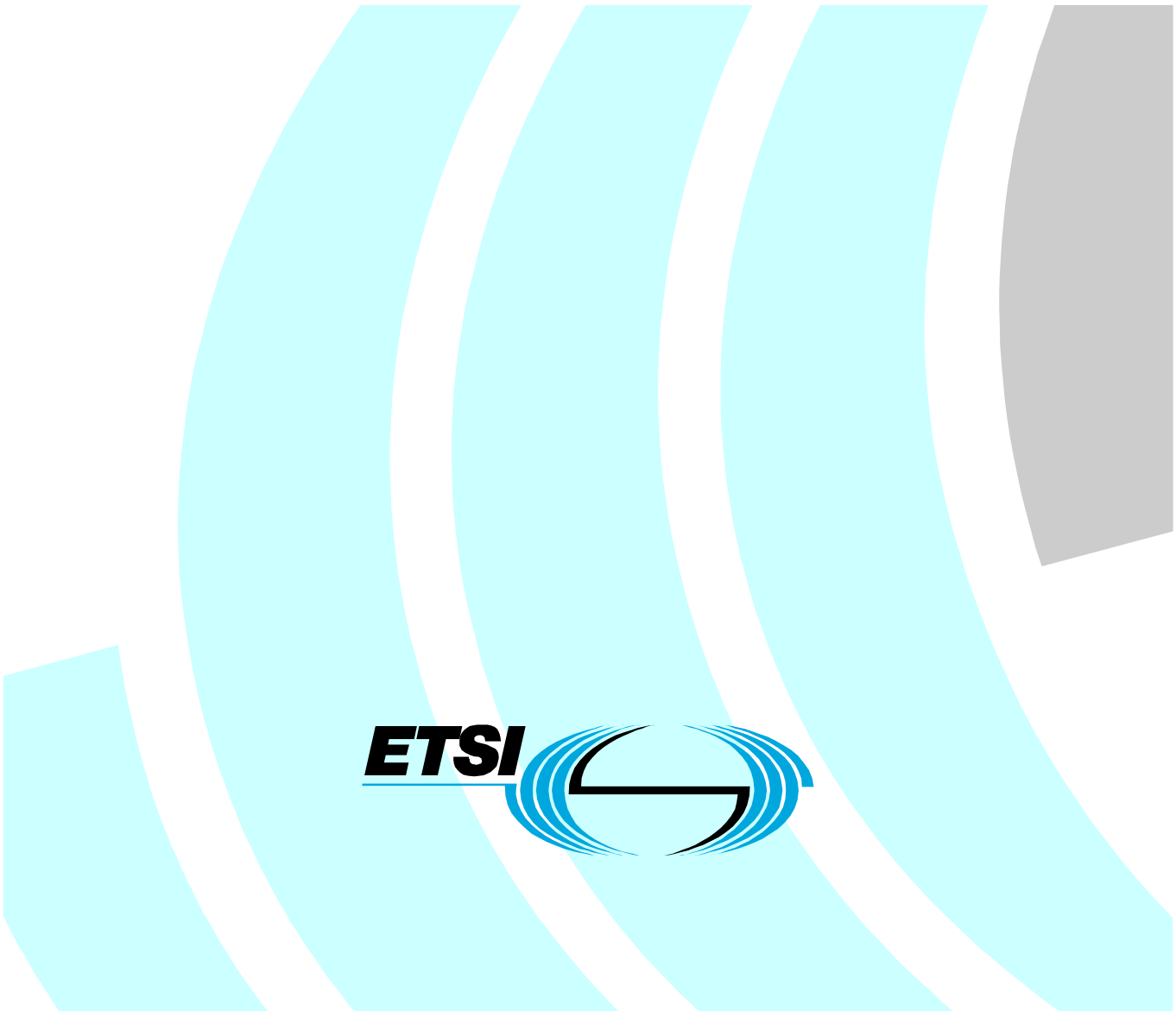
ETSI TS 102 188-4 V1.1.2 (2004-07)

Technical Specification

Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 4: Modulation



Reference
RTS/SES-00206-4

Keywords
air interface, broadband, IP, multimedia, satellite

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Contents

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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 part 4 of a multi-part deliverable covering the BSM Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification, as identified below:

Part 1: "General description";

Part 2: "Frame structure";

Part 3: "Channel coding";

Part 4: "Modulation";

Part 5: "Radio transmission and reception";

Part 6: "Radio link control";

Part 7: "Synchronization".

1 Scope

The present document defines the modulation used within the SES BSM Regenerative Satellite Mesh - A (RSM-A) air interface family. 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, and describes the required transmit filtering in general terms.

2 References

Void.

3 Definitions and abbreviations

3.1 Definitions

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

Network Operations Control Centre (NOCC): centre that controls the access of the satellite terminal to an IP network and also provides element management functions and control of the address resolution and resource management functionality

satellite payload: part of the satellite that provides air interface functions

NOTE: The satellite payload operates as a packet switch that provides direct unicast and multicast communication between STs at the link layer.

Satellite Terminal (ST): terminal installed in the user premises

terrestrial host: entity on which application level programs are running

NOTE: It may be connected directly to the Satellite Terminal or through one or more networks.

3.2 Abbreviations

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

IP	Internet Protocol
kbps	kilo bits per second (thousands of bits per second)
Mbps	Mega bits per second (millions of bits per second)
NOCC	Network Operations Control Centre
NRZ	Non Return to Zero
OQPSK	Offset Quaternary Phase Shift Keying
PSK	Phase Shift Keying
PTP	Point-To-Point
QPSK	Quaternary Phase Shift Keying
RSM	Regenerative Satellite Mesh
ST	Satellite Terminal

4 General

The functions of the physical layer are different for the uplink and downlink. The major functions are illustrated in figure 4.

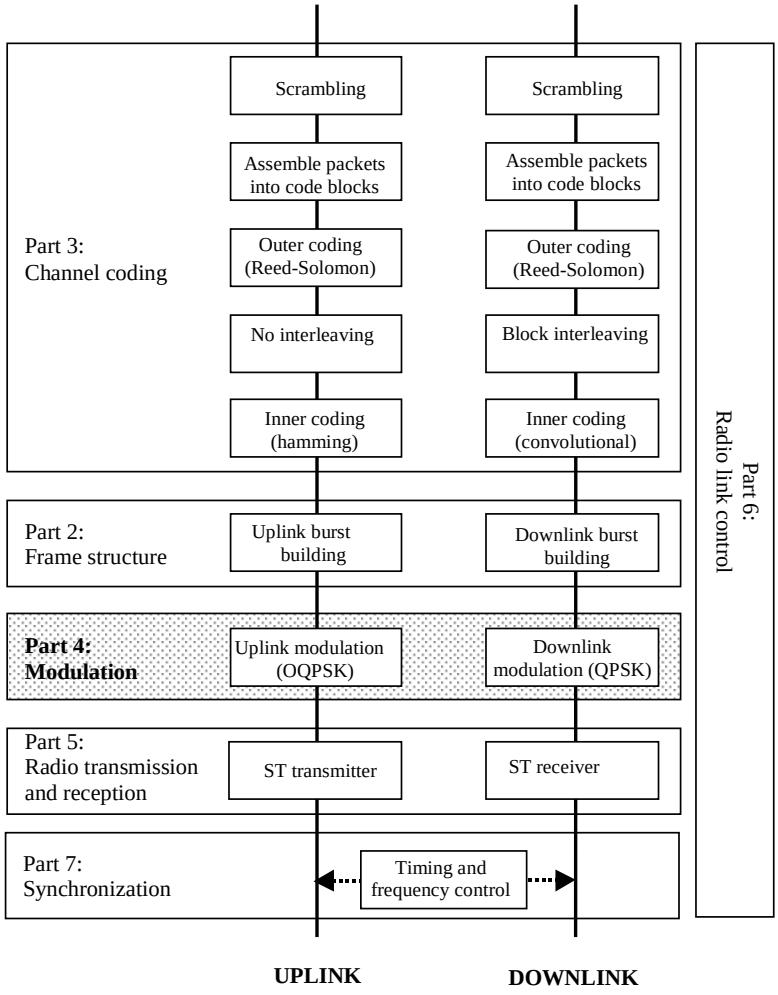

Figure 4: Physical layer functions

The present document describes the modulation functions - this group of functions is highlighted in figure 4.

The uplink modulation requirements are described in clause 5, and the downlink modulation requirements are described in clause 6.

5 Uplink

The uplink shall use Offset Quaternary Phase Shift Keying (OQPSK) modulation with square root raised cosine pulse shaping.

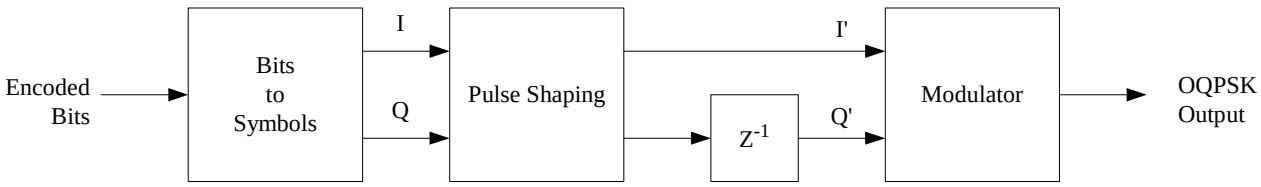

Figure 5: Uplink modulator block diagram

5.1 Symbol rates and periods

The OQPSK symbol rates and corresponding symbol durations are as defined in table 5.1.

Table 5.1: Symbol rates and periods

Carrier mode	Symbol rate, symbol/s	Symbol duration, ns
128 kbps (see note)	520 5/6 × 10^3	1 920
512 kbps	520 5/6 × 10^3	1 920
2 Mbps	2 1/12 × 10^6	480
16 Mbps	16 ⅔ × 10^6	60
NOTE: Each symbol is repeated four times.		

The symbol rate is defined as:

$$\text{Symbol rate} = \frac{62{,}5 \times 10^6}{\boldsymbol{N} \times \boldsymbol{B}}$$

where B = 1,25 and N is defined below:

$$N = \begin{cases} 96 & \text{for the 128 Kbps and 512 Kbps carrier modes} \\ 24 & \text{for the 2 Mbps carrier mode} \\ 3 & \text{for the 16 Mbps carrier mode} \end{cases}$$

The symbol duration is the reciprocal of the symbol rate.

5.2 Signalling constellation

Each uplink symbol conveys two binary units of information, one on each of the I and Q arms. In offset QPSK, the I arm data leads the Q arm data by one-half symbol.

The ST I-Q constellation plane is defined as a right-hand coordinate plane as shown in figure 5.2.1. On the I-Q constellation plane, a binary 0 value bit is defined as a positive (logical high), and a binary value 1 bit is defined as a negative (logical low).

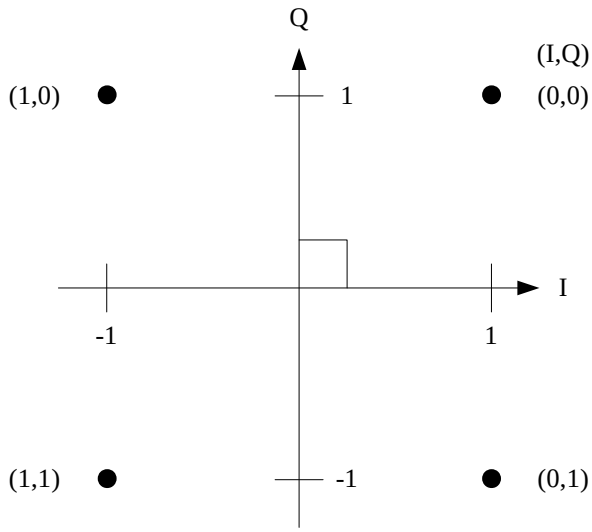

Figure 5.2.1: Uplink modulation constellation convention

The ST uplink modulator phasing convention is shown in figure 5.2.2.

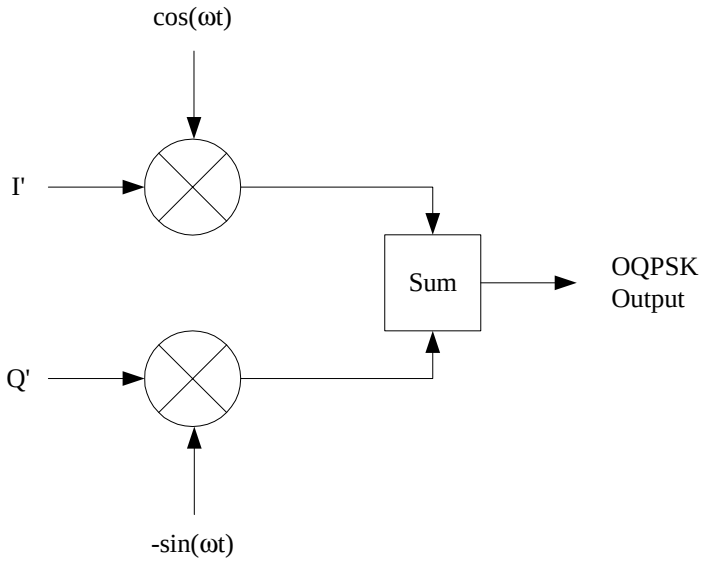

Figure 5.2.2: Uplink modulator phasing convention

5.3 Pulse shaping

Each data bit to be modulated via the I and Q data arms is shaped by the following ideal time domain (impulse response) function:

$$h(t) = \left(\frac{4 \cdot \sqrt{s} \cdot \beta}{\pi}\right)\left(\frac{\cos[(1+\beta)\cdot\pi\cdot s\cdot t] + (1/(4\cdot\beta\cdot s\cdot t))\sin[(1-\beta)\cdot\pi\cdot s\cdot t]}{\left(1-(4\cdot\beta\cdot s\cdot t)^2\right)}\right)$$

where $\beta = 0{,}4$ is the roll-off factor, t is the time, and s is the symbol rate.

6 Downlink

The downlink modulation for the PTP mode shall be Quaternary Phase Shift Keying (QPSK) with square root raised cosine pulse shaping. The downlink modulation for the CONUS broadcast shall be NRZ QPSK.

6.1 Symbol rates and periods

The downlink operates at one of three possible transmission rates the ⅓-rate, the ¼-rate, and full-rate modes. The QPSK symbol rates and corresponding symbol durations are as defined in table 6.1.

Table 6.1: Symbol rates and periods

Carrier mode	Symbol rate, symbol/s	Symbol duration, ns
¼-rate	100×10^6	10
⅓-rate	$133\ ⅓ \times 10^6$	7,5
Full rate	400×10^6	2,5

6.2 Signalling constellation

Each downlink symbol conveys two coded binary units of information, one on each of the I and Q arms.

The downlink I-Q constellation plane is defined as a right-hand coordinate plane as shown in figure 6.2.1. On the I-Q constellation plane, a binary 0 value bit (coded bit) is defined as a positive (logical high), and a binary value 1 bit is defined as a negative (logical low).

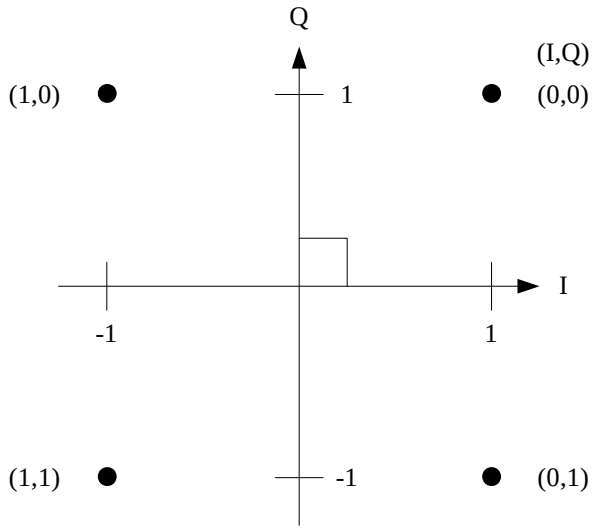

Figure 6.2.1: Downlink modulation constellation convention

The downlink modulator phasing convention is shown in figure 6.2.2.

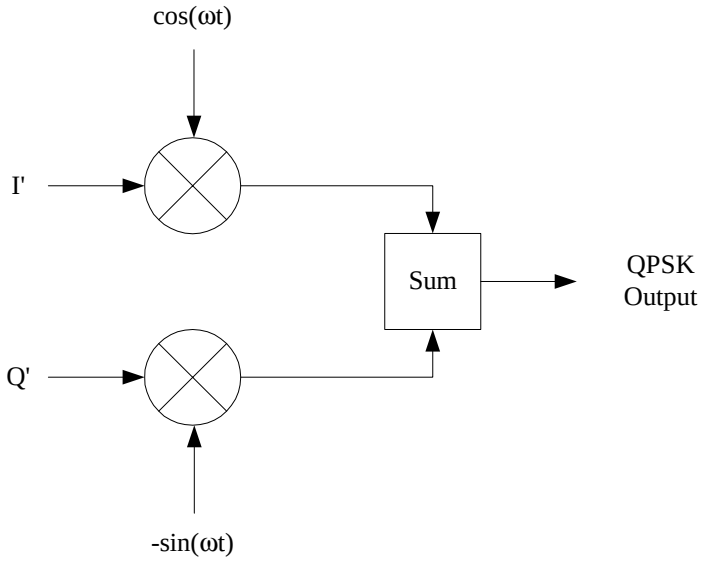

Figure 6.2.2: Downlink modulator phasing convention

6.3 Pulse shaping

6.3.1 PTP slots

Each PTP slot data bit to be modulated via the I and Q data arms is shaped by the following ideal time domain (impulse response) function:

$$h(t) = \left(\frac{4 \cdot \sqrt{s} \cdot \beta}{\pi}\right)\left(\frac{\cos\left[(1+\beta)\cdot\pi\cdot s\cdot t\right] + (1/(4\cdot\beta\cdot s\cdot t))\sin\left[(1-\beta)\cdot\pi\cdot s\cdot t\right]}{\left(1-(4\cdot\beta\cdot s\cdot t)^2\right)}\right)$$

where $\beta = 0{,}25$ is the roll-off factor, t is the time, and s is the symbol rate. For PTP mode, s = 400 Mbps. A block diagram of the PTP pulse shaping is shown in figure 6.3.1.

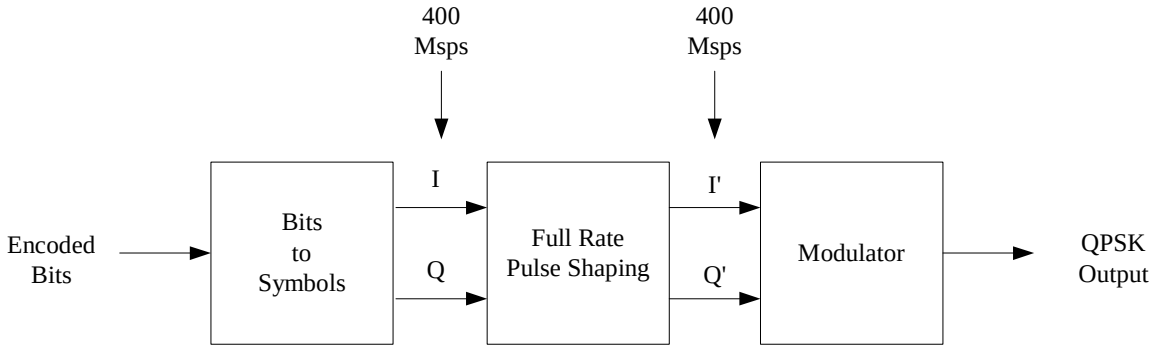

Figure 6.3.1: PTP PSK symbol shaping

6.3.2 Shaped-broadcast and idle slots

Each symbol is repeated three times (or four times in the case of the ¼-rate) as illustrated in figure 6.3.2, before passing the data through the pulse-shaping filter that is used for the full-rate PTP slots as described in clause 6.3.1.

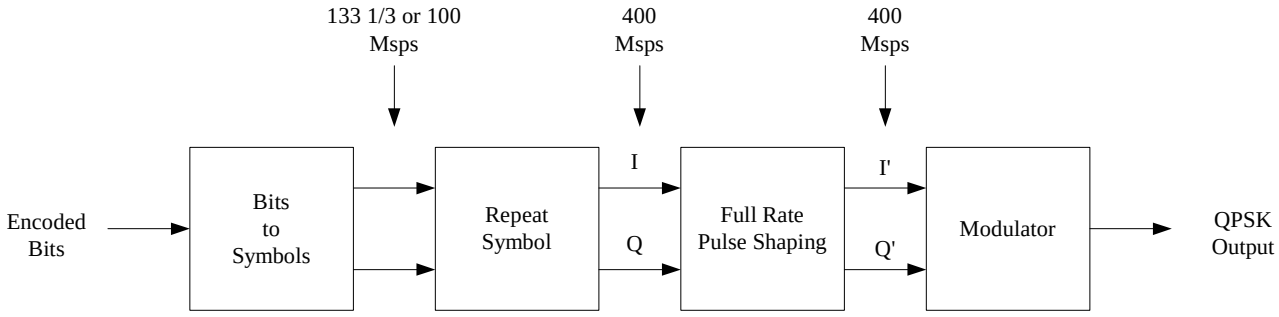

Figure 6.3.2: Shaped-broadcast and idle PSK symbol shaping

Annex A (informative): Bibliography

ETSI TR 101 984: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; Services and Architectures".

ETSI TS 102 188-1: "Satellite Earth Stations and Systems (SES); RSM-A Air Interface; Physical Layer specification; Part 1: General description".

ETSI TS 102 188-2: "Satellite Earth Stations and Systems (SES); RSM-A Air Interface; Physical Layer specification; Part 2: Frame structure".

ETSI TS 102 188-3: "Satellite Earth Stations and Systems (SES); RSM-A Air Interface; Physical Layer specification; Part 3: Channel coding".

ETSI TS 102 188-5: "Satellite Earth Stations and Systems (SES); RSM-A Air Interface; Physical Layer specification; Part 5: Radio transmission and reception".

ETSI TS 102 188-6: "Satellite Earth Stations and Systems (SES); RSM-A Air Interface; Physical Layer specification; Part 6: Radio link control".

ETSI TS 102 188-7: "Satellite Earth Stations and Systems (SES); RSM-A Air Interface Physical Layer specification; Part 7: Synchronization".

History

Document history		
V1.1.1	March 2004	Publication
V1.1.2	July 2004	Publication