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**Digital cellular telecommunications system (Phase 2+);  
Rate adaption on the Mobile Station - Base Station System  
(MS - BSS) Interface  
(GSM 04.21 version 5.1.2)**

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## Foreword

This European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) of the European Telecommunications Standards Institute (ETSI).

This ETS defines the rate adaptation functions to be used in Mobile Stations (MS) for adapting terminal interface data rates to the Mobile Station - Base Station System (MS - BSS) interface data rates within the digital cellular telecommunications system.

The specification from which this ETS has been derived was originally based on CEPT documentation, hence the presentation of this ETS may not be entirely in accordance with the ETSI/PNE Rules.

<b>Transposition dates</b>	
Date of adoption:	8 August 1997
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Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 May 1998
Date of withdrawal of any conflicting National Standard (dow):	31 May 1998

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## 1 Scope

This European Telecommunication Standard (ETS) defines the rate adaptation functions to be used in GSM PLMN Mobile Stations (MS)s for adapting terminal interface data rates to the Mobile Station - Base Station System (MS-BSS) interface data rates in accordance with GSM 03.10 [3].

The provision of these functions will depend on the services a particular station is designed to support.

NOTE: This ETS should be considered together with GSM 08.20 [9] (Rate Adaptation on the BSS-MSC Interface) to give a complete description of PLMN rate adaptation.

## 2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

- [1] GSM 01.04 (ETR 350): "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".
- [2] GSM 02.34: "Digital cellular telecommunications system (Phase 2+); High Speed Circuit Switched Data (HSCSD) -Stage 1".
- [3] GSM 03.10: "Digital cellular telecommunications system (Phase 2+); GSM Public Land Mobile Network (PLMN) connection types".
- [4] GSM 03.34 (TS 101 038): "Digital cellular telecommunications system (Phase 2+); High Speed Circuit Switched Data (HSCSD) - Stage 2 Service Description".
- [5] GSM 05.03 (ETS 300 909): "Digital cellular telecommunications system (Phase 2+); Channel coding".
- [6] GSM 07.01 (ETS 300 913): "Digital cellular telecommunications system (Phase 2+); General on Terminal Adaptation Functions (TAF) for Mobile Stations (MS)".
- [7] GSM 07.02 (ETS 300 914): "Digital cellular telecommunications system (Phase 2+); Terminal Adaptation Functions (TAF) for services using asynchronous bearer capabilities".
- [8] GSM 07.03 (ETS 300 915): "Digital cellular telecommunications system (Phase 2+); Terminal Adaptation Functions (TAF) for services using synchronous bearer capabilities".
- [9] GSM 08.20: "Digital cellular telecommunications system; Rate adaption on the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface".
- [10] CCITT Recommendation V.110: "Support of data terminal equipments (DTEs) with V-Series interfaces by an integrated services digital network".
- [11] CCITT Recommendation X.30: "Support of X.21,X.21 bis and X.20 bis based terminal equipments (DTEs) by integrated services digital network (ISDN)".

### 2.1 Abbreviations and definitions

Abbreviations used in this ETS are listed in GSM 01.04.

**overall data stream:** The data stream in those parts of the network where the data flow is not split into multiple channels.

**substream:** Stream of data with explicit or implicit numbering between splitter and combiner functions.

**channel:** A physical full rate channel on the radio interface (TCH/F) independent of the contents.

**multislot intermediate rate:** Intermediate rate per substream in those parts of the network where the overall data stream is split into substreams.

**intermediate rate:** Intermediate rate in the overall data stream.

**substream rate:** The user rate including padding, if applicable, on one individual substream.

### 3 General approach

GSM 03.10 defines the PLMN connection types necessary to support the GSM PLMN data and telematic services.

Within the MS there are several different data rate adaptation functions - and a Split/Combine-function in case of a multislot data configuration - which are combined as shown in GSM 03.10 as part of the connection type.

The rate adaptation functions are RA0, RA1, RA2, RA1', RA1'' and RA1/RA1'. The RA0, RA1 and RA2 are equivalent to those functions described in CCITT Recommendation V.110 [11].

The RA1' function is similar to RA1 but has a reduced bit rate output compatible with the coding scheme proposed for data services on the radio interface.

The RA1'' function is used for converting between synchronous user rates of 48 and 56 kbit/s and the rate 64 kbit/s.

The RA1/RA1' is a relay function, used as indicated in GSM 03.10.

In multislot data-configurations the overall data stream is split into parallel substreams between the Split/Combine-functions.

#### 3.1 Overview of the multislot data rates

For 9,6/4,8 kbps channel coding, the maximum multislot intermediate rate is 16 kbit/s per TCH/F.

For 14,4/7,2 kbps channel coding, the maximum multislot intermediate rate is to be defined.

Between the TE and the Split/Combine-function at the MS, where the overall data stream is not split, intermediate rates of 8, 16, 32 and 64 kbit/s are applicable.



Table 1: AIUR/Multislot intermediate rates

Air interface user rate	DTE/DCE statuses	RA0	RA1		RA1'	
			Multislot intermediate rate	Frame type	Radio interface rate	Padding
≤ 600 bit/s	X	X	8 kbit/s	80 bit frames	3,6 kbit/s	
1 200 bit/s	X	X	8 kbit/s	80 bit frames	3,6 kbit/s	
2,4 kbit/s	X	X	8 kbit/s	80 bit frames	3,6 kbit/s	
4,8 kbit/s	X	X	8 kbit/s	80 bit frames	6 kbit/s	
7,2 kbit/s	X	X	16 kbit/s note 7		7,4 kbit/s	
9,6 kbit/s	X	X	16 kbit/s or 2 × 8 kbit/s	80 bit frames	12 kbit/s or 2 × 6 kbit/s	
14,4 kbit/s	X	X	2 × 16 kbit/s or 3 × 8 kbit/s	80 bit frames	2 × 12 kbit/s or 3 × 6 kbit/s	P (note 1)
			Note 8		14,5 kbit/s 2 × 7,4 kbit/s	
19,2 kbit/s	X	X	2 × 6 kbit/s or 4 × 8 kbit/s	80 bit frames	2 × 12 kbit/s or 4 × 6 kbit/s	P (note 6)
			Note 8		2 × 14,5 kbit/s 3 × 7,4 kbit/s	
28,8 kbit/s	X	X	3 × 16 kbit/s	80 bit frames	3 × 12 kbit/s	
			Note 8		2 × 14,5 kbit/s 4 × 7,4 kbit/s	
38,4 kbit/s	X	X	4 × 16 kbit/s	80 bit frames	4 × 12 kbit/s	P (note 6)
			Note 8		3 × 14,5 kbit/s	
48 kbit/s	X		Note 2	Note 2	5 × 12 kbit/s	P (note 6)
			Note 8		4 × 14,5 kbit/s	
56 kbit/s			Note 2	Note 2	5 × 12 kbit/s (note 3)	P (note 6)
			Note 8		4 × 14,5 kbit/s	
64 kbit/s			Note 2	Note 2	6 × 12 kbit/s (note 3)	P (note 1) (note 6)
					5 × 14,5 kbit/s	

P=Padding used

Table 2: AIUR / Intermediate rates

Air interface user rate	DTE/DCE statuses	RA0	RA1		RA1'	
			Intermediate rate	Frame type	Radio interface rate	Padding
≤ 600 bit/s	X	X	8 kbit/s	80 bit frames	3,6 kbit/s	
1 200 bit/s	X	X	8 kbit/s	80 bit frames	3,6 kbit/s	
2,4 kbit/s	X	X	8 kbit/s	80 bit frames	3,6 kbit/s	
4,8 kbit/s	X	X	8 kbit/s	80 bit frames	6 kbit/s	
7,2 kbit/s	X	X	16 kbit/s	80 bit frames	7,4 kbit/s	
9,6 kbit/s	X	X	16 kbit/s	80 bit frames	12 kbit/s or 2 × 6 kbit/s	
14,4 kbit/s	X	X	32 kbit/s	80 bit frames	2 × 12 kbit/s or 3 × 6 kbit/s 1 × 14,5 kbit/s 2 × 7,4 kbit/s	P (note 1)
19,2 kbit/s	X	X	32 kbit/s	80 bit frames	2 × 12 kbit/s or 4 × 6 kbit/s 2 × 14,5 kbit/s 3 × 7,4 kbit/s	P (note 6)
28,8 kbit/s	X	X	64 kbit/s	80 bit frames	3 × 12 kbit/s 2 × 14,5 kbit/s 4 × 7,4 kbit/s	
38,4 kbit/s	X	X	64 kbit/s	80 bit frames	4 × 12 kbit/s 3 × 14,5 kbit/s	P (note 6)
48 kbit/s	X		Note 4	Note 4	5 × 12 kbit/s 4 × 14,5 kbit/s	P (note 6)
56 kbit/s			Note 4	Note 4	5 × 12 kbit/s (note 3) 4 × 14,5 kbit/s	P (note 6)
64 kbit/s			Note 5	Note 5	6 × 12 kbit/s (note 3) 5 × 14,5 kbit/s	P (note 1) (note 6)

P=Padding used

NOTE 1: For information on the padding procedure, please refer to clause 10 of this document.

NOTE 2: No multislot intermediate rate; substreams combined at the BSS when 9,6/4,8 channel coding is used.

NOTE 3: AIUR 11,2 kbit/s per channel.

NOTE 4: For this rate GSM-specific rate adaptation function RA1" rather than RA1 is applied.

NOTE 5: For this rate RA1- and RA2- adaptations are not applied.

NOTE 6: Padding used as specified for 14,5/7,4 channel codings.

NOTE 7: RA1 not applied; instead a GSM-specific adaptation RAA' used.

NOTE 8: N/A for radio interface. Network implementation is to be defined.

## 4 The RA0 Function

### 4.1 Asynchronous-to-Synchronous Conversion (RA0)

The RA0 Function is only used with asynchronous interfaces. Incoming asynchronous data is padded by the addition of stop elements to fit the nearest higher rate defined by 2 to the power n (where  $n \leq 6$ ) times 600 bit/s or to either 7,2, 14,4, or 28,8 kbit/s if these rates are nearer than the ones defined by  $2^n \times 600$  bit/s. Thus both 75 bit/s and 300 bit/s user data signalling rates shall be adapted to a synchronous 600 bit/s stream. The resultant synchronous stream is fed to RA1 or RA1'.

Asynchronous user rate	Synchronous user rate
$\leq 0,6$ kbit/s	0,6 kbit/s
1,2 kbit/s	1,2 kbit/s
2,4 kbit/s	2,4 kbit/s
4,8 kbit/s	4,8 kbit/s
7,2 kbit/s	7,2 kbit/s
9,6 kbit/s	9,6 kbit/s
14,4 kbit/s	14,4 kbit/s
19,2 kbit/s	19,2 kbit/s
28,8 kbit/s	28,8 kbit/s
38,4 kbit/s	38,4 kbit/s

### 4.2 Break signal

The RA0 shall detect and transmit the break signal in the following fashion:

If the converter detects M to  $2M+3$  bits, all of start polarity, where M is the number of bits per character in the selected format including start and stops bits, the converter shall transmit  $2M+3$  bits of start polarity.

If the converter detects more than  $2M+3$  bits all of start polarity, the converter shall transmit all these bits as start polarity.

The  $2M+3$  or more bits of start polarity received from the transmitting sides shall be output to the receiving terminal.

The terminal must transmit on circuit 103 at least  $2M$  bits stop polarity after the start polarity break signal before sending further data character. The converter shall then regain character synchronism from the following stop to start transition.

### 4.3 Overspeed/Underspeed

A RA0 shall insert additional stop elements when its associated terminal is transmitting with a lower than nominal character rate. If the terminal is transmitting characters with an overspeed of up to 1 %, the asynchronous-to-synchronous converter may delete stop elements as often as is necessary to a maximum of one for every eight characters at 1 % overspeed. The converter on the receiving side shall detect the deleted stop elements and reinsert them in the received data stream (circuit 104).

The realization of overspeed handling, as described above, at the interface to the associated terminal is implementation dependent. Possible implementations are e.g. the reduction of the length of the stop elements according to V.110 [9] or increased data rates between the TA and terminal.

### 4.4 Parity Bits

Possible parity bits included in the user data are considered as data bits by the RA0 function (and RA1 function).

### 4.5 Flow Control

Where applicable, this function is as specified in the relevant terminal adaptation function Specification (see GSM 07 series).

## 5 The RA1 Function

This function is used to adapt between the synchronous user rates, or the output of the RA0 function and the intermediate rate of 8, 16, 32 or 64 kbit/s.

### 5.1 Adaptation of synchronous data rates up to 38,4 kbit/s

Synchronous user rate	Intermediate rate
≤ 2,4 kbit/s	8 kbit/s
4,8 kbit/s	8 kbit/s
7,2 kbit/s	16 kbit/s
9,6 kbit/s	16 kbit/s
14,4 kbit/s	32 kbit/s
19,2 kbit/s	32 kbit/s
28,8 kbit/s	64 kbit/s
38,4 kbit/s	64 kbit/s

A CCITT V.110 80 bits frame is constructed using the user data bits received (from the RA0 in the asynchronous case), the values of the S bits are deduced from the R interface.

Adaptation of 600 bit/s to 8Kbit/s is performed by 8 times consecutive duplication of each user data bit (figure 9).

Adaptation of 1 200 bit/s to 8 Kbit/s is performed by 4 times consecutive duplication of each user data bit (figure 8).

Adaptation of 2 400 bit/s to 8kbit/s is performed by 2 times consecutive duplication of each user data bit (figure 7).

Adaptation of 4 800 bit/s to 8 Kbit/s is performed by transmitting the bit stream with no duplication (figure 3).

Adaptation of 7 200 bit/s to 16 Kbit/s is performed as for 3 600 bit/s to 8 kbit/s (the emitting period is divided by two with respect to the 3 600 bit/s case). (Adaptation of 3 600 bit/s to 8 kbit/s is performed by transmitting the bit stream with no duplication). (figure 12)

Adaptation of 9 600 bit/s to 16 Kbit/s is performed by transmitting the bit stream with no duplication (the emitting period is halved with respect to the 4 800 bit/s case). (figure 3)

Adaptation of 14 400 bit/s to 32 Kbit/s is performed as for 3 600 bit/s to 8 kbit/s (the emitting period is divided by four with respect to the 3 600 bit/s case). (Adaptation of 3 600 bit/s to 8 kbit/s is performed by transmitting the bit stream with no duplication.) (figure 12)

#### Adaptations applicable to multislot data connections of 2-4 TCH/Fs

Adaptation of 14 400 bit/s to 32 Kbit/s is performed as for 3 600 bit/s to 8 kbit/s (the emitting period is divided by four with respect to the 3 600 bit/s case). (Adaptation of 3 600 bit/s to 8 kbit/s is performed by transmitting the bit stream with no duplication.) (figure 12)

Adaptation of 19 200 bit/s to 32 Kbit/s is performed as for 4 800 bit/s to 8 kbit/s (the emitting period is divided by four with respect to the 4 800 bit/s case). (figure 3)

Adaptation of 28 800 bit/s to 64 Kbit/s is performed as for 3 600 bit/s to 8 kbit/s (the emitting period is divided by eight with respect to the 3 600 bit/s case). (figure 12)

Adaptation of 38 400 bit/s to 64 Kbit/s is performed as for 4 800 bit/s 8 kbit/s (the emitting period is divided by eight with respect to the 4 800 bit/s case). (figure 3)

The CCITT V.110 80 bit frames shown in figures 3 and 12 are used. The D bits are used to convey the user data and the S and X bits are used to convey channel control information according to the relevant terminal adapter function Specification.

The E bits are used to convey the following information:

- i) User Data Rate - E1, E2, E3 (for single slot operation see figure 4, and for multislot operation figure 4 and subclause 10.7).
- ii) Network Independent Clocking - E4, E5, E6.
- iii) Multiframe Synchronization - E7.

The order of transmission of the 80 bit frame is from left to right and top to bottom.

### 5.1.1 Network Independent Clocking

Synchronous data signals received by the MT from the DTE at the MS or by IWF from the modem on the PSTN may not be synchronized to the PLMN. The following method shall be used to enable transfer of those data signals and the corresponding bit timing information via the V.110 frames. Such a situation would exist where the signals received from the modem at the IWF require its own clock or where the signals received from the DTE at the MS employs its own network independent clock. In any case, the frequency tolerance of the clocks involved is 100 ppm.

#### 5.1.1.1 Multiframe Structure

The transmitting end of the GSM PLMN connection shall establish a multiframe structure utilizing bit E7 consisting of four frames by setting E7 in every fourth frame to binary 0. This structure is identical to the use of E7 in V.110 (and X.30) except that such a multiframe structure will exist for all user data rates. This frame synchronization will be achieved and maintained during the entire call so that corrections for the network independent clocking by the receiving end of the GSM PLMN connection can be easily recognized and applied based on the code words (in c1, c2, c3, c4 and c5) positioned in bits E4, E5 and E6 of two consecutive V.110 frames as illustrated in figure 1. Thus, the multiframe structure allows for one 5-bit code words to be transmitted every two V.110 frames for the purposes of network independent clocking. The two code-words may be different from each other within the multiframe shown in figure 1.

Frame	E4	E5	E6	E7
MF 0a	c1	c2	1	0
MF 1a	c3	c4	c5	1
MF 0b	c1	c2	1	1
MF 1b	c3	c4	c5	1

Figure 1: NIC Multiframe Structure

Once Multiframe synchronization is achieved, each code word is independently evaluated to determine the compensation needed, if any. The compensation is applied as explained in subclause 3.1.2 in V.110 frames MF 1a and MF 1b.

#### 5.1.1.2 Encoding and compensation

The V.110 transmitter will use the following 5-bit code words, as shown in figure 2, to indicate the four possible states of compensation required for network independent clocking.

	c1	c2	c3	c4	c5
No compensation	1	1	1	1	1
Negative compensation	1	0	0	1	0
Positive compensation of a zero	0	1	0	0	1
Positive compensation of one	0	0	1	0	0

Figure 2: NIC Code Words

When negative compensation is indicated, one less user data bit than normal is transported in the affected frame (MF1a or MF1b). A negative compensation shall cause the receiver to delete the user data bit occupied by bit position D25, since the transmitter sets this to binary 1 and does not utilize this position for user data. At those user data rates where the user data bit is repeated, all copies of D25 shall be discarded.

When a positive compensation is indicated, one additional user data bit is transferred by means of the code word. At the receiver, a positive compensation will cause a user data bit of binary value 0 or 1, as indicated by the code word, to be inserted between the user data bits carried in bit positions D24 and D25 (in MF1a or MF1b) of the V.110 frame illustrated in figure 3.

When no compensation is necessary, or when NIC is applied, the values of E4, E5, E6, E7, on the 4 multi frame scheme is:

Frame	E4	E5	E6	E7
MF 0a	1	1	1	0
MF 1a	1	1	1	1
MF 0b	1	1	1	1
MF 1b	1	1	1	1

When NIC is not applicable, the MS and the IWF shall disregard the received value of bits E4, E5, E6 and E7 in the data transmission phase.

NOTE: NIC is not applicable in the following cases:

- transparent asynchronous bearer services;
- the facsimile teleservices in the transparent mode;
- every transparent bearer services when interworking with an UDI Information Transfer Capability.

## 6 The RA1" function

The RA1" function is used for converting between synchronous user rates of 48 and 56 kbit/s and the 'intermediate' rate of 64 kbit/s. (RA1" is a GSM-specific term which is used for the one-step adaptation of 48 and 56 kbit/s rates into 64 kbit/s as specified in ITU-T V.110. For the purposes of GSM specifications the term 'intermediate rate' is used for the resulting 64 kbit/s rate although this is not done in V.110 Recommendation.)

### 6.1 Rate adaptation of 48 kbit/s user rates with DTE/DCE status to 64 kbit/s

A CCITT V.110 32 bits frame is constructed using the user data bits received, the values of the S bits are deduced from the R interface.

The CCITT V.110 32 bit frame shown in figure 13 is used. The D bits are used for conveying the user data and the S and X bits are used for conveying channel control information according to the relevant terminal adapter function Specification. The order of transmission of the 32 bit frame is from left to right and top to bottom.

### 6.2 Rate adaptation of 56 kbit/s user rate to 64 kbit/s

A CCITT V.110 64 bits frame is constructed using the user data bits received.

The CCITT V.110 64 bit frame shown in figure 14 is used. The D bits are used for conveying the user data.

The order of transmission of the 64 bit frame is from left to right and top to bottom.

## 7 The RA2 Function

This procedure is based on the RA2 function as specified in CCITT V.110. It is used to rate adapt to/from the intermediate rates of 8, 16 or 32 kbit/s from/to the 64 kbit/s rate used at the S interface.

Intermediate rate	Rate at the S interface
8 kbit/s	64 kbit/s
16 kbit/s	64 kbit/s
32 kbit/s	64 kbit/s
64 kbit/s	64 kbit/s

For the intermediate- and user data rate of 64 kbit/s, the RA2 transmits the bit stream over the S-interface as it is.

It considers the 64 kbit/s stream over the S-interface to consist of octets, bits 1 through 8, with bit 1 being transmitted first.

The procedure requires that:

- i) The 8 kbit/s stream occupies bit position 1.
- ii) The 16 kbit/s bitstream occupies bit positions (1,2).
- iii) The 32 kbit/s bitstream occupies bit positions (1,2,3,4) .
- iv) The order of transmission of the bits of the subrate stream is identical before and after rate adaptation.
- v) All unused bits in the 64 kbit/s stream are set to binary "1".

## 8 The RA1/RA1' Function

The RA1/RA1' function is used in transparent cases to convert between the intermediate rate and the input rate to the channel coder function for transmission by the radio subsystem. This conversion also appears on the infrastructure side as specified in GSM 08.20 except for channel codings 7,4 and 14,5 kbit/s.

### 8.1 Single slot rates

Intermediate rate	Radio interface rate
8 kbit/s	3,6 kbit/s
8 kbit/s	6 kbit/s
16 kbit/s	7,4 kbit/s
16 kbit/s	12 kbit/s
32 kbit/s	14,5 kbit/s

There are five data rates (known as Radio Interface rates) used for data transfer to the channel coder. These are 14,5 kbit/s, 12 kbit/s, 7,4 kbit/s, 6 kbit/s and 3,6 kbit/s, and in order to adapt the 8,16, and 32 kbit/s intermediate rates to these data rates, three processes are used.

Firstly the 17 synchronization bits are removed.

Secondly the E1, E2 and E3 bits are removed. For transparent services, the values of the E1, E2, E3 bits are determined at the MT and the BTS based on the indication given by outband signalling (either in the User Rate field of the BC-IE of the SETUP message for the MT or in the Channel Type information in the ASSIGNMENT REQUEST message for the BSS). For non transparent services, the coding of the E1, E2 and E3 bits is described in GSM 08.20.

Thirdly, in the 3,6 kbit/s case, half the data bits are discarded. These processes result in modified CCITT V.110 frames of sizes 60,60 and 36 bits for the 12, 6 and 3,6 kbit/s data rates respectively. The resultant modified CCITT V.110 frames for the various user data rates are shown in figures 5 - 9.

Further procedures for 14,5 and 7,4 kbit/s channel coder input rates in subclauses 8.1.1 and 8.1.3.

**8.1.1 Radio interface rate of 14,5 kbit/s**

In this case one modified CCITT V.110 frame is received/sent from/to the radio subsystem every 2,5 ms (see GSM 05.03). The RA1/RA1' function adds/subtracts the 17-bit synchronization pattern, the F-, E-, X-, and S-bits to/from the 80-bit V.110-frames.

Two bits, namely M1 and M2, can be used by the RA1/RA1'-function for deriving/mapping the E-, S-, and X-bits. These bits are transmitted independently from the modified 36-bit V.110 frames every 20 ms over the radio interface (see GSM 05.03). These bits are also used for multislot synchronization. The usage of these bits is further elaborated in subclause 8.1.1.2.

The modified CCITT V.110 36-bit frame received/sent from/to the radio subsystem at 14,4:

D1	D2	D3	D4	D5	D6
D7	D8	D9	D10	D11	D12
D13	D14	D15	D16	D17	D18
D19	D20	D21	D22	D23	D24
D25	D26	D27	D28	D29	D30
D31	D32	D33	D34	D35	D36

is converted/derived into/from the following 80-bit V.110-frame at 32 kbit/s. The E-, S-, and X-bits are mapped/extracted to/from the M1 and M2 bits.

0	0	0	0	0	0	0	0
1	D1	D2	D3	D4	D5	D6	S1
1	D7	D8	D9	D10	F	F	X
1	D11	D12	F	F	D13	D14	S3
1	F	F	D15	D16	D17	D18	S4
1	E1	E2	E3	E4	E5	E6	E7
1	D19	D20	D21	D22	D23	D24	S6
1	D25	D26	D27	D28	F	F	X
1	D29	D30	F	F	D31	D32	S8
1	F	F	D33	D34	D35	D36	S9

In the case of non-transparent operation bits S1, X, S3, S4, E6, E7, S6, X (second occurrence), S8, and S9 are fill-bits. Bits E4 and E5 are used for RLP-multiframe indication together with bits E2 and E3 as described in GSM 08.20.

For the 36-bit frames the received D-bits are set as they were transmitted. For transparent services E, S, and X-bits are reproduced based on the M1 and M2 bit stream as described in subclause 8.1.1.2. Bits E1, E2, and E3 are set according to the user data rate as shown in figure 4 for transparent services, and the RLP-multiframe and DTX indication as explained in GSM 08.20 in the non-transparent case.

**8.1.1.1 Multiframe structure over the radio-interface**

Bit M1 carries a 31-bit PN multiframe code 0000 1001 0110 0111 1100 0110 1110 101. One multiframe bit is transmitted every 20 ms, which means that one whole multiframe consists of 248 36-bit 2,5 ms frames.

Bit M2 carries V.24 circuit status information, network independent clocking (NIC) information and substream numbering as indicated in the following figure:

bit number	0 1 2 3	4 5 6 7	8 - 11	12- 15	16 - 19	20 - 23	24 - 27	28 - 30
M1:	0 0 0 0	1 0 0 1	0 1 1 0	0 1 1 1	1 1 0 0	0 1 1 0	1 1 1 0	1 0 1
M2:	## # S	S S ##	# S S S	## # S	S S ##	# S S S	NNNN	N s s

where ## # = Subchannel number (multilink operation)  
 SSS = V.24 statuses (SA, SB, and X)  
 NNNN = Network independent clocking  
 s = spare bit

In the MS→ Network direction the information carried by M2 is mapped in the following manner:



Eight 36-bit frames, which have been derived from the 80-bit V.110 frames, are sent in the 20 ms that is the frequency of M1 and M2 bit transmission. If the first 80-bit frame corresponding to a multiframe sequence is referred to as frame n, then the S-bit in bit position 3 in the M2 sequence carries SA-status as indicated by bits S1, S3, S6 and S8 in 80-bit V.110 frame n+31. The S-bit in bit position 4 in the M2 sequence carries SB-status as indicated by bits S4 and S9 in 80-bit V.110 frame n+31. The S-bit in bit position 5 in the M2 sequence carries X-status as indicated by the X-bits in 80-bit V.110 frame n+31. In other words, the three-bit S-sequence carries the SA-, SB-, and X-statuses as they are in the V.110-frame corresponding to the last 36-bit frame in the block where the first (number 3 in sequence of blocks 3,4, and 5) of these S-bits is transmitted.

The S-bits in positions 9-11 of the M2 sequence carry V.24-status information as indicated in the 80-bit V.110-frame n+79. The S-bits in positions 15-17 of the M2 sequence carry V.24-status information as indicated in the 80-bit V.110-frame n+127. The S-bits in positions 21-23 of the M2 sequence carry V.24-status information as indicated in the 80-bit V.110-frame n+175.

The five N-bits in the M2 sequence indicate 'negative compensation' or 'positive compensation' if such an indication has been carried by the V.110 -frames (subclause 5.1.1) since the last transmission of the N-bits in the M2 sequence. Otherwise 'no compensation' is indicated by the N-bits. For the exact procedure for carrying NIC-information over a 14,5-channel, please refer to subclause 10.5.1.

	N-bit 24 in M2- sequence	N-bit 25 in M2- sequence	N-bit 26 in M2- sequence	N-bit 27 in M2- sequence	N-bit 28 in M2- sequence
No compensation	1	1	1	1	1
Negative compensation	1	0	0	1	0
Positive compensation of a zero	0	1	0	0	1
Positive compensation of a one	0	0	1	0	0

In the Network→ MS direction the information carried by the M2-sequence is mapped in the following manner:

After a set of three consecutive S-bits have been received from the radio-interface the SA-, SB-, and X-statuses carried by these bits are mapped to the appropriate bit positions in the 80-bit V.110-frames. This status information is carried by all 80-bit V.110-frames until the next set of three S-bits is received in the M2-sequence.

For NIC-procedure, please refer to subclause 10.5.1.

### 8.1.1.2 Radio-interface data block for 14,4 kbit/s channel coding

A radio-interface data block for a 14,5 kbit/s channel consists of 8 36-bit data frames and bits M1 and M2 as shown in the following table:

1	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
2	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
3	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36

4	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
5	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
6	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
7	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
8	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
	M1	M2																

The number on the left indicates the order of the data frames in the 290-bit block; the 36-bit frame in position one was received before that in position two etc. One such block is transmitted over the radio interface every 20 ms.

### 8.1.2 Radio Interface rate of 12 kbit/s

In this case one modified CCITT V.110 60 bit frame is received/sent from/to the radio subsystem every 5ms (see GSM 05.03). The RA1/RA1' function will add/subtract the 17 bit synchronization pattern and the E1,E2 and E3 bits to/from each CCITT V.110 80 bit frame as follows:

The modified CCITT V.110 60 bits frame received/sent from/to the radio interface at 12 Kbit/s,

D1	D2	D3	D4	D5	D6	S1	
D7	D8	D9	D10	D11	D12	X	
D13	D14	D15	D16	D17	D18	S3	
D19	D20	D21	D22	D23	D24	S4	
E4	E5	E6	E7	D25	D26	D27	
D28	D29	D30	S6	D31	D32	D33	
D34	D35	D36	X	D37	D38	D39	
D40	D41	D42	S8	D43	D44	D45	
D46	D47	D48	S9				

is converted into the following a CCITT V.110 80 bits frame at 16 Kbit/s:

0	0	0	0	0	0	0	0
1	D1	D2	D3	D4	D5	D6	S1
1	D7	D8	D9	D10	D11	D12	X
1	D13	D14	D15	D16	D17	D18	S3
1	D19	D20	D21	D22	D23	D24	S4
1	E1	E2	E3	E4	E5	E6	E7
1	D25	D26	D27	D28	D29	D30	S6
1	D31	D32	D33	D34	D35	D36	X
1	D37	D38	D39	D40	D41	D42	S8
1	D43	D44	D45	D46	D47	D48	S9

In the case of the non transparent services, bits S1, X, S3, S4, E4, E5, E6, E7, S6, X (second occurrence), S8, and S9 carry bits D'1, D'2, D'3, D'4, D'5, D'6, D'7, D'8, D'9, D'10, D'11, and D'12, respectively.

For a modified CCITT V.110 60 bit frames received from the radio subsystem, the received D, S and X bits or D and D' bits are set to the same value as the transmitted bits. Bits E1, E2, E3 are set according to the user data rate as shown in figure 4 for the transparent services, or the RLP multiframe and DTX indication as per GSM 08.20 in the non transparent case.

For modified CCITT V.110 60 bit frames transmitted over the radio subsystem, the received D, S, and X bits or D and D' are set to the same value as the transmitted bits. Bits E1, E2, E3 are discarded.

### 8.1.3 Radio Interface rate of 7,4 kbit/s

Rate 7,4 kbit/s follows the same principles as the 14,5 rate. The difference is that an 80-bit V.110 frame is received and a 36-bit frame (see subclause 8.1.1) is sent to the radio subsystem only every 5 ms. This means that a multiframe corresponds to 124 80-bit V.110-frames, whereas in the 14,5 case the multiframe structure corresponds to 248 80-bit V.110 frames. An M1 and an M2 bit is still transmitted every 20 ms. The mapping/derivation of status-, NIC-, and substream numbering to/from the M2 sequence is performed in the following fashion:

In the MS→ Network direction the information carried by M2 is mapped in the following manner:

Four 36-bit frames which have been derived from the 80-bit V.110 frames are sent in the 20 ms that is the frequency of M1 and M2 bit transmission. The three-bit S-code in the M2 sequence carries the SA-, SB-, and X-statuses as they are in the V.110-frame corresponding to the last 36-bit frame in the block where the first of these S-bits is transmitted.

The five N-bits in the M2 sequence indicate 'negative compensation' or 'positive compensation' if such an indication has been carried by the V.110 -frames (subclause 5.1.1) since the last transmission of the N-bits in the M2 sequence. Otherwise 'no compensation' is indicated by the N-bits. For the exact procedure for carrying NIC-information over a 14,5-channel, please refer to subclause 10.5.1.

In the Network→ MS direction the information carried by the M2 sequence is mapped in the following manner:

After a set of three consecutive S-bits have been received from the radio-interface the SA-, SB-, and X-statuses carried by these bits are mapped to the appropriate bit positions in the 80-bit V.110-frames. This status information is carried by all 80-bit V.110-frames until the next set of three S-bits is received in the M2 sequence.

For NIC-procedure, please refer to subclause 10.5.1.

#### 8.1.3.1 Radio-interface data block for 7,2 channel coding

A radio-interface data block for a 7,4 channel consists of 4 36-bit data frames and bits M1 and M2 as shown in the following figure:

1	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
2	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
3	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
4	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36
	M1	M2	s	s														

s=spare

The number on the left indicates the order of the data frames in the 148-bit block; the 36-bit frame in position one was received before that in position two etc. One such block is transmitted over the radio-interface every 20 ms.

**8.1.4 Radio Interface rate of 6 kbit/s**

In this case one modified CCITT V.110 60 bit frame is received/sent from/to the radio subsystem every 10 ms (see GSM 05.03). The RA1/RA1' function will add/subtract the 17 bit synchronization pattern and the E1,E2 and E3 bits to/from each CCITT V.110 80 bit frame as follows:

The modified CCITT V.110 60 bits frame received/sent from/to the radio interface at 6 Kbit/s,

D1	D2	D3	D4	D5	D6	S1
D7	D8	D9	D10	D11	D12	X
D13	D14	D15	D16	D17	D18	S3
D19	D20	D21	D22	D23	D24	S4
E4	E5	E6	E7	D25	D26	D27
D28	D29	D30	S6	D31	D32	D33
D34	D35	D36	X	D37	D38	D39
D40	D41	D42	S8	D43	D44	D45
D46	D47	D48	S9			

is converted into the following a CCITT V.110 80 bits frame at 8 Kbit/s:

0	0	0	0	0	0	0	0
1	D1	D2	D3	D4	D5	D6	S1
1	D7	D8	D9	D10	D11	D12	X
1	D13	D14	D15	D16	D17	D18	S3
1	D19	D20	D21	D22	D23	D24	S4
1	E1	E2	E3	E4	E5	E6	E7
1	D25	D26	D27	D28	D29	D30	S6
1	D31	D32	D33	D34	D35	D36	X
1	D37	D38	D39	D40	D41	D42	S8
1	D43	D44	D45	D46	D47	D48	S9

In the case of the non transparent services, bits S1, X, S3, S4, E4, E5, E6, E7, S6, X (second occurrence), S8, and S9 carry bits D'1, D'2, D'3, D'4, D'5, D'6, D'7, D'8, D'9, D'10, D'11, and D'12, respectively.

For a modified CCITT V.110 60 bit frames received from the radio subsystem, the received D, S and X bits or D and D' bits are set to the same value as the transmitted bits. Bits E1, E2, E3 are set according to the user data rate as shown in figure 4 for the transparent services, or the RLP multiframe and DTX indication as per GSM 08.20 in the non transparent case.

For modified CCITT V.110 60 bit frames transmitted over the radio subsystem, the received D, S, and X bits or D and D' bits are set to the same value as the transmitted bits. Bits E1, E2, E3 are discarded.

It should be noted that this process is identical to that used for the 12 kbit/s case except that the frame repetition rates are halved.

**8.1.5 Radio Interface rate of 3,6 kbit/s (transparent services only)**

In this case one modified CCITT V.110 36 bit frame is received/sent from/to the radio subsystem every 10ms (see GSM 05.03 [3]). The RA1/RA1' function will add/subtract the 17 bit synchronization pattern and the E1,E2 and E3 bits to/from each CCITT V.110 80 bit frame as follows:

The modified CCITT V.110 36 bits frame received/sent from/to the radio interface at 3,6 Kbit/s,

D1	D2	D3	S1	D4	D5	D6	X
D7	D8	D9	S3	D10	D11	D12	S4
E4	E5	E6	E7	D13	D14	D15	S6
D16	D17	D18	X	D19	D20	D21	S8
D22	D23	D24	S9				

is converted into the following a CCITT V.110 80 bits frame at 8 Kbit/s:

0	0	0	0	0	0	0	0
1	D1	D1	D2	D2	D3	D3	S1
1	D4	D4	D5	D5	D6	D6	X
1	D7	D7	D8	D8	D9	D9	S3
1	D10	D10	D11	D11	D12	D12	S4
1	E1	E2	E3	E4	E5	E6	E7
1	D13	D13	D14	D14	D15	D15	S6
1	D16	D16	D17	D17	D18	D18	X
1	D19	D19	D20	D20	D21	D21	S8
1	D22	D22	D23	D23	D24	D24	S9

For modified CCITT V.110 36 bit frames transmitted by the radio subsystem, E1, E2, E3 are discarded. For modified CCITT V.110 36 bit frames received from the radio subsystem, E1, E2, E3 are set as shown in figure 2.

NOTE: The action to be taken in the case where two bits which should have the same value (e.g. bits noted D1 are received with different values is for further study).

### 8.1.6 Synchronization

Synchronization shall be in accordance with CCITT specification V.110, subclause 2.1.3.1 "Search of frame synchronization".

On loss of synchronization, subclause 2.1.3.2 of V.110, "Frame synchronization monitoring and recovery", shall apply. In this case, idle frames with all data, status and E-bits set to binary "1" shall be sent to the radio interface.

As the synchronization process uses the V.110 frame alignment pattern only, the action is the same for Transparent and Non Transparent network support.

### 8.1.7 Idle frames

Whenever no data is received from the radio interface (e.g. frame stealing applies, layer 2 fill frames are received, etc.) idle frames shall be sent. These are V.110 frames with frame alignment pattern according to CCITT Recommendation. V.110 [11] and all data, status and E-bits set to binary "1".

## 8.2 Multislot rates

In multislot operation the transmission is performed using parallel substreams between the Split/Combine-functions.

### 8.2.1 AIURs up to 38,4 kbit/s using 12/6 kbit/s channel codings

Intermediate rate/AIUR	Radio interface rate
16 kbit/s / 9,6 kbit/s	2 × 6 kbit/s
32 kbit/s / 14,4; 19,2 kbit/s	2 × 12 or 3 × 6 or 4 × 6 kbit/s
64 kbit/s / 28,8; 38,4 kbit/s	3 × 12 or 4 × 12 kbit/s

In these cases, the data stream is mapped from 80-bit intermediate rate frames into modified frames of 60 bits for radio-interface transmission as specified in subclause 8.1 for 12 kb/s and 6 kb/s except for the following cases:

For AIURs 14,4 and 28,8 kbit/s using channel codings TCH/F 4,8 and TCH/F 9,6, respectively, four consecutive V.110 80-bit frames (figure 12) are mapped onto three consecutive modified 60-bit V.110 (figure 5 or 6) frames at the MS. The 4 × 36 data bits in the 80-bit frames are mapped onto the 3 × 48 data bits in the 60-bit frames. However, bits E4-E7 in the 80-bit frames are mapped onto the E4-E7 bits in the 60-bit frames when their value indicate either positive or negative compensation (NIC; see subclause 5.1.1). The E4-E7 bits that indicate 'No compensation' in the 80-bit frames need not be mapped onto the 60-bit frames. The S- and X-bits in every fourth 80-bit frame are not mapped onto the 60-bit frames.

When radio interface rate of  $2 \times 12$  kbit/s is used for carrying AIUR 14,4 kbit/s, padding is used in the 60-bit frames of the higher substream number (subclause 10.6).

For substream numbering information, please refer to clause 10 of this document.

### 8.2.1.1 AIURs up to 38,4 kbit/s using 14,5/7,4 kbit/s channel codings

Intermediate rate/AIUR	Radio interface rate
32 kbit/s / 14,4; 19,2 kbit/s	$2 \times 7,4$ or $2 \times 14,5$ or $3 \times 7,4$
64 kbit/s / 28,8; 38,4 kbit/s	$2 \times 14,5$ or $4 \times 7,4$ or $3 \times 14,5$

For AIURs 14,4 and 28,8 kbit/s the 36 data bits in the 80-bit V.110 intermediate rate frames are extracted and sent through the substreams in 36-bit frames as described in subclause 8.1.1. All consecutive 36-bit frames corresponding to the multiframe indicated by M1 as described in subclause 8.1.1.2 are sent through the same channel; e.g. for 14,4 kbit/s channel coding 248 36-bit frames make up a multiframe which is sent through one channel. The M1 and M2 bits are sent over the radio-interface along the data frames every 20 ms. These bits carry the multiframe, substream, V.24 status, and NIC information as described in subclause 8.1.1.2.

For AIURs 19,2 and 38,4 kbit/s the 80-bit V.110 intermediate rate frames carry 48 bits. In the case of  $2 \times 14,5$  supporting 19,2 kbit/s the substream of the lower substream number carries 36 bits per each radio subsystem frame whereas the other substream carries 12 bits per 36-bit radio subsystem frame while the rest of the frame is padded with '1's. In the first substream bits 1-36 of the intermediate rate frame  $n$  are mapped into radio subsystem frame  $m$  whereas the remaining bits 37-48 are mapped to the first 12 bit positions in radio subsystem frame  $m+1$ . Bits 1-24 of the intermediate rate frame  $n+1$  are mapped to bit positions 13-36 of radio subsystem frame  $m+1$ . The mapping of the intermediate rate frames to the radio subsystem frames is carried on in this manner; three intermediate rate frames are mapped into four radio subsystem frames. In the second substream four radio subsystem frames carry the data of one intermediate frame. The data from the intermediate rate frames is mapped to bit positions 1-12 of four radio subsystem frames. When three subchannels are used, two of the available substreams carry 36 bits of user data per each 36 bit frame from/to the radio subsystem. The third substream, however, carries only 24 bits of user data per a 36-bit radio subsystem frame, while the rest of the frame is padded with '1's. Three 48-bit intermediate rate frames are mapped into four 36-bit frames. In the third subchannel one intermediate rate frame is mapped into two 36-bit frames.

NOTE: For procedures on NIC-compensation see subclause 10.5.1. The status and NIC-information is mapped into the M2 bits.

In the MS→ Network direction the information carried by M2 is mapped in the following manner:

The three-bit S-code in the M2-sequence carries the SA-, SB-, and X-statuses as they are in the V.110-frame corresponding to the last 36-bit frame in the block where the first of these S-bits is transmitted. The five N-bits in the M2-sequence indicate 'negative compensation' or 'positive compensation' if such an indication has been carried by the V.110 -frames (subclause 5.1.1) since the last transmission of the N-bits in the M2-sequence. Otherwise 'no compensation' is indicated by the N-bits. For the exact procedure for carrying NIC-information over a 14,5-channel, please refer to subclause 10.5.1.

No NIC-values are transported in association with AIUR 38,4; the N-bits are set to 'no compensation'.

In the Network→ MS direction the information carried by the M2-sequence is mapped in the following manner:

After a set of three consecutive S-bits have been received from the radio-interface the SA-, SB-, and X-statuses carried by these bits are mapped to the appropriate bit positions in the 80-bit V.110-frames. This status information is carried by all 80-bit V.110-frames until the next set of three S-bits is received in the M2-sequence.

For NIC-procedure. please refer to subclause 10.5.1. No NIC-values are transported in association with AIUR 38,4; the N-bits are set to 'no compensation'.

**8.2.2 AIUR of 48 kbit/s; Intermediate rate of 64 kbit/s****8.2.2.1 Radio interface rate of 5 x 12 kbit/s**

One modified CCITT V.110 60 bit frame (figure 5) is received/sent from/to a TCH/F every 5 ms (see GSM 05.03) resulting in an radio-interface rate of 12 kbit/s per channel.

One 60-bit radio-interface frame is converted into two CCITT V.110 32-bit frames at 64 kbit/s (figure 13):

1	D1	D2	D3	D4	D5	D6	S1
0	D7	D8	D9	D10	D11	D12	X
1	D13	D14	D15	D16	D17	D18	S3
1	D19	D20	D21	D22	D23	D24	S4

**8.2.2.2 Radio interface rate of 4 x 14,5 kbit/s**

For AIUR 48 kbit/s the 24 data bits in the 32-bit V.110 frames are extracted and sent through the substreams in 36-bit frames as described in subclause 8.1.1. All consecutive 36-bit frames corresponding to the multiframe indicated by M1 as described in subclause 8.1.1.2 are sent through the same channel; i.e. 248 36-bit frames make up a multiframe which is sent through one channel. The M1 and M2 bits are sent over the radio-interface along the data frames every 20 ms. These bits carry the multiframe, substream, and V.24 status information as described in subclause 8.1.1.2.

Here three of the available substreams carry 36 bits of user data per each 36 bit frame from/to the radio subsystem. The fourth substream, however, carries only 12 bits of user data per a 36-bit radio subsystem frame, while the rest of the frame is padded with '1's. Bits D1-D24 in the intermediate rate frames are mapped into the 36-bit frames in the following manner: bits 1-24 of intermediate frame n are mapped in bit positions 1-24 of 36-bit frame m. Bits 1-12 of the intermediate rate frame n+1 are mapped to bit positions 25-36 of the 36-bit frame m. Bits 13-24 of the intermediate rate frame n+1 are mapped to bit positions 1-12 of 36-bit frame m+1. Bits 1-24 of intermediate frame n+2 are mapped in bit positions 13-36 of 36-bit frame m+1. Thus the user data from three intermediate frames is mapped to two 36-bit frames. The status information is mapped into the M2-bits as described in subclause 8.1.1.2.

In the MS→ Network direction the information carried by M2 is mapped in the following manner:

The three-bit S-code in the M2-sequence carries the SA-, SB-, and X-statuses as they are in the V.110-frame corresponding to the last 36-bit frame in the block where the first of these S-bits is transmitted. No NIC-values are transported in association with AIUR 48.0; the N-bits are set to 'no compensation'.

In the Network→ MS direction the information carried by the M2-sequence is mapped in the following manner:

After a set of three consecutive S-bits have been received from the radio-interface the SA-, SB-, and X-statuses carried by these bits are mapped to the appropriate bit positions in the 32-bit V.110-frames. This status information is carried by all 32-bit V.110-frames until the next set of three S-bits is received in the M2-sequence. No NIC-values are transported in association with AIUR 48.0; the N-bits are set to 'no compensation'.

**8.2.3 AIUR of 56 kbit/s; Intermediate rate of 64 kbit/s****8.2.3.1 Radio interface rate of 5 x 12 kbit/s**

One modified CCITT V.110 60 bit frame (figure 10) is received/sent from/to the radio subsystem every 5 ms (see GSM 05.03) resulting in an radio-interface rate of 12 kbit/s per channel.

A modified CCITT V.110 60 bits radio-interface frame:

D1	D2	D3	D4	D5	D6	T1
D7	D8	D9	D10	D11	D12	T2
D13	D14	D15	D16	D17	D18	T3
D19	D20	D21	D22	D23	D24	T4
D25	D26	D27	D28	D29	D30	D31
D32	D33	D34	D35	D36	D37	D38
D39	D40	D41	D42	D43	D44	D45
D46	D47	D48	D49	D50	D51	D52
D53	D54	D55	D56			

NOTE: For information on the T-bits, please refer to subclause 10.2 of this document.

is converted into a CCITT V.110 64 bits frame at 64 kbit/s:

D1	D2	D3	D4	D5	D6	D7	1
D8	D9	D10	D11	D12	D13	D14	1
D15	D16	D17	D18	D19	D20	D21	1
D22	D23	D24	D25	D26	D27	D28	1
D29	D30	D31	D32	D33	D34	D35	1
D36	D37	D38	D39	D40	D41	D42	1
D43	D44	D45	D46	D47	D48	D49	1
D50	D51	D52	D53	D54	D55	D56	1

### 8.2.3.2 Radio interface rate of 4 x 14,5 kbit/s

For AIUR 56 kbit/s the 56 data bits in the 64-bit V.110 frames are extracted and sent through the substreams in 36-bit frames as described in subclause 8.1.1. All consecutive 36-bit frames corresponding to the multiframe indicated by M1 as described in subclause 8.1.1.2 are sent through the same channel; i.e. 248 36-bit frames make up a multiframe which is sent through one channel. The M1 and M2 bits are sent over the radio-interface along the data frames every 20 ms. These bits carry the multiframe and substream information as described in subclause 8.1.1.2.

Here all four substreams carry 35 bits of user data per each 36 bit frame from/to the radio subsystem while bit position 36 is padded with a '1'. Bits D1-D56 of five consecutive intermediate rate frames are mapped into eight 36-bit frames following the principles presented for the lower AIURs in the previous sections.

No V.24 status or NIC-values are transported in association with AIUR 56.0; the N-bits are set to 'no compensation'.

### 8.2.4 AIUR of 64 kbit/s

#### 8.2.4.1 Radio interface rate of 6 x 12 kbit/s

One modified CCITT V.110 60 bit frame (figure 10) is received/sent from/to the radio subsystem every 5 ms (see GSM 05.03) resulting in an radio-interface rate of 12 kbit/s per channel.

A modified CCITT V.110 60 bits radio-interface frame:

D1	D2	D3	D4	D5	D6	T1
D7	D8	D9	D10	D11	D12	T2
D13	D14	D15	D16	D17	D18	T3
D19	D20	D21	D22	D23	D24	T4
D25	D26	D27	D28	D29	D30	D31
D32	D33	D34	D35	D36	D37	D38
D39	D40	D41	D42	D43	D44	D45
D46	D47	D48	D49	D50	D51	D52
D53	D54	D55	D56			

NOTE: For information on the T-bits, please refer to subclause 10.2 of this document.



The data bits are extracted from the 60-bit frames received from the radio subsystem; six frames, one of which carries padding as explained in subclause 10.6, carry 320 bits of user data per 5 ms resulting in a 64 kbit/s user rate which is sent forward as such.

#### 8.2.4.2 AIUR of 64 kbit/s; Radio interface rate of 5 x 14,4 kbit/s

For AIUR 64 kbit/s the 64 data bits in the 64-bit V.110 frames are extracted and sent through the substreams in 36-bit frames as described in subclause 8.1.1. All consecutive 36-bit frames corresponding to the multiframe indicated by M1 as described in subclause 8.1.1.2 are sent through the same channel; i.e. 248 36-bit frames make up a multiframe which is sent through one channel. The M1 and M2 bits are sent over the radio-interface along the data frames every 20 ms. These bits carry the multiframe and substream information as described in subclause 8.1.1.2.

Here all five substreams carry 32 bits of user data per each 36 bit frame from/to the radio subsystem while bit positions 33-36 are padded with '1's. Bits D1-D64 of one 64-bit frame are mapped into two 36-bit frames following the principles presented for the lower AIURs in the previous sections.

No V.24 status or NIC-values are transported in association with AIUR 64.0; the N-bits are set to 'no compensation'.

## 9 The RA1' Function

This function is used to adapt between the synchronous user data rates, or the output of the RA0 function and the radio interface data rates of 3,6, 6, 7,4 or 12 kbit/s.

### 9.1 Synchronous user rates up to 9,6 kb/s

Synchronous user rate	Rate at the radio interface
≤ 2,4 kbit/s	3,6 kbit/s
4,8 kbit/s	6 kbit/s
7,2 kbit/s	7,4 kbit/s
9,6 kbit/s	12 kbit/s or 2x6 kbit/s

The modified CCITT V.110 36 or 60 bit frame structures for each user rate except 7,2 is shown in figures 5 - 9. The meaning of the bits is described in clause 5. The radio-interface frame format for the 7,2 user rate is described in subclause 8.1.3.

### 9.2 Synchronous user rates from 9,6 kbit/s onward; 9,6/4,8 kbit/s channel codings

Synchronous user rate	Total rate at the radio interface	DTE/DCE statuses	60 Bit frame structure	Single slot rate at the radio interface
14,4 kbit/s	24 kbit/s or 18 kbit/s	X	9,6 kbit/s or 4,8 kbit/s (figs. 5 and 15) Note	12 kbit/s or 6 kbit/s
19,2 kbit/s	24 kbit/s	X	9,6 kbit/s or 4,8 kbit/s (fig. 5)	12 kbit/s or 6 kbit/s
28,8 kbit/s	36 kbit/s	X	9,6 kbit/s (fig. 5)	12 kbit/s
38,4 kbit/s	48 kbit/s	X	9,6 kbit/s (fig. 5)	12 kbit/s
48 kbit/s	60 kbit/s	X	9,6 kbit/s (fig. 5)	12 kbit/s
56 kbit/s	60 kbit/s		11,2 kbit/s (fig.10)	12 kbit/s
64 kbit/s	72 kbit/s		11,2 kbit/s (figs. 10 and 16) Note	12 kbit/s

NOTE: Padding is used in frames making up the data substream of the highest substream number.

Modified CCITT V.110 60 bit frames structures are those shown in figures 5, (6,) and 10. The structure to apply is that for the partial user rate. The meaning of the bits is described in clauses 5 and 7. For description of the padding procedure, please refer to clause 10 of this document.

### 9.3 Synchronous user rates from 9,6 kbit/s onward; 14,4/7,2 kbit/s channel codings

Synchronous user rate	Total rate at the radio interface	DTE/DCE statuses	Air-interface bit frame structure	Single slot rate at the radio interface
14,4 kbit/s	14,5 kbit/s 14,8 kbit/s	X	36 bits, 290-bit block 36 bits, 148-bit block	14,5 kbit/s 7,4 kbit/s
19,2 kbit/s	29,0 kbit/s 22,2 kbit/s	X	36 bits, 290-bit block 36 bits, 148-bit block	14,5 kbit/s (note) 7,4 kbit/s (note)
28,8 kbit/s	29,0 kbit/s 29,6 kbit/s	X	36 bits, 290-bit block 36 bits, 148-bit block	14,5 kbit/s 7,4 kbit/s
38,4 kbit/s	43,5 kbit/s	X	36 bits, 290-bit block	14,5 kbit/s (note)
48 kbit/s	58,0 kbit/s	X	36 bits, 290-bit block	14,5 kbit/s (note)
56 kbit/s	58,0 kbit/s		36 bits, 290-bit block	14,5 kbit/s (note)
64 kbit/s	72,5 kbit/s		36 bits, 290-bit block	14,5 kbit/s (note)

NOTE: Padding used as specified for 14,5/7,4 channel codings.

## 10 The Split/Combine and Padding-functions

### 10.1 Data frame distribution into the substreams/channels by the Split/Combine function

#### 10.1.1 Data frame distribution into the substreams/channels by the Split/Combine function (12/6 kbit/s channel codings)

a) In the transparent case the Split/Combine-function distributes the V.110-frames into the substreams and recombines the overall data stream from the substreams according to the following rules:

In the overall data stream:

- 1) the frame in position  $p$  in substream  $q$  precedes the frame in position  $p$  in substream  $q+1$ ,  $0 \leq q < n-1$ ;
- 2) the frame in position  $p$  in substream  $n-1$  precedes the frame in position  $p+1$  in substream  $0$ ;

where in the rules above  $n$  is the number of substreams.

b) In the non-transparent case the Split/Combine-function distributes the RLP-frames — or the four V.110-frames making up an RLP-frame (Reference: GSM 08.20, clause 10) — into channels so that one whole RLP-frame is carried through one channel. Furthermore the RLP-frames are distributed into the available channels cyclically; i.e. the frames are sent in the available time slots in a recurring sequence in which only every  $n$ th RLP-frame is sent through the same channel ( $n$  is the number of the available time slots). The receiving Split/Combine-function recombines the overall data stream according to the inherent RLP-frame numbering, i.e. the  $N(S)$ -numbers in the RLP-frame header (GSM 04.22).

#### 10.1.2 Data block distribution into the substreams/channels by the Split/Combine function (14,5/7,4 kbit/s channel codings)

##### a) Transparent services

When 14,5/7,4 kbit/s channel codings are used, the Split/Combine function distributes the data into the substreams per 290-/148-bit blocks so that all blocks making up a multiframe are sent in the same substream. A multiframe is recognized by the multiframe sequence carried by bit M1. The multiframe sequence also indicates the order of multiframes in relation to multiframes received through parallel substreams.

In the overall data stream:

- 1) the multiframe in substream  $q$  precedes the corresponding multiframe in substream  $q+1$ ,  $0 \leq q < n-1$ ;
- 2) the multiframe in substream  $n-1$  precedes the corresponding multiframe in substream  $0$ ;

where in the rules above  $n$  is the number of substreams.

## b) Non-transparent services

In the non-transparent operation the Split/Combine-function distributes the RLP-frames into channels so that one whole RLP-frame is carried through one channel. This means that in case a 14,5 channel is used the two 290-bit radio-interface blocks are transmitted through the same channel; for 7,4 channels four 148-bit blocks are transmitted through the same channel. Furthermore the RLP-frames are distributed into the available channels cyclically; i.e. the frames are sent in the available time slots in a recurring sequence in which only every  $n$ th RLP-frame is sent through the same channel ( $n$  is the number of the available time slots). The receiving Split/Combine-function recombines the overall data stream according to the inherent RLP-frame numbering, i.e. the  $N(S)$ -numbers in the RLP-frame header (GSM 04.22).

### **10.2 Substream numbering in transparent operation**

In transparent multislot data configurations of more than one TCH/F the parallel data substreams between the Split/Combine-functions carry inband substream numbering. The status bits S1, S3, and the X-bit between data bits D12 and D13 (figures 5 and 6) are used for transferring this substream numbering information (S1 is the MSB and S3 the LSB). The substreams are numbered 0, 1, 2, 3 etc. regardless of the physical channels through which the substreams are transmitted.

The S4-bit is used for frame synchronization between the parallel substreams. This bit follows a 31-bit PN-sequence of 0000 1001 0110 0111 1100 0110 1110 101. This thirty one bit sequence is used for substream resynchronization in cases where delay has occurred on one or more substream(s); the position of a frame in a substream can be determined modulo 31 by the values of the S4-bit in a sequence of 5 consecutive frames including the frame in question. Provided that the relative delay between substreams is less than 75 ms (i.e. less than a 15-frame displacement), this and the frame distribution rules given in subclause 10.1 are sufficient to determine the correct order of the frames.

Bits S6, S8, S9, and the other X-bit are used for conveying channel control information according to the relevant terminal adapter function specification.

These rules apply to all multislot data AIURs up to and including 48 kbit/s. When the received 48 kbit/s AIUR is converted into 64 kbit/s rate, the bits extracted from the 60-bit radio interface frames (figure 5) are mapped into the 32-bit frame format of figure 13. Here the values for the status bits S1, X, S3, and S4 in the 32-bit frame must be derived from status bits S6, X, S8, and S9 in the radio-interface frame because status bits S1, X, S3, and S4 in the upper right hand corner of the 60-bit frame have been used for data substream numbering as described above.

In the 11,2 kbit/s frames used for AIURs 56 and 64 kbit/s (figure 10) the T1, T2, T3 (T1 the MSB and T3 the LSB) are used for carrying the substream numbering as status bits S1, X, and S3 do according to the definition given in the first paragraph of subclause 10.1. Bit T4 is used for carrying the substream synchronization sequence just as status bit S4 does in the description given in the second paragraph of subclause 10.2.

#### **10.2.1 Substream numbering for 14,5/7,4 channel codings**

Bit M1 carries the multiframe sequence 0000 1001 0110 0111 1100 0110 1110 101. The number of the substream in which a multiframe is sent is carried in bit stream M2 four times. In the three-bit number code the bit in the lowest bit position is the MSB (see table in subclause 8.1.1.2).

### **10.3 Initial Substream Synchronization for 9,6/4,8 kbit/s channel coding**

The Split and combine-function is responsible for controlling the initial synchronization procedure as described in GSM 07.01.

#### **10.3.1 Initial Substream Synchronization for 14,5/7,4 kbit/s channel codings**

The Split and combine-function is responsible for controlling the initial synchronization procedure as described in GSM 07.01.

#### **10.4 Action on loss of synchronization**

Two interfaces are involved in the TAF regarding the need for the data frame synchronization, i.e. the TAF/multichannel interface and the TAF/TE interface.

##### **10.4.1 Non-transparent services (9,6/4,8 kbit/s channel coding)**

If the TAF detects a loss of frame synchronization on the TAF/TE interface, the TAF initiates re-synchronization on that link, in line with the procedures specified in CCITT V.110. No related action shall be taken by the TAF on the TAF/multichannel link(s) or on the V.110 frames being transmitted towards the TE.

If the TAF detects a loss of synchronization on the TAF/multichannel link(s) - on one or more channels - then the TAF initiates re-synchronization process on the channel(s) which are out of synchronization. In this case the TAF searches for the data frame structure in those channels in which the synchronization has been lost. No related action shall be taken regarding the frames generated towards the TE by the TAF during the re-synchronization process.

No action shall be taken on the frames being transmitted towards the MSC, other than to continue sending them normally.

##### **10.4.2 Transparent services (9,6/4,8 kbit/s channel coding)**

If the TAF detects a loss of frame synchronization on the TAF/TE interface, the TAF initiates a re-synchronization on that link, in line with the procedures specified in CCITT V.110. No further action shall be taken by the TAF on the TAF/multichannel link or on the V.110 frames being transmitted towards the TE.

If the TAF detects a loss of synchronization on the TAF/multichannel link - on one or more channels - the TAF initiates re-synchronization process on the channel(s) which are out of synchronization. In this case the TAF searches for the data frame structure in those channels in which the synchronization has been lost. The information received from the channels shall continue to be processed as if the synchronization had not been lost; corrupted data is forwarded towards the TE during the re-synchronization process.

No action shall be taken on the frames being transmitted towards the MSC, other than to continue sending them normally.

##### **10.4.3 Non-transparent services (14,4/7,2 kbit/s channel coding)**

If the TAF detects a loss of frame synchronization on the TAF/TE interface, the TAF initiates re-synchronization on that link, in line with the procedures specified in CCITT V.110. No related action shall be taken by the TAF on the TAF/multichannel link(s) or on the V.110 frames being transmitted towards the TE.

If the TAF detects a loss of synchronization on the TAF/multichannel link(s) - on one or more channels - then the TAF initiates re-synchronization process on the channel(s) which are out of synchronization. In this case the TAF searches for the multiframe structure in those channels in which the synchronization has been lost. No related action shall be taken regarding the frames generated towards the TE by the TAF during the re-synchronization process.

No action shall be taken on the frames being transmitted towards the MSC, other than to continue sending them normally.

##### **10.4.4 Transparent services (14,4/7,2 kbit/s channel coding)**

If the TAF detects a loss of frame synchronization on the TAF/TE interface, the TAF initiates a re-synchronization on that link, in line with the procedures specified in CCITT V.110. No further action shall be taken by the TAF on the TAF/multichannel link or on the V.110 frames being transmitted towards the TE.

If the TAF detects a loss of synchronization on the TAF/multichannel link - on one or more channels - the TAF initiates re-synchronization process on the channel(s) which are out of synchronization. In this case

the TAF searches for the multiframe structure in those channels in which the synchronization has been lost. The information received from the channels shall continue to be processed as if the synchronization had not been lost; corrupted data is forwarded towards the TE during the re-synchronization process.

No action shall be taken on the frames being transmitted towards the MSC, other than to continue sending them normally.

## 10.5 Network Independent Clocking

The frames of a multiframe (subclause 5.1.1) indicating a positive or negative compensation are distributed into the substreams according to subclause 10.1.

### 10.5.1 Network Independent Clocking for channel codings 14,5 and 7,4 kbit/s (both single- and multilinks)

If a NIC-compensation is indicated in the data flow in between two multiframe NIC-transmissions:

-negative compensation: For radio-interface transmission the data in the V.110 frames is extracted to be mapped for the radio interface 14,4/7,2 blocks of 290/148 bits. The 'extra null' bit (subclause 5.1.1) is dropped here and remapped to bit position 288/144 of radio interface block number 28 (the remaining data bits are moved up by one step in the data frames), which is the block carrying the fifth N-bit in the 31-block multiframe structure. The null bit is eventually stripped at the receiving end.

-positive compensation: For radio-interface transmission the data in the V.110 frames is extracted to be mapped for the radio interface 14,4/7,2 blocks of 290/148 bits. The extra bit — either 0 or 1 — is added to the data flow in the correct position (subclause 5.1.1). This means that the block where this has taken place would have 291/149 bits. The overflow of one bit is carried over to the next blocks; i.e. bit position 1 of the following blocks would carry the user data bit that originally was bit 288 in the previous block. The overflow is halted in block 25; the value of the N-bit carried by this block (by bit M2) is set to either 1 or 0 depending on the value of bit 19 in the last 36-bit frame making up the block. If bit 19 is 1, the N-bit is set to 0 (positive compensation of a 1); if bit 19 is 0, the N-bit is set to 1 (positive compensation of a 0). Thus the value of bit 271/127 in block 25 is indicated by bit M2; the two first bits of the NIC-code either 00 or 01. The data bits that would be mapped to bit positions 272-288 when NIC-compensation does not take place are moved up by one step in the frame to bit positions 271-287. The 'overflow' bit that would have been carried over to the next block is mapped to bit position 288.

When block 25 indicating positive compensation is received from the radio, the NIC is decoded and the data is mapped into 80-bit V.110-frames. Decoding the NIC means that an 'extra bit' emerges. This extra bit (bit number '289') is carried on to position D1 of the first V.110-frame corresponding to the following block. This carry-over is performed until block 28 has been fully received. After block 28 is received the next two suitable V.110-frames carry an NIC-code; the overflow of one bit which has been carried over a sequence of V.110-frames halts here as the second V.110-frame carries one extra bit; the value of the D-bit following the E4-E7 sequence in the V.110-frame is carried by the NIC-code and the following data bits are moved up by one step in the V.110-frame.

## 10.6 Padding TCH/F frames when the AIUR is not a multiple of 9,6 or 4,8 kbit/s

When the required AIUR is not a multiple of the rates supported by TCH/F 4,8 or TCH/F 9,6, padding is used for producing the required AIUR.

To achieve the required AIUR the data bits are distributed across the substreams 1 to n as follows:

- Substream(s) 1 (to n-1) carry multiples of the rate supported by the channel coding used.
- Substream n carries the remaining amount of data bits required to achieve the required AIUR. The remainder of data stream n carries padding bits set to binary value '1'.

### Padding for AIUR 14,4:

The frame of the lower substream number carries full 9,6 kbit/s. The frame of the higher substream number carries 4,8 kbit/s of user data in bit positions D1-D24 while bit positions D25-D48 are inserted with binary "1"s (figure 15).

Padding for AIUR 64 kbit/s:

The frames numbered 1-5 carry full 11,2 kbit/s. Frame number 6 carries 8,0 kbit/s of user data in bit positions D1-D40 while bit positions D41-D56 are inserted with binary "1"s (figure 16).

**10.6.1 Padding for 14,5/7,4 channel codings**

Padding for 14,5/7,4 channel codings is presented in the corresponding parts of clause 8.

**10.7 Handling of the E1-E3 bits in multislot operation**

Between the Split / Combine functions the substreams carry the code associated with the substream rate as defined in figure 4. When the substreams are combined the code is set to correspond to the overall AIUR according to figure 4.

**11 Support of Non-Transparent Bearer Services**

In the case of non-transparent services, the RA1' function provides access to the **14,5**, 12, **7,4** and 6 kbit/s (alignment of RLP frames with the four TDMA slots makes it physically impossible to provide 3,6 kbit/s) radio interface data rates.

Air interface user rate	Radio interface rate
4,8 kbit/s	6 kbit/s
7,2 kbit/s	7,4 kbit/s
9,6 kbit/s	12 kbit/s or 2 × 6 kbit/s
14,4 kbit/s	14,5 kbit/s or 2 × 7,4 kbit/s or 2 × 12 kbit/s or 3 × 6 kbit/s
19,2 kbit/s	2 × 12 kbit/s or 3 × 7,4 kbit/s or 4 × 6 kbit/s
21,6 kbit/s	3 × 7,4 kbit/s
28,8 kbit/s	2 × 14,5 kbit/s or 4 × 7,4 kbit/s or 3 × 12 kbit/s
38,4 kbit/s	3 × 14,5 kbit/s or 4 × 12 kbit/s
43,2 kbit/s	3 × 14,5 kbit/s
57,6 kbit/s	4 × 14,5 kbit/s

**11.1 Support of non-transparent operation for 9,6/4,8 kbit/s channel codings**

This access results in the use of a modified CCITT V.110 60 bit frame for non-transparent services (figure 11). In this case, the RA1' function also provides for alignment of four modified CCITT V.110 60 bit frames sent on the same radio slot corresponding with each complete 240 bit frame to be encoded by the radio subsystem as a single unit (see GSM 05.03). The difference between the non-transparent 60 bit frame and the 60 bit frame for the transparent service is that the bit positions used for status in a transparent frame are used to carry data (designated as D' bits in figure 11).

NOTE: The status bits SA, SB, and the X bit are embedded in the L2R-PDU frames (see GSM 07.01, 07.02, and 07.03).

The first bit of each RLP frame to be transmitted will correspond to the first bit (D1) of the first 60 bit frame in a four frame sequence and the last bit will correspond to the last bit (D'12) of the last 60 bit frame in a four frame sequence. Each 60 bit frame is filled from left to right starting at D1 (see figure 11).

The radio subsystem provides for the synchronous transmission and reception of 240 bit RLP frames through a connection consisting of up to four TCH/Fs. An RLP-frame is received/sent from/to a particular radio channel every 20 ms (12 kbit/s radio interface rate) or every 40 ms (6 kbit/s radio interface rate) irrespective of the user rate.

The request to use 6 kbit/s radio interface rate on a Full Rate Channel is indicated in the BC-IE by setting the NIRR bit to 6 kbit/s (Negotiation procedure see GSM 07.01) and selecting a Full Rate Channel and Non-Transparent service. If the entity receiving the BC-IE is unable to support this request then the 12 kbit/s radio interface rate shall be provided automatically.

Occasions may arise when there is no RLP frame ready to be transmitted. In this case a frame of 240 zeroes will be transmitted. This frame will be discarded by the distant RLP function, due to FCS failure, but will allow physical link synchronization to be maintained between the MS and the MSC.

In the case of an asymmetric connection the BTS shall send V110 idle frames towards the MSC on the channels which are unused in the direction from the MS towards the MSC. This will ensure that the IWF does not interpret V110 frames which are not originated from the MS as complete RLP frames.

## 11.2 Support of non-transparent operation for 14,5/7,4 kbit/s channel codings

In 14,5 or 7,4 kbit/s channels 576-bit RLP-frames are used.

### - 14,5 kbit/s channel:

At RA1'-function the RLP-data is extracted from the 80-bit V.110-frames (subclause 8.1.1). The resulting 36-bit frames are used for constructing radio-interface blocks as defined in subclause 8.1.1.3. The M1- bit is used for indicating the RLP-frame halves: in the first half M1=0 and in the second half M1=1. Bit M2 is spare in non-transparent 14,5 channel radio-interface blocks.

### - 7,4 kbit/s channel:

At RA1'-function the RLP-data is extracted from the 80-bit V.110-frames (subclause 8.1.1). The resulting 36-bit frames are used for constructing radio-interface blocks as defined in subclause 8.1.1.3. The M1- and M2 bits are used for indicating the RLP-frame quarters: the first quarter carries code M1M2=00, the second quarter carries code M1M2=01, the third quarter carries code M1M2=10, and the fourth quarter code M1M2=11.

In cases where no RLP-frame is ready to be transmitted a sequence of 576 '0' is transmitted. This frame will be discarded by the distant RLP-function due to FCS failure.

In the case of an asymmetric connection the BTS shall send idle (all user data bits set to '0') frames towards the IWF on the channels which are unused in the direction from the MS towards the MSC. This will ensure that the IWF does not interpret sequences of frames which are not originated from the MS as complete RLP frames.

## 12 Figures on Frame structures

Octet No.	Bit number							
	1	2	3	4	5	6	7	8
0	0	0	0	0	0	0	0	0
1	1	D1	D2	D3	D4	D5	D6	S1
2	1	D7	D8	D9	D10	D11	D12	X
3	1	D13	D14	D15	D16	D17	D18	S3
4	1	D19	D20	D21	D22	D23	D24	S4
5	1	E1	E2	E3	E4	E5	E6	E7
6	1	D25	D26	D27	D28	D29	D30	S6
7	1	D31	D32	D33	D34	D35	D36	X
8	1	D37	D38	D39	D40	D41	D42	S8
9	1	D43	D44	D45	D46	D47	D48	S9

Figure 3: The CCITT V.110 80 bit RA1 frame structure

Intermediate Data Rate						
8 kbit/s	16 kbit/s	32 kb/s	64 kb/s	E1	E2	E3
600				1	0	0 Note
1 200				0	1	0
2 400				1	1	0
4 800	9 600	19 200	38 400	0	1	1
		14 400	28 800	1	0	1

NOTE: The 300 bit/s user data rate is carried on the 600 bit/s synchronous stream by adding stop elements, see subclause 4.1.

Figure 4: Coding of data rates

D1	D2	D3	D4	D5	D6	S1
D7	D8	D9	D10	D11	D12	X
D13	D14	D15	D16	D17	D18	S3
D19	D20	D21	D22	D23	D24	S4
E4	E5	E6	E7	D25	D26	D27
D28	D29	D30	S6	D31	D32	D33
D34	D35	D36	X	D37	D38	D39
D40	D41	D42	S8	D43	D44	D45
D46	D47	D48	S9			

Figure 5: Modified CCITT V.110 60 bit frame for 9,6 kbit/s transparent data

D1	D2	D3	D4	D5	D6	S1
D7	D8	D9	D10	D11	D12	X
D13	D14	D15	D16	D17	D18	S3
D19	D20	D21	D22	D23	D24	S4
E4	E5	E6	E7	D25	D26	D27
D28	D29	D30	S6	D31	D32	D33
D34	D35	D36	X	D37	D38	D39
D40	D41	D42	S8	D43	D44	D45
D46	D47	D48	S9			

Figure 6: Modified CCITT V.110 60 bit frame for 4,8. kbit/s transparent data



a)

D1	D2	D3	S1	D4	D5	D6	X
D7	D8	D9	S3	D10	D11	D12	S4
E4	E5	E6	E7	D13	D14	D15	S6
D16	D17	D18	X	D19	D20	D21	S8
D22	D23	D24	S9				

b)

0	0	0	0	0	0	0	0
1	D1	D1	D2	D2	D3	D3	S1
1	D4	D4	D5	D5	D6	D6	X
1	D7	D7	D8	D8	D9	D9	S3
1	D10	D10	D11	D11	D12	D12	S4
1	1	1	0	E4	E5	E6	E7
1	D13	D13	D14	D14	D15	D15	S6
1	D16	D16	D17	D17	D18	D18	X
1	D19	D19	D20	D20	D21	D21	S8
1	D22	D22	D23	D23	D24	D24	S9

**Figure 7: a) Modified CCITT V.110 36 bit frame for 2,4 kbit/s transparent data and  
b) the corresponding intermediate rate frame at 8 kbit/s**

a)

D1	D1	D2	S1	D2	D3	D3	X
D4	D4	D5	S3	D5	D6	D6	S4
E4	E5	E6	E7	D7	D7	D8	S6
D8	D9	D9	X	D10	D10	D11	S8
D11	D12	D12	S9				

b)

0	0	0	0	0	0	0	0
1	D1	D1	D1	D1	D2	D2	S1
1	D2	D2	D3	D3	D3	D3	X
1	D4	D4	D4	D4	D5	D5	S3
1	D5	D5	D6	D6	D6	D6	S4
1	0	1	0	E4	E5	E6	E7
1	D7	D7	D7	D7	D8	D8	S6
1	D8	D8	D9	D9	D9	D9	X
1	D10	D10	D10	D10	D11	D11	S8
1	D11	D11	D12	D12	D12	D12	S9

**Figure 8: a) Modified CCITT V.110 36 bit frame for 1,2 kbit/s transparent data and  
b) the corresponding intermediate rate frame at 8 kbit/s**

a)

D1	D1	D1	S1	D1	D2	D2	X
D2	D2	D3	S3	D3	D3	D3	S4
E4	E5	E6	E7	D4	D4	D4	S6
D4	D5	D5	X	D5	D5	D6	S8
D6	D6	D6	S9				

NOTE: The 300 bit/s user data rate is carried on the 600 bit/s synchronous stream by adding stop elements, see subclause 4.1.

b)

0	0	0	0	0	0	0	0
1	D1	D1	D1	D1	D1	D1	S1
1	D1	D1	D2	D2	D2	D2	X
1	D2	D2	D2	D2	D3	D3	S3
1	D3	D3	D3	D3	D3	D3	S4
1	1	0	0	E4	E5	E6	E7 (note)
1	D4	D4	D4	D4	D4	D4	S6
1	D4	D4	D5	D5	D5	D5	X
1	D5	D5	D5	D5	D6	D6	S8
1	D6	D6	D6	D6	D6	D6	S9

NOTE: In order to maintain compatibility with Recommendation X.30 (I.461), for the 600 bit/s user rate bit E7 is coded to enable the 4x80 bit multiframe synchronization. To this end, E7 in the fourth 80 bit frame is set to binary '0'. See Table 6 of ITU-T Recommendation V.110(09/92).

**Figure 9: a) Modified CCITT V.110 36 bit frame for 600 bit/s transparent data and b) the corresponding intermediate rate frame at 8 kbit/s**

D1	D2	D3	D4	D5	D6	T1
D7	D8	D9	D10	D11	D12	T2
D13	D14	D15	D16	D17	D18	T3
D19	D20	D21	D22	D23	D24	T4
D25	D26	D27	D28	D29	D30	D31
D32	D33	D34	D35	D36	D37	D38
D39	D40	D41	D42	D43	D44	D45
D46	D47	D48	D49	D50	D51	D52
D53	D54	D55	D56			

**Figure 10: Modified CCITT V.110 60 bit frame for 11,2 kbit/s partial rate**

D1	D2	D3	D4	D5	D6	D'1
D7	D8	D9	D10	D11	D12	D'2
D13	D14	D15	D16	D17	D18	D'3
D19	D20	D21	D22	D23	D24	D'4
D'5	D'6	D'7	D'8	D25	D26	D27
D28	D29	D30	D'9	D31	D32	D33
D34	D35	D36	D'10	D37	D38	D39
D40	D41	D42	D'11	D43	D44	D45
D46	D47	D48	D'12			

**Figure 11: Modified CCITT V.110 60 bit frame for non-transparent data**

0	0	0	0	0	0	0	0
1	D1	D2	D3	D4	D5	D6	S1
1	D7	D8	D9	D10	F	F	X
1	D11	D12	F	F	D13	D14	S3
1	F	F	D15	D16	D17	D18	S4
1	1	0	1	E4	E5	E6	E7
1	D19	D20	D21	D22	D23	D24	S6
1	D25	D26	D27	D28	F	F	X
1	D29	D30	F	F	D31	D32	S8
1	F	F	D33	D34	D35	D36	S9

F=Fill bits, which are set to 1.

Figure 12: The CCITT V.110 80 bit frame for 3,6 kbit/s transparent data (8 kbit/s intermediate rate)

1	D1	D2	D3	D4	D5	D6	S1
0	D7	D8	D9	D10	D11	D12	X
1	D13	D14	D15	D16	D17	D18	S3
1	D19	D20	D21	D22	D23	D24	S4

Figure 13: The CCITT V.110 32 bit 48 kbit/s frame structure (64 kbit/s intermediate rate)

D1	D2	D3	D4	D5	D6	D7	1
D8	D9	D10	D11	D12	D13	D14	1
D15	D16	D17	D18	D19	D20	D21	1
D22	D23	D24	D25	D26	D27	D28	1
D29	D30	D31	D32	D33	D34	D35	1
D36	D37	D38	D39	D40	D41	D42	1
D43	D44	D45	D46	D47	D48	D49	1
D50	D51	D52	D53	D54	D55	D56	1

Figure 14: The CCITT V.110 64 bit 56 kbit/s frame structure (64 kbit/s intermediate rate, option without status bits)

D1	D2	D3	D4	D5	D6	S1
D7	D8	D9	D10	D11	D12	X
D13	D14	D15	D16	D17	D18	S3
D19	D20	D21	D22	D23	D24	S4
E4	E5	E6	E7	1	1	1
1	1	1	S6	1	1	1
1	1	1	X	1	1	1
1	1	1	S8	1	1	1
1	1	1	S9			

Figure 15: Modified CCITT V.110 60 bit frame for a padded 9,6 kbit/s transparent data frame carrying 4,8 kbit/s with padding

D1	D2	D3	D4	D5	D6	T1
D7	D8	D9	D10	D11	D12	T2
D13	D14	D15	D16	D17	D18	T3
D19	D20	D21	D22	D23	D24	T4
D25	D26	D27	D28	D29	D30	D31
D32	D33	D34	D35	D36	D37	D38
D39	D40	1	1	1	1	1
1	1	1	1	1	1	1
1	1	1	1			

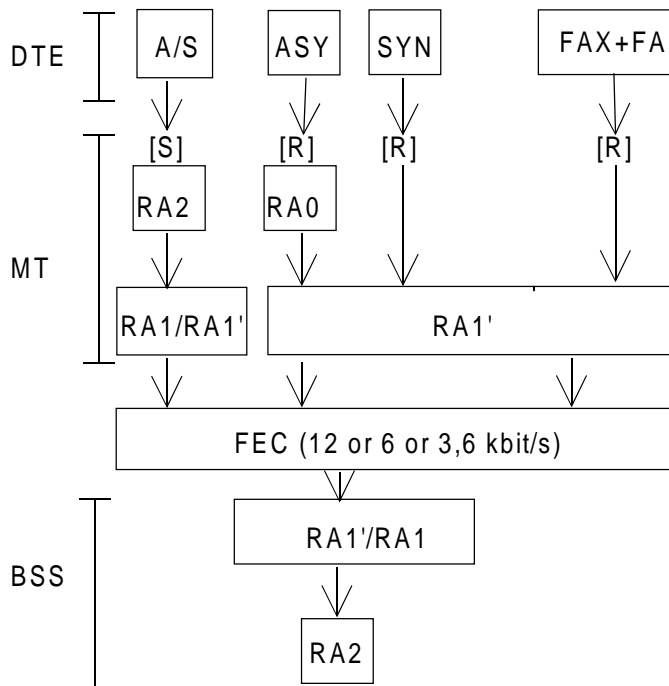
**Figure 16: Modified CCITT V.110 60 bit frame for a padded 11,2 kbit/s transparent data frame carrying 8,0 kbit/s with padding**

D1	D2	D3	D4	D5	D6
D7	D8	D9	D10	D11	D12
D13	D14	D15	D16	D17	D18
D19	D20	D21	D22	D23	D24
D25	D26	D27	D28	D29	D30
D31	D32	D33	D34	D35	D36

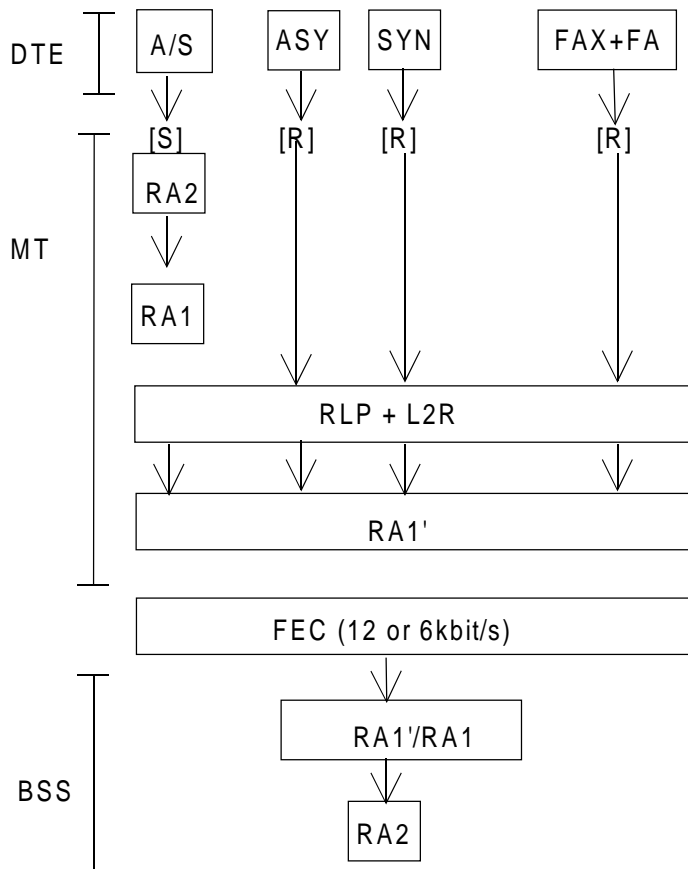
**Figure 17: Modified CCITT V.110 36-bit frame received/sent from/to the radio subsystem at 14,4 kbit/s**

### Annex A (informative): Stacks of rate adaptation

For transparent data services, the following stacks of rate adaption are possible:



For the non-transparent services, the following stacks of rate adaption and functions are possible:



## History

Document history			
December 1996	Unified Approval Procedure	UAP 60:	1996-12-02 to 1997-03-28
April 1997	One-step Approval Procedure (Second Edition)	OAP 9731:	1997-04-04 to 1997-08-01
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