EUROPEAN
TELECOMMUNICATION
STANDARD

ETS 300 936

April 1997

Source: ETSI TC-SMG

Reference: DE/SMG-030404Q

ICS: 33.020

Key words: Digital cellular telecommunications system, Global System for Mobile communications (GSM)

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

Digital cellular telecommunications system;
Layer 1;
General requirements
(GSM 04.04 version 5.0.1)

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) Technical Committee (TC) of the European Telecommunications Standards Institute (ETSI).

This ETS defines the services offered by the physical layer (layer 1) of the Mobile Station - Base Station System (MS - BSS) interface within the digital cellular telecommunications system.

The contents of this ETS is subject to continuing work within TC-SMG and may change following formal TC-SMG approval. Should TC-SMG modify the contents of this ETS, it will be resubmitted for OAP by ETSI with an identifying change of release date and an increase in version number as follows:

Version 5.x.y

where:

- y the third digit is incremented when editorial only changes have been incorporated in the specification;

- x the second digit is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

The specification from which this ETS has been derived was originally based on CEPT documentation, hence the presentation of this ETS may not be entirely in accordance with the ETSI drafting rules.

Transposition dates	
Date of adoption:	28 March 1997
Date of latest announcement of this ETS (doa):	31 July 1997
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 January 1998
Date of withdrawal of any conflicting National Standard (dow):	31 January 1998

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1 General

1.1 Scope

This European Telecommunication Standard (ETS) defines the service offered by the physical layer (GSM 05-series of Technical Specifications) of the MS-BS interface (GSM 05- and 04-series of Technical Specifications). Its main objective is to be a guidance for the interface between the GSM Technical Specifications in the 05-series and the 04-series. It also specifies the format of signalling channels and the order of bit transmission.

As far as possible, this ETS makes use of the layering principles of the Reference Model for Open System Interconnection (OSI) as contained in CCITT Recommendations X.200 and X.210.

1.2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1] GSM 01.04 (ETR 350): "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 02.11 (ETS 300 921): "Digital cellular telecommunications system; Service accessibility".

[3] GSM 03.13: "Digital cellular telecommunications system (Phase 2+); Discontinuous Reception (DRX) in the GSM system".

[4] GSM 03.20 (ETS 300 929): "Digital cellular telecommunications system (Phase 2+); Security related network functions".

[5] GSM 04.01: "Digital cellular telecommunications system; Mobile Station - Base Station System (MS - BSS) interface; General aspects and principles".

[6] GSM 04.02: "Digital cellular telecommunications system (Phase 2+); GSM Public Land Mobile Network (PLMN) access reference configuration".

[7] GSM 04.03: "Digital cellular telecommunications system (Phase 2+); Mobile Station - Base Station System (MS - BSS) interface Channel structures and access capabilities".

[8] GSM 04.05 (ETS 300 937): "Digital cellular telecommunications system; Data Link (DL) layer General aspects".

[9] GSM 04.06 (ETS 300 938): "Digital cellular telecommunications system (Phase 2+); Mobile Station - Base Station System (MS - BSS) interface; Data Link (DL) layer specification".

[10] GSM 04.07 (ETS 300 939): "Digital cellular telecommunications system (Phase 2+); Mobile radio interface signalling layer 3; General aspects".

[11] GSM 04.08 (ETS 300 940): "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification".

[12] GSM 04.10 (ETS 300 941): "Digital cellular telecommunications system; Mobile radio interface layer 3 Supplementary services specification; General aspects".

[13] GSM 04.11 (ETS 300 942): "Digital cellular telecommunications system (Phase 2+); Point-to-Point (PP) Short Message Service (SMS) support on mobile radio interface".

[14] GSM 04.12 (ETS 300 943): "Digital cellular telecommunications system (Phase 2+); Short Message Service Cell Broadcast (SMSCB) support on the mobile radio interface".

[15] GSM 04.13 (ETS 300 944): "Digital cellular telecommunications system (Phase 2+); Performance requirements on mobile radio interface".

[16] GSM 04.21 (ETS 300 945): "Digital cellular telecommunications system (Phase 2+); Rate adaption on the Mobile Station - Base Station System (MS - BSS) Interface".

[17] GSM 04.22 (ETS 300 946): "Digital cellular telecommunications system (Phase 2+); Radio Link Protocol (RLP) for data and telematic services on the Mobile Station - Base Station System (MS - BSS) interface and the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface".

[18] GSM 04.80 (ETS 300 950): "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 supplementary services specification; Formats and coding".

[19] GSM 04.81 (ETS 300 951): "Digital cellular telecommunications system; Line identification supplementary services - Stage 3".

[20] GSM 04.82 (ETS 300 952): "Digital cellular telecommunications system; Call Forwarding (CF) supplementary services - Stage 3".

[21] GSM 04.83 (ETS 300 953): "Digital cellular telecommunications system; Call Waiting (CW) and Call Hold (HOLD) supplementary services - Stage 3".

[22] GSM 04.84 (ETS 300 954): "Digital cellular telecommunications system; MultiParty (MPTY) supplementary services - Stage 3".

[23] GSM 04.85: "Digital cellular telecommunications system; Closed User Group (CUG) supplementary services - Stage 3".

[24] GSM 04.86 (ETS 300 955): "Digital cellular telecommunications system; Advice of Charge (AoC) supplementary services - Stage 3".

[25] GSM 04.88 (ETS 300 956): "Digital cellular telecommunications system; Call Barring (CB) supplementary services - Stage 3".

[26] GSM 04.90 (ETS 300 957): "Digital cellular telecommunications system; Unstructured Supplementary Services Data (USSD) - Stage 3".

[27] GSM 05.01: "Digital cellular telecommunications system (Phase 2+); Physical layer on the radio path; General description".

[28] GSM 05.02 (ETS 300 908): "Digital cellular telecommunications system (Phase 2+); Multiplexing and multiple access on the radio path".

[29] GSM 05.03 (ETS 300 909): "Digital cellular telecommunications system (Phase 2+); Channel coding".

[30] GSM 05.04 (ETS 300 959): "Digital cellular telecommunications system; Modulation".

[31] GSM 05.05 (ETS 300 910): "Digital cellular telecommunications system (Phase 2+); Radio transmission and reception".

[32] GSM 05.08 (ETS 300 911): "Digital cellular telecommunications system (Phase 2+); Radio subsystem link control".

[33] GSM 05.10 (ETS 300 579): "Digital cellular telecommunications system (Phase 2+); Radio subsystem synchronization".

[34] GSM 05.90 (ETR 357): "Digital cellular telecommunications system; GSM Electro Magnetic Compatibility (EMC) considerations".

[35] CCITT Recommendation X.200: "Reference Model of open systems interconnection for CCITT applications".

[36] CCITT Recommendation X.210: "Open systems interconnection layer service definition conventions".

1.3 Definitions and abbreviations

Abbreviations used in this ETS are listed in GSM 01.04.

2 Interfaces to the physical layer

The physical layer (layer 1) is the lowest layer in the OSI Reference Model and it supports all functions required for the transmission of bit streams on the physical medium. These bit streams are transferred on traffic and control channels as defined in GSM 04.03.

NOTE: For GSM application the physical layer may also be referred to as the radio subsystem. However, the radio subsystem supports functions additional to those described in this ETS.

The physical layer interfaces the Data Link Layer and the supported functional units of the application (figure 2.1).

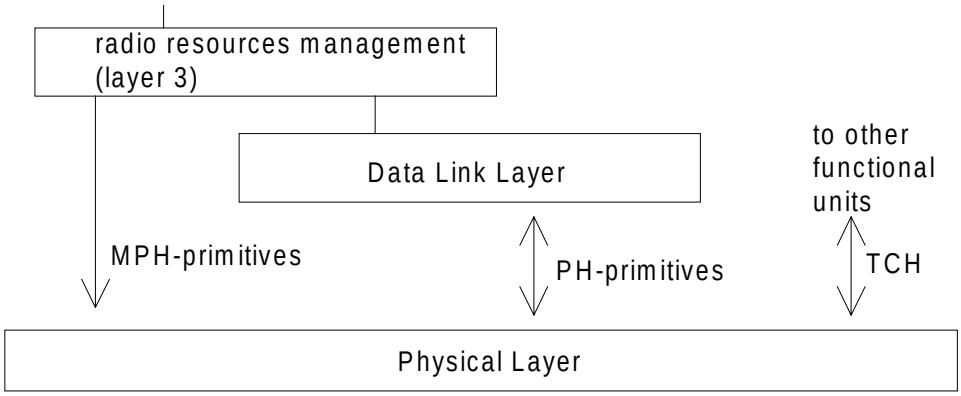


Figure 2.1: Interfaces with the Physical Layer

2.1 Interface to the Data Link Layer

The physical layer interfaces the data link layer. On this interface control channels are supported. The data link layer is specified in GSM 04.05 and 04.06. Communication between the Physical Layer and the Data Link Layer is in an abstract way performed by means of PH-primitives defined do not constrain implementations.

NOTE: The terms physical layer and layer 1, and data link layer and layer 2, will be used synonymously in this ETS.

The PH-primitives exchanged between the physical layer and the data link layer are used for the transfer of layer 2 frames. They are also used to indicate the establishment of channels to layer 2.

2.2 Interface to radio resource management

The physical layer interfaces the radio resource management (RR-management) entity of layer 3 in the MS and in the network.

Communication is performed in an abstract way by means of MPH-primitives. They do not constrain implementations.

The primitives exchanged with the RR-management entity are related to the assignment of channels, physical layer system information (including measurement results), etc.

2.3 Interface to other functional units

The physical layer interfaces other functional units in the MS and in the network for supporting traffic channels. These interfaces are described in the 06 and 07 series of Technical Specifications.

3 Service of the physical layer

The physical layer supports transfer of bit streams on the radio medium according to the Technical Specifications of the 05-series. The scope of the 05-series of Technical Specifications is the definition of a framework for operation on the radio medium. The application of this framework on the radio medium results in a transmission service. General characteristics of the service obtained by applying the framework of the 05-series at the operation on the radio medium are described in this clause.

3.1 Service Access Point

In the Reference Model for Open System Interconnection, Service Access Points (SAPs) of a layer are defined as gates through which services are offered to an adjacent higher layer (figure 3.1). Through a SAP the physical layer offers a service to the data link layer. The SAP is used both for the control of the service providing entity (in case this is the physical layer; commands related to the establishment and release of channels) and the transfer of data (in case of the physical layer; the transfer of bits). The physical layer service access points defined in this ETS differ from the OSI physical layer Service Access Points; the layer 3 RR-management instead of the data link layer controls the SAPs (establishment and release of channels).

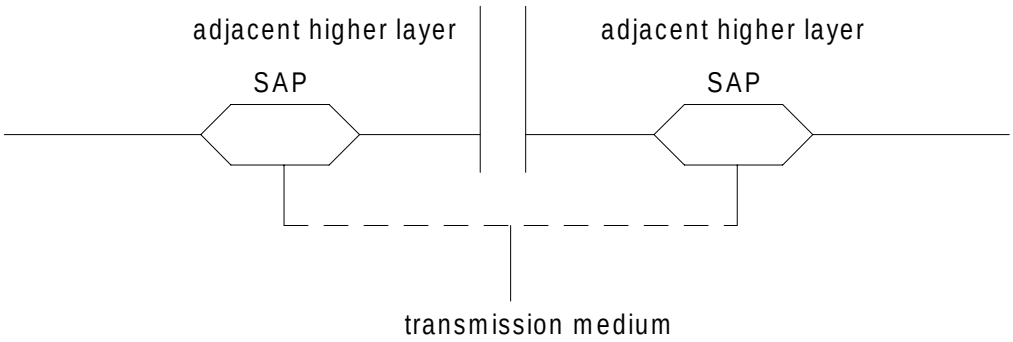


Figure 3.1: Service Access Point principle

On the physical layer of the GSM system a SAP is defined between the physical layer and the data link layer for each control channel (figure 3.2). The characteristics of SAPs (channels) are listed in GSM 04.03.

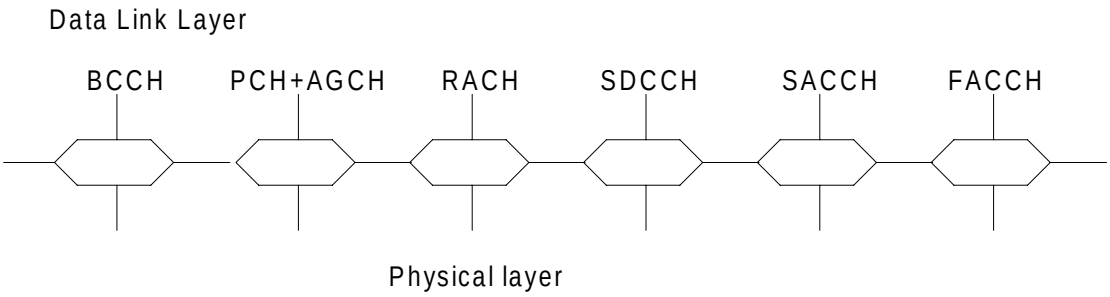


Figure 3.2: SAPs between the physical layer and the data link layer in the MS

3.2 Service of the physical layer

*** Access capabilities:**

The physical layer offers a transmission service on a limited set of logical channels. The BS and MS access capabilities and the characteristics of logical channels (SAPs) are defined in GSM 04.03.

NOTE: Between GSM 04.03 and the 05-series there is a slight difference in terminology. The "channels" mentioned in 04.03 are "logical channels" according to the 05-series (especially 05.02). The "CCCH", a channel name commonly used in the 04-series, covers the logical channels of the type RACH, PCH and AGCH.

Logical channels are multiplexed on physical channels. Physical channels are the units scheduled on the radio medium. Some are reserved by the network for common use (a combination of CCCH and BCCH), others are assigned to connections with MSs (dedicated physical channels). In time the combination of logical channels used on an assigned dedicated physical channel may change. Allowed combinations of logical channels on a dedicated physical channel are defined in GSM 04.03. Data on SAPs of control channels is exchanged in discrete blocks with a size of 23 or 21 (SACCH) octets. Synchronization between layer 1 and layer 2 is provided for piggy-backing of RR (receive ready) frames, and the starting of timers (T200). See also GSM 04.06.

*** Error detection:**

The physical layer offers an error protected transmission service, it includes error detection functions and to a lower level, error correction functions. Erroneous received frames are not offered to the data link layer. The probability of one or more errors in a physical block transferred by the physical layer is defined in GSM 05.03. Due to not specified methods of quality detection, the probability of residual errors in transferred blocks may vary between implementations.

*** Encryption:**

Security related functions implemented at the physical layer are described in GSM 03.20.

An overview of the functions specified in the 05-series which create the service of the physical layer can be found in GSM 05.01.

3.2.1 Specific services of the physical layer in the MS

The access capability service of the physical layer in the MS is different for dedicated physical channels than for BCCH/CCCHs.

*** Establishment of dedicated physical channels:**

Establishment of dedicated physical channels on the physical layer is controlled by the radio resources management of layer 3 (GSM 04.08). During operation on a dedicated physical channel, the physical layer measures the signals of neighbouring base stations and the signal quality of the used dedicated physical channel. Measurements are transferred to layer 3, measurement control information is offered by layer 3.

*** cell/PLMN selection in idle mode:**

In idle mode the physical layer selects the best cell with its BCCH/CCCH in close co-operation with layer 3, meeting requirements for PLMN selection specified in GSM 02.11. The idle mode procedures are not modelled within this ETS. Examples of procedures for cell selection are described in GSM 05.08. The physical layer performs automatic crossover.

4 Primitives of the physical layer

The Physical layer interacts with other entities as illustrated in figure 2.1. The interactions with the data link layer of Dm channels are shown in terms of primitives where the primitives represent the logical exchange of information and control between the physical layer and adjacent layers. They do not specify or constrain implementations. The interactions between the physical layer and layer 1 entities for Bm/Lm channels are for further study. For the physical layer two sets of primitives are defined:

*** Primitives between layer 1 and 2:**

PH - Generic name - Type: Parameters.

*** Primitives between layer 1 and the RR-management layer 3 entity:**

MPH - Generic name - Type: Parameters.

4.1 Generic names of primitives between layers 1 and 2 for the transfer of layer 2 frames

The following primitive generic names are defined on the SAPs between the physical layer and the data link layer:

a) PH-DATA:
The PH-DATA primitives are used on a SAP to pass message units containing frames used for data link layer peer-to-peer communications to and from the physical layer.

b) PH-RANDOM ACCESS:
The PH-RANDOM ACCESS (PH-RA) primitives are used on the SAP of the RACH to request and confirm (in the MS) the sending of a random access frame and to indicate (in the network) the arrival of a random access frame. The random access protocol is specified GSM 04.08.

c) PH-CONNECT:
The PH-CONNECT primitive is used on a SAP to indicate that the physical connection on the corresponding control channel has been established.

d) PH-READY-TO-SEND:
The PH-READY-TO-SEND primitive is used by the physical layer to trigger if applicable piggy backing, the start of timer for layer 2 and the forwarding a data unit to layer 1. It is passed to layer 2 just before a new physical block is transmitted.

e) PH-EMPTY-FRAME:
The PH-EMPTY-FRAME primitive can be used by the data link layer to indicate that no frame has to be transmitted after receiving the PH-READY-TO-SEND primitive. It enables polling of several layer 2 entities by layer 1 and support DTX.

4.2 Generic names of primitives between layer 1 and the RR- management entity of layer 3

The following primitive generic name is defined between layer 1 and the RR-management entity of layer 3:

- MPH-INFORMATION:
MPH-INFORMATION (MPH-INFO) primitives are used for the control of the physical layer by the RR-management of layer 3. This information activates and deactivates, configures and deconfigures, through connects and disconnects physical and logical channels. It is also used for the transfer of measurements and measurement control information from layer 1 to layer 3.

4.3 Primitive types

The primitive types defined in this ETS are:

a) REQUEST:
The REQUEST primitive type is used when a higher layer is requesting a service from a lower layer.

b) INDICATION:
The INDICATION primitive type is used by a layer providing a service to notify the next higher layer of activities in the layer. This activities are directly related to the occurrence of a REQUEST primitive on the peer-protocol side.

c) RESPONSE:
The RESPONSE primitive type is used by a layer to acknowledge receipt from the INDICATION primitive type.

d) CONFIRM:
The CONFIRM primitive type is used by the layer providing the requested service to confirm that the activity has been completed.

4.4 Parameter definition

Primitives contain a variable amount of parameters. The primitives with included parameters are listed in table 4.1.

Table 4.1: Primitives of the physical layer

primitive	entity	direction	message unit	dedicated channel control parameters	idle mode system information	absoluteframe No.	measurement
MPH-INFO-REQ MS/BS	R(L3)	>L1		x	x		
MPH-INFO-CON MS/BS	L1	->RR(L3)		x	x		
MPH-INFO-IND MS/BS	L1	->RR(L3)		x	x		x
PH-CONNECT-IND MS/BS	L1	->L2		x			
PH-DATA-REQ MS/BS	L2	->L1	x	x			
PH-DATA-IND MS/BS	L1	->L2	x	x			
PH-RA-REQ MS	L2	->L1	x				
PH-RA-IND BS	L1	->L2	x				x
PH-RA-CON MS	L1	->L2	x				x

Parameters involved in the primitive exchange with the physical layer are:

a) Message unit:
The message unit contains peer-to-peer information of a layer. It is transferred by the physical layer to the peer layer.

b) Dedicated channel control parameters:
These parameters contain information for channel control, specified in GSM 04.08.

c) Idle mode system information:
This information is exchanged in the cell/PLMN selection procedures. It may also contain control information for DRX (sleep mode, see GSM 03.13).

d) Absolute Frame Number:
The absolute frame number is used (in combination with a random access identifier) to uniquely identify a random access.

e) Measurements:
This parameter is used to report the quality of a dedicated physical channel (MS and network) and to report the quality of surrounding BCCH carriers (MS only).

5 Physical layer procedures

The main body of physical layer procedures is specified in GSM 04.08 and 05.08.

5.1 States of the physical layer

In the physical layer of the MS the following states are defined:

NULL: the equipment is switched off;

SEARCHING BCH: the physical layer tracks the best BCCH;

BCH: the physical layer listens to a BCCH/CCCH and is able to do random access;

TUNING DCH: the physical layer seizes on a dedicated physical channel;

DCH: the physical layer has seized a dedicated physical channel and may establish and through connect logical channels.

NOTE: BCH = Bcch/ccch physical CHannel;
DCH = Dedicated physical CHannel.

Figure 5.1 gives a general state diagram of the physical layer. All state transitions of the physical layer are controlled by MPH-INFORMATION primitives.

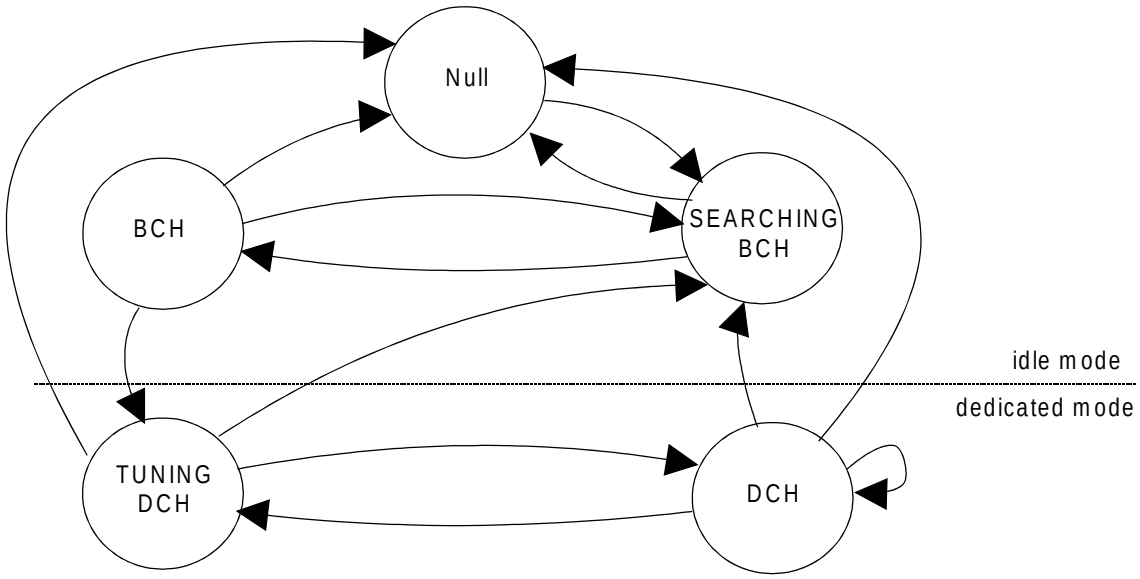


Figure 5.1: States of the physical layer in the MS

The states of the physical layer in the network are not specified. The states in the network will reflect the other characteristics of operation on channels.

5.2 Control procedures

Requirements and examples of procedures for idle mode operation of the MS are specified in GSM 02.11 and 05.08. In the idle mode procedures the physical layer tracks the best cell and may tune on their BCCH in order to enable layer 3 to read the system information of the BCCH. This system information of the BCCH is used in the selection process.

5.3 Physical layer interface procedures

Three types of primitives are defined for the communication between the physical layer and the data link layer both in the MS and the network. When a control channel is being established, a PH-CONNECT-INDICATION is offered to the data link layer on the corresponding SAP. On an established full duplex control channel (DCCHs) in both MS and network or on the established BCCH/CCCH in the MS, physical blocks received correctly are offered on the corresponding SAP in PH-DATA-INDICATION primitives. On a full duplex control channel (DCCHs) or on the BCCH/CCCH in the network, the data link layer will offer physical blocks to be transmitted in PH-DATA-REQUEST primitives. In the MS in idle mode, random accesses can be offered in PH-RANDOM ACCESS-REQUEST primitives. The physical layer of the MS will perform a random access as soon as possible. The physical layer of the MS will confirm the data link layer the transmission of the random access attempt in a PH-RANDOM ACCESS-CONFIRM. This confirmation contains the absolute frame number in which the random access is transmitted. The physical layer of the BS offers correctly received random accesses to the data link layer in a PH-RANDOM ACCESS-INDICATION. This indication contains the absolute frame number in which the random access is received.

6 Physical layer protocol header

The physical layer implements a peer-to-peer protocol for the control of timing advance and power control at the operation on dedicated physical channels. For this purpose a two octet physical header is defined on all blocks transferred via the SACCH, a logical channel always present on a dedicated physical channel.

6.1 Physical layer protocol fields and procedures

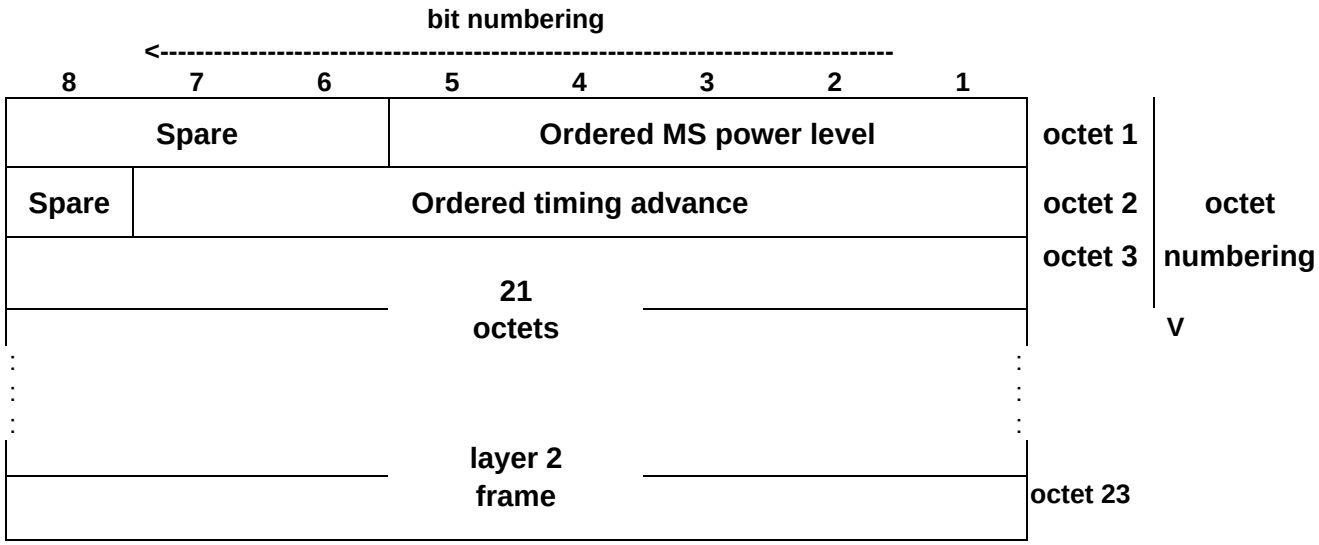
Procedures for handling the ordered and actual power level fields are specified in Technical Specifications GSM 05.05 and 05.08. The ordered MS power level field and the actual MS power level field are coded as the binary representation of the "power control level", see GSM 05.05.

Procedures for handling the ordered and actual timing advance fields are specified in GSM 05.10. The numbers corresponding to the timing advance steps in GSM 05.10 are included binary coded in the 6 bit ordered and actual timing advance fields of the physical layer header. The bit pattern "1111111" indicates that the field does not contain a timing advance value. All other bit combinations (64 to 126 decimal) are reserved.

7 Block transmission

7.1 SACCH downlink block format

The originally 23 octets of SACCH blocks are used downlink in the following way:

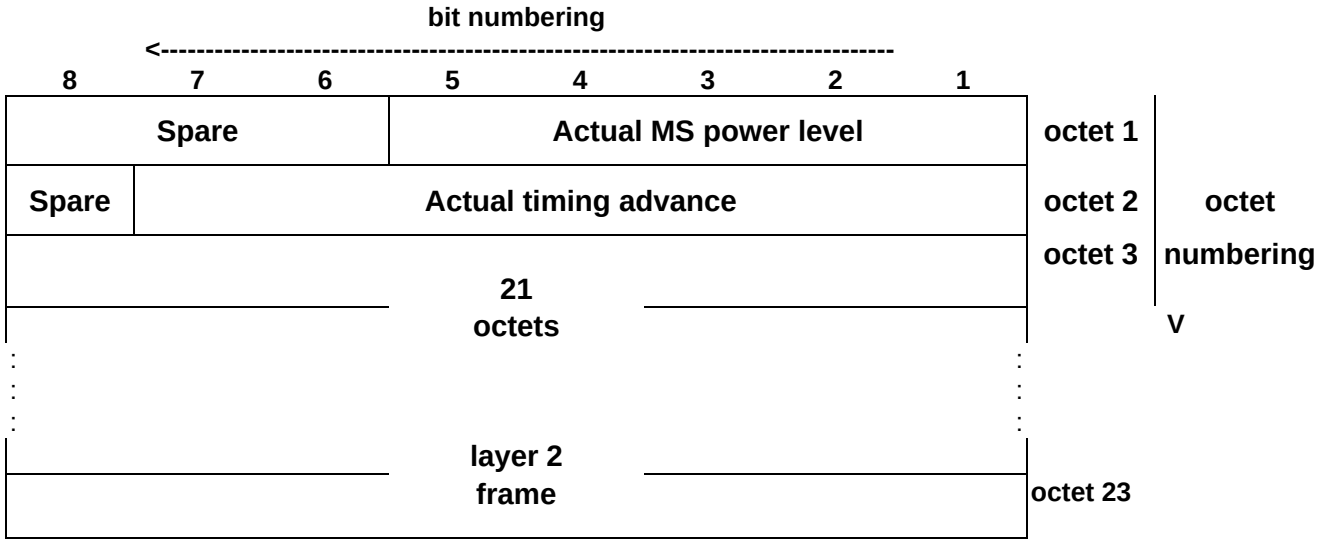


NOTE: The numbering convention specified in GSM 04.06 applies.

Figure 7.1: SACCH downlink block format

7.2 SACCH uplink block format

The originally 23 octets of SACCH blocks are used uplink in the following way:

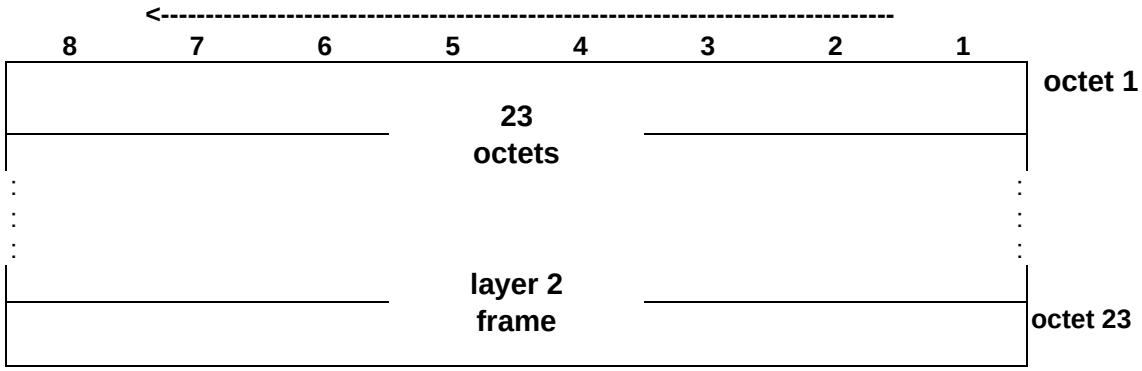


NOTE: The numbering convention specified in GSM 04.06 applies.

Figure 7.2: SACCH uplink block format

7.3 FACCH/SDCCH/CCCH/BCCH/CBCH downlink block format

The originally 23 octets blocks are used downlink in the following way:

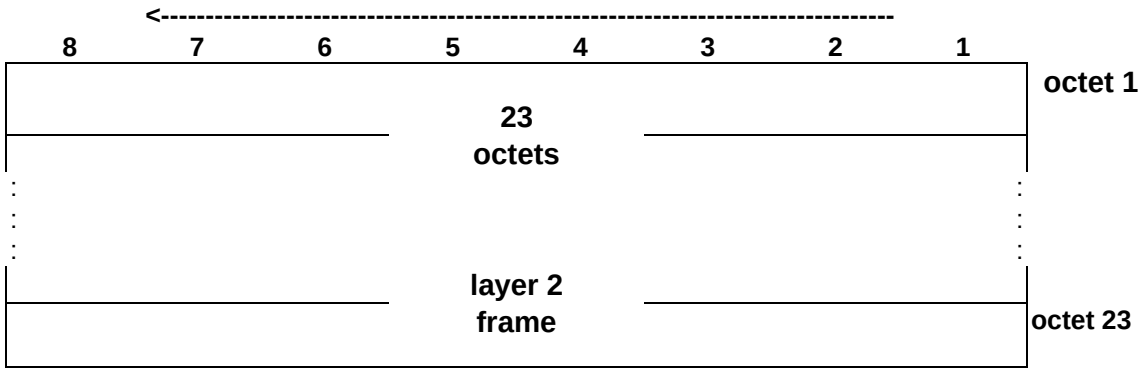


NOTE: The numbering convention specified in GSM 04.06 and 04.12 applies.

Figure 7.3: FACCH/SDCCH/BCCH/CCCH/CBCH downlink block format

7.4 FACCH/SDCCH uplink block format

The originally 23 octets blocks are used uplink in the following way:



NOTE: The numbering convention specified in GSM 04.06 applies.

Figure 7.4: FACCH/SDCCH uplink block format

7.5 Order of bit transmission

On channels for normal burst transmission the 23 octets are mapped onto 184 bits, d(0) to d(183), defined in GSM 05.03 clause 4 as follows:

> Bit m of octet n shall be transmitted as bit d((n-1)*8+m-1) with m=(1..8) and n=(1..23).

For transmission which does not follow the normal burst transmission (refer e.g. to CHANNEL REQUEST message, HANDOVER ACCESS message and SYNCHRONIZATION CHANNEL INFORMATION message defined in GSM 04.08) this rule applies accordingly:

> Bit m of octet n shall be transmitted as bit d((n-1)*8+m-1) with m=(1..x) and n=(1..y) where x and y are given by the definition of the respective layer 3 information in GSM 04.08.

8 Vocabulary

The terminology used in this ETS is as follows:

- Idle mode:
  In this mode the MS is not allocated any dedicated physical channel; it listens to the CCCH and the BCCH.

- Dedicated mode:
  In this mode the MS is allocated a dedicated physical channel, at least containing two logical channels, only one of them being a SACCH.

- Physical block:
  The physical block is the minimal unit which can be transferred by the physical layer.

History

Document history			
November 1996	Unified Approval Procedure	UAP 59:	1996-11-25 to 1997-03-21
April 1997	First Edition		

ISBN 2-7437-1409-3
Dépôt légal : Avril 1997