Datasheet ☐
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DVB-S2: a short overview

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INTRODUCTION

Is DVB-S2 the second generation satellite broadcasting standard due to replace the well-know and world widely used DVB-S? Yes and no… It does better, actually, since standard encompasses lots of applications: broadcasting, interactive servicing, news gathering…

Driven by an increasing demand for satellite broadband and mobile services, this standardization process was initiated by the DVB-S2 ad-hoc group of DVB consortium. It is a very complete standard featuring several profiles applying to different application fields (DTH, DSNG, contribution, interactive services…). And where DVB-S specified the use of one modulation and one encoding method (QPSK with Reed Solomon), DVB-S2 introduces flexibility in broadband satellite applications with new modulation schemes and new FEC systems, dynamically switching upon broadcasting conditions (channel quality, service component type…). This document aims at presenting the new features of DVB-S2, and all derived benefits that will be taken by satellite broadcasting applications.

DVB-S2 OVERVIEW

Rationale

First aim of DVB-S2 specification group was to define an advanced channel coding and modulation scheme for broadband satellite services. Main expectations about DVB-S2 compared to DVB-S were to achieve a 30% higher data throughput given the same satellite transmission power, while keeping provision for compatibility with DVB-S receivers, and remain transmission neutral (e.g. bandwidth and frequency band).

The whole list of DVB-S2 performances targeted in this standard can be found in the Commercial Requirements of the group.

Typical application areas of DVB-S2

The following scenarios of use were identified during DVB-S2 standardisation process: Broadcast, Interactive Services, DSNG and professional service delivery.

1. Broadcast Services

Typically dedicated to DTH services for IRDs, SMATV, head end stations, DVB-S2 stands as the natural successor for DVB-S current standard. As such, it may be introduced for new services and also allow for a long term migration. Two modes of broadcasting services exist:

Backwards Compatible mode

Delivers a waveform that can be partially decoded by legacy DVB-S receivers. This profile ensures a smooth continuity with equipments in the field and may exploit the hierarchical modulation as defined in DVB-S2. Indeed, to optimise the satellite power resources, it is possible to map a high priority DVB-S signal and a low priority DVB-S2 signal and combine them into the broadcast channel.

Non Backwards Compatible mode

Incompatible with current DVB-S receivers but fully takes advantages of DVB-S2 broadcast capacities.

2. Interactive Services

Intended to feed IRDs and personal computers with interactive data services (e.g. internet access). Interactivity is ensured using any of the DVB Return Channel protocols and data services are transported in TS (using MPE or other encapsulation protocols) or in Generic Streams.

3. Digital TV Contribution / DSNG

Consists in either point-to-point or point-to-multipoint transmissions to connect any uplink station with the receiving/processing station.

4. Data content distribution / trunking and other professional applications

Consists in point point-to-point or point-to-multipoint transmissions for professional head ends to redistribute data content over other media.

KEY POINTS IN DVB-S2

The following technical solutions have been put in place to fulfil DVB-S2 Commercial Requirements:

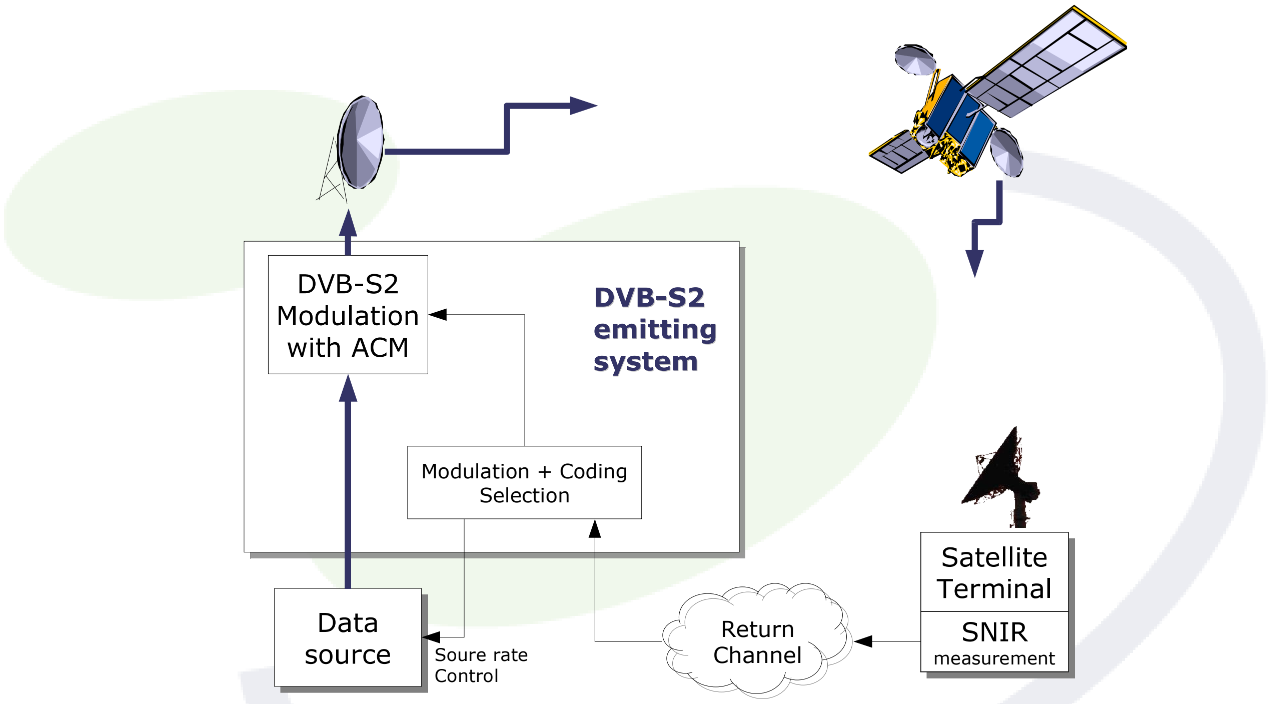
Adaptive Coding and Modulation: the heart of DVB-S2

Adaptive Coding and Modulation (ACM) functionality allows different modulation formats and error protection levels (i.e. coding rates) to be used and changed on a frame-by-frame basis within the transmitted data stream. Principle is that each receiving station has the possibility to control the protection mode of the transmission by sending reports on traffic quality.

With current DVB-S standard, any transmission happens with fixed coding and modulation format, which are set once according to the expected coverage, data throughput and targeted broadcasting application. Dimensioning of these parameters always takes into account the worst-case propagation and interferences conditions to make sure that any end receiver located within the satellite beam can demodulate data with a reasonable BER. But in average, fading attenuation and channel path variations in time would allow for higher SNR than expected, thus allow a higher throughput!

To work around this waste in bandwidth and satellite power, DVB-S2 provides a means to continuously adapt coding and modulation parameters to the real propagation conditions:

- received data rate thus becomes location and time dependent, and this is achieved by means of a return channel informing the transmitter of the actual receiving conditions
- each portion of the input data stream addressed to each satellite end station are coded and modulated according to information received from it.



When severe fades occur on the transmission way (e.g. bad weather conditions), a more robust modulation and coding scheme simply is requested by the satellite terminal using the ACM protocol.

A simplified scheme derived from ACM is the VCM (Variable Coding and Modulation) where transmitter decides the modulation parameters to apply for broadcast, and provides a differentiated level of signal robustness according to predefined criteria – for example, service component type (SDTV, HDTV, audio, multimedia). Rather dedicated to one way broadcasting systems, no return channel is needed in that mode since transmitter sets its own modulation configuration rules.

The most basic Coding and Modulation scheme obviously is the CCM, which features static modulation parameters all along transmission. This mode is the one basically available on DVB-S and DVB-DSNG standards.

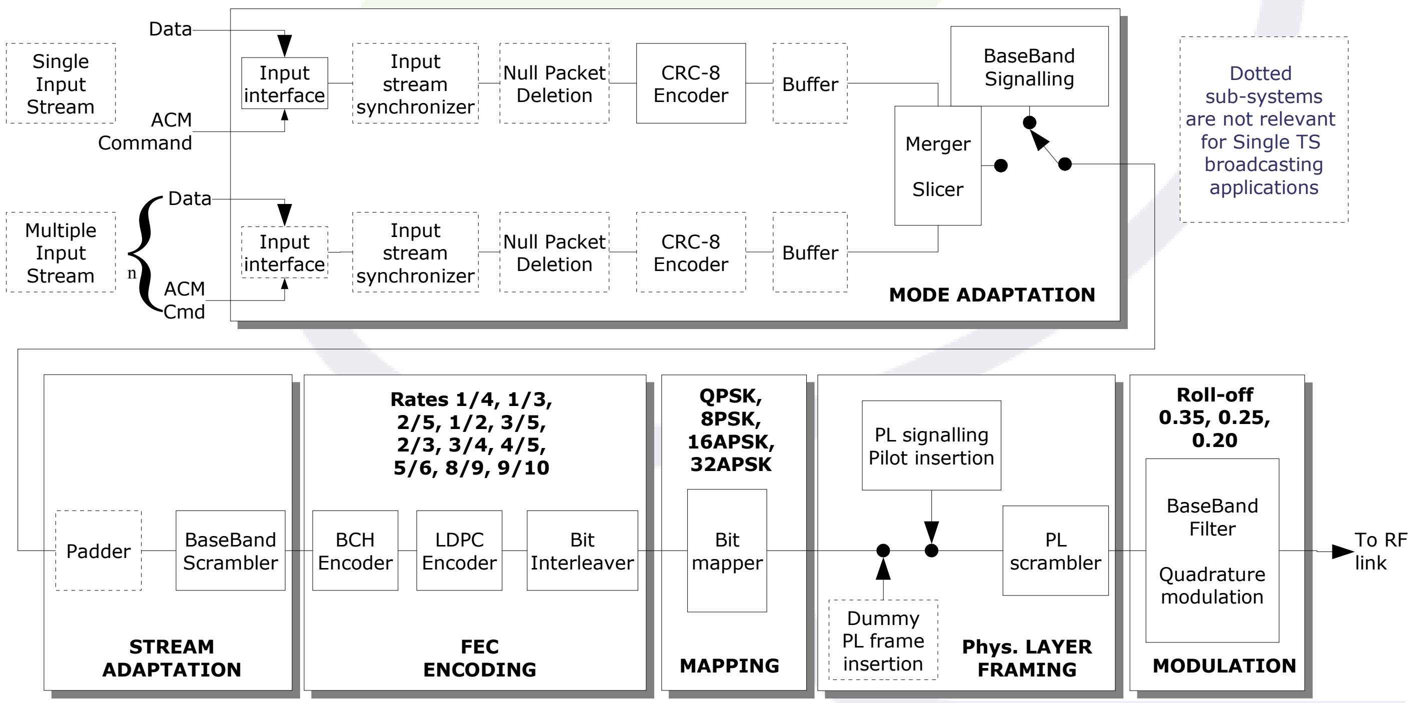
ACM is included as normative for the interactive application area and optional for DSNG and professional services. Actually, DVB-S2 specifies which Coding and Modulation profiles (ACM, VCM, CCM) must be implemented or are optional only, given each application area of the standard (Broadcast, Interactive services, DSNG or Professional Services).

System Architecture

DVB-S2 accommodates any input stream format. In addition to the widely used MPEG transport stream, generic streams (of constant or variable length packets) are encompassed by the standard, allowing IP, ATM packets or any future data format to be used without the need for a new specification.

Basically, input stream is transformed into a sequence of frames. Within these frames, the modulation and coding scheme is homogeneous, but may change (VCM) in adjacent frames. They also carry signally data to configure the receiver according to the application scenarios: single or multiple input streams, generic or transport stream, CCM or ACM/VCM.

Directly extracted from DVB-S2 guidelines, here follows the block diagram of such a modulator (implementing ACM, the most complex design case). Each input features a stream input plus an ACM command input:



Mode adaptation interfaces input streams from different types and brings to DVB-S2 its full flexibility regarding supported input data formats. In case where a MPEG TS is set in input, mode adaptation process prepares TS data to be directly processed by ACM modulation stage (to ensure a constant bit rate and end-to-end transmission delay and reduce the transmitted data rate to its net bit rate). Mode adaptation also provides a merging functionality of several TSs or GSs into baseband frames.

CRC-8 encoding for error detection only stands for packetized input streams.

FEC protection stage performs BCH outer coding, LDPC inner coding and bit interleaving.

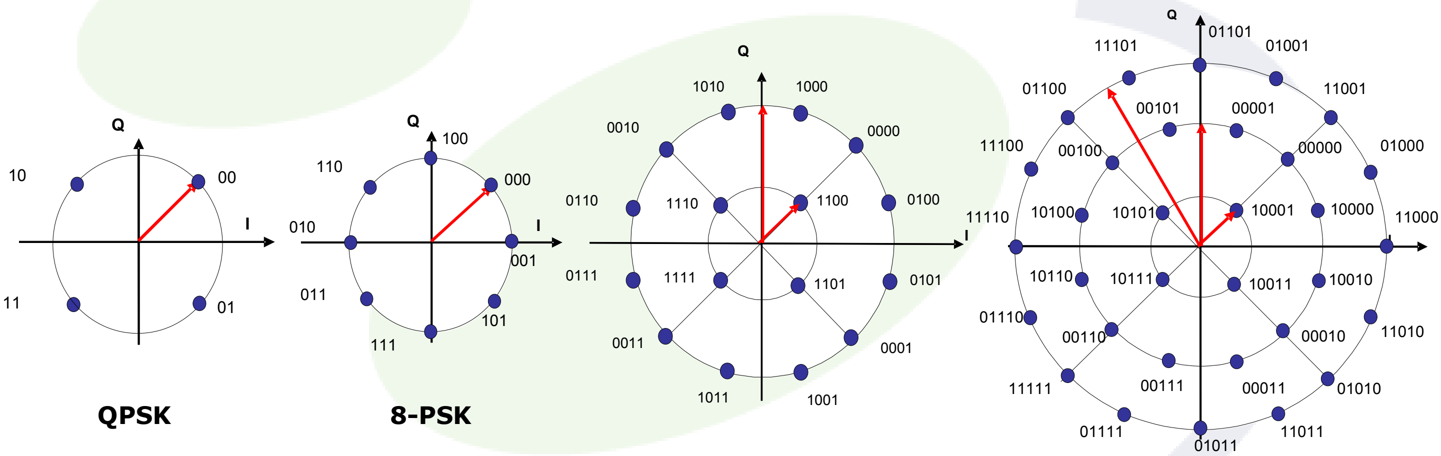
Mapping stage process bit mapping of frames into QPSK, 8-PSK, 16-APSK or 32-APSK constellations, generating sequences of (I,Q) symbols.

Physical Layer inserts signalling (SOF and PLS codes), Pilot blocks where required (non modulated, predefined symbols to ease carrier recovery) and randomises the (I,Q) symbols for energy dispersal.

Modulation stage then shapes the signal spectrum before outputting the RF signal.

About modulations

DVB-S2 enhanced the choice of constellations that can be used to modulate the transmitted payload. The following four constellations have been selected by the DVB-S2 standard:



QPSK **8-PSK** **16-APSK** **32-APSK**

QPSK and **8-PSK** are typically proposed for broadcast applications. **16-APSK** and **32-APSK** modulations are dedicated to more specific broadcasting applications (i.e. regional spot beams or interactive applications) operating with multi-beam satellites. On certain conditions, these can achieve much better data throughputs than the two others. This is why DVB-S2 specified which modulation types are mandatory (or should be implemented as an option only) given each application area (Broadcast, Interactive services, DSNG or Professional Services):

- 8PSK and QPSK must be implemented in transmitters and receivers for Broadcast services, while 16-APSK and 32-APSK can be provided as an option.

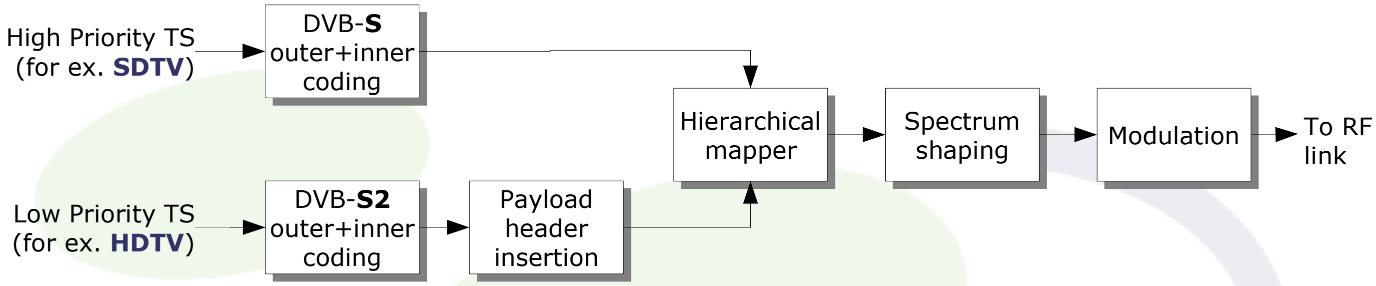
- For Interactive Services, DSNG and Professional Services profiles, implementation of the four modulation types is mandatory on transmitter and receiver side.

Along with these constellations, the following code rates can be adopted for transmission:

QPSK	1/4,1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10
8PSK	3/5, 2/3, 3/4, 5/6, 8/9, 9/10
16APSK	2/3, 3/4, 4/5, 5/6, 8/9, 9/10
32APSK	3/4, 4/5, 5/6, 8/9, 9/10

Hierarchical modulation system

A hierarchical mapper has been specified to combine two Transport Streams on a single satellite channel, each TS having a high or low priority in reception at terminal satellite receiver. This is a means to provide a differentiated level of protection for each TS.



This can be implemented on backwards compatible DVB-S2 systems by synchronously combining High Priority and Low Priority streams at modulation symbol level on an asymmetric 8PSK constellation.

Note: specification of receiver able to decode hierarchical streams is not under the scope of DVB-S2 standard.

IP data encapsulation

Another real benefit of DVB-S2 is its flexible architecture regarding input streams.

Currently, IP data are usually carried over Transport Streams following the Multi-Protocol Encapsulation of EN 301 192. With DVB-S2, it is possible to directly access physical media with IP data and avoid lengths of headers inserted in the MPEG stream.

This smart encapsulation of IP data allows for a better efficiency, thus for achieving required Q.o.S. with less efforts. Indeed, longer frames (64800 or 16800 bits) are used for encapsulation while MPEG packet size (fixed to 188 bytes) statistically results in recurrent payload slicing (implying all the required MPEG+IP headers addition).

CONCLUSION

Requirements set by DVB CM have been successfully addressed by DVB-S2 and expected increase in system performance has been reached: throughput increase (>30%), satellite bands optimization, media independence... All these resulting in huge savings in per-channel cost of satellite capacity.

Price to pay for improvement will be, of course, a quite complicated implementation at both transmitting and receiving side, but today's breakthrough in broadcast technologies will rapidly raise systems prices down. Anyway, backwards compatible mode will probably be the first being implemented in systems during migration period and it is worth noting here that DVB-S2 recommended to implement DVB-S in DVB-S2 chips.

References

ETSI EN 302 307 V1.1.1 (2004-01)
"Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications".

ISO/IEC 13818 (parts 1 and 2)
"Coding of moving pictures and associated audio".

ETSI EN 301 210
"Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for Digital Satellite News Gathering (DSNG) and other contribution applications by satellite".

ETSI EN 301 192
"Digital Video Broadcasting (DVB); DVB specification for data broadcasting".

ETSI Draft
"Digital Video Broadcasting (DVB); User guidelines for the second generation system for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications"

DVB document, CM373
Advanced Coding and Modulation Schemes for Broadband Satellite Services - Commercial Requirements

Abbreviations

ACM	Adaptive Coding and Modulation
APSK	Amplitude and Phase Shift Keying (16-APSK = 16-ary APSK, 32-APSK= 32-ary APSK)
BER	Bit Error Ratio
BCH	Bose-Chaudhuri-Hocquenghem multiple error correction binary block code
DSNG	Digital Satellite News Gathering
DTH	Direct To Home
FEC	Forward Error Correction
HDTV	High Definition Television
IRD	Integrated Receiver Decoder
MPE	Multi-Protocol Encapsulation
MPEG	Moving Pictures Experts Group
LDPC	Low Density Parity Check code
PSK	Phase Shift Keying (QPSK= Quaternary PSK, 8-PSK= 8-ary PSK)
RF	Radio Frequency
QOS	Quality of Service
SDTV	Standard Definition Television
SNIR	Signal to Interference plus Noise Ratio

ENENSYS Technologies

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ENENSYS Technologies is specializing in broadcast solutions for interworking issues. Designed by experienced technical and commercial experts from the Digital TV field, ENENSYS Technologies product lines are "convergence oriented", aiming at interworking of network/IT and broadcast equipments. The products cover MPEG, DVB, ATSC fields and are providing solutions for ASI, SSI, SMPTE-310M, GigaEthernet, QPSK, OFDM… These products are far from these expensive swiss-knife interfacing products that can potentially cope with many formats but run only one. ENENSYS Technologies interfaces are the clean and direct answer to one interfacing need. Secret behind is compactness, portability and professional robustness… ENENSYS' product lines are the real proof that it is no more required to engage new operating expenses to protect your [past or forthcoming] investments.

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