2014-07-14

Withdrawal of SMPTE RP 175-1997

Digital Interface for 4:4:4:4 Component Video Signals (Dual Link)

This Recommended Practice has been withdrawn and its content is no longer endorsed by the Society. This action has been taken because it is judged that there is a significant possibility that use of the document may cause harm.

The content of SMPTE RP 175 'Digital Interface for 4:4:4:4 Component Video Signals (Dual Link)' has been folded into SMPTE ST 125 'SDTV Component Video Signal Coding 4:4:4 and 4:2:2, for 13.5 MHz and 18 MHz Systems' including updated information and some corrections.

The references in RP 175 are also not current.

To avoid confusion, especially as to the number of active lines, RP 175 has been withdrawn.

The following statement has been added at the beginning of the Scope of this withdrawn document:

"This Recommended Practice has been withdrawn. The information contained in it, with updates, has been incorporated into SMPTE ST 125:2013."

SMPTE RECOMMENDED PRACTICE

RP 175-1997
Revision of RP 175-1993

Digital Interface for 4:4:4:4 Component Video Signals (Dual Link)

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1 Scope

This practice describes a means of interconnecting digital video equipment operating in system M (525/60) and complying with the 4:4:4 sampling and encoding parameters defined in ITU-R BT.601, annex 1, with a nominal sampling frequency of 13.5 MHz. Provision is made to carry a fourth, auxiliary, channel as part of the signal multiplex, yielding 4:4:4:4 (or 4x4) overall.

The interface is primarily defined to convey signals having luminance, color-difference, and auxiliary components. Signals having green, red, blue, and auxiliary components may alternatively be conveyed, as described in clause 6.

This is a 10-bit interface, however, provision has been made to interconnect all signals with 8- or 10-bit precision.

The interface consists of two unidirectional interconnections between one device and another. These interconnections carry the data corresponding to the television signal and associated data.

The two interconnections are referred to as link A and link B. Each link shall conform separately to the transmission standards and protocols described in either ANSI/SMPTE 125M or ANSI/SMPTE 259M.

Link A carries all the main channel luminance samples plus those C_B and C_R samples which are located at even-numbered sample points.

Link B contains the samples of the auxiliary channel (most commonly used for, but not restricted to, key signal information) and the C_B and C_R samples from the odd-numbered sample points.

NOTE – Although it is common to refer to link A as 4:2:2 and link B as 2:2:4, it must be noted that link A is not a true 4:2:2 signal because the color-difference data it contains were sampled at 13.5 MHz to obtain a 4x4 signal, rather than at 6.75 MHz as specified in ANSI/SMPTE 125M. Therefore, if an attempt is made to use link A as a conventional 4:2:2 signal, there will be aliasing in the subsampled color-difference signals. This quasi-4:2:2 channel could be used for noncritical monitoring, but the full 4x4 signal should be correctly filtered and subsampled before critical use.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI/SMPTE 125M-1995, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

ANSI/SMPTE 259M-1997, Television — 10-Bit 4:2:2 Component and $4f_{SC}$ Composite Digital Signals — Serial Digital Interface

SMPTE RP 157-1995, Key Signals

Approved December 5, 1997

3 4x4 component signal transmission

The input source for generating the two component digital signals shall be a 4x4 signal as described below.

3.1 Encoding parameters

Table 1 specifies the encoding parameters in accordance with the 4:4:4 level of ITU-R BT.601, with the addition of the fourth, auxiliary, channel.

3.2 Data signal format

Used to express quantized values are 1016 of the 1024 levels (digital levels 4 through 1019 or 004_h through $3FB_h$ in the hexadecimal representation) of the 10-bit word.

3.3 Samples

The samples of each of the four signals shall be cosited at each of the 858 sample points on every line.

4 Analog waveform to digital data timing relationship

4.1 Samples

During each line of video, a total of 3432 samples is taken. For the active period of the line, 2880 samples are obtained. These samples consist of 720 samples each of the Y, C_B, C_R, and A (auxiliary) signals. The points are designated 0-857 and the individual samples are designated by suffixes such as "sample $135C_R$" or "sample 429Y."

4.2 Data streams

The 3432 total samples are separated into two data streams, each consisting of 1716 samples, 1440 of which represent the active line area. Link A's data stream contains all the Y channel samples plus the even-numbered (0, 2, 4, etc.) samples from the C_B and C_R channels. Link B's data stream contains the odd-numbered (1, 3, 5, etc.) samples from the C_B and C_R channels plus all the A-channel samples (see figure 1).

Table 1 – Encoding parameters

Matrixing formulas:	Y = 0.587G + 0.114B + 0.299R C_B = 0.564 (B–Y) = 0.500B – 0.169R – 0.331G C_R = 0.713 (R–Y) = 0.500R – 0.419G – 0.081B
Number of samples per line:	Total / Active
– each of the 3 video components	858 / 720
– auxiliary channel	858 / 720
– total number of samples	3432 / 2880
Sampling structure:	Orthogonal: line, field, and frame repetitive.
Sampling frequency:	
– each of 3 video components	13.5 MHz nominal
– auxiliary channel	13.5 MHz nominal
Form of encoding:	Uniformly quantized PCM, 10 bits/sample, for each of the primary signals and the auxiliary channel.
Correspondence between video signal levels and quantization levels:	Decimal representation of 10-bit values:
– each of the 3 primaries (G, B, R), the luminance signal (Y), and the auxiliary channel (A)	877 quantization levels with black corresponding to level 64 and peak white level corresponding to level 940.
– each color-difference signal	897 quantization levels symmetrically distributed about level 512, which corresponds to zero signal.

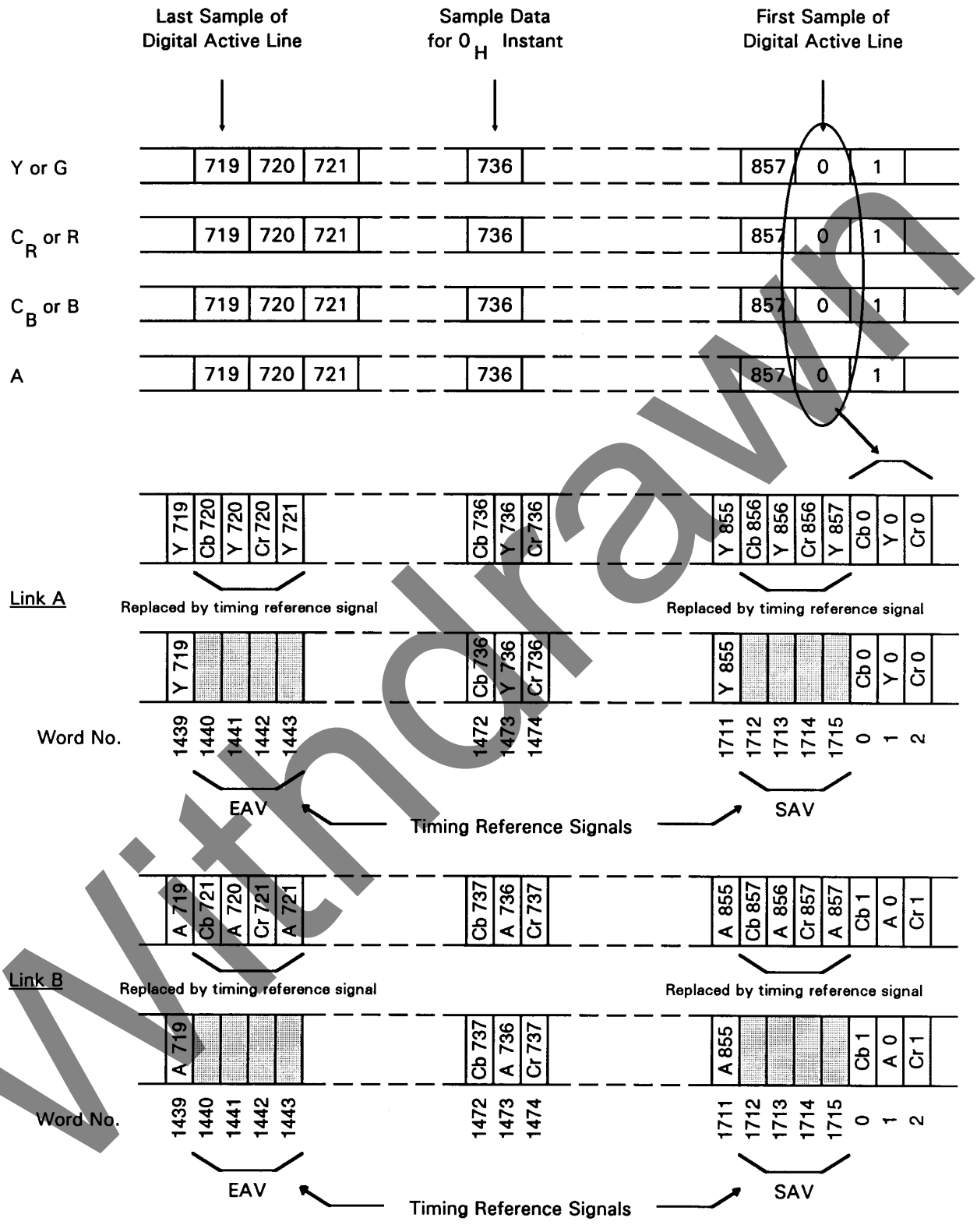


Figure 1 – Multiplex structure

4.3 Clock intervals

Each horizontal line contains 1716 clock intervals, 1440 in the active video area and 276 in horizontal blanking. The first of these 1716 clock intervals is designated line word zero for purposes of reference only. The 1716 sample points per line are numbered 0-1715. Intervals 0-1439, inclusive, contain active video. The interface clock intervals occurring during digital blanking are designated 1440-1715.

Eight clock intervals in horizontal blanking are used to transmit synchronizing information. The remaining 268 interface clock intervals may be used to carry ancillary information. Intervals 1440-1443 are reserved for the end-of-active-video (EAV) timing reference. Intervals 1712-1715 are reserved for the start-of-active-video (SAV) timing reference. These are described in 4.7.1.

4.4 Horizontal sync relationship

Figure 2 shows the relationship between video signals in the digital and analog domains for 525-line systems. The half-amplitude point of the leading (falling) edge of the analog horizontal sync signal shall be coincident with a sample which would be conveyed by word number 1473 if carried across the interface.

4.5 Vertical sync relationship

Figure 3 shows the relationship between video signals in the digital and analog domains for the 525-line system.

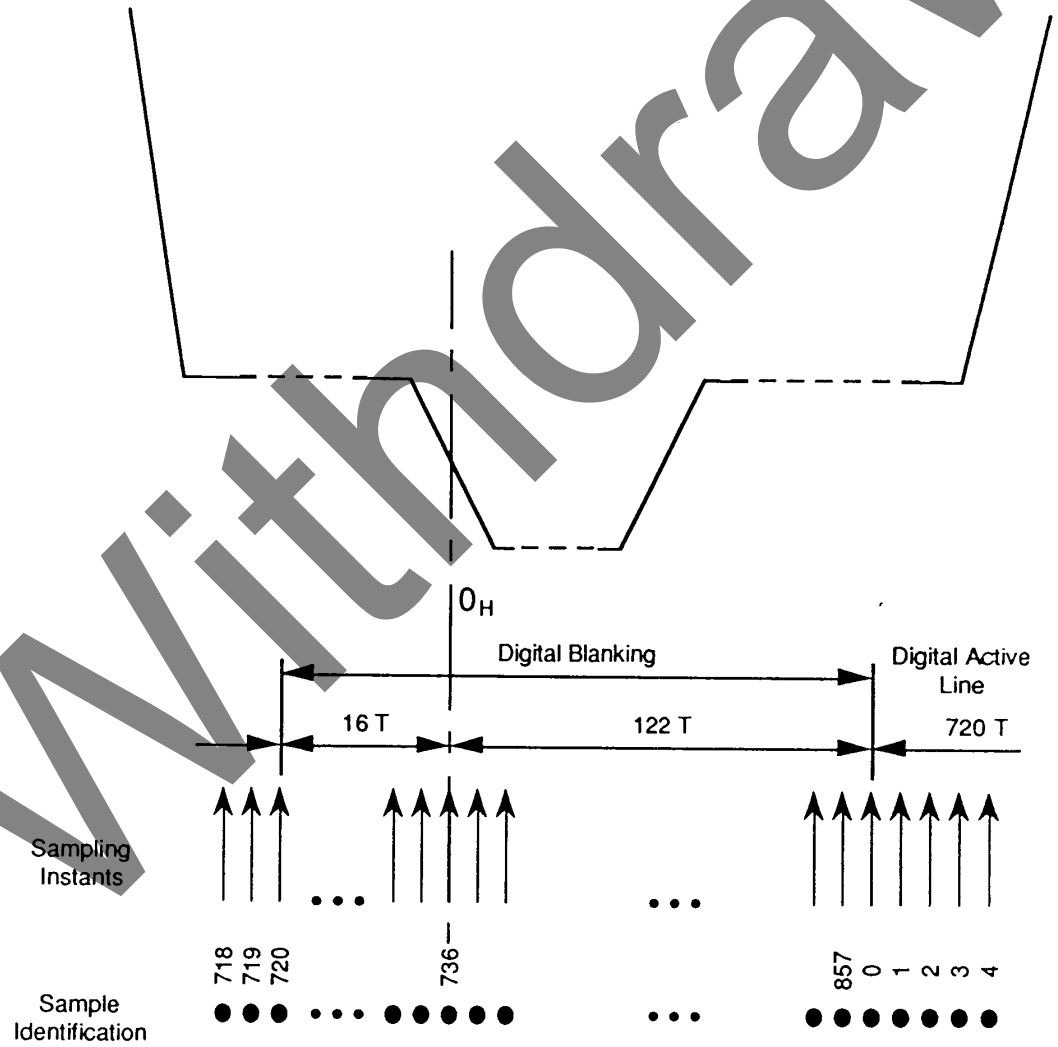
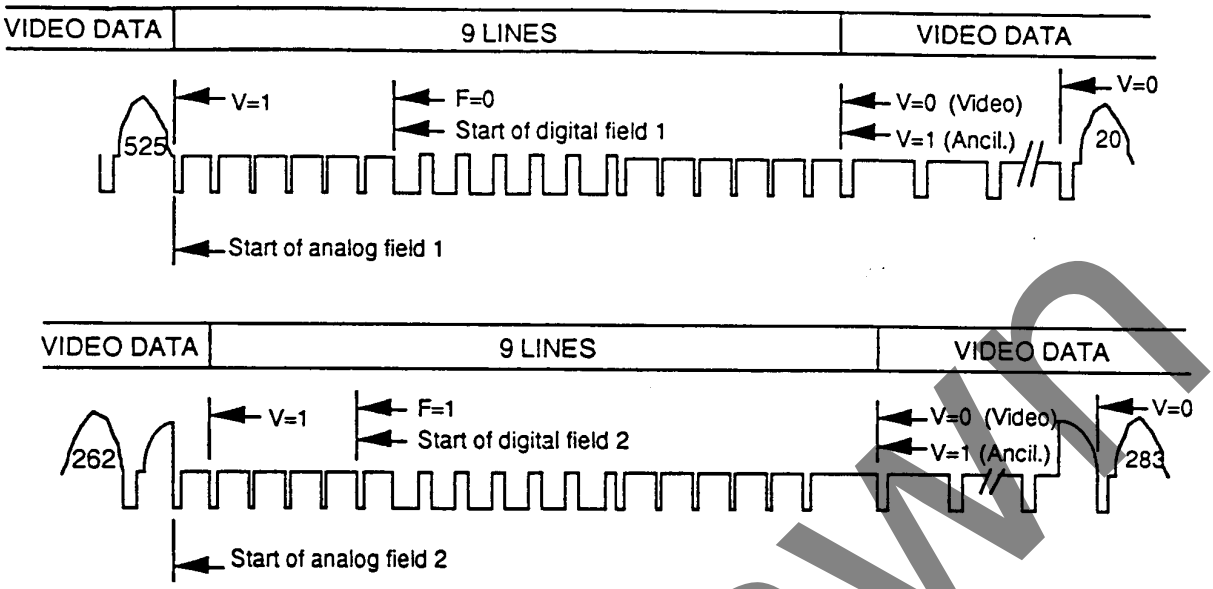


Figure 2 – Horizontal sync relationship



Digital field 1 has 262 lines
Digital field 2 has 263 lines

Figure 3 – Vertical sync relationship

4.6 Multiplex structure

The video data words shall be conveyed in the following order:

Link A data stream:
$0C_B$, 0Y, $0C_R$, 1Y, $2C_B$, 2Y, $2C_R$, 3Y ...

Link B data stream:
$1C_B$, 0A, $1C_R$, 1A, $3C_B$, 2A, $3C_R$, 3A ...

See figures 1 and 4.

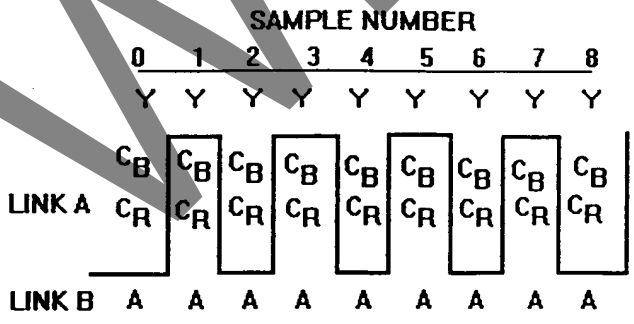


Figure 4 – Link content representation for Y, C_B, C_R, A

4.7 Timing reference signals — Video

4.7.1 Position

Figure 1 shows the position of the timing reference signals with respect to horizontal blanking in the multiplexed data stream. It is implicit that the timing reference signals are contiguous with the video data, when present, and continue through the vertical blanking interval.

Each timing reference signal consists of a four-word sequence in the following format: 3FF 000 000 PQR.

The first three words are a fixed preamble. The fourth word shall contain information defining:

– even field (field 2) identification;

– state of vertical blanking;

– state of horizontal blanking (see ANSI/SMPTE 125M for this definition).

Figure 5 is a spatial representation of the timing reference signals during a television frame.

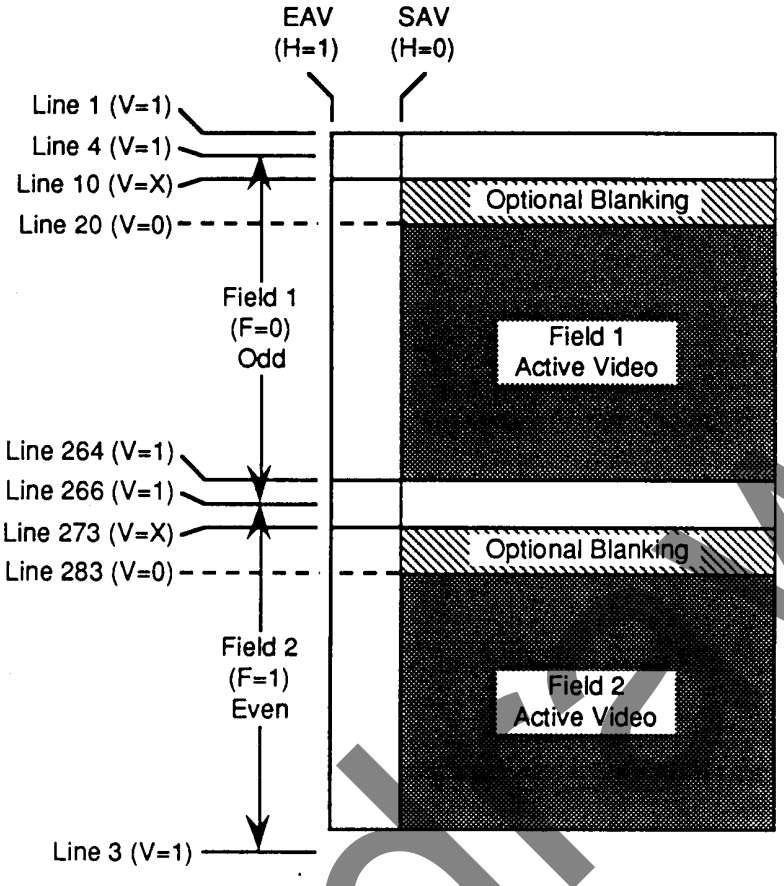


Figure 5 – Timing reference signal locations

4.7.2 Signal timing considerations

The timing differential between the two links should not exceed 100 ns at the source. This differential should be taken into consideration when designing systems and destination equipment input stages.

4.8 Auxiliary signal

If the auxiliary (A) signal is not used, the values of the auxiliary channel samples should all be set to black (decimal value 64). If the auxiliary channel is used for key signals, those signals should conform to SMPTE RP 157.

5 GBRA signals

5.1 Interface

This interface may also be used to connect GBRA signals instead of Y, C_B, C_R, A signals.

5.2 Multiplex structure

When GBRA signals are used, the samples will be sent as follows:

– The G signal will be sent in the sample locations referred to above as Y;

– The B signal will be sent in the sample locations referred to above as C_B;

– The R signal will be sent in the sample locations referred to above as C_R;

– The A signal will be sent in the sample locations referred to above as A.

Link A data stream:
0B, 0G, 0R, 1G, 2B, 2G, 2R, 3G ...

Link B data stream:
1B, 0A, 1R, 1A, 3B, 2A, 3R, 3A ...

See figure 6.

6 Transmission

This signal format is intended for use with two 4:2:2 component interfaces. The parallel form of the interface is defined in ANSI/SMPTE 125M. The serial form is defined in ANSI/SMPTE 259M.

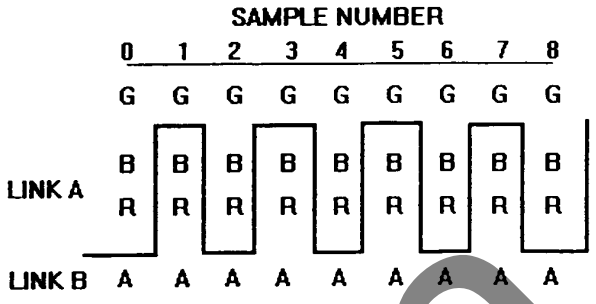
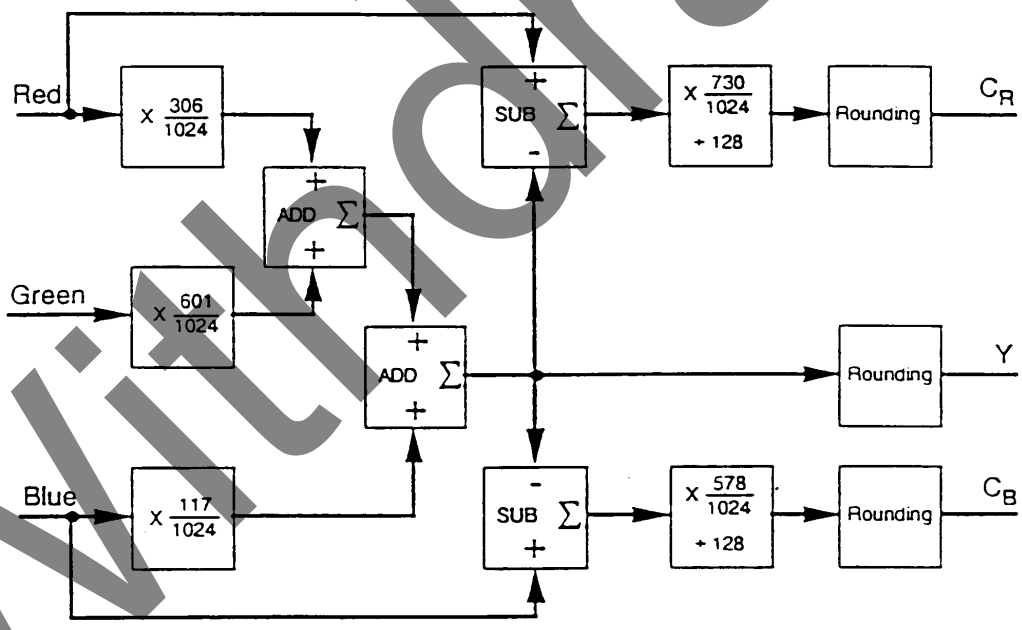


Figure 6 – Link content representation for GBRA

Annex A (informative)
Possible implementations

Figures A.1 and A.2 show possible implementations of encoding and decoding matrices for the luminance and chrominance components.



$\frac{306}{1024} = 0.299$

$\frac{601}{1024} = 0.587$

$\frac{117}{1024} = 0.114$

$\frac{730}{1024} = 0.713$

$\frac{578}{1024} = 0.564$

Figure A.1 – Matrix G, B, R / Y, C_B, C_R

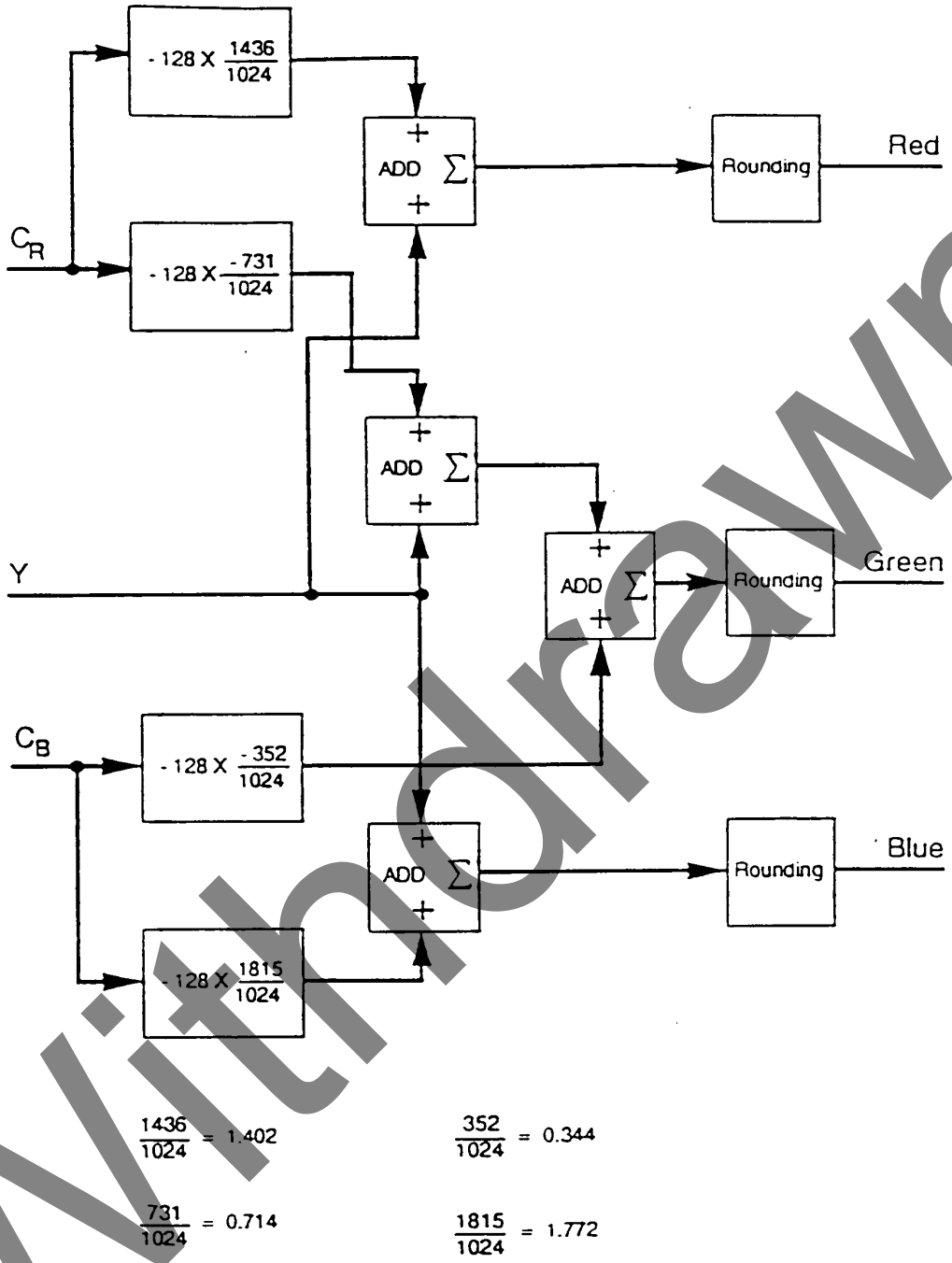


Figure A.2 – Matrix Y, C_B, C_R / G, B, R

Annex B (informative)
Bibliography

ITU-R BT.601-5, Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-Screen 16:9 Aspect Ratios

ITU-R BT.799-2, Interfaces for Digital Component Video Signals in 525-Line and 625-Line Television Systems Operating at the 4:4:4 Level of ITU-R BT.601 (Part A)