ROHDE&SCHWARZ

BROADCASTING DIVISION

APPLICATION NOTE

The most common abbreviations used in the standards for digital TV: MPEG2, DVB and ATSC

Products:

MPEG2 DTV RECORDER GENERATOR	***DVRG***
MPEG2 MEASUREMENT GENERATOR	***DVG***
MPEG2 REAL TIME MONITOR	***DVRM***
MPEG2 MEASUREMENT DECODER	***DVMD***
QAM TEST RECEIVER/DEMODULATOR	***EFA***
TV TEST TRANSMITTER	***SFQ***

7BM27_0E

The most common abbreviations used in the standards for digital TV: MPEG2, DVB and ATSC

The introduction of the transmission of compressed TV signals to MPEG2 and DVB for cable, satellite and terrestrial (COFDM) lead to the creation of many abbreviations that have to be explained to the "uninitiated". In the previous three lines, three abbreviations whose meanings are not obvious have already been mentioned. A table explaining what these abbreviations mean is therefore essential.

1 MPEG2 Abbreviations

Adaptation Field
Ancillary program data (especially PCR) which are uncoded and are transmitted at least every 100ms acc. to MPEG2 or 40 ms acc. to DVB specifications

BAT **Bouquet Association Table**
Table describing a bouquet of programs offered by a broadcaster

Block 8x8 pixel block, *MPEG2* coded

CA **Conditional Access**
Information of whether the program is scrambled

CAT **Conditional Access Table**
(*PID*=1):
Reference to scrambled programs

CIF **Common Intermediate Format**
Picture format

CRC **Cyclic Redundancy Check**

DCT **Discrete Cosine Transform**

DCT^{-1} / IDCT **Inverse Discrete Cosine Transform**

DFD **Displaced Frame Difference**
Differential picture if there is motion

DPCM **Differential Pulse Code Modulation**

DTS **Decoding Time Stamp**
Stamp for decoding time, only transmitted if not identical with PTS; reference to PID

EIT **Event Information Table**
TV guide

ES **Elementary Stream**
Compressed data stream for video, audio or data.
Preliminary stage to PES

GOP **Group of Pictures**

I, P, and B pictures
Intra-coded pictures (I), predicted pictures (P) and bi-directional prediction pictures (B)

IRD **Integrated Receiver Decoder**
Receiver with (MPEG) decoder

MPEG **Motion Picture Experts Group**
sometimes called Moving Picture Experts Group

MUSICAM **Masking Pattern Adapted Universal Subband Integrated Coding and Multiplexing**
Compression method for audio coding

NIT **Network Information Table**
Information about orbit, transponder etc.

PAT **Program Association Table** (*PID*=0):
List of all the programs contained in TS Multiplex with reference to PID of PMT

Pay Load Useful data in TS

PCM **Pulse Code Modulation**

PCR **Program Clock Reference**
Reference in *TS* for the 27-MHz clock recovery. Transmitted at least every 0.1 sec

PES **Packetized Elementary Stream**
Video and audio data packets and ancillary data of definable length

PES Header Ancillary data for an elementary stream

PID **Packet Identification**
Identification of programs in the transport stream

PMT **Program Map Table:**
Reference to packets with PCR
Name of programs, copyright, reference of the data streams with PIDs etc. belonging to the relevant program

Prediction Prediction of a picture (P or B) with indication of a motion vector

Profile Subdivision of video coding into different resolutions

PS **Program Stream**
Multiplex of several audio and video PES using the same clock.

PSI **Program Specific Information**
Data transmitted in TS for the demultiplexer in the receiver (eg PAT, PMT, CAT)

PTS **Presentation Time Stamp**
Time stamp for vision and sound, transmitted at least every 0.7 sec. Integrated into PES

Q Quantization

Q^{-1} Inverse quantization

QS Quantization scaling

RLC **Run Length Coding**
Coding of data with different number of bits. Frequently reoccurring data has the smallest number of bits, data seldom reoccurring have the highest number of bits.

RST **Running Status Table**
Accurate and fast adaptation to a new program run if time changes occur in the schedule

Section A table is subdivided into several sections. If there is a change, only the section affected is transmitted

SI **Service Information**
All the data required by the receiver to demultiplex and decode the various programs in the TS

SIF **Source Input Format**

SCR **System Clock Reference**
Reference in ES for synchronizing the system demultiplex clock in the receiver, transmitted at least every 0.7 sec. Integrated into PES

SDT **Service Description Table**
Description of programs offered

STC **System Time Clock**
27-MHz clock, regenerated from PCR for a jitter-free readout of MPEG data

SYNC(_byte) Synchronization byte in TS header value 0x47

TS **Transport Stream**

TS Header The first 4 bytes of each TS packet contain the data (PID) required for the demultiplexer in addition to the sync byte (0x47). These bytes are never scrambled.

TDT **Time and Date table**
UTC time and date

TOT **Time Offset Table**
UTC time and date with indication of local time offset

UTC **Universal Time, Co-ordinated**
Greenwich meantime

VBR **Variable Bit Rate**

VLC **Variable Length Coding**
Coding of data with variable number of bits (also see *RLC*)

ZigZag Scan Zigzag scan of quantized *DCT* coefficient matrix. This gives an efficient run length coding (*RLC*)

2 DVB and ATSC Abbreviations

ADSL **Asymmetric digital subscriber line**
A *COFDM-coded* digital data stream with a rate up to 8 Mbit/s (down stream) and 1 Mbit/s (up stream) is transmitted via telephone lines, mainly for video on demand.

ATSC **Advanced Television Systems Committee**
american standardization group for digital terrestrial transmission

CNR **Carrier to Noise Ratio**
Indicates how far the noise level is down on carrier level

COFDM **Coded Orthogonal Frequency Domain Multiplex**
Up to 6817 single carriers 1.116 kHz apart are QAM-modulated with up to 64 states.
"Coded" means that the data to be modulated has error control.
Orthogonality means that the spectra of the individual carriers do (almost) not influence each other as a spectral maximum always coincides with a spectrum zero of the adjacent carriers.
A *single-frequency network* is used for the actual transmission.

Constellation Diagram
Way of representing the I and Q components for *QAM* or *QPSK* modulation. The position of the points in the constellation diagram provides information about distortions in the *QAM* or *QPSK* modulator as well as about distortions after the transmission of digitally coded signals.

DVB **Digital Video Broadcasting**
Broadcasting TV signals to a digital standard

DVB-C **Digital Video Broadcasting-Cable**
Broadcasting TV signals to a digital standard by cable

DVB-S **Digital Video Broadcasting-Satellite**
Broadcasting TV signals to digital standard via satellite

DVB-T **Digital Video Broadcasting-Terrestrial**
Terrestrial broadcasting of TV signals to digital standard

Convolutional Coding
The data stream to be transmitted via satellite and terrestrial *(DVB-S, DVB-T)* is loaded bit by bit into shift registers. The data which is split and delayed as it is shifted through different registers is combined in several paths. This means that double the data rate (2 paths) is usually obtained. Puncturing follows to reduce the data rate: the time sequence of the bits is predefined by this coding and is represented by the *trellis diagram*.

FEC **Forward Error Correction**
Error control bits added to useful data in the *QAM/QPSK* modulator for DVB-C, -S and DVB-T.

Single-frequency network
Transmitter network in which all the transmitters use the same frequency. The coverage areas overlap. Influece of echoes are minimized by g*uard intervals*. The transmitters are separated by up to 60 km. The special feature of these networks is efficient frequency utilization

Guard interval additional safety margin between two transmitted sym-

bols in the *COFDM* standard. The guard interval ensures that echoes occurring in the single-frequency network are eliminated until the received symbol is processed.

Interleaver The *RS*-protected transport packets are reshuffled byte by byte by the 12-channel interleaver. (RS FEC Reed Solomon FEC) Due to this reshuffle what were neighbouring bytes are now separated by a maximum of 2244 bytes from other TS packets. The purpose of this is the burst error control for defective data blocks

Mapping Conversion of bytes (8 bits) to 2n-bit wide symbols. n is thus the bit width for the I and Q quantization; eg at 64 *QAM* the symbol width is 2n = 6 bit, n = 3, ie I and Q are subdivided into 2^3 = 8 amplitude values each

Puncturing *Puncturing (DVB-S and -T)* follows to reduce the increased data rate after convolutional coding: Various registers are not used. The additional redundancy is used for error control. The two data streams after puncturing are directly applied as I and Q input signals to the QAM or *QPSK* modulator after filtering to fulfil the first Nyquist criterion.

QAM **Quadrature Amplitude Modulation**
Type of modulation for digital signals *(DVB-C and -T)*. Two signal components I and Q are each quantized and modulated onto two orthogonal carriers as appropriate for the *QAM* level (4, 16, 32, 64, 128, 256). The *constellation diagram* is obtained by plotting the signal components with I and Q as the coordinate axes. Therefore, 2, 4, 5, 6, 7 or 8 bits of a data stream are transmitted with one symbol, depending on the *QAM* level (4, 16, 32, 64, 128, 256). This type of modulation is used in cable systems and for coding the *COFDM* single carriers

QEF **Quasi Error Free**
Less than one uncorrected error per hour at the input of the *MPEG2* decoder.
(BER $\leq 10^{-11}$)

QPSK **Quadrature Phase Shift Keying**
Type of modulation for digital signals *(DVB-S and -T)*. The digital, serial signal components I and Q directly control phase shift keying. The *constellation diagram* with its four discrete states is obtained by representing the signal components using the I and Q signals as coordinate axes. Due to the high nonlinear distortion in the satellite channel, this type of modulation is used for satellite transmission: The 4 discrete states all have the same amplitude that is why non-linear amplitude distortions have no effect.

RS Protection Code **RS(204,188,8)**
(RS = Reed Solomon)
16-byte long error control code added to every transport packet consisting of 187 (scrambled) bytes +1 syncbyte with the following result:
The packet has a length of 204 bytes and the decoder can correct up to T = 8 errored bytes. This code ensures a residual Bit Error ratio BER of approx. $1x10^{-11}$ at an input error ratio of $2x10^{-4}$.

SFN **Single Frequency Network**

Trellis Diagram
The time sequence of the bits *(DVB-S and -T)* is predefined by convolutional coding and, like the state diagram of a finite automaton, is represented as a trellis diagram.

Viterbi Decoding
Viterbi decoding makes use of the predefined time sequence of the bits through convolutional coding *(DVB-S and -T).* Thanks to a series of logic decisions, the most probably correct way is searched for through the *trellis diagram* and incorrectly transmitted bits are corrected.

n VSB Modulation
Transmission of n discrete amplitude values using the vestigial sideband method on normal terrestrial *(ATSC)* channels and conventional IF modulators. The most common variant is 8-VSB transmission already tested in the US. With 8 VSB, 3 bits ($2^3 = 8$) of the data stream are transmitted per amplitude value

3. ATSC Tables and Protocols

ATSC **Advanced Television Systems Committee**
american standardization group for digital terrestrial transmission

CAT **Conditional Access Table** (*PID*=1):
Reference to scrambled programs
Table ID 0x01

CVCT **Cable Virtual Channel Table**
Table ID 0xC9

EIT **Event Information Table**
Table ID 0xCB

ETT **Extended Text Table**
Table ID 0xCC

ETM **Extended Text Message**

MGT **Master Giude Table**
Table ID 0xC7

PAT **Program Association Table** (*PID*=0):
List of all the programs contained in TS Multiplex with reference to PID of PMT
Table ID 0x00

PIT **Program Identification Table**

PMT **TS Program Map Table:**
Reference to packets with PCR
Name of programs, copyright, reference of the data streams with PIDs etc. belonging to the relevant program
Table ID 0x02

PSIP **Program and System Information Protocol**

PTC **Physical Transmission Channel**

RRT **Rating Region Table**
Table ID 0xCA

SI **Sytem Information**

STT **System Time Table**
Table ID 0xCD

TVCT **Terrestrial Virtual Channel Table**, Table ID 0xC8

8 VSB **Vestigial Side Band Modulation**
digital terrestrial broadcast mode

16 VSB **Vestigial Side Band Modulation**
High Data Rate mode especially for Cable Systems

4 The Digital TV System

The transmission of digitized vision and sound together with different ancillary data is subdivided into precisely defined areas.

The first area is the *MPEG2* level
In the coder this comprises

- video compression,
- sound compression,
- processing of *all* ancillary data (including SI (see page 3), teletext etc.),
- *PES* generation,
- *TS* generation,
- *TS* multiplexing ,

or the inverse functions in the decoder.

The output of the *MPEG2* block is the output of the *TS* multiplexer.

The second area consists of transmission levels *DVB - C, DVB - S, DVB - T*
At the transmitter end this comprises

- energy dispersal (scrambler) and the sync inverter in the 8-sync sequence,
- Reed Solomon error-control coder,
- interleaver,
- convolutional coding and puncturing *(DVB - S),*
- symbol mapping *(DVB - C),*
- modulation in *QAM (DVB - C, DVB - T in COFDM), QPSK (DVB - S)* or *8 VSB (DVB - T),*

or the inverse functions in the receiver.

The input of the transmission block is the output of the *TS* multiplexer.