ETSI TS 101 851-3-1 V2.1.1 (2008-01)

Technical Specification

Satellite Earth Stations and Systems (SES);
Satellite Component of UMTS/IMT-2000;
Part 3: Spreading and modulation;
Sub-part 1: G-family (S-UMTS-G 25.213)

Reference

RTS/SES-00298-3-1

Keywords

interface, MES, MSS, radio, satellite, UMTS

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Foreword

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

The present document is specifying the Satellite Radio Interface referenced as SRI Family G at ITU-R, in the frame of the modification of ITU-R Recommendation M.1457 [4]. This modification has been approved at SG8 meeting in November 2005.

The present document is part 3, sub-part 1 of a multi-part deliverable covering Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; G-family, as identified below:

Part 1: "Physical channels and mapping of transport channels into physical channels";

Part 2: "Multiplexing and channel coding";

Part 3: "Spreading and modulation";

Sub-part 1: "G-family (S-UMTS-G 25.213)";

Sub-part 2: "A-family (S-UMTS-A 25.213)";

Part 4: "Physical layer procedures";

Part 5: "UE Radio Transmission and Reception";

Part 6: "Ground stations and space segment radio transmission and reception".

Introduction

S-UMTS stands for the Satellite component of the Universal Mobile Telecommunication System. S-UMTS systems will complement the terrestrial UMTS (T-UMTS) and inter-work with other IMT-2000 family members through the UMTS core network. S-UMTS will be used to deliver 3rd generation Mobile Satellite Services (MSS) utilizing either low (LEO) or medium (MEO) earth orbiting, or geostationary (GEO) satellite(s). S-UMTS systems are based on terrestrial 3GPP specifications and will support access to GSM/UMTS core networks.

NOTE 1: The term T-UMTS will be used in the present document to further differentiate the Terrestrial UMTS component.

Due to the differences between terrestrial and satellite channel characteristics, some modifications to the terrestrial UMTS (T-UMTS) standards are necessary. Some specifications are directly applicable, whereas others are applicable with modifications. Similarly, some T-UMTS specifications do not apply, whilst some S-UMTS specifications have no corresponding T-UMTS specification.

Since S-UMTS is derived from T-UMTS, the organization of the S-UMTS specifications closely follows the original 3rd Generation Partnership Project (3GPP) structure. The S-UMTS numbers have been designed to correspond to the 3GPP terrestrial UMTS numbering system. All S-UMTS specifications are allocated a unique S-UMTS number as follows:

S-UMTS-n xx.yyy

Where:

- The numbers xx and yyy correspond to the 3GPP numbering scheme.
- n (n = A, B, C, etc.) denotes the family of S-UMTS specifications.

An S-UMTS system is defined by the combination of a family of S-UMTS specifications and 3GPP specifications, as follows:

- If an S-UMTS specification exists it takes precedence over the corresponding 3GPP specification (if any). This precedence rule applies to any references in the corresponding 3GPP specifications.

NOTE 2: Any references to 3GPP specifications within the S-UMTS specifications are not subject to this precedence rule.

EXAMPLE: An S-UMTS specification may contain specific references to the corresponding 3GPP specification.

- If an S-UMTS specification does not exist, the corresponding 3GPP specification may or may not apply. The exact applicability of the complete list of 3GPP specifications shall be defined at a later stage.

1 Scope

The present document describes spreading and modulation for the Physical Layer for family G of the satellite component of UMTS (S-UMTS-G).

It is based on the FDD mode of UTRA defined by TS 101 851-1-1 [1], TS 101 851-2-1 [2], TS 101 851-4-1 [3] and adapted for operation over satellite transponders.

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.

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

For online referenced documents, information sufficient to identify and locate the source shall be provided. Preferably, the primary source of the referenced document should be cited, in order to ensure traceability. Furthermore, the reference should, as far as possible, remain valid for the expected life of the document. The reference shall include the method of access to the referenced document and the full network address, with the same punctuation and use of upper case and lower case letters.

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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] ETSI TS 101 851-1-1: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 1: Physical channels and mapping of transport channels into physical channels; Sub-part 1: G-family (S-UMTS-G 25.211)".

[2] ETSI TS 101 851-2-1: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 2: Multiplexing and channel coding; Sub-part 1: G-family (S-UMTS-G 25.212)".

[3] ETSI TS 101 851-4-1: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 4: Physical layer procedures; Sub-part 1: G-family (S-UMTS-G 25.214)".

[4] ITU-R Recommendation M.1457 (2006): "Detailed specifications of the radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)".

3 Symbols and abbreviations

3.1 Symbols

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

$C_{ch,SF,n}$	n:th channelization code with spreading factor SF
$C_{pre,n,s}$	PRACH preamble code for *n*:th preamble scrambling code and signature *s*
$C_{sig,s}$	PRACH/PCPCH signature code for signature *s*
$S_{dpch,n}$	*n*:th DPCCH/DPDCH uplink scrambling code
$S_{r\text{-}pre,n}$	*n*:th PRACH preamble scrambling code
$S_{r\text{-}msg,n}$	*n*:th PRACH message scrambling code
$S_{dl,n}$	DL scrambling code
C_{psc}	PSC code
$C_{ssc,n}$	n:th SSC code

3.2 Abbreviations

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

AICH	Acquisition Indicator CHannel
CCPCH	Common Control Physical CHannel
CPICH	Common PIlot CHannel
DCH	Dedicated CHannel
DPCCH	Dedicated Physical Control CHannel
DPCH	Dedicated Physical CHannel
DPDCH	Dedicated Physical Data CHannel
DTX	Discontinuous Transmission
FDD	Frequency Division Duplex
GEO	Geostationary Earth Orbit
LEO	Low Earth Orbit
Mcps	Mega chip per second
MEO	Medium Earth Orbit
MICH	MBMS Indication CHannel
MSS	Mobile Satellite Services
OVSF	Orthogonal Variable Spreading Factor (codes)
PICH	Page Indication CHannel
PRACH	Physical Random Access CHannel
PSC	Primary Synchronization Code
QPSK	Quaternary Phase Shift Keying
SCH	Synchronization CHannel
SF	Spreading Factor
SSC	Secondary Synchronization Code
USRAN	UMTS Satellite Radio Access Network
UTRA	UMTS Terrestrial Radio Access

4 Uplink spreading and modulation

4.1 Overview

Spreading is applied to the physical channels. It consists of two operations. The first is the channelization operation, which transforms every data symbol into a number of chips, thus increasing the bandwidth of the signal. The number of chips per data symbol is called the Spreading Factor (SF). The second operation is the scrambling operation, where a scrambling code is applied to the spread signal.

With the channelization, data symbols on so-called I- and Q-branches are independently multiplied with an OVSF code. With the scrambling operation, the resultant signals on the I- and Q-branches are further multiplied by complex-valued scrambling code, where I and Q denote real and imaginary parts, respectively.

4.2 Spreading

4.2.1 DPCCH/DPDCH

Figure 1 illustrates the principle of the uplink spreading of DPCCH and DPDCHs. The binary DPCCH and DPDCHs to be spread are represented by real-valued sequences, i.e. the binary value "0" is mapped to the real value +1, and the binary value "1" is mapped to the real value -1. The DPCCH is spread to the chip rate by the channelization code c_c. The *n*:th DPDCH called $DPDCH_n$ is spread to the chip rate by the channelization code $c_{d,n}$. One DPCCH, up to six parallel DPDCHs, i.e. $1 \leq n \leq 6$.

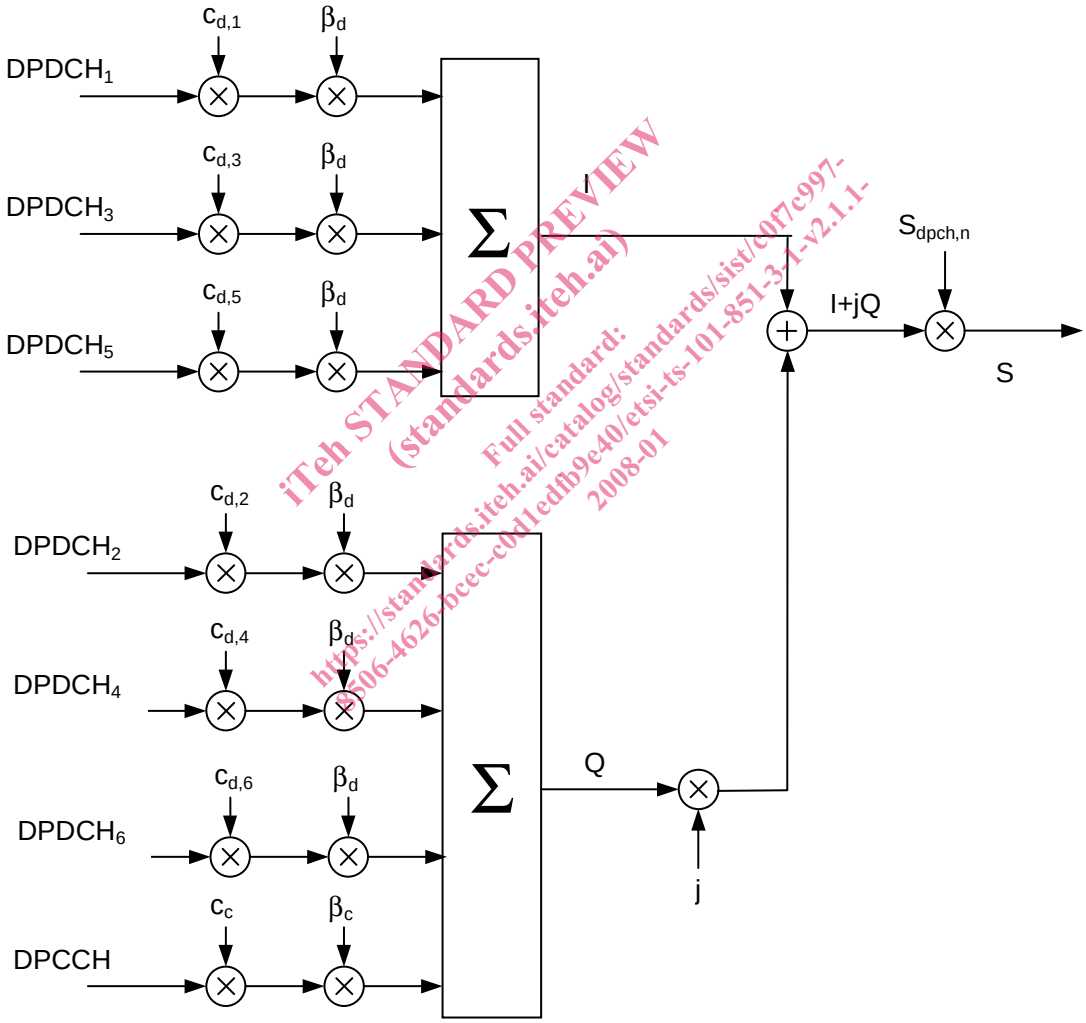

Figure 1: Spreading for uplink DPCCH and DPDCHs

After channelization, the real-valued spread signals are weighted by gain factors, β_c for DPCCH, and β_d for all DPDCHs.

The β_c and β_d values are signalled by higher layers or calculated as described in TS 101 851-4-1 [3]. At every instant in time, at least one of the values β_c and β_d has the amplitude 1,0. The β_c and β_d values are quantized into 4 bit words. The quantization steps are given in table 1.

Table 1: The quantization of the gain parameters

Signalling values for β_c and β_d	Quantized amplitude ratios β_c and β_d
15	1,0
14	14/15
13	13/15
12	12/15
11	11/15
10	10/15
9	9/15
8	8/15
7	7/15
6	6/15
5	5/15
4	4/15
3	3/15
2	2/15
1	1/15
0	Switch off

After the weighting, the stream of real-valued chips on the I- and Q-branches are then summed and treated as a complex-valued stream of chips. This complex-valued signal is then scrambled by the complex-valued scrambling code $S_{dpch,n}$. The scrambling code is applied aligned with the radio frames, i.e. the first scrambling chip corresponds to the beginning of a radio frame.

4.2.2 PRACH

4.2.2.1 PRACH preamble part

The PRACH preamble part consists of a complex-valued code, described in clause 4.3.3.

4.2.2.2 PRACH message part

Figure 2 illustrates the principle of the spreading and scrambling of the PRACH message part, consisting of data and control parts. The binary control and data parts to be spread are represented by real-valued sequences, i.e. the binary value "0" is mapped to the real value +1, while the binary value "1" is mapped to the real value -1. The control part is spread to the chip rate by the channelization code c_c, while the data part is spread to the chip rate by the channelization code c_d.

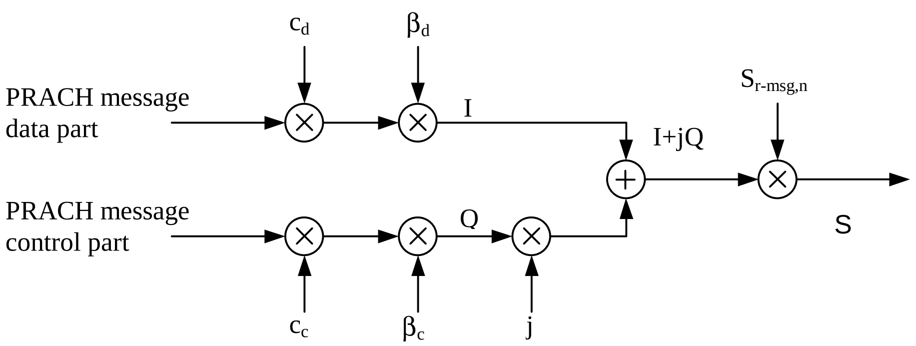

Figure 2: Spreading of PRACH message part

After channelization, the real-valued spread signals are weighted by gain factors, β_c for the control part and β_d for the data part. At every instant in time, at least one of the values β_c and β_d has the amplitude 1,0. The β-values are quantized into 4 bit words. The quantization steps are given in clause 4.2.1.

After the weighting, the stream of real-valued chips on the I- and Q-branches is treated as a complex-valued stream of chips. This complex-valued signal is then scrambled by the complex-valued scrambling code $S_{r\text{-}msg,n}$. The 10 ms scrambling code is applied aligned with the 10 ms message part radio frames, i.e. the first scrambling chip corresponds to the beginning of a message part radio frame.

4.3 Code generation and allocation

4.3.1 Channelization codes

4.3.1.1 Code definition

The channelization codes of figure 1 are Orthogonal Variable Spreading Factor (OVSF) codes that preserve the orthogonality between a user's different physical channels. The OVSF codes can be defined using the code tree of figure 3.

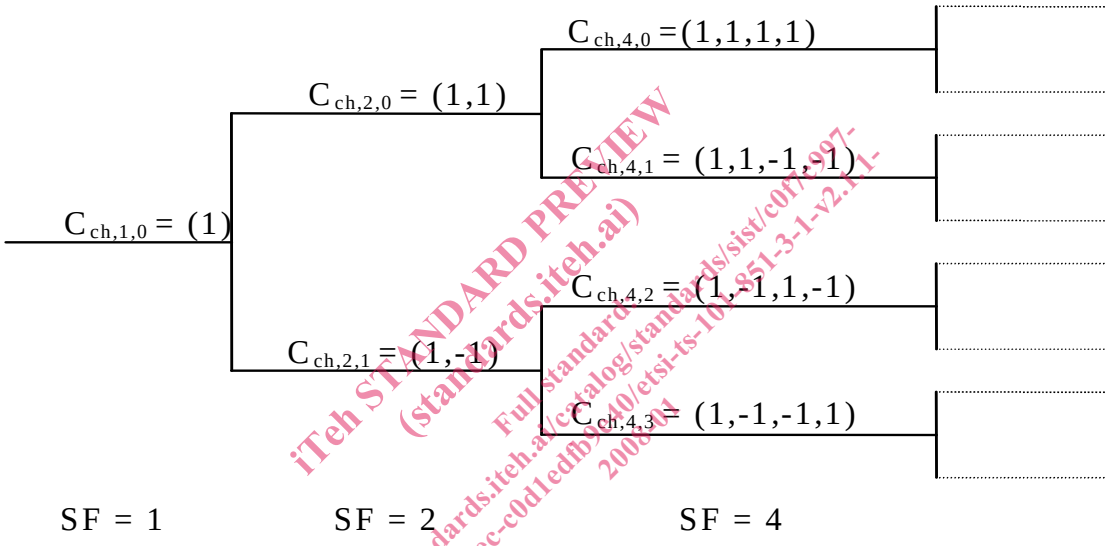

Figure 3: Code-tree for generation of Orthogonal Variable Spreading Factor (OVSF) codes

In figure 3, the channelization codes are uniquely described as $C_{ch,SF,k}$, where SF is the spreading factor of the code and k is the code number, $0 \leq k \leq SF- 1$.

Each level in the code tree defines channelization codes of length SF, corresponding to a spreading factor of SF in figure 3.

The generation method for the channelization code is defined as:

$$C_{ch,1,0} = 1,$$

$$\begin{bmatrix} C_{ch,2,0} \\ C_{ch,2,1} \end{bmatrix} = \begin{bmatrix} C_{ch,1,0} & C_{ch,1,0} \\ C_{ch,1,0} & -C_{ch,1,0} \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$