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25.221 CR 010 Current Version: V3.0.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to: TSG RAN #6	for approval: X	strategic:	(for SMG use only)
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Proposed change affects: (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]
(at least one should be marked with an X)

Source: Nokia, Siemens **Date:** 03.12.1999

Subject: Introduction of the timeslot formats to the TDD specifications

Work item: TS25.221

Category: *(only one category shall be marked with an X)*

F	Correction	
A	Corresponds to a correction in an earlier release	
B	Addition of feature	
C	Functional modification of feature	
D	Editorial modification	X

Release:

Phase 2	
Release 96	
Release 97	
Release 98	
Release 99	X
Release 00	

Reason for change: In order to keep the harmonisation between the FDD and TDD specs it would be very useful to have the timeslot formats in the TDD specifications

Clauses affected: 5.2.2.3, 5.2.3, 5.2.4, 5.3

Other specs affected:

Other 3G core specifications		→ List of CRs:
Other GSM core specifications		→ List of CRs:
MS test specifications		→ List of CRs:
BSS test specifications		→ List of CRs:
O&M specifications		→ List of CRs:

Other comments:

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5.2.2.3 Timeslot formats

5.2.2.3.1 Downlink timeslot formats

The downlink timeslot format depends on the spreading factor, midamble length and on the number of the TFCI bits, as depicted in the table 4a.

Table 4a: Time slot formats for the Downlink

Slot Format #	Spreading Factor	Midamble length (chips)	N_{TFCI} (bits)	Bits/slot	$N_{Data/Slot}$ (bits)	$N_{data/data\ field}$ (bits)
0	16	512	0	244	244	122
1	16	512	4	244	240	120
2	16	512	8	244	236	118
3	16	512	16	244	228	114
4	16	512	32	244	212	106
5	16	256	0	276	276	138
6	16	256	4	276	272	136
7	16	256	8	276	268	134
8	16	256	16	276	260	130
9	16	256	32	276	244	122
10	1	512	0	3904	3904	1952
11	1	512	4	3904	3900	1950
12	1	512	8	3904	3896	1948
13	1	512	16	3904	3888	1944
14	1	512	32	3904	3872	1936
15	1	256	0	4416	4416	2208
16	1	256	4	4416	4412	2206
17	1	256	8	4416	4408	2204
18	1	256	16	4416	4400	2200
19	1	256	32	4416	4384	2192

5.2.2.3.2 Uplink timeslot formats

The uplink timeslot format depends on the spreading factor, midamble length, the TPC presence and on the number of the TFCI bits. In the case that TPC is used, different amount of bits are mapped to the two data fields. The timeslot formats are depicted in the table 4b.

Table 4b: Timeslot formats for the Uplink

Slot Format #	Spreading Factor	Midamble length (chips)	N_{TFCI} (bits)	N_{TPC} (bits)	Bits/slot	$N_{Data/Slot}$ (bits)	$N_{data/data\ field(1)}$ (bits)	$N_{data/data\ field(2)}$ (bits)
0	16	512	0	0	244	244	122	122
1	16	512	4	0	244	240	120	120
2	16	512	8	0	244	236	118	118
3	16	512	16	0	244	228	114	114
4	16	512	32	0	244	212	106	106
5	16	512	0	2	244	242	122	120
6	16	512	4	2	244	238	120	118
7	16	512	8	2	244	234	118	116
8	16	512	16	2	244	226	114	112
9	16	512	32	2	244	210	106	104
10	16	256	0	0	276	276	138	138
11	16	256	4	0	276	272	136	136
12	16	256	8	0	276	268	134	134
13	16	256	16	0	276	260	130	130
14	16	256	32	0	276	244	122	122
15	16	256	0	2	276	274	138	136
16	16	256	4	2	276	270	136	134
17	16	256	8	2	276	266	134	132
18	16	256	16	2	276	258	130	128
19	16	256	32	2	276	242	122	120
20	8	512	0	0	488	488	244	244
21	8	512	4	0	488	484	242	242
22	8	512	8	0	488	480	240	240
23	8	512	16	0	488	472	236	236
24	8	512	32	0	488	456	228	228
25	8	512	0	2	488	486	244	242
26	8	512	4	2	488	482	242	240
27	8	512	8	2	488	478	240	238
28	8	512	16	2	488	470	236	234
29	8	512	32	2	488	454	228	226

30	8	256	0	0	552	552	276	276
31	8	256	4	0	552	548	274	274
32	8	256	8	0	552	544	272	272
33	8	256	16	0	552	536	268	268
34	8	256	32	0	552	520	260	260
35	8	256	0	2	552	550	276	274
36	8	256	4	2	552	546	274	272
37	8	256	8	2	552	542	272	270
38	8	256	16	2	552	534	268	266
39	8	256	32	2	552	518	260	258
40	4	512	0	0	976	976	488	488
41	4	512	4	0	976	972	486	486
42	4	512	8	0	976	968	484	484
43	4	512	16	0	976	960	480	480
44	4	512	32	0	976	944	472	472
45	4	512	0	2	976	974	488	486
46	4	512	4	2	976	970	486	484
47	4	512	8	2	976	966	484	482
48	4	512	16	2	976	958	480	478
49	4	512	32	2	976	942	472	470
50	4	256	0	0	1104	1104	552	552
51	4	256	4	0	1104	1100	550	550
52	4	256	8	0	1104	1096	548	548
53	4	256	16	0	1104	1088	544	544
54	4	256	32	0	1104	1072	536	536
55	4	256	0	2	1104	1102	552	550
56	4	256	4	2	1104	1098	550	548
57	4	256	8	2	1104	1094	548	546
58	4	256	16	2	1104	1086	544	542
59	4	256	32	2	1104	1070	536	534
60	2	512	0	0	1952	1952	976	976
61	2	512	4	0	1952	1948	974	974
62	2	512	8	0	1952	1944	972	972
63	2	512	16	0	1952	1936	968	968
64	2	512	32	0	1952	1920	960	960
65	2	512	0	2	1952	1950	976	974
66	2	512	4	2	1952	1946	974	972
67	2	512	8	2	1952	1942	972	970

68	2	512	16	2	1952	1934	968	966
69	2	512	32	2	1952	1918	960	958
70	2	256	0	0	2208	2208	1104	1104
71	2	256	4	0	2208	2204	1102	1102
72	2	256	8	0	2208	2200	1100	1100
73	2	256	16	0	2208	2192	1096	1096
74	2	256	32	0	2208	2176	1088	1088
75	2	256	0	2	2208	2206	1104	1102
76	2	256	4	2	2208	2202	1102	1100
77	2	256	8	2	2208	2198	1100	1098
78	2	256	16	2	2208	2190	1096	1094
79	2	256	32	2	2208	2174	1088	1086
80	1	512	0	0	3904	3904	1952	1952
81	1	512	4	0	3904	3900	1950	1950
82	1	512	8	0	3904	3896	1948	1948
83	1	512	16	0	3904	3888	1944	1944
84	1	512	32	0	3904	3872	1936	1936
85	1	512	0	2	3904	3902	1952	1950
86	1	512	4	2	3904	3898	1950	1948
87	1	512	8	2	3904	3894	1948	1946
88	1	512	16	2	3904	3886	1944	1942
89	1	512	32	2	3904	3870	1936	1934
90	1	256	0	0	4416	4416	2208	2208
91	1	256	4	0	4416	4412	2206	2206
92	1	256	8	0	4416	4408	2204	2204
93	1	256	16	0	4416	4400	2200	2200
94	1	256	32	0	4416	4384	2192	2192
95	1	256	0	2	4416	4414	2208	2206
96	1	256	4	2	4416	4410	2206	2204
97	1	256	8	2	4416	4406	2204	2202
98	1	256	16	2	4416	4398	2200	2198
99	1	256	32	2	4416	4282	2192	2190

5.2.3 Training sequences for spread bursts

As explained in the section 5.2.1, two options are being considered for the spreading. The training sequences presented here are common to both options.

The training sequences, i.e. midambles, of different users active in the same time slot are time shifted versions of one single periodic basic code. Different cells use different periodic basic codes, i.e. different midamble sets. In this way a joint channel estimation for the channel impulse responses of all active users within one time slot can be done by one single cyclic correlation. The different user specific channel impulse response estimates are obtained sequentially in time at the output of the correlator. Following this principle it is shown hereafter how to derive the midambles from the periodic basic code.

Section 5.2.2 contains a description of the spread speech/data bursts. These bursts contain Lm midamble chips, which are also termed midamble elements. The Lm elements $\underline{m}_i^{(k)}$; i=1,...,Lm; k=1,...,K; of the midamble codes $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; are taken from the complex set

$$\underline{\mathrm{V}}_{\mathrm{m}} = \{1, \mathrm{j}, -1, -\mathrm{j}\}. \qquad (1)$$

K is the maximum number of users, i.e. the available number of spreading codes per time slot.

The elements $\underline{m}_i^{(k)}$ of the complex midamble codes $\underline{\mathbf{m}}^{(k)}$ fulfil the relation

$$\underline{m}_i^{(k)} = (\mathrm{j})^i \cdot m_i^{(k)} \quad m_i^{(k)} \in \{1, -1\}; i = 1,\dots,L_m; k = 1,\dots,K. \qquad (2)$$

Hence, the elements $\underline{m}_i^{(k)}$ of the complex midamble codes $\underline{\mathbf{m}}^{(k)}$ of the K users are alternating real and imaginary.

With W being the number of taps of the impulse response of the mobile radio channels, the Lm binary elements $m_i^{(k)}; \mathrm{i} = 1,\dots,L_{\mathrm{m}}; k = 1,\dots,K;$ of (2) for the complex midambles $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; of the K users are generated according to the following method from a single periodic basic code

$$\mathbf{m} = \left(m_1, m_2, \dots, m_{L_m + (K'-1)W + \lfloor P/K \rfloor}\right)^{\mathrm{T}} \quad m_i \in \{1, -1\}; \quad i = 1,\dots,(L_m + (K'-1)W + \lfloor P/K \rfloor). \qquad (3)$$

$\lfloor \mathrm{x} \rfloor$ denotes the largest integer smaller or equal to x, K' = K/2.

The elements $m_i; i = 1,\dots,(L_m + (K'-1)W + \lfloor P/K \rfloor)$, of (3) fulfil the relation

$$m_i = m_{i-P} \text{ for the subset } i = (P+1),\dots,(L_m + (K'-1)W + \lfloor P/K \rfloor). \qquad (4)$$

The P elements $m_i; i = 1,\dots,P,$ of one period of m according to (3) are contained in the vector

$$\mathbf{m}_{\mathrm{P}} = (m_1, m_2, \dots, m_P)^{\mathrm{T}}. \qquad (5)$$

With $\mathbf{m}$ according to (3) the Lm binary elements $m_i^{(k)}; \mathrm{i} = 1,\dots,\mathrm{L}_{\mathrm{m}}; k = 1,\dots,K;$ of (2) for the midambles of the first K' users are generated based on the following formula

$$m_i^{(k)} = m_{i+(K-k)W} \quad i = 1,\dots,L_m; k = 1,\dots,K. \qquad (6)$$

The midambles for the second K' users are generated based on a slight modification of this formula introducing intermediate shifts

$$m_i^{(k)} = m_{i+(K'-k)W + \lfloor P/K \rfloor} \quad i = 1,\dots,L_m; k = K'+1,\dots,K. \qquad (7)$$

Whether intermediate shifts are allowed in a cell is broadcast on the BCH.

In the following the term 'a midamble code set' or 'a midamble code family' denotes K specific midamble codes $\underline{\mathbf{m}}^{(k)}$; k=1,...,K. Different midamble code sets $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; are specified based on different periods $\mathbf{m}_{\mathrm{P}}$ according (5).

In adjacent cells of the cellular mobile radio system, different midamble codes sets $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; should be used to guarantee a proper channel estimation.

As mentioned above a single midamble code set $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; consisting of K midamble codes is based on a single period $\mathbf{m}_P$ according to (5).

In the Annex A the periods $\mathbf{m}_P$ according to (5), i.e. the Basic Midamble Codes, which shall be used to generate different midamble code sets $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; are listed in tables in a hexadecimal representation. As shown in table 54 always 4 binary elements m_i are mapped on a single hexadecimal digit.

Table 54: Mapping of 4 binary elements m_i on a single hexadecimal digits

4 binary elements m_i	Mapped on hexadecimal digit
-1 -1 -1 -1	0
-1 -1 -1 1	1
-1 -1 1 –1	2
-1 -1 1 1	3
-1 1 -1 –1	4
-1 1 -1 1	5
-1 1 1 –1	6
-1 1 1 1	7
1 -1 -1 –1	8
1 -1 -1 1	9
1 -1 1 –1	A
1 -1 1 1	B
1 1 -1 –1	C
1 1 -1 1	D
1 1 1 –1	E
1 1 1 1	F

As different Basic Midamble Codes are required for different burst formats, the Annex A shows the codes m_{PL} for burst type 1 and m_{PS} for burst type 2. It should be noted that the different burst types must not be mixed in the same timeslot of one cell.

5.2.3.1 Midamble Transmit Power

If in the downlink all users in one time slot have a common midamble, the transmit power of this common midamble is such that there is no power offset between the data part and the midamble part of the transmit signal within the time slot.

In the case of user specific midambles, the transmit power of the user specific midamble is such that there is no power offset between the data parts and the midamble part for this user within one slot.

5.2.4 Beamforming and Transmit Diversity

When DL beamforming or TX Diversity is used, at least that user to which beamforming/Tx Diversity is applied and which has a dedicated channel shall get one individual midamble according to chapter 5.2.3, even in DL.

5.3 Common control physical channels (CCPCH)

5.3.1 Downlink common control physical channel

Either the BCH, the PCH or the FACH as described in section 4.1.2 are mapped onto one or more downlink common control physical channels (CCPCH). In such a way the capacity of BCH, PCH and FACH can be adopted depending on the operators need.

5.3.1.1 Spreading codes

The downlink CCPCH uses fixed spreading with a spreading factor SF = 16 as described in section 5.2.1.1.

5.3.1.2 Burst Types

The burst type 1 as described in section 5.2.2 is used for the downlink CCPCH. No TFCI is applied for CCPCHs.

5.3.1.3 Training sequences for spread bursts

The training sequences, i.e. midambles, as described in section 5.2.3 are used for the downlink CCPCH.

5.3.1.4 Primary Common Control Physical Channels (PCCPCH)

A CCPCH is referred to as Primary Common Control Physical Channel (PCCPCH) if it is characterised by:

- Transmitted with reference power
- No beamforming
- Known position (timeslot, burst format and code) in frame. The position is known from the Synchronisation Channel (SCH), see section 5.4.
- Carrying BCH

If another physical channel is allocated to the same channelisation code and same timeslot as a PCCPCH, i.e. the same physical resource is used in a multiframe pattern, then this channel has also to use reference power and no beamforming can be applied.

5.3.2 The physical random access channel (PRACH)

The RACH or in case of ODMA networks the ORACH as described in section 4.1.2 are mapped onto one or more uplink physical random access channels (PRACH). In such a way the capacity of RACH and ORACH can be flexibly scaled depending on the operators need.

This description of the physical properties of the PRACH also applies to bursts carrying other signaling or user traffic if they are scheduled on a time slot which is (partly) allocated to the RACH or ORACH.

5.3.2.1 PRACH Spreading codes

The uplink PRACH uses either spreading factor SF=16 or SF=8 as described in section 5.2.1.1. The set of admissible spreading codes for use on the PRACH and the associated spreading factors are broadcast on the BCH (within the RACH configuration parameters on the BCH).

5.3.2.2 PRACH Burst Types

The mobile stations send the uplink access bursts randomly in the PRACH. The PRACH burst consists of two data symbol fields, a midamble and a guard period. The second data symbol field is shorter than the first symbol data field by 96 chips in order to provide additional guard time at the end of the PRACH time slot.

The precise number of collision groups depends on the spreading codes (i.e. the selected RACH configuration. The access burst is depicted in figure 10, the contents of the access burst fields are listed in table 8~~7~~ and table 9~~8~~.

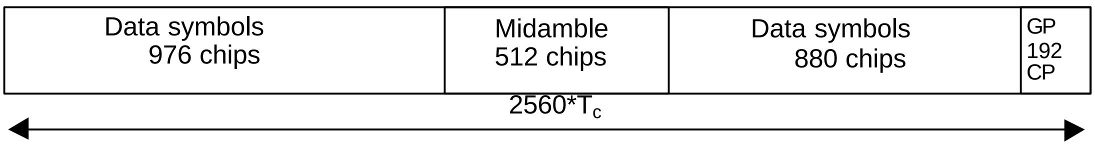

Figure 12: PRACH burst, GP denotes the guard period

Table 8~~7~~: number of symbols per data field in PRACH burst

Spreading factor (Q)	Number of symbols in data field 1	Number of symbols in data field 2
8	122	110
16	61	55

Table 98: The contents of the PRACH burst field

Chip number (CN)	Length of field in chips	Length of field in symbols	Contents of field
0-975	976	cf table 1	Data symbols
976-1487	512	-	Midamble
1488-2367	880	cf table 1	Data symbols
2368-2559	192	-	Guard period

5.3.2.3 PRACH Training sequences

The training sequences, i.e. midambles, of different users active in the same time slot are time shifted versions of a single periodic basic code. The basic midamble codes used for PRACH bursts are the same as for burst type 1 and are shown in Annex A. The necessary time shifts are obtained by choosing either *all* k=1,2,3...,K' (for cells with small radius) or *uneven* k=1,3,5,...≤K' (for cells with large radius). Different cells use different periodic basic codes, i.e. different midamble sets.

For cells with large radius additional midambles may be derived from the time-inverted Basic Midamble Sequence. Thus, the second Basic Midamble Code m_2 is the time inverted version of Basic Midamble Code m_1.

In this way, a joint channel estimation for the channel impulse responses of all active users within one time slot can be performed by a maximum of two cyclic correlations (in cells with small radius, a single cyclic correlator suffices). The different user specific channel impulse response estimates are obtained sequentially in time at the output of the cyclic correlators.

5.3.2.4 Association between Training Sequences and Spreading Codes

For the PRACH there exists a fixed association between the training sequence and the spreading code. The generic rule to define this association is based on the order of the spreading codes $\mathbf{a}_Q^{(k)}$ given by *k* and the order of the midambles $\mathbf{m}_j^{(k)}$ given by *k*, firstly, and *j*, secondly, with the constraint that the midamble for a spreading factor *Q* is the same as in the upper branch for the spreading factor 2*Q*. The index *j=1 or 2* indicates whether the original Basic Midamble Sequence (j=1) or the time-inverted Basic Midamble Sequence is used (j=2).

- For the case that all *k* are allowed and only one periodic basic code m_1 is available for the RACH, the association depicted in figure 13 is straightforward.

- For the case that only odd *k* are allowed the principle of the association is shown in figure 14. This association is applied for one and two basic periodic codes.

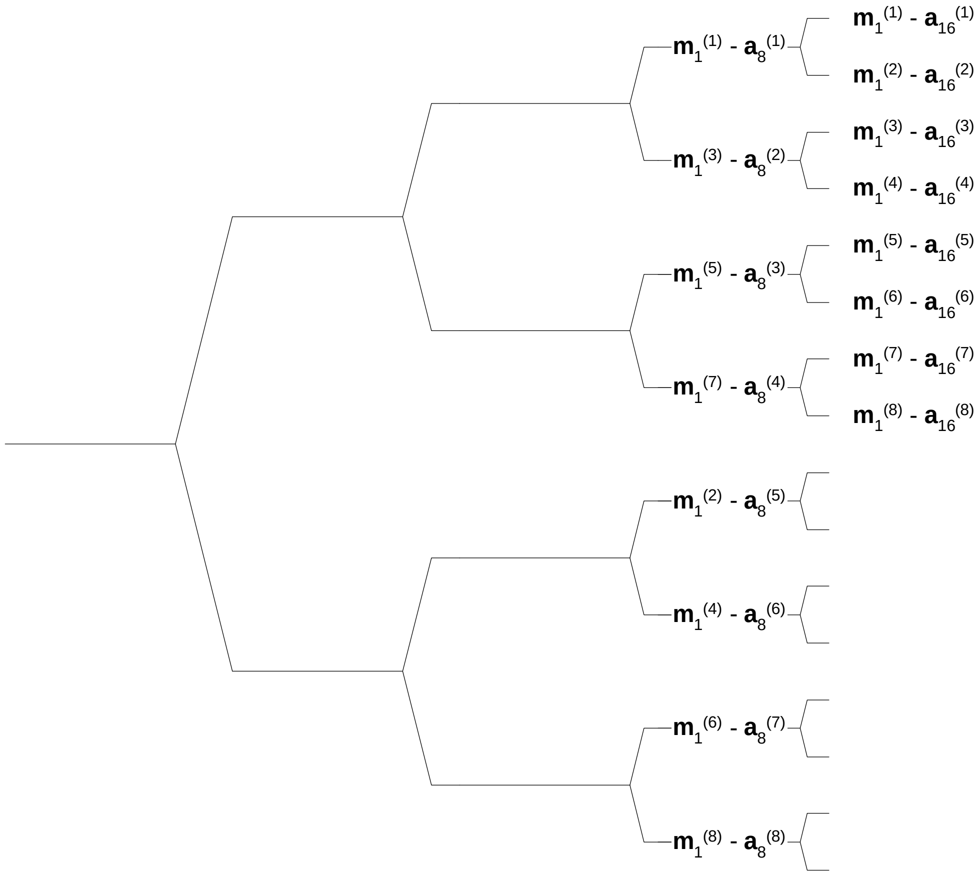

Figure 13: Association of Midambles to Spreading Codes in the OVSF tree for all *k*

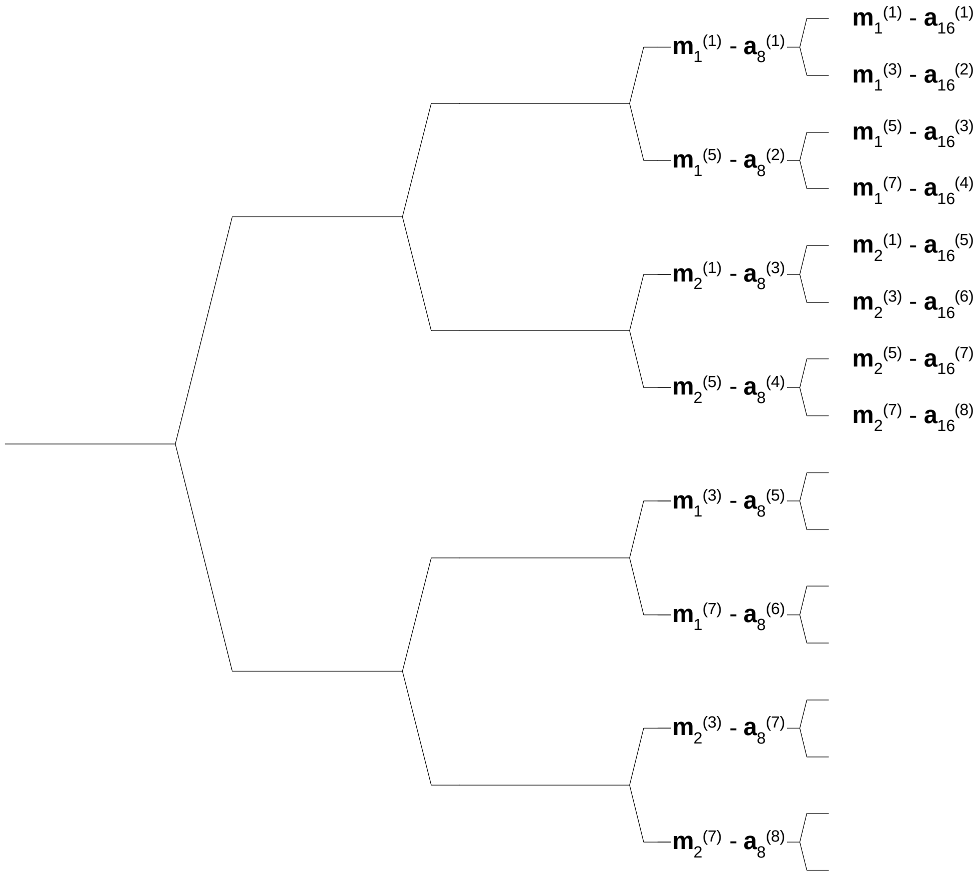

Figure 14: Association of Midambles to Spreading Codes in the OVSF tree for odd *k*

5.4 The physical synchronisation channel (PSCH)

In TDD mode code group of a cell can be derived from the synchronisation channel. Additional information, received from higher layers on SCH transport channel, is also transmitted to the UE in PSCH in case 3 from below. In order not to limit the uplink/downlink asymmetry the PSCH is mapped on one or two downlink slots per frame only.

There are three cases of PSCH and PCCPCH allocation as follows:

Case 1) PSCH and PCCPCH allocated in TS#k, k=0….14

Case 2) PSCH in two TS and PCCPCH in the same two TS: TS#k and TS#k+8, k=0…6

Case 3) PSCH in two TS, TS#k and TS#k+8, k=0…6, and the PCCPCH in TS#i, i=0…14, pointed by PSCH. Pointing is determined via the SCH from the higher layers.

These three cases are addressed by higher layers using the SCCH in TDD Mode. The position of PSCH (value of k) in frame can change on a long term basis in any case.

Due to this PSCH scheme, the position of PCCPCH is known from the PSCH. The PCCPCH are using burst type 1, spreading code $a_{Q=16}^{(k=1)}$ and midamble $m_1^{(1)}$. To simplify measurements of PCCPCH power, this midamble shall not be used by other physical channels in the same timeslot.

Figure 15 is an example for transmission of PSCH, k=0, of Case 2 or Case 3.

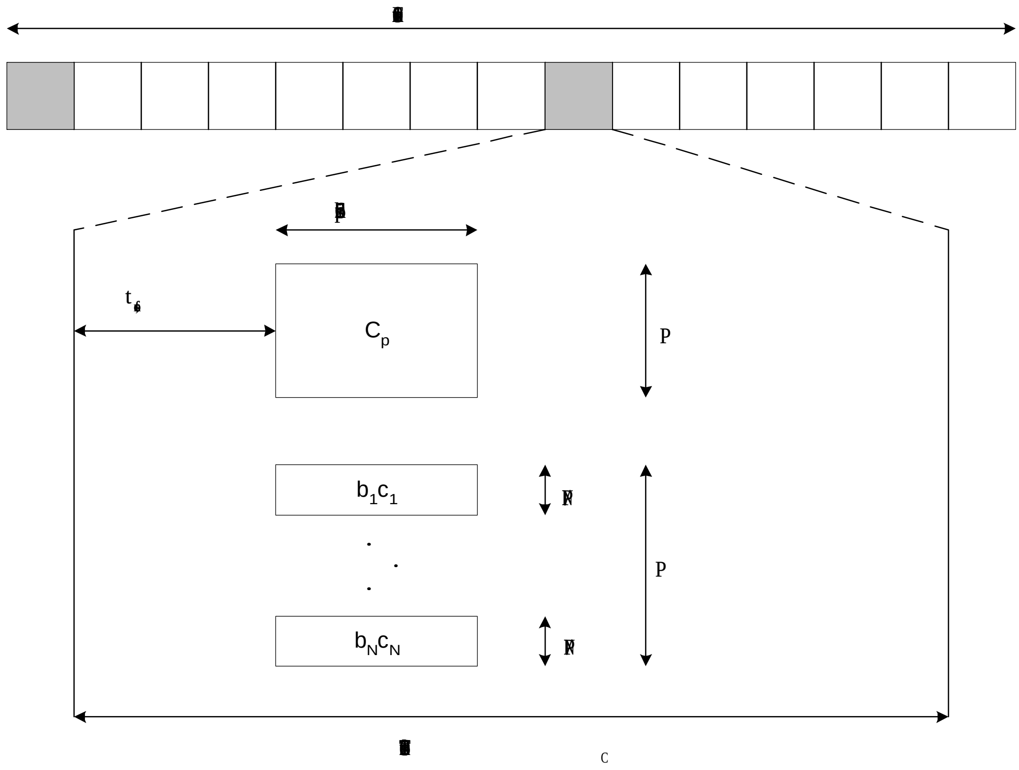

Figure 15: Scheme for Physical Synchronisation channel PSCH consisting of one primary sequence C_p and N=3 parallel secondary sequences in slot k and k+8

(example for k=0 in Case 2 or Case 3)

As depicted in figure 15, the PSCH consists of a primary and three secondary code sequences with 256 chips length. The primary and secondary code sequences are defined in TS 25.223 chapter 7 'Synchronisation codes'. The secondary codes are transmitted either in the I channel or the Q channel, depending on the code group.

Due to mobile to mobile interference, it is mandatory for public TDD systems to keep synchronisation between base stations. As a consequence of this, a capture effect concerning PSCH can arise. The time offset t_{offset} enables the system to overcome the capture effect.

The time offset t_{offset} is one of 32 values, depending on the cell parameter, thus on the code group of the cell, cf. 'table 7 Mapping scheme for Cell Parameters, Code Groups, Scrambling Codes, Midambles and t_{offset}' in [8]. The exact value for t_{offset}, regarding column 'Associated t_{offset}' in table 7 ~~from~~ in [8] is given by:

$$
\begin{aligned}
t_{offset,n} &= n \cdot T_c \left\lfloor \frac{2560-96-256}{31} \right\rfloor \\
&= n \cdot 71 T_c \;; \quad n = 0,\ldots,31
\end{aligned}
$$

Please note that $\lfloor x \rfloor$ denotes the largest integer number less or equal to x and that T_c denotes the chip duration.