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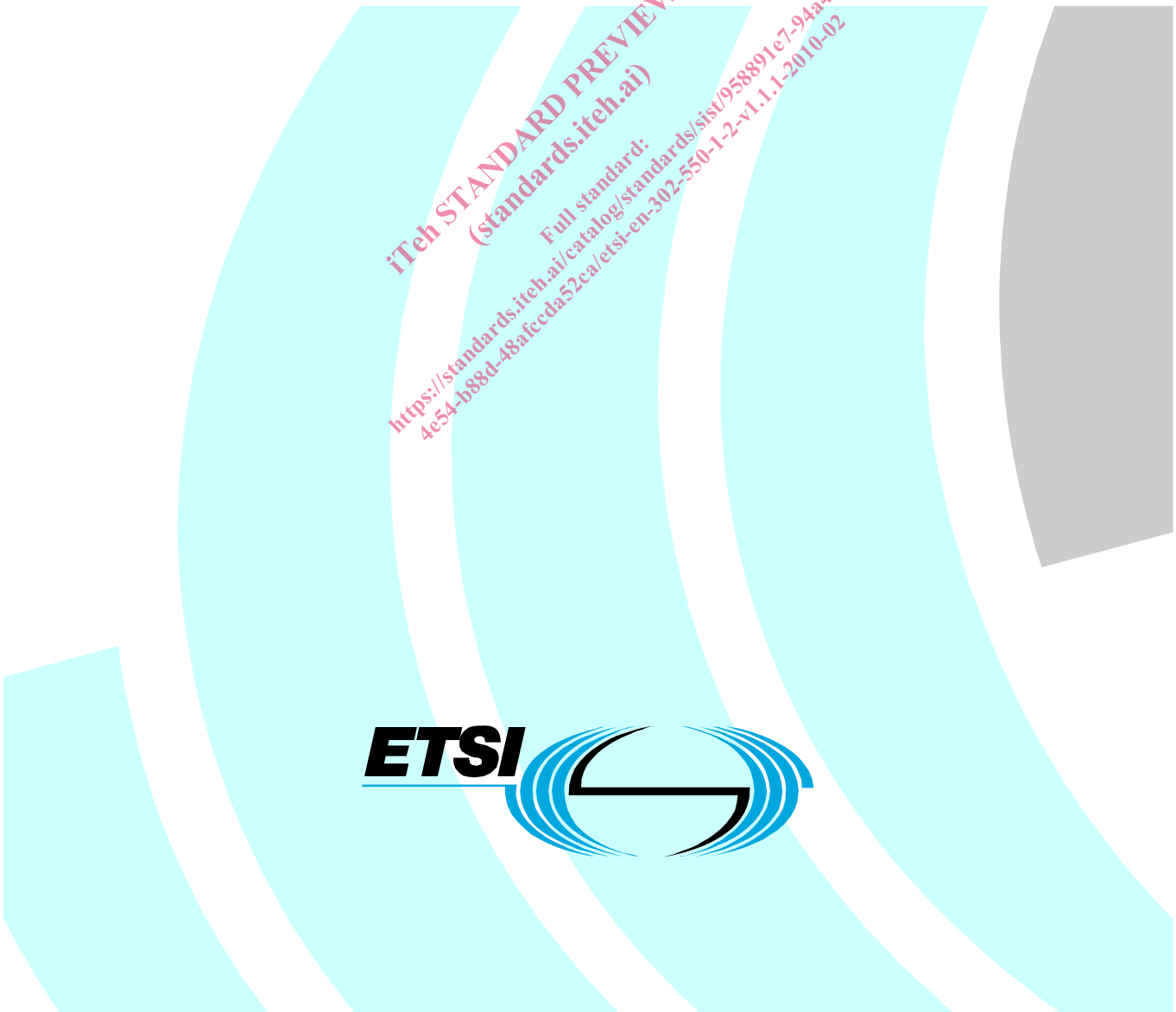
European Standard (Telecommunications series)

Satellite Earth Stations and Systems (SES); Satellite Digital Radio (SDR) Systems; Part 1: Physical Layer of the Radio Interface; Sub-part 2: Inner Physical Layer Single Carrier Modulation



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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES), and is now submitted for the Vote phase of the ETSI standards Two-step Approval Procedure.

The present document is part 1, sub-part 2 of a multi-part deliverable. Full details of the entire series can be found in part 1, sub-part 1 [i.4].

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Introduction

An SDR system enables broadcast to fixed and mobile receivers through satellites and complementary terrestrial transmitters. Functionalities, architecture and technologies of such systems are described in TR 102 525 [i.5].

Several existing and planned ETSI standards specify parts of the SDR system, with the aim of interoperable implementations. The physical layer of the radio interface (air interface) is divided up into the outer physical layer, the inner physical layer with single carrier modulation, and the inner physical layer with multi carrier modulation. These parts can be used all together in SDR compliant equipment, or in conjunction with other existing and future specifications.

The present document specifies the inner physical layer with single carrier modulation. The inner physical layer with multi carrier modulation is specified in EN 302 550-1-3 [i.3], and the outer physical layer in EN 305 550-1-1 [i.4]. Guidelines for using the physical layer standard can be found in TR 102 604 [i.6].

The physical layer specifications have previously been published as "Technical Specification (TS)" type ETSI deliverables. The present document supersedes TS 102 551-1 [i.7] and is recommended for new implementations. The functional difference between the previous TS 102 551-1 [i.7] and the present document is that the exclusion of the IPL-MC Mode 1 is taken into account.

1 Scope

The present document concerns the radio interface of SDR broadcast receivers. It specifies functionality of the inner physical layer with single carrier modulation. It allows implementing this part of the system in an interoperable way.

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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NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

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.

Not applicable.

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.

[i.1] ETSI EN 302 307 (V1.1.1): "Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications".

[i.2] ITU-T Recommendation O.153 (1992): "Basic parameters for the measurement of error performance at bit rates below the primary rate".

[i.3] ETSI EN 302 550-1-3: "Satellite Earth Stations and Systems (SES); Satellite Digital Radio (SDR) Systems; Part 1: Physical Layer of the Radio Interface; Sub-part 3: Inner Physical Layer Multi Carrier Modulation".

[i.4] ETSI EN 302 550-1-1: "Satellite Earth Stations and Systems (SES); Satellite Digital Radio (SDR) Systems; Part 1: Physical Layer of the Radio Interface; Sub-part 1: Outer Physical Layer".

[i.5] ETSI TR 102 525 (V1.1.1): "Satellite Earth Stations and Systems (SES); Satellite Digital Radio (SDR) service; Functionalities, architecture and technologies".

[i.6] ETSI TR 102 604: "Satellite Earth Stations and Systems (SES); Satellite Digital Radio (SDR) Systems; Guidelines for the use of the physical layer standards".

[i.7] ETSI TS 102 551-1 (V1.1.1): "Satellite Earth Stations and Systems (SES); Satellite Digital Radio (SDR) Systems; Inner Physical Layer of the Radio Interface; Part 1: Single Carrier Transmission".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

floor function: function that rounds number down, towards zero, to the nearest integer

3.2 Symbols

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

α	roll off factor

3.3 Abbreviations

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

16APSK	16 Amplitude and Phase Shift Keying
8PSK	8 Phase Shift Keying
BW	BandWidth
C/N	Carrier to Noise ratio
C-TS	Channel Transport Stream
CU	Capacity Unit
DVB	Digital Video Broadcasting
I	In-phase
IPL	Inner Physical Layer
IPL-MC	Inner Physical Layer, Multi Carrier
IPL-SC	Inner Physical Layer, Single Carrier
ISI	Inter Symbol Interference
ksps	kilo symbols per second
LSB	Least Significant Bit
MSB	Most Significant Bit
Msps	Mega symbols per second
OPL	Outer Physical Layer
Q	Quadrature
QPSK	Quaternary Phase Shift Keying
RF	Radio Frequency
RFU	Reserved for Future Use
S-TS	Service Transport Stream

4 Inner physical layer - Single Carrier

The functionality of the Inner Physical Layer (Single Carrier), in the following denoted IPL-SC, is to provide a robust modulation scheme for single carrier transmissions. The single carrier modulation is mainly applicable to satellite signal transmission but may be reused in other transmission environments. However, certain parameters are especially designed and optimized for satellite requirements.

The IPL-SC is embedded between the OPL (C-TS delivery) and the RF frontend (modulation) as depicted in figure 1.

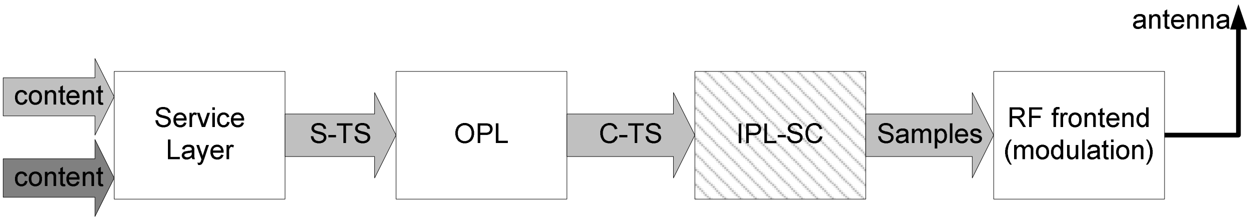

Figure 1: General block diagram of the ETSI SES SDR system concept with selection of IPL-SC

The general block diagram of the IPL-SC functionality is given in figure 2. Please notify that the generation of each Phy section can be handled individually (dashed box), whereas rolloff filtering is applied to the stream of mapped symbols of many Phy section (due to its dispersive nature).

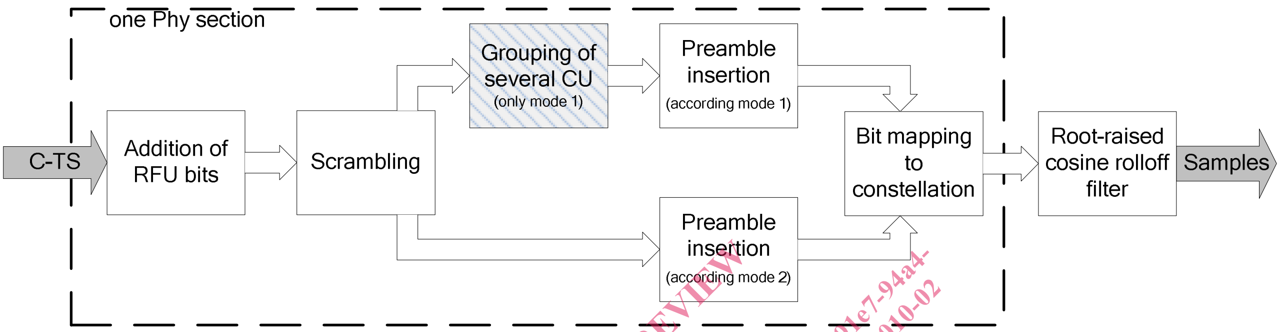

Figure 2: Block diagram of the ETSI SES SDR compliant IPL-SC

4.1 Interfacing to OPL (Outer Physical Layer)

Its interface to the OPL (Outer Physical Layer) is the C-TS (channel transport stream), which is defined in EN 302 550-1-1 [i.4]. For this special IPL-SC, the parameters which are passed to the OPL are derived within EN 302 550-1-1 [i.4].

This IPL-SC provides an input for only one single C-TS and generates the signal for one RF carrier. If more than one carrier needs to be supported, multiple instances of the IPL-SC need to be instantiated in parallel.

The parameters that are passed to the OPL are as follows:

- frame length in integer number of CU (capacity units).

One IPL-SC frame is composed by a number of Phy sections. Their parameters are denoted in clause 5.

As different modes are distinguished (see clause 4.3), the interfacing to the OPL is also slightly different for the two modes:

- For mode 1, it is mandatory to have integer numbers of CU which can be divided without remainder by 2 (for QPSK), by 3 (for 8PSK) and by 4 (for 16APSK). Other numbers of CU lead to Phy sections that miss some CU, and non-periodic preamble structure would be introduced.

- For mode 2, it is desirable to have integer numbers of CU which can be divided without remainder by 2 (for QPSK), by 3 (for 8PSK) and by 4 (for 16APSK). Other numbers of CU lead to non-periodic preamble structure for the different modulation orders.

Examples for a reasonable choice of parameters are given in clause 5.

With these parameters, the exact throughput of the IPL-SC can be derived in CU per time. The smallest unit to be processed by the IPL-SC is one CU.

To be able to benefit from the gain of hybrid configurations (e.g. using IPL-SC together with IPL-MC), it is mandatory to have equal frame lengths on both IPLs.

If modes 2, 2s, 3 or 4 of the IPL-MC [i.3] were used, the joint frame length of 432 ms is chosen for the IPL-MC frame length.

4.2 The profile approach - different single carrier modes

To cope with different design constraints that arise from the possible use scenarios of the IPL-SC, two modes (denoted mode 1 and mode 2) are defined which use a different share of pilots.

These modes are associated to profiles that are distinguished by their symbol rate and number of capacity units per inserted preamble, so that their adaptation to different channel bandwidths is easily possible. Profile IPL-SC-A is related to mode 1, and IPL-SC-B is related to mode 2, respectively.

For each profile, two examples are given.

To comply with the different profiles, profile IPL-SC-A needs to be capable to work with all symbol rates ranging from 3 Msps up to 12 Msps. A granularity (or step-size) of 88 ksps for the choice of symbol rates is provided in mode 1.

If compliance with profile IPL-SC-B is desired, symbol rates ranging from 1 Msps up to 3 Msps need to be supported. A granularity (or step-size) of 5 ksps for the choice of symbol rates is provided in mode 2.

The main target frequency bands and channel bandwidths are:

Table 1: Different examples for the two profiles IPL-SC-A and IPL-SC-B

	S-Band 4,31 Msps			L-Band 10,87 Msps	L-Band 1,84 Msps	L-Band or S-Band 1,49 Msps
Profile name	IPL-SC-A			IPL-SC-A	IPL-SC-B	IPL-SC-B
Supported modes	1			1	2	2
Carrier frequency	2,0 GHz to 2,3 GHz			1,4 GHz to 1,5 GHz	1,4 GHz to 1,5 GHz	1,4 GHz to 1,5 GHz 2,0 GHz to 2,3 GHz
Channel bandwidth	4,96 MHz			12,5 MHz	2,12 MHz	1,71 MHz
Symbol rate	4,31 Msps			10,87 Msps	1,84 Msps	1,49 Msps
min/max symbol rate	3 Msps/12 Msps			3 Msps / 12 Msps	1 Msps / 3 Msps	1 Msps / 3 Msps
IPL-SC frame length	432 ms			432 ms	432 ms	432 ms

The present document does not restrict its use to the application scenarios as denoted above. Other frequency bands or channel bandwidths may be used but the parameter selection may not be optimal.

4.3 Generation of one Phy section

4.3.1 Overview

One Phy section consists of the following 3 parts:

- preamble;
- data payload (capacity units, CU, etc.);
- signalling bits (RFU: reserved for future use).

Insertion of preambles is different for mode 1 and mode 2, therefore the preamble insertion is distinguished within the following clauses.

4.3.1.1 Overview of mode 1

Figure 3 displays the generation of one Phy section in mode 1.

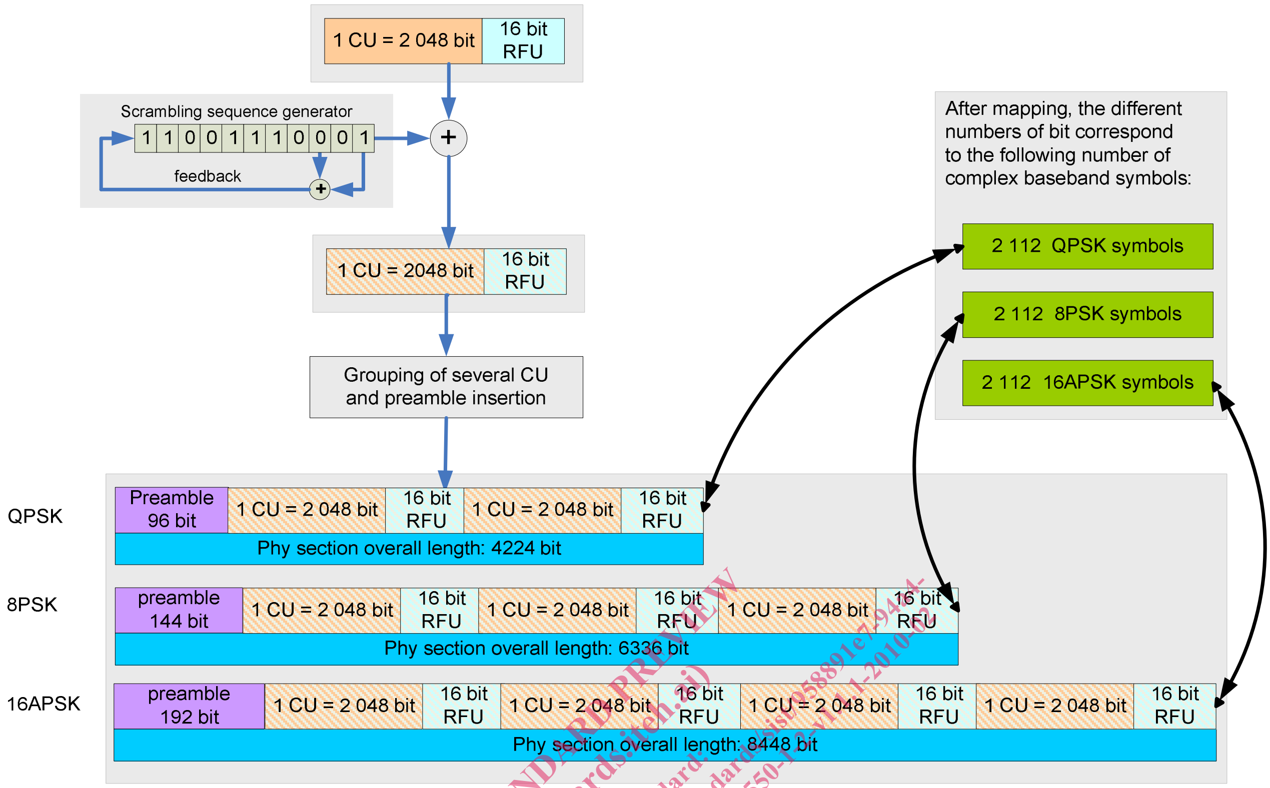

Figure 3: Overview of the generation of one Phy section in mode 1

The length of one Phy section (in bit) depends on the chosen modulation order. The number of complex baseband symbols after mapping is kept constant in mode 1 to be 2 112 symbols for all three modulation orders. The procedure to generate one Phy section is described below.