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Contents

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Foreword

This final draft 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), and is now submitted for the Voting phase of the ETSI standards approval procedure.

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 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 *.

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Proposed transposition dates	
Date of latest announcement of this ETS (doa):	3 months after ETSI publication
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Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

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1 Scope

This European Telecommunication Standard (ETS) is applicable to 625-line PAL/SECAM systems B, G, H, I, L, D and K broadcast on the VHF / UHF terrestrial networks, including their distribution on cable networks.

It specifies reference signals that may be inserted into the vertical blanking interval of the baseband video signal prior to transmission, and the way of incorporating these reference signals into the television system. These reference signals are intended for use by appropriately equipped television receivers to reduce or eliminate the effects of multi-path reception on displayed pictures and, in addition, to improve the eye-height of received teletext data so as to reduce the likelihood of errors in teletext decoding.

This ETS specifies the waveform inserted into the baseband video signal, at the point of insertion.

2 Normative reference

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.470: "Television Systems".

3 Abbreviations

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

GCR	Ghost Cancellation Reference
MACP	Motion Adaptive Colour Plus
PAL	Phased Alternate Line
SECAM	Sequentielle Couleur Avec Memoire (French colour-TV system)

4 Ghost Cancellation Reference (GCR) signal

4.1 GCR waveform

The GCR waveform shall be derived according to the formula given in annex A.

The GCR waveform shall be placed on a pedestal of amplitude V1, as indicated in figure 1, using the parameters listed in table 1.

4.1.1 GCR amplitude

The maximum peak-to-peak amplitude of the GCR signal at the point of insertion into the television signal shall be: 700 mV + 0 / - 70 mV.

NOTE: The maximum peak-to-peak amplitude of the GCR signal is reached only at the high frequency end of its energy spectrum.

The amplitude of the GCR shall have a frame-to-frame consistency within 5 mV peak-to-peak.

4.1.2 GCR pedestal

The pedestal amplitude with respect to black level shall be the mean of the nominal values V2 and V3:

$$V1 = \frac{(V2 + V3)}{2} \text{ mV.}$$

NOTE: The nominal pedestal amplitude equates to 350 mV.

The rise and fall times of the pedestal shall be: 300 ± 100 ns.

The amplitude of the pedestal shall have a frame-to-frame consistency within 5 mV peak-to-peak.

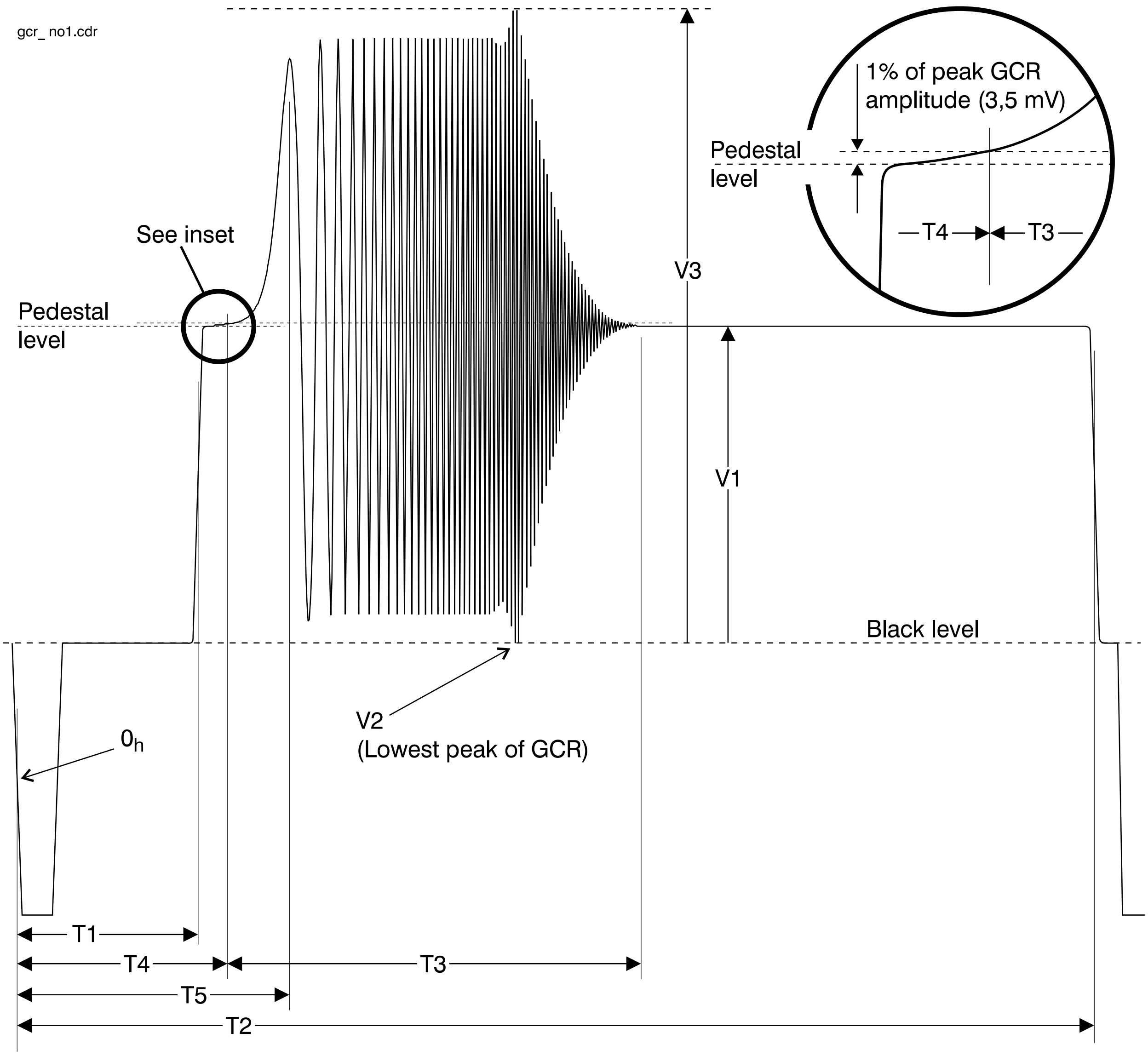

Figure 1: Amplitude and timing of the GCR signal

4.2 Location of the GCR signal

The GCR signal on its pedestal shall be inserted into the television waveform on line 318.

The preceding line, 317, shall contain no time-varying information.

NOTE 1: Line 318 begins with an equalising pulse, as described in ITU-R Recommendation BT.470 [1].

NOTE 2: Line 317 contains equalising pulses.

Table 1: Parameter values

Parameter	Description	Value
V1	amplitude of pedestal	$\frac{(V2 + V3)}{2}$ (note 1)
T1	start of pedestal	10,5 ± 0,2 µs (notes 2, 3 & 7)
T2	finish of pedestal	62,5 ± 0,2 µs (notes 2, 3 & 7)
T3	duration of GCR	(notes 3, 5 & 7)
T4	start of GCR	12,2 ± 0,2 µs (notes 2, 3, & 7)
T5	first peak of GCR	(notes 2, 6 & 7)
V2	lowest peak of GCR	0 mV (notes 1 & 4)
V3	highest peak of GCR	700 mV (notes 1 & 4)

NOTE 1: Values of V1, V2 and V3 are given with respect to black level.

NOTE 2: Values of T1, T2, T4 and T5 are given with respect to 0_h, the line time reference point at the half-amplitude point of the leading edge of the line sync (equalising) pulse.

NOTE 3: Values of T1 and T2 are given with respect to the 50% amplitude point of the rise and fall respectively of the pedestal, while T3 and T4 relate to the 1% amplitude point of the maximum amplitude (relative to the pedestal) of the GCR.

NOTE 4: The mean value of V2 shall be within + 35 / - 0 mV of its nominal value; the mean value of V3 shall be within + 0 / - 35 mV of its nominal value.

NOTE 5: The duration of the GCR, T3, arising from application of the formula in annex A, is nominally 23,23 µs.

NOTE 6: The first peak of the GCR, arising from application of the formula given in annex A, and from the value specified above for T4, occurs at nominally 15,8 ± 0,2 µs.

NOTE 7: The parameters T1, T2, T3, T4, and T5 shall have a frame-to-frame timing consistency within ± 15 ns (i.e., within 30 ns peak-to-peak).

NOTE 8: Guidelines on tolerances in the distribution path are given in annex B, clause B.2.

4.3 GCR polarity and transmission sequence

On alternate frames, the polarity of the GCR waveform shall be inverted prior to its placement on the pedestal, forming positive-going GCR "line A" as shown in figure 2, and negative-going GCR "line B" as shown in figure 3.

Transmissions of GCR line A and GCR line B shall alternate, following either one of the two alternative sequences shown in table 2.

Table 2: The two alternative GCR transmission sequences

Frame	GCR (sequence 1)	GCR (sequence 2)
1	line A	line B
2	line B	line A
3	line A	line B
4	line B	line A

NOTE: There is no absolute relationship between the polarity of the GCR transmission sequence and the 8-field sequence of PAL, and no absolute relationship with the sequence of colour reference signals of SECAM.

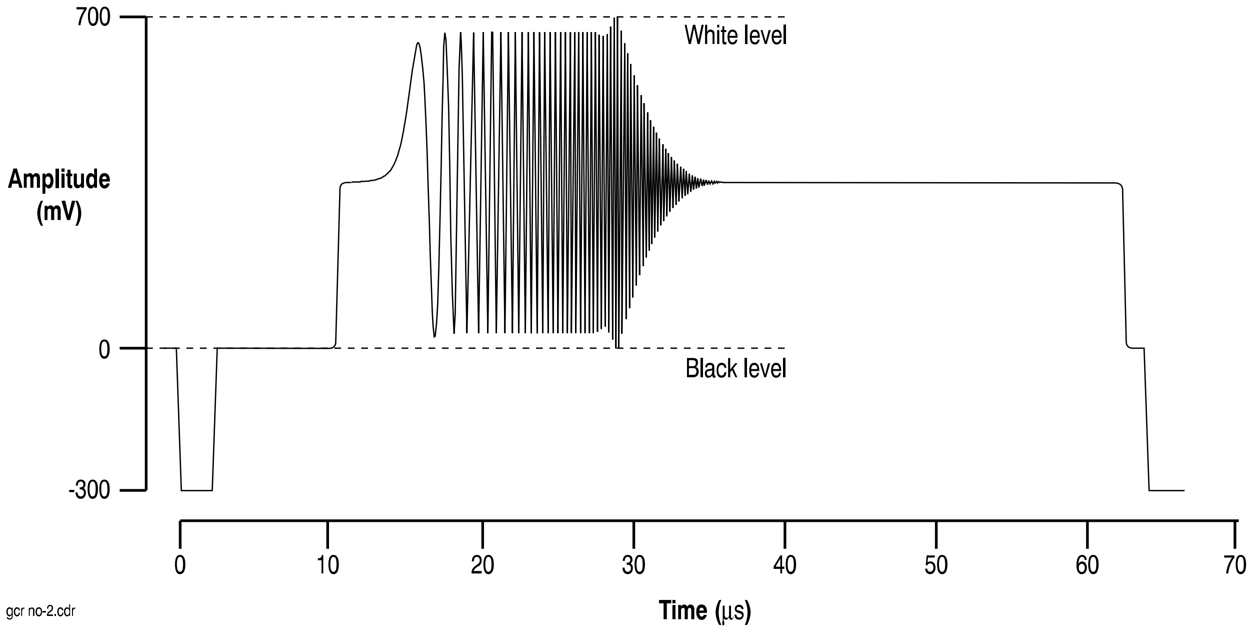

Figure 2: Line A (positive going) GCR signal

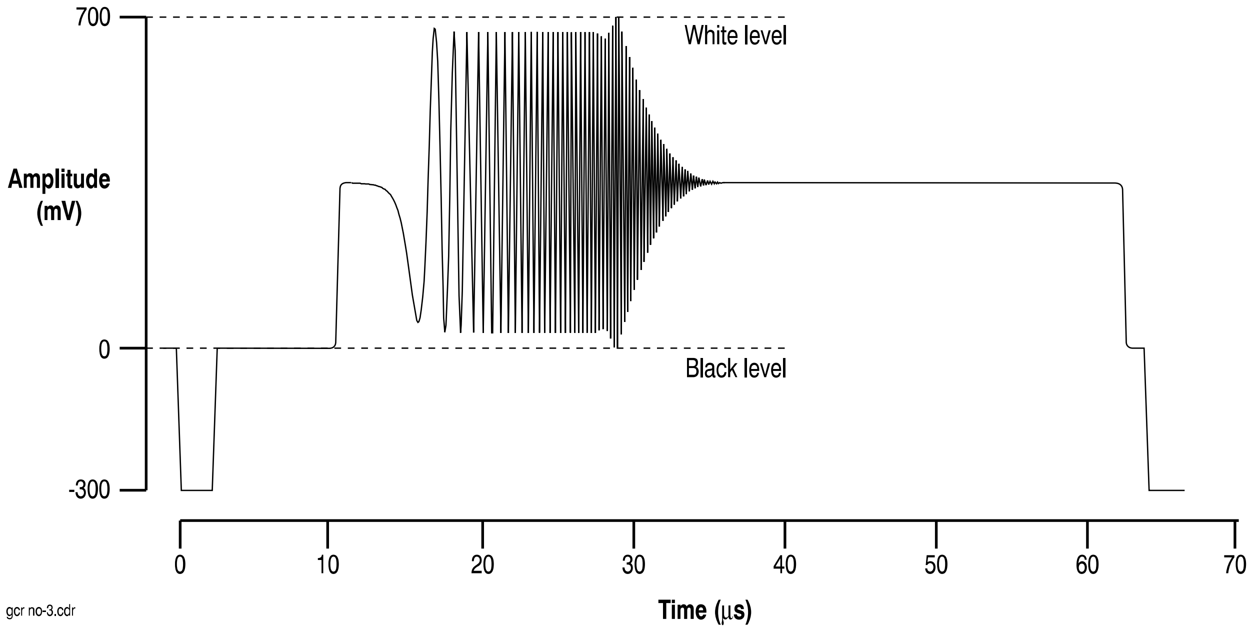

Figure 3: Line B (negative going) GCR signal

Annex A (normative): Derivation of the GCR waveform

A.1 Defining equations

Numerical values of the reference signal as a function of time shall be derived according to the following formula:

$$f(t) = \frac{A}{2\pi}\left[\int_{0}^{\Omega} \left[\cos(b\omega^2) + j\sin(b\omega^2)\right] W(\omega) e^{j\omega t}\, d\omega \;+\; \int_{-\Omega}^{0} \left[\cos(b\omega^2) - j\sin(b\omega^2)\right] W(\omega) e^{j\omega t}\, d\omega \right]$$

where W(ω) is the window function defined as follows:

$$W \int_{-\frac{\pi}{c}}^{\frac{\pi}{c}} \left[\left[\frac{1}{2} + \frac{1}{2}\cos(ct) \right] \left[\frac{1}{2\pi} \int_{-\Omega_1}^{\Omega_1} e^{j\gamma t}\, d\gamma \right] \right] e^{-j\omega t}\, dt$$

and where the constants A, b, c, Ω and Ω_1 are given in table A.1.

Table A.1: Parameter values for GCR waveform equations

Parameter	Value
A	$0{,}30358\ 10^{-6}$ V s
b	$0{,}2829\ 10^{-12}$ s^2 rad^{-1}
Ω	$2\pi\ 5{,}5\ 10^{6}$ rad s^{-1}
c	$0{,}9121\ 10^{6}$ rad s^{-1}
Ω_1	$2\pi\ 5{,}0\ 10^{6}$ rad s^{-1}

Annex B (informative): GCR generation and transmission

B.1 General

To act as an effective reference signal, the GCR contains high energy across the whole range of video frequencies over which equalisation is sought. The parameters of the GCR given in annex A are chosen such as to result in a nominally flat energy spectrum up to almost 5 MHz, as illustrated in figure B.1, with a very low level of energy beyond 5,2 MHz. The signal may therefore be included in any European PAL/SECAM 625-line terrestrial transmission channel.

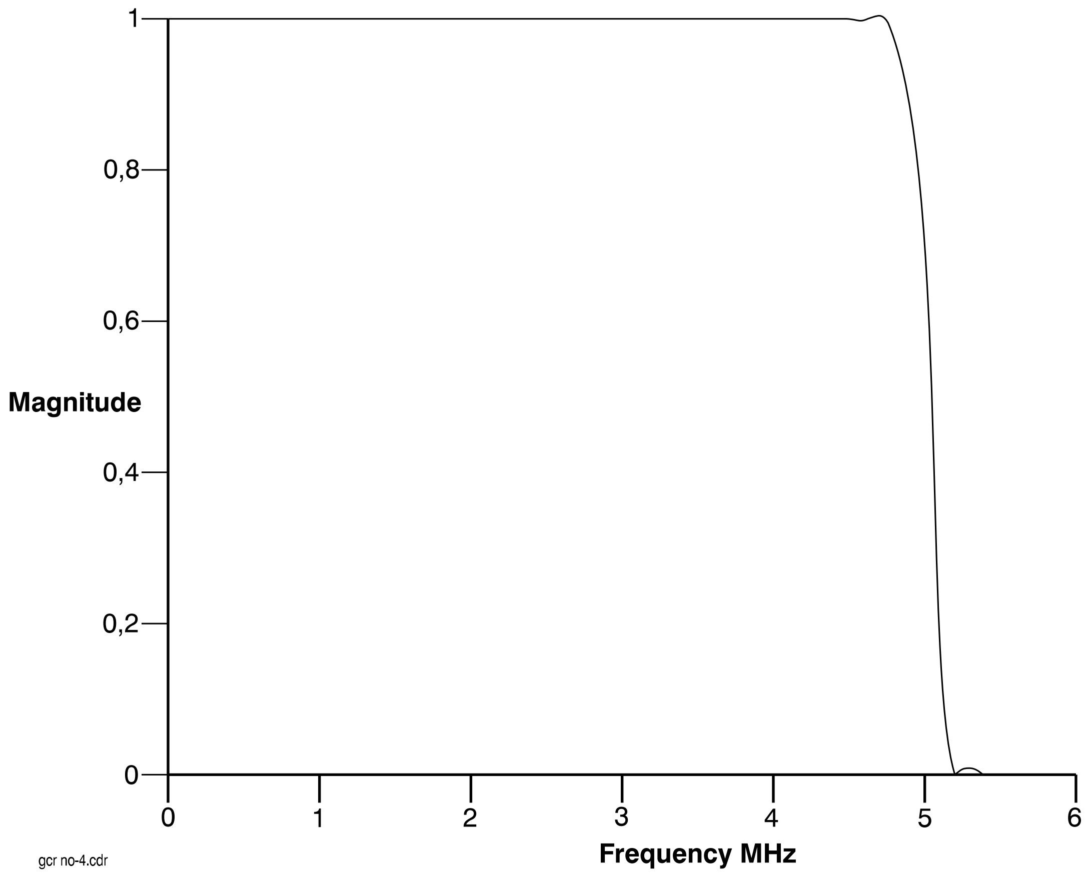

Figure B.1: Magnitude of the energy spectrum of the GCR signal

The energy spectrum shown in figure B.1, and the idealised GCR waveforms illustrated in figures 2 and 3 at the point of insertion into the baseband television signal, will subsequently be modified according to any distortions and echoes present in the distribution and transmission paths.

B.2 Tolerances of the GCR signal

Based on experience of ghost cancellation with the PAL system, to allow effective operation of a ghost canceller the amplitude and timing parameter values of the GCR should be maintained throughout the distribution path to a frame-to-frame consistency within 5 mV (peak-to-peak) and 5 ns (r.m.s.) respectively.

Assuming that jitter is distributed in a gaussian fashion, the above timing guideline equates, for measurement purposes, to a frame-to-frame consistency of ± 15 ns (i.e., within 30 ns peak-to-peak) with respect to the absolute value of 0_h.

Frame-to-frame jitter greater than the above values is likely to result in reduced performance of ghost cancellers, particularly under severe echo conditions.

B.3 Transparency of digital codecs to the GCR

Where it is required to distribute a television signal containing the GCR via a digital contribution/distribution circuit (for example, at 34 Mbit/s or 14 Mbit/s), particular attention should be given to the design of the codec interface if it is required to ensure effective transparency of the GCR signals.

In practice, it is likely to be cost effective to re-insert the GCR signals at the output of the codec.

It might also be necessary to ensure that processing (for example, comb filtering) carried out by a codec PAL/SECAM interface does not result in the generation of spurious signals on lines 317, 318 and 319 at the codec output, arising from the presence of a GCR at the codec input.

Annex C (informative): Operation of ghost cancellers

C.1 Cancellation range and response time

To allow detection of echoes, the GCR signal must be both preceded and followed by a period of time within which the television signal contains no time-varying information. The parameters of the GCR signal have been chosen so as to allow the detection and cancellation of multiple echoes with delays up to approximately 40 µs, without regard as to the content of the following line, 319.

NOTE: Detection and cancellation of echoes of longer durations than nominally 40 µs is theoretically possible, but account would have to be taken of the likely presence of time-varying information on line 319 (for example, teletext) which could be expected to lead to increased complexity for the canceller and longer cancellation times. In practical reception situations, the great majority of echoes can be expected to fall well within the above target cancellation range of delays of up to nominally 40 µs.

Detection and cancellation of pre-echoes is possible, and this depends on the canceller algorithm and is not constrained by the GCR itself. Similarly, the number of echoes that may be cancelled depends on the design of the canceller.

In the case of PAL, for echoes with long delays which fall beyond the start of the colour synchronising burst on line 319 (greater than approximately 33,4 µs), it is necessary for an echo canceller to take account of the presence of the colour burst. The cancellation range can be maximised by extracting the received GCR signals using a four-frame (or multiple thereof) running average in the following manner:

$$(GCR_{frame\ N} + GCR_{frame\ N+2}) - (GCR_{frame\ N+1} + GCR_{frameN+3}).$$

This has the effect of eliminating static information, such as sync pulses, together with the colour synchronising burst on line 319, thereby maximising the cancellation range.

A consequence of using a running average of extracted GCR signals in this way is to increase the signal-to-noise ratio of the extracted GCR information. However, the greater the number of GCR signals used to form the running average, the slower the response time is likely to be in equalising time-varying ghosting.

Depending on the cancellation algorithm, It can be expected that practical ghost cancellers could establish equalisation within a few seconds (perhaps within under one second) of first being presented with a signal containing echoes.

C.2 Ghost cancellation and Motion Adaptive Colour Plus (MACP)

Correct operation of the Motion Adaptive Colour Plus process (as used by the PALplus system - see note) relies on the fact that points separated by 312 lines within a frame have a precise phase relationship.

In order to avoid disturbing this relationship, any changes to the equalisation of the signal applied by a ghost canceller located in either the transmission or reception chain should be made during the period of lines 624 to 22.

NOTE: The operation of the PALplus system and of Motion Adaptive Colour Plus (MACP) is described in working draft prETS 300 731 on "Television systems; Enhanced 625-line Phased Alternate Line (PAL) television; PALplus".

History

Document history			
May 1996	Public Enquiry	PE 106:	1996-05-20 to 1996-09-13
October 1996	Vote	V 113:	1996-10-21 to 1996-12-13