TSG-RAN Meeting #13 ***RP-010523***
Beijing, China, 18 - 21, September, 2001

Title: **Agreed CRs (R99 and Rel-4 Category A) to TS 25.222**

Source: **TSG-RAN WG1**

Agenda item: **8.1.3**

No.	Spec	CR	Rev	R1 T-doc	Subject	Release	Cat	W/I Code	V_old	V_new
1	25.222	056	-	R1-01-0781	TFCI Terminology	R99	F	TEI	3.6.0	3.7.0
2	25.222	057	-	R1-01-0781	TFCI Terminology	REL-4	A	TEI	4.0.0	4.1.0

3GPP TSG RAN Meeting #13
Beijing, China, 18th – 21st , September, 2001

R1-01-0781

CR-Form-v3

CHANGE REQUEST

⌘	**25.222**	**CR**	**056**	⌘ rev	**-**	⌘ Current version:	**3.6.0** ⌘

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

Title:	⌘	TFCI Terminology		
Source:	⌘	TSG RAN WG1		
Work item code:	⌘	TEI	***Date:*** ⌘	20.08.2001
Category:	⌘	**F**	***Release:*** ⌘	R99

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:	⌘	The Terminology of the TFCI is corrected in this CR, because the current usage of the term TFCI, TFCI information and TFCI code word can cause confusion and misunderstandings
Summary of change:	⌘	TFCI is the indicator, indicating the TFC and the term TFCI code word is used for the coded TFCI bits after FEC.
Consequences if not approved:	⌘	Possible misunderstandings

Clauses affected:	⌘	3.2, 4.2.7.1, 4.2.14.1, 4.3.1	
Other specs affected:	⌘	[ ] Other core specifications	⌘
		[ ] Test specifications	
		[ ] O&M Specifications	
Other comments:	⌘		

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3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

TrCH number: transport channel number represents a TrCH ID assigned to L1 by L2. Transport channels are multiplexed to the CCTrCH in the ascending order of these IDs.

3.2 Symbols

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

$\lceil x \rceil$	round towards ∞, i.e. integer such that $x \le \lceil x \rceil < x+1$
$\lfloor x \rfloor$	round towards $-\infty$, i.e. integer such that $x-1 < \lfloor x \rfloor \le x$
$\lvert x \rvert$	absolute value of x

Unless otherwise is explicitly stated when the symbol is used, the meaning of the following symbols are:

i	TrCH number
j	TFC number
k	Bit number
l	TF number
m	Transport block number
n	Radio frame number
p	PhCH number
r	Code block number
I	Number of TrCHs in a CCTrCH.
C_i	Number of code blocks in one TTI of TrCH i.
F_i	Number of radio frames in one TTI of TrCH i.
M_i	Number of transport blocks in one TTI of TrCH i.
$N_{TCFI\ code\ word}$	Number of TFCI code word bits after TFCI encoding
P	Number of PhCHs used for one CCTrCH.
PL	Puncturing Limit. Signalled from higher layers
RM_i	Rate Matching attribute for TrCH i. Signalled from higher layers.

Temporary variables, i.e. variables used in several (sub)clauses with different meaning.

x, X
y, Y
z, Z

4.2.7.1 Determination of rate matching parameters

The following relations, defined for all TFC *j*, are used when calculating the rate matching pattern:

$$Z_{0,j} = 0$$

$$Z_{i,j} = \left\lfloor \frac{\left(\left(\sum_{m=1}^{i} RM_m \times N_{m,j}\right) \times N_{data,j}\right)}{\sum_{m=1}^{I} RM_m \times N_{m,j}} \right\rfloor \quad \text{for all i = 1 ... } I \text{ (1)}$$

$$\Delta N_{i,j} = Z_{i,j} - Z_{i-1,j} - N_{i,j} \quad \text{for all i = 1 ... } I$$

Puncturing can be used to minimise the required transmission capacity. The maximum amount of puncturing that can be applied is 1-PL, PL is signalled from higher layers. The possible values for N_{data} depend on the number of physical channels P_{max} , allocated to the respective CCTrCH, and on their characteristics (spreading factor, length of midamble and TFCI code word, usage of TPC and multiframe structure), which is given in [7].

Denote the number of data bits in each physical channel by $U_{p,Sp}$, where p refers to the sequence number $1 \le p \le P_{max}$ of this physical channel as detailed in section 4.2.11, and the second index Sp indicates the spreading factor with the possible values {*16, 8, 4, 2, 1*}, respectively. For each physical channel an individual minimum spreading factor Sp_{min} is transmitted by means of the higher layers. Then, for N_{data} one of the following values in ascending order can be chosen:

$$\left\{U_{1,S1_{\min}}, U_{1,S1_{\min}} + U_{2,S2_{\min}}, U_{1,S1_{\min}} + U_{2,S2_{\min}} + \ldots + U_{P_{\max},(SP_{\max})_{\min}}\right\}$$

Optionally, if indicated by higher layers for the UL the UE shall vary the spreading factor autonomously, so that N_{data} is one of the following values in ascending order:

$$\left\{U_{1,16},\ldots,U_{1,S1_{\min}}, U_{1,S1_{\min}} + U_{2,16},\ldots,U_{1,S1_{\min}} + U_{2,S2_{\min}},\ldots,U_{1,S1_{\min}} + U_{2,S2_{\min}} + \ldots + U_{P_{\max},16},\ldots,U_{1,S1_{\min}} + U_{2,S2_{\min}} + \ldots + U_{P_{\max},(SP_{\max})_{\min}}\right\}$$

$N_{data,j}$ for the transport format combination j is determined by executing the following algorithm:

$$\text{SET1} = \{\ N_{data} \text{ such that } \left(\min_{1 \le y \le I}\{RM_y\}\right) \times N_{data} - PL \times \sum_{x=1}^{I} RM_x \times N_{x,j} \text{ is non negative }\}$$

$N_{data,j}$ = min SET1

The number of bits to be repeated or punctured, $\Delta N_{i,j}$, within one radio frame for each TrCH i is calculated with the relations given at the beginning of this subclause for all possible transport format combinations j and selected every radio frame.

If $\Delta N_{i,j} = 0$ then the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 4.2.7.3 does not need to be executed.

Otherwise, the rate matching pattern is calculated with the algorithm described in subclause 4.2.7.3. For this algorithm the parameters e_{ini}, e_{plus}, e_{minus}, and X_i are needed, which are calculated according to the equations in subclauses 4.2.7.1.1 and 4.2.7.1.2.

4.2.14 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 used, i.e. the receiver side uses the possible transport format combinations as a priori information.

4.2.14.1 Blind transport format detection

Blind Transport Format Detection is optional both in the UE and the UTRAN. Therefore, for all CCTrCH a TFCI shall be transmitted, including the possibilty of a TFCI code word length zero, if only one TFC is defined.

4.2.14.2 Explicit transport format detection based on TFCI

4.2.14.2.1 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)

Encoding of the TFCI depends on its length. If there are 6-10 bits of TFCI the channel encoding is done as described in subclause 4.3.1.1. Also specific coding of less than 6 bits is possible as explained in subclause 4.3.1.2.

4.3.1.1 Coding of long TFCI lengths

The TFCI is encoded using a (32, 10) sub-code of the second order Reed-Muller code. The coding procedure is as shown in figure 6.

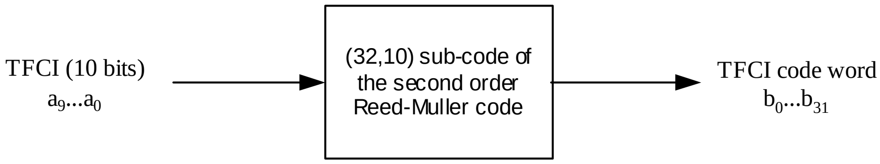

Figure 6: Channel coding of <u>the</u> TFCI ~~information~~ bits

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. The basis sequences are as follows in table 8.

Table 8: Basis sequences for (32,10) 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	1	0	0	0	0
1	0	1	0	0	0	1	1	0	0	0
2	1	1	0	0	0	1	0	0	0	1
3	0	0	1	0	0	1	1	0	1	1
4	1	0	1	0	0	1	0	0	0	1
5	0	1	1	0	0	1	0	0	1	0
6	1	1	1	0	0	1	0	1	0	0
7	0	0	0	1	0	1	0	1	1	0
8	1	0	0	1	0	1	1	1	1	0
9	0	1	0	1	0	1	1	0	1	1
10	1	1	0	1	0	1	0	0	1	1
11	0	0	1	1	0	1	0	1	1	0
12	1	0	1	1	0	1	0	1	0	1
13	0	1	1	1	0	1	1	0	0	1
14	1	1	1	1	0	1	1	1	1	1
15	1	0	0	0	1	1	1	1	0	0
16	0	1	0	0	1	1	1	1	0	1
17	1	1	0	0	1	1	1	0	1	0
18	0	0	1	0	1	1	0	1	1	1
19	1	0	1	0	1	1	0	1	0	1
20	0	1	1	0	1	1	0	0	1	1
21	1	1	1	0	1	1	0	1	1	1
22	0	0	0	1	1	1	0	1	0	0
23	1	0	0	1	1	1	1	1	0	1
24	0	1	0	1	1	1	1	0	1	0
25	1	1	0	1	1	1	1	0	0	1
26	0	0	1	1	1	1	0	0	1	0
27	1	0	1	1	1	1	1	1	0	0
28	0	1	1	1	1	1	1	1	1	0
29	1	1	1	1	1	1	1	1	1	1
30	0	0	0	0	0	1	0	0	0	0
31	0	0	0	0	1	1	1	0	0	0

The TFCI ~~information~~ bits a_0 , a_1 , a_2 , a_3 , a_4 , a_5 , a_6 , a_7 , a_8 , a_9 (where a_0 is LSB and a_9 is MSB) 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 TFCI code word bits b_i are given by:

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

where $i = 0,\ldots,31$. $N_{\text{TFCI code word}} = 32$.

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 times giving 4-bit transmission ($N_{\text{TFCI code word}}$=4) for a single TFCI bit and 8-bit transmission ($N_{\text{TFCI code word}}$=8) for 2 TFCI bits. The TFCI ~~information~~ bit(s) b_0 (or b_0 and b_1 where b_0 is the LSB) 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. In the case of two TFCI bits denoted b_0 and b_1 the TFCI code word shall be { $b_0, b_1, b_0, b_1, b_0, b_1, b_0, b_1$ }.

4.3.1.2.2 Coding short TFCIs using bi-orthogonal codes

If the number of TFCI bits is in the range 3 to 5 the TFCI is encoded using a (16, 5) bi-orthogonal (or first order Reed-Muller) code. The coding procedure is as shown in figure 7.

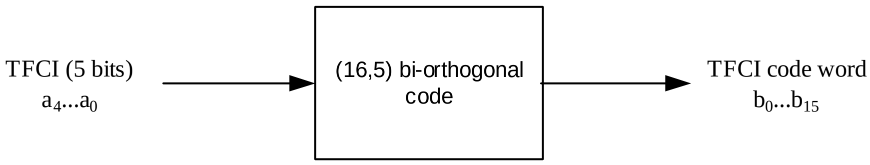

Figure 7: Channel coding of short length TFCI ~~information~~ bits

The code words of the (16,5) bi-orthogonal code are linear combinations of 5 basis sequences as defined in table 9.

Table 9: Basis sequences for (16,5) TFCI code

i	$M_{i,0}$	$M_{i,1}$	$M_{i,2}$	$M_{i,3}$	$M_{i,4}$
0	1	0	0	0	1
1	0	1	0	0	1
2	1	1	0	0	1
3	0	0	1	0	1
4	1	0	1	0	1
5	0	1	1	0	1
6	1	1	1	0	1
7	0	0	0	1	1
8	1	0	0	1	1
9	0	1	0	1	1
10	1	1	0	1	1
11	0	0	1	1	1
12	1	0	1	1	1
13	0	1	1	1	1
14	1	1	1	1	1
15	0	0	0	0	1

The TFCI ~~information~~ bits a_0 , a_1 , a_2 , a_3 , a_4 (where a_0 is LSB and a_4 is MSB) 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_j are given by:

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

where i = 0,…,15. $N_{TFCI\ code\ word}$ = 16.

4.3.1.3 Mapping of TFCI code word

The mapping of the TFCI code word to the TFCI bit positions in a timeslot shall be as follows.

Denote the number of bits in the TFCI word by $N_{TFCI\ code\ word}$, denote the TFCI code word bits by b_k where k=0… $N_{TFCI\ code\ word}$-1.

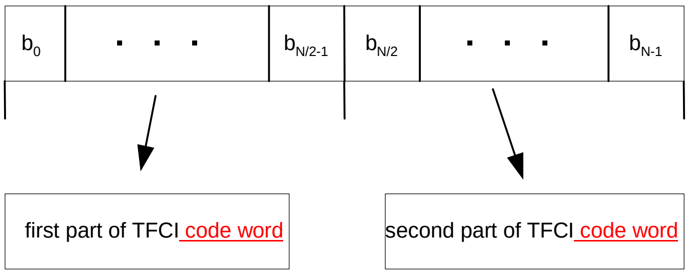

Figure 8: Mapping of TFCI code word bits to timeslot

The locations of the first and second parts of the TFCI code word in the timeslot is defined in [7].

If the shortest transmission time interval of any constituent TrCH is at least 20 ms the successive TFCI code words in the frames in the TTI shall be identical. If TFCI is transmitted on multiple timeslots in a frame each timeslot shall have the same TFCI code word.

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CR-Form-v3

CHANGE REQUEST

⌘ **25.222 CR 057**	⌘ rev **-**	⌘	Current version: **4.0.0**	⌘	

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Category:	⌘	**A**	***Release:*** ⌘	REL-4
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M_i	Number of transport blocks in one TTI of TrCH i.
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PL	Puncturing Limit. Signalled from higher layers
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Temporary variables, i.e. variables used in several (sub)clauses with different meaning.

x, X
y, Y
z, Z

4.2.7.1 Determination of rate matching parameters

The following relations, defined for all TFC *j*, are used when calculating the rate matching pattern:

$$Z_{0,j} = 0$$

$$Z_{i,j} = \left\lfloor \frac{\left(\left(\sum_{m=1}^{i} RM_m \times N_{m,j} \right) \times N_{data,j} \right)}{\sum_{m=1}^{I} RM_m \times N_{m,j}} \right\rfloor \quad \text{for all i = 1 ... } I \text{ (1)}$$

$$\Delta N_{i,j} = Z_{i,j} - Z_{i-1,j} - N_{i,j} \quad \text{for all i = 1 ... } I$$

Puncturing can be used to minimise the required transmission capacity. The maximum amount of puncturing that can be applied is 1-PL, PL is signalled from higher layers. The possible values for N_{data} depend on the number of physical channels P_{max} , allocated to the respective CCTrCH, and on their characteristics (spreading factor, length of midamble and TFCI code word, usage of TPC and multiframe structure), which is given in [7].

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$$\left\{ U_{1,S1_{min}}, U_{1,S1_{min}} + U_{2,S2_{min}}, U_{1,S1_{min}} + U_{2,S2_{min}} + \ldots + U_{P_{max},(SP_{max})_{min}} \right\}$$

Optionally, if indicated by higher layers for the UL the UE shall vary the spreading factor autonomously, so that N_{data} is one of the following values in ascending order:

$$\left\{ U_{1,16},\ldots,U_{1,S1_{min}}, U_{1,S1_{min}} + U_{2,16},\ldots,U_{1,S1_{min}} + U_{2,S2_{min}},\ldots,U_{1,S1_{min}} + U_{2,S2_{min}} + \ldots + U_{P_{max},16},\ldots,U_{1,S1_{min}} + U_{2,S2_{min}} + \ldots + U_{P_{max},(SP_{max})_{min}} \right\}$$

$N_{data,j}$ for the transport format combination j is determined by executing the following algorithm:

$$\text{SET1} = \{ N_{data} \text{ such that } \left(\min_{1 \le y \le I} \{ RM_y \} \right) \times N_{data} - PL \times \sum_{x=1}^{I} RM_x \times N_{x,j} \text{ is non negative } \}$$

$$N_{data,j} = \min \text{SET1}$$

The number of bits to be repeated or punctured, $\Delta N_{i,j}$, within one radio frame for each TrCH i is calculated with the relations given at the beginning of this subclause for all possible transport format combinations j and selected every radio frame.

If $\Delta N_{i,j} = 0$ then the output data of the rate matching is the same as the input data and the rate matching algorithm of subclause 4.2.7.3 does not need to be executed.

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4.2.15 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 used, i.e. the receiver side uses the possible transport format combinations as a priori information.

4.2.15.1 Blind transport format detection

Blind Transport Format Detection is optional both in the UE and the UTRAN. Therefore, for all CCTrCH a TFCI shall be transmitted, including the possibilty of a TFCI code word length zero, if only one TFC is defined.

4.3 Coding for layer 1 control for the 3.84 Mcps option

4.3.1 Coding of transport format combination indicator (TFCI)

Encoding of the TFCI depends on its length. If there are 6-10 bits of TFCI the channel encoding is done as described in subclause 4.3.1.1. Also specific coding of less than 6 bits is possible as explained in subclause 4.3.1.2.

4.3.1.1 Coding of long TFCI lengths

The TFCI is encoded using a (32, 10) sub-code of the second order Reed-Muller code. The coding procedure is as shown in figure 6.

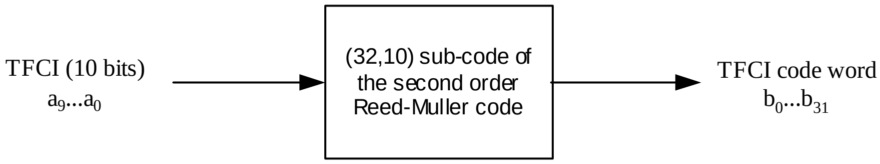


Figure 6: Channel coding of the TFCI ~~information~~ bits

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. The basis sequences are as follows in table 9.

Table 9: Basis sequences for (32,10) 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	1	0	0	0	0
1	0	1	0	0	0	1	1	0	0	0
2	1	1	0	0	0	1	0	0	0	1
3	0	0	1	0	0	1	1	0	1	1
4	1	0	1	0	0	1	0	0	0	1
5	0	1	1	0	0	1	0	0	1	0
6	1	1	1	0	0	1	0	1	0	0
7	0	0	0	1	0	1	0	1	1	0
8	1	0	0	1	0	1	1	1	1	0
9	0	1	0	1	0	1	1	0	1	1
10	1	1	0	1	0	1	0	0	1	1
11	0	0	1	1	0	1	0	1	1	0
12	1	0	1	1	0	1	0	1	0	1
13	0	1	1	1	0	1	1	0	0	1
14	1	1	1	1	0	1	1	1	1	1
15	1	0	0	0	1	1	1	1	0	0
16	0	1	0	0	1	1	1	1	0	1
17	1	1	0	0	1	1	1	0	1	0
18	0	0	1	0	1	1	0	1	1	1
19	1	0	1	0	1	1	0	1	0	1
20	0	1	1	0	1	1	0	0	1	1
21	1	1	1	0	1	1	0	1	1	1
22	0	0	0	1	1	1	0	1	0	0
23	1	0	0	1	1	1	1	1	0	1
24	0	1	0	1	1	1	1	0	1	0
25	1	1	0	1	1	1	1	0	0	1
26	0	0	1	1	1	1	0	0	1	0
27	1	0	1	1	1	1	1	1	0	0
28	0	1	1	1	1	1	1	1	1	0
29	1	1	1	1	1	1	1	1	1	1
30	0	0	0	0	0	1	0	0	0	0
31	0	0	0	0	1	1	1	0	0	0

The TFCI ~~information~~ bits a_0 , a_1 , a_2 , a_3 , a_4 , a_5 , a_6 , a_7 , a_8 , a_9 (where a_0 is LSB and a_9 is MSB) 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 TFCI code word bits b_i are given by:

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

where $i = 0,\ldots,31$. $N_{\text{TFCI code word}} = 32$.

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 times giving 4-bit transmission ($N_{\text{TFCI code word}}$=4) for a single TFCI bit and 8-bit transmission ($N_{\text{TFCI code word}}$=8) for 2 TFCI bits. The TFCI ~~information~~ bit(s) b_0 (or b_0 and b_1 where b_0 is the LSB) 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. In the case of two TFCI bits denoted b_0 and b_1 the TFCI code word shall be { $b_0, b_1, b_0, b_1, b_0, b_1, b_0, b_1$ }.

4.3.1.2.2 Coding short TFCIs using bi-orthogonal codes

If the number of TFCI bits is in the range 3 to 5 the TFCI is encoded using a (16, 5) bi-orthogonal (or first order Reed-Muller) code. The coding procedure is as shown in figure 7.

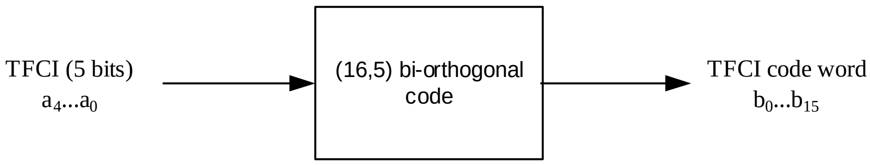


Figure 7: Channel coding of short length TFCI ~~information~~ bits

The code words of the (16,5) bi-orthogonal code are linear combinations of 5 basis sequences as defined in table 10.

Table 10: Basis sequences for (16,5) TFCI code

i	$M_{i,0}$	$M_{i,1}$	$M_{i,2}$	$M_{i,3}$	$M_{i,4}$
0	1	0	0	0	1
1	0	1	0	0	1
2	1	1	0	0	1
3	0	0	1	0	1
4	1	0	1	0	1
5	0	1	1	0	1
6	1	1	1	0	1
7	0	0	0	1	1
8	1	0	0	1	1
9	0	1	0	1	1
10	1	1	0	1	1
11	0	0	1	1	1
12	1	0	1	1	1
13	0	1	1	1	1
14	1	1	1	1	1
15	0	0	0	0	1

The TFCI ~~information~~ bits a_0 , a_1 , a_2 , a_3 , a_4 (where a_0 is LSB and a_4 is MSB) 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_j are given by:

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

where i = 0,…,15. $N_{TFCI\ code\ word}$ = 16.

4.3.1.3 Mapping of TFCI code word

The mapping of the TFCI code word to the TFCI bit positions in a timeslot shall be as follows.

Denote the number of bits in the TFCI code word by $N_{TFCI\ code\ word}$, denote the TFCI code word bits by b_k where k=0… $N_{TFCI\ code\ word}$-1.

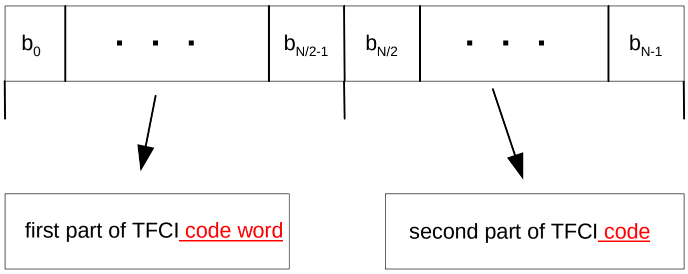


Figure 8: Mapping of TFCI code word bits to timeslot

The locations of the first and second parts of the TFCI code word in the timeslot is defined in [7].

If the shortest transmission time interval of any constituent TrCH is at least 20 ms the successive TFCI code words in the frames in the TTI shall be identical. If TFCI is transmitted on multiple timeslots in a frame each timeslot shall have the same TFCI code word.

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

The coding of TFCI for 1.28Mcps TDD is same as that of 3.84Mcps TDD.cf.[4.3.1 'Coding of transport format combination indicator'].

4.4.1.1 Mapping of TFCI code word

Denote the number of bits in the TFCI code word by $N_{TFCI\ code\ word}$, and denote the TFCI code word bits by b_k, where k = 0, …, $N_{TFCI\ code\ word}$-1

When the number of bits in the TFCI code word is 8, 16, 32, the mapping of the TFCI code word to the TFCI bit positions shall be as follows~~.~~:

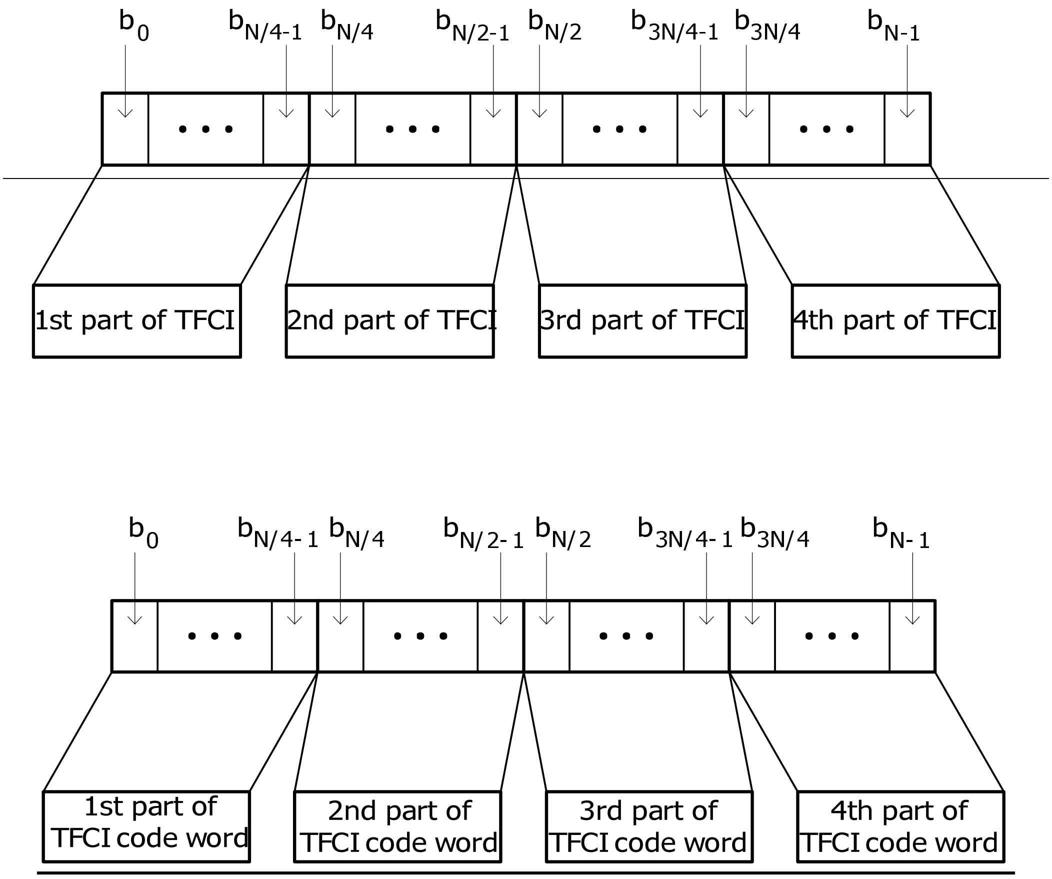
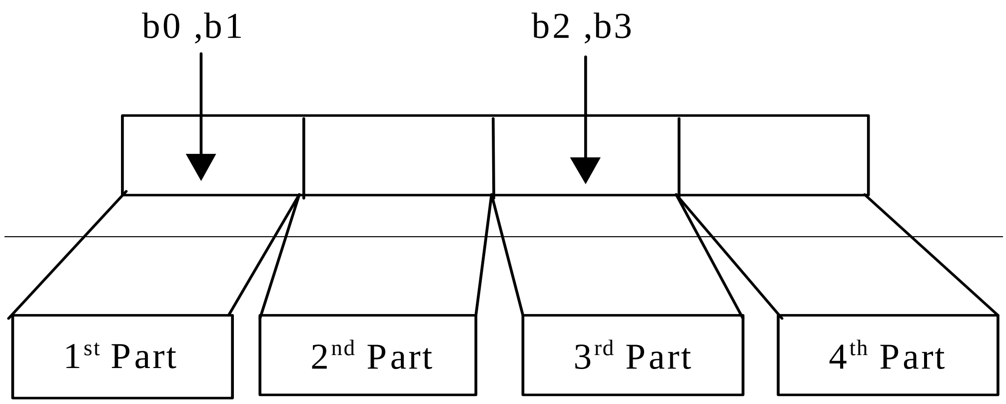


Figure 9: Mapping of TFCI code word bits to TFCI position in 1.28 Mcps TDD option, where N = $N_{TFCI\ code\ word}$.

When the number of bits ~~in~~ of the TFCI code word is 4 , then the TFCI code word is equally divided into two parts for the consecutive two subframe and mapped onto the end of the first data field in each of the consecutive subframes. The mapping for $N_{TFCI\ code\ word}$~~,~~=4 is shown in figure 10:



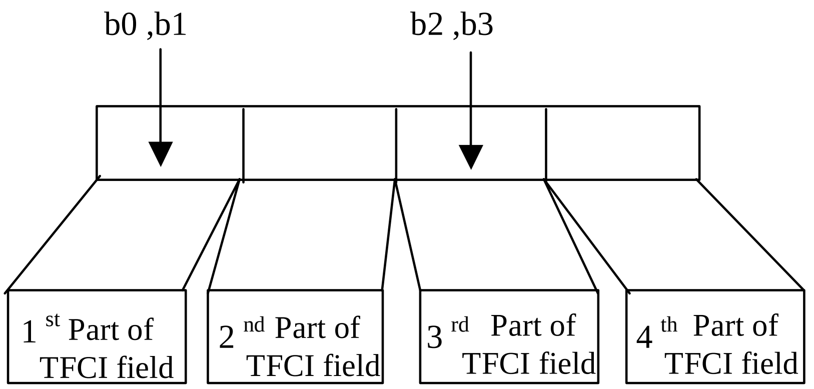


Figure 10: Mapping of TFCI code word bits to TFCI position in 1.28 Mcps TDD option, when $N_{TFCI\ code\ word}$=4

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

If the shortest transmission time interval of any constituent TrCH is at least 20 ms, then successive TFCI code words in the frames within the TTI shall be identical. If a TFCI is transmitted on multiple timeslots in a frame each timeslot shall have the same TFCI code 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 encoding scheme for TFCI when the number of bits are 6 – 10, and less than 6 bits ~~are~~ is 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~~ is 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 11.

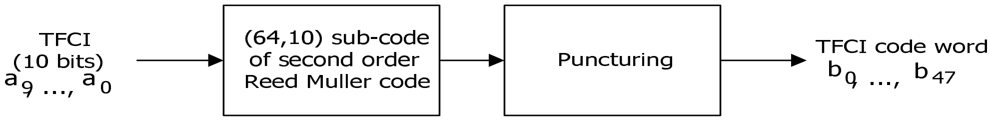


Figure 11: Channel coding of long TFCI bits for 8PSK

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 12.

Table 12: 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 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 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 TFCI 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. $N_{TFCI\ code\ word}$=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 ($N_{TFCI\ code\ word}$ = 6) for a single TFCI bit and 12-bit transmission ($N_{TFCI\ code\ word}$ = 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 two 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 is 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 12.

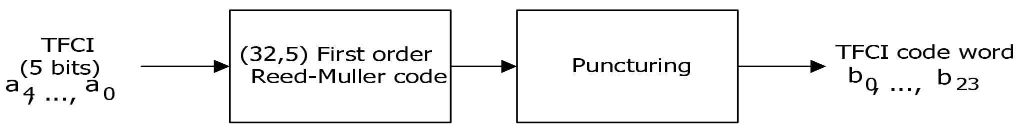


Figure 12: Channel coding of short TFCI bits for 8PSK

The code words of the punctured (32,5) first order Reed-Muller codes are linear combination of 5 basis sequences shown in Table 13.

Table 13: 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 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 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:

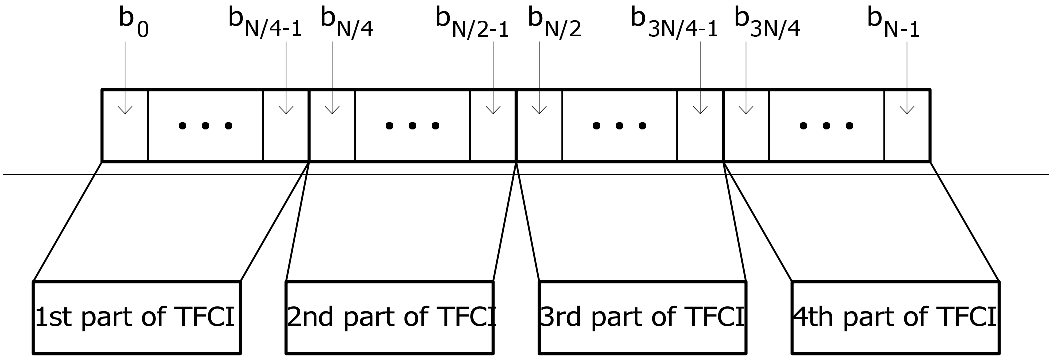
$$b_i = \sum_{n=0}^{4} (a_n \times M_{i,n}) \bmod 2$$

where i=0…23. $N_{\text{TFCI code word}}$=24.

4.4.2.3 Mapping of TFCI code word

Denote the number of bits in the TFCI code word by $N_{\text{TFCI code word}}$, and denote the TFCI code word bits by b_k, where k = 0, …, $N_{\text{TFCI code word}}$-1.

When the number of bits in the TFCI code word is 12, 24~~,~~ or 48, the mapping of the TFCI code word to the TFCI bit positions in a time slot shall be as follows.



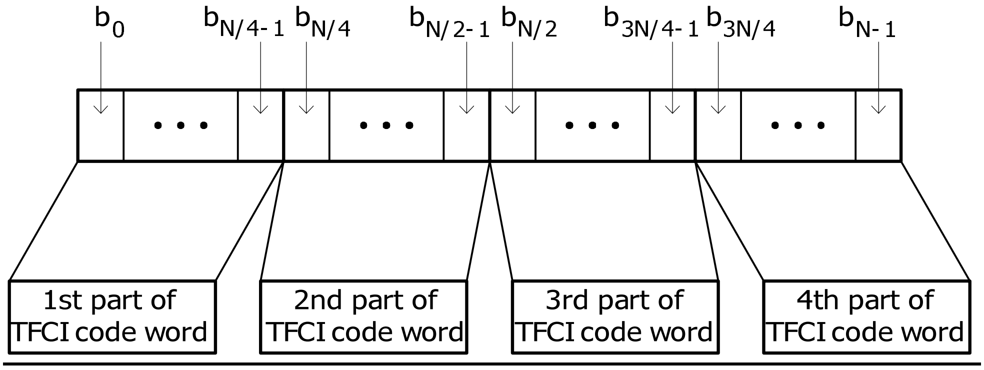


Figure 13: Mapping of TFCI code word bits to timeslot in 1.28 Mcps TDD option, where N = $N_{TFCI\ code\ word}$.

When the number of bits in the TFCI code word is 6, the TFCI code word is equally divided into two parts for the consecutive two sub-frames and mapped onto the first data field in each of the consecutive sub-frames. The mapping of the TFCI code word to the TFCI bit positions in a time slot shall be as shown in figure 14.

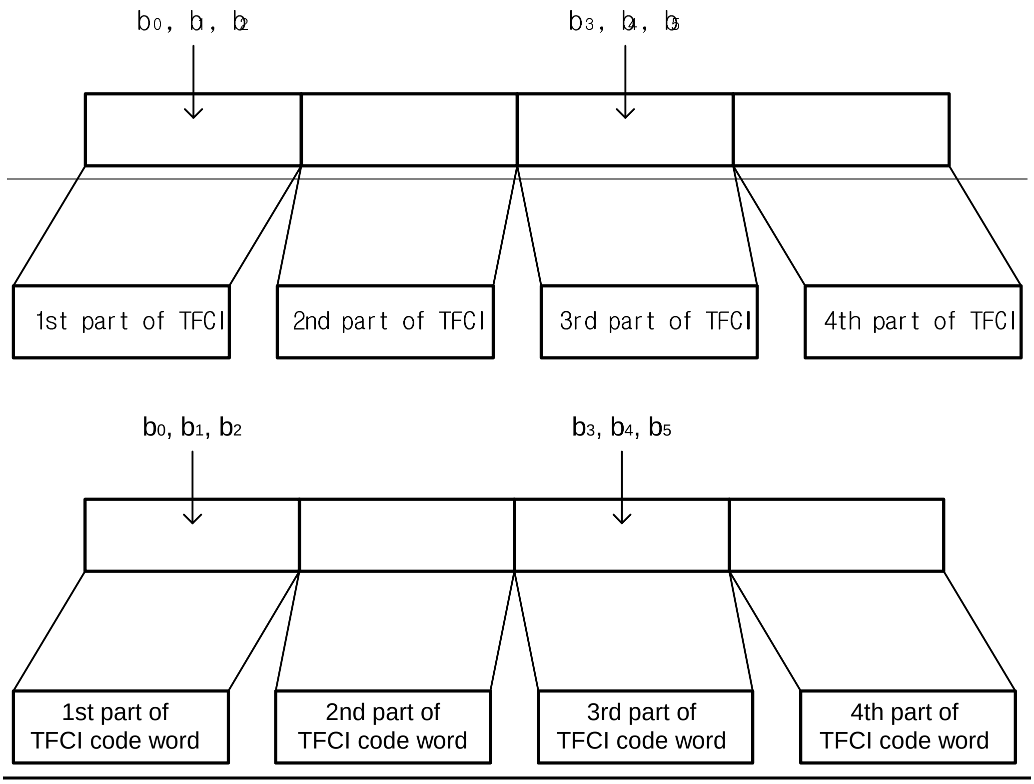


Figure 14: Mapping of TFCI code word bits to timeslot in 1.28 Mcps TDD option when $N_{TFCI\ code\ word}$ = 6

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