# SLOVENSKI STANDARD
# SIST ETS 300 731 E1:2003

**01-december-2003**

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**Televizijski sistemi ï Izboljġana televizija s fazno spreminjajoḷ o se vrstico (PAL) s 625 vrsticami ï PALplus**

Television systems; Enhanced 625-line Phased Alternate Line (PAL) television; PALplus



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# Television Systems; Enhanced 625-line Phased Alternate Line (PAL) television; PALplus

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## Foreword

This European Telecommunication Standard (ETS) has been produced by the Joint Technical Committee (JTC) of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE: The EBU/ETSI JTC was established in 1990 to co-ordinate the drafting of ETSs in the specific field of broadcasting and related fields. Since 1995 the JTC 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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## 1 Scope

This European Telecommunication Standard (ETS) is applicable to 625-line PAL systems B, G, H, I, D and K.

It specifies an enhanced transmission system which allows PAL broadcasters to offer wide-screen pictures in the 16:9 aspect ratio format, maintaining compatibility with existing PAL receivers.

This ETS specifies the transmitted signal. It specifies the method of coding for accommodating wide aspect ratio signals, and the method of coding for reducing conventional PAL cross-effects and for making optimal use of the video signal spectrum. The method for reduction of PAL artefacts may also be used for studio contribution or distribution purposes. Annex C provides details of a reference PALplus decoder that makes full use of the picture enhancements offered by PALplus. Annex F gives rules of operation for the minimum requirements for a PALplus receiver.

## 2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ITU-R Recommendation BT.601-5: "Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-screen 16:9 Aspect Ratio".

[2] ITU-R Recommendation BT.470-4: "Television Systems".

[3] EBU Technical Recommendation R62: "Recommended dominant field for 625-line 50-Hz video processing".

[4] ETS 300 294: "Television Systems; 625-Line television Wide Screen Signalling (WSS)".



## 3 Abbreviations

For the purpose of this ETS, the following abbreviations apply in the construction of system coefficient names:

| | |
|---|---|
| BB | Black Bands |
| BPF | Band-Pass Filter |
| BSPLIT | Band-SPLITing filter |
| C | Camera mode |
| CHROM | Modulated PAL CHROMinance |
| CLIP | CLIPping |
| CS | motion detector Chrominance Switching control |
| CVBS | Composite Video, Blanking and Sync |
| DEC | DECoder |
| DS | Down-Sampling |
| ENC | ENCoder |
| F | Film mode |
| HDTV | High-Definition TeleVision |
| IFA | Intra-Frame Averaging |
| IFD | Inter-Frame Difference |
| ISS | Inverse Spectrum Shaping |
| L | motion detector Luminance level control signal |
| LPF | Low-Pass Filter |
| LUT | Look-Up Table |
| M | Motion detector chain chrominance motion signal |
| MAC | Multiplexed Analogue Components |
| MACP | Motion Adaptive Colour Plus |
| MD | Motion Detector chain |

| | |
|---|---|
| NDL | Not incorporating PAL Delay Line function |
| NYQ | NYQuist |
| PAL | Phased Alternate Line |
| POST_MOD | POST-(de)MODulation |
| PRE_MOD | PRE-(de)MODulation |
| QMF | Quadrature Mirror Filter |
| S | motion detector chrominance Switching control signal |
| SS | Spectrum Shaping |
| U | present in $C_B$ path |
| US | Up-Sampling |
| UV | present in both colour-difference signal ($C_B$ and $C_R$) paths |
| V | present in $C_R$ path |
| VAA | Vertical Anti-Aliasing |
| VERT | VERTical |
| VSRC | Vertical Sample-Rate Conversion |
| Y | luminance signal |
| YL | motion detector luminance Level control |

# 4 Basic PALplus system description

## 4.1 Introduction

PALplus is an enhanced transmission system which has been designed to allow PAL broadcasters to offer wide-screen pictures with greatly reduced levels of conventional PAL artefacts, whilst retaining a high level of compatibility with the PAL transmission infrastructure and with existing PAL receivers. The system is intended to co-exist with both MAC and digital television services in a complementary fashion, enabling viewers to receive enhanced quality wide-screen pictures originated in component form. The objective of the PALplus project has not been to design an HDTV system. The expected cost of PALplus receivers is therefore lower than that of HDTV receivers.



The format of the primary input and output signals for PALplus shall be 625/50/2:1, with 16:9 aspect ratio. HDTV 1250/50/2:1 sources can be used after down-conversion to 625/50/2:1.



The wide-screen picture shall be transmitted in letterbox format to achieve compatibility with existing 4:3 receivers. Loss of vertical resolution (as compared to the 576 active line source picture) is minimized in the PALplus receiver by making use of a vertical helper signal transmitted in the black bands above and below the letterbox picture.

The PALplus system has two modes of operation. These are called "film mode", which should be used only with film sources, and "camera mode" which should be used with normal 50 Hz video sources. Both the vertical conversion (to the letterbox picture) and the Motion Adaptive Colour Plus (MACP) method of improved chrominance/luminance separation make use of a camera mode and a film mode to give optimum system performance.

Starting from a 625/50/2:1 4:2:2 digital component input signal (in accordance with ITU-R Recommendation BT.601-5 [1], based on 13,5 MHz sampling) with 576 active lines per frame and an aspect ratio of 16:9, a conversion to 430 active picture lines shall be first carried out.

NOTE: All references to ITU-R Recommendation BT.601-5 [1] refer to the 13,5 MHz sampling rate variant specified in part A thereof.

In "camera mode" (when the source provides 50 Hz motion), this conversion shall be performed intra-field in order to avoid motion artefacts but, in "film mode" (when the source is known to have only 25 Hz motion), then an intra-frame conversion shall be used. The letterbox picture signal used for transmission has only three quarters of the number of active picture lines as the source; in order to minimize loss of vertical resolution in the PALplus display, the black bands shall be used to transmit a vertical helper signal.

An enhanced PAL encoding and decoding technique known as "Motion Adaptive Colour Plus" shall be used to reduce PAL luminance/chrominance cross-talk artefacts and to maximize horizontal resolution. In film mode, the system takes advantage of the known temporal redundancy of the signal and uses an intra-frame PAL encoding technique ("fixed" Colour Plus). In camera mode, the same technique shall be applied to appropriate areas of each picture frame. However, in areas containing moving saturated colour (usually representing only small parts of typical pictures), there is likely to be a significant amount of

movement between the adjacent fields of a source picture frame, which could lead to occasionally visible colour judder if fixed Colour Plus processing were applied. To minimize this problem, in such areas of the picture the system shall revert adaptively to a simpler form of PAL encoding, making use of motion detectors in both the encoder and decoder to identify areas of fast colour motion between adjacent frames.

Ghost cancellation is an optional enhancement. The parameters of the ghost cancellation reference signal are given in ITU-R Recommendation BT.1 124, annex 1, section 1.3.

### 4.2 Normative features of a PALplus transmission

A PALplus signal shall be derived according to the processes illustrated in figure 1. These are summarized below and detailed descriptions of each process are given in clause 6. The signal at the output of the encoder shall be described as "PALplus" only when all of the following processes are implemented:

a) Vertical conversion (QMF process) to 430-line letterbox;

- this is the conversion of the 16:9 aspect ratio source picture with 576 active lines to a 16:9 aspect ratio letterbox picture with 430 active lines. The QMF (Quadrature Mirror Filter) format conversion process also yields vertical luminance resolution information that shall be encoded and transmitted in the black bands.

b) Vertical helper encoding;

- this is the method of processing and modulating the vertical luminance information derived from the QMF format conversion process, resulting in the "vertical helper" signal that shall be transmitted in the black bands above and below the active letterbox picture.



c) Motion Adaptive Colour Plus (MACP);

- this is the encoding technique that makes possible improved separation of chrominance and luminance in the PALplus receiver.



d) Wide Screen Signalling (WSS);

- this shall be used to convey essential information about the content of the transmitted signal to the decoder. The system used is defined in ETS 300 294 [4].

e) Reference signals;

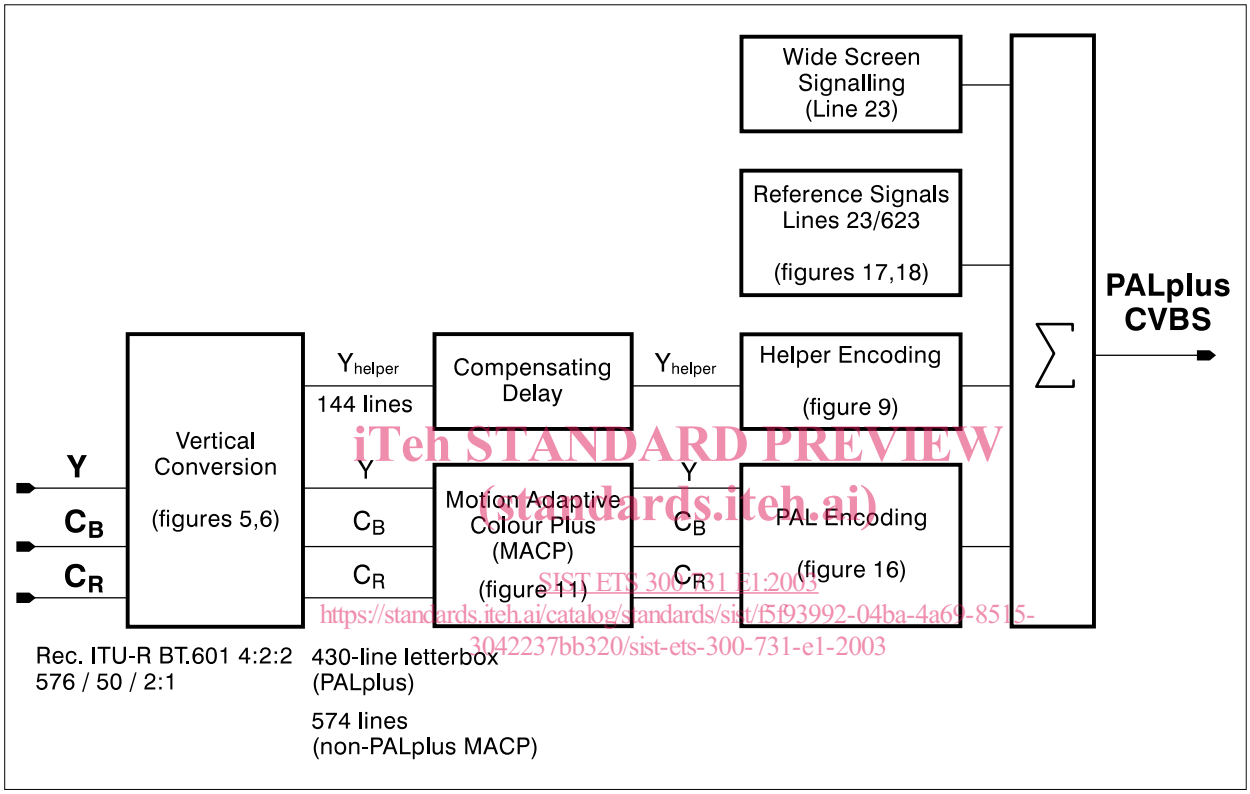
- the transmission shall contain reference signals in lines 23 and 623 that may be used by the PALplus receiver for the accurate setting of the levels of the incoming luminance and vertical helper signals. Details are given in subclause 6.5.

The PALplus signal at the output of the encoder shall consist of the combination of the PAL-encoded MACP pre-processed letterbox picture, the modulated helper signal resulting from the QMF conversion process, the reference signals, and the signalling bits, as shown in figure 1.

The features of a PALplus transmission are summarized in table 1. Compensating delays should be included in associated audio paths prior to transmission, so as to match the vision processing time in the PALplus encoder.

**Table 1: The enhancement features incorporated in a PALplus transmission**

| Enhancement | Normative for PALplus? |
|---|---|
| Format conversion (QMF) from ITU-R Recommendation BT.601-5 [1] source with 16:9 aspect ratio to central 430-line letterbox | YES |
| Vertical helper encoding | YES |
| Motion Adaptive Colour Plus | YES |
| Reference signals (lines 23/623) | YES |
| Wide Screen Signalling (ETS 300 294 [4]) | YES |
| Ghost cancellation reference signal | OPTIONAL |






NOTE: Helper not used with non-PALplus MACP.

**Figure 1: Outline of PALplus encoding process**

## 5 The PALplus signal

Figure 1 gives a top-level block diagram of the encoding process. All operations are carried out in the digital domain, using line-locked sampling rates of 13,5 MHz, 27 MHz, and 6,75 MHz.

### 5.1 Input picture signal to the PALplus encoder

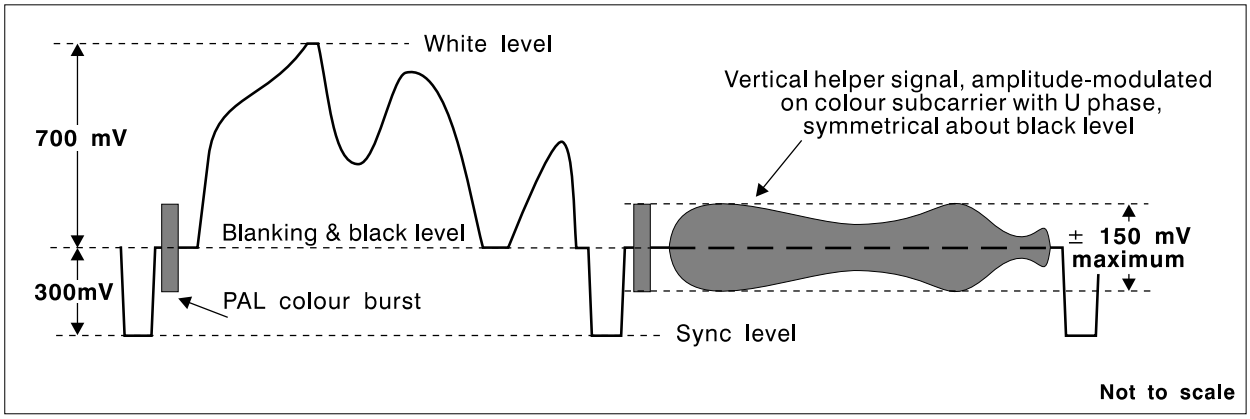
The input to the PALplus encoder shall be a component digital 625-line, 50 field/s interlaced 4:2:2 $YC_BC_R$ signal (according to ITU-R Recommendation BT.601-5 [1], minimum 8-bit resolution), with 576 (nominal) active picture lines and an aspect ratio of 16:9. Field 1 shall be the dominant field (see EBU Technical Recommendation R62 [3]) at all times in the case of material to be PALplus encoded in film mode.

### 5.2 The encoded composite PALplus signal

The output of the PALplus encoder shall be a standard analogue PAL composite signal containing 430 active picture lines in letterbox format, together with helper information contained in the black bands above and below the visible letterbox picture area (see figures 2 and 3). In addition, signalling bits are contained in the first half of Line 23 (see subclause 6.6), and reference signals for use by the PALplus decoder are inserted

into the second half of Line 23 and the first half of Line 623 (see subclause 6.5 and figures 17 and 18). The structure of the PALplus frame is illustrated in figure 3.

All general characteristics of the encoded PALplus signal shall conform to the parameters listed in ITU-R Recommendation BT.470-4 [2]. These include all aspects of the standard PAL colour burst, which shall be retained on the same lines as for a standard PAL signal.




NOTE 1: Standard PAL horizontal blanking shall be applied in lines carrying the vertical helper signal.

NOTE 2: Burst blanking shall be identical to that of a standard PAL signal.

**Figure 2: Waveforms showing typical lines of PALplus letterbox and vertical helper signals**



All operations in the encoder are performed in digital form. Prior to digital-to-analogue conversion at the output of the encoder, the encoded PALplus signal shall have the following characteristics:



- sampling rate: 13,5 MHz (or multiple thereof), quantizing range: $0,00_{10}$ to $25255,755_{10}$ (unsigned), 10-bit resolution. Black level = $64,00_{10}$, peak-white level = $192,00_{10}$;

- the quantizing range is illustrated in figure 4. The use of 10-bit resolution within this range reduces the effects of quantizing errors in critical areas of processing;

- permitted signal data levels for this 10-bit signal shall be in the range $1,00_{10}$ to $254,75_{10}$ for compatibility with the signal data levels of ITU-R Recommendation BT.601-5 [1]. (All vision signals lie within this range);

- using the above quantizing scale, the maximum peak-to-peak amplitudes of the modulated chrominance signals shall be: U = $112,00_{10}$, V = $157,50_{10}$.

NOTE 1: Within this ETS, the contents of digital words are expressed in decimal form. To avoid confusion between 8-bit and 10-bit unsigned representations, the eight most significant bits are considered to be an integer part while the two additional bits, if present, are considered to be fractional parts. (For example, the bit pattern 10 010 001 would be expressed as $145_{10}$, and 1 001 000 101 as $145,25_{10}$). Where no fractional part is shown, it is to be assumed to have binary value 00.

Each active line of letterbox picture and of helper shall be formed from 702 digital active samples, and the structure of the PALplus frame shall be as shown in figure 3.

NOTE 2: For convenience, the sampling clock period numbers are indicated in this ETS as being in the range 1 to 864, where clock period 1 represents the leading edge of line syncs, half amplitude reference (see figure 3). Sampling clock period 1 therefore corresponds to ITU-R Recommendation BT.601-5 [1] luminance sample number 732. The first active sample of each line shall be in clock period 143, which corresponds to the 11th sample of the digital active luminance line of ITU-R Recommendation BT.601-5 [1] (luminance sample number 10).

The frequency spectrum occupied by the chrominance signal shall be 4,43 MHz ± 1,3 MHz at -3 dB.