

ETSI TS 136 212 V12.9.1 (2018-01)



LTE;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Multiplexing and channel coding
(3GPP TS 36.212 version 12.9.1 Release 12)

Standard PREVIEW
(standard: iteh:ai)
Full standard: https://standards.iteh.ai/catalog/standards/sist/61cfd11b-3a88-4ff-b045-6c24645e90d2/etsi-ts-136-212-v12-9-1-2018-01



ReferenceRTS/TSGR-0136212vc91

Keywords

LTE

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:

<http://www.etsi.org/standards-search>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status.

Information on the current status of this and other ETSI documents is available at

<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:

<https://portal.etsi.org/People/CommiteeSupportStaff.aspx>

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2018.

All rights reserved.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members.

3GPP™ and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.

oneM2M logo is protected for the benefit of its Members.

GSM® and the GSM logo are trademarks registered and owned by the GSM Association.

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "*Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards*", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (<https://ipr.etsi.org/>).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

Foreword

This Technical Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under <http://webapp.etsi.org/key/queryform.asp>.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Contents

Intellectual Property Rights	2
Foreword.....	2
Modal verbs terminology.....	2
Foreword.....	5
1 Scope	6
2 References	6
3 Definitions, symbols and abbreviations	6
3.1 Definitions	6
3.2 Symbols.....	6
3.3 Abbreviations	7
4 Mapping to physical channels	7
4.1 Uplink.....	7
4.2 Downlink.....	8
4.3 Sidelink	8
5 Channel coding, multiplexing and interleaving.....	8
5.1 Generic procedures.....	9
5.1.1 CRC calculation.....	9
5.1.2 Code block segmentation and code block CRC attachment	9
5.1.3 Channel coding	11
5.1.3.1 Tail biting convolutional coding	12
5.1.3.2 Turbo coding	12
5.1.3.2.1 Turbo encoder.....	12
5.1.3.2.2 Trellis termination for turbo encoder.....	14
5.1.3.2.3 Turbo code internal interleaver.....	14
5.1.4 Rate matching	15
5.1.4.1 Rate matching for turbo coded transport channels	15
5.1.4.1.1 Sub-block interleaver.....	16
5.1.4.1.2 Bit collection, selection and transmission.....	17
5.1.4.2 Rate matching for convolutionally coded transport channels and control information.....	19
5.1.4.2.1 Sub-block interleaver.....	20
5.1.4.2.2 Bit collection, selection and transmission.....	21
5.1.5 Code block concatenation.....	21
5.2 Uplink transport channels and control information	22
5.2.1 Random access channel	22
5.2.2 Uplink shared channel	22
5.2.2.1 Transport block CRC attachment.....	23
5.2.2.2 Code block segmentation and code block CRC attachment.....	23
5.2.2.3 Channel coding of UL-SCH.....	24
5.2.2.4 Rate matching	24
5.2.2.5 Code block concatenation	24
5.2.2.6 Channel coding of control information	24
5.2.2.6.1 Channel quality information formats for wideband CQI reports.....	36
5.2.2.6.2 Channel quality information formats for higher layer configured subband CQI reports.....	37
5.2.2.6.3 Channel quality information formats for UE selected subband CQI reports	41
5.2.2.6.4 Channel coding for CQI/PMI information in PUSCH.....	42
5.2.2.6.5 Channel coding for more than 11 bits of HARQ-ACK information	43
5.2.2.7 Data and control multiplexing.....	44
5.2.2.8 Channel interleaver	45
5.2.3 Uplink control information on PUCCH.....	47
5.2.3.1 Channel coding for UCI HARQ-ACK	47
5.2.3.2 Channel coding for UCI scheduling request	52
5.2.3.3 Channel coding for UCI channel quality information.....	52
5.2.3.3.1 Channel quality information formats for wideband reports.....	53

5.2.3.3.2	Channel quality information formats for UE-selected sub-band reports	56
5.2.3.4	Channel coding for UCI channel quality information and HARQ-ACK	60
5.2.4	Uplink control information on PUSCH without UL-SCH data	60
5.2.4.1	Channel coding of control information	61
5.2.4.2	Control information mapping	61
5.2.4.3	Channel interleaver	62
5.3	Downlink transport channels and control information	62
5.3.1	Broadcast channel	62
5.3.1.1	Transport block CRC attachment	62
5.3.1.2	Channel coding	63
5.3.1.3	Rate matching	63
5.3.2	Downlink shared channel, Paging channel and Multicast channel	63
5.3.2.1	Transport block CRC attachment	64
5.3.2.2	Code block segmentation and code block CRC attachment	64
5.3.2.3	Channel coding	65
5.3.2.4	Rate matching	65
5.3.2.5	Code block concatenation	65
5.3.3	Downlink control information	65
5.3.3.1	DCI formats	66
5.3.3.1.1	Format 0	66
5.3.3.1.2	Format 1	67
5.3.3.1.3	Format 1A	68
5.3.3.1.3A	Format 1B	70
5.3.3.1.4	Format 1C	72
5.3.3.1.4A	Format 1D	73
5.3.3.1.5	Format 2	74
5.3.3.1.5A	Format 2A	78
5.3.3.1.5B	Format 2B	80
5.3.3.1.5C	Format 2C	81
5.3.3.1.5D	Format 2D	83
5.3.3.1.6	Format 3	84
5.3.3.1.7	Format 3A	84
5.3.3.1.8	Format 4	84
5.3.3.1.9	Format 5	86
5.3.3.2	CRC attachment	87
5.3.3.3	Channel coding	87
5.3.3.4	Rate matching	87
5.3.4	Control format indicator	88
5.3.4.1	Channel coding	88
5.3.5	HARQ indicator (HI)	88
5.3.5.1	Channel coding	89
5.4	Sidelink transport channels and control information	89
5.4.1	Sidelink broadcast channel	89
5.4.1.1	Transport block CRC attachment	89
5.4.1.2	Channel coding	90
5.4.1.3	Rate matching	90
5.4.2	Sidelink shared channel	90
5.4.3	Sidelink control information	90
5.4.3.1	SCI formats	90
5.4.3.1.1	SCI format 0	91
5.4.4	Sidelink discovery channel	91
Annex A (informative):	Change history	92
History		96

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
 - 1 presented to TSG for information;
 - 2 presented to TSG for approval;
 - 3 or greater indicates TSG approved document under change control.
- Y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

PREVIEW
iTech STANDARD
(standards.iteh.ai)
Full standard:
<https://standards.iteh.ai/catalog/standards/sist/61cfd11b-3a88-4ff-b045-6c24645e90d2/etsi-ts-136-212-v12.9.1-2018-01>

1 Scope

The present document specifies the coding, multiplexing and mapping to physical channels for E-UTRA.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation".
- [3] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures".
- [4] 3GPP TS 36.306: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio access capabilities".
- [5] 3GPP TS36.321, "Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification"
- [6] 3GPP TS36.331, "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC) protocol specification"

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in [1].

Definition format

<defined term>: <definition>.

3.2 Symbols

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

N_{RB}^{DL}	Downlink bandwidth configuration, expressed in number of resource blocks [2]
N_{RB}^{UL}	Uplink bandwidth configuration, expressed in number of resource blocks [2]
N_{RB}^{SL}	Sidelink bandwidth configuration, expressed in number of resource blocks [2]
N_{sc}^{RB}	Resource block size in the frequency domain, expressed as a number of subcarriers

$N_{\text{symb}}^{\text{PUSCH}}$	Number of SC-FDMA symbols carrying PUSCH in a subframe
$N_{\text{symb}}^{\text{PUSCH-initial}}$	Number of SC-FDMA symbols carrying PUSCH in the initial PUSCH transmission subframe
$N_{\text{symb}}^{\text{UL}}$	Number of SC-FDMA symbols in an uplink slot
$N_{\text{symb}}^{\text{SL}}$	Number of SC-FDMA symbols in a sidelink slot
N_{SRS}	Number of SC-FDMA symbols used for SRS transmission in a subframe (0 or 1).

3.3 Abbreviations

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

BCH	Broadcast channel
CFI	Control Format Indicator
CP	Cyclic Prefix
CSI	Channel State Information
DCI	Downlink Control Information
DL-SCH	Downlink Shared channel
EPDCCH	Enhanced Physical Downlink Control channel
FDD	Frequency Division Duplexing
HI	HARQ indicator
MCH	Multicast channel
PBCH	Physical Broadcast channel
PCFICH	Physical Control Format Indicator channel
PCH	Paging channel
PDCCH	Physical Downlink Control channel
PDSCH	Physical Downlink Shared channel
PHICH	Physical HARQ indicator channel
PMCH	Physical Multicast channel
PMI	Precoding Matrix Indicator
PRACH	Physical Random Access channel
PSBCH	Physical Sidelink Broadcast Channel
PSCCH	Physical Sidelink Control Channel
PSDCH	Physical Sidelink Discovery Channel
PSSCH	Physical Sidelink Shared Channel
PUCCH	Physical Uplink Control channel
PUSCH	Physical Uplink Shared channel
RACH	Random Access channel
RI	Rank Indication
SCI	Sidelink Control Information
SL-BCH	Sidelink Broadcast Channel
SL-DCH	Sidelink Discovery Channel
SL-SCH	Sidelink Shared Channel
SR	Scheduling Request
SRS	Sounding Reference Signal
TDD	Time Division Duplexing
TPMI	Transmitted Precoding Matrix Indicator
UCI	Uplink Control Information
UL-SCH	Uplink Shared channel

4 Mapping to physical channels

4.1 Uplink

Table 4.1-1 specifies the mapping of the uplink transport channels to their corresponding physical channels. Table 4.1-2 specifies the mapping of the uplink control channel information to its corresponding physical channel.

Table 4.1-1

TrCH	Physical Channel
UL-SCH	PUSCH
RACH	PRACH

Table 4.1-2

Control information	Physical Channel
UCI	PUCCH, PUSCH

4.2 Downlink

Table 4.2-1 specifies the mapping of the downlink transport channels to their corresponding physical channels. Table 4.2-2 specifies the mapping of the downlink control channel information to its corresponding physical channel.

Table 4.2-1

TrCH	Physical Channel
DL-SCH	PDSCH
BCH	PBCH
PCH	PDSCH
MCH	PMCH

Table 4.2-2

Control information	Physical Channel
CFI	PCFICH
HI	PHICH
DCI	PDCCH, EPDCCH

4.3 Sidelink

Table 4.3-1 specifies the mapping of the sidelink transport channels to their corresponding physical channels. Table 4.3-2 specifies the mapping of the sidelink control information to its corresponding physical channel.

Table 4.3-1

TrCH	Physical Channel
SL-SCH	PSSCH
SL-BCH	PSBCH
SL-DCH	PSDCH

Table 4.3-2

Control information	Physical Channel
SCI	PSCCH

5 Channel coding, multiplexing and interleaving

Data and control streams from/to MAC layer are encoded /decoded to offer transport and control services over the radio transmission link. Channel coding scheme is a combination of error detection, error correcting, rate matching, interleaving and transport channel or control information mapping onto/splitting from physical channels.

5.1 Generic procedures

This section contains coding procedures which are used for more than one transport channel or control information type.

5.1.1 CRC calculation

Denote the input bits to the CRC computation by $a_0, a_1, a_2, a_3, \dots, a_{A-1}$, and the parity bits by $p_0, p_1, p_2, p_3, \dots, p_{L-1}$. A is the size of the input sequence and L is the number of parity bits. The parity bits are generated by one of the following cyclic generator polynomials:

- $g_{\text{CRC24A}}(D) = [D^{24} + D^{23} + D^{18} + D^{17} + D^{14} + D^{11} + D^{10} + D^7 + D^6 + D^5 + D^4 + D^3 + D + 1]$ and;
- $g_{\text{CRC24B}}(D) = [D^{24} + D^{23} + D^6 + D^5 + D + 1]$ for a CRC length $L = 24$ and;
- $g_{\text{CRC16}}(D) = [D^{16} + D^{12} + D^5 + 1]$ for a CRC length $L = 16$.
- $g_{\text{CRC8}}(D) = [D^8 + D^7 + D^4 + D^3 + D + 1]$ for a CRC length of $L = 8$.

The encoding is performed in a systematic form, which means that in GF(2), the polynomial:

$$a_0 D^{A+23} + a_1 D^{A+22} + \dots + a_{A-1} D^{24} + p_0 D^{23} + p_1 D^{22} + \dots + p_{22} D^1 + p_{23}$$

yields a remainder equal to 0 when divided by the corresponding length-24 CRC generator polynomial, $g_{\text{CRC24A}}(D)$ or $g_{\text{CRC24B}}(D)$, the polynomial:

$$a_0 D^{A+15} + a_1 D^{A+14} + \dots + a_{A-1} D^{16} + p_0 D^{15} + p_1 D^{14} + \dots + p_{14} D^1 + p_{15}$$

yields a remainder equal to 0 when divided by $g_{\text{CRC16}}(D)$, and the polynomial:

$$a_0 D^{A+7} + a_1 D^{A+6} + \dots + a_{A-1} D^8 + p_0 D^7 + p_1 D^6 + \dots + p_6 D^1 + p_7$$

yields a remainder equal to 0 when divided by $g_{\text{CRC8}}(D)$.

The bits after CRC attachment are denoted by $b_0, b_1, b_2, b_3, \dots, b_{B-1}$, where $B = A + L$. The relation between a_k and b_k is:

$$b_k = a_k \quad \text{for } k = 0, 1, 2, \dots, A-1$$

$$b_k = p_{k-A} \quad \text{for } k = A, A+1, A+2, \dots, A+L-1.$$

5.1.2 Code block segmentation and code block CRC attachment

The input bit sequence to the code block segmentation is denoted by $b_0, b_1, b_2, b_3, \dots, b_{B-1}$, where $B > 0$. If B is larger than the maximum code block size Z , segmentation of the input bit sequence is performed and an additional CRC sequence of $L = 24$ bits is attached to each code block. The maximum code block size is:

- $Z = 6144$.

If the number of filler bits F calculated below is not 0, filler bits are added to the beginning of the first block.

Note that if $B < 40$, filler bits are added to the beginning of the code block.

The filler bits shall be set to $\langle \text{NULL} \rangle$ at the input to the encoder.

Total number of code blocks C is determined by:

if $B \leq Z$

$$L = 0$$

Number of code blocks: $C = 1$

$$B' = B$$

else

$$L = 24$$

Number of code blocks: $C = \lceil B / (Z - L) \rceil$.

$$B' = B + C \cdot L$$

end if

The bits output from code block segmentation, for $C \neq 0$, are denoted by $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-1)}$, where r is the code block number, and K_r is the number of bits for the code block number r .

Number of bits in each code block (applicable for $C \neq 0$ only):

First segmentation size: $K_+ =$ minimum K in table 5.1.3-3 such that $C \cdot K \geq B'$

if $C = 1$

the number of code blocks with length K_+ is $C_+ = 1$, $K_- = 0$, $C_- = 0$

else if $C > 1$

Second segmentation size: $K_- =$ maximum K in table 5.1.3-3 such that $K < K_+$

$$\Delta_K = K_+ - K_-$$

$$\text{Number of segments of size } K_-: C_- = \left\lfloor \frac{C \cdot K_+ - B'}{\Delta_K} \right\rfloor.$$

$$\text{Number of segments of size } K_+: C_+ = C - C_-.$$

end if

Number of filler bits: $F = C_+ \cdot K_+ + C_- \cdot K_- - B'$

for $k = 0$ to $F-1$ -- Insertion of filler bits

$$c_{0k} = \langle \text{NULL} \rangle$$

end for

$$k = F$$

$$s = 0$$

for $r = 0$ to $C-1$

if $r < C_-$

$$K_r = K_-$$

else

$$K_r = K_+$$

end if

while $k < K_r - L$

$c_{rk} = b_s$

$k = k + 1$

$s = s + 1$

end while

if $C > 1$

The sequence $c_{r0}, c_{r1}, c_{r2}, c_{r3}, \dots, c_{r(K_r-L-1)}$ is used to calculate the CRC parity bits $p_{r0}, p_{r1}, p_{r2}, \dots, p_{r(L-1)}$ according to section 5.1.1 with the generator polynomial $g_{\text{CRC24B}}(D)$. For CRC calculation it is assumed that filler bits, if present, have the value 0.

while $k < K_r$

$c_{rk} = p_{r(k+L-K_r)}$

$k = k + 1$

end while

end if

$k = 0$

end for

5.1.3 Channel coding

The bit sequence input for a given code block to channel coding is denoted by $c_0, c_1, c_2, c_3, \dots, c_{K-1}$, where K is the number of bits to encode. After encoding the bits are denoted by $d_0^{(i)}, d_1^{(i)}, d_2^{(i)}, d_3^{(i)}, \dots, d_{D-1}^{(i)}$, where D is the number of encoded bits per output stream and i indexes the encoder output stream. The relation between c_k and $d_k^{(i)}$ and between K and D is dependent on the channel coding scheme.

The following channel coding schemes can be applied to TrCHs:

- tail biting convolutional coding;
- turbo coding.

Usage of coding scheme and coding rate for the different types of TrCH is shown in table 5.1.3-1. Usage of coding scheme and coding rate for the different control information types is shown in table 5.1.3-2.

The values of D in connection with each coding scheme:

- tail biting convolutional coding with rate 1/3: $D = K$;
- turbo coding with rate 1/3: $D = K + 4$.

The range for the output stream index i is 0, 1 and 2 for both coding schemes.

Table 5.1.3-1: Usage of channel coding scheme and coding rate for TrCHs.

TrCH	Coding scheme	Coding rate
UL-SCH	Turbo coding	1/3
DL-SCH		
PCH		
MCH		
SL-SCH		
SL-DCH		
BCH	Tail biting convolutional coding	1/3
SL-BCH		

Table 5.1.3-2: Usage of channel coding scheme and coding rate for control information.

Control Information	Coding scheme	Coding rate
DCI	Tail biting convolutional coding	1/3
CFI	Block code	1/16
HI	Repetition code	1/3
UCI	Block code	variable
	Tail biting convolutional coding	1/3
SCI	Tail biting convolutional coding	1/3

5.1.3.1 Tail biting convolutional coding

A tail biting convolutional code with constraint length 7 and coding rate 1/3 is defined.

The configuration of the convolutional encoder is presented in figure 5.1.3-1.

The initial value of the shift register of the encoder shall be set to the values corresponding to the last 6 information bits in the input stream so that the initial and final states of the shift register are the same. Therefore, denoting the shift register of the encoder by $s_0, s_1, s_2, \dots, s_5$, then the initial value of the shift register shall be set to

$$s_i = c_{(K-1-i)}$$

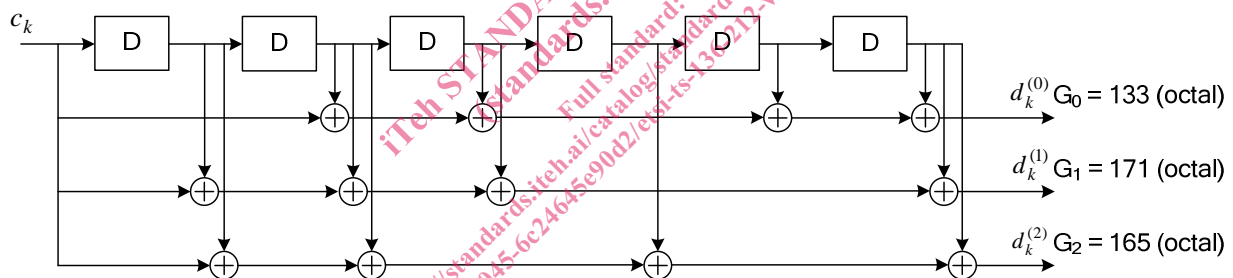


Figure 5.1.3-1: Rate 1/3 tail biting convolutional encoder.

The encoder output streams $d_k^{(0)}$, $d_k^{(1)}$ and $d_k^{(2)}$ correspond to the first, second and third parity streams, respectively as shown in Figure 5.1.3-1.

5.1.3.2 Turbo coding

5.1.3.2.1 Turbo encoder

The scheme of turbo encoder is a Parallel Concatenated Convolutional Code (PCCC) with two 8-state constituent encoders and one turbo code internal interleaver. The coding rate of turbo encoder is 1/3. The structure of turbo encoder is illustrated in figure 5.1.3-2.

The transfer function of the 8-state constituent code for the PCCC is:

$$G(D) = \left[1, \frac{g_1(D)}{g_0(D)} \right],$$

where

$$g_0(D) = 1 + D^2 + D^3,$$