

With video recorders according to the VHS system, Video 2000 and Betamax it is known to lower the PAL colour carrier from its original frequency of 4.43 MHz to a frequency of approximately 625 kHz and to record with this reduced frequency which is below the frequency spectrum of the picture carrier which is frequency modulated by the video signal. While the original PAL colour carrier has a band width of ± 1 MHz, the recorded colour carrier for example has only a band width of ± 300 kHz.

Due to this reduced band width of the recorded colour carrier, on playback, there is a reduction in the definition with abrupt changes in chroma in a horizontal direction especially when there is a high degree of colour saturation. The definition may be improved essentially by the colour carrier being recorded with a fairly large band width of e.g. 500 - 600 kHz. For such a band width however there is not always a sufficient frequency range below the frequency spectrum of the picture carrier, particularly when other signals are recorded there such as for example control signals.

The object underlying the invention is to improve the definition during playback when recording with a frequency reduced colour carrier and a low band width, without the band width of the recorded colour carrier having to be increased.

Thus the invention is based on a prior art as known for example from US-A- 4 188 638.

This object is achieved by the invention described in claim 1. Advantageous further refinements of the invention are described in the dependent claims.

The invention is based on the following consideration. If a PAL colour carrier is divided up in a propagation time signal division circuit into its two components which correspond to the modulation axes, then these two colour carrier frequency signals do not contain any phase modulation, but only an amplitude modulation with a suppressed carrier, namely phase changes of 180° . These two colour carrier frequency components are each lowered individually in frequency by the same amount. Then the amplitude modulation, which is impaired by the frequency reduction, of these signals is removed and reintroduced by a broad band video signal, which is obtained from the two colour carrier frequency signals before the frequency reduction. This occurs preferably with an amplitude limiter, the limit levels of which are controlled in a positive and negative direction by the video frequency signals obtained from the colour carrier frequency signals of large band width. The colour resolution itself is not affected by the solution in accordance with the invention, because the band width of the recorded colour carrier

remains unchanged. The loss of definition which is particularly disturbing during picture replay and which occurs when there are abrupt changes in colour chroma is however considerably decreased.

An embodiment of the invention is described by way of the drawing. In which:

- Fig. 1 shows a block circuit diagram for the recording.
- Fig. 2 shows a circuit example of a limiter,
- Fig. 3 shows curves for illustrating the mode of operation of the circuit according to Fig. 2
- Fig. 4 shows a circuit for producing the video frequency signals and
- Fig. 5 shows in outline the increased steepness achieved by the invention when there are abrupt changes in shade. The small letters a - d show at what points in Figs. 2 and 4 the signals according to Fig. 3 apply.

In Fig. 1 the PAL composite colour signal is applied to the terminal 1. The luminance signal Y is separated out from the composite colour signal with the low pass filter and is supplied via the FM modulator 3 and the high pass filter 4 at a limit frequency of 1 MHz as a picture carrier BT to the adding stage 5. The colour carrier F having the frequency of $4.43 \text{ MHz} \pm 1 \text{ MHz}$ is evaluated by the band pass filter 6 having an open band width of $4.43 \text{ MHz} \pm 1 \text{ MHz}$ and said carrier F is supplied to the propagation time signal division circuit having the line delay line 7, the adding stage 8 and the subtracting stage 9. The mode of operation of this division circuit is described in greater detail in DE-PS 12 52 731. The quadrature modulated PAL colour carrier F is subdivided by the circuit 7 - 9 into the two colour carrier frequency signals F_0 and $\pm F_0$ which correspond to the modulation axes. The U corresponds to the modulation axis B-Y and V of the modulation axis R-Y. The colour carrier frequency signal F_0 is changed in the frequency changer 11, which is controlled by the oscillator 10 and acts as a mixing stage, into a colour carrier frequency signal F_0' of $625 \text{ kHz} \pm 300 \text{ kHz}$. This signal reaches the amplitude limiter 13 via the low pass filter 12 with a limit frequency of 700 kHz, the limiter delivering the colour carrier frequency signal F_0'' to the adding stage 14. The fluctuations in the colour carrier frequency signal are made steeper in the amplitude limiter 13 by a correspondingly high amplitude of the signal F_0' . The amplitude modulation of the signal F_0' is initially lost. The signal F_0 at the output of the adding stage 8 with the frequency of 4.43 MHz and the band width of $\pm 1 \text{ MHz}$ is rectified in the amplitude rectifier 15, and in fact separately for the positive and negative half waves. The video frequency signals U, V obtained thereby control the limit level of the amplitude limiter 13 in a positive and negative direction. The effect of the limiter is felt therefore in each case at a level which corresponds to the amplitude value of the video frequency signals supplied. Thus the signal F_0'' again has

the original amplitude modulation, but with a larger video band width, because the signal F_v still has the full video band width of ± 1 MHz before the frequency change. The signal F_v'' is therefore improved as compared to the signal F_v' with respect to the steepness of the colour carrier fluctuations and the band width of the modulated signal.

The stages 11a, 12a, 13a, 15a act in the same way for the signal $\pm F_v$. Its line frequency change in polarity based on the PAL switching does not need to be taken into account by the circuit and is maintained. In the adding stage 14 the sum $F_v'' \pm F_v''$ produces the quadrature modulated, modified colour carrier F_m having the frequency of 625 kHz. The latter is added in the adding stage 5 to picture carrier BT and possibly other signals such as modulated sound carriers or control signals and is then recorded on the magnetic tape 17 by the video head 16. The colour carrier F_m according to Fig. 1 causes a better definition on playback when there are abrupt changes in chroma in a horizontal direction than a colour carrier which is only obtained by reducing the frequency of the colour carrier F .

Fig. 2 shows a circuit for the amplitude limiter 13. The mode of operation is explained by way of Fig. 3. The first part of the amplitude limiter with the two parallel connected transistors 18, 19 acts for the negative half waves of the colour carrier frequency signal F_v' which are supplied to the terminal a, according to Fig. 3a. Due to the reduced band width of this signal the colour synchronous signal 20 and the signal F_v' shown for different chroma and showing a perpendicular colour bars do not have a rectangular envelope, but rather the degraded curve shown in Fig. 3a, which causes the described loss of definition during playback. At terminal c the signal obtained by rectifying the negative half waves of the signal F_v is supplied from the output of the rectifier 15. At the emitter/operating resistor 21 colour carrier fluctuations of negative amplitude arise with a steepness increased by the amplitude limitation and with a steeper envelope which is determined by the limit level and is in accordance with the signal according to Fig. 3c. This signal reaches the second stage via the line 22 with the transistors 23, 24 and the emitter/operating resistor 25. The signal according to Fig. 3b is supplied to the terminal b and is obtained by rectifying the positive half waves in the rectifier 15. At the output d according to Fig. 3d the colour carrier frequency signal F_v'' arises. Its envelope in a positive and negative direction is again nearly rectangular according to the original colour carrier F and the two broad band signals F_v and $\pm F_v$ in desired manner because of the signals according to Fig. 3b and c.

The circuit according to Fig. 2 is once again provided with the same construction for the amplitude limiter 13a and accordingly

delivers the signal $\pm F_v''$ according to Fig. 1.

Fig. 4 shows a circuit for the rectifier 15 and 15a for producing the video frequency signals for controlling the limit level of the amplitude limiters 13 and 13a. The signal F_v is supplied via the emitter follower stage 26 to a first rectifier circuit 27 for producing the positively directed signal according to Fig. 3b and to the rectifier circuit 28 for producing the negatively directed signal according to Fig. 3c. This circuit is similarly provided for the rectifier 15 and rectifier 15a.

Fig. 5 shows the increased steepness of a colour change which is achieved. The colour change 29 applies to a band width of the recorded colour carrier of ± 300 kHz, as occurs without using the invention. The colour change 30 applies to a colour carrier prepared in accordance with the invention and corresponds to a band width change of ± 600 kHz. It is clear that the colour change 30 produces a better definition on playback than the colour change 29.

PATENT CLAIMS

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1. A video recorder with recording of a modified colour carrier (F_m), which is obtained by lowering the frequency of a PAL colour carrier (F), and is supplied in the said PAL colour carrier (F) to a PAL propagation time signal division circuit (7 - 9), which delivers at its two outputs two colour carrier frequency signals ($F_u, \pm F_v$) corresponding to the two modulation axes (U, V) and in which these colour carrier frequency signals are relieved of their amplitude modulation and are re-modulated and the re-modulated colour carrier frequency signals are added together in order to produce the modified colour carrier, characterised by the following features:
 - a) the two colour carrier frequency signals ($F_u', \pm F_v'$) are each lowered per se in frequency by the same amount (stages 11, 11a),
 - b) the colour carrier frequency signals ($F_u', \pm F_v'$) which have been reduced in frequency are supplied to amplitude limiters (13, 13a) in order to relieve them of their amplitude modulation and are remodulated by video frequency signals (b and c in Figs. 3b and 3c) which are obtained by amplitude modulation (15) of the colour carrier frequency signals ($F_u, \pm F_v$) before frequency conversion
 - c) the amplitude re-modulated colour carrier frequency signals ($F_u'', \pm F_v''$) are added together to produce the modified colour carrier (F_m) which is to be recorded.
2. A recorder according to claim 1, characterised in that the limit level of the amplitude limiters (13, 13a) is controlled in a positive and a negative direction symmetrically by the video frequency signals (b and c in Figs. 3b and 3c).
3. A recorder according to claim 2, characterised in that the limiter (13, 13a) includes a stage with two transistors (18, 19; 23, 24), the emitters and collectors of which are connected together, that the carrier frequency signal ($F_u', \pm F_v'$) is supplied to the base of one transistor (18, 24) and the video frequency signal (Fig. 3b, c) is supplied to the base of the other transistor (19, 23) and the colour carrier frequency signal ($F_u'', \pm F_v''$) limited in amplitude according to the video frequency signal is tapped in the emitter circuit by an operating resistor (21, 25).



4. A recorder according to claim 3, characterised in that a first limiter stage (18,19,21) for the positive half waves and a second limiter stage (23 - 25) for the negative half waves of the colour carrier frequency signal (F_u' , $\pm F_v'$) are connected in series.