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Rate Adaptation on MS-BSS Interface

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No changes since the previously distributed version.

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ETSI

European Telecommunications Standards Institute

ETSI Secretariat: B.P.152 . F - 06561 Valbonne Cedex . France

TP. + 33 92 94 42 00 TF. + 33 93 65 47 16 Tx. 47 00 40 F

Foreword

This second Final draft Interim European Telecommunication Standard (I-ETS) has been produced by the Special Mobile Group (SMG), a Technical Committee of the European Telecommunications Standards Institute (ETSI).

The final drafts dealing with the GSM system were adopted by vote in May 1991 but were not published. This was because amendments, agreed by ETSI TC-SMG at subsequent meetings, were made to some of the drafts. However, other drafts have not been amended since the first vote.

This updated draft is now considered to be stable enough for submission to second vote.

This I-ETS describes the rate adaptation functions used for adapting terminal interface data rates to the data rates at the Mobile Station- Base Station System (MS-BSS) interface within the European digital cellular telecommunications system (phase 1).

Reference is made within this I-ETS to the following technical specifications (NOTE 1):

GSM 03.10	Public Land Mobile Network (PLMN) connection types.
GSM 04.22	Radio link protocol for data and telematic services on the Mobile Station - Base Station System (MS-BSS) interface.
GSM 05.03	Channel coding.
GSM 07.01	General on terminal adaptation functions for Mobile Stations.
GSM 07.02	Terminal adaptation functions for services using asynchronous bearer capabilities.
GSM 07.03	Terminal adaptation functions for services using synchronous bearer capabilities.
GSM 08.20	Rate adaptation on the Base Station System - Mobile services Switching Centre (BSS-MSC) interface.

The above specifications are normative.

NOTE 1: ETSI has constituted stable and consistent documents which give technical specifications for the implementation of the European digital cellular telecommunications system. Historically, these documents have been identified as "GSM recommendations".

Some of these recommendations may subsequently become Interim European Telecommunication Standards (I-ETSs) or European Telecommunication Standards (ETSs), whilst the others will be renamed ETSI-GSM Technical Specifications. These ETSI-GSM Technical Specifications are, for editorial reasons, still referred to as GSM recommendations in some current GSM documents.

The numbering and version control system used for ETSI-GSM Technical Specifications is the same as that used for GSM recommendations.

NOTE 2: Items in this draft indicated as not complete, or requiring further study or work, are not required for the Phase 1 implementation of the European digital cellular telecommunications system.

ETSI/GSM

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Title: RATE ADAPTATION ON THE MS-BSS INTERFACE

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0. SCOPE

This recommendation defines the rate adaptation functions to be used in GSM PLMN Mobile Stations for adapting terminal interface data rates to the MS-BSS interface data rates in accordance with GSM recommendation 03.10.

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

Note: This recommendation should be considered together with GSM Recommendation 08.20 (Rate Adaptation on the BSS-MSC Interface) to give a complete description of PLMN rate adaptation.

1. GENERAL APPROACH

GSM recommendation 03.10 (section 4) 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 which are combined as shown in GSM 03.10 as part of the connection type.

These functions are RA0, RA1, RA2, RA1' and RA1/RA1'. The RA0, RA1 and RA2 are equivalent to those functions described in CCITT recommendation V.110.

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

2. THE RA0 FUNCTION

2.1. 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 channel defined by (2 to the power 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'.

2.2. 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.

2.3. 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% (or 2.5% in the case of nominal speeds lower than 600 bit/s), 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 nominal length of the start and data elements shall be the same for all characters. The length of the stop elements may be reduced by as much as 12.5% for nominal speeds exceeding 300 bit/s to allow for overspeed in the transmitting terminal. For nominal speeds less than or equal to 300 bit/s a 25% reduction in stop element is allowed.

2.4. Parity Bits

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

2.5. Flow Control

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

3. 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 or 16 kbit/s.

The CCITT V.110 80 bit frame shown in Figure 3 is 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 recommendation.

The E bits are used to convey the following information:

i) User Data Rate - E1, E2, E3 (see Figure 4)

ii) Network Independent Clocking - E4, E5, E6

iii) Multiframe Synchronisation - E7

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

3.1. Network Independent Clocking

Synchronous data signals received from the DTE at the MS or from the modem on the PSTN may not be synchronised 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 are synchronized to the far end modem clock on the other side of the land network (PSTN/3.1 Khz Audio service ISDN) 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.

3.1.1. Multiframe Structure

The transmitting end shall establish a multiframe structure utilising 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 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

NIC Multiframe Structure
Figure 1

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 section 3.1.2 in V.110 frames MF 1a and MF 1b.

3.1.2. 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

NIC Code Words
Figure 2

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.

4. 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 or 16 kbit/s from/to the 64 kbit/s rate used at the S interface.

It considers the 64 kbit/s stream 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 order of transmission of the bits of the subrate stream is identical before and after rate adaptation.
iv) All unused bits in the 64 kbit/s stream are set to binary "1".

5. THE RA1/RA1' FUNCTION

The RA1/RA1' function is used to convert between the CCITT V.110 80 bit frames produced at the 8 and 16 kbit/s intermediate rates and the input rate to the channel coder function for transmission by the radio subsystem.

There are three data rates (known as Radio Interface rates) used for data transfer to the channel coder. These are 12 kbit/s, 6 kbit/s and 3.6 kbit/s, and in order to adapt the 8 and 16 kbit/s intermediate rates to these data rates, three processes are used. Firstly the 17 synchronisation bits are removed. Secondly the E1, E2 and E3 bits are removed. 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. These functions are described below (note that the designations "tb" and "rb" are used to designate bits sent/received on the RA1 and RA1' side of the RA1/RA1' function respectively).

5.1. 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 synchronisation pattern and the E1,E2 and E3 bits to/from each CCITT V.110 80 bit frame as follows:

Modified CCITT V.110 60 bit frame:

```
rb1,2,3...rb7
rb8.......rb14
rb15......rb21
rb22......rb28
rb29......rb35       = 60 bits/frame or 12 kbit/s
rb36......rb42
rb43......rb49
rb50......rb56
rb57......rb60
```

CCITT V.110 80 bit frame:

```
0 0 0 0 0 0 0 0
1 tb1,2,3...tb7
1 tb8.......tb14
1 tb15......tb21
1 tb22......tb28
1 tb29......tb35
1 tb36......tb42     = 80 bits/frame or 16 kbit/s
1 tb43......tb49
1 tb50......tb56
1 tb57......tb63
```

For modified CCITT V.110 60 bit frames received from the radio subsystem, the bits tb1 - tb28 are set to the same value as bits rb1 - rb28. Bits tb29 - tb31 are set according to the user data rate as shown in Figure 4. Bits tb32 - tb63 are set to the same value as rb29 - rb60.

For modified CCITT V.110 60 bit frames transmitted over the radio subsystem, the bits rb1 - rb28 are set to the same value as tb1 - tb28. Bits tb29 - tb31 are discarded. Bits rb29 - rb60 are set to the same value as bits tb32 - tb63.

5.2. 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 10ms (see GSM 05.03). The RA1/RA1' function will add/subtract the 17 bit synchronisation pattern and the E1,E2 and E3 bits to/from each CCITT V.110 80 bit frame as follows:

Modified CCITT V.110 60 bit frame:

```
rb1,2,3...rb7
rb8.......rb14
rb15......rb21
rb22......rb28
rb29......rb35          = 60 bits/frame or 6 kbit/s
rb36......rb42
rb43......rb49
rb50......rb56
rb57......rb60
```

CCITT V.110 80 bit frame:

```
0 0 0 0 0 0 0 0
1 tb1,2,3...tb7
1 tb8.......tb14
1 tb15......tb21
1 tb22......tb28
1 tb29......tb35
1 tb36......tb42        = 80 bits/frame or 8 kbit/s
1 tb43......tb49
1 tb50......tb56
1 tb57......tb63
```

For modified CCITT V.110 60 bit frames received from the radio subsystem, the bits tb1 - tb28 are set to the same value as the bits rb1 - rb28. Bits tb29 - tb31 are set according to Figure 4. Bits tb32 - tb63 are set to the same value as rb29 - rb60.

For modified CCITT V.110 60 bit frames transmitted over the radio subsystem, the bits rb1 - rb28 are set to the same value as bits tb1 - tb28. Bits tb29 - tb31 are discarded. Bits rb29 - rb60 are set to the same value as bits tb32 - tb63.

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.

5.3. Radio Interface rate of 3.6 kbit/s

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). The RA1/RA1' function will add/subtract the 17 bit synchronisation pattern and the E1,E2 and E3 bits to/from each CCITT V.110 80 bit frame as follows:

Modified CCITT V.110 36 bit frame:

```
rb1,2,3...rb7
rb8.......rb14
rb15......rb21
rb22......rb28
rb29......rb35          = 36 bits/frame or 3.6 kbit/s
tb36......rb36
```

CCITT V.110 80 bit frame:

```
0 0 0 0 0 0 0 0
1 tb1,2,3...tb7
1 tb8.......tb14
1 tb15......tb21
1 tb22......tb28
1 tb29......tb35
1 tb36......tb42        = 80 bits/frame or 8 kbit/s
1 tb43......tb49
1 tb50......tb56
1 tb57......tb63
```

In this case, the mapping between the bits is as follows:

```
rb1  = tb1  = tb2
rb2  = tb3  = tb4
rb3  = tb5  = tb6
rb4  = tb7
rb5  = tb8  = tb9
rb6  = tb10 = tb11
rb7  = tb12 = tb13
rb8  = tb14
rb9  = tb15 = tb16
rb10 = tb17 = tb18
rb11 = tb19 = tb20
rb12 = tb21
rb13 = tb22 = tb23
rb14 = tb24 = tb25
rb15 = tb26 = tb27
tb16 = tb28
rb17 = tb32
rb18 = tb33
rb19 = tb34
rb20 = tb35
rb21 = tb36 = tb37
rb22 = tb38 = tb39
rb23 = tb40 = tb41
rb24 = tb42
rb25 = tb43 = tb44
rb26 = tb45 = tb46
rb27 = tb47 = tb48
rb28 = tb49
rb29 = tb50 = tb51
rb30 = tb52 = tb53
rb31 = tb54 = tb55
rb32 = tb56
rb33 = tb57 = tb58
rb34 = tb59 = tb60
rb35 = tb61 = tb62
rb36 = tb63
```

For modified CCITT V.110 36 bit frames transmitted by the radio subsystem, tb29 -tb31 are discarded. For modified CCITT V.110 36 bit frames received from the radio subsystem, tb29 - tb31 are set as shown in Figure 4.

Note: The action to be taken in the case where two bits which should have the same value (e.g. tb1 and tb2 or tb61 and tb62) are received with different values is for further study.

5.4. Synchronisation

Synchronisation shall be in accordance with CCITT specification V.110, section 2.1.3.1 "Search of frame synchronisation".

On loss of synchronisation, section 2.1.3.2 of V.110, "Frame synchronisation monitoring and recovery", shall apply. However, the use of SA, SB and X bits as in section 4 of V.110 has no relevance.

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

6. 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 or 12 kbit/s.

The modified CCITT V.110 36 or 60 bit frame structures for each of the user rates is shown in figures 5-9. The meaning of the bits is described in section 3.

7. SUPPORT OF NON-TRANSPARENT BEARER SERVICES

In the case of non-transparent services, the RA1' function provides access to the 12 and 6 kbit/s radio interface data rates. This access results in the use of a modified CCITT V.110 60 bit frame for non-transparent services (figure 10). In this case, the RA1' function also provides for alignment of four modified CCITT V.110 60 bit frames 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 10). The mapping is carried out as per section 5.

The first bit of each RLP frame to be transmitted will correspond to the first bit of the first 60 bit frame in a four frame sequence.

The radio subsystem provides for the synchronous transmission and reception of 240 bit RLP frames every 20 or 40 ms for full and half rate TChs respectively. 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 synchronisation to be maintained between the MS and the MSC.

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	E1	E2	E3	
600		1	0	0	Note
1200		0	1	0	
2400		1	1	0	
4800	9600	0	1	1	

Note: The 300 bit/s user data rate is carried on the 600 bit/s synchronous stream by adding stop elements, see section 2.1.

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

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				

Figure 7: Modified CCITT V.110 36 bit frame for 2.4 kbit/s transparent data

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				

Figure 8: Modified CCITT V.110 36 bit frame for 1.2 kbit/s transparent data

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 section 2.1.

Figure 9: Modified CCITT V.110 36 bit frame for 600 bit/s transparent data

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 10: Modified CCITT V.110 60 bit frame for non-transparent data

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