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GLOBAL SYSTEM FOR
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Digital cellular telecommunications system; Modulation (GSM 05.04 version 5.0.0)

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 4 92 94 42 00 - Fax: +33 4 93 65 47 16

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Foreword

This draft European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) Technical Committee (TC) of the European Telecommunications Standards Institute (ETSI) and is now submitted for the Unified Approval Procedure phase of the ETSI approval procedure.

This ETS specifies the modulation format used within the digital cellular telecommunications system. This ETS corresponds to GSM 05.04 Phase 2 version 4.0.3. This ETS is a GSM technical specification version 5 and is part of the 1996 release of the GSM Technical Specifications.

The specification from which this ETS has been derived was originally based on CEPT documentation, hence the presentation of this ETS may not be entirely in accordance with the ETSI/PNE rules.

Reference is made within this ETS to GSM-TSs.

NOTE: TC-SMG has produced documents which give the technical specifications for the implementation of the European digital cellular telecommunications system. Historically, these documents have been identified as GSM Technical Specifications (GSM-TSs). These TSs may have subsequently become I-ETSs (Phase 1), or ETSs (Phase 2), whilst others may become ETSI Technical Reports (ETRs). GSM-TSs are, for editorial reasons, still referred to in GSM ETSs.

Proposed transposition dates	
Date of latest announcement of this ETS (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

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1 Scope

The modulator receives the bits from the encryption unit, see GSM 05.01 [1], and produces an RF signal. The filtering of the Radio Frequency (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 GSM 05.05 [4].

1.1 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1] GSM 01.04 (ETR 350): "Digital cellular telecommunication system (Phase 2+); Abbreviations and acronyms".

[2] GSM 05.01: "Digital cellular telecommunication system (Phase 2+); Physical layer on the radio path General description".

[3] GSM 05.02 (ETS 300 908): "Digital cellular telecommunication system (Phase 2+); Multiplexing and multiple access on the radio path".

[4] GSM 05.05 (ETS 300 910): "Digital cellular telecommunication system (Phase 2+); Radio transmission and reception".

1.2 Abbreviations

Abbreviations used in this specification are listed in GSM 01.04 [1].

2 Modulation format

2.1 Modulating bit rate

The modulating bit rate is 1/T = 1 625/6 kbit/s (i.e. approximately 270,833 kbit/s).

2.2 Start and stop of the burst

Before the first bit of the bursts as defined in GSM 05.02 [3] 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 figure 1. Nothing is specified about the actual phase of the modulator output signal outside the useful part of the burst.

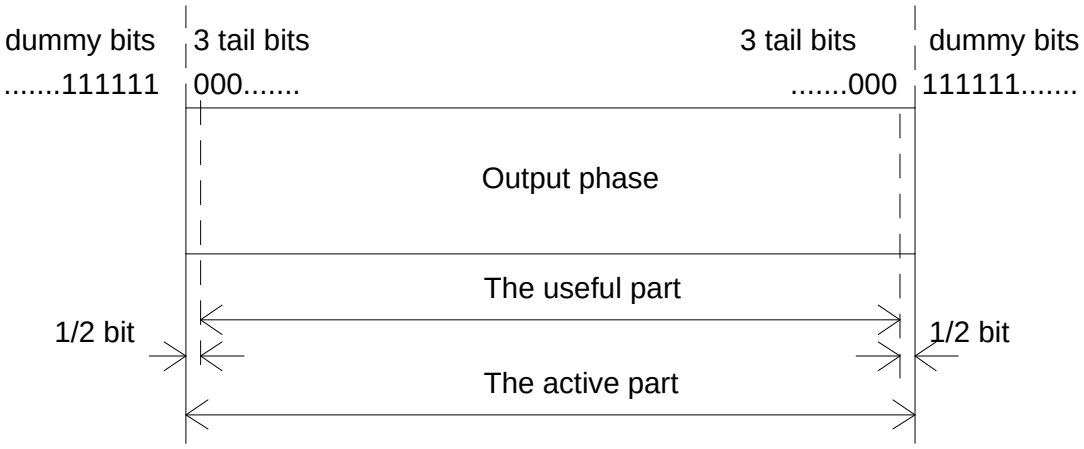

Figure 1: Relation between active part of burst, tail bits and dummy bits.
For the normal burst the useful part lasts for 147 modulating bits

2.3 Differential encoding

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

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

where $\oplus$ denotes modulo 2 addition.

The modulating data value α_i input to the modulator is:

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

2.4 Filtering

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

$$g(t) = h(t) * rect(t/T)$$

where the function rect(x) is defined by:

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

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

$$h(t) = \exp(-t^2/(2\delta^2T^2))/((2\pi)^{0.5}\delta T)$$

where $\delta = (\ln(2))^{0.5}/2\pi BT$ and BT = 0.3

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 GSM 05.05 [4].

2.5 Output phase

The phase of the modulated signal is:

$$\varphi(t') = \sum_{I} \alpha_i \pi h \int_{-\infty}^{t'-iT} g(u)du$$

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

The time reference t' = 0 is the start of the active part of the burst as shown in figure 1. This is also the start of the bit period of bit number 0 (the first tail bit) as defined in GSM 05.02 [2].

2.6 Modulation

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

$$x(t') = (2E_c/T)^{0.5} \cos(2\pi f_0 t' + \varphi(t') + \varphi_0)$$

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.

History

Document history			
December 1996	Unified Approval Procedure	UAP 60:	1996-12-02 to 1997-04-11