

Method and circuit for converting RGB signals to component signals

The present invention relates to a method and a circuit for converting digital RGB signals to digital component signals.

Background

In "Telefunken Zeitung", Heft 1, 1965, page 51, a circuit for converting analogue RGB signals to analogue YIQ signals is shown.

Invention

It is one object of the invention to disclose a method for inserting text signals into digital component signals. This object is reached by the inventive method disclosed in claim 1.

In principle the inventive method consists in converting RGB signals to component signals, whereby said RGB signals are considered to be one bit digital signals (R, G, B), e.g. text signals, and are converted by latching to a luminance component signal (Y) and by inverting, adding and/or subtracting to a first (U) and to a second (V) colour component signal, and whereby conversion matrix coefficients are represented by an according power-of-two wiring of latch inputs to said RGB input signals and of the inputs of adding/subtracting means (15, 16) to said RGB input signals and/or to inverted such RGB input signals. Thereby the value 'one' may be fed to carry inputs (C) of said adding means (15, 16).

Advantageous additional embodiments of the inventive method are resulting from the respective subclaims.

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It is a further object of the invention to disclose a circuit which utilises the inventive method. This object is reached by the inventive circuit disclosed in claim 6.

In principle the inventive circuit consists in three inverters (11, 12, 13) of one bit RGB input signals (R, G, B), of a latch (14) outputting a luminance component (Y) and two adders (15, 16) outputting a first colour component (U) and a second colour component (V), whereby the value 'one' is fed to carry inputs (C) of said adders and matrix coefficients are represented by according wiring of the inputs of said latch to said RGB input signals and of the inputs of said adders to said RGB input signals and to the outputs of said inverters.

Normally text signals are added to component signals in an analogue manner. Special problems may arise in case of upconverting such interlace video signals to a higher field frequency. In case of motion adaptive upconversion vertical unsharpness of the text can be introduced because of different motion velocities of the background of the text.

In the RGB domain text signals can be represented by digital-like amplitude values. Therefore such text signals are generated digitally in the RGB domain and converted digitally to the component domain.

The text signals may stem from teletext signals or on-screen display signals, e.g. a menu-driven user control of a TV set or a VCR.

Drawing

Preferred embodiments of the invention will now be described with reference to the accompanying drawing, in which:

Fig. 1 shows a block diagram of an inventive RGB to YUV matrix for text signals.



Preferred embodiments

In Fig. 1 input text signals R, G and B, coded as red, green and blue signals are either present or not and can be considered to be one bit digital signals. Therefore the full eight bit range normally used for digital YUV component signals is not required. Only certain discrete values are used. Advantageously a circuit simplification resulting from this effect is possible.

Within the signal format of the corresponding output signals Y, U and V such a simple insertion of one bit signals is not feasible.

The following matrix equations describe the conversion of RGB input signals to YUV component signals (values corresponding to PAL systems):

$$\begin{aligned} Y &= 0.299*R + 0.587*G + 0.144*B \\ U &= 0.493*(B-Y) = -0.147*R - 0.289*G + 0.437*B \\ V &= 0.877*(R-Y) = 0.612*R - 0.515*G - 0.100*B \end{aligned}$$

If the RGB signal is normalised to a maximum of 1.0, then an eight bit representation of this value corresponds to the value 255. The equivalent eight bit digital coefficients for the above matrix are therefore as follows:

$$\begin{aligned} Y &= 1/256*(77*R + 150*G + 29*B) \\ U &= 1/256*(-38*R - 74*G + 112*B) \\ V &= 1/256*(157*R - 132*G - 26*B) \end{aligned}$$

The coefficients are simply realised for the case of Y by inputting the one bit RGB signals to an eight bit latch 14 at the correct power of two to form the eight bit value of the Y component, as shown in the attached block diagram. The coefficients for RGB→Y are formed as the following sums:



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$$R = 64 + 8 + 4 = 76 \quad (77)$$

$$G = 128 + 16 + 2 + 1 = 147 \quad (150)$$

$$B = \quad \quad \quad = 32 \quad (29)$$

Note that these do not correspond exactly with the required values, but the error is small enough to be negligible.

In the case of U and V eight bit adders 15, 16 are used to form the subtractions necessary. The RGB signals are being inverted using three inverters 11, 12 and 13.

The value 'one' is added via the adder's 15 and 16 carry inputs C and a two's complement subtraction is performed.

The coefficients for U are formed as follows:

$$R = -32 - 4 - 2 = -38 \quad (-38)$$

$$G = -64 - 8 - 1 = -73 \quad (-74)$$

$$B = 128 - 16 = 112 \quad (112)$$

In case of V signals the coefficients are formed as follows:

$$R = 128 + 16 + 8 + 4 + 1 = 157 \quad (157)$$

$$G = -128 - 4 = -132 \quad (-132)$$

$$B = -16 - 8 - 2 = -26 \quad (-26)$$

The eight bit adders 15 and 16, respectively, are followed by latches 17 and 18, respectively.

The complete eight bit YUV component signals are therefore formed from the one bit RGB inputs and can be processed later using the same circuitry as any subsequent digital video processing.

By using respective coefficients, i.e. wiring, also the conversion from RGB signals to other than YUV signal formats is possible, e.g. YIQ format.



Also a simple mixing of text signals can be performed by OR-ing the text signals within the RGB domain.

The following integrated circuits can be used:

Inverter 74F04
Eight bit adder 2* 74F283 (4 bit adder)
Eight bit latch 74F574

The inventive circuit can easily be modified for digital component signals with other than eight bit resolution.

The advantages of this invention are that the circuitry required is very simple (Three eight bit latches, two adders and three inverters only) and the accuracy of the matrixing to YUV is very high.



Claims

1. Method for converting RGB signals to component signals, characterized in that RGB signals considered to be one bit digital signals, (R, G, B), e.g. text signals, are converted by latching to a luminance component signal (Y) and by inverting, adding and/or subtracting to a first (U) and to a second (V) colour component signal, whereby conversion matrix coefficients are represented by an according power-of-two wiring of latch inputs to said RGB input signals and of the inputs of adding/subtracting means (15, 16) to said RGB input signals and/or to inverted such RGB input signals.
2. Method according to claim 1, characterized in that the value 'one' is fed to carry inputs (C) of said adding means (15, 16).
3. Method according to claim 1 or 2, characterized in that in case of an eight bit resolution of said luminance component signal (Y) said matrix coefficients have the following values:
connected with R: 64, 8 and 4;
connected with G: 128, 16, 2 and 1;
connected with B: 32.
4. Method according to any of claims 1 to 3, characterized in that in case of an eight bit resolution of said first colour component signal (U) said matrix coefficients have the following values:
connected with inverted R: 32, 4 and 2;
connected with inverted G: 64, 8 and 1;
connected with B: 128;
connected with inverted B: 16.
5. Method according to any of claims 1 to 4, characterized in that in case of an eight bit resolution of said sec-



ond colour component signal (V) said matrix coefficients have the following values:

connected with R: 128, 16, 8, 4 and 1;

connected with inverted G: -128 and -4;

connected with inverted B: -16, -8 and -2.

6. Circuit for a method according to any of claims 1 to 5, consisting of three inverters (11, 12, 13) of one bit RGB input signals (R, G, B), of a latch (14) outputting a luminance component (Y) and two adders (15, 16) outputting a first colour component (U) and a second colour component (V), whereby the value 'one' is fed to carry inputs (C) of said adders and matrix coefficients are represented by according wiring of the inputs of said latch to said RGB input signals and of the inputs of said adders to said RGB input signals and to the outputs of said inverters.

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