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Technical Specification

GEO-Mobile Radio Interface Specifications (Release 3)
Third Generation Satellite Packet Radio Service;
Part 5: Radio interface physical layer specifications;
Sub-part 4: Modulation;
GMR-1 3G 45.004

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Foreword

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The present document is part 5, sub-part 4 of a multi-part deliverable covering the GEO-Mobile Radio Interface Specifications (Release 3); Third Generation Satellite Packet Radio Service, 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";

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

Sub-part 3: "Channel Coding";

Sub-part 4: "Modulation";

Sub-part 5: "Radio Transmission and Reception";

Sub-part 6: "Radio Subsystem Link Control";

Sub-part 7: "Radio Subsystem Synchronization";

Part 6: "Speech coding specifications";

Part 7: "Terminal adaptor specifications".

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 document is part of the GMR Release 3 specifications. Release 3 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).
- Release 3 specifications have a GMR-1 3G prefix in the title and a version number starting with "3" (V3.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.

The GMR release 3 specifications evolve packet mode services of GMR release 2 to 3rd generation UMTS compatible services. The GMR release 3 specifications introduce the GEO-Mobile Radio Third Generation (GMR-1 3G) packet radio service. Where applicable, GMR-3G is derived from the terrestrial digital cellular standard 3GPP and it supports access to 3GPP core networks.

Due to the differences between terrestrial and satellite channels, some modifications to the GSM or 3GPP standard are necessary. Some GSM and 3GPP specifications are directly applicable, whereas others are applicable with modifications. Similarly, some GSM and 3GPP specifications do not apply, while some GMR specifications have no corresponding GSM or 3GPP specification.

Since GMR is derived from GSM and 3GPP, the organization of the GMR specifications closely follows that of GSM or 3GPP as appropriate. The GMR numbers have been designed to correspond to the GSM and 3GPP numbering system. All GMR specifications are allocated a unique GMR number. This GMR number has a different prefix for Release 2 and Release 3 specifications as follows:

- Release 1: GMR n xx.zyy.
- Release 2: GMPRS n xx.zyy.
- Release 3: GMR-1 3G xx.zyy

where:

xx.0yy (z = 0) is used for GMR specifications that have a corresponding GSM or 3GPP specification. In this case, the numbers xx and yy correspond to the GSM or 3GPP numbering scheme.

xx.2yy (z = 2) is used for GMR specifications that do not correspond to a GSM or 3GPP specification. In this case, only the number xx corresponds to the GSM or 3GPP 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 and 3GPP specifications as follows:

- If a GMR specification exists it takes precedence over the corresponding GSM or 3GPP specification (if any). This precedence rule applies to any references in the corresponding GSM or 3GPP specifications.

NOTE: Any references to GSM or 3GPP 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 or 3GPP specification.

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- If a GMR specification does not exist, the corresponding GSM or 3GPP specification may or may not apply. The applicability of the GSM or 3GPP specifications is defined in GMR-1 3G 41.201 [2].

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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.

2 References

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.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

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2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] GMPRS-1 01.004 (ETSI TS 101 376-1-1): "GEO-Mobile Radio Interface Specifications (Release 2); General Packet Radio Service (GMPRS); Part 1: General specifications; Sub-part 1: Abbreviations and acronyms".

NOTE: This is a reference to a GMR-1 Release 2 specification. See the introduction for more details.

[2] GMR-1 3G 41.201 (ETSI TS 101 376-1-2): "GEO-Mobile Radio Interface Specifications (Release 3); Third Generation Satellite Packet Radio Service; Part 1: General specifications; Sub-part 2 : Introduction to the GMR-1 family".

[3] GMR-1 3G 45.002 (ETSI TS 101 376-5-2): "GEO-Mobile Radio Interface Specifications (Release 3); Third Generation Satellite Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 2: Multiplexing and Multiple Access; Stage 2 Service Description".

[4] GMR-1 05.004 (ETSI TS 101 376-5-4): "GEO-Mobile Radio Interface Specifications (Release 1); Part 5: Radio interface physical layer specifications; Sub-part 4: Modulation".

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area**.** For non-specific references, the latest version of the referenced document (including any amendments) applies.

Not applicable.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in GMR-1 3G 41.201 [2] apply.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in GMPRS-1 01.004 [1] apply.

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 × *m* ksps, where *m* is an integer *m* = 1,2, 4 or 5. The symbol period time for PNB(*m*,*n*), PNB2(m,n), and PNB3(m,n), where *m* is the bandwidth factor and *n* is the duration of the burst in timeslots, is defined as 1/(23,4 × *m*) seconds, where {*m* = 4 or 5; and *n* = 3} or {*m* = 1 or 2; and *n* = 6} or {*m* = 5; and *n* = 12} or {*m* = 10; and *n* = 3}.

Packet Access Burst (PAB) and PAB3 are modulated at a symbol rate of 23,4 ksps.

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4.5.2 Start and stop of the burst

For packet normal bursts, the time interval [0, 39*nT*] is the burst time window, where $n = 3$, $n = 6$, $n = 8$, and $n = 12$ for the burst types defined in GMR-1 3G 45.002 [3] and T is as defined in clause 4.2. The time window of the active part of different burst types is listed in table 4.1. The content of the active part of the burst corresponds to data symbols, i.e. reference and free symbols. The remaining time corresponds to the guard intervals (see GMR-1 3G 45.002 [3]). These guard intervals correspond to the transition from no signal to a continuous carrier and vice versa.

Table 4.1: Useful Duration For Different Packet Normal Burst Types

Burst	Direction	Active Part of Burst
PNB(1,6)	U/D	[2,5*T*, 39*nT*-2,5*T*]
PNB(2,6)	D	[2,5T/*m*, 39*n*T-2,5T/*m*]
PNB(4,3)	U/D	[2,5*T*, 39*nT*-2,5*T*]
PNB(5,3)	U/D	[2,5*T*, 39*nT*-2,5*T*]
PNB2(5,3)	U/D	[2,5*T*, 39*nT*-2,5*T*]
PNB2(5,12)	U/D	[2,5*T*, 39*nT*-2,5*T*]
PNB3(1,3)	U/D	[2,5*T*, 39*nT*-2,5*T*]
PNB3(1,6)	U/D	[2,5*T*, 39*nT*-2,5*T*]
PNB3(1,8)	U/D	[2,5*T*, 39*nT*-2,5*T*]
PNB3(2,6)	U	[2,5*T*, 39*nT*-2,5*T*]
PNB3(2,6)	D	[2,5T/*m*, 39*n*T-2,5T/*m*]
PNB3(5,3)	U	[2,5*T*, 39*nT*-2,5*T*]
PNB3(5,3)	D	[2,5T/*m*, 39*n*T-2,5T/*m*]
PNB3(5,12)	U	[2,5*T*, 39*nT*-2,5*T*]
PNB3(5,12)	D	[2,5T/*m*, 39*n*T-2,5T/*m*]
PNB3(10,3)	D	[2,5T/*m*, 39*n*T-2,5T/*m*]

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4.5.3 Data bits and data symbols

4.5.3.1 QPSK modulation

For π/4-CQPSK (Coherent Quadrature Phase-Shift Keying) modulated packet normal bursts, there are 78*mn* binary data bits defined in {0,1} in each burst, including header and payload (as defined in GMR-1 3G 45.002 [3]). For π/4-CQPSK, the burst bits are represented by $[b_0\, b_1\, b_2\, b_3 \ldots b_{78mn-2}\, b_{78mn-1}]$, where b_0 to b_{5m-1} and $b_{78mn-5m}$ to b_{78mn-1} are guard bits for $m = 1$, 4, and 5, and where b_0 to b_4 and b_{78mn-5} to b_{78mn-1} are guard bits for $m = 2$. When modulating these bits, we want to avoid grouping one guard bit with one information bit. Thus, for π/4-CQPSK with $m = 1$, 2, and 5, the mapping rule from data bits to data symbols shall be:

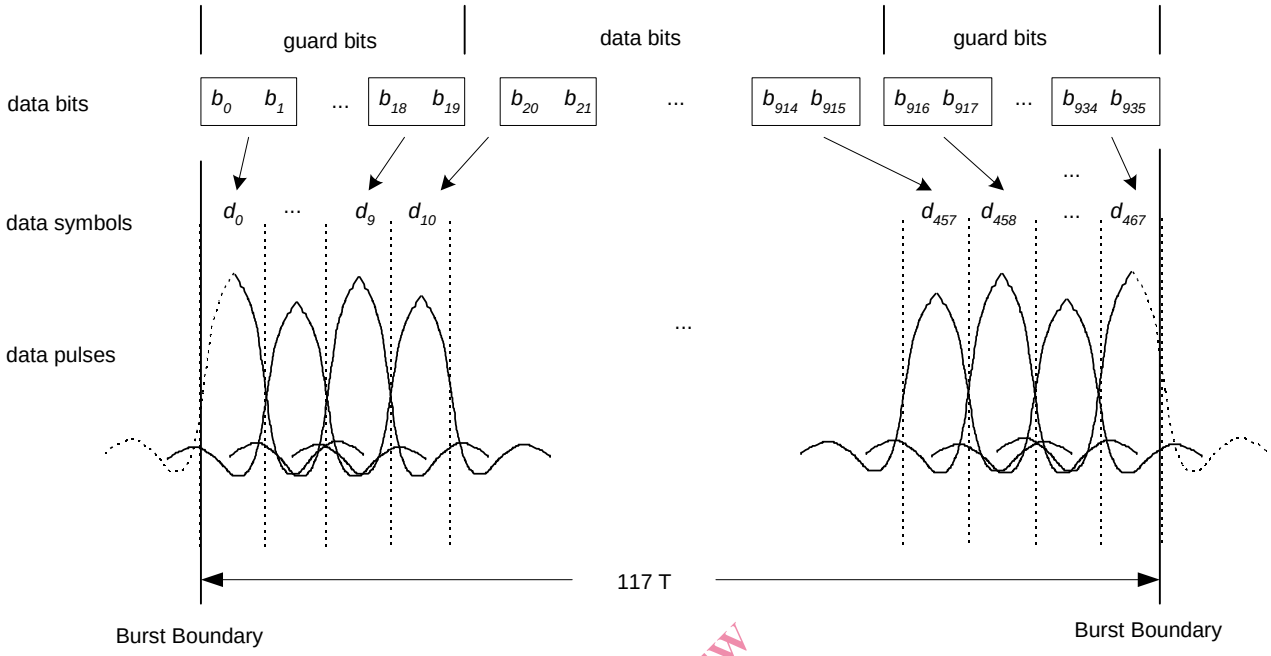
$$d_k = (b_{2k-1} b_{2k}), \quad k = 0, 1, \ldots, 39mn$$

which results in 39*mn* + 1 different symbols being transmitted during 39*nT* (39*mn* 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}.

For π/4-CQPSK with $m = 4$, the mapping rule from data bits to data symbols shall be:

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

which results in 39*mn* different symbols being transmitted during 39*nT* (39*mn* symbol duration) as shown in figure 4.1.



Note: The vertical dotted lines represent the symbol boundaries

Figure 4.1: Relationship of data bits, data symbols, burst timing, and symbol timing for PNB(4,3)

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.

4.5.3.2 BPSK modulation

For π/2-CBPSK (Coherent Binary Phase-Shift Keying) modulated packet normal bursts, there are 39*mn* binary data bits defined in {0,1} in each burst. The burst bits are represented by $[b_0\ b_1\ b_2\ b_3\ \ldots\ b_{38mn-2}\ b_{39mn-1}]$, where b_0 to b_{3m-1} and b_{39mn-2} to b_{39mn-1} are guard bits (total 5*m* guard bits). For π/2-CBPSK, the mapping rule from data bits to data symbols shall be:

$$d_k = b_k, \quad k = 0,1,...,39mn$$

where b_{39mn} is considered to be a dummy bit. Figure 4.2 clearly illustrates the relationship of data bits, dummy bits, data symbols, burst boundary, and symbol boundary for a π/2-CBPSK modulated burst.

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