Description

This invention relates generally to composite video signal processing apparatus of the type employing comb filter circuits to effect the separation of the luminance and chrominance components of the composite signal, and particularly to a system for use therein to effect reduction of picture disturbances of the so-called "hanging dot" type that may be associated with the comb filter operation.

The success of the separation function performed by typical forms of comb filters in color television receivers is dependent upon the existence of redundancy of picture information in adjacent regions of successive scan lines. For picture areas where a transition in the direction of field scanning (hereinafter referred to as a vertical transition) occurs, the difference in picture information in adjacent regions of sucessive scan lines can result in imperfect performance of the separation function, with one consequence being the appearance of a chrominance component in the luminance signal output of the comb filter. If not removed, the interloping chrominance component will be reproduced as "hanging dots", i.e., as an undesirable array of dots extending across the region of the vertical transition in the displayed picture.

U.S. Patent No. US-A-4,241,363 illustrates one prior art approach to the detection of "hanging dot" occurrences, wherein the indication of such an occurrence is developed by a signal multiplier responsive to chrominance signal and high frequency luminance signal outputs of comb filter apparatus.

It is herein recognized that the signal multiplier apparatus of the aforesaid patent serves as a correlation indicator, relying upon a recognition of correlation between signal components in the respective outputs of the comb filter apparatus to identify "hanging dot" occurrences. For certain types of vertical transitions, such as transitions between colored and uncolored areas, the disclosed apparatus of said patent can provide a reliable identification of "hanging dot" occurrences.

However, it is additionally recognized herein that the disclosed apparatus of the aforesaid patent fails in its role of identification of "hanging dot" occurrences in instances of certain vertical transitions between areas of different colors. For example, for certain transitions of this type, the interloping chrominance component appearing in the high frequency luminance signal output of the comb filter apparatus bears a substantially quadrature phase relationship to the chrominance component appearing in the chrominance signal output of the comb filter apparatus. In such an instance, the signal multiplier of the aforesaid patent fails to develop an indication of a "hanging dot" occurrence, and, as a result, an undesired dot array will be subject to display in the vertical transition region.

Pursuant to the principles of the present invention, the identification of "hanging dot" occurrences is carried out by apparatus employing a pair of correlation indicators: (a) one correlation indicator being responsive to inputs comprising chrominance signal and high frequency luminance outputs derived without difference in delay from the comb filter apparatus, and (b) another correlation indicator being responsive to inputs comprising chrominance signal and high frequency luminance outputs derived with a relative delay difference from the comb filter apparatus, the delay difference substantially corresponding to one-quarter of the length of a period at the nominal subcarrier frequency associated with the chrominance component. Through reliance upon the development of an output by either (or both) of the correlation indicator pair to identify "hanging dot" occurrences, a more reliable "hanging dot" identifier is obtained, which avoids the quadrature relationship failure of the prior art apparatus described above. During periods of "hanging dot" identification, the luminance signal output of the comb filter is subjected to appropriate modification (e.g., high frequency component deletion) to preclude "hanging dot" display.

In the accompanying drawing:

The sole figure illustrates a portion of a color television receiver employing comb filter apparatus incorporating a "hanging dot" reduction system in accordance with an embodiment of the present invention.

In the illustrated color TV receiver apparatus, composite video signals (inclusive of a luminance component, and of a chrominance component comprising sidebands developed by the modulation of a color subcarrier f_{sc}) appear at a composite video signal input terminal CV and are supplied to the input of a 1-H delay line 11. The delayed signal output of delay line 11 is additively combined with signals derived directly from terminal CV in signal combiner 13, and also is subtractively combined with signals derived directly from terminal CV in signal combiner 15.

The combination of delay line 11 and the subtractive signal combiner 15 forms a first comb filter having a frequency response characteristic exhibiting a succession of response peaks at odd multiples of half the line frequency of the composite signals (interspersed with response minima at even multiples of half the line frequency). High frequency components of the output of the first comb filter, falling within the band of frequencies occupied by the chrominance component, are selectively passed by a bandpass filter 17 coupled to the output of signal combiner 15 to form a combed chrominance signal suitable for delivery to the re-

ceiver's chrominance channel.

The combination of delay line 11 and the additive signal combiner 13 forms a second comb filter having a frequency response characteristic exhibiting a succession of response peaks at even multiples of half the line frequency (interspersed with response minima at odd multiples of half the line frequency). The output of signal combiner 13 constitutes a combed luminance signal, substantially freed of chrominance component accompaniment, but also undesirably stripped of low frequency components representative of vertical detail. Restoration of vertical detail information to the combed luminance signal is effected by an additional signal combiner 21, which additively combines the output of signal combiner 13 with the output of a vertical detail filter 19. Vertical detail filter 19 is responsive to the output of the first comb filter, accepting the output of signal combiner 15 and selectively passing low frequency components thereof falling within a frequency band below that occupied by the chrominance component.

The output of signal combiner 21 is normally employed as the signal input to the receiver's luminance channel. For this purpose, the output of signal combiner 21 is coupled via a signal delay device 23 (with a compensating function to be subsequently explained) to signal input terminal A of electronic switching apparatus 25. In a first of the two switching states of apparatus 25, which state is normally existent (and is represented in the drawing by the solid-line representation of a switch blade the switching apparatus output terminal LO (which is coupled to deliver signals to the luminance channel input) is linked to input terminal A. In the second of the switching states of apparatus 25, however, the link between terminals A and LO is disrupted, and output terminal LO is instead linked to signal input terminal B of the switching apparatus 25 (as represented in the drawing by the interrupted-line switch blade).

In the second switching state of apparatus 25, the signal delivered to the receiver's luminance channel corresponds to the output of signal combiner 21, subject, however, to removal of its high frequency components. For production of such a reduced-bandwidth signal, the illustrated apparatus includes a subtractive signal combiner 31, responsive to the output of signal combiner 21 (supplied therefrom via delay device 23) and to the output of a bandpass filter 27 (supplied therefrom via an additional delay device 29). Bandpass filter 27 is responsive to the output of signal combiner 21, and illustratively has a passband substantially identical with that of bandpass filter 17. The delay imparted to signals by delay device 23 exceeds the delay imparted by delay device 29 by an amount comparable to the signal delay introduced by bandpass filter 27, so as to align the timing of the high frequency components of the signal inputs to combiner 31 in a manner ensuring high frequency component cancellation therein.

Control of the switching of apparatus 25 between its respective switching states is effected by a switching control signal delivered to the control input terminal SC of apparatus 25. The switching control signal is developed by a control signal generator 60, responsive to the outputs of a pair of correlation indicators, 40 and 50, now to be described.

Correlation indicator 40 is illustrated as comprising a signal multiplier 41, a low pass filter 43, and a voltage comparator 45. signal multiplier 41 functions to multiply the high frequency components of the respective outputs of the first and second comb filters. The respective multiplier inputs are derived (without difference in delay) from the outputs of bandpass filters 17 and 27. The products of multiplication developed by multiplier 41 are filtered by lowpass filter 43 to develop a filtered multiplier output signal, which is subject to comparison with a threshold voltage supplied from terminal V_T in voltage comparator 45. A hanging dot occurrence indication is provided at the output terminal CA of voltage comparator 45 whenever the level of the filtered multiplier output signal exceeds the threshold voltage input from terminal V_T.

The configuration of correlation indicator 50 is similar to that of correlation indicator 40, incorporating signal multiplier 52, low pass filter 53 and voltage comparator 55. The inputs to multiplier 51, like the inputs to multiplier 41, comprise the respective outputs of the bandpass filters 17 and 27. However, unlike the signal delivery to multiplier 41, the respective signals are delivered to multiplier 51 with a difference in delay caused by the interposition of delay device 52 in the signal path between bandpass filter 17 and signal multiplier 51. The amount of delay imparted by delay device 52 corresponds to 90° at the nominal subcarrier frequency of the chrominance component (*i.e.*, a quarter period at f_{sc}). The products of multiplication developed by multiplier 51 are filtered by lowpass filter 53 to develop a filtered multiplier output signal, which is subject to comparison with a threshold voltage from terminal V_T' in voltage comparator 55. A hanging dot occurrence indication is provided at output terminal CB of voltage comparator 55 whenever the level of the filtered multiplier output signal exceeds the threshold voltage input from terminal V_T'.

Control signal generator 60, responsive to the voltages at terminals CA and CB, develops a control signal at control input terminal SC which (a) swings to a level establishing the second switching state for apparatus 25 (linking switch input terminal

B to switch output terminal LO), whenever a hanging dot occurrence indication appears at either (or both) of terminals CA and CB; and (b) remains at a level retaining the first switching state for apparatus 25 (linking switch input terminal A to switch output terminal LO) during periods of absence of a hanging dot occurrence indication from both of the terminals CA, CB.

The magnitude of the delay imparted by delay device 23 is selected to substantially match the delay associated with control signal development so as to ensure appropriate timing of the switching action of apparatus 25 relative to the timing of the hanging dot occurrences in the signals being delivered to apparatus 25.

In operation of the illustrated system, use of the pair of correlation indicators 40,50 avoids the quadrature relationship failure previously referred to herein. Whenever a vertical transition occurrence results in appearances of a chrominance component in outputs of both of the first and second comb filters, the ability to recognize such joint appearances is rendered independent of the phase relationship between the respective components. Where the phase relationship is an in-phase (or 180° out of phase) relationship, the joint appearance is recognized by correlation indicator 40. Where the phase relationship is a quadrature relationship, the joint appearance is recognized by correlation indicator 50. For intermediate phase relationships, the joint appeance will be recognized by one or the other, or both, of the correlation indicators.

The provision of the voltage comparators (45,55) in the respective correlation indicators is for the purpose of associating a thresholding action with the operation of the hanging dot reduction system. When the magnitude of the interloping chrominance component is quite small, the visibility of the resulting dot pattern will be sufficiently insignificant as to not warrant a suppression action, wherefore alteration of the switching state of apparatus 25 is not desired. Use of such a thresholding action will affect the operation of the correlation indicators 40,50 for the aforementioned cases of intermediate phase relationships. For example, for an intermediate phase relationship close to a quadrature relationship, the result may be an above-threshold indication only from the correlation indicator 50, whereas for an intermediate phase relationship further from a quadrature relationship, the result may be of an above-threshold indication from both of the correlation indicators 40 and 50. However, this is of no adverse consequence, since the operation of generator 60 is the same in the presence of an indication by both correlation indicators as it is in the presence of an indication by only one of the correlation indicators.

The principles of the present invention are applicable to solution of the hanging dot problem in both receivers of the type employing analog signal processing circuits and receivers of the type employing digital signal processing circuits. The form of correlation indicator illustrated herein, employing a signal multiplier, is readily implemented in receivers of the analog signal processing type. The aforementioned patent provides circuit details for one example of such implementation. The illustrated form of correlation indicator may also be implemented in receivers of the digital signal processing type, using well known techniques for digital signal multiplication and filtering. However, a less expensive digital embodiment of the present invention may be realized with use of a novel form of correlator, which is described in cofiled European Patent Application 86302845.2 (EP-A-0200420 published 05.11.1986) corresponding to copending US Patent Application, Ser. No. 724,555 entitled "Digital Correlation Indicator and Hanging Dot Reduction System Employing Same".

Claims

1. An apparatus for processing composite color television signals inclusive of a luminance signal component and a chrominance signal component comprising modulated subcarrier waves, said apparatus including comb filter apparatus comprising a delay line (11) having an input (CV) to which undelayed composite signals are applied and having an output at which delayed composite signals appear, means (15) for subtractively combining said undelayed and said delayed composite signals to form a first comb filtered signal output, and means (13) for additively combining said undelayed and delayed composite signal to form a second comb filtered signal output; said apparatus further comprising:

a first filter (17) responsive to said first comb filtered signal output, and removing low frequency components therefrom;

chrominance signal component utilization means responsive to an output of said first filter;

a second filter (27) responsive to said second comb filtered signal output, and removing low frequency components therefrom;

a first correlation indicator (50,51,52,53,55) responsive to the respective outputs of said first and second filters, for developing a first indication signal (CB) in the presence of correlation between a relatively undelayed signal derived from the output of one of said first and second filters and a relatively delayed signal derived from the output of

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B to switch output terminal LO), whenever a hanging dot occurrence indication appears at either (or both) of terminals CA and CB; and (b) remains at a level retaining the first switching state for apparatus 25 (linking switch input terminal A to switch output terminal LO) during periods of absence of a hanging dot occurrence indication from both of the terminals CA, CB.

The magnitude of the delay imparted by delay device 23 is selected to substantially match the delay associated with control signal development so as to ensure appropriate timing of the switching action of apparatus 25 relative to the timing of the hanging dot occurrences in the signals being delivered to apparatus 25.

In operation of the illustrated system, use of the pair of correlation indicators 40,50 avoids the quadrature relationship failure previously referred to herein. Whenever a vertical transition occurrence results in appearances of a chrominance component in outputs of both of the first and second comb filters, the ability to recognize such joint appearances is rendered independent of the phase relationship between the respective components. Where the phase relationship is an in-phase (or 180° out of phase) relationship, the joint appearance is recognized by correlation indicator 40. Where the phase relationship is a quadrature relationship, the joint appearance is recognized by correlation indicator 50. For intermediate phase relationships, the joint appeance will be recognized by one or the other, or both, of the correlation indicators.

The provision of the voltage comparators (45,55) in the respective correlation indicators is for the purpose of associating a thresholding action with the operation of the hanging dot reduction system. When the magnitude of the interloping chrominance component is quite small, the visibility of the resulting dot pattern will be sufficiently insignificant as to not warrant a suppression action, wherefore alteration of the switching state of apparatus 25 is not desired. Use of such a thresholding action will affect the operation of the correlation indicators 40,50 for the aforementioned cases of intermediate phase relationships. For example, for an intermediate phase relationship close to a quadrature relationship, the result may be an above-threshold indication only from the correlation indicator 50, whereas for an intermediate phase relationship further from a quadrature relationship, the result may be of an above-threshold indication from both of the correlation indicators 40 and 50. However, this is of no adverse consequence, since the operation of generator 60 is the same in the presence of an indication by both correlation indicators as it is in the presence of an indication by only one of the correlation indicators.

The principles of the present invention are applicable to solution of the hanging dot problem in both receivers of the type employing analog signal processing circuits and receivers of the type employing digital signal processing circuits. The form of correlation indicator illustrated herein, employing a signal multiplier, is readily implemented in receivers of the analog signal processing type. The aforementioned patent provides circuit details for one example of such implementation. The illustrated form of correlation indicator may also be implemented in receivers of the digital signal processing type, using well known techniques for digital signal multiplication and filtering. However, a less expensive digital embodiment of the present invention may be realized with use of a novel form of correlator, which is described in cofiled European Patent Application 86302845.2 (EP-A-0200420 published 05.11.1986) corresponding to copending US Patent Application, Ser. No. 724,555 entitled "Digital Correlation Indicator and Hanging Dot Reduction System Employing Same".

Claims

1. An apparatus for processing composite color television signals inclusive of a luminance signal component and a chrominance signal component comprising modulated subcarrier waves, said apparatus including comb filter apparatus comprising a delay line (11) having an input (CV) to which undelayed composite signals are applied and having an output at which delayed composite signals appear, means (15) for subtractively combining said undelayed and said delayed composite signals to form a first comb filtered signal output, and means (13) for additively combining said undelayed and delayed composite signal to form a second comb filtered signal output; said apparatus further comprising:

   a first filter (17) responsive to said first comb filtered signal output, and removing low frequency components therefrom;

   chrominance signal component utilization means responsive to an output of said first filter;

   a second filter (27) responsive to said second comb filtered signal output, and removing low frequency components therefrom;

   a first correlation indicator (50,51,52,53,55) responsive to the respective outputs of said first and second filters, for developing a first indication signal (CB) in the presence of correlation between a relatively undelayed signal derived from the output of one of said first and second filters and a relatively delayed signal derived from the output of

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the other of said first and second filters; the difference in delay between said relatively undelayed and relatively delayed signals being substantially equal to a quarter period at the nominal frequency of said subcarrier waves;

a second correlation indicator (40,41,43,45), responsive to the respective outputs of said first and second filters, for developing a second indication signal (CA) in the presence of correlation between respective signals derived without difference in delay from the outputs of said first and second filters;

luminance signal component utilization means;

means (60) responsive to the outputs of said first and second correlation indicators, for developing a control signal (SC) in response to the presence of either or both of said first and second indication signals; and

controlled means (23,29,31,25), responsive to said second comb filtered signal output and to said control signal, for delivering a modified version of said second comb filtered signal output to said luminance signal component utilization means during periods of development of said control signal, and for delivering an unmodified version of said second comb filtered signal output to said luminance signal component utilization means in the absence of development of said control signal.

2. Apparatus in accordance with Claim 1 including means (31) for subjecting said second comb filtered signal output to high frequency component removal to develop said modified version of said second comb filtered signal output.

3. Apparatus in accordance with Claim 2 wherein said subjecting means (31) comprises means for subtractively combining the output of said second filter with said second comb filtered signal output.

4. Apparatus in accordance with claim 1,2 or 3 also including means for selectively passing low frequency components of said first comb filtered signal output, and wherein the output of said passing means is delivered to said luminance signal component utilization means independent of the operating condition of said control signal developing means.

Revendications

1. Un appareil pour traiter des signaux de télévision couleur composés renfermant une composante d'un signal de luminance et une composante d'un signal de chrominance comprenant des ondes sous-porteuses modulées ledit appareil comprenant un dispositif à filtre en peigne comprenant une ligne à retard (11) ayant une entrée (CV) à laquelle sont appliqués des signaux composés non retardés et ayant une sortie à laquelle appaissent des signaux composés retardés un moyen (15) pour combiner soustractivement lesdits signaux composés non retardés et retardés pour former une première sortie de signal filtré en peigne, et un moyen (13) pour combiner additivement lesdits signaux composés non retardés et retardés pour former une seconde sortie de signal filtré en peigne; ledit appareil comprenant de plus :

un premier filtre (17) répondant à la première sortie de signal filtré en peigne et retirant de celle-ci des composantes de basse fréquence;

un moyen d'utilisation de composante du signal de chrominance répondant à une sortie dudit premier filtre;

un second filtre (27) répondant à la seconde sortie de signal filtré en peigne et retirant de celle-ci des composantes de basse fréquence;

un premier indicateur de corrélation (50,51,52,53,55), répondant aux sorties respectives des premier et second filtres, pour produire un premier signal d'indication (CB) en présence de corrélation entre un signal relativement non retardé et dérivé de la sortie de l'un des premier et second filtres et un signal relativement retardé dérivé de la sortie de l'autre des premier et second filtres; la différence en retard entre lesdits signaux relativement non retardés et relativement retardés étant sensiblement égale à un quart de période de la fréquence nominale desdites ondes sous-porteuses;

un second indicateur de corrélation (40,41,43,45), répondant aux sorties respectives desdits premier et second filtres, pour produire un second signal d'indication (CA) en présence de corrélation entre les signaux respectifs dérivés sans différence en retard des sorties desdits premier et second filtres;

un moyen d'utilisation de la composante du signal de luminance;

un moyen (60) répondant aux sorties desdits premier et second indicateurs de corrélation pour produire un signal de commande (SC) en réponse à la présence soit de l'un desdits premier et second signaux d'indication, soit des deux; et

un moyen commandé (23,29,31,25) répondant à la seconde sortie du signal filtré en peigne et au signal de commande, pour pro-

duire une version modifiée de la seconde sortie du signal filtré en peigne au moyen d'utilisation de la composante du signal de luminance pendant des périodes de production du signal de commande et pour produire une version non modifiée de la seconde sortie du signal filtré en peigne au moyen d'utilisation de la composante du signal de luminance en l'absence de production du signal de commande.

2. Appareil selon la revendication 1 comprenant un moyen (31) pour soumettre la seconde sortie précitée du signal filtré en peigne à un retrait de composante de haute fréquence pour produire la version modifiée précitée de la seconde sortie du signal filtré en peigne.

3. Appareil selon la revendication 2, où le moyen de soumission (31) comprend un moyen pour combiner soustractivement la sortie du second filtre précité à la seconde sortie précitée du signal filtré en peigne.

4. Appareil selon la revendication 1, 2 ou 3 comprenant également un moyen pour laisser passer sélectivement des composantes de basse fréquence de la première sortie du signal filtré en peigne précité et où la sortie dudit moyen de passage est produite au moyen d'utilisation de la composante du signal de luminance indépendant de la condition de fonctionnement du moyen de production du signal de commande précité.

Patentansprüche

1. Einrichtung zum Verarbeiten von Farbfernsehgemischsignalen einschließlich einer Leuchtdichtesignalkomponente und einer Farbartsignalkomponente, die modulierte Hilfsträgerschwingungen enthält, mit einer Kammfiltereinrichtung, welche eine Verzögerungsleitung (11) mit einem Eingang (CV), dem ein unverzögertes Signalgemisch zugeführt wird und mit einem Ausgang, an dem ein verzögertes Signalgemisch auftritt, einer Anordnung (15) zum subtraktiven Vereinigen des unverzögerten und des verzögerten Signalgemisches unter Erzeugung eines ersten kammgefilterten Ausgangssignales, und einer Anordnung (13) zum additiven Kombinieren des unverzögerten und des verzögerten Signalgemisches unter Bildung eines zweiten kammgefilterten Ausgangssignales, ferner mit
einem ersten Filter (17), das auf das erste kammgefilterte Ausgangssignal anspricht und niederfrequente Komponenten aus diesem entfernt;
einer Farbartsignalkomponenten-Nutzbarmachungseinrichtung, welche auf ein Ausgangssignal des ersten Filters anspricht; ein zweites Filter (27), welches auf das zweite kammgefilterte Ausgangssignal anspricht und niederfrequente Komponenten aus diesem entfernt;
einem ersten Korrelationsanzeiger (50, 51, 52, 53, 55), der auf die jeweiligen Ausgangssignale des ersten und des zweiten Filters anspricht, um ein erstes Anzeigesignal (CB) beim Vorhandensein einer Korrelation zwischen einem verhältnismäßig unverzögerten Signal, das vom Ausgang eines der beiden Filter gewonnen wurde und einem relativ verzögerten Signal, das aus dem Ausgang des anderen der beiden Filter gewonnen wurde, zu erzeugen, wobei der Unterschied in der Verzögerung zwischen dem relativ unverzögerten und dem relativ verzögerten Signal im wesentlichen gleich einem Viertel der Periode der Hilfsträgerschwingungen bei der Nennfrequenz ist;
einem zweiten Korrelationsanzeiger (40, 41, 43, 45), der auf die jeweiligen Ausgangssignale des ersten und des zweiten Filters anspricht, um ein zweites Anzeigesignal (CA) beim Vorhandensein einer Korrelaton zwischen ohne Differenz in der Verzögerung von den Ausgängen des ersten und des zweiten Filters gewonnenen Signalen zu liefern;
eine Leuchtdichtesignalkomponenten-Nutzbarmachungseinrichtung; eine auf die Ausgangssignale des ersten und des zweiten Korrelationsanzeigers ansprechende Einrichtung (60) zum Erzeugen eines Steuersignals (SC) in Ansprache auf das Vorhandensein eines oder beider Anzeigesignale, und eine gesteuerte Einrichtung (23, 29, 31, 25), die auf das zweite kammgefilterte Ausgangssignal und das Steuersignal anspricht, um während Perioden der Erzeugung des Steuersignals eine modifizierte Version des zweiten kammgefilterten Ausgangssignals an die Leuchtdichtesignalkomponenten-Nutzbarmachungseinrichtung zu liefern und um in Abwesenheit der Erzeugung des Steuersignals eine unmodifizierte Version des zweiten kammgefilterten Ausgangssignals an die Leuchtdichtekomponenten-Nutzbarmachungseinrichtung zu liefern.

2. Einrichtung nach Anspruch 1 mit einer Anordnung (31), um das zweite kammgefilterte Ausgangssignal einer Hochfrequenzanteilentfernung zu unterwerfen, um die modifizierte Version des zweiten kammgefilterten Ausgangssignals zu erzeugen.

3. Einrichtung nach Anspruch 2, bei der die Unterwerfungseinrichtung (31) eine Anordnung

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zum subtraktiven Vereinigen des Ausgangssignals des zweiten Filters mit dem zweiten kammgefilterten Ausgangssignal enthält.

4. Einrichtung nach Anspruch 1, 2 oder 3, die ferner eine Anordnung zum selektiven Durchlassen von niederfrequenten Anteilen des ersten kammgefilterten Ausgangssignals enthält und bei der das Ausgangssignal der Durchlaßeinrichtung der Leuchtdichtesignalkomponenten-Nutzbarmachungseinrichtung unabhängig vom Betriebszustand der das Steuersignal erzeugenden Einrichtung zugeführt wird.