IMPLEMENTATION OF BPSK IN DIGITAL VIDEO BROADCASTING SATELLITE TRANSMISSION SYSTEMS

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Foreword

This Bluebook has been produced under the authority of the Joint Technical Committee (JTC) of the European Broadcasting Union (EBU) and the European Telecommunications Standards Institute (ETSI) and in conjunction with the Digital Video Broadcasting (DVB) project.

This Bluebook is used to publish material, relating to the use or the application of DVB system related ETSs.

NOTE: This EBU/ETSI JTC was established in 1990 to co-ordinate the drafting of European Telecommunications Standards in the specific field of radio, television and data broadcasting.

The EBU is a professional association of broadcasting organisations whose work includes the co-ordination of its Members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 Countries in the European Broadcasting area; its headquarters is in Geneva *.

* European Broadcasting Union
Case Postale 67
CH-1218 GRAND SACONNEX (Geneva)
Switzerland

Tel: +41 22 717 21 11
Fax: +41 22 717 24 81

Digital Video Broadcasting (DVB) Project

Founded in September 1993, the DVB Project is a market-led consortium of public and private sector organizations in the television industry. Its aim is to establish the framework for the introduction of MPEG-2 based digital television services. Now comprising over 200 organizations from more than 25 countries around the world, DVB fosters market-led systems, which meet the real needs, and economic circumstances, of the consumer electronics and the broadcast industry.

1 Scope

This Bluebook supplements the European Telecommunication Standard (ETS) ETS 300 421 [1] which describes the transmission of MPEG-2/DVB transport stream via satellite. This Bluebook covers a special case, where the use of BPSK modulation is required, rather than that specified in ETS 300 421 [1].

2 References

[1]	ETS 300 421: "Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for 11/12 GHz satellite services".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this Bluebook, the definitions given in ETS 300 421 [1] apply.

3.2 Abbreviations

For the purposes of this Bluebook, the following abbreviations apply:

BPSK	Binary Phase Shift Keying
C/N	Signal to Noise ratio
DVB	Digital Video Broadcasting
E_b/N_o	Ratio between the energy per useful bit and twice the noise power spectral density
I	Interferences
I, Q	In-phase, Quadrature phase components of the modulated signal
MPEG-2	Moving Picture Experts Group
N	Additive White Gaussian Noise
QPSK	Quaternary Phase Shift Keying
R_u	Useful bitrate after RS outer coder

4 Background information

Under typical conditions for DTH emissions by satellite, the QPSK modulation adopted in ETS 300 421 [1] achieves an optimum trade-off between spectrum and power efficiencies. Compared to BPSK, QPSK offers a double spectrum efficiency and a comparable power efficiency at the same useful bit-rate R_u, in the presence of Additive White Gaussian Noise (N) and interferences (I).

In general the best system performance by satellite is met by adopting QPSK at the maximum symbol rate compatible with the transponder bandwidth (see Annex C, ETS 300 421 [1]). This configuration is indicated here as "*full-band*" transmission, in contrast with a "*reduced-band*" transmission where part of the transponder bandwidth is not exploited by the signal. The maximisation of the useful bit-rate R_u compatible with the available C/N+I is achieved by considering *full-band* QPSK associated with progressively decreasing coding rates (from 7/8 to 1/2). If a configuration is found which meets the C/N+I requirements, there is no BPSK scheme with comparable or better performance in terms of R_u or in terms of generated interference power density affecting other services. For example comparing *full-band* QPSK 1/2 with *full-band* BPSK 7/8 (i.e. at the same symbol rate), the latter shows a 12.5% loss in terms of R_u and at the same time a power loss of about 1.3 dB, while the generated interference power density affecting other services is similar.

Only under exceptionally critical transmission conditions, *full-band* BPSK can out-perform *reduced-band* QPSK 1/2 at the same R_u. This can happen when the available C/N+I ratio can not even support the bit-rate R_u of *full-band* QPSK 1/2, and in the presence of strong narrow-band co-channel interferences (I). For example assuming a narrow-band interference at C/I=10 dB, and taking as a reference *reduced-band* QPSK 1/2 at the same R_u, *full-band* BPSK 2/3 requires similar E_b/N_o, but generates an interference power density 1.7 dB lower. Under the same conditions but at even smaller bit-rates R_u, *full-band* BPSK 1/2 offers reductions of about 0.8 dB in terms of required E_b/N_o, and of 3 dB in terms of generated interference power density. On the other hand, in some cases the lower spectrum occupation of QPSK can allow to avoid co-channel interference, by shifting the signal within the transponder bandwidth.

This Bluebook describes a preferred implementation of BPSK for those applications which do not conform to the ETS 300421 standard in the modulation format only.

5 BPSK implementation

The inner code puncturing conforms to Table 2 of ETS 300 421 (relevant to QPSK modulation), to generate the **I** and Q parallel signals. By means of a parallel-to-serial conversion, these two signals **I** and Q are merged in a single signal R, at double rate, following the rule: R = **I** Q.

This results in the puncturing scheme summarised in Table 1.

Table 1: Puncturing scheme for BPSK

Code Rates	1/2	2/3	3/4	5/6	7/8
X: Y:	1 1	1 0 1 1	1 0 1 1 1 0	1 0 1 0 1 1 1 0 1 0	1 0 0 0 1 0 1 1 1 1 1 0 1 0
R =	X_1Y_1	$X_1Y_1Y_2\ X_3Y_3Y_4$	$X_1Y_1Y_2\ X_3$	$X_1Y_1Y_2\ X_3Y_4\ X_5$	$X_1Y_1Y_2\ Y_3\ Y_4\ X_5Y_6\ X_7$

The mapping of signal R into the BPSK constellation is absolute (no differential coding).

Baseband filtering for spectrum shaping conforms to the QPSK specification.