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Technical Specification

Satellite Component of UMTS/IMT 2000;
A-family;
Part 1: Physical channels and mapping of transport channels into physical channels
(S-UMTS-A 25.211)

Reference
DTS/SES-00-U-1-25-01

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Contents

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Foreword

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- the third digit (n) is incremented when editorial only changes have been incorporated in the specification;
- the second digit (m) is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

The present document is part 1 of a multi-part deliverable covering the Satellite Component of UMTS/IMT 2000; A-family, as identified below:

Part 1: "Physical channels and mapping of transport channels into physical channels";

Part 2: "Multiplexing and channel coding";

Part 3: "Spreading and modulation";

Part 4: "Physical layer procedures".

Introduction

S-UMTS stands for the Satellite component of the Universal Mobile Telecommunication System. S-UMTS systems will complement the terrestrial UMTS (T-UMTS) and inter-work with other IMT-2000 family members through the UMTS core network. S-UMTS will be used to deliver 3rd generation mobile satellite services (MSS) utilizing either low (LEO) or medium (MEO) earth orbiting, or geostationary (GEO) satellite(s). S-UMTS systems are based on terrestrial 3GPP specifications and will support access to GSM / UMTS core networks.

NOTE: The term T-UMTS will be used in the present document to further differentiate the Terrestrial UMTS component.

Due to the differences between terrestrial and satellite channel characteristics, some modifications to the terrestrial UMTS (T-UMTS) standards are necessary. Some specifications are directly applicable, whereas others are applicable with modifications. Similarly, some T-UMTS specifications do not apply, whilst some S-UMTS specifications have no corresponding T-UMTS specification.

Since S-UMTS is derived from T-UMTS, the organization of the S-UMTS specifications closely follows the original 3rd Generation Partnership Project (3GPP) structure. The S-UMTS numbers have been designed to correspond to the

3GPP terrestrial UMTS numbering system. All S-UMTS specifications are allocated a unique S-UMTS number as follows:

S-UMTS-n xx.yyy

Where :

The numbers xx and yyy correspond to the 3GPP-numbering scheme,

n (n = A, B, C, …) denotes the family of S-UMTS specifications.

An S-UMTS system is defined by the combination of a family of S-UMTS specifications and 3GPP specifications, as follows:

- If an S-UMTS specification exists it takes precedence over the corresponding 3GPP specification (if any). This precedence rule applies to any references in the corresponding 3GPP specifications.

NOTE: Any references to 3GPP specifications within the S-UMTS specifications are not subject to this precedence rule. For example, an S-UMTS specification may contain specific references to the corresponding 3GPP specification.

- If an S-UMTS specification does not exist, the corresponding 3GPP specification may or may not apply. The exact applicability of the complete list of 3GPP specifications shall be defined at a later stage.

1 Scope

The present document defines the Layer 1 transport channels and physical channels used for family A of the satellite component of UMTS (S-UMTS-A).

It is based on the FDD mode of UTRA defined by 3GPP [4], [5], [6], [7] and adapted for operation over satellite transponders.

2 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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] ETSI TS 101 851-2: "Satellite Component of UMTS/IMT 2000; A-family; Part 2: Multiplexing and channel coding (S-UMTS-A 25.212)".

[2] ETSI TS 101 851-3: "Satellite Component of UMTS/IMT 2000; A-family; Part 3: Spreading and modulation (S-UMTS-A 25.213)".

[3] ETSI TS 101 851-4: "Satellite Component of UMTS/IMT 2000; A-family; Part 4: Physical layer procedures (S-UMTS-A 25.214)".

[4] ETSI TS 125 211: "Universal Mobile Telecommunication System (UMTS); Physical channels and mapping of transport channels onto physical channels (FDD) (3G TS 25.211 version 3.3.0 Release 1999)".

[5] ETSI TS 125 212: "Universal Mobile Telecommunication System (UMTS); Multiplexing and channel coding (FDD) (3G TS 25.212 version 3.3.0 Release 1999)".

[6] ETSI TS 125 213: "Universal Mobile Telecommunication System (UMTS); Spreading and modulation (FDD) (3G TS 25.213 version 3.3.0 Release 1999)".

[7] ETSI TS 125 214: "Universal Mobile Telecommunication System (UMTS); Physical layer procedures (FDD) (3G TS 25.214 version 3.3.0 Release 1999)".

[8] ETSI TS 125 302: "Universal Mobile Telecommunication System (UMTS); Services provided by the physical layer (3G TS 25.302 version 3.5.0 Release 1999)".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	Third Generation Partnership Project
AP	Access Preamble
BCH	Broadcast Channel
CCPCH	Common Control Physical Channel
CCTrCH	Coded Composite Transport Channel
CPICH	Common Pilot Channel
DCH	Dedicated Channel
DPCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel
DPDCH	Dedicated Physical Data Channel

DSCH	Downlink Shared Channel
DTX	Discontinuous Transmission
FACH	Forward Access Channel
FSW	Frame Synchronization Word
GEO	Geostationary Orbit
HPPICH	High Penetration Page Indicator Channel
ICH	Indicator Channel
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
PCH	Paging Channel
P-CCPCH	Primary Common Control Physical Channel
PCPCH	Physical Common Packet Channel
PDSCH	Physical Downlink Shared Channel
PI	Page Indicatior
PICH	Page Indication Channel
PRACH	Physical Random Access Channel
PSC	Primary Synchronization Code
RACH	Random Access Channel
S-CCPCH	Secondary Common Control Physical Channel
SCH	Synchronization Channel
SF	Spreading Factor
SFN	System Frame Number
TFCI	Transport Format Combination Indicator
TPC	Transmit Power Control
UE	User Equipment
USRAN	UMTS Satellite Radio Access Network

4 Services offered to higher layers

4.1 Transport channels

Transport channels are services offered by Layer 1 to the higher layers. General concepts about transport channels are described in [8].

A transport channel is defined by how and with what characteristics data are transferred over the air interface. A general classification of transport channels is into two groups:

- Dedicated channels, using inherent addressing of UE;
- Common channels, using explicit addressing of UE if addressing is needed.

4.1.1 Dedicated transport channels

There exists only one type of dedicated transport channel, the Dedicated Channel (DCH).

4.1.1.1 DCH - Dedicated Channel

The Dedicated Channel (DCH) is a downlink or uplink transport channel. The DCH is transmitted over the entire cell or over only a part of the cell using e.g. beam-forming antennas.

4.1.2 Common transport channels

There are six types of common transport channels: BCH, FACH, PCH, RACH, CPCH and DSCH.

4.1.2.1 BCH - Broadcast Channel

The Broadcast Channel (BCH) is a downlink transport channel that is used to broadcast system and cell-specific information. The BCH is always transmitted over the entire cell and has a single transport format.

4.1.2.2 FACH - Forward Access Channel

The Forward Access Channel (FACH) is a downlink transport channel. The FACH is transmitted over the entire cell or over only a part of the cell using e.g. beam-forming antennas. The FACH can be transmitted using slow power control.

4.1.2.3 PCH - Paging Channel

The Paging Channel (PCH) is a downlink transport channel. The PCH is always transmitted over the entire cell. The transmission of the PCH is associated with the transmission of physical-layer generated Paging Indicators, to support efficient sleep-mode procedures.

4.1.2.4 RACH - Random Access Channel

The Random Access Channel (RACH) is an uplink transport channel. The RACH is always received from the entire cell. The RACH is characterized by a collision risk and by being transmitted using open loop power control.

4.1.2.5 CPCH – Common Packet Channel

This channel is not used in S-UMTS-A.

4.1.2.6 DSCH – Downlink Shared Channel

The Downlink Shared Channel (DSCH) is a downlink transport channel shared by several UE. The DSCH is associated with one or several downlink DCH. The DSCH is transmitted over the entire cell or over only a part of the cell using e.g. beam-forming antennas.

4.2 Indicators

Indicators are means of fast low-level signalling entities that are transmitted without using information blocks sent over transport channels. The meaning of indicators is implicit to the receiver.

The indicators defined in the current version of the specifications are: Page Indicator (PI).

Indicators may be either Boolean (two-valued) or three-valued. Their mapping to indicator channels is channel specific.

Indicators are transmitted on those physical channels that are indicator channels (ICH).

5 Physical channels and physical signals

Physical channels are defined by a specific carrier frequency, scrambling code, channellization code (optional), time start & stop (giving a duration) and, on the uplink, relative phase (0 or $\pi/2$). Scrambling and channellization codes are specified in TS 101 851-3 [2]. Time durations are defined by start and stop instants, measured in integer multiples of chips. Suitable multiples of chips also used in specification are:

Radio frame: A radio frame is a processing duration which consists of 15 slots. The length of a radio frame corresponds to 38 400 chips.

Slot: A slot is a duration which consists of fields containing bits. The length of a slot corresponds to 2 560 chips.

The default time duration for a physical channel is continuous from the instant when it is started to the instant when it is stopped. Physical channels that are not continuous will be explicitly described.

Transport channels are described (in more abstract higher layer models of the physical layer) as being capable of being mapped to physical channels. Within the physical layer itself the exact mapping is from a composite coded transport channel (CCTrCH) to the data part of a physical channel. In addition to data parts there also exist channel control parts and physical signals.

5.1 Physical signals

Physical signals are entities with the same basic on-air attributes as physical channels but do not have transport channels or indicators mapped to them. Physical signals may be associated with physical channels in order to support the function of physical channels.

5.2 Uplink physical channels

5.2.1 Dedicated uplink physical channels

There are two types of uplink dedicated physical channels, the uplink Dedicated Physical Data Channel (uplink DPDCH) and the uplink Dedicated Physical Control Channel (uplink DPCCH).

The DPDCH and the DPCCH are I/Q code multiplexed within each radio frame (see TS 101 851-3 [2]).

The uplink DPDCH is used to carry the DCH transport channel. There may be zero, one, or several uplink DPDCHs on each radio link.

The uplink DPCCH is used to carry control information generated at Layer 1. The Layer 1 control information consists of known pilot bits to support channel estimation for coherent detection, transmit power-control (TPC) commands and an (optional) transport-format combination indicator (TFCI). The transport-format combination indicator informs the receiver about the instantaneous transport format combination of the transport channels mapped to the simultaneously transmitted uplink DPDCH radio frame. There is one and only one uplink DPCCH on each radio link.

Figure 1 shows the frame structure of the uplink dedicated physical channels. Each radio frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2 560 chips, corresponding to one power-control period.

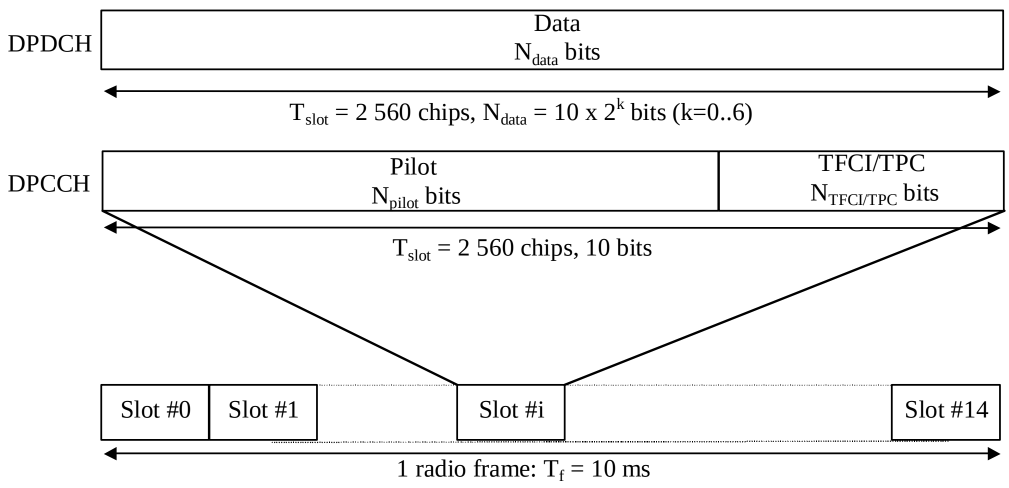

Figure 1: Frame structure for uplink DPDCH/DPCCH

The parameter k in figure 1 determines the number of bits per uplink DPDCH slot. It is related to the spreading factor SF of the DPDCH as SF = $256/2^k$. The DPDCH spreading factor may range from 256 down to 4. The spreading factor of the uplink DPCCH is always equal to 256, i.e. there are 10 bits per uplink DPCCH slot.

The exact number of bits of the uplink DPDCH and the different uplink DPCCH fields (N_{pilot} and $N_{TFCI/TPC}$) is given by table 1 and table 2. What slot format to use is configured by higher layers and can also be reconfigured by higher layers.

The channel bit and symbol rates given in table 1 and table 2 are the rates immediately before spreading. The pilot patterns are given in table 3. The TFCI/TPC bit pattern is described in TS 101 851-2 [1].

Table 1: DPDCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{data}
0	15	15	256	150	10	10
1	30	30	128	300	20	20
2	60	60	64	600	40	40
3	120	120	32	1 200	80	80
4	240	240	16	2 400	160	160
5	480	480	8	4 800	320	320
6	960	960	4	9 600	640	640

There are two types of uplink dedicated physical channels; those that include TFCI (e.g. for several simultaneous services) and those that do not include TFCI (e.g. for fixed-rate services). These types are reflected by the duplicated rows of table 2. It is the USRAN that determines if a TFCI should be transmitted and it is mandatory for all UEs to support the use of TFCI in the uplink. The mapping of TFCI bits onto slots is described in TS 101 851-2 [1].

In compressed mode, DPCCH slot formats with TFCI fields are changed.

Table 2: DPCCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	$N_{TFCI/TPC}$	Transmitted slots per radio frame
0	15	15	256	150	10	8	2	8-15

The pilot bit patterns are described in table 3. The shadowed column part of pilot bit pattern is defined as FSW and FSWs can be used to confirm frame synchronization (the value of the pilot bit pattern other than FSWs shall be "1").

Table 3: Pilot bit patterns for uplink DPCCH with N_{pilot} = 8

	N_{pilot} = 8							
Bit #	0	1	2	3	4	5	6	7
Slot #0	1	1	1	1	1	1	1	0
1	1	0	1	0	1	1	1	0
2	1	0	1	1	1	0	1	1
3	1	0	1	0	1	0	1	0
4	1	1	1	0	1	0	1	1
5	1	1	1	1	1	1	1	0
6	1	1	1	1	1	0	1	0
7	1	1	1	0	1	0	1	0
8	1	0	1	1	1	1	1	0
9	1	1	1	1	1	1	1	1
10	1	0	1	1	1	0	1	1
11	1	1	1	0	1	1	1	1
12	1	1	1	0	1	0	1	0
13	1	0	1	0	1	1	1	1
14	1	0	1	0	1	1	1	1

Multi-code operation is possible for the uplink dedicated physical channels. When multi-code transmission is used, several parallel DPDCH are transmitted using different channellization codes, see TS 101 851-3 [2]. However, there is only one DPCCH per radio link.

A power control preamble may be used for initialization of a DCH. Both the UL and DL DPCCHs shall be transmitted during the power control preamble. The length of the power control preamble is a UE-specific higher layer parameter, N_{pcp} (see [4] clause 5.1.2.4), signalled by the network. The UL DPCCH shall take the same slot format in the power control preamble as afterwards, as given in table 2. When, $N_{pcp} > 0$ the pilot patterns from slot #(15- N_{pcp}) to slot #14 of table 3 shall be used. The timing of the power control preamble is shown in figure 15 in clause 7.7. The TFCI field is filled with "1" bits.

5.2.2 Common uplink physical channels

5.2.2.1 Physical Random Access Channel (PRACH)

The Physical Random Access Channel (PRACH) is used to carry the RACH.

5.2.2.1.1 Overall structure of random-access transmission

The random-access transmission is based on an ALOHA approach.

The structure of the random-access transmission is shown in figure 2. The random-access transmission consists of one or several packets consisting of a preamble of length 9 x 4 096 = 36 864 chips and a message of length 10 ms or 20 ms.

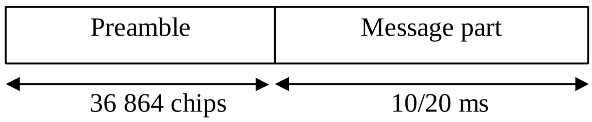

Figure 2: Structure of the random-access transmission

5.2.2.1.2 RACH preamble part

The preamble part of the random-access burst consists of 8 x 256 repetitions of a signature and a unique word to ease one-shot synchronization. There are a total of 16 different signatures, based on the Hadamard code set of length 16 (see TS 101 851-3 [2] for more details).

5.2.2.1.3 RACH message part

Figure 3 shows the structure of the Random-access message part. The 10 ms message is split into 15 slots, each of length T_{slot} = 2 560 chips. Each slot consists of two parts, a data part to which the RACH transport channel is mapped and a control part that carries Layer 1 control information. The data and control parts are transmitted in parallel
A 10 ms message part consists of one message part radio frame, while a 20 ms message part consists of two consecutive 10 ms message part radio frames. The message part length is configured by higher layers.

The data part consists of 10 x 2^k bits, where k = 0, 1, 2, 3. This corresponds to a spreading factor of 256, 128, 64, and 32 respectively for the message data part.

The control part consists of 8 known pilot bits to support channel estimation for coherent detection and 2 TFCI bits. This corresponds to a spreading factor of 256 for the message control part. The pilot bit pattern is described in table 6. The total number of TFCI bits in the random-access message is 15 x 2 = 30. The TFCI of a radio frame indicates the transport format of the RACH transport channel mapped to the simultaneously transmitted message part radio frame. In case of a 20 ms PRACH message part, the TFCI is repeated in the second radio frame.

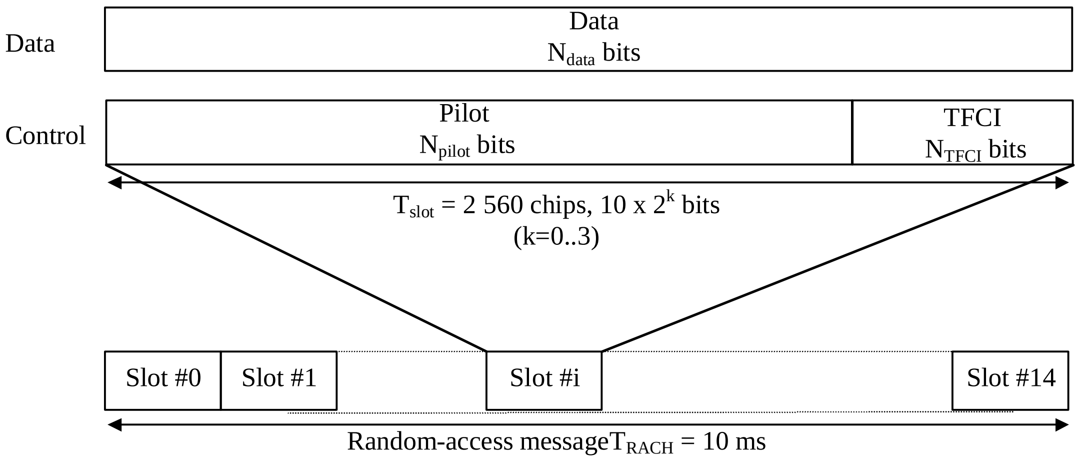

Figure 3: Structure of the random-access message part

Table 4: Random-access message data fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{data}
0	15	15	256	150	10	10
1	30	30	128	300	20	20
2	60	60	64	600	40	40
3	120	120	32	1 200	80	80

Table 5: Random-access message control fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TFCI}
0	15	15	256	150	10	8	2

Table 6: Pilot bit patterns for RACH message part with N_{pilot} = 8

	N_{pilot} = 8							
Bit #	0	1	2	3	4	5	6	7
Slot #0	1	1	1	1	1	1	1	0
1	1	0	1	0	1	1	1	0
2	1	0	1	1	1	0	1	1
3	1	0	1	0	1	0	1	0
4	1	1	1	0	1	0	1	1
5	1	1	1	1	1	1	1	0
6	1	1	1	1	1	0	1	0
7	1	1	1	0	1	0	1	0
8	1	0	1	1	1	1	1	0
9	1	1	1	1	1	1	1	1
10	1	0	1	1	1	0	1	1
11	1	1	1	0	1	1	1	1
12	1	1	1	0	1	0	1	0
13	1	0	1	0	1	1	1	1
14	1	0	1	0	1	1	1	1

5.2.2.2 Physical Common Packet Channel (PCPCH)

This channel is not used in S-UMTS-A.

5.3 Downlink physical channels

5.3.1 Downlink transmit diversity

This feature is not used in S-UMTS-A.

5.3.2 Dedicated downlink physical channels

There is only one type of downlink dedicated physical channel, the Downlink Dedicated Physical Channel (downlink DPCH).

Within one downlink DPCH, dedicated data generated at Layer 2 and above, i.e. the dedicated transport channel (DCH), is transmitted in time-multiplex with control information generated at Layer 1 (known pilot bits, TPC commands, and an optional TFCI). The downlink DPCH can thus be seen as a time multiplex of a downlink DPDCH and a downlink DPCCH, compare clause 5.2.1.

Figure 4 shows the frame structure of the downlink DPCH. Each frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2 560 chips. One frame corresponds to one power-control period.

The parameter k in figure 4 determines the total number of bits per downlink DPCH slot. It is related to the spreading factor SF of the physical channel as $SF = 512/2^k$. The spreading factor may thus range from 512 down to 4.

The exact number of bits of the different downlink DPCH fields (N_{pilot}, $N_{TFCI/TPC}$, N_{data}) is determined in table 7. What slot format to use is configured by higher layers and can also be reconfigured by higher layers.

There are basically two types of downlink Dedicated Physical Channels; those that include TFCI (e.g. for several simultaneous services) and those that do not include TFCI (e.g. for fixed-rate services). It is the USRAN that determines if a TFCI should be transmitted and it is mandatory for all UEs to support the use of TFCI in the downlink. The mapping of TFCI bits onto slots is described in TS 101 851-2 [1].

Table 7 shows the number of bits per slot of the various fields. The channel bit and symbol rates given in table 7 are the rates immediately before spreading. For the baseline configuration (table 7-a) no pilot bits are contained in the DPDCH field. The optional configuration with pilot bits is shown in table 7b.

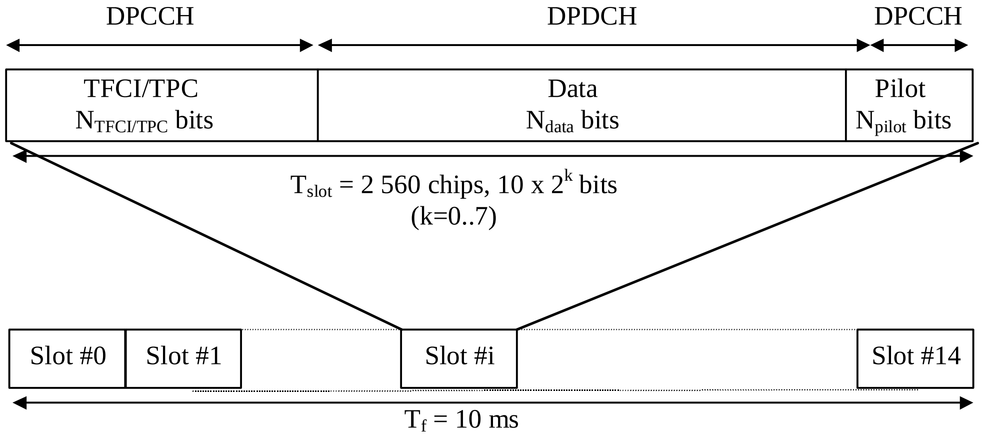

Figure 4: Frame structure for downlink DPCH

Table 7a: Frame structure for the baseline configurations without pilot bits in the DPDCH

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame			Bits/ Slot	DPDCH Bits/Slot	DPCCH	Bits/Slot
				DPDCH	DPCCH	TOT		N_{data}	$N_{TFCI/TPC}$	N_{pilot}
0	15	7,5	512	120	30	150	10	8	2	0
1	30	15	256	270	30	300	20	18	2	0
2	60	30	128	570	30	600	40	38	2	0
3	120	60	64	1 020	180	1 200	80	68	4(+8) (see note)	0
4	240	120	32	2 200	180	2 400	160	148	4(+8) (see note)	0
5	480	240	16	4 560	240	4 800	320	304	8(+8) (see note)	0
6	960	480	8	9 360	240	9 600	640	624	8(+8) (see note)	0
7	1 920	960	4	18 960	240	19 200	1 280	1 264	8(+8) (see note)	0
NOTE: DTX bits (in brackets) shall be used at the beginning of the field.										

Table 7b: Frame structure for the optional configurations with pilot bits in the DPDCH

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame			Bits/ Slot	DPDCH Bits/Slot	DPCCH	Bits/Slot
				DPDCH	DPCCH	TOT		N_{Data}	$N_{TFCI/TPC}$	N_{pilot}
0	15	7,5	512	60	90	150	10	4	2	4
1	30	15	256	240	60	300	20	16	2	2
2	30	15	256	210	90	300	20	14	2	4
3	30	15	256	150	150	300	20	10	2	8
4	60	30	128	510	90	600	40	34	2	4
5	60	30	128	450	150	600	40	30	2	8
6	120	60	64	900	300	1 200	80	60	4(+8) (see note)	8
7	240	120	32	2 100	300	2 400	160	140	4(+8) (see note)	8
8	480	240	16	4 320	480	4 800	320	288	8(+8) (see note)	16
9	960	480	8	9 120	480	9 600	640	608	8(+8) (see note)	16
10	1 920	960	4	18 720	480	19 200	1 280	1 248	8(+8) (see note)	16
NOTE: DTX bits (in brackets) shall be used at the beginning of the field.										

The pilot symbol pattern is described in table 8. The shadowed part can be used as frame synchronization words (the symbol pattern of the pilot symbols other than the frame synchronization word shall be "11"). In table 8, the transmission order is from left to right (each two-bit pair represents an I/Q pair of QPSK modulation.).

Table 8: Pilot Symbol Pattern

	N_{pilot} = 2	N_{pilot} = 4		N_{pilot} = 8				N_{pilot} = 16							
Symbol #	0	0	1	0	1	2	3	0	1	2	3	4	5	6	7
Slot #0	11	11	11	11	11	11	10	11	11	11	10	11	11	11	10
1	00	11	00	11	00	11	10	11	00	11	10	11	11	11	00
2	01	11	01	11	01	11	01	11	01	11	01	11	10	11	00
3	00	11	00	11	00	11	00	11	00	11	00	11	01	11	10
4	10	11	10	11	10	11	01	11	10	11	01	11	11	11	11
5	11	11	11	11	11	11	10	11	11	11	10	11	01	11	01
6	11	11	11	11	11	11	00	11	11	11	00	11	10	11	11
7	10	11	10	11	10	11	00	11	10	11	00	11	10	11	00
8	01	11	01	11	01	11	10	11	01	11	10	11	00	11	11
9	11	11	11	11	11	11	11	11	11	11	11	11	00	11	11
10	01	11	01	11	01	11	01	11	01	11	01	11	11	11	10
11	10	11	10	11	10	11	11	11	10	11	11	11	00	11	10
12	10	11	10	11	10	11	00	11	10	11	00	11	01	11	01
13	00	11	00	11	00	11	11	11	00	11	11	11	00	11	00
14	00	11	00	11	00	11	11	11	00	11	11	11	10	11	01

The relationship between the TPC symbol and the transmitter power control command is presented in table 9.

Table 9: TPC Bit Pattern

TPC Bit Pattern	Transmitter power control command
00	Reduce large power step
01	Reduce small power step
10	Increase small power step
11	Increase large power step

The TFCI/TPC bits represent the transmitted power control command (at frame level) and the particular combination of bit rates of the DCHs currently in use. The correspondence between this combination of bit rates and the TFCI/TPC bits is (re-) negotiated at each addition/removal. The mapping is shown in TS 101 851-2 [1].

When the total bit rate to be transmitted on one downlink CCTrCH exceeds the maximum bit rate for a downlink physical channel, multicode transmission is employed, i.e. several parallel downlink DPCHs are transmitted for one CCTrCH using the same spreading factor. In this case, the Layer 1 control information is put on only the first downlink DPCH. The additional downlink DPCHs belonging to the CCTrCH do not transmit any data during the corresponding time period, see figure 5.

In the case of several CCTrCHs of dedicated type for one UE different spreading factors can be used for each CCTrCH and only one DPCCH would be transmitted for them in the downlink.

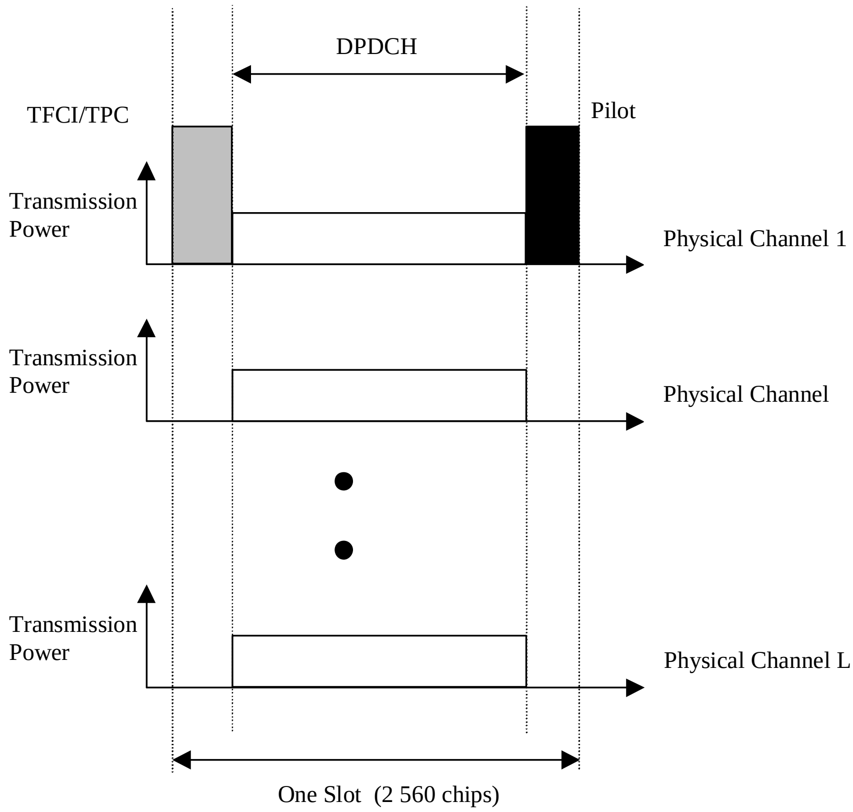

Figure 5: Downlink slot format in case of multi-code transmission

5.3.2.1 STTD for DPCH

This feature is not used in S-UMTS-A.

5.3.2.2 Dedicated channel pilots with closed loop mode transmit diversity

This feature is not used in S-UMTS-A.

5.3.2.3 DL-DPCCH for CPCH

This feature is not used in S-UMTS-A.

5.3.3 Common downlink physical channels

5.3.3.1 Common Pilot Channel (CPICH)

The CPICH is a fixed rate (30 kbps, SF = 256) downlink physical channel that carries a pre-defined bit/symbol sequence. Figure 6 shows the frame structure of the CPICH.

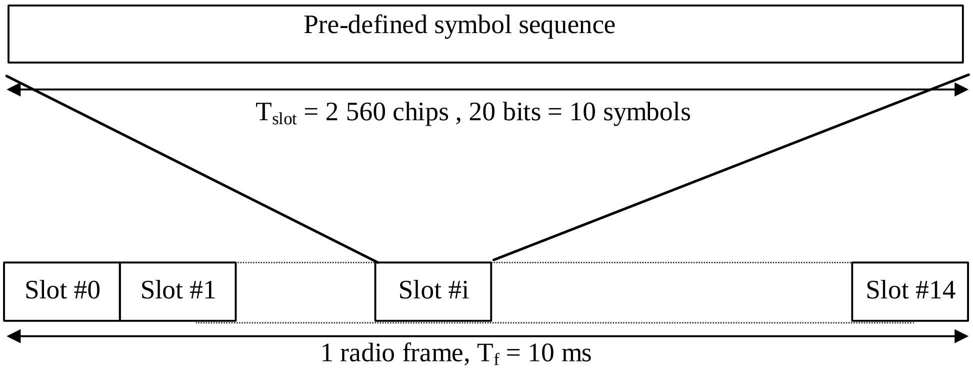

Figure 6: Frame structure for Common Pilot Channel

There are two types of Common pilot channels, the Primary and Secondary CPICH. They differ in their use and the limitations placed on their physical features.

5.3.3.1.1 Primary Common Pilot Channel

The Primary Common Pilot Channel (P-CPICH) has the following characteristics:

- The same channellization code is always used for this channel, see TS 101 851-3 [2];
- Scrambled by the primary scrambling code, see TS 101 851-3 [2];
- One per cell;
- Broadcast over the entire cell.

The Primary CPICH is the phase reference for the following downlink channels: SCH, Primary CCPCH and PICH. The Primary CPICH is also the *default* phase reference for all other downlink physical channels.

5.3.3.1.2 Secondary Common Pilot Channel

A Secondary Common Pilot Channel the following characteristics:

- can use an arbitrary channellization code of SF = 256, see TS 101 851-3 [2];
- scrambled by either the primary or a secondary scrambling code, see TS 101 851-3 [2];
- zero, one, or several per cell;
- may be transmitted over only a part of the cell;
- a Secondary CPICH may be the reference for the Secondary CPCCH and the downlink DPCH. If this is the case, the UE is informed about this by higher-layer signalling.

5.3.3.2 Primary Common Control Physical Channel (P-CCPCH)

The Primary CCPCH is a fixed rate (30 kbps, SF = 256) downlink physical channels used to carry the BCH.

Figure 7 shows the frame structure of the Primary CCPCH. The frame structure differs from the downlink DPCH in that no TPC commands, no TFCI and no pilot bits are transmitted. The Primary CCPCH is not transmitted during the first 256 chips of each slot. Instead, the SCH is transmitted during this period (see clause 5.3.3.4).

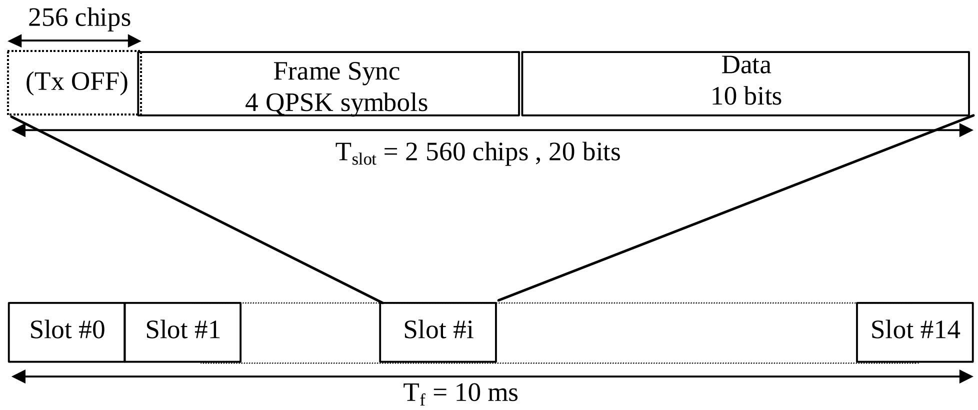

Figure 7: Frame structure for Primary Common Control Physical Channel

In each time slot 4 QPSK symbols of the FSW are transmitted. A whole FSW is 60 symbol-long.

The proposed FSW pattern is obtained by quaternary differential encoding of the following 60-bit long I and Q streams:

- I component: 0xEE89687045DA5E3;
- Q component: 0x32B180B73539FD2.

The differential encoding process is reset at the start of each time slot and initialized with the last Pilot Symbol from the SCH.

5.3.3.2.1 Primary CCPCH structure with STTD encoding

This feature is not used in S-UMTS-A.

5.3.3.3 Secondary Common Control Physical Channel (S-CCPCH)

The Secondary CCPCH is used to carry the FACH and PCH. There are two types of Secondary CCPCH: those that include TFCI and those that do not include TFCI. It is the USRAN that determines if a TFCI should be transmitted, hence making it mandatory for all UEs to support the use of TFCI. The set of possible rates is the same as for the downlink DPCH, see clause 5.3.2. The frame structure of the Secondary CCPCH is shown in figure 8.

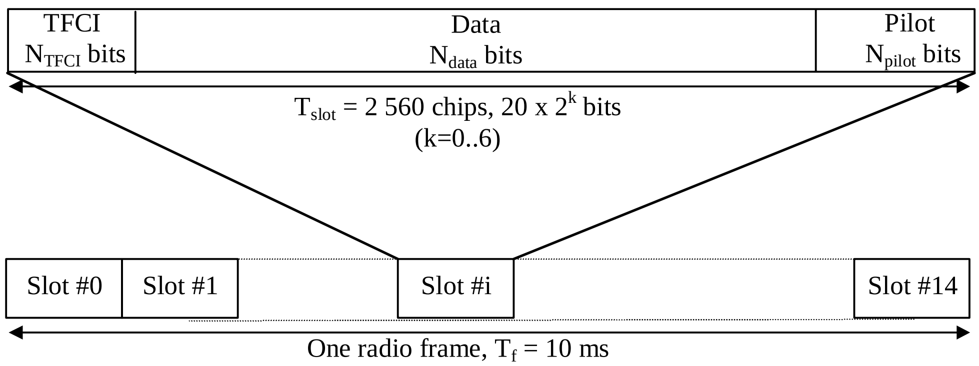

Figure 8: Frame structure for Secondary Common Control Physical Channel

The parameter k in figure 8 determines the total number of bits per downlink Secondary CCPCH slot. It is related to the spreading factor SF of the physical channel as $SF = 256/2^k$. The spreading factor range is from 256 down to 4.

The values for the number of bits per field are given in table 10. The channel bit and symbol rates given in table 10 are the rates immediately before spreading. The pilot patterns are given in table 11.

The FACH and PCH can be mapped to the same or to separate Secondary CCPCHs. If FACH and PCH are mapped to the same Secondary CCPCH, they can be mapped to the same frame. The main difference between a CCPCH and a downlink dedicated physical channel is that a CCPCH is not inner-loop power controlled. The main difference between the Primary and Secondary CCPCH is that the transport channel mapped to the Primary CCPCH (BCH) can only have a fixed predefined transport format combination, while the Secondary CCPCH support multiple transport format combinations using TFCI.

Table 10: Secondary CCPCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{data}	N_{pilot}	N_{TFCI}
0	30	15	256	300	20	20	0	0
1	30	15	256	300	20	12	8	0
2	30	15	256	300	20	18	0	2
3	30	15	256	300	20	10	8	2
4	60	30	128	600	40	40	0	0
5	60	30	128	600	40	32	8	0
6	60	30	128	600	40	38	0	2
7	60	30	128	600	40	30	8	2
8	120	60	64	1 200	80	72	0	8 (see note)
9	120	60	64	1 200	80	64	8	8 (see note)
10	240	120	32	2 400	160	152	0	8 (see note)
11	240	120	32	2 400	160	144	8	8 (see note)
12	480	240	16	4 800	320	312	0	8 (see note)
13	480	240	16	4 800	320	296	16	8 (see note)
14	960	480	8	9 600	640	632	0	8 (see note)
15	960	480	8	9 600	640	616	16	8 (see note)
16	1 920	960	4	19 200	1 280	1 272	0	8 (see note)
17	1 920	960	4	19 200	1 280	1 256	16	8 (see note)
NOTE: If TFCI bits are not used, then DTX shall be used in TFCI field.								

The pilot symbol pattern is described in table 11. The shadowed part can be used as frame synchronization words (the symbol pattern of pilot symbols other than the frame synchronization word shall be "11"). In table 11, the transmission order is from left to right (each two-bit pair represents an I/Q pair of QPSK modulation.).

Table 11: Pilot Symbol Pattern

	N_{pilot} = 8				N_{pilot} = 16							
Symbol #	0	1	2	3	0	1	2	3	4	5	6	7
Slot #0	11	11	11	10	11	11	11	10	11	11	11	10
1	11	00	11	10	11	00	11	10	11	11	11	00
2	11	01	11	01	11	01	11	01	11	10	11	00
3	11	00	11	00	11	00	11	00	11	01	11	10
4	11	10	11	01	11	10	11	01	11	11	11	11
5	11	11	11	10	11	11	11	10	11	01	11	01
6	11	11	11	00	11	11	11	00	11	10	11	11
7	11	10	11	00	11	10	11	00	11	10	11	00
8	11	01	11	10	11	01	11	10	11	00	11	11
9	11	11	11	11	11	11	11	11	11	00	11	11
10	11	01	11	01	11	01	11	01	11	11	11	10
11	11	10	11	11	11	10	11	11	11	00	11	10
12	11	10	11	00	11	10	11	00	11	01	11	01
13	11	00	11	11	11	00	11	11	11	00	11	00
14	11	00	11	11	11	00	11	11	11	10	11	01

For slot formats using TFCI, the TFCI value in each radio frame corresponds to a certain transport format combination of the FACHs and/or PCHs currently in use. This correspondence is (re-) negotiated at each FACH/PCH addition/removal. The mapping of the TFCI bits onto slots is described in TS 101 851-2 [1].

5.3.3.3.1 Secondary CCPCH structure with STTD encoding

This feature is not used in S-UMTS-A.

5.3.3.4 Synchronization Channel (SCH)

The Synchronization Channel (SCH) is a downlink signal used for cell search. The 10 ms radio frames of the SCH are divided into 15 slots, each of length 2 560 chips. Figure 9 illustrates the structure of the SCH radio frame.

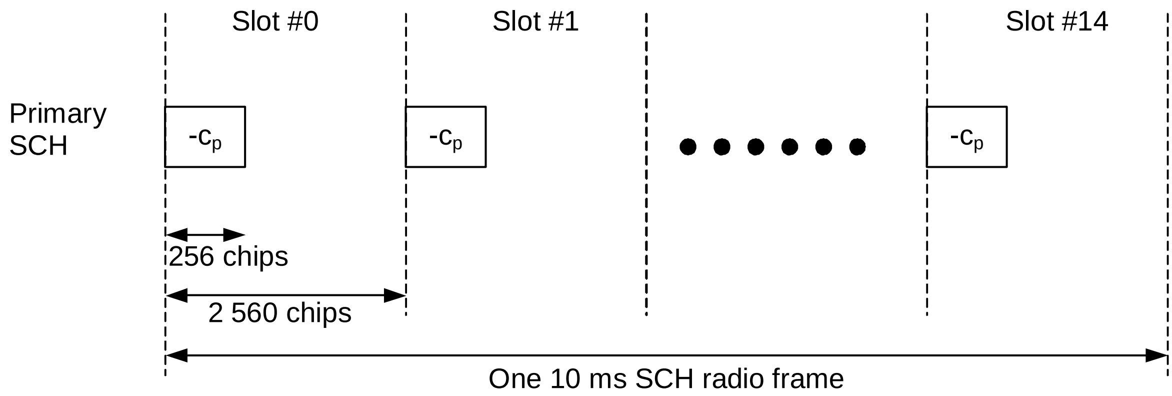

Figure 9: Structure of Synchronization Channel (SCH)

The SCH consists of a modulated code of length 256 chips, the Primary Synchronization Code (PSC) denoted c_p in figure 9, transmitted once every slot. The PSC is the same for every cell in the system.

5.3.3.4.1 SCH transmitted by TSTD

This feature is not used in S-UMTS-A.

5.3.3.5 Physical Downlink Shared Channel (PDSCH)

The Physical Downlink Shared Channel (PDSCH) is used to carry the Downlink Shared Channel (DSCH).

A PDSCH corresponds to a channellization code below or at a PDSCH root channellization code. A PDSCH is allocated on a radio frame basis to a single UE. Within one radio frame, USRAN may allocate different PDSCHs under the same PDSCH root channellization code to different UEs based on code multiplexing. Within the same radio frame, multiple parallel PDSCHs, with the same spreading factor, may be allocated to a single UE. This is a special case of multicode transmission. All the PDSCHs under the same PDSCH root channellization code are operated with radio frame synchronization.

PDSCHs allocated to the same UE on different radio frames may have different spreading factors.

The frame and slot structure of the PDSCH are shown on figure 10.

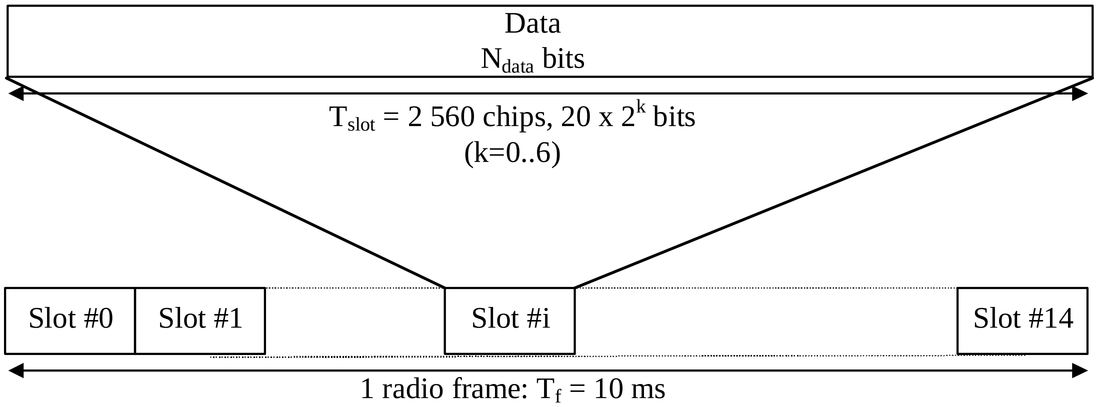

Figure 10: Frame structure for the PDSCH

For each radio frame, each PDSCH is associated with one downlink DPCH. The PDSCH and associated DPCH do not necessarily have the same spreading factors and are not necessarily frame aligned.

All relevant Layer 1 control information is transmitted on the DPCCH part of the associated DPCH, i.e. the PDSCH does not carry Layer 1 information. To indicate for UE that there is data to decode on the DSCH, two signalling methods are possible, either using the TFCI field of the associated DPCH, or higher layer signalling carried on the associated DPCH.

In case of TFCI based signalling, the TFCI informs the UE of the instantaneous transport format parameters related to the PDSCH as well as the channellization code of the PDSCH.

In the other case, the information is given by higher layer signalling.

The channel bit rates and symbol rates for PDSCH are given in table 12.

For PDSCH the allowed spreading factors may vary from 256 to 4.

Table 12: PDSCH fields

Slot format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{data}
0	30	15	256	300	20	20
1	60	30	128	600	40	40
2	120	60	64	1 200	80	80
3	240	120	32	2 400	160	160
4	480	240	16	4 800	320	320
5	960	480	8	9 600	640	640
6	1 920	960	4	19 200	1 280	1 280

5.3.3.6 Acquisition Indicator Channel (AICH)

This channel is not used in S-UMTS-A.

5.3.3.7 CPCH Access Preamble Acquisition Indicator Channel (AP-AICH)

This channel is not used in S-UMTS-A.

5.3.3.8 CPCH Collision Detection/Channel Assignment Indicator Channel (CD/CA-ICH)

This channel is not used in S-UMTS-A.

5.3.3.9 Page Indication Channel (PICH)

The Page Indicator Channel (PICH) is a fixed rate (SF = 256) physical channel used to carry the Page Indicators (PI). The PICH is always associated with an S-CCPCH to which a PCH transport channel is mapped.

Figure 11 illustrates the frame structure of the PICH. One PICH frame of length 10 ms consists 300 bits. Of these, 288 bits are used to carry Page Indicators. The remaining 12 bits are not used.

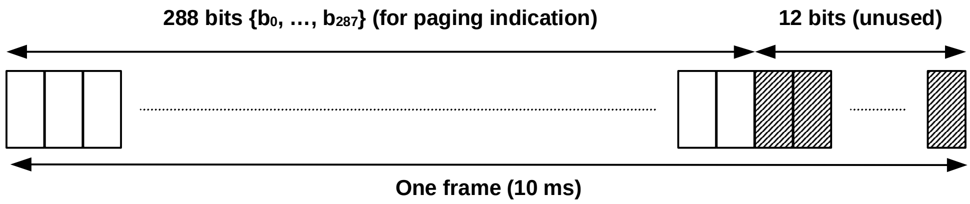

Figure 11: Structure of Page Indicator Channel (PICH)

N Page Indicators $\{PI_0, \ldots, PI_{N-1}\}$ are transmitted in each PICH frame, where N = 18, 36, 72, or 144. The mapping from $\{PI_0, \ldots, PI_{N-1}\}$ to the PICH bits $\{b_0, \ldots, b_{287}\}$ are according to table 13.

Table 13: Mapping of Page Indicators (PI) to PICH bits

Number of PI per frame (N)	$PI_i = 1$	$PI_i = 0$
N = 18	$\{b_{16i}, \ldots, b_{16i+15}\} = \{1,1,\ldots,1\}$	$\{b_{16i}, \ldots, b_{16i+15}\} = \{0,0,\ldots,0\}$
N = 36	$\{b_{8i}, \ldots, b_{8i+7}\} = \{1,1,\ldots,1\}$	$\{b_{8i}, \ldots, b_{8i+7}\} = \{0,0,\ldots,0\}$
N = 72	$\{b_{4i}, \ldots, b_{4i+3}\} = \{1, 1,\ldots,1\}$	$\{b_{4i}, \ldots, b_{4i+3}\} = \{0, 0,\ldots,0\}$
N = 144	$\{b_{2i}, b_{2i+1}\} = \{1,1\}$	$\{b_{2i}, b_{2i+1}\} = \{0,0\}$

If a Paging Indicator in a certain frame is set to "1" it is an indication that UEs associated with this Page Indicator should read the corresponding frame of the associated S-CCPCH.

5.3.3.10 CPCH Status Indicator Channel (CSICH)

This channel is not used in S-UMTS-A.

5.3.3.11 High Penetration Page Indication Channel (HPPICH)

The High Penetration Page Indication Channel (HPPICH) is a physical channel used to carry page indicators (PI). Normal paging operation makes use of both PICH and S-CCPCH (onto which the transport PCH is mapped). However, the system can decide to use this physical HPPICH in case paging was not successful. In this case, the transport PCH is not sent until a new trial in the PICH has been made.

Information is transmitted in short packets of length 10 ms. Transmission timing of this HPPICH does not depend on the general timing relationships described in clause 7, i.e., it is independent of the transmission of other channels.

Information is transmitted at a rate of 15 kbps, making a total of 150 bits. Frame structure is shown in figure 12. It is made of an unmodulated preamble of 24 bits (all bits set to zero), an UW of 12 bits (the sequence 110001001011) and a data field of 114 bits.

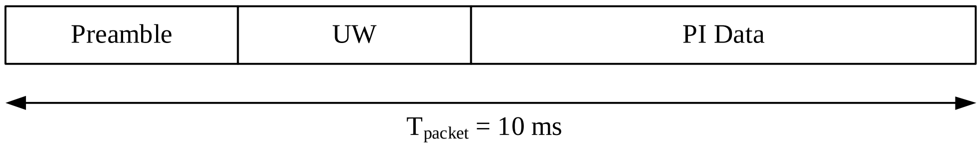

Figure 12: Packet structure for HPPICH

The data field carries a 24-bit word user identifier and an 8-bit CRC part. They are encoded with the convolutional code rate 1/3, and punctured to 114 bits. This encoding process is described in [1].

Differently from the rest of the physical channels, HPPICH is not spread. It is modulated onto a BPSK signal, as described in [2].

6 Mapping and association of physical channels

6.1 Mapping of transport channels onto physical channels

Table 14 summarizes the mapping of transport channels onto physical channels.

Table 14: Transport-channel to physical-channel mapping

Transport Channels	Physical Channels
BCH	Primary Common Control Physical Channel (P-CCPCH)
FACH	Secondary Common Control Physical Channel (S-CCPCH)
PCH	Secondary Common Control Physical Channel (S-CCPCH)
RACH	Physical Random Access Channel (PRACH)
DCH	Dedicated Physical Data Channel (DPDCH) Dedicated Physical Control Channel (DPCCH)
DSCH	Physical Downlink Shared Channel (PDSCH)

The DCHs are coded and multiplexed as described in TS 101 851-2 [1], and the resulting data stream is mapped sequentially (first-in-first-mapped) directly to the physical channel(s). The mapping of BCH and FACH/PCH is equally straightforward, where the data stream after coding and interleaving is mapped sequentially to the Primary and Secondary CCPCH respectively. Also for the RACH, the coded and interleaved bits are sequentially mapped to the physical channel, in this case the message part of the random access burst on the PRACH.

7 Timing relationship between physical channels

7.1 General

The P-CCPCH, on which the cell SFN is transmitted, is used as timing reference for all the physical channels, directly for downlink and indirectly for uplink.

Figure 13 describes the frame timing of the downlink physical channels. Timing for uplink physical channels is given by the downlink timing, as described in the following clauses.

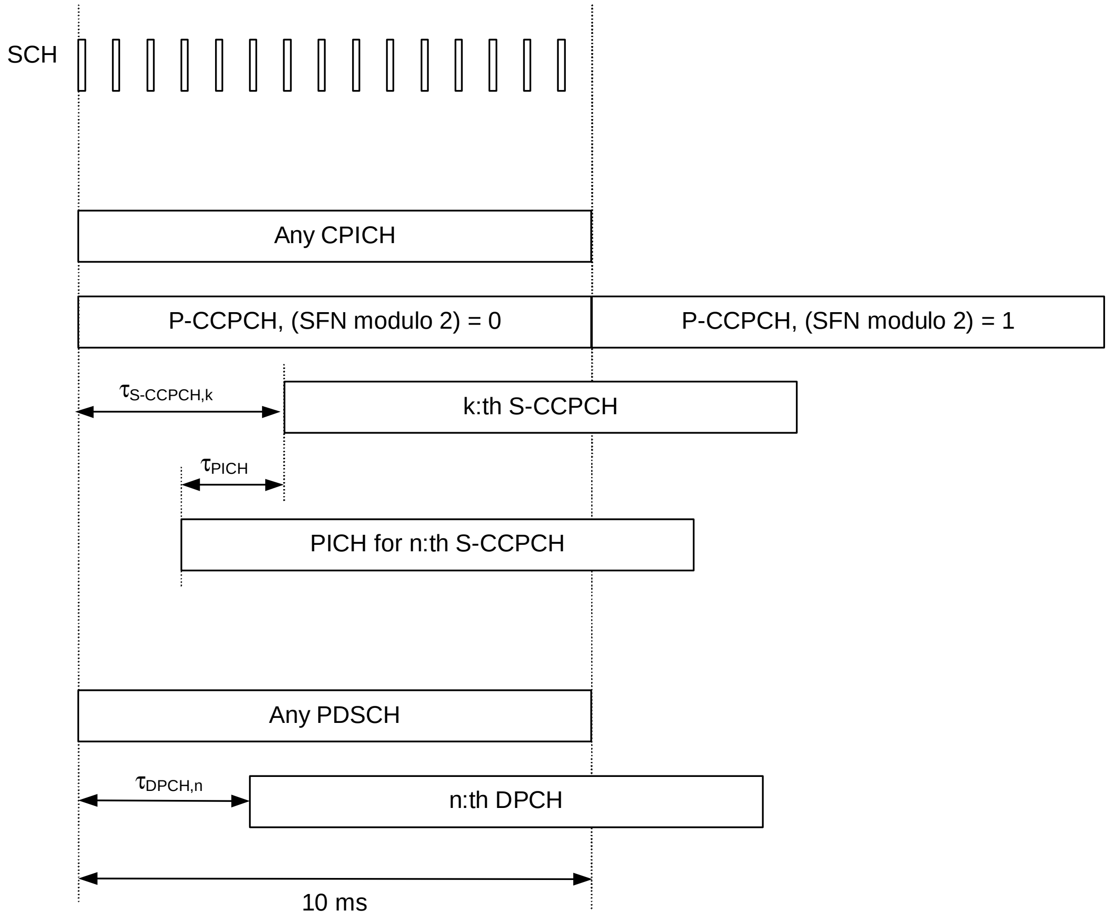

Figure 13: Frame timing and access slot timing of downlink physical channels

In figure 13, the following applies:

- SCH, CPICH (primary and secondary), P-CCPCH, and PDSCH have identical frame timings;
- The S-CCPCH timing may be different for different S-CCPCHs, but the offset from the P-CCPCH frame timing is a multiple of 256 chips, i.e. $\tau_{S\text{-}CCPCH,k} = T_k \times 256$ chip, $T_k \in \{0, 1, \ldots, 149\}$;
- The PICH timing is τ_{PICH} = 7 680 chips prior to its corresponding S-CCPCH frame timing. The PICH timing relation to the S-CCPCH is described more in clause 7.2;
- The PDSCH timing relative the DPCH timing is described in clause 7.5;
- The DPCH timing may be different for different DPCHs, but the offset from the P-CCPCH frame timing is a multiple of 256 chips, i.e. $\tau_{DPCH,n} = T_n \times 256$ chip, $T_n \in \{0, 1, \ldots, 149\}$. The DPCH (DPCCH/DPDCH) timing relation with uplink DPCCH/DPDCHs is described in clause 7.6.

7.2 PICH/S-CCPCH timing relation

Figure 14 illustrates the timing between a PICH frame and its associated S-CCPCH frame. A paging indicator set in a PICH frame means that the paging message is transmitted on the PCH in the S-CCPCH frame starting τ_{PICH} chips after the transmitted PICH frame. τ_{PICH} is defined in clause 7.1.

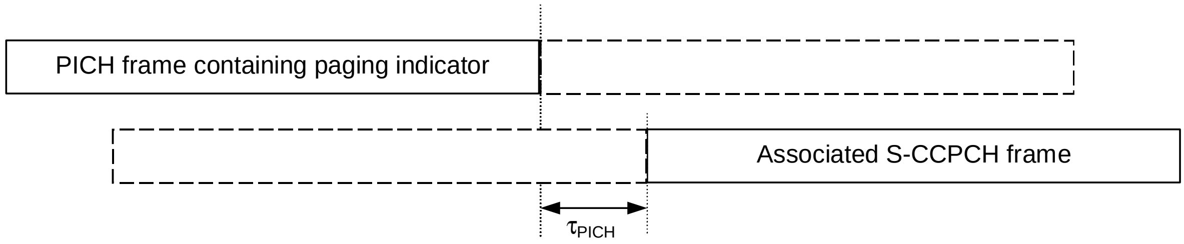

Figure 14: Timing relation between PICH frame and associated S-CCPCH frame

7.3 PRACH/AICH timing relation

Void.

7.4 PCPCH/AICH timing relation

Void.

7.5 DPCH/PDSCH timing

The relative timing between a DPCH frame and the associated PDSCH frame is shown in figure 15.

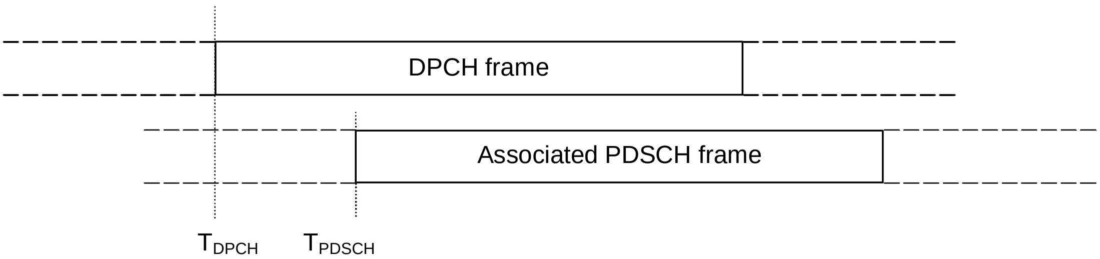

Figure 15: Timing relation between DPCH frame and associated PDSCH frame

The start of a DPCH frame is denoted T_{DPCH} and the start of the associated PDSCH frame is denoted T_{PDSCH}. Any DPCH frame is associated to one PDSCH frame through the relation $-35\,840$ chips < $T_{DPCH} - T_{PDSCH} \leq 2\,560$ chips, i.e. the associated PDSCH frame starts anywhere between 1 slot before or up to 14 slots behind the DPCH.

7.6 DPCCH/DPDCH timing relations

7.6.1 Uplink

In uplink the DPCCH and all the DPDCHs transmitted from one UE have the same frame timing.

7.6.2 Downlink

In downlink, the DPCCH and all the DPDCHs carrying CCTrCHs of dedicated type to one UE have the same frame timing.

7.6.3 Uplink/downlink timing at UE

At the UE, the uplink DPCCH/DPDCH frame transmission takes place approximately T_0 chips after the reception of the first significant path of the corresponding downlink DPCCH/DPDCH frame. T_0 is a constant defined to be 1 024 chips. More information about the uplink/downlink timing relation and meaning of T_0 can be found in TS 101 851-4 [3] clause 4.5.

7.7 Timing relations for initialization of channels

Figure 16 shows the timing relationships between the physical channels involved in the initialization of a DCH.

The maximum time permitted for the UE to decode the relevant FACH frame before the first frame of the DPCCH is received shall be $T_{B\text{-min}}$ = 38 400 chips (i.e.15 slots).

The downlink DPCCH shall commence at a time T_B after the end of the relevant FACH frame, where $T_B \geq T_{B\text{-min}}$ according to the following equation:

$$T_B = (T_n - T_k) \times 256 - N_{pcp} \times 2560 + N_{offset\_1} \times 38400 \text{ chips}$$, where:

N_{pcp} is a higher layer parameter set by the network, and represents the length (in slots) of the power control preamble (see TS 101 851-4 [3] clause 5.1.2.4).

N_{offset_1} is a parameter set by higher layers and derived from the activation time if one is specified. In order that $T_B \geq T_{B\text{-min}}$, N_{offset_1} shall be an integer number of frames such that:

$$N_{offset\_1} \geq \begin{cases} 1 \text{ when } T_n - T_k \geq \frac{T_{B-\min}}{256} + 10N_{pcp} - 150 \\ 2 \text{ when } \frac{T_{B-\min}}{256} + 10N_{pcp} - 300 \leq T_n - T_k < \frac{T_{B-\min}}{256} + 10N_{pcp} - 150 \\ 3 \text{ when } T_n - T_k < \frac{T_{B-\min}}{256} + 10N_{pcp} - 300 \end{cases}$$

T_n and T_k are parameters defining the timing of the frame boundaries on the DL DPCCH and S-CCPCH respectively (see clause 7.1). These parameters are provided by higher layers.

The uplink DPCCH shall commence at a time T_C after the end of the relevant FACH frame, where:

$$T_C = T_B + T_0 + N_{offset\_2} \times 38\,400 \text{ chips},$$

where T_0 is as in clause 7.6.3. If an activation time for the uplink DPCCH is specified, then N_{offset_2} shall be set to zero. Otherwise the stating time of the uplink DPCCH shall be determined by higher layers according to the procedure in TS 101 851-4 [3] clause 4.3.2, subject to the constraint that N_{offset_2} shall be an integer number of frames greater than or equal to zero.

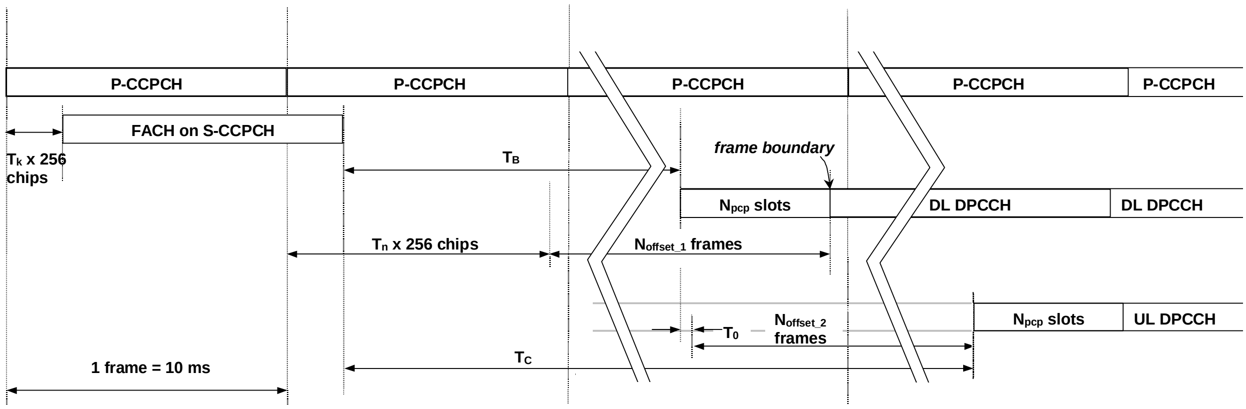

Figure 16: Timing for initialization of DCH

The data channels shall not commence before the end of the power control preamble.

History

Document history		
V1.1.1	December 2000	Publication