SLOVENSKI STANDARD

SIST EN 300 963 V8.0.1:2003

01-december-2003

Digitalni celiļ ni telekomunikacijski sistem (faza 2+) ï Govor s polno hitrostjo ï Nadomeģļ anje in utiģanje izgubljenih okvirov za kanale s polno hitrostjo govora (GSM 06.11, razliļ ica 8.0.1, izdaja 1999)

Digital cellular telecommunications system (Phase 2+) (GSM); Full rate speech; Comfort noise aspect for full rate speech traffic channels (GSM 06.12 version 8.0.1 Release 1999)

Ta slovenski standard je istoveten z: EN 300 963 Version 8.0.1

ICS:

33.070.50	Globalni sistem za mobilno telekomunikacijo (GSM)	Global System for Mobile Communication (GSM)

SIST EN 300 963 V8.0.1:2003 **en**

ETSI EN 300 963 V8.0.1 (2000-11)

European Standard (Telecommunications series)

Digital cellular telecommunications system (Phase 2+); Full rate speech; Comfort noise aspect for full rate speech traffic channels (GSM 06.12 version 8.0.1 Release 1999)

GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

Reference
REN/SMG-110612Q8

Keywords
Digital cellular telecommunications system,
Global System for Mobile communications (GSM)

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

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Special Mobile Group (SMG).

The present document specifies the comfort noise aspect for full rate speech traffic channels for the digital cellular telecommunications system.

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

Version 8.x.y

where:

8 indicates Release 1999of GSM Phase 2+.

x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

y the third digit is incremented when editorial only changes have been incorporated in the specification.

National transposition dates	
Date of adoption of this EN:	3 November 2000
Date of latest announcement of this EN (doa):	28 February 2001
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 August 2001
Date of withdrawal of any conflicting National Standard (dow):	31 August 2001

1 Scope

The present document gives the detailed requirements for the correct operation of the background acoustic noise evaluation, noise parameter encoding/decoding and comfort noise generation in GSM Mobile Stations (MS)s and Base Station Systems (BSS)s during Discontinuous Transmission (DTX) on full rate speech traffic channels.

The requirements described in the present document are mandatory for implementation in all GSM MSs. The receiver requirements are mandatory for implementation in all GSM BSSs, the transmitter requirements only for those where downlink DTX will be used.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- For this Release 1999 document, references to GSM documents are for Release 1999 versions (version 8.x.y).

[1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 05.03: "Digital cellular telecommunications system (Phase 2+); Channel coding".

[3] GSM 06.10: "Digital cellular telecommunications system (Phase 2+); Full rate speech; Transcoding".

[4] GSM 06.31: "Digital cellular telecommunications system (Phase 2+); Full rate speech; Discontinuous Transmission (DTX) for full rate speech traffic channel".

3 Definitions and abbreviations

Definitions and abbreviations used in the present document are listed in GSM 01.04 [1].

The definitions of terms used in this technical specification can be found in GSM 06.31 [4].

4 General

The overall operation of Discontinuous Transmission is described in GSM 06.31 [4].

A basic problem when using DTX is that the background acoustic noise, which is transmitted together with the speech, would disappear when the radio transmission is cut, resulting in a modulation of the background noise. Since the DTX switching can take place rapidly, it has been found that this effect can be very annoying for the listener - especially in a car environment with high background noise levels. In bad cases the speech may be hardly intelligible.

The present document specifies the way to overcome this problem by generating on the receive side synthetic noise similar to the transmit side background noise. The parameters of this so called comfort noise are estimated on the transmit side and transmitted to the receive side before the radio transmission is cut and at a regular low rate afterwards. This allows the comfort noise to adapt to the changes of the noise on the transmit side.

5 Functions on the transmit side

The comfort noise evaluation algorithm uses the unquantized block amplitude and Log Area Ratio (LAR) parameters of the full rate speech encoder, defined in clauses 4.2.15 and 4.2.6 of GSM 06.10 [3]. These parameters give information on the level and the spectrum of the background noise, respectively.

The evaluated comfort noise parameters are encoded into a special frame, called a SID (Silence Descriptor) frame, for transmission to the receive side.

The SID frame also serves to initiate the comfort noise generation on the receive side, as a SID frame is always sent at the end of a speech burst, i.e. before the radio transmission is cut.

The scheduling of SID or speech frames on the radio path is described in GSM 06.31 [4].

5.1 Background acoustic noise evaluation

The comfort noise parameters to be encoded into a SID frame are calculated over N=4 consecutive frames marked with VAD=0, as follows:

The Log Area Ratio parameters shall be averaged according to the equation:

$$mean(LAR(i)) = \frac{1}{N}\sum_{n=1}^{N} LAR[j-n](i) \qquad i = 1,2..8$$

where LAR[j](i) is the i'th Log Area Ratio coefficient of the current frame j and j-n indicates the previous frames.

The block amplitude parameter shall be averaged according to the equation:

$$mean(x_{max}) = \frac{1}{(4N)}\sum_{n=1}^{N}\sum_{i=1}^{4} x_{max}[j-n](i) \qquad i = 1,2..8$$

where x_{max}[j](i) is the block amplitude in sub-segment i of the current frame. The SID frame containing these averaged parameters is passed to the Radio Subsystem instead of frame number j.

5.2 SID-frame encoding

The SID-frame encoding algorithm exploits the fact that only some of the 260 bits in a frame are needed to code the comfort noise parameters. The other bits can then be used to mark the SID-frame by means of a fixed bit pattern, called the SID code word.

The log area ratio coefficients are replaced by the mean (LAR(i)) values defined above and encoded as described in GSM 06.10 [3].

The block amplitude values are replaced by the mean (x_{max}) value defined above, repeated four times inside the frame and encoded as described in GSM 06.10 [3].

The SID code word consists of 95 bits which are all zero. The bits of the SID code word are inserted in the SID field defined as the positions of those 95 bits of the encoded RPE-pulses Xmc, which are in the error protection class I (see GSM 05.03 [2], table 2).

The remaining bits in the SID frame are set to zero. The use of these bits is for further study.

6 Functions on the receive side

The situations in which comfort noise shall be generated on the receive side are defined in GSM 06.31 [4]. Generally speaking, the comfort noise generation is started or updated whenever a valid SID frame is received.

6.1 Comfort noise generation and updating

The comfort noise generation procedure uses the RPE-LTP speech decoder algorithm defined in GSM 06.10 [3].

When comfort noise is to be generated, then the various encoded parameters are set as follows.

The RPE pulses (X_{mcr}) are replaced by a locally generated random integer sequence, uniformly distributed between 1 and 6.

Also the grid position parameters (M_{cr}) are set to random integer values, uniformly distributed between 0 and 3.

The LTP gain values (b_{cr}) are set to 0.

The LTP lag values (N_{cr}) of the 4 sub-segments are set to 40, 120, 40 and 120 respectively.

The 4 block amplitude values (X_{maxcr}) used are those received in the SID frame.

The log area ratio parameters (LAR_{cr}) used are those received in the SID frame.

With these parameters, the speech decoder now performs the standard operations described in GSM 06.10 [3] and synthesizes comfort noise.

Updating of the comfort noise parameters occurs each time a valid SID frame is received, as described in GSM 06.31 [4].

When updating the comfort noise, the parameters above should preferably be interpolated over a few frames to obtain smooth transitions.