENT.

Typographical Conventions

ZTE documents employ with the following typographical conventions.

TABLE 1 TYPOGRAPHICAL CONVENTIONS

Typeface	Meaning
Italics	References to other guides and documents.
"Quotes"	Links on screens.
Bold	Menus, menu options, function names, input fields, radio button names, check boxes, drop-down lists, dialog box names, window names.
CAPS	Keys on the keyboard and buttons on screens and company name.
`Constant width`	Text that you type, program code, files and directory names, and function names.
[ ]	Optional parameters
{ }	Mandatory parameters
|	Select one of the parameters that are delimited by it
	Note: Provides additional information about a certain topic.
	Checkpoint: Indicates that a particular step needs to be checked before proceeding further.
	Tip: Indicates a suggestion or hint to make things easier or more productive for the reader.
	Indicates some supplementary comments to the content.

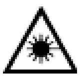
Mouse Operation Conventions

TABLE 2 MOUSE OPERATION CONVENTIONS

Typeface	Meaning
Click	Refers to clicking the primary mouse button (usually the left mouse button) once.
Double-click	Refers to quickly clicking the primary mouse button (usually the left mouse button) twice.
Right-click	Refers to clicking the secondary mouse button (usually the right mouse button) once.
Drag	Refers to pressing and holding a mouse button and moving the mouse.

Safety Signs

TABLE 3 SAFETY SIGNS

Safety Signs	Meaning
	Danger: Indicates an imminently hazardous situation, which if not avoided, will result in death or serious injury. This signal word should be limited to only extreme situations.
	Warning: Indicates a potentially hazardous situation, which if not avoided, could result in death or serious injury.
	Caution: Indicates a potentially hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used to alert against unsafe practices.
	Erosion: Beware of erosion.
	Electric shock: There is a risk of electric shock.
	Electrostatic: The device may be sensitive to static electricity.
	Microwave: Beware of strong electromagnetic field.
	Laser: Beware of strong laser beam.
	No flammables: No flammables can be stored.
	No touching: Do not touch.
	No smoking: Smoking is forbidden.

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Chapter 1

System Architecture

This chapter describes the background, the standards followed, major functions, system features, working principles and the general structure of both the software and hardware of the ZXG10-BTS (V2.9).

System Description

System Background

The ZXG10-BTS (V2.9), an indoor type macro cell BTS, is ZTE's second generation BTS product.

Apart from the advantages from the ZXG10-BTS (V1A), the ZXG10-BTS (V2.9) features large capability (single cabinet holding twelve 40WTRXs), compactness (the size similar to overseas 6-carrier unit), high reliability, high cost performance ratio, comprehensive functions, and powerful service support capability (supporting GPRS/EDGE data service function and ARM adaptive multi rate voice service).

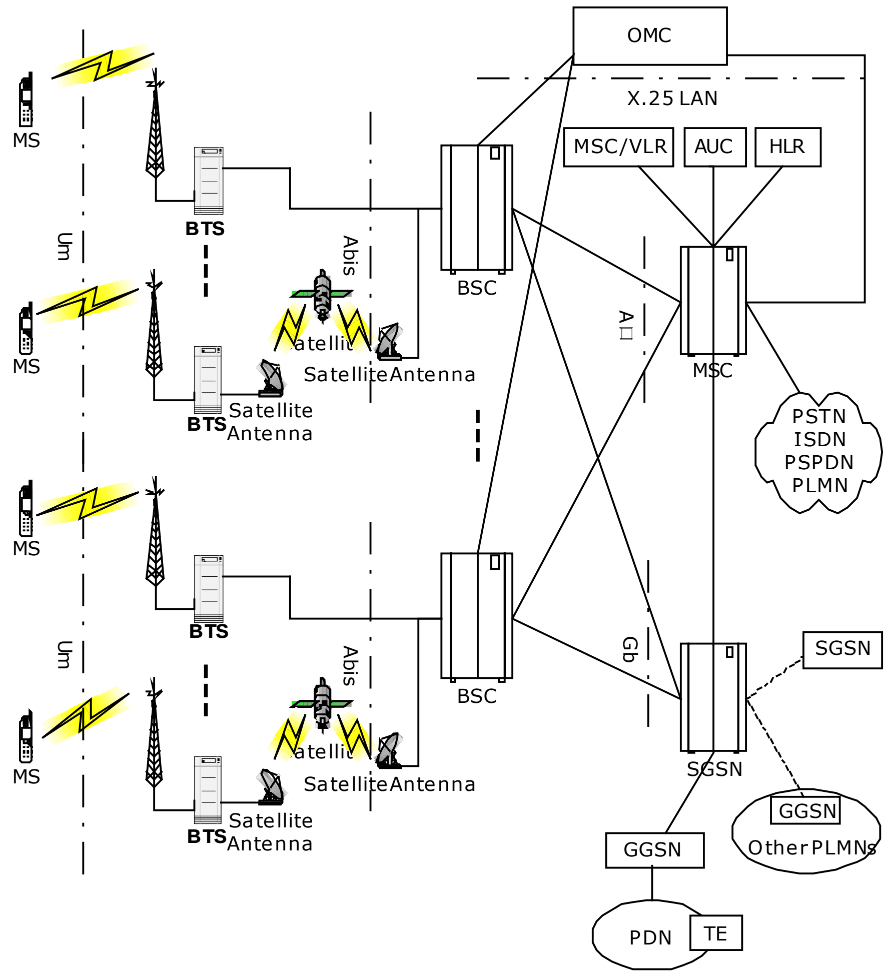
Note: AMR, which is the voice coding scheme of 3GPP, has eight rate modes including 4.75, 5.15, 5.90, 6.70, 7.40, 7.95, 10.20 and 12.20. They can adaptively change coding rates from terminals and networks respectively according to different channel quality reports, which reduce influences caused by fading error of channels, data congestion and delay, improve voice quallities to the maximum extent. In order to implement smooth transition from GSM to 3G, the GSM network need provide AMR-support to realize switching the roaming of mobile phones between 2G and 3G network.

The ZXG10-BTS (V2.9) is not only applied to the large and medium-sized cities with heavy traffic and the districts with heavy traffic in medium and small-sized cities, like busy business districts and airports, but also to the districts with little traffic in medium and small cities and rural areas. In addition, proper network planning can make it applicable to different zones like mountains, hills and expressways.

Development of the ZXG10 BTS(V2.9) enriches ZTE's series of BTS products and enables the system with more flexible networking modes, thus producing stronger market competitiveness.

Figure 1 shows the ZXG10-BTS (V2.9) in a GSM network.

FIGURE 1 BTS IN GSM NETWORK



In a GSM network, the ZXG10-BTS (V2.9) is the radio transceiver for the GSM BSS. It is controlled by BSC and serves in a certain cell.

BTS is connected to BSC through the Abis interface. It helps BSC implement radio resources management, radio transmission with MS and relevant control functions through the Um interface. In addition, it implements the layer-1 and layer-2 protocols on the radio link and related control functions.

Standards Followed

The ZXG10-BTS (V2.9) is compatible with integrated GSM900/1800/1900. It adopts the GSM Phase II standard, capable of smooth upgrading to Phase II+.

Its radio frequency (RF) interface complies with ETSI TS 101 087 Version 5.0.0 GSM05.05 and GSM11.21.

Its Abis interface complies with the ITU-T G.703/ITU-T G.704 interface standards.

Its high/low temperature indices comply with the specifications in GSM11.21.

In terms of radio services, it complies with the following protocols and specifications.

GSM03.60 General Packet Radio Service (GPRS) Service description

GSM03.64 General Packet Radio Service (GPRS) Overall description of the GPRS radio interface

GSM04.04 Technical Specification Group GSM/EDGE Radio Access Network Layer 1 General requirements

GSM04.06 Mobile Station - Base Station System (MS - BSS) interface Data Link (DL) layer specification

GSM04.08 Mobile radio interface layer 3 specification

GSM04.60 General Packet Radio Service (GPRS) Mobile Station (MS) - Base Station System (BSS) interface Radio Link Control/ Medium Access Control (RLC/MAC) protocol

GSM05.02 Multiplexing and multiple access on the radio path

GSM05.08 Radio subsystem link control

GSM08.58 Base Station Controller - Base Transceiver Station (BSC - BTS) interface Layer 3 specification

The EMC complies with the ETSI 301489-8 and the R&TTE Directive 1999/5/EC.

Main Functions

The ZXG10-BTS (V2.9) has the following functions:

- It supports GSM Phase I/ GSM Phase II/GSM Phase II + standards.
- It supports multiple service functions:

  FS: Full rate voice service

  EFS: Enhanced full rate voice service

  HS: Half rate voice service

  AFS: Adaptive full rate voice service

  AHS: Adaptive half rate voice service

  F9.6: 9.6kbit/s full rate data service

  F4.8: 4.8kbit/s full rate data service

  F2.4: ≤2.4kbit/s full rate data service

GPRS/EDGE: GPRS/EDGE packet data service

- It supports the GSM900, EGSM900, GSM850, GSM1800 and GSM1900 systems. Modules of different bands can be inserted in the same cabinet. It also supports EDGE carrier module ETRM and common carrier module TRM to be inserted in the same cabinet.
- It supports CS1 ~ CS4 encoding modes of GPRS and MCS1 ~ MCS9 channel encoding modes of EGPRS, and it can adjust the channel encoding mode dynamically according to the monitoring and measurement results.
- It supports space diversity, frequency diversity, time diversity, polarization diversity, and maximum ratio combination diversity technologies.
- The receiving end adopts the Viterbi soft decision algorithm, improving the channel decoding performance and increasing the system receiving sensitivity and anti-interference capability.
- It supports frequency hopping, improving the system capability against Rayleigh fading.
- It supports DTX, decreasing transmitter power, lowering total interference level of air signals.
- It supports calculation of timing advance TA.
- It supports cells covered with a maximum 120 kilometers in radius.
- It calculates the time advance amount.
- It supports two types of power output, 40W and 80W, in the bands GSM900 and EGSM900. It supports 40 W output in the GSM1800, GSM1900 and GSM850 bands.
- A single cabinet (40 W) supports 12 TRXs, and can be expanded to 36 TRXs at the same site. One site supports S12/12/12 expansion.
- A single (80 W) supports 6 TRXs, and can be expanded to 18 TRXs at the same site. One site supports S6/6/6 expansion.
- Star, chain and tree networking modes of the Abis interface are supported.
- The Abis interface implements E1 transmission through satellite link. Unidirectional transmission delay of the Abis interface is 260 ms.
- The Abis interface supports 1: 4 TEI multiplexing of LapD signaling. That is, it can multiplex four pieces of LapD signaling to one 64 Kbit/s signaling timeslot through TEI
- When multiple BTSs are cascaded, the automatic crossover protection function is provided for the Abis interface link when any BTS is powered off.
- It supports preprocessing of the measurement reports of the BTS.
- It supports base station power control: static, level-6; dynamical, level-15.
- It supports all paging modes specified in GSM.
- It supports synchronous handover, asynchronous handover, pseudo-synchronous handover, and pre-synchronous handover.

- The Um interface supports A51/A52 encryption algorithm.
- It has an overall timely alarm system.

  It supports fan alarms and internal cabinet temperature alarms.

  It supports inputs for 10 pairs of external environment trunk nodes, and outputs for 2 pairs of trunk nodes.

  It provides a transparent channel for the operation and maintenance of the external intelligent equipment.

  It supports unattended BS and automatic alarm function.

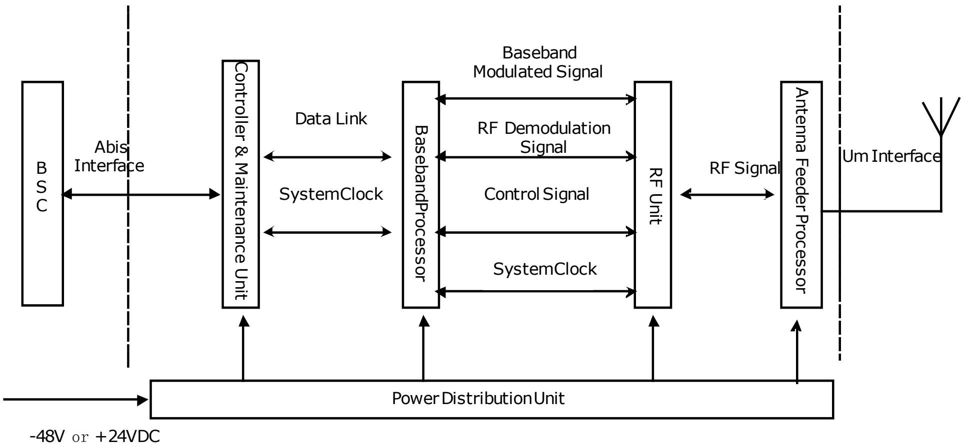
  It provides power supply and alarm for the built-in tower amplifier system.
- It supports Common BCCH.

  Carriers of different frequency bands can be used in a cell. They share the same BCCH and are responsible for different services.

Working Principles of System

The working principle diagram of ZXG10-BTS (V2.9) is shown in Figure 2.

FIGURE 2 WORKING PRINCIPLE DIAGRAM OF ZXG10-BTS (V2.9)



The ZXG10-BTS (V2.9) system includes the controller & maintenance unit, base band processor (BBP), RF unit, antenna feeder processor and power distribution unit.

In the downlink direction, the BTS receives the data from BSC, including voice and signaling data. Here, the signaling data are sent to the control, operation & maintenance unit for processing. The voice data are first sent to the base band processor for processing such as rate conversion, encryption and interleaving, sent to the RF unit to be modulated to high-frequency signals, and then finally transmitted via the antenna feeder processor.

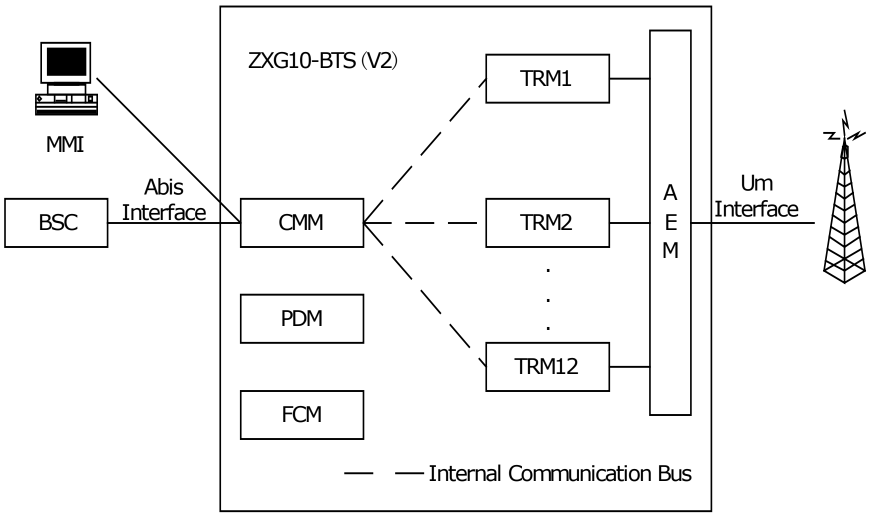
In the uplink direction, the antenna feeder processor receives RF signals from MS, and sends them to the RF unit to convert them into digital signals. Then, the signals are sent to the base band processor for rate conversion, decryption and de-interleaving. Finally, after being converted to the code pattern suitable for long-distance transmission, the signals are sent to BSC through the Abis interface.

Hardware Architecture

The ZXG10-BTS (V2.9) consists of the controller & maintenance module (CMM), transceiver module (TRM), antenna feeder equipment module (AEM), fan control modules (FCM)and power distribution module (PDM).

The hardware architecture of the ZXG10-BTS (V2.9) is shown in Figure 3.

FIGURE 3 HARDWARE ARCHITECTURE OF ZXG10-BTS (V2.9)



The main functions of each module are as follows:

1. CMM

   CMM implements Abis interface processing, BTS operation & maintenance, clock synchronization and generation, internal/external alarm collection and processing and other functions.

2. TRM

   TRM controls and processes the radio channels; transmits and receives the radio channel data; modulates and demodulates the baseband signals on the radio carrier; and transmits and receives radio carriers in the GSM system.

   The TRM is divided into three units by function:

   i. Transceiver Processing Unit (TPU)

The TPU implements all functions of baseband data processing of all full-duplex channels on a TDMA frame, and the conversion between LapDm protocol and LapD protocol. It supports GPRS packet data service functions, CS1, CS2, CS3, CS4 coding modes, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7, MCS8 and MCS9 coding modes, and 8PSK modulation modes.

ii. Radio Carrier Unit (RCU)

RCU modulates baseband signals to carrier signals and up-converts frequency. At the same time, it down-converts the frequency of received carrier signals. In addition, it can control the power statically and dynamically in the downlink direction as required in GSM specifications.

iii. Power Amplifier Unit (PAU)

PAU amplifies the power of the radio carrier to provide the BS equipment with sufficient transmission power.

3. AEM

AEM implements the combination/distribution of air signals. It is composed of three types of combiner/distribution units.

i. Combiner Distribution Unit (CDU)

CDU supports one 2-in-1 combiner unit and one 1-to-4 distribution unit. It has two low noise amplifiers with extended receiving output and one built-in duplexer.

ii. Receiver Distribution Unit (RDU)

RDU supports one 1-to-4 distribution unit and has two low-noise amplifiers with extended receiving output and one receiving filter.

iii. Combiner Extension Unit (CEU)

CEU supports two 1-to-2 power distribution units and two 2-in-1 combiner units.

Through the combination of CDU, RDU and CEU, AEM provides various site configurations for ZXG10-BTS (V2.9).

4. FCM

In the thermal design of the ZXG10-BTS (V2.9), one fan layer with two fans is installed on each carrier shelf to ensure the system to work normally since the carrier shelf is the major heat source.

FCM collects and monitors the temperature in the carrier shelf and use the fans to dissipate the heat out of the cabinet.

5. PDM

PDM distributes the DC power supply (-48 V) to the modules, and provides overload open-circuit protection and filtering of the basic power input.

Figure 4 shows the positions of modules in a fully configured 40 W single cabinet.

FIGURE 4 SINGLE CABINET (40 W) IN FULL CONFIGURATION

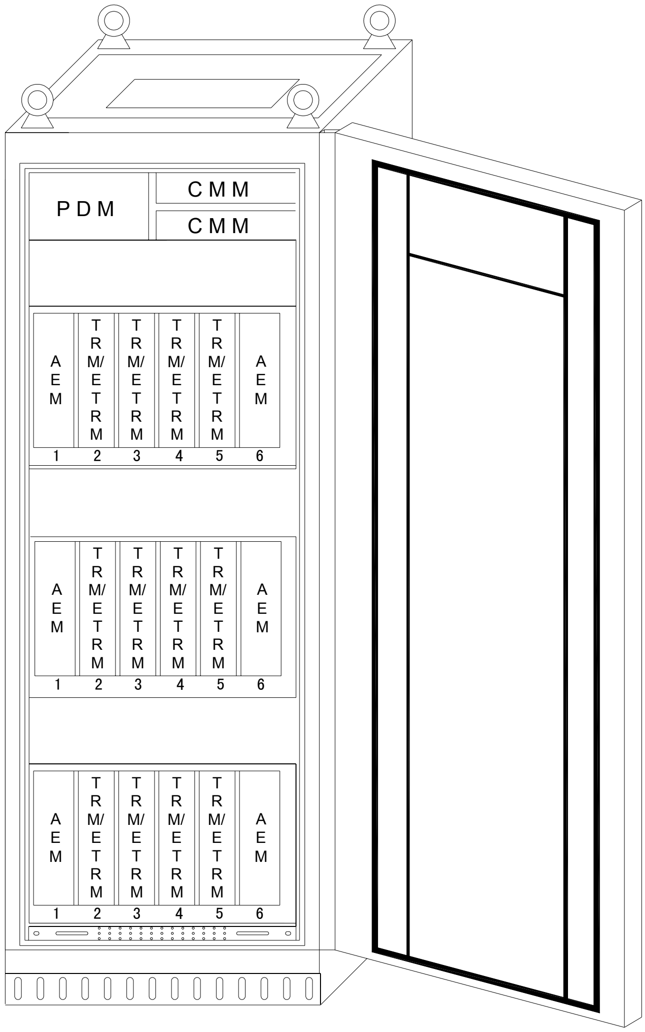
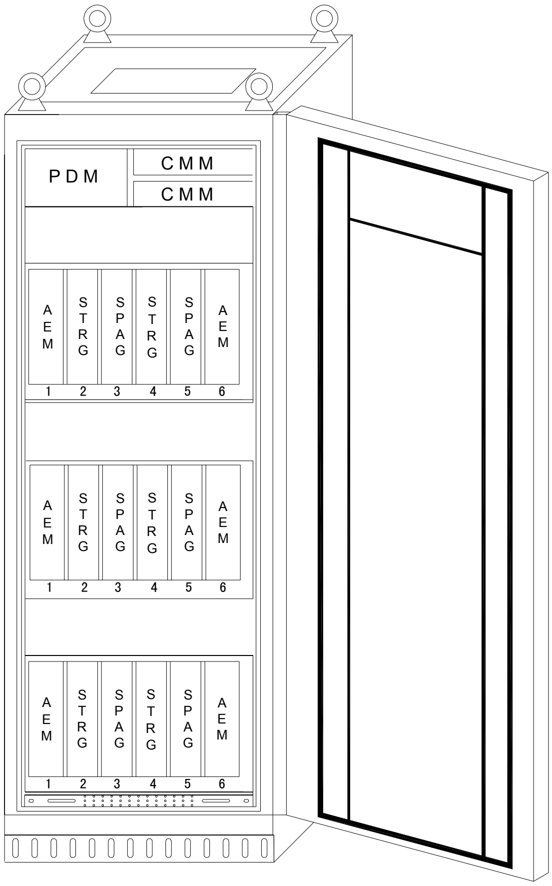


Figure 5 shows a fully configured 80 W single cabinet with TRM modules consisting of two types of modules: STRU and SPA.

FIGURE 5 SINGLE CABINET (80 W) IN FULL CONFIGURATION



Software Architecture

In software design, the ZXG10-BTS (V2.9) adopts modular and hierarchical concepts to facilitate future development and maintenance.

The software is distributed on boards.

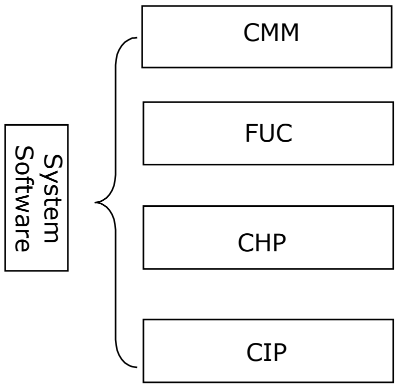
There is little correlation between various software. The board software is independent in function and associates with each other through the internal interfaces.

The core software can be downloaded from the background, facilitating service upgrade and version maintenance. It also provides external interfaces, through which the software can be maintained, BTS information can be collected, and BTS local tests can be performed.

The internal software of ZXG10-BTS (V2.9) is divided into four parts: CMM (Controller & Maintenance Module), FUC (Frame Unit Controller), CHP (Channel Codec Module) and CIP (Carrier Interface Processor).

Different software platforms are adopted for the software according to their functions, as shown in Figure 6.

FIGURE 6 SOFTWARE COMPOSITION AND MODULE DIVISION OF ZXG10-BTS (V2.9)



Controller & Maintenance Module (CMM)

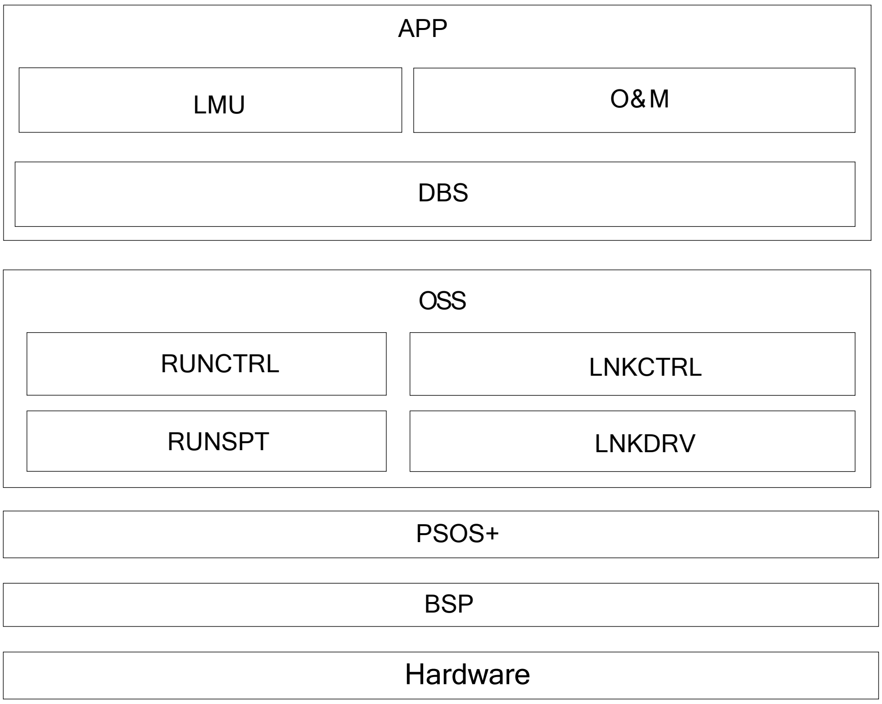
CMM is the control & maintenance module of the ZXG10-BTS (V2.9).

Its main functions are as follows:

- BTS status management.
- BTS configuration management
- BTS equipment management
- BTS monitoring management
- BTS test management
- BTS database management
- Supporting local operation and management (O&M) function, including local parameter configurations and alarm query

The CMM software is designed in layers, as shown in Figure 7.

FIGURE 7 MODULE STRUCTURE OF CMM SOFTWARE



The whole CMM software is divided into five layers,

1. Hardware

   The physical platform on which the CMM software is running.

2. BSP (board-level support package)

   BSP initializes CMM boards and provides drivers for the relevant parts of the equipment. It provides consistent operation interfaces for the specific details of the upper-level encapsulated hardware equipment and simplifies the OSS design.

3. pSOS + operating system

   It is a real-time multi-task operating system for commercial purposes and with superior performance. The operating system has been successfully applied to the next-generation BTS.

4. Operation support system (OSS) layer

   in particular:

   i. RUNSPT

      It is the core layer of the OSS.

      It is a dispatch system of the state machine, providing process dispatch, process communication, memory management, timer management, process monitoring and exceptional capture.

   ii. RUNCTRL

      It is the operation control layer of the system.

It includes the system control module and implements the power-on sequence for application processes. In addition, this layer includes some miscellaneous functions of the operating system such as redirection of the printing messages.

iii. LNKDRV

It is the device driver.

Working with BSP, LNKDRV provides equipment-independent drivers for LNKCTR. At the same time, this part also includes a frame number synchronization module, implementing the frame number synchronization between active/standby CMMs, active CMMs of the master rack and the secondary rack, and master CMM and TRMs.

iv. LNKCTRL

It is the communication link control layer module.

It consists of multiple communication link control modules, like LapD, HDLC, LMComm.

- LapD communication link control module

  LapD is the communication link control module of the Abis interface.

- HDLC communication link control module

  HDLC is the communication link control module inside the rack. They all communicate in a point-to-point way.

  There are three types of communication links: CCComm, CMComm and CTComm.

  CCComm: The CCComm is the auxiliary communication link between the master CMM of the master rack and that of the slave rack. Physically, it is a 2 M PCM line, which facilitates the centralized data collection of LMU.

  CMComm: As the communication link between the active CMM and the standby CMM, it implements the data synchronization between the active CMM and standby CMM. Physically, it uses 1 M HW.

  CTComm: As the communication link between the active CMM and 1 ~ 12 TRMs of its racks, the CTComm implements the parameter configuration of TRM and alarm collection. Physically, it uses a 64 Kbit/s timeslot in 4 M HW.

- LMComm

  Foreground/background link control module with RS232 as its physical interface. It is a self-defined point-to-point link control protocol and character-oriented single-bit stop and wait protocol.

5. APP layer:

It is the application layer, consisting of three parts:

i. O&M

As the core of the application layer, it receives the O&M messages of the Abis interface and implements parameter configuration, status and alarm management, software version management, equipment test and external alarm collection.

ii. DBS

The whole application layer is designed with the database as a core. The database coordinates to assign configuration parameters and also synchronizes data between the active and standby CMMs and the foreground and background.

iii. LMU

It is the local O&M unit, including two parts: foreground agent and background operation interface.

It works with the database synchronization module to complete the local parameter configuration, equipment status and alarm collection. It also includes operating interface of equipment test to implement test functions of the local BTS.

The system tool part is a series of developer-oriented tools for system diagnosis and test to rapidly locate faults.

FUC

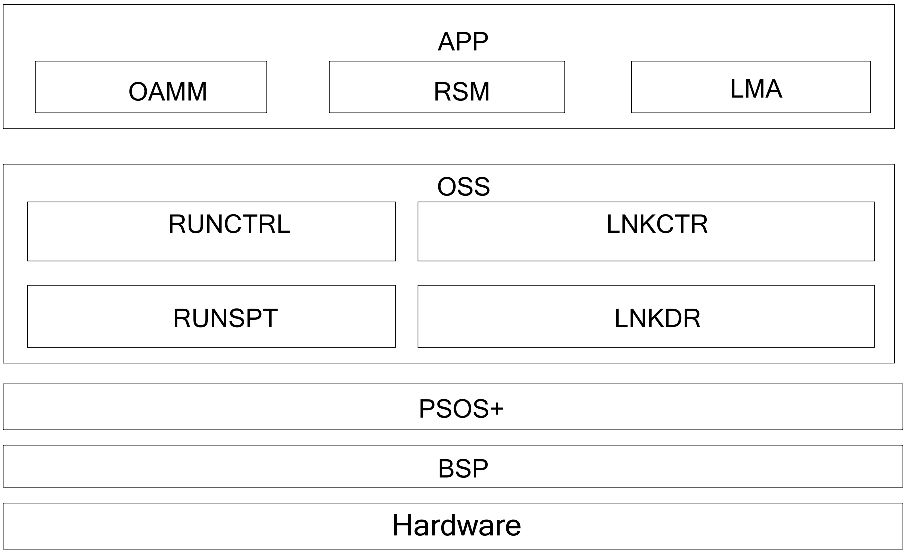
FUC (Frame Unit Controller)

The FUC software module is located in the TPU of the TRM module. It processes the radio signaling over every radio carrier and signaling on the BSC interface and manages all channels. Its major functions are as follows:

1. Responsible for processing and converting GSM signaling protocols, including the layer-2 protocol LAPD with BSC, the layer-2 protocol HDLC with CMM, the layer-2 protocol LAPDm with the Um interface and the layer-3 radio resources management protocol of GSM.
2. Responsible for the TDMA multi-frame framing on the Um interface, frame number (FN) receiving, frequency hopping calculation and management & control over CHP.
3. It also manages BTS and loads the FUC software and DCP program. It supports global packet switching services (GPRS or PS for short).

   The whole FUC software can be divided into two layers: system software and application, as shown in Figure 8.

FIGURE 8 FUC SOFTWARE MODULE STRUCTURE



The concept of virtual operating system is adopted for the system software. Based on the commercial operating system pSOS+, the running support layer RUNSPT of the limited state machine is oriented to make the application irrelevant with the actual real-time operating system, simplify the application implementation and improve the application grafting.

RUNCTRL implements the power-on boot sequence of system's modules and some auxiliary functions of the operating system. It collects and redirects the output messages.

The drivers are also designed with a hierarchical structure, including equipment-dependent and equipment-independent drivers. All communications within the current equipment adopt the address transfer mode to reduce the overhead of the memory block copies.

The application layer contains the operation and maintenance module (OAMM), radio signaling processing module (RSM) and local O&M agent module (LMA).The OAMM configures and manages the software, parameters, status and alarms of the TPU board. The RSM can be divided into the FURRM (Radio Resource Management Module), PAGCHM (Paging Access Channel Message Processing Module) and FHM (Frequency Hopping Module).These modules implement the signaling flows of circuit switched service and packet switched service according to the GSM protocol, and they support frequency hopping. LMA is used in system debugging.

CHP

CHP (Channel Codec Module)

The CHP software module is located in the TPU of the TRM in the system.

It implements all baseband channel processing and some corresponding control functions, including channel encoding, channel decoding and demodulation.

CIP

CIP (Carrier Interface Unit)

The CIP software module is located in the TPU of the TRM in the system.

The functions of CIP software are GMSK (GSM modulation mode), 8PSK (EDGE modulation mode), software modulation, power control and the collection and handling of AEM, amplifier, RCU and fan alarm information.

System Features

The ZXG10-BTS (V2.9) has the following features:

1. High jumping-off point in technology

   The ZXG10 BTS (V2.9) starts from the new generation of GSM technology, and the standards of GSM Phase II are adopted. It can be upgraded to GSM Phase II+ smoothly.

2. Advanced functions, complete services and flexible configuration

   It meets GSM specification requirements, and can be configured as required by users.

   It supports GPRS/EDGE data service functions and AMR voice service.

   It supports multiple bands, mixed insertion of modules of different bands, and mixed insertion of modules of different services.

   It supports 40 W and 80 W configurations.

   Frequency hopping is supported.

3. Large capacity

   A single rack supports a maximum of 12 TRXs.

   Each station supports a maximum expansion of 36 TRXs.

   Each station supports a maximum expansion of S12/12/12.

4. Beautiful appearance and compact structure

   The ZXG10 BTS (V2.9) is designed in a rack-type modular structure with simple appearance, compact structure, superior electromagnetic shielding performance and good internal ventilation and heat sinking. Both the front door and back door of the rack can be opened to facilitate maintenance.

5. Modular design in software/hardware.

   The hardware of the ZXG10 BTS (V2.9) has a modular design, making it possible to use fewer types of boards and modules, thus enhancing board integration, facilitating project installation and maintenance, and improving the reliability of the system.

6. Advanced software radio technology.

   The ZXG10 BTS (V2.9) uses software radio technology to ensure the long-term reliable operation of the RF parts and improve the batch consistency and mass productivity of equipment.

7. Flexible and reliable Abis interface

   Advanced flow control algorithms and variable rate signaling link technology are used so that multiple logical signaling links can be configured on the 64 Kbit/s physical link to fully share the bandwidth.

   An E1 can be shared by 15 carriers (under special configuration).

   When multiple BTSs are cascaded, the automatic crossover protection function is provided for the Abis interface link when any BTS is powered off.

8. Secure and reliable power supply system.

   The primary power supply supports -48 V supply; the secondary power supply with a distributed design is integrated in various modules, improving the reliability of the system.

9. Perfect environment monitoring capability

   Providing inputs for 10 pairs of external environment trunk nodes, and outputs for 8 pairs of trunk nodes.

10. Good heat design

    A fan layer is designed on the carrier shelf of each layer and can hold two fans, monitoring and collecting the temperature inside the carrier shelf, thus automatically adjusting the rotational speed of the fans.

    Each layer of the carrier shelf has a separate ventilation duct, and heat is dissipated out of the rack through the common duct of the rack.

11. Convenient local operation and maintenance

    It adopts a standard RS232 interface to connect with the local operation and maintenance terminal to spare special cables.

    The local operation and maintenance terminal is easy to learn and use since it is consistent with the OMCR interface.

    Perfect local operation and maintenance

    Rapid and reliable online software upgrade.

Chapter 2

Technical Indices

This chapter describes the system indices and external interfaces of the ZXG10-BTS (V2.9).

Working Band

1. Working frequency band

   The ZXG10-BTS (V2.9) can support 900 MHz, extended 900 MHz, 850 MHz, 1800 MHz and 1900 MHz by being configured with different functional modules.

   i. 900 MHz band

      Uplink (transmitted by MS and received by BS) frequency range: 890 MHz ~ 915 MHz

      Downlink (transmitted by BS and received by MS) frequency range: 935 MHz ~ 960 MHz

   ii. Extended 900 MHz band

      Uplink (transmitted by MS and received by BS) frequency range: 880 MHz ~ 915 MHz

      Downlink (transmitted by BS and received by MS) frequency range: 925 MHz ~ 960 MHz

   iii. 850MHz band

      Uplink (transmitted by MS and received by BS) frequency range: 824 MHz ~849 MHz

      Downlink (transmitted by BS and received by MS) frequency range: 869 MHz ~894 MHz

   iv. 1,800 MHz band

      Uplink (transmitted by MS and received by BS) frequency range: 1,710 MHz ~ 1,785 MHz

      Downlink (transmitted by BS and received by MS) frequency range: 1,805 MHz ~ 1,880 MHz

v. 1,900 MHz band

Uplink (transmitted by MS and received by BS) frequency range: 1,805 MHz ~ 1,910 MHz

Downlink (transmitted by BS and received by MS) frequency range: 1,930 MHz ~ 1,990 MHz

2. Channel interval

The interval between two adjacent channels in any band is 200 kHz.

3. Channel configuration

All channels are configured with the same interval.

i. 900 MHz band

The channel number is in the range of 1 ~ 124. There are 124 frequency bands in all.

The relationship between the channel numbers and frequency band nominal central frequency is illustrated as follows:

$Fu(n) = 890 + 0.2 \times n$ (MHz), uplink

$Fd(n) = Fu(n) + 45$ (MHz), downlink

Here, $1 \le n \le 124$, n is a channel number, or an ARFCN (Absolute Radio Frequency Channel Number).

ii. Extended 900 MHz band

The channel number is in the range of 0 ~ 124 and 975 ~ 1023. There are 174 frequency bands in all.

The relationship between the channel numbers and frequency band nominal central frequency is illustrated as follows:

$Fu(n) = 890 + 0.2 \times n$ (MHz), $0 \le n \le 124$

$Fu(n) = 890 + 0.2 \times (n - 1024)$ (MHz), $975 \le n \le 1023$

$Fd(n) = Fu(n) + 45$ (MHz)

iii. 850 MHz band

The channel number is in the range of 128 ~ 251. There are 124 frequency bands in all.

The relationship between the channel numbers and frequency band nominal central frequency is illustrated as follows:

$Fu(n) = 824.2 + 0.2 \times (n - 128)$ (MHz)

$Fd(n) = 869.2 + 0.2 \times (n - 128)$ (MHz)

$128 \le n \le 251$

iv. 1,800 MHz band

The channel number is in the range of 512 ~ 885. There are 374 frequency bands in all.

The relationship between the channel numbers and frequency band nominal central frequency is illustrated as follows:

$Fu(n) = 1710.2 + 0.2 \times (n - 512)$ (MHz)

Fd (n) = Fu (n) + 95 (MHz)

512 ≤ n ≤ 885

v. 1,900 MHz band

The channel number is in the range of 512 ~ 811. There are 300 frequency bands in all.

The relationship between the channel numbers and frequency band nominal central frequency is illustrated as follows:

Fu (n) = 1850.2 + 0.2 × (n - 512) (MHz)

Fd (n) = Fu (n) 80 (MHz)

512 ≤ n ≤ 811

4. Duplex transceiving interval

i. 900 MHz band

The duplex transceiving interval is 45 MHz.

ii. Extended 900 MHz band

The duplex transceiving interval is 45 MHz.

iii. 850 MHz band

The duplex transceiving interval is 45 MHz.

iv. 1,800 MHz band

The duplex transceiving interval is 95 MHz.

v. 1,900 MHz band

The duplex transceiving interval is 80 MHz.

Physical Indices

Dimensions, Color and Structure

Rack dimensions (H × W × D) (excluding the base):

1,600 mm × 600 mm × 550 mm (H × W × D)

Its color is light grey (ZX-P02*02).

It is a welded-style rack with doors that can be opened to both sides.

Weight of Integrated Equipment and Weight Bearing Requirements of Equipment Room Ground

The maximal static weight of a single rack is 270 kg.

The weight bearing capacity of the equipment room ground should be 1,200 kg/m^{2}.

Power Supply of Equipment

Voltage

Nominal working voltage: -48 VDC

Range: -57 VDC ~ -40 VDC

Power Consumption

The maximal power consumption of each module is as follows:

TRM: 160 W

TRM: 175 W

CMM: 16 W

Fan: 60 W

CDU or RDU: 5 W

The power consumption of the integrated equipment in full configuration is less than 2,200 W.

Heat in the rack is from the TRM and AEM in the carrier plug-in shelf.

The heat consumption distribution of each module:

TRM: 120 W

ETRM: 135 W

AEM: 45 W

CMM (two): 20 W

Fan and other parts: 30 W

Under full configuration:

- Without ETRM, the heat consumption of each carrier shelf, 600 W; integrated equipment, less than 2,200 W
- With ETRM, the heat consumption of each carrier shelf (fan included), 600 W; integrated equipment, less than 2,350 W

Environmental Conditions

Temperature and Humidity Requirements

Working temperature: -5 ºC ~ 45 ºC

Relative humidity: 10% ~ 90 %, no condensation

Grounding Requirements

The case of the rack should be grounded well, with the grounding resistance less than 5 ohm.

Atmospheric Pressure Requirements

1.08×10^{5} pa ~ 5.1×10^{4} pa (-500 mm ~ +500 mm)

Lighting

Direct sunshine should be avoided to prevent the circuit boards and other components from aging and deforming. The average illumination should be 300x ~ 450lx and no glare should exist.

Air Pollution

Erosive gases, smog and smoking are prohibited in the equipment room.

Interface Indices

Abis Interface Indices

The Abis interface adopts the standard E1 interface.

The performance of the Abis interface meets the requirements specified by ITU-T G.703 and ITU-T G.704. Details are as follows:

1. Basic requirements
   i. Nominal bit rate: 2,048 Kbit/s
   ii. Bit rate tolerance: $\pm 50 \times 10^{-6}$
   iii. Signal code pattern: HDB3
2. Electrical features
   i. Pulse shape: rectangular
   ii. Nominal peak voltage of pulse (mark):
   2.37 V (75 ohm, a pair of coaxial cables).

3 V (120 ohm, a pair of symmetrical cables).

iii. Peak voltage when without pulse (vacant number):

0±0.237 V (75 ohm, one pair of coaxial cables).

0.3 V (120 ohm, a pair of symmetrical cables).

iv. Nominal pulse duration: 244 ns

v. The amplitude ratio between the positive pulse and the negative pulse

The amplitude ratio of positive and negative pulses is at the intermediate point in pulse duration: superior than 0.955 ~ 1.05

Positive and negative pulse duration ratio at half nominal pulse amplitude: superior than 0.95 ~ 1.05

vi. Digital signal jittering features (1UI = 488ns):

1.5 UI (peak-peak value, 20 Hz ~ 100 kHz).

0.2 UI (peak-peak value, 18 Hz ~ 100 kHz).

vii. Input impedance features

Corresponding to the nominal bit rate (2,048 Kbit/s) 2.5% ~ 5%; that is, when it is 51.2 Kbit/s ~ 102.4 Kbit/s, echo attenuation ≥ 12 dB.

Corresponding to the nominal bit rate (2,048 Kbit/s) 5% ~ 100%; that is, when it is 102.4 Kbit/s ~ 2,048 Kbit/s, echo attenuation ≥ 18 dB.

Corresponding to the nominal bit rate (2,048 Kbit/s) 100% ~ 150%; that is, when it is 2,048 Kbit/s ~ 3072 Kbit/s, echo attenuation ≥ 14 dB.

Um Interface Indices

Main indices are as follows:

1. Wireless channel

   Co-channel interference protection ratio C/I ≥ 9 dB (static).

   Interference protection ratio of the adjacent channels ≥ - 9 dB

   Interference protection ratio the second adjacent channel ≥ -43 dB

   The wireless channel selection adopts the shared signaling channel mode.

2. Wireless RF modulation mode

   It adopts gauss minimal shift keying (GMSK) to perform modulation. BT = 0.3 and the modulation coefficient is 1.35.

3. Performance of the transmitter

   i. Phase error of the transmitter

   The phase error of the transmitter is the error between the actual phase and the theoretical one.

The root mean square of the BS phase error is not greater than 5°and the peak value is not over 20°.

ii. Frequency error of the transmitter

The frequency error of the transmitter is the error between the actual frequency and the theoretical one.

The BS frequency error is not over 0.05 ppm.

iii. Average transmitted carrier power (requirement for the power amplifier output)

40 W or 80 W.

It is provided with the 6-level static power control function. Based on the maximum output power, it can adjust downwards 6 power levels with the step of 2dB ± 1.0dB. At the same time, BS has the downlink power control function. Based on the set power level, it can decrease the power from level zero to level-15 with the step of 2dB ± 1.5dB.

iv. Transmitted RF carrier power/time envelop

Compliant with GSM 11.21 and GSM 05.05.

v. The inter-modulation attenuation of the transmitter

Compliant with GSM 11.21 and GSM 05.05.

vi. The inter-modulation attenuation in BSS

Compliant with GSM 11.21 and GSM 05.05.

vii. Transmitted adjacent channel power

Compliant with GSM 11.21 and GSM 05.05.

viii. Spurious emission of the transmitter

Compliant with GSM 11.21 and GSM 05.05.

4. Performance of the transmitter

i. The static layer-1 function of the transmitter (nominal error rate)

The static first layer functions of the receiver are the floorboard of such functions of RF part, multiplexing and multi-addressing, equalizer de-encryption, de-interleaving and the channel encoding.

The static layer-1 function is signified by the nominal error rate (bit error rate (BER)) before channel decoding.

Compliant with GSM 11.21 and GSM 05.05.

ii. Static referential sensitivity level

The static referential sensitivity level means that when inputting a standard test signal under the static environment, the FER, RBER or BER performance of the data, generated after modulation and channel decoding, meets the specified requirements when the level is configured as the referential sensitivity level.

Compliant with GSM 11.21 and GSM 05.05.

iii. Multi-path referential sensitivity

A standard testing signal is inputted in the multi-path environment. When the level is set as the reference sensitivity level, the data generated after modulation and channel encoding have the FER, RBER or BER performance that can satisfy the requirements specified.

Compliant with GSM 11.21 and GSM 05.05.

iv. Referential interference level (interference and suppression of the same frequency and adjacent channels).

The referential interference level means the capability that the transmitter receives the expected modulation signal not over the given degraded quantity, which is caused by the unexpected modulation signal on the same carrier frequency (inference of the same channel) or any adjacent carrier frequency (inference of the adjacent channel).

Compliant with GSM 11.21 and GSM 05.05.

v. Block and spurious response suppression

The block and spurious response suppression is to test the capability that the BSS transmitter receives the GSM modulation signal when interferential signal exists.

Compliant with GSM 11.21 and GSM 05.05.

vi. Inter-modulation suppression

This index is for measuring the linear degree of the RF part of the transmitter. It indicates, when two or multiple unexpected signals which are relative to the expected signal in frequency exist, the transmitter’s capability of receiving the respected modulation signal is not over the given degraded quantity.

Compliant with GSM 11.21 and GSM 05.05.

vii. AM suppression

AM suppression means the transmitter’s capability of receiving the expected modulation signals is not over the given degraded quantity when an unexpected modulation signal exists.

Compliant with GSM 11.21 and GSM 05.05.

viii. Spurious emission

The spurious emission is the emission on the frequencies except that of the RF channel of the transmitter and adjacent frequencies.

Compliant with GSM 11.21 and GSM 05.05.

Capacity Indices

A single rack holds twelve 40 W carriers or six 80 W carriers when configured to the full capacity.

A site supports three racks, thirty-six 40 W carriers or eighteen 80 W carriers at most.

Clock Indices

It provides a two-level clock, whose indices are as follows:

Clock accuracy: $\pm 1.0\times 10^{-9}$

Pull in range: $\pm 1.0\times 10^{-9}$

Maximum frequency bias: 1×10^{-9}/day

Initial maximum frequency bias: 1×10^{-7}

Reliability Indices

MTBF (Mean Time Between Failure) (hour): 6.3 ~ 10^4 hours

Mean Time To Repairs (MTTR): 0.57 hours

Availability ratio A (%): 99.9991%

Annual average interruption time of the system (hour): 0.080 hours

The product successfully passed the CE certification. The personal safety, electromagnetic security, EMC and guarantee of the wireless frequency spectrum comply with international standards.

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Chapter 3

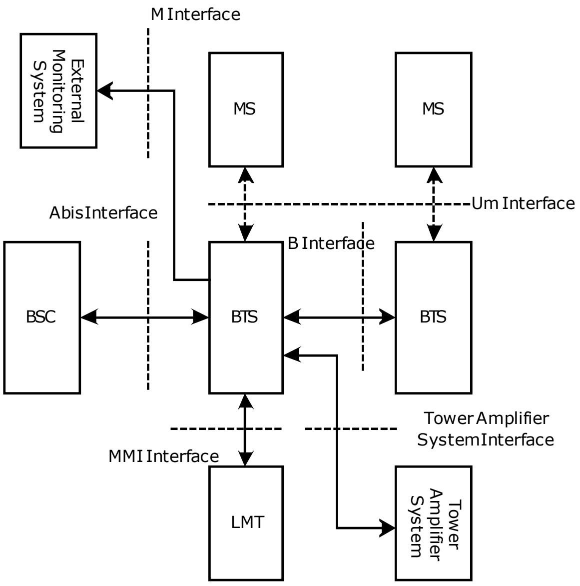
Interfaces and Communications

This chapter details different external interfaces of the ZXG10-BTS (V2.9) and different interface protocols.

Overview

Figure 9. Illustrates the positions of the main interfaces of the ZXG10-BTS(V2.9)in the system.

FIGURE 9 EXTERNAL INTERFACE POSITIONS OF ZXG10-BTS (V2.9)



Apart from the Abis and Um interfaces, the ZXG10-BTS (V2.9) has the cascaded interface (B interface) between BTSs, interface (M interface) with the external environment monitoring system, interface of the tower amplifier system and the local O&M interface.

The Abis interface is a communication interface between BTS and BSC. The Um interface is the interface between BTS and MS. The B interface is actually an extension of the Abis interface. The M interface between BTS and the monitoring system of the external environment provides a transparent path for the O&M of the ZXG10-BTS (V2.9).The tower amplifier system provides the power supply and the alarm interfaces. The man-machine interface (MMI) is an interface between the local O&M terminal (LMT) and BTS.

Interfaces

Abis Interface

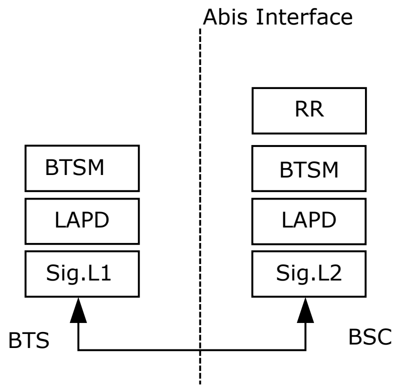
The Abis interface is defined as an interface between BSC and BTS.

The Abis interface sends the signal from the BSC to the BTS, usually the standard E1 signal of PCM 2M.The unbalanced input mode of 75 ohm coaxial cable is adopted for it to implement access through the transmission equipment digital microwave, fiber transmission (SDH and PDH) and satellite link.

Physically, an E1 interface is adopted as the Abis interface, and it is connected with the thin coaxial cable & D-socket.

Protocols on the Abis interface are hierarchical, and the protocol hierarchy of circuit service is shown in Figure 10. The Abis interface does not process the packet service protocol, and it is transparent for the packet signaling.

FIGURE 10 CIRCUIT SERVICE PROTOCOL LAYERED STRUCTURE OF ABIS INTERFACE



On the Abis interface, the circuit service protocols fall into three layers:

1. Layer-1 (physical layer) is the PCM digital link at the rate of 2,048 Kbit/s.
2. Layer-2 (data link layer) is based on the LAPD.
3. Layer-3 transparently transmits the layer-3 messages on the A interface and manages radio resources.

The protocols related to the Abis interface are as follows:

GSM 08.52 presents the basic principles and rules of other specifications for the Abis interface and how the service functions are divided between BSC and BTS.

GSM 08.54 specifies the physical structure of the Abis interface.

GSM 08.56 specifies the data link layer protocol for the Abis interface.

GSM08.58 stipulates the layer-3 protocols of the Abis interface.

GSM 12.21 specifies the O&M message transmission mechanism on the Abis interface.

The data format of Abis interface can be flexibly configured. Configuration examples of the Abis interface are shown in Figure 11.

FIGURE 11 TIMESLOT CONFIGURATION EXAMPLES OF ABIS INTERFACE

	0 1	2 3	4 5	6 7
TS0	SYNC			
TS1	TCH0	TCH1	TCH2	TCH3
TS2	TCH4	TCH5	TCH6	TCH7
TS3	TCH0	TCH1	TCH2	TCH3
TS4	TCH4	TCH5	TCH6	TCH7
TS5	TCH0	TCH1	TCH2	TCH3
TS6	TCH4	TCH5	TCH6	TCH7
TS7	TCH0	TCH1	TCH2	TCH3
TS8	TCH4	TCH5	TCH6	TCH7
TS9	TCH0	TCH1	TCH2	TCH3
TS10	TCH4	TCH5	TCH6	TCH7
TS11	TCH0	TCH1	TCH2	TCH3
TS12	TCH4	TCH5	TCH6	TCH7
TS13	TCH0	TCH1	TCH2	TCH3
TS14	TCH4	TCH5	TCH6	TCH7
TS15	TCH0	TCH1	TCH2	TCH3
TS16	TCH4	TCH5	TCH6	TCH7
TS17	TCH0	TCH1	TCH2	TCH3
TS18	TCH4	TCH5	TCH6	TCH7
TS19	FUL			
TS20	FUL			
TS21	FUL			
TS22	FUL			
TS23	FUL			
TS24	EAM3			
TS25	EAM2			
TS26	EAM1			
TS27	EAM0			
TS28	O&M3			
TS29	O&M2			
TS30	O&M1			
TS31	O&M0			

	0 1	2 3	4 5	6 7
TS0	SYNC			
TS1	TCH0	TCH1	TCH2	TCH3
TS2	TCH4	TCH5	TCH6	TCH7
TS3	TCH0	TCH1	TCH2	TCH3
TS4	TCH4	TCH5	TCH6	TCH7
TS5	TCH0	TCH1	TCH2	TCH3
TS6	TCH4	TCH5	TCH6	TCH7
TS7	TCH0	TCH1	TCH2	TCH3
TS8	TCH4	TCH5	TCH6	TCH7
TS9	TCH0	TCH1	TCH2	TCH3
TS10	TCH4	TCH5	TCH6	TCH7
TS11	TCH0	TCH1	TCH2	TCH3
TS12	TCH4	TCH5	TCH6	TCH7
TS13	TCH0	TCH1	TCH2	TCH3
TS14	TCH4	TCH5	TCH6	TCH7
TS15	TCH0	TCH1	TCH2	TCH3
TS16	TCH4	TCH5	TCH6	TCH7
TS17	TCH0	TCH1	TCH2	TCH3
TS18	TCH4	TCH5	TCH6	TCH7
TS19	TCH0	TCH1	TCH2	TCH3
TS20	TCH4	TCH5	TCH6	TCH7
TS21	TCH0	TCH1	TCH2	TCH3
TS22	TCH4	TCH5	TCH6	TCH7
TS23	TCH0	TCH1	TCH2	TCH3
TS24	TCH4	TCH5	TCH6	TCH7
TS25	FUL			
TS26	FUL			
TS27	FUL			
TS28	FUL			
TS29	FUL			
TS30	FUL			
TS31	FUL			

An O&M timeslot on the Abis interface is multiplexed in each site, and the O&M signaling at different sites occupies the fixed timeslot on the Abis interface. At initialization, the OMM reads the ID signal from the rack top, and specifies the timeslot of the BS O&M information in the Abis interface according to the ID. For the ID description, refer to *ZXG10-BTS (V2.9) Base Transceiver Station Hardware Manual*.

For example, the site that is directly connected to BSC occupies the TS 30 Link A for O&M signaling, while the level-1 cascaded site occupies the TS 28 Link A for O&M signaling. The rest may be deduced by analogy. If the previous-level faulty E1 interface is bridged, the next-level site can identify the O&M channel corresponding to the site. The level of the site can be read out on the DIP switch on the CMM board.

The Abis interface is provided with four timeslots: TRM service timeslot TCH, TRM signaling timeslot FUL, O&M timeslot and the environment monitoring transparent channel EAM.

The Abis interface processing is as follows:

1. Transparently transmit the TCH, FUL, O&M and EAM between cascaded sites.
2. In the downlink direction in the same site, the service TCH and signaling FUL are transparently transmitted to each TRM. The Q&M will be transparently switched to the QMC interface of CMM in each rack. The CMM will identify the O&M signaling according to TEI. EAM will be transparently transmitted by the main rack.
3. In the uplink direction in the same site, the service TCH is transmitted transparently, the TRM signaling FUL in the same rack is compressed and packed in the CMM, the O&M timeslot is multiplexed based on TEI, and the EAM timeslot is transmitted transparently in the master rack.

Um Interface

The Um interface is the interface between BTS to MS, an important external interface of the BTS.

In the PLMN, MS connects the fixed part of the network via a radio channel to enable subscribers to access communication services.

To interconnect the MS and BTS, a series of stipulations are provided for signal transmission over the radio channel, and a set of standards is set up. This set of specifications about signal transmission over radio channel is the Um interface.

The Ums interface is designed with a hierarchical model. The circuit service protocol hierarchy is shown in Figure 12, and the packet service protocol hierarchy is shown in Figure 13. The packet service protocol is implemented at the BSC side, and only physical layer is discussed here.

FIGURE 12 CIRCUIT SERVICE PROTOCOL HIERARCHY OF THE UM INTERFACE

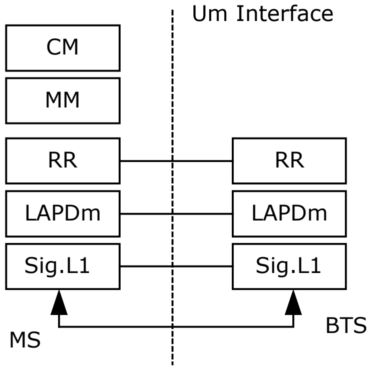
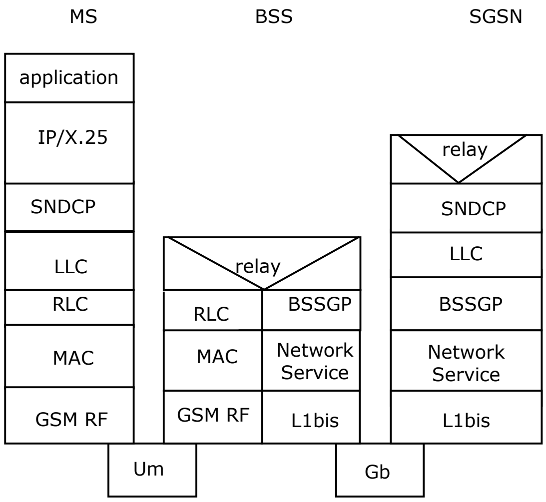


FIGURE 13 PACKET SERVICE PROTOCOL STACK STRUCTURE OF THE UM INTERFACE



On the Um interface, the circuit service protocols fall into three layers:

The first layer is the physical layer and also the underlying layer. It consists of various channels and provides the basic wireless channels for upper-level message transmission.

The second layer is the data link layer and also the medium layer, with the LapDm adopted. It comprises various data transmission structures and controls data transmission.

The third layer (L3) is the highest layer. It comprises various messages and programs and provides service control.L3 consists of three sub-layers: radio resource management (RR), mobility management (MM) and connection management (CM).

The relevant protocols of the Um interface are as follows:

GSM 04.03 describes the channel structure and access capability of the Um interface.

GSM 04.04 specifies the physical layer structure of the Um interface.

GSM 04.05 specifies the data link layer protocol for the Um interface.

GSM 04.08 stipulates the layer-3 protocols of the Um interface.

Inter-Rack Cascaded Interface of Same Site

The inter-rack star connection is supported at the same site (one site supports three BTS racks at most).

The data interface between racks also employs the standard PCM 2M E1 signal to transfer service, TRM signaling, inter-rack O&M signaling and FN (Frame Number).Service signaling and TRM signaling will be transparently transmitted, while O&M and FN will be transmitted via the time division HDLC link.

The inter-rack data interface format is shown in Figure 14.

FIGURE 14 INTER-RACK DATA INTERFACES INSIDE A SITE

	Inter-rack Downlink Interface
	0 1 2 3 4 5 6 7
TS0	SYNC
TS1	CC_COM
TS2	FN
TS3	FN
TS4	The same as Abis interface
TS5	The same as Abis interface
TS6	The same as Abis interface
TS7	The same as Abis interface
	. . .
TS15	The same as Abis interface
TS16	The same as Abis interface
TS17	The same as Abis interface
TS18	The same as Abis interface
	. . .
TS31	O&M timeslot

	Inter-rack Uplink Interface
	0 1 2 3 4 5 6 7
TS0	SYNC
TS1	CC_COM
TS2	The same as Abis interface
	. . . . . .
TS14	The same as Abis interface
TS15	The same as Abis interface
TS16	The same as Abis interface
TS17	The same as Abis interface
TS18	The same as Abis interface
	. . .
TS31	O&M timeslot

After CMM is powered on, it reads the ID signal to locate the position of the O&M TS. The master rack generates and outputs FN and SYNCLK while the slave rack receives them. The rack category is read by the CMM from the rack top ID signal.

The inter-rack FN will be transmitted and broadcasted via the HDLC protocol, the inter-rack O&M TS via the HDLC protocol and inter-rack communication (CC_COM) via the HDLC protocol. Details are introduced as follows:

In the downlink direction, the CMM will transparently switch the O&M timeslot of the Abis interface to the processor of this board and other racks of the same site. The CMM will identify the O&M according to TEI.

In the uplink direction, CMM compresses the O&M TSs of this rack and the next rack to send to the upper-level CMM. Thus, the master rack compresses the O&M messages of three racks into one O&M message for reporting to the BSC.

Interface with External Environment Monitoring System

The external environment monitoring equipment provides two types of interfaces: One is in the serial port communication mode based on RS232, and the other is in the communication mode that directly reflects the alarm status in the backbone node mode.

The DB25 pin socket is adopted at the rack top of the ZXG10-BTS (V2.9) to access the backbone node alarm status signal. The CMM can collect 10 pairs of backbone nodes for input and provide two pairs of backbone nodes for output in the ZXG10-BTS (V2.9).

In addition, it provides one RS232 interface at the top of the ZXG10-BTS (V2.9), which acts as an EAM transparent path to BSC for external environment monitoring equipment.

Interfaces of Tower Amplifier System

During installation of the tower amplifier for BTS, the interfaces of the tower amplifier system should be reserved, including the tower amplifier power interface and the tower amplifier alarm interface. In general, they are interfaces for providing the DC feed and alarm monitoring, and the alarm is detected from the DC current.

BTS can provide +12 V power supply and up to 300 mA current for the tower amplifier system via the power interface.

The tower amplifier alarm is accessed to the backbone node in the BTS through the backbone node alarm mode, and it is monitored by the BTS. When two lines of the backbone node in BTS are connected or connected at a low resistance, it indicates there is alarm output for the tower amplifier, and Alarm is ON. When two lines of the backbone node in BTS are not connected or connected at a high resistance, it indicates there is no alarm output for the tower amplifier, and Alarm is OFF.

The tower amplifier power interface is located on the rack top, and one BTS rack can provide 3 tower amplifier power interfaces.

Man-Machine Interface (MMI)

The MMI is a serial communication interface between the BTS and local O&M terminal.

It is realized by the 10-BaseT network interface or RS 232 interface between the CMM and local O&M terminal.

It can be connected to the serial interface of a local O&M terminal computer or network interface through the ETP interface of the CMM panel.

Protocol Overview

For the ZXG10-BTS (V2.9), there are two important external interfaces: Abis interface and Um interface.

The LapD, LapDm and RR/MM/CM protocols are processed on the two interfaces. The three protocols are discussed in light of the actual system conditions.

Um Interface Physical Layer

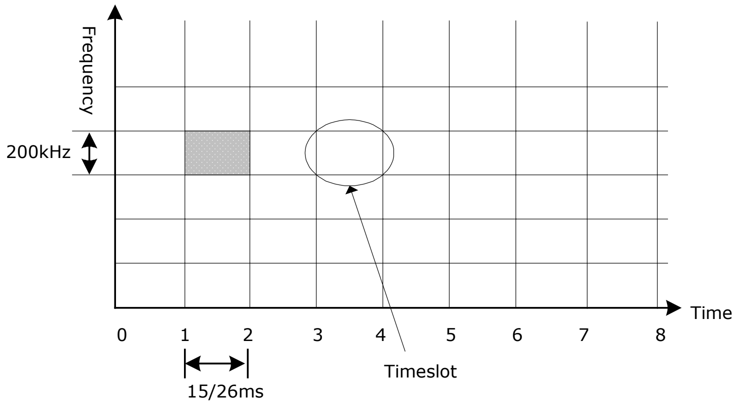
Timeslot

The multiple access technology enables several subscribers to share one channel. It consists of FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access) and CDMA (Code Division Multiple Access).

In the GSM system, the air interface employs a mix of FDMA and TDMA technologies. The interval of the carrier channels is 200 kHz. A carrier is divided into eight timeslots. Each TS, 15/26ms (about 577μs), serves as a channel, so a carrier supports eight mobile subscribers at the same time.

Figure 15 shows a channel in the GSM system in terms of time domain and frequency domain.

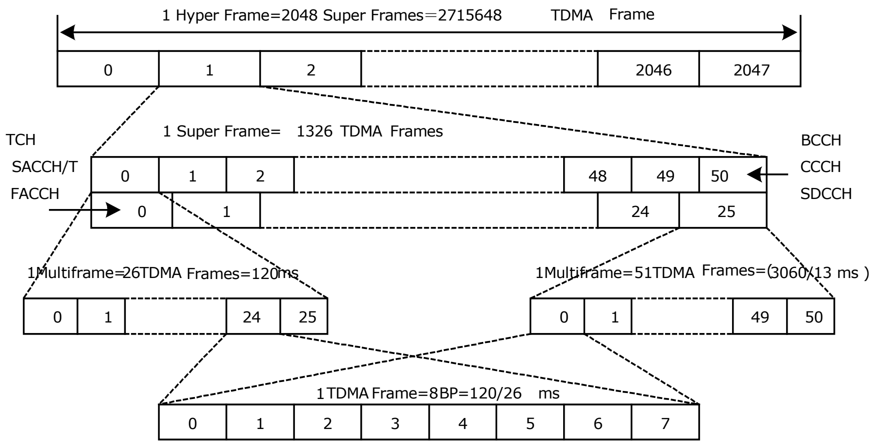
FIGURE 15 TIMESLOTS IN THE TIME AND FREQUENCY DOMAIN



TDMA Frame Structure

In the GSM system, each carrier has eight timeslots. Eight adjacent Timeslots form a basic unit, called a TDMA frame. Several TDMA frames form a multi-frame, as shown in Figure 16.

FIGURE 16 SCHEMATIC DIAGRAM OF THE FRAME STRUCTURE



The GSM circuit service has two kinds of multi-frames: 26-frame multi-frame and 51-frame multi-frame.

26-frame multi-frame: It contains 26 TDMA frames, with a period 120 ms, used for traffic channel and associated control channel.

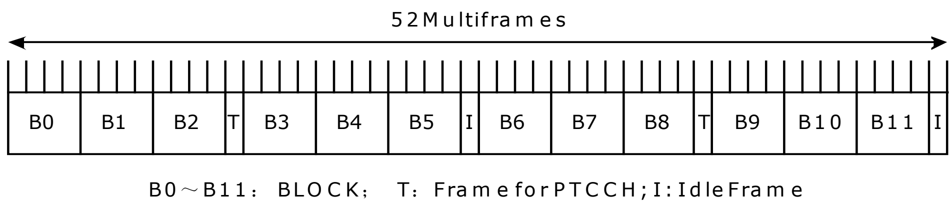
51-frame multi-frame: It contains 51 TDMA frames, with a period 3,060/13 ms (about 235ms), used for control channel.

Multiple multiframes constitute a super frame, which is a continuous 51 × 26 TDMA frame. The period of the super frame is 1326 TDMA frames, i.e., 6.12s.

A hyper frame consists of 2,048 super frames and its period is 12,533.76 s. Each period of a hyper frame contains 2,715,648 TDMA frames, that is, the TDMA FNs (Frame Numbers) range from 0 to 2,715,647.

Compared to the 26 multi-frame and 51-frame multi-frame structures in the circuit service, the multi-frame structure consisting of 52 TDMA frames is introduced in the GPRS system. Mapping of logical channels on all PDCHs (Packet Data Channels) is based on such a frame structure, as shown in Figure 17.

FIGURE 17 SCHEMATIC DIAGRAM OF THE 52-MULTIFRAME STRUCTURE



The multiframe structure of PDCH contains 12 blocks, each consisting of four consecutive TDMA frames. There are also two idle TDMA frames and another two for the Packet Time advance Control CHannel (PTCCH), making a total of 52 TDMA frames.

In the packet service, the basic composition unit of all packet logical channels except the PRACH (Packet Random Access Channel) and PTCCH/U is block.

In a 52 multi-frame, the occupation order of 12 blocks is like this: B0, B6, B3, B9, B1, B7, B4, B10, B2, B8, B5 and B11.

CS Logic Channel

Channels are divided into physical channels and logic channels.

The timeslot is a basic physical channel. The logical channels are defined differently depending on the message types transmitted between the BTS and MS. The logical channels are mapped to the physical channels for the purpose of transmission.

By type, the logical channels are classified into CS and PS channels. By function, they are classified into traffic channels and control channels.

1. Traffic channel (TCH)

   TCHs, which carry encoded voice signals or subscriber data, include TCH/FS (TCH/Full Speed) and TCH/HS (TCH/Half Speed).

   i. Voice TCH

TCH/FS: The full speed speech TCH, with a total rate up to 22.8Kbit/s

TCH/HS: Half speed speech TCH, with a total rate up to 11.8Kbit/s

ii. Data TCH

TCH/F9.6: 9.6Kbit/s full-rate data traffic channel

TCH/F4.8: 4.8Kbit/s full-rate data traffic channel

TCH/H4.8: 4.8Kbit/s half-rate data traffic channel

TCH/F2.4: ≤ 2.4Kbit/s full-rate data traffic channel

TCH/H2.4: ≤ 2.4Kbit/s half-rate data traffic channel

2. Control channel (CCH)

Control channels carry signaling or synchronization data, and they can be divided into three types: broadcasting channel, common control channel and dedicated control channel.

i. BCH

Designed to broadcast various messages to MS, broadcasting channel is a kind of point-to-multipoint unidirectional downlink CCH (that is, unidirectional transmission from BS to MS), including three kinds of channels:

FCCH: Frequency calibration channel, carrying information used in MS frequency calibration.

SCH: Synchronization channel, carrying identification information of MS frame synchronization and BTS (Base Transceiver Station)

BCCH: Broadcasting control channel, used to send cell information; In every BTS, there is always a transceiver with such a channel to broadcast system information to all MSs in this cell.

ii. Common control channel

As a point-to-multipoint bi-directional CCH, CCCH is shared by MSs in the network. There are three types of such channels:

PCH: Paging channel, used by BTS to page MS (down channel).

RACH: Random access channel, used by MS to apply for random network-access, that is, for dedicated control channel (up channel).

AGCH: Access granted channel, used by BTS to answer the MS random access request, that is. to assign a dedicated control channel or directly a TCH (down channel).

iii. Dedicated control channel

Dedicated control channel is a point-to-point bi-directional CCH. It is allocated by the BTS to MS to fulfill point-to-point transmission between BTS and MS.

- SDCCH: Stand-alone DCCH, used to transmit channel allocation information and other relevant information; It consists of:

  SDCCH/8: Stand-alone dedicated control channel

  SDCCH/4: The stand-alone dedicated control channel combined with BCCH /CCCH

- SACCH: Slow Associated Control CHannel, working together with a traffic channel or an SDCCH to transmit specific information in the user information, such as power and frame adjustment control information and measurement data; This channel can be divided into the following types:

  SACCH/TF: SACCH associated with TCH/F

  SACCH/TH: SACCH associated with TCH/H

  SACCH/C4: SACCH associated with SACCH/C4

  SACCH/C8: SACCH associated with SACCH/C8

- FACCH: Short for fast associated control channel, used in combination with a TCH to carry the same signals as SDCCH, but FACCH will be allocated only if no SDCCH is allocated. Connection is realized via the frame borrowed by TCH (stolen frame) to transmit such instructions as "handover". FACCH comes in the following types:

  FACCH/F: Fast Associated Control CHannel/Full Rate

  FACCH/H: Fast Associated Control CHannel/Half Rate;

  TCH/F and SACCH are generally allocated in pairs. The combination of TCH/F and SACCH is represented as TACH/F.

3. Channel Combination

   In practice, logic channels of different types are usually mapped to the same physical channel, which is called channel combination.

   Following are nine channel combinations:

   i. TCHFull (Traffic CHannel Full-rate): TCH/F + FACCH/F + SACCH/TF

   ii. TCHHalf (Traffic CHannel Half rate): TCH/H (0, 1) + FACCH/H (0, 1) + SACCH/TH (0, 1)

   iii. TCHHalf2 (Traffic CHannel Half rate 1): TCH/H (0, 0) + FACCH/H (0, 1) + SACCH/TH (0, 1) + TCH/H (1, 1)

   iv. SDCCH (Stand-alone Dedicated Control CHannel): SDCCH/8 (0, …, 7) + SACCH/C8 (0, …, 7)

   v. MainBCCH (Main Broadcasting Control Channel): FCCH + SCH + BCCH + CCCH

   vi. BCCHCombined (Broadcasting Control CHannel Combined): FCCH + SCH + BCCH + CCCH + SDCCH/4 (0, …, 3) + SACCH/C4 (0, …, 3)

   vii. BCH (Broadcasting CHannel): FCCH + SCH + BCCH

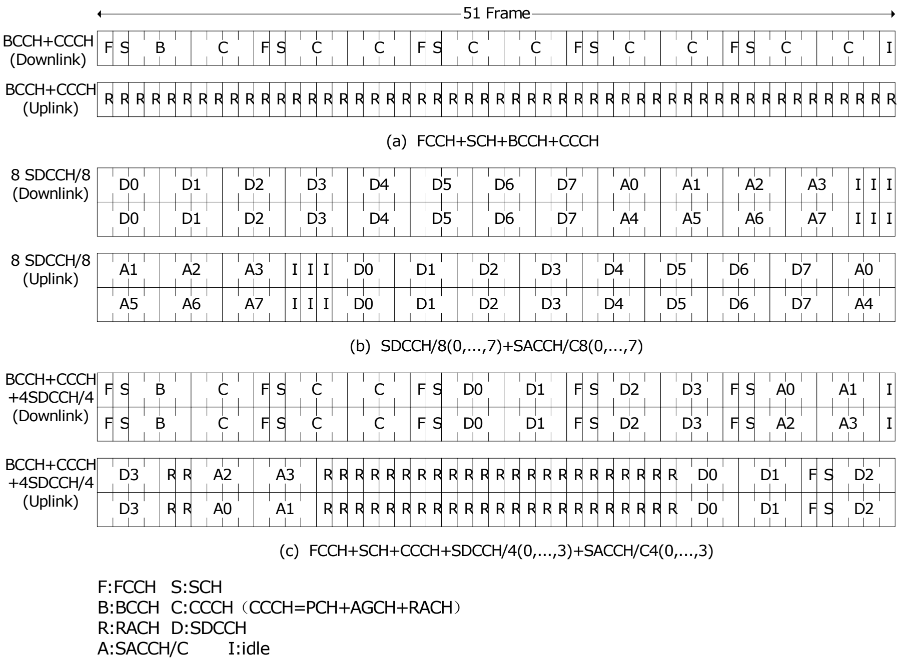
   viii. BCCHwithCBCH (Cell Broadcasting CHannel): FCCH + SCH + BCCH + CCCH + SDCCH/4 (0, …, 3) + SACCH/C4 (0, …, 3) + CBCH

   ix. SDCCHwithCBCH (Slow Dedicated CCH): SDCCH + SACCH + CBCH

   Among the above channel combinations, CCCH = PCH + RACH + AGCH.CBCH: Only downlink channels are available, carrying cell broadcast information and sharing the physical channel with SDCCH.

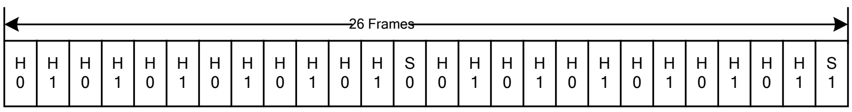
   Each cell broadcasts an FCCH and an SCH. The basic combination in the downlink direction includes an FCCH, an SCH, a BCCH and a CCCH (PCH + AGCH), allocated strictly to TN0 of BCCH carrier configured for a cell, as shown in Figure 18.

FIGURE 18 SCHEMATIC DIAGRAM OF 51-FRAME CHANNEL STRUCTURE



For the half-rate voice channel combination, each timeslot has two half-rate sub-channels and corresponding SACCH, with 26TDMA frames as the multi-frame. The frame structure is shown in Figure 19.

FIGURE 19 STRUCTURE OF THE HALF-RATE VOICE CHANNEL



4. Channel arrangement in the cell

   Given below are several examples of channel combination in a cell (in the brackets are sub-channels).

   i. Channel combination in a small-capacity cell with only one TRX

      TN0: FCCH + SCH + BCCH + CCCH + SDCCH/4 (0, …, 3) + SACCH/C4 (0, …, 3)

      TN1 ~ 7: TCH/F + FACCH/F + SACCH/TF

   ii. Channel combination in a medium-capacity cell with four TRXs

      One TN0 group: FCCH + SCH + BCCH + CCCH

      Two SDCCH/8 (0, …, 7) + SACCH/C8 (0, …, 7)

      29 TCH/F + FACCH/F + SACCH/TF

   iii. Channel combination in a large-capacity cell with 12 TRXs

One TN0 group: FCCH + SCH + BCCH + CCCH

One TN2 group, one TN4 group and one TN6 group: BCCH + CCCH

Five SDCCH/8 (0, …, 7) + SACCH/C8 (0, …, 7)

87 TCH/F + FACCH/F + SACCH/TF

PS Logic Channel

By function, packet logical channels are divided into packet data transmission channel (PDTCH) and packet control channel (PCCH).

1. PDTCH

   Unlike the circuit service, all PDTCHs in the packet service are unidirectional; that is, the up link and down link are independent of each other.

   PDTCHs include PDTCH/U (uplink) and PDTCH/D (downlink).

   PDTCHs carry user data. They are allocated temporarily to a specific MS or a group of MSs. In multi-timeslot mode, an MS can use at most eight PDTCHs at the same time.

   PDTCH/U is used by MS to send packet data to the network and PDTCH/D is used by the MS to receive packet data from the network.

2. PCCH

   PCCHs are listed in Table 4.

TABLE 4 PCCH

<table>
<tr><th>Name</th><th colspan="2">Classification</th></tr>
<tr><td rowspan="8">PCCH</td><td rowspan="4">Packet Common Control Channel (PCCCH)</td><td>Packet random access channel (PRACH) (uplink)</td></tr>
<tr><td>Packet paging channel (PPCH) (downlink)</td></tr>
<tr><td>Packet access granted channel (PAGCH) (downlink)</td></tr>
<tr><td>Packet notification channel (PNCH) (downlink)</td></tr>
<tr><td>Packet Broadcast Control Channel (PBCCH)</td><td>PBCCH (downlink)</td></tr>
<tr><td rowspan="3">Packet dedicated control channel</td><td>Packet Associated Control Channel (PACCH)</td></tr>
<tr><td>Packet time lead control channel (PTCCH/U) (uplink)</td></tr>
<tr><td>Packet time lead control channel (PTCCH/U) (downlink)</td></tr>
</table>

i. Packet Common Control Channel (PCCCH)

- PRACH sends packet access burst pulse and extended access burst pulse or responds to BSS paging.
- PPCH is used for both CS paging and PS paging, but CS paging is only applicable to MS level-A and level-B.PPCH also uses paging group and can support DRX.

- Before an MS sends a packet, PAGCH allocates one or more PDTCHs to the MS for packet transfer. When the MS already works in the packet transmission mode, the resources allocated can also be transferred in the PACCH.
- PNCH is used for notifying the MS of PTM-M calls. The DRX mode is necessary for monitoring PNCH.

  ii. Packet Broadcast Control Channel (PBCCH)

  PBCCH broadcasts the PSI (Packet System Information) and the parameters carried by PSI determine the mapping of all kinds of channels on the multi-frames.

  If no PBCCH is allocated, the information can also be transferred over the BCCH.BCCH will clearly indicate whether the cell supports packet data service. If the cell supports packet data service and PBCCH is available, then the combined configuration information on the PBCCH will be presented.

  iii. Packet dedicated control channel

- The PACCH transmits signaling information, such as confirmation and power control. It also carries resource allocation and reallocation messages, which can be used to allocate PDTCH capacity or add new PACCH in the future. When an MS is making packet transmission, it can page via PACCH and enter the circuit switching mode. The PACCH is dynamically allocated to the physical channel which carries PDTCH. It is a bidirectional channel.
- PTCCH/U transfers the random access burst pulse and estimates the time advance amount of an MS in the packet transmission mode.

  The period of PTCCH/U is 8 52-multiframes, including 16 PTCCH/U sub-channels. The PTCCH/U sub-channel number possessed by each MS is determined by the TAI (Time Advance Index) obtained by the MS in resource allocation.

  Figure 1-6 shows the mapping of PTCCH/U on the physical channel.
- PTCCH/D is used to correct the time lead of several MSs.

  One PTCCH/D corresponds to several PTCCH/U.

  PTCCH/D is interleaved on four bursts.

  Figure 20 shows the mapping of PTCCH/D on the physical channel.

Figure 20 Mapping of PTCCH on the Physical Channel

52-multiframe number n:

uplink TAI=0 TAI=1

B0	B1	B2	0	B3	B4	B5	1	B6	B7	B8	2	B9	B10	B11	3

downlink TA-message 1 TA-message 1

52-multiframe number n+1:

uplink TAI=2 TAI=3

B0	B1	B2	4	B3	B4	B5	5	B6	B7	B8	6	B9	B10	B11	7

downlink TA-message 1 TA-message 1

52-multiframe number n+2:

uplink TAI=4 TAI=5

B0	B1	B2	8	B3	B4	B5	9	B6	B7	B8	10	B9	B10	B11	11

downlink TA-message 2 TA-message 2

52-multiframe number n+3:

uplink TAI=6 TAI=7

B0	B1	B2	12	B3	B4	B5	13	B6	B7	B8	14	B9	B10	B11	15

downlink TA-message 2 TA-message 2

52-multiframe number n+4:

uplink TAI=8 TAI=9

B0	B1	B2	16	B3	B4	B5	17	B6	B7	B8	18	B9	B10	B11	19

downlink TA-message 3 TA-message 3

52-multiframe number n+5:

uplink TAI=10 TAI=11

B0	B1	B2	20	B3	B4	B5	21	B6	B7	B8	22	B9	B10	B11	23

downlink TA-message 3 TA-message 3

52-multiframe number n+6:

uplink TAI=12 TAI=13

B0	B1	B2	24	B3	B4	B5	25	B6	B7	B8	26	B9	B10	B11	27

downlink TA-message 4 TA-message 4

52-multiframe number n+7:

uplink TAI=14 TAI=15

B0	B1	B2	28	B3	B4	B5	29	B6	B7	B8	30	B9	B10	B11	31

downlink TA-message 4 TA-message 4

B0~B11=Radio blocks
Idle frames are numbered from 1 to 31 [odd numbers]
PTCCH frames are numbered from 0 to 30 [even numbers]

All packet logical channels are mapped on a certain physical channel (PDCH).

Physical channels are shared in the unit of block; that is, the type of logical channel to which each block on a PDCH belongs may change from block to block. Channel type is the message type ID contained in the head of a block (except for PRACH).

For each PDCH allocated to the MS, MS will be allocated with an USF (Uplink State Flag).

On the network, the USF controls the multiplexing of radio blocks of multiple MSs on the PDCH.

USF is at the head of each downlink radio block and points to the next uplink radio block.

If the MS finds its own USF at the head of a downlink block of a PDCH, then the MS can use the B_{X+1} (if X ≠ 11) or B_0 (if X = 11) uplink block in the PDCH. If the network permits, the MS can also use three consecutive blocks.

In the downlink, the MS reads every downlink block in the allocated PDCH and judges whether the block belongs to itself according to TFI (the ID allocated to the MS).

Burst Pulse Sequence

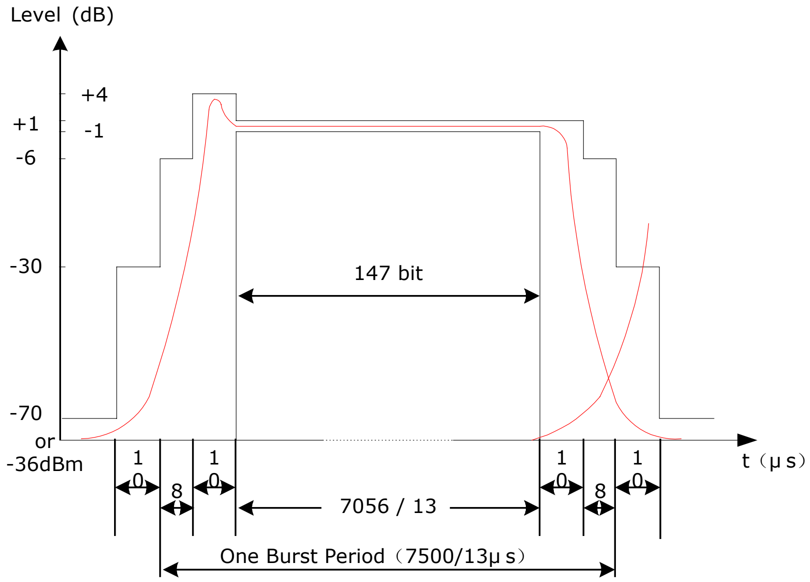
Burst pulse sequence refers to the information bit stream sent by the BTS or MS in any TS.

A burst period is a timeslot, which is about 577 μs, containing 156.25 bits. Different bits are differentiated by BNs (Bit Numbers), for example BN = 0, 1, …, or 156.

The transmission time of burst pulse within a timeslot depends on the BN. The transmission starts from the low bit, that is, from BN0.

Figure 21 shows the time-amplitude of the burst pulse sequence. It indicates the acceptable restriction range. The constant amplitude lasts 147 bits, that is, 142 information bits plus two 2.5bits on both sides.

FIGURE 21 TIME-AMPLITUDE OF THE NORMAL BURST



A training sequence is a given bit sequence of the receiver.

GSM defines eight types of different training sequences. Messages obtained from the transmission training sequence enable the receiver to accurately locate the useful signals in the receiving window and the distortion during transmission. These messages are important for high quality demodulation.

These eight different types of training sequences are used by the adaptive equalizer circuit at the receiving end as a reference for delay compensation. TSC (Training Sequence Code) ranges from 0 to 7, representing 8 different types of training sequences. As for broadcasting and control channels, TSC should be equal to the BCC (BS Color Code).

Training sequence bits (from BN61, BN62 to BN86) are listed in Table 5.

TABLE 5 TRAINING SEQUENCE IN GSM

TSC	Hexadecimal	Binary
		BN61 ~ BN86
0	970897	00100101110000100010010111
1	B778B7	00101101110111100010110111
2	10EE90E	01000011101110100100001110
3	11ED11E	01000111101101000100011110
4	6B906B	00011010111001000001101011
5	13AC13A	01001110101100000100111010
6	29F629F	10100111110110001010011111
7	3BC4BBC	11101111000100101110111100

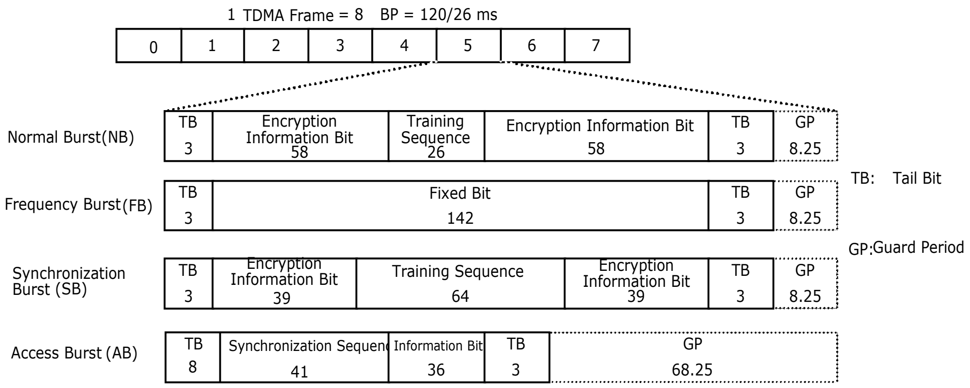
Five types of bursts are defined on the Um interface, as shown in Figure 22.

1. Normal burst

   Normal Burst (NB) is applied to general traffic channels and dedicated control channels.

   The information bits of NB are divided into two groups, each containing 58 bits. Fifty-seven bits of the group are data, and the remained bit is the stealing flag, indicating that this data is subscriber data or signaling (they are the bits closest to the training sequence on both sides). A 26-bit training sequence is inserted between the two segments of information. The 3-bit 0-code tail bits are added to both sides of the information segment. Up to 8.25 bits time is left at the end of NB, and it serves only as a protection segment between adjacent timeslots without transmitting any signal. This is necessary for the MS to raise or lower the transmitting power, to avoid the interference between adjacent timeslots.

FIGURE 22 BURST TYPES



2. Access burst

   Access burst pulse sequence (AB) is used in the uplink direction, transmitted on the RACH channel, and enables the mobile subscriber to apply to BS for network access.

   AB is the only short Burst defined in GSM.

   The AB contains 41 bits of synchronization sequence (also a kind of training sequence), 36 bits of information, 8 tail bits at the beginning, and 3 tail bits at the end. The tail bits at the beginning are called as extension tail bits, whose states are as follows: (BN0, BN1, …, BN7) = (0, 0, 1, 1, 1, 0, 1, 0).The three bits at the end are all "0".

   Synchronization sequence can be used for modulate bits.

   Generally, the bit states of the synchronization sequence are: (BN8,BN9,…,BN48)=(0,1,0,0,1,0,1,1,0,1,1,1,1,1,1,1,1,0,0,1,1,0,0,1,1,0,1,0,1,0,1,0,0,0,1,1,1,1,0,0,0).

The bit states of the synchronization sequence “TS1” are: (BN8,BN9,...,BN48)=(0,1,0,1,0,1,0,0,1,1,1,1,1,0,0,0,1,0,0,0,0,1,1,0,0,0,1,0,1,1,1,1,0,0,1,0,0,1,1,0,1).

The bit states of the synchronization sequence “TS2” are: (BN8,BN9,...,BN48)=(1,1,1,0,1,1,1,1,0,0,1,0,0,1,1,1,0,1,0,1,0,1,1,0,0,0,0,0,1,1,0,1,1,0,1,1,1,0,1,1,1).

3. Synchronization burst

   Synchronization burst pulse sequence (SB) is transmitted on the SCH in the downlink direction, and is used to capture the starting synchronization of MS.

   Like AB, SB is the first sequence in the downlink direction that needs to be demodulated. Therefore, its training sequence is longer than that of NB.

   The training sequence of SB is called extension training sequence, which is stand-alone and functions to keep MS aware which training sequence has been chosen by BTS.

4. Frequency correction burst (FB)

   Frequency correction burst (FB) is used to correct the carrier frequency of the MS.

   All its 148 bits are set to 0 so that the modulated signal will be a pure sine wave, with its frequency higher than the carrier 1625/24kHz or about 67.7 kHz.

5. Dummy burst

   Dummy burst pulse sequence (DB) is chiefly used to fill in vacancies, and its format is exactly the same as that of NB.

   For the 26 bits of the training sequence of DB, the three tail bits at the beginning and end are the same as those of NB. The 58 hybrid bits on both sides of the training sequence arranged as follows:

   (BN3, BN4, ..., BN60) = (1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0)

   (BN87, BN88, ..., BN144) = (0, 1, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0)

Radio Block Structure

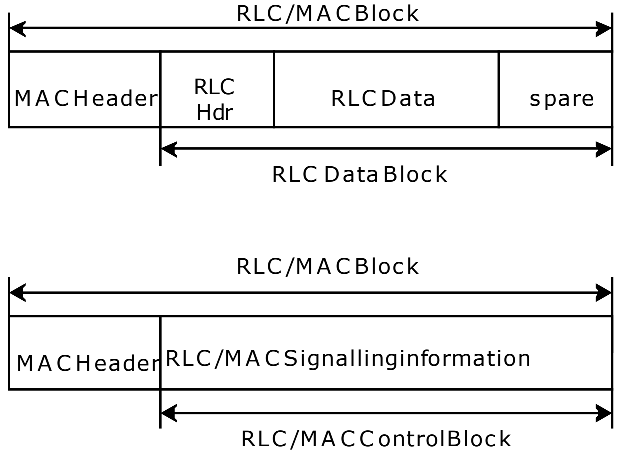
In the packet service, all packet logical channels other than PRACH and PTCCH/U are composed of RLC/MAC blocks.

AB is used on PRACH and PTCCH/U, and the radio block consisting of four NBs is used on all the other packet logical channels.

In some special cases, some information on the PACCH/U is composed of four continuous ABs.

The radio block structure is shown in Figure 23.

FIGURE 23 STRUCTURE OF THE RADIO BLOCK



A block is carried by four NBs composed of the MAC header, RLC data block or RLC/MAC control block.

The MAC header contains different control fields for uplink and downlink directions and has a fixed length of 8 bits. The RLC header contains different control fields for uplink and downlink directions but has an indefinite length. The RLC data block contains the data from the upper layer, and the RLC/MAC control block contains an RLC/MAC control message.

LapD Protocol

LapD (link access procedure of "D" channel) is a data link procedure for signaling transmission between BTS(V2.9) and BSC, with the purpose of using the D channel to transmit messages between respective Layer-3 entities.

LapD is a point-to-multipoint communication protocol that employs the frame structure.

In ZXG10-BTS(V2.9), LapD implements the following functions:

1. Providing one or multiple data connections in the D channel

   The data link connections are identified by the DLCIs in the respective frames. DLCI consists of the TEI (Terminal Equipment Identifier) and SAPI (Service Access Point Identifier), indicating the service and entity that are accessed.

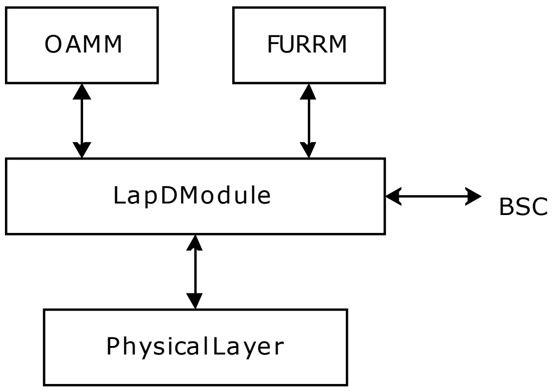
2. Delimitation, location and transparency of the frame
3. Sequence control, ensuring sequential transmission of the frames
4. Error detection
5. Error recovering
6. Notifying the management entity of the un-recoverable error

7. Traffic control

Functions 1, 2 and 4 hereof are completed automatically by the hardware, while functions 3, 5, 6 and 7 are implemented via the software.

In ZXG10-BTS(V2.9), LapD is mainly realized in the LapD module of RSL. The position of the LapD module in RSL is shown in Figure 24.

FIGURE 24 POSITION OF THE LAPD MODULE



The LapD module communicates with the physical layer and L3.The L3 protocol is processed in FURRM.

OAMM configures the parameters such as TEI and values of the timer necessary for the LapD module to run.

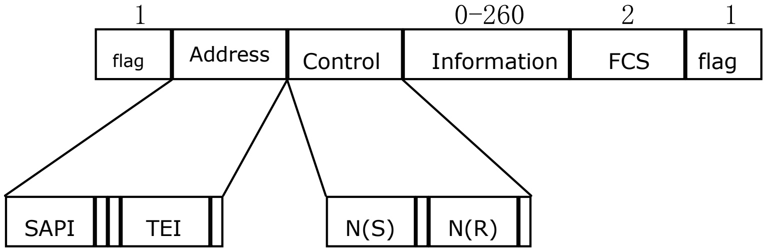
The LapD module provides the FURRM with two information transmission modes: I-frame multi-frame operation and UI frame operation.

1. I-frame multi-frame operation

   The L3 message is sent in the information frame mode which requires the confirmation from the receiver. This mode provides a whole set of control mechanism for error recovering and flow control, the establishment mechanism and release mechanism for multi-frame operations.

   The I-frame structure is shown in Figure 25, including the flag sequence, address field, control field, information field and check field.

FIGURE 25 I-FRAME STRUCTURE OF LAPD



The address field contains SAPI and TEI. It performs addressing for different units via TEI in the Abis interface link. Generally, a unit has multiple functional entities, and the logical physical links between different functional entities are identified by the functional address SAPI. LapD supports three kinds of information: Signaling (including short messages), O&M and LapD layer management information. Links of the three kinds of information are distinguished by SAPI.SAPI=0 represents the signaling link, SAPI=62 represents the O&M link, and SAPI=63 represents the management link of the LapD layer.

In the control field, N (S) represents the sending serial number and the I frame's serial number currently sent by the sending end; N (R) represents the receiving serial number, the expected sending serial number of the next I frame. N (R) is used to predict the instruction from the receiving end.

FCS (Frame Check Sequence) is used for error code detection.

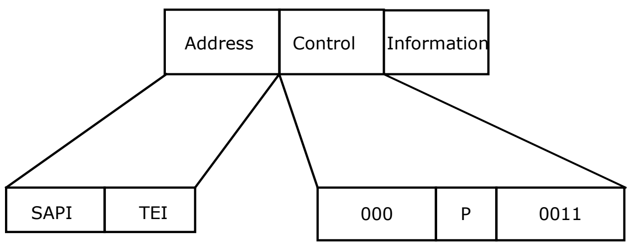
Flag is the beginning and the end token of a frame, namely, an 8-bit font containing six consecutive 1s.

2. UI frame operation

The L3 message is sent in the no-serial-number frame mode, and the receiver is not required to send the received confirmation after receiving the UI frame. This operation mode does not provide a flow control or error recovering mechanism.

The UI frame structure is shown in Figure 26. It is made up of the address field, control field and information field.

FIGURE 26 UI FRAME STRUCTURE OF LAPD



The address field contains SAPI and TEI. In the address field, P represents the query bit, and if this bit is set to 1, it means requiring the response frame from the opposite-end peer entity.

LapDm Protocol

In GSM, LapDm is a data link protocol for signaling transmission between MS and BTS (V2.9), with the purpose of using the Dm channel to transmit messages for respective entities of Layer 3 via the radio interface. LapDm is based on LapD, with some simplification and modification.

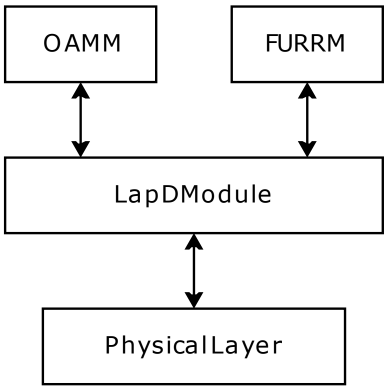
In the ZXG10-BTS(V2.9), LapDm implements the following functions:

1. In a Dm channel, providing a point-to-point data link connection and multiple services for the upper layer. The data link connections are identified by the DLCIs in the respective frames. The DLCI only contains SAPI, indicating the service that is accessed.
2. Supporting the identification of diversified frame types.
3. Supporting the transparent transmission of the L3 message between respective L3 entities.
4. Sequence control, to maintain the sequence of respective frames connected via data link.
5. Checking the format and operation errors in the data link layer.
6. Notifying the L3 entities to process the unrecoverable errors.
7. Flow control
8. Supporting access of the burst solution mode after the RACH channel access is instantly assigned.

In the ZXG10-BTS(V2.9), LapDm is implemented in the LapDm module of RSL.

The position of LapDm module in RSL is shown in Figure 27.

FIGURE 27 LAPDM MODULE



The LapDm module communicates with the physical layer and L3.The L3 protocol is processed in FURRM.OAMM configures the value of the timer necessary for LapDm module to run.

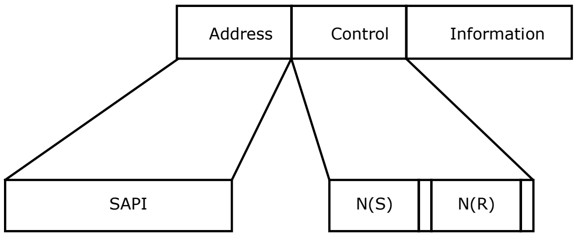
The LapDm module provides the FURRM with two information transmission modes: UI frame operation and I-frame multi-frame operation. In terms of frame structure, LapDm cancels the frame delimiter flag (FLAG) and the FCS (Frame Check Sequence).In LapDm, the synchronization scheme of the radio interface can be used to transmit the boundary message without the corresponding start frame or end frame flags. The transmission scheme provided by the physical layer of the Um interface boasts the error check function, so frame check sequence (FCS) is not used for LapDm.

1. I-frame multi-frame operation

The L3 message is sent in the information frame mode which requires the confirmation from the receiver. This mode provides a whole set of control mechanism for error recovering and flow control, the establishment mechanism and release mechanism for multi-frame operations.

The I frame structure of is shown in Figure 28.

FIGURE 28 I-FRAME STRUCTURE OF LAPDM



The I-frame in LapDm is made up of the address field, control field and information field.

The address field contains the SAPI (Service Access Point Identifier). At the radio interface, LapDm supports two kinds of information: Signaling and short message service. These two kinds of information links are distinguished by the SAPI.SAPI=0 represents the signaling link, and SAPI=3 represents the short message link.

In the LapDm frame, the maximum length of the information on all the TCHs is 23 bytes, and that on the SACCH is 21 bytes. This difference is because each SACCH block has two special bytes: Time advance amount and transmitting power control. Since the maximal length of the frame on the radio interface is of 21 or 23 bytes which cannot meet the need of most signaling, segmentation and regrouping need to be defined in LapDm. Thus an "additional" bit is used to distinguish the last packet frame from other frames. Thanks to this mechanism, there will be no restriction to fix the packet length on the radio path, with the only exception that these messages must be transmitted on other interfaces, namely, 260 bytes mentioned in the radio interface specification.

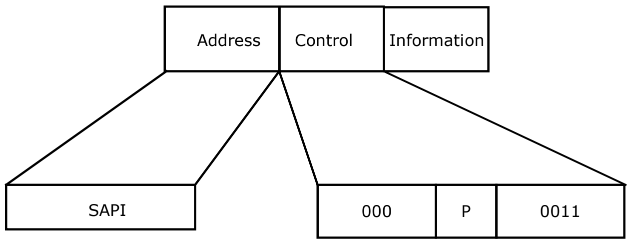
In the control field, N (S) represents the sending serial number and the I frame's serial number currently sent by the sending end; N (R) represents the receiving serial number, the expected sending serial number of the next I frame. N (R) is used to predict the instruction from the receiving end.

2. UI frame operation

The L3 message is sent in the no-serial-number frame mode, and the receiver is not required to send the received confirmation after receiving the UI frame. This operation mode does not provide a flow control or error recovering mechanism.

The UI frame structure of is shown in Figure 29:

FIGURE 29 UI FRAME STRUCTURE OF LAPDM



The UI frame in LapDm is made up of the address field, control field and information field. The address field contains the SAPI. In the address field, P represents the query bit; and if this bit is set to 1, it means requiring the response frame from the opposite-end peer entity.

RR/MM/CM Protocol

The RR/MM/CM protocol, consisting of CM, MM and RR sub-layers, is responsible for control and management. It packets and arranges the information of the subscriber and system control process into the designated logical channels according to certain protocols.

1. CM layer: Responsible for communication management, including establishing a connection between subscribers, maintaining and releasing a call; it further includes CC (Call Control), SSM (Subjoin Service Management) and SMS (Short Message Service).
2. MM layer: Mobility and security management, that is, the necessary processing when the MS initiates location update
3. RR layer: Radio resource management, including establishing and releasing connection between the MS and MSC during the call process

In the ZXG10-BTS (V2.9), the radio resource management module and paging module of RSL are used to implement the RR/MM/CM protocol, and perform the processing of transparent and non-transparent messages in L3.

Transparent message: The ZXG10-BTS (V2.9) is responsible for forwarding this kind of messages, without any analysis or change.

Non-transparent message: They are only transmitted between the BSC and The ZXG10-BTS (V2.9), and the ZXG10-BTS(V2.9) performs corresponding processing according to the specific message content.

1. Um interface

   The signaling on the Um interface includes all messages of RR, MM and CM, and most of the messages are transparent to The ZXG10-BTS(V2.9).

   The L3 message structure on the Um interface is shown in Figure 30.

FIGURE 30 L3 MESSAGE STRUCTURE ON THE UM INTERFACE

TI flag		Protocol indicator
0	Type	
Information unit (mandatory)		
Information unit (optional)		

The protocol indicator is used to indicate the protocol type (RR, CM or SMS.). TI, a transaction identifier, is used to distinguish multiple concurrent CM connections.

The message type indicates the function of the L3 message.

2. Abis interface

   On the Abis interface, most of the radio interface signaling messages are transmitted transparently in L3.It performs management over the physical and logical equipment of BTS (V2.9), including equipment start, release, parameter control and performance monitoring, thus ensuring normal communication services. It divides the managed objects into four types: radio link layer, dedicated channel, control channel and transceiver.

   The message structure of L3 on the Abis interface is shown in Figure 31

FIGURE 31 MESSAGE STRUCTURE OF L3 ON THE ABIS INTERFACE

Message discriminator	T
Type	
Channel number	
Link identifier	
Other information cell	

The message discriminator indicates the message type (management message of the radio link layer, management message of the dedicated channel, management message of the common channel or management message of TRX).

T indicates whether it is a transparent message. The message type indicates the function of the L3 message. The channel number indicates the channel combination type as well as marks the timeslot number.

The link flag contains the contents like SAPI and so on.

Chapter 4

System Functions

This chapter discusses the functions of the ZXG10-BTS (V2.9), including FR, baseband processing, signaling processing and O&M.

Overview

The BTS receives the management and controls from BSC, and works with the BSC to manage radio resources and radio network, control the establishment, connection and disconnection of the radio connections between MS and BTS, control the access, handover and paging of MS, provide voice coding, transcoding and rate adaptation functions, provide the adaptation and interconnection functions of GPRS services, and implement the operation and maintenance functions of the BSS.

BTS has the following four major functions to implement the above service functions:

1. RF function: Implementing the radio connection between MS and BS
2. Baseband processing function: Providing voice coding, transcoding and rate adaptation.
3. Signaling processing function: Based on the BSC instructions, controlling the establishment, connection and disconnection of the radio connections between MS and BTS, and controlling the access, handover and paging of MS,
4. O&M function: Providing O&M agents for BSC, and implementing radio resources and radio network management and the O&M function for BSS

Major RF Functions

The RF function of the BTS meets the requirements of the GSM 05.05 protocol, featuring the advantages of high sensitivity, flexible configuration and easy O&M,

High Receiving Sensitivity

The static receiving sensitivity of the BTS reaches up to -112 dBm. The high sensitivity guarantees the uplink channel performance of the BTS, and is one of the prerequisites for a wide coverage of the BTS.

Flexible Configuration

The BTS supports 1 ~ 36 carriers per site in omnidirectional coverage or directional coverage. It can support 1 ~ 3 sector configuration mode, which can be selected by the user as required .Through the adjustment of front-end gain (such as tower amplifier and low-noise amplifier), the loss in different length of feeder of the BTS can be compensated to guarantee consistent receiving system gain.

Easy O&M

The RF part of the BTS can be controlled remotely through OMCR, to change the transmitting power, transmitting/receiving frequency and more. The alarm signals generated from the RF part are reported to OMCR, so that the operators at the background can control the operation of the RF part and know about the operation statuses.

Diversity Receiving

The BTS provides the diversity receiving function.

The diversity receiving is implemented by two sets of independent receiving equipment working at the same time.

The receiving equipment includes the antenna, tower top amplifier (optional), feeder, divider and receiver.

The application of the diversity receiving function enhances the anti-fading capability of the BTS receiver, enabling excellent receiving performance of the BTS even in complex radio transmission environment.

Frequency Hopping

Frequency hopping is another important measure to enhance BTS performance, which not only improves the anti-fading capability in the downlink channels, but strengthens the communication security.

The BTS supports two working modes: Hopping or no hopping.

With hopping on, the transceiver changes working frequencies according to a certain hopping sequence, while with hopping off, the transceiver locks a specified working frequency.

Power Control

The BTS can provide static power control, dynamic power control and idle timeslot transmitting shutoff functions.

The static power control enables the user to adjust the BTS coverage. The static power control range is up to 12 dB, 2dB per step.

The dynamical power control means that the BSC can adjust the BTS transmit power according to the distance between mobile subscribers and BS. The dynamical power control range is up to 30dB, 2dB per step.

In case of idle timeslot, since there is no downlink signal, the BSC commands the BTS to shut off the transmitting power of that timeslot.

These power control functions above increase the efficiency of the BTS transmitter and reliability of the power amplifier, and minimize the transmitter interference.

Baseband Processing

The baseband processing implements the function of the physical layer on the Um interface, processing all full-duplex channel baseband data on one TDMA frame.

In the downlink direction, the baseband processing involves rate adaptation, channel coding and interweaving, encryption, and generation of TDMA burst pulse;

In the uplink direction, it involves digital demodulation, decryption, deinterleaving, channel decoding and rate adaptation.

Signaling Processing

The BTS signaling processing implements the following two functions:

1. Interconnection between the MS and BSS/NSS on the Um interface layer
2. Management of some radio resources under control of the BSC

Specifically, the BTS signaling processing functions are wireless link layer management function, dedicated channel management function, common channel management function and TRX management function.

Wireless Link Management Function

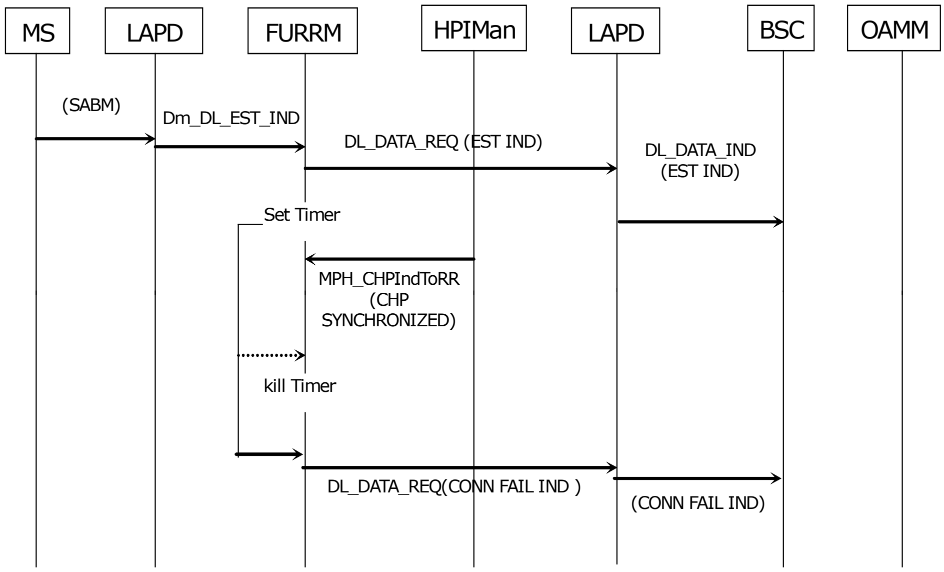
This function supports the following procedures:

1. Link establishment indication procedure: The BTS informs the BSC that a multi-frame mode link initiated by MS is set up successfully through this procedure. Through this indication, the BSC establishes an SCCP link to the MSC.
2. Link establishment request procedure: With this procedure, the BSC requests to establish a multi-frame mode link on a radio path.
3. Link release request procedure: With this procedure, the BSC requests the BTS to release a radio link.
4. Link release indication procedure: With this procedure, the BTS gives the BSC an indication that the MS-originated radio link has been released.
5. Transparent forwarding procedure of the Um interface L3 message in the acknowledgment mode: With this procedure, the BSC requests the BTS to forward a Um interface L3 message transparently in the acknowledgment mode.
6. Transparent receiving procedure of the Um interface L3 message in the acknowledgment mode: With this procedure, the BTS instructs the BSC to receive a Um interface L3 message transparently in the acknowledgment mode.
7. Transparent forwarding procedure of the Um interface L3 message in the non-acknowledgment mode: With this procedure, the BSC requests the BTS to forward a Um interface L3 message transparently in the non-acknowledgment mode.
8. Transparent receiving procedure of the Um interface L3 message in the non-acknowledgment mode: With this procedure, the BTS instructs the BSC to receive a Um interface L3 message transparently in the non-acknowledgment mode.
9. Link error indication procedure: With this procedure, the BTS gives the BSC an indication that the radio link layer gets abnormal.

Link Establishment

The link establishing flow originated by MS is shown in Figure 32.

FIGURE 32 PROCEDURE OF ESTABLISHING AN MS-ORIGINATED LINK



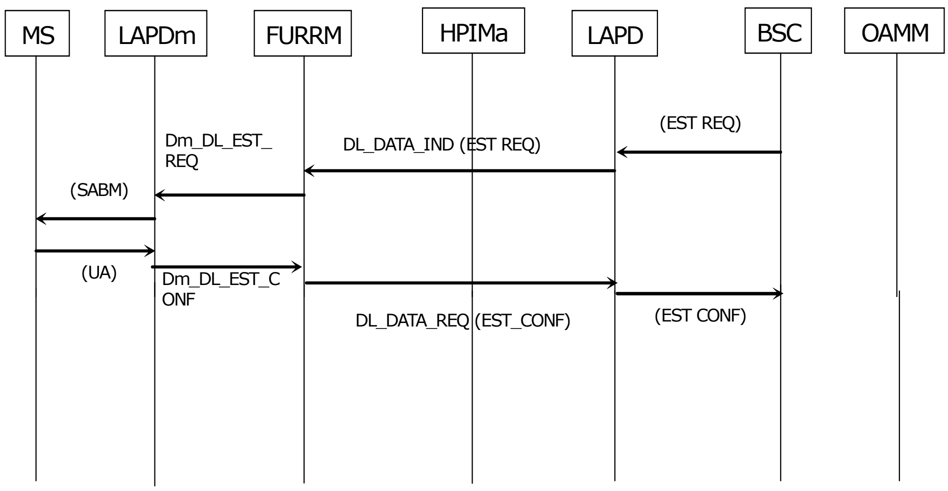
The BTS gives the BSC an indication that one multi-frame-mode L2 link has been established on the wireless path.

During the paging, the GSM04.08 message PAGING RESPONSE will be contained in DL_EST_IND and sent to the BTS.

After the FURRM module sends the EST IND message, if the current channel is the TCH activated in the service mode, the synchronization timer will be enabled to wait for the synchronization between CHP and TC. If the synchronization is not implemented till the timer expires, the FURRM sends the CONN FAIL IND message to the BSC, to wait for the BSC to release the channel where the conversation cannot be established normally.

The link establishing flow originated by the BSC is shown in Figure 33.

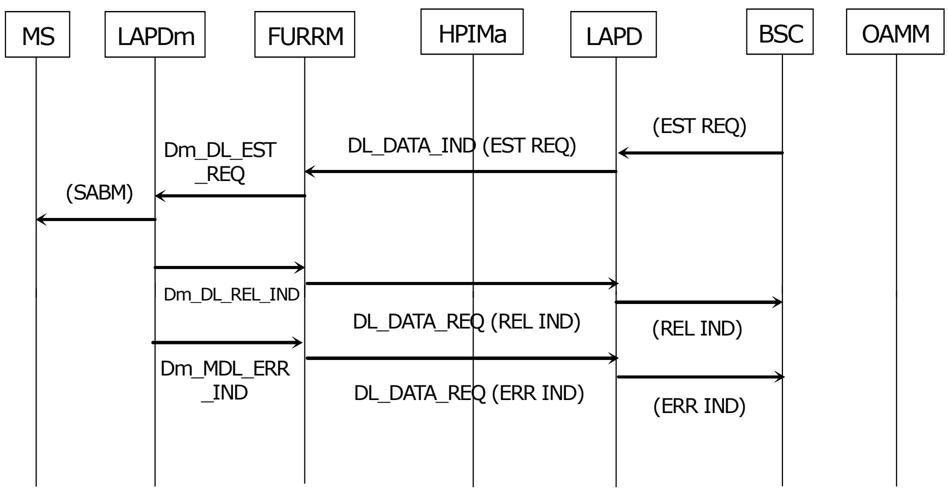
FIGURE 33 ESTABLISHING A BSC-ORIGINATED LINK



The BSC request the BTS to establish a link for point-to-point transmission (SAPI=3) on the wireless path.

A failure of link establishment is shown in Figure 34.

FIGURE 34 LINK ESTABLISHING FAILURE

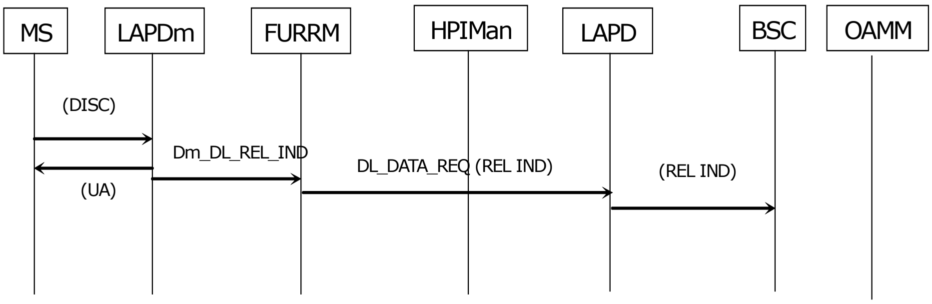


When the link connection fails, the FURRM will receive the Dm_DL_REL_IND and Dm_MDL_ERROR_IND primitives from the data link layer, and the latter one will record the cause "Timer T200 expires for N200 + 1 times: Execution released abnormally". The FURRM places this cause in the ERROR REPORT message and reports it to the BSC.

Link Release

The link releasing procedure originated by an MS is shown in Figure 35.

FIGURE 35 LINK RELEASE ORIGINATED BY MS

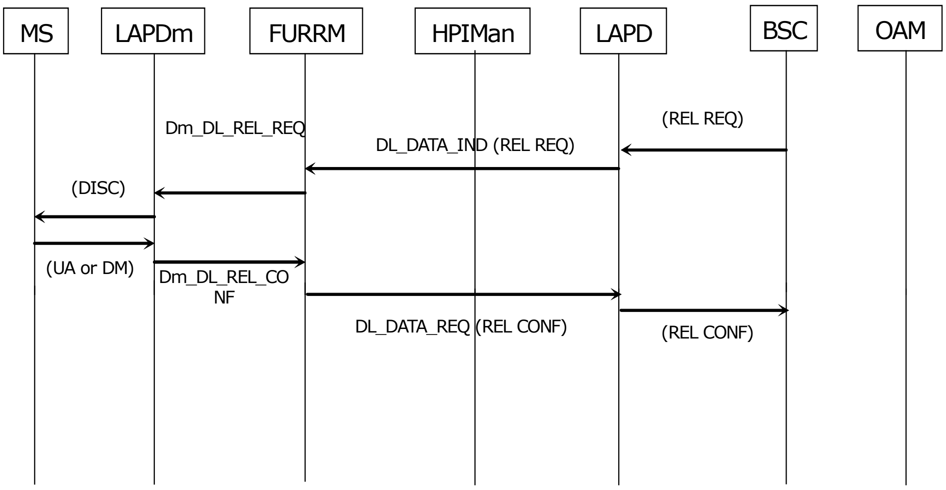


The BTS gives the BSC an indication that the link-layer connection has been released on the wireless path.

If the link layer is in idle mode, the BTS returns DM frame to MS but not notifies the BSC.

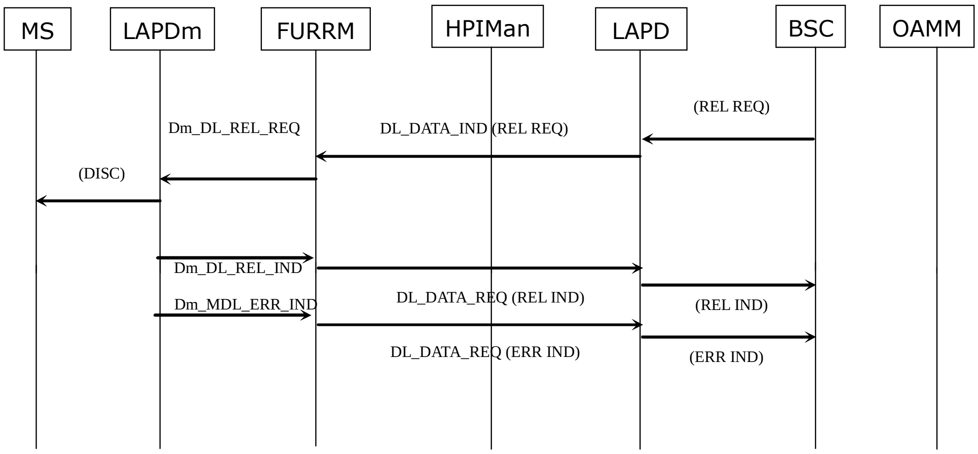
The releasing procedure required by a BSC is shown in Figure 36.

FIGURE 36 LINK RELEASING PROCEDURE REQUIRED BY A BSC



A failure of link release is shown in Figure 37.

FIGURE 37 LINK RELEASE FAILURE



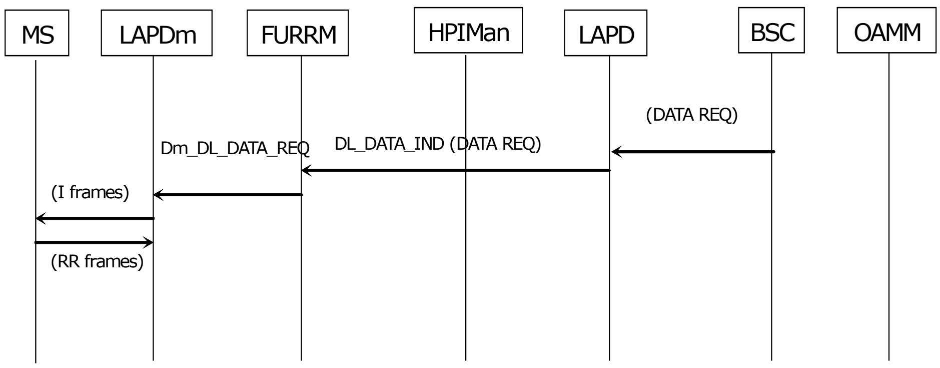
The BSC requests the release of one multi-frame-mode link layer connection (SAPI=3) on the wireless path.

The BTS sends the DISC frame and starts the timer T200 at the same time. If the UA or DM frame is not received when T200 expires, the DISC will be resent and the resending times will increase by one. If the failure persists, the Dm_DL_RELEASE_INDICATION and MDL_ERROR_INDICATION primitives from the data link layer will be received in L3. The latter primitive records the failure cause: "Timer T200 expires for N200 + 1 times: Execution released abnormally".

Sending and Receiving of Transparent L3 Message in Acknowledgment Mode

The transmitting is shown in Figure 38.

FIGURE 38 SENDING A TRANSPARENT L3 MESSAGE IN THE ACKNOWLEDGMENT MODE

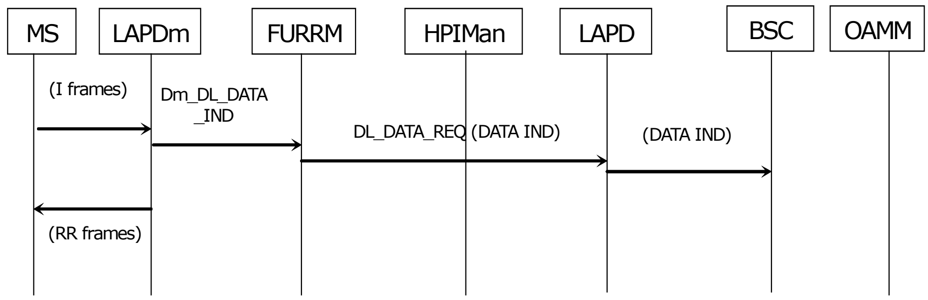


The BSC requests to send a acknowledgment mode L3 transparent message to the MS.

The DATA REQ message contains the complete acknowledgment mode L3 transparent message. At the time when the BTS sends the I frame, the BTS starts timer T200 and records the I frame resend times N200. When T200 expires for N200 times or the REJ frame is received, the BTS sends the ERROR IND message to the BSC.

The receiving is shown in Figure 39.

FIGURE 39 RECEIVING A TRANSPARENT L3 MESSAGE IN THE ACKNOWLEDGMENT MODE

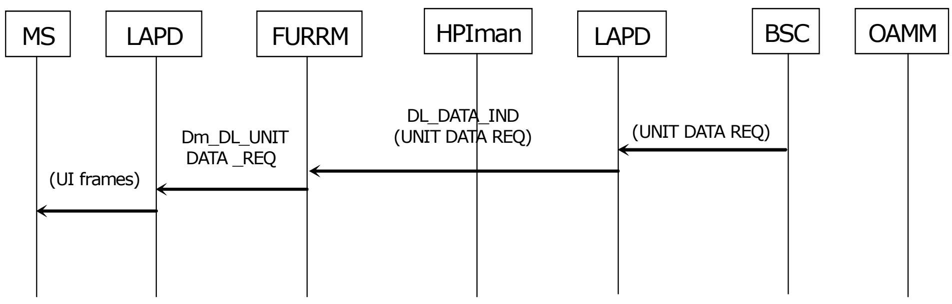


The BSC transfers to the BSC with the acknowledgment mode L3 transparent message that is received from MS. The DATA IND message contains the complete acknowledgment mode L3 transparent message.

Transmission and Receiving of Transparent L3 Message in Non-Acknowledgment Mode

The procedure of transmitting a L3 transparent message from the BSC is shown in Figure 40.

FIGURE 40 TRANSMITTING A L3 TRANSPARENT MESSAGE IN THE NON-ACKNOWLEDGMENT MODE

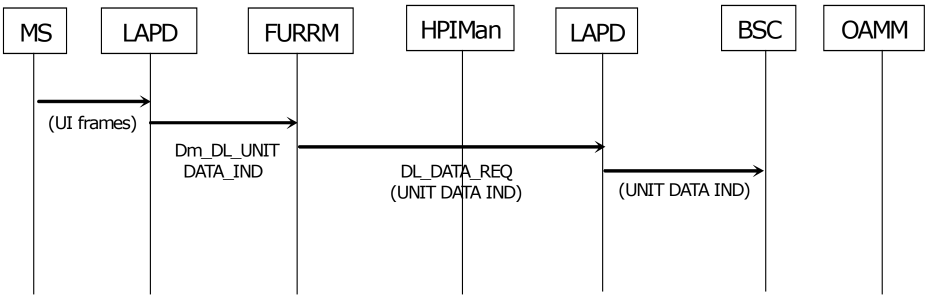


The BSC requests to send a transparent L3 message in the non-acknowledgment mode to the MS.

UNIT DATA REQ message contains the complete non-acknowledgment mode L3 transparent message.

The procedure of transmitting a L3 transparent message from the MS is shown in Figure 41.

FIGURE 41 RECEIVING A L3 TRANSPARENT MESSAGE IN THE NON-ACKNOWLEDGMENT MODE



The BSC transfers to the BSC with the non-acknowledgment mode L3 transparent message that is received from MS.

UNIT DATA IND message contains the complete non-acknowledgment mode L3 transparent message.

Dedicated Channel Management Function

This function supports the following procedures:

1. Channel activation procedure: This procedure allows the BSC to make the BTS activate a dedicated channel for an MS. When the channel is activated successfully, the BSC has the MS handed over to this channel through an assignment command or handover command.
2. Channel mode change procedure: With this procedure, the BSC requests the BTS to change the mode of an activated channel.
3. Handover detection procedure: This procedure is used by the target BTS and target BSC to detect the access of a handed-over MS.
4. Start encryption procedure: This procedure is used to start the encryption procedure stipulated by the TS GSM 04.08.
5. Measurement report procedure: It includes the mandatory basic measurement report procedure and optional preprocessed measurement report procedure. These two procedures are used by the BTS to report all the parameters related to the handover decisions to the BSC.
6. SACCH deactivation procedure: This procedure is used by the BSC to deactivate the TRX related SACCH according to the requirements of the channel release procedure in the TS GSM 04.08.
7. Radio channel release procedure: With this procedure, the BSC instructs the BTS to release a radio link that is not used any longer.
8. MS power control procedure: With this procedure, the BSS controls the transmitting power of the MS related to a specific activated channel.

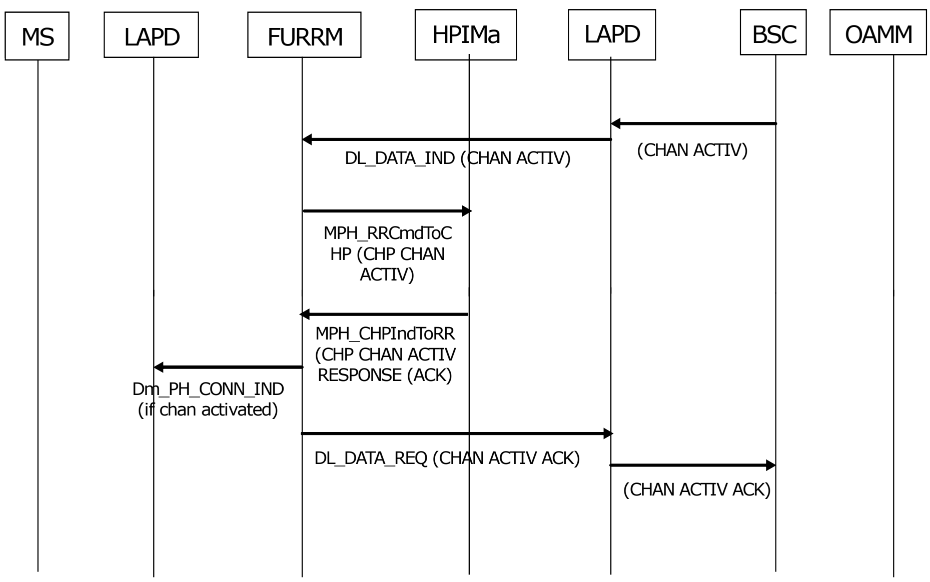
9. BS power control procedure: With this procedure, the BSS controls the transmitting power of the activated channel in the TRX.
10. Connection failure procedure: With this procedure, the BTS gives the BSC an indication that an activated dedicated channel has been disconnected.
11. Physical environment content request/acknowledgement procedure: With this procedure, the BSC obtains the physical parameters of a specified channel, which usually occurs before a channel change is decided. This procedure is optional.
12. SACCH fill-in information change procedure: With this procedure, the BSC instructs the BTS to change the fill-in information (system message) on a specific SACCH.

Channel Establishment

1. Channel activation

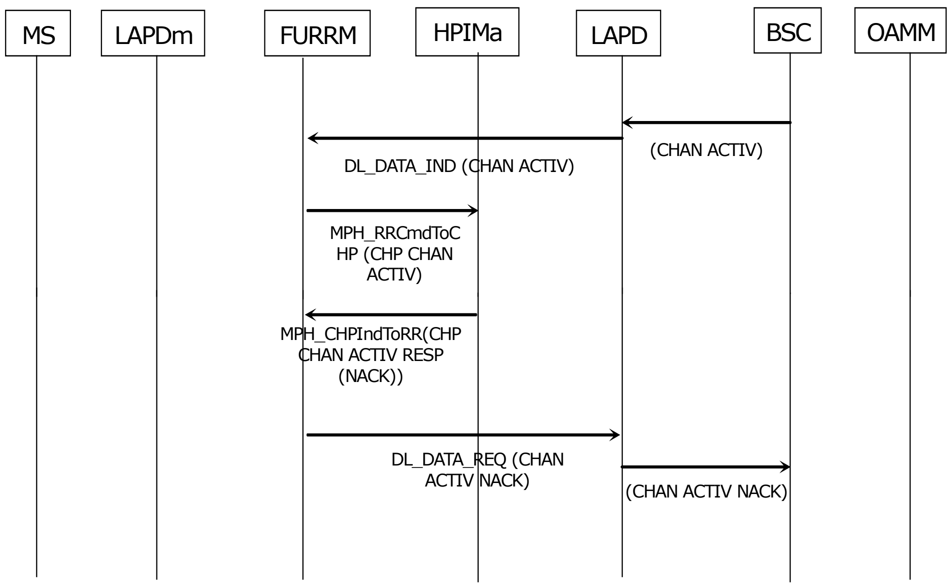
   The procedure of activating a channel successfully is shown in Figure 42.

FIGURE 42 CHANNEL ACTIVATED SUCCESSFULLY



A channel activation failure is shown in Figure 43.

Figure 43 Channel Activation Failed



The TRX detects the MS random access request on the RACH, and activates a channel for the MS.

The BSC decides to use which channel, and sends the CHAN ACTIV message to the TRX to enable that channel. This message contains the activation reason (immediate assignment, allocation, asynchronous/synchronous and additional allocation), channel ID and complete channel description (full/half rate, voice/data, code/rate adaptation, frequency hopping sequence, key, etc.).If there is encrypted information, it uses the encryption activation mode.

When the FURRM module receives the CHAN ACTIV message, it sends related information unit (activation reason, etc.) contents to the CHP for processing through the HPIMan module, and reports the results to the BSC when the response arrives.

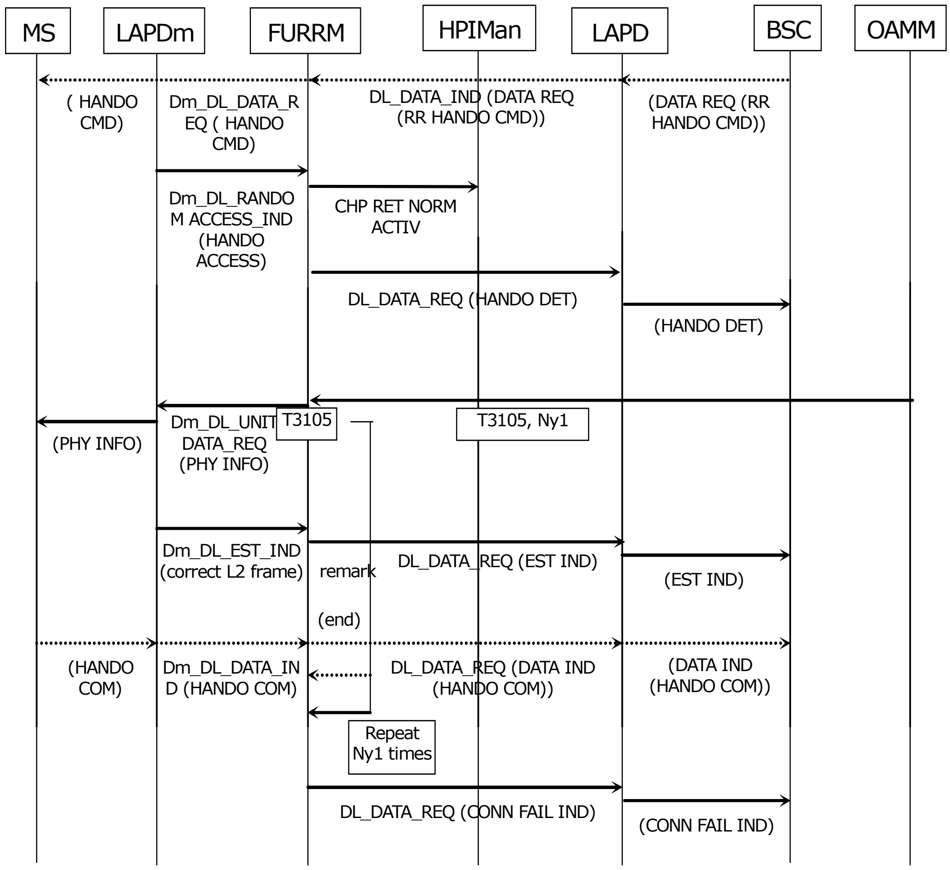
When the channel is activated, the TRX responds with the CHAN ACTIV ACK message that contains the number of the current frame with the BTS. The BSC uses this frame number to decide the Starting Time parameter in the immediate assignment message that will be then sent to the MS side.

If the TRX cannot activate the channel, it will return the CHAN ACTIV NACK message that contains the failure cause. The reason may be O&M interference (channel blocked, for example), no resource (no voice encoder, for example), equipment error, channel activated, etc.

2. Handover

   The handover flow is shown in Figure 44.

FIGURE 44 HANDOVER



The handover enables an MS in the dedicated mode to move into another channel of another cell.

When the BSC receives the HANDO REQ message from the MSC, the BSC enables the new channel activation procedure. The CHAN ACTIV message sent to the TRX contains Handover Reference, which will be used to detect the Handover Access message from MS.

When the channel for handover is activated, the FURRM uses the CHP RET NORM ACTIV message to notify the CHP to resume the normal mode.

The FURRM should save the Handover Reference in the CHAN ACTIV message, to compare it with the Handover Reference in the Handover Access message that is sent by the LAPDm.

The (RR) HANDOVER COMMAND message is sent on the active DCCH. This transparent message contains new channel characteristics, power command, physical channel establish procedure indication, handover reference, time lead (optional) and encryption mode setting (optional).It also controls whether to connect MS first in synchronous activation mode.

About the physical channel establishment, in case of synchronous handover, when MS is to be connected on the allocated channel, it will send four (RR) HANDOVER ACCESS messages on the active DCCH in one access burst, whose content is the handover reference information unit. The BTS starts message transmission immediately over the active channel in the specified mode. The message is encrypted if there is an encryption indication. If there are MS power and time lead, or only MS power, the BTS will use the parameter to start the send on SACCH. When the BTS receives one access burst with correct handover reference or one correct decoding frame, the BTS starts the normal receiving procedure on the active channel and SACCH, and starts the handover detection procedure that is sent to the BSC. The measured access burst delay is contained in the HANDO DET message.

In asynchronous handover, when MS is connected to the allocated channel, the first half procedure is the same as that in the synchronous handover (see above).When the HANDO DET message is sent, the BTS sends the (RR) PHY INFO message to MS in non-acknowledgement mode on the active signaling channel, and starts T3105 at the same time. If T3105 expires before a correct decoding frame is received, the message will be resent. If no correct decoding frame is not received when the message has been resent for Ny1 times, the BTS will send to the BSC a CONNECTION FAILURE message with the cause “Handover access failed”. When the message is received, the network side will disconnect the new channel. Then, it enters the RR session release procedure to release the channel and link.

Pseudo-synchronous cell case: Same to the synchronous case. When the bottom connection is established, the MS returns a (RR) HANDOVER COMPLETE message (transparent) on the active DCCH. If the bottom connection fails, the MS returns a HANDOVER FAILURE message. When the message is received, the network side will disconnect the new channel and enter the RR session release procedure.

The two parameters T3105 and Ny1 are sent by the OAMM module to the FURRM during the system initialization.

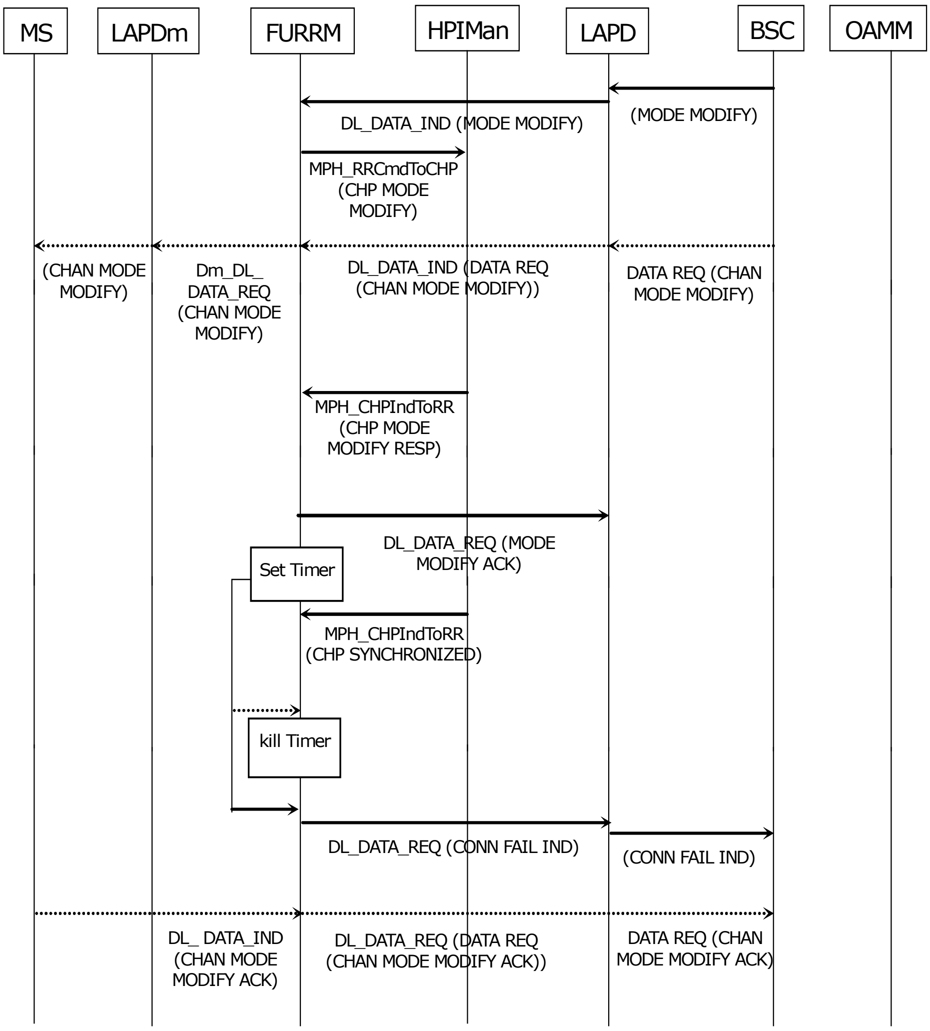
Remarks: Same to the link establishment. For the service mode TCH channel, the synchronous message is waited for after the link establishment.

Channel Mode Change

1. Mode modification

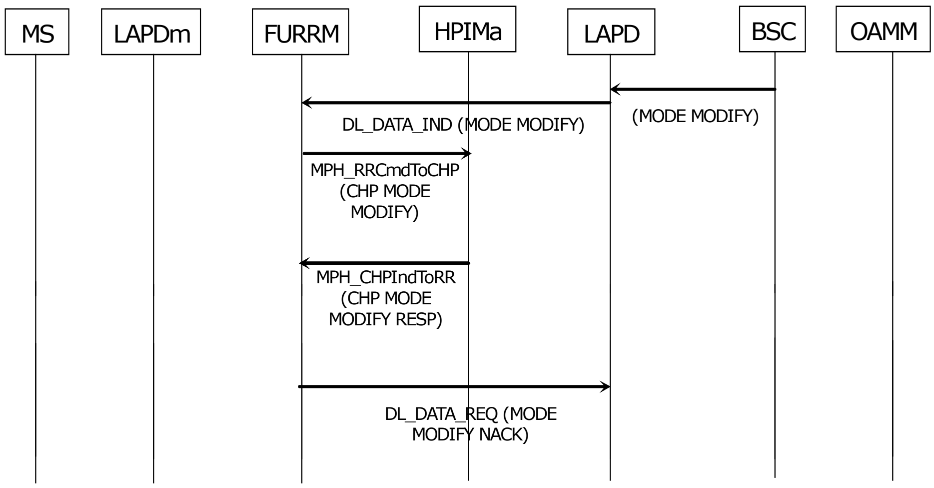
   The successful mode modification is shown in Figure 45.

FIGURE 45 MODE MODIFIED SUCCESSFULLY



The failed mode modification is shown in Figure 46.

FIGURE 46 MODE MODIFICATION FAILED



The BSC requests to change the channel mode of an activated channel.

The BSC sends a MODE MODIFY to the BTS to trigger the reconfiguration of the BTS. When the BTS receives the message, it modifies the encoding and decoding algorithms (the CHP module implements this operation), and modifies the inband mode of the BTS-TRAU frame. After it changes into the new mode, the BTS returns a MODE MODIFY ACK message. If the TRX cannot change the mode for some reasons, it returns a MODE MODIFY NACK message.

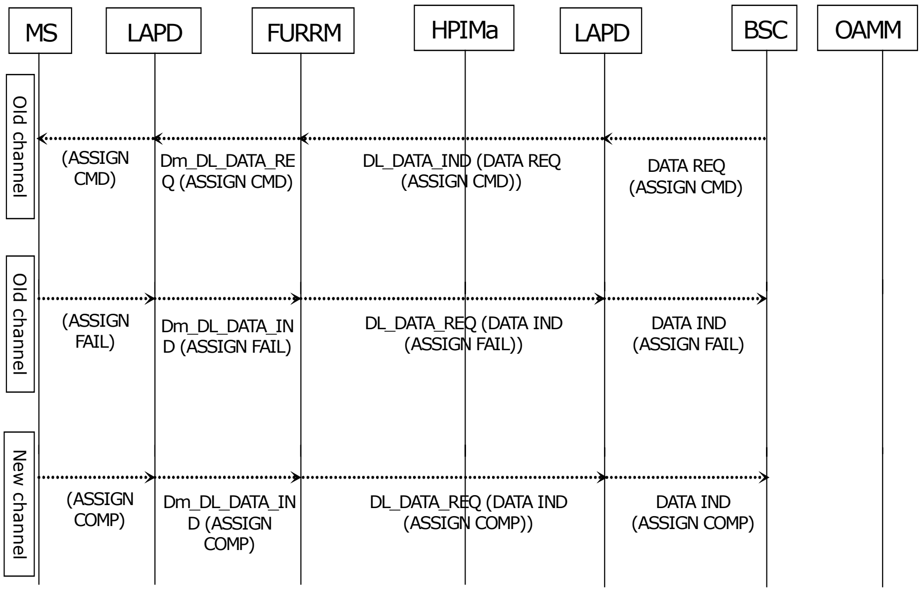
If the response message indicates the successful mode change and the TCH channel changes into the service mode, the FURRM starts the timer to wait for the CHP SYNCHRONIZED message for the synchronization between CHP and TC. If the message is not received when the timer expires, it sends the CONN FAIL IND message to the BSC.

At the same time, the BSC sends a (RR) CHANNEL MODE MODIFY message that contains the new mode to be used to trigger the reconfiguration of the MS. When it is implemented, the MS responds with the (RR) CHANNEL MODE MODIFY ACKNOWLEDGE message to the BSC through the BTS. If the MS does not support the channel to be modified, it will keep its original mode, and place related information in the CHANNEL MODE MODIFY ACKNOWLEDGE message. These two are transparent messages.

2. Connection allocation

   The procedure of connection assignment is shown in Figure 47.

FIGURE 47 CONNECTION ASSIGNMENT



The wireless link is changed in the same cell.

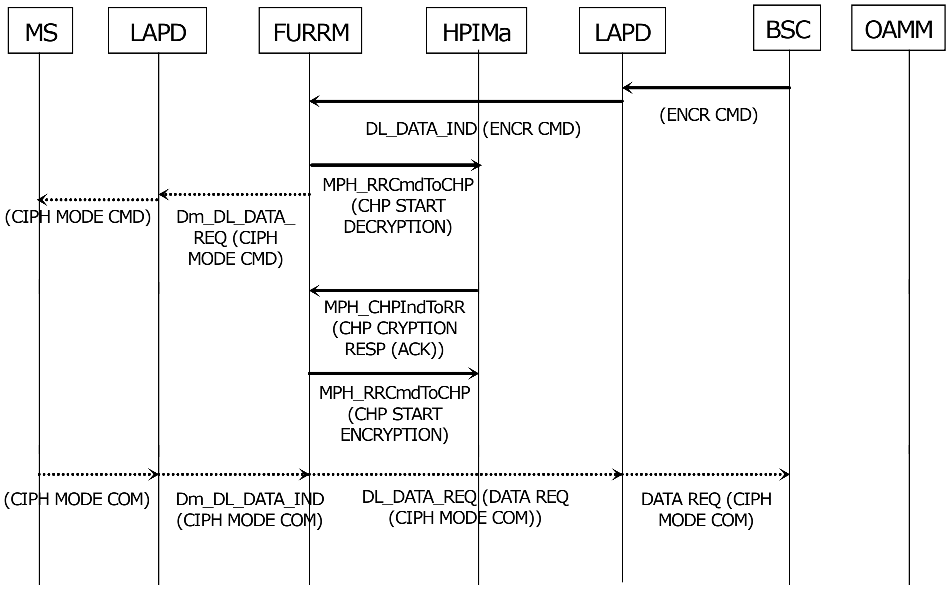
The BSC commands the BTS activation through a simple request/acknowledgement procedure (see the CHAN ACTIV and CHAN ACTIV ACK of the "access" procedure).Once the BTS is activated, the BSC commands the MS to perform channel change through the (RR) ASSIGNMENT COMMAND message. When the MS changes its settings according to the new information and establishes a new signaling link, the MS sends a (RR) ASSIGNMENT COMPLETE message to the BSC. If the MS cannot implement the connection allocation for some reasons, it will send the (RR) ASSIGNMENT FAILURE message on the original channel.

The FURRM transfers transparently the (RR) ASSIGNMENT COMMAND, (RR) ASSIGNMENT COMPLETE and (RR) ASSIGNMENT FAILURE messages.

Encryption

The encryption is shown in Figure 48.

FIGURE 48 ENCRYPTION



To set an encryption mode for the network means specifying whether the transmission needs to be encrypted and which algorithm should be used.

This procedure is initiated after the BSC receives the CIPHER MODE COMMAND message from the MSC. The ENCR CMD message that is sent by the BSC to the TRX and related channel contains all information to be selected, loading user data, encryption equipment and the complete (RR) CIPH MODE CMD message that is sent to the MS.

When the ENCR CMD is received, the TRX sends the (RR) CIPH MODE CMD to the MS in the non-encryption mode, and begins the decryption at the same time (the CHP implements this operation).The BTS, at this time, actually sends configurations in the old mode, and receives configurations in the new mode.

When the MS receives the (RR) CIPH MODE CMD, it will be configured into the complete new mode, and sends the (RR) CIPH MOD COM to the BTS. Whenever the BTS receives a correctly decoded message (in the new mode), it indicates that the MS has been correctly changed into the new mode. Only after that, the BTS fully changes into the new mode, and the sending is also in the new mode (the CHP implements this operation).

If the TRX cannot implement encryption according to the ENCR CMD requirement for some reasons, the CHP sends the CHP CYPTION RESPONSE (NACK) message to the FURRM, and then the FURRM returns an ERROR REPORT message, with the cause “Encryption algorithm cannot be executed” for example.

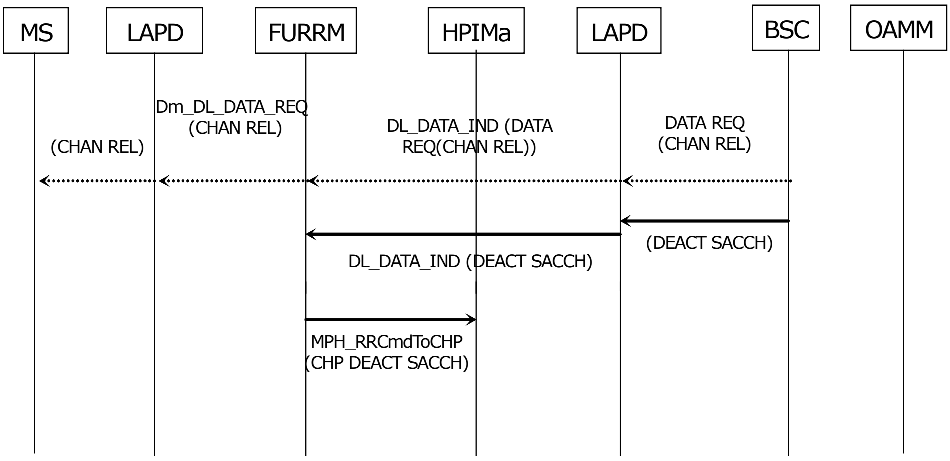
If the (RR) CIPH MODE CMD message is considered wrong, the MS returns a (RR) RR STATUS message with the cause “Protocol error unspecified” and perform no operation after that.

Channel Release

1. SACCH deactivation

   The procedure of SACCH deactivation is shown in Figure 49.

FIGURE 49 SACCH DEACTIVATION



The BSC releases the SACCH in the BTS according to the (RR) CHANNEL RELEASE procedure.

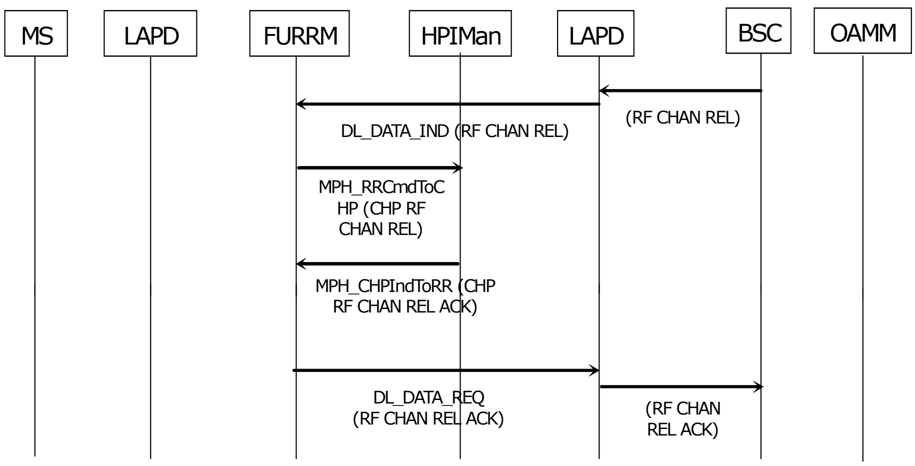
When the BSC sends the (RR) CHANNEL RELEASE, it sends the DEACT SACCH message to the BTS, to command the BTS to stop transmitting the downlink SACCH frame.

The FURRM module sends the related information in the DEACT SACCH message to the CHP for processing.

2. Wireless channel release

   The wireless channel release procedure is shown in Figure 50.

FIGURE 50 WIRELESS CHANNEL RELEASE



The BSC releases a wireless link that is not used any longer.

When an activated wireless channel is not used any longer, the BSC will send a RF channel release message (RF CHAN REL) to the related TRX and channel. The CHP module processes the channel release. When the related resources are released, the BTS returns a RF channel release acknowledgement message (RF CHAN REL ACK) to the BSC. If the CHP cannot release the channel successfully, the FURRM will send the ERROR REPORT message to the BSC.

SACCH Procedure

1. Measurement report

The data from the MS and BTS measurement results are processed by the BSC and will be used for the transmission power control and handover preparation.

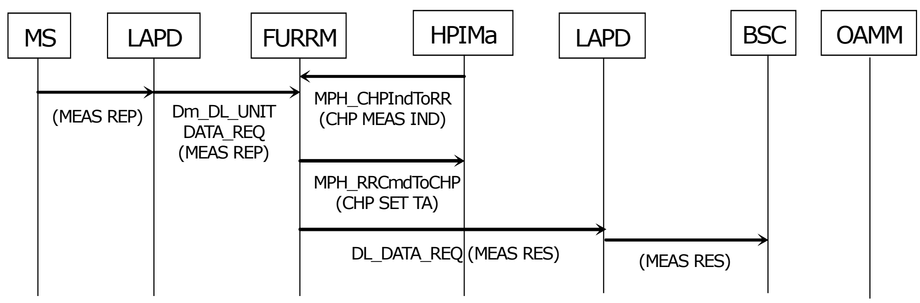
The MS measurement result is in the (RR) MEASurement REPort message and will be reported once every SACCH block (480 ms), or if the SACCH is being used by other signaling, reported once every two SACCH blocks (960 ms).The TRX measures the level and quality of the received signals in the current uplink channel. The average time is the period of one SACCH block. The (RR) MEASurement REPort message that is sent by the MS to the BTS contains the measurement results for the dedicated channel and adjacent cells.

The BTS and MS measurement results form basic original data that must be transmitted on the Abis interface. See "Basic measurement report" for details. In addition, the BTS and BSC also support preprocessing for these basic measurement data in BTS, to lessen the signaling load on the Abis interface. See "Measurement report preprocessing" for details.

The FURRM receives the CHP measurement report ahead of the MS measurement report. As a result, when the FURRM triggers group sending of the Abis MEAS RESULT according to the CHP measurement report, the problem of timing adjustment arises.

The basic measurement report is shown in Figure 51.

FIGURE 51 BASIC MEASUREMENT REPORT



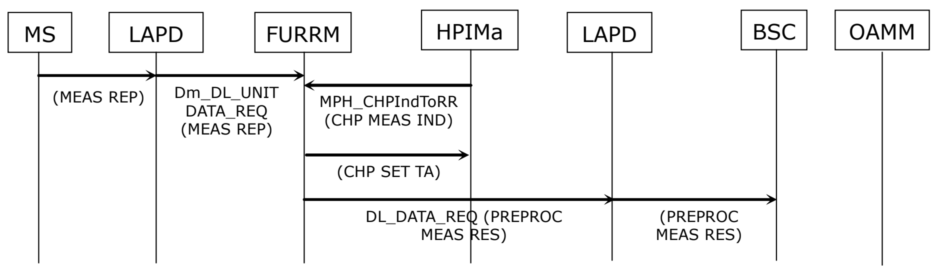
The BTS reports the basic wireless measurement results (GSM 05.08 and GSM 05.05) that are generated by the MS and TRX.

This procedure is a default procedure, unless another plan (preprocessing, as described below) is used.

The TRS places these results in the MEAS RES message and reports to the BSC. The sending of this message is synchronous with the receiving of the SACCH block from the MS. If this uplink SACCH block does not contain the measurement report from the MS (in case of short messages, for example), the MEAS RES that is sent by the BTS will indicate this.

The procedure of measurement report preprocessing is shown in Figure 52.

FIGURE 52 MEASUREMENT REPORT PREPROCESSING

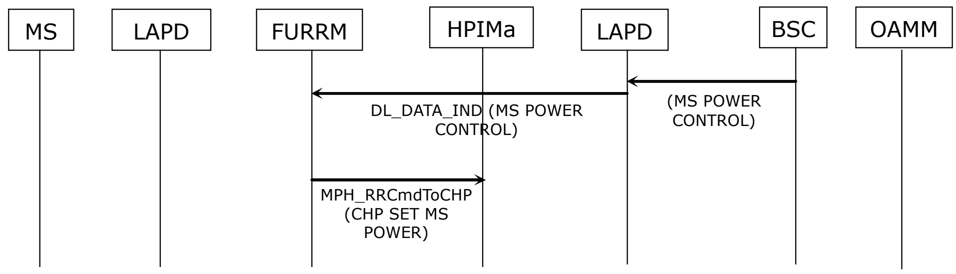


The BTS first preprocesses the MS measurement report, and then sends it together with the BTS measurement result to the BSC through the PREPROC MEAS RES message.

2. Power control

   The MS power control is shown in Figure 53.

FIGURE 53 MS POWER CONTROL



The BSC sets the MS power control parameters according to the TRX requirement.

The initial parameters are set in the CHAN ACTIV message by the BSC. If these parameters are to be changed, the BSC will send the MS POWER CONTROL message to the TRX.

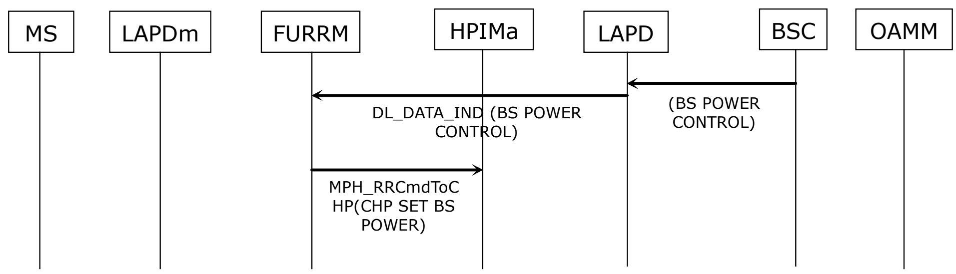
The BTS power control is optional, which is indicated by the parameters in the MS POWER CONTROL or CHAN ACTIV message. By changing the frame header of the power level L1 that is sent to the MS, the TRX tries to control the power control parameter within certain range according to the message requirement (the CHP module implements this operation).

When the BTS is executing the MS power control, the BSC can change the MS power parameters during the connection (caused by a level change of the MS power for example).

The MS POWER CONTROL and CHAN ACTIV messages must contain an MS-allowed maximum power value.

The procedure of BS power control executed by the BSC is shown in Figure 54.

FIGURE 54 BS POWER CONTROL



This optional procedure can have the BSC set the TRX transmission power level or the parameter that the TRX uses to control the TRX transmission power.

The initial parameters are set in the CHAN ACTIV message by the BSC. If these parameters are to be changed, the BSC will send the BS POWER CONTROL message to the TRX.

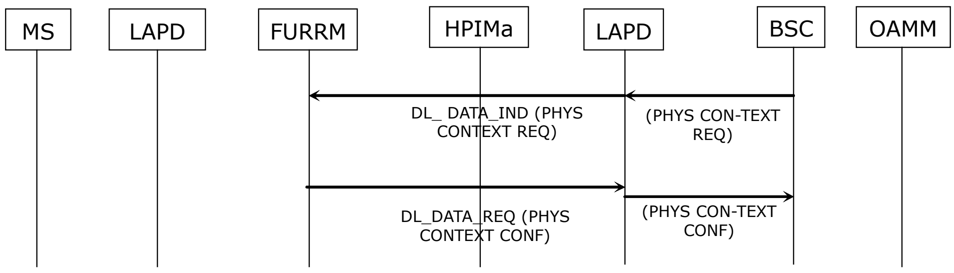
The BTS power control is optional, which is indicated by the parameters in the BS POWER CONTROL or CHAN ACTIV message. By changing the transmission power, the TRX tries to control the power control parameter within a certain range according to the message requirement (the CHP module implements this operation).

The maximum power of the TRX is determined by the network design specifications, but the BSC can specify a smaller maximum power value in the BS POWER CONTROL and CHAN ACTIV messages.

3. Physical environment request/acknowledgement

   The procedure of physical environment request/acknowledgement is shown in Figure 55.

Figure 55 Physical Environment Request/Acknowledgement



This optional procedure enables the BSC to obtain the physical environment information before the channel change.

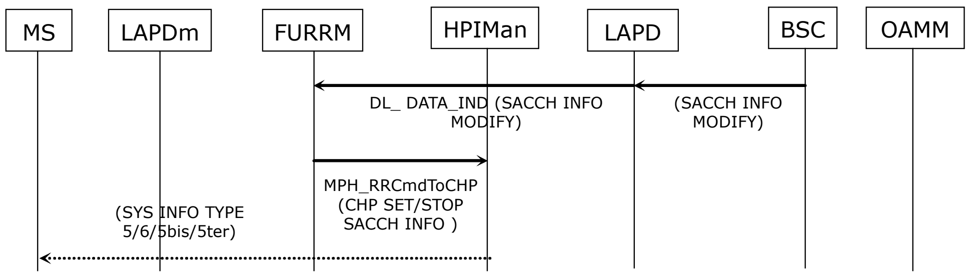
The physical environment information can be sent to a new TRX (which may be in another cell).

The PHY CONTEXT CONF message to be returned by the BTS to the BSC contains the MS/BS power and TA that are obtained from the channel , and the BTS does not process the physical environment information temporarily.

4. SACCH fill-in information change

   The procedure of modifying the SACCH fill-in information is shown in Figure 56.

Figure 56 Procedure of Modifying SACCH Fill-in Information



The BSC instructs the BTS that the new system message (<RR> System Information Type 5/5bis/5ter/6) will change the original system message that is filled in the SACCH.

The SACCH fill-in information in the SACCH INFO MODIFY message will be sent in the specified channel, till the channel is released or changed by another SACCH INFO MODIFY message.

When the BTS receives the SACCH INFO MODIFY message, it takes out the system message (<RR> System Information Type 5/5bis/5ter/6) and sends to the CHP module to change the original system information. If there is no system message content, it indicates that such system messages will stop being sent on this channel.

Public Channel Management Function

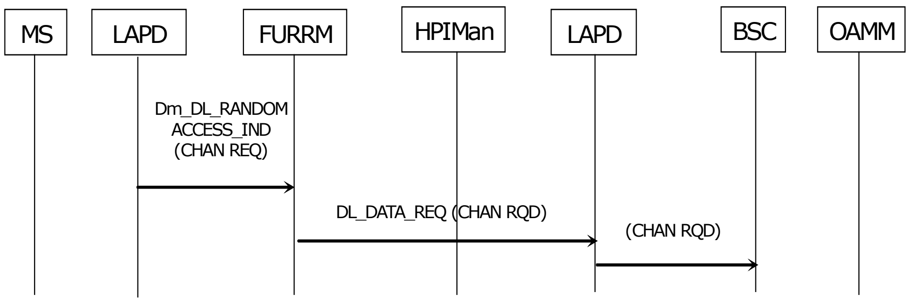
This function supports the following procedures:

1. MS channel request procedure: This procedure is triggered when the TRX detects the random access of an MS.
2. Paging procedure: This procedure is used to page an MS in the specified paging sub-channel. It is used for the mobile called, and is started by the MSC through the BSC. The BSC determines the paging team according to the IMSI of the called MS. The value of the paging team and the MS IMSI are sent to the BTS.
3. Immediate assignment procedure: With this procedure, the BSC immediately assigns a dedicated channel to the MS that just accesses the BTS.
4. Deletion indication procedure: With this procedure, the BTS gives the BSC an indication that an immediate assignment message is deleted due to overload on the AGCH.
5. CCCH overload indication procedure: With this procedure, the BTS indicates to the BSC the load of the specified CCCH.
6. Broadcast information change procedure: With this procedure, the BSC indicates to the BTS the new system messages broadcast on the BCCH.
7. Short message cell broadcast procedure: With this procedure, the BSC requests the BTS to send the cell broadcast short message.

Access Request

The access request is shown in Figure 57.

FIGURE 57 ACCESS REQUEST



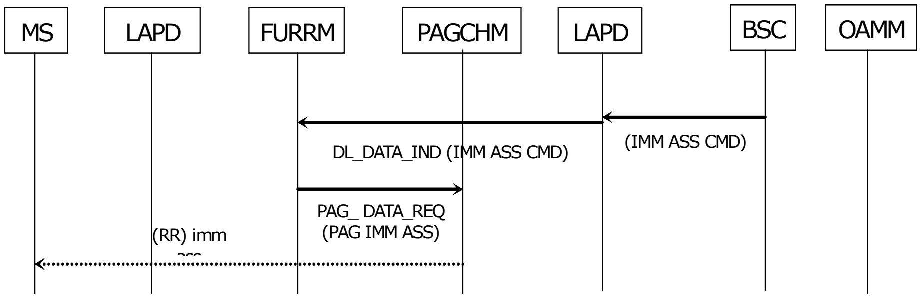
When the TRX receives the MS random access request, it sends the channel request message to the BSC.

The CHAN RQD message contains the Request Reference parameter (MS-selected random number, low-order bit of the TDMA frame number) and access burst pulse sequence measurement delay.

Immediate Assignment

The procedure of immediate assignment is shown in Figure 58.

FIGURE 58 IMMEDIATE ASSIGNMENT PROCEDURE



The immediate assignment message is transmitted in the downlink CCCH (AGCH) channel.

The immediate assignment message that is from the network side may be (RR) IMMEDIATE ASSIGNMENT, (RR) IMMEDIATE ASSIGNMENT EXTENDED or (RR) IMMEDIATE ASSIGNMENT REJECT. On the Abis interface, it is contained in the IMM ASS CMD message, which contains complete the "immediate assignment" message and where the "paging mode" unit is set as "unchanged". When this message is received, the FURRM sends it to the PAGCHMan sub-module of the PAGCHM module. That sub-module places the message in the buffer. When the trigger is received from the ISR, the PAGCHDaemon sub-module of the PAGCHM module forms the messages in the waiting queue into the (RR) IMMEDIATE ASSIGNMENT EXTENDED or (RR) IMMEDIATE ASSIGNMENT REJECT message and sends to the CHP. Before the sending, the BTS changes the "paging mode".

If no channel can be assigned, the BSC sends the (RR) IMMEDIATE ASSIGNMENT REJECT on the same CCCH timeslot where the channel request message is received.

If the downlink CCCH is overloaded, the FURRM sends the DELETE IND message to the BSC, notifying that an IMM ASS CMD command is deleted.

Paging

The paging procedure is shown in Figure 59, and the MS paging response is shown in Figure 60.

FIGURE 59 PAGING

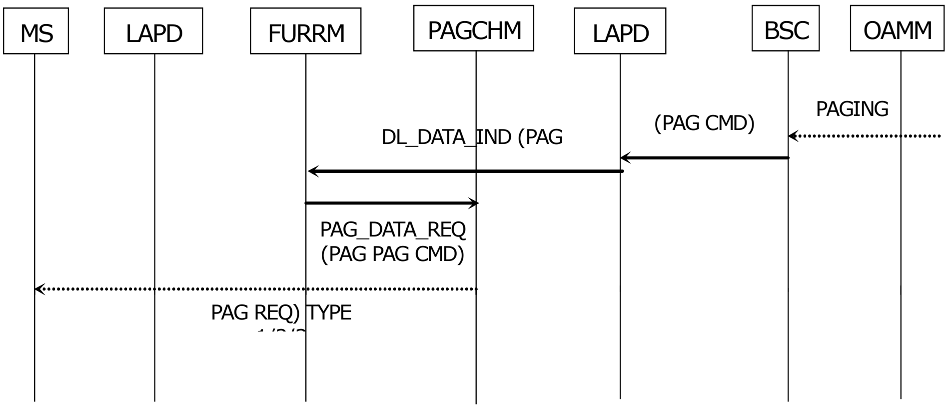
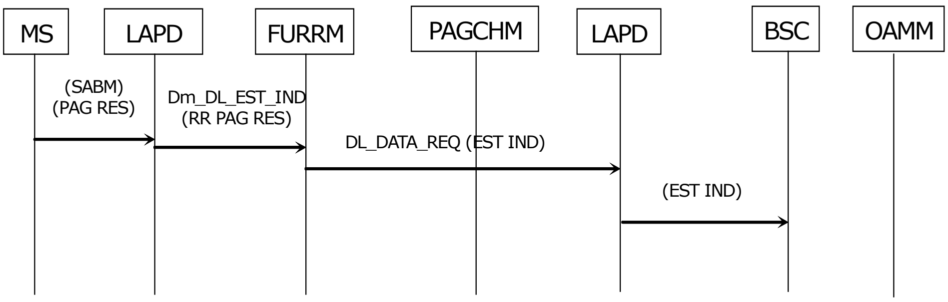


FIGURE 60 PAGING RESPONSE



Page an MS in the specified paging sub-channel.

The PAG CMD message contains the MS ID (TMSI or IMSI) and paging sub-channel number, or additional call-related channel combination that is indicated to the MS and will be used for follow-up processing.

The (RR) PAGing REQuest type 1/2/3 messages are buffered by the PAGCHMan sub-module of the PAGCHM module. The PAGCHDaemon sub-module combines and sends them, and calculates the correct DRX (paging message arrangement) paging block to correctly transmit them.

When the MS receives the (RR) PAGing REQuest message and is allowed to access the network, it triggers the immediate assignment procedure. The main signaling link establishment is triggered by SABM, and the SABM's information fields contain the (RR) PAGing RESponse message.

Short Message Cell Broadcast

The short message cell broadcast procedure is shown in Figure 61 and Figure 62.

FIGURE 61 PROCEDURE OF SHORT MESSAGE CELL BROADCAST REQUEST

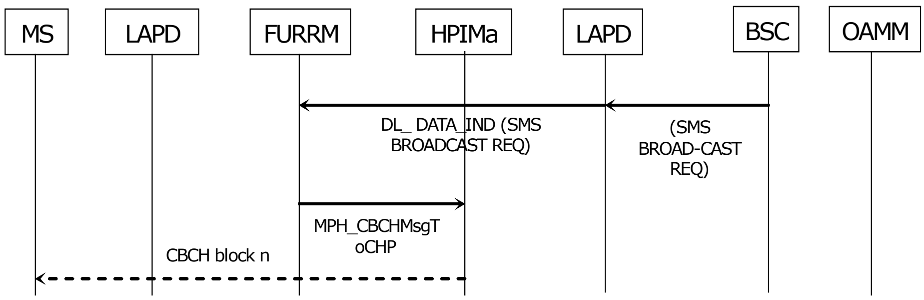
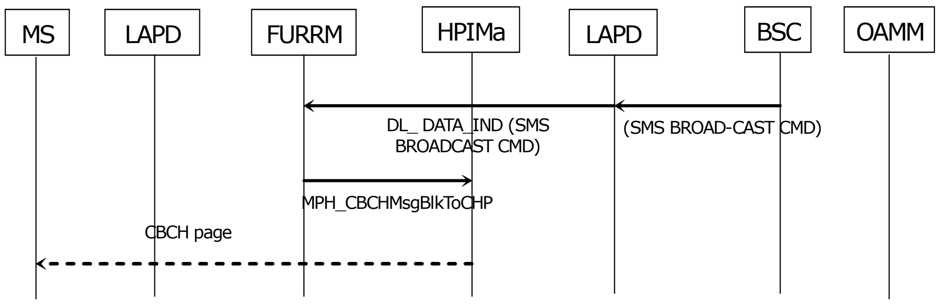


FIGURE 62 PROCEDURE OF SHORT MESSAGE CELL BROADCAST COMMAND



The BSC sends the Short Message Service Cell Broadcast messages to the BTS.

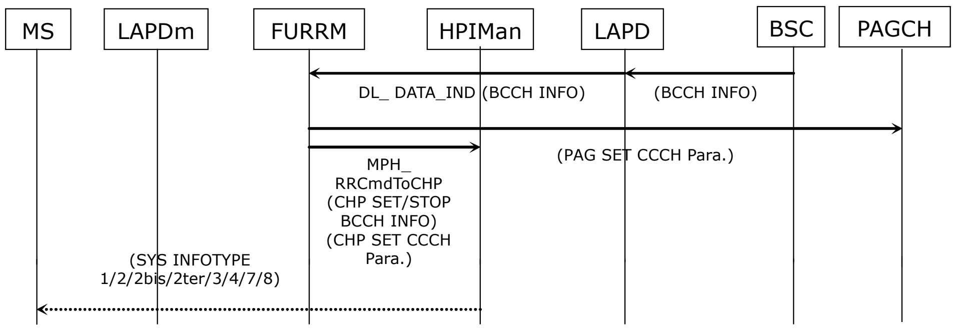
These messages are sent by the BSC to the BTS with the SMS BROADCAST REQ or SMS BROADCAST CMD message. In these two messages, the BSC considers the CBCH capacity and then queues, repeats and transmits the messages. The BSC also splits the SMS Cell Broadcast message on the air interface. The difference between the two messages is that, the SMS BROADCAST CMD message can request broadcasting of a complete cell broadcast message (sent in every message by pages) and the BTS splits it into blocks. For the SMS BROADCAST REQ message, it has been split by the BSC, 23 bytes per block.

With the SMS BROADCAST CMD message, the BSC can set the BTS broadcast to the default mode. When there are no other messages to be broadcast in this mode, the BTS will send a default message.

Broadcast Information 1 Change Procedure

The procedure of broadcast information 1 change is shown in Figure 63.

FIGURE 63 BROADCAST INFORMATION 1 CHANGE PROCEDURE



The BSC indicates to the BTS that the new system messages (like (RR) System Information Type 1/2/2bis/2ter 3/4/7/8) will be broadcast on the BCCH.

When the BTS receives the BCCH INFO message, the FURRM module will send the CHP SET BCCH INFORMATION message to the CHP if there is any system message. Then, the CHP sends it to the MS. If there is no system message, the FURRM module will send the CHP STOP BCCH INFORMATION message to the CHP, indicating to stop sending these system messages to the MS.

For easy observation of the system message sending, the TRU panel of the BTS has a signal indicator marked as "MOD".

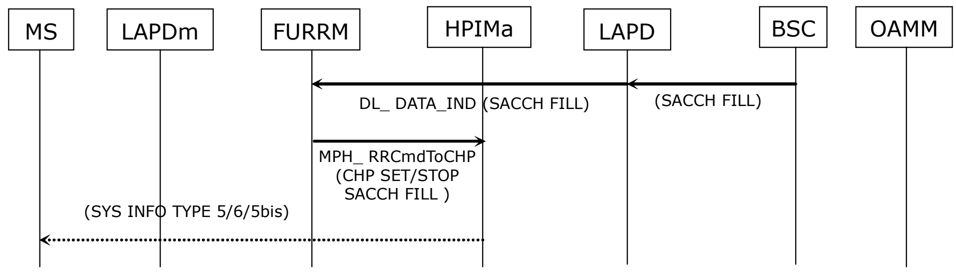
System Information Type 1 contains the RACH control parameter and cell configurations, and System Information Type 2 contains the RACH control parameter and BCCH configurations of adjacent cells. The System Information Type 2bis and System Information Type 2ter are optional messages, containing the BCCH extended configurations of the adjacent cells. System Information Type 3 contains the location area ID, cell ID and other cell information, and System Information Type 4 contains the RACH control information, location area ID, cell ID and other information. The System Information Type 7 and System Information Type 8 contain cell reselection parameters.

The FURRM takes out three parameters (BS_PA_MFRMS, BS_AG_BLKS_RES and CCCH_CONF) from the Control Channel Description information unit of the System Information Type 3 message, and sends them to the CHP and PAGCHM modules.

Broadcast Information 2 (SACCH FILL) Change Procedure

The broadcast information 2 (SACCH FILL) change procedure is shown in Figure 64.

FIGURE 64 BROADCAST INFORMATION 2 (SACCH FILL) CHANGE PROCEDURE



The BSC indicates to the BTS that the new system information ((RR) System Information Type 5/6/5bis/5ter) will be sent in the downlink SACCH as fill-in information, generally when channel connection starts (especially after a handover) and the channel changes.

When the FURRM receives the SACCH FILL message, it takes out the information unit and sends it to the CHP module for the system message transmission. If it does not receive the message, it indicates that the system message sending will stop.

The System Information Type 5 contains the adjacent cell BCCH frequency table. The System Information Type 5bis and System Information Type 5ter contain adjacent cell BCCH extended configuration information. The System Information Type 6 contains the location area ID and cell ID.

When the fill-in information uploaded in the SACCH needs to be changed, the BSC will send a SACCH INFO MODIFY message to the BTS. The SACCH fill-in information in this message will be transmitted in the specified channel, till the channel is released or changed by another SACCH INFO MODIFY message.

TRX Management Function

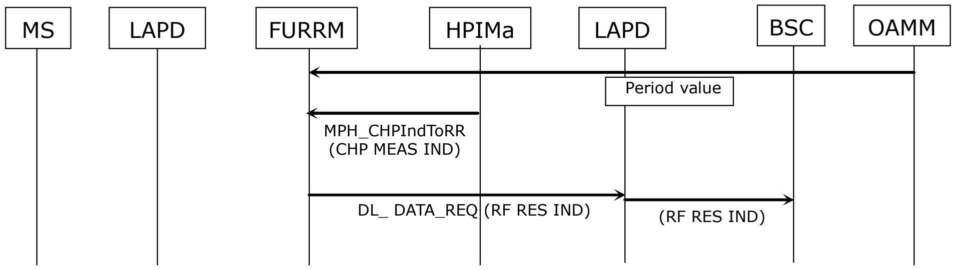
This function supports the following procedures:

1. Radio resource indication procedure: With this procedure, the BTS gives the BSC an indication of interference level on the idle dedicated channel of each TRX.
2. Flow control procedure: The FUC indicates overload of this TRX to the BSC, including the following possible causes: CCCH overload, ACCCH overload and processor overload.
3. Error report procedure: With this procedure, the BTS reports to the BSC the detected downlink message error that cannot be reported with other procedures.

Radio Resource Indication

The radio resource indication is shown in Figure 65.

FIGURE 65 RADIO RESOURCE INDICATION



It notifies the BSC the interference level of the idle channel of one TRX.

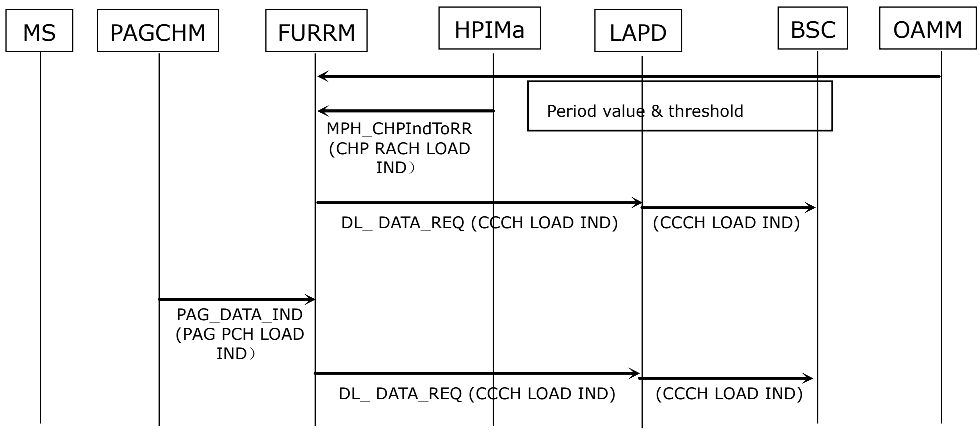
The interference level value of the idle channel is provided by the CHP, and reported in the CHP MEASUREMENT INDICATION message, just like the measurement report. This message is reported once every 102 frames (51 multiframes) or 104 frames (26 multiframes).

Load Management

1. Load indication

   The procedure of load indication on the common channel is shown in Figure 66.

FIGURE 66 PROCEDURE OF LOAD INDICATION ON PUBLIC CHANNEL



   The BTS gives the BSC the load information in a specific CCCH timeslot, mainly involving RACH and PCH loads.

   The CHP calculates the exact load on the RACH. The PAGCHM calculates the load on the PCH. The thresholds and sending period are configured in the OAMM.

2. General overload

The BTS instructs the BSC that the receiver must reduce the traffic. According to the protocol, it can be used to indicate the TRX overload, downlink CCCH overload and ACCH overload.

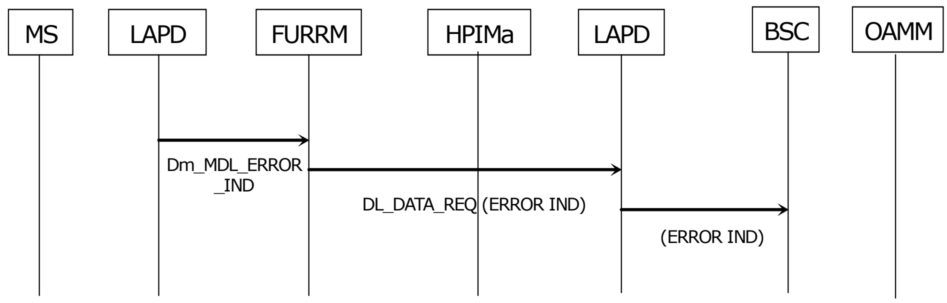
The TRX processor provides data from the bottom running operating system. The downlink CCCH load calculation is just the same as the above-mentioned CCCH LOAD IND, the CHP provides the RACH load, and the PAGCHM provides the PCH load. The ACCH load calculation is not determined.

According to the negotiation with the BSC, the current general overload (OVER LOAD) is only used to report the RACH load that is provided by the CHP.

Error Indication

The procedure of error indication is shown in Figure 67.

FIGURE 67 ERROR INDICATION



The ERROR IND message that is sent from the BTS to the BSC indicates to the BSC that the following abnormities happen in the radio data link layer.

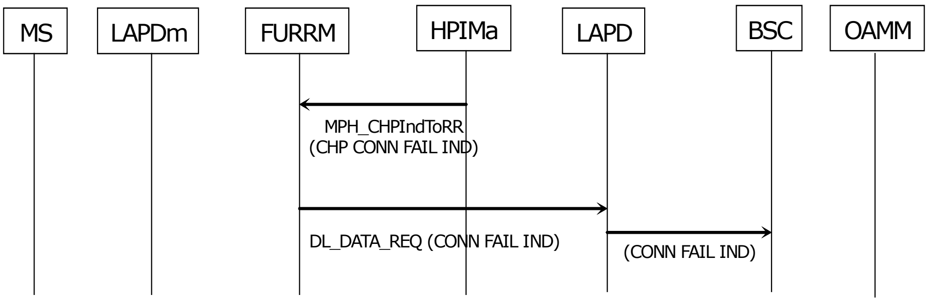
The ERROR IND message contains the related error cause information, including the following causes:

1. Protocol errors, as listed in Sections 5.6.4, 5.7.3 and Appendix G in TS GSM 04.06;
2. Error with one link layer. In other words, the I frame is repeated for N200 times but is not acknowledged.
3. The SABM or DISC frame is repeated for N200 times but is not acknowledged.
4. The SABM frame received in the multiframe establishment status

Connection Failure

The procedure of connection failure is shown in Figure 68.

FIGURE 68 CONNECTION FAILURE



The CONN FAIL IND message that is sent from the BTS to the BSC indicates the BSC that one activated channel cannot be used as more for some reasons.

When this message is received, the network side will release the channel. The message contains the cause parameter, including the following causes:

1. Radio link fault (Section 5 in GSM 05.08): At the BTS, a fault can be judged according to the bit error rate of the uplink SACCH or the test condition of RXLEV/RXQUAL.
2. Hardware error (decoder fault, for example).
3. Others

The CHP module will report the error to the FURRM module. In addition, in case of failed handover or mis-synchronization between CHP and TC, the FURRM also sends this message to the BSC.

Error Report

The BTS sends the ERROR REPORT message to the BSC, notifying the following errors that cannot be reported with other procedures.

When the BTS receives the error message, it ignores the message and reports to the BSC. Here, the ERROR REPORT is the message involving all error causes other than the CHAN ACTIV NACK for channel activation and the MODE MODIFY NACK for channel mode modification.

The error causes include message ID error, message type error, message sequence error, information unit error, and channel status mismatch.

O&M

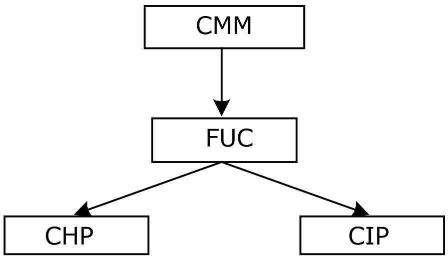
The BTS provides powerful O&M functions to implement management and maintenance of the BTS equipment. Main functions are divided into three parts: Parameter configuration, alarm and status report and software online loading.

Parameter Configuration

It supports the BTS parameter configuration by the BSC.

The parameter configuration flow is shown in Figure 69.

FIGURE 69 PARAMETER CONFIGURATION FLOW



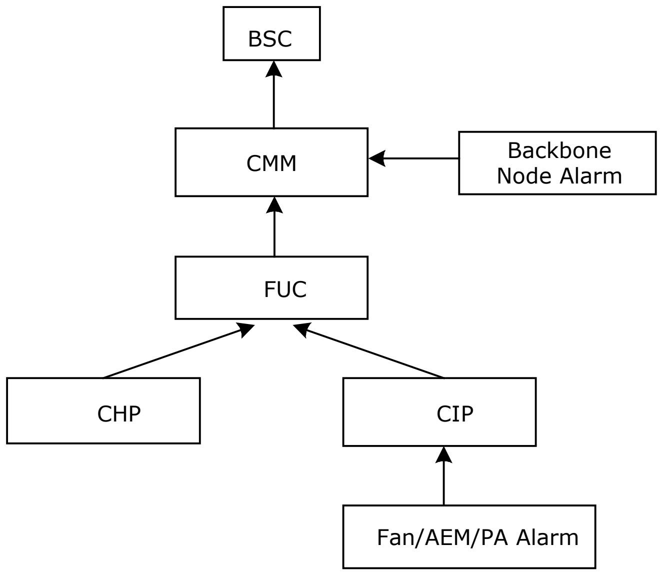
The messages from the BSC are sent to the CMM board through the BIE board through the LapD link, and then forwarded to application processes through the message distribution process of the Abis interface of the CMM software. The CMM configuration process processes the configuration messages and implements the BTS static data configuration by the BSC. The CMM software distributes the BSC parameters, and through the HDLC, configures the data to the TRM board FUC software that is managed by the CMM software. After receiving the configuration message from the CMM software, the FUC software configures the board attributes, notifies the CMM software of the successful configuration message at the same time, and configures the CHP and CIP.

Alarm and Status Reporting

The ZXG10-BTS (V2.9) supports reporting the alarms and status of the BTS to the BSC.

The alarm reporting flow is shown in Figure 70.

FIGURE 70 ALARM REPORTING FLOW



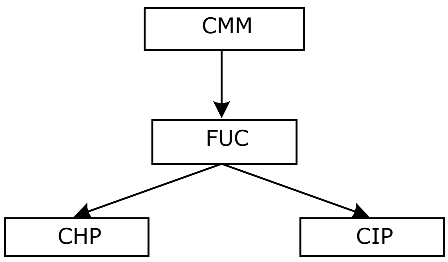
The CIP software collects the alarms of itself and the fan/AEM/PA alarms, and then reports them to the FUC software. The CHP software collects the alarms of itself and reports them to the FUC software. The FUC software reports the collected alarms and its own alarms to the CMM software. The alarms of the backbone nodes are collected by the CMM software, which reports all alarms of this site to BSC through LapD, and implements some relevant alarm processing, such as power amplification shut-down.

Online Software Loading

It supports the BTS software online loading by the BSC.

The software loading flow is shown in Figure 71.

FIGURE 71 SOFTWARE LOADING FLOW



All software versions are downloaded into the CMM's FLASH memory through the BSC. The CMM validates the versions, and loads the software to the FUC when it finds any difference with the TRM software.

The TRM software is stored in the FLASH memory on the FUC board. After the DSP is restarted, the FUC software loads the CHP software to the CHP and CIP through the HPI interface.

The software loading procedure is described as follows:

1. The CMM sends to the FUC the “software loading initialization” message.
2. The FUC returns the CMM the “software loading initialization finished” message.
3. The CMM divides the software versions into message segments and sends them to the FUC one by one.
4. When all software data are sent, the CMM sends to the FUC the “software loading finished” message.
5. The FUC returns the CMM the “software loading finished acknowledgement” message.

Ultra Distance Coverage

Configured into a super-large cell, theoretically, it can support the ultra distance cell with a coverage radius of up to 120 km.

According to the GSM protocol, the maximum access radius of the GSM system is 35 km, and the corresponding time advance (TA) is 63. Some application cases, however, require a coverage radius of larger than 35 km(i.e. time advance is greater than 63), such as ocean and islands, desert and rare route area.

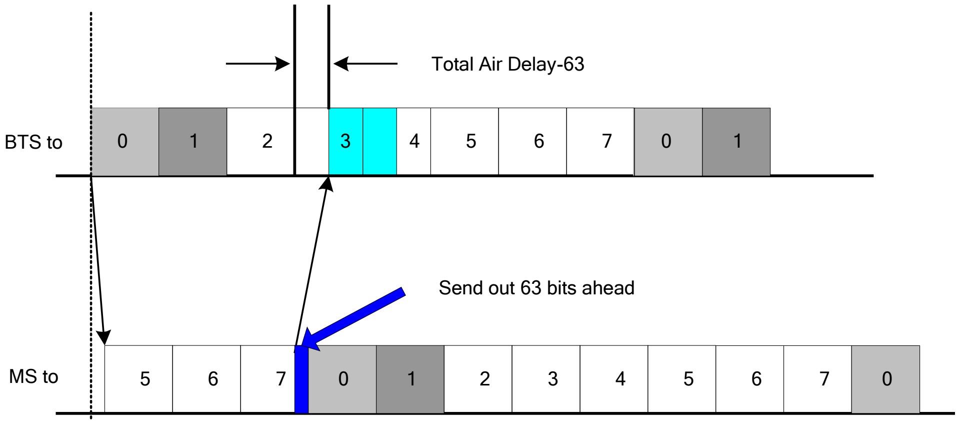
When the coverage radius is larger than 35 km, the MS should support a time advance > 63. However, the GSM900 MS can only recognize the time advance of up to 63. It is impractical to upgrade the great number of existing MSs, so the BSS should be upgraded to break the 35 km limitation.

The system implementation plan is: To implement the functions of one channel by using two timeslots. In this way, the software processing may guarantee the coverage is within 0 km ~ 120 km in radius.

In the case the GSM900 system has a coverage of larger than 35 km in radius, when an MS sends a channel request, the access burst pulse received at the BTS side will cross two timeslots, so the control channel needs two physical channels, which are two continuous timeslots.

The maximum timing advance of the MS on a wireless interface is 63. When the air delay is greater than 63, the time when the signal arrives at the BTS will cross two timeslots, as shown in Figure 72. As a result, the dedicated control channel and service channel need two adjacent physical channels too.

FIGURE 72 DELAY RELATIONS



When the BTS uses two timeslots to process the data of one subscriber, the second timeslot is called the extended channel, a shown in Figure 73.

FIGURE 73 EXTENDED CHANNEL

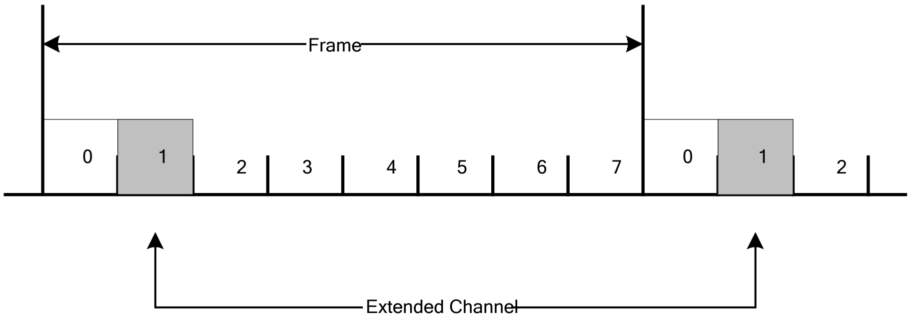


Figure 74 shows an extended carrier. As shown in the figure, the original TRX can provide eight physical channels, but the number of physical channels is reduced by half after the channels are extended.

FIGURE 74 THE ACTUAL NUMBER OF PHYSICAL CHANNELS IN A CARRIER

OriginalTRX	0	1	2	3	4	5	6	7
Extended Channel TRX	0		1		2		3	

With extended channels, the coverage of the BTS is theoretically up to a radius of 120 km, and the maximum time advance is 219.Due to the relatively large transmission loss and the problems in uplink and downlink balancing, the actual coverage radius in the GSM900 is less than 120 km.

Chapter 5

Networking Modes and System Configurations

This chapter introduces the networking modes, system configurations, and networking examples of the ZXG10-BTS (V2.9).

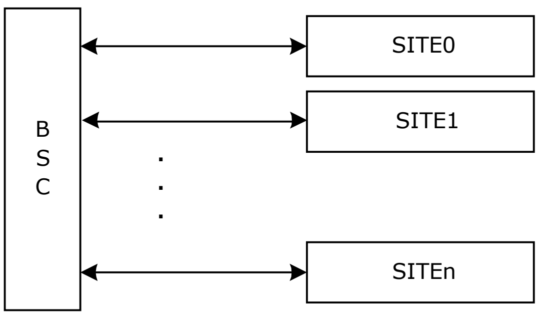
Networking Modes

The ZXG10-BTS (V2.9) is connected with the BSC through the Abis interface and supports these networking modes: Star, chain and tree networking.

1. Star networking mode

   The star networking mode of the ZXG10-BTS (V2.9) is shown in Figure 75.

FIGURE 75 STAR NETWORKING MODE OF ZXG10-BTS (V2.9)



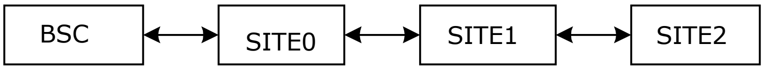
Each line represents a bidirectional E1 line. The specific ID DIP switch at the site should be set based on the actual configuration.

In star networking, n E1 PCM links are led into each SITE directly from BSC. The BTS device on each site is end equipment. The networking mode is simple, accompanied by convenient construction and maintenance. Since the signals are transmitted through fewer intermediate links along the path, the reliability of transmission is higher. This networking mode is typically employed in densely populated urban areas.

2. Chain networking mode

   The chain networking mode of the ZXG10-BTS (V2.9) is shown in Figure 76.

FIGURE 76 CHAIN NETWORKING MODE



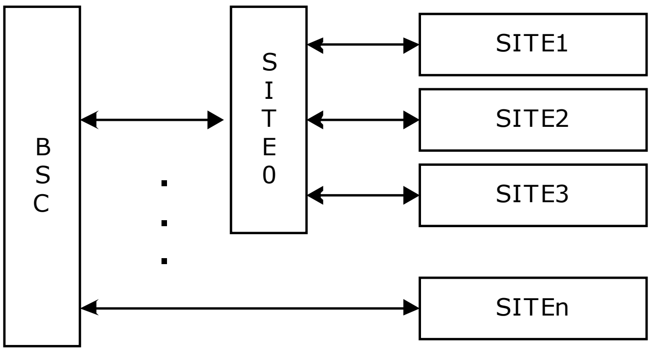
Each line represents a bidirectional E1 line. The specific ID DIP switch at the site should be set based on the actual configuration.

Chain networking is also applicable to the one-site multi-BTS situation. Since signals go through more links, the line reliability is relatively poor. This networking mode is applicable to stripe-like areas with a small population, thus saving a large number of transmission devices. To prevent the clock performance deterioration, it is recommended no more than four BTSs be cascaded in the chain networking mode.

3. Tree networking mode

   The tree networking mode of the ZXG10-BTS (V2.9) is shown in Figure 77.

FIGURE 77 TREE NETWORKING MODE



Each line represents a bidirectional E1 line. The specific ID DIP switch at the site should be set based on the actual configuration.

The tree networking mode is applicable to large yet sparsely populated areas. This mode is complicated, in which signals have to pass many nodes and the line reliability is relatively low. And the fault from the upper-level SITE may affect the proper running of the lower-level SITE. In the tree networking mode, the BTS connected with BSC is the central node, which may branch into five nodes, or BTSs.

In actual networking projects, due to the decentralized sites, unlike basic networking modes, the transmission equipment is usually used for intermediate connection between BSC and BTS. The transmission modes commonly employed are Microwave, optical cable, HDSL cable and coaxial cable. Satellite links can be used for special transmission modes.

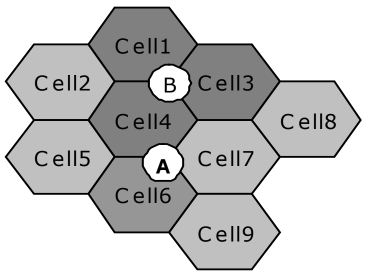
System Configuration

There are many ways of BS configuration. In common practice, a proper number and types of sites are selected to cater for the requirements of the operators as well as the concrete geographical environment, and a minimum hardware configuration should be used to meet the maximum traffic requirement.

Number and Types of Sites

A radio cellular mobile network, according to its frequency resources and cell planning, can be divided into a certain number of cells that abut on each other with one cellular system. Figure 78 illustrates the structure.

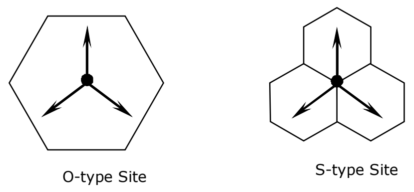
FIGURE 78 CELLS IN A CELLULAR SYSTEM



In the system, each cellular cell is covered by multiple radio channels. If an omni-antenna is employed, a base station will be set at the center of each cell (as A in the diagram). And if a directional sectorized antenna is used, the base station will be established at the intersection of three cells (as B in the diagram). Such a base station covers three adjacent cells, and in fact it contains at least three TRXs. Usually, a base station in this kind of network is called a site. The base stationsite with an omni-antenna covers only one cell; while the base stationsite with a directional antenna covers three cells.

There are two types of sites: O-type and S-type. An O-type site refers to an omni-directional cell. That is, all the frequencies of one site serve this O-type cell. An S-type site refers to a sectorized cell. Typically, a three-sector site is preferred; that is, each site has three sectors. Models of the O-type site and S-type site are shown in Figure 79.

FIGURE 79 TWO SITE TYPES

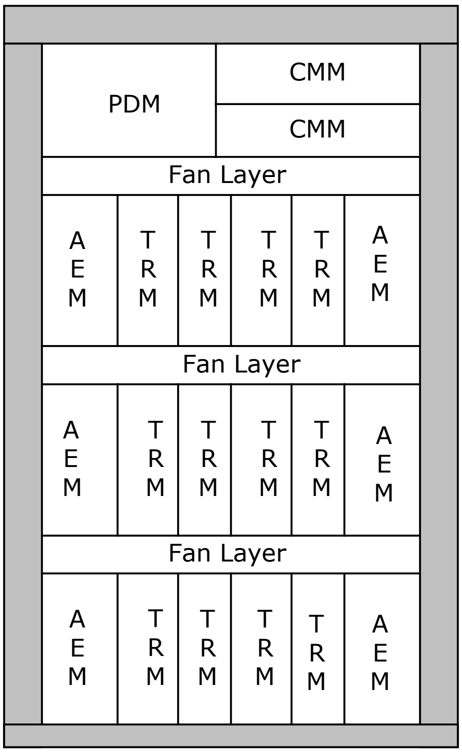


Base Station Configuration Principles

Configuration of the Standard Rack

For 40W configuration, the installation positions of respective functional modules of the ZXG10-BTS (V2.9) in the rack are shown in Figure 80.

FIGURE 80 CARD LAYOUT OF THE CARRIER FRAME OF ZXG10-BTS (V2.9) FOR 40 W CONFIGURATION

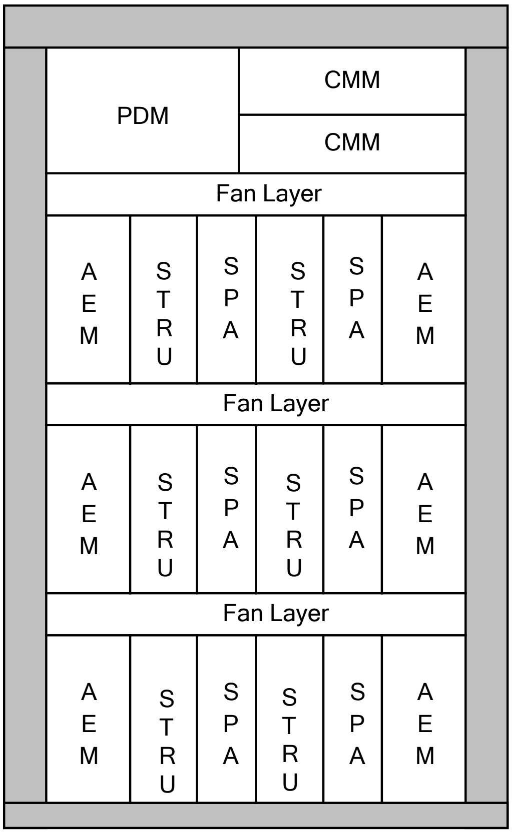


For 40 W configuration, a single rack of BTS can be configured with a maximum of 12 transceiver modules.

For 80 W configuration, the installation positions of respective functional modules of the ZXG10-BTS (V2.9) in the rack are shown in Figure 81.

For 80 W configuration, a single rack of BTS can be configured with a maximum of 6 transceiver modules.

FIGURE 81 CARD LAYOUT OF THE CARRIER FRAME OF ZXG10-BTS (V2.9) FOR 80 W CONFIGURATION



Configuration of Carrier Frame

Configuration of the carrier frame is listed in Table 6.

TABLE 6 CARRIER FRAME CONFIGURATION

No.	Unit Name	Configuration	Description
1	Transceiver module (TRM)	1 ~ 4 TRXs	A carrier shelf can be configured with up to 4 carriers, depending on the actual requirements. TRMs include 900 M, extended 900 M, 1800 M, 1900 M and 850 M modules.
2	Antenna equipment module (AEM)	Refer to the configuration principle of the antenna feeder equipment module.	The configuration quantity depends on the specific site type.

For the carrier configuration, , TRM in one cell should in principle be configured inside one ZXG10-BTS (V2.9) rack, so as to minimize the length of the rack-crossing RF connection cable and reduce the loss over cables. The rack-crossing cables should be as short as possible in configuration.

Configuration Principle of AEM

AEM has three types of combiner distribution units: CDU, RDU & CEU. By different combinations of combiner distribution units, the ZXG10-BTS (V2.9) can provide configurations for various sites.

For GSM900 cells, GSM900 CDU is configured; for GSM1800 cells, GSM1800 CDU is configured; and so on for other GSM systems.

Each site may be configured as either an omni-directional cell or a multiple directional cell. Based on different field strength coverage modes, there are two types of base station antenna: omni-antenna and directional antenna. An omni-antenna can provide omni-directional coverage, thus saving site construction costs. However, the omni-antenna has low gain and poor anti-interference capability. The directional antenna is of directivity with high gain and strong anti-interference capability. To ensure the complete coverage of a service area, combination of multiple antennas is required.

The number of configured carriers for all 40 W TRXs and the corresponding relationship between CDUs and antennae configured in one cell are shown in Table 7.

Table 7 Number of Configured Carriers for all 40 W TRXs and the Corresponding Relationship Between CDUs and Antennae Configured in One Cell

TRX QTY.	Antenna QTY. and Configuration	CDU QTY.	RDU QTY.	CEU QTY.	Remarks
1	2,TX/RX,RX	1	1	-	Special treatment for CDU. See Appendix C
2	2,TX/RX,TX/RX	2	-	-	Special treatment for CDU. See Appendix C
3~4	2,TX/RX,TX/RX	2	-	-	
5~8	2,TX/RX,TX/RX	2	-	2	

The number of configured carriers for all 80 W TRXs and the corresponding relationship between CDUs and antennae configured in one cell are shown in Table 8.

Table 8 Number of Configured Carriers for all 80 W TRXs and the Corresponding Relationship Between CDUs and Antennae Configured in One Cell

TRX QTY.	Antenna QTY. and Configuration	CDU QTY.	RDU QTY.	CEU QTY.	Remarks
1	2,TX/RX,RX	1	1	-	Special treatment for CDU. See Appendix C
2	2,TX/RX,TX/RX	2	-	-	Special treatment for CDU. See Appendix C
3~4	2,TX/RX,TX/RX	2	-	-	
5~6	2,TX/RX,TX/RX	2	-	2	

For different configuration requirements of different site types, the combinations listed above can be used.

Expansion Configuration

To increase the cell subscribers, one to three racks can be configured in one cell generally. In principle, a cell should be configured with as fewer racks as possible. For 40 W PA configuration, ZXG10-BTS (V2.9) can be configured as a S12/12/12-type site at maximum; and for 80 W PA configuration, ZXG10-BTS (V2.9) can be configured as a S6/6/6-type site at maximum.

Configuration Example

The ZXG10-BTS (V2.9) has multiple configuration modes with different combinations, and all configurations are based on the user requirements and network planning. Therefore, system configuration modes vary with different application sites. A site is typically configured as an omni-directional site, 2-sector site or 3-sector site.

Configuration Examples of O-type Site

Introduction to the configuration of O1/O2/O4/O6/O8 type sites is given as follows.

Figure 82 illustrates the configuration of the O1-type site.

For the O1-type site, the configuration with one CDU, one RDU, one omni-directional transceiving antenna and one omni-directional receiving antenna is generally employed.

The logical connection relationship between the combiner units and distribution units is shown in Figure 83.

FIGURE 82 CONFIGURATION MODE OF THE O1-TYPE SITE

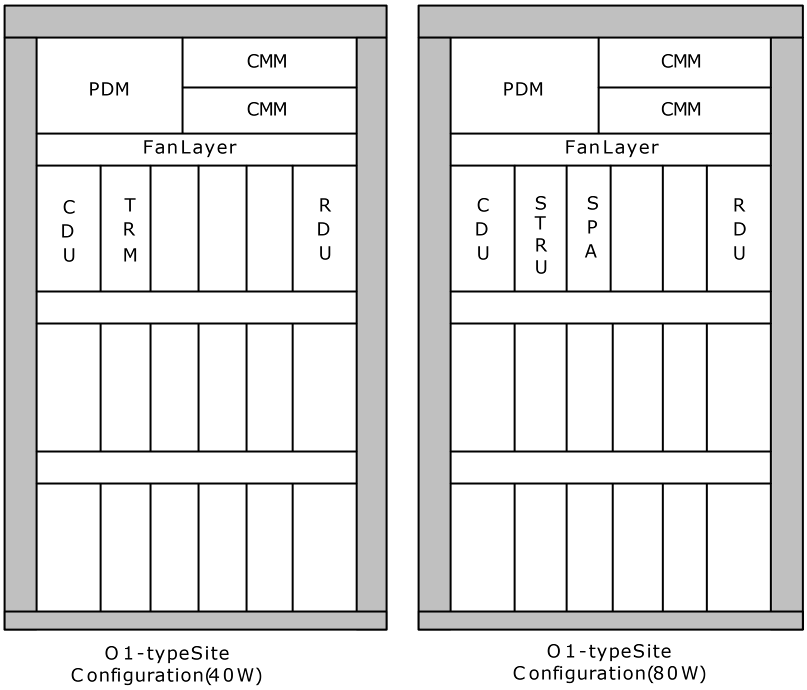


FIGURE 83 LOGICAL CONNECTION RELATIONSHIP BETWEEN THE COMBINER UNITS AND DISTRIBUTION UNITS OF THE O1-TYPE SITE

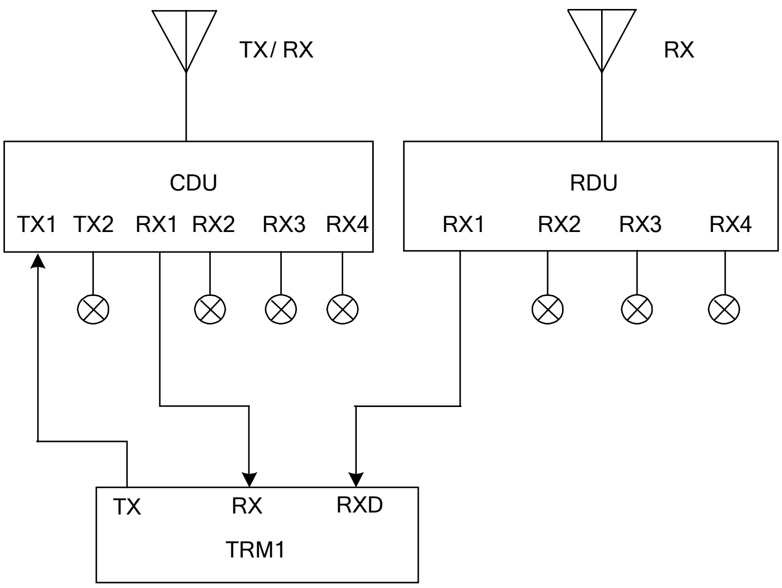


Figure 84 illustrates the configuration of the O2-type site. Generally, the O2-type site is configured with 2 CDUs and 2 omni-directional receiving antenna. The logical connection relationship between the combiner units and distribution units is shown in Figure 85.

FIGURE 84 CONFIGURATION MODE OF O2-TYPE SITE

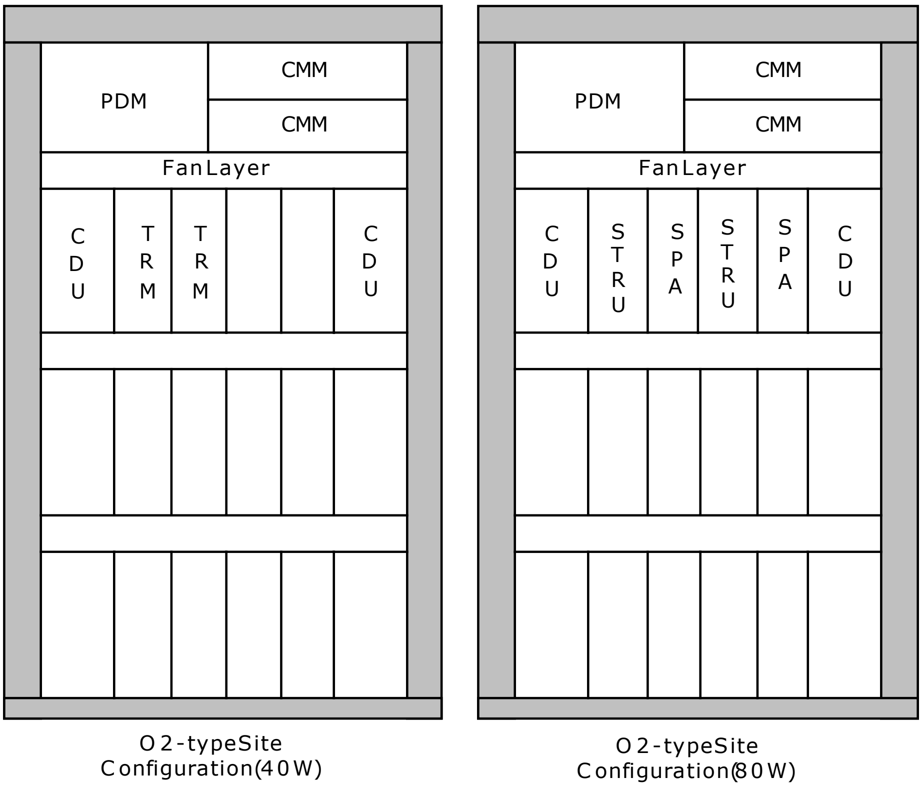


FIGURE 85 LOGICAL CONNECTION RELATIONSHIP BETWEEN THE COMBINER UNITS AND DISTRIBUTION UNITS OF O2-TYPE SITE

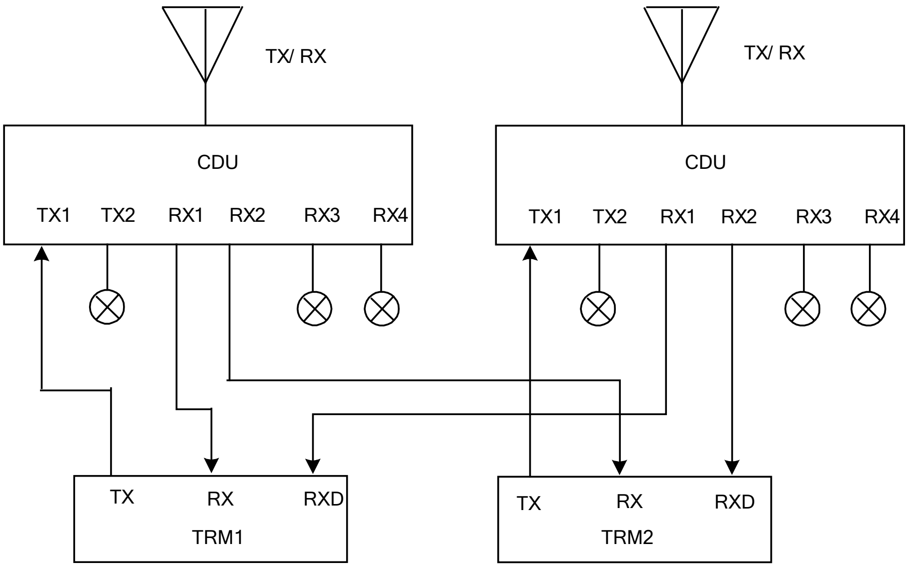


Figure 86 illustrates the configuration of the O4-type site. Generally, the O4-type site is configured with 2 CDUs and 2 omni-directional receiving antenna. The logical connection relationship between the combiner units and distribution units is shown in Figure 87.

FIGURE 86 CONFIGURATION MODE OF O9-TYPE SITE

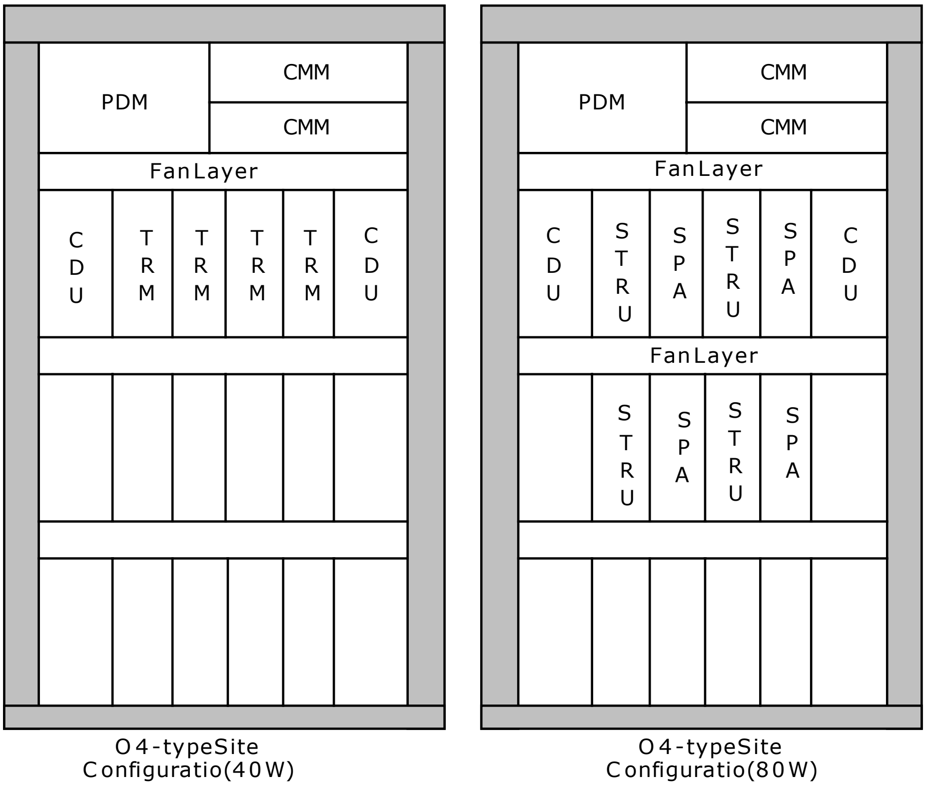


FIGURE 87 LOGICAL CONNECTION RELATIONSHIP BETWEEN THE COMBINER UNITS AND DISTRIBUTION UNITS OF O4-TYPE SITE

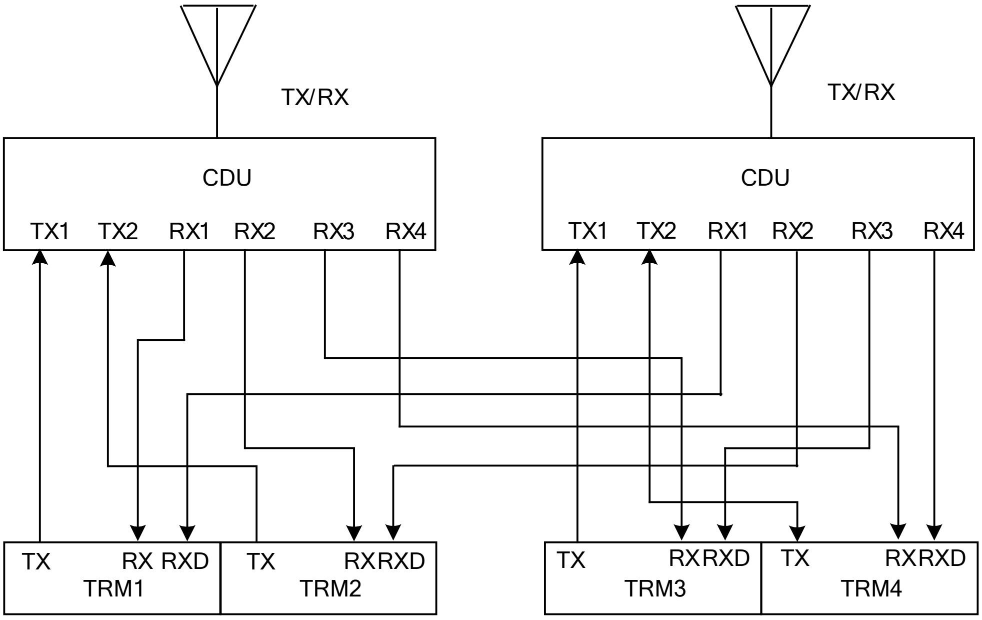
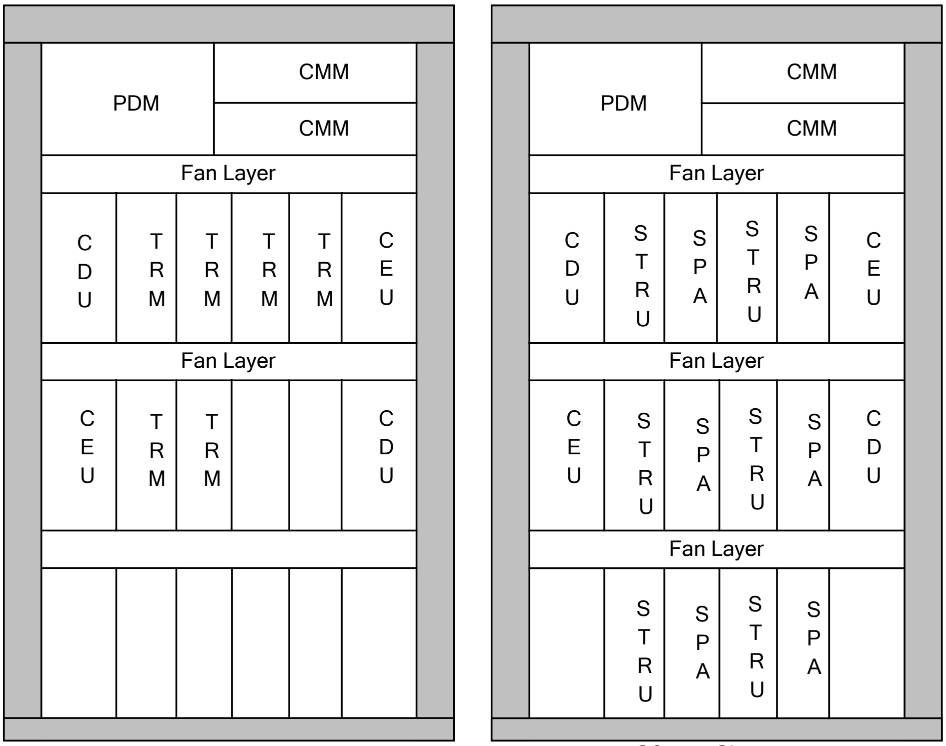


Figure 88 illustrates the configuration of the O6-type site.

Generally, the O6-type site is configured with 2 CDUs, 2 CEUs and 2 omni-directional receiving antennas.

The logical connection relationship between the combiner units and distribution units is shown in Figure 89.

FIGURE 88 06-TYPE SITE CONFIGURATION MODE



O6-type Site Configuration（ 40W ） O6-type Site Configuration（ 80W ）

FIGURE 89 LOGICAL CONNECTION RELATIONSHIP BETWEEN THE COMBINER UNITS AND DISTRIBUTION UNITS OF O6-TYPE SITE

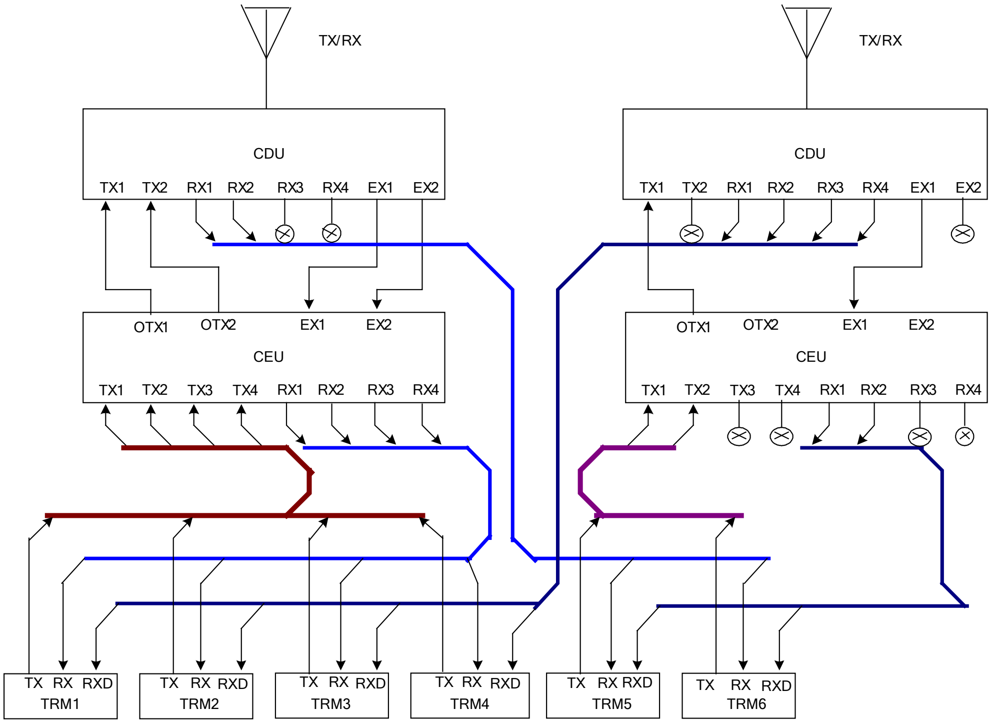
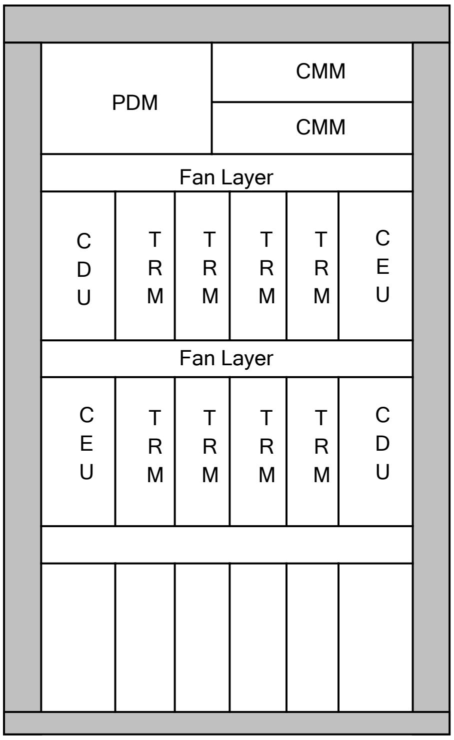


Figure 90 illustrates the configuration of the O8-type site.

The O8-type site is configured with two CDUs, two RDUs, and two omni-antennas.

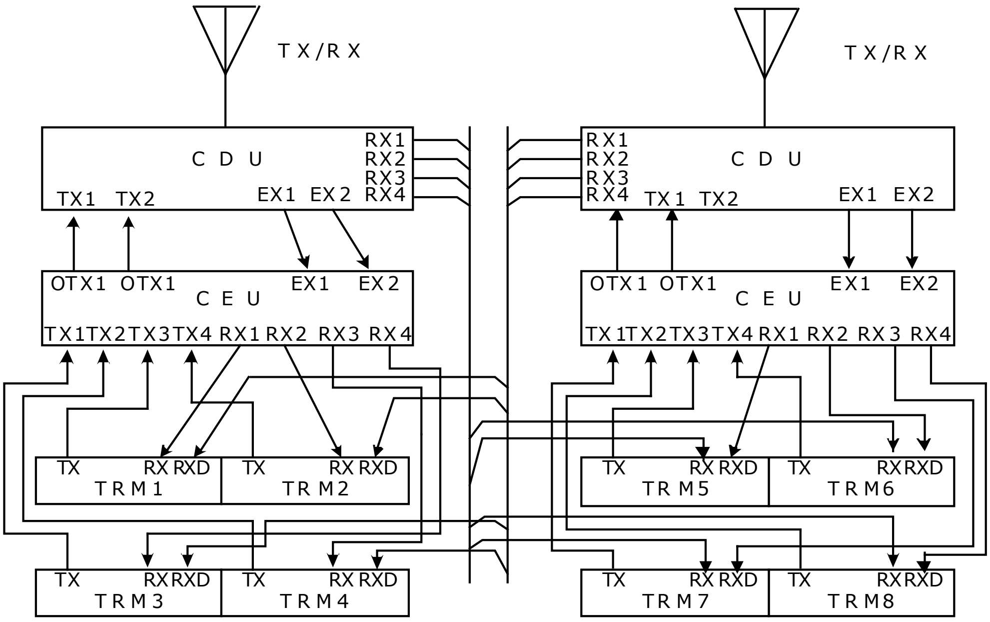
The logical connection relationship between the combiner units and distribution units is shown in Figure 91.

FIGURE 90 O8-TYPE SITE CONFIGURATION MODE



O8-type Site Configuration(40W)

FIGURE 91 LOGICAL CONNECTION RELATIONSHIP BETWEEN THE COMBINER UNITS AND DISTRIBUTION UNITS OF THE O8-TYPE SITE



Configuration Examples of S-Type Site

The S-type site may serve either two-sector cells or three-sector cells. And the directional antenna is often employed.

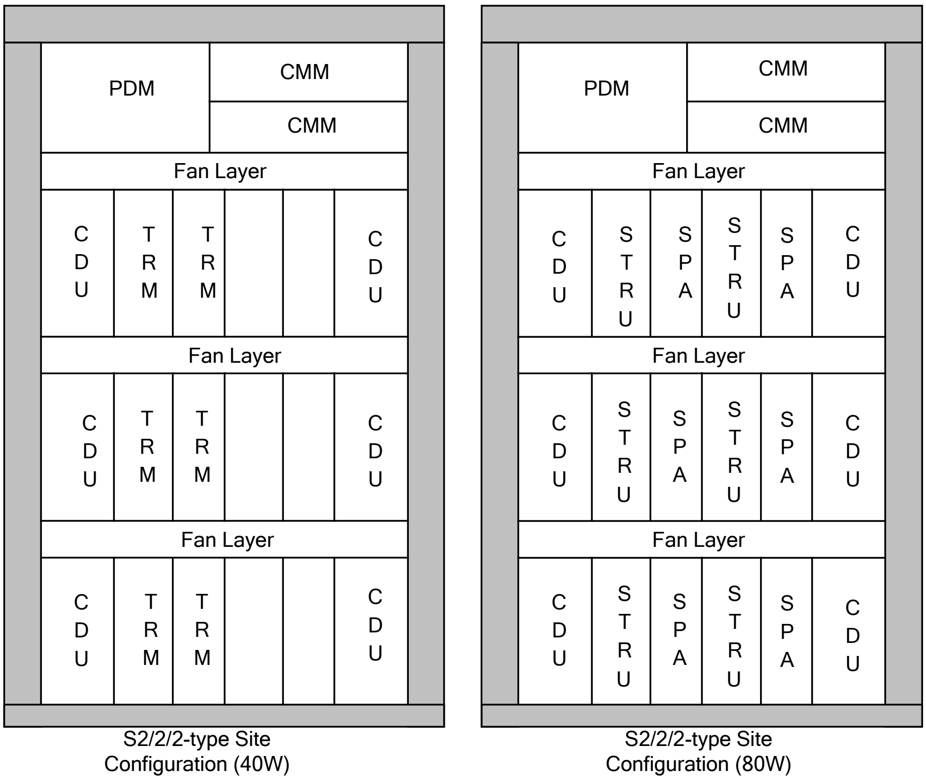
The configuration of the S2/2/2-type site will be described below.

The configuration of the S2/2/2-type site is shown in Figure 92.

Generally, the S2/2/2-type site is configured with 2 CDUs (special treatment for CDU, see Appendix C) for each sector and 2 omni-antennas.

For the logical connection relationship between the combiner units and distribution units of each sectorized cell, refer to the connections of O2.

FIGURE 92 CONFIGURATION MODE OF THE S2/2/2-TYPE SITE



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Appendix A

Normative References

The numbers and names of standards quoted in this manual are listed below.

ETSI TS 100 910 Version 3.16.0 European Digital Cellular Communication System (Phase One); Radio Transmitting and Receiving (GSM 05.05)

ETSI I-ETS 300 609 Digital Cellular Communication System (Phase Two); Part One of BSS Equipment Specifications: About Radio (GSM 11.21)

ITU-T G.703 Physical/Electrical Characteristics of System Digital Interfaces

ITU-T G.704 Synchronous Frame Structure used for the Rate Series of 1544, 6312, 2048, 8448 and 44736 kbs/s

GSM03.60 General Packet Radio Service (GPRS) Service description

GSM03.64 General Packet Radio Service (GPRS) Overall description of the GPRS radio interface

GSM04.04 Technical Specification Group GSM/EDGE Radio Access Network Layer 1 General requirements

GSM04.06 Mobile Station - Base Station System (MS - BSS) interface Data Link (DL) layer specification

GSM04.08 Mobile radio interface layer 3 specification

GSM04.60 General Packet Radio Service (GPRS) Mobile Station (MS) - Base Station System (BSS) interface Radio Link Control/ Medium Access Control (RLC/MAC) protocol

GSM05.02 Multiplexing and multiple access on the radio path

GSM05.08 Radio subsystem link control

GSM08.58 Base Station Controller - Base Transceiver Station (BSC - BTS) interface Layer 3 specification

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Appendix B

Abbreviations

Abbreviation	Full Name
AB	Access Burst
Abis	Abis
AEM	Antenna Equipment Module
AFR	Adaptive Full-Rate speech
AGCH	Access granted Channel
AHS	Adaptive Half-Rate Speech
AMR	Adaptive Multi-Rate
ARFCN	Absolute Radio Frequency Channel No
ATM	Asynchronous Transfer Mode
AUC	Authentication Center
BBP	Base Band Processor
BCCH	Broadcast Control Channel
BER	Bit Error Rate
BFI	Bad Frame Indication
BIE	Base station Interface Equipment
BP	Burst Period(pulse)
BSC	Base Station Controller
BSIC	Base Station Identify Code
BSS	Base Station Subsystem
BTS	Base Transceiver Station
CCCH	Calling Control Channel
CCH	Common Channel
CDU	Combiner Distribution Unit
CELL	Cellular
CELP	Code Excited Linear Prediction Coding
CEU	Combiner Extension Unit
CHP	Channel Processor

Abbreviation	Full Name
C/I	Carrier to Interference Ratio
CIP	Carrier Interface Part
CLK	CLocK
CM	Communication Management
CMM	Controller & Maintenance Module
CS	Circuit Switched
CU	Carrier Unit
DB	Data Base
DBS	Data Base Subsystem
DCDU	"D" Combiner Distribution Unit
DLCI	Data Link Connection Identifier
DRX	Discontinued Receiving
DSP	Digital Signal Processor
DTX	Discontinuous Transmission
E1	E1
EAM	External Alarm Module
ECDU	"E" Combiner Distribution Unit
ECU	Environment Control Unit
EDGE	Enhanced Data rates for GSM Evolution
EIR	Equipment Identity Register
EPLD	Erasable Programmable Logic Device
ETP	Extend Test Port
FACCH	Fast Associated Control Channel
FB	Frequency correction Burst
FCCH	Frequency Correction Channel
FCLK	Frame Clock
FCM	Fan Control Module
FCS	Frame Check Sequence
FDMA	Frequency Division Multiplex Access
FN	Frame Number
FU	Frame Unit
FUC	Frame Unit Controller
GGSN	Gateway GPRS Support Node
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Globe System for Mobile communication
HDB3	High Degree Bipolar coding

Abbreviation	Full Name
HDLC	High Level Data Link Controller
HLR	Home Location Register
HPI	Host Processor Interface
HW	HighWay
ID	IDentification/IDentity
I/Q	In phase/quadrature
ISDN	Integrated Services Digital Network
LapD	Link Access Procedure “D” Channel
LapDm	Link Access Procedure “Dm”(mobile “D”)Channel
LLC	Logical Link Control
LM	Local Manager
LMT	Local Manager Terminal
LNA	Low Noise Amplifier
LO	Local Oscillator
LP	Local Poll
LPF	Loop Filter
LVDS	Low Voltage Differential Signaling
MAC	Medium Access Control
McBSP	Multi-channel Buffer Serial Port
MM	Mobility Management
MMI	Man-Machine Interface
MO	Manage Object
MS	Mobile Station
MSC	Mobile Switch Center
MSS	Mobile Switch System
MTBF	Mean Time Between Failures
NB	Normal Burst
NRZ	Non-Return to Zero coding
OAMM	Operational And Maintenance Module
OBCLK	Octet Binary clock
OMC	Operation and Maintenance Center
PA	Power Amplifier
PACCH	Packet Associated Control Channel
PAGCH	Packet Access granted Channel
PAGCHM	PCH&AGCH Management
PAU	Power Amplifier Unit
PBCCH	Packet Broadcast Control Channel

Abbreviation	Full Name
PCCCH	Packet Common Control Channel
PCH	Paging Channel
PCM	Pulse Code Modulation
PCU	Packet Control Unit
PLMN	Public Land Mobile Network
PDCH	Packet Data Channel
PDM	Power Distribution Module
PDN	Packet Data Network
PDTCH	Packet Data Traffic Channel
PDU	Protocol Data Unit
PLL	PhaseLock Loop
PNCH	Packet Notification Channel
PPCH	Packet Paging Channel
PRACH	Packet Random Access Channel
PS	Power Supply
PSI	Packet System Information
PTCCH	Packet Timing advance Control Channel
PTM	Point To Multipoint
RACH	Random Access Channel
RCU	Radio Carrier Unit
RDU	Receiver Distribute Unit
RF	Radio Frequency
RLC	Radio Link Control
RR	Radio Resource management
RSL	Radio Signal Layer
RX	Receiver
SACCH	Slow Associated Control Channel
SAPI	Service Access Point Indicator
SB	Synchronization Burst
SCH	Synchronization CHannel
SDCCH	Stand Alone Dedicated Control Channel
SGSN	Serving GPRS Support Node
SI	System Information
SID	Silence Descriptor
SMC	Short Message Center
SNDCP	Subnetwork Dependent Convergence protocol
SPAU	Super Power Amplifier Unit

Abbreviation	Full Name
STRM	Super Transceiver Unit
Synclk	Synchronous Clock
TAI	Timing Advance Index
TAF	Time Alignment Flag
TBF	Temporary Block Flow
TC	Transcoder
TCH	Traffic Channel
TDMA	Time Division Multiple Access
TEI	Terminal Equipment Identification
TFI	Temporary Flow Identity
TPF	Tracking Phase lock Frequency synthesizer
TPU	Transceiver Process Unit
TRM	Transceiver Module
TRX	Transceivers
Time Slot	TS
TX	Transmitter
Um	Um
USF	Uplink State Flag
VCO	Voltage Control Oscillator
VLR	Visitor Location Register
VSWR	Voltage Standing Wave Ratio

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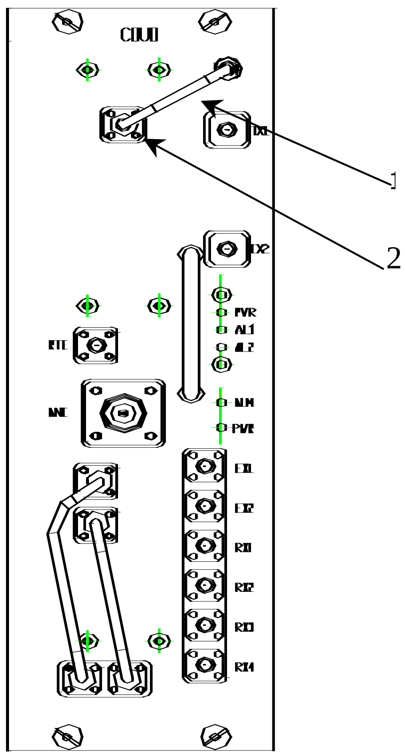
Appendix C

Method for CDU TX Input Crossing Combiner

To obtain the maximum downlink coverage or the minimum power consumption at the same configuration condition in the cells of O1 and O2, it is required to connect the TRM TX output directly to the input of the CDU duplexer TX crossing CDU combiner.

FIGURE 93 CDU PANEL



1: Cable connecting combiner TX output to duplexer TX input; 2: Duplexer TX input

Solution: As shown in Figure 93, remove the cable connecting the combiner TX output pointed by arrow 1 to the duplexer TX input; connect the TRM TX output directly to the duplexer TX input pointed by arrow 2.

Appendix D

FCC STATEMENT

Before using this GSM Macro Base Transceiver Station, read this important RF energy awareness and control information and operational instructions to ensure compliance with the FCC RF exposure guidelines.

NOTICE: Working with the equipment while in operation, may expose the technician to RF electromagnetic fields that exceed FCC rules for human exposure. Visit the FCC website at www.fcc.gov/oet/rfsafety to learn more about the effects of exposure to RF electromagnetic fields.

Changes or modifications to this unit not expressly approved by the party responsible for compliance will void the user's authority to operate the equipment. Any change to the equipment will void FCC grant.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to the FCC Rules. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

For OUTDOOR use, a Directional Antenna with a maximum gain of 17dBi is authorized for use with this unit. Outside antennas must be positioned to observe minimum separation of 4M (13.12 feet) for 850MHz unit and 3M (9.84 feet) for 1900MHz unit from all users and bystanders. For the protection of personnel working in the vicinity of outside antennas, the following guidelines for minimum distances between the human body and the antenna must be observed.

The installation of an OUTDOOR antenna must be such that, under normal conditions, all personnel cannot come within 4M (13.12 feet) for 850MHz unit and 3M (9.84 feet) for 1900MHz unit from the outside antenna. Exceeding this minimum separation will ensure that the worker or bystander does not receive RF-exposure beyond the Maximum Permissible Exposure according to section 1.1310 i.e. limits for Controlled Exposure.

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Appendix E

CE STATEMENT

Before using this GSM Macro Base Transceiver Station, read this important RF energy awareness and control information and operational instructions to ensure compliance with the CE RF exposure guidelines.

The assessment of compliance boundary is performed by calculation in accordance with EN50383:2002.

Changes or modifications to this unit not expressly approved by the party responsible for compliance will void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to the CE Rules. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

For OUTDOOR use, a Directional Antenna with a maximum gain of 11dBi is authorized for use with this unit. Outside antennas must be positioned to observe minimum separation of 4.2M (13.78 feet) for 900MHz unit and 3M (9.84 feet) for 1800MHz unit from all users and bystanders. For the protection of personnel working in the vicinity of outside antennas, the following guidelines for minimum distances between the human body and the antenna must be observed.

The installation of an OUTDOOR antenna must be such that, under normal conditions, all personnel cannot come within 4.2M (13.78 feet) for 900MHz unit and 3M (9.84 feet) for 1800MHz unit from the outside antenna. Exceeding this minimum separation will ensure that the worker or bystander does not receive RF-exposure beyond the Maximum Permissible Exposure according to section EN50383:2002 limits for Controlled Exposure.

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Figures

Tables