3GPP TSG RAN WG1 Meeting #9
Dresden, Germany, 30 Nov - 3 Dec 1999

Document R1-99J16
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.

25.222 CR 008 Current Version: 3.0.0

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

For submission to: TAG-RAN#6	for approval: X	strategic:	(for SMG use only)
list expected approval meeting # here ↑	for information:	non-strategic:	

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

Source: Siemens **Date:** 1999-11-22

Subject: TFCI coding

Work item:

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

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

Release:

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

Reason for change: Description of TFCI coding for normal and short length cases is quite different and does not specify coding/puncturing process completely. Also dependancy on OVSF sequences defined externally which should be removed.

Clauses affected: 4.2.13, 4.3.1, 4.3.1.1, 4.3.1.2

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:

4.2.13 Transport format detection

Transport format detection can be performed both with and without Transport Format Combination Indicator (TFCI). If a TFCI is transmitted, the receiver detects the transport format combination from the TFCI. When no TFCI is transmitted, so called blind transport format detection may be~~is~~ used, i.e. the receiver side uses the possible transport format combinations as a priori information.

4.2.13.1 Blind transport format detection

Blind transport format detection may be performed in the receiver by trying all possible combinations of the transport format.

4.2.13.2 Explicit transport format detection based on TFCI

4.2.13.2.1 Transport Format Combination Indicator (TFCI)

The Transport Format Combination Indicator (TFCI) informs the receiver of the transport format combination of the CCTrCHs . As soon as the TFCI is detected, the transport format combination, and hence the individual transport channels' transport formats are known, and decoding of the transport channels can be performed.

4.3 Coding for layer 1 control

4.3.1 Coding of transport format combination indicator (TFCI)

~~The number of TFCI bits is variable and is set at the beginning of the call via higher layer signalling.~~ Encoding of the TFCI bits depends on the number of them. If there are 6-10 bits of TFCI the channel encoding is done as described in section 4.3.1.1. Also specific coding of less than 6 bits is possible as explained in section 4.3.1.2~~3~~. ~~For improved TFCI detection reliability repetition is used to increase the number of TFCI bits.~~ Additionally, with any TFCI coding scheme it is assumed that in the receiver combining of two successive TFCI words will be performed if the shortest transmission time interval of any TrCH is at least 20 ms.

4.3.1.1 ~~Default TFCI word~~Coding of long TFCI lengths

The TFCI bits are encoded using a (30, 10) punctured sub-code of the second order Reed-Muller code. The coding procedure is as shown in figure 4.3.3.1-1.

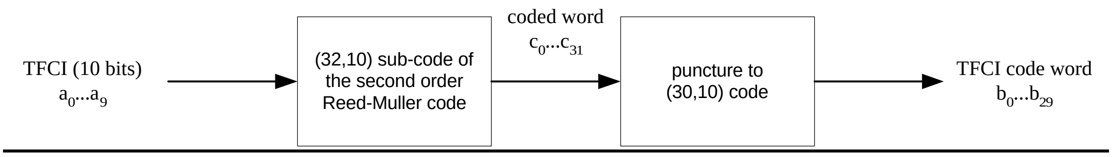

Figure 4.3.3.1-1: Channel coding of TFCI bits

TFCI is encoded by the (32,10) sub-code of second order Reed-Muller code. The code words of the (32,10) sub-code of second order Reed-Muller code are linear combination of some among 10 basis sequences: all 1's, 5 Hadamard~~OVSF~~ codes ($H_{5,1}$, $H_{5,2}$, $H_{5,4}$, $H_{5,8}$, $H_{5,16}$ ~~$C_5(1)$, $C_5(2)$, $C_5(4)$, $C_5(8)$, $C_5(16)$~~), and 4 masks (Mask1, Mask2, Mask3, Mask4). The ~~4 mask~~ sequences are as follows in table 4.3.1-1.

Table 4.3.1-1: Mask and Hadamard sequences

	Mask1	Mask2	Mask3	Mask4		$H_{5,1}$	$H_{5,2}$	$H_{5,4}$	$H_{5,8}$	$H_{5,16}$
bit0	0	0	0	0		0	0	0	0	0
bit1	0	0	0	0		1	0	0	0	0

bit2	1	0	0	0		0	1	0	0	0
bit3	0	0	0	1		1	1	0	0	0
bit4	1	0	1	1		0	0	1	0	0
bit5	0	0	0	1		1	0	1	0	0
bit6	0	0	1	0		0	1	1	0	0
bit7	0	1	0	0		1	1	1	0	0
bit8	0	1	1	0		0	0	0	1	0
bit9	1	1	1	0		1	0	0	1	0
bit10	1	0	1	1		0	1	0	1	0
bit11	0	0	1	1		1	1	0	1	0
bit12	0	1	1	0		0	0	1	1	0
bit13	0	1	0	1		1	0	1	1	0
bit14	1	0	0	1		0	1	1	1	0
bit15	1	1	1	1		1	1	1	1	0
bit16	1	0	0	0		0	0	0	0	1
bit17	1	1	0	0		1	0	0	0	1
bit18	1	1	0	1		0	1	0	0	1
bit19	1	0	1	0		1	1	0	0	1
bit20	0	1	1	1		0	0	1	0	1
bit21	0	1	0	1		1	0	1	0	1
bit22	0	0	1	1		0	1	1	0	1
bit23	0	1	1	1		1	1	1	0	1
bit24	0	1	0	0		0	0	0	1	1
bit25	1	1	0	1		1	0	0	1	1
bit26	1	0	1	0		0	1	0	1	1
bit27	1	0	0	1		1	1	0	1	1
bit28	0	0	1	0		0	0	1	1	1
bit29	1	1	0	0		1	0	1	1	1
bit30	1	1	1	0		0	1	1	1	1
bit31	1	1	1	1		1	1	1	1	1

~~Mask 1~~	~~00101000011000111111000001110111~~
~~Mask 2~~	~~00000001110011010110110111000111~~
~~Mask 3~~	~~00001010111110010001101100101011~~
~~Mask 4~~	~~00011100001101110010111101010001~~

For information bits a_0 , a_1 , a_2 , a_3 , a_4 , a_5 , a_6 , a_7 , a_8 , a_9 (a_0 is LSB and a_9 is MSB), the encoder structure is as follows in figure 4-7.

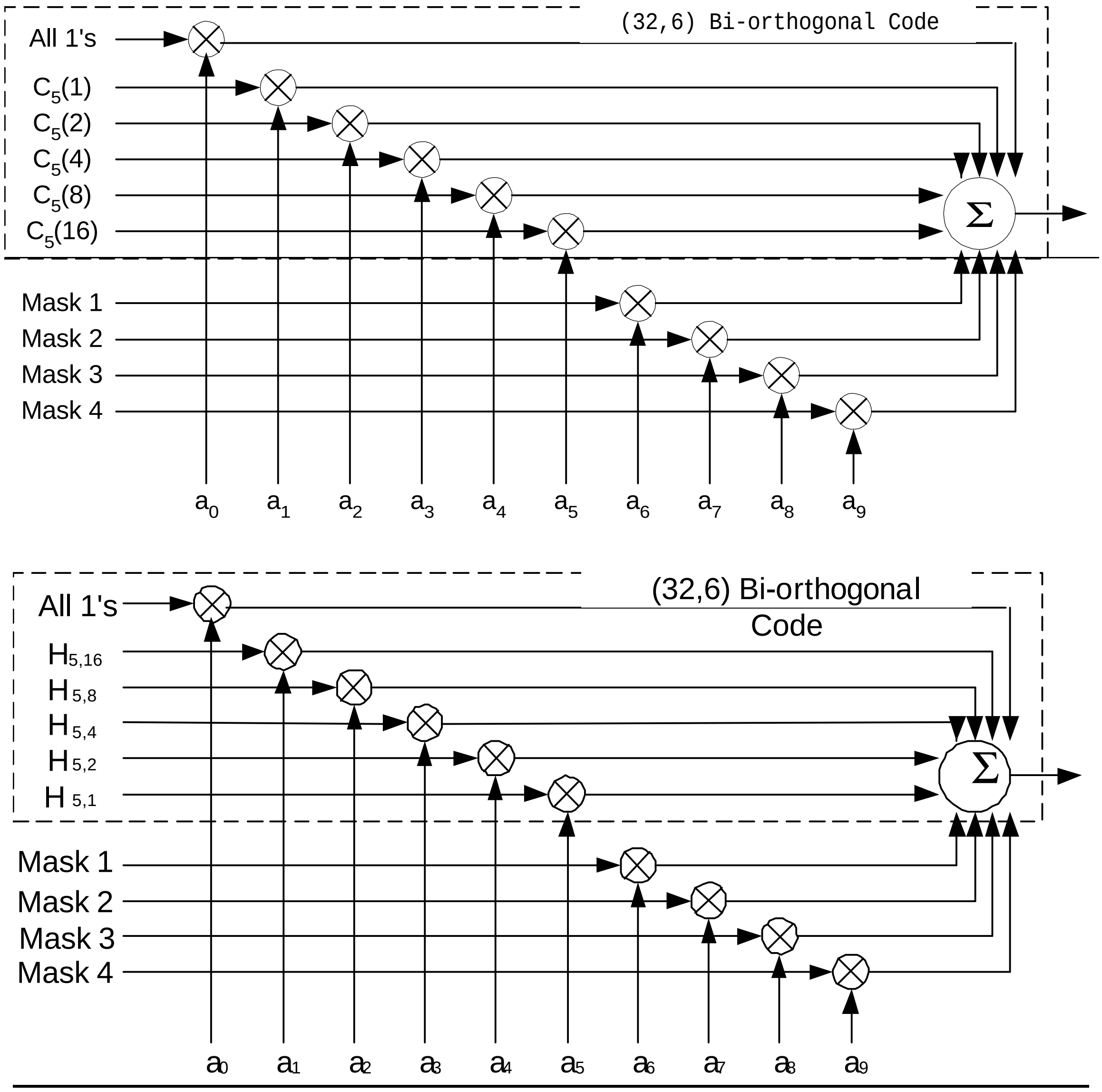

Figure 4-7: Encoder structure for (32,10) sub-code of second order Reed-Muller code

Then, the output words of the (32,10) sub-code of second order Reed-Muller coder are punctured into length 30 by puncturing output bits c_0 and c_{16}. The remaining punctured bits are denoted by b_k, $k = 0, 1, 2, \ldots, 29$ ($k = 29$ corresponds to the MSB bit).

4.3.1.2 Coding of short TFCI lengths

4.3.1.2.1 Coding very short TFCIs by repetition

If the number of TFCI bits is 1 or 2, then repetition will be used for coding. In this case each bit is repeated to a total of 4~~3~~ times giving 4-bit transmission for a single TFCI bit and 8-bit transmission for 2 TFCI bits.

4.3.1.2.2 Coding short TFCIs using bi-orthogonal codes

~~If the number of TFCI bits is in the range of 3 to 5, then one word of the biorthogonal (16,5) block code will be used.~~

~~The code words of the biorthogonal (16, 5) code are from two mutually biorthogonal sets, $S_{C_4} = \{C_4(0), C_4(1), \ldots, C_4(15)\}$ and its binary complement, $\bar{S}_{C_4} = \{\bar{C}_4(0), \bar{C}_4(1), \ldots, \bar{C}_4(15)\}$. Words of set~~

~~S_{C_4} are from the level 4 of the code three, which is generated, using the short code generation method defined in TS 25.223. The mapping of information bits to code words is shown in the table 4.3.1-2.~~

~~Table 4.3.1-2: Mapping of information bits to code words for biorthogonal (16, 5) code~~

~~Information bits~~	~~Code word~~
~~00000~~	~~$C_4(0)$~~
~~00001~~	~~$\overline{C_4(0)}$~~
~~00010~~	~~$C_4(1)$~~
~~...~~	~~...~~
~~11101~~	~~$\overline{C_4(14)}$~~
~~11110~~	~~$C_4(15)$~~
~~11111~~	~~$\overline{C_4(15)}$~~

The TFCI bits are encoded using a (15, 5) punctured bi-orthogonal code. The coding procedure is as shown in figure 4-8.

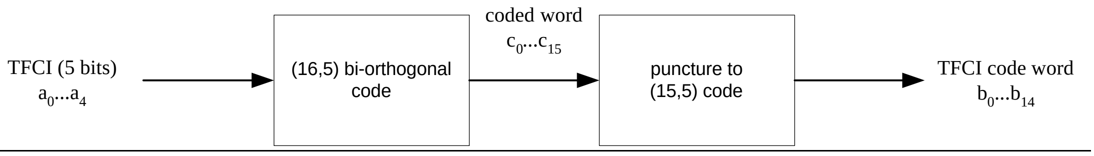

Figure 4-8: Channel coding of short length TFCI bits

Firstly, TFCI is encoded by the (16,5) bi-orthogonal (or first order Reed-Muller) code. The code words of the (16,5) bi-orthogonal code are linear combinations of 5 basis sequences: the all 1's sequence and 4 Hadamard codes ($H_{4,1}$, $H_{4,2}$, $H_{4,4}$, $H_{4,8}$) as defined in table 4.3.1-2 below.

Table 4.3.1-2: Hadamard sequences

	$H_{4,1}$	$H_{4,2}$	$H_{4,4}$	$H_{4,8}$
bit0	0	0	0	0
bit1	1	0	0	0
bit2	0	1	0	0
bit3	1	1	0	0
bit4	0	0	1	0
bit5	1	0	1	0
bit6	0	1	1	0
bit7	1	1	1	0
bit8	0	0	0	1
bit9	1	0	0	1
bit10	0	1	0	1
bit11	1	1	0	1
bit12	0	0	1	1
bit13	1	0	1	1

bit14	0	1	1	1
bit15	1	1	1	1

For information bits a_0 , a_1 , a_2 , a_3 , a_4 (a_0 is LSB and a_4 is MSB), the encoder structure is as following figure 13 (summation is modulo 2).

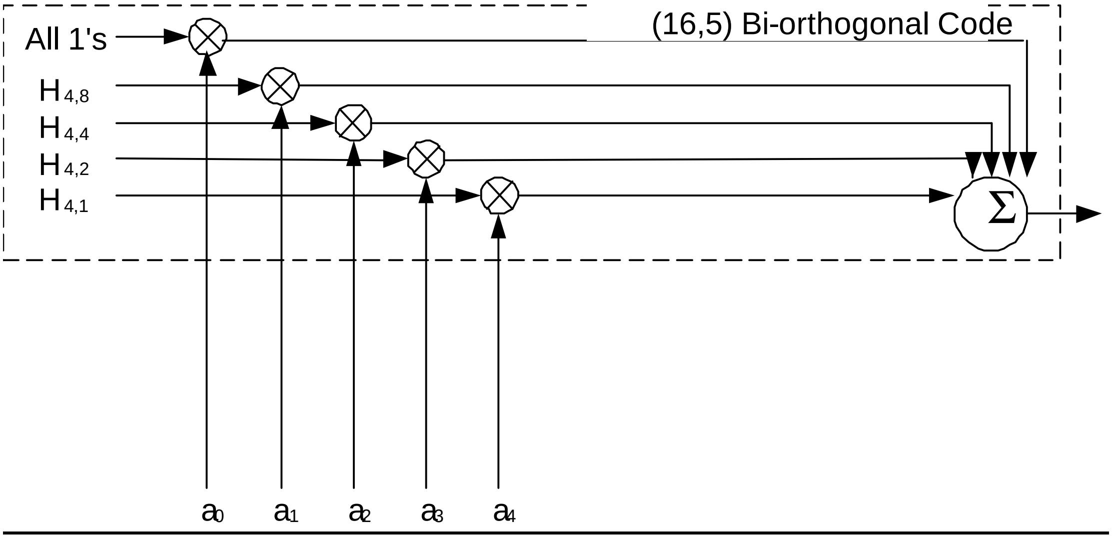

Figure 13: Encoder structure for (16,5) bi-orthogonal code

Then the output words of the (16,5) bi-orthogonal coder are punctured to length 15 by puncturing bits c_0 (the lsb).

The bits in the punctured code word are denoted by b_k , where subscript *k* indicates bit position in the code word (*k* =14 corresponds to the MSB bit).