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CHANGE REQUEST

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25.222	**CR**	**xxx**	Current Version:	3.3.0

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

For submission to:	RAN#10	for approval	X	strategic		*(for SMG use only)*
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Proposed change affects: *(at least one should be marked with an X)*	(U)SIM		ME	X	UTRAN / Radio	X	Core Network	

Source:	CWTS	**Date:**	
Subject:	CR for TS25.222 regarding the 1.28 Mcps TDD		
Work item:	Low Chip Rate TDD option, Physical Layer		

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

Reason for change: This CR collects the principally agreed wording of the changes necessary for introducing the feature 'Low Chip Rate TDD option' in the TS25.222. In its last revision it should be editorially changed to reflect the correct changes needed for the latest approved version of this specification.

Clauses affected:

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: In this first version, a proposed structure has been included in this CR. The structure was copied from TS25.222 vers. 3.3.0. In addition to that the proposals that were agreed in principle from WG1#14 to WG#15 were included in this CR.

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2 References

<For clarity, this chapter will currently collect only the references that are needed in addition to the already existing abbreviations. In its last version this chapter has to be modified, so that it includes the revisions with respect to the latest versions of TS25.222.>

3 Definitions, symbols and abbreviations

<For clarity, this chapter will currently collect only the definitions, symbols and abbreviations that are needed in addition to the already existing ones. In its last version this chapter has to be modified, so that it includes the revisions with respect to the latest versions of TS25.222.>

3.1 Definitions

3.2 Symbols

3.3 Abbreviations

4 Multiplexing, channel coding and interleaving

4.1 General

Data stream from/to MAC and higher layers (Transport block / Transport block set) is encoded/decoded to offer transport services over the radio transmission link. Channel coding scheme is a combination of error detection, error correcting (including rate matching), and interleaving and transport channels mapping onto/splitting from physical channels.

In the UTRA-TDD mode, the total number of basic physical channels (a certain time slot one spreading code on a certain carrier frequency) per frame is given by the maximum number of time slots which is 15 and the maximum number of CDMA codes per time slot.

4.2 Transport channel coding/multiplexing

Figure 1 illustrates the overall concept of transport-channel coding and multiplexing. Data arrives to the coding/multiplexing unit in form of transport block sets, once every transmission time interval. The transmission time interval is transport-channel specific from the set {10 ms, 20 ms, 40 ms, 80 ms}.

The following coding/multiplexing steps can be identified:

- add CRC to each transport block (see subclause 4.2.1);
- TrBk concatenation / Code block segmentation (see subclause 4.2.2);
- channel coding (see subclause 4.2.3) ;
- radio frame size equalization (see subclause 4.2.4);
- interleaving (two steps, see subclauses 4.2.5 and 4.2.10);
- radio frame segmentation (see subclause 4.2.6);
- rate matching (see subclause 4.2.7);

- multiplexing of transport channels (see subclause 4.2.8);
- physical channel segmentation (see subclause 4.2.9);
- sub-frame segmentation (see subclause 4.2.11, only for 1.28Mcps TDD)
- mapping to physical channels (see subclause 4.2.~~11~~12).

The coding/multiplexing steps for uplink and downlink are shown in figure 1.

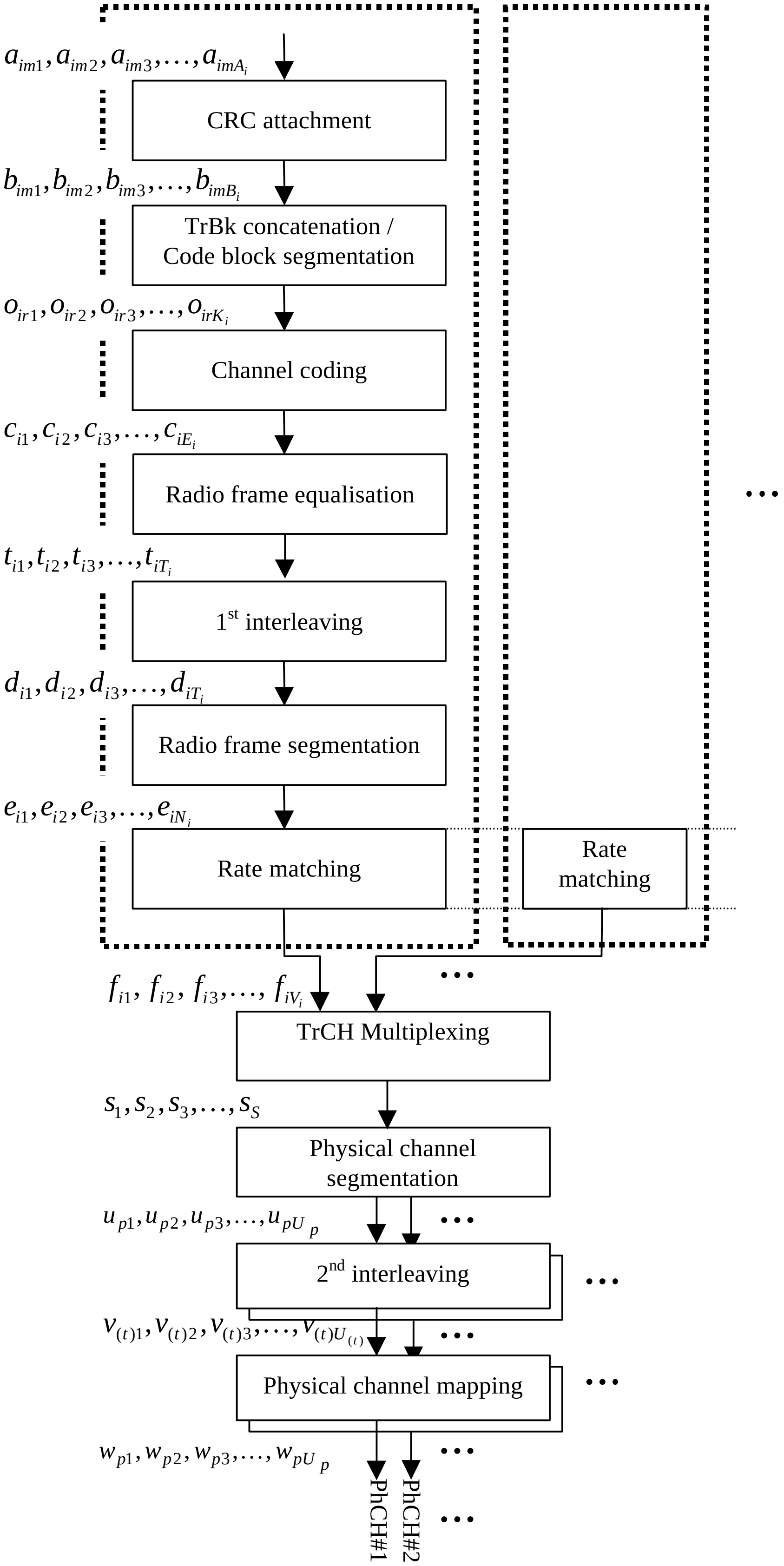

Figure 1: Transport channel multiplexing structure for uplink and downlink for 3.84Mcps TDD

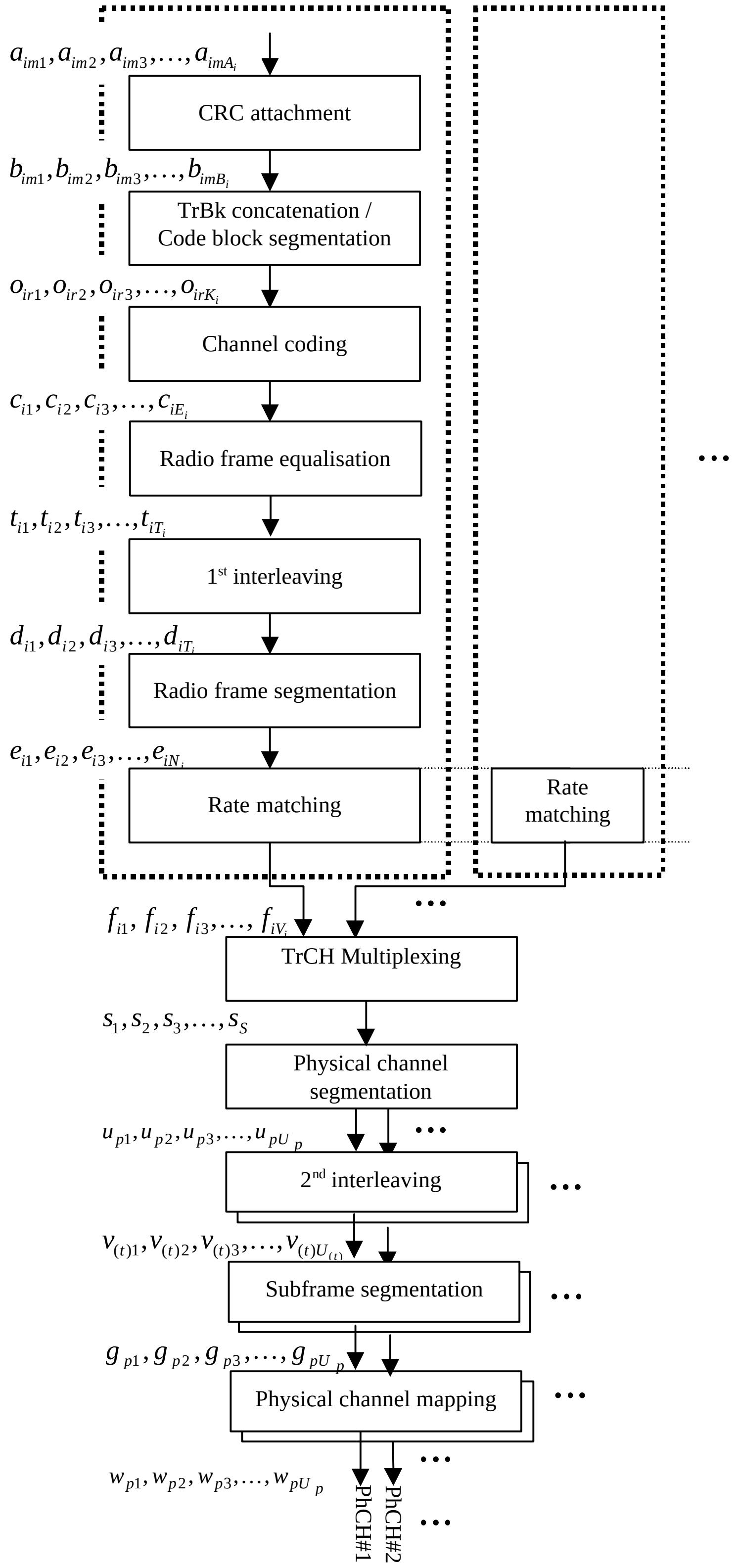

Figure X1: Transport channel multiplexing structure for uplink and downlink of 1.28Mcps TDD

Primarily, transport channels are multiplexed as described above, i.e. into one data stream mapped on one or several physical channels. However, an alternative way of multiplexing services is to use multiple CCTrCHs (Coded Composite Transport Channels), which corresponds to having several parallel multiplexing chains as in figure 1, resulting in several data streams, each mapped to one or several physical channels.

4.2.3 Channel coding

Code blocks are delivered to the channel coding block. They are denoted by $o_{ir1}, o_{ir2}, o_{ir3}, \ldots, o_{irK_i}$, where i is the TrCH number, r is the code block number, and K_i is the number of bits in each code block. The number of code blocks on TrCH i is denoted by C_i. After encoding the bits are denoted by $y_{ir1}, y_{ir2}, y_{ir3}, \ldots, y_{irY_i}$, where Y_i is the number of encoded bits. The relation between o_{irk} and y_{irk} and between K_i and Y_i is dependent on the channel coding scheme.

The following channel coding schemes can be applied to transport channels:

- convolutional coding;
- turbo coding;
- no coding.

Usage of coding scheme and coding rate for the different types of TrCH is shown in table 1. The values of Y_i in connection with each coding scheme:

- convolutional coding with rate 1/2: $Y_i = 2*K_i + 16$; rate 1/3: $Y_i = 3*K_i + 24$;
- turbo coding with rate 1/3: $Y_i = 3*K_i + 12$;
- no coding: $Y_i = K_i$.

Table 1: Usage of channel coding scheme and coding rate

<table>
<tr><th>Type of TrCH</th><th>Coding scheme</th><th>Coding rate</th></tr>
<tr><td>BCH</td><td rowspan="4">Convolutional coding</td><td rowspan="3">½</td></tr>
<tr><td>PCH</td></tr>
<tr><td>RACH</td></tr>
<tr><td rowspan="3">DCH, DSCH, FACH, USCH</td><td>1/3, ½</td></tr>
<tr><td>Turbo coding</td><td>1/3</td></tr>
<tr><td colspan="2">No coding</td></tr>
</table>

4.2.11 Sub-frame segmentation for the 1.28 Mcps option

In the 1.28Mcps TDD, it is needed to add a sub-frame segmentation unit between 2nd interleaving unit and physical channel mapping unit. The operation of rate-matching guarantees that the bit streams is a even number and can be subdivided into 2 sub-frames. The transport channel multiplexing structure for uplink and downlink is shown in figure X1.

The input bit sequence is denoted by $x_{i1}, x_{i2}, x_{i3}, \ldots, x_{iX_i}$ where i is the TrCH number and Xi is the number bits.

The two output bit sequences per radio frame are denoted by $y_{i,n_i1}, y_{i,n_i2}, y_{i,n_i3}, \ldots, y_{i,n_iY_i}$ where ni is the sub-frame number in current radio frame and Yi is the number of bits per radio frame for TrCH i. The output sequences are defined as follows:

$y_{i,n_ik} = x_{i,((n_i-1)Y_i)+k}$, ni = 1 or 2, k = 1…Yi

where

Yi = (Xi / 2) is the number of bits per sub-frame,

x_{ik} is the kth bit of the input bit sequence and

y_{i,n_ik} is the kth bit of the output bit sequence corresponding to the nth sub-frame

The input bit sequence to the sub-frame segmentation is denoted by $v_{(t)1}, v_{(t)2}, \ldots, v_{(t)U_{(t)}}$, xik = v(t)k and Xi = U(t).

The output bit sequence corresponding to subframe n_i is denoted by $g_{p1}, g_{p2}, \ldots, g_{pU_p}$, where p is the PhCH number and Up is the number of bits in one subframe for the respective PhCH. Hence, $g_{pk} = y_{i,n_i k}$ and Up = Yi.

4.2.12 Physical channel mapping

4.2.12.1~~1~~ Physical channel mapping for the 3.84 Mcps option

<No changes will be made in this chapter in this CR, only the title and numbering have to be changed. [former section 4.2.11]>

4.2.12.2 Physical channel mapping for the 1.28 Mcps option

The bit streams from the sub-frame segmentation unit are mapped onto code channels of time slots in sub-frames.

The bits after physical channel mapping are denoted by $w_{p1}, w_{p2}, \ldots, w_{pU_p}$, where p is the PhCH number and Up is the number of bits in one sub-frame for the respective PhCH. The bits wpk are mapped to the PhCHs so that the bits for each PhCH are transmitted over the air in ascending order with respect to k.

The mapping of the bits $g_{p1}, g_{p2}, \ldots, g_{pU_p}$ is performed like block interleaving, writing the bits into columns, but a PhCH with an odd number is filled in forward order, were as a PhCH with an even number is filled in reverse order.

The mapping scheme, as described in the following subclause, shall be applied individually for each timeslot t used in the current subframe. Therefore, the bits $g_{p1}, g_{p2}, \ldots, g_{pU_p}$ are assigned to the bits of the physical channels $w_{t1,1 \ldots U_{t1}}, w_{t2,1 \ldots U_{t2}}, \ldots, w_{tP_t,1 \ldots U_{tP_t}}$ in each timeslot.

In uplink there are at most two codes allocated (P≤2). If there is only one code, the same mapping as for downlink is applied. Denote SF1 and SF2 the spreading factors used for code 1 and 2, respectively. For the number of consecutive bits to assign per code bsk the following rule is applied:

if

SF1 >= SF2 then bs1 = 1 ; bs2 = SF1/SF2 ;

else

SF2 > SF1 then bs1 = SF2/SF1; bs2 = 1 ;

end if

In the downlink case bsp is 1 for all physical channels.

4.2.12.2.1 Mapping scheme

Notation used in this subclause:

P t:number of physical channels for timeslot t , Pt = 1..2 for uplink ; Pt = 1...16 for downlink

Utp: capacity in bits for the physical channel p in timeslot t

Ut.: total number of bits to be assigned for timeslot t

bsp: number of consecutive bits to assign per code

for downlink all bsp = 1

for uplink if SF1 >= SF2 then bs1 = 1 ; bs2 = SF1/SF2 ;

if SF2 > SF1 then bs1 = SF2/SF1; bs2 = 1 ;

fbp: number of already written bits for each code

pos: intermediate calculation variable

for p=1 to P t -- reset number of already written bits for every physical channel

fbp = 0

end for

p = 1 -- start with PhCH #1

for k=1 to Ut.

do while (fbp == Utp) -- physical channel filled up already ?

p = (p mod P t) + 1 ;

end do

if (p mod 2) == 0

pos = Utp - fbp -- reverse order

else

pos = fbp + 1 -- forward order

end if

wtp,pos = gt,k -- assignment

fbp = fbp + 1 -- Increment number of already written bits

If (fbp mod bsp) == 0 -- Conditional change to the next physical channel

p = (p mod P t) + 1 ;

end if

end for

4.2.~~12~~13 Multiplexing of different transport channels onto one CCTrCH, and mapping of one CCTrCH onto physical channels

<No changes will be made in this chapter in this CR, only the numbering has to be changed. >

4.2.~~13~~14 Transport format detection

<No changes will be made in this chapter in this CR, only the numbering has to be changed. >

4.3 Coding for layer 1 control for the 3.84 Mcps option

<No changes will be made in this chapter in this CR, only the numbering has to be changed. >

4.4 Coding for layer 1 control for the 1.28 Mcps option

4.4.1 Coding of transport format combination indicator (TFCI) for QPSK

4.4.1.1 Coding of long TFCI lengths

4.4.1.2 Coding of short TFCI lengths

4.4.1.2.1 Coding very short TFCIs by repetition

4.4.1.2.2 Coding short TFCIs using bi-orthogonal codes

4.4.1.3 Mapping of TFCI word

4.4.2 Coding of transport format combination indicator (TFCI) for 8PSK

Encoding of TFCI bits depends on the number of them and the modulation in use. When 2 Mcps service is transmitted, 8PSK modulation is applied in 1.28 Mcps TDD option. The coding scheme for TFCI when the number of bits are 6 – 10, and less than 6 are described in section 4.4.2.1 and 4.4.2.2, respectively.

4.4.2.1 Coding of long TFCI lengths

When the number of TFCI bits are 6 – 10, the TFCI bits are encoded by using a (64,10) sub-code of the second order Reed-Muller code, then 16 bits out of 64 bits are punctured (Puncturing positions are 0, 4, 8, 13, 16, 20, 27, 31, 34, 38, 41, 44, 50, 54, 57, 61st bits). The coding procedure is shown in Figure [F1].

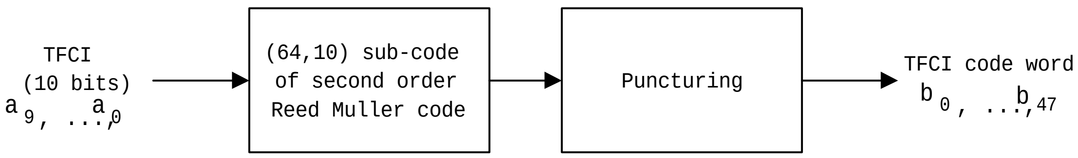

Figure [F1]: Channel coding of long TFCI bits for 8PSK

The code words of the punctured (48,10) sub-code of the second order Reed-Muller codes are linear combination of 10 basis sequences. The basis sequences are shown in Table [T1].

Table [T1]: Basis sequences for (48,10) TFCI code

I	$M_{i,0}$	$M_{i,1}$	$M_{i,2}$	$M_{i,3}$	$M_{I,4}$	$M_{i,5}$	$M_{i,6}$	$M_{I,7}$	$M_{I,8}$	$M_{i,9}$
0	1	0	0	0	0	0	1	0	1	0
1	0	1	0	0	0	0	1	1	0	0
2	1	1	0	0	0	0	1	1	0	1
3	1	0	1	0	0	0	1	1	1	0
4	0	1	1	0	0	0	1	0	1	0
5	1	1	1	0	0	0	1	1	1	0
6	1	0	0	1	0	0	1	1	1	1
7	0	1	0	1	0	0	1	1	0	1
8	1	1	0	1	0	0	1	0	1	0
9	0	0	1	1	0	0	1	1	0	0
10	0	1	1	1	0	0	1	1	0	1
11	1	1	1	1	0	0	1	1	1	1
12	1	0	0	0	1	0	1	0	1	1
13	0	1	0	0	1	0	1	1	1	0
14	1	1	0	0	1	0	1	0	0	1
15	1	0	1	0	1	0	1	0	1	1
16	0	1	1	0	1	0	1	1	0	0
17	1	1	1	0	1	0	1	1	1	0
18	0	0	0	1	1	0	1	0	0	1
19	1	0	0	1	1	0	1	0	1	1
20	0	1	0	1	1	0	1	0	1	0
21	0	0	1	1	1	0	1	0	1	0
22	1	0	1	1	1	0	1	1	0	1
23	0	1	1	1	1	0	1	1	1	0
24	0	0	0	0	0	1	1	1	0	1
25	1	0	0	0	0	1	1	1	1	0
26	1	1	0	0	0	1	1	1	1	1
27	0	0	1	0	0	1	1	0	1	1
28	1	0	1	0	0	1	1	1	0	1
29	1	1	1	0	0	1	1	0	1	1
30	0	0	0	1	0	1	1	0	0	1
31	0	1	0	1	0	1	1	0	0	1
32	1	1	0	1	0	1	1	1	1	1
33	1	0	1	1	0	1	1	0	0	1
34	0	1	1	1	0	1	1	1	1	0
35	1	1	1	1	0	1	1	1	0	1
36	0	0	0	0	1	1	1	1	1	0
37	1	0	0	0	1	1	1	0	1	1
38	1	1	0	0	1	1	1	1	1	1
39	0	0	1	0	1	1	1	1	0	0
40	1	0	1	0	1	1	1	1	0	0
41	1	1	1	0	1	1	1	1	1	1
42	0	0	0	1	1	1	1	1	1	1
43	0	1	0	1	1	1	1	0	1	0
44	1	1	0	1	1	1	1	0	1	0
45	0	0	1	1	1	1	1	0	1	1
46	0	1	1	1	1	1	1	0	0	1
47	1	1	1	1	1	1	1	1	0	0

Let's define the TFCI information bits as a_0 , a_1 , a_2 , a_3 , a_4 , a_5 , a_6 , a_7 , a_8 , a_9, where a_0 is the LSB and a_9 is the MSB. The TFCI information bits shall correspond to the TFC index (expressed in unsigned binary form) defined by the RRC layer to reference the TFC of the CCTrCH in the associated DPCH radio frame.

The output code word bits b_i are given by:

$$b_i = \sum_{n=0}^{9} (a_n \times M_{i,n}) \bmod 2$$

where i=0…47. N_{TFCI}=48.

4.4.2.2 Coding of short TFCI lengths

4.4.2.2.1 Coding very short TFCIs by repetition

When the number of TFCI bits is 1 or 2, then repetition will be used for the coding. In this case, each bit is repeated to a total of 6 times giving 6-bit transmission (N_{TFCI} = 6) for a single TFCI bit and 12-bit transmission (N_{TFCI} = 12) for 2 TFCI bits. For a single TFCI bit b_0, the TFCI code word shall be $\{b_0, b_0, b_0, b_0, b_0, b_0\}$. For TFCI bits b_0 and b_1, the TFCI code word shall be $\{b_0, b_1, b_0, b_1, b_0, b_1, b_0, b_1, b_0, b_1, b_0, b_1\}$.

4.4.2.2.2 Coding short TFCIs using bi-orthogonal codes

If the number of TFCI bits are in the range of 3 to 5, the TFCI bits are encoded using a (32,5) first order Reed-Muller code, then 8 bits out of 32 bits are punctured (Puncturing positions are 0, 1, 2, 3, 4, 5, 6, 7th bits). The coding procedure is shown in Figure [F2].

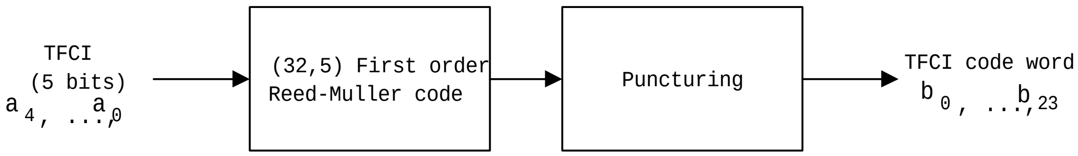

Figure [F2]: Channel coding of short TFCI bits for 8PSK

The code words of the punctured (32,5) first order Reed-Muller codes are linear combination of 5 basis sequences shown in Table [T2].

Table [T2]: Basis sequences for (24,5) TFCI code

I	$M_{i,0}$	$M_{i,1}$	$M_{i,2}$	$M_{i,3}$	$M_{i,4}$
0	0	0	0	1	0
1	1	0	0	1	0
2	0	1	0	1	0
3	1	1	0	1	0
4	0	0	1	1	0
5	1	0	1	1	0
6	0	1	1	1	0
7	1	1	1	1	0
8	0	0	0	0	1
9	1	0	0	0	1
10	0	1	0	0	1
11	1	1	0	0	1
12	0	0	1	0	1
13	1	0	1	0	1
14	0	1	1	0	1
15	1	1	1	0	1
16	0	0	0	1	1
17	1	0	0	1	1
18	0	1	0	1	1
19	1	1	0	1	1
20	0	0	1	1	1
21	1	0	1	1	1
22	0	1	1	1	1
23	1	1	1	1	1

Let's define the TFCI information bits as a_0 , a_1 , a_2 , a_3 , a_4, where a_0 is the LSB and a_4 is the MSB. The TFCI information bits shall correspond to the TFC index (expressed in unsigned binary form) defined by the RRC layer to reference the TFC of the CCTrCH in the associated DPCH radio frame.

The output code word bits b_i are given by:

$$b_i = \sum_{n=0}^{4} (a_n \times M_{i,n}) \bmod 2$$

where i=0…23. N_{TFCI}=24.

4.4.2.3 Mapping of TFCI word

Denote the number of bits in the TFCI word by N_{TFCI}, and denote the code word bits by b_k, where k = 0, …, N_{TFCI}-1. The mapping of the TFCI word to the TFCI bit positions in a time slot shall be as follows.

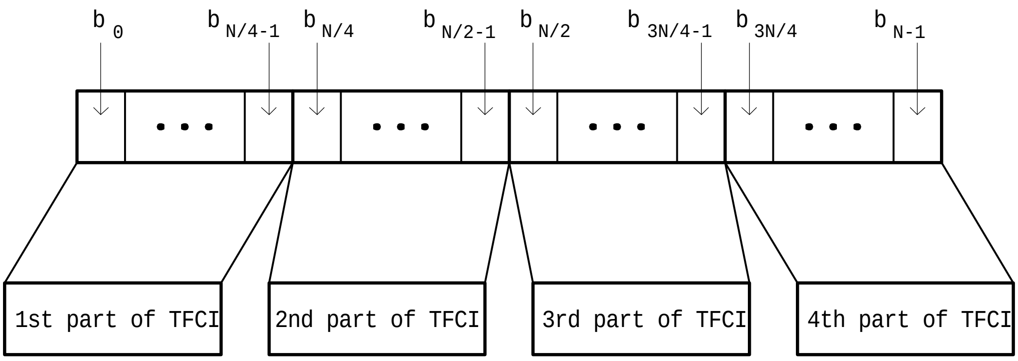

Figure [F3]: Mapping of TFCI word bits to timeslot in 1.28 Mcps TDD option, where N = N_{TFCI}.

The location of the 1st to 4th parts of TFCI in the timeslot is defined in [7].

4.4.3 Coding of Paging Indicator (PI)

4.4.4 Coding of Transmit Power Control (TPC)

4.4.4.1 Coding of TPC for QPSK

4.4.4.2 Coding of TPC for 8PSK

4.4.5 Coding of Synchronisation Shift Control (SS)

4.4.5.1 Coding of SS for QPSK

4.4.5.2 Coding of SS for 8PSK