

Description

This invention relates to television receivers of the type employing comb filters for providing luminance and chrominance signal separation and particularly to receivers in which the comb filter exhibits a non-uniform amplitude response with frequency and in which a compensation circuit is provided for reducing the response variations.

The advantages of using a comb filter for providing luminance and chrominance signal separation in a television receiver are quite well known. A conventional comb filter includes a delay device for imparting a one horizontal line (1-H) delay to the video input signal, an adder for adding the delayed and non-delayed input signals to provide a luminance output signal and a subtractor for subtracting the delayed and non-delayed signals to provide a chrominance output signal.

The delay element used in a comb filter has a very significant effect on the comb filter frequency response characteristic. The ideal delay element would have a constant delay independent of frequency thereby providing a linear phase response and thus a uniform amplitude response throughout the video frequency band to be filtered. The delay element presently closest to this ideal is the digital delay line employing binary storage elements. Unfortunately, digital delay lines are costly and relatively complex because video signals are conventionally received in analog form and so conversion to digital form is necessary to use digital delay lines of the binary storage type.

Analog delay elements, such as glass delay lines, are conventionally used in comb filters as a means of reducing the cost and complexity of the filter. Comb filters employing glass delay elements (or other analog delay elements) are however subject to delay variations with frequency (i.e., non-linear phase response) and thus the overall amplitude response of such comb filters tends to vary with frequency.

Manufacturers of comb filters of the glass delay line type have recognized this problem and have taken steps to correct for undesired amplitude variations which, to a certain extent, minimizes the problem. As an example, amplitude response 2 of FIGURE 2 (PRIOR ART) herein illustrates the uncorrected response of a commercially available comb filter employing a glass delay line. As shown, the uncorrected response exhibits a rising response from about 2.5 MHz to 4.5 MHz with a peak of about +6dB. The manufacture of this filter has included a correction circuit having the characteristic shown by response 3. The resultant corrected response is illustrated by curve 4. As seen the amplitude corrected comb filtered signal (4) exhibits a dip of about 2dB at a frequency of about 2.5 MHz, it returns to zero dB at about 3 MHz and decreases thereafter. As shown, the rather large 6dB variation of the uncorrected comb filter has been re-

duced to only 2dB by internal correction circuits provided by the manufacturer (TDK Incorporated, model HCF0020C).

The comb filter correction (to 2dB) provided by the filter manufacturer is quite good considering the rather large (+6dB) variations typical of uncompensated comb filters with glass delay lines. It has been recognized by the present inventor, however, that it would be desirable to provide a further correction of the comb filter response to reduce the luminance signal variations to a few tenths of a decibel in the luminance frequency range. To this end the present inventor has previously designed a receiver in which an auxiliary luminance amplitude correction circuit was included which achieved this goal. This receiver has been manufactured and sold under the brand name "RCA" in receivers employing chassis identification numbers CTC 148/149 and is shown herein as FIGURE 1 (PRIOR ART). An understanding of this prior art receiver (10) is helpful to appreciating the subtle nature of the present invention and so this receiver will now be described in detail.

Receiver 10 includes an RF processor 12 having an antenna or cable input terminal 14 for receiving an RF video input signal S1. Processor 12 includes conventional elements such as a tuner for selecting channels, an IF amplifier and sound trap and a video detector for providing a demodulated (baseband) composite video output signal S2 at its output. A video switch 14 is provided for selecting signal S2 or an auxiliary composite video baseband signal S3 applied to an auxiliary input terminal 16. The selected signal S4 provided by video switch 14 is applied to a comb filter 18 of the type employing an analog type delay element (e.g., a glass delay line). The filter 18 exhibits uncompensated amplitude variations as a function of frequency and has a luminance signal output 20 for providing a luminance output signal Y1 and a chrominance signal output 22 for providing a chrominance output signal C1.

The chrominance signal C1 is applied to a first input 24 of a luminance-chrominance (Y-C) processor 26. The luminance signal Y1 is applied to a second (luminance) input 28 of processor 26 by means of a cascade connection comprising, in the exact order named of: a contrast control 30, a luminance/chrominance delay correction circuit 32 having source (R1) and termination (R2) resistors and a comb filter correction circuit 34 (outlined in phantom).

The function of contrast control 30 is to control the peak-to-peak amplitude of the comb filtered luminance signal. In the prior art receiver this control is provided by a 300 Ohm potentiometer coupled in series with a 430 Ohm resistor, the latter serving as a minimum limit to the potentiometer output. The function of luma delay 32 is to delay the comb filtered luminance signal by about 300 nano-seconds. This compensates for difference in luminance and chromi-

nance signal delay in the receiver due to their different bandwidths and thus provides proper registration of the luminance and chrominance signals for display on display 36. The function of the comb filter correction circuit 34 is to correct uncompensated errors in the amplitude response of comb filter 18. This correction is shown in FIGURE 2 by curve 5 which has a +2dB peak at a frequency of about 2.5 MHz. As a result the uncorrected comb filter output (response 4) is flattened to the response 6 which is essentially constant up to a frequency of about 4.2 MHz, the full extent of the luma band in the NTSC standard. Processor 26 includes conventional circuits for providing functions such as chroma demodulation, hue and saturation control and matrixing for providing a suitable output regional (e.g., RGB) for display by display unit 36.

The correction circuit 34 (outlined in phantom) comprises an input 40 connected to the output 38 of luma delay unit 32 (e.g., 300 nanoseconds) and an output 42 connected to input 28 of processor 26. Internally unit 34 includes a parallel resonant circuit comprising an inductor L1 and a capacitor C1 connected in common to terminals 40 and 42 at one end thereof and coupled to ground at the other end thereof by means of a resistor R3. Representative values for L1, C1 and R3 are 100 micro-Henrys, 39 pico-Farads and 8200 Ohms, respectively. This circuit provides the luma signal boost of about 2dB shown in FIGURE 2 as response 5 which flattens the overall response 6 to within less than 1dB over the full luma band as shown.

It is herein recognized that the substantial improvements in comb filter performance provided by the present inventor in the design of the prior art receiver of FIGURE 1 can be improved to an even higher standard of performance. Specifically, it has been discovered that slight image blurring may occur in the PRIOR ART example of FIGURE 1.

The present invention resides in: (1) discovery of the existence of the problem of image distortion in the prior art receiver, (2) discovery of the cause of the problem and (3) discovery of solutions which are both technically effective and cost effective.

The cause of this problem has been found, in accordance with the present invention, to be related to the specific point in the prior art receiver 10 where the luminance signal amplitude correction circuit 34 is connected. In particular, the connection of circuit 34 has been discovered to cause reflections in delay line 32. The visual effect of these reflections or "ringing" is to create double images or ghosts of very short displacement relative to the main image and thus may be manifested visually as image blur.

The technical reason that delay line 32 exhibits ringing is two fold. Specifically, the delay correction circuit 34 exhibits a frequency dependent impedance variation because the impedance of elements L1 and

C1 changes with frequency. The luminance delay circuit 32, however, is a conventional analog delay line and so is sensitive to variations in impedance of its source and load elements. With circuit 34 directly connected to the load resistor R2 of delay line 32 the effective load impedance thus varies with frequency thereby causing frequency dependent load variations for delay line 32.

One approach to avoidance of the above-discussed delay line reflection problem is employment of an isolation amplifier as a buffer between the delay line and the frequency-dependent impedance of the correction circuit. U.S. Patent US-A-4,158,852 provides an example of the isolating interposition of an amplifier between a delay line and a correction network having a frequency-dependent impedance.

In accordance with the principles of the invention, the reflections are prevented utilizing existing receive components without the need for an isolation amplifier.

According to the invention, there is provided a television receiver, comprising: a source having an output providing a video signal to be displayed; a display having an input for receiving said video signal; a circuit path including a comb filter and a delay line connected in the order named between said output of said source and said input of said display; and a comb filter correction circuit in said path for correcting amplitude variations of said comb filter, said correction circuit exhibiting frequency dependent impedance variations; characterised in that: said circuit path includes first coupling means coupling said correction circuit between said output of said source and an input of said comb filter and includes second coupling means coupling an output of said delay line to said input of said display for preventing said impedance variations of said comb filter correction circuit from causing reflections in said delay line.

The invention is illustrated in the accompanying drawing wherein like elements are denoted by like reference designators and in which:

FIGURE 1 is a diagram in block and schematic form of a PRIOR ART receiver having correction for the response of a comb filter employing a glass delay line element;

FIGURE 2 is a response diagram of a PRIOR ART comb filter employing a glass delay element and illustrates response corrections used by a filter manufacturer and a receiver manufacturer to correct for amplitude errors of the comb filter;

FIGURE 3 is a diagram in block and schematic form of a preferred embodiment of a television receiver embodying the invention.

Prior art FIGURES 1 and 2 have been previously discussed in detail.

The receiver 600 of FIGURE 3 is a presently preferred embodiment of the invention. This embodiment of the invention utilizes existing receiver circuits to

solve the newly discovered problem without requiring the use of an isolation amplifier.

In detail, in the embodiment of FIGURE 3, the comb filter correction circuit is relocated. Specifically, the following changes have been made in the receiver 10 of FIGURE 1 to implement receiver 600 of FIGURE 3:

- (1) the output 38 of luma delay line 32 has been connected directly (by means of connection 602) to the input of Y-C processor 26; and
- (2) the comb filter correction circuit 34 has been relocated between the output 20 of video switch 14 and the input of comb filter 18.

More specifically, in this embodiment of the invention the output 20 of video switch 14 is connected to input 40 of comb filter correction circuit 34 the output 42 of which is connected to the input of comb filter 18. By this connection the source and termination impedances of luminance signal delay line 32 are not influenced by impedance variations with frequency of the comb filter correction circuit 34 and thus the image blur problem is solved with the technical and economic advantages noted above. In this new location of circuit 34 exemplary element values of L1, C1 and R3 are 47 micro-Henrys, 82 pico-Forads and 1500 Ohms, respectively. Also a series input resistor R5 (e.g., 390 Ohms) has been added and the L-C elements L1, C1 are coupled to a supply terminal 43 rather than to ground. The DC path thus provided (L1, R3, R5) advantageously provides DC bias to the input of comb filter 18 which employs an input amplifier biased by the video signal DC input component. Advantageously, the DC bias applied by correction circuit 34 eliminates the need for a separate bias network and blocking capacitor for comb filter 18.

Claims

1. A television receiver, comprising:
 - a source (14, 20) having an output providing a video signal to be displayed;
 - a display (36, 26) having an input (28) for receiving said video signal;
 - a circuit path including a comb filter (18) and a delay line (32) connected in the order named between said output of said source and said input of said display; and
 - a comb filter correction circuit (34) in said path for correcting amplitude variations of said comb filter, said correction circuit exhibiting frequency dependent impedance variations; characterized in that:
 - said circuit path includes first coupling means coupling said correction circuit (34) between said output of said source and an input of said comb filter (18) and includes second coupling means (602) coupling an output (38) of said

delay line to said input (28) of said display for preventing said impedance variations of said comb filter correction circuit from causing reflections in said delay line.

2. A television receiver as recited in Claim 1 further characterized by:
 - a supply terminal (43) and means coupling said supply terminal to said correction circuit (34) for applying a DC bias (via L1, R3) to said input of said comb filter.
3. A television receiver as recited in claim 2 further characterized in that:
 - said correction circuit comprises a first resistor (R3) connected in series with an inductor (L1) between said supply terminal (43) and said input of said comb filter;
 - a capacitor (C1) connected in parallel with said inductor;
 - and a second resistor (R5) connected between said output of said source and said input of said comb filter.

Patentansprüche

1. Fernsehempfänger, umfassend:
 - eine Quelle (14, 20) mit einem Ausgang, der ein anzuzeigendes Videosignal liefert;
 - eine Anzeigevorrichtung (36, 26) mit einem Eingang (28) zum Empfang des Videosignals;
 - einen Schaltungsweg mit einem Kammfilter (18) und einer verzögerungsleitung (32), die in der angegebenen Reihenfolge zwischen dem Ausgang der Quelle und dem Eingang der Anzeigevorrichtung liegen, und
 - eine Kammfilter-Korrekturschaltung in dem Weg, um Amplitudenänderungen des Kammfilters zu korrigieren, wobei die Korrekturschaltung frequenzabhängige Impedanzänderungen aufweist; dadurch gekennzeichnet, daß der Schaltungsweg erste Verbindungsmittel, die die Korrekturschaltung (34) zwischen den Ausgang der Quelle und einen Eingang des Kammfilters (18) schalten, und zweite Verbindungsmittel (602), die einen Ausgang (38) der Verzögerungsleitung mit dem Eingang (28) der Anzeigevorrichtung verbinden, enthält, um die Impedanzänderungen der Kammfilter-Korrekturschaltung daran zu hindern, Reflexionen in der Verzögerungsleitung zu verursachen.
2. Fernsehempfänger nach Anspruch 1, gekennzeichnet durch:
 - einen Versorgungsanschluß (43) und Mittel, die den Versorgungsanschluß mit der Korrektur-



solve the newly discovered problem without requiring the use of an isolation amplifier.

In detail, in the embodiment of FIGURE 3, the comb filter correction circuit is relocated. Specifically, the following changes have been made in the receiver 10 of FIGURE 1 to implement receiver 600 of FIGURE 3:

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delay line to said input (28) of said display for preventing said impedance variations of said comb filter correction circuit from causing reflections in said delay line.

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 - a supply terminal (43) and means coupling said supply terminal to said correction circuit (34) for applying a DC bias (via L1, R3) to said input of said comb filter.
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 - said correction circuit comprises a first resistor (R3) connected in series with an inductor (L1) between said supply terminal (43) and said input of said comb filter;
 - a capacitor (C1) connected in parallel with said inductor;
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 - einen Schaltungsweg mit einem Kammfilter (18) und einer verzögerungsleitung (32), die in der angegebenen Reihenfolge zwischen dem Ausgang der Quelle und dem Eingang der Anzeigevorrichtung liegen, und
 - eine Kammfilter-Korrekturschaltung in dem Weg, um Amplitudenänderungen des Kammfilters zu korrigieren, wobei die Korrekturschaltung frequenzabhängige Impedanzänderungen aufweist; dadurch gekennzeichnet, daß
 - der Schaltungsweg erste Verbindungsmittel, die die Korrekturschaltung (34) zwischen den Ausgang der Quelle und einen Eingang des Kammfilters (18) schalten, und zweite Verbindungsmittel (602), die einen Ausgang (38) der Verzögerungsleitung mit dem Eingang (28) der Anzeigevorrichtung verbinden, enthält, um die Impedanzänderungen der Kammfilter-Korrekturschaltung daran zu hindern, Reflexionen in der Verzögerungsleitung zu verursachen.
2. Fernsehempfänger nach Anspruch 1, gekennzeichnet durch:
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turschaltung (34) verbinden, um dem Eingang des Kammfilters eine Gleichstrom-Vorspannung (über L1, R3) zuzuführen.

3. Fernsehempfänger nach Anspruch 2, dadurch gekennzeichnet, daß die Korrekturschaltung einen ersten Widerstand (R3) enthält, der in Reihe mit einer Induktivität (L1) zwischen dem Versorgungsanschluß (43) und dem Eingang des Kammfilters geschaltet ist; 5
- daß ein Kondensator (C1) parallel zu der Induktivität geschaltet ist; und 10
- daß ein zweiter Widerstand (R5) zwischen dem Ausgang der Quelle und dem Eingang des Kammfilters liegt. 15

(43) et ladite entrée dudit filtre en peigne ;
un condensateur (C1) connecté en parallèle audit inducteur ;
et une seconde résistance (R5) connectée entre ladite sortie de ladite source et ladite entrée dudit filtre en peigne.

Revendications

1. Récepteur de télévision, comprenant : 20
- une source (14,20) possédant une sortie délivrant un signal vidéo à afficher ;
- un afficheur (36,26) possédant une entrée (28) destinée à recevoir ledit signal vidéo ;
- un parcours de circuit comprenant un filtre en peigne (18) et une ligne à retard (32) connectés dans l'ordre cité entre ladite sortie de ladite source et ladite entrée dudit afficheur ; et 25
- un circuit de correction de filtre en peigne (34) dans ledit parcours pour corriger les variations d'amplitude dudit filtre en peigne, ledit circuit de correction présentant des variations d'impédance en fonction de la fréquence ; caractérisé en ce que : 30
- ledit parcours de circuit comprend des premiers moyens de couplage couplant ledit circuit de correction (34) entre ladite sortie de ladite source et une entrée dudit filtre en peigne (18) et comprend des seconds moyens de couplage (602) couplant une sortie (38) de ladite ligne à retard à ladite entrée (28) dudit afficheur pour éviter auxdites variations d'impédance dudit circuit de correction de filtre en peigne de provoquer des réflexions dans la ligne à retard. 35
2. Récepteur de télévision selon la revendication 1, caractérisé de plus par : 40
- une borne d'alimentation (43) et des moyens couplant ladite borne d'alimentation audit circuit de correction (34) pour appliquer une polarisation en courant continu (par l'intermédiaire de L1, R3) à ladite entrée dudit filtre en peigne. 45
3. Récepteur de télévision selon la revendication 2, caractérisé de plus en ce que : 50
- ledit circuit de correction comprend une première résistance (R3) connectée en série à l'inducteur (L1) entre ladite borne d'alimentation 55