

ETSI/TC SMG

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**RELEASE NOTE**

**Recommendation GSM 06.12**

**Comfort Noise Aspects for Full-Rate Speech Traffic Channels**

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**1. Reason for changes**

Only the page numbering has been changed since the previous distributed version.



Recommendation: GSM 06.12

Title: Comfort noise aspects for full-rate speech traffic channels

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## 0. SCOPE

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This recommendation 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 and Base Station Systems during Discontinuous Transmission (DTX) on full rate speech traffic channels.

The requirements described in this recommendation are mandatory for implementation in all GSM Mobile Stations. The receiver requirements are mandatory for implementation in all GSM Base Station Systems, the transmitter requirements only for those where downlink DTX will be used.

## 1. GENERAL

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The definitions of terms used in this recommendation can be found in recommendation GSM 06.31.

The overall operation of Discontinuous Transmission is described in recommendation GSM 06.31.

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.

This recommendation 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.

## 2. FUNCTIONS ON THE TRANSMIT SIDE

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The comfort noise evaluation algorithm uses the unquantized block amplitude and Log Area Ratio (LAR) parameters of the full rate speech encoder, defined in section 4.2.15 and 4.2.6 of recommendation GSM 06.10. 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, ie before the radio transmission is cut.

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

### 2.1. BACKGROUND ACOUSTIC NOISE EVALUATION

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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:

$$\text{mean (LAR}(i)) = 1/N \text{ SUM [n=1 to N] LAR[j-n]}(i) \quad i=1,2..8$$

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:

$$\text{mean (xmax)} = 1/(4N) \text{ SUM [n=1 to N] SUM [i=1 to 4] xmax[j-n]}(i) \\ i = 1,2,..8$$

where xmax[j](i) is the block amplitude in subsegment i of the current frame. The SID frame containing these averaged parameters is passed to the Radio Subsystem instead of frame number j.

## 2.2. SID-FRAME ENCODING

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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 recommendation GSM 06.10.

The block amplitude values are replaced by the mean (xmax) value defined above, repeated four times inside the frame and encoded as described in recommendation GSM 06.10.

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  $X_{mc}$ , which are in the error protection class I (see recommendation GSM 06.10, table 1.2.a).

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

## 3. FUNCTIONS ON THE RECEIVE SIDE

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

### 3.1. COMFORT NOISE GENERATION AND UPDATING

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

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 subsegments 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 recommendation GSM 06.10 and synthesizes comfort noise.

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

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