

ETSI TS 126 101 V9.0.0 (2010-01)

Technical Specification

**Digital cellular telecommunications system (Phase 2+);
Universal Mobile Telecommunications System (UMTS);
LTE;
Mandatory speech codec speech processing functions;
Adaptive Multi-Rate (AMR) speech codec frame structure
(3GPP TS 26.101 version 9.0.0 Release 9)**



Reference

RTS/TSGS-0426101v900

Keywords

GSM, LTE, UMTS

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Sous-Préfecture de Grasse (06) N° 7803/88

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1 Scope

The present document describes a generic frame format for the Adaptive Multi-Rate (AMR) speech codec and the Enhanced Full Rate (GSM-EFR) speech codec. This format shall be used as a common reference point when interfacing speech frames between different elements of the 3G system and between different systems. Appropriate mappings to and from this generic frame format will be used within and between each system element.

Annex A describes a second frame format which shall be used when octet alignment of AMR frames is required.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
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- [1] TS 26.090: "AMR Speech Codec; Speech Transcoding Functions".
- [2] TS 26.093: "AMR Speech Codec; Source Controlled Rate Operation".
- [3] TS 26.092: "AMR Speech Codec; Comfort Noise Aspects".
- [4] TS 46.060: "EFR Speech Codec; Speech Transcoding Functions".
- [5] TS 46.062: "EFR Speech Codec; Comfort Noise Aspects".

3 Definitions and Abbreviations

3.1 Definitions

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

AMR mode: one of the eight AMR codec bit-rates denoted also with indices 0 to 7 where 0 maps to the 4.75 kbit/s mode and 7 maps to the 12.2 kbit/s mode.

AMR codec mode: same as AMR mode.

RX_TYPE: classification of the received frame as defined in [2].

TX_TYPE: classification of the transmitted frame as defined in [2].

3.2 Abbreviations

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

| | |
|-----|--|
| CRC | Cyclic Redundancy Check |
| FQI | Frame Quality Indicator |
| GSM | Global System for Mobile communication |
| LSB | Least Significant Bit |

| | |
|------|--|
| MSB | Most Significant Bit |
| RX | Receive |
| PDC | Personal Digital Communication (ARIB standard) |
| SCR | Source Controlled Rate operation |
| SID | Silence Descriptor (Comfort Noise Frame) |
| TDMA | Time Division Multiple Access (IS-641) |
| TX | Transmit |

4 AMR codec frame format (AMR IF1)

This clause describes the generic frame format for both the speech and comfort noise frames of the AMR speech codec. This format is referred to as AMR Interface Format 1 (AMR IF1). Annex A describes AMR Interface Format 2 (AMR IF2).

Each AMR codec mode follows the generic frame structure depicted in figure 1. The frame is divided into three parts: AMR Header, AMR Auxiliary Information, and AMR Core Frame. The AMR Header part includes the Frame Type and the Frame Quality Indicator fields. The AMR auxiliary information part includes the Mode Indication, Mode Request, and Codec CRC fields. The AMR Core Frame part consists of the speech parameter bits or, in case of a comfort noise frame, the comfort noise parameter bits. In case of a comfort noise frame, the comfort noise parameters replace Class A bits of AMR Core Frame while Class B and C bits are omitted.

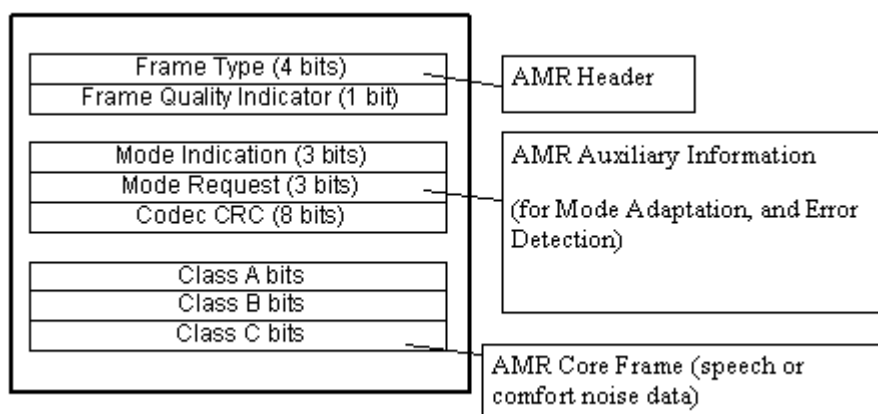


Figure 1: Generic AMR frame structure

4.1 AMR Header and AMR Auxiliary Information

This subclause describes the AMR Header of figure 1.

4.1.1 Frame Type, Mode Indication, and Mode Request

Table 1a defines the 4-bit Frame Type field. Frame Type can indicate the use of one of the eight AMR codec modes, one of four different comfort noise frames, or an empty frame. In addition, three Frame Type Indices are reserved for future use. The same table is reused for the Mode Indication and Mode Request fields which are 3-bit fields each and are defined only in the range 0...7 to specify one of the eight AMR codec modes.

Table 1a: Interpretation of Frame Type, Mode Indication and Mode Request fields

| Frame Type | Mode Indication | Mode Request | Frame content (AMR mode, comfort noise, or other) |
|------------|-----------------|--------------|---|
| 0 | 0 | 0 | AMR 4,75 kbit/s |
| 1 | 1 | 1 | AMR 5,15 kbit/s |
| 2 | 2 | 2 | AMR 5,90 kbit/s |
| 3 | 3 | 3 | AMR 6,70 kbit/s (PDC-EFR) |
| 4 | 4 | 4 | AMR 7,40 kbit/s (TDMA-EFR) |
| 5 | 5 | 5 | AMR 7,95 kbit/s |
| 6 | 6 | 6 | AMR 10,2 kbit/s |
| 7 | 7 | 7 | AMR 12,2 kbit/s (GSM-EFR) |
| 8 | - | - | AMR SID |
| 9 | - | - | GSM-EFR SID |
| 10 | - | - | TDMA-EFR SID |
| 11 | - | - | PDC-EFR SID |
| 12-14 | - | - | For future use |
| 15 | - | - | No Data (No transmission/No reception) |

4.1.2 Frame Quality Indicator

The content of the Frame Quality Indicator field is defined in Table 1b. The field length is one bit. The Frame Quality Indicator indicates whether the data in the frame contains errors.

Table 1b: Definition of Frame Quality Indicator

| Frame Quality Indicator (FQI) | Quality of data |
|-------------------------------|--|
| 0 | Bad frame or Corrupted frame (bits may be used to assist error concealment) |
| 1 | Good frame |

4.1.3 Mapping to TX_TYPE and RX_TYPE

Table 1c shows how the AMR Header data (FQI and Frame Type) maps to the TX_TYPE and RX_TYPE frames defined in [2].

Table 1c: Mapping of Frame Quality Indicator and Frame Type to TX_TYPE and RX_TYPE [2], respectively

| Frame Quality Indicator | Frame Type Index | TX_TYPE or RX_TYPE | Comment |
|-------------------------|------------------|----------------------------|---|
| 1 | 0-7 | SPEECH_GOOD | The specific Frame Type Index depends on the bit-rate being used. |
| 0 | 0-7 | SPEECH_BAD | The specific Frame Type Index depends on the bit-rate being used. The corrupted data may be used to assist error concealment. |
| 1 | 8 | SID_FIRST or SID_UPDATE | For AMR: SID_FIRST and SID_UPDATE are differentiated using one Class A bit: STI. |
| 0 | 8 | SID_BAD | For AMR |
| 1 | 9 | GSM-EFR SID | For GSM-EFR |
| 0 | 9 | GSM-EFR SID_BAD | For GSM-EFR |
| 1 | 10-11 | SID_UPDATE | For TDMA-EFR and PDC-EFR |
| 0 | 10-11 | SID_BAD | For TDMA-EFR and PDC-EFR |
| 1 | 15 | NO_DATA | Typically a non-transmitted frame or an erased or stolen frame with no data usable to assist error concealment. |

4.1.4 Codec CRC

Generic AMR codec frames with Frame Type 0.11 are associated with an 8-bit CRC for error-detection purposes. The Codec CRC field of AMR Auxiliary Information in figure 1 contains the value of this CRC. These eight parity bits are generated by the cyclic generator polynomial:

$$- G(x)=D^8 + D^6 + D^5 + D^4 + 1$$

which is computed over all Class A bits of AMR Core Frame. Class A bits for Frame Types 0.7 are defined in subclause 4.2.2 (for speech bits) and for Frame Types 8.11 in subclause 4.2.3 (for comfort noise bits).

When Frame Type Index of table 1a is 15 the CRC field is not included in the Generic AMR frame.

4.2 AMR Core Frame

This subclause contains the description of AMR Core Frame of figure 1. The descriptions for AMR Core Frame with speech bits and with comfort noise bit are given separately.

4.2.1 AMR Core Frame with speech bits: Bit ordering

This subclause describes how AMR Core Frame carries the coded speech data. The bits produced by the speech encoder are denoted as $\{s(1),s(2),\dots,s(K)\}$, where K refers to the number of bits produced by the speech encoder as shown in table 2. The notation $s(i)$ follows that of [1]. The speech encoder output bits are ordered according to their subjective importance. This bit ordering can be utilized for error protection purposes when the speech data is, for example, carried over a radio interface. Tables B.1 to B.8 in Annex B define the AMR IF1 bit ordering for all the eight AMR codec modes. In these tables the speech bits are numbered in the order they are produced by the corresponding speech encoder as described in the relevant tables of TS 26.090 [1]. The reordered bits are denoted below, in the order of decreasing importance, as $\{d(0),d(1),\dots,d(K-1)\}$.

The ordering algorithm is described in pseudo code as:

- for $j = 0$ to $K-1$
- $d(j) := s(\text{table}_m(j)+1)$;

where $\text{table}_m(j)$ refers to the relevant table in Annex B depending on the AMR mode $m=0..7$. The Annex B tables should be read line by line from left to right. The first element of the table has the index 0.

4.2.2 AMR Core Frame with speech bits: Class division

The reordered bits are further divided into three indicative classes according to their subjective importance. This class division is only informative and provides supporting information for mapping this generic format into specific formats. The three different importance classes can then be subject to different error protection in the network.

The importance classes are Class A, Class B, and Class C. Class A contains the bits most sensitive to errors and any error in these bits typically results in a corrupted speech frame which should not be decoded without applying appropriate error concealment. This class is protected by the Codec CRC in AMR Auxiliary Information. Classes B and C contain bits where increasing error rates gradually reduce the speech quality, but decoding of an erroneous speech frame is usually possible without annoying artefacts. Class B bits are more sensitive to errors than Class C bits. The importance ordering applies also within the three different classes and there are no significant step-wise changes in subjective importance between neighbouring bits at the class borders.

The number of speech bits in each class (Class A, Class B, and Class C) for each AMR mode is shown in table 2. The classification in table 2 and the importance ordering $d(j)$, together, are sufficient to assign all speech bits to their correct classes. For example, when the AMR codec mode is 4.75, then the Class A bits are $d(0)..d(41)$, Class B bits are $d(42)..d(94)$, and there are no Class C bits.

Table 2: Number of bits in Classes A, B, and C for each AMR codec mode

| Frame Type | AMR codec mode | Total number of bits | Class A | Class B | Class C |
|------------|----------------|----------------------|---------|---------|---------|
| 0 | 4,75 | 95 | 42 | 53 | 0 |
| 1 | 5,15 | 103 | 49 | 54 | 0 |
| 2 | 5,90 | 118 | 55 | 63 | 0 |
| 3 | 6,70 | 134 | 58 | 76 | 0 |
| 4 | 7,40 | 148 | 61 | 87 | 0 |
| 5 | 7,95 | 159 | 75 | 84 | 0 |
| 6 | 10,2 | 204 | 65 | 99 | 40 |
| 7 | 12,2 | 244 | 81 | 103 | 60 |

4.2.3 AMR Core Frame with comfort noise bits

The AMR Core Frame content for the additional frame type with Frame Type Index 8 in table 1a is described in this subclause. This consists of the frame related to Source Controlled Rate Operation specified in [2].

The data content (comfort noise bits) of the additional frame types is carried in AMR Core Frame. The comfort noise bits are all mapped to Class A of AMR Core Frame and Classes B and C are not used. This is a notation convention only and the class division has no meaning for comfort noise bits.

The number of bits in each class (Class A, Class B, and Class C) for the AMR comfort noise bits (Frame Type Index 8) is shown in table 3. The contents of SID_UPDATE and SID_FIRST are divided into three parts (SID Type Indicator (STI), Mode Indication ($mi(i)$), and Comfort Noise Parameters ($s(i)$) as defined in [2]. In case of SID_FIRST the Comfort Noise Parameters bits ($s(i)$) shall be set to '0'.

The comfort noise parameter bits produced by the AMR speech encoder are denoted as $s(i) = \{s(1), s(2), \dots, s(35)\}$. The notation $s(i)$ follows that of [3]. These bits are numbered in the order they are produced by the AMR encoder without any reordering. These bits are followed by the SID Type Indicator **STI** and the Mode Indication $mi(i) = \{mi(0), mi(1), mi(2)\} = \{LSB .. MSB\}$. Thus, the AMR SID or comfort noise bits $\{d(0), d(1), \dots, d(38)\}$ are formed as defined by the pseudo code below.

- for $j = 0$ to 34;
- $d(j) := s(j+1)$;
- $d(35) := \mathbf{STI}$;
- for $j = 36$ to 38;
- $d(j) := mi(j-36)$. Note: This mapping is different to the usual mapping: LSB first.

Note: The alternative would be: $d(j) := mi(38-j)$: MSB first.

Table 3. Bit classification for Frame Type 8 (AMR SID)

| Frame Type Index | FQI | AMR TX_TYPE or RX_TYPE | Total number of bits | Class A | | | Class B | Class C |
|------------------|-----|------------------------|----------------------|--------------------------|-----------------------|-----------------------------|---------|---------|
| | | | | SID Type Indicator (STI) | Mode Indication mi(i) | Comfort Noise Parameters(i) | | |
| 8 | 1 | SID_UPDATE | 39 | 1 (= "1") | 3 | 35 | 0 | 0 |
| 8 | 1 | SID_FIRST | 39 | 1 (= "0") | 3 | 35 (= "0") | 0 | 0 |
| 8 | 0 | SID_BAD | 39 | 1 | 3 | 35 | 0 | 0 |

The number of bits in each class (Class A, Class B, and Class C) for the comfort noise bits of Frame Types 9-11 is shown in Table 7.

Table 4: void

4.3 AMR frame composition

The generic AMR frame is formed as a concatenation of AMR Header, AMR Auxiliary Information and the AMR Core Frame, in this order. The MSB of the Frame Type is placed in bit 8 of the first octet (see example in table 5 below), the LSB of the Frame Type is placed in bit 5. Then the next parameter follows, which is the Frame Quality Indicator, and so on. Between Mode Request and Codec CRC five spare bits are inserted to align the Codec CRC and the AMR Core frame to the octet boundary. The first bit of the AMR Core frame $d(0)$ is placed in bit 8 of octet 4. The last bit of the generic AMR frame is the last bit of AMR Core Frame, which is the last bit of speech bits or the last bit of comfort noise bits, as defined in subclauses 4.2.1 and 4.2.3. Table 5 shows the composition for the example of the Codec Mode 6.7kbit/s and table 6 shows the composition for the AMR SID frame.

Table 5: Mapping of an AMR speech coding mode into the generic AMR frame, AMR IF1, example: AMR 6.7 kbit/s, "good frame", Mode Request = 1.

| Octet | Mapping of bits AMR 6.7 | | | | | | | LSB bit 1 |
|-------|---------------------------|----------|----------|----------|----------|----------------------|-----------|-----------|
| | MSB bit 8 | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | |
| 1 | Frame Type (=3) | | | FQI | | Mode Indication (=3) | | |
| | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 2 | Mode Request (=1) | | | spare | | | | |
| | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | Codec CRC | | | | | | | |
| | CRC(7) | CRC(6) | CRC(5) | CRC(4) | CRC(3) | CRC(2) | CRC(1) | CRC(0) |
| 4 | AMR Core Frame (octet 1) | | | | | | | |
| | $d(0)$ | $d(1)$ | $d(2)$ | $d(3)$ | $d(4)$ | $d(5)$ | $d(6)$ | $d(7)$ |
| 5..19 | | | | | | | | |
| 20 | AMR Core Frame (octet 17) | | | | | | undefined | |
| | $d(128)$ | $d(129)$ | $d(130)$ | $d(131)$ | $d(132)$ | $d(133)$ | | |

Table 6: Mapping of an AMR SID frame into the generic AMR frame, AMR IF1, example: AMR SID_Update, "good frame", Mode Indication = 3, Mode Request = 2.

| Octet | Mapping of bits AMR SID | | | | | | | LSB bit 1 |
|-------|----------------------------|-----------|------------------|--------|----------------------|-----------------|----------|--------------|
| | MSB bit 8 | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | |
| 1 | Frame Type (=8) | | | | FQI | Mode Indication | | |
| | 1 | 0 | 0 | 0 | 1 | undefined | | |
| 2 | Mode Request (=2) | | | spare | | | | |
| | MSB 0 | ... | LSB 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Codec CRC | | | | | | | |
| | CRC(7) | CRC(6) | CRC(5) | CRC(4) | CRC(3) | CRC(2) | CRC(1) | CRC(0) |
| 4 | AMR Core Frame (octet 1) | | | | | | | |
| | d(0)=s(1) | d(1)=s(2) | d(2) | d(3) | d(4) | d(5) | d(6) | d(7) |
| 5..7 | | | | | | | | |
| 8 | | | | STI | Mode Indication (=3) | | | undef. |
| | d(32) | d(33) | d(34) = s(35) | 1 | LSB 1 | ... | MSB 0 | |

Table 7 summarizes all possible AMR frame format combinations in terms of number of bits in each field.

Table 7. Number of bits for different fields in different AMR frame compositions

| Frame Type Index | Frame Type | Frame Quality Indicator | Mode Indication | Mode Request | Codec CRC | Class A | Class B | Class C | Total |
|------------------|------------|-------------------------|-----------------|--------------|-----------|----------------|---------|---------|-------|
| | | | | | | AMR Core Frame | | | |
| 0 | 4 | 1 | 3 | 3 | 8 | 42 | 53 | 0 | 114 |
| 1 | 4 | 1 | 3 | 3 | 8 | 49 | 54 | 0 | 122 |
| 2 | 4 | 1 | 3 | 3 | 8 | 55 | 63 | 0 | 137 |
| 3 | 4 | 1 | 3 | 3 | 8 | 58 | 76 | 0 | 153 |
| 4 | 4 | 1 | 3 | 3 | 8 | 61 | 87 | 0 | 167 |
| 5 | 4 | 1 | 3 | 3 | 8 | 75 | 84 | 0 | 178 |
| 6 | 4 | 1 | 3 | 3 | 8 | 65 | 99 | 40 | 223 |
| 7 | 4 | 1 | 3 | 3 | 8 | 81 | 103 | 60 | 263 |
| 8 | 4 | 1 | 3 | 3 | 8 | 39 | 0 | 0 | 58 |
| 9 | 4 | 1 | 3 | 3 | 8 | 43 | 0 | 0 | 62 |
| 10 | 4 | 1 | 3 | 3 | 8 | 38 | 0 | 0 | 57 |
| 11 | 4 | 1 | 3 | 3 | 8 | 37 | 0 | 0 | 56 |
| 12 | Not used | | | | | | | | |
| 13 | Not used | | | | | | | | |
| 14 | Not used | | | | | | | | |
| 15 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |

4.4 GSM-EFR Frame Composition

This subclause contains the description of the generic GSM-EFR Frame of Figure 1. The descriptions for the generic GSM-EFR Frame with speech bits and with comfort noise bit are given separately.

4.4.1 GSM-EFR Frame with speech bits

The generic GSM-EFR frame for speech data bits is formed like for the AMR mode 12.2 kbit/s. The same Frame Type (Frame Type 7) is used also for GSM-EFR. The Mode Indication and Mode Request fields are set to '7'. The GSM-EFR Core Frame for speech data bits is identical to the AMR Core Frame for speech data bits in the AMR mode with 12.2 kbit/s.

4.4.2 GSM-EFR Frame with comfort noise bits

The GSM-EFR Frame content for the additional frame type with Frame Type Index 9 in Table 1a are described in this subclause. This consists of the frame related to GSM-EFR Comfort Noise Aspects as specified in [4] and [5].

The comfort noise bits are all mapped to Class A. Classes B and C are not used (see Table 7).

The contents of GSM-EFR SID is the Comfort Noise Parameters ($s(i)$) as defined in [4]. The Comfort noise parameters are computed as described in [5] by the GSM-EFR speech encoder and are denoted as $s(i) = \{s(1),s(2),\dots,s(38),s(87),s(88),\dots,s(91)\}$. The notation $s(i)$ follows that of [4] (Table 6). The notation $d(j) = \{d(0) \dots d(42)\}$ is local to the present document and is formed as defined by the pseudo code below.

```

for j = 0 to 37
    d(j) := s(j+1); /* LSP parameters in s(1) to s(38) */;

for j = 38 to 42
    d(j) := s(j+49); /* fixed codebook gain parameter in s(87)-s(91) */
    
```

Table 8 shows the composition for the generic GSM-EFR SID frame.

Table 8: Mapping of the GSM-EFR SID frame into the generic AMR frame format, AMR IF1, Example of a good GSM-EFR SID frame (FQI=1).

| Octet | Mapping of bits for GSM-EFR SID | | | | | | | LSB bit 1 |
|-------|---------------------------------|-------------|-------------|--------|----------------------|-------------|-------------|--------------|
| | MSB bit 8 | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | |
| 1 | Frame Type (=9) | | | FQI | Mode Indication (=7) | | | |
| | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 2 | Mode Request (=7) | | | spare | | | | |
| | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | Codec CRC | | | | | | | |
| | CRC(7) | CRC(6) | CRC(5) | CRC(4) | CRC(3) | CRC(2) | CRC(1) | CRC(0) |
| 4 | Core Frame (octet 1) | | | | | | | |
| | d(0)=s(1) | d(1)=s(2) | d(2) | d(3) | d(4) | d(5) | d(6) | d(7) |
| 5..7 | | | | | | | | |
| 8 | | | | | | | | |
| | d(32) | d(33) | d(34) | d(35) | d(36)=s(37) | d(37)=s(38) | d(38)=s(87) | d(39)=s(88) |
| 9 | spare | | | | | | | |
| | d(40)=s(89) | d(41)=s(90) | d(42)=s(91) | 0 | 0 | 0 | 0 | 0 |

Annex A (informative): AMR Interface Format 2 (with octet alignment)

This annex defines an octet-aligned frame format for the AMR codec. This format is useful, for example, when the AMR codec is used in connection with applicable ITU-T H-series of recommendations. The format is referred to as AMR Interface Format 2 (AMR IF2).

The AMR IF2 frame is formed by concatenation of the 4-bit Frame Type field (as defined for AMR IF1 in subclause 4.1.1) and the AMR Core Frame (as defined for AMR IF1 in subclause 4.2) as shown in figure A.1. The length of the AMR Core Frame field depends on the particular Frame Type. The total number of bits in the AMR IF2 speech frames in the different modes is typically not a multiple of eight and bit stuffing is needed to achieve an octet structure.

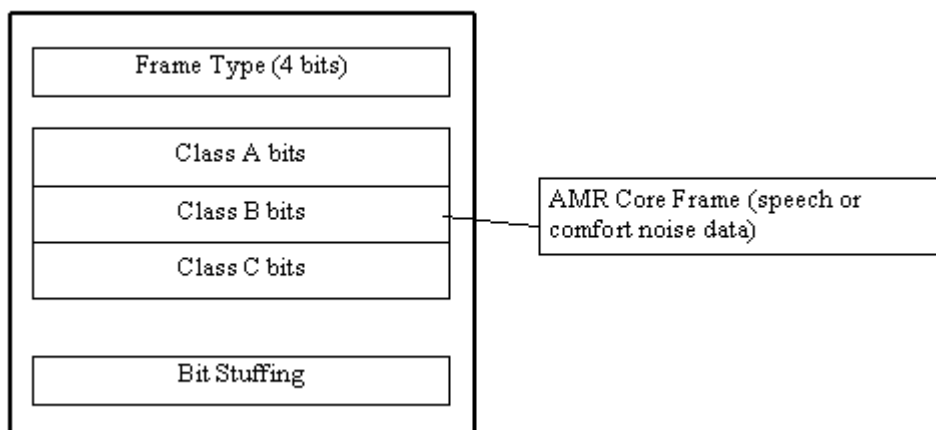


Figure A.1: Frame structure for AMR IF2

Table A.1a shows an example how the AMR 6.7 kbit/s mode is mapped into AMR IF2. The four LSBs of the first octet (octet 1) consist of the Frame Type(=3) for the AMR 6.7 kbit/s mode (see table 1a in AMR IF1 specification). This data field is followed by the 134 AMR Core Frame speech bits ($d(0) \dots d(133)$) which consist of 58 Class A bits and 76 Class B bits as described in table 2 for AMR IF1. This results in a total of 138 bits and 6 bits are needed for Bit Stuffing to arrive to the closest multiple of 8 which is 144 bits.

Table A.1a: Example mapping of the AMR speech coding mode 6.7kbit/s into AMR IF2. The bits used for Bit Stuffing are denoted as UB (for "unused bit").

| Octet | Mapping of bits AMR 6.7 | | | | | | | MSB | LSB |
|-------|----------------------------|-------|-------|-------|------------------|-------|--------|--------|-----|
| | bit 8 | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | |
| 1 | d(3) | d(2) | d(1) | d(0) | Frame Type (= 3) | | | 1 | |
| | | | | | MSB LSB | | | | |
| 2 | d(11) | d(10) | d(9) | d(8) | d(7) | d(6) | d(5) | d(4) | |
| 3 | ... | ... | ... | ... | ... | ... | ... | d(12) | |
| 18 | Stuffing bits | | | | | | d(133) | d(132) | |
| | UB | UB | UB | UB | UB | UB | d(133) | d(132) | |

Table A.1b shows the composition of AMR IF2 frames for all Frame Types in terms of how many bits are used for each field of figure A.1.

Tables A.2 to A.5 specify how the AMR Core Frame comfort noise bits of Frame Types 8-11 are mapped to AMR IF2. Table A.6 specifies the mapping for an empty frame ("no transmission").

Table A.1b: Composition of AMR IF2 Frames for all Frame Types.

| Frame Type Index | Frame content | Number of bits in Frame Type | Number of Bits in AMR Core Frame | Number of Bits in Bit Stuffing | Number of octets (N) |
|------------------|----------------|------------------------------|----------------------------------|--------------------------------|----------------------|
| 0 | AMR 4,75 | 4 | 95 | 5 | 13 |
| 1 | AMR 5,15 | 4 | 103 | 5 | 14 |
| 2 | AMR 5,90 | 4 | 118 | 6 | 16 |
| 3 | AMR 6,70 | 4 | 134 | 6 | 18 |
| 4 | AMR 7,40 | 4 | 148 | 0 | 19 |
| 5 | AMR 7,95 | 4 | 159 | 5 | 21 |
| 6 | AMR 10,2 | 4 | 204 | 0 | 26 |
| 7 | AMR 12,2 | 4 | 244 | 0 | 31 |
| 8 | AMR SID | 4 | 39 | 5 | 6 |
| 9 | GSM-EFR SID | 4 | 43 | 1 | 6 |
| 10 | TDMA-EFR SID | 4 | 38 | 6 | 6 |
| 11 | PDC-EFR SID | 4 | 37 | 7 | 6 |
| 12-14 | For future use | - | - | - | - |
| 15 | No Data | 4 | 0 | 4 | 1 |

**Table A.2: Mapping of bits for Frame Type 8 (AMR SID)
(Bits s1 to s35 refer to TS 26.092)**

| Octet | MSB | Mapping of bits AMR SID | | | | | | LSB |
|-------|--|--|-------|-------|------------------|-----------------|--------------|--|
| | bit 8 | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 |
| 1 | Index of 1 st LSF subvector | index of LSF reference vector | | | Frame Type (= 8) | | | |
| | s4 | s3 | s2 | s1 | MSB 1 | 0 | LSB 0 | 0 |
| 2 | Index of 2 nd LSF subvector | index of 1 st LSF subvector | | | | | | |
| | s12 | s11 | s10 | s9 | s8 | s7 | s6 | s5 |
| 3 | index of 2 nd LSF subvector | | | | | | | |
| | s20 | s19 | s18 | s17 | s16 | s15 | s14 | s13 |
| 4 | index of 3 rd LSF subvector | | | | | | | |
| | s28 | s27 | s26 | s25 | s24 | s23 | s22 | s21 |
| 5 | SID Type Indicator | frame energy | | | | | | index of 3 rd LSF subvector |
| | t1 | s35 | s34 | s33 | s32 | s31 | s30 | s29 |
| 6 | Stuffing bits | | | | | Mode Indication | | |
| | UB | UB | UB | UB | UB | MSB mi(2) | LSB mi(1) | mi(0) |

Definitions of additional descriptor bits needed for the silence descriptor in the table are as follows: SID-type Indicator STI is {0=SID_FIRST, 1=SID_UPDATE }, Mode Indication (mi(0)- mi(2)) is the AMR codec mode according to the first eight entries in table 1a.

Table A.3: Mapping of bits for Frame Type 9 (GSM-EFR SID)
 (Bits s1 to s91 refer to GSM 46.060)

| | MSB | Mapping of bits GSM-EFR SID | | | | | | LSB |
|-------|--|--------------------------------|-------|-------|---|--|---|-------|
| Octet | bit 8 | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 |
| 1 | Index of 1 st LSF subMatrix | | | | Frame Type (= 9) | | | |
| | s4 | s3 | s2 | s1 | 1 | 0 | 0 | 1 |
| 2 | Index of 2 nd LSF submatrix | | | | index of 1 st LSF subMatrix | | | |
| | s12 | s11 | s10 | s9 | s8 | s7 | s6 | s5 |
| 3 | Index of 3 rd LSF submatrix | | | | Index of 2 nd LSF submatrix | | | |
| | s20 | s19 | s18 | s17 | s16 | s15 | s14 | s13 |
| 4 | index of 4 th LSF submatrix | | | | sign of 3 rd LSF submatrix | index of 3 rd LSF submatrix | | |
| | s28 | s27 | s26 | s25 | s24 | s23 | s22 | s21 |
| 5 | index of 5 th LSF submatrix | | | | index of 4 th LSF submatrix | | | |
| | s36 | s35 | s34 | s33 | s32 | s31 | s30 | s29 |
| 6 | Stuffing bit | fixed codebook gain | | | | | index of 5 th LSF submatrix | |
| | UB | s91 | s90 | s89 | s88 | s87 | s38 | s37 |

Table A.4: Mapping of bits for Frame Type 10 (TDMA-EFR SID)
 (Bits cn0 to cn37 refer to IS-641-A)

| | MSB | Mapping of bits TDMA-EFR SID | | | | | | LSB |
|-------|--|---------------------------------|--|--|--|-------|--|-------|
| Octet | bit 8 | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 |
| 1 | Index of 1 st LSF subvector | | | | Frame Type (= 10) | | | |
| | cn3 | cn2 | cn1 | cn0 | 1 | 0 | 1 | 0 |
| 2 | Index of 2 nd LSF subvector | | | | index of 1 st LSF subvector | | | |
| | cn11 | Cn10 | cn9 | cn8 | cn7 | cn6 | cn5 | cn4 |
| 3 | Index of 3 rd LSF subvector | | | Index of 2 nd LSF subvector | | | | |
| | cn19 | cn18 | cn17 | cn16 | cn15 | cn14 | cn13 | cn12 |
| 4 | Random Excitation Gain | | index of 3 rd LSF subvector | | | | | |
| | cn27 | cn26 | cn25 | cn24 | cn23 | cn22 | cn21 | cn20 |
| 5 | Index of 1 st RESC parameter | | Random Excitation Gain | | | | | |
| | cn35 | cn34 | cn33 | cn32 | cn31 | cn30 | cn29 | cn28 |
| 6 | Stuffing bits | | | | | | Index of 2 nd RESC parameter | |
| | UB | UB | UB | UB | UB | UB | cn37 | cn36 |

Table A.5: Mapping of bits for Frame Type 11 (PDC-EFR SID)
(Bits s1 to s35 refer to ARIB xx)

| | MSB | Mapping of bits PDC-EFR SID | | | | | | LSB |
|-------|--|--|-------|-------|-------------------|-------|-------|--|
| Octet | bit 8 | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 |
| 1 | index of 1 st LSF subvector | index of LSF reference vector | | | Frame Type (= 11) | | | |
| | s4 | s3 | s2 | s1 | 1 | 0 | 1 | 1 |
| 2 | index of 2 nd LSF subvector | index of 1 st LSF subvector | | | | | | |
| | s12 | s11 | s10 | s9 | s8 | s7 | s6 | s5 |
| 3 | index of 2 nd LSF subvector | | | | | | | |
| | s20 | s19 | s18 | s17 | s16 | s15 | s14 | s13 |
| 4 | index of 3 rd LSF subvector | | | | | | | |
| | s28 | s27 | s26 | s25 | s24 | s23 | s22 | s21 |
| 5 | SID type | frame energy | | | | | | Index of 3 rd LSF subvector |
| | t1 | s35 | s34 | s33 | s32 | s31 | s30 | s29 |
| 6 | Stuffing bits | | | | | | | SID type |
| | UB | UB | UB | UB | UB | UB | UB | t2 |

Definition of additional descriptor bits needed for the table is as follows: SID-type is {0=POST0, 1=POST1(SID_UPDATE), 2=PRE, 3=POST1_BAD }, where LSB of SID_type is t1 and MSB of SID-type is t2.

Table A.6: Mapping of bit for Frame Type 15 (No Data)

| | MSB | Mapping of Bits No Data | | | | | | LSB |
|-------|---------------|----------------------------|-------|-------|-------------------|-------|-------|-------|
| Octet | bit 8 | bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 |
| 1 | Stuffing bits | | | | Frame Type (= 15) | | | |
| | UB | UB | UB | UB | 1 | 1 | 1 | 1 |

Annex B (normative): Tables for AMR Core Frame bit ordering

This annex contains the tables required for ordering the AMR Core Frame speech bits corresponding to the different AMR modes. These tables represent $table_m(j)$ in subclause 4.2.1 where $m=0..7$ is the AMR mode. The tables are read from left to right so that the first element (top left corner) of the table has index 0 and the last element (the rightmost element of the last row) has the index $K-1$ where K is the total number of speech bits in the specific mode. For example, $table_0(20)=27$, as defined in table B.1.

Table B.1: Ordering of the speech encoder bits for the 4.75 kbit/s mode: $table_0(j)$

| j=0 | j=1 | j=2 | ... | ... | ... | ... | ... | ... | ... |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 23 | 24 | 25 | 26 |
| 27 | 28 | 48 | 49 | 61 | 62 | 82 | 83 | 47 | 46 |
| 45 | 44 | 81 | 80 | 79 | 78 | 17 | 18 | 20 | 22 |
| 77 | 76 | 75 | 74 | 29 | 30 | 43 | 42 | 41 | 40 |
| 38 | 39 | 16 | 19 | 21 | 50 | 51 | 59 | 60 | 63 |
| 64 | 72 | 73 | 84 | 85 | 93 | 94 | 32 | 33 | 35 |
| 36 | 53 | 54 | 56 | 57 | 66 | 67 | 69 | 70 | 87 |
| 88 | 90 | 91 | 34 | 55 | 68 | 89 | 37 | 58 | 71 |
| 92 | 31 | 52 | 65 | 86 | | | | | |

Table B.2: Ordering of the speech encoder bits for the 5.15 kbit/s mode: $table_1(j)$

| | | | | | | | | | |
|----|----|----|-----|-----|-----|----|----|----|----|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 15 | 14 |
| 13 | 12 | 11 | 10 | 9 | 8 | 23 | 24 | 25 | 26 |
| 27 | 46 | 65 | 84 | 45 | 44 | 43 | 64 | 63 | 62 |
| 83 | 82 | 81 | 102 | 101 | 100 | 42 | 61 | 80 | 99 |
| 28 | 47 | 66 | 85 | 18 | 41 | 60 | 79 | 98 | 29 |
| 48 | 67 | 17 | 20 | 22 | 40 | 59 | 78 | 97 | 21 |
| 30 | 49 | 68 | 86 | 19 | 16 | 87 | 39 | 38 | 58 |
| 57 | 77 | 35 | 54 | 73 | 92 | 76 | 96 | 95 | 36 |
| 55 | 74 | 93 | 32 | 51 | 33 | 52 | 70 | 71 | 89 |
| 90 | 31 | 50 | 69 | 88 | 37 | 56 | 75 | 94 | 34 |
| 53 | 72 | 91 | | | | | | | |

Table B.3: Ordering of the speech encoder bits for the 5.9 kbit/s mode: $table_2(j)$

| | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|----|-----|-----|-----|
| 0 | 1 | 4 | 5 | 3 | 6 | 7 | 2 | 13 | 15 |
| 8 | 9 | 11 | 12 | 14 | 10 | 16 | 28 | 74 | 29 |
| 75 | 27 | 73 | 26 | 72 | 30 | 76 | 51 | 97 | 50 |
| 71 | 96 | 117 | 31 | 77 | 52 | 98 | 49 | 70 | 95 |
| 116 | 53 | 99 | 32 | 78 | 33 | 79 | 48 | 69 | 94 |
| 115 | 47 | 68 | 93 | 114 | 46 | 67 | 92 | 113 | 19 |
| 21 | 23 | 22 | 18 | 17 | 20 | 24 | 111 | 43 | 89 |
| 110 | 64 | 65 | 44 | 90 | 25 | 45 | 66 | 91 | 112 |
| 54 | 100 | 40 | 61 | 86 | 107 | 39 | 60 | 85 | 106 |
| 36 | 57 | 82 | 103 | 35 | 56 | 81 | 102 | 34 | 55 |
| 80 | 101 | 42 | 63 | 88 | 109 | 41 | 62 | 87 | 108 |
| 38 | 59 | 84 | 105 | 37 | 58 | 83 | 104 | | |

Table B.4: Ordering of the speech encoder bits for the 6.7 kbit/s mode: $table_3(j)$

| | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 1 | 4 | 3 | 5 | 6 | 13 | 7 | 2 | 8 |
| 9 | 11 | 15 | 12 | 14 | 10 | 28 | 82 | 29 | 83 |
| 27 | 81 | 26 | 80 | 30 | 84 | 16 | 55 | 109 | 56 |
| 110 | 31 | 85 | 57 | 111 | 48 | 73 | 102 | 127 | 32 |
| 86 | 51 | 76 | 105 | 130 | 52 | 77 | 106 | 131 | 58 |
| 112 | 33 | 87 | 19 | 23 | 53 | 78 | 107 | 132 | 21 |
| 22 | 18 | 17 | 20 | 24 | 25 | 50 | 75 | 104 | 129 |
| 47 | 72 | 101 | 126 | 54 | 79 | 108 | 133 | 46 | 71 |
| 100 | 125 | 128 | 103 | 74 | 49 | 45 | 70 | 99 | 124 |
| 42 | 67 | 96 | 121 | 39 | 64 | 93 | 118 | 38 | 63 |
| 92 | 117 | 35 | 60 | 89 | 114 | 34 | 59 | 88 | 113 |
| 44 | 69 | 98 | 123 | 43 | 68 | 97 | 122 | 41 | 66 |
| 95 | 120 | 40 | 65 | 94 | 119 | 37 | 62 | 91 | 116 |
| 36 | 61 | 90 | 115 | | | | | | |

Table B.5: Ordering of the speech encoder bits for the 7.4 kbit/s mode: $table_4(j)$

| | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 26 | 87 | 27 |
| 88 | 28 | 89 | 29 | 90 | 30 | 91 | 51 | 80 | 112 |
| 141 | 52 | 81 | 113 | 142 | 54 | 83 | 115 | 144 | 55 |
| 84 | 116 | 145 | 58 | 119 | 59 | 120 | 21 | 22 | 23 |
| 17 | 18 | 19 | 31 | 60 | 92 | 121 | 56 | 85 | 117 |
| 146 | 20 | 24 | 25 | 50 | 79 | 111 | 140 | 57 | 86 |
| 118 | 147 | 49 | 78 | 110 | 139 | 48 | 77 | 53 | 82 |
| 114 | 143 | 109 | 138 | 47 | 76 | 108 | 137 | 32 | 33 |
| 61 | 62 | 93 | 94 | 122 | 123 | 41 | 42 | 43 | 44 |
| 45 | 46 | 70 | 71 | 72 | 73 | 74 | 75 | 102 | 103 |
| 104 | 105 | 106 | 107 | 131 | 132 | 133 | 134 | 135 | 136 |
| 34 | 63 | 95 | 124 | 35 | 64 | 96 | 125 | 36 | 65 |
| 97 | 126 | 37 | 66 | 98 | 127 | 38 | 67 | 99 | 128 |
| 39 | 68 | 100 | 129 | 40 | 69 | 101 | 130 | | |

Table B.6: Ordering of the speech encoder bits for the 7.95 kbit/s mode: $table_5(j)$

| | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 14 | 16 | 9 |
| 10 | 12 | 13 | 15 | 11 | 17 | 20 | 22 | 24 | 23 |
| 19 | 18 | 21 | 56 | 88 | 122 | 154 | 57 | 89 | 123 |
| 155 | 58 | 90 | 124 | 156 | 52 | 84 | 118 | 150 | 53 |
| 85 | 119 | 151 | 27 | 93 | 28 | 94 | 29 | 95 | 30 |
| 96 | 31 | 97 | 61 | 127 | 62 | 128 | 63 | 129 | 59 |
| 91 | 125 | 157 | 32 | 98 | 64 | 130 | 1 | 0 | 25 |
| 26 | 33 | 99 | 34 | 100 | 65 | 131 | 66 | 132 | 54 |
| 86 | 120 | 152 | 60 | 92 | 126 | 158 | 55 | 87 | 121 |
| 153 | 117 | 116 | 115 | 46 | 78 | 112 | 144 | 43 | 75 |
| 109 | 141 | 40 | 72 | 106 | 138 | 36 | 68 | 102 | 134 |
| 114 | 149 | 148 | 147 | 146 | 83 | 82 | 81 | 80 | 51 |
| 50 | 49 | 48 | 47 | 45 | 44 | 42 | 39 | 35 | 79 |
| 77 | 76 | 74 | 71 | 67 | 113 | 111 | 110 | 108 | 105 |
| 101 | 145 | 143 | 142 | 140 | 137 | 133 | 41 | 73 | 107 |
| 139 | 37 | 69 | 103 | 135 | 38 | 70 | 104 | 136 | |

Table B.7: Ordering of the speech encoder bits for the 10.2 kbit/s mode: $table_6(j)$

| | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 16 | 15 |
| 14 | 13 | 12 | 11 | 10 | 9 | 8 | 26 | 27 | 28 |
| 29 | 30 | 31 | 115 | 116 | 117 | 118 | 119 | 120 | 72 |
| 73 | 161 | 162 | 65 | 68 | 69 | 108 | 111 | 112 | 154 |
| 157 | 158 | 197 | 200 | 201 | 32 | 33 | 121 | 122 | 74 |
| 75 | 163 | 164 | 66 | 109 | 155 | 198 | 19 | 23 | 21 |
| 22 | 18 | 17 | 20 | 24 | 25 | 37 | 36 | 35 | 34 |
| 80 | 79 | 78 | 77 | 126 | 125 | 124 | 123 | 169 | 168 |
| 167 | 166 | 70 | 67 | 71 | 113 | 110 | 114 | 159 | 156 |
| 160 | 202 | 199 | 203 | 76 | 165 | 81 | 82 | 92 | 91 |
| 93 | 83 | 95 | 85 | 84 | 94 | 101 | 102 | 96 | 104 |
| 86 | 103 | 87 | 97 | 127 | 128 | 138 | 137 | 139 | 129 |
| 141 | 131 | 130 | 140 | 147 | 148 | 142 | 150 | 132 | 149 |
| 133 | 143 | 170 | 171 | 181 | 180 | 182 | 172 | 184 | 174 |
| 173 | 183 | 190 | 191 | 185 | 193 | 175 | 192 | 176 | 186 |
| 38 | 39 | 49 | 48 | 50 | 40 | 52 | 42 | 41 | 51 |
| 58 | 59 | 53 | 61 | 43 | 60 | 44 | 54 | 194 | 179 |
| 189 | 196 | 177 | 195 | 178 | 187 | 188 | 151 | 136 | 146 |
| 153 | 134 | 152 | 135 | 144 | 145 | 105 | 90 | 100 | 107 |
| 88 | 106 | 89 | 98 | 99 | 62 | 47 | 57 | 64 | 45 |
| 63 | 46 | 55 | 56 | | | | | | |

Table B.8: Ordering of the speech encoder bits for the 12.2 kbit/s mode: $table_7(j)$

| | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 23 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 24 | 25 | 26 | 27 | 28 | 38 |
| 141 | 39 | 142 | 40 | 143 | 41 | 144 | 42 | 145 | 43 |
| 146 | 44 | 147 | 45 | 148 | 46 | 149 | 47 | 97 | 150 |
| 200 | 48 | 98 | 151 | 201 | 49 | 99 | 152 | 202 | 86 |
| 136 | 189 | 239 | 87 | 137 | 190 | 240 | 88 | 138 | 191 |
| 241 | 91 | 194 | 92 | 195 | 93 | 196 | 94 | 197 | 95 |
| 198 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 50 | 100 |
| 153 | 203 | 89 | 139 | 192 | 242 | 51 | 101 | 154 | 204 |
| 55 | 105 | 158 | 208 | 90 | 140 | 193 | 243 | 59 | 109 |
| 162 | 212 | 63 | 113 | 166 | 216 | 67 | 117 | 170 | 220 |
| 36 | 37 | 54 | 53 | 52 | 58 | 57 | 56 | 62 | 61 |
| 60 | 66 | 65 | 64 | 70 | 69 | 68 | 104 | 103 | 102 |
| 108 | 107 | 106 | 112 | 111 | 110 | 116 | 115 | 114 | 120 |
| 119 | 118 | 157 | 156 | 155 | 161 | 160 | 159 | 165 | 164 |
| 163 | 169 | 168 | 167 | 173 | 172 | 171 | 207 | 206 | 205 |
| 211 | 210 | 209 | 215 | 214 | 213 | 219 | 218 | 217 | 223 |
| 222 | 221 | 73 | 72 | 71 | 76 | 75 | 74 | 79 | 78 |
| 77 | 82 | 81 | 80 | 85 | 84 | 83 | 123 | 122 | 121 |
| 126 | 125 | 124 | 129 | 128 | 127 | 132 | 131 | 130 | 135 |
| 134 | 133 | 176 | 175 | 174 | 179 | 178 | 177 | 182 | 181 |
| 180 | 185 | 184 | 183 | 188 | 187 | 186 | 226 | 225 | 224 |
| 229 | 228 | 227 | 232 | 231 | 230 | 235 | 234 | 233 | 238 |
| 237 | 236 | 96 | 199 | | | | | | |

Annex C (informative): Change history

| Change history | | | | | | | |
|----------------|---------|-----------|-----|-----|---|-------|-------|
| Date | TSG SA# | TSG Doc. | CR | Rev | Subject/Comment | Old | New |
| 1999-12 | 6 | SP-990562 | | | Approved at TSG-SA#6 Plenary | | 3.0.0 |
| 2000-03 | 7 | SP-000025 | 001 | | Correction of indices in Annex B table | 3.0.0 | 3.1.0 |
| 2000-03 | 7 | SP-000025 | 002 | | Addition of comfort noise bit ordering | 3.0.0 | 3.1.0 |
| 2000-03 | 7 | SP-000025 | 003 | | Correction of table indexing for AMR Core Frame class division | 3.0.0 | 3.1.0 |
| 2000-03 | 7 | SP-000025 | 004 | | Clarification of bit transmission order for AMR frame structure parameters for AMR Interface Format 1 (AMR IF1) | 3.0.0 | 3.1.0 |
| 2001-03 | 11 | | | | Version for Release 4 | | 4.0.0 |
| 2001-06 | 12 | SP-010305 | 006 | | Correction to SID Frame Mapping | 4.0.0 | 4.1.0 |
| 2002-03 | 15 | SP-020077 | 008 | | Correction of AMR codec output bitstream | 4.1.0 | 4.2.0 |
| 2002-06 | 16 | | | | Version for Release 5 | 4.2.0 | 5.0.0 |
| | | | | | | | |
| 2004-09 | 25 | SP-040644 | 009 | 2 | Generic Frame Structure for GSM-EFR SID | 5.0.0 | 6.0.0 |
| 2004-09 | 25 | SP-040644 | 010 | 1 | Error Corrections | 5.0.0 | 6.0.0 |
| 2007-06 | 36 | | | | Version for Release 7 | 6.0.0 | 7.0.0 |
| 2008-12 | 42 | | | | Version for Release 8 | 7.0.0 | 8.0.0 |
| 2009-12 | 46 | | | | Version for Release 9 | 8.0.0 | 9.0.0 |

History

| Document history | | |
|-------------------------|--------------|-------------|
| V9.0.0 | January 2010 | Publication |
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