TSG RAN Meeting #28 **RP-050247**
Quebec, Canada, 1 - 3 June 2005

Title	**CRs (Rel-5 & Rel-6) to TS25.211 & TS25.214 for Feature clean up: Removal of the 'TX diversity closed loop mode 2'**
Source	**TSG RAN WG1**
Agenda Item	**7.7.5**

RAN1 Tdoc	Spec	CR	Rev	Rel	Cat	Current Version	Subject	Work item	Remarks
R1-050523	25.211	216	-	Rel-5	C	5.6.0	Feature clean up: Removal of the 'TX diversity closed loop mode 2'	TEI5	
R1-050523	25.211	217	-	Rel-6	C	6.4.0	Feature clean up: Removal of the 'TX diversity closed loop mode 2'	TEI6	
R1-050523	25.214	386	1	Rel-5	C	5.10.0	Feature clean up: Removal of the 'TX diversity closed loop mode 2'	TEI5	
R1-050523	25.214	387	1	Rel-6	C	6.5.0	Feature clean up: Removal of the 'TX diversity closed loop mode 2'	TEI6	

3GPP TSG RAN WG1 Meeting #41
Athens, Greece, May 9-13, 2005

Tdoc ⌘R1-050523

CR-Form-v7.1

CHANGE REQUEST

⌘	**25.211**	**CR**	**216**	⌘**rev**	**-**	⌘	Current version:	**5.6.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: UICC apps⌘ [ ] ME [X] Radio Access Network [X] Core Network [ ]

Title: ⌘	Feature clean up: Removal of the 'TX diversity closed loop mode 2'		
Source: ⌘	RAN WG1		
Work item code: ⌘	TEI5	***Date:*** ⌘	18/04/2005
Category: ⌘	**C** *Use one of the following categories:* ***F*** *(correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.	***Release:*** ⌘	Rel-5 *Use one of the following releases:* *Ph2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *Rel-4 (Release 4)* *Rel-5 (Release 5)* *Rel-6 (Release 6)* *Rel-7 (Release 7)*

Reason for change: ⌘	The feature 'TX diversity closed loop mode 2' is not defined for HSDPA and F-DPCH and therefore it is not efficiently usable in the networks. RAN #27 decided with RP-050144 to remove this feature.
Summary of change: ⌘	Text reagarding the feature 'TX diversity closed loop mode 2' was removed.
Consequences if not approved: ⌘	Simplification of specifications, reduction of complexity and easier evolution chance would be missed and a RAN #27 decision would be violated.

Clauses affected: ⌘	5.3.1, 5.3.1.2, 5.3.2.2				
	Y	**N**			
Other specs affected: ⌘	**X**		Other core specifications	⌘	25.101, 25.214, 25.331, 25.423, 25.433
			Test specifications		
		X	O&M Specifications		
Other comments: ⌘	Contents of this CR is unchanged compared to R1-050478.				

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm. Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be

downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

5 Physical channels and physical signals

Physical channels are defined by a specific carrier frequency, scrambling code, channelization code (optional), time start & stop (giving a duration) and, on the uplink, relative phase (0 or $\pi/2$). Scrambling and channelization codes are specified in [4]. 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 38400 chips.

Slot: A slot is a duration which consists of fields containing bits. The length of a slot corresponds to 2560 chips.

Sub-frame: A sub-frame is the basic time interval for HS-DSCH transmission and HS-DSCH-related signalling at the physical layer. The length of a sub-frame corresponds to 3 slots (7680 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 three types of uplink dedicated physical channels, the uplink Dedicated Physical Data Channel (uplink DPDCH), the uplink Dedicated Physical Control Channel (uplink DPCCH), and the uplink Dedicated Control Channel associated with HS-DSCH transmission (uplink HS-DPCCH).

The DPDCH, the DPCCH and the HS-DPCCH are I/Q code multiplexed (see [4]).

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, feedback information (FBI), 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 DPDCH and the uplink DPCCH. Each radio frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2560 chips, corresponding to one power-control period. The DPDCH and DPCCH are always frame aligned with each other.

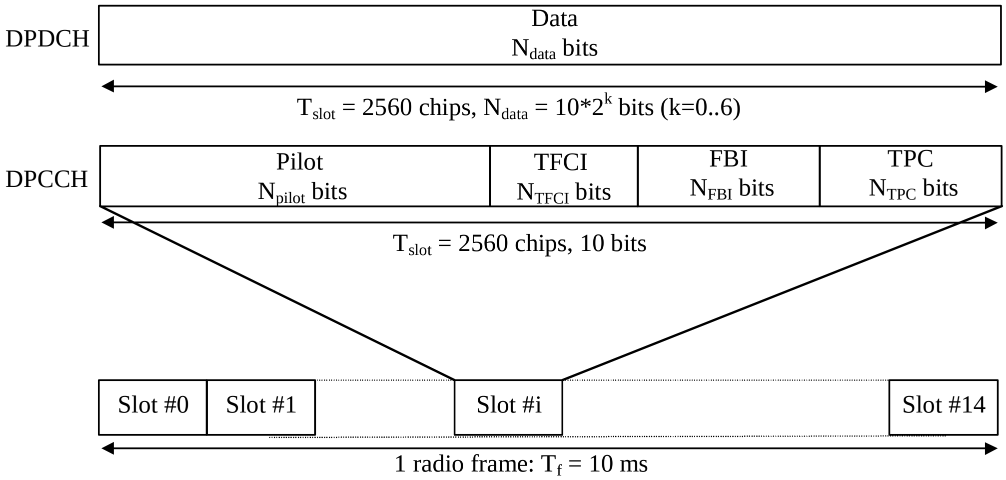

Figure 1: Frame structure for uplink DPDCH/DPCCH

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}, N_{TFCI}, N_{FBI}, and N_{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 and table 4, the TPC bit pattern is given in table 5.

The FBI bits are used to support techniques requiring feedback from the UE to the UTRAN Access Point, including closed loop mode transmit diversity and site selection diversity transmission (SSDT). The structure of the FBI field is shown in figure 2 and described below.

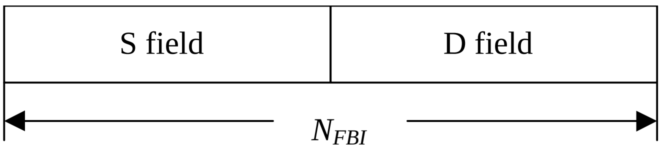

Figure 2: Details of FBI field

The S field is used for SSDT signalling, while the D field is used for closed loop mode transmit diversity signalling. The S field consists of 0, 1 or 2 bits. The D field consists of 0 or 1 bit. The total FBI field size N_{FBI} is given by table 2. If total FBI field is not filled with S field or D field, FBI field shall be filled with "1". When N_{FBI} is 2bits, S field is 0bit and D field is 1bit, left side field shall be filled with "1" and right side field shall be D field. The use of the FBI fields is described in detail in [5].

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	1200	80	80
4	240	240	16	2400	160	160
5	480	480	8	4800	320	320
6	960	960	4	9600	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 UTRAN 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 [3].

In compressed mode, DPCCH slot formats with TFCI fields are changed. There are two possible compressed slot formats for each normal slot format. They are labelled A and B and the selection between them is dependent on the number of slots that are transmitted in each frame in compressed mode.

Table 2: DPCCH fields

Slot Form at #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TPC}	N_{TFCI}	N_{FBI}	Transmitted slots per radio frame
0	15	15	256	150	10	6	2	2	0	15
0A	15	15	256	150	10	5	2	3	0	10-14
0B	15	15	256	150	10	4	2	4	0	8-9
1	15	15	256	150	10	8	2	0	0	8-15
2	15	15	256	150	10	5	2	2	1	15
2A	15	15	256	150	10	4	2	3	1	10-14
2B	15	15	256	150	10	3	2	4	1	8-9
3	15	15	256	150	10	7	2	0	1	8-15
4	15	15	256	150	10	6	2	0	2	8-15
5	15	15	256	150	10	5	1	2	2	15
5A	15	15	256	150	10	4	1	3	2	10-14
5B	15	15	256	150	10	3	1	4	2	8-9

The pilot bit patterns are described in table 3 and table 4. 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} = 3, 4, 5 and 6

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

Table 4: Pilot bit patterns for uplink DPCCH with N_{pilot} = 7 and 8

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

The relationship between the TPC bit pattern and transmitter power control command is presented in table 5.

Table 5: TPC Bit Pattern

TPC Bit Pattern		Transmitter power control command
N_{TPC} = 1	N_{TPC} = 2	
1	11	1
0	00	0

Multi-code operation is possible for the uplink dedicated physical channels. When multi-code transmission is used, several parallel DPDCH are transmitted using different channelization codes, see [4]. However, there is only one DPCCH per radio link.

A period of uplink DPCCH transmission prior to the start of the uplink DPDCH transmission (uplink DPCCH power control preamble) shall be used for initialisation of a DCH. The length of the power control preamble is a higher layer parameter, N_{pcp} , signalled by the network [5]. 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 of table 3 and table 4 shall be used. The timing of the power control preamble is described in [5], subclause 4.3.2.3. The TFCI field is filled with "0" bits.

Figure 2A illustrates the frame structure of the HS-DPCCH. The HS-DPCCH carries uplink feedback signalling related to downlink HS-DSCH transmission. The HS-DSCH-related feedback signalling consists of Hybrid-ARQ Acknowledgement (HARQ-ACK) and Channel-Quality Indication (CQI) [3]. Each sub frame of length 2 ms (3*2560 chips) consists of 3 slots, each of length 2560 chips. The HARQ-ACK is carried in the first slot of the HS-DPCCH sub-frame. The CQI is carried in the second and third slot of a HS-DPCCH sub-frame. There is atmost one HS-DPCCH on each radio link. The HS-DPCCH can only exist together with an uplink DPCCH. The timing of the HS-DPCCH relative to the uplink DPCCH is shown in section 7.7.

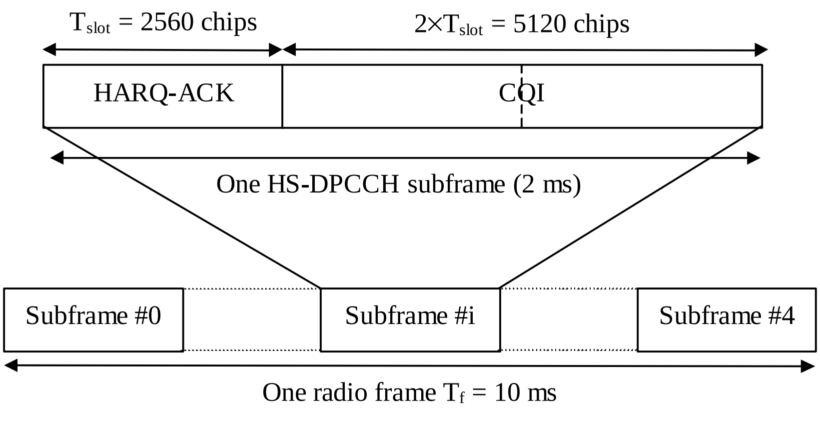

Figure 2A: Frame structure for uplink HS-DPCCH

The spreading factor of the HS-DPCCH is 256 i.e. there are 10 bits per uplink HS-DPCCH slot. The slot format for uplink HS-DPCCH is defined in Table 5A.

Table 5A: HS-DPCCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Subframe	Bits/ Slot	Transmitted slots per Subframe
0	15	15	256	30	10	3

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 a Slotted ALOHA approach with fast acquisition indication. The UE can start the random-access transmission at the beginning of a number of well-defined time intervals, denoted *access slots*. There are 15 access slots per two frames and they are spaced 5120 chips apart, see figure 3. The timing of the access slots and the acquisition indication is described in subclause 7.3. Information on what access slots are available for random-access transmission is given by higher layers.

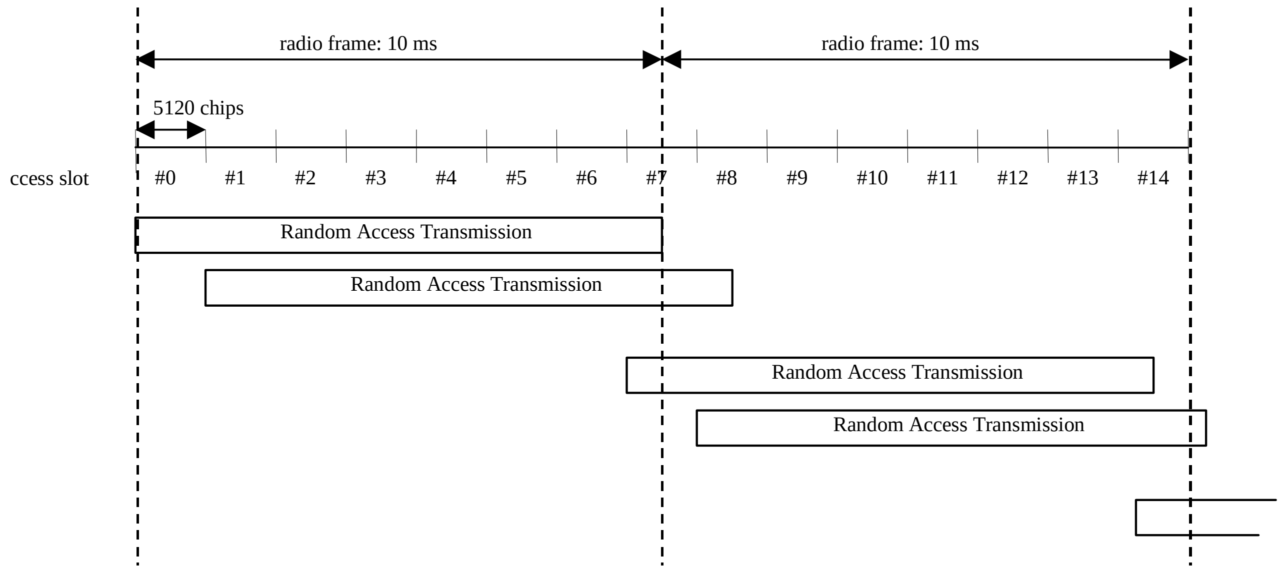

Figure 3: RACH access slot numbers and their spacing

The structure of the random-access transmission is shown in figure 4. The random-access transmission consists of one or several *preambles* of length 4096 chips and a *message* of length 10 ms or 20 ms.

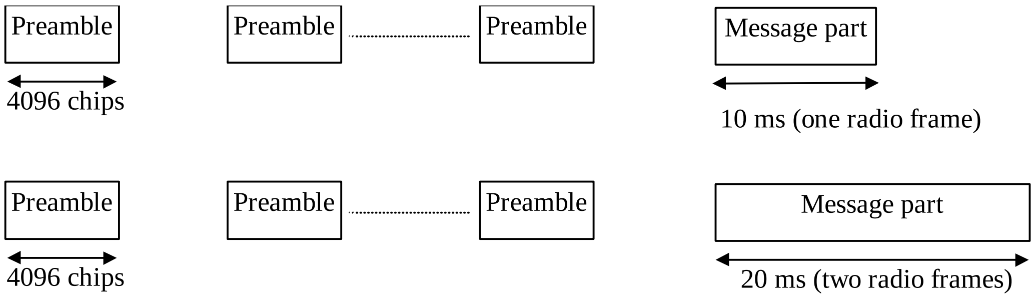

Figure 4: Structure of the random-access transmission

5.2.2.1.2 RACH preamble part

Each preamble is of length 4096 chips and consists of 256 repetitions of a signature of length 16 chips. There are a maximum of 16 available signatures, see [4] for more details.

5.2.2.1.3 RACH message part

Figure 5 shows the structure of the random-access message part radio frame. The 10 ms message part radio frame is split into 15 slots, each of length T_{slot} = 2560 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 equal to the Transmission Time Interval of the RACH Transport channel in use. This TTI length is configured by higher layers.

The data part consists of $10*2^k$ 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 8. The total number of TFCI bits in the random-access message is 15*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.

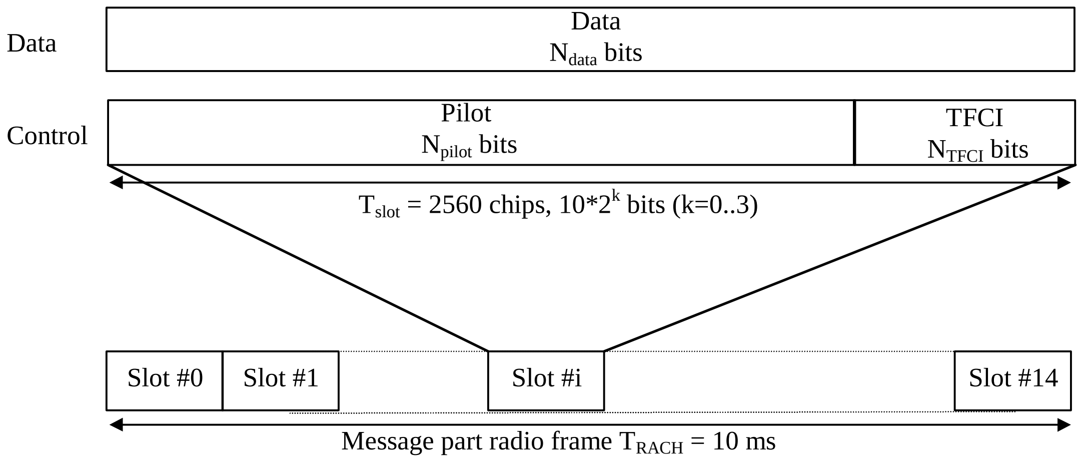

Figure 5: Structure of the random-access message part radio frame

Table 6: 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	1200	80	80

Table 7: 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 8: 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)

The Physical Common Packet Channel (PCPCH) is used to carry the CPCH.

5.2.2.2.1 CPCH transmission

The CPCH transmission is based on DSMA-CD approach with fast acquisition indication. The UE can start transmission at the beginning of a number of well-defined time-intervals, relative to the frame boundary of the received BCH of the current cell. The access slot timing and structure is identical to RACH in subclause 5.2.2.1.1. The structure of the CPCH access transmission is shown in figure 6. The PCPCH access transmission consists of one or several Access Preambles [A-P] of length 4096 chips, one Collision Detection Preamble (CD-P) of length 4096 chips, a DPCCH Power Control Preamble (PC-P) which is either 0 slots or 8 slots in length, and a message of variable length Nx10 ms.

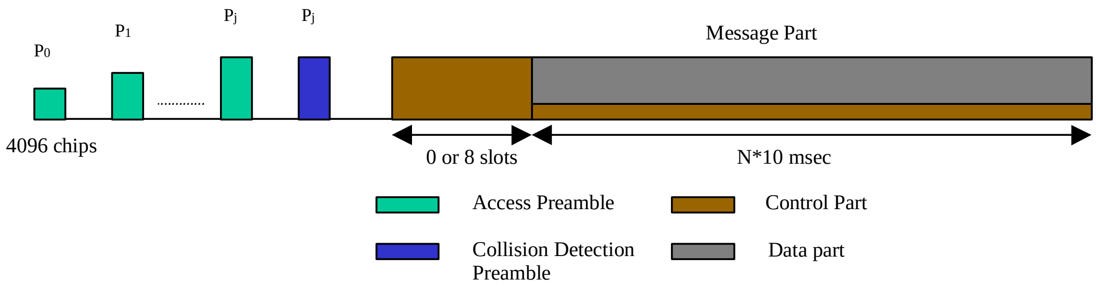

Figure 6: Structure of the CPCH access transmission

5.2.2.2.2 CPCH access preamble part

Similar to 5.2.2.1.2 (RACH preamble part). The RACH preamble signature sequences are used. The number of sequences used could be less than the ones used in the RACH preamble. The scrambling code could either be chosen to be a different code segment of the Gold code used to form the scrambling code of the RACH preambles (see [4] for more details) or could be the same scrambling code in case the signature set is shared.

5.2.2.2.3 CPCH collision detection preamble part

Similar to 5.2.2.1.2 (RACH preamble part). The RACH preamble signature sequences are used. The scrambling code is chosen to be a different code segment of the Gold code used to form the scrambling code for the RACH and CPCH preambles (see [4] for more details).

5.2.2.2.4 CPCH power control preamble part

The power control preamble segment is called the CPCH Power Control Preamble (PC-P) part. The slot format for CPCH PC-P part shall be the same as for the following message part in Table 9 in subclause 5.2.2.2.5. The Power Control Preamble length is a higher layer parameter, $L_{pc\text{-}preamble}$ (see [5], section 6.2), which shall take the value 0 or 8 slots. When $L_{pc\text{-}preamble} > 0$, the pilot bit patterns from slot #(15- $L_{pc\text{-}preamble}$) to slot #14 of table 3 and 4 in subclause 5.2.1 shall be used for CPCH PC-P pilot bit patterns. The TFCI field is filled with "1" bits.

5.2.2.2.5 CPCH message part

Figure 1 in subclause 5.2.1 shows the structure of the CPCH message part. Each message consists of up to N_Max_frames 10 ms frames. N_Max_frames is a higher layer parameter. Each 10 ms frame is split into 15 slots, each of length T_{slot} = 2560 chips. Each slot consists of two parts, a data part that carries higher layer information and a control part that carries Layer 1 control information. The data and control parts are transmitted in parallel.

The entries of table 1 in subclause 5.2.1 apply to the data part of the CPCH message part. The spreading factor for the control part of the CPCH message part shall be 256. Table 9 defines the slot format of the control part of CPCH message part. The pilot bit patterns of table 3 in subclause 5.2.1 shall be used for pilot bit patterns of the CPCH message part.

Table 9: Slot format of the control part of CPCH message part

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TPC}	N_{TFCI}	N_{FBI}
0	15	15	256	150	10	6	2	2	0
1	15	15	256	150	10	5	2	2	1

Figure 7 shows the frame structure of the uplink common packet physical channel. Each frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2560 chips, corresponding to one power-control period.

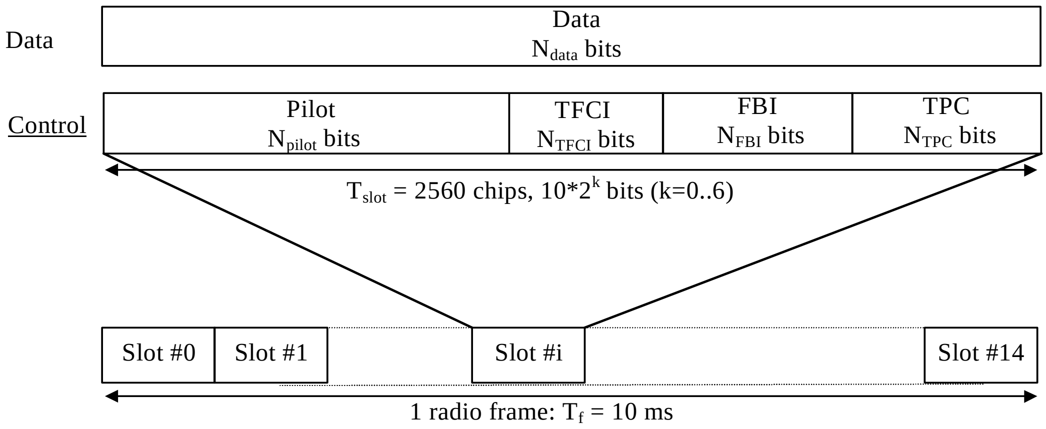

Figure 7: Frame structure for uplink Data and Control Parts Associated with PCPCH

The data part consists of $10*2^k$ bits, where k = 0, 1, 2, 3, 4, 5, 6, corresponding to spreading factors of 256, 128, 64, 32, 16, 8, 4 respectively.

5.3 Downlink physical channels

5.3.1 Downlink transmit diversity

Table 10 summarises the possible application of open and closed loop transmit diversity modes on different downlink physical channel types. Simultaneous use of STTD and closed loop modes on the same physical channel is not allowed. In addition, if Tx diversity is applied on any of the downlink physical channels it shall also be applied on P-CCPCH and SCH. Regarding CPICH transmission in case of transmit diversity, see subclause 5.3.3.1.

With respect to the usage of Tx diversity for DPCH on different radio links within an active set, the following rules apply:

- Different Tx diversity modes (STTD and closed loop) shall not be used on the radio links within one active set.
- No Tx diversity on one or more radio links shall not prevent UTRAN to use Tx diversity on other radio links within the same active set.
- If STTD is activated on one or several radio links in the active set, the UE shall operate STTD on only those radio links where STTD has been activated. Higher layers inform the UE about the usage of STTD on the individual radio links in the active set.
- If closed loop TX diversity is activated on one or several radio links in the active set, the UE shall operate closed loop TX diversity on only those radio links where closed loop TX diversity has been activated. Higher layers inform the UE about the usage of closed loop TX diversity on the individual radio links in the active set.

Furthermore, the transmit diversity mode used for a PDSCH frame shall be the same as the transmit diversity mode used for the DPCH associated with this PDSCH frame. The transmit diversity mode on the associated DPCH may not change during a PDSCH frame and within the slot prior to the PDSCH frame. This includes any change between no Tx diversity, open loop or~~,~~ closed loop mode 1~~ or closed loop mode 2~~.

Also, the transmit diversity mode used for a HS-PDSCH subframe shall be the same as the transmit diversity mode used for the DPCH associated with this HS-PDSCH subframe. If the DPCH associated with an HS-SCCH subframe is using either open or closed loop transmit diversity on the radio link transmitted from the HS-DSCH serving cell, the HS-SCCH subframe from this cell shall be transmitted using STTD, otherwise no transmit diversity shall be used for this HS-SCCH subframe. The transmit diversity mode on the associated DPCH may not change during a HS-SCCH and or HS-PDSCH subframe and within the slot prior to the HS-SCCH subframe. This includes any change between no Tx diversity and either open loop or closed loop mode.

Table 10: Application of Tx diversity modes on downlink physical channel types "X" – can be applied, "–" – not applied

Physical channel type	Open loop mode		Closed loop mode	
	TSTD	STTD	Mode 1	Mode 2
P-CCPCH	–	X	–	–
SCH	X	–	–	–
S-CCPCH	–	X	–	–
DPCH	–	X	X	X
PICH	–	X	–	–
PDSCH	–	X	X	X
HS-PDSCH	–	X	X	–
HS-SCCH	–	X	–	–
AICH	–	X	–	–
CSICH	–	X	–	–
AP-AICH	–	X	–	–
CD/CA-ICH	–	X	–	–
DL-DPCCH for CPCH	–	X	X	X

Physical channel type	Open loop mode		Closed loop mode
	TSTD	STTD	Mode 1
P-CCPCH	–	X	–
SCH	X	–	–
S-CCPCH	–	X	–
DPCH	–	X	X
PICH	–	X	–
PDSCH	–	X	X
HS-PDSCH	–	X	X
HS-SCCH	–	X	–
AICH	–	X	–
CSICH	–	X	–
AP-AICH	–	X	–
CD/CA-ICH	–	X	–
DL-DPCCH for CPCH	–	X	X

5.3.1.1 Open loop transmit diversity

5.3.1.1.1 Space time block coding based transmit antenna diversity (STTD)

The open loop downlink transmit diversity employs a space time block coding based transmit diversity (STTD).

The STTD encoding is optional in UTRAN. STTD support is mandatory at the UE.

If higher layers signal that neither P-CPICH nor S-CPICH can be used as phase reference for the downlink DPCH for a radio link in a cell, the UE shall assume that STTD is not used for the downlink DPCH (and the associated PDSCH if applicable) in that cell.

A block diagram of a generic STTD encoder is shown in the figure 8 and figure 8A below. Channel coding, rate matching and interleaving are done as in the non-diversity mode. For QPSK, the STTD encoder operates on 4 symbols b_0, b_1, b_2, b_3 as shown in figure 8. For AICH, AP-AICH and CD/CA-ICH, the b_i are real valued signals, and $\bar{b}_i$ is defined as $-b_i$. For channels other than AICH, AP-AICH and CD/CA-ICH, the b_i are 3-valued digits, taking the values 0, 1, "DTX", and $\bar{b}_i$ is defined as follows: if b_i = 0 then $\bar{b}_i$ = 1, if b_i = 1 then $\bar{b}_i$ = 0, otherwise $\bar{b}_i$ = b_i.

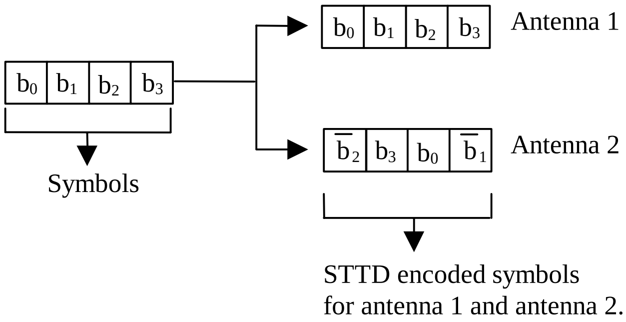

Figure 8: Generic block diagram of the STTD encoder for QPSK

For 16QAM, STTD operates on blocks of 8 consecutive symbols b_0, b_1, b_2, b_3, b_4, b_5, b_6, b_7 as shown in figure 8A below.

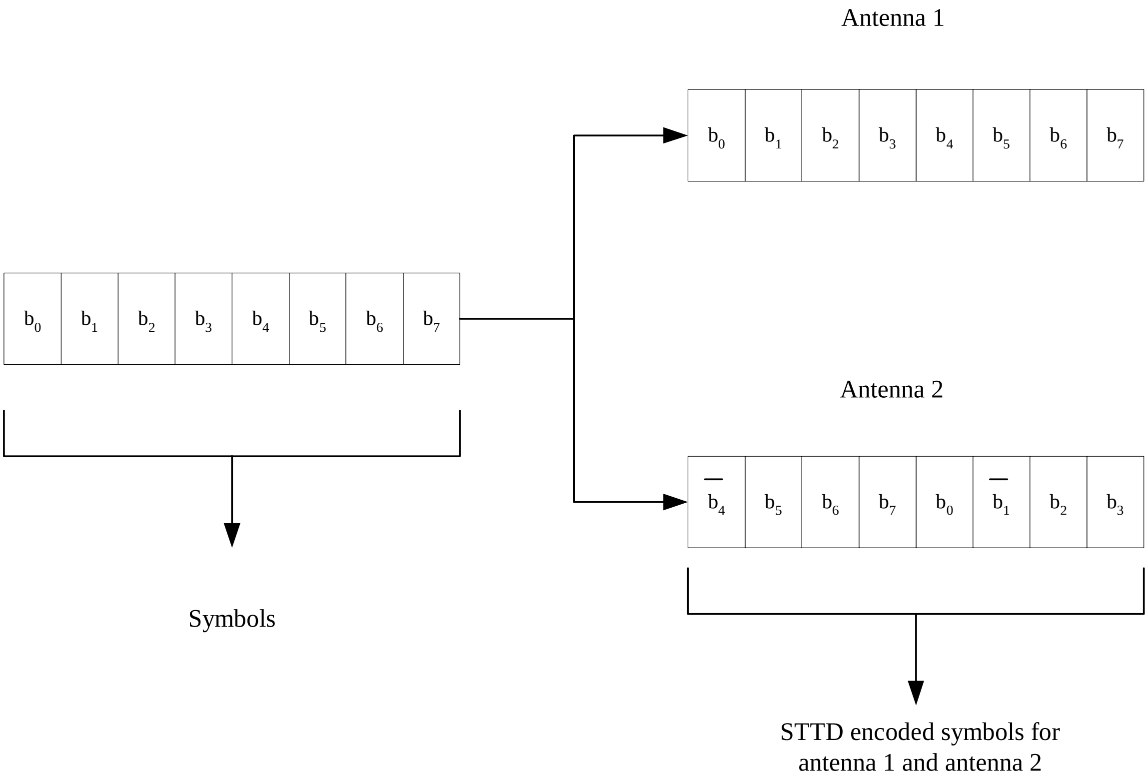

Figure 8A: Generic block diagram of the STTD encoder for 16QAM

5.3.1.1.2 Time Switched Transmit Diversity for SCH (TSTD)

Transmit diversity, in the form of Time Switched Transmit Diversity (TSTD), can be applied to the SCH. TSTD for the SCH is optional in UTRAN, while TSTD support is mandatory in the UE. TSTD for the SCH is described in subclause 5.3.3.5.1.

5.3.1.2 Closed loop transmit diversity

Closed loop transmit diversity is described in [5]. ~~Both c~~Closed loop transmit diversity mode 1~~s~~ shall be supported at the UE and may be supported in the UTRAN.

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 subclause 5.2.1.

Figure 9 shows the frame structure of the downlink DPCH. Each frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2560 chips, corresponding to one power-control period.

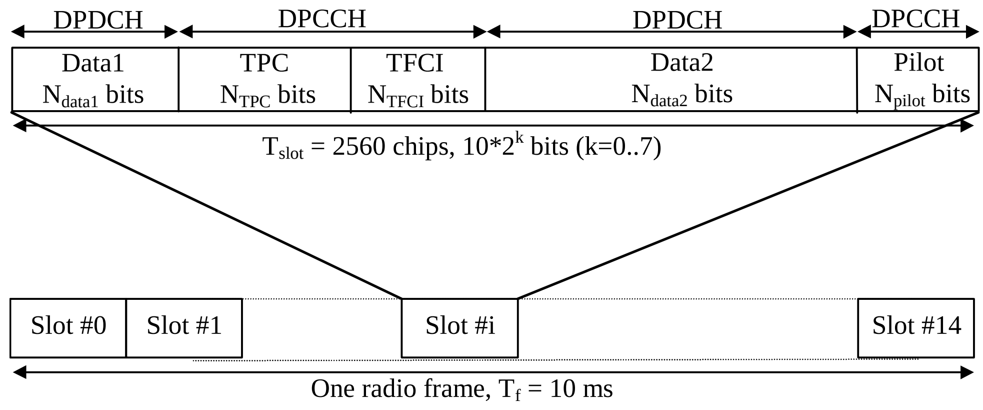

Figure 9: Frame structure for downlink DPCH

The parameter k in figure 9 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_{TPC}, N_{TFCI}, N_{data1} and N_{data2}) is given in table 11. 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). These types are reflected by the duplicated rows of table 11. It is the UTRAN 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 [3].

In compressed frames, a different slot format is used compared to normal mode. There are two possible compressed slot formats that are labelled A and B. Slot format B shall be used in frames compressed by spreading factor reduction and slot format A shall be used in frames compressed by puncturing or higher layer scheduling. The channel bit and symbol rates given in table 11 are the rates immediately before spreading.

Table 11: DPDCH and DPCCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Slot	DPDCH Bits/Slot		DPCCH Bits/Slot			Transmitted slots per radio frame N_{Tr}
					N_{Data1}	N_{Data2}	N_{TPC}	N_{TFCI}	N_{Pilot}	
0	15	7.5	512	10	0	4	2	0	4	15
0A	15	7.5	512	10	0	4	2	0	4	8-14
0B	30	15	256	20	0	8	4	0	8	8-14
1	15	7.5	512	10	0	2	2	2	4	15
1B	30	15	256	20	0	4	4	4	8	8-14
2	30	15	256	20	2	14	2	0	2	15
2A	30	15	256	20	2	14	2	0	2	8-14
2B	60	30	128	40	4	28	4	0	4	8-14
3	30	15	256	20	2	12	2	2	2	15
3A	30	15	256	20	2	10	2	4	2	8-14
3B	60	30	128	40	4	24	4	4	4	8-14
4	30	15	256	20	2	12	2	0	4	15
4A	30	15	256	20	2	12	2	0	4	8-14
4B	60	30	128	40	4	24	4	0	8	8-14
5	30	15	256	20	2	10	2	2	4	15
5A	30	15	256	20	2	8	2	4	4	8-14
5B	60	30	128	40	4	20	4	4	8	8-14
6	30	15	256	20	2	8	2	0	8	15
6A	30	15	256	20	2	8	2	0	8	8-14
6B	60	30	128	40	4	16	4	0	16	8-14
7	30	15	256	20	2	6	2	2	8	15
7A	30	15	256	20	2	4	2	4	8	8-14
7B	60	30	128	40	4	12	4	4	16	8-14
8	60	30	128	40	6	28	2	0	4	15
8A	60	30	128	40	6	28	2	0	4	8-14
8B	120	60	64	80	12	56	4	0	8	8-14
9	60	30	128	40	6	26	2	2	4	15
9A	60	30	128	40	6	24	2	4	4	8-14
9B	120	60	64	80	12	52	4	4	8	8-14
10	60	30	128	40	6	24	2	0	8	15
10A	60	30	128	40	6	24	2	0	8	8-14
10B	120	60	64	80	12	48	4	0	16	8-14
11	60	30	128	40	6	22	2	2	8	15
11A	60	30	128	40	6	20	2	4	8	8-14
11B	120	60	64	80	12	44	4	4	16	8-14
12	120	60	64	80	12	48	4	8*	8	15
12A	120	60	64	80	12	40	4	16*	8	8-14
12B	240	120	32	160	24	96	8	16*	16	8-14
13	240	120	32	160	28	112	4	8*	8	15
13A	240	120	32	160	28	104	4	16*	8	8-14
13B	480	240	16	320	56	224	8	16*	16	8-14
14	480	240	16	320	56	232	8	8*	16	15
14A	480	240	16	320	56	224	8	16*	16	8-14
14B	960	480	8	640	112	464	16	16*	32	8-14
15	960	480	8	640	120	488	8	8*	16	15
15A	960	480	8	640	120	480	8	16*	16	8-14
15B	1920	960	4	1280	240	976	16	16*	32	8-14
16	1920	960	4	1280	248	1000	8	8*	16	15
16A	1920	960	4	1280	248	992	8	16*	16	8-14

* If TFCI bits are not used, then DTX shall be used in TFCI field.

NOTE 1: Compressed mode is only supported through spreading factor reduction for SF=512 with TFCI.

NOTE 2: Compressed mode by spreading factor reduction is not supported for SF=4.

NOTE 3: If the Node B receives an invalid combination of data frames for downlink transmission, the procedure specified in [15], sub-clause 5.1.2,may require the use of DTX in both the DPDCH and theTFCI field of the DPCCH.

The pilot bit patterns are described in table 12. 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 "11".) In table 12, the transmission order is from left to right.

In downlink compressed mode through spreading factor reduction, the number of bits in the TPC and Pilot fields are doubled. Symbol repetition is used to fill up the fields. Denote the bits in one of these fields in normal mode by x_1, x_2, x_3, …, x_X. In compressed mode the following bit sequence is sent in corresponding field: x_1, x_2, x_1, x_2, x_3, x_4, x_3, x_4,…, x_X,.

Table 12: Pilot bit patterns for downlink DPCCH with N_{pilot} = 2, 4, 8 and 16

	N_{pilot} = 2	N_{pilot} = 4 (*1)		N_{pilot} = 8 (*2)				N_{pilot} = 16 (*3)							
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

NOTE *1: This pattern is used except slot formats 2B and 3B.
NOTE *2: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *3: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE: For slot format *n*B where n = 0, …, 15, the pilot bit pattern corresponding to $N_{pilot}/2$ is to be used and symbol repetition shall be applied.

The relationship between the TPC symbol and the transmitter power control command is presented in table 13.

Table 13: TPC Bit Pattern

TPC Bit Pattern			Transmitter power control command
N_{TPC} = 2	N_{TPC} = 4	N_{TPC} = 8	
11	1111	11111111	1
00	0000	00000000	0

Multicode transmission may be employed in the downlink, i.e. the CCTrCH (see [3]) is mapped onto several parallel downlink DPCHs using the same spreading factor. In this case, the Layer 1 control information is transmitted only on the first downlink DPCH. DTX bits are transmitted during the corresponding time period for the additional downlink DPCHs, see figure 10.

In case there are several CCTrCHs mapped to different DPCHs transmitted to the same UE different spreading factors can be used on DPCHs to which different CCTrCHs are mapped. Also in this case, Layer 1 control information is only transmitted on the first DPCH while DTX bits are transmitted during the corresponding time period for the additional DPCHs.

Note : support of multiple CCTrChs of dedicated type is not part of the current release.

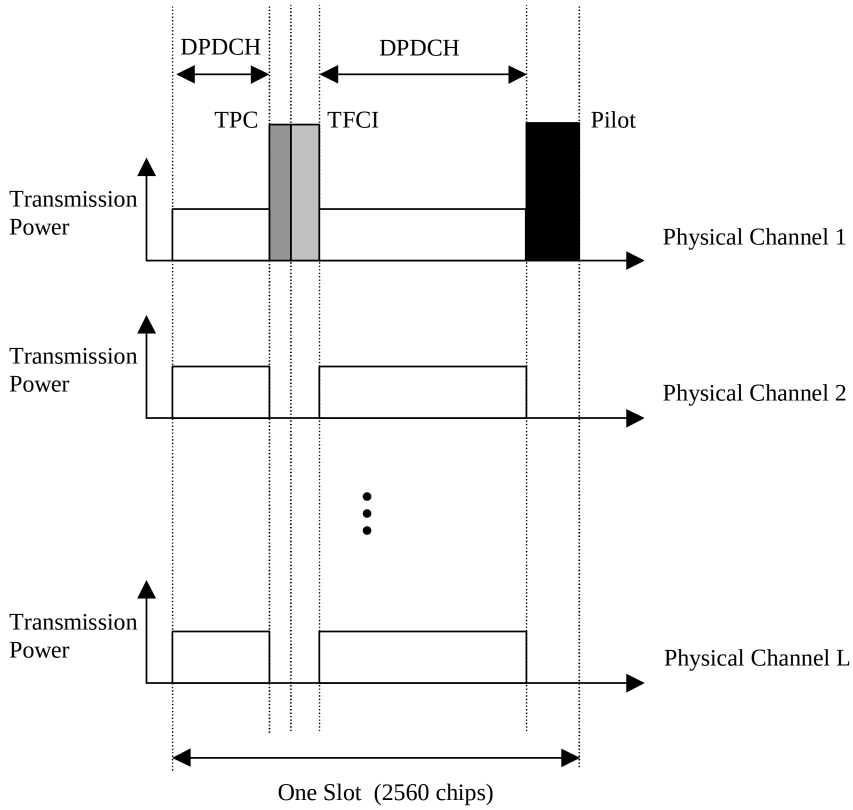

Figure 10: Downlink slot format in case of multi-code transmission

5.3.2.1 STTD for DPCH

The pilot bit pattern for the DPCH channel transmitted on antenna 2 is given in table 14.

- For N_{pilot} = 8, 16 the shadowed part indicates pilot bits that are obtained by STTD encoding the corresponding (shadowed) bits in Table 12. The non-shadowed pilot bit pattern is orthogonal to the corresponding (non-shadowed) pilot bit pattern in table 12.

- For N_{pilot} = 4, the diversity antenna pilot bit pattern is obtained by STTD encoding both the shadowed and non-shadowed pilot bits in table 12.

- For N_{pilot} = 2, the diversity antenna pilot pattern is obtained by STTD encoding the two pilot bits in table 12 with the last two bits (data or DTX) of the second data field (data2) of the slot. Thus for N_{pilot} = 2 case, the last two bits of the second data field (data 2) after STTD encoding, follow the diversity antenna pilot bits in Table 14.

STTD encoding for the DPDCH, TPC, and TFCI fields is done as described in subclause 5.3.1.1.1. For the SF=512 DPCH, the first two bits in each slot, i.e. TPC bits, are not STTD encoded and the same bits are transmitted with equal power from the two antennas. The remaining four bits are STTD encoded.

For compressed mode through spreading factor reduction and for N_{pilot} > 4, symbol repetition shall be applied to the pilot bit patterns of table 14, in the same manner as described in 5.3.2. For slot formats 2B and 3B, i.e. compressed mode through spreading factor reduction and N_{pilot} = 4, the pilot bits transmitted on antenna 2 are STTD encoded, and thus the pilot bit pattern is as shown in the most right set of table 14.

Table 14: Pilot bit patterns of downlink DPCCH for antenna 2 using STTD

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

NOTE *1: The pilot bits precede the last two bits of the data2 field.
NOTE *2: This pattern is used except slot formats 2B and 3B.
NOTE *3: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *4: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE *5: This pattern is used for slot formats 2B and 3B.
NOTE: For slot format *n*B where *n* = 0, 1, 4, 5, 6, …, 15, the pilot bit pattern corresponding to $N_{pilot}/2$ is to be used and symbol repetition shall be applied.

5.3.2.2 Dedicated channel pilots with closed loop mode transmit diversity

In closed loop mode 1 orthogonal pilot patterns are used between the transmit antennas. Closed loop mode 1 shall not be used with DPCH slot formats for which Npilot=2. Pilot patterns defined in the table 12 will be used on antenna 1 and pilot patterns defined in the table 15 on antenna 2. This is illustrated in the figure 11 a which indicates the difference in the pilot patterns with different shading.

Table 15: Pilot bit patterns of downlink DPCCH for antenna 2 using closed loop mode 1

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

NOTE *1: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *2: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE: For slot format *n*B where *n* = 0, 1, 4, 5, 6, …, 15, the pilot bit pattern corresponding to $N_{pilot}/2$ is to be used and symbol repetition shall be applied.

~~In closed loop mode 2 same pilot pattern is used on both of the antennas (see figure 11 b). The pattern to be used is according to the table 12.~~

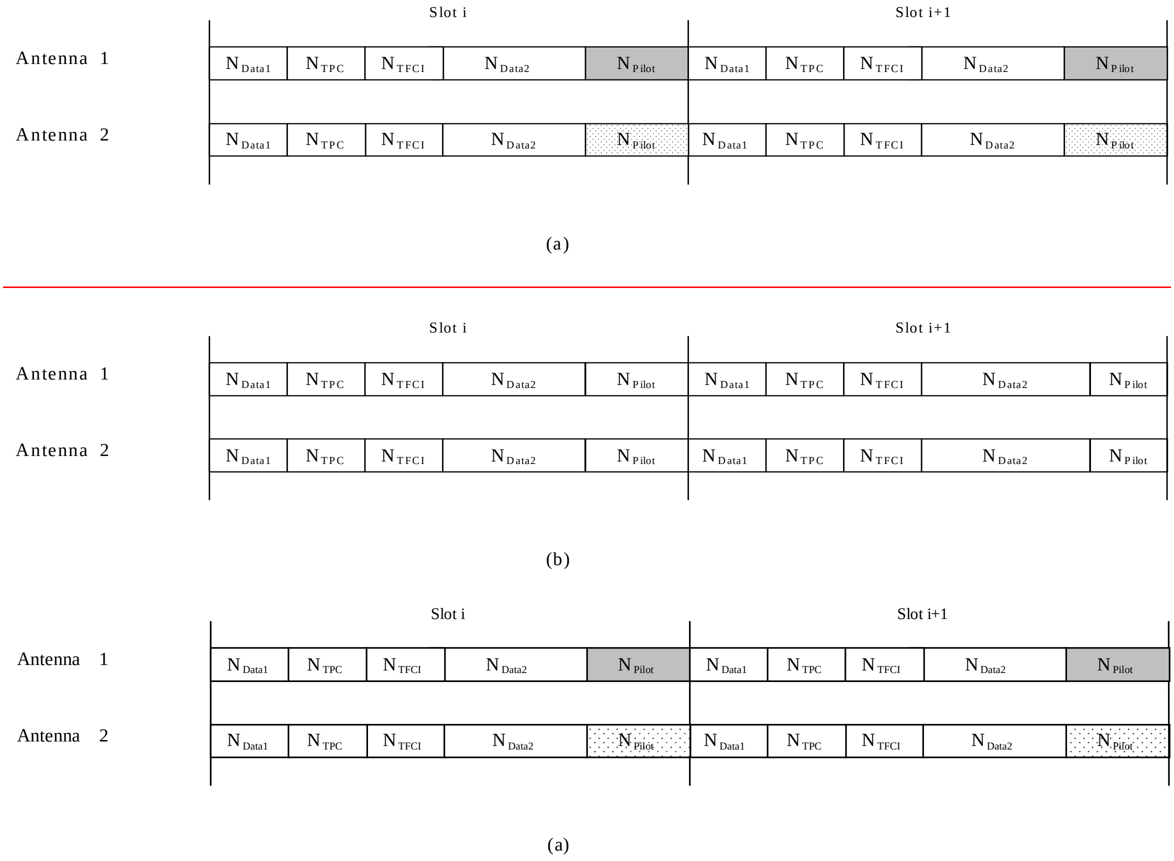

Figure 11: Slot structures for downlink dedicated physical channel diversity transmission. Structure (a) is used in closed loop mode 1.
~~Structure (b) is used in closed loop mode 2.~~
Different shading of the pilots indicate orthogonality of the patterns

5.3.2.3 DL-DPCCH for CPCH

The downlink DPCCH for CPCH is a special case of downlink dedicated physical channel of the slot format #0 in table 11. The spreading factor for the DL-DPCCH is 512. Figure 12 shows the frame structure of DL-DPCCH for CPCH.

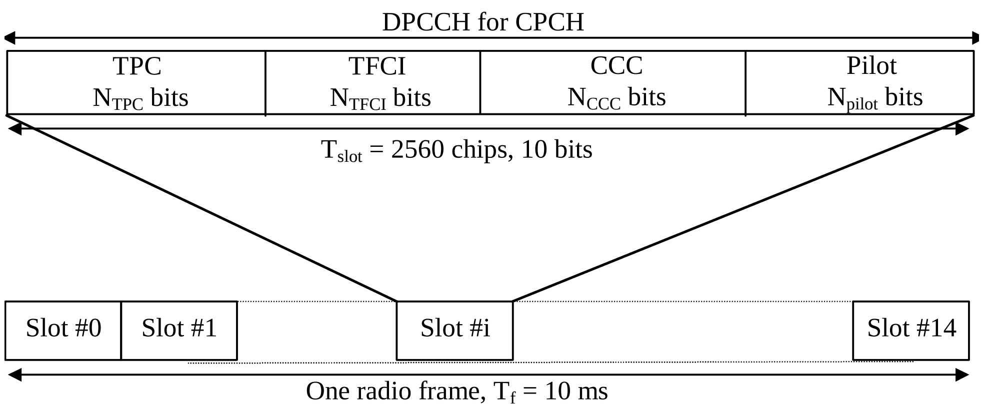

Figure 12: Frame structure for downlink DPCCH for CPCH

DL-DPCCH for CPCH consists of known pilot bits, TFCI, TPC commands and CPCH Control Commands (CCC). CPCH control commands are used to support CPCH signalling. There are two types of CPCH control commands: Layer

1 control command such as Start of Message Indicator, and higher layer control command such as Emergency Stop command. The exact number of bits of DL DPCCH fields (N_{pilot}, N_{TFCI}, N_{CCC} and N_{TPC}) is determined in Table 16. The pilot bit pattern for N_{pilot}=4 of table 12 is used for DPCCH for CPCH.

Table 16: DPCCH fields for CPCH message transmission

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Slot	DPCCH Bits/Slot				Transmitted slots per radio frame N_{Tr}
					N_{TPC}	N_{TFCI}	N_{CCC}	N_{Pilot}	
0	15	7.5	512	10	2	0	4	4	15

The DL DPCCH power control preamble for CPCH shall take the same slot format as afterwards, as given in Table 16. The length of the power control preamble is a higher-layer parameter, $L_{pc\text{-}preamble}$ (see [5], section 6.2), signalled by the network. When $L_{pc\text{-}preamble} > 0$, the pilot patterns from slot #(15 – $L_{pc\text{-}preamble}$)to slot #14 of table 12 shall be used for the power control preamble pilot patterns. The TFCI field is filled with "1" bits.

CCC field in figure 12 is used for the transmission of CPCH control command. On CPCH control command transmission request from higher layer, a certain pattern is mapped onto CCC field, otherwise nothing is transmitted in CCC field. There is one to one mapping between the CPCH control command and the pattern. In case of Emergency Stop of CPCH transmission, [1111] pattern is mapped onto CCC field. The Emergency Stop command shall not be transmitted during the first $N_{Start\_Message}$ frames of DL DPCCH after Power Control preamble.

Start of Message Indicator shall be transmitted during the first $N_{Start\_Message}$ frames of DL DPCCH after Power Control preamble. [1010] pattern is mapped onto CCC field for Start of Message Indicator. The value of $N_{Start\_Message}$ shall be provided by higher layers.

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 sequence. Figure 13 shows the frame structure of the CPICH.

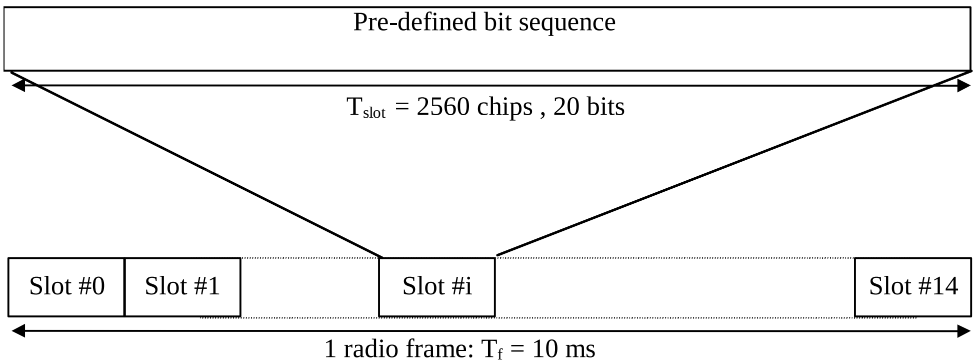

Figure 13: Frame structure for Common Pilot Channel

In case transmit diversity (open or closed loop) is used on any downlink channel in the cell, the CPICH shall be transmitted from both antennas using the same channelization and scrambling code. In this case, the pre-defined bit sequence of the CPICH is different for Antenna 1 and Antenna 2, see figure 14. In case of no transmit diversity, the bit sequence of Antenna 1 in figure 14 is used.

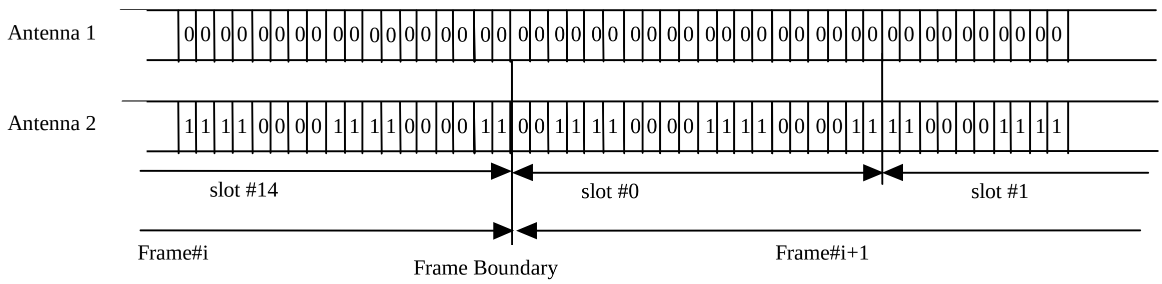

Figure 14: Modulation pattern for Common Pilot Channel

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 (P-CPICH)

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

- The same channelization code is always used for the P-CPICH, see [4];
- The P-CPICH is scrambled by the primary scrambling code, see [4];
- There is one and only one P-CPICH per cell;
- The P-CPICH is broadcast over the entire cell.

The Primary CPICH is a phase reference for the following downlink channels: SCH, Primary CCPCH, AICH, PICH AP-AICH, CD/CA-ICH, CSICH, DL-DPCCH for CPCH and the S-CCPCH. By default, the Primary CPICH is also a phase reference for downlink DPCH and any associated PDSCH, HS-PDSCH and HS-SCCH. The UE is informed by higher layer signalling if the P-CPICH is not a phase reference for a downlink DPCH and any associated PDSCH, HS-PDSCH and HS-SCCH.

The Primary CPICH is always a phase reference for a downlink physical channel using closed loop TX diversity.

5.3.3.1.2 Secondary Common Pilot Channel (S-CPICH)

A Secondary Common Pilot Channel (S-CPICH) has the following characteristics:

- An arbitrary channelization code of SF=256 is used for the S-CPICH, see [4];
- A S-CPICH is scrambled by either the primary or a secondary scrambling code, see [4];
- There may be zero, one, or several S-CPICH per cell;
- A S-CPICH may be transmitted over the entire cell or only over a part of the cell;

A Secondary CPICH may be a phase reference for a downlink DPCH. If this is the case, the UE is informed about this by higher-layer signalling.

The Secondary CPICH can be a phase reference for a downlink physical channel using open loop TX diversity, instead of the Primary CPICH being a phase reference.

Note that it is possible that neither the P-CPICH nor any S-CPICH is a phase reference for a downlink DPCH.

5.3.3.2 Downlink phase reference

Table 17 summarizes the possible phase references usable on different downlink physical channel types.

Table 17: Application of phase references on downlink physical channel types "X" – can be applied, "–" – not applied

Physical channel type	Primary-CPICH	Secondary-CPICH	Dedicated pilot
P-CCPCH	X	–	–
SCH	X	–	–
S-CCPCH	X	–	–
DPCH	X	X	X
PICH	X	–	–
PDSCH*	X	X	X
HS-PDSCH*	X	X	X
HS-SCCH*	X	X	X
AICH	X	–	–
CSICH	X	–	–
DL-DPCCH for CPCH	X	–	–

Note *: The same phase reference as with the associated DPCH shall be used. The support for dedicated pilots as phase reference for HS-PDSCH and HS-SCCH is optional for the UE.

Furthermore, during a PDSCH frame, and within the slot prior to that PDSCH frame, the phase reference on the associated DPCH shall not change. During a DPCH frame overlapping with any part of an associated HS-DSCH or HS-SCCH subframe, the phase reference on this DPCH shall not change.

5.3.3.3 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 transport channel.

Figure 15 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, Primary SCH and Secondary SCH are transmitted during this period (see subclause 5.3.3.5).

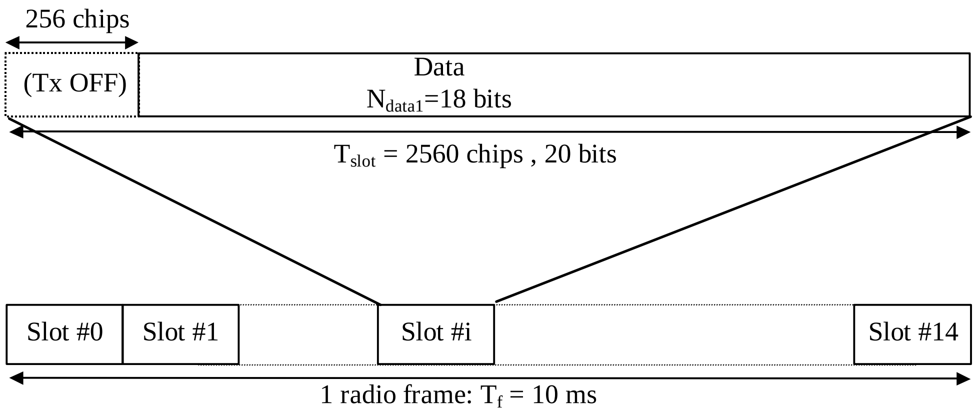

Figure 15: Frame structure for Primary Common Control Physical Channel

5.3.3.3.1 Primary CCPCH structure with STTD encoding

In case the diversity antenna is present in UTRAN and the P-CCPCH is to be transmitted using open loop transmit diversity, the data bits of the P-CCPCH are STTD encoded as given in subclause 5.3.1.1.1. The last two data bits in even numbered slots are STTD encoded together with the first two data bits in the following slot, except for slot #14 where the two last data bits are not STTD encoded and instead transmitted with equal power from both the antennas, see figure 16. Higher layers signal whether STTD encoding is used for the P-CCPCH or not. In addition the presence/absence of STTD encoding on P-CCPCH is indicated by modulating the SCH, see 5.3.3.4. During power on and hand over between cells the UE can determine the presence of STTD encoding on the P-CCPCH, by either receiving the higher layer message, by demodulating the SCH channel, or by a combination of the above two schemes.

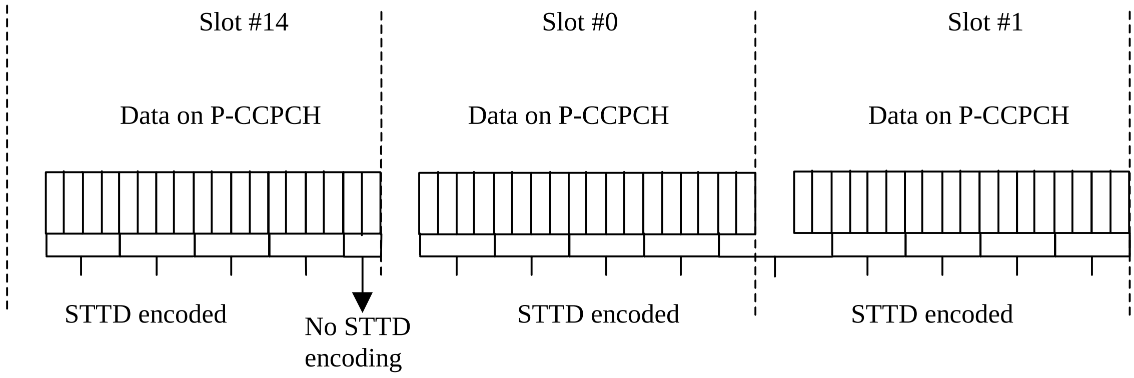

Figure 16: STTD encoding for the data bits of the P-CCPCH

5.3.3.4 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 UTRAN 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 for the Secondary CCPCH is the same as for the downlink DPCH, see subclause 5.3.2. The frame structure of the Secondary CCPCH is shown in figure 17.

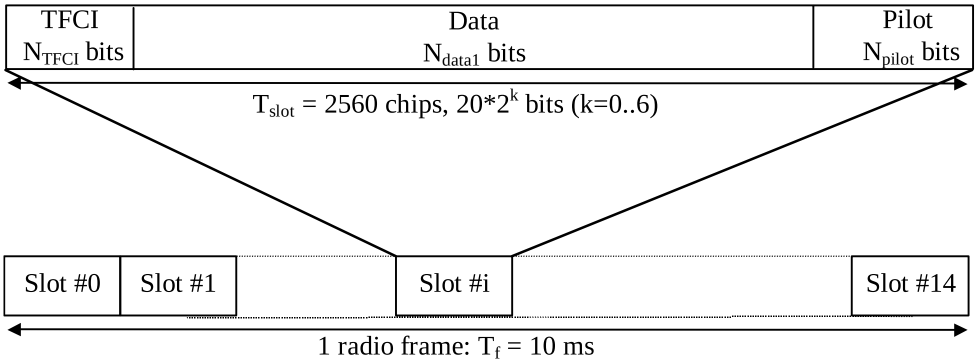

Figure 17: Frame structure for Secondary Common Control Physical Channel

The parameter k in figure 17 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 18. The channel bit and symbol rates given in Table 18 are the rates immediately before spreading. The slot formats with pilot bits are not supported in this release. The pilot patterns are given in Table 19.

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 18: Secondary CCPCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{data1}	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	1200	80	72	0	8*
9	120	60	64	1200	80	64	8	8*
10	240	120	32	2400	160	152	0	8*
11	240	120	32	2400	160	144	8	8*
12	480	240	16	4800	320	312	0	8*
13	480	240	16	4800	320	296	16	8*
14	960	480	8	9600	640	632	0	8*
15	960	480	8	9600	640	616	16	8*
16	1920	960	4	19200	1280	1272	0	8*
17	1920	960	4	19200	1280	1256	16	8*

* If TFCI bits are not used, then DTX shall be used in TFCI field.

The pilot symbol pattern described in Table 19 is not supported in this release. 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 19, the transmission order is from left to right. (Each two-bit pair represents an I/Q pair of QPSK modulation.)

Table 19: 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 [3].

5.3.3.4.1 Secondary CCPCH structure with STTD encoding

In case the diversity antenna is present in UTRAN and the S-CCPCH is to be transmitted using open loop transmit diversity, the data and TFCI bits of the S-CCPCH are STTD encoded as given in subclause 5.3.1.1.1. The pilot symbol pattern for antenna 2 for the S-CCPCH given in Table 20 is not supported in this release.

Table 20: Pilot symbol pattern for antenna 2 when STTD encoding is used on the S-CCPCH

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

5.3.3.5 Synchronisation Channel (SCH)

The Synchronisation Channel (SCH) is a downlink signal used for cell search. The SCH consists of two sub channels, the Primary and Secondary SCH. The 10 ms radio frames of the Primary and Secondary SCH are divided into 15 slots, each of length 2560 chips. Figure 18 illustrates the structure of the SCH radio frame.

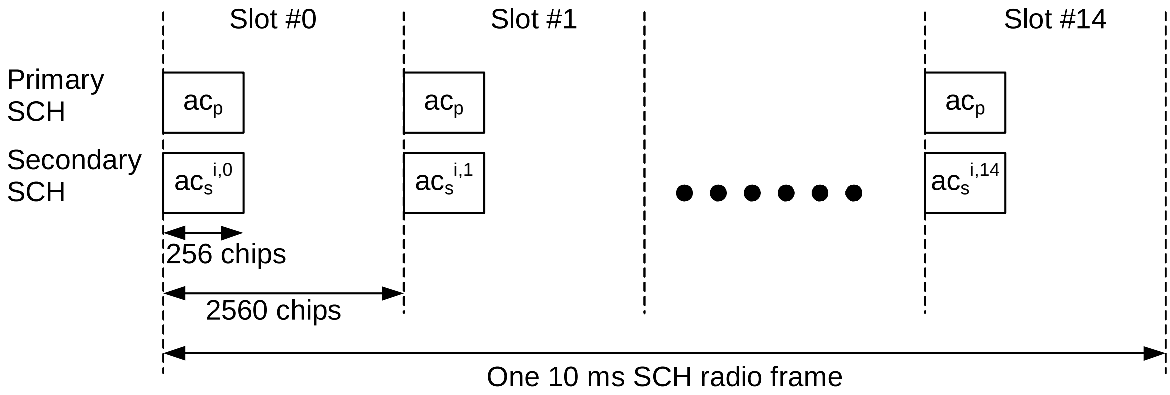

Figure 18: Structure of Synchronisation Channel (SCH)

The Primary SCH consists of a modulated code of length 256 chips, the Primary Synchronisation Code (PSC) denoted c_p in figure 18, transmitted once every slot. The PSC is the same for every cell in the system.

The Secondary SCH consists of repeatedly transmitting a length 15 sequence of modulated codes of length 256 chips, the Secondary Synchronisation Codes (SSC), transmitted in parallel with the Primary SCH. The SSC is denoted $c_s^{i,k}$ in figure 18, where i = 0, 1, …, 63 is the number of the scrambling code group, and k = 0, 1, …, 14 is the slot number. Each SSC is chosen from a set of 16 different codes of length 256. This sequence on the Secondary SCH indicates which of the code groups the cell's downlink scrambling code belongs to.

The primary and secondary synchronization codes are modulated by the symbol a shown in figure 18, which indicates the presence/ absence of STTD encoding on the P-CCPCH and is given by the following table:

P-CCPCH STTD encoded	a = +1
P-CCPCH not STTD encoded	a = -1

5.3.3.5.1 SCH transmitted by TSTD

Figure 19 illustrates the structure of the SCH transmitted by the TSTD scheme. In even numbered slots both PSC and SSC are transmitted on antenna 1, and in odd numbered slots both PSC and SSC are transmitted on antenna 2.

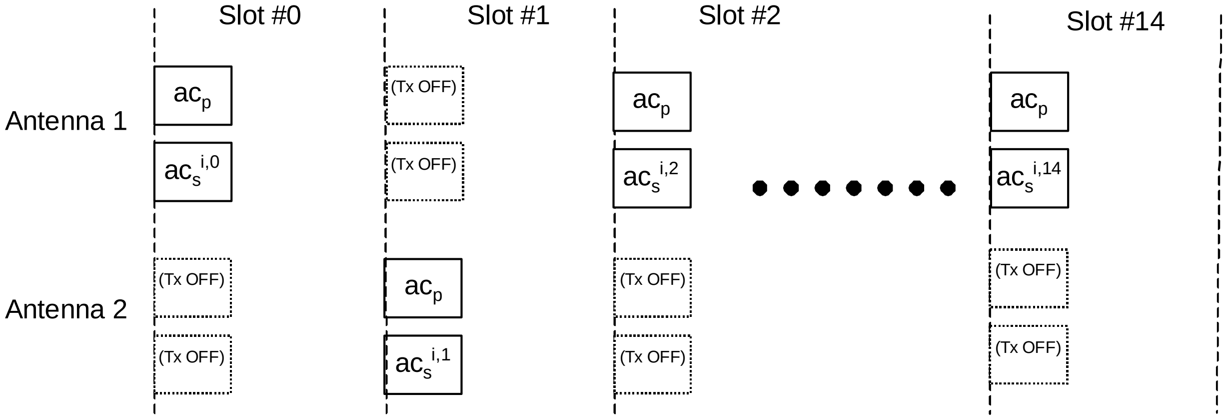

Figure 19: Structure of SCH transmitted by TSTD scheme

5.3.3.6 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 channelisation code below or at a PDSCH root channelisation code. A PDSCH is allocated on a radio frame basis to a single UE. Within one radio frame, UTRAN may allocate different PDSCHs under the same PDSCH root channelisation 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 are operated with radio frame synchronisation.

The notion of PDSCH root channelisation code is defined in [4].

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 20.

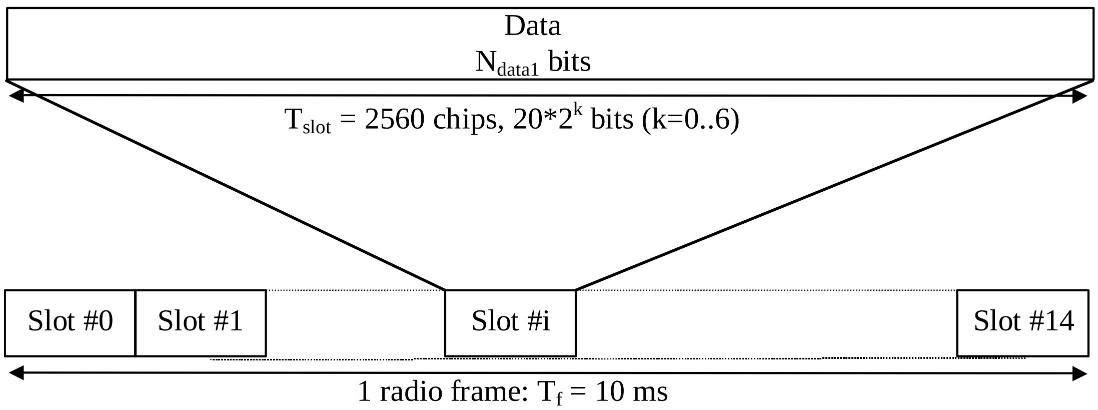

Figure 20: Frame structure for the PDSCH

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, the TFCI field of the associated DPCH shall be used.

The TFCI informs the UE of the instantaneous transport format parameters related to the PDSCH as well as the channelisation code of the PDSCH.

The channel bit rates and symbol rates for PDSCH are given in Table 21.

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

Table 21: PDSCH fields

Slot format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{data1}
0	30	15	256	300	20	20
1	60	30	128	600	40	40
2	120	60	64	1200	80	80
3	240	120	32	2400	160	160
4	480	240	16	4800	320	320
5	960	480	8	9600	640	640
6	1920	960	4	19200	1280	1280

When open loop transmit diversity is employed for the PDSCH, STTD encoding is used on the data bits as described in subclause 5.3.1.1.1.

When closed loop transmit diversity is employed on the associated DPCH, it shall be used also on the PDSCH as described in [5].

5.3.3.7 Acquisition Indicator Channel (AICH)

The Acquisition Indicator channel (AICH) is a fixed rate (SF=256) physical channel used to carry Acquisition Indicators (AI). Acquisition Indicator AI_s corresponds to signature s on the PRACH.

Figure 21 illustrates the structure of the AICH. The AICH consists of a repeated sequence of 15 consecutive *access slots* (AS), each of length 5120 chips. Each access slot consists of two parts, an *Acquisition-Indicator* (AI) part consisting of 32 real-valued signals $a_0, \ldots, a_{31}$ and a part of duration 1024 chips with no transmission that is not formally part of the AICH. The part of the slot with no transmission is reserved for possible use by CSICH or possible future use by other physical channels.

The spreading factor (SF) used for channelisation of the AICH is 256.

The phase reference for the AICH is the Primary CPICH.

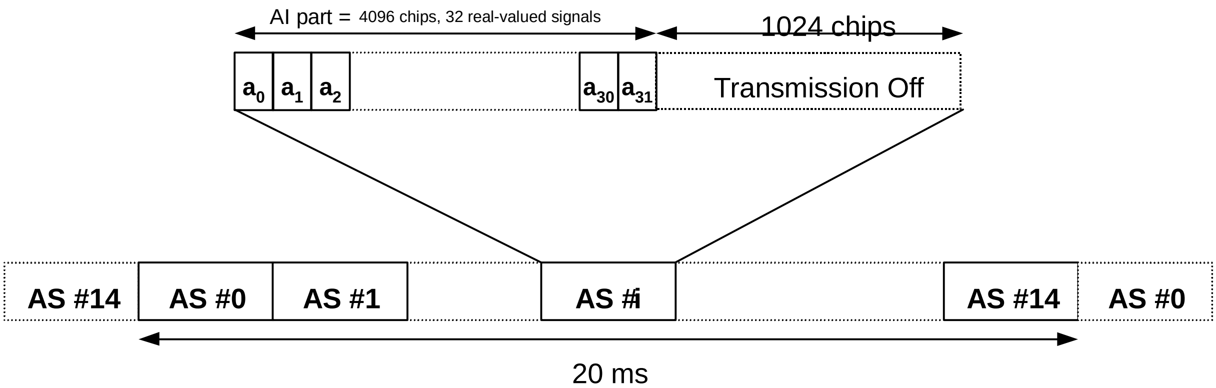

Figure 21: Structure of Acquisition Indicator Channel (AICH)

The real-valued signals $a_0, a_1, \ldots, a_{31}$ in figure 21 are given by

$$a_j = \sum_{s=0}^{15} AI_s b_{s,j}$$

where AI_s, taking the values +1, -1, and 0, is the acquisition indicator corresponding to signature s and the sequence $b_{s,0}$, …, $b_{s,31}$ is given by Table 22. If the signature s is not a member of the set of available signatures for all the Access Service Class (ASC) for the corresponding PRACH (cf [5]), then AI_s shall be set to 0.

The use of acquisition indicators is described in [5]. If an Acquisition Indicator is set to +1, it represents a positive acknowledgement. If an Acquisition Indicator is set to -1, it represents a negative acknowledgement.

The real-valued signals, a_j, are spread and modulated in the same fashion as bits when represented in { +1, -1 } form.

In case STTD-based open-loop transmit diversity is applied to AICH, STTD encoding according to subclause 5.3.1.1.1 is applied to each sequence $b_{s,0}$, $b_{s,1}$, ..., $b_{s,31}$ separately before the sequences are combined into AICH signals a_0, …, a_{31}.

Table 22: AICH signature patterns

s	$b_{s,0}$, $b_{s,1}$…, $b_{s,31}$																															
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1
2	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1
3	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1
4	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1
5	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1
6	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1
7	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
9	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1
10	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1
11	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1
12	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	1	1	1
13	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1
14	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	-1	-1	-1
15	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1

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

The Access Preamble Acquisition Indicator channel (AP-AICH) is a fixed rate (SF=256) physical channel used to carry AP acquisition indicators (API) of CPCH. AP acquisition indicator API_s corresponds to AP signature *s* transmitted by UE.

AP-AICH and AICH may use the same or different channelisation codes. The phase reference for the AP-AICH is the Primary CPICH. Figure 22 illustrates the structure of AP-AICH. The AP-AICH has a part of duration 4096 chips where the AP acquisition indicator (API) is transmitted, followed by a part of duration 1024chips with no transmission that is not formally part of the AP-AICH. The part of the slot with no transmission is reserved for possible use by CSICH or possible future use by other physical channels.

The spreading factor (SF) used for channelisation of the AP-AICH is 256.

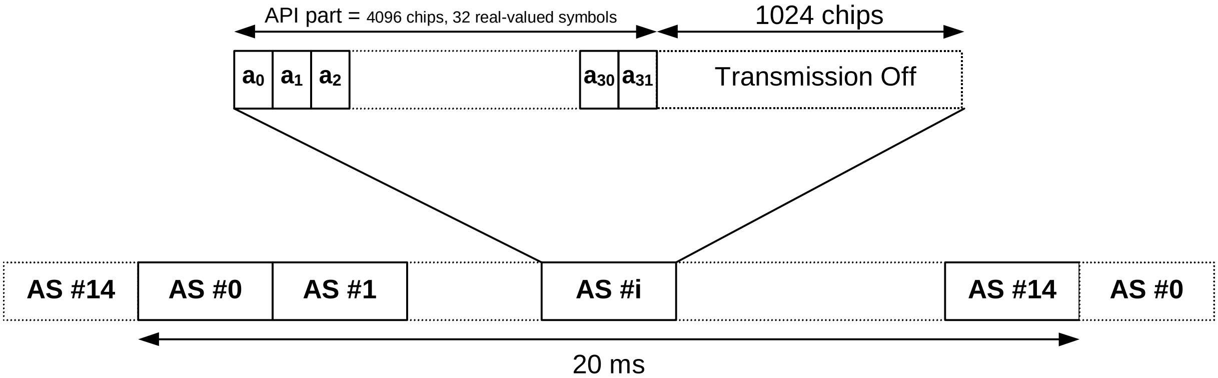

Figure 22: Structure of AP Acquisition Indicator Channel (AP-AICH)

The real-valued symbols $a_0, a_1, \ldots, a_{31}$ in figure 22 are given by

$$a_j = \sum_{s=0}^{15} API_s \times b_{s,j}$$

where API_s, taking the values +1, -1, and 0, is the AP acquisition indicator corresponding to Access Preamble signature s transmitted by UE and the sequence $b_{s,0}, \ldots, b_{s,31}$ is given in Table 22. If the signature s is not a member of the set of UL Access Preamble signatures for the corresponding PCPCH (cf [5] then API_s shall be set to 0.

The use of acquisition indicators is described in [5]. If an AP acquisition indicator is set to +1, it represents a positive acknowledgement. If an AP acquisition indicator is set to -1, it represents a negative acknowledgement.

The real-valued symbols, a_j, are spread and modulated in the same fashion as bits when represented in { +1, -1 } form.

In case STTD-based open-loop transmit diversity is applied to AP-AICH, STTD encoding according to subclause 5.3.1.1.1 is applied to each sequence $b_{s,0}, b_{s,1}, \ldots, b_{s,31}$ separately before the sequences are combined into AP-AICH symbols $a_0, \ldots, a_{31}$.

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

The Collision Detection Channel Assignment Indicator channel (CD/CA-ICH) is a fixed rate (SF=256) physical channel used to carry CD Indicator (CDI) only if the CA is not active, or CD Indicator/CA Indicator (CDI/CAI) at the same time if the CA is active. The structure of CD/CA-ICH is shown in figure 23. CD/CA-ICH and AP-AICH may use the same or different channelisation codes.

The CD/CA-ICH has a part of duration of 4096chips where the CDI/CAI is transmitted, followed by a part of duration 1024chips with no transmission that is not formally part of the CD/CA-ICH. The part of the slot with no transmission is reserved for possible use by CSICH or possible future use by other physical channels.

The spreading factor (SF) used for channelisation of the CD/CA-ICH is 256.

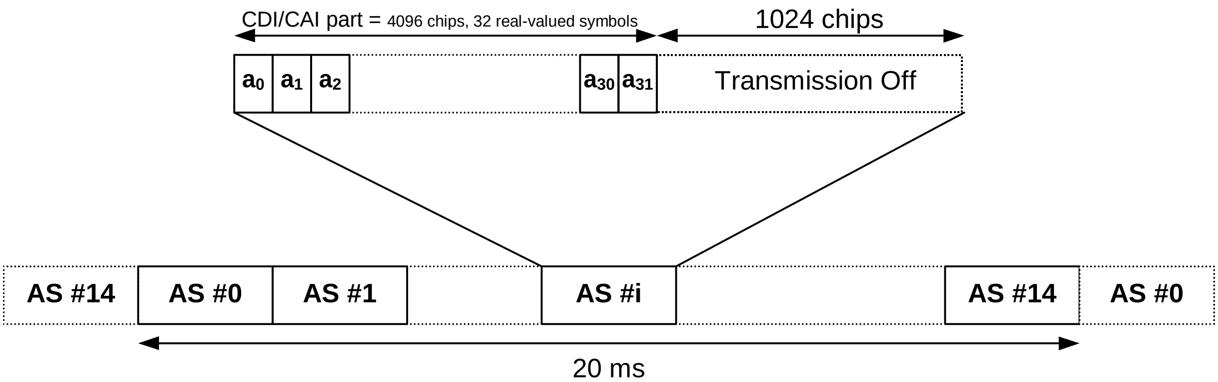

Figure 23: Structure of CD/CA Indicator Channel (CD/CA-ICH)

In case STTD-based open-loop transmit diversity is applied to CD/CA-ICH, STTD encoding according to subclause 5.3.1.1.1 is applied to each sequence $b_{s,0}, b_{s,1}, \ldots, b_{s,31}$ separately before the sequences are combined into CD/CA-ICH symbols $a_0, \ldots, a_{31}$.

In case CA is not active, the real-valued symbols $a_0, a_1, \ldots, a_{31}$ in figure 23 are given by

$$a_j = \sum_{s=0}^{15} CDI_s \times b_{s,j}$$

where CDI_s, taking the values +1, and 0, is the CD indicator corresponding to CD preamble signature *s* transmitted by UE and the sequence $b_{s,0}, \ldots, b_{s,31}$ is given in Table 22. If the signature *s* is not a member of the set of CD Preamble signatures for the corresponding PCPCH (cf [5]), then CDI_s shall be set to 0.

The real-valued symbols, a_j, are spread and modulated in the same fashion as bits when represented in { +1, -1 } form.

In case CA is active, the real-valued symbols $a_0, a_1, \ldots, a_{31}$ in figure 23 are given by

$$a_j = \sum_{i=0}^{15} \mathrm{CDI}_i \times b_{s_i,j} + \sum_{k=0}^{15} \mathrm{CAI}_k \times b_{s_k,j}$$

where the subscript s_i, s_k depend on the indexes *i*, *k* according to Table 23, respectively, and indicate the signature number *s* in Table 22. The sequence $b_{s,0}, \ldots, b_{s,31}$ is given in Table 22. CDI_i, taking the values +1/0 or -1/0, is the CD indicator corresponding to the CD preamble *i* transmitted by the UE, and CAI_k, taking the values +1/0 or -1/0, is the CA indicator corresponding to the assigned channel index *k* as given in Table 23. If the signature s_i is not a member of the set of CD Preamble signatures for the corresponding PCPCH (cf [5]), then CDI_s shall be set to 0. Similarly, if the signature s_k is not a member of the set of CD Preamble signatures for the corresponding PCPCH (cf [5]), then CDI_s shall be set to 0.

Table 23. Generation of $\mathrm{CDI}_i/\mathrm{CAI}_k$

UE transmitted CD Preamble i	CDI_i	signature s_i	Channel Assignment Index k	CAI_k	signature s_k
0	+1/0	1	0	+1/0	0
1	-1/0		1	-1/0	
2	+1/0	3	2	+1/0	8
3	-1/0		3	-1/0	
4	+1/0	5	4	+1/0	4
5	-1/0		5	-1/0	
6	+1/0	7	6	+1/0	12
7	-1/0		7	-1/0	
8	+1/0	9	8	+1/0	2
9	-1/0		9	-1/0	
10	+1/0	11	10	+1/0	10
11	-1/0		11	-1/0	
12	+1/0	13	12	+1/0	6
13	-1/0		13	-1/0	
14	+1/0	15	14	+1/0	14
15	-1/0		15	-1/0	

5.3.3.10 Paging Indicator Channel (PICH)

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

Figure 24 illustrates the frame structure of the PICH. One PICH radio frame of length 10 ms consists of 300 bits (b_0, b_1, …, b_{299}). Of these, 288 bits (b_0, b_1, …, b_{287}) are used to carry paging indicators. The remaining 12 bits are not formally part of the PICH and shall not be transmitted (DTX). The part of the frame with no transmission is reserved for possible future use.

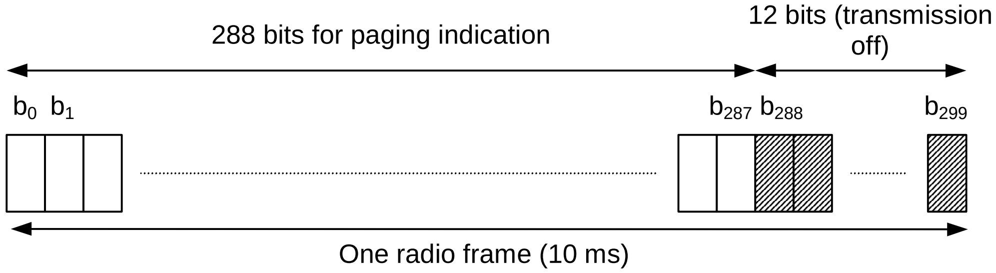

Figure 24: Structure of Paging Indicator Channel (PICH)

In each PICH frame, Np paging indicators $\{P_0, \ldots, P_{Np-1}\}$ are transmitted, where Np=18, 36, 72, or 144.

The PI calculated by higher layers for use for a certain UE, is associated to the paging indicator P_q, where q is computed as a function of the PI computed by higher layers, the SFN of the P-CCPCH radio frame during which the start of the PICH radio frame occurs, and the number of paging indicators per frame (Np):

$$q = \left(PI + \left\lfloor \left(\left(18 \times \left(SFN + \lfloor SFN/8 \rfloor + \lfloor SFN/64 \rfloor + \lfloor SFN/512 \rfloor \right) \right) \bmod 144 \right) \times \frac{Np}{144} \right\rfloor \right) \bmod Np$$

Further, the PI calculated by higher layers is associated with the value of the paging indicator P_q. If a paging indicator in a certain frame is set to "1" it is an indication that UEs associated with this paging indicator and PI should read the corresponding frame of the associated S-CCPCH.

The PI bitmap in the PCH data frames over Iub contains indication values for all higher layer PI values possible. Each bit in the bitmap indicates if the paging indicator associated with that particular PI shall be set to 0 or 1. Hence, the calculation in the formula above is to be performed in Node B to make the association between PI and P_q.

The mapping from $\{P_0, \ldots, P_{Np-1}\}$ to the PICH bits $\{b_0, \ldots, b_{287}\}$ are according to Table 24.

Table 24: Mapping of paging indicators P_q to PICH bits

Number of paging indicators per frame (Np)	$P_q = 1$	$P_q = 0$
Np=18	$\{b_{16q}, \ldots, b_{16q+15}\} = \{1, 1, \ldots, 1\}$	$\{b_{16q}, \ldots, b_{16q+15}\} = \{0, 0, \ldots, 0\}$
Np=36	$\{b_{8q}, \ldots, b_{8q+7}\} = \{1, 1, \ldots, 1\}$	$\{b_{8q}, \ldots, b_{8q+7}\} = \{0, 0, \ldots, 0\}$
Np=72	$\{b_{4q}, \ldots, b_{4q+3}\} = \{1, 1, \ldots, 1\}$	$\{b_{4q}, \ldots, b_{4q+3}\} = \{0, 0, \ldots, 0\}$
Np=144	$\{b_{2q}, b_{2q+1}\} = \{1, 1\}$	$\{b_{2q}, b_{2q+1}\} = \{0, 0\}$

When transmit diversity is employed for the PICH, STTD encoding is used on the PICH bits as described in subclause 5.3.1.1.1.

5.3.3.11 CPCH Status Indicator Channel (CSICH)

The CPCH Status Indicator Channel (CSICH) is a fixed rate (SF=256) physical channel used to carry CPCH status information.

A CSICH is always associated with a physical channel used for transmission of CPCH AP-AICH and uses the same channelization and scrambling codes. Figure 25 illustrates the frame structure of the CSICH. The CSICH frame consists of 15 consecutive access slots (AS) each of length 40 bits. Each access slot consists of two parts, a part of duration 4096 chips with no transmission that is not formally part of the CSICH, and a Status Indicator (SI) part consisting of 8 bits $b_{8i}, \ldots, b_{8i+7}$, where i is the access slot number. The part of the slot with no transmission is reserved for use by AICH, AP-AICH or CD/CA-ICH. The modulation used by the CSICH is the same as for the PICH. The phase reference for the CSICH is the Primary CPICH.

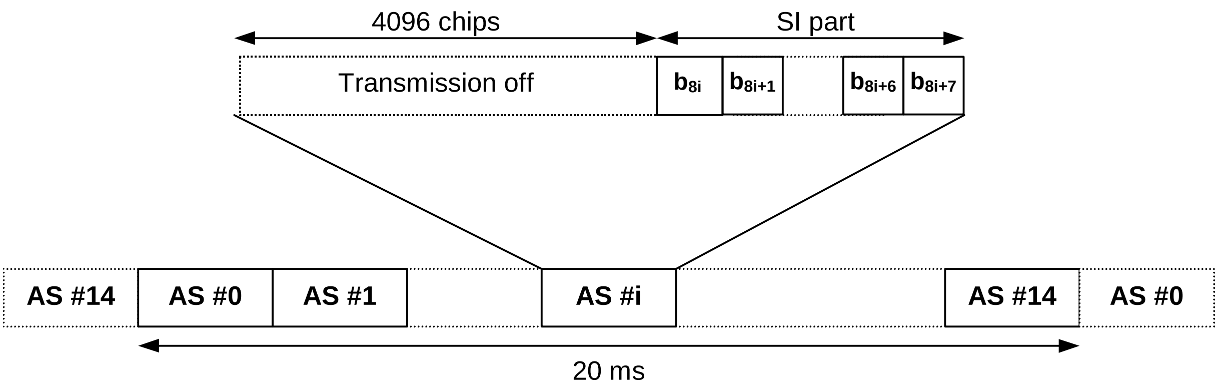

Figure 25: Structure of CPCH Status Indicator Channel (CSICH)

N Status Indicators $\{SI_0, \ldots, SI_{N-1}\}$ shall be transmitted in each CSICH frame. The mapping from $\{SI_0, \ldots, SI_{N-1}\}$ to the CSICH bits $\{b_0, \ldots, b_{119}\}$ is according to Table 25. The Status Indicators shall be transmitted in all the access slots of the CSICH frame, even if some signatures and/or access slots are shared between CPCH and RACH.

Table 25: Mapping of Status Indicators (SI) to CSICH bits

Number of SI per frame (N)	$SI_n = 1$	$SI_n = 0$
N=1	$\{b_0, \ldots, b_{119}\} = \{1, 1,\ldots, 1\}$	$\{b_0, \ldots, b_{119}\} = \{0, 0,\ldots, 0\}$
N=3	$\{b_{40n}, \ldots, b_{40n+39}\} = \{1, 1,\ldots, 1\}$	$\{b_{40n}, \ldots, b_{40n+39}\} = \{0, 0,\ldots, 0\}$
N=5	$\{b_{24n}, \ldots, b_{24n+23}\} = \{1, 1,\ldots, 1\}$	$\{b_{24n}, \ldots, b_{24n+23}\} = \{0, 0,\ldots, 0\}$
N=15	$\{b_{8n}, \ldots, b_{8n+7}\} = \{1, 1,\ldots, 1\}$	$\{b_{8n}, \ldots, b_{8n+7}\} = \{0, 0,\ldots, 0\}$
N=30	$\{b_{4n}, \ldots, b_{4n+3}\} = \{1, 1, 1, 1\}$	$\{b_{4n}, \ldots, b_{4n+3}\} = \{0, 0, 0, 0\}$
N=60	$\{b_{2n}, b_{2n+1}\} = \{1, 1\}$	$\{b_{2n}, b_{2n+1}\} = \{0, 0\}$

When transmit diversity is employed for the CSICH, STTD encoding is used on the CSICH bits as described in subclause 5.3.1.1.1.

The CPCH Status Indicator mode (CSICH mode) defines the structure of the information carried on the CSICH. At the UTRAN the value of the CPCH Status Indicator mode is set by higher layers. There are two CSICH modes depending on whether Channel Assignment is active or not. The CSICH mode defines the number of status indicators per frame and the content of each status indicator. Layer 1 transmits the CSICH information according to the CSICH mode and the structures defined in the following paragraphs.

5.3.3.11.1 CSICH Information Structure when Channel Assignment is not active

In this mode, CPCH Status Indication conveys the PCPCH Channel Availability value which is a 1 to 16 bit value which indicates the availability of each of the 1 to 16 defined PCPCHs in the CPCH set. PCPCHs are numbered from PCPCH0 through PCPCH15. There is one bit of the PCPCH Resource Availability (PRA) value for each defined PCPCH channel. If there are 2 PCPCHs defined in the CPCH set, then there are 2 bits in the PRA value. And likewise for other numbers of defined PCPCH channels up to 16 maximum CPCH channels per set when Channel Assignment is not active.

The number of SIs (Status Indicators) per frame is a function of the number of defined PCPCH channels.

Number of defined PCPCHs(=K)	Number of SIs per frame(=N)
1, 2, 3	3
4,5	5
6,7,8,9,10,11,12,13,14,15	15
16	30

The value of the SI shall indicate the PRA value for one of the defined PCPCHs, where PRA(n)=1 indicates that the PCPCH is available, and PRA(n)=0 indicates that the PCPCHn is not available. SI(0) shall indicate PRA(0) for PCPCH0, SI(1) shall indicate PRA(1) for PCPCH1, etc., for each defined PCPCH. When the number of SIs per frame exceeds the number of defined PCPCHs (K), the SIs which exceed K shall be set to repeat the PRA values for the defined PCPCHs. In general ,

$SI(n) = PRA(n \bmod (K))$,

where PRA(i) is availability of PCPCHi,

and n ranges from 0 to N-1.

5.3.3.11.2 PCPCH Availability when Channel Assignment is active

In this mode, CPCH Status Indication conveys two pieces of information. One is the Minimum Available Spreading Factor (MASF) value and the other is the PCPCH Resource Availability (PRA) value.

- MASF is a 3 bit number with bits MASF(0) through MASF(2) where MASF(0) is the MSB of the MASF value and MASF(2) is the LSB of the MASF value.

The following table defines MASF(0), MASF(1) and MASF(2) values to convey the MASF. All spreading factors greater than MASF are available

Minimum Available Spreading Factor (MASF)	MASF(0)	MASF(1)	MASF(2)
N/A (No available CPCH resources)	0	0	0
256	0	0	1
128	0	1	0
64	0	1	1
32	1	0	0
16	1	0	1
08	1	1	0
04	1	1	1

The number of SIs (Status Indicators) per frame, N is a function of the number of defined PCPCH channels, K.

Number of defined PCPCHs(K)	Number of SIs per frame(N)
1, 2,	5
3,4,5,6,7,8,9,10,11,12	15
13,14,15,16,17,18,19,20,21,22,23,24,25,26,27	30
28….57	60

PRA(n)=1 indicates that the PCPCHn is available, and PRA(n)=0 indicates that the PCPCHn is not available. PRA value for each PCPCH channel defined in a CPCH set shall be assigned to one SI (Status Indicator), and 3-bit MASF value shall be assigned to SIs as shown in Figure 26.

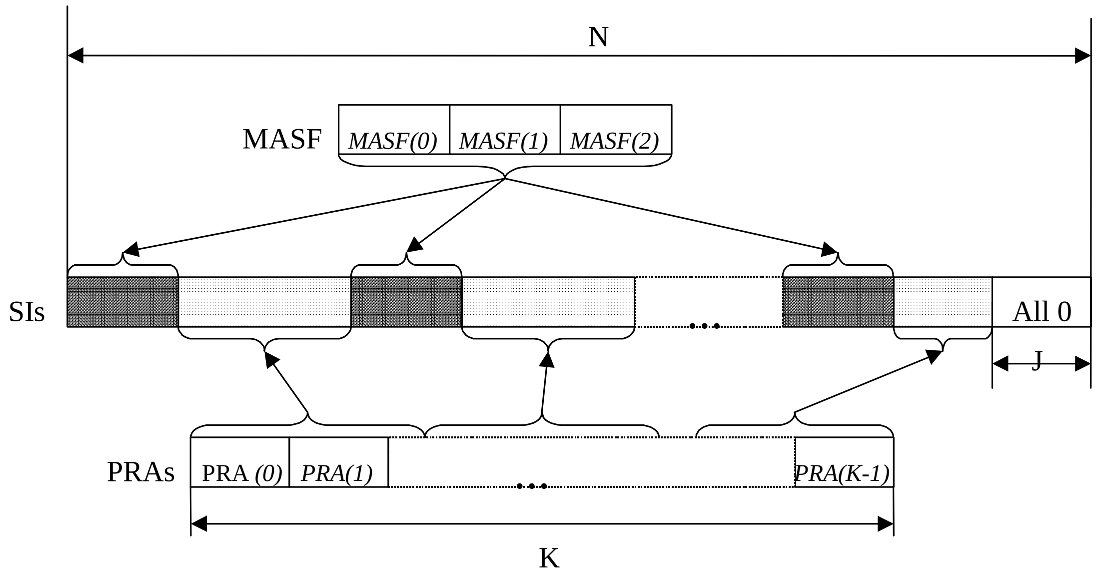

Figure 26: Mapping of MASF and PRAs to SIs in CSICH

The number of repetition that 3-bit MASF values shall be repeated is

$$T = \lfloor (N-K)/3 \rfloor$$

where $\lfloor x \rfloor$ is largest integer less than or equal to x. Each MASF value it, MASF(n), shall be mapped to SI as follows.

$$SI_{l(t+4)+i} = MASF(i), \quad 0 \le i \le 2 \quad l = 0,1, \ldots, s-1$$
$$SI_{s+l(t+3)+i} = MASF(i), \quad 0 \le i \le 2 \quad l = s, s+1, \ldots, T-1 ,$$

where

$$t = \lfloor K/T \rfloor$$

and

$$s = K - t \cdot T$$

Each PRA value bit, PRA(n), shall be mapped to SI as follows.

$$SI_{l(t+4)+j+3} = PRA(l + l \cdot t + j), \quad 0 \le j \le t \qquad l = 0, 1, \ldots, s-1$$
$$SI_{s+l(t+3)+j+3} = PRA(s + l \cdot t + j), \quad 0 \le j \le t-1 \qquad l = s, s+1, \ldots, T-1$$

The remaining

$$J = N - (3T + K)$$

SIs shall be set to 0.

5.3.3.12 Shared Control Channel (HS-SCCH)

The HS-SCCH is a fixed rate (60 kbps, SF=128) downlink physical channel used to carry downlink signalling related to HS-DSCH transmission. Figure 26A illustrates the sub-frame structure of the HS-SCCH.

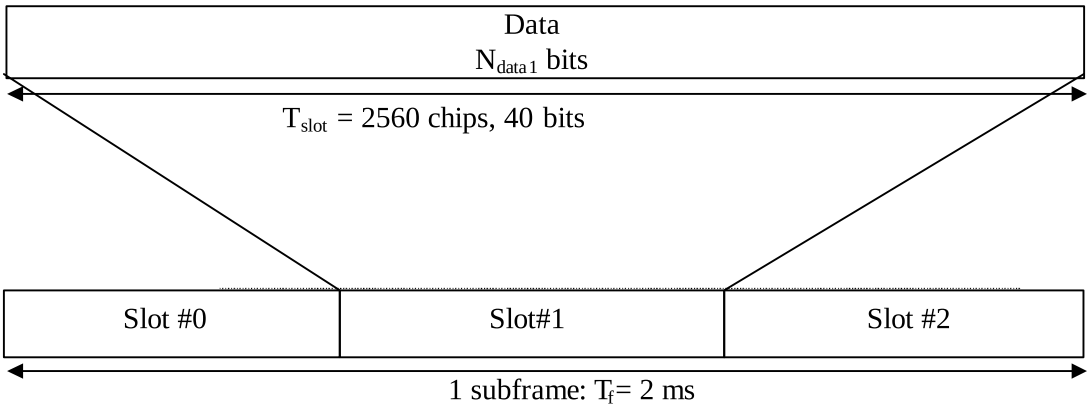

Figure 26A: Subframe structure for the HS-SCCH

5.3.3.13 High Speed Physical Downlink Shared Channel (HS-PDSCH)

The High Speed Physical Downlink Shared Channel (HS- PDSCH) is used to carry the High Speed Downlink Shared Channel (HS-DSCH).

A HS-PDSCH corresponds to one channelization code of fixed spreading factor SF=16 from the set of channelization codes reserved for HS-DSCH transmission. Multi-code transmission is allowed, which translates to UE being assigned multiple channelisation codes in the same HS-PDSCH subframe, depending on its UE capability.

The subframe and slot structure of HS-PDSCH are shown in figure 26B.

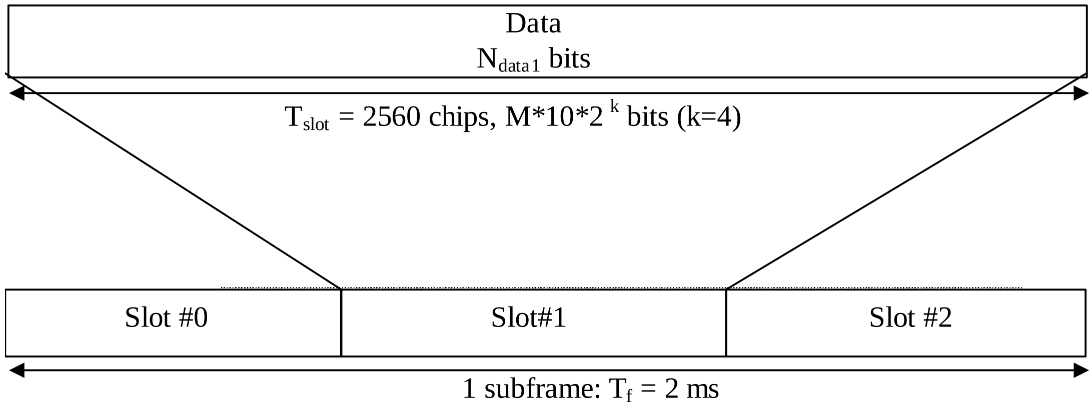

Figure 26B: Subframe structure for the HS-PDSCH

An HS-PDSCH may use QPSK or 16QAM modulation symbols. In figure 26B, M is the number of bits per modulation symbols i.e. M=2 for QPSK and M=4 for 16QAM. The slot formats are shown in table 26.

Table 26: HS-DSCH fields

Slot format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ HS-DSCH subframe	Bits/ Slot	Ndata
0(QPSK)	480	240	16	960	320	320
1(16QAM)	960	240	16	1920	640	640

All relevant Layer 1 information is transmitted in the associated HS-SCCH i.e. the HS-PDSCH does not carry any Layer 1 information.

3GPP TSG RAN WG1 Meeting #41
Athens, Greece, May 9-13, 2005

Tdoc ⌘R1-050523

CR-Form-v7.1

CHANGE REQUEST

⌘ **25.211 CR 217** ⌘ **rev -** ⌘ Current version: **6.4.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: UICC apps⌘ [ ] ME [X] Radio Access Network [X] Core Network [ ]

Title:	⌘	Feature clean up: Removal of the 'TX diversity closed loop mode 2'		
Source:	⌘	RAN WG1		
Work item code:	⌘	TEI6	***Date:*** ⌘	18/04/2005
Category:	⌘	**C** *Use one of the following categories:* ***F*** *(correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.	***Release:*** ⌘	Rel-6 *Use one of the following releases:* *Ph2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *Rel-4 (Release 4)* *Rel-5 (Release 5)* *Rel-6 (Release 6)* *Rel-7 (Release 7)*

Reason for change:	⌘	The feature 'TX diversity closed loop mode 2' is not defined for HSDPA and F-DPCH and therefore it is not efficiently usable in the networks. RAN #27 decided with RP-050144 to remove this feature.
Summary of change:	⌘	Text reagarding the feature 'TX diversity closed loop mode 2' was removed.
Consequences if not approved:	⌘	Simplification of specifications, reduction of complexity and easier evolution chance would be missed and a RAN #27 decision would be violated.

Clauses affected:	⌘	5.3.1, 5.3.1.2, 5.3.2.2				
		Y	**N**			
Other specs affected:	⌘	X		Other core specifications	⌘	25.101, 25.214, 25.331, 25.423, 25.433
				Test specifications		
			X	O&M Specifications		
Other comments:	⌘	Contents of this CR is unchanged compared to R1-050478.				

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm. Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be

downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

5 Physical channels and physical signals

Physical channels are defined by a specific carrier frequency, scrambling code, channelization code (optional), time start & stop (giving a duration) and, on the uplink, relative phase (0 or $\pi/2$). The downlink E-HICH and E-RGCH are each further defined by a specific orthogonal signature sequence. Scrambling and channelization codes are specified in [4]. 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 38400 chips.

Slot: A slot is a duration which consists of fields containing bits. The length of a slot corresponds to 2560 chips.

Sub-frame: A sub-frame is the basic time interval for E-DCH and HS-DSCH transmission and E-DCH and HS-DSCH-related signalling at the physical layer. The length of a sub-frame corresponds to 3 slots (7680 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 five types of uplink dedicated physical channels, the uplink Dedicated Physical Data Channel (uplink DPDCH), the uplink Dedicated Physical Control Channel (uplink DPCCH), the uplink E-DCH Dedicated Physical Data Channel (uplink E-DPDCH), the uplink E-DCH Dedicated Physical Control Channel (uplink E-DPCCH) and the uplink Dedicated Control Channel associated with HS-DSCH transmission (uplink HS-DPCCH).

The DPDCH, the DPCCH, the E-DPDCH, the E-DPCCH and the HS-DPCCH are I/Q code multiplexed (see [4]).

5.2.1.1 DPCCH and DPDCH

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, feedback information (FBI), 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 DPDCH and the uplink DPCCH. Each radio frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2560 chips, corresponding to one power-control period. The DPDCH and DPCCH are always frame aligned with each other.

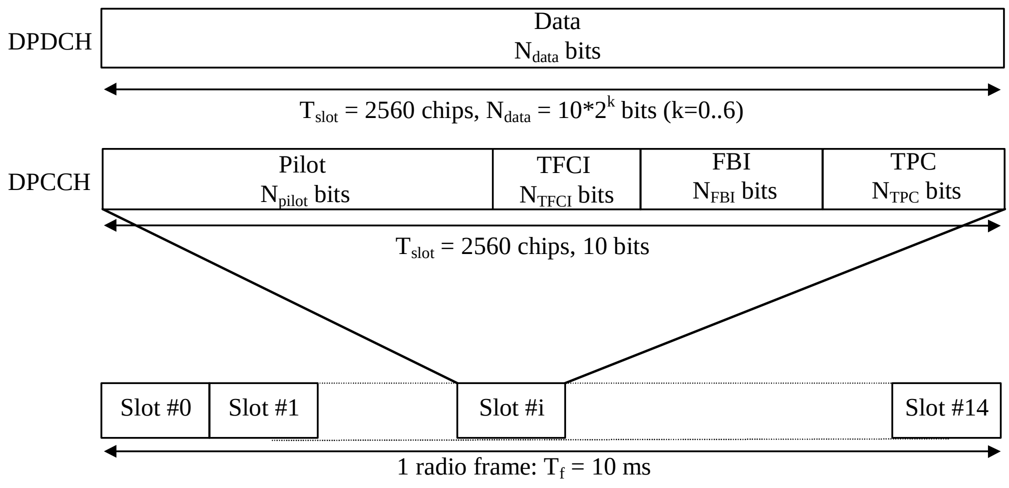

Figure 1: Frame structure for uplink DPDCH/DPCCH

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}, N_{TFCI}, N_{FBI}, and N_{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 and table 4, the TPC bit pattern is given in table 5.

The FBI bits are used to support techniques requiring feedback from the UE to the UTRAN Access Point, including closed loop mode transmit diversity and site selection diversity transmission (SSDT). The structure of the FBI field is shown in figure 2 and described below.

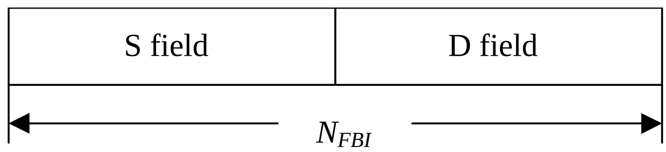

Figure 2: Details of FBI field

The S field is used for SSDT signalling, while the D field is used for closed loop mode transmit diversity signalling. The S field consists of 0, 1 or 2 bits. The D field consists of 0 or 1 bit. The total FBI field size N_{FBI} is given by table 2. If total FBI field is not filled with S field or D field, FBI field shall be filled with "1". When N_{FBI} is 2bits, S field is 0bit and D field is 1bit, left side field shall be filled with "1" and right side field shall be D field. The use of the FBI fields is described in detail in [5].

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	1200	80	80
4	240	240	16	2400	160	160
5	480	480	8	4800	320	320
6	960	960	4	9600	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 UTRAN 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 [3].

In compressed mode, DPCCH slot formats with TFCI fields are changed. There are two possible compressed slot formats for each normal slot format. They are labelled A and B and the selection between them is dependent on the number of slots that are transmitted in each frame in compressed mode.

Table 2: DPCCH fields

Slot Form at #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TPC}	N_{TFCI}	N_{FBI}	Transmitted slots per radio frame
0	15	15	256	150	10	6	2	2	0	15
0A	15	15	256	150	10	5	2	3	0	10-14
0B	15	15	256	150	10	4	2	4	0	8-9
1	15	15	256	150	10	8	2	0	0	8-15
2	15	15	256	150	10	5	2	2	1	15
2A	15	15	256	150	10	4	2	3	1	10-14
2B	15	15	256	150	10	3	2	4	1	8-9
3	15	15	256	150	10	7	2	0	1	8-15
4	15	15	256	150	10	6	2	0	2	8-15
5	15	15	256	150	10	5	1	2	2	15
5A	15	15	256	150	10	4	1	3	2	10-14
5B	15	15	256	150	10	3	1	4	2	8-9

The pilot bit patterns are described in table 3 and table 4. 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} = 3, 4, 5 and 6

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

Table 4: Pilot bit patterns for uplink DPCCH with N_{pilot} = 7 and 8

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

The relationship between the TPC bit pattern and transmitter power control command is presented in table 5.

Table 5: TPC Bit Pattern

TPC Bit Pattern		Transmitter power control command
N_{TPC} = 1	N_{TPC} = 2	
1	11	1
0	00	0

Multi-code operation is possible for the uplink dedicated physical channels. When multi-code transmission is used, several parallel DPDCH are transmitted using different channelization codes, see [4]. However, there is only one DPCCH per radio link.

A period of uplink DPCCH transmission prior to the start of the uplink DPDCH transmission (uplink DPCCH power control preamble) shall be used for initialisation of a DCH. The length of the power control preamble is a higher layer parameter, N_{pcp} , signalled by the network [5]. 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 of table 3 and table 4 shall be used. The timing of the power control preamble is described in [5], subclause 4.3.2.3. The TFCI field is filled with "0" bits.

5.2.1.2 HS-DPCCH

Figure 2A illustrates the frame structure of the HS-DPCCH. The HS-DPCCH carries uplink feedback signalling related to downlink HS-DSCH transmission. The HS-DSCH-related feedback signalling consists of Hybrid-ARQ Acknowledgement (HARQ-ACK) and Channel-Quality Indication (CQI) [3]. Each sub frame of length 2 ms (3*2560 chips) consists of 3 slots, each of length 2560 chips. The HARQ-ACK is carried in the first slot of the HS-DPCCH sub-frame. The CQI is carried in the second and third slot of a HS-DPCCH sub-frame. There is at most one HS-DPCCH on each radio link. The HS-DPCCH can only exist together with an uplink DPCCH. The timing of the HS-DPCCH relative to the uplink DPCCH is shown in section 7.7.

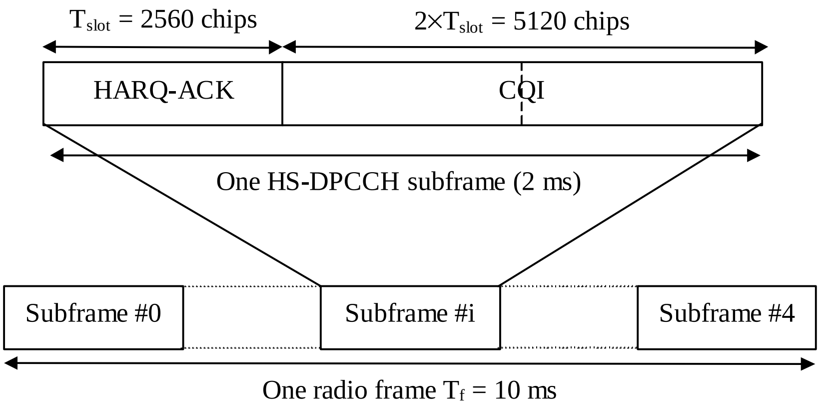

Figure 2A: Frame structure for uplink HS-DPCCH

The spreading factor of the HS-DPCCH is 256 i.e. there are 10 bits per uplink HS-DPCCH slot. The slot format for uplink HS-DPCCH is defined in Table 5A.

Table 5A: HS-DPCCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Subframe	Bits/ Slot	Transmitted slots per Subframe
0	15	15	256	30	10	3

5.2.1.3 E-DPCCH and E-DPDCH

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

The E-DPCCH is a physical channel used to transmit control information associated with the E-DCH. There is at most one E-DPCCH on each radio link.

Figure 2B shows the E-DPDCH and E-DPCCH (sub)frame structure. Each radio frame is divided in 5 subframes, each of length 2 ms; the first subframe starts at the start of each radio frame and the 5th subframe ends at the end of each radio frame. The E-DPDCH slot formats, corresponding rates and number of bits are specified in Table 5B. The E-DPCCH slot format is listed in Table 5C.

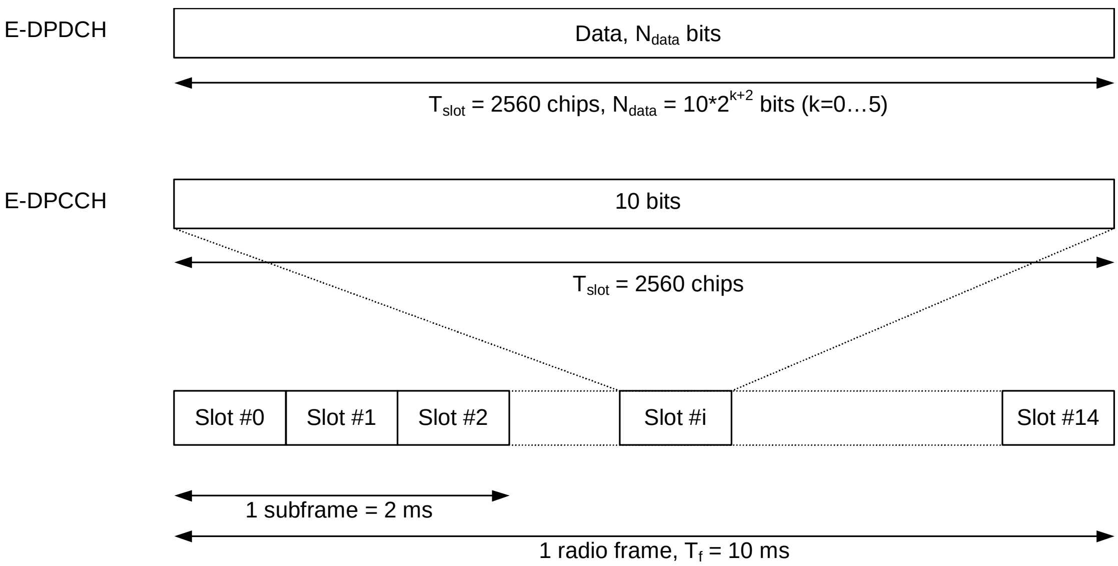

Figure 2B: E-DPDCH frame structure

Table 5B: E-DPDCH slot formats

Slot Format #i	Channel Bit Rate (kbps)	SF	Bits/ Frame	Bits/ Subframe	Bits/Slot N_{data}
0	60	64	600	120	40
1	120	32	1200	240	80
2	240	16	2400	480	160
3	480	8	4800	960	320
4	960	4	9600	1920	640
5	1920	2	19200	3840	1280

Table 5C: E-DPCCH slot formats

Slot Format #i	Channel Bit Rate (kbps)	SF	Bits/ Frame	Bits/ Subframe	Bits/Slot N_{data}
0	15	256	150	30	10

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 a Slotted ALOHA approach with fast acquisition indication. The UE can start the random-access transmission at the beginning of a number of well-defined time intervals, denoted *access slots*. There are 15 access slots per two frames and they are spaced 5120 chips apart, see figure 3. The timing of the access slots and the acquisition indication is described in subclause 7.3. Information on what access slots are available for random-access transmission is given by higher layers.

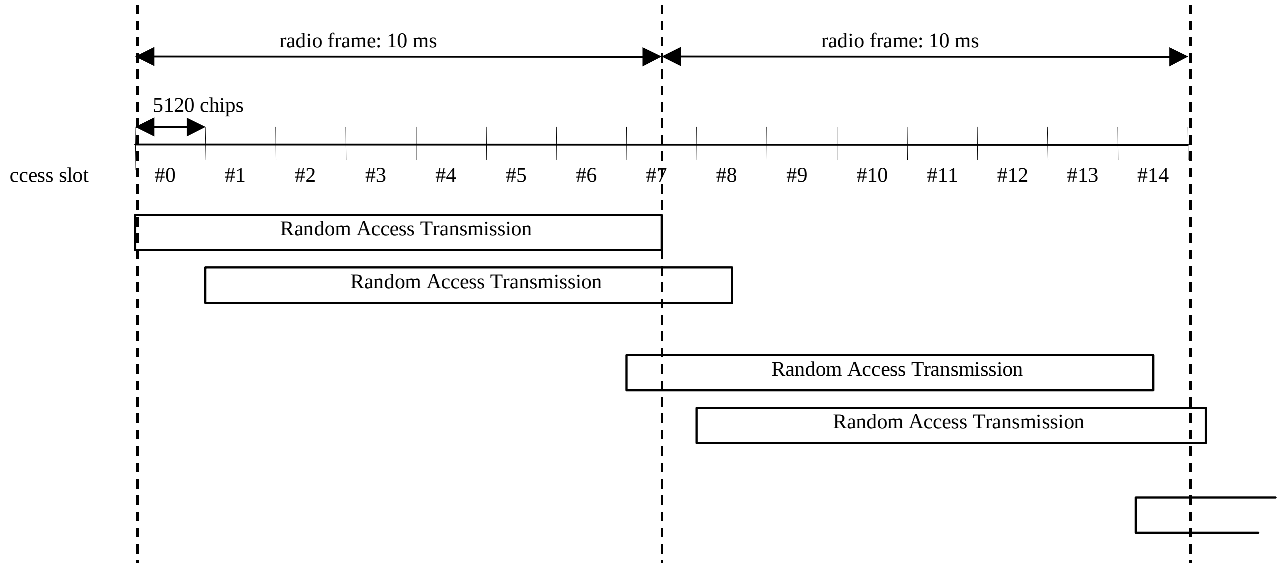

Figure 3: RACH access slot numbers and their spacing

The structure of the random-access transmission is shown in figure 4. The random-access transmission consists of one or several *preambles* of length 4096 chips and a *message* of length 10 ms or 20 ms.

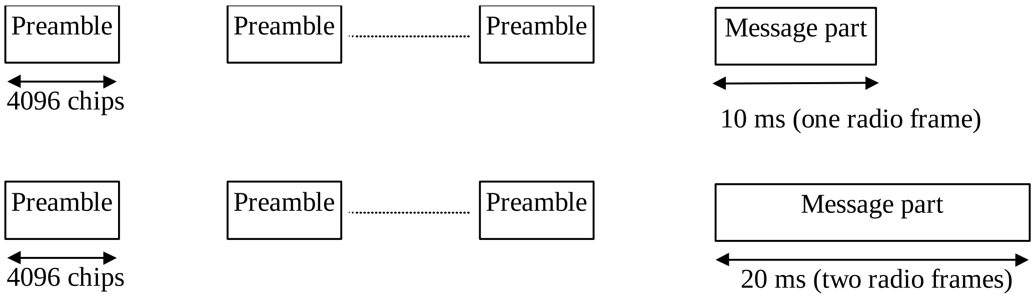

Figure 4: Structure of the random-access transmission

5.2.2.1.2 RACH preamble part

Each preamble is of length 4096 chips and consists of 256 repetitions of a signature of length 16 chips. There are a maximum of 16 available signatures, see [4] for more details.

5.2.2.1.3 RACH message part

Figure 5 shows the structure of the random-access message part radio frame. The 10 ms message part radio frame is split into 15 slots, each of length T_{slot} = 2560 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 equal to the Transmission Time Interval of the RACH Transport channel in use. This TTI length is configured by higher layers.

The data part consists of $10*2^k$ 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 8. The total number of TFCI bits in the random-access message is 15*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.

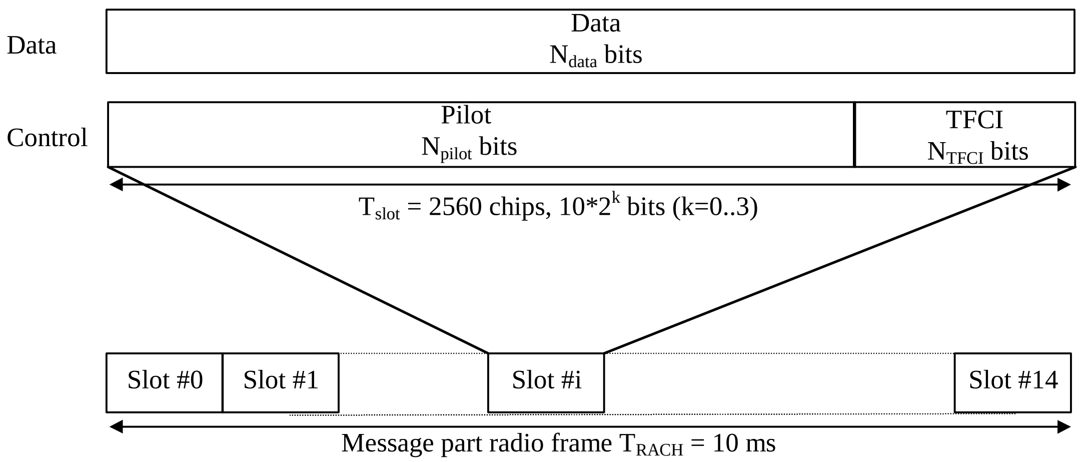

Figure 5: Structure of the random-access message part radio frame

Table 6: 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	1200	80	80

Table 7: 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 8: 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)

The Physical Common Packet Channel (PCPCH) is used to carry the CPCH.

5.2.2.2.1 CPCH transmission

The CPCH transmission is based on DSMA-CD approach with fast acquisition indication. The UE can start transmission at the beginning of a number of well-defined time-intervals, relative to the frame boundary of the received BCH of the current cell. The access slot timing and structure is identical to RACH in subclause 5.2.2.1.1. The structure of the CPCH access transmission is shown in figure 6. The PCPCH access transmission consists of one or several Access Preambles [A-P] of length 4096 chips, one Collision Detection Preamble (CD-P) of length 4096 chips, a DPCCH Power Control Preamble (PC-P) which is either 0 slots or 8 slots in length, and a message of variable length Nx10 ms.

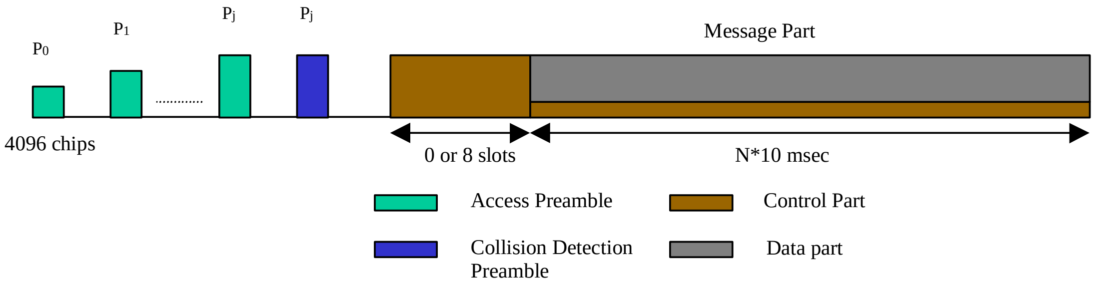

Figure 6: Structure of the CPCH access transmission

5.2.2.2.2 CPCH access preamble part

Similar to 5.2.2.1.2 (RACH preamble part). The RACH preamble signature sequences are used. The number of sequences used could be less than the ones used in the RACH preamble. The scrambling code could either be chosen to be a different code segment of the Gold code used to form the scrambling code of the RACH preambles (see [4] for more details) or could be the same scrambling code in case the signature set is shared.

5.2.2.2.3 CPCH collision detection preamble part

Similar to 5.2.2.1.2 (RACH preamble part). The RACH preamble signature sequences are used. The scrambling code is chosen to be a different code segment of the Gold code used to form the scrambling code for the RACH and CPCH preambles (see [4] for more details).

5.2.2.2.4 CPCH power control preamble part

The power control preamble segment is called the CPCH Power Control Preamble (PC-P) part. The slot format for CPCH PC-P part shall be the same as for the following message part in Table 9 in subclause 5.2.2.2.5. The Power Control Preamble length is a higher layer parameter, $L_{pc\text{-}preamble}$ (see [5], section 6.2), which shall take the value 0 or 8 slots. When $L_{pc\text{-}preamble} > 0$, the pilot bit patterns from slot #(15- $L_{pc\text{-}preamble}$) to slot #14 of table 3 and 4 in subclause 5.2.1 shall be used for CPCH PC-P pilot bit patterns. The TFCI field is filled with "1" bits.

5.2.2.2.5 CPCH message part

Figure 1 in subclause 5.2.1 shows the structure of the CPCH message part. Each message consists of up to N_Max_frames 10 ms frames. N_Max_frames is a higher layer parameter. Each 10 ms frame is split into 15 slots, each of length T_{slot} = 2560 chips. Each slot consists of two parts, a data part that carries higher layer information and a control part that carries Layer 1 control information. The data and control parts are transmitted in parallel.

The entries of table 1 in subclause 5.2.1 apply to the data part of the CPCH message part. The spreading factor for the control part of the CPCH message part shall be 256. Table 9 defines the slot format of the control part of CPCH message part. The pilot bit patterns of table 3 in subclause 5.2.1 shall be used for pilot bit patterns of the CPCH message part.

Table 9: Slot format of the control part of CPCH message part

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TPC}	N_{TFCI}	N_{FBI}
0	15	15	256	150	10	6	2	2	0
1	15	15	256	150	10	5	2	2	1

Figure 7 shows the frame structure of the uplink common packet physical channel. Each frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2560 chips, corresponding to one power-control period.

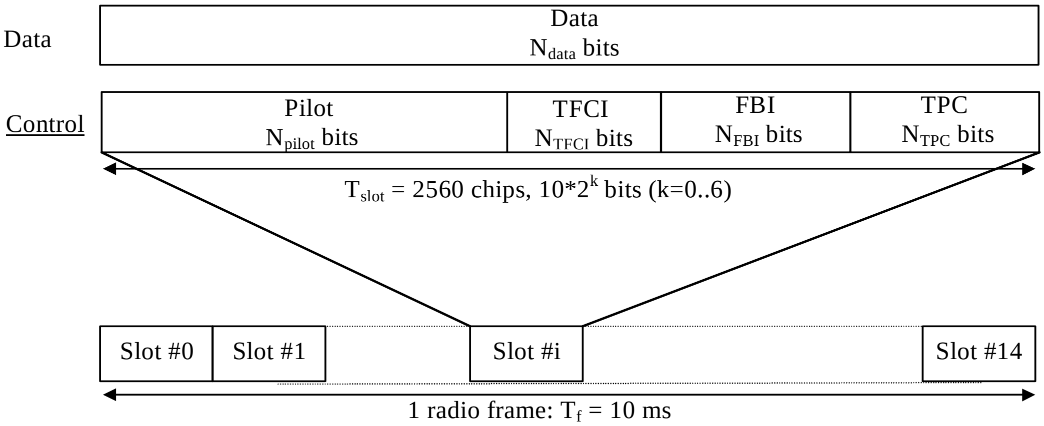

Figure 7: Frame structure for uplink Data and Control Parts Associated with PCPCH

The data part consists of $10*2^k$ bits, where k = 0, 1, 2, 3, 4, 5, 6, corresponding to spreading factors of 256, 128, 64, 32, 16, 8, 4 respectively.

5.3 Downlink physical channels

5.3.1 Downlink transmit diversity

Table 10 summarises the possible application of open and closed loop transmit diversity modes on different downlink physical channel types. Simultaneous use of STTD and closed loop modes on the same physical channel is not allowed. In addition, if Tx diversity is applied on any of the downlink physical channels it shall also be applied on P-CCPCH and SCH. Regarding CPICH transmission in case of transmit diversity, see subclause 5.3.3.1.

With respect to the usage of Tx diversity for DPCH on different radio links within an active set, the following rules apply:

- Different Tx diversity modes (STTD and closed loop) shall not be used on the radio links within one active set.
- No Tx diversity on one or more radio links shall not prevent UTRAN to use Tx diversity on other radio links within the same active set.
- If STTD is activated on one or several radio links in the active set, the UE shall operate STTD on only those radio links where STTD has been activated. Higher layers inform the UE about the usage of STTD on the individual radio links in the active set.
- If closed loop TX diversity is activated on one or several radio links in the active set, the UE shall operate closed loop TX diversity on only those radio links where closed loop TX diversity has been activated. Higher layers inform the UE about the usage of closed loop TX diversity on the individual radio links in the active set.

Furthermore, the transmit diversity mode used for a PDSCH frame shall be the same as the transmit diversity mode used for the DPCH associated with this PDSCH frame. The transmit diversity mode on the associated DPCH may not change during a PDSCH frame and within the slot prior to the PDSCH frame. This includes any change between no Tx diversity, open loop, closed loop mode 1~~ or closed loop mode 2~~.

Also, if a DPCH is associated with an HS-PDSCH subframe, the transmit diversity mode used for the HS-PDSCH subframe shall be the same as the transmit diversity mode used for the DPCH associated with this HS-PDSCH subframe. If a F-DPCH is associated with an HS-PDSCH subframe, the transmit diversity mode used for the HS-PDSCH subframe shall be the same as the transmit diversity mode signalled for the F-DPCH associated with this HS-PDSCH subframe. If the DPCH associated with an HS-SCCH subframe is using either open or closed loop transmit diversity on the radio link transmitted from the HS-DSCH serving cell, the HS-SCCH subframe from this cell shall be transmitted using STTD, otherwise no transmit diversity shall be used for this HS-SCCH subframe. If a F-DPCH for which STTD is signalled is associated with an HS-SCCH subframe, the HS-SCCH subframe shall be transmitted using STTD, otherwise no transmit diversity shall be used for this HS-SCCH subframe. The transmit diversity mode on the associated DPCH or F-DPCH may not change during a HS-SCCH and or HS-PDSCH subframe and within the slot prior to the HS-SCCH subframe. This includes any change between no Tx diversity and either open loop or closed loop mode.

If the UE is receiving a DPCH on which transmit diversity is used from a cell, or if the UE is receiving a F-DPCH for which STTD is signalled from a cell, the UE shall assume that the E-AGCH, E-RGCH, and E-HICH from the same cell are transmitted using STTD.

Table 10: Application of Tx diversity modes on downlink physical channel types "X" – can be applied, "–" – not applied

Physical channel type	Open loop mode		Closed loop mode
	TSTD	**STTD**	**Mode 1**
P-CCPCH	–	X	–
SCH	X	–	–
S-CCPCH	–	X	–
DPCH	–	X	X
PICH	–	X	–
PDSCH	–	X	X
HS-PDSCH	–	X	X
HS-SCCH	–	X	–
AICH	–	X	–
CSICH	–	X	–
AP-AICH	–	X	–
CD/CA-ICH	–	X	–
DL-DPCCH for CPCH	–	X	X

~~Physical channel type~~	~~Open loop mode~~		~~Closed loop mode~~	
	~~TSTD~~	~~STTD~~	~~Mode 1~~	~~Mode 2~~
~~P-CCPCH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~SCH~~	~~X~~	~~–~~	~~–~~	~~–~~
~~S-CCPCH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~DPCH~~	~~–~~	~~X~~	~~X~~	~~X~~
~~F-DPCH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~PICH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~MICH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~PDSCH~~	~~–~~	~~X~~	~~X~~	~~X~~
~~HS-PDSCH~~	~~–~~	~~X~~	~~X~~	~~–~~
~~HS-SCCH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~E-AGCH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~E_RGCH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~E-HICH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~AICH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~CSICH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~AP-AICH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~CD/CA-ICH~~	~~–~~	~~X~~	~~–~~	~~–~~
~~DL-DPCCH for CPCH~~	~~–~~	~~X~~	~~X~~	~~X~~

5.3.1.1 Open loop transmit diversity

5.3.1.1.1 Space time block coding based transmit antenna diversity (STTD)

The open loop downlink transmit diversity employs a space time block coding based transmit diversity (STTD).

The STTD encoding is optional in UTRAN. STTD support is mandatory at the UE.

If higher layers signal that neither P-CPICH nor S-CPICH can be used as phase reference for the downlink DPCH for a radio link in a cell, the UE shall assume that STTD is not used for the downlink DPCH (and the associated PDSCH if applicable) in that cell.

A block diagram of a generic STTD encoder is shown in the figure 8 and figure 8A below. Channel coding, rate matching and interleaving are done as in the non-diversity mode. For QPSK, the STTD encoder operates on 4 symbols b_0, b_1, b_2, b_3 as shown in figure 8. For AICH, E-RGCH, E-HICH, AP-AICH and CD/CA-ICH, the b_i are real valued signals, and $\bar{b}_i$ is defined as $-b_i$. For channels other than AICH, E-RGCH, E-HICH, AP-AICH and CD/CA-ICH, the b_i are 3-valued digits, taking the values 0, 1, "DTX", and $\bar{b}_i$ is defined as follows: if b_i = 0 then $\bar{b}_i$ = 1, if b_i = 1 then $\bar{b}_i$ = 0, otherwise $\bar{b}_i$ = b_i .

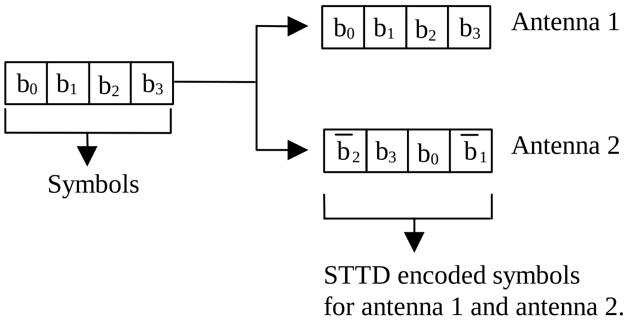

Figure 8: Generic block diagram of the STTD encoder for QPSK

For 16QAM, STTD operates on blocks of 8 consecutive symbols b_0, b_1, b_2, b_3, b_4, b_5, b_6, b_7 as shown in figure 8A below.

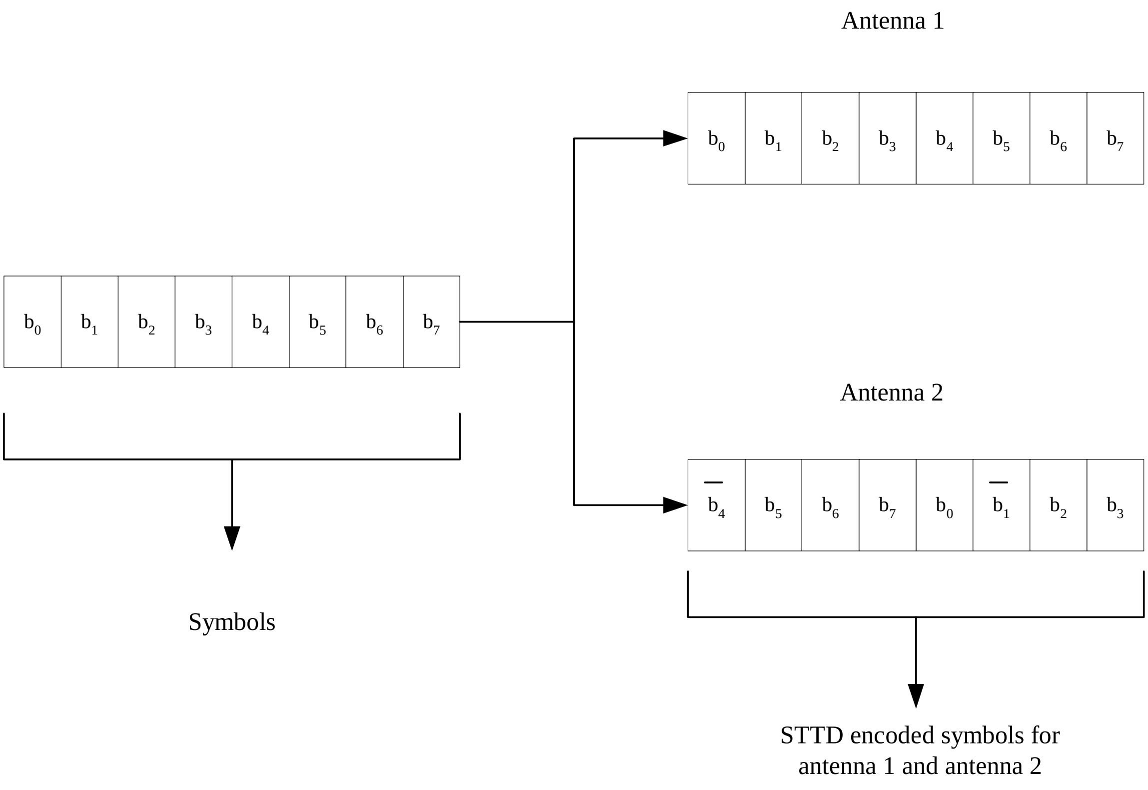

Figure 8A: Generic block diagram of the STTD encoder for 16QAM

5.3.1.1.2 Time Switched Transmit Diversity for SCH (TSTD)

Transmit diversity, in the form of Time Switched Transmit Diversity (TSTD), can be applied to the SCH. TSTD for the SCH is optional in UTRAN, while TSTD support is mandatory in the UE. TSTD for the SCH is described in subclause 5.3.3.5.1.

5.3.1.2 Closed loop transmit diversity

Closed loop transmit diversity is described in [5]. ~~Both c~~Closed loop transmit diversity mode 1~~s~~ shall be supported at the UE and may be supported in the UTRAN.

5.3.2 Dedicated downlink physical channels

There are four types of downlink dedicated physical channels, the Downlink Dedicated Physical Channel (downlink DPCH), the Fractional Dedicated Physical Channel (F-DPCH), the E-DCH Relative Grant Channel (E-RGCH), and the E-DCH Hybrid ARQ Indicator Channel (E-HICH).

The F-DPCH is described in subclause 5.3.2.6.

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 subclause 5.2.1.

Figure 9 shows the frame structure of the downlink DPCH. Each frame of length 10 ms is split into 15 slots, each of length T_{slot} = 2560 chips, corresponding to one power-control period.

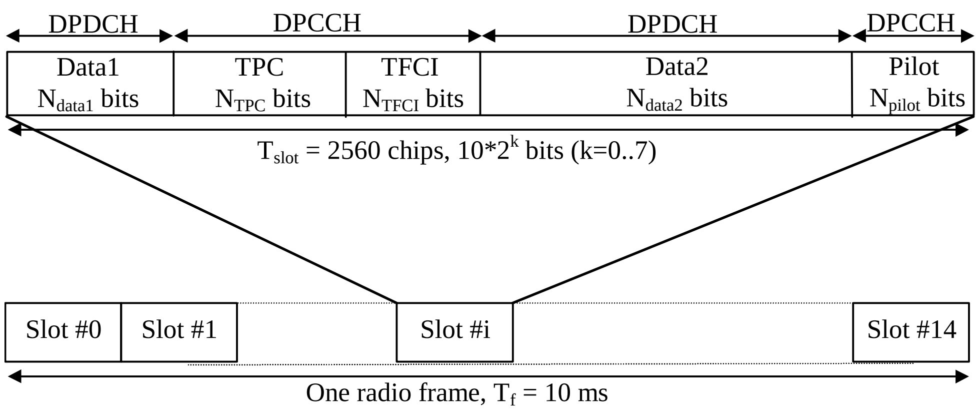

Figure 9: Frame structure for downlink DPCH

The parameter k in figure 9 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_{TPC}, N_{TFCI}, N_{data1} and N_{data2}) is given in table 11. 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). These types are reflected by the duplicated rows of table 11. It is the UTRAN 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 [3].

In compressed frames, a different slot format is used compared to normal mode. There are two possible compressed slot formats that are labelled A and B. Slot format B shall be used in frames compressed by spreading factor reduction and slot format A shall be used in frames compressed by puncturing or higher layer scheduling. The channel bit and symbol rates given in table 11 are the rates immediately before spreading.

Table 11: DPDCH and DPCCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Slot	DPDCH Bits/Slot		DPCCH Bits/Slot			Transmitted slots per radio frame N_{Tr}
					N_{Data1}	N_{Data2}	N_{TPC}	N_{TFCI}	N_{Pilot}	
0	15	7.5	512	10	0	4	2	0	4	15
0A	15	7.5	512	10	0	4	2	0	4	8-14
0B	30	15	256	20	0	8	4	0	8	8-14
1	15	7.5	512	10	0	2	2	2	4	15
1B	30	15	256	20	0	4	4	4	8	8-14
2	30	15	256	20	2	14	2	0	2	15
2A	30	15	256	20	2	14	2	0	2	8-14
2B	60	30	128	40	4	28	4	0	4	8-14
3	30	15	256	20	2	12	2	2	2	15
3A	30	15	256	20	2	10	2	4	2	8-14
3B	60	30	128	40	4	24	4	4	4	8-14
4	30	15	256	20	2	12	2	0	4	15
4A	30	15	256	20	2	12	2	0	4	8-14
4B	60	30	128	40	4	24	4	0	8	8-14
5	30	15	256	20	2	10	2	2	4	15
5A	30	15	256	20	2	8	2	4	4	8-14
5B	60	30	128	40	4	20	4	4	8	8-14
6	30	15	256	20	2	8	2	0	8	15
6A	30	15	256	20	2	8	2	0	8	8-14
6B	60	30	128	40	4	16	4	0	16	8-14
7	30	15	256	20	2	6	2	2	8	15
7A	30	15	256	20	2	4	2	4	8	8-14
7B	60	30	128	40	4	12	4	4	16	8-14
8	60	30	128	40	6	28	2	0	4	15
8A	60	30	128	40	6	28	2	0	4	8-14
8B	120	60	64	80	12	56	4	0	8	8-14
9	60	30	128	40	6	26	2	2	4	15
9A	60	30	128	40	6	24	2	4	4	8-14
9B	120	60	64	80	12	52	4	4	8	8-14
10	60	30	128	40	6	24	2	0	8	15
10A	60	30	128	40	6	24	2	0	8	8-14
10B	120	60	64	80	12	48	4	0	16	8-14
11	60	30	128	40	6	22	2	2	8	15
11A	60	30	128	40	6	20	2	4	8	8-14
11B	120	60	64	80	12	44	4	4	16	8-14
12	120	60	64	80	12	48	4	8*	8	15
12A	120	60	64	80	12	40	4	16*	8	8-14
12B	240	120	32	160	24	96	8	16*	16	8-14
13	240	120	32	160	28	112	4	8*	8	15
13A	240	120	32	160	28	104	4	16*	8	8-14
13B	480	240	16	320	56	224	8	16*	16	8-14
14	480	240	16	320	56	232	8	8*	16	15
14A	480	240	16	320	56	224	8	16*	16	8-14
14B	960	480	8	640	112	464	16	16*	32	8-14
15	960	480	8	640	120	488	8	8*	16	15
15A	960	480	8	640	120	480	8	16*	16	8-14
15B	1920	960	4	1280	240	976	16	16*	32	8-14
16	1920	960	4	1280	248	1000	8	8*	16	15
16A	1920	960	4	1280	248	992	8	16*	16	8-14

* If TFCI bits are not used, then DTX shall be used in TFCI field.

NOTE 1: Compressed mode is only supported through spreading factor reduction for SF=512 with TFCI.

NOTE 2: Compressed mode by spreading factor reduction is not supported for SF=4.

NOTE 3: If the Node B receives an invalid combination of data frames for downlink transmission, the procedure specified in [15], sub-clause 5.1.2,may require the use of DTX in both the DPDCH and theTFCI field of the DPCCH.

The pilot bit patterns are described in table 12. 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 "11".) In table 12, the transmission order is from left to right.

In downlink compressed mode through spreading factor reduction, the number of bits in the TPC and Pilot fields are doubled. Symbol repetition is used to fill up the fields. Denote the bits in one of these fields in normal mode by x_1, x_2, x_3, …, x_X. In compressed mode the following bit sequence is sent in corresponding field: x_1, x_2, x_1, x_2, x_3, x_4, x_3, x_4,…, x_X,.

Table 12: Pilot bit patterns for downlink DPCCH with N_{pilot} = 2, 4, 8 and 16

	N_{pilot} = 2	N_{pilot} = 4 (*1)		N_{pilot} = 8 (*2)				N_{pilot} = 16 (*3)							
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

NOTE *1: This pattern is used except slot formats 2B and 3B.
NOTE *2: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *3: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE: For slot format *n*B where *n* = 0, …, 15, the pilot bit pattern corresponding to N_{pilot}/2 is to be used and symbol repetition shall be applied.

The relationship between the TPC symbol and the transmitter power control command is presented in table 13.

Table 13: TPC Bit Pattern

TPC Bit Pattern			**Transmitter power control command**
N_{TPC} = 2	N_{TPC} = 4	N_{TPC} = 8	
11	1111	11111111	1
00	0000	00000000	0

Multicode transmission may be employed in the downlink, i.e. the CCTrCH (see [3]) is mapped onto several parallel downlink DPCHs using the same spreading factor. In this case, the Layer 1 control information is transmitted only on the first downlink DPCH. DTX bits are transmitted during the corresponding time period for the additional downlink DPCHs, see figure 10.

In case there are several CCTrCHs mapped to different DPCHs transmitted to the same UE different spreading factors can be used on DPCHs to which different CCTrCHs are mapped. Also in this case, Layer 1 control information is only transmitted on the first DPCH while DTX bits are transmitted during the corresponding time period for the additional DPCHs.

Note : support of multiple CCTrChs of dedicated type is not part of the current release.

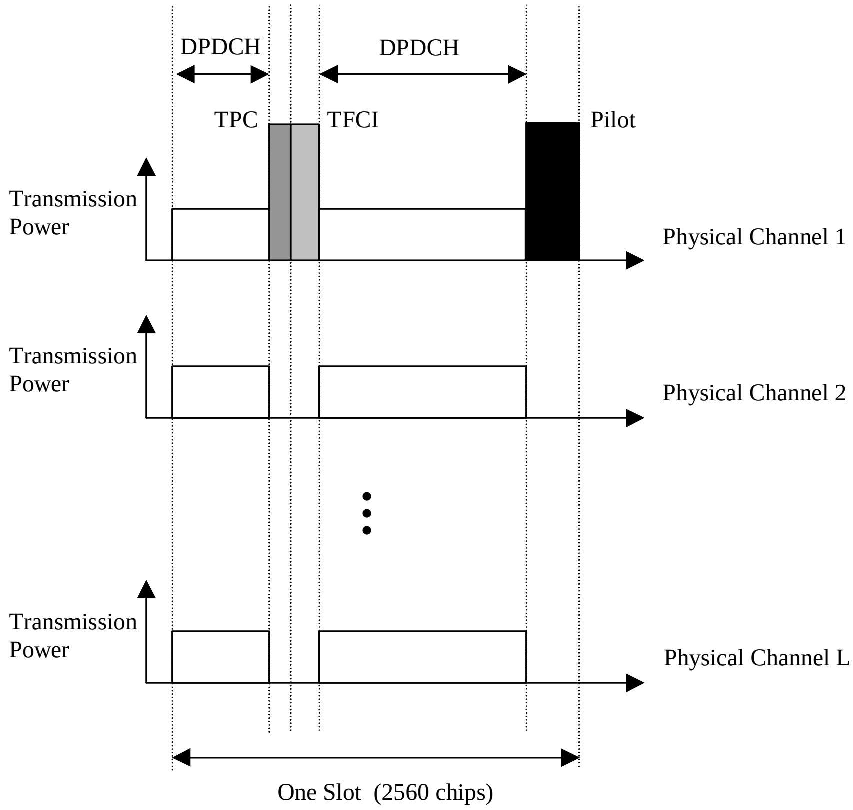

Figure 10: Downlink slot format in case of multi-code transmission

5.3.2.1 STTD for DPCH and F-DPCH

The pilot bit pattern for the DPCH channel transmitted on antenna 2 is given in table 14.

- For N_{pilot} = 8, 16 the shadowed part indicates pilot bits that are obtained by STTD encoding the corresponding (shadowed) bits in Table 12. The non-shadowed pilot bit pattern is orthogonal to the corresponding (non-shadowed) pilot bit pattern in table 12.

- For N_{pilot} = 4, the diversity antenna pilot bit pattern is obtained by STTD encoding both the shadowed and non-shadowed pilot bits in table 12.

- For N_{pilot} = 2, the diversity antenna pilot pattern is obtained by STTD encoding the two pilot bits in table 12 with the last two bits (data or DTX) of the second data field (data2) of the slot. Thus for N_{pilot} = 2 case, the last two bits of the second data field (data 2) after STTD encoding, follow the diversity antenna pilot bits in Table 14.

STTD encoding for the DPDCH, TPC, and TFCI fields is done as described in subclause 5.3.1.1.1. For the SF=512 DPCH, the first two bits in each slot, i.e. TPC bits, are not STTD encoded and the same bits are transmitted with equal power from the two antennas. The remaining four bits are STTD encoded.

For F-DPCH, the TPC bits are not STTD encoded and the same bits are transmitted with equal power from the two antennas.

For compressed mode through spreading factor reduction and for $N_{pilot} > 4$, symbol repetition shall be applied to the pilot bit patterns of table 14, in the same manner as described in 5.3.2. For slot formats 2B and 3B, i.e. compressed mode through spreading factor reduction and N_{pilot} = 4, the pilot bits transmitted on antenna 2 are STTD encoded, and thus the pilot bit pattern is as shown in the most right set of table 14.

Table 14: Pilot bit patterns of downlink DPCCH for antenna 2 using STTD

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

NOTE *1: The pilot bits precede the last two bits of the data2 field.
NOTE *2: This pattern is used except slot formats 2B and 3B.
NOTE *3: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *4: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE *5: This pattern is used for slot formats 2B and 3B.
NOTE: For slot format *n*B where *n* = 0, 1, 4, 5, 6, …, 15, the pilot bit pattern corresponding to $N_{pilot}/2$ is to be used and symbol repetition shall be applied.

5.3.2.2 Dedicated channel pilots with closed loop mode transmit diversity

In closed loop mode 1 orthogonal pilot patterns are used between the transmit antennas. Closed loop mode 1 shall not be used with DPCH slot formats for which Npilot=2. Pilot patterns defined in the table 12 will be used on antenna 1 and pilot patterns defined in the table 15 on antenna 2. This is illustrated in the figure 11 a which indicates the difference in the pilot patterns with different shading.

Table 15: Pilot bit patterns of downlink DPCCH for antenna 2 using closed loop mode 1

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

NOTE *1: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.
NOTE *2: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.
NOTE: For slot format *n*B where *n* = 0, 1, 4, 5, 6, …, 15, the pilot bit pattern corresponding to $N_{pilot}/2$ is to be used and symbol repetition shall be applied.

~~In closed loop mode 2 same pilot pattern is used on both of the antennas (see figure 11 b). The pattern to be used is according to the table 12.~~

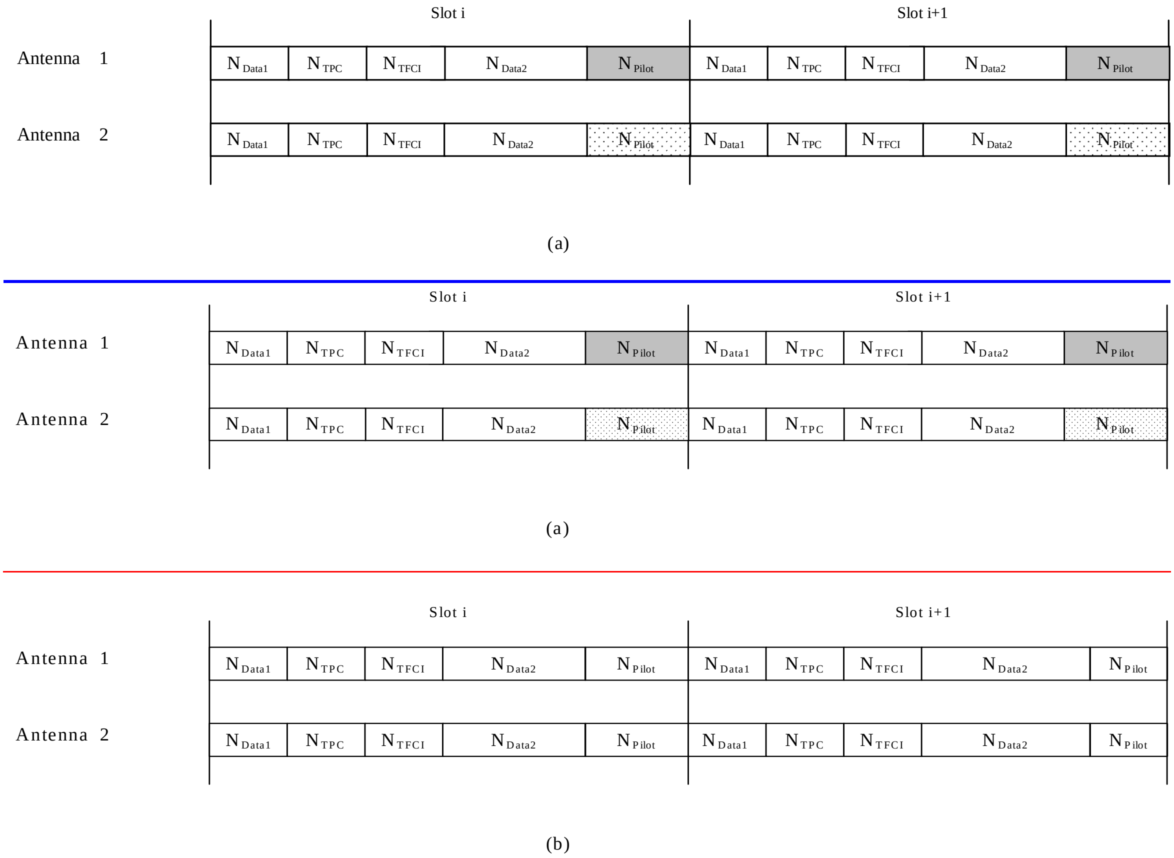

Figure 11: Slot structures for downlink dedicated physical channel diversity transmission. Structure (a) is used in closed loop mode 1.
~~Structure (b) is used in closed loop mode 2.~~
Different shading of the pilots indicate orthogonality of the patterns

5.3.2.3 DL-DPCCH for CPCH

The downlink DPCCH for CPCH is a special case of downlink dedicated physical channel of the slot format #0 in table 11. The spreading factor for the DL-DPCCH is 512. Figure 12 shows the frame structure of DL-DPCCH for CPCH.

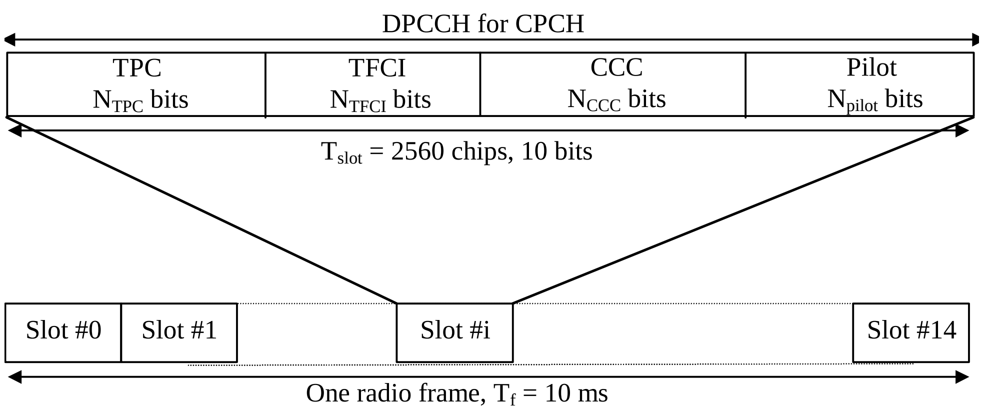

Figure 12: Frame structure for downlink DPCCH for CPCH

DL-DPCCH for CPCH consists of known pilot bits, TFCI, TPC commands and CPCH Control Commands (CCC). CPCH control commands are used to support CPCH signalling. There are two types of CPCH control commands: Layer 1 control command such as Start of Message Indicator, and higher layer control command such as Emergency Stop command. The exact number of bits of DL DPCCH fields (N_{pilot}, N_{TFCI}, N_{CCC} and N_{TPC}) is determined in Table 16. The pilot bit pattern for N_{pilot}=4 of table 12 is used for DPCCH for CPCH.

Table 16: DPCCH fields for CPCH message transmission

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Slot	DPCCH Bits/Slot				Transmitted slots per radio frame N_{Tr}
					N_{TPC}	N_{TFCI}	N_{CCC}	N_{Pilot}	
0	15	7.5	512	10	2	0	4	4	15

The DL DPCCH power control preamble for CPCH shall take the same slot format as afterwards, as given in Table 16. The length of the power control preamble is a higher-layer parameter, $L_{pc\text{-}preamble}$ (see [5], section 6.2), signalled by the network. When $L_{pc\text{-}preamble} > 0$, the pilot patterns from slot #($15 - L_{pc\text{-}preamble}$) to slot #14 of table 12 shall be used for the power control preamble pilot patterns.

CCC field in figure 12 is used for the transmission of CPCH control command. On CPCH control command transmission request from higher layer, a certain pattern is mapped onto CCC field, otherwise nothing is transmitted in CCC field. There is one to one mapping between the CPCH control command and the pattern. In case of Emergency Stop of CPCH transmission, [1111] pattern is mapped onto CCC field. The Emergency Stop command shall not be transmitted during the first $N_{Start\_Message}$ frames of DL DPCCH after Power Control preamble.

Start of Message Indicator shall be transmitted during the first $N_{Start\_Message}$ frames of DL DPCCH after Power Control preamble. [1010] pattern is mapped onto CCC field for Start of Message Indicator. The value of $N_{Start\_Message}$ shall be provided by higher layers.

5.3.2.4 E-DCH Relative Grant Channel

The E-DCH Relative Grant Channel (E-RGCH) is a fixed rate (SF=128) dedicated downlink physical channel carrying the uplink E-DCH relative grants. Figure 12A illustrates the structure of the E-RGCH. A relative grant is transmitted using 3, 12 or 15 consecutive slots and in each slot a sequence of 40 ternary values is transmitted. The 3 and 12 slot duration shall be used to control UEs for which the cell is the E-DCH serving cell and which E-DCH TTI is respectively 2 and 10 ms. The 15 slot duration shall be used to control UEs for which the cell is not the E-DCH serving cell.

The sequence $b_{i,0}$, $b_{i,1}$, …, $b_{i,39}$ transmitted in slot i in Figure 12A is given by $b_{i,j} = a\, C_{ss,40,m(i),j}$. In a serving E-DCH radio link set, the relative grant a is set to +1, 0, or -1 and in a non-serving E-DCH radio link set, the relative grant a is set to 0 or -1. The orthogonal signature sequences $C_{ss,40,\, m(i)}$ is given by Table 16A and the index m(i) in slot i is given by Table 16B. The E-RGCH signature sequence index l in Table 16B is given by higher layers.

In case STTD-based open loop transmit diversity is applied for E-RGCH, STTD encoding according to subclause 5.3.1.1.1 is applied to the sequence $b_{i,j}$.

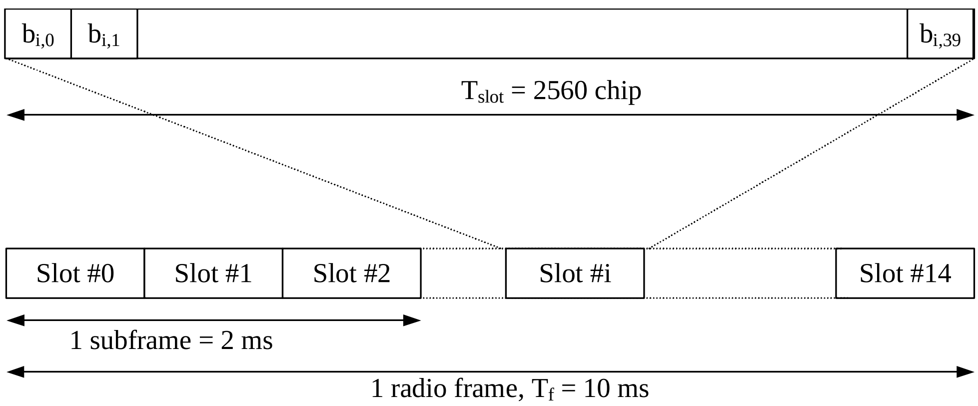

Figure 12A: E-RGCH and E-HICH structure

Table 16A: E-RGCH and E-HICH signature sequences

$C_{ss,40,0}$	-1	-1	-1	1	-1	1	-1	-1	1	1	-1	-1	1	-1	1	1	-1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	-1	1	-1	-1	1	1	1	1	1	-1	-1	-1
$C_{ss,40,1}$	-1	1	1	-1	-1	1	1	1	1	-1	1	-1	1	1	-1	-1	-1	-1	1	1	1	-1	-1	-1	-1	1	-1	-1	-1	-1	-1	-1	-1	1	1	-1	1	1	-1	-1
$C_{ss,40,2}$	-1	-1	-1	1	-1	1	1	1	1	-1	-1	-1	1	-1	-1	1	1	-1	-1	1	1	-1	1	1	1	-1	-1	1	1	1	-1	1	-1	1	-1	-1	-1	-1	-1	-1
$C_{ss,40,3}$	1	-1	-1	-1	-1	-1	-1	1	1	1	-1	1	-1	1	-1	1	-1	-1	1	1	-1	1	-1	-1	1	1	-1	1	-1	-1	1	1	-1	1	1	-1	-1	-1	-1	-1
$C_{ss,40,4}$	1	1	1	-1	-1	1	-1	1	1	-1	1	1	1	-1	1	1	1	1	1	1	-1	1	1	1	-1	-1	-1	1	1	-1	1	-1	1	1	1	1	-1	1	-1	-1
$C_{ss,40,5}$	-1	1	-1	-1	1	1	1	-1	1	1	-1	1	1	1	-1	1	1	1	-1	-1	1	-1	-1	1	-1	1	-1	1	-1	-1	1	-1	1	1	-1	-1	-1	1	1	-1
$C_{ss,40,6}$	1	1	-1	-1	-1	1	1	-1	1	1	-1	-1	1	-1	-1	-1	-1	1	1	-1	1	1	1	-1	1	-1	1	-1	1	-1	-1	1	1	1	1	-1	-1	1	-1	1
$C_{ss,40,7}$	-1	1	-1	1	1	1	-1	-1	1	-1	-1	1	1	1	1	-1	-1	-1	1	-1	-1	-1	1	-1	1	1	-1	-1	1	1	1	1	-1	1	1	1	-1	1	1	-1
$C_{ss,40,8}$	1	1	-1	1	1	-1	1	1	1	1	-1	-1	-1	-1	1	-1	1	-1	1	1	1	1	-1	1	-1	-1	-1	-1	-1	1	-1	-1	-1	1	1	1	-1	1	1	-1
$C_{ss,40,9}$	-1	1	-1	-1	-1	-1	1	-1	1	-1	-1	1	-1	-1	1	1	1	-1	1	-1	1	-1	-1	1	1	-1	1	1	-1	-1	1	1	-1	1	1	1	1	1	-1	1
$C_{ss,40,10}$	-1	1	1	-1	1	1	-1	1	1	1	1	-1	1	-1	1	1	-1	-1	-1	1	-1	-1	-1	-1	1	-1	1	1	-1	-1	-1	1	-1	1	-1	1	-1	1	1	1
$C_{ss,40,11}$	-1	1	-1	-1	-1	-1	-1	1	1	1	-1	-1	-1	1	1	-1	1	1	-1	1	-1	-1	1	1	1	1	-1	-1	1	-1	-1	1	1	1	-1	1	1	1	-1	-1
$C_{ss,40,12}$	-1	-1	-1	-1	1	-1	1	1	1	-1	-1	-1	-1	1	1	1	-1	1	1	1	1	-1	1	-1	-1	1	1	1	1	-1	-1	-1	1	1	1	1	-1	-1	1	1
$C_{ss,40,13}$	1	1	1	1	-1	-1	1	-1	1	-1	1	-1	-1	1	1	1	-1	1	-1	-1	1	1	-1	-1	1	1	-1	1	-1	1	-1	1	1	1	-1	1	-1	1	-1	-1
$C_{ss,40,14}$	-1	1	1	1	-1	-1	-1	-1	1	1	1	-1	-1	1	-1	1	1	-1	1	-1	-1	-1	1	1	-1	1	1	1	1	1	-1	-1	-1	1	1	-1	-1	1	-1	1
$C_{ss,40,15}$	-1	-1	1	1	-1	1	1	1	1	1	1	1	1	1	1	-1	1	1	1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	1	1	1	1	1	-1	-1	-1	1
$C_{ss,40,16}$	1	-1	-1	-1	-1	1	-1	-1	1	-1	-1	-1	1	1	1	-1	1	-1	-1	-1	-1	1	-1	1	-1	1	1	-1	-1	-1	-1	-1	-1	1	-1	1	-1	-1	-1	1
$C_{ss,40,17}$	1	-1	1	-1	1	1	1	-1	1	1	1	-1	1	1	1	1	1	-1	1	-1	1	1	1	1	1	1	-1	1	1	-1	-1	1	-1	1	1	1	1	-1	1	-1
$C_{ss,40,18}$	1	1	-1	1	-1	1	1	1	1	1	-1	1	1	1	1	1	-1	-1	-1	1	1	1	1	-1	-1	1	1	1	1	1	1	-1	-1	1	-1	1	1	1	-1	1
$C_{ss,40,19}$	1	1	-1	1	1	1	-1	1	1	-1	-1	-1	1	1	-1	1	1	1	1	1	-1	1	-1	1	1	1	1	1	-1	1	-1	1	1	1	1	-1	1	1	1	1
$C_{ss,40,20}$	1	1	1	-1	1	1	-1	1	1	1	-1	1	-1	-1	-1	1	-1	-1	1	-1	1	-1	-1	1	1	1	1	-1	1	1	-1	-1	1	1	-1	1	-1	-1	-1	-1
$C_{ss,40,21}$	-1	1	1	-1	-1	-1	-1	1	1	1	-1	-1	1	-1	-1	1	1	-1	-1	-1	1	1	1	-1	-1	1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	1	1
$C_{ss,40,22}$	-1	-1	-1	1	-1	-1	-1	1	1	1	1	-1	1	1	-1	-1	-1	-1	1	-1	1	1	-1	1	1	-1	-1	1	1	-1	1	-1	1	1	-1	1	-1	1	1	1
$C_{ss,40,23}$	1	-1	-1	-1	-1	1	1	1	1	-1	1	1	-1	-1	-1	-1	1	-1	-1	-1	-1	-1	1	-1	1	1	-1	1	-1	1	-1	-1	1	1	1	1	-1	1	1	1
$C_{ss,40,24}$	-1	-1	-1	1	1	1	-1	-1	1	-1	1	-1	-1	-1	-1	1	1	-1	1	1	1	1	1	-1	1	1	1	-1	-1	-1	1	-1	1	1	-1	1	1	1	-1	-1
$C_{ss,40,25}$	-1	1	-1	-1	1	-1	-1	-1	1	-1	1	1	1	-1	-1	-1	-1	1	1	1	1	1	1	1	-1	1	-1	1	-1	1	-1	1	-1	1	-1	1	-1	-1	-1	1
$C_{ss,40,26}$	-1	-1	1	1	1	1	1	1	1	1	-1	1	-1	-1	1	-1	-1	-1	1	-1	-1	1	1	1	-1	1	-1	1	-1	-1	-1	1	1	1	-1	-1	1	1	-1	1
$C_{ss,40,27}$	1	-1	1	-1	-1	1	-1	1	1	-1	-1	-1	-1	1	-1	-1	-1	1	1	-1	1	-1	1	1	-1	-1	1	1	-1	1	1	1	-1	1	-1	1	1	1	1	-1
$C_{ss,40,28}$	1	1	-1	1	1	1	-1	1	1	-1	1	-1	-1	1	1	1	-1	-1	-1	-1	1	-1	1	1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	-1	-1	-1	-1	1
$C_{ss,40,29}$	-1	1	-1	-1	-1	1	-1	-1	1	1	1	1	-1	1	1	-1	-1	-1	-1	1	1	1	1	1	1	-1	1	1	-1	1	-1	-1	1	1	1	-1	1	-1	1	-1
$C_{ss,40,30}$	-1	1	1	-1	1	-1	1	1	1	-1	-1	-1	1	1	1	-1	1	-1	1	-1	-1	1	1	-1	1	-1	1	1	-1	1	1	-1	1	1	-1	-1	-1	-1	-1	-1
$C_{ss,40,31}$	-1	1	-1	-1	-1	1	1	1	1	-1	1	-1	-1	-1	1	1	-1	1	1	-1	-1	1	-1	1	1	1	-1	-1	1	1	1	-1	-1	1	-1	-1	1	-1	1	1
$C_{ss,40,32}$	1	1	1	1	-1	-1	1	-1	1	-1	-1	1	1	1	-1	1	-1	-1	1	1	-1	-1	1	1	1	-1	-1	-1	-1	-1	-1	-1	1	1	-1	1	1	-1	1	1
$C_{ss,40,33}$	-1	-1	-1	-1	1	-1	1	1	1	-1	1	1	1	1	-1	1	-1	-1	-1	-1	-1	1	-1	1	-1	-1	1	-1	1	1	-1	1	1	1	1	1	1	1	-1	-1
$C_{ss,40,34}$	1	-1	-1	-1	1	-1	-1	1	1	1	1	1	1	1	1	1	1	1	1	-1	1	-1	1	-1	1	-1	-1	-1	-1	1	-1	-1	-1	1	-1	-1	1	1	-1	1
$C_{ss,40,35}$	-1	-1	1	1	-1	-1	-1	1	1	-1	-1	1	1	-1	1	1	-1	1	-1	-1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	1	1	-1	-1	1	1	-1
$C_{ss,40,36}$	-1	1	1	1	1	1	-1	1	1	-1	-1	1	-1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	1
$C_{ss,40,37}$	1	-1	1	-1	1	-1	-1	-1	1	-1	-1	-1	1	-1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	-1	1	1	1	1	-1	1	1	1	-1	1	1	-1	1
$C_{ss,40,38}$	-1	-1	1	-1	1	1	1	-1	1	1	-1	-1	-1	1	-1	1	-1	1	-1	1	-1	1	1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	-1	1	-1	1
$C_{ss,40,39}$	-1	-1	1	-1	-1	1	-1	-1	1	-1	-1	1	-1	1	1	1	1	-1	1	1	1	1	-1	-1	-1	-1	-1	-1	1	1	-1	1	1	1	-1	-1	-1	1	1	1

The bits are transmitted in order from left to right, i.e., column 2 corresponds to index j=0 and the rightmost column corresponds to index j=39.

Table 16B: E-HICH and E-RGCH signature hopping pattern

Sequence index l	Row index $m(i)$ for slot i		
	$i \bmod 3 = 0$	$i \bmod 3 = 1$	$i \bmod 3 = 2$
1	1	18	18
2	2	8	33
3	3	16	32
4	4	13	10
5	5	3	25
6	6	12	16
7	7	6	1
8	8	19	39
9	9	34	14
10	10	4	5
11	11	17	34
12	12	29	30

13	13	11	23
14	14	24	22
15	15	28	21
16	16	35	19
17	17	21	36
18	18	37	2
19	19	23	11
20	20	39	9
21	21	22	3
22	22	9	15
23	23	36	20
24	24	0	26
25	25	5	24
26	26	7	8
27	27	27	17
28	28	32	29
29	29	15	38
30	30	30	12
31	31	26	7
32	32	20	37
33	33	1	35
34	34	14	0
35	35	33	31
36	36	25	28
37	37	10	27
38	38	31	4
39	39	38	6

5.3.2.5 E-DCH Hybrid ARQ Indicator Channel

The E-DCH Hybrid ARQ Indicator Channel (E-HICH) is a fixed rate (SF=128) dedicated downlink physical channel carrying the uplink E-DCH hybrid ARQ acknowledgement indicator. Figure 12A illustrates the structure of the E-HICH. A hybrid ARQ acknowledgement indicator is transmitted using 3 or 12 consecutive slots and in each slot a sequence of 40 binary values is transmitted. The 3 and 12 slot duration shall be used for UEs which E-DCH TTI is set to respectively 2 ms and 10 ms.

The sequence $b_{i,0}$, $b_{i,1}$, …, $b_{i,39}$ transmitted in slot i in Figure 12A is given by $b_{i,j} = a\ C_{ss,40,\ m(i),j}$. In a radio link set containing the serving E-DCH radio link set, the hybrid ARQ acknowledgement indicator a is set to +1 or –1, and in a radio link set not containing the serving E-DCH radio link set the hybrid ARQ indicator a is set to +1 or 0. The orthogonal signature sequences $C_{ss,40,m(i)}$ is given by Table 16A and the index m(i) in slot i is given by Table 16B. The E-HICH signature sequence index l is given by higher layers.

In case STTD-based open loop transmit diversity is applied for E-HICH, STTD encoding according to subclause 5.3.1.1.1 is applied to the sequence $b_{i,j}$

5.3.2.6 Fractional Dedicated Physical Channel (F-DPCH)

The F-DPCH carries control information generated at layer 1 (TPC commands). It is a special case of downlink DPCCH.

Figure 12B shows the frame structure of the F-DPCH. Each frame of length 10ms is split into 15 slots, each of length T_{slot} = 2560 chips, corresponding to one power-control period.

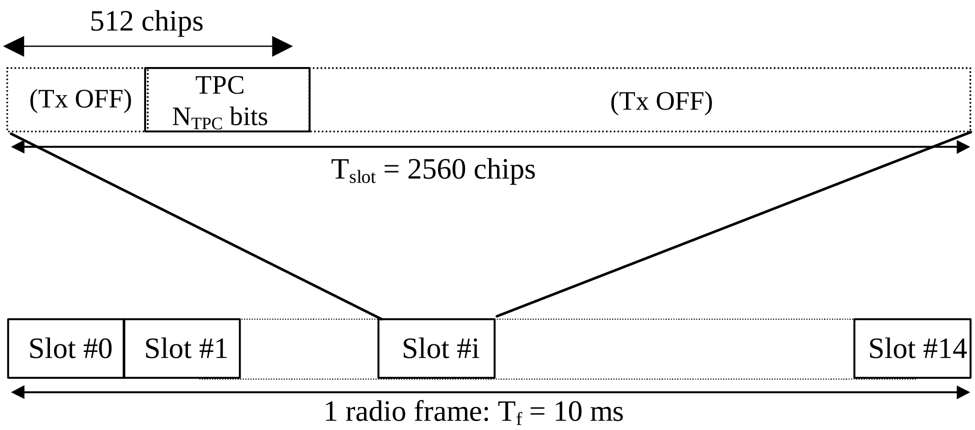

Figure 12B: Frame structure for F-DPCH

The exact number of bits of the F-DPCH fields (N_{TPC}) is described in table 16C.

Table 16C: F-DPCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Slot	F-DPCH Bits/Slot
					N_{TPC}
0	3	1.5	256	2	2

In compressed frames, F-DPCH is not transmitted in downlink transmission gaps given by transmission gap pattern sequences signalled by higher layers.

The relationship between the TPC symbol and the transmitter power control command is according to table 13.

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 sequence. Figure 13 shows the frame structure of the CPICH.

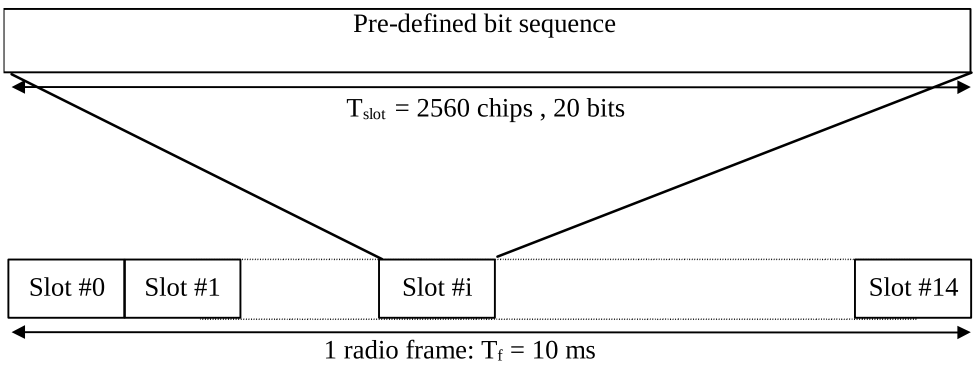

Figure 13: Frame structure for Common Pilot Channel

In case transmit diversity (open or closed loop) is used on any downlink channel in the cell, the CPICH shall be transmitted from both antennas using the same channelization and scrambling code. In this case, the pre-defined bit sequence of the CPICH is different for Antenna 1 and Antenna 2, see figure 14. In case of no transmit diversity, the bit sequence of Antenna 1 in figure 14 is used.

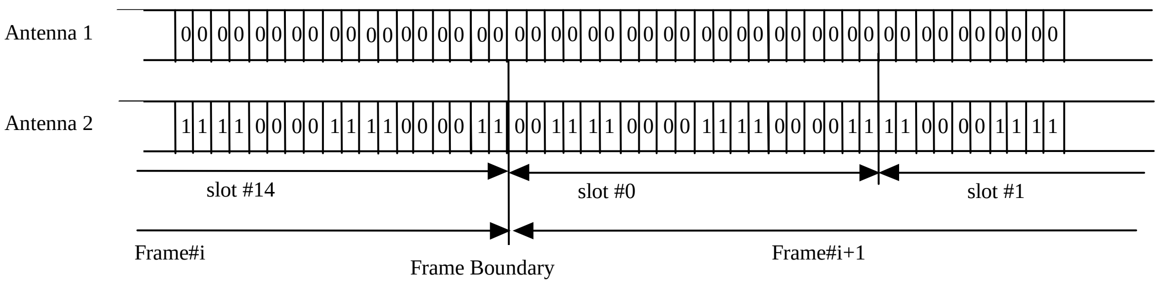

Figure 14: Modulation pattern for Common Pilot Channel

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 (P-CPICH)

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

- The same channelization code is always used for the P-CPICH, see [4];
- The P-CPICH is scrambled by the primary scrambling code, see [4];
- There is one and only one P-CPICH per cell;
- The P-CPICH is broadcast over the entire cell.

The Primary CPICH is a phase reference for the following downlink channels: SCH, Primary CCPCH, AICH, PICH AP-AICH, CD/CA-ICH, CSICH, DL-DPCCH for CPCH and the S-CCPCH. By default, the Primary CPICH is also a phase reference for downlink DPCH or F-DPCH and any associated PDSCH, HS-PDSCH and HS-SCCH. The UE is informed by higher layer signalling if the P-CPICH is not a phase reference for a downlink DPCH or F-DPCH and any associated PDSCH, HS-PDSCH and HS-SCCH.

5.3.3.1.2 Secondary Common Pilot Channel (S-CPICH)

A Secondary Common Pilot Channel (S-CPICH) has the following characteristics:

- An arbitrary channelization code of SF=256 is used for the S-CPICH, see [4];
- A S-CPICH is scrambled by either the primary or a secondary scrambling code, see [4];
- There may be zero, one, or several S-CPICH per cell;
- A S-CPICH may be transmitted over the entire cell or only over a part of the cell;

A Secondary CPICH may be a phase reference for a downlink DPCH or F-DPCH. If this is the case, the UE is informed about this by higher-layer signalling.

The Secondary CPICH can be a phase reference for a downlink physical channel using open loop or closed loop TX diversity, instead of the Primary CPICH being a phase reference.

Note that it is possible that neither the P-CPICH nor any S-CPICH is a phase reference for a downlink DPCH.

5.3.3.2 Downlink phase reference

Table 17 summarizes the possible phase references usable on different downlink physical channel types.

Table 17: Application of phase references on downlink physical channel types "X" – can be applied, "–" – not applied

Physical channel type	Primary-CPICH	Secondary-CPICH	Dedicated pilot
P-CCPCH	X	–	–
SCH	X	–	–
S-CCPCH	X	–	–
DPCH	X	X	X
F-DPCH	X	X	–
PICH	X	–	–
MICH	X	–	–
PDSCH*	X	X	X
HS-PDSCH*	X	X	X
HS-SCCH*	X	X	X
E-AGCH*	X	X	X
E-RGCH*	X	X	X
E-HICH*	X	X	X
AICH	X	–	–
CSICH	X	–	–
DL-DPCCH for CPCH	X	–	–

Note *: The same phase reference as with the associated DPCH or F-DPCH shall be used. The support for dedicated pilots as phase reference for HS-PDSCH, HS-SCCH, E-AGCH, E-RGCH and E-HICH is optional for the UE.

Furthermore, during a PDSCH frame, and within the slot prior to that PDSCH frame, the phase reference on the associated DPCH shall not change. During a DPCH or F-DPCH frame overlapping with any part of an associated HS-DSCH or HS-SCCH subframe, the phase reference on this DPCH or F-DPCH shall not change.

5.3.3.3 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 transport channel.

Figure 15 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, Primary SCH and Secondary SCH are transmitted during this period (see subclause 5.3.3.5).

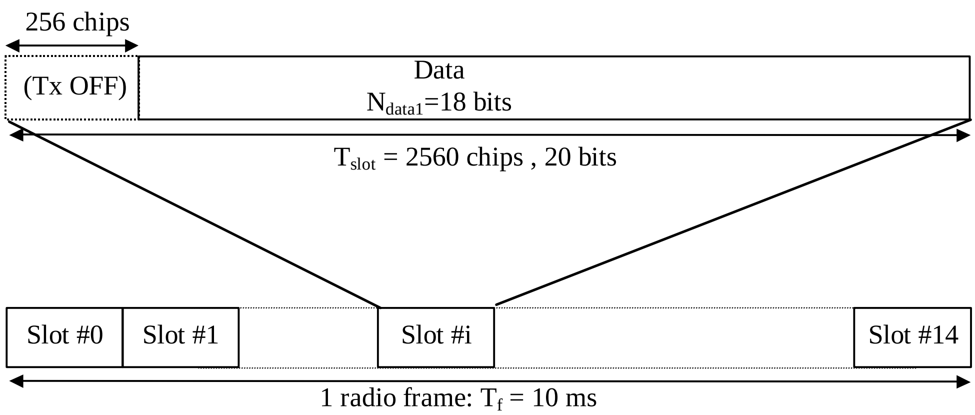

Figure 15: Frame structure for Primary Common Control Physical Channel

5.3.3.3.1 Primary CCPCH structure with STTD encoding

In case the diversity antenna is present in UTRAN and the P-CCPCH is to be transmitted using open loop transmit diversity, the data bits of the P-CCPCH are STTD encoded as given in subclause 5.3.1.1.1. The last two data bits in even numbered slots are STTD encoded together with the first two data bits in the following slot, except for slot #14 where the two last data bits are not STTD encoded and instead transmitted with equal power from both the antennas, see figure 16. Higher layers signal whether STTD encoding is used for the P-CCPCH or not. In addition the presence/absence of STTD encoding on P-CCPCH is indicated by modulating the SCH, see 5.3.3.4. During power on and hand over between cells the UE can determine the presence of STTD encoding on the P-CCPCH, by either receiving the higher layer message, by demodulating the SCH channel, or by a combination of the above two schemes.

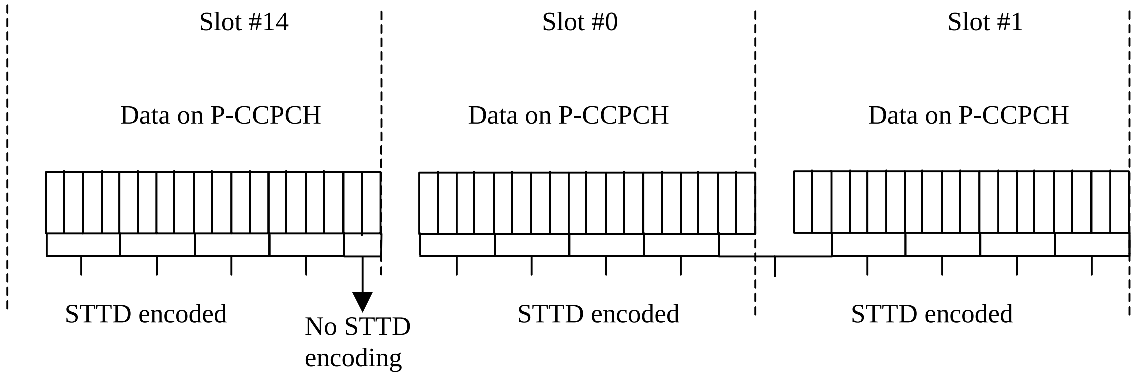

Figure 16: STTD encoding for the data bits of the P-CCPCH

5.3.3.4 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 UTRAN 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 for the Secondary CCPCH is the same as for the downlink DPCH, see subclause 5.3.2. The frame structure of the Secondary CCPCH is shown in figure 17.

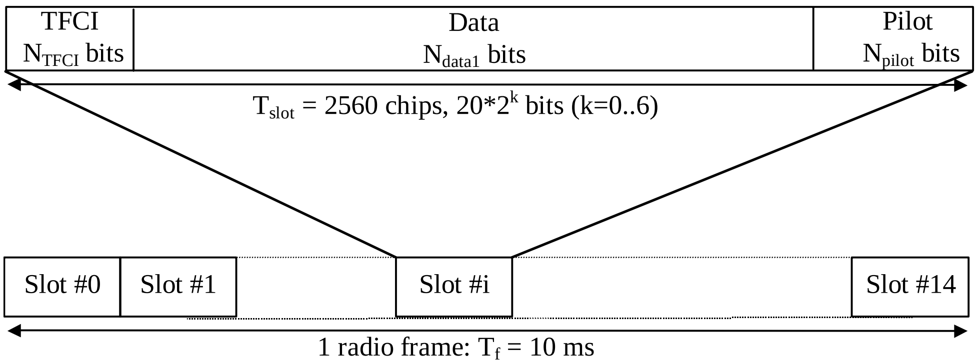

Figure 17: Frame structure for Secondary Common Control Physical Channel

The parameter k in figure 17 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 18. The channel bit and symbol rates given in Table 18 are the rates immediately before spreading. The slot formats with pilot bits are not supported in this release. The pilot patterns are given in Table 19.

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 18: Secondary CCPCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{data1}	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	1200	80	72	0	8*
9	120	60	64	1200	80	64	8	8*
10	240	120	32	2400	160	152	0	8*
11	240	120	32	2400	160	144	8	8*
12	480	240	16	4800	320	312	0	8*
13	480	240	16	4800	320	296	16	8*
14	960	480	8	9600	640	632	0	8*
15	960	480	8	9600	640	616	16	8*
16	1920	960	4	19200	1280	1272	0	8*
17	1920	960	4	19200	1280	1256	16	8*

* If TFCI bits are not used, then DTX shall be used in TFCI field.

The pilot symbol pattern described in Table 19 is not supported in this release. 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 19, the transmission order is from left to right. (Each two-bit pair represents an I/Q pair of QPSK modulation.)

Table 19: 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 [3].

5.3.3.4.1 Secondary CCPCH structure with STTD encoding

In case the diversity antenna is present in UTRAN and the S-CCPCH is to be transmitted using open loop transmit diversity, the data and TFCI bits of the S-CCPCH are STTD encoded as given in subclause 5.3.1.1.1. The pilot symbol pattern for antenna 2 for the S-CCPCH given in Table 20 is not supported in this release.

Table 20: Pilot symbol pattern for antenna 2 when STTD encoding is used on the S-CCPCH

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

5.3.3.5 Synchronisation Channel (SCH)

The Synchronisation Channel (SCH) is a downlink signal used for cell search. The SCH consists of two sub channels, the Primary and Secondary SCH. The 10 ms radio frames of the Primary and Secondary SCH are divided into 15 slots, each of length 2560 chips. Figure 18 illustrates the structure of the SCH radio frame.

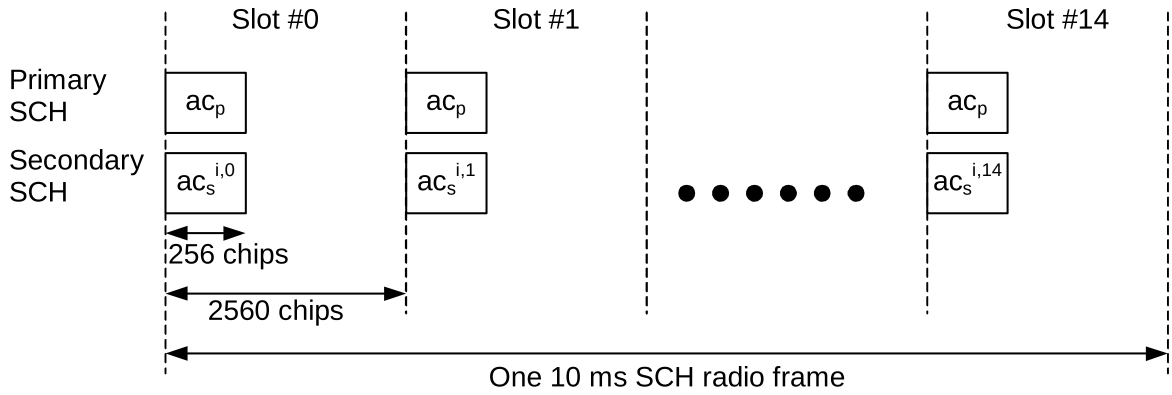

Figure 18: Structure of Synchronisation Channel (SCH)

The Primary SCH consists of a modulated code of length 256 chips, the Primary Synchronisation Code (PSC) denoted c_p in figure 18, transmitted once every slot. The PSC is the same for every cell in the system.

The Secondary SCH consists of repeatedly transmitting a length 15 sequence of modulated codes of length 256 chips, the Secondary Synchronisation Codes (SSC), transmitted in parallel with the Primary SCH. The SSC is denoted $c_s^{i,k}$ in figure 18, where i = 0, 1, …, 63 is the number of the scrambling code group, and k = 0, 1, …, 14 is the slot number. Each SSC is chosen from a set of 16 different codes of length 256. This sequence on the Secondary SCH indicates which of the code groups the cell's downlink scrambling code belongs to.

The primary and secondary synchronization codes are modulated by the symbol a shown in figure 18, which indicates the presence/ absence of STTD encoding on the P-CCPCH and is given by the following table:

P-CCPCH STTD encoded	a = +1
P-CCPCH not STTD encoded	a = -1

5.3.3.5.1 SCH transmitted by TSTD

Figure 19 illustrates the structure of the SCH transmitted by the TSTD scheme. In even numbered slots both PSC and SSC are transmitted on antenna 1, and in odd numbered slots both PSC and SSC are transmitted on antenna 2.

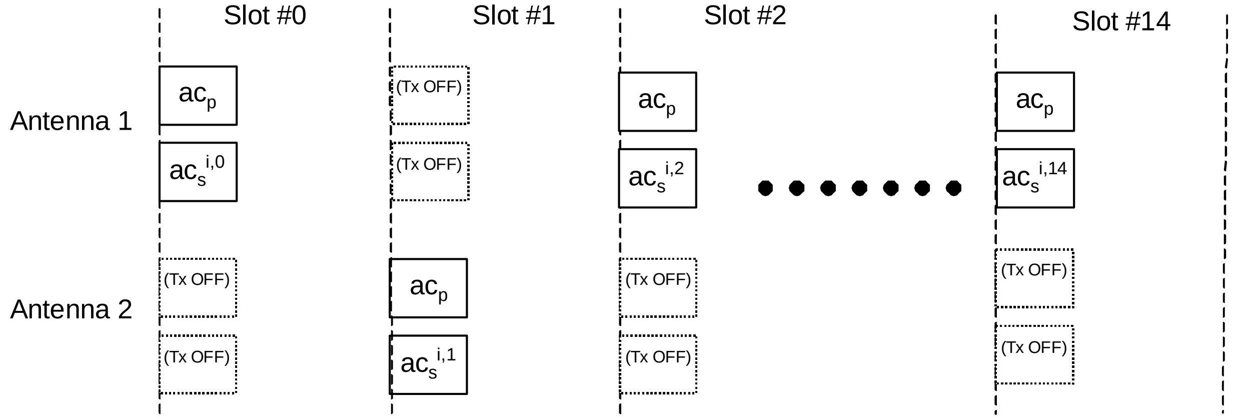

Figure 19: Structure of SCH transmitted by TSTD scheme

5.3.3.6 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 channelisation code below or at a PDSCH root channelisation code. A PDSCH is allocated on a radio frame basis to a single UE. Within one radio frame, UTRAN may allocate different PDSCHs under the same PDSCH root channelisation 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 are operated with radio frame synchronisation.

The notion of PDSCH root channelisation code is defined in [4].

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 20.

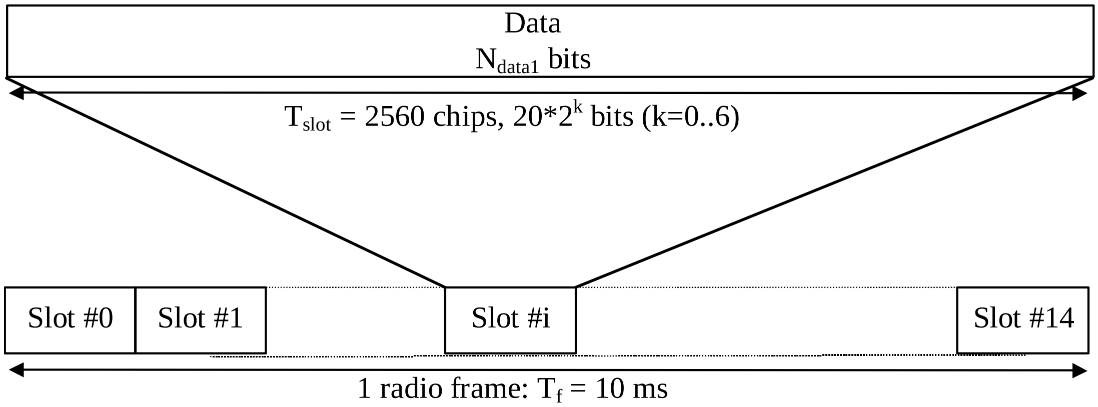

Figure 20: Frame structure for the PDSCH

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, the TFCI field of the associated DPCH shall be used.

The TFCI informs the UE of the instantaneous transport format parameters related to the PDSCH as well as the channelisation code of the PDSCH.

The channel bit rates and symbol rates for PDSCH are given in Table 21.

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

Table 21: PDSCH fields

Slot format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{data1}
0	30	15	256	300	20	20
1	60	30	128	600	40	40
2	120	60	64	1200	80	80
3	240	120	32	2400	160	160
4	480	240	16	4800	320	320
5	960	480	8	9600	640	640
6	1920	960	4	19200	1280	1280

When open loop transmit diversity is employed for the PDSCH, STTD encoding is used on the data bits as described in subclause 5.3.1.1.1.

When closed loop transmit diversity is employed on the associated DPCH, it shall be used also on the PDSCH as described in [5].

5.3.3.7 Acquisition Indicator Channel (AICH)

The Acquisition Indicator channel (AICH) is a fixed rate (SF=256) physical channel used to carry Acquisition Indicators (AI). Acquisition Indicator AI_s corresponds to signature s on the PRACH.

Figure 21 illustrates the structure of the AICH. The AICH consists of a repeated sequence of 15 consecutive *access slots* (AS), each of length 5120 chips. Each access slot consists of two parts, an *Acquisition-Indicator* (AI) part consisting of 32 real-valued signals $a_0, \ldots, a_{31}$ and a part of duration 1024 chips with no transmission that is not formally part of the AICH. The part of the slot with no transmission is reserved for possible use by CSICH or possible future use by other physical channels.

The spreading factor (SF) used for channelisation of the AICH is 256.

The phase reference for the AICH is the Primary CPICH.

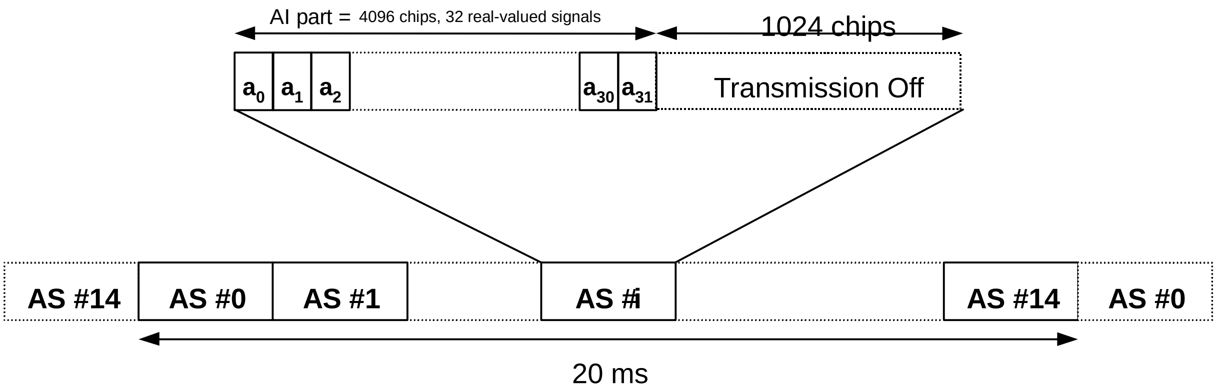

Figure 21: Structure of Acquisition Indicator Channel (AICH)

The real-valued signals $a_0, a_1, \ldots, a_{31}$ in figure 21 are given by

$$a_j = \sum_{s=0}^{15} AI_s b_{s,j}$$

where AI_s, taking the values +1, -1, and 0, is the acquisition indicator corresponding to signature s and the sequence $b_{s,0}$, …, $b_{s,31}$ is given by Table 22. If the signature s is not a member of the set of available signatures for all the Access Service Class (ASC) for the corresponding PRACH (cf [5]), then AI_s shall be set to 0.

The use of acquisition indicators is described in [5]. If an Acquisition Indicator is set to +1, it represents a positive acknowledgement. If an Acquisition Indicator is set to -1, it represents a negative acknowledgement.

The real-valued signals, a_j, are spread and modulated in the same fashion as bits when represented in { +1, -1 } form.

In case STTD-based open-loop transmit diversity is applied to AICH, STTD encoding according to subclause 5.3.1.1.1 is applied to each sequence $b_{s,0}$, $b_{s,1}$, ..., $b_{s,31}$ separately before the sequences are combined into AICH signals a_0, …, a_{31}.

Table 22: AICH signature patterns

s	$b_{s,0}$, $b_{s,1}$…, $b_{s,31}$																														
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1
2	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1
3	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1
4	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1
5	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1
6	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1
7	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
9	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1
10	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1
11	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1
12	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	1	1	1
13	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1
14	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	-1	-1	-1
15	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1

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

The Access Preamble Acquisition Indicator channel (AP-AICH) is a fixed rate (SF=256) physical channel used to carry AP acquisition indicators (API) of CPCH. AP acquisition indicator API_s corresponds to AP signature *s* transmitted by UE.

AP-AICH and AICH may use the same or different channelisation codes. The phase reference for the AP-AICH is the Primary CPICH. Figure 22 illustrates the structure of AP-AICH. The AP-AICH has a part of duration 4096 chips where the AP acquisition indicator (API) is transmitted, followed by a part of duration 1024chips with no transmission that is not formally part of the AP-AICH. The part of the slot with no transmission is reserved for possible use by CSICH or possible future use by other physical channels.

The spreading factor (SF) used for channelisation of the AP-AICH is 256.

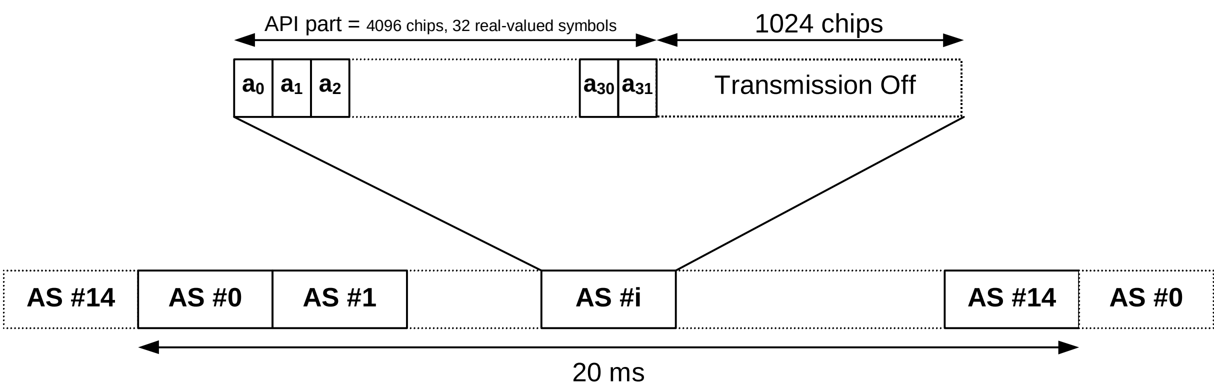

Figure 22: Structure of AP Acquisition Indicator Channel (AP-AICH)

The real-valued symbols $a_0, a_1, \ldots, a_{31}$ in figure 22 are given by

$$a_j = \sum_{s=0}^{15} API_s \times b_{s,j}$$

where API_s, taking the values +1, -1, and 0, is the AP acquisition indicator corresponding to Access Preamble signature s transmitted by UE and the sequence $b_{s,0}, \ldots, b_{s,31}$ is given in Table 22. If the signature s is not a member of the set of UL Access Preamble signatures for the corresponding PCPCH (cf [5] then API_s shall be set to 0.

The use of acquisition indicators is described in [5]. If an AP acquisition indicator is set to +1, it represents a positive acknowledgement. If an AP acquisition indicator is set to -1, it represents a negative acknowledgement.

The real-valued symbols, a_j, are spread and modulated in the same fashion as bits when represented in { +1, -1 } form.

In case STTD-based open-loop transmit diversity is applied to AP-AICH, STTD encoding according to subclause 5.3.1.1.1 is applied to each sequence $b_{s,0}, b_{s,1}, \ldots, b_{s,31}$ separately before the sequences are combined into AP-AICH symbols $a_0, \ldots, a_{31}$.

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

The Collision Detection Channel Assignment Indicator channel (CD/CA-ICH) is a fixed rate (SF=256) physical channel used to carry CD Indicator (CDI) only if the CA is not active, or CD Indicator/CA Indicator (CDI/CAI) at the same time if the CA is active. The structure of CD/CA-ICH is shown in figure 23. CD/CA-ICH and AP-AICH may use the same or different channelisation codes.

The CD/CA-ICH has a part of duration of 4096chips where the CDI/CAI is transmitted, followed by a part of duration 1024chips with no transmission that is not formally part of the CD/CA-ICH. The part of the slot with no transmission is reserved for possible use by CSICH or possible future use by other physical channels.

The spreading factor (SF) used for channelisation of the CD/CA-ICH is 256.

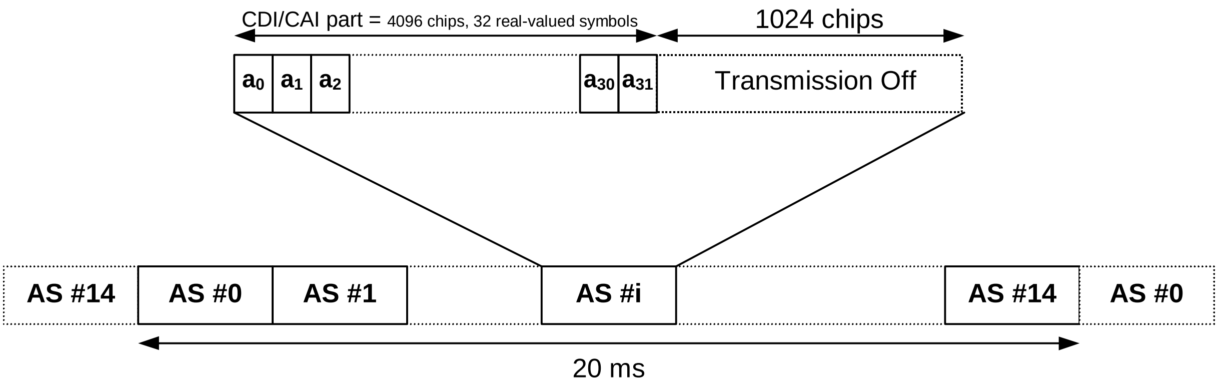

Figure 23: Structure of CD/CA Indicator Channel (CD/CA-ICH)

In case STTD-based open-loop transmit diversity is applied to CD/CA-ICH, STTD encoding according to subclause 5.3.1.1.1 is applied to each sequence $b_{s,0}, b_{s,1}, \ldots, b_{s,31}$ separately before the sequences are combined into CD/CA-ICH symbols $a_0, \ldots, a_{31}$.

In case CA is not active, the real-valued symbols $a_0, a_1, \ldots, a_{31}$ in figure 23 are given by

$$a_j = \sum_{s=0}^{15} CDI_s \times b_{s,j}$$

where CDI_s, taking the values +1, and 0, is the CD indicator corresponding to CD preamble signature *s* transmitted by UE and the sequence $b_{s,0}, \ldots, b_{s,31}$ is given in Table 22. If the signature *s* is not a member of the set of CD Preamble signatures for the corresponding PCPCH (cf [5]), then CDI_s shall be set to 0.

The real-valued symbols, a_j, are spread and modulated in the same fashion as bits when represented in { +1, -1 } form.

In case CA is active, the real-valued symbols a_0, a_1, …, a_{31} in figure 23 are given by

$$a_j = \sum_{i=0}^{15} \mathrm{CDI}_i \times b_{s_i,j} + \sum_{k=0}^{15} \mathrm{CAI}_k \times b_{s_k,j}$$

where the subscript s_i, s_k depend on the indexes i, k according to Table 23, respectively, and indicate the signature number s in Table 22. The sequence $b_{s,0}$, …, $b_{s,31}$ is given in Table 22. CDI_i, taking the values +1/0 or -1/0, is the CD indicator corresponding to the CD preamble i transmitted by the UE, and CAI_k, taking the values +1/0 or -1/0, is the CA indicator corresponding to the assigned channel index k as given in Table 23. If the signature s_i is not a member of the set of CD Preamble signatures for the corresponding PCPCH (cf [5]), then CDI_s shall be set to 0. Similarly, if the signature s_k is not a member of the set of CD Preamble signatures for the corresponding PCPCH (cf [5]), then CDI_s shall be set to 0.

Table 23. Generation of CDI_i/CAI_k

UE transmitted CD Preamble i	CDI_i	signature s_i	Channel Assignment Index k	CAI_k	signature s_k
0	+1/0	1	0	+1/0	0
1	-1/0		1	-1/0	
2	+1/0	3	2	+1/0	8
3	-1/0		3	-1/0	
4	+1/0	5	4	+1/0	4
5	-1/0		5	-1/0	
6	+1/0	7	6	+1/0	12
7	-1/0		7	-1/0	
8	+1/0	9	8	+1/0	2
9	-1/0		9	-1/0	
10	+1/0	11	10	+1/0	10
11	-1/0		11	-1/0	
12	+1/0	13	12	+1/0	6
13	-1/0		13	-1/0	
14	+1/0	15	14	+1/0	14
15	-1/0		15	-1/0	

5.3.3.10 Paging Indicator Channel (PICH)

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

Figure 24 illustrates the frame structure of the PICH. One PICH radio frame of length 10 ms consists of 300 bits (b_0, b_1, …, b_{299}). Of these, 288 bits (b_0, b_1, …, b_{287}) are used to carry paging indicators. The remaining 12 bits are not formally part of the PICH and shall not be transmitted (DTX). The part of the frame with no transmission is reserved for possible future use.

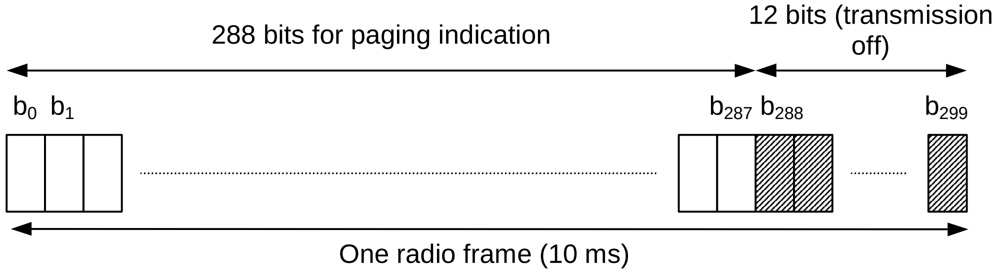

Figure 24: Structure of Paging Indicator Channel (PICH)

In each PICH frame, Np paging indicators $\{P_0, \ldots, P_{Np-1}\}$ are transmitted, where Np=18, 36, 72, or 144.

The PI calculated by higher layers for use for a certain UE, is associated to the paging indicator P_q, where q is computed as a function of the PI computed by higher layers, the SFN of the P-CCPCH radio frame during which the start of the PICH radio frame occurs, and the number of paging indicators per frame (Np):

$$q = \left(PI + \left\lfloor \left(\left(18 \times \left(SFN + \lfloor SFN/8 \rfloor + \lfloor SFN/64 \rfloor + \lfloor SFN/512 \rfloor \right) \right) \bmod 144 \right) \times \frac{Np}{144} \right\rfloor \right) \bmod Np$$

Further, the PI calculated by higher layers is associated with the value of the paging indicator P_q. If a paging indicator in a certain frame is set to "1" it is an indication that UEs associated with this paging indicator and PI should read the corresponding frame of the associated S-CCPCH.

The PI bitmap in the PCH data frames over Iub contains indication values for all higher layer PI values possible. Each bit in the bitmap indicates if the paging indicator associated with that particular PI shall be set to 0 or 1. Hence, the calculation in the formula above is to be performed in Node B to make the association between PI and P_q.

The mapping from $\{P_0, \ldots, P_{Np-1}\}$ to the PICH bits $\{b_0, \ldots, b_{287}\}$ are according to Table 24.

Table 24: Mapping of paging indicators P_q to PICH bits

Number of paging indicators per frame (Np)	$P_q = 1$	$P_q = 0$
Np=18	$\{b_{16q}, \ldots, b_{16q+15}\} = \{1, 1,\ldots, 1\}$	$\{b_{16q}, \ldots, b_{16q+15}\} = \{0, 0,\ldots, 0\}$
Np=36	$\{b_{8q}, \ldots, b_{8q+7}\} = \{1, 1,\ldots, 1\}$	$\{b_{8q}, \ldots, b_{8q+7}\} = \{0, 0,\ldots, 0\}$
Np=72	$\{b_{4q}, \ldots, b_{4q+3}\} = \{1, 1,\ldots, 1\}$	$\{b_{4q}, \ldots, b_{4q+3}\} = \{0, 0,\ldots, 0\}$
Np=144	$\{b_{2q}, b_{2q+1}\} = \{1, 1\}$	$\{b_{2q}, b_{2q+1}\} = \{0, 0\}$

When transmit diversity is employed for the PICH, STTD encoding is used on the PICH bits as described in subclause 5.3.1.1.1.

5.3.3.11 CPCH Status Indicator Channel (CSICH)

The CPCH Status Indicator Channel (CSICH) is a fixed rate (SF=256) physical channel used to carry CPCH status information.

A CSICH is always associated with a physical channel used for transmission of CPCH AP-AICH and uses the same channelization and scrambling codes. Figure 25 illustrates the frame structure of the CSICH. The CSICH frame consists of 15 consecutive access slots (AS) each of length 40 bits. Each access slot consists of two parts, a part of duration 4096 chips with no transmission that is not formally part of the CSICH, and a Status Indicator (SI) part consisting of 8 bits $b_{8i},\ldots b_{8i+7}$, where i is the access slot number. The part of the slot with no transmission is reserved for use by AICH, AP-AICH or CD/CA-ICH. The modulation used by the CSICH is the same as for the PICH. The phase reference for the CSICH is the Primary CPICH.

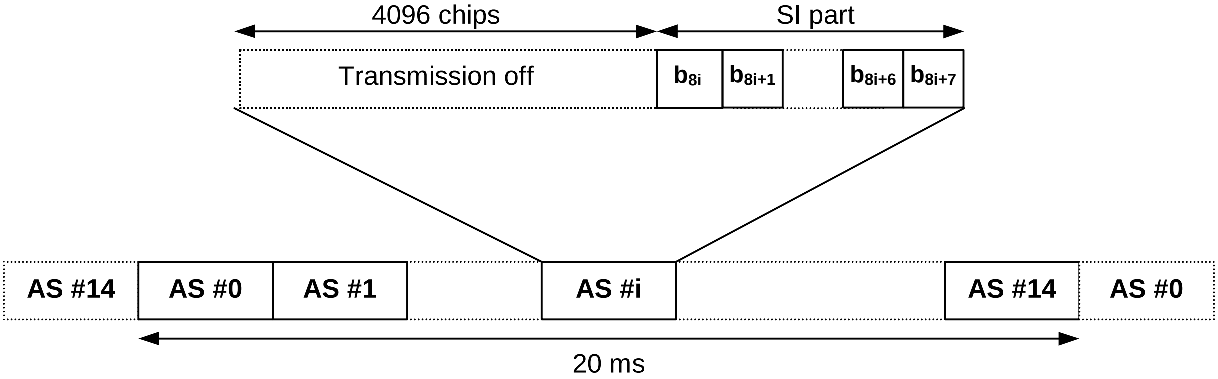

Figure 25: Structure of CPCH Status Indicator Channel (CSICH)

N Status Indicators $\{SI_0, \ldots, SI_{N-1}\}$ shall be transmitted in each CSICH frame. The mapping from $\{SI_0, \ldots, SI_{N-1}\}$ to the CSICH bits $\{b_0, \ldots, b_{119}\}$ is according to Table 25. The Status Indicators shall be transmitted in all the access slots of the CSICH frame, even if some signatures and/or access slots are shared between CPCH and RACH.

Table 25: Mapping of Status Indicators (SI) to CSICH bits

Number of SI per frame (N)	$SI_n = 1$	$SI_n = 0$
N=1	$\{b_0, \ldots, b_{119}\} = \{1, 1,\ldots, 1\}$	$\{b_0, \ldots, b_{119}\} = \{0, 0,\ldots, 0\}$
N=3	$\{b_{40n}, \ldots, b_{40n+39}\} = \{1, 1,\ldots, 1\}$	$\{b_{40n}, \ldots, b_{40n+39}\} = \{0, 0,\ldots, 0\}$
N=5	$\{b_{24n}, \ldots, b_{24n+23}\} = \{1, 1,\ldots, 1\}$	$\{b_{24n}, \ldots, b_{24n+23}\} = \{0, 0,\ldots, 0\}$
N=15	$\{b_{8n}, \ldots, b_{8n+7}\} = \{1, 1,\ldots, 1\}$	$\{b_{8n}, \ldots, b_{8n+7}\} = \{0, 0,\ldots, 0\}$
N=30	$\{b_{4n}, \ldots, b_{4n+3}\} = \{1, 1, 1, 1\}$	$\{b_{4n}, \ldots, b_{4n+3}\} = \{0, 0, 0, 0\}$
N=60	$\{b_{2n}, b_{2n+1}\} = \{1, 1\}$	$\{b_{2n}, b_{2n+1}\} = \{0, 0\}$

When transmit diversity is employed for the CSICH, STTD encoding is used on the CSICH bits as described in subclause 5.3.1.1.1.

The CPCH Status Indicator mode (CSICH mode) defines the structure of the information carried on the CSICH. At the UTRAN the value of the CPCH Status Indicator mode is set by higher layers. There are two CSICH modes depending on whether Channel Assignment is active or not. The CSICH mode defines the number of status indicators per frame and the content of each status indicator. Layer 1 transmits the CSICH information according to the CSICH mode and the structures defined in the following paragraphs.

5.3.3.11.1 CSICH Information Structure when Channel Assignment is not active

In this mode, CPCH Status Indication conveys the PCPCH Channel Availability value which is a 1 to 16 bit value which indicates the availability of each of the 1 to 16 defined PCPCHs in the CPCH set. PCPCHs are numbered from PCPCH0 through PCPCH15. There is one bit of the PCPCH Resource Availability (PRA) value for each defined PCPCH channel. If there are 2 PCPCHs defined in the CPCH set, then there are 2 bits in the PRA value. And likewise for other numbers of defined PCPCH channels up to 16 maximum CPCH channels per set when Channel Assignment is not active.

The number of SIs (Status Indicators) per frame is a function of the number of defined PCPCH channels.

Number of defined PCPCHs(=K)	Number of SIs per frame(=N)
1, 2, 3	3
4,5	5
6,7,8,9,10,11,12,13,14,15	15
16	30

The value of the SI shall indicate the PRA value for one of the defined PCPCHs, where PRA(n)=1 indicates that the PCPCH is available, and PRA(n)=0 indicates that the PCPCHn is not available. SI(0) shall indicate PRA(0) for PCPCH0, SI(1) shall indicate PRA(1) for PCPCH1, etc., for each defined PCPCH. When the number of SIs per frame exceeds the number of defined PCPCHs (K), the SIs which exceed K shall be set to repeat the PRA values for the defined PCPCHs. In general ,

SI(n) = PRA(n mod (K)),

where PRA(i) is availability of PCPCHi,

and n ranges from 0 to N-1.

5.3.3.11.2 PCPCH Availability when Channel Assignment is active

In this mode, CPCH Status Indication conveys two pieces of information. One is the Minimum Available Spreading Factor (MASF) value and the other is the PCPCH Resource Availability (PRA) value.

- MASF is a 3 bit number with bits MASF(0) through MASF(2) where MASF(0) is the MSB of the MASF value and MASF(2) is the LSB of the MASF value.

The following table defines MASF(0), MASF(1) and MASF(2) values to convey the MASF. All spreading factors greater than MASF are available

Minimum Available Spreading Factor (MASF)	MASF(0)	MASF(1)	MASF(2)
N/A (No available CPCH resources)	0	0	0
256	0	0	1
128	0	1	0
64	0	1	1
32	1	0	0
16	1	0	1
08	1	1	0
04	1	1	1

The number of SIs (Status Indicators) per frame, N is a function of the number of defined PCPCH channels, K.

Number of defined PCPCHs(K)	Number of SIs per frame(N)
1, 2,	5
3,4,5,6,7,8,9,10,11,12	15
13,14,15,16,17,18,19,20,21,22,23,24,25,26,27	30
28….57	60

PRA(n)=1 indicates that the PCPCHn is available, and PRA(n)=0 indicates that the PCPCHn is not available. PRA value for each PCPCH channel defined in a CPCH set shall be assigned to one SI (Status Indicator), and 3-bit MASF value shall be assigned to SIs as shown in Figure 26.

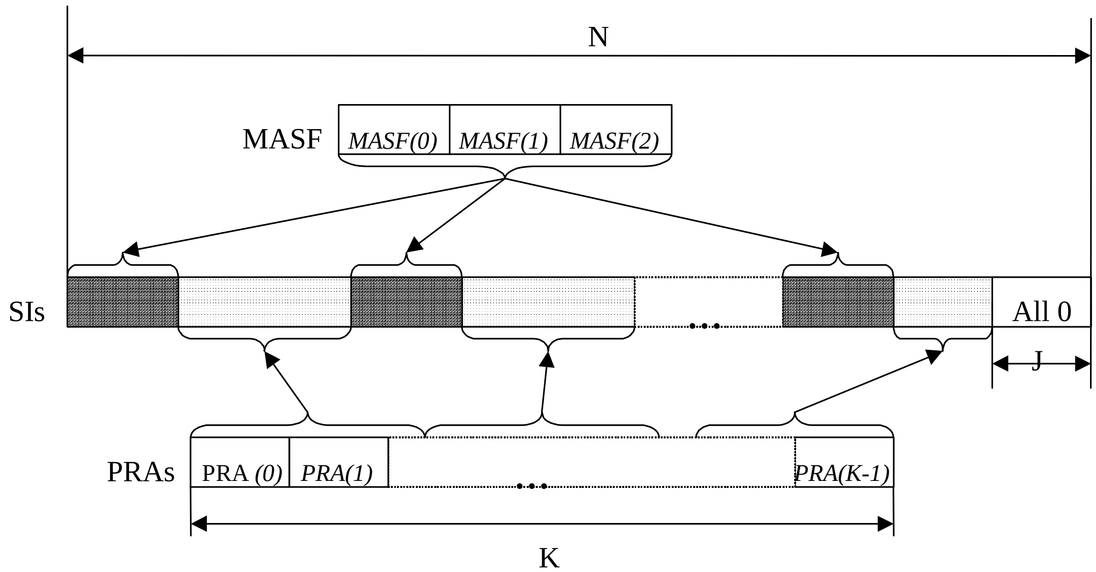

Figure 26: Mapping of MASF and PRAs to SIs in CSICH

The number of repetition that 3-bit MASF values shall be repeated is

$$T = \lfloor (N - K)/3 \rfloor$$

where $\lfloor x \rfloor$ is largest integer less than or equal to x. Each MASF value it, MASF(n), shall be mapped to SI as follows.

$$SI_{l(t+4)+i} = MASF(i), \quad 0 \le i \le 2 \quad l = 0,1, \ldots, s-1$$
$$SI_{s+l(t+3)+i} = MASF(i), \quad 0 \le i \le 2 \quad l = s, s+1, \ldots, T-1,$$

where

$$t = \lfloor K/T \rfloor$$

and

$$s = K - t \cdot T$$

Each PRA value bit, PRA(n), shall be mapped to SI as follows.

$$SI_{l(t+4)+j+3} = PRA(l + l \cdot t + j), \quad 0 \le j \le t \qquad l = 0,1,\ldots,s-1$$
$$SI_{s+l(t+3)+j+3} = PRA(s + l \cdot t + j), \quad 0 \le j \le t-1 \quad l = s, s+1, \ldots, T-1$$

The remaining

$$J = N - (3T + K)$$

SIs shall be set to 0.

5.3.3.12 Shared Control Channel (HS-SCCH)

The HS-SCCH is a fixed rate (60 kbps, SF=128) downlink physical channel used to carry downlink signalling related to HS-DSCH transmission. Figure 26A illustrates the sub-frame structure of the HS-SCCH.

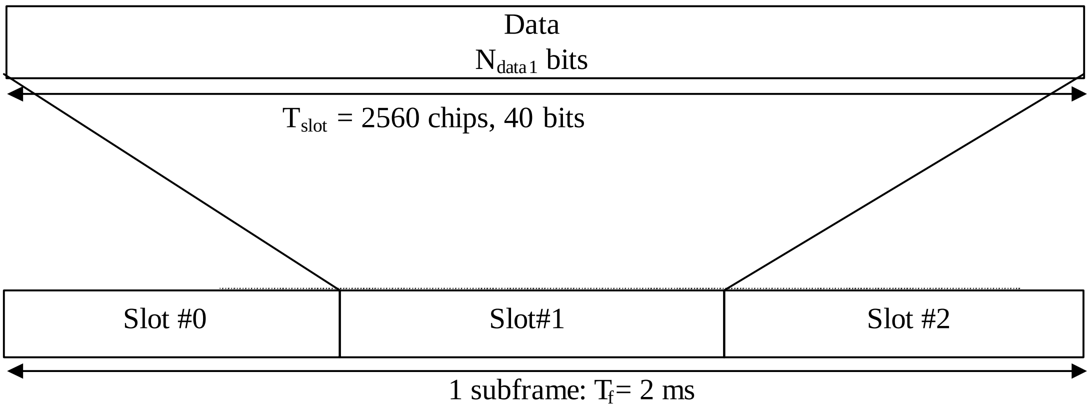

Figure 26A: Subframe structure for the HS-SCCH

5.3.3.13 High Speed Physical Downlink Shared Channel (HS-PDSCH)

The High Speed Physical Downlink Shared Channel (HS- PDSCH) is used to carry the High Speed Downlink Shared Channel (HS-DSCH).

A HS-PDSCH corresponds to one channelization code of fixed spreading factor SF=16 from the set of channelization codes reserved for HS-DSCH transmission. Multi-code transmission is allowed, which translates to UE being assigned multiple channelisation codes in the same HS-PDSCH subframe, depending on its UE capability.

The subframe and slot structure of HS-PDSCH are shown in figure 26B.

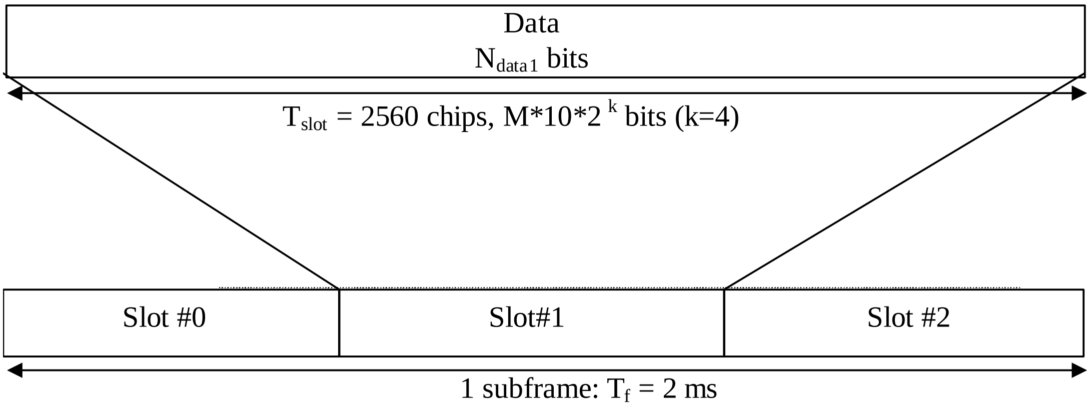

Figure 26B: Subframe structure for the HS-PDSCH

An HS-PDSCH may use QPSK or 16QAM modulation symbols. In figure 26B, M is the number of bits per modulation symbols i.e. M=2 for QPSK and M=4 for 16QAM. The slot formats are shown in table 26.

Table 26: HS-DSCH fields

Slot format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ HS-DSCH subframe	Bits/ Slot	Ndata
0(QPSK)	480	240	16	960	320	320
1(16QAM)	960	240	16	1920	640	640

All relevant Layer 1 information is transmitted in the associated HS-SCCH i.e. the HS-PDSCH does not carry any Layer 1 information.

5.3.3.14 E–DCH Absolute Grant Channel (E-AGCH)

The E-DCH Absolute Grant Channel (E-AGCH) is a fixed rate (30 kbps, SF=256) downlink physical channel carrying the uplink E-DCH absolute grant. Figure 26C illustrates the frame and sub-frame structure of the E-AGCH.

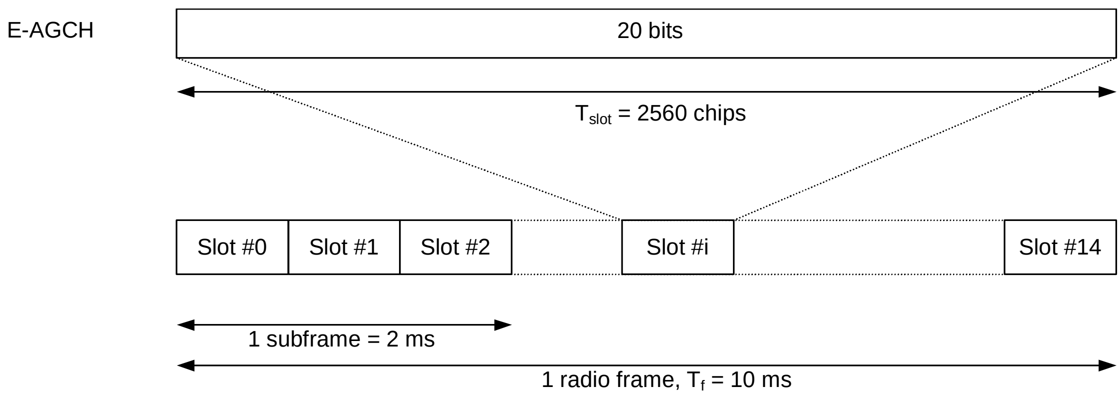

Figure 26C: Sub-frame structure for the E-AGCH

5.3.3.15 MBMS Indicator Channel (MICH)

The MBMS Indicator Channel (MICH) is a fixed rate (SF=256) physical channel used to carry the MBMS notification indicators. The MICH is always associated with an S-CCPCH to which a FACH transport channel is mapped.

Figure 26D illustrates the frame structure of the MICH. One MICH radio frame of length 10 ms consists of 300 bits (b_0, b_1, …, b_{299}). Of these, 288 bits (b_0, b_1, …, b_{287}) are used to carry notification indicators. The remaining 12 bits are not formally part of the MICH and shall not be transmitted (DTX).

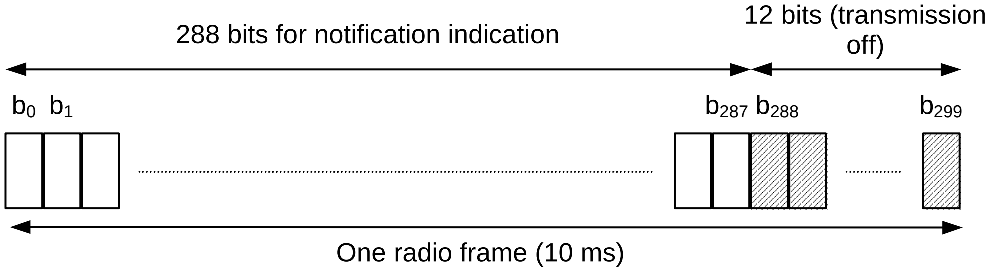

Figure 26D: Structure of MBMS Indicator Channel (MICH)

In each MICH frame, Nn notification indicators {N_0, …, N_{Nn-1}} are transmitted, where Nn=18, 36, 72, or 144.

The set of NI calculated by higher layers, is associated to a set of notification indicators N_q, where q is computed as a function of the NI computed by higher layers, the SFN of the P-CCPCH radio frame during which the start of the MICH radio frame occurs, and the number of notification indicators per frame (Nn):

$$q = \left\lfloor \left(\left(C \times \left(\mathrm{NI} \oplus \left(\left(C \times SFN \right) \bmod G \right) \right) \right) \bmod G \right) \times \frac{Nn}{G} \right\rfloor$$

where G = 2^{16} and C = 25033.

The set of NI signalled over Iub indicates all higher layer NI values for which the notification indicator on MICH should be set to 1 during the corresponding modification period; all other indicators shall be set to 0. Hence, the calculation in the formula above shall be performed in the Node B every MICH frame to make the association between NI and N_q.

The mapping from {N_0, …, N_{Nn-1}} to the MICH bits {b_0, …, b_{287}} are according to table 27.

Table 27: Mapping of paging indicators N_q to MICH bits

Number of notification indicators per frame (Nn)	N_q = 1	N_q = 0
Nn=18	{b_{16q}, …, b_{16q+15}} = {1, 1,…, 1}	{b_{16q}, …, b_{16q+15}} = {0, 0,…, 0}
Nn=36	{b_{8q}, …, b_{8q+7}} = {1, 1,…, 1}	{b_{8q}, …, b_{8q+7}} = {0, 0,…, 0}
Nn=72	{b_{4q}, …, b_{4q+3}} = {1, 1,…, 1}	{b_{4q}, …, b_{4q+3}} = {0, 0,…, 0}
Nn=144	{b_{2q}, b_{2q+1}} = {1, 1}	{b_{2q}, b_{2q+1}} = {0, 0}

When transmit diversity is employed for the MICH, STTD encoding is used on the MICH bits as described in subclause 5.3.1.1.1.

3GPP TSG-RAN1 Meeting #41
Athens, Greece, 9 - 13 May 2005

Tdoc ⌘R1-050523

CR-Form-v7.1

CHANGE REQUEST

⌘	**25.214**	**CR**	**386**	⌘ **rev**	**1**	⌘	Current version:	**5.10.0**	⌘

For ***HELP*** *on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects:	UICC apps⌘		ME	X	Radio Access Network	X	Core Network	

Title: ⌘	Feature clean up: Removal of the 'TX diversity closed loop mode 2'		
Source: ⌘	RAN WG1		
Work item code: ⌘	TEI5	***Date:*** ⌘	12/05/2005
Category: ⌘	**C**	***Release:*** ⌘	Rel-5
	Use one of the following categories: ***F*** *(correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *Ph2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *Rel-4 (Release 4)* *Rel-5 (Release 5)* *Rel-6 (Release 6)* *Rel-7 (Release 7)*

Reason for change: ⌘	RAN #27 decision in RP-050144 to remove Closed Loop Tx Diversity Mode 2
Summary of change: ⌘	Text regarding Closed Loop Tx Diversity Mode 2 is removed. Minor editorial changes are made to improve consistency.
Consequences if not approved: ⌘	The RAN #27 decision would be violated.

Clauses affected: ⌘	7, 7.1, 7.3, 7.3.1, 7.3.2, 7.3.3, 7.3.3.1, 7.3.3.2, 7.3.3.3, 7.3.4, 7.3.4.1, 7.3.4.2, A1				
	Y	**N**			
Other specs affected: ⌘	X		Other core specifications	⌘	25.101, 25.211, 25.331, 25.423, 25.433
			Test specifications		
		X	O&M Specifications		
Other comments: ⌘	Revision of R1-050478 according to comments from NEC.				

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm. Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

7 Closed loop mode 1 transmit diversity

The general transmitter structure to support closed loop mode transmit diversity for DPCH transmission is shown in figure 3. Channel coding, interleaving and spreading are done as in non-diversity mode. The spread complex valued signal is fed to both TX antenna branches, and weighted with antenna specific weight factors w_1 and w_2. The weight factors are complex valued signals (i.e., $w_i = a_i + jb_i$), in general.The weight factor w_1 is a constant scalar and the weight factor w_2 is complex valued signal.

The weight factors (actually the corresponding phase adjustments in closed loop mode 1 and phase/amplitude adjustments in closed loop mode 2) are The weight factor w_2. (actually the corresponding phase adjustment) is determined by the UE, and signalled to the UTRAN access point (=i.e. cell transceiver) using the D sub-field of the FBI field of uplink DPCCH.

For the closed loop mode 1 different orthogonal dedicated pilot symbols in the DPCCH are sent on the 2 different antennas. For closed loop mode 2 the same dedicated pilot symbols in the DPCCH are sent on both antennas.

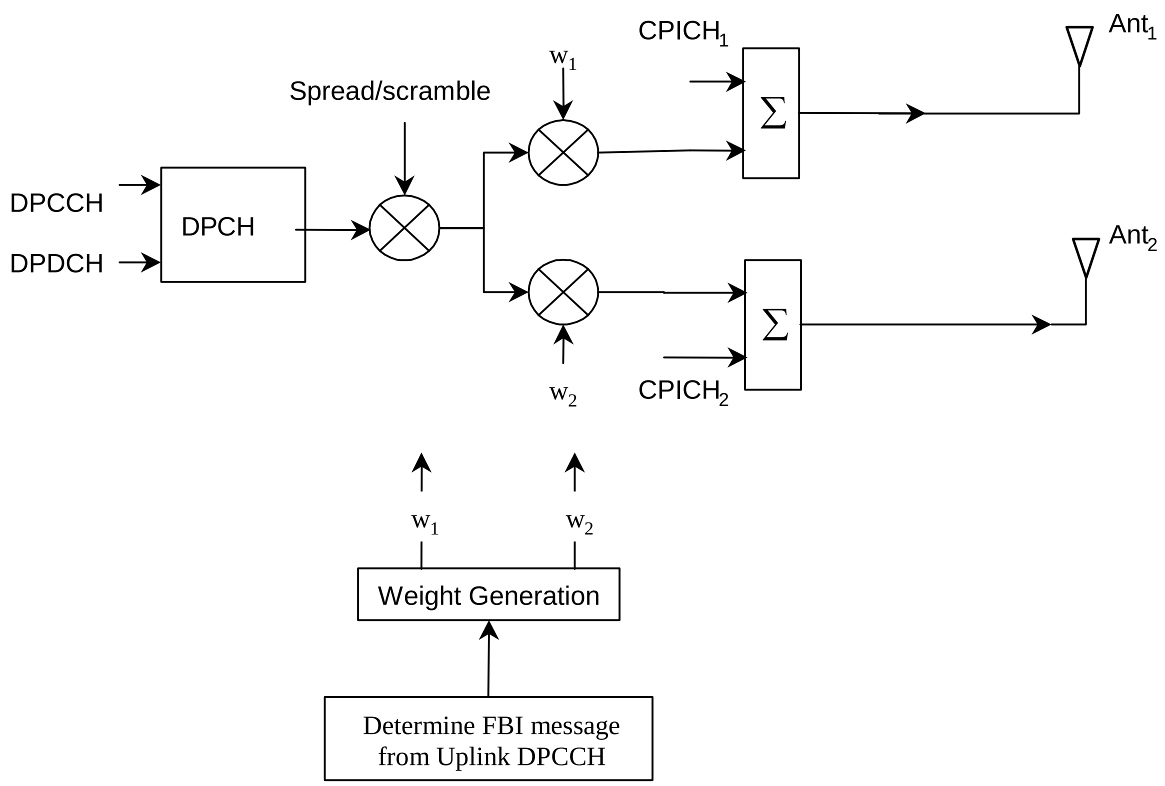

Figure 3: The generic downlink transmitter structure to support closed loop mode transmit diversity for DPCH transmission.

There are two closed loop modes whose characteristics are summarised in the table 8. The use of the modes is controlled via higher layer signalling.Closed loop mode 1 characteristics are summarised in the table 8. The use of the closed loop mode 1 is controlled via higher layer signalling.

Table 8: Summary of number of feedback information bits per slot, N_{FBD}, feedback command length in slots, N_W, feedback command rate, feedback bit rate, number of phase bits, N_{ph}, per signalling word, number of amplitude bits, N_{po}, per signalling word and amount of constellation rotation at UE for the ~~two~~ closed loop mode~~s~~ 1.

~~Closed loop mode~~	~~N_{FBD}~~	~~N_W~~	~~Update rate~~	~~Feedback bit rate~~	~~N_{po}~~	~~N_{ph}~~	~~Constellation rotation~~
~~1~~	~~1~~	~~1~~	~~1500 Hz~~	~~1500 bps~~	~~0~~	~~1~~	~~π/2~~
~~2~~	~~1~~	~~4~~	~~1500 Hz~~	~~1500 bps~~	~~1~~	~~3~~	~~N/A~~

N_{FBD}	N_W	Update rate	Feedback bit rate	N_{po}	N_{ph}	Constellation rotation
1	1	1500 Hz	1500 bps	0	1	π/2

7.1 ~~Determination of feedback information~~General procedure

The UE uses the CPICH to separately estimate the channels seen from each antenna.

Once every slot, the UE computes the phase adjustment, ϕ, ~~and for mode 2 the amplitude adjustment~~ that should be applied at the UTRAN access point to maximise the UE received power. During soft handover, the UE computes the phase adjustment ~~and for mode 2 the amplitude adjustment~~ to maximise the total UE received power from the cells in the active set. –In the case that a PDSCH or HS-PDSCH is associated with a DPCH for which closed loop mode 1~~closed loop transmit diversity~~ is applied, the antenna weights applied to the PDSCH and HS-PDSCH, respectively, are the same as the antenna weights applied to the associated DPCH. In case a PDSCH or HS-PDSCH is associated with a DPCH during soft handover, the UE may emphasize the radio link transmitted from DSCH or HS-DSCH serving cell, respectively, when calculating the antenna weights. An example of how the computations can be accomplished is given in Annex A.2.

The UE feeds back to the UTRAN access point the information on which phase/power settings to use. Feedback Signalling Message (FSM) bits are transmitted in the portion of FBI field of uplink DPCCH slot(s) assigned to closed loop mode transmit diversity, the FBI D field (see [1]). Each message is of length $N_W = N_{po}+N_{ph}$ bits and its format is shown in the figure 4. The transmission order of bits is from MSB to LSB, i.e. MSB is transmitted first. FSM_{po} and FSM_{ph} subfields are used to transmit the power and phase settings, respectively.

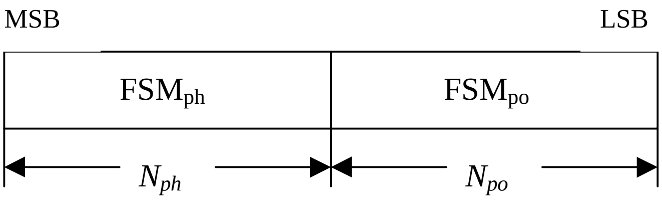

Figure 4: Format of feedback signalling message. FSM_{po} transmits the power setting and FSM_{ph} the phase setting.

The adjustments are made by the UTRAN Access Point at the beginning of the downlink DPCCH pilot field. The downlink slot in which the adjustment is done is signalled to L1 of UE by higher layers. Two possibilities exist:

1) When feedback command is transmitted in uplink slot i, which is transmitted approximately 1024 chips in offset from the received downlink slot j, the adjustment is done at the beginning of the pilot field of the downlink slot (j+1) mod 15.

2) When feedback command is transmitted in uplink slot i, which is transmitted approximately 1024 chips in offset from the received downlink slot j, the adjustment is done at the beginning of the pilot field of the downlink slot (j+2) mod 15.

Thus, adjustment timing at UTRAN Access Point is either according to 1) or 2) as controlled by the higher layers.

In case of soft handover, Layer 1 shall support different adjustment timing values for different radio links in the same active set.

The timing of the weight adjustment of the PDSCH is such that the PDSCH weight adjustment is done at the PDSCH slot border, N chips after the adjustment of the associated DPCH, where $0 \le N < 2560$.

The timing of the weight adjustment of the HS-PDSCH is such that the HS-PDSCH weight adjustment is done at the HS-PDSCH slot border, respectively, M chips after the adjustment of the associated DPCH, where $0 \le M < 2560$.

7.2 Determination of feedback information~~Closed loop mode 1~~

The UE uses the CPICH transmitted both from antenna 1 and antenna 2 to calculate the phase adjustment to be applied at UTRAN access point to maximise the UE received power. In each slot, UE calculates the optimum phase adjustment, ϕ, for antenna 2, which is then quantized into ϕ_Q having two possible values as follows:

$$\phi_Q = \begin{cases} \pi, & \text{if } \pi/2 < \phi - \phi_r(i) \le 3\pi/2 \\ 0, & \text{otherwise} \end{cases} \qquad (1)$$

where:

$$\phi_r(i) = \begin{cases} 0, & i = 0,2,4,6,8,10,12,14 \\ \pi/2, & i = 1,3,5,7,9,11,13 \end{cases} \qquad (2)$$

If $\phi_Q = 0$, a command '0' is send to UTRAN using the FSM_{ph} field. Correspondingly, if $\phi_Q = \pi$, command '1' is send to UTRAN using the FSM_{ph} field.

Due to rotation of the constellation at UE the UTRAN interprets the received commands according to table 9 which shows the mapping between phase adjustment, ϕ_i, and received feedback command for each uplink slot.

Table 9: Phase adjustments, ϕ_i, corresponding to feedback commands for the slots *i* of the UL radio frame

Slot #		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
FSM	0	0	π/2	0	π/2	0	π/2	0	π/2	0	π/2	0	π/2	0	π/2	0
	1	π	-π/2	π	-π/2	π	-π/2	π	-π/2	π	-π/2	π	-π/2	π	-π/2	π

The weight w_2 is then calculated by averaging the received phases over 2 consecutive slots. Algorithmically, w_2 is calculated as follows:

$$w_2 = \frac{\sum_{i=n-1}^{n} \cos(\phi_i)}{2} + j\frac{\sum_{i=n-1}^{n} \sin(\phi_i)}{2} \qquad (3)$$

where:

$$\phi_i \in \{0, \pi, \pi/2, -\pi/2\} \qquad (4)$$

For antenna 1, w_1 is constant:

$$w_1 = 1/\sqrt{2} \qquad (5)$$

7.2.1 ~~Mode 1 e~~End of frame adjustment

In closed loop mode 1 at frame borders the averaging operation is slightly modified. Upon reception of the FB command for slot 0 of a frame, the average is calculated based on the command for slot 13 of the previous frame and the command for slot 0 of the current frame, i.e. ϕ_i from slot 14 is not used:

$$w_2 = \frac{\cos(\phi_{13}^{j-1}) + \cos(\phi_0^j)}{2} + j\frac{\sin(\phi_{13}^{j-1}) + \sin(\phi_0^j)}{2} \qquad (6)$$

where:

- ϕ_{13}^{j-1} = phase adjustment from frame j-1, slot 13.

- ϕ_0^j = phase adjustment from frame j, slot 0.

7.2.2 ~~Mode 1 n~~Normal initialisation

For the first frame of transmission UE determines the feedback commands in a normal way and sends them to UTRAN.

Before the first FB command is received, the UTRAN shall use the initial weight $w_2 = \frac{1}{2}(1+j)$.

Having received the first FB command the UTRAN calculates w_2 as follows:

$$w_2 = \frac{\cos(\pi/2) + \cos(\phi_0)}{2} + j\frac{\sin(\pi/2) + \sin(\phi_0)}{2} \qquad (7)$$

where:

ϕ_0 = phase adjustment from slot 0 of the first frame.

7.2.3 ~~Mode 1 o~~Operation during compressed mode

7.2.3.1 Downlink in compressed mode and uplink in normal mode

When downlink is in compressed mode but uplink is operating normally (i.e. not compressed) the UTRAN continues it's Tx diversity related functions in the same way as in non-compressed downlink mode.

In downlink transmission gaps there are uplink slots for which no new estimate of the phase adjustment is calculated. During these slots the following rules are applied in UE when determining the feedback command:

1) If no new estimate of phase adjustment ϕ_i exists corresponding to the feedback command to be sent in uplink slot *i*:

- If $1 < i < 15$:
  - the feedback command sent in uplink slot *i*-2 is used;
- else if $i = 0$:
  - the feedback command sent in uplink slot 14 of previous frame is used;
- else if $i = 1$:
  - the feedback command sent in uplink slot 13 of previous frame is used;
- end if.

2) When transmission in downlink is started again in downlink slot $N_{last}+1$ (if $N_{last}+1 = 15$, then slot 0 in the next frame) the UE must resume calculating new estimates of the phase adjustment. The feedback command corresponding to the first new estimate of ϕ_i must be sent in the uplink slot which is transmitted approximately 1024 chips in offset from the downlink slot $N_{last}+1$.

7.2.3.2 Both downlink and uplink in compressed mode

During the uplink transmission gaps no FB commands are sent from UE to UTRAN. When transmission in downlink is started again in downlink slot $N_{last}+1$ (if $N_{last}+1 = 15$, then slot 0 in the next frame) the UE must resume calculating new estimates of the phase adjustment. The feedback command corresponding to the first new estimate of ϕ_i must be sent in the uplink slot which is transmitted approximately 1024 chips in offset from the downlink slot $N_{last}+1$.

The UTRAN continues to update the weight w_2 until the uplink transmission gap starts and no more FB commands are received. When the transmission in downlink resumes in slot $N_{last}+1$, the value of w_2, calculated after receiving the last FB command before the start of the uplink transmission gap, is applied to antenna 2 signal.

After the UE resumes transmission in uplink and sends the first FB command, the new value of w_2 is calculated as follows:

- S_1 = {0, 2, 4, 6, 8, 10, 12 14}.
- S_2 = {1, 3, 5, 7, 9, 11, 13}.
- i = number of uplink slot at which the transmission resumes.
- j = number of uplink slot at which the last FB command was sent before the start of the uplink transmission gap.
- Do while ($i \in S_1$ *and* $j \in S_1$) or ($i \in S_2$ *and* $j \in S_2$):
  - j = j-1;
  - if j < 0;
  - j = 14;
- end if;
- end do;
- calculate w_2 based on FB commands received in uplink slots i and j.

Note that for $N_{last} = 13$ the end of frame adjustment procedure shall be based on the FB commands for the last odd slot prior to the uplink transmission gap and slot 0.

7.2.3.3 Uplink in compressed mode and downlink in normal mode

The UTRAN continues to update the value of w_2 until the uplink transmission gap starts and no more FB commands are received. Then, the value of w_2 calculated after receiving the last FB command before the uplink transmission gap is applied to the antenna 2 signal. When the UE resumes transmission in uplink, it shall send FB commands according to section 7.2 equations 2 and 3 (normal operation) and the UTRAN Access Point shall interpret the FB commands according to Table 9.

The calculation of w_2 by the UTRAN following the uplink transmission gap, and before the first two FB commands following the gap are received is not specified.

7.2.4 ~~Mode 1 i~~Initialisation during compressed mode

7.2.4.1 Downlink in compressed mode

When closed loop mode 1 is initialised during the downlink transmission gap of compressed mode there are slots for which no estimate of the phase adjustment is calculated and no previous feedback command is available.

In this case, if the UE is required to send feedback in the uplink, the FB command to the UTRAN shall be ‘0’.

When transmission in downlink is started again in slot $N_{last}+1$ (if $N_{last}+1 = 15$, then slot 0 in the next frame), the UTRAN shall use the initial weight $w_2 = \frac{1}{2}(1+j)$. The UE must start calculating estimates of the phase adjustment. The feedback command corresponding to the first estimate of ϕ_i must be sent in the uplink slot which is transmitted approximately 1024 chips in offset from the downlink slot N_{last}+1. Having received this feedback command the UTRAN calculates w_2 as follows:

$$w_2 = \frac{\cos(\phi_i) + \cos(\phi_j)}{2} + j\frac{\sin(\phi_i) + \sin(\phi_j)}{2} \quad (8)$$

where:

ϕ_i = phase adjustment in uplink slot i , which is transmitted approximately 1024 chips in offset from the downlink slot N_{last}+1.

$\phi_j = \frac{\pi}{2}$, if slot i is even ($i \in \{0, 2, 4, 6, 8, 10, 12, 14\}$) and

$\phi_j = 0$, if slot i is odd ($i \in \{1, 3, 5, 7, 9, 11, 13\}$)

7.2.4.2 Uplink in compressed mode

Initialisation of closed loop mode 1 operation during uplink compressed mode only is not specified.

7.3 Closed loop mode 2

In closed loop mode 2 there are 16 possible combinations of phase and power adjustment from which the UE selects and transmits the FSM according to table 10 and table 11. As opposed to closed loop Mode 1, no constellation rotation is done at UE and no filtering of the received weights is performed at the UTRAN.

Table 10: FSM_{po} subfield of closed loop mode 2 signalling message

FSM_{po}	Power_ant1	Power_ant2
0	0.2	0.8
1	0.8	0.2

Table 11: FSM_{ph} subfield of closed loop mode 2 signalling message

FSM_{ph}	Phase difference between antennas (radians)
000	π
001	-3π/4
011	-π/2
010	-π/4
110	0
111	π/4
101	π/2
100	3π/4

To obtain the best performance, progressive updating is performed at both the UE and the UTRAN Access point. The UE procedure shown below is an example of how to determine FSM at UE. Different implementation is allowed. Every slot time, the UE may refine its choice of FSM, from the set of weights allowed given the previously transmitted bits of the FSM. This is shown in figure 5, where, in this figure b_i ($0 \le i \le 3$) are the bits of the FSM (from table 10 and table 11) from the MSB to the LSB and m=0, 1, 2, 3 (the end of frame adjustment given in subclause 7.3.1 is not shown here).

At the beginning of a FSM to be transmitted, the UE chooses the best FSM out of the 16 possibilities. Then the UE starts sending the FSM bits from the MSB to the LSB in the portion of FBI field of the uplink DPCCH during 4 (FSM message length) slots. Within the transmission of the FSM the UE refines its choice of FSM. This is defined in the following:

- define the 4 bits of FSM, which are transmitted from slot number k to k+3, as $\{b_3(k)\ b_2(k+1)\ b_1(k+2)\ b_0(k+3)\}$, where k=0, 4, 8, 12. Define also the estimated received power criteria defined in Equation 1 for a given FSM as $P(\{x_3\ x_2\ x_1\ x_0\})$, where $\{x_3\ x_2\ x_1\ x_0\}$ is one of the 16 possible FSMs which defines an applied phase and power offset according to table 10 and table 11. The $b_i()$ and x_i are 0 or 1.

The bits transmitted during the m'th FSM of the frame, where m=0,1,2,3, are then given by:

- $b_3(4m)=X_3$ from the $\{X_3\ X_2\ X_1\ X_0\}$ which maximises $P(\{x_3\ x_2\ x_1\ x_0\})$ over all x_3,x_2,x_1,x_0 (16 possible combinations);

- $b_2(4m+1)=X_2$ from the $\{b_3(4m)\ X_2\ X_1\ X_0\}$ which maximises $P(\{b_3(4m)\ x_2\ x_1\ x_0\})$ over all x_2,x_1,x_0 (8 possible combinations);

- $b_1(4m+2)=X_1$ from the $\{b_3(4m)\ b_2(4m+1)\ X_1\ X_0\}$ which maximises $P(\{b_3(4m)\ b_2(4m+1)\ \ x_1\ x_0\})$ over all x_1,x_0 (4 possible combinations);

- $b_0(4m+3)=X_0$ from the $\{b_3(4m)\ b_2(4m+1)\ b_1(4m+2)\ \ X_0\}$ which maximises $P(\{b_3(4m)\ b_2(4m+1)\ b_1(4m+2)\ x_0\})$ over x_0 (2 possible combinations).

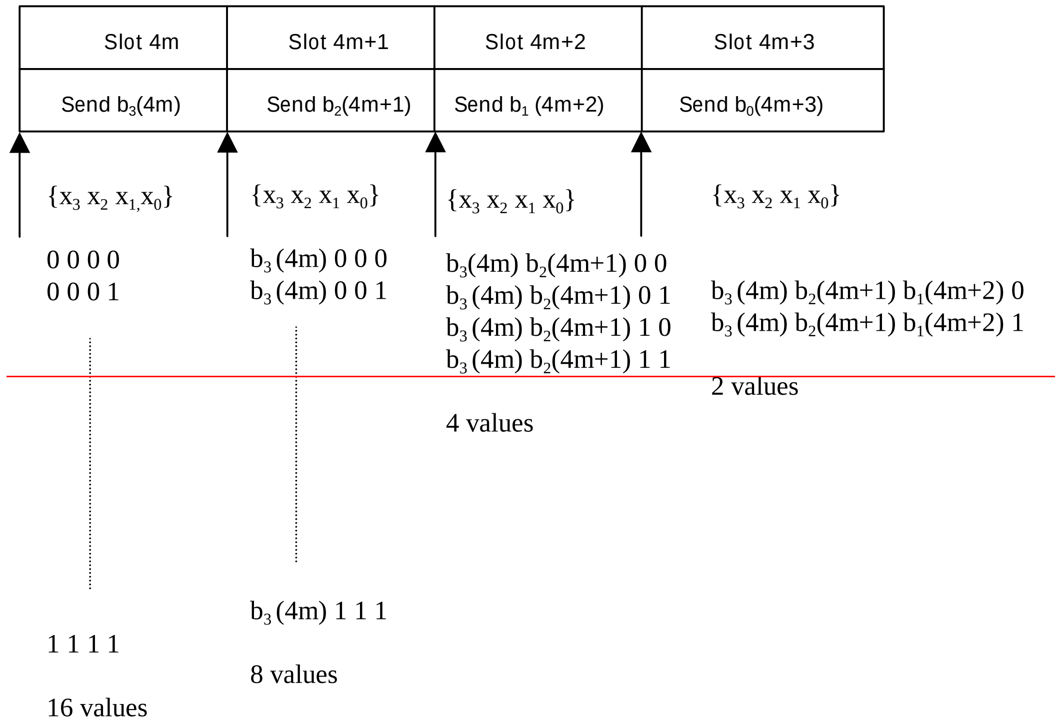

Figure 5: Progressive Refinement at the UE for closed loop mode 2

Every slot time the UTRAN constructs the FSM from the most recently received bits for each position in the word and applies the phase and amplitude (derived from power) as defined by table 10 and table 11. More precisely, the UTRAN operation can be explained as follows. The UTRAN maintains a register $\mathbf{z}=\{z_3\ z_2\ z_1\ z_0\}$, which is updated every slot time according to $z_i=b_i(ns)$ (i=0:3, ns=0:14). Every slot time the contents of register $\mathbf{z}$ are used to determine the phase and power adjustments as defined by table 10 and table 11, with $FSM_{ph}=\{z_3\ z_2\ z_1\}$ and $FSM_{po}=z_0$.

Special procedures for initialisation and end of frame processing are described below.

The weight vector, $\underline{w}$, is then calculated as:

$$\underline{w}=\begin{bmatrix}\sqrt{power\_ant1}\\ \sqrt{power\_ant2}\exp(j\ phase\_diff)\end{bmatrix} \qquad (9)$$

7.3.1 Mode 2 end of frame adjustment

The FSM must be wholly contained within a frame. To achieve this an adjustment is made to the last FSM in the frame where the UE only sends the FSM_{ph} subfield, and the UTRAN takes the power bit FSM_{po} of the previous FSM.

7.3.2 Mode 2 normal initialisation

For the first frame of transmission using closed loop mode 2, the operation is as follows.

The UE starts sending the FSM message from slot 0 in the normal way. The UE may refine its choice of FSM in slots 1 to 3 from the set of weights allowed given the previously transmitted bits of the FSM.

The UTRAN Access Point operation is as follows. Until the first FSM_{po} bit is received and acted upon (depending on the timing control specified via the higher layer parameter described in section 7.1) the power in both antennas shall be set to 0.5. Until the first FSM_{ph} bit is received and acted upon the phase difference between antennas shall be π radians.

The phase offset applied between the antennas is updated according to the number and value of FSM_{ph} bits received as given in table 12.

Table 12: FSM_{ph} normal initialisation for closed loop mode 2

FSM_{ph}	Phase difference between antennas (radians)
- - -	π (normal initialisation) or held from previous setting (compressed mode recovery)
0 - -	π
1 - -	0
0 0 -	π
0 1 -	-π/2
1 1 -	0
1 0 -	π/2
0 0 0	π
0 0 1	-3π/4
0 1 1	-π/2
0 1 0	-π/4
1 1 0	0
1 1 1	π/4
1 0 1	π/2
1 0 0	3π/4

This operation applies in both the soft handover and non soft handover cases.

7.3.3 Mode 2 operation during compressed mode

7.3.3.1 Downlink in compressed mode and uplink in normal mode

When the downlink is in compressed mode and the uplink is in normal mode, the closed loop mode 2 functions are described below.

When the UE is not listening to the CPICH from antennas 1 and 2 during the downlink transmission gap, the UE sends the last FSM bits calculated before the start of the downlink transmission gap.

Recovery from compressed mode is described in the following. Downlink transmissions commence at the pilot field of slot Nlast as described in [2].

After a transmission gap, UTRAN Access Point sets the power in both antennas to 0.5 until a FSM_{po} bit is received and acted upon. Until the first FSM_{ph} bit is received and acted upon, UTRAN uses the phase offset, which was applied before the transmission interruption (table 12).

If the uplink slot Nlast+1 (modulo 15) occurs at the beginning of a FSM period (that is at slot 0,4,8,or 12), the UE sends the FSM message in the normal way, with 3 FSM_{ph} bits and with the FSM_{po} bit on slot 3, 7 or 11, and the UTRAN Access Point acts on the FSM_{ph} bits according to table 12.

If the uplink slot Nlast+1 (modulo 15) does not occur at the beginning of a FSM period, the following operation is performed. In each of the remaining slots of the partial FSM period, that is from slot Nlast+1 (modulo 15) until the final slot (slot 3, 7, 11or 14), and for the first slot of the next full FSM period, the UE sends the first (i.e. MSB) bit of the FSM_{ph} message, and at the UTRAN access point the phase offset applied between the antennas is updated according to the number and value of FSM_{ph} bits received as given in table 13. During the following full FSM period, which starts on slot 0, 4, 8, or 12, the UE sends the FSM message in the normal way, with 3 FSM_{ph} bits and with the FSM_{po} bit on slot 3, 7 or 11, and the UTRAN Access Point acts on the FSM_{ph} bits according to table 12.

Table 13: FSM_{ph} subfield of closed loop mode 2 in compressed mode recovery period

FSM_{ph}	Phase difference between antennas (radians)
-	held from previous setting
0	π
1	0

7.3.3.2 Both downlink and uplink in compressed mode

During both downlink and uplink compressed mode, the UTRAN and the UE performs the functions of recovery after transmission gaps as described in the previous subclause 7.3.3.1.

7.3.3.3 Uplink in compressed mode and downlink in normal mode

The UTRAN continues to update the weight vector *w* until the uplink transmission gap starts and no more FSM bits are received. Then, UTRAN Access Point continues to apply the weight vector *w*, which was used before the transmission gap. When the UE resumes transmission in uplink, it chooses FSM according to normal operation as described in section 7.3 and 7.3.1. If the uplink signalling does not resume at the beginning of a FSM period, the UE shall calculate the remaining FSM bits according to section 7.3, using the last FSM(s) sent before the uplink gap as the "previously transmitted bits of the FSM".

The calculation of the phase adjustment by UTRAN remains unspecified until all 3 FSM_{ph} bits have been received following the uplink transmission gap. The calculation of the power adjustment by UTRAN remains unspecified until an FSM_{po} bit has been received following the uplink transmission gap.

7.3.4 Mode 2 initialisation during compressed mode

7.3.4.1 Downlink in compressed mode

When closed loop mode 2 is initialised during the downlink transmission gap of compressed mode there are slots for which no FSM bit is calculated and no previous sent FSM bit is available.

In this case, if the UE is required to send feedback in the uplink, the FB command to the UTRAN shall be '0'.

The UTRAN and the UE perform the functions of recovery after the downlink transmission gap as described in the previous subclause 7.3.3.1. If no previous phase setting is available, UTRAN shall use the phase offset π, until the first FSM_{ph} bit is received and acted upon.

7.3.4.2 Uplink in compressed mode

Initialisation of closed loop mode 2 operation during uplink compressed mode only is not specified.

8 Idle periods for IPDL location method

8.1 General

To support time difference measurements for location services, idle periods can be created in the downlink (hence the name IPDL) during which time transmission of all channels from a Node B is temporarily seized. During these idle periods the visibility of neighbour cells from the UE is improved.

The idle periods are arranged in a predetermined pseudo random fashion according to higher layer parameters. Idle periods differ from compressed mode in that they are shorter in duration, all channels are silent simultaneously, and no attempt is made to prevent data loss.

In general there are two modes for these idle periods:

- Continuous mode, and
- Burst mode.

In continuous mode the idle periods are active all the time. In burst mode the idle periods are arranged in bursts where each burst contains enough idle periods to allow a UE to make sufficient measurements for its location to be calculated. The bursts are separated by a period where no idle periods occur.

8.2 Parameters of IPDL

The following parameters are signalled to the UE via higher layers:

IP_Status: This is a logic value that indicates if the idle periods are arranged in continuous or burst mode.

IP_Spacing: The number of 10 ms radio frames between the start of a radio frame that contains an idle period and the next radio frame that contains an idle period. Note that there is at most one idle period in a radio frame.

IP_Length: The length of the idle periods, expressed in symbols of the CPICH.

IP_Offset: A cell specific offset that can be used to synchronise idle periods from different sectors within a Node B.

Seed: Seed for the pseudo random number generator.

Additionally in the case of burst mode operation the following parameters are also communicated to the UE.

Burst_Start: Specifies the start of the first burst of idle periods. 256×Burst_Start is the SFN where the first burst of idle periods starts.

Burst_Length: The number of idle periods in a burst of idle periods.

Burst_Freq: Specifies the time between the start of a burst and the start of the next burst. 256×Burst_Freq is the number of radio frames of the primary CPICH between the start of a burst and the start of the next burst.

8.3 Calculation of idle period position

In burst mode, burst #0 starts in the radio frame with SFN = 256×Burst_Start. Burst #*k* starts in the radio frame with SFN = 256×Burst_Start + *k*×256×Burst_Freq(*k* = 0,1,2, …). The sequence of bursts according to this formula continues up to and including the radio frame with SFN = 4095. At the start of the radio frame with SFN = 0, the burst sequence is terminated (no idle periods are generated) and at SFN = 256×Burst_Start the burst sequence is restarted with burst #0 followed by burst #1 etc., as described above.

Continuous mode is equivalent to burst mode, with only one burst spanning the whole SFN cycle of 4096 radio frames, this burst starting in the radio frame with SFN = 0.

Assume that IP_Position(x) is the position of idle period number x within a burst, where x = 1, 2, …, and IP_Position(x) is measured in number of CPICH symbols from the start of the first radio frame of the burst.

The positions of the idle periods within each burst are then given by the following equation:

$$\text{IP\_Position}(x) = (x \times \text{IP\_Spacing} \times 150) + (\text{rand}(x \text{ modulo } 64) \text{ modulo } (150 - \text{IP\_Length})) + \text{IP\_Offset};$$

where rand(m) is a pseudo random generator defined as follows:

$$\text{rand}(0) = \text{Seed};$$

$$\text{rand}(m) = (106\times\text{rand}(m-1) + 1283) \text{ modulo } 6075,\ m = 1, 2, 3, \ldots.$$

Note that x is reset to $x = 1$ for the first idle period in every burst.

Figure 6 below illustrates the idle periods for the burst mode case.

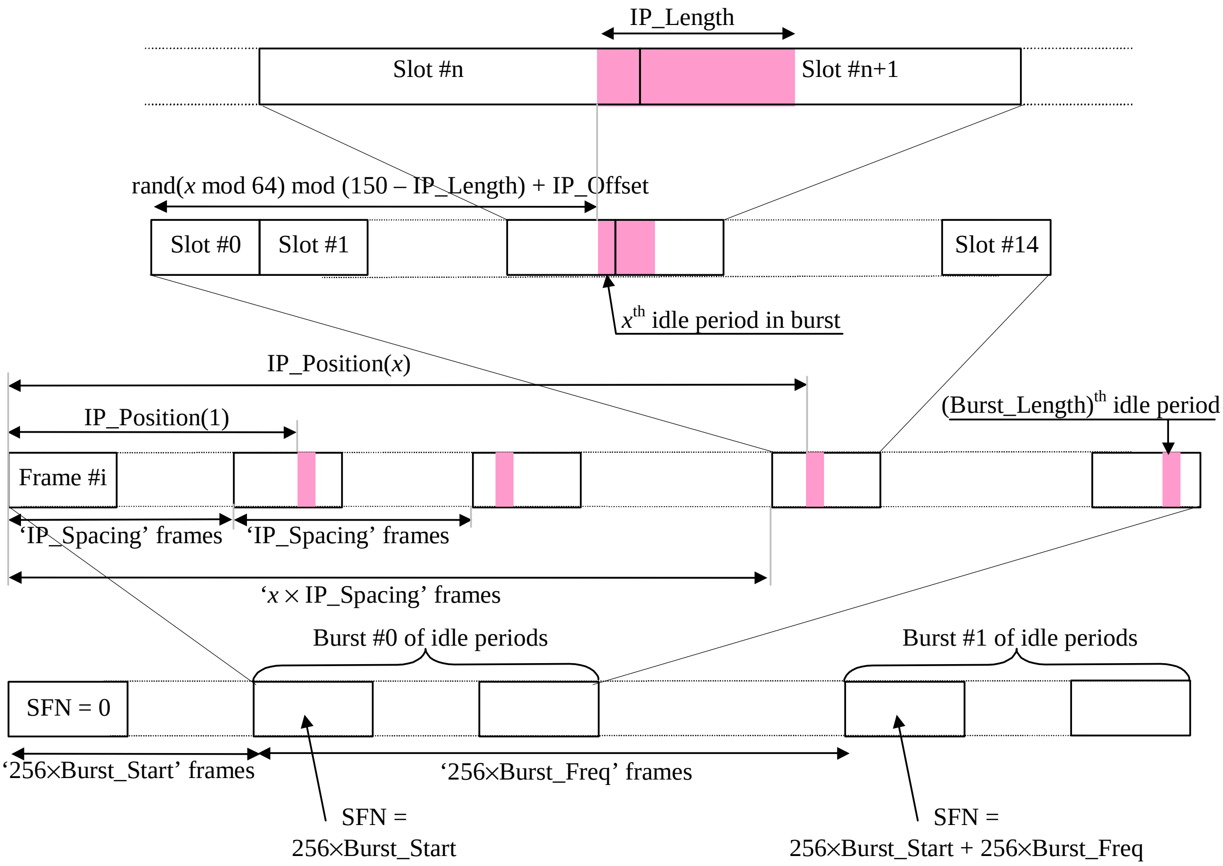

Figure 6: Idle Period placement in the case of burst mode operation

Annex A (informative):

A.1 Antenna verification

In closed loop mode 1, if channel estimates are taken from the Primary CPICH, the performance will also suffer if the UE cannot detect errors since the channel estimates will be taken for the incorrect phase settings. To mitigate this problem, antenna verification can be done, which can make use of antenna specific pilot patterns of the dedicated physical channel. The antenna verification can be implemented with several different algorithms. A straightforward algorithm can use a 4-hypothesis test per slot. Alternatively, a simplified beam former verification (SBV) requiring only a 2-hypothesis test per slot can be used.

Consider

$$2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Re}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\bar{p}(\phi_{Rx}=\pi)}{\bar{p}(\phi_{Rx}=0)}\right)$$

Then define the variable x_0 as 0 if the above inequality holds good and $x_0 = \pi$ otherwise.

Similarly consider

$$-2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Im}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\bar{p}(\phi_{Rx}=\pi/2)}{\bar{p}(\phi_{Rx}=-\pi/2)}\right)$$

then define the variable x_1 as $-\pi/2$ if the above inequality holds good and $x_1 = \pi/2$ oherwise.

Whether x_0 or x_1 is to be calculated for each slot is given by the following table , where the first row contains the UL slot index of the feedback bit to be verified.

UL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0

The estimate for the transmitted phase is now obtained from

$$\sin(\phi_{Tx}) + j\cos(\phi_{Tx}) = \frac{\sum_{i=0}^{1}\sin(x_i)}{\sqrt{2}} + j\frac{\sum_{i=0}^{1}\cos(x_i)}{\sqrt{2}}$$

where:

- the x_i values are used corresponding to the current slot and the previous slot taking into account the end-of-frame adjustment and the used CL timing adjustment delay
- $h_{2,i}^{(p)}$ is the *i*'th estimated channel tap of antenna 2 using the CPICH;
- $h_{2,i}^{(d)}$ is the *i*'th estimated channel tap of antenna 2 using the DPCCH;
- γ^2 is the DPCH Pilot SNIR/ CPICH SNIR;
- σ_i^2 is the noise plus interference power on the *i*'th path.

In normal operation the *a priori* probability for selected pilot pattern is assumed to be 96% (assuming there are 4% of errors in the feedback channel for power control and antenna selection).

For closed loop mode 2, if channel estimates are taken from the Primary CPICH, antenna verification can also be performed, for example using a 16-hypothesis test per slot. For closed loop mode 2, the same pilot sequence is transmitted on both antennas for DPCCH. Therefore, we obtain channel estimates from the DPCCH that correspond to the combined channel from both transmitting antennas:

$$\vec{h}^{(d)} = \gamma(\beta_1 \vec{h}_1 + \beta_2 \vec{h}_2) + \vec{b}^{(d)}$$

where β_1, β_2 are the applied coefficients on the antennas at the UTRAN, γ is as defined above for mode 1 verification, $\vec{h}_i$ is the actual channel vector from the *i-th* antenna, and $\vec{b}^{(d)}$ is the noise vector for the DPCCH channel estimate. Furthermore we have channel estimates made on the CPICH Pilots for each antenna:

$$\vec{h}_1^{(p)} = \vec{h}_1 + \vec{b}_1^{p}$$

$$\vec{h}_2^{(p)} = \vec{h}_2 + \vec{b}_2^{p}$$

where $\vec{h}_i^{(p)}$ is the estimated channel vector using the CPICH, and $\vec{b}_i^{p}$ is the noise vector for the CPICH channel estimate, from the *i-th* antenna.

At the receiver, verification consists in choosing a pair of applied coefficients, $(\hat{\beta}_1, \hat{\beta}_2)$, which results in a combined channel estimate from CPICH which best fits the channel estimate obtained from the DPCCH, taking into account the *a priori* probability of error on the FBI bits.

One possible way of implementing verification for mode 2 is by choosing $(\hat{\beta}_1, \hat{\beta}_2)$ from the whole set of possibilities $T = \{\alpha_1, \alpha_2\}$, using the logarithmic form of the following decision rule:

$$(\hat{\beta}_1, \hat{\beta}_2) = \arg\left\langle \max_{\alpha_1,\alpha_2 \in T} \left\{ \ln(\hat{p}(\alpha_1, \alpha_2)) + \ln(\overline{p}(\alpha_1, \alpha_2)) \right\} \right\rangle$$

where the *a priori* probability $\overline{p}(\alpha_1, \alpha_2)$ for each candidate antenna coefficient pair is determined from the antenna coefficient pair asked for by the mobile, combined with the *a priori* probability of each FSM bit used to represent the antenna coefficient pair. The *a priori* probability of each FSM bit is assumed to be 96% (assuming there are 4% of errors in the feedback channel). Also

$$\ln(\hat{p}(\alpha_1, \alpha_2)) = -\left(\sum_{i=1}^{Npath} \frac{\left| h_i^{(d)} - \gamma\left(\alpha_1 h_{1,i}^{(p)} + \alpha_2 h_{2,i}^{(p)}\right)\right|^2}{\sigma_i^2 \left(1 + \gamma^2 \left(|\alpha_1|^2 + |\alpha_2|^2\right)\right)} \right)$$

where σ_i^2 is as defined above for mode 1 verification.

A.2 Computation of feedback information for closed loop mode 1 transmit diversity

3GPP TSG-RAN1 Meeting #41
Athens, Greece, 9 - 13 May 2005

Tdoc ⌘R1-050523

CR-Form-v7.1

CHANGE REQUEST

⌘	**25.214**	**CR**	**387**	⌘ **rev**	**1**	⌘	Current version:	**6.5.0**	⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects:	UICC apps⌘	[ ]	ME	[X]	Radio Access Network	[X]	Core Network	[ ]

Title:	⌘	Feature clean up: Removal of the 'TX diversity closed loop mode 2'		
Source:	⌘	RAN WG1		
Work item code:	⌘	TEI6	***Date:*** ⌘	12/05/2005
Category:	⌘	**C**	***Release:*** ⌘	Rel-6
		Use one of the following categories: ***F*** *(correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *Ph2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *Rel-4 (Release 4)* *Rel-5 (Release 5)* *Rel-6 (Release 6)* *Rel-7 (Release 7)*

Reason for change:	⌘	RAN #27 decision in RP-050144 to remove Closed Loop Tx Diversity Mode 2
Summary of change:	⌘	Text regarding Closed Loop Tx Diversity Mode 2 is removed. Minor editorial changes are made to improve consistency.
Consequences if not approved:	⌘	The RAN #27 decision would be violated.

Clauses affected:	⌘	7, 7.1, 7.3, 7.3.1, 7.3.2, 7.3.3, 7.3.3.1, 7.3.3.2, 7.3.3.3, 7.3.4, 7.3.4.1, 7.3.4.2, A1				
		Y	**N**			
Other specs affected:	⌘	**X**		Other core specifications	⌘	25.101, 25.211, 25.331, 25.423, 25.433
				Test specifications		
			X	O&M Specifications		
Other comments:	⌘	Revision of R1-050478 according to comments from NEC.				

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1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text.   Delete those parts of the specification which are not relevant to the change request.

7 Closed loop mode 1 transmit diversity

The general transmitter structure to support closed loop mode transmit diversity for DPCH transmission is shown in figure 3. Channel coding, interleaving and spreading are done as in non-diversity mode. The spread complex valued signal is fed to both TX antenna branches, and weighted with antenna specific weight factors w_1 and w_2. ~~The weight factors are complex valued signals (i.e., $w_i = a_i + jb_i$), in general.~~The weight factor w_1 is a constant scalar and the weight factor w_2 is complex valued signal.

~~The weight factors (actually the corresponding phase adjustments in closed loop mode 1 and phase/amplitude adjustments in closed loop mode 2) are~~ The weight factor w_2. (actually the corresponding phase adjustment) is determined by the UE, and signalled to the UTRAN access point (i.e. =cell transceiver) using the D sub-field of the FBI field of uplink DPCCH.

For the closed loop mode 1 different orthogonal dedicated pilot symbols in the DPCCH are sent on the 2 different antennas. ~~For closed loop mode 2 the same dedicated pilot symbols in the DPCCH are sent on both antennas.~~

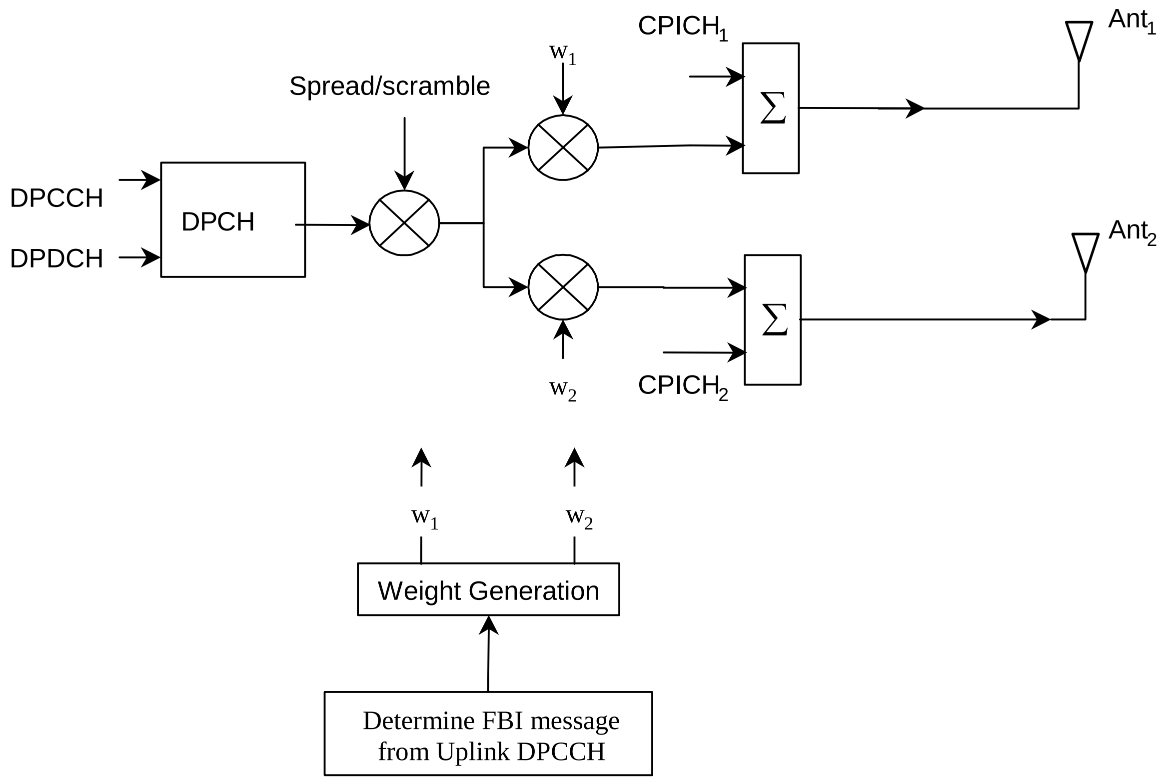

Figure 3: The generic downlink transmitter structure to support closed loop mode transmit diversity for DPCH transmission.

~~There are two closed loop modes whose characteristics are summarised in the table 8. The use of the modes is controlled via higher layer signalling.~~Closed loop mode 1 characteristics are summarised in the table 8. The use of the closed loop mode 1 is controlled via higher layer signalling.

Table 8: Summary of number of feedback information bits per slot, N_{FBD}, feedback command length in slots, N_W, feedback command rate, feedback bit rate, number of phase bits, N_{ph}, per signalling word, number of amplitude bits, N_{po}, per signalling word and amount of constellation rotation at UE for the ~~two~~ closed loop mode~~s~~ 1.

~~Closed loop mode~~	~~N_{FBD}~~	~~N_W~~	~~Update rate~~	~~Feedback bit rate~~	~~N_{po}~~	~~N_{ph}~~	~~Constellation rotation~~
~~1~~	~~1~~	~~1~~	~~1500 Hz~~	~~1500 bps~~	~~0~~	~~1~~	~~π/2~~
~~2~~	~~1~~	~~4~~	~~1500 Hz~~	~~1500 bps~~	~~1~~	~~3~~	~~N/A~~

N_{FBD}	N_W	Update rate	Feedback bit rate	N_{po}	N_{ph}	Constellation rotation
1	1	1500 Hz	1500 bps	0	1	π/2

7.1 ~~Determination of feedback information~~General procedure

The UE uses the CPICH to separately estimate the channels seen from each antenna.

Once every slot, the UE computes the phase adjustment, ϕ, ~~and for mode 2 the amplitude adjustment~~ that should be applied at the UTRAN access point to maximise the UE received power. During soft handover, the UE computes the phase adjustment ~~and for mode 2 the amplitude adjustment~~ to maximise the total UE received power from the cells in the active set. In the case that a PDSCH or HS-PDSCH is associated with a DPCH for which closed loop mode 1~~closed loop transmit diversity~~ is applied, the antenna weights applied to the PDSCH and HS-PDSCH, respectively, are the same as the antenna weights applied to the associated DPCH. In case a PDSCH or HS-PDSCH is associated with a DPCH during soft handover, the UE may emphasize the radio link transmitted from DSCH or HS-DSCH serving cell, respectively, when calculating the antenna weights. An example of how the computations can be accomplished is given in Annex A.2.

The UE feeds back to the UTRAN access point the information on which phase/power settings to use. Feedback Signalling Message (FSM) bits are transmitted in the portion of FBI field of uplink DPCCH slot(s) assigned to closed loop mode transmit diversity, the FBI D field (see [1]). Each message is of length $N_W = N_{po}+N_{ph}$ bits and its format is shown in the figure 4. The transmission order of bits is from MSB to LSB, i.e. MSB is transmitted first. FSM_{po} and FSM_{ph} subfields are used to transmit the power and phase settings, respectively.

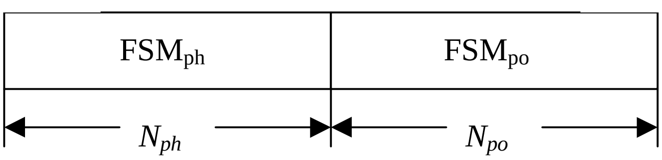

Figure 4: Format of feedback signalling message. FSM_{po} transmits the power setting and FSM_{ph} the phase setting.

The adjustments are made by the UTRAN Access Point at the beginning of the downlink DPCCH pilot field. The downlink slot in which the adjustment is done is signalled to L1 of UE by higher layers. Two possibilities exist:

1) When feedback command is transmitted in uplink slot *i*, which is transmitted approximately 1024 chips in offset from the received downlink slot *j*, the adjustment is done at the beginning of the pilot field of the downlink slot (*j*+1) mod 15.

2) When feedback command is transmitted in uplink slot *i*, which is transmitted approximately 1024 chips in offset from the received downlink slot *j*, the adjustment is done at the beginning of the pilot field of the downlink slot (*j*+2) mod 15.

Thus, adjustment timing at UTRAN Access Point is either according to 1) or 2) as controlled by the higher layers.

In case of soft handover, Layer 1 shall support different adjustment timing values for different radio links in the same active set.

The timing of the weight adjustment of the PDSCH is such that the PDSCH weight adjustment is done at the PDSCH slot border, N chips after the adjustment of the associated DPCH, where 0 ≤ N < 2560.

The timing of the weight adjustment of the HS-PDSCH is such that the HS-PDSCH weight adjustment is done at the HS-PDSCH slot border, respectively, M chips after the adjustment of the associated DPCH, where 0 ≤ M < 2560.

7.2 Determination of feedback information~~Closed loop mode 1~~

The UE uses the CPICH transmitted both from antenna 1 and antenna 2 to calculate the phase adjustment to be applied at UTRAN access point to maximise the UE received power. In each slot, UE calculates the optimum phase adjustment, ϕ, for antenna 2, which is then quantized into ϕ_Q having two possible values as follows:

$$\phi_Q = \begin{cases} \pi, & \text{if } \pi/2 < \phi - \phi_r(i) \le 3\pi/2 \\ 0, & \text{otherwise} \end{cases} \qquad (1)$$

where:

$$\phi_r(i) = \begin{cases} 0, & i = 0,2,4,6,8,10,12,14 \\ \pi/2, & i = 1,3,5,7,9,11,13 \end{cases} \qquad (2)$$

If $\phi_Q = 0$, a command '0' is send to UTRAN using the FSM_{ph} field. Correspondingly, if $\phi_Q = \pi$, command '1' is send to UTRAN using the FSM_{ph} field.

Due to rotation of the constellation at UE the UTRAN interprets the received commands according to table 9 which shows the mapping between phase adjustment, ϕ_i, and received feedback command for each uplink slot.

Table 9: Phase adjustments, ϕ_i, corresponding to feedback commands for the slots *i* of the UL radio frame

Slot #		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
FSM	0	0	π/2	0	π/2	0	π/2	0	π/2	0	π/2	0	π/2	0	π/2	0
	1	π	-π/2	π	-π/2	π	-π/2	π	-π/2	π	-π/2	π	-π/2	π	-π/2	π

The weight w_2 is then calculated by averaging the received phases over 2 consecutive slots. Algorithmically, w_2 is calculated as follows:

$$w_2 = \frac{\sum_{i=n-1}^{n} \cos(\phi_i)}{2} + j\frac{\sum_{i=n-1}^{n} \sin(\phi_i)}{2} \qquad (3)$$

where:

$$\phi_i \in \{0, \pi, \pi/2, -\pi/2\} \qquad (4)$$

For antenna 1, w_1 is constant:

$$w_1 = 1/\sqrt{2} \qquad (5)$$

7.2.1 ~~Mode 1 e~~End of frame adjustment

In closed loop mode 1 at frame borders the averaging operation is slightly modified. Upon reception of the FB command for slot 0 of a frame, the average is calculated based on the command for slot 13 of the previous frame and the command for slot 0 of the current frame, i.e. ϕ_i from slot 14 is not used:

$$w_2 = \frac{\cos(\phi_{13}^{j-1}) + \cos(\phi_0^j)}{2} + j\frac{\sin(\phi_{13}^{j-1}) + \sin(\phi_0^j)}{2} \qquad (6)$$

where:

- ϕ_{13}^{j-1} = phase adjustment from frame j-1, slot 13.
- ϕ_0^j = phase adjustment from frame j, slot 0.

7.2.2 ~~Mode 1 n~~Normal initialisation

For the first frame of transmission UE determines the feedback commands in a normal way and sends them to UTRAN.

Before the first FB command is received, the UTRAN shall use the initial weight $w_2 = \frac{1}{2}(1+j)$.

Having received the first FB command the UTRAN calculates w_2 as follows:

$$w_2 = \frac{\cos(\pi/2) + \cos(\phi_0)}{2} + j\frac{\sin(\pi/2) + \sin(\phi_0)}{2} \qquad (7)$$

where:

ϕ_0 = phase adjustment from slot 0 of the first frame.

7.2.3 ~~Mode 1 o~~Operation during compressed mode

7.2.3.1 Downlink in compressed mode and uplink in normal mode

When downlink is in compressed mode but uplink is operating normally (i.e. not compressed) the UTRAN continues it's Tx diversity related functions in the same way as in non-compressed downlink mode.

In downlink transmission gaps there are uplink slots for which no new estimate of the phase adjustment is calculated. During these slots the following rules are applied in UE when determining the feedback command:

1) If no new estimate of phase adjustment ϕ_i exists corresponding to the feedback command to be sent in uplink slot *i*:
   - If $1 < i < 15$:
     - the feedback command sent in uplink slot *i*-2 is used;
   - else if $i = 0$:
     - the feedback command sent in uplink slot 14 of previous frame is used;
   - else if $i = 1$:
     - the feedback command sent in uplink slot 13 of previous frame is used;
   - end if.

2) When transmission in downlink is started again in downlink slot $N_{last}+1$ (if $N_{last}+1 = 15$, then slot 0 in the next frame) the UE must resume calculating new estimates of the phase adjustment. The feedback command corresponding to the first new estimate of ϕ_i must be sent in the uplink slot which is transmitted approximately 1024 chips in offset from the downlink slot $N_{last}+1$.

7.2.3.2 Both downlink and uplink in compressed mode

During the uplink transmission gaps no FB commands are sent from UE to UTRAN. When transmission in downlink is started again in downlink slot N_{last}+1 (if N_{last}+1 = 15, then slot 0 in the next frame) the UE must resume calculating new estimates of the phase adjustment. The feedback command corresponding to the first new estimate of ϕ_i must be sent in the uplink slot which is transmitted approximately 1024 chips in offset from the downlink slot N_{last}+1.

The UTRAN continues to update the weight w_2 until the uplink transmission gap starts and no more FB commands are received. When the transmission in downlink resumes in slot N_{last}+1, the value of w_2, calculated after receiving the last FB command before the start of the uplink transmission gap, is applied to antenna 2 signal.

After the UE resumes transmission in uplink and sends the first FB command, the new value of w_2 is calculated as follows:

- S_1 = {0, 2, 4, 6, 8, 10, 12 14}.
- S_2 = {1, 3, 5, 7, 9, 11, 13}.
- i = number of uplink slot at which the transmission resumes.
- j = number of uplink slot at which the last FB command was sent before the start of the uplink transmission gap.
- Do while ($i \in S_1$ *and* $j \in S_1$) or ($i \in S_2$ *and* $j \in S_2$):
  - j = j-1;
  - if j < 0;
  - j = 14;
- end if;
- end do;
- calculate w_2 based on FB commands received in uplink slots i and j.

Note that for N_{last} = 13 the end of frame adjustment procedure shall be based on the FB commands for the last odd slot prior to the uplink transmission gap and slot 0.

7.2.3.3 Uplink in compressed mode and downlink in normal mode

The UTRAN continues to update the value of w_2 until the uplink transmission gap starts and no more FB commands are received. Then, the value of w_2 calculated after receiving the last FB command before the uplink transmission gap is applied to the antenna 2 signal. When the UE resumes transmission in uplink, it shall send FB commands according to section 7.2 equations 2 and 3 (normal operation) and the UTRAN Access Point shall interpret the FB commands according to Table 9.

The calculation of w_2 by the UTRAN following the uplink transmission gap, and before the first two FB commands following the gap are received is not specified.

7.2.4 ~~Mode 1 i~~Initialisation during compressed mode

7.2.4.1 Downlink in compressed mode

When closed loop mode 1 is initialised during the downlink transmission gap of compressed mode there are slots for which no estimate of the phase adjustment is calculated and no previous feedback command is available.

In this case, if the UE is required to send feedback in the uplink, the FB command to the UTRAN shall be ‘0’.

When transmission in downlink is started again in slot N_{last}+1 (if N_{last}+1 = 15, then slot 0 in the next frame), the UTRAN shall use the initial weight $w_2 = \frac{1}{2}(1+j)$. The UE must start calculating estimates of the phase adjustment. The feedback command corresponding to the first estimate of ϕ_i must be sent in the uplink slot which is transmitted approximately 1024 chips in offset from the downlink slot N_{last}+1. Having received this feedback command the UTRAN calculates w_2 as follows:

$$w_2 = \frac{\cos(\phi_i) + \cos(\phi_j)}{2} + j\frac{\sin(\phi_i) + \sin(\phi_j)}{2} \qquad (8)$$

where:

ϕ_i = phase adjustment in uplink slot i , which is transmitted approximately 1024 chips in offset from the downlink slot N_{last}+1.

$\phi_j = \frac{\pi}{2}$, if slot i is even ($i \in \{0, 2, 4, 6, 8, 10, 12, 14\}$) and

$\phi_j = 0$, if slot i is odd ($i \in \{1, 3, 5, 7, 9, 11, 13\}$)

7.2.4.2 Uplink in compressed mode

Initialisation of closed loop mode 1 operation during uplink compressed mode only is not specified.

7.3 Closed loop mode 2

In closed loop mode 2 there are 16 possible combinations of phase and power adjustment from which the UE selects and transmits the FSM according to table 10 and table 11. As opposed to closed loop Mode 1, no constellation rotation is done at UE and no filtering of the received weights is performed at the UTRAN.

Table 10: FSM_{po} subfield of closed loop mode 2 signalling message

FSM_{po}	Power_ant1	Power_ant2
0	0.2	0.8
1	0.8	0.2

Table 11: FSM_{ph} subfield of closed loop mode 2 signalling message

FSM_{ph}	Phase difference between antennas (radians)
000	π
001	-3π/4
011	-π/2
010	-π/4
110	0
111	π/4
101	π/2
100	3π/4

To obtain the best performance, progressive updating is performed at both the UE and the UTRAN Access point. The UE procedure shown below is an example of how to determine FSM at UE. Different implementation is allowed. Every slot time, the UE may refine its choice of FSM, from the set of weights allowed given the previously transmitted bits of the FSM. This is shown in figure 5, where, in this figure b_i ($0 \le i \le 3$) are the bits of the FSM (from table 10 and table 11) from the MSB to the LSB and m=0, 1, 2, 3 (the end of frame adjustment given in subclause 7.3.1 is not shown here).

At the beginning of a FSM to be transmitted, the UE chooses the best FSM out of the 16 possibilities. Then the UE starts sending the FSM bits from the MSB to the LSB in the portion of FBI field of the uplink DPCCH during 4 (FSM message length) slots. Within the transmission of the FSM the UE refines its choice of FSM. This is defined in the following:

- define the 4 bits of FSM, which are transmitted from slot number k to k+3, as $\{b_3(k)\ b_2(k+1)\ b_1(k+2)\ b_0(k+3)\}$, where k=0, 4, 8, 12. Define also the estimated received power criteria defined in Equation 1 for a given FSM as $P(\{x_3\ x_2\ x_1\ x_0\})$, where $\{x_3\ x_2\ x_1\ x_0\}$ is one of the 16 possible FSMs which defines an applied phase and power offset according to table 10 and table 11. The $b_i()$ and x_i are 0 or 1.

The bits transmitted during the m'th FSM of the frame, where m=0,1,2,3, are then given by:

- $b_3(4m)=X_3$ from the $\{X_3\ X_2\ X_1\ X_0\}$ which maximises $P(\{x_3\ x_2\ x_1\ x_0\})$ over all x_3,x_2,x_1,x_0 (16 possible combinations);

- $b_2(4m+1)=X_2$ from the $\{b_3(4m)\ X_2\ X_1\ X_0\}$ which maximises $P(\{b_3(4m)\ x_2\ x_1\ x_0\})$ over all x_2,x_1,x_0 (8 possible combinations);

- $b_1(4m+2)=X_1$ from the $\{b_3(4m)\ b_2(4m+1)\ X_1\ X_0\}$ which maximises $P(\{b_3(4m)\ b_2(4m+1)\ x_1\ x_0\})$ over all x_1,x_0 (4 possible combinations);

- $b_0(4m+3)=X_0$ from the $\{b_3(4m)\ b_2(4m+1)\ b_1(4m+2)\ X_0\}$ which maximises $P(\{b_3(4m)\ b_2(4m+1)\ b_1(4m+2)\ x_0\})$ over x_0 (2 possible combinations).

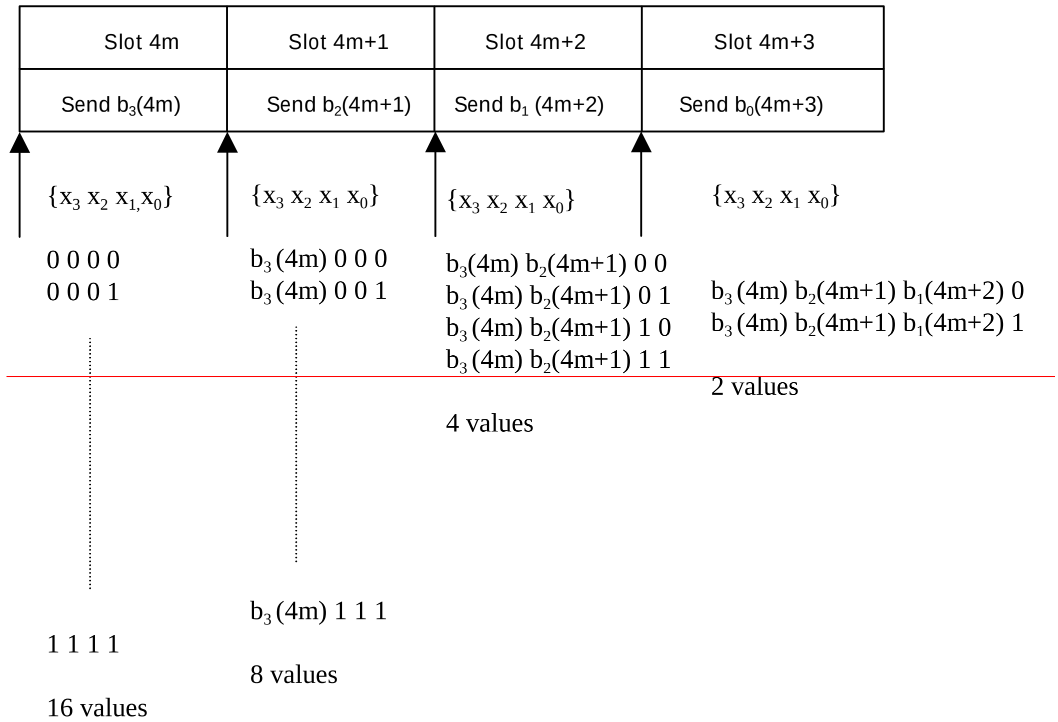

Figure 5: Progressive Refinement at the UE for closed loop mode 2

Every slot time the UTRAN constructs the FSM from the most recently received bits for each position in the word and applies the phase and amplitude (derived from power) as defined by table 10 and table 11. More precisely, the UTRAN operation can be explained as follows. The UTRAN maintains a register $\mathbf{z}=\{z_3\ z_2\ z_1\ z_0\}$, which is updated every slot time according to $z_i=b_i(ns)$ (i=0:3, ns=0:14). Every slot time the contents of register $\mathbf{z}$ are used to determine the phase and power adjustments as defined by table 10 and table 11, with $FSM_{ph}=\{z_3\ z_2\ z_1\}$ and $FSM_{po}=z_0$.

Special procedures for initialisation and end of frame processing are described below.

The weight vector, $\underline{w}$, is then calculated as:

$$\underline{w}=\begin{bmatrix}\sqrt{power\_ant1}\\ \sqrt{power\_ant2}\exp(j\ phase\_diff)\end{bmatrix} \qquad (9)$$

7.3.1 Mode 2 end of frame adjustment

The FSM must be wholly contained within a frame. To achieve this an adjustment is made to the last FSM in the frame where the UE only sends the FSM_{ph} subfield, and the UTRAN takes the power bit FSM_{po} of the previous FSM.

7.3.2 Mode 2 normal initialisation

For the first frame of transmission using closed loop mode 2, the operation is as follows.

The UE starts sending the FSM message from slot 0 in the normal way. The UE may refine its choice of FSM in slots 1 to 3 from the set of weights allowed given the previously transmitted bits of the FSM.

The UTRAN Access Point operation is as follows. Until the first FSM_{po} bit is received and acted upon (depending on the timing control specified via the higher layer parameter described in section 7.1) the power in both antennas shall be set to 0.5. Until the first FSM_{ph} bit is received and acted upon the phase difference between antennas shall be π radians.

The phase offset applied between the antennas is updated according to the number and value of FSM_{ph} bits received as given in table 12.

Table 12: FSM_{ph} normal initialisation for closed loop mode 2

FSM_{ph}	Phase difference between antennas (radians)
- - -	π (normal initialisation) or held from previous setting (compressed mode recovery)
0 - -	π
1 - -	0
0 0 -	π
0 1 -	-π/2
1 1 -	0
1 0 -	π/2
0 0 0	π
0 0 1	-3π/4
0 1 1	-π/2
0 1 0	-π/4
1 1 0	0
1 1 1	π/4
1 0 1	π/2
1 0 0	3π/4

This operation applies in both the soft handover and non soft handover cases.

7.3.3 Mode 2 operation during compressed mode

7.3.3.1 Downlink in compressed mode and uplink in normal mode

When the downlink is in compressed mode and the uplink is in normal mode, the closed loop mode 2 functions are described below.

When the UE is not listening to the CPICH from antennas 1 and 2 during the downlink transmission gap, the UE sends the last FSM bits calculated before the start of the downlink transmission gap.

Recovery from compressed mode is described in the following. Downlink transmissions commence at the pilot field of slot Nlast as described in [2].

After a transmission gap, UTRAN Access Point sets the power in both antennas to 0.5 until a FSM_{po} bit is received and acted upon. Until the first FSM_{ph} bit is received and acted upon, UTRAN uses the phase offset, which was applied before the transmission interruption (table 12).

If the uplink slot Nlast+1 (modulo 15) occurs at the beginning of a FSM period (that is at slot 0,4,8,or 12), the UE sends the FSM message in the normal way, with 3 FSM_{ph} bits and with the FSM_{po} bit on slot 3, 7 or 11, and the UTRAN Access Point acts on the FSM_{ph} bits according to table 12.

If the uplink slot Nlast+1 (modulo 15) does not occur at the beginning of a FSM period, the following operation is performed. In each of the remaining slots of the partial FSM period, that is from slot Nlast+1 (modulo 15) until the final slot (slot 3, 7, 11or 14), and for the first slot of the next full FSM period, the UE sends the first (i.e. MSB) bit of the FSM_{ph} message, and at the UTRAN access point the phase offset applied between the antennas is updated according to the number and value of FSM_{ph} bits received as given in table 13. During the following full FSM period, which starts on slot 0, 4, 8, or 12, the UE sends the FSM message in the normal way, with 3 FSM_{ph} bits and with the FSM_{po} bit on slot 3, 7 or 11, and the UTRAN Access Point acts on the FSM_{ph} bits according to table 12.

Table 13: FSM_{ph} subfield of closed loop mode 2 in compressed mode recovery period

FSM_{ph}	Phase difference between antennas (radians)
-	held from previous setting
0	π
1	0

7.3.3.2 Both downlink and uplink in compressed mode

During both downlink and uplink compressed mode, the UTRAN and the UE performs the functions of recovery after transmission gaps as described in the previous subclause 7.3.3.1.

7.3.3.3 Uplink in compressed mode and downlink in normal mode

The UTRAN continues to update the weight vector $\underline{w}$ until the uplink transmission gap starts and no more FSM bits are received. Then, UTRAN Access Point continues to apply the weight vector $\underline{w}$, which was used before the transmission gap. When the UE resumes transmission in uplink, it chooses FSM according to normal operation as described in section 7.3 and 7.3.1. If the uplink signalling does not resume at the beginning of a FSM period, the UE shall calculate the remaining FSM bits according to section 7.3, using the last FSM(s) sent before the uplink gap as the "previously transmitted bits of the FSM".

The calculation of the phase adjustment by UTRAN remains unspecified until all 3 FSM_{ph} bits have been received following the uplink transmission gap. The calculation of the power adjustment by UTRAN remains unspecified until an FSM_{po} bit has been received following the uplink transmission gap.

7.3.4 Mode 2 initialisation during compressed mode

7.3.4.1 Downlink in compressed mode

When closed loop mode 2 is initialised during the downlink transmission gap of compressed mode there are slots for which no FSM bit is calculated and no previous sent FSM bit is available.

In this case, if the UE is required to send feedback in the uplink, the FB command to the UTRAN shall be ‘0’.

The UTRAN and the UE perform the functions of recovery after the downlink transmission gap as described in the previous subclause 7.3.3.1. If no previous phase setting is available, UTRAN shall use the phase offset π, until the first FSM_{ph} bit is received and acted upon.

7.3.4.2 Uplink in compressed mode

Initialisation of closed loop mode 2 operation during uplink compressed mode only is not specified.

8 Idle periods for IPDL location method

8.1 General

To support time difference measurements for location services, idle periods can be created in the downlink (hence the name IPDL) during which time transmission of all channels from a Node B is temporarily seized. During these idle periods the visibility of neighbour cells from the UE is improved.

The idle periods are arranged in a predetermined pseudo random fashion according to higher layer parameters. Idle periods differ from compressed mode in that they are shorter in duration, all channels are silent simultaneously, and no attempt is made to prevent data loss.

In general there are two modes for these idle periods:

- Continuous mode, and
- Burst mode.

In continuous mode the idle periods are active all the time. In burst mode the idle periods are arranged in bursts where each burst contains enough idle periods to allow a UE to make sufficient measurements for its location to be calculated. The bursts are separated by a period where no idle periods occur.

8.2 Parameters of IPDL

The following parameters are signalled to the UE via higher layers:

IP_Status: This is a logic value that indicates if the idle periods are arranged in continuous or burst mode.

IP_Spacing: The number of 10 ms radio frames between the start of a radio frame that contains an idle period and the next radio frame that contains an idle period. Note that there is at most one idle period in a radio frame.

IP_Length: The length of the idle periods, expressed in symbols of the CPICH.

IP_Offset: A cell specific offset that can be used to synchronise idle periods from different sectors within a Node B.

Seed: Seed for the pseudo random number generator.

Additionally in the case of burst mode operation the following parameters are also communicated to the UE.

Burst_Start: Specifies the start of the first burst of idle periods. 256×Burst_Start is the SFN where the first burst of idle periods starts.

Burst_Length: The number of idle periods in a burst of idle periods.

Burst_Freq: Specifies the time between the start of a burst and the start of the next burst. 256×Burst_Freq is the number of radio frames of the primary CPICH between the start of a burst and the start of the next burst.

8.3 Calculation of idle period position

In burst mode, burst #0 starts in the radio frame with SFN = 256×Burst_Start. Burst #*k* starts in the radio frame with SFN = 256×Burst_Start + *k*×256×Burst_Freq(*k* = 0,1,2, …). The sequence of bursts according to this formula continues up to and including the radio frame with SFN = 4095. At the start of the radio frame with SFN = 0, the burst sequence is terminated (no idle periods are generated) and at SFN = 256×Burst_Start the burst sequence is restarted with burst #0 followed by burst #1 etc., as described above.

Continuous mode is equivalent to burst mode, with only one burst spanning the whole SFN cycle of 4096 radio frames, this burst starting in the radio frame with SFN = 0.

Assume that IP_Position(x) is the position of idle period number x within a burst, where x = 1, 2, …, and IP_Position(x) is measured in number of CPICH symbols from the start of the first radio frame of the burst.

The positions of the idle periods within each burst are then given by the following equation:

$$\text{IP\_Position}(x) = (x \times \text{IP\_Spacing} \times 150) + (\text{rand}(x \text{ modulo } 64) \text{ modulo } (150 - \text{IP\_Length})) + \text{IP\_Offset};$$

where rand(m) is a pseudo random generator defined as follows:

$$\text{rand}(0) = \text{Seed};$$

$$\text{rand}(m) = (106\times\text{rand}(m-1) + 1283) \text{ modulo } 6075,\ m = 1, 2, 3, \ldots.$$

Note that x is reset to $x = 1$ for the first idle period in every burst.

Figure 6 below illustrates the idle periods for the burst mode case.

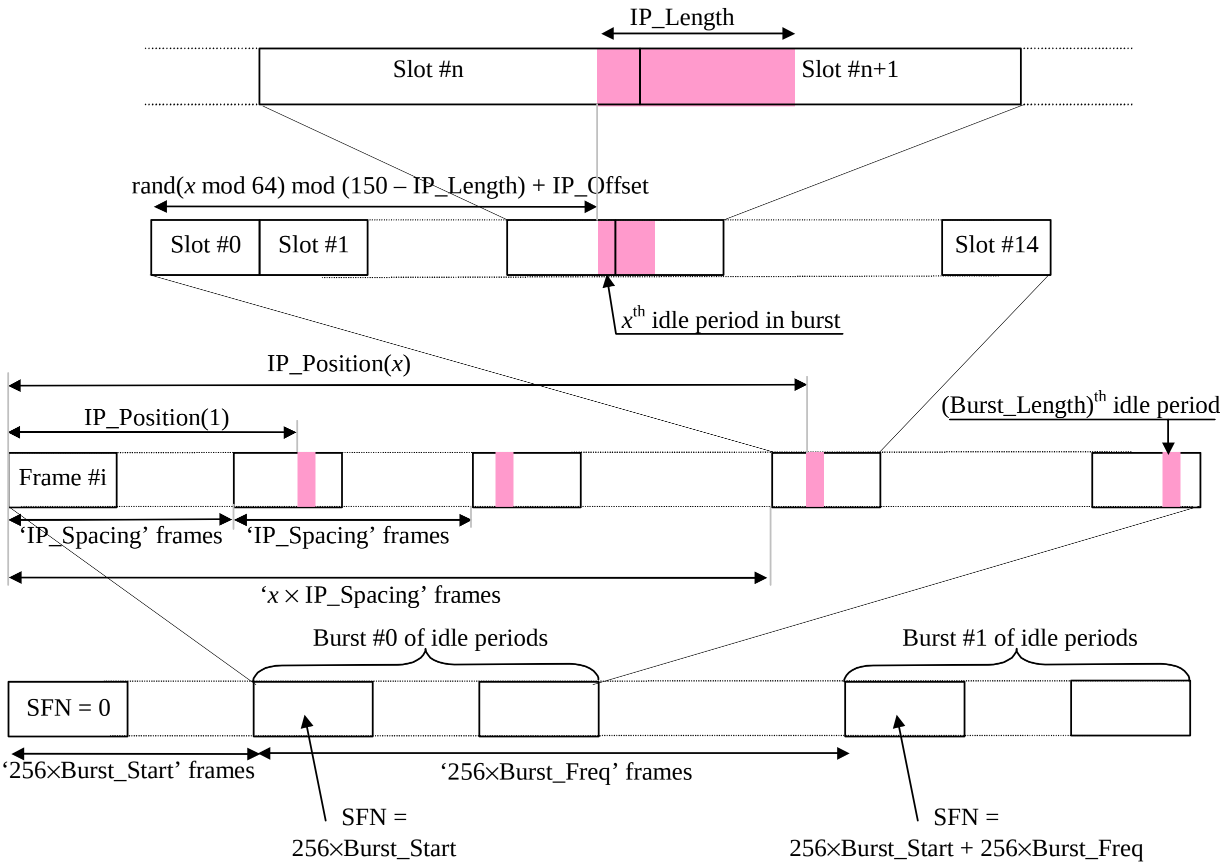

Figure 6: Idle Period placement in the case of burst mode operation

Annex A (informative):

A.1 Antenna verification

In closed loop mode 1, if channel estimates are taken from the Primary CPICH, the performance will also suffer if the UE cannot detect errors since the channel estimates will be taken for the incorrect phase settings. To mitigate this problem, antenna verification can be done, which can make use of antenna specific pilot patterns of the dedicated physical channel. The antenna verification can be implemented with several different algorithms. A straightforward algorithm can use a 4-hypothesis test per slot. Alternatively, a simplified beam former verification (SBV) requiring only a 2-hypothesis test per slot can be used.

Consider

$$2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Re}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\bar{p}(\phi_{Rx}=\pi)}{\bar{p}(\phi_{Rx}=0)}\right)$$

Then define the variable x_0 as 0 if the above inequality holds good and $x_0 = \pi$ otherwise.

Similarly consider

$$-2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Im}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\bar{p}(\phi_{Rx}=\pi/2)}{\bar{p}(\phi_{Rx}=-\pi/2)}\right)$$

then define the variable x_1 as $-\pi/2$ if the above inequality holds good and $x_1 = \pi/2$ oherwise.

Whether x_0 or x_1 is to be calculated for each slot is given by the following table , where the first row contains the UL slot index of the feedback bit to be verified.

UL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0

The estimate for the transmitted phase is now obtained from

$$\sin(\phi_{Tx}) + j\cos(\phi_{Tx}) = \frac{\sum_{i=0}^{1}\sin(x_i)}{\sqrt{2}} + j\frac{\sum_{i=0}^{1}\cos(x_i)}{\sqrt{2}}$$

where:

- the x_i values are used corresponding to the current slot and the previous slot taking into account the end-of-frame adjustment and the used CL timing adjustment delay
- $h_{2,i}^{(p)}$ is the *i*'th estimated channel tap of antenna 2 using the CPICH;
- $h_{2,i}^{(d)}$ is the *i*'th estimated channel tap of antenna 2 using the DPCCH;
- γ^2 is the DPCH Pilot SNIR/ CPICH SNIR;
- σ_i^2 is the noise plus interference power on the *i*'th path.

In normal operation the *a priori* probability for selected pilot pattern is assumed to be 96% (assuming there are 4% of errors in the feedback channel for power control and antenna selection).

For closed loop mode 2, if channel estimates are taken from the Primary CPICH, antenna verification can also be performed, for example using a 16-hypothesis test per slot. For closed loop mode 2, the same pilot sequence is transmitted on both antennas for DPCCH. Therefore, we obtain channel estimates from the DPCCH that correspond to the combined channel from both transmitting antennas:

$$\vec{h}^{(d)} = \gamma(\beta_1 \vec{h}_1 + \beta_2 \vec{h}_2) + \vec{b}^{(d)}$$

where β_1, β_2 are the applied coefficients on the antennas at the UTRAN, γ is as defined above for mode 1 verification, $\vec{h}_i$ is the actual channel vector from the *i-th* antenna, and $\vec{b}^{(d)}$ is the noise vector for the DPCCH channel estimate. Furthermore we have channel estimates made on the CPICH Pilots for each antenna:

$$\vec{h}_1^{(p)} = \vec{h}_1 + \vec{b}_1^{p}$$

$$\vec{h}_2^{(p)} = \vec{h}_2 + \vec{b}_2^{p}$$

where $\vec{h}_i^{(p)}$ is the estimated channel vector using the CPICH, and $\vec{b}_i^{p}$ is the noise vector for the CPICH channel estimate, from the *i-th* antenna.

At the receiver, verification consists in choosing a pair of applied coefficients, $(\hat{\beta}_1, \hat{\beta}_2)$, which results in a combined channel estimate from CPICH which best fits the channel estimate obtained from the DPCCH, taking into account the *a priori* probability of error on the FBI bits.

One possible way of implementing verification for mode 2 is by choosing $(\hat{\beta}_1, \hat{\beta}_2)$ from the whole set of possibilities $T = \{\alpha_1, \alpha_2\}$, using the logarithmic form of the following decision rule:

$$(\hat{\beta}_1, \hat{\beta}_2) = \arg\left\langle \max_{\alpha_1, \alpha_2 \in T} \left\{ \ln(\hat{p}(\alpha_1, \alpha_2)) + \ln(\overline{p}(\alpha_1, \alpha_2)) \right\} \right\rangle$$

where the *a priori* probability $\overline{p}(\alpha_1, \alpha_2)$ for each candidate antenna coefficient pair is determined from the antenna coefficient pair asked for by the mobile, combined with the *a priori* probability of each FSM bit used to represent the antenna coefficient pair. The *a priori* probability of each FSM bit is assumed to be 96% (assuming there are 4% of errors in the feedback channel). Also

$$\ln(\hat{p}(\alpha_1, \alpha_2)) = -\left(\sum_{i=1}^{Npath} \frac{\left| h_i^{(d)} - \gamma\left(\alpha_1 h_{1,i}^{(p)} + \alpha_2 h_{2,i}^{(p)}\right) \right|^2}{\sigma_i^2 \left(1 + \gamma^2 \left(|\alpha_1|^2 + |\alpha_2|^2\right)\right)} \right)$$

where σ_i^2 is as defined above for mode 1 verification.

A.2 Computation of feedback information for closed loop mode 1 transmit diversity