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RELEASE NOTE

Recommendation GSM 05.04

Modulation

Previously distributed version : 3.1.2 (Updated Release 1/90)
New Released version February 92 : 3.1.2 (Release 92, Phase 1)

1. Reason for changes

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 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) and has been adopted having undergone the ETSI standards approval procedure.

This I-ETS specifies the modulation scheme of the Radio Frequency carrier used within the European digital cellular telecommunications system.

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

GSM 05.01 Physical layer on the radio path (general description).

GSM 05.02 Multiplexing and multiple access on the radio path.

GSM 05.05 Radio transmission and reception.

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

GSM Recommendation: 05.04
version: 3.1.2

Title: MODULATION

Date: February 1992

CONTENTS:

Number of pages: 3

MODULATION

1 SCOPE

The modulator receives the bits from the encryption unit, see Rec.05.01, and produces an RF signal. The filtering of the RF signal necessary to obtain the spectral purity is not defined, neither are the tolerances associated with the theoretical filter requirements specified. These are contained in Rec.05.05.

2 MODULATION FORMAT

2.1 Modulating bit rate:

The modulating bit rate is 1/T = 1625/6 kbit/s (ie app. 270.833 kbit/s).

2.2 Start and stop of the burst:

Before the first bit of the bursts as defined in 05.02 enters the modulator, the modulator has an internal state as if a modulating bit stream consisting of consecutive ones (d_i = 1) had entered the differential encoder. Also after the last bit of the time slot, the modulator has an internal state as if a modulating bit stream consisting of consecutive ones (d_i = 1) had continued to enter the differential encoder. These bits are called dummy bits and define the start and the stop of the active and the useful part of the burst as illustrated in Fig.1. Nothing is specified about the actual phase of the modulator output signal outside the useful part of the burst.

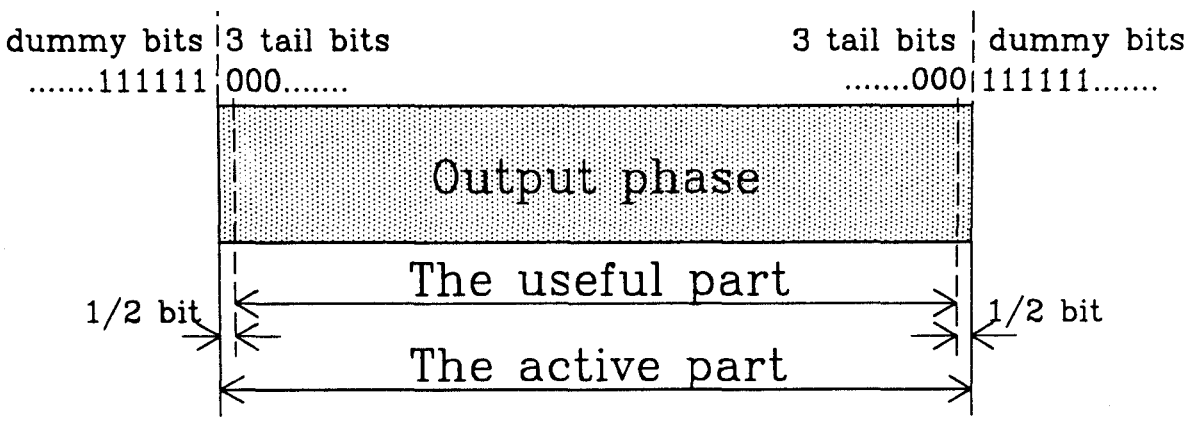

Figure 1: Relation between active part of burst, tail bits and dummy bits. For the normal burst the useful part lasts for 147 modulating bits.

2.3 Differential encoding:

Each data value d_i = [0,1] is differentially encoded. The output of the differential encoder is:

$$\hat{d}_i = d_i \oplus \hat{d}_{i-1} \qquad (d_i \in \{0, 1\}) \qquad (1)$$

where $\oplus$ denotes modulo 2 addition.

The modulating data value α_i input to the modulator is:

$$\alpha_i = 1 - 2\hat{d}_i \qquad (\alpha_i \in \{-1, +1\}) \qquad (2)$$

2.4 Filtering:

The modulating data values α_i as represented by Dirac pulses excite a linear filter with impulse response defined by:

$$g(t) = h(t) * \mathrm{rect}(t/T) \qquad (3)$$

where the function rect(x) is defined by:

$$\mathrm{rect}(t/T) = 1/T \quad \text{for } |t| < T/2 \qquad (4)$$
$$\mathrm{rect}(t/T) = 0 \quad \text{otherwise}$$

and * means convolution. h(t) is defined by:

$$h(t) = \exp(-t^2/(2\sigma^2T^2))/((\sqrt{2\pi})\sigma T) \qquad (5)$$

$$\text{where } \sigma = \sqrt{\ln(2)}/2\pi BT \quad \text{and } BT = 0.3 \qquad (6)$$

where B is the 3 dB bandwidth of the filter with impulse response h(t), and T is the duration of one input data bit. This theoretical filter is associated with tolerances defined in 05.05.

2.5 Output phase:

The phase of the modulated signal is:

$$\varphi(t) = \sum_i \alpha_i \, \pi \, h \int_{-\infty}^{t-iT} g(u)\,du \qquad (7)$$

where the modulating index h is 1/2 (maximum phase change in radians is $\pi/2$ per data interval).

2.6 Modulation:

The modulated RF carrier, except for start and stop of the TDMA burst may therefore be expressed as:

$$x(t) = \sqrt{(2E_c/T)}\,\cos(2\pi f_0 t + \varphi(t) + \varphi_0) \qquad (8)$$

where E_c is the energy per modulating bit, f_0 is the centre frequency and φ_0 is a random phase and is constant during one burst.

Document history		
March 1992	First edition	-