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R1-01-0202

CR-Form-v3

CHANGE REQUEST

25.223	**CR 016**	rev	**-**	Current version:	**3.4.0**

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

Proposed change affects:	(U)SIM [ ]	ME/UE [ ]	Radio Access Network [X]	Core Network [ ]

Title:	Cell synchronisation codes for R'4 Node B sync over air interface in UTRA TDD		
Source:	Mitsubishi Electric		
Work item code:	RANimp-NBsync	***Date:***	14/02/2001
Category:	**B**	***Release:***	REL-4
	Use one of the following categories: ***F*** *(essential 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:* *2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *REL-4 (Release 4)* *REL-5 (Release 5)*

Reason for change:	This CR contains the description of the cell synchronisation codes for the R'4 work item Node B sync over air interface in UTRA TDD.
Summary of change:	Proposes the introduction of a new section 10 into TS 25.223 R'4 that describes how to generate cell synchronisation codes from Golay Complementary Pairs and their respective code offset versions.
Consequences if not approved:	Work item not feasible.

Clauses affected:	New section 10		
Other specs affected:	[X] Other core specifications		R'4 - CR042 to 25.221, CR044 to 25.224, CR022 to 25.225
	[ ] Test specifications		
	[ ] O&M Specifications		
Other comments:	(1) Additional new sections introduced into TS25.223 R'4 by the working CR on 1.28 Mcps TDD are taken into account. (2) More details on the generation of the cell synchronisation codes can be found in R1-00-1351 or TR25.836 V2.0.0.		

3 Symbols and abbreviations

3.1 Symbols

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

C_p:	PSC
C_i:	i:th secondary SCH code
$C_{CSC,m}^{(k)}$:	CSC derived as k:th offset version from m:th applicable constituent Golay complementary pair

3.2 Abbreviations

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

CDMA	Code Division Multiple Access
CSC	Cell Synchronisation Code
OVSF	Orthogonal Variable Spreading Factor
P-CCPCH	Primary Common Control Physical Channel
PN	Pseudo Noise
PRACH	Physical Random Access Channel
PSC	Primary Synchronisation Code
QPSK	Quadrature Phase Shift Keying
RACH	Random Access Channel
SCH	Synchronisation Channel

10 Cell synchronisation codes

The cell synchronisation codes (CSCs) are constructed as so-called CEC sequences, i.e. concatenated and periodically extended complementary sequences. They are complex-valued sequences that are derived as cyclically offset versions from a set of possible constituent Golay complementary pairs.

The CSCs are chosen to have good aperiodic auto correlation properties. The aperiodic auto correlations of the applicable constituent Golay complementary pairs and every pair of their derived cyclically offset versions are complementary. Furthermore, orthogonality is preserved for all CSCs which are derived from the same constituent Golay complementary pair due to this complementary property.

The delay and weight matrices for the set of M = 8 possible constituent Golay complementary pairs are listed in the table below:

Code ID *m*	**Delay matrices D_m and weight matrices W_m of constituent Golay complementary pairs**
0	D_0 = <512, 64, 128, 1, 16, 4, 256, 32, 8, 2>, W_0 = <1, 1, 1, 1, -1, -1, 1, 1, 1, 1>
1	D_1 = <2, 16, 32, 256, 1, 8, 128, 4, 512, 64>, W_1 = <1, -1, 1, -1, 1, -1, -1, 1, -1, -1>
2	D_2 = <16, 512, 32, 256, 4, 1, 64, 8, 2, 128>, W_2 = <-1, 1, 1, -1, -1, 1, -1, 1, -1, -1>
3	D_3 = <512, 16, 8, 4, 2, 256, 128, 64, 32, 1>, W_3 = <-1, -1, -1, -1, -1, 1, -1, 1, 1, 1>
4	D_4 = <512, 128, 256, 32, 2, 4, 64, 1, 16, 8>, W_4 = <1, -1, 1, -1, -1, -1, -1, -1, -1, 1>
5	D_5 = <1, 2, 4, 64, 512, 16, 32, 256, 128, 8>, W_5 = <-1, 1, 1, 1, 1, -1, -1, 1, -1, 1>
6	D_6 = <8, 16, 128, 2, 32, 1, 256, 512, 4, 64>, W_6 = <-1, -1, 1, 1, 1, 1, -1, -1, -1, 1>
7	D_7 = <1, 2, 128, 16, 256, 32, 8, 512, 64, 4>, W_7 = <1, 1, -1, -1, -1, -1, 1, -1, -1, -1>

A constituent Golay complementary pair of length N = 1024, defined as:

$$s_m = \langle s_m(0), s_m(1), s_m(2), \ldots, s_m(1023)\rangle \text{ and } g_m = \langle g_m(0), g_m(1), g_m(2), \ldots, g_m(1023)\rangle$$

shall be derived from the selected delay and weight matrices:

$$D_m = \langle D_m(0), D_m(1), D_m(2), \ldots, D_m(9)\rangle \text{ and } W_m = \langle W_m(0), W_m(1), W_m(2), \ldots, W_m(9)\rangle$$

as follows.

Define:

$$a^{(0)} = \langle a^{(0)}(0), a^{(0)}(1), a^{(0)}(2), \ldots, a^{(0)}(1023)\rangle = \langle 1, 0, 0, \ldots, 0\rangle \text{ and}$$

$$b^{(0)} = \langle b^{(0)}(0), b^{(0)}(1), b^{(0)}(2), \ldots, b^{(0)}(1023)\rangle = \langle 1, 0, 0, \ldots, 0\rangle.$$

Then, the elements of the set of auxiliary sequences:

$$a^{(n)} = \langle a^{(n)}(0), a^{(n)}(1), a^{(n)}(2), \ldots, a^{(n)}(1023)\rangle \text{ and } b^{(n)} = \langle b^{(n)}(0), b^{(n)}(1), b^{(n)}(2), \ldots, b^{(n)}(1023)\rangle$$

are given by the recursive relations:

$$a^{(n+1)}(i) = a^{(n)}(i) + W_m(n) ?\ b^{(n)}(i - D_m(n)) \text{ and}$$

$$b^{(n+1)}(i) = a^{(n)}(i) - W_m(n) ?\ b^{(n)}(i - D_m(n))$$

with element index i = 0, 1, 2, …, 1023 and iteration index n = 0, 1, 2, …, 9. Operations on the element index shall be performed modulo 1024.

The elements of the constituent Golay complementary pairs s_m and g_m are then obtained from the output of the last iteration step using:

$$s_m(i) = a^{(10)}(i) \text{ and } g_m(i) = b^{(10)}(i) \text{ for } i = 0, 1, 2, \ldots, 1023$$

From each applicable constituent Golay complementary pair s_m and g_m, up to K = 8 different cyclically offset pairs $s_m^{(k)}$ and $g_m^{(k)}$, with offset index k = 0, 1, 2, …, K-1, of length 1152 chips can be derived. The complementary property of the respective aperiodic auto correlation is preserved for each particular pair of sequences $s_m^{(k)}$ and $g_m^{(k)}$. The generation of the K cyclically offset pairs from s_m and g_m is done in a similar way as the generation of the user midambles from a periodic basic midamble sequence as described in [7].

With N = 1024, K = 8, W = 128, the elements of a cyclically offset pair:

$$s_m^{(k)} = <s_m^{(k)}(0), s_m^{(k)}(1), s_m^{(k)}(2), \ldots, s_m^{(k)}(1151)> \text{ and } g_m^{(k)} = <g_m^{(k)}(0), g_m^{(k)}(1), g_m^{(k)}(2), \ldots, g_m^{(k)}(1151)>$$

for a particular offset k, with k = 0, 1, 2, …, K-1, shall be derived from the elements of the constituent Golay complementary pairs s_m and g_m using:

$$s_m^{(k)}(i) = (j)^i \; ? \; s_m(i + k \; ? \; W) \text{ and } g_m^{(k)}(i) = (j)^i \; ? \; g_m(i + k \; ? \; W) \text{ for } i = 0, 1, 2, \ldots, N - k \; ? \; W - 1,$$

$$s_m^{(k)}(i) = (j)^i \; ? \; s_m(i - N + k \; ? \; W) \text{ and } g_m^{(k)}(i) = (j)^i \; ? \; g_m(i - N + k \; ? \; W) \text{ for } i = N - k \; ? \; W, N - k \; ? \; W + 1, \ldots, 1151.$$

Hence, the elements of $s_m^{(k)}$ and $g_m^{(k)}$ are alternating real and imaginary.

Note that both $s_m^{(0)}$ and $g_m^{(0)}$ simply correspond to s_m and g_m respectively, followed by its first W elements as post extension and that both $s_m^{(7)}$ and $g_m^{(7)}$ simply correspond to the last W elements of s_m and g_m in form of a pre extension, followed by s_m and g_m respectively.

Finally, the CSC $C_{CSC,m}^{(k)}$ derived from the m:th applicable constituent Golay complementary pair s_m and g_m, and for the k:th offset is then defined as a concatenation of $s_m^{(k)}$ and $g_m^{(k)}$ by:

$$C_{CSC,m}^{(k)} = <s_m^{(k)}(0), s_m^{(k)}(1), s_m^{(k)}(2), \ldots, s_m^{(k)}(1151), g_m^{(k)}(0), g_m^{(k)}(1), g_m^{(k)}(2), \ldots, g_m^{(k)}(1151)>$$

where the leftmost element $s_m^{(k)}(0)$ in the sequence corresponds to the chip to be first transmitted in time. An CSC has therefore length 2304 chips.

Note that due to this construction method, the auto correlations for all CSCs derived from one particular constituent Golay complementary pair s_m and g_m can be obtained simultaneously and in sequential order from the sum of partial correlations with s_m and g_m, these CSCs remaining orthogonal.

CSCs derived according to above have complex values and shall not be subject to the channelisation or scrambling process, i.e. its elements represent complex chips for usage in the pulse shaping process at modulation.