SLOVENSKI STANDARD
SIST EN 301 926 V1.2.1:2003

01-april-2003

Satelitske zemeljske postaje in sistemi (SES) - Radiofrekvenļ ni in modulacijski standard za telemetrijo, vodenje in merjenje oddaljenosti (TCR) geostacionarnih komunikacijskih satelitov

Satellite Earth Stations and Systems (SES); Radio Frequency and Modulation Standard for Telemetry, Command and Ranging (TCR) of Geostationary Communications Satellites

Ta slovenski standard je istoveten z: **EN 301 926 Version 1.2.1**

ICS:

33.070.40 Satelit Satellite

SIST EN 301 926 V1.2.1:2003 **en**

ETSI EN 301 926 V1.2.1 (2002-06)

European Standard (Telecommunications series)

Satellite Earth Stations and Systems (SES); Radio Frequency and Modulation Standard for Telemetry, Command and Ranging (TCR) of Geostationary Communications Satellites

Reference
DEN/SES-000-ECSS-1

Keywords
control, modulation, satellite, telemetry

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Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

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National transposition dates	
Date of adoption of this EN:	14 June 2002
Date of latest announcement of this EN (doa):	30 September 2002
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 March 2003
Date of withdrawal of any conflicting National Standard (dow):	31 March 2003

1 Scope

The present document applies to Telemetry, Command and Ranging (TCR) systems operating typically in the following bands:

- 5 850 MHz; 6 725 MHz uplink; 3 400 MHz; 4 200 MHz downlink;
- 12 750 MHz; 14 800 MHz and 17 300 MHz; 18 100 MHz uplink; 10 700 MHz; 12 750 MHz downlink;

for Geostationary Communications Satellites.

The present document sets out the minimum performance requirements and technical characteristics of the ground/satellite Radio Frequency (RF) interface partially based on Spread Spectrum Multiple Access (SSMA).

With the growing number of satellites, the co-location constraints and the maximization of bandwidth for Communications Missions, and interference has motivated the elaboration of the present document for geostationary satellites based on Spread Spectrum techniques.

The present document addresses the following applications:

- Telemetry;
- Command (Telecommand);
- Ranging.

Currently, no RF and Modulation standard exists for the TCR of geostationary communication satellites. The aim of the present document is to respond to such requirements. There are consequently similarities with existing agency standards, such as those listed in annex I, although some specifics have been introduced to respond to the requirement of multiple access for collocated geostationary communication satellites.

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] ETSI TR 101 956: "Satellite Earth Stations and Systems (SES); Technical analysis of Spread Spectrum Solutions for Telemetry Command and Ranging (TCR) of Geostationary Communications Satellites".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

binary channel: binary communications channel (BPSK has 1 channel, QPSK has 2 channels)

Spread Spectrum Multiple Access (SSMA)(== Code Division Multiple Access (CDMA)): modulation of a carrier by a code sequence, with association of a code to each user

data rate: total number of uncoded data bits per second after packet and frame encoding

NOTE: See figures 1 and 2. This is the Data Rate used in Link Budgets in [1].

symbol rate: rate of binary elements, considered on a single wire, after FEC coding

NOTE: See figures 1 and 2.

channel symbol rate: rate of binary elements, considered on a single wire, after FEC coding and channel allocation

NOTE: See figure 2. This applies only to multi-channel modulations, thus to spread spectrum QPSK modes and not to standard PM/FM modes.

Co-located Equivalent Capacity (CEC): number of collocated satellites that can be controlled with a perfect power balanced link between the ground and the satellite

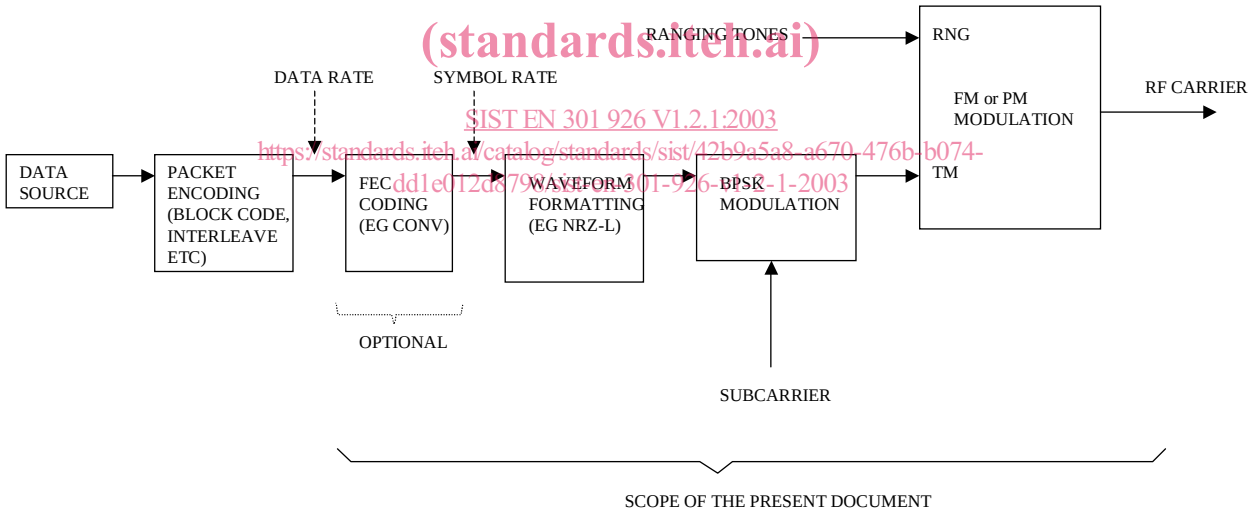

Figure 1: Functional stages of transmit chain for standard modulation

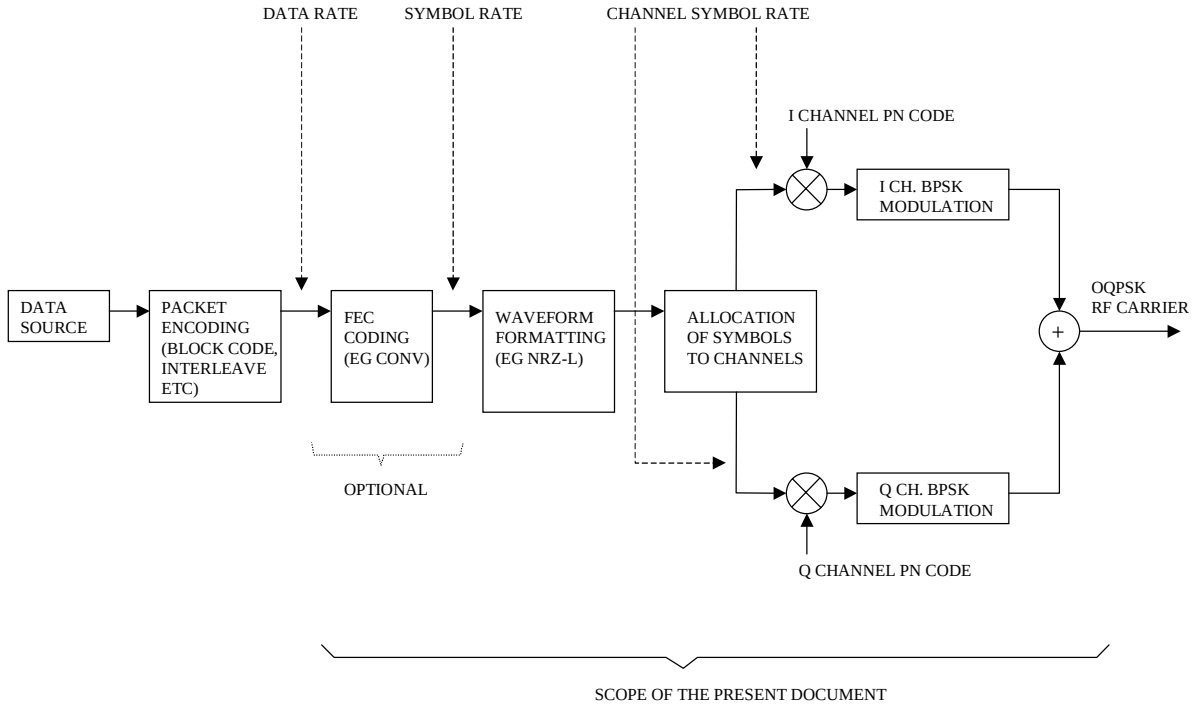

Figure 2: Functional stages of transmission chain for spread spectrum modulation

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

BPSK	Binary Phase Shift Keying
CDMA	Code Division Multiple Access
CEC	Co-located Equivalent Capacity
COM	COMmunication channel
CW	Continuous Wave
DSSS	Direct Sequence Spread Spectrum
DRSS	Data Relay Satellite System (ESA)
DRTS	Data Relay and Tracking System (NASDA)
ECSS	European Co-operation for Space Standardization
ESA	European Space Agency
FEC	Forward Error Correction
FM	Frequency Modulation
GTO	Geostationary Transfer Orbit
HPA	High Power Amplifier
LEOP	Launch and Early Orbit Phase
MTC1	TeleCommand Mode 1
MTC2	TeleCommand Mode 2
MTM1	TeleMetry Mode 1
MTM2	TeleMetry Mode 2
MTM3	TeleMetry Mode 3
NASA	National Aeronautics and Space Administration (USA)
NASDA	National Astronautics and Space Development Administration (Japan)
NRZ-L	Non Return to Zero-Level
NRZ-M	Non Return to Zero-Mark
OQPSK	Offset Quaternary Phase Shift Keying
PCM	Pulse Coded Modulation
PDF	Probability Density Function
PM	Phase Modulation
PN	Pseudo Noise

PSD	Power Spectral Density
QPSK	Quaternary Phase Shift Keying
RF	Radio Frequency
RG	RanGing
SP-L	Split Phase-Level (alias Bi-Φ -Level or Manchester encoded)
SRRC	Square Root Raised Cosine
SS	Spread Spectrum
SSMA	Spread Spectrum Multiple Access
STD	STanDard (for standard modulation)
TC	TeleCommand
TCR	Telemetry, Command and Ranging
TDRSS	Tracking and Data Relay Satellite System (NASA)
TM	TeleMetry
TTC/TT&C	Telemetry Tracking and Command (== Telemetry, Command and Ranging, TCR)
UQPSK	Unbalanced Quaternary Phase Shift Keying
w.r.t	with respect to

4 Applicability

The present document applies to the typical TCR scenario shown in figure 3. The scenario comprises k satellites, which may be co-located on the same orbital position. Each satellite also goes through other mission phases like LEOP, drift and possibly emergency mode. These satellites may be controlled/monitored by N different TCR Ground Stations. The TCR links defined in the present document have to coexist with the Communication ground terminals and associated links also shown in figure 3.

The present document defines the modulation on the TCR links. Modulation formats are described in clause 5 and the associated mission phases are described in annex A.

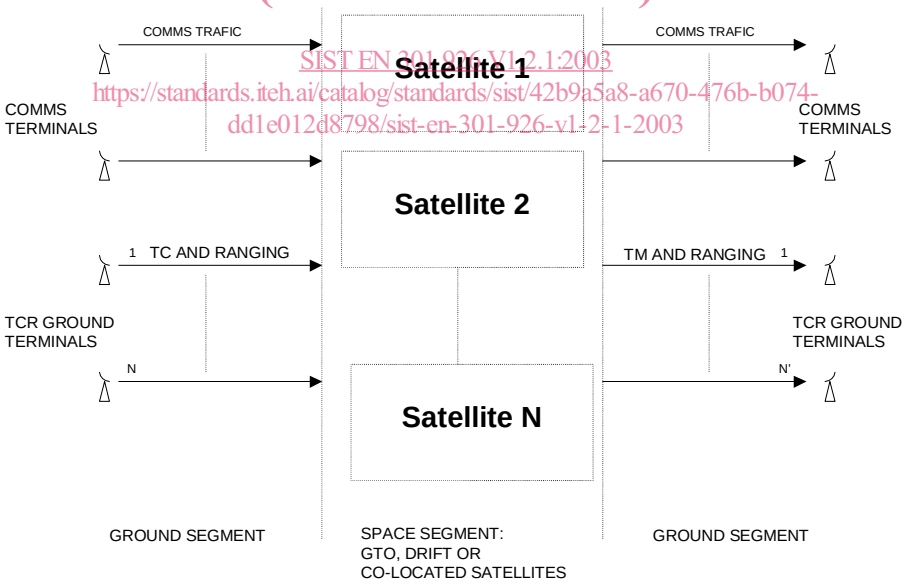

Figure 3: Typical applicable scenario

5 Modulation requirements

5.1 General

The generic system functional block diagram is shown in figure 4. Modulation modes and configurations are shown in table 1.

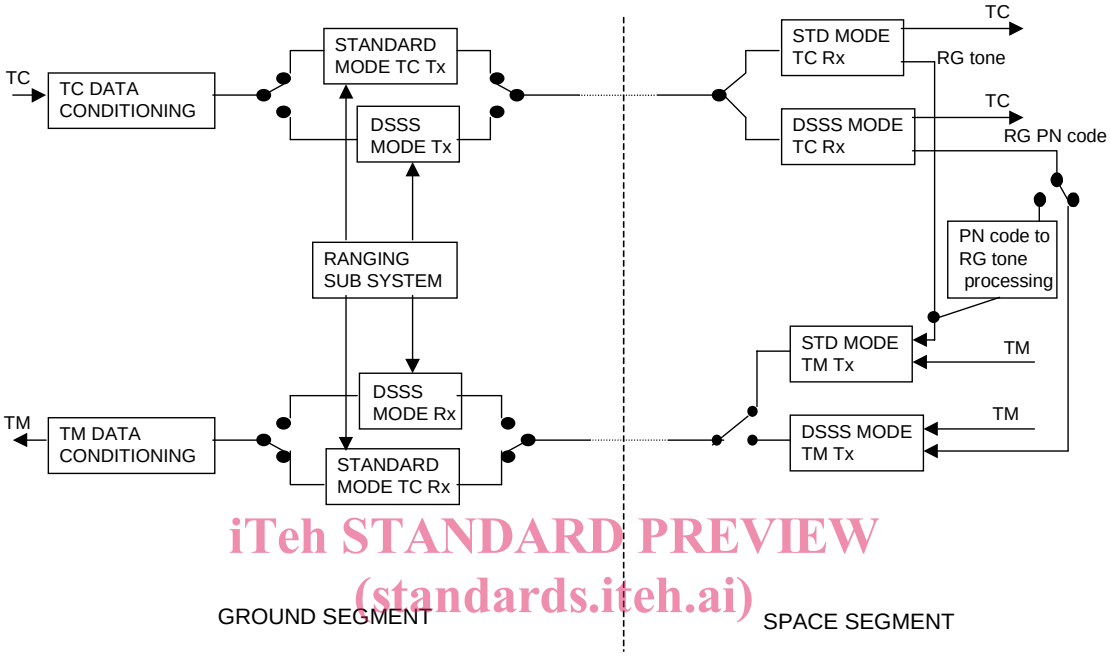

Figure 4: Generic system functional block diagram

Table 1: Modulation modes and potential configurations

	All standard mode	All spread mode	Hybrid mode
Uplink	MTC1: PCM/BPSK/FM	MTC2: PCM/SRRC-UQPSK	MTC2: PCM/SRRC-UQPSK
Downlink (with ranging (see note): requires uplink present)	MTM1: PCM/BPSK/PM	MTM2: PCM/SRRC-OQPSK (PN code clock/epoch sync to uplink clock/epoch)	MTM1: PCM/BPSK/PM
Downlink (without ranging: can operate without uplink present))	MTM1: PCM/BPSK/PM	MTM3: PCM/SRRC-OQPSK (PN code clock/epoch independent of uplink clock/epoch)	MTM1: PCM/BPSK/PM
NOTE: Further definition of ranging signals is given in following clauses.			

In order to retain backward compatibility with existing ground networks and to allow simple operation during LEOP, in addition to the new Spread Spectrum modes, the existing "standard" FM/PM modulation modes are retained. It is envisaged that telecommand and telemetry modulation formats shall be independently configurable, allowing for example the following configuration possibilities (see also annex A for implementations and TR 101 956 [1]):

- all standard mode (as has existed in previous systems) using tone ranging on FM uplink (MTC1) and PM (MTM1) downlink;
- all spread mode (Direct Sequence Spread Spectrum: DSSS) using PN spreading code regenerative ranging on suppressed carrier up-and down-links (MTC2 and MTM2);
- hybrid mode using PN spreading code ranging on suppressed carrier DSSS uplink (MTC2), and tone ranging on PM downlink (MTM1).

In addition, on the spread spectrum (DSSS) mode downlink, there are 2 PN code sets defined, for coherent and non-coherent modes (modes MTM2 and MTM3 respectively). The physical partitioning of the functions may not exactly follow that shown in the system functional block diagram. The modulation configuration of the various modes is described in the rest of clause 5. Possible allocation of modes to mission phases is defined in annex A.

5.2 Standard modulation

The Standard mode modulation formats shall be Frequency Modulation (FM) on Telecommand uplink and Phase Modulation (PM) on Telemetry downlink. The standard modes shall be known as MTC1 and MTM1 respectively.

5.2.1 Modulating waveforms

The following modulating waveforms are permitted in standard modes:

- Telemetry (mode MTM1): a sine wave sub carrier, itself BPSK modulated by PCM data;
- Telecommand (mode MTC1): a sine wave subcarrier, itself BPSK modulated by PCM data;
- Ranging (mode MTC1 + MTM1): an unmodulated sinewave subcarrier or combination of a number of such subcarriers.