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Technical Specification

GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 4: Modulation; GMR-2 05.004

Reference

DTS/SES-002-05004

Keywords

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Contents

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IPRs:

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TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,715,365	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,754,974	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,226,084	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,701,390	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,826,222	US

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Ericsson Mobile Communication	Improvements in, or in relation to, equalisers	GB	GB 2 215 567	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Power Booster	GB	GB 2 251 768	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Receiver Gain	GB	GB 2 233 846	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Transmitter Power Control for Radio Telephone System	GB	GB 2 233 517	GB

IPR Owner: Ericsson Mobile Communications (UK) Limited
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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Hughes Network Systems		US	Pending	US

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	2.4-to-3 KBPS Rate Adaptation Apparatus for Use in Narrowband Data and Facsimile Communication Systems	US	US 6,108,348	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Cellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic ThroughputCellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic Throughput	US	US 5,717,686	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Enhanced Access Burst for Random Access Channels in TDMA Mobile Satellite System	US	US 5,875,182	
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,314	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,315	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Mutual Offset High-argin Forward Control Signals	US	US 6,072,985	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Spot Beam Pairing for Reduced Updates	US	US 6,118,998	US

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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; GMR-2 05.001";

Sub-part 2: "Multiplexing and Multiple Access on the Radio Path; GMR-2 05.002";

Sub-part 3: "Channel Coding; GMR-2 05.003";

Sub-part 4: "Modulation; GMR-2 05.004";

Sub-part 5: "Radio Transmission and Reception; GMR-2 05.005";

Sub-part 6: "Radio Subsystem Link Control; GMR-2 05.008";

Sub-part 7: "Radio Subsystem Synchronization; GMR-2 05.010";

Part 6: "Speech coding 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.

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 as follows:

GMR-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-n 01.201.

1 Scope

The modulator receives the bits from the encryption unit, (see GMR-2 05.001 [2]), 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 GMR-2 05.005 [4].

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.

[1] GMR-2 01.004 (ETSI TS 101 377-1-1): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 1: Abbreviations and Acronyms; GMR-2 01.004".

[2] GMR-2 05.001 (ETSI TS 101 377-5-1): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 1: Physical Layer on the Radio Path; GMR-2 05.001".

[3] GMR-2 05.002 (ETSI TS 101 377-5-2): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 2: Multiplexing and Multiple Access on the Radio Path; GMR-2 05.002".

[4] GMR-2 05.005 (ETSI TS 101 377-5-5): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 5: Radio Transmission and Reception; GMR-2 05.005".

3 Abbreviations

For the purposes of the present document, the abbreviations given in GMR-2 01.004 [1] apply.

4 Modulation Format

a) RETURN Link (MES-to-Ground Station):

the return link modulation format is constant-envelope GMSK with a BT of 0,3.

b) FORWARD Link (Ground Station-to-MES):

the forward link modulation format is linear, filtered OQPSK which is pre-coded such that it is compatible with GMSK-type demodulator.

c) Single Hop Link (MES-to-MES):

transmit: MESs will transmit GMSK (BT = 0,3) signals with characteristics as described in the RETURN Link (MES-to-Ground Station) sections in the present document;

receive: MES will receive both GMSK (BT = 0,3) signals and filtered OQPSK with characteristics as described in the RETURN Link (MES-to-Ground Station) and FORWARD Link (Ground Station-to-MES) sections in the present document. Signals received from the connected MES (S-TCH, S-FACCH) will have GMSK (BT = 0,3) modulation format and signals received from a Ground Station (S-SACCH) will have filtered OQPSK modulation format.

4.1 Modulating Bit Rate

a) RETURN Link (MES-to-Ground Station):

the modulating bit rate is 1/Treturn = 1 625/24 kbit/s (i.e. ≈67,70833 kbit/s).

b) FORWARD Link (Ground Station-to-MES):

the modulating bit rate is 1/Tforward = 1 625/6 kbit/s (i.e. ≈270,833 kbit/s).

c) Single Hop Link (MES-to-MES):

- the modulating bit rate of signals transmitted by a MES is 1/T return = 1 625/24 kbit/s (i.e. ≈67,7083 kbit/s);
- the modulating bit rate of signals received by a MES is 1/T forward = 1 625/6 kbit/s (i.e. ≈270,833 kbit/s).

4.2 Start and Stop of the Burst

a) RETURN Link (MES-to-Ground Station):

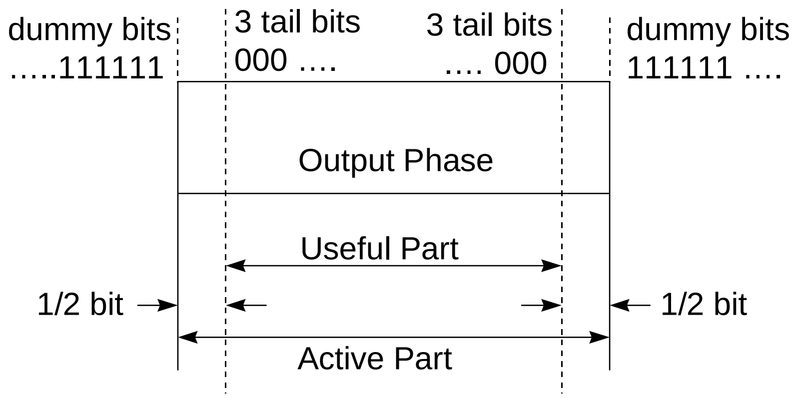
before the first bit of the bursts as defined in GMR-2 05.002 [3] enters the modulator, the modulator has an internal state as if a modulating bit stream consisting of consecutive ones (di = 1) had entered the differential encoder. Also after the last bit of the time slot, the modulator has an internal state as if a modulating bit stream consisting of consecutive ones (di = 1) had continued to enter the differential encoder. These bits are called dummy bits and define the start and the stop of the active part of the burst as illustrated in figure 4.2.1. Nothing is specified about the actual phase of the modulator output signal outside the useful part of the burst.

b) FORWARD Link (Ground Station-to-MES):

not applicable.

c) Single Hop Link (MES-to-MES):

the start and stop of bursts during single hop connections is determined based on the modulation format of a burst. The start and stop of bursts with GMSK modulation format (received from the connecting MES) are as previously described for the RETURN Link, and the start and stop of bursts with filtered OQPSK modulation format (received from a Ground Station) are as previously described for the FORWARD Link.



NOTE: For the normal burst, the useful part lasts for 147 modulating bits.

Figure 4.2.1: Relation Between Active Part of Burst, Tail Bits and Dummy Bits

4.3 Pre-Coding

a) RETURN Link (MES-to-Ground Station):

each data value $d_i = [0,1]$ is differentially encoded;

the output of the differential encoder is:

$$d'_i = d_i \oplus d_{i-1} \quad (d'_i \in \{0, 1\}),$$

where $\oplus$ denotes modulo 2 addition.

The modulating data value α_i input to the modulator is:

$$\alpha_i = 1\text{-}2\, d'_i \quad (\alpha_i \in \{-1, +1\}).$$

b) FORWARD Link (Ground Station-to-MES):

data values $d_i = [0,1]$ are not differentially encoded;

the modulating data value α_i input to the modulator is:

$$\alpha_i = (1-2d_i)\,(-1)^{[i/2]} \quad (\alpha_i \in \{-1, +1\}),$$

where [x] represents the integer part of x.

c) Single Hop Link (MES-to-MES):

data bits are pre-coded to be consistent with the modulation format. Bits which will be GMSK modulated are pre-coded as previously described for the RETURN Link, and bits which will be OQPSK modulated are pre-coded as previously described for the FORWARD Link.

4.4 Filtering

a) RETURN Link (MES-to-Ground Station):

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

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

$$rect(t/T) = 1/T \text{ for } [t] < T/2$$

$$0 \text{ otherwise,}$$

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

$$h(t) = \exp(-t^2/(2\delta^2T^2))/((2\pi)^{0,5}\delta T),$$

where:

$$\delta = (\ln(2))^{0,5}/(2\pi BT) \text{ and } BT = 0,3,$$

where B is the 3 dB bandwidth of the filter with impulse response h(t), and $T = T_{return}$ is the duration of one input data bit as defined in clause 4.1. This theoretical filter is associated with tolerances defined in GMR-2 05.005 [4].

b) FORWARD Link (Ground Station-to-MES):

Dirac impulses of timing corresponding to the even-numbered modulating data values are applied to α_i to provide $m_i(t)$. In other words, the Dirac impulses are spaced at intervals of 2T or T'. Similarly, Dirac impulses of timing corresponding to the odd-numbered modulating data values are applied to α_i to provide $m_q(t)$. $m_i(t)$ and $m_q(t)$ excite a linear filter with the impulse response h(t) of a square root raised cosine filter with a rolloff factor of 0,35. h(t) may be expressed as the inverse Fourier transform of the transfer function H(f). H(f) is defined to be:

$$H(f) = [\ 0,5\ \{1-\sin[\ (\pi/(2r))\ (2|f|T'-1)]\ \}\ ]^{0,5}, \qquad (1-r)/(2T') \le |f| \le (1+r)/(2T')$$

$$1, \quad 0 \le |f| \le (1-r)/(2T')$$

$$0, \quad |f| \ge (1+r)/(2T'),$$

where r is the rolloff factor and $T' = 2T_{forward}$ is the duration of one input data symbol with $T_{forward}$ as defined in clause 4.1. This filter is associated with tolerances as defined in GMR-2 05.005 [4]. Figure 4.5.1 illustrates a theoretical raised cosine filter.

c) Single Hop Link (MES-to-MES):

filtering will be consistent with modulation format. Data which is GMSK modulated will be filtered as previously described for the RETURN Link, and data which is OQPSK modulated will be filtered as previously described for the FORWARD Link.

4.5 Output Phase

a) RETURN Link (MES to-Ground Station):

the phase of the modulated signal is:

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

where the modulating index h is 1/2 (a 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 a shown in figure 4.2.1. This is also the start of the bit period of bit number 0 (the first tail bit) as defined in GMR-2 05.002 [3].

b) FORWARD Link (Ground Station-to-MES):

not applicable.

c) Single Hop Link (MES-to-MES):

the output phase for a signal which is GMSK modulated will be as previously described for the RETURN Link, and the output phase for a signal which is OQPSK modulated will be as previously described for the FORWARD Link.

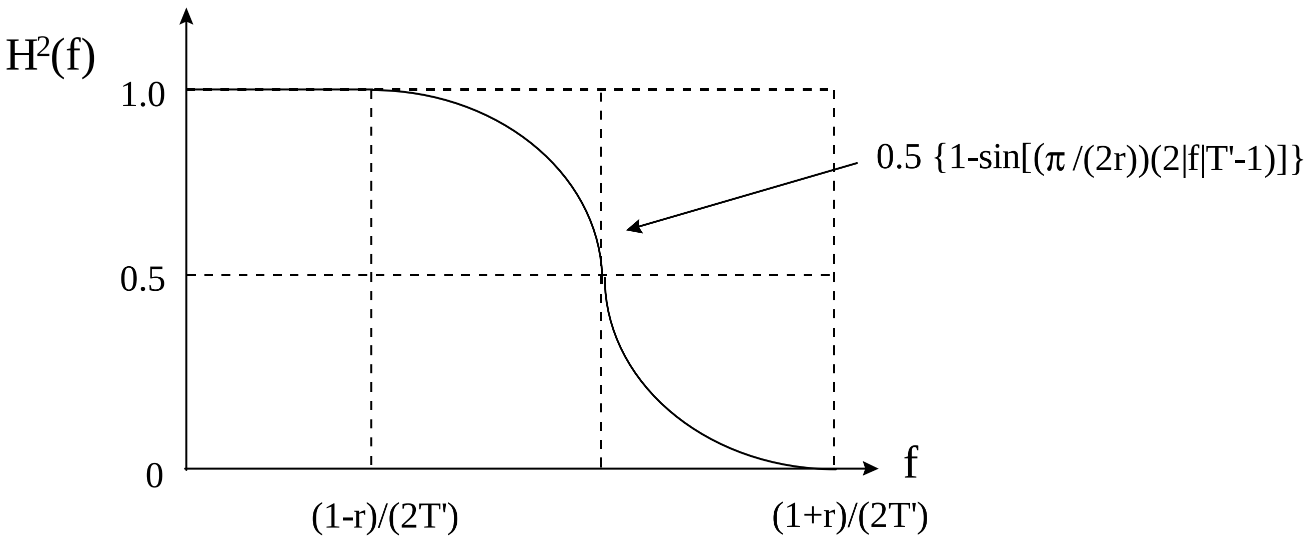


Figure 4.5.1: Raised Cosine Filter [H2(f)]

4.6 Modulation

a) RETURN Link (MES-to-Ground Station):

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.

b) FORWARD Link (Ground Station-to-MES):

the OQPSK carrier is obtained by modulating a cosine carrier with $m_i(t)$ to provide and in-phase (I) channel and by modulating a sine carrier with $m_q(t)$ one-half symbol period later to provide a quadrature (Q) channel. The modulated RF carrier is defined as the sum of the I and Q channels, or:

$$x(t') = (2E_c/T)^{0,5} [m_i(t) \cos (2\pi f_0 t' + \varphi_0) - m_q(t) \sin (2\pi f_0 t' + \varphi_0)],$$

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.

The basic functionality of this modulation scheme is illustrated in figure 4.6.1.

c) Single Hop Link (MES-to-MES):

modulation will be consistent with the source of each data burst. Bursts received from the connecting MES will be modulated as previously described for the RETURN Link, and bursts received from a Ground Station will be modulated as previously described for the FORWARD Link.

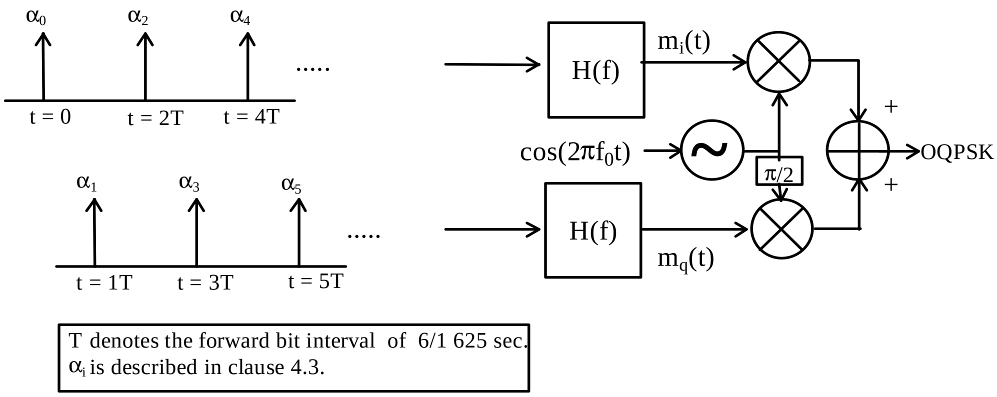


Figure 4.6.1: Basic Functionality of Forward-Link Modulator

History

Document history		
V1.1.1	March 2001	Publication