ETSI TS 145 001 V13.2.0 (2016-08)

Digital cellular telecommunications system (Phase 2+) (GSM);
Physical layer on the radio path;
General description
(3GPP TS 45.001 version 13.2.0 Release 13)

3GPP A GLOBAL INITIATIVE
GSM® GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

Reference

RTS/TSGG-0145001vd20

Keywords

GSM

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Copyright Notification

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document is an introduction to the 45 series of the digital cellular telecommunications systems GSM technical specifications. It is not of a mandatory nature, but consists of a general description of the organization of the physical layer with reference to the technical specifications where each part is specified in detail. It introduces furthermore, the reference configuration that will be used throughout this series of technical specifications.

1.1 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] 3GPP TR 21.905: 'Vocabulary for 3GPP Specifications'.

[2] 3GPP TR 23.003: 'Numbering, Addressing and Identification'.

[3] 3GPP TS 23.034: 'High Speed Circuit Switched Data (HSCSD); Stage 2'.

[4] 3GPP TS 43.020: 'Security-related Networks Functions'.

[5] 3GPP TS 43.022: 'Functions related to Mobile Station (MS) in idle mode and group receive mode'.

[6] 3GPP TR 43.030: 'Radio network planning aspects'

[7] 3GPP TS 43.052: 'Lower layers of the GSM Cordless Telephony System (CTS) radio interface; Stage 2'.

[8] 3GPP TS 43.064: 'Overall description of the GPRS radio interface; Stage 2'.

[9] 3GPP TS 44.003: 'Mobile Station - Base Station System (MS - BSS) Interface Channel Structures and Access Capabilities'.

[10] 3GPP TS 44.018: 'Mobile radio interface layer 3 specification; Radio Resource Control Protocol'

[11] 3GPP TS 44.021: 'Rate Adaption on the Mobile Station - Base Station System (MS-BSS) Interface'

[12] 3GPP TS 44.060: 'General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control/ Medium Access Control (RLC/MAC) protocol'.

[13] 3GPP TS 45.002: 'Multiplexing and multiple access on the radio path'.

[14] 3GPP TS 45.003: 'Channel coding'.

[15] 3GPP TS 45.004: 'Modulation'.

[16] 3GPP TS 45.005: 'Radio transmission and reception'.

[17] 3GPP TS 45.008: 'Radio subsystem link control'.

[18] 3GPP TS 45.009: 'Link adaptation'.

[19] 3GPP TS 45.010: 'Radio subsystem synchronization'.

[20] 3GPP TS 45.056: 'GSM Cordless Telephony System (CTS); Phase 1; CTS-FP Radio subsystem'.

[21] 3GPP TR 45.902: 'Flexible Layer One'.

[22] 3GPP TR 45.914: 'Circuit Switched Voice Capacity Evolution for GERAN'.

1.2 Abbreviations

Abbreviations used in the present document are listed in 3GPP TR 21.905. In addition to abbreviations in 3GPP TR 21.905 the following abbreviations apply:

BTTI	Basic Transmission Time Interval
CC	Coverage Class
FANR	Fast Ack/Nack Reporting
PAN	Piggy-backed Ack/Nack
PCS	PAN Check Sequence
RTTI	Reduced Transmission Time Interval
VAMOS	Voice services over Adaptive Multi-user Channels on One Slot
AQPSK	Adaptive Quadrature Phase Shift Keying

1.2a Definitions

Coverage Class: see definition in 3GPP TS 43.064 [8].

EC-GSM-IoT: see definition in 3GPP TS 43.064 [8].

Extended Coverage: see definition in 3GPP TS 43.064 [8].

1.3 Restrictions

Independently of what is stated elsewhere in this and other 3GPP specifications, mobile station support for PBCCH and PCCCH is optional for A/Gb-mode of operation. The network shall never enable PBCCH and PCCCH.

2 Set of channels

The radio subsystem provides a certain number of logical channels that can be separated into two categories according to 3GPP TS 44.003, 3GPP TS 43.064 and 3GPP TS 43.052:

1) The traffic channels (TCH): they are intended to carry two types of user information streams: encoded speech and data. The following types of traffic channels are defined: Bm or full-rate (TCH/F), Lm or half-rate (TCH/H), cell broadcast (CBCH), full rate packet data ((EC-)PDTCH/F) and half rate packet data (PDTCH/H) traffic channels. For the purpose of this series of technical specifications, the following traffic channels are distinguished:

   - full rate speech TCH (TCH/FS);
   - enhanced full rate speech TCH (TCH/EFS)
   - half rate speech TCH (TCH/HS);
   - adaptive full rate speech TCH (TCH/AFS);
   - adaptive half rate speech TCH (TCH/AHS);
   - adaptive half rate 8-PSK speech TCH (O-TCH/AHS);
   - adaptive full rate wideband speech (TCH/WFS)
   - adaptive full rate 8-PSK wideband speech (O-TCH/WFS)
   - adaptive half rate 8-PSK wideband speech (O-TCH/WHS)
   - 28,8 kbit/s full rate data E-TCH (E-TCH/F28.8);

- 32,0 kbit/s full rate data E-TCH (E-TCH/F32.0);
- 43,2 kbit/s full rate data E-TCH (E-TCH/F43.2);
- 14,4 kbit/s full rate data TCH (TCH/F14.4);
- 9,6 kbit/s full rate data TCH (TCH/F9.6);
- 4,8 kbit/s full rate data TCH (TCH/F4.8);
- 4,8 kbit/s half rate data TCH (TCH/H4.8);
- ≤ 2,4 kbit/s full rate data TCH (TCH/F2.4);
- ≤ 2,4 kbit/s half rate data TCH (TCH/H2.4);
- cell broadcast channel (CBCH);
- full rate packet data traffic channel (PDTCH/F);
- extended coverage full rate packet data traffic channel (EC-PDTCH/F);
- half rate packet data traffic channel (PDTCH/H).

Adaptive speech traffic channels are channels for which part of the radio bandwidth is reserved for transmission of in band signalling to allow in call adaptation of the speech and channel codec. 8 full rate block structures for TCH/AFS, 8 half rate block structures for O-TCH/AHS, 6 half rate block structures for TCH/AHS, 3 full rate block structures for TCH/WFS, 5 full rate block structures for O-TCH/WFS and 3 half rate block structures for O-TCH/WHS are defined.

All channels are bi-directional unless otherwise stated. Unidirectional downlink full rate channels, TCH/FD are defined as the downlink part of the corresponding TCH/F. Unidirectional uplink full rate channels are FFS.

The assigned uplink and downlink (EC-)PDTCHs are used independently of each other. Dependent assignment of uplink and downlink is possible. A PDTCH/F may be defined either in BTTI configuration or in RTTI configuration. An EC-PDTCH/F shall be defined in BTTI configuration.

Multislot configurations for circuit switched connections are defined as multiple (1 up to 8) full rate channels assigned to the same MS. At least one channel shall be bi-directional (TCH/F). The multislot configuration is symmetric if all channels are bi-directional (TCH/F) and asymmetric if at least one channel is unidirectional (TCH/FD).

High Speed Circuit Switched Data (HSCSD) is an example of multislot configuration, in which all channels shall have the same channel mode.

NOTE: For the maximum number of timeslots to be used for a HSCSD configuration, see 3GPP TS 23.034.

Multislot configurations for packet switched connections are defined as multiple (1 up to 8) (EC-)PDTCH/Us and one (EC-)PACCH for one mobile originated communication, or multiple (1 up to 8) (EC-)PDTCH/Ds and one (EC-)PACCH for one mobile terminated communication respectively, assigned to the same MS. In this context 'assignment' refers to the list of PDCHs in BTTI configuration or PDCH-pairs in RTTI configuration that may dynamically carry the (EC-)PDTCHs for that specific MS. One exception applies in case of EC operation where the PDCHs of a mobile originated communication carry the EC-PDTCHs by means of a fixed uplink allocation.

The (EC-)PACCH shall have the same TTI configuration as the (EC-)PDTCH that it is associated with. The rules for mapping of (EC-)PACCH onto physical channels are specified in 3GPP TS 44.060. In the case of point-to-multipoint transmission for MBMS, multiple (1 up to 5) PDTCH/Ds and one PACCH can be assigned for simultaneous communication with multiple mobiles.

Multislot configurations for dual transfer mode are defined as one bi-directional, traffic channel (TCH/H, O-TCH/H, TCH/F, O-TCH/F or E-TCH/F) and one packet channel combination. The packet channel combination may consist of multiple PDTCH/Us and one PACCH for one mobile originated communication, or multiple PDTCH/Ds and one PACCH for one mobile terminated communication respectively, assigned to the same MS. The PDTCHs may be transmitted either in BTTI configuration or in RTTI configuration. The rules for mapping of PACCH onto physical channels are specified in 3GPP TS 44.060.

An MS capable of dual transfer mode (DTM) shall support, as a minimum, DTM multislot class 5, which utilises the two-timeslot channelization method, i.e. a single TCH/F or O-TCH/F plus a single PDTCH/F. In addition, the MS supporting DTM shall support TCH/H + PDCH/F configuration with the adaptive multirate (AMR) speech coder for voice coding.

2) The signalling channels: these can be sub-divided into BCCH (broadcast control channel, including packet broadcast control channel (PBCCH), see sub clause 1.3, and extended coverage broadcast control channel (EC-BCCH)), CCCH (common control channel, including packet common control channel (PCCCH), see sub clause 1.3, and extended coverage common control channel (EC-CCCH)), SDCCH (stand-alone dedicated control channel), (P)ACCH ((packet) associated control channel, including extended coverage packet associated control channel (EC-PACCH)), packet timing advance control channel (PTCCH) and CTSCCH (CTS control channel). An associated control channel is always assigned in conjunction with, either a TCH, or an SDCCH. A packet associated control channel is always assigned in conjunction to one or multiple (EC-)PDTCH, concurrently assigned to one MS. Two types of ACCH for circuit switched connections are defined: continuous stream (slow ACCH) and burst stealing mode (fast ACCH). For the purpose of this series of technical specifications, the following signalling channels are distinguished:

- stand-alone dedicated control channel, four of them mapped on the same basic physical channel as the CCCH (SDCCH/4);
- stand-alone dedicated control channel, eight of them mapped on a separate basic physical channel (SDCCH/8);
- full rate fast associated control channel (FACCH/F);
- enhanced circuit switched full rate fast associated control channel (E-FACCH/F);
- half rate fast associated control channel (FACCH/H);
- full rate octal fast associated control channel (O-FACCH/F);
- half rate octal fast associated control channel (O-FACCH/H);
- slow, TCH/F, O-TCH/F or E-TCH/F associated, control channel (SACCH/TF);
- slow, TCH/F or O-TCH/F associated, control channel for enhanced power control (SACCH/TPF);
- slow, TCH/H or O-TCH/H associated, control channel (SACCH/TH);
- slow, TCH/H or O-TCH/H associated, control channel for enhanced power control (SACCH/TPH);
- slow, TCH/F, O-TCH/F or E-TCH/F associated, control channel for multislot configurations (SACCH/M);
- slow, TCH/F or O-TCH/F associated, control channel for enhanced power control in multislot configurations (SACCH/MP);
- slow, TCH/F associated, control channel for CTS (SACCH/CTS);
- slow, SDCCH/4 associated, control channel (SACCH/C4);
- slow, SDCCH/8 associated, control channel (SACCH/C8);
- packet associated control channel (PACCH);
- extended coverage packet associated control channel (EC-PACCH);
- packet timing advance control channel (PTCCH);
- broadcast control channel (BCCH);
- packet broadcast control channel (PBCCH);
- extended coverage broadcast control channel (EC-BCCH);
- random access channel (i.e. uplink CCCH) (RACH);
- packet random access channel (i.e. uplink PCCCH) (PRACH);

- extended coverage random access channel (i.e. uplink EC-CCCH) (EC-RACH);
- paging channel (part of downlink CCCH) (PCH);
- extended coverage paging channel (part of downlink EC-CCCH) (EC-PCH);
- packet paging channel (part of downlink PCCCH) (PPCH);
- access grant channel (part of downlink CCCH) (AGCH);
- packet access grant channel (part of downlink PCCCH) (PAGCH);
- extended coverage access grant channel (part of downlink EC-CCCH) (EC-AGCH);
- notification channel (part of downlink CCCH) (NCH);
- CTS beacon channel (part of downlink CTSCCH) (CTSBCH-FB and CTSBCH-SB);
- CTS paging channel (part of downlink CTSCCH) (CTSPCH);
- CTS access request channel (part of uplink CTSCCH) (CTSARCH);
- CTS access grant channel (part of downlink CTSCCH) (CTSAGCH);
- enhanced inband associated control channel (E-IACCH);
- enhanced power control channel (EPCCH);
- enhanced power control channel for multislot configurations (EPCCH/M);
- packet random access channel for MBMS (MPRACH).

All associated control channels have the same direction (bi-directional or unidirectional) as the channels they are associated to. The unidirectional SACCH/MD, SACCH/MPD or EPCCH/MD are defined as the downlink part of SACCH/M, SACCH/MP or EPCCH/M respectively.

When there is no need to distinguish between different sub-categories of the same logical channel, only the generic name will be used, meaning also all the sub-categories, irrespective of modulation used (SACCH will mean all categories of SACCHs, SACCH/T will mean both the slow, TCH associated, control channels with and without enhanced power control, etc.). Also EC-channels are considered to be a sub-category of the same logical channels as non-EC-channels, unless otherwise stated.

The logical channels mentioned above are mapped on physical channels that are described in this set of technical specifications. The different physical channels provide for the transmission of information pertaining to higher layers according to a block structure.

3 Reference configuration

For the purpose of elaborating the physical layer specification, a reference configuration of the transmission chain is used as shown in annex A. This reference configuration also indicates which parts are dealt with in details in which technical specification. It shall be noted that only the transmission part is specified, the receiver being specified only via the overall performance requirements. With reference to this configuration, the technical specifications in the 45 series address the following functional units:

- 3GPP TS 45.002: burst building, and burst multiplexing;
- 3GPP TS 45.003: coding, reordering and partitioning, interleaving, and for EC-channels blind physical layer transmissions;
- 3GPP TS 45.004: differential encoding, modulation, and for EC-GSM-IoT overlaid CDMA;
- 3GPP TS 45.005: transmitter, antenna, and receiver (overall performance).

NOTE: 3GPP TS 45.056 addresses the transmitter and receiver of the CTS-FP.

This reference configuration defines also a number of points of vocabulary in relation to the name of bits at different levels in the configuration. It must be outlined, in the case of the encrypted bits, that they are named only with respect to their position after the encryption unit, and not to the fact that they pertain to a flow of information that is actually encrypted.

4 The block structures

The different block structures are described in more detail in 3GPP TS 45.003. A summarised description appears in table 1, in terms of net bit rate, length and recurrence of blocks.

Table 1: Channel block structures

Type of channel	net bit rate (kbit/s)	block length (bits)	block recurrence (ms)
full rate speech TCH[1]	13,0	182 + 78	20
enhanced full rate speech TCH[1]	12,2	170 + 74	20
half rate speech TCH[2]	5,6	95 + 17	20
Adaptive full rate speech TCH (12,2 kbit/s)	12,2	244	20
Adaptive full rate speech TCH (10,2 kbit/s)	10,2	204	20
Adaptive full rate speech TCH (7,95 kbit/s)	7,95	159	20
Adaptive full rate speech TCH (7,4 kbit/s)	7,4	148	20
Adaptive full rate speech TCH (6,7 kbit/s)	6,7	134	20
Adaptive full rate speech TCH (5,9 kbit/s)	5,9	118	20
Adaptive full rate speech TCH (5,15 kbit/s)	5,15	103	20
Adaptive full rate speech TCH (4,75 kbit/s)	4,75	95	20
Adaptive half rate speech TCH (7,95 kbit/s)[8]	7,95	123 + 36	20
Adaptive half rate speech TCH (7,4 kbit/s)[8]	7,4	120 + 28	20
Adaptive half rate speech TCH (6,7 kbit/s)[8]	6,7	110 + 24	20
Adaptive half rate speech TCH (5,9 kbit/s)[8]	5,9	102 + 16	20
Adaptive half rate speech TCH (5,15 kbit/s)[8]	5,15	91 + 12	20
Adaptive half rate speech TCH (4,75 kbit/s)[8]	4,75	83 + 12	20
Adaptive half rate 8-PSK speech TCH (12,2 kbit/s)	12,2	244	20
Adaptive half rate 8-PSK speech TCH (10,2 kbit/s)	10,2	204	20
Adaptive half rate 8-PSK speech TCH (7,95 kbit/s)	7,95	159	20
Adaptive half rate 8-PSK speech TCH (7,4 kbit/s)	7,4	148	20
Adaptive half rate 8-PSK speech TCH (6,7 kbit/s)	6,7	134	20
Adaptive half rate 8-PSK speech TCH (5,9 kbit/s)	5,9	118	20
Adaptive half rate 8-PSK speech TCH (5,15 kbit/s)	5,15	103	20
Adaptive half rate 8-PSK speech TCH (4,75 kbit/s)	4,75	95	20
Wideband Adaptive full rate speech TCH (12,65 kbit/s)	12,65	253	20
Wideband Adaptive full rate speech TCH (8,85 kbit/s)	8,85	177	20
Wideband Adaptive full rate speech TCH (6,60 kbit/s)	6,60	132	20
Wideband Adaptive full rate 8-PSK speech TCH (23,85 kbit/s)	23,85	477	20
Wideband Adaptive full rate 8-PSK speech TCH (15,85 kbit/s)	15,85	317	20
Wideband Adaptive full rate 8-PSK speech TCH (12,65 kbit/s)	12,65	253	20
Wideband Adaptive full rate 8-PSK speech TCH (8,85 kbit/s)	8,85	177	20
Wideband Adaptive full rate 8-PSK speech TCH (6,6 kbit/s)	6,60	132	20
(continued)			