3GPP TSG-RAN Working Group 1, Meeting #11 TDoc TSG RAN WG1 (00)0228
San Diego, USA, February 29 – March 3, 2000

Source: Siemens AG
Title: Signal Point Constellation
Agenda Item: Plenary
Document for: Approval

Introduction

The following changes are proposed in order to align the spreading and modulation procedure and the resulting signal point constellation with FDD. The modifications also lead to a uniform signal point constellation for midamble and data parts of a TDD burst.

1. The channelisation and spreading procedure has been aligned with FDD, i.e. the channelisation is now performed by a real valued channelisation code and the scrambling is performed by a complex valued scrambling code.

2. The definition of the Synchronisation Channel has been aligned with the FDD description and the Signal Point Constellation has been changed to an offset QPSK.

Conclusion

The proposed changes have been included in the following CRs: 25.223 CR006r1, 25.224 CR013 and 25.221 CR 015r1.

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25.221	**CR**	**015r1**	Current Version: 3.1.0

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

For submission to:	TSG RAN#7	for approval	X	strategic		*(for SMG use only)*
list expected approval meeting # here ↑		for information		non-strategic		

Form: CR cover sheet, version 2 for 3GPP and SMG The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

Proposed change affects: *(at least one should be marked with an X)*	(U)SIM		ME	X	UTRAN / Radio	X	Core Network	

Source: Siemens AG **Date:** 2000-02-25

Subject: Signal Point Constellation

Work item:

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

F	Correction	X	**Release:**	Phase 2	
A	Corresponds to a correction in an earlier release			Release 96	
B	Addition of feature			Release 97	
C	Functional modification of feature			Release 98	
D	Editorial modification			Release 99	X
				Release 00	

Reason for change: Corresponds to modification in TS25.223 CR 006 regarding Signal Point Constellation

Clauses affected: 5.3.1, 5.3.3.4, 5.3.4, 5.4.1, A.3.1-A.3.5

Other specs affected:

Other 3G core specifications	X	→ List of CRs:	25.223 CR006r1, 25.224 CR013
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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5.3 Common physical channels

5.3.1 Primary common control physical channel (P-CCPCH)

The BCH as described in section 4.1.2 is mapped onto the Primary Common Control Physical Channel (P-CCPCH). The position (time slot / code) of the P-CCPCH is known from the Physical Synchronisation Channel (PSCH), see section 5.3.4.

5.3.1.1 P-CCPCH Spreading

The P-CCPCH uses fixed spreading with a spreading factor SF = 16 as described in section 5.2.1.1. The P-CCPCH always uses channelisation code $\cancel{a_{Q=16}^{(k=1)}}$ $c_{Q=16}^{(k=1)}$.

5.3.1.2 P-CCPCH Burst Types

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

5.3.1.3 P-CCPCH Training sequences

The training sequences, i.e. midambles, as described in section 5.2.3 are used for the P-CCPCH. For those timeslots in which the P-CCPCH is transmitted, the midambles $m^{(1)}$, $m^{(2)}$, $m^{(9)}$ and $m^{(10)}$ are reserved for P-CCPCH in order to support Block STTD antenna diversity and the beacon function, see 5.3.1.4 and 5.4. The use of midambles depends on whether Block STTD is applied to P-CCPCH, see 5.3.1.4.

5.3.1.4 Block STTD antenna diversity for P-CCPCH

Block STTD antenna diversity can be optionally applied for the P-CCPCH. Its support is mandatory for the UE. Two possibilities exist :

- If no antenna diversity is applied to P-CCPCH, $m^{(1)}$ is used and $m^{(2)}$ is left unused.
- If Block STTD antenna diversity is applied to P-CCPCH, $m^{(1)}$ is used for the first antenna and $m^{(2)}$ is used for the diversity antenna.

5.3.3.4 Association between Training Sequences and Channelisation Codes

For the PRACH there exists a fixed association between the training sequence and the channelisation code. The generic rule to define this association is based on the order of the channelisation codes $\cancel{\mathbf{a}}\mathbf{c}_Q^{(k)}$ 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 $2Q$. 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.

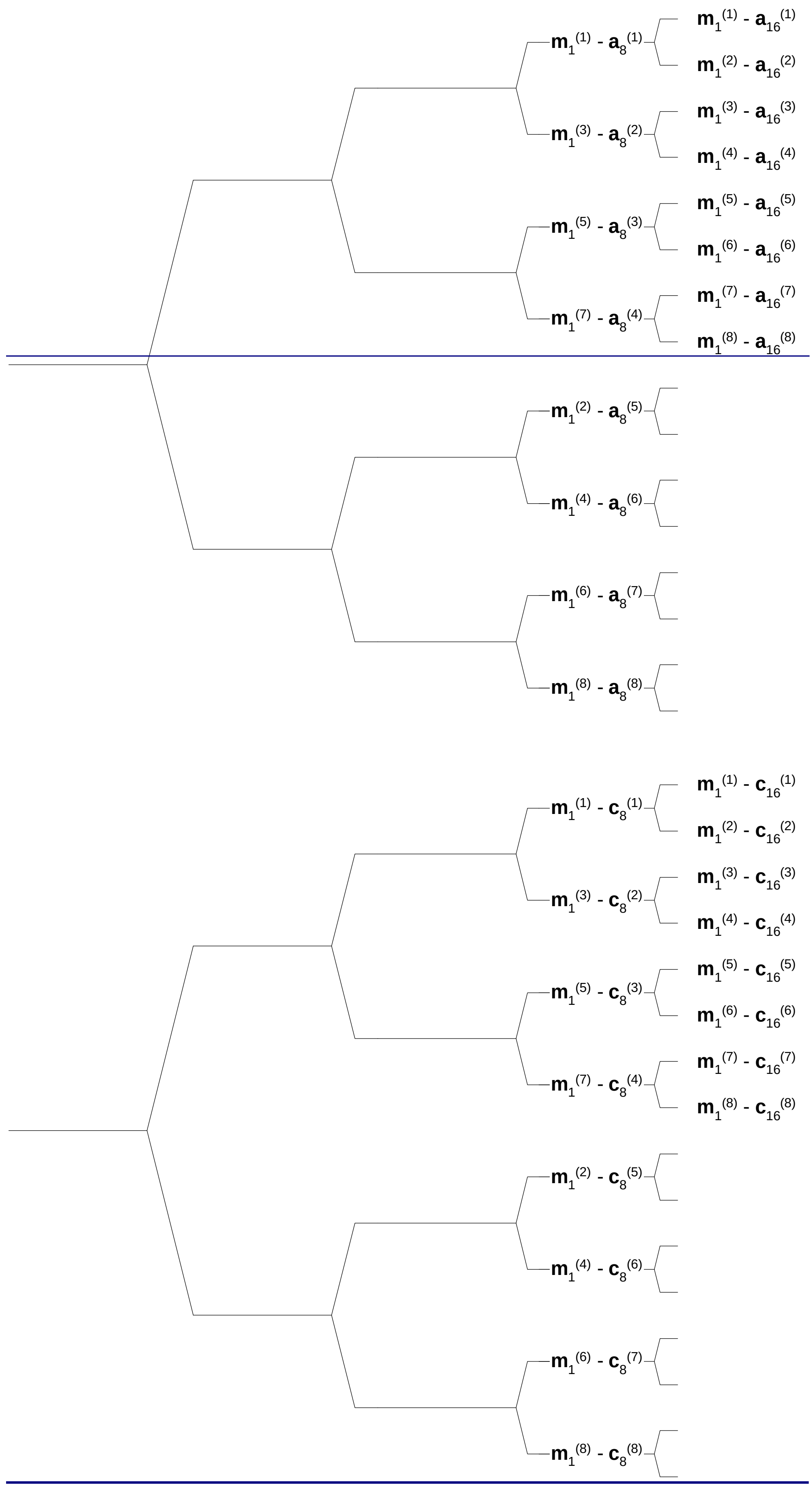


Figure 13: Association of Midambles to Channelisation Codes in the OVSF tree for all *k*

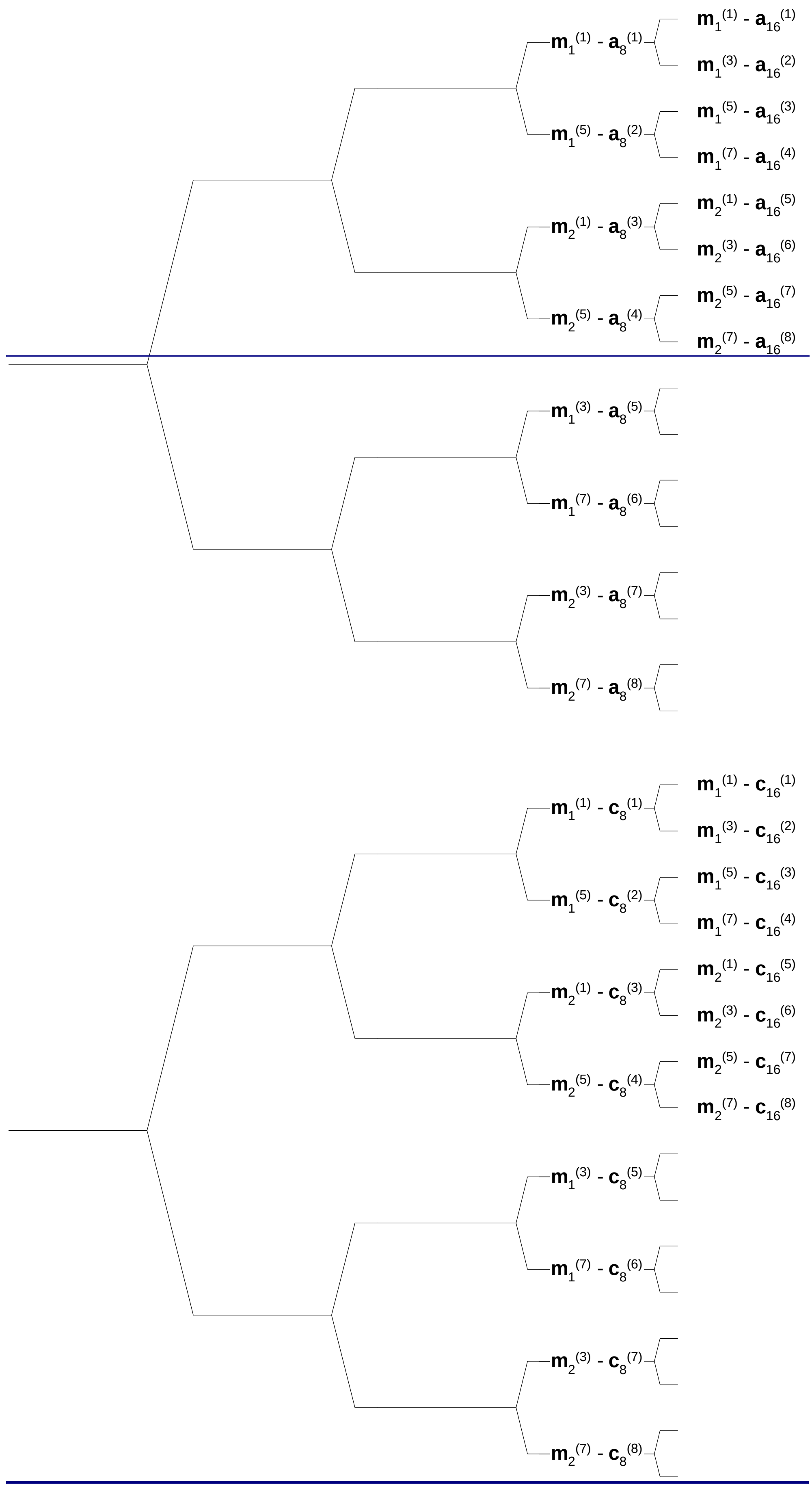


Figure 14: Association of Midambles to Channelisation Codes in the OVSF tree for odd *k*

5.3.4 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 P-CCPCH allocation as follows:

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

Case 2) PSCH allocated in two TS: TS#k and TS#k+8, k=0…6; P-CCPCH allocated in TS#k.

Case 3) PSCH allocated in two TS, TS#k and TS#k+8, k=0…6, and the P-CCPCH allocated in TS#i, i=0…6, 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.
Figure 15 is an example for transmission of PSCH, k=0, of Case 2 or Case 3.

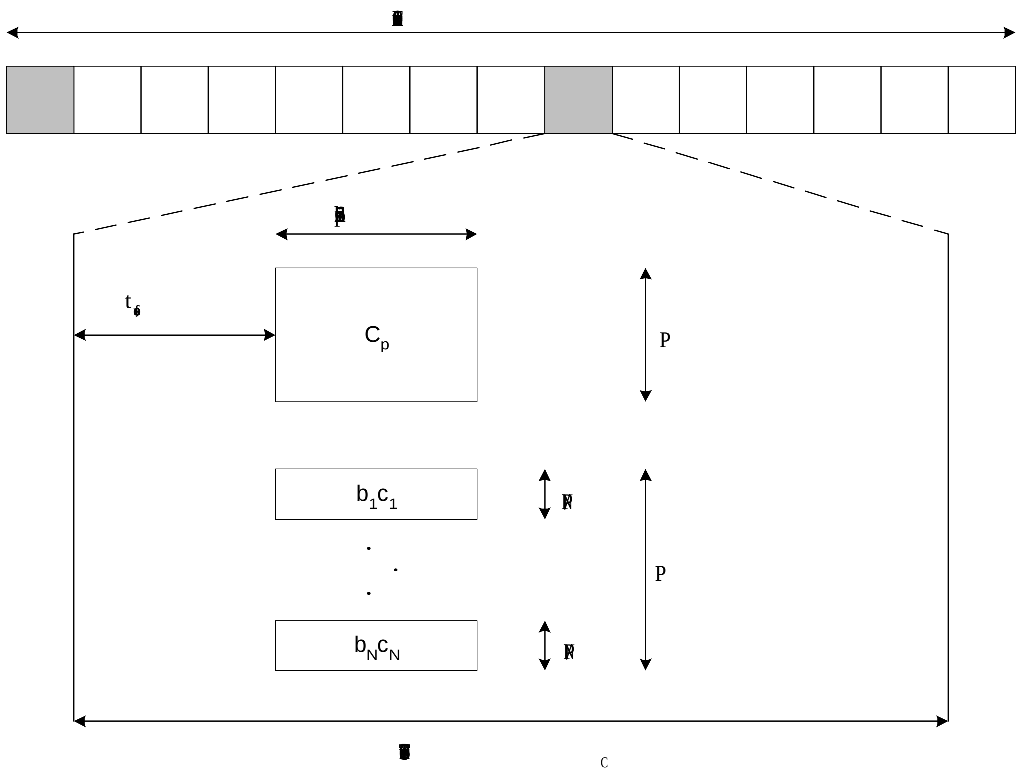


Figure 15: Scheme for Physical Synchronisation channel PSCH consisting of one primary sequence C_p and N=3 parallel secondary sequences in slot k and k+8

(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 [8] 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 in [8] is given by:

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

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

5.4.1 Location of physical channels with beacon function

The location of the physical channels with beacon function is determined by the PSCH and depends on the PSCH allocation case, see 5.3.4:

Case 1) All physical channels that are allocated to channelisation code $\cancel{a^{(k=1)}_{Q=16}}\,\underline{c^{(k=1)}_{Q=16}}$ and in TS#k, k=0….14 shall provide the beacon function.

Case 2) All physical channels that are allocated to channelisation code $\cancel{a^{(k=1)}_{Q=16}}\,\underline{c^{(k=1)}_{Q=16}}$ and in TS#k and TS#k+8, k=0…6, shall provide the beacon function.

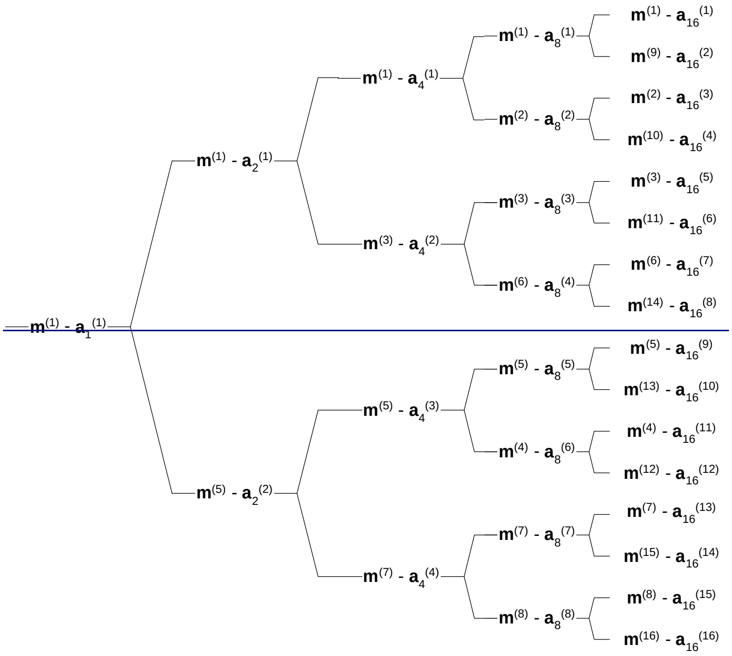
Case 3) All physical channels that are allocated to channelisation code $\cancel{a^{(k=1)}_{Q=16}}\,\underline{c^{(k=1)}_{Q=16}}$ and in TS#i and TS#i+8, i=0…6, pointed by PSCH, shall provide the beacon function.

Note that by this definition the P-CCPCH always provides the beacon function.

A.3 Association between Midambles and Channelisation Codes

The following mapping schemes apply for the association between midambles and channelisation codes if no midamble is allocated by higher layers. Secondary channelisation codes are marked with a (*). These associations apply both for UL and DL.

A.3.1 Association for Burst Type 1 and K=16 Midambles



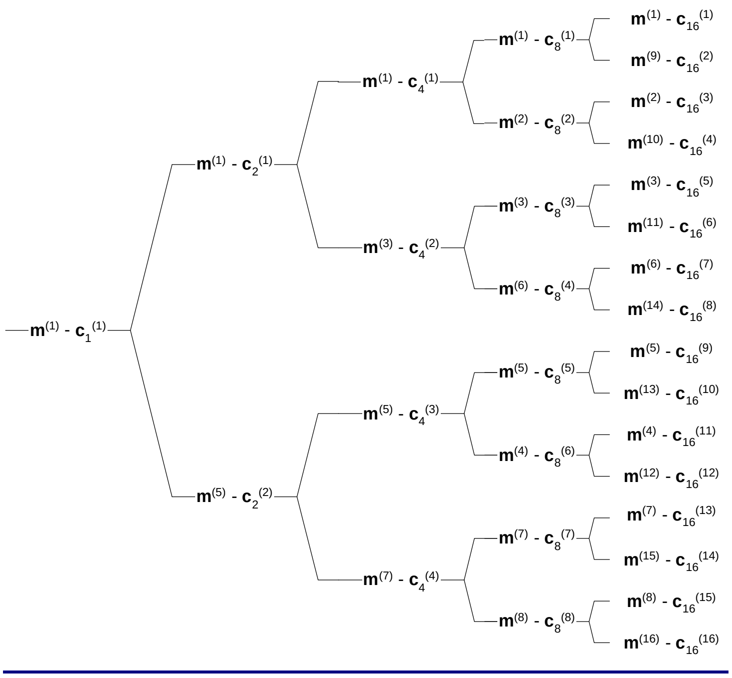
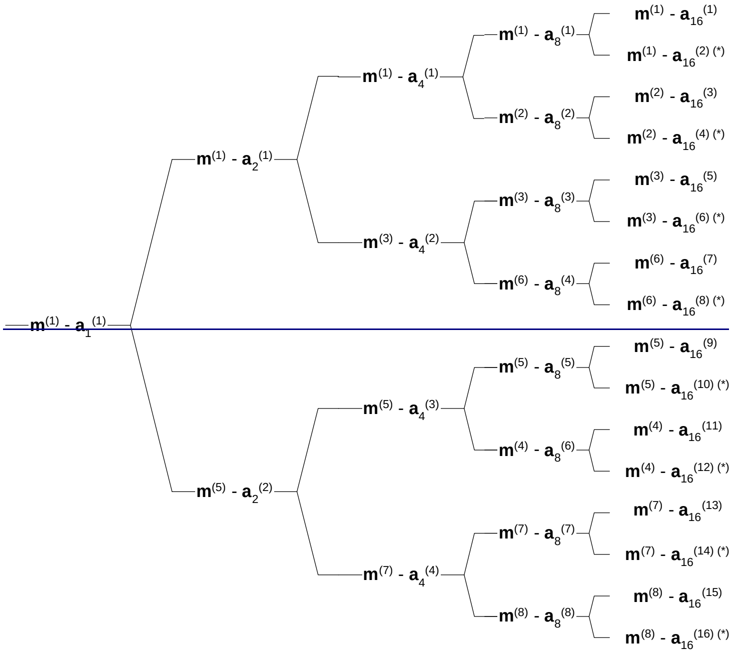


Figure A-1 Association of Midambles to Spreading Codes for Burst Type 1 and K=16

A.3.2 Association for Burst Type 1 and K=8 Midambles



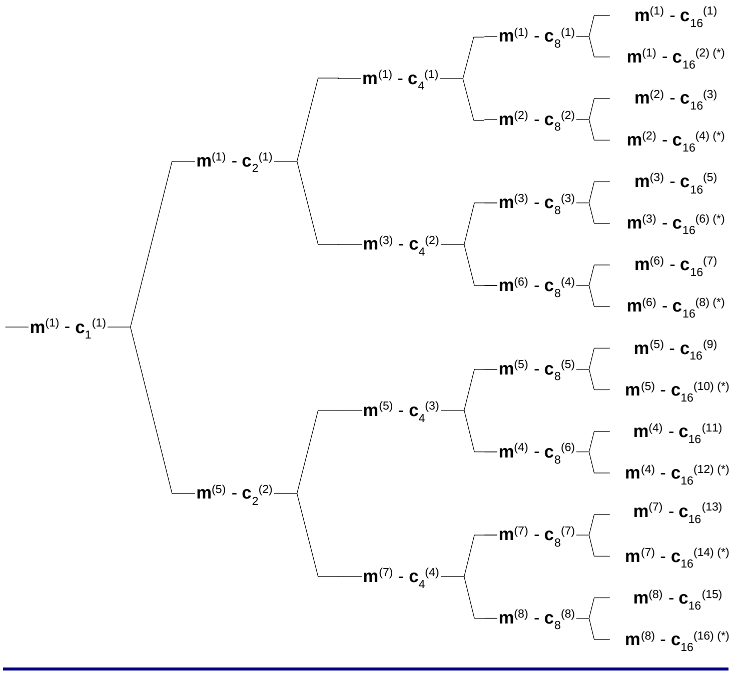


Figure A-2 Association of Midambles to Spreading Codes for Burst Type 1 and K=8

A.3.3 Association for Burst Type 1 and K=4 Midambles

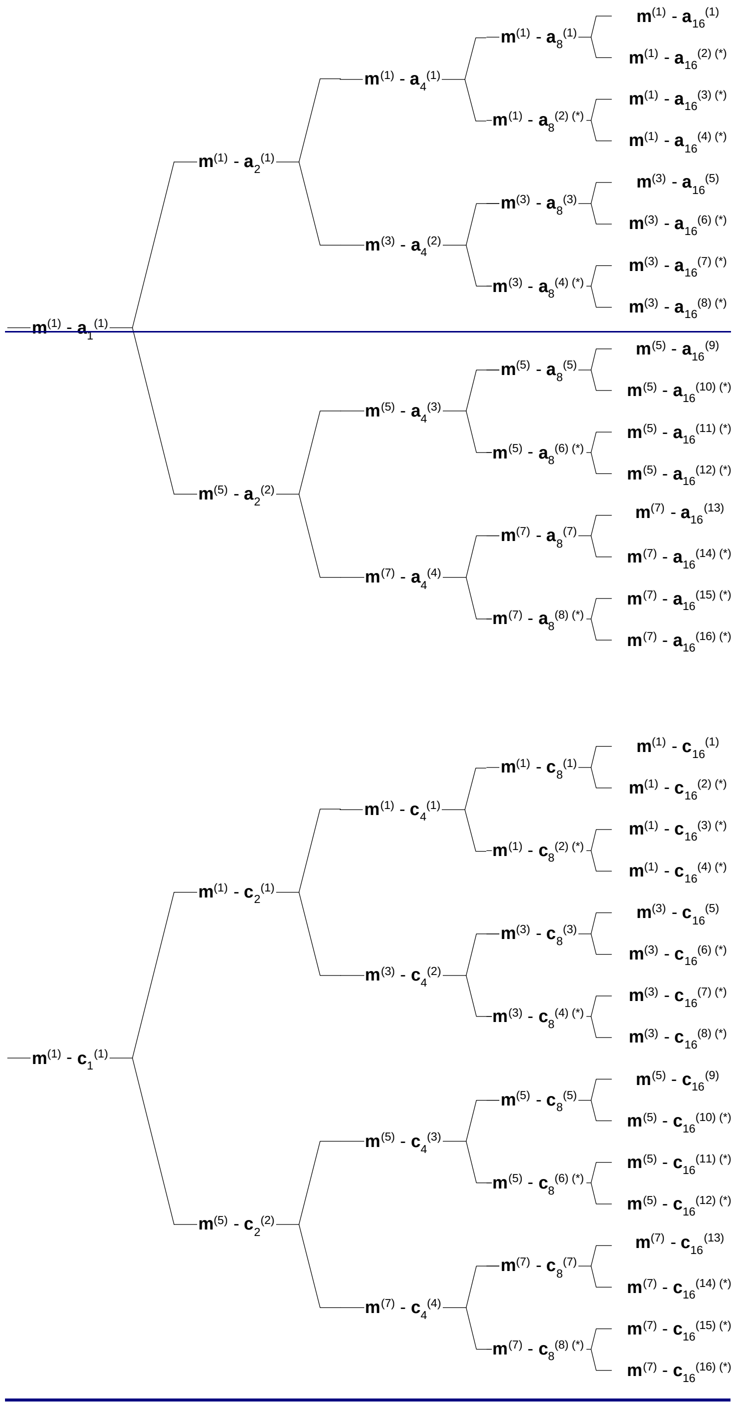


Figure A-3 Association of Midambles to Spreading Codes for Burst Type 1 and K=4

A.3.4 Association for Burst Type 2 and K=6 Midambles

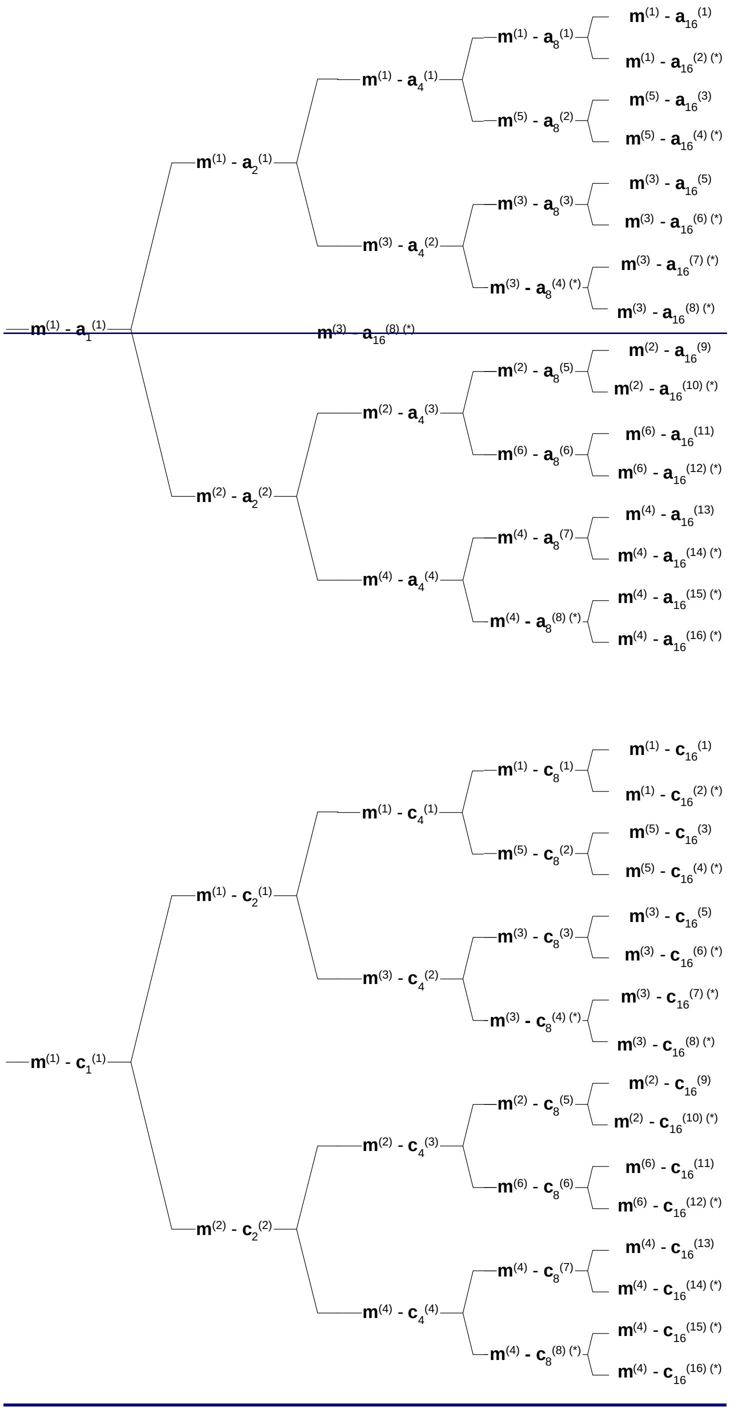


Figure A-4 Association of Midambles to Spreading Codes for Burst Type 2 and K=6

A.3.5 Association for Burst Type 2 and K=3 Midambles

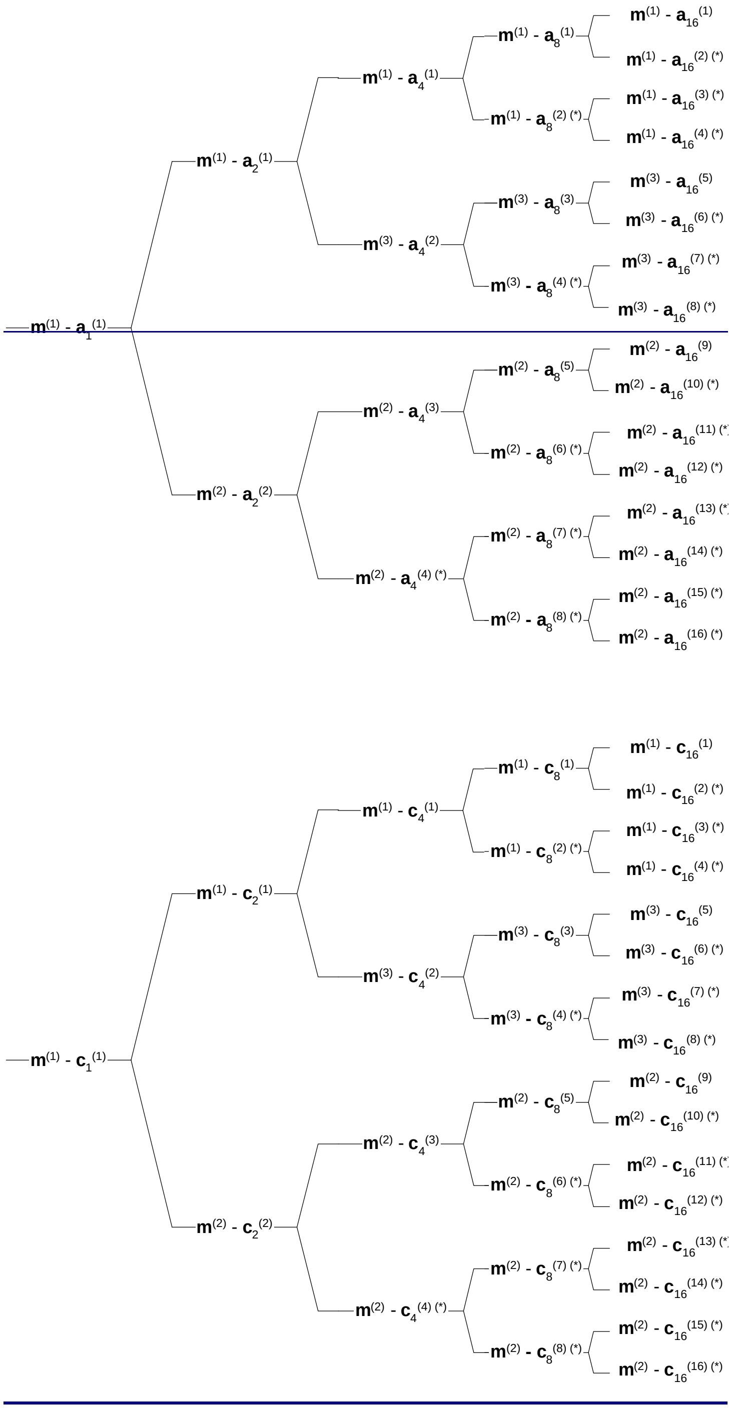


Figure A-5 Association of Midambles to Spreading Codes for Burst Type 2 and K=3

Note that the association for burst type 2 can be derived from the association for burst type 1, using the following table:

Burst Type 1	m(1)	m(2)	m(3)	m(4)	m(5)	m(6)	m(7)	m(8)
Burst Type 2	m(1)	m(5)	m(3)	m(6)	m(2)	m(4)	-	-

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25.223	**CR**	**006r1**	Current Version:	3.1.0

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

For submission to:	TSG RAN#7	for approval	X	strategic		*(for SMG use only)*
list expected approval meeting # here ↑		for information		non-strategic		

Form: CR cover sheet, version 2 for 3GPP and SMG   The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

Proposed change affects: *(at least one should be marked with an X)*	(U)SIM		ME	X	UTRAN / Radio	X	Core Network	

Source:	Siemens AG	**Date:**	2000-02-25
Subject:	Signal Point Constellation		
Work item:			

Category:	F	Correction	X	**Release:**	Phase 2	
	A	Corresponds to a correction in an earlier release			Release 96	
(only one category shall be marked with an X)	B	Addition of feature			Release 97	
	C	Functional modification of feature			Release 98	
	D	Editorial modification			Release 99	X
					Release 00	

Reason for change:
-description of signal point constellation aligned to FDD
-channelisation and scrambling operation modified and aligned with FDD
-SCH description aligned with FDD and signal point constellation of SCH modified

Clauses affected: 5.2, 5.2.1, 5.2.2, 6.1, 6.2, 6.3, 6.4, 6.5, 7.1

Other specs affected:	Other 3G core specifications	X	→ List of CRs:	25.221 CR015r1, 25.224 CR013
	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 Data modulation

5.1 Symbol rate

The symbol duration T_S depends on the spreading factor Q and the chip duration T_C: $T_s = Q \times T_c$, where $T_c = \frac{1}{chiprate}$.

5.2 Mapping of bits onto signal point constellation

5.2.1 Mapping for burst type 1 and 2

~~A certain number K of CDMA codes can be assigned to either a single user or to different users who are simultaneously transmitting bursts in the same time slot and the same frequency. The maximum possible number of CDMA codes, which is smaller or equal to 16, depends on the individual spreading factors, the actual interference situation and the service requirements. The applicable burst formats are shown in[7].~~ The data modulation is performed to the bits from the output of the physical channel mapping procedure in [8] and combines always 2 consecutive binary bits to a complex valued data symbol. Each user burst has two data carrying parts, termed data blocks:

$$\underline{\mathbf{d}}^{(k,i)} = (\underline{d}_1^{(k,i)}, \underline{d}_2^{(k,i)}, \ldots, \underline{d}_{N_k}^{(k,i)})^{\mathrm{T}} \quad i = 1, 2;\ k = 1,\ldots,K. \tag{1}$$

N_k is the number of symbols per data field for the user k. This number is linked to the spreading factor Q_k as described in table 1 of [7].

Data block $\underline{\mathbf{d}}^{(k,1)}$ is transmitted before the midamble and data block $\underline{\mathbf{d}}^{(k,2)}$ after the midamble. Each of the N_k data symbols $\underline{d}_n^{(k,i)}$; i=1, 2; k=1,...,K; n=1,...,N_k; of equation 1 has the symbol duration $T_s^{(k)} = Q_k . T_c$ as already given.

The data modulation is QPSK, thus the data symbols $\underline{d}_n^{(k,i)}$ are generated from two ~~interleaved and encoded~~consecutive data bits from the output of the physical channel mapping procedure in [8]:

$$b_{l,n}^{(k,i)} \in \{0,1\} \qquad l = 1,2;\ k = 1,\ldots K;\ n = 1,\ldots,N_k;\ i = 1,2 \tag{2}$$

using the ~~equation~~following mapping to complex symbols:

consecutive binary bit pattern	complex symbol
$b_{1,n}^{(k,i)}\ b_{2,n}^{(k,i)}$	$\underline{d}_n^{(k,i)}$
00	+j
01	+1
10	-1
11	-j

$$\mathrm{Re}\{\underline{d}_n^{(k,i)}\} = \frac{1}{\sqrt{2}}(2b_{1,n}^{(k,i)} - 1)$$

$$\mathrm{Im}\{\underline{d}_n^{(k,i)}\} = \frac{1}{\sqrt{2}}(2b_{2,n}^{(k,i)} - 1) \qquad k = 1,\ldots,K;\ n = 1,\ldots,N_k;\ i = 1, 2. \qquad \text{~~(3)~~}$$

The mapping~~Equation 3~~ corresponds to a QPSK modulation of the interleaved and encoded data bits $b_{l,n}^{(k,i)}$ of equation 2.

5.2.2 Mapping for PRACH burst type

In case of PRACH burst type, the definitions in subclause 5.2.1 apply with a modified number of symbols in the second data block.. For the PRACH burst type, the number of symbols in the second data block $\underline{\mathbf{d}}^{(k,2)}$ is decreased by $\frac{96}{Q_K}$ symbols.

6 Spreading modulation

6.1 Basic spreading parameters

Spreading of data consists of two operations: Channelisation and Scrambling. Firstly, each complex valued data symbol $\underline{d}_n^{(k,i)}$ of equation 1 is spread with a ~~complex~~ real valued channelisation code $\mathbf{c}^{(k)}$ ~~$\underline{\mathbf{c}}^{(k)}$~~ of length $Q_k \in \{1,2,4,8,16\}$. The resulting sequence is then scrambled by a complex sequence ~~$\mathbf{v}$~~ $\underline{\mathbf{v}}$ of length 16.

6.2 Channelisation codes

The elements $c_q^{(k)}$ ~~$\underline{c}_q^{(k)}$~~; k=1,...,K; q=1,...,Q_k; of the real valued ~~complex~~ channelisation codes $\mathbf{c}^{(k)}=(c_1^{(k)},c_2^{(k)},...,c_{Q_k}^{(k)})$ ~~$\underline{\mathbf{c}}^{(k)}=(\underline{c}_1^{(k)},\underline{c}_2^{(k)},...,\underline{c}_{Q_k}^{(k)})$~~; k=1,...,K; shall be taken from the ~~complex~~ set

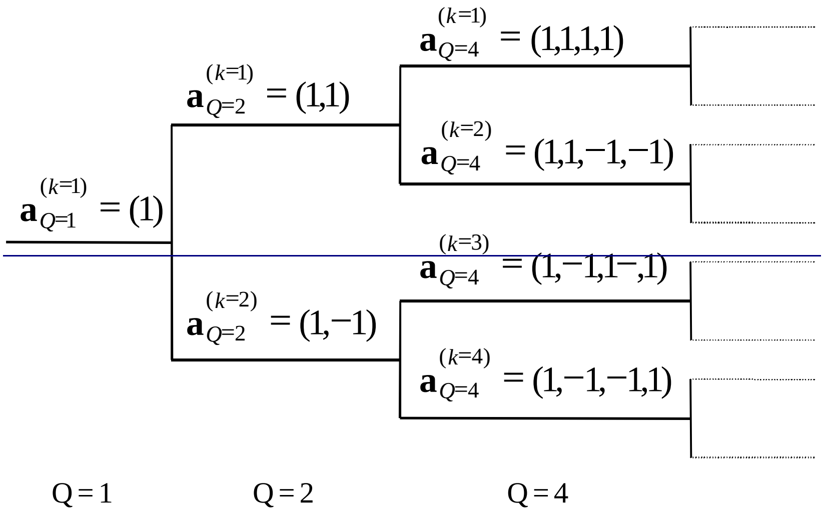
$$\cancel{\underline{V}_c = \{1, j, -1, -j\}}\; V_c = \{1, -1\} \quad (3~~4~~)$$

~~In equation 4 the letter j denotes the imaginary unit. A complex channelisation code $\underline{\mathbf{c}}^{(k)}$ is generated from the binary codes $\mathbf{a}_{Q_k}^{(k)} = (a_1^{(k)}, a_2^{(k)}, \ldots, a_{Q_k}^{(k)})$ of length Q_k shown in figure 2 allocated to the k^{th} user. The relation between the elements $\underline{c}_q^{(k)}$ and $\underline{a}_q^{(k)}$ is given by:~~

$$\cancel{\underline{c}_q^{(k)} = (j)^q \cdot a_q^{(k)} \quad a_q^{(k)} \in \{1, -1\}; q = 1,\ldots,Q_k} \quad \cancel{(5)}$$

~~Hence, the elements $\underline{c}_q^{(k)}$ of the complex channelisation codes $\underline{\mathbf{c}}^{(k)}$ are alternating real and imaginary.~~

The $\mathbf{c}_{Q_k}^{(k)}$ ~~$\mathbf{a}_{Q_k}^{(k)}$~~ are Orthogonal Variable Spreading Factor (OVSF) codes, allowing to mix in the same timeslot channels with different spreading factors while preserving the orthogonality. The OVSF codes can be defined using the code tree of figure ~~2~~1.



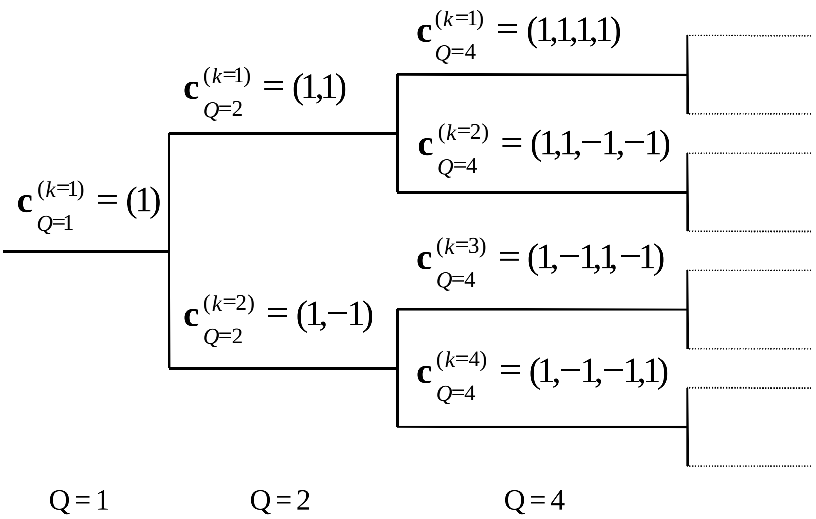


Figure 1: Code-tree for generation of Orthogonal Variable Spreading Factor (OVSF) codes for Channelisation Operation

Each level in the code tree defines a spreading factor indicated by the value of Q in the figure. All codes within the code tree cannot be used simultaneously in a given timeslot. A code can be used in a timeslot if and only if no other code on the path from the specific code to the root of the tree or in the sub-tree below the specific code is used in this timeslot. This means that the number of available codes in a slot is not fixed but depends on the rate and spreading factor of each physical channel.

The spreading factor goes up to Q_{MAX}=16.

6.3 Scrambling codes

The spreading of data by a ~~complex~~ real valued channelisation code $\mathbf{c}^{(k)}$ of length Q_k is followed by a cell specific complex scrambling sequence ~~v=(v1, v2, … vQMAX)~~ $\underline{\mathbf{v}} = (\underline{v}_1, \underline{v}_2, \ldots, \underline{v}_{16})$. The elements $\underline{v}_i; i = 1,\ldots,16$ of the complex valued scrambling codes shall be taken from the complex set

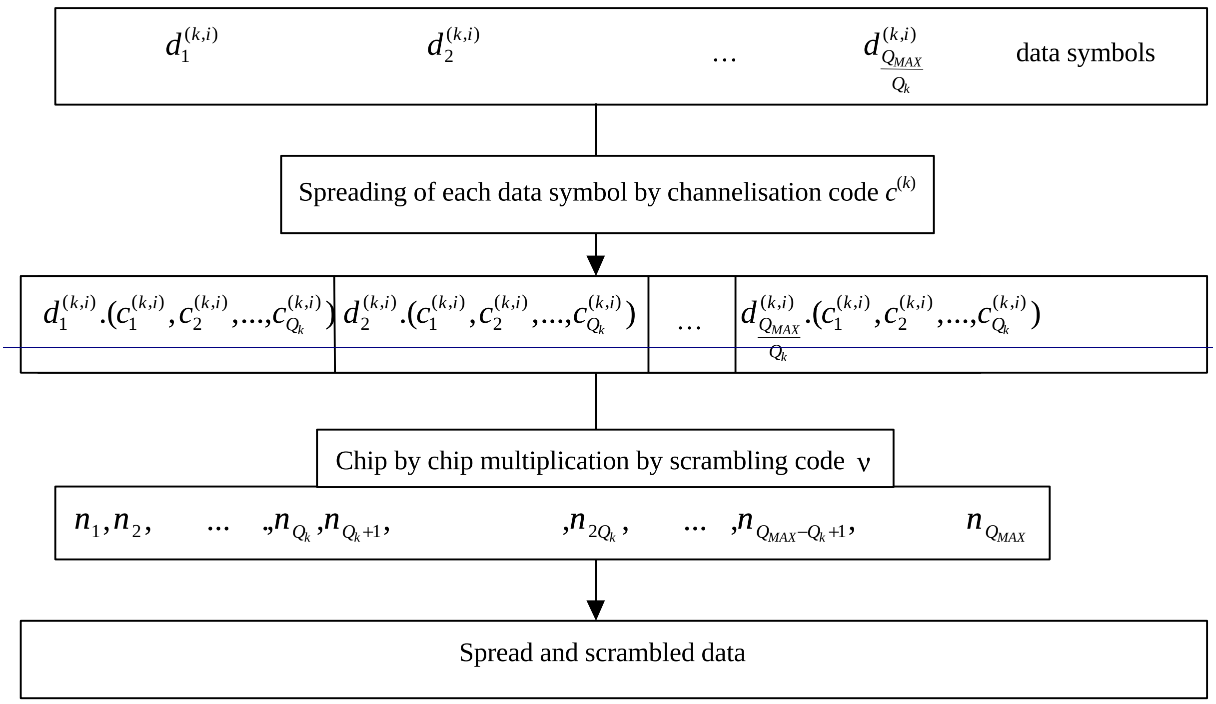
$$\underline{V}_{\underline{v}} = \{1, j, -1, -j\} \quad (5)$$

In equation 5 the letter j denotes the imaginary unit. A complex scrambling code **í** is generated from the binary scrambling codes $\nu = (n_1, n_2, \ldots, n_{16})$ of length 16 shown in Annex A. The relation between the elements **í** and **í** is given by:

$$\underline{v}_i = (\mathrm{j})^i \cdot n_i \qquad n_i \in \{1, -1\}, \ \mathrm{i} = 1, \ldots, 16 \tag{6}$$

Hence, the elements $\underline{n}_i$ of the complex scrambling code **í** are alternating real and imaginary.

The length matching is obtained by concatenating Q_{MAX}/Q_k spread words before the scrambling. The scheme is illustrated in figure 3 below and is described in more detail in section 6.4. ~~The applicable scrambling codes are shown in Annex A.~~



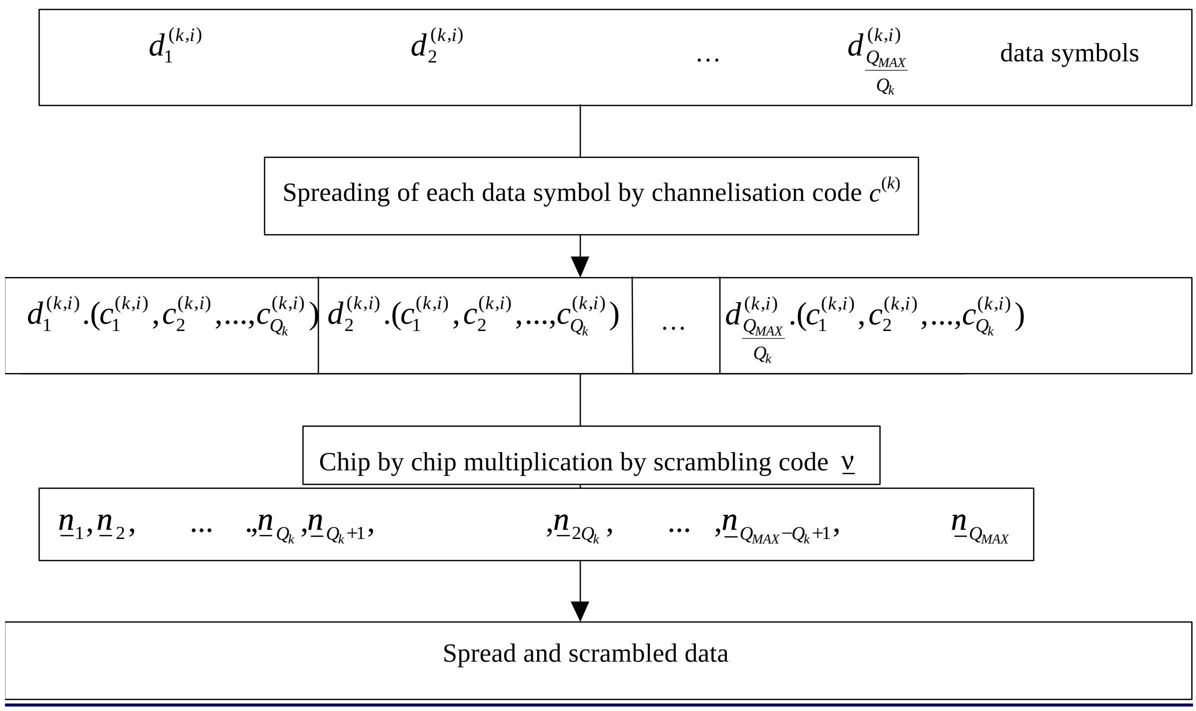


Figure 2: Spreading of data symbols

6.4 Spread signal of data symbols and data blocks

The combination of the user specific channelisation and cell specific scrambling codes can be seen as a user and cell specific spreading code $\mathbf{s}^{(k)} = \left(s_p^{(k)}\right)$ with

$s_p^{(k)} = c^{(k)}_{1+[(p-1) \bmod Q_k]} \cdot \acute{\imath}_{1+[(p-1) \bmod Q_{MAX}]}$ ~~$s_p^{(k)} = c^{(k)}_{1+[(p-1) \bmod Q_k]} \cdot \acute{\imath}_{1+[(p-1) \bmod Q_{MAX}]}$~~, k=1,…,K, p=1,…,$N_k Q_k$.

With the root raised cosine chip impulse filter $Cr_0(t)$ the transmitted signal belonging to the data block $\underline{\mathbf{d}}^{(k,1)}$ of equation 1 transmitted before the midamble is

$$\underline{d}^{(k,1)}(t) = \sum_{n=1}^{N_k} \underline{d}_n^{(k,1)} \sum_{q=1}^{Q_k} s^{(k)}_{(n-1)Q_k+q} \cdot Cr_o(t-(q-1)T_c-(n-1)Q_k T_c) \qquad (6)$$

and for the data block $\underline{\mathbf{d}}^{(k,2)}$ of equation 1 transmitted after the midamble

$$\underline{d}^{(k,2)}(t) = \sum_{n=1}^{N_k} \underline{d}_n^{(k,2)} \sum_{q=1}^{Q_k} s^{(k)}_{(n-1)Q_k+q} \cdot Cr_0(t-(q-1)T_C-(n-1)Q_k T_c - N_k Q_k T_c - L_m T_c). \qquad (7)$$

where L_m is the number of midamble chips.

6.5 Modulation

The complex-valued chip sequence is QPSK modulated as shown in Figure 3 below.

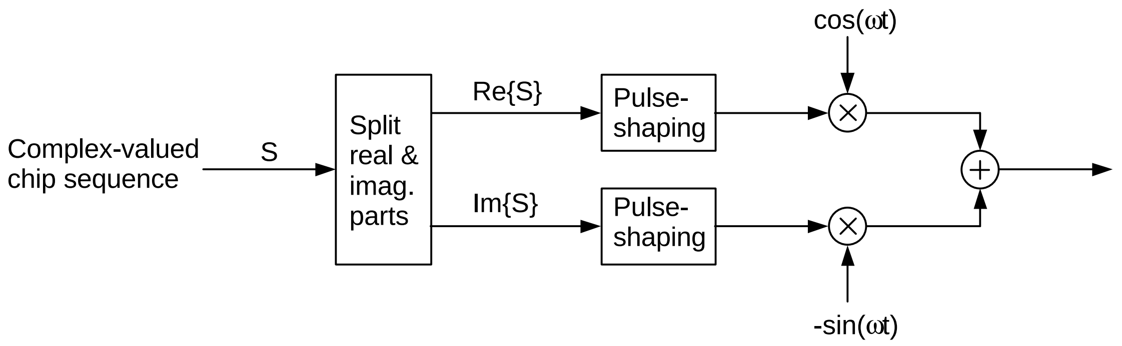


Figure 3: Modulation of complex valued chip sequences

7 Synchronisation codes

7.1 Code Generation

~~The Primary code sequence, C_p is constructed as a so-called generalised hierarchical Golay sequence. The Primary SCH is furthermore chosen to have good aperiodic auto correlation properties.~~

~~Letting a = < x_1, x_2, x_3, …, x_{16} > = < 0, 0, 0, 0, 0, 0, 1, 1, 0, 1,0, 1, 0, 1, 1, 0 > and~~

~~b = $< x_1, \ldots, x_8, \overline{x}_9, \ldots, \overline{x}_{16} >$ = <0,0,0,0,0,0,1,1,1,0,1,0,1,0,0,1>~~

~~The PSC code is generated by repeating sequence ‘a’ modulated by a Golay complementary sequence.~~

~~Letting $y = < a, a, a, \overline{a}, \overline{a}, a, \overline{a}, \overline{a}, a, a, a, \overline{a}, a, \overline{a}, a, a >$~~

~~The definition of the PSC code word C_p follows (the left most index corresponds to the chip transmitted first in each time slot):~~

~~C_p =< y(0),y(1),y(2),…,y(255) >.~~

~~Let the length 256 mask sequence z be given as, z = $< b, b, b, \overline{b}, b, b, \overline{b}, \overline{b}, b, \overline{b}, b, \overline{b}, \overline{b}, \overline{b}, \overline{b}, \overline{b} >$.~~

~~Then the Secondary Synchronization code words, {C_0,…,C_{15}} are constructed as the position wise addition modulo 2 of a Hadamard sequence and the sequence *z*.~~

~~The Hadamard sequences are obtained as the rows in a matrix H_8 constructed recursively by:~~

$$H_0 = (0)$$

$$H_k = \begin{pmatrix} H_{k-1} & H_{k-1} \\ H_{k-1} & \overline{H_{k-1}} \end{pmatrix}, \quad k \ge 1$$

~~The rows are numbered from the top starting with row *0* (the all zeros sequence), h_0.~~
~~The Hadamard sequence *h* depends on the chosen code number *n* and is denoted h_n in the sequel.~~
~~This code word is chosen from every 16th row of the matrix H_8., which yields 16 possible codewords $n = 0, 1,…,15$.~~
~~Furthermore, let $h_n(i)$ and $z(i)$ denote the *i*:th symbol of the sequence h_n and *z*, respectively.~~
~~The definition of the *n*:th SCH code word follows (the left most index correspond to the chip transmitted first in each slot):~~

~~$C_{SCH,n}$ = < $h_n(0)$+ z(0), $h_n(1)$+ z(1), $h_n(2)$+ z(2), …,$h_n(255)$+ z(255) >,~~

~~All sums of symbols are taken modulo 2.~~

~~These PSC and SSC binary code words are converted to real valued sequences by the transformation '0' -> '+1', '1' -> '-1'.~~
~~The Secondary SCHcode words are defined in terms of $C_{SCH,n}$ and the definition of {C_0,…,C_{15}} now follows as:~~

~~$C_i = C_{SCH,i}$, i=0,…,15~~

The Primary code sequence, C_p is constructed as a so-called generalised hierarchical Golay sequence. The Primary SCH is furthermore chosen to have good aperiodic auto correlation properties.
Define a = < x_1, x_2, x_3, …, x_{16} > = < 1, 1, 1, 1, 1, 1, -1, -1, 1, -1, 1, -1, 1, -1, -1, 1 >
The PSC code word is generated by repeating the sequence 'a' modulated by a Golay complementary sequence and creating a complex-valued sequence with identical real and imaginary components.
The PSC code word C_p is defined as C_p=< y(0),y(1),y(2),...,y(255) >
where $y = (1+\mathrm{j}) \times < a,a,a,-a,-a,a,-a,-a,a,a,a,-a,a,-a,a,a >$
and the left most index corresponds to the chip transmitted first in each time slot.
The 16 secondary synchronization code words, {C_0,…,C_{15}} are complex valued with identical real and imaginary components, and are constructed from the position wise multiplication of a Hadamard sequence and a sequence z, defined as

z = $< b,b,b,-b,b,b,-b,-b,b,-b,b,-b,-b,-b,-b,-b >$, where

b = $< x_1,\dots,x_8,-x_9,\dots,-x_{16} >$ = <1, 1, 1, 1, 1, 1, -1, -1, -1, 1, -1, 1, -1, 1, 1, -1>.

The Hadamard sequences are obtained as the rows in a matrix H_8 constructed recursively by:

$$H_0 = (1)$$

$$H_k = \begin{pmatrix} H_{k-1} & H_{k-1} \\ H_{k-1} & -H_{k-1} \end{pmatrix}, \quad k \ge 1$$

The rows are numbered from the top starting with row *0* (the all zeros sequence).
Denote the *n*:th Hadamard sequence as a row of H_8 numbered from the top, n = 0, 1, 2, …, 255, in the sequel.
Furthermore, let $h_m(i)$ and $z(i)$ denote the *i*:th symbol of the sequence h_m and *z*, respectively where $i = 0, 1, 2, …, 255$ and $i = 0$ corresponds to the leftmost symbol.
The i:th SCH code word, $C_{SCH,i}$, i = 0, …, 15 is then defined as

$C_{SCH,i} = (1 + j) \times <h_m(0) \times z(0), h_m(1) \times z(1), h_m(2) \times z(2), \dots, h_m(255) \times z(255)>$,

where $m = (16\times i)$ and the leftmost chip in the sequence corresponds to the chip transmitted first in time .

This code word is chosen from every 16th row of the matrix H_8., which yields 16 possible codewords.
The Secondary SCH code words are defined in terms of $C_{SCH,i}$ and the definition of {C_0,…,C_{15}} now follows as:

$C_i = C_{SCH,i}$, i=0,…,15

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San Diego, USA, 29 Feb – 03 March 2000

***Document* R1-00-228**
e.g. for 3GPP use the format TP-99xxx
or for SMG, use the format P-99-xxx

CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

25.224	**CR**	**013**	Current Version:	3.1.0

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

For submission to:	TSG RAN#7	for approval	X	strategic		*(for SMG use only)*
list expected approval meeting # here ↑		for information		non-strategic		

Form: CR cover sheet, version 2 for 3GPP and SMG The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

Proposed change affects: *(at least one should be marked with an X)*	(U)SIM		ME	X	UTRAN / Radio	X	Core Network	

Source:	Siemens AG	**Date:**	2000-02-25
Subject:	Signal Point Constellation		
Work item:			

Category:	F	Correction		**Release:**	Phase 2	
	A	Corresponds to a correction in an earlier release			Release 96	
(only one category	B	Addition of feature			Release 97	
shall be marked	C	Functional modification of feature			Release 98	
with an X)	D	Editorial modification	X		Release 99	X
					Release 00	

Reason for change:	Only editorial modification, corresponds to modification in TS25.223 CR 006r1 regarding Signal Point Constellation
Clauses affected:	4.4.1

Other specs affected:	Other 3G core specifications	X	→ List of CRs:	25.223 CR006r1, 25.221 CR015r1
	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:	

help.doc

<--------- double-click here for help and instructions on how to create a CR.

4.4.1 Cell Search

During the initial cell search, the UE searches for a cell. It then determines the midamble, the downlink scrambling code and frame synchronisation of that cell. The initial cell search uses the Physical Synchronisation Channel (PSCH) described in [8]. The generation of synchronisation codes is described in [10].

This initial cell search is carried out in three steps:

Step 1: Slot synchronisation

During the first step of the initial cell search procedure the UE uses the primary synchronisation code c_p to acquire slot synchronisation to the strongest cell. Furthermore, frame synchronisation with the uncertainty of 1 out of 2 is obtained in this step. A single matched filter (or any similar device) is used for this purpose, that is matched to the primary synchronisation code which is common to all cells.

Step 2: Frame synchronisation and code-group identification

During the second step of the initial cell search procedure, the UE uses the modulated Secondary Synchronisation Codes to find frame synchronisation and identify one out of 32 code groups. Each code group is linked to a specific t_{Offset}, thus to a specific frame timing, and is containing 4 specific scrambling codes. Each scrambling code is associated with a specific short and long basic midamble code.

In Cases 2 and 3 it is required to detect the position of the next synchronization slots. To detect the position of the next synchronization slots, the primary synchronization code is correlated with the received signal at offsets of 7 and 8 time slots from the position of the primary code that was detected in Step 1.

Then, the received signal at the positions of the synchronization codes is correlated with the primary synchronization Code C_p and the secondary synchronization codes $\{C_0,\ldots,C_{15}\}$. Note that the correlations can be performed coherently over M time slots, where at each slot a phase correction is provided by the correlation with the primary code. The minimal number of time slots is M=1, and the performance improves with increasing M.

Step 3: Scrambling code identification

During the third and last step of the initial cell-search procedure, the UE determines the exact basic midamble code and the accompanying scrambling code used by the found cell. They are identified through correlation over the P-CCPCH with all four midambles of the code group identified in the second step . Thus the third step is a one out of four decision. This step is taking into account that the P-CCPCH containing the BCH is transmitted using the first channelization code ($\cancel{a^{(h=1)}_{Q=16}}$ $c^{(h=1)}_{Q=16}$ in [10]) and using the first midamble $\mathbf{m}^{(1)}$ (derived from basic midamble code $\mathbf{m}_P$ in [8]). Thus P-CCPCH code and midamble can be immediately derived when knowing scrambling code and basic midamble code.