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*Technical Specification*

**GEO-Mobile Radio Interface Specifications (Release 2);  
General Packet Radio Service;  
Part 5: Radio interface physical layer specifications;  
Sub-part 4: Modulation;  
GMPRS-1 05.004**

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Reference

RTS/SES-001-GMPRS-1-05004

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Keywords

GMPRS, GMR, GSM, GSO, interface, MES, mobile, modulation, MSS, radio, satellite, S-PCN

**ETSI**

650 Route des Lucioles  
F-06921 Sophia Antipolis Cedex - FRANCE

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

Siret N° 348 623 562 00017 - NAF 742 C  
Association à but non lucratif enregistrée à la  
Sous-Préfecture de Grasse (06) N° 7803/88

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## Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The contents of the present document are subject to continuing work within TC-SES and may change following formal TC-SES approval. Should TC-SES modify the contents of the present document it will then be republished by ETSI with an identifying change of release date and an increase in version number as follows:

Version 1.m.n

where:

- the third digit (n) is incremented when editorial only changes have been incorporated in the specification;
- the second digit (m) is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

The present document is part 5, sub-part 4 of a multi-part deliverable covering the GEO-Mobile Radio Interface Specifications, as identified below:

Part 1: "General specifications";

Part 2: "Service specifications";

Part 3: "Network specifications";

Part 4: "Radio interface protocol specifications";

**Part 5: "Radio interface physical layer specifications";**

Sub-part 1: "Physical Layer on the Radio Path: General Description; GMR-1 05.001";

Sub-part 2: "Multiplexing and Multiple Access; Stage 2 Service Description; GMR-1 05.002";

Sub-part 3: "Channel Coding; GMR-1 05.003";

**Sub-part 4: "Modulation; GMR-1 05.004";**

Sub-part 5: "Radio Transmission and Reception; GMR-1 05.005";

Sub-part 6: "Radio Subsystem Link Control; GMR-1 05.008";

Sub-part 7: "Radio Subsystem Synchronization; GMR-1 05.010";

Part 6: "Speech coding specifications";

Part 7: "Terminal adaptor specifications".

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## Introduction

GMR stands for GEO (Geostationary Earth Orbit) Mobile Radio interface, which is used for mobile satellite services (MSS) utilizing geostationary satellite(s). GMR is derived from the terrestrial digital cellular standard GSM and supports access to GSM core networks.

The present specification is part of the GMR Release 2 specifications. Release 2 specifications are identified in the title and can also be identified by the version number:

- Release 1 specifications have a GMR-1 prefix in the title and a version number starting with "1" (V1.x.x.)
- Release 2 specifications have a GMPRS-1 prefix in the title and a version number starting with "2" (V2.x.x.)

The GMR release 1 specifications introduce the GEO-Mobile Radio interface specifications for circuit mode mobile satellite services (MSS) utilizing geostationary satellite(s). GMR release 1 is derived from the terrestrial digital cellular standard GSM (phase 2) and it supports access to GSM core networks.

The GMR release 2 specifications add packet mode services to GMR release 1. The GMR release 2 specifications introduce the GEO-Mobile Packet Radio Service (GMPRS). GMPRS is derived from the terrestrial digital cellular standard GPRS (included in GSM Phase 2+) and it supports access to GSM/GPRS core networks.

Due to the differences between terrestrial and satellite channels, some modifications to the GSM standard are necessary. Some GSM specifications are directly applicable, whereas others are applicable with modifications. Similarly, some GSM specifications do not apply, while some GMR specifications have no corresponding GSM specification.

Since GMR is derived from GSM, the organization of the GMR specifications closely follows that of GSM. The GMR numbers have been designed to correspond to the GSM numbering system. All GMR specifications are allocated a unique GMR number. This GMR number has a different prefix for Release 2 specifications as follows:

- Release 1: GMR-n xx.zyy
- Release 2: GMPRS-n xx.zyy

where:

- xx.0yy ( $z = 0$ ) is used for GMR specifications that have a corresponding GSM specification. In this case, the numbers xx and yy correspond to the GSM numbering scheme.
- xx.2yy ( $z = 2$ ) is used for GMR specifications that do not correspond to a GSM specification. In this case, only the number xx corresponds to the GSM numbering scheme and the number yy is allocated by GMR.
- n denotes the first ( $n = 1$ ) or second ( $n = 2$ ) family of GMR specifications.

A GMR system is defined by the combination of a family of GMR specifications and GSM specifications as follows:

- If a GMR specification exists it takes precedence over the corresponding GSM specification (if any). This precedence rule applies to any references in the corresponding GSM specifications.

**NOTE:** Any references to GSM specifications within the GMR specifications are not subject to this precedence rule. For example, a GMR specification may contain specific references to the corresponding GSM specification.

- If a GMR specification does not exist, the corresponding GSM specification may or may not apply. The applicability of the GSM specifications is defined in GMR-1 01.201.

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# 1 Scope

The present document defines the modulation used within the GMR-1 Mobile Satellite System. It includes the various modulation formats that are required for different physical channel types. It also defines the concept of the transmission burst and the mapping of modulated symbols to the burst, describes the required transmit filtering in general terms, and specifies the modulation accuracy.

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# 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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

- [1] GMR-1 01.004 (ETSI TS 101 376-1-1): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 1: Abbreviations and acronyms; GMR-1 01.004".
- [2] GMPRS-1 01.201 (ETSI TS 101 376-1-2): "GEO-Mobile Radio Interface Specifications (Phase 2); General Packet Radio Service; Part 1: General specifications; Sub-part 2 : Introduction to the GMR-1 family; GMPRS-1 01.201".
- [3] GMPRS-1 05.002 (ETSI TS 101 376-5-2): "GEO-Mobile Radio Interface Specifications (Release 2); General Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 2: Multiplexing and Multiple Access; Stage 2 Service Description; GMPRS-1 05.002".
- [4] GMR-1 05.004 (ETSI TS 101 376-5-4) V1.2.1: "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 4: Modulation; GMR-1 05.004".
- [5] GMPRS-1 05.005 (ETSI TS 101 376-5-5): "GEO-Mobile Radio Interface Specifications (Release 2); General Packet Radio Service Part 5: Radio interface physical layer specifications; Sub-part 5: Radio Transmission and Reception; GMPRS-1 05.005".

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## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in GMR-1 01.004 [1] apply.

### 3.2 Abbreviations

For the purposes of the present document, the abbreviations defined in GMR-1 01.004 [1] and the following apply:

PAB	Packet Access Burst
PDCH	Packet Data CHannel
PNB	Packet Normal Burst

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## 4 Burst structure

### 4.1 Signal representation

Same as clause 4.1 in GMR-1 05.004 [4].

### 4.2 Modulating symbol rate

Same as clause 4.2 in GMR-1 05.004 [4].

### 4.3 Start and stop of the burst

Same as clause 4.3 in GMR-1 05.004 [4].

### 4.4 Data bits and data symbols

Same as clause 4.4 in GMR-1 05.004 [4].

### 4.5 Packet burst structure

#### 4.5.1 Modulating symbol rate

Packet Normal Bursts (PNBs) are modulated at a symbol rate of  $23,4 \times m$  ksps, where  $m$  is an integer  $m=4$  or  $5$ . The symbol period time for  $PNB(m,n)$ , where  $m$  is the bandwidth factor and  $n$  is the duration of the burst in timeslots, is defined as  $1/(23,4 \times m)$ , where  $m=4$  or  $5$ ; and  $n=3$ .

Packet Access Burst (PAB) is modulated at a symbol rate of  $23,4$  ksps.

#### 4.5.2 Start and stop of the burst

For packet normal bursts, the time interval  $[0, 39nT]$  is the burst time window, where  $n=3$ , for the burst types defined in GMPRS-1 05.002 [3]. The time interval  $[2,5T, 39nT-2,5T]$  is the burst time window corresponding to the active part of this burst, where  $n=3$ . The content of this part corresponds to data symbols, i.e. reference and free symbols. The remaining time corresponds to the guard intervals (see GMPRS-1 05.002 [3]). These guard intervals correspond to the transition from no signal to a continuous carrier and vice-versa.

### 4.5.3 Data bits and data symbols

Bursts transmitted over the forward and reverse Packet Data Channels (PDCHs) consist of two parts:

- Burst header, which is  $\pi/4$ -CQPSK modulated.
- Payload, which is  $\pi/4$ -CQPSK.

For packet normal bursts, there are  $78mn$  binary data bits defined in  $\{0,1\}$  in each burst, including header and payload, for  $\pi/4$ -CQPSK (Coherent Quadrature Phase-Shift Keying) modulation. For  $\pi/4$ -CQPSK, the burst bits are represented by  $[b_0 b_1 b_2 b_3 \dots b_{78mn-2} b_{78mn-1}]$ , where  $b_0$  to  $b_{5m-1}$  and  $b_{78mn-5m-1}$  to  $b_{78mn-1}$  are guard bits. When modulating these bits, we want to avoid grouping one guard bit with one information bit. Thus, for  $\pi/4$ -CQPSK, the mapping rule from data bits to data symbols shall be:

$$d_k = (b_{2k-1} b_{2k}), \quad k = 0, 1, \dots, 39mn$$

which results in  $39mn+1$  different symbols being transmitted during  $3mnT$  ( $39mn$  symbol duration). However, the signals contained in the first and the last half-symbol duration are not actually transmitted according to the burst window definition in clause 4.5.2. To generate the first and the last symbols, one needs to use two dummy bits, which are represented by  $b_{-1}$  and  $b_{78mn}$ . The dummy bits can be either of the two binary values  $\{0,1\}$ .

The header of the PNB is modulated by  $\pi/4$ -CQPSK modulation. The burst header contains the following compositions:

- Guard Band (GB):  $2,5m$  symbol at the start and  $2,5m$  at the end of a burst;
- Unique Word(UW):  $6m$  symbols;
- Public Information (PUI): 48 bits;
- Payload Transition:  $m$  symbols.

For Packet Access Burst (PAB), there are 234 binary data bits defined  $\{0,1\}$  in each burst.

Finally, the mapping of  $\{d_k\}$  to the constellation points is defined in clause 5.3.

## 5 Normal burst

Same as clause 5 in GMR-1 05.004 [4].

### 5.1 $\pi/4$ -CQPSK modulation

Same as clause 5.1 in GMR-1 05.004 [4].

#### 5.1.1 Filtering

Same as clause 5.1.1 of GMR-1 05.004 [4].

#### 5.1.2 Power ramp

Same as clause 5.1.2 of GMR-1 05.004 [4].

### 5.2 $\pi/4$ -CBPSK modulation

Same as clause 5.2 of GMR-1 05.004 [4].

## 5.3 PNB modulation

PNBs are modulated by  $\pi/4$ -CQPSK. The complex envelope of the transmitted signal is defined as follows:

$$x(t) = p(t) \left[ e^{j\varphi_0} \sum_{k=-\infty}^{\infty} \alpha_k h(t - kT) \right]$$

where  $\varphi_0$  is a random phase,  $h(t)$  is the impulse response of a shaping filter defined in clause 5.1.1,  $p(t)$  is the ramp function as defined in clause 5.1.2, and  $\{\alpha_k\}$  is the modulating symbol, defined as follows:

$$\begin{cases} k < 0 : & \alpha_k = 0 \\ 0 \leq k \leq 39mn : & \text{see table 5.1 for } \pi/4\text{-CQPSK} \\ k > 39mn : & \alpha_k = 0 \end{cases}$$

where  $n=3$  and  $m=4$  or  $5$ , depending on the type of the burst. The modulating symbols are derived from the data symbols (free and reference symbols) according to table 5.1.

**Table 5.1:  $\pi/4$ -CQPSK bits-to-symbols mapping**

$a_{k-1}$	$a_k$	Modulating symbols
0	0	$(1 + j0) \exp(jk\pi/4)$
0	1	$(0 + j1) \exp(jk\pi/4)$
1	1	$(-1 + j0) \exp(jk\pi/4)$
1	0	$(0 - j1) \exp(jk\pi/4)$

## 6 DKABs

### 6.1 $\pi/4$ -DBPSK modulation

Same as clause 6.1 of GMR-1 05.004 [4].

## 7 BACH

Same as clause 7 of GMR-1 05.004 [4].

### 7.1 Modulation format

Same as clause 7.1 of GMR-1 05.004 [4].

## 8 Frequency correction burst

### 8.1 Modulation format

Same as clause 8.1 of GMR-1 05.004 [4].

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## 9 Modulation accuracy

Same as clause 9 of GMR-1 05.004 [4].

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## History

<b>Document history</b>		
V1.1.1	March 2001	Publication
V1.2.1	April 2002	Publication
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