PROPOSED STANDARD

For Field-Sequential 3D Video -
A method for the Recording and Playback of Stereoscopic 3D Images and Video Sequences with the NTSC, PAL and SECAM Video Standards.

INTRODUCTION:

The NTSC, PAL and SECAM video standards can all be used for the recording and playback of stereoscopic 3D video by storing the left and right views in alternate fields of the video signal. This is commonly known as "field-sequential 3D video" or occasionally "alternate-field 3D video". Unfortunately the choice of which image (left or right) to store in which field (even or odd) is arbitrary.

SCOPE:

This proposed standard seeks to (a) provide a definition for field-sequential 3D Video, (b) formalize a labeling technique to signify the 3D image/field polarity of field-sequential 3D video, and (c) recommend a preferred 3D image/field polarity (yet to be chosen). This standard will apply directly to the NTSC, PAL and SECAM video standards however its results could be extrapolated to apply to any 2:1 interlaced video signal.

BACKGROUND:

The NTSC, PAL and SECAM video standards are all 2:1 interlaced systems, i.e. each full image (frame) is scanned in two parts (fields) - the odd field scans half of the scan lines (counting from the top of the image, lines 1,3,5, etc) and the even field scans the remaining lines.
The NTSC standard is a 525/60 system (525 lines per frame, 60 fields per second) whereas the PAL and SECAM standards are a 625/50 system (625 lines per frame, 50 fields per second).

DEFINITION OF FIELDS:

In these systems the odd field (field 1) is defined as the field which has its horizontal sync pulses in phase with the leading edge of the vertical sync pulse at the beginning of that field. The even field (field 2) is defined as the field which has its horizontal sync pulses offset by 0.5H from the leading edge of the vertical sync pulse at the beginning of that field (See Figure 1).

DEFINITION OF FIELD-SEQUENTIAL 3D VIDEO:

Field-Sequential 3D video consists of an interlaced video signal in which one of the images of a stereo pair are stored in the odd fields of the video sequence and the other image of the stereo pair is stored in the even fields of the video sequence. When a FS3D video signal is viewed without glasses it will be seen to flicker or alternate between the left and right images at field rate. The placement of the left and right images in the odd and even fields should also be such that good image alignment is maintained - particularly in the vertical direction.

LABELING OF 3D IMAGE/FIELD POLARITY:

3D Video sequences in which the left image is stored in the odd field (field 1) will be labeled "L1".
3D Video sequences in which the right image is stored in the odd field (field 1) will be labeled "R1".
An equivalent label for "R1" is "L2", and an equivalent label for "L1" is "R2".
The label can either be placed on the video tape cassette or shown at the header of the video footage.
Where 3D equipment can be switched between the two 3D polarities, the two states should be labeled "L1" and "R1". Where the equipment cannot be switched, it should be labeled as to which 3D polarity it supports.

DEFINITION OF 3D POLARITY:

This document also seeks to define a preferred 3D image/field polarity - whether it be R1 or L1.
The preferred polarity will be determined in consultation with a representative group of people & companies who generate, develop and use stereoscopic video equipment and footage.
Please note that the same polarity L1 or R1 should be defined for both 525/60 and 625/50 systems since the recommendations of this standard can then be generalized to all 2:1 interlaced systems.

IN SUMMARY:
Odd Field = Field 1 **=** Hsync aligned with leading edge of Vsync at the beginning of that field.
Even Field = Field 2 = Hsync offset by 1/2H with leading edge of Vsync at the beginning of that field
R1 = L2 **=** Right image stored in odd field (field 1), left image stored in even field (field 2).
L1 = R2 = Left image stored in odd field (field 1), right image stored in even field (field 2).
A preferred 3D image/field polarity will be chosen and specified at a later date.

REFERENCES:
* NTSC Standard: "ANSI/SMPTE 170M - 1994" - "SMPTE Standard for Television - Composite Analog Video Signal - NTSC for Studio Applications", SMPTE (Society for Motion Picture and Television Engineers).
* PAL Standard: "Recommendation ITU-R BT.470-6" - "Conventional Television Systems", ITU (International Telecommunication Union).

ANNEX A (informative)
HOW TO DETERMINE THE 3D POLARITY OF A 3D VIDEO SIGNAL:

USING BASIC PRINCIPLES:
Equipment: CRT-based Video Monitor, Dual-Trace Analog Cathode-Ray-Oscilloscope (CRO) with Video Triggering, Liquid Crystal Shutter (LCS) Glasses and Driver Box, 3D Video Source.
Procedure:
(a) Connect 3D Video signal to video monitor and channel 1 of CRO.
(b) Adjust CRO to dual trace mode (second channel no input), set trigger to channel 1 Vsync, and adjust timebase such that full width of screen is approximately 30-50us (less than one field). (In this mode the CRO will hopefully only display half of the fields on the channel 1 display - channel 2 is just being used to gate out half of the fields).
(c) Observe 3D video signal on Video Monitor through LCS glasses and confirm whether 3D image is correct (case A) or pseudo (case B).
(d) Observe the CRO display through the LCS glasses and confirm that only one eye sees the displayed video signal - if both eyes can see in full the displayed video signal, the either the CRO being used is unsuitable or the CRO hasn't been configured correctly. NB: both eyes may be able to see the vertical interval because of LCS switching timing, the slew rate of the LCS, or CRO phosphor persistence.
(e) Take note whether the field being displayed is seen by the left eye (case C) or the right eye (case D).
(f) Expand the display (by adjusting the timebase control) such that detail in the vertical interval can be seen (ensure that the field being displayed does not change) and using the timing diagrams shown in Figure 1 (for NTSC or PAL/SECAM) determine whether the field is the odd field (case E) or the even field (case F). (Probably the easiest way of identifying the correct field is to count the number of post-equalization pulses: 6 for NTSC odd field, 5 for NTSC even field, 5 for PAL/SECAM odd field, 4 for PAL/SECAM even field).
The following case combinations indicate "R1" 3D polarity: ACF, ADE, BCE, BDF.
The following case combinations indicate "L1" 3D polarity: ACE, ADF, BCF, BDE.

USING CALIBRATED EQUIPMENT:
If a calibrated LCS glasses driver box was used to view a 3D video sequence, the 3D polarity could be identified by noting the polarity of the viewed video and the position of the polarity switch on the driver box (if present). A register of equipment which conforms with this standard may be kept at the http://www.stereoscopic.org website (to be decided).

This document represents intermediate workings towards the development of a recommended standard for field-sequential 3D video.
The contents are still in draft form (version 0.4) and will be discussed in the lead up and at the Standards Forum at the January 2001 "Stereoscopic Displays and Applications" Conference.
For more information, see: http://www.stereoscopic.org/standard

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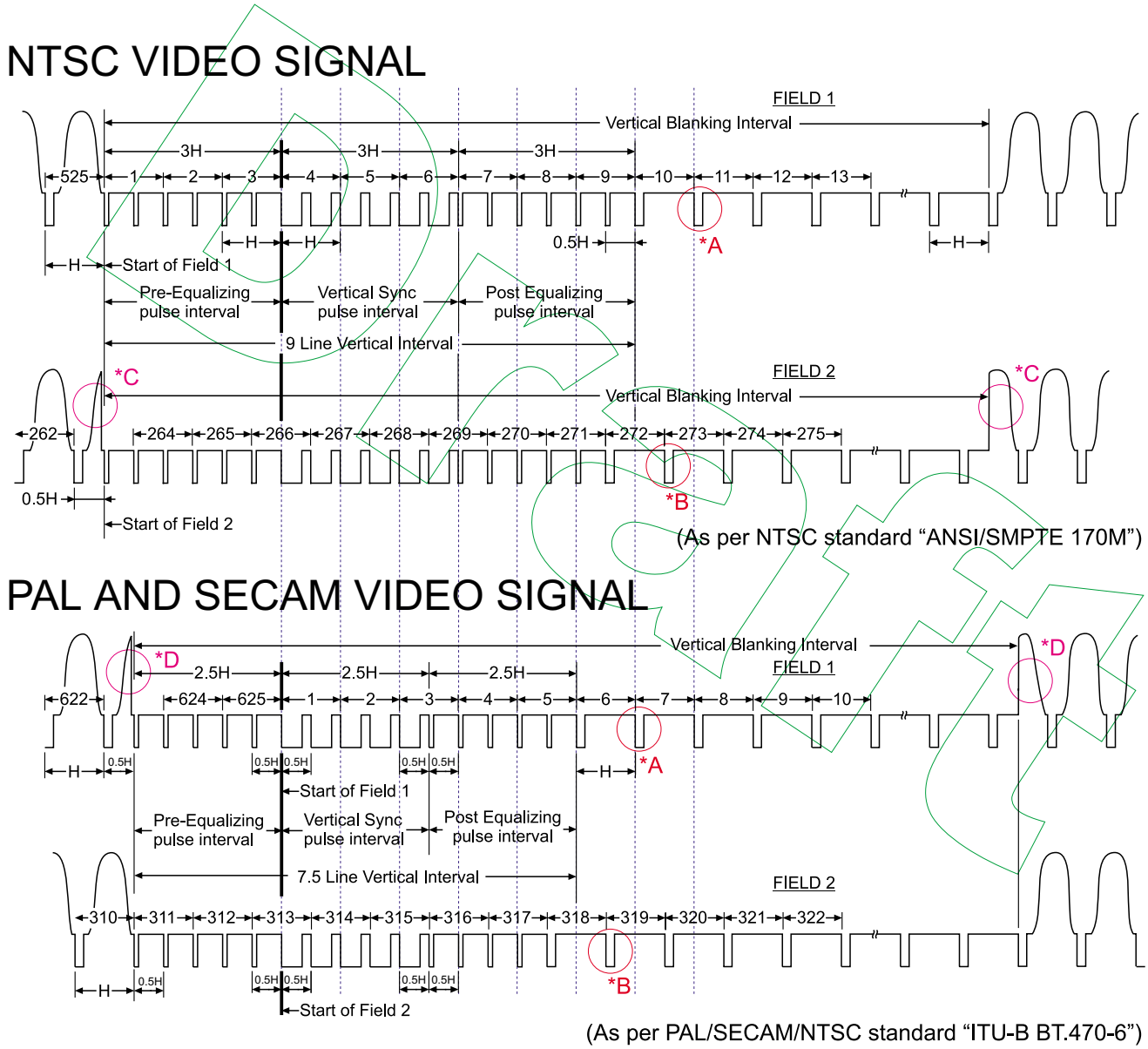
Figure 1: NTSC, PAL and SECAM timing diagrams showing vertical interval and field definitions.



The technique of identifying odd and even fields (fields 1 and 2) is as follows. Locate the start of the vertical sync pulse interval. Step out 1H steps (1 line steps) from the start of the Vertical Sync Pulse Interval to the right past the vertical interval period (see the blue dashed vertical lines). If the horizontal sync pulses coincide with the blue construction lines (see point *A), it is Field 1. If the horizontal sync pulses do not coincide with the blue construction lines (see point *B), it is Field 2. (This technique works for NTSC, PAL and SECAM).

NOTES:
NTSC and PAL/SECAM are very similar in the structure and timing of their signals however there are some notable differences:
1. For NTSC, the length of the pre-equalization, vertical sync and post equalization periods is 3H each (i.e. Vertical Interval = 9 lines) whereas for PAL/SECAM it is 2.5Heach (i.e. Vertical Interval = 7.5 lines).
2. For NTSC, half lines occur at end of Field 1 and start of Field 2 (*C) whereas for PAL/SECAM, the half lines occur at end of Field 2 and start of Field 1 (*D). The use of this method to identify field1/2 should be avoided since it is not standard independant.
3. For NTSC, convention states that the start of fields (and hence the start of line numbering) is at the start of pre-equalization interval, whereas for PAL/SECAM, convention states that the start of fields (and hence the start of line numbering) is at the start of the vertical sync interval.

The main difference between PAL and SECAM is the color encoding technique, however, this has no bearing on the identification of odd and even fields.