

Specification

State of the art

During the recording of a colour television signal with a magnetic tape recorder, it is known (radio mentor elektronik 1973, No. 8, pages 343-345) to record the luminance signal by frequency-modulation of a picture carrier and the colour signals with a chrominance carrier which is below the frequency spectrum occupied by the picture carrier. For this purpose, the frequency of the quadrature-modulated chrominance carrier is reduced from 4.43 MHz to a value of the order of magnitude of 0.63 MHz and converted back to the value of 4.43 MHz again during the reproduction.

This method of recording has the disadvantage that, as a result of non-linearity in the recording medium, crosstalk occurs between the luminance signal and the chrominance carrier. In order to keep influencing of the luminance signal by the chrominance carrier low, the amplitude of the chrominance carrier has to be reduced considerably in comparison with that of the picture carrier as a result of which the signal-to-noise ratio is reduced during the colour reproduction.

It is also known (DE-PS 20 56 684) to compress the luminance signal and the colour signal in time, to record them in succession in time during a line period and during the reproduction to expand them in time and make them available simultaneously again. Since with this solution, luminance signal and colour signal are never recorded simultaneously but successively in time, crosstalk between these signals is reliably avoided. In addition, the dynamic range of the recording medium can be fully utilized for both signals.

In a recording method of this kind known by the name "Timeplex" (Fernseh- und Kino-Technik 1983, No. 5, pages

193-194) in one line, after the line synchronizing pulse, first the time-compressed colour-difference signal (B-Y) and then the time-compressed luminance signal Y and in the next line first the time-compressed colour-difference signal (R - Y) and the time-compressed luminance signal Y are transmitted alternately. In this case, the time-compression during the recording and the time-expansion during the reproduction are effected by timed stores into which signals are read with a first timing and read out again with a different timing according to the time-compression or the time-expansion.

With such a system, therefore, during the reproduction, the colour-difference signal and the luminance signal are expanded again in time, in each line, to the length of the line trace interval, and made available simultaneously for the picture reproduction.

It has been found in practice that, during the reproduction, shifts in time occur between the luminance signal and the colour-difference signal and lead to distortions during the colour reproduction. A displacement of $1 \mu\text{s}$ between the two signals already means a displacement of the order of magnitude of 10 mm on the screen with a picture diagonal of 65 cm, as a result of which, serious hue errors and so-called colour smearing may occur particularly at vertical edges.

Further faults such as differences in phase, amplitude and/or group delay time may also occur between the two signals during the reproduction with time-sequential transmission of the signals compressed in time.

It is true that it is possible to adjust a reproduction circuit each time so that the two signals needed for the reproduction, for example the luminance signal and the colour-difference signal, are in the correct relationship to one another, that is to say, in particular, that they coincide in time and have the correct amplitude relationship.

This coincidence is no longer assured, however, in the event of reproduction with a different reproduction set or even after re-recording with one recording system.

It is the object of the invention to develop further the time-sequential system described so that the said deviations between the two signals, particularly with regard to position in time, amplitude and phase, are avoided during the reproduction.

This problem is solved by the invention described in Claim 1. Advantageous further developments of the invention are described in the sub-claims.

The invention is based on the following consideration. The two like signals in the two signal paths are in a defined relationship to one another, particularly with regard to position in time and amplitude, at the transmitting end. The two marking signals used in the solution according to the invention are preferably identical in that, for example, at the defined moments, the first signal travels through the signal path of the second signal in addition to its own signal path. All the errors occurring during the time-compression, the transmission and the time-expansion therefore also affect the marking signals in that these have, for example, a displacement in time in relation to one another during the reproduction. At the receiving end, therefore, a correction signal which indicates errors which have arisen during the transmission can be obtained by comparison of the marking signals. The errors which have occurred can then be eliminated by means of this correction signal by influencing the first signal or the second signal at the receiving end.

The invention can be used to particular advantage during the transmission or recording of a colour television signal by the said timeplex recording method. In this case the following considerations and knowledge form the starting point:

During the time expansion during the reproduction, all the pulses are dependent on the leading edge of the line synchronizing pulse. Since the compression factor is the same for the luminance signal and the synchronizing signal, tolerances and time shifts are automatically compensated during the reproduction with a video recorder. The colour signal on the other hand, travels through a different signal path. As a result of the higher compression and expansion factor, deviations in time are much more noticeable than in the path of the luminance signal. If a timebase error occurs between recording and reproduction, this will appear enlarged for the colour signal and the expansion factor.

In one form of embodiment of the invention, a marking pulse is deliberately associated with a defined moment in a line, in the path of the luminance signal and of the colour signal. Any time shifts between the luminance signal and the colour signal during the reproduction then also affect the position in time of these two marking pulses. By evaluating the position in time of the two marking pulses to one another, that is to say the deviation of this position in time from a desired value preset during the recording, a correcting variable can thus be obtained which indicates the extent of the time shift occurring between the luminance signal and the colour signal. Thus one of the two signals can be shifted in time by means of this correcting variable so that the marking pulses and hence necessarily also the luminance signal and the colour signal coincide in their position in time in each line.

The marking pulse may have different forms since it is essentially only intended to mark a specific moment in a line. The marking pulse is preferably a so-called black-to-white transition, in order to utilize the full dynamic range. The marking pulse may also consist of a plurality of individual pulses following one another. During the reproduction, the comparison of the position in time is then

effected between the n^{th} pulse in the luminance signal path and the n^{th} pulse in the colour signal path. A pulse already present in the signal, for example the line synchronizing pulse, may also be used as a marking pulse. This would then have to be additionally added to the colour signal. The pulse present in the path of the colour signal for the achromatic value may also be used as a marking pulse, which pulse likewise has a defined position in relation to the line period and, by its amplitude, indicates the achromatic value, that is to say $(R - Y) = 0$ and $(B - Y) = 0$, and, by its duration, identifies the particular colour difference signal, that is to say $B - Y$ or $R - Y$.

It is also possible to couple the signal of the first signal path, for example the luminance signal Y , into the other signal path for the colour signal C whereupon a correction signal is derived from the signal difference of the two channels at the receiving end.

The transmission of the marking pulses is preferably effected during the vertical blanking intervals in the region of the test lines, for example in the lines 17 and 18 as well as in the lines 330 and 331. Actually, it is sufficient if the marking pulse is transmitted in both signal paths in one line only. Preferably, the marking pulses are transmitted in both signal paths in two successive lines because, as a result of the peculiarity of the timeplex system, the luminance signal from the line $n-1$ and the colour-difference signal from the line n appear simultaneously each time during the reproduction.

It is sufficient if the marking pulses are transmitted periodically with a relatively long interval because the displacement of the signals is a relatively slow fault. In practice, the correcting variable obtained for the correction during the reproduction changes relatively slowly. The transmission of the marking pulses is preferably effected each time at the beginning of a field so that, during the reproduction, a measurement of the deviation in time between

luminance signal and colour signal, if necessary a change in the correcting variable and a reduction in the deviation in time are effected from field to field.

Fundamentally, the correcting variable causes a shift in time of one of the two signals during the reproduction. For example, it may control an electronically controllable delay line lying in the path of the signal.

The correcting variable is preferably used to shift the reading timing out of the store serving for the time expansion because this reading timing determines the position in time of the signals expanded in time. Thus the stores which are in any case necessary for the time expansion can be utilized, by means of an additional control, to vary the position in time of one of the two signals.

The invention will be explained in more detail with reference to the drawing in connection with the example of recording a timeplex signal.

In the drawing,

Figure 1 shows a simplified block circuit diagram for the recording and the reproduction,

Figure 2 shows curves to explain the mode of operation of the block circuit diagram of Figure 1,

Figure 3 shows an enlarged block circuit diagram for the recording end and

Figure 4 shows an enlarged block circuit diagram for the reproduction end.

In Figure 1, the luminance signal Y is fed from the terminal 1, via the adding stage 2, to the time compressor 3, which compresses the luminance signal (composite video signal) by the factor 0.8, that is to say to 80% of its original duration. The luminance signal thus time-compressed is fed to the change-over switch 4. The colour signal C, containing the colour-difference signals B - Y and R - Y alternately from line to line, is fed from terminal 5, via the adding stage 6, to the time compressor 7 which compresses

the colour signal by the factor 0.2, that is to say to 20% of its original duration. This compressed colour signal C is fed to the other input of the change-over switch 4.

A timeplex time control circuit 8 is synchronized by the sync pulses S from the luminance signal Y. Via the line 9, this circuit controls the change-over switch 4 in the sense of the timeplex system so that the time-compressed signals Y and C are recorded on the video recorder 10 successively in time in each line.

In addition, the sync pulses S control the pulse stage 11 which contains a counter and a keying-pulse generator. In each of the lines 17 and 18 as well as 330 and 331, the stage 11 generates marking pulses 12, 13 which are added to the signals Y and C in the adding stages 2, 6. The marking pulses 12, 13 have a defined position in relation to the line period.

During the reproduction, the signal Y is fed each time to the time expander 16 and the signal C to the time expander 17 by the change-over switch 14 which is controlled like the change-over switch 4 by the timeplex time control circuit 15 fed with the sync pulses S. The expander 16 causes a time expansion by the factor 1.25 and the expander 17 a time expansion by the factor 5. The signals Y at the terminal 18 and C at the terminal 19 then again have the original duration.

In addition, the signals Y and C are fed to the comparison stage 20. In the stage 20, the marking pulses 12, 13 are compared with one another in their position in time by time-selective evaluation. By this means, the correcting variable U_s is obtained which indicates the unwanted displacement in time between the signals Y and C. The correcting variable U_s influences the control circuit 15 and hence the reading timing of the expanders 16, 17 in such a manner that the displacement in time between the signals Y and C is compensated and these signals Y and C appear in coincidence in time at the terminals 18, 19.

Figure 2a shows the construction of the time-compressed timeplex signal at the output of the change-over switch 4 or at the input of the change-over switch 14. Each time, after the line synchronizing pulse Z in the line n, the signal contains first the time-compressed colour-difference signal B - Y, then the time-compressed luminance signal Y and in the line n-1, first the time-compressed colour-difference signal R - Y and then the time-compressed luminance signal Y.

Figure 2b shows the marking pulses 12 during the lines 17 and 18 in the luminance signal Y and Figure 2c shows the marking pulses 13 in the same lines in the colour signal C. These pulses 12, 13 are identical with regard to position in time, duration, amplitude and pulse shape and extend each time from the black level to the white level.

Figures 2d, e, show the marking pulses 12, 13 at the inputs of the comparison stage 20. As a result of the mode of operation of the timeplex reproduction circuit, the marking pulse 12 from the line n-1 and the marking pulse 13 from the line n coincide. The correcting variable U_s is obtained by comparison of the position in time of the two leading edges of the marking pulses 12, 13 at t_1 . In the event of a displacement of the signals Y and C which would cause the said picture fault, the leading edges are displaced in time in relation to one another by Δt , so that a correcting variable U_s corresponding to this displacement Δt appears. The value of the correcting variable depends on the amount of the displacement in time and the sign of the correcting variable depends on the direction of the displacement. For example, the correcting variable is positive if Y is in advance of C and negative if Y is lagging behind C so that the correction is effected by the correct amount and in the right direction.

In Figure 3, the counter 35 is controlled by the vertical-frequency pulses V and the line-frequency pulses H. In the lines 17, 18 and 330 and 331, the counter 35 produces the blanking pulse 20 with the duration of the line trace

interval. The pulse 20 blanks out the signals Y and C, via the blanking stages 21 and 22 in order to eliminate signals present in these lines for the insertion of the marking pulses. The pulse 20 controls the pulse stage 23 which generates the marking pulses 12, 13 like the stage 11 in Figure 1. As in Figure 1, these marking pulses are added to the signals Y and C in the adding stages 2, 6.

In Figure 4, the time-sequential, time-compressed signal C, Y coming from the video recorder 10 and corresponding to the signal at the output of the change-over switch 4 in Figure 3, again appears at the terminal 24. By means of the synchronous separating stage 25, the pulses V and H are again obtained from the Y signal and fed to the counter 26. By counting out the lines 17, 18 and 330, 331, this generates gating pulses 27 which, via the gates 28, 29, switch the signals Y and C in these lines to the counter 30. At its two inputs, the counter 30 receives the marking pulses 12, 13 recorded in the said parts. The left-hand input of the counter 30 is constructed in the form of a start/stop input and the right-hand input of the counter 30 is constructed in the form of a stop/start input. At the output of the counter 30 there appears a voltage, the magnitude of which depends on the deviation in time between the marking pulses 12, 13 at the two inputs of the counter 30 and the sign of which depends on the direction of this deviation. This voltage is compared, in the comparison stage 31, with a desired value from the stage 32. As a result, the correcting variable U_s is again obtained on the line 33. This correcting variable acts, via the low-pass filter 34, as in Figure 1, on the timeplex control circuit 15 in the sense that the deviation in time between the marking pulses 12, 13 is compensated and so the signals Y and C coincide in time at the outputs of the circuit. The low-pass filter 34 has the effect that the control is effected slowly, in stages, in the desired manner and has a time constant of 100 ms for example. The time constant can be

selected relatively great since the deviation in time is only a fault which varies slowly. As a result, the correction circuit can work with particular freedom from malfunctioning.

It is not absolutely essential for the marking pulses 12, 13 to be isochronous during the recording and there, too, they may already be offset in time. The control by the correcting variable U_s during the reproduction can then be effected so that an adjustment is made not to a deviation in time of 0 but to a defined finite deviation in the position in time of the marking pulses 12, 13 at the inputs of the counter 30.

The mode of operation of the invention for an error in time between the two signals was explained with reference to Figures 1-4. A correction of further faults can likewise be effected by means of the marking signals or the marking pulses, for example in that the amplitude or the phase of one of the signals is influenced by the correcting variable obtained by comparison of the marking signals.

The invention is not restricted to television signals but can also be used for stereo signals and radio signals.



Patent Claims

1. A time-sequential transmission system wherein a first signal and a second signal are compressed in time at the transmitting end, transmitted time-sequentially and again expanded in time at the receiving end, characterised in that, at the transmitting end, the first signal and the second signal each contain a marking signal (12, 13) at defined moments, which marking signals are in a defined relationship to one another and that, at the receiving end, a correction signal is obtained by comparison of the marking signals (12, 13), for the correction of the first and/or second signals.

2. A system as claimed in Claim 1, characterised in that, at the transmitting end, the first signal travels, at the defined moments, through the signal path of the second signal in addition to its own signal path and that, at the receiving end, the originally like signals from the two signal paths are compared and the correction signal which acts on the second signal path is obtained from the differences in phase, amplitude or group delay time.

3. A system as claimed in Claim 1, characterised in that it serves as a transmission system for colour television signals.

4. A system as claimed in Claim 3, characterised in that it serves for the phase correction of a luminance signal (Y) and of a colour signal (C).



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5. A system as claimed in Claims 2 and 3, characterised in that the first signal is the luminance signal (Y) and the second signal is the colour signal (C).

6. A system as claimed in Claims 2 and 3, characterised in that the first signal is the colour signal (C) and the second signal is the luminance signal (Y).

7. A system as claimed in Claim 4, characterised in that, at the transmitting end, a time marking pulse (12, 13) associated with a specific moment in the line period is introduced into the luminance signal (Y) and the colour signal (C) respectively and at the receiving end, a correcting variable (U_s) is obtained from the interval in time (Δt) between the two marking pulses (12, 13) to adjust the correct position in time between luminance signal (Y) and colour signal (C).

8. A system as claimed in Claim 7, characterised in that a synchronizing pulse or achromatic value pulse, present in the signal in any case, is used as a marking pulse.

9. A system as claimed in Claim 7, characterised in that the marking pulse (12, 13) comprises the voltage values for black and white.

10. A system as claimed in Claim 7, characterised in that the two marking pulses (12, 13) have the same position in time, duration, shape and/or amplitude.



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11. A system as claimed in Claim 7, characterised in that the marking pulse (12, 13) consists of a plurality of individual pulses and an individual pulse having a specific ordinal number is used to obtain the correcting variable (Us).

12. A system as claimed in Claim 7, characterised in that the marking pulse (12, 13) is transmitted during a blank line or test line during the vertical blanking time.

13. A system as claimed in Claim 7, characterised in that the marking pulse (12, 13) is transmitted in each of two lines (17, 18; 330, 331) succeeding one another in time.

14. A system as claimed in Claim 7, characterised in that the correcting variable (Us) is obtained by evaluating the edges of the marking pulses (12, 13).

15. A system as claimed in Claims 7 and 12, characterised in that a filter section (34) lies in the path of the correcting variable and has such a time constant that a deviation from the correct position in time is reduced in small stages from one field to the next.

16. A system as claimed in Claim 7, characterised in that the correcting variable (Us) controls a delay network lying in the path of one of the signals (B-Y, Y).

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17. A system as claimed in Claim 7, characterised in that the correcting variable (Us) controls the reading timing of the store (16, 17) serving for the expansion in time.



Figure 1

Compressor
x 0.8

Expander
x 1.25

Compressor
x 0.2

Expander
x 5

Figure 2

Line

Line

Figure 3

Counter

Compressor
x 0.8

Compressor
x 0.2

Figure 4

Expander
x 1.25

Counter

Desired value

Sync
separation

Expander
x 5

Counter