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Digital Video Broadcasting (DVB); Next Generation broadcasting system to Handheld, physical layer specification (DVB-NGH); Part 4: Hybrid MIMO Profile

Reference

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NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations 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.

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The DVB Project is an industry-led consortium of broadcasters, manufacturers, network operators, software developers, regulators and others from around the world committed to designing open, interoperable technical specifications for the global delivery of digital media and broadcast services. DVB specifications cover all aspects of digital television from transmission through interfacing, conditional access and interactivity for digital video, audio and data. The consortium came together in 1993.

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

National transposition dates	
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Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document describes the next generation transmission system for digital hybrid (combination of terrestrial with satellite transmissions) MIMO broadcasting to handheld terminals making use of multi-aerial structures at the transmitting and receiving ends. It specifies the relationship of the hybrid MIMO profile physical layer part to the physical layer part of the other three profiles, namely the base profile ETSI EN 303 105-1 [1], the MIMO profile ETSI EN 303 105-2 [2] and the hybrid profile ETSI EN 303 105-3 [3], from the input streams to the transmitted signal. This transmission system is intended for carrying Transport Streams or generic data streams feeding linear and non-linear applications like television, radio and data services. DVB-NGH terminals might also process DVB-T2-lite signals.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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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.

The following referenced documents are necessary for the application of the present document.

[1] ETSI EN 303 105-1: "Digital Video Broadcasting (DVB); Next Generation broadcasting system to Handheld, physical layer specification (DVB-NGH); Part 1: Base Profile".

[2] ETSI EN 303 105-2: "Digital Video Broadcasting (DVB); Next Generation broadcasting system to Handheld, physical layer specification (DVB-NGH); Part 2: MIMO Profile".

[3] ETSI EN 303 105-3: "Digital Video Broadcasting (DVB); Next Generation broadcasting system to Handheld, physical layer specification (DVB-NGH); Part 3: Hybrid Profile".

2.2 Informative references

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

Not applicable.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI EN 303 105-1 [1] apply.

3.2 Symbols

For the purposes of the present document, the symbols given in ETSI EN 303 105-1 [1] apply.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 303 105-1 [1] apply.

4 DVB-NGH hybrid MIMO system definition

4.1 System overview and architecture

4.1.1 Overview

The hybrid MIMO profile - reflected by the present document - is an optional profile facilitating the use of MIMO on the terrestrial and/or satellite elements within a hybrid transmission scenario.

The ACE PAPR technique cannot be applied to frames of preamble format "NGH-MIMO".

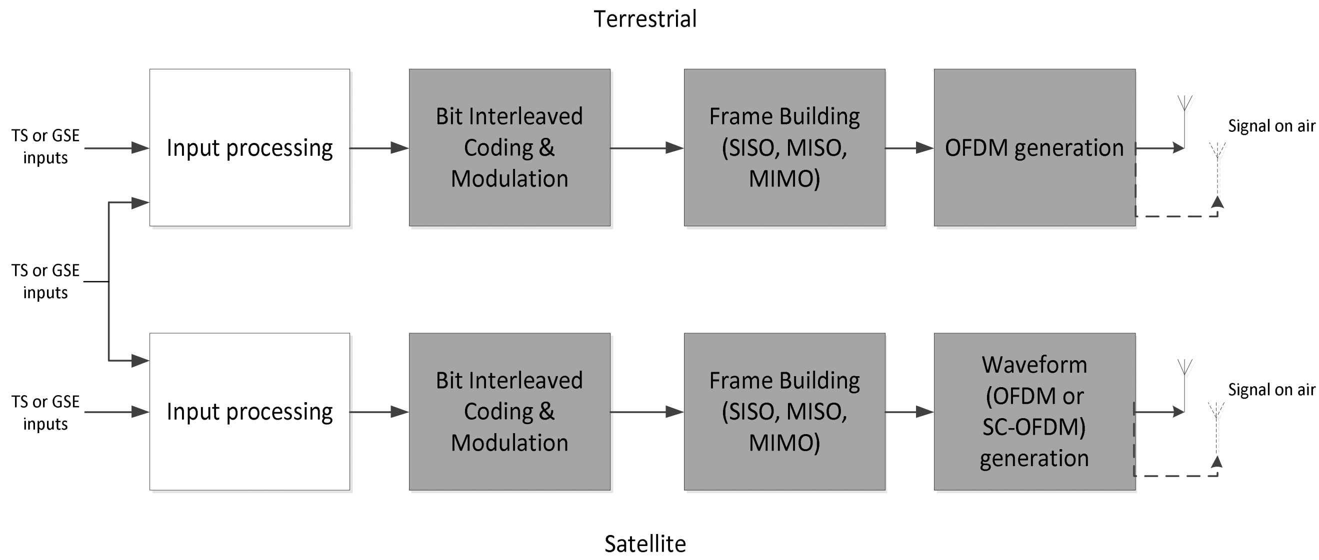
Two modes within this profile are available.

4.1.2 Hybrid MIMO SFN

The hybrid MIMO SFN describes the case where the satellite and terrestrial parts of the transmission utilize the same carrier frequency and radiate synchronized signals intended to create an effective SFN. In the case of a SISO SFN, covered in the hybrid profile, the signals are nominally identical (except for the possible application of eSFN) but in the case of a hybrid MIMO SFN MIMO pre-coding may exist in conjunction with eSFN pre-processing. The cases defined in the hybrid MIMO SFN mode are those where MIXO pre-coding is applied within or across the satellite and terrestrial transmission elements. In the case of mixed SISO/MIXO transmission the MIXO pre-coding is applicable solely during MIXO frames; during the hybrid SISO frames eSFN may be applied.

4.1.3 Hybrid MIMO MFN

The hybrid MIMO MFN describes the case where the satellite and terrestrial parts of the transmission are on different carrier frequencies, and do not necessarily share any common frame or symbol timing at the physical layer. They may however share content in terms of data payload. At least one of the transmission elements (i.e. terrestrial or satellite) shall be configured using multiple antennas, otherwise the form of transmission belongs to the Hybrid Profile ETSI EN 303 105-3 [3], not the Hybrid MIMO Profile reflected by the present document.



NOTE: Blocks differing from the Base Profile ETSI EN 303 105-1 [1] are shaded to grey.

Figure 1: High level NGH physical layer block diagram of the Hybrid MIMO Profile reflected by the present document

NOTE 1: This block diagram is common to both hybrid MIMO MFN and hybrid MIMO SFN.

NOTE 2: One of the two paths is using two transmission antennas.

4.1.4 Time interleaving

For rate 2 schemes of the Hybrid MIMO Profile reflected by the present document, both MIMO branches, i.e. the signal generation for both transmit antennas, shall use the same time interleaver configuration. The required time de-interleaver memory sizes $N_{\mathrm{MUs,PLP}}$ and $N_{\mathrm{MUs,PLP,1\,frame}}$ per MIMO branch can be calculated in the same way as described for the SISO scheme of the Hybrid Profile in ETSI EN 303 105-3 [3], clause 6.2, when setting 1 MU corresponding always to 1 cell. The total required de-interleaver memory for both MIMO branches is twice this size. The applicable limits for the hybrid MIMO profile are still $\sum 2N_{\mathrm{MUs,PLP}} \leq 2^{21}$ and $\sum 2N_{\mathrm{MUs,PLP,1\,frame}} \leq 2^{18}$, where the sum is taken over all PLPs in a given PLP cluster and the factor 2 comes from the fact, that the size for both MIMO branches is double that per single MIMO branch.

When two signals are transmitted that shall be (hybridly) combined in the receiver, the same rules apply as laid down in ETSI EN 303 105-3 [3], clause 6.2, i.e. the sum of the required time de-interleaver sizes (in MUs) for both signals shall not exceed the aforementioned limits.

The Receiver Buffer Model (RBM) to use for the hybrid MIMO profile is the one of the Hybrid Profile in ETSI EN 303 105-3 [3], annex B.

5 Hybrid MIMO SFN

5.1 Transmit/receive system compatibility

To make use of the hybrid MIMO SFN, the proposed transmission hardware shall include individually-fed terrestrial and satellite transmitters with suitable antennas as outlined below, delivering an OFDM waveform on both the terrestrial and satellite sides. Cases included are one or two (cross-polar, linear polarization) terrestrial antennas in combination with one or two (cross-polar, counter-rotating circular polarization) satellite antennas. In the case of rate 2 MIMO transmission (e.g. eSM) from either the satellite or terrestrial equipments the receiver shall be equipped with a dual-polarized (linear polarization or counter-rotating circular) pair of antennas. For rate 1 transmission, (e.g. Alamouti, eSFN) a cross-polar receive antenna is recommended but a single antenna is sufficient.

In all SFN cases the satellite transmission appears as 'transparent' to the receiver which sees an equivalent terrestrial transmission via an enhanced channel partly delivered by the satellite transmission. The pilot patterns for SISO/MIXO are retained on both the terrestrial and satellite transmission.

SC-OFDM is not an option for the hybrid SFN profile.

5.2 Operational SFN modes

In each of the operational mode combinations shown in tables 1 and 2, the technical descriptions of the signals specified as forming the terrestrial and satellite components can be found in one or more of the Base Profile ETSI EN 303 105-1 [1], MIMO Profile ETSI EN 303 105-2 [2] or Hybrid Profile ETSI EN 303 105-3 [3].

NOTE 1: Where a modulation is described as A+B, 'A' refers to the terrestrial part, 'B' to the satellite part.

NOTE 2: eSFN may optionally be applied to any transmission component not already having it present.

NOTE 3: The TX identifier mentioned in table 1 below is described in ETSI EN 303 105-1 [1], clause 11.5.2.

Table 1: Rate 1 transmission schemes for hybrid SFN

Terrestrial transmission	Satellite transmission	MIXO scheme(s)
Single polarization (VP or HP)	Single polarization (RHCP or LHCP)	eSFN: Terr and Sat with 2 different TX identifiers (during SISO frames)
		Alamouti code (during MIXO frames)
Dual polarization (VP and HP)	Single polarization (RHCP or LHCP)	eSFN: 2 x Terr + Sat with 3 different TX identifiers (during SISO frames)
		Alamouti+ QAM (during MIXO frames)
Single polarization (VP or HP)	Dual polarization (RHCP and LHCP)	eSFN: Terr + 2 x Sat with 3 different TX identifiers (during SISO frames)
		Alamouti+ QAM (during MIXO frames)
Dual polarization (VP and HP)	Dual polarization (RHCP and LHCP)	eSFN: 2 x Terr + 2 x Sat with 4 different TX identifiers (during SISO frames)
Dual polarization (VP and HP)	Dual polarization (RHCP and LHCP)	Alamouti + Alamouti (during MIXO frames)

Table 2: Rate 2 transmission schemes for hybrid SFN

Terrestrial transmission	Satellite transmission	MIXO scheme(s)
Dual polarization (VP and HP)	Dual polarization (RHCP and LHCP)	eSM+PH Terr + eSM+PH+eSFN Sat (during MIMO frames)

5.3 Power imbalance cases

In the case of terrestrial power imbalance, the satellite transmission maintains a fixed 0 dB imbalance, but adopts the same values of parameters θ and α as the terrestrial transmission for the chosen imbalance. Table 3 shows the corresponding set of parameters.

Table 3: eSM parameters for satellite, SFN case

Intentional power imbalance between two terrestrial Tx antennas			**0 dB**			**3 dB**			**6 dB**		
n_{bpcu}	Modulation		β	Θ	α	B	θ	α	β	θ	α
6	f_{2i}(tx1)	QPSK	0,50	45°	0,44	0,50	0°	0,50	0,50	0°	0,50
	f_{2i+1}(tx2)	16-QAM									
8	f_{2i}(tx1)	16-QAM	0,50	$\text{atan}\left(\frac{\sqrt{2}+4}{\sqrt{2}+2}\right)$	0,50	0,50	25°	0,50	0,50	0°	0,50
	f_{2i+1}(tx2)	16-QAM									
10	f_{2i}(tx1)	16-QAM	0,50	22°	0,50	0,50	15°	0,50	0,50	0°	0,50
	f_{2i+1}(tx2)	64-QAM									

6 Hybrid MIMO MFN

6.1 Transmit/receive system compatibility

To make use of the hybrid MIMO MFN, the proposed transmission hardware shall include individually-fed terrestrial and satellite transmitters with suitable antennas, delivering an OFDM waveform on the terrestrial side and OFDM or SC-OFDM on the satellite side. Cases included are one or two (cross-polar, linear polarization) terrestrial antennas in combination with one or two (cross-polar, counter-rotating circular polarization) satellite antennas. In the case of rate 2 MIMO transmission (e.g. eSM) from either or both of the satellite or terrestrial equipments the receiver shall be equipped with a cross-polar (linear polarization or counter-rotating circular) pair of antennas in the corresponding frequency band or bands. For rate 1 transmission from either the satellite or terrestrial equipments, (e.g. Alamouti, eSFN) a dual-polarized receive antenna is recommended but a single antenna is sufficient for the corresponding satellite or terrestrial frequency band.

6.2 Operational MFN modes

Any terrestrial SISO or MIMO mode (from base and MIMO profiles respectively) may be used in conjunction with any satellite SISO mode (taken from the hybrid profile) or the MIMO modes defined in tables 1 and 2, with the following addition/exception:

- The satellite rate 2 MIMO modes add a 2 x QPSK option but exclude any use of 64-QAM.

The resulting eSM parameters for the satellite component delivering an OFDM waveform are indicated in table 4.

Table 4: eSM parameters for satellite OFDM, MFN case

n_{bpcu}	**Modulation**		**β**	**θ**	**α**
4	f_{2i}(tx1)	QPSK	0,50	$\text{atan}(\sqrt{2}+1)$	0,50
	f_{2i+1}(tx2)	QPSK			
6	f_{2i+1}(tx1)	QPSK	0,50	45°	0,44
	f_{2i+1}(tx2)	16-QAM			
8	f_{2i}(tx1)	16-QAM	0,50	$\text{atan}\left(\frac{\sqrt{2}+4}{\sqrt{2}+2}\right)$	0,50
	f_{2i+1}(tx2)	16-QAM			

NOTE 1: In the case that the satellite waveform is SC-OFDM, spatial multiplexing encoding for rate 2 MIMO is simple SM as described in ETSI EN 303 105-2 [2], clause 9.1, instead of eSM.

NOTE 2: All parameters are for 0 dB intentional power imbalance between satellite transmitting antennas.

The only constraint is that at least one transmission should be MIXO in order to qualify as hybrid MIMO; otherwise the transmission falls within the Hybrid Profile ETSI EN 303 105-3 [3].