

In colour television systems utilising PAL or NTSC, the chrominance signal in the form of the phase quadrature modulated colour carrier F, the brightness signal Y, the blanking signal A and the synchronising signal S is transmitted as a so-called combination FBAS signal. In so doing, the brightness signal and the chrominance signal are frequency interlaced. In practice, it is frequently necessary to separate the brightness signal on the one hand and the chrominance signal on the other hand in order to feed these signals over separate signal paths for the further processing or the video reproduction. The separation is also necessary in a video recorder because there, the chrominance signal is subjected to a special conversion.

It is known to submit the chrominance signal separated by a band pass filter from the brightness signal to a line delay and to obtain a comb filtered chrominance signal by combination of the signals from the input and output of the line delay. The pure brightness signal is then obtained by subtracting the extracted comb filtered chrominance signal from the combination FBAS signal. In a comb filter of this type, there is an inevitable averaging over several lines because signals from successive lines are added. Thus, with a PAL signal for example, for each high frequency signal jump or colour transition in the vertical direction, the first two lines as well as the two lines after the "HF signal" are always distorted as is illustrated in the following list.

Line	direct Signal	after the comb filter
1	_____	_____
2		 (distorted)
3		 (distorted)
4		
5		
6	_____	 (distorted)
7	_____	_____ (distorted)
8	_____	_____

However, for improved transmission systems such as in recorders using the S-VHS system or in high definition television systems, increased demands are made on a comb filter.

The object of the invention is to develop a comb filter of the type described such that, in so far as possible, interference effects are avoided while maintaining good signal separation.

This object is achieved in accordance with the invention by the features given in claim 1. Advantageous developments of the invention are specified in the appendant claims.

Basically, for the features causing the described errors within a picture structure, either only the non-delayed, band pass filtered chrominance signal or else, in the PAL version, no colour signal, is supplied, in place of the comb filtered chrominance signal, to the subtracting stage for the production of the pure brightness signal. The decision, as to which of the signals is to be switched through, is taken by a selection circuit whose method of operation will be described more fully by way of example with the help of the Figures.

Fig. 1 shows the principle of an adaptive comb filter by means of a block circuit diagram. Fig. 1A for signals in accordance with PAL and Fig. 1B for signals in accordance with NTSC. Auxiliary circuits (phase-, transit time-, amplitude correction, etc), which are of course necessary for the functioning of the circuit but which do not contribute to the understanding of the basic principle, are disregarded in the illustration.

In Fig. 1A, the PAL/FBAS signal present at the input is supplied on the one hand to an input of a subtracting stage 3 and on the other hand via a band pass filter to a selection circuit consisting of the blocks 4, 5 and 6 in which, in accordance with predetermined criteria, it is determined which chrominance signal, C_1 = two lines comb filtered, or C = only band pass filtered, is to be fed to the subtracting stage 3 for the formation of the brightness signal. Controllable switches K_1 and K_2 , with which the current chrominance signal path is selected, are present in the blocks 4 and 5. The switching states of these switches is controlled by a signal evaluation circuit contained in block 6 whereby the phase state of the signals S_1 , S_2 and S_3 present on the 1H delay lines 1 and 2 are evaluated for the production of the control signal.

In Fig. 1B, in block 5, the NTSC/FBAS signal present at the input is supplied via a wide band, 1 line, delay line 1 to an input of the subtracting stage 3. The comb filtering for the chrominance signal C_1 takes place by means of a second, narrow band, 1 line, delay line 2 in combination with subtracting stage 18 which is connected down stream, in series with an up-stream band pass filter of the first delay line 1. The delay line 1, which of itself is not necessary for the NTSC comb filter, is required in order to receive a non delayed signal S_1 , analogously to Fig. 1A. The latter may be the colour carrier signal or the band pass filtered luminance signal. This signal

is drawn upon, in the evaluation circuit contained in block 6, for the comparison with the signal S2 delayed by one line and the signal S3 delayed by 2 lines. A control voltage is emitted by the evaluation circuit 6, by virtue of which, that chrominance signal C, C1, which corresponds to the optimal conditions for the formation of the brightness signal Y, is selected in block 5 by means of switch K5 and supplied to the subtracting stage 3.

Fig. 2 shows with the aid of a detailed block circuit diagram, the signal evaluation circuit of the blocks referenced 4, 5 and 6 in Fig. 1A for a PAL signal. Control signals A, B, D and F, which are supplied to the input of the AND circuit 16, are generated in accordance with predetermined criteria. The further AND circuit 17 is controlled by the inverted output signals of circuit 16 as well as by the control signal E generated in the evaluation circuit 8. The changing over of the signal path is effected by switches K3 and K4 which are controlled by the output signals of the AND circuits. The criterion here is that the switches are open for a H signal.

As already explained in the description, distortions of conventional comb filters can be avoided in that, with the help of a special evaluation circuit which recognises all of the vertical signal jumps, the adaptive control switches over from the comb filtered signal C1 to the band pass filtered signal C or, if necessary, completely switches off the chrominance signal for each of these jumps. The comb filtered chrominance signal is taken from the output of the subtracting stage 18 to whose inputs the band pass filtered and the chrominance signal delayed by two lines is supplied. The resistors 19 and 20 serve for the decoupling and the amplifier stage 21 for the amplitude matching.

There are the following switching criteria:

A) The comb filter is only to be switched on i.e. the emission of signal C1 (control signal A = H) if a chrominance signal or a high frequency Y signal appears after the 2H delay (signal S3). The control signal A which triggers off the switching process may be obtained from the signal S3 for example in the following manner:

1. Full wave rectification in block 11
2. Amplification/limiting in block 13
3. Filtering with a very short time constant in block 15.

B) The comb filter must be switched off (control signal $B = L$) if a chrominance signal or a high frequency Y signal is not in existence before the 2H delay (signal S1). The control voltage B may be obtained, likewise as for A):

1. Full wave rectification in block 10
2. Amplification/limiting in block 12
3. Filtering with a very short time constant in block 14.

C) For colour changes in the vertical direction, there must likewise be a switching over to the band pass filtered signal C (control signal $F = L$). If, for this purpose, the 0H and the 2H delayed signals were to be directly compared in phase, then one signal would have to be inverted due to the 1/4 line off-set. Thereby, however, the comb filter would be permanently switched off for high frequency Y signals. For this reason, the phase of the signals S1 and S3 full wave rectified in the blocks 10 and 11, is compared in recognition circuit 9 from which the control signal F is emitted.

D) For a 180° colour jump, for which too there has to be a switch over to the band pass filtered signal C (control signal $D = L$), a special recognition circuit 7, from which the control signal D is emitted, is necessary. For this, a division of the 2H delay line into two 1H lines 1, 2 is required in order to be able to recognise the phase angle of the signal S2 delayed by one line. If now, a phase difference on one of the two lines and simultaneously phase equality on both line is determined, it can be concluded therefrom that there is a 180° jump. (The same situation also arises with other, but not in practice, relevant, signals.)

E) If a signal jump to a high frequency Y signal occurs, the chrominance signal output must be completely turned off. (Control signal $E = L$). As to whether it relates to a luminance signal can only be determined by the recognition circuit 8 at the earliest after one line. This means, one line is inevitably distorted. Subsequently, for equal signals before and after the first delay line (S1 and S2), the chrominance signal output is turned off if a signal is not simultaneously detected by the recognition in accordance with A).

The following criteria are effective for the recognition circuits 7, 8 and 9:

recognition circuit 7: if $\phi_0 \neq \phi_1$
for 180° colour jump (or
 $\phi_1 \neq \phi_2$)
 and $\phi_0 = \phi_2$
 then D = L
 otherwise D = H

recognition circuit 8: if $\phi_0 = \phi_1$
for signal jump to a and
high frequency Y signal A = L
 then E = L
 otherwise E = H

recognition circuit 9: if $\phi_2 = \phi_0$
for colour change then F = H
in the vertical direction otherwise F = L

Fig. 3 shows the signal evaluation circuit of the blocks 5 and 6 indicated in Fig. 1B for an NTSC signal. Control signals A, B, C, D and F, which are supplied to the input of the AND circuit 16, are generated in accordance with predetermined criteria. The changing over of the signal path is effected by switch K5 which is controlled by the output signal of the AND circuit 16. Effective here is that switch K5 is connected to the signal C1 for a H signal and to the signal C for an L signal.

As already explained in the description, distortions of conventional comb filters can be avoided in that, with the help of a special evaluation circuit which recognises all of the vertical signal jumps, the adaptive control switches over from the comb filtered signal C1 to the band pass filtered signal C for each of these jumps. The comb filtered chrominance signal C1 is taken from the output of the subtracting stage 18 to whose inputs the undelayed and the chrominance signal delayed by one line of the stage 2 is supplied. The amplifier stage 21 serves for the amplitude matching.

There are the following switching criteria:

A, B) Switch K5 switches on the comb filtered chrominance signal C1 (control signal A = H and/or B = H) if a high frequency chrominance- or Y signal is present. The control signal A may be obtained from the signal S3 as follows:

1. Full wave rectification in block 11
2. Amplification/limiting in block 13
3. Filtering with a very short time constant in block 15.

The control voltage B may be obtained, similarly to that for the control voltage A, from the signal S2:

1. Full wave rectification in block 10
2. Amplification/limiting in block 12
3. Filtering with a very short time constant in block 14.

C) For colour changes in the vertical direction (colour phase jump), the band pass filtered signal C (control signal $F = L$) must be switched on. If, for this purpose, the signals S2 and S3 were to be directly compared in phase, then one signal would have to be inverted due to the line off-set. Thereby, however, the comb filter would be permanently switched off for high frequency Y signals. For this reason, the phase of the signals S1 and S3, full wave rectified in the blocks 10 and 11, is compared in recognition circuit 9 from which the control signal F is emitted.

D) For a 180° colour phase jump, for which too there has to be a switch over to the band pass filtered signal C (control signal $D = L$), a special recognition circuit 7, from which the control voltage D is emitted, is necessary. For this, the series circuit of two 1H lines 1, 2 is required in order to be able to recognise the phase angle of the signal S2 delayed by one line as well as the signal S3 delayed by 2 lines. If a phase difference on delay line 1 and simultaneously on both lines 1, 2 is determined, it can be concluded therefrom that there is a 180° jump. This also arises if phase equality is determined on line 2.

E) If a signal jump from a low frequency to a high frequency Y signal occurs, the band pass filtered signal C (control signal $E = L$) must likewise be switched on. For equal signals before and after the first delay line 1, and if no signal is simultaneously detected by the recognition in accordance with A), the control signal is $E = L$.

The following criteria are effective for the recognition circuits 7, 8 and 9:

recognition circuit 7:	if $\phi_0 \neq \phi_1$
for 180° colour jump	and
	$(\phi_0 \neq \phi_2)$
	and/or
	$\phi_1 = \phi_2$
	then $D = L$
	otherwise $D = H$

recognition circuit 8:	if $\phi_0 = \phi_1$
for signal jump to a	and
high frequency Y signal	$A = L$
	then $E = L$
	otherwise $E = H$

recognition circuit 9:	if $\phi_1 \neq \phi_2$
for colour change	then $F = L$
in the vertical direction	otherwise $F = H$

The circuits illustrated in Figures 2 and 3 are examples of a plurality of envisagable circuit variations. They may be realised in analogue as well as in digital form. It is also possible to combine the circuits into an integrated circuit.

Claims

1. Circuit for an adaptive comb filter for the separation of the brightness signal (Y) and chrominance signal (C) of an FBAS-PAL or NTSC signal including a series circuit of a first and second line delaying line (1, 2) and a subtracting stage (3) delivering the brightness signal (Y) to whose inputs the FBAS signal and the extracted chrominance signal are applied, characterised in that, from a phase comparison in an evaluation circuit (6), of the signals (S1, S2, S3) present on the delay lines (1, 2) in the presence of a vertical jump signal, a switching voltage is generated by means of which the band pass filtered chrominance signal (C) is supplied to the subtracting stage (3) in place of the extracted comb filtered chrominance signal (C1).
2. Circuit in accordance with claim 1, characterised in that, for a PAL signal, the comb filtered chrominance signal (C1) is supplied to the subtracting stage (3) if a chrominance signal or a high frequency Y signal is detected in the evaluation circuit (6) after the 2H delay (S3).
3. Circuit in accordance with claim 1, characterised in that, for colour transitions of successive lines in the vertical direction, the non comb filtered chrominance signal (C) is supplied to the subtracting stage (3).
4. Circuit in accordance with claim 1, characterised in that, for signal jumps to high frequency Y signals within successive lines of an FBAS-PAL signal, no signal is subtracted.
5. Circuit in accordance with claim 1, characterised in that, for an NTSC signal, the comb filtered chrominance signal (C1) is supplied to the subtracting stage (3) if a high frequency chrominance signal or a high frequency Y signal is detected from the signals (S2, S3) before and after the second delay line (2) in the evaluation circuit (6).

