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(54) LAND PRE-PIT SIGNAL PROCESSING METHOD AND RELATED APPARATUS

FLECK-PREPIT-SIGNALVERARBEITUNGSVERFAHREN UND DIESBEZÜGLICHE VORRICHTUNG

PROCEDE DE TRAITEMENT DE SIGNAL DE PRE-DEPRESSION D'INTERSILLONS ET APPAREIL ASSOCIE

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(73) Proprietor: **NXP B.V.**
5656 AG Eindhoven (NL)

(72) Inventors:
- **WU, Xinyan; c/o Philips Intell. Prop. & Standards Redhill Surrey RH1 5HA (GB)**
- **HAROLD-BARRY, J.A.; c/o Philips Intell. Prop. St. Redhill Surrey RH1 5HA (GB)**

(74) Representative: **Williamson, Paul Lewis et al**
NXP Semiconductors UK Ltd.
Intellectual Property Department
Betchworth House
Station Road
Redhill
Surrey RH1 1DL (GB)

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EP 1 761 919 B9

Description

[0001] The present invention relates to a Land Pre-Pit (LPP) signal processing method and related apparatus.

[0002] Recordable optical discs such as DVD-R and DVD-RW discs are arranged to provide for a LPP signal, which is used primarily for the detection of disc-addressing information and for providing other auxiliary data.

[0003] The LPP signal is produced by means of a Land Pre-Pit, which comprises a microstructure embossed at predetermined positions along a land of an optical disc. In current DVD-R and DVD-RW recording systems, the LPP signal is employed during reading from the disc both before and after recording and so as, for example, to confirm the physical address at which data blocks have been written.

[0004] However, it has been found that the quality of the LPP signal when data is being read from the disc is disadvantageously limited primarily due to High Frequency (HF) crosstalk arising from the adjacent lands and grooves which, as is known, are arranged to provide for a so-called wobble signal serving to assist with tracking of the optical head of the optical disc drive during recording and playback.

[0005] Further, while recording arrangements such as the provision of a push-pull signal normalised on the Radio Frequency (RF) analogue signal can serve to improve the LPP signal within a limited range there is nevertheless a disadvantageous inherent lack of flexibility. Limitations of such techniques within the recording system can further disadvantageously provide a "divided by zero" problem if the offset for the HF crosstalk signal is not appropriately set.

[0006] A further disadvantage that arises is that fast-normalisation proves problematic to implement within the digital domain.

[0007] A further disadvantage that arises is that fast-normalisation proves problematic to implement within the digital domain.

[0008] EP-A-1 225 570 discloses a pre-pit detecting apparatus wherein first and second read signals generated on the basis of the outputs of electrical signals from a light receiving portion are input to an amplitude correcting circuit, the first and second read signals are added to generate an addition signal. Then the amplitudes of the first and second read signals are corrected for the each RF signal component corresponding to each recording pit, which is contained in the first and second read signals on the basis of the addition signal. Finally, the difference between the first and second read signals is computed to generate a difference signal so that a pre-pit signal will be detected on the basis of the difference signal.

[0009] The present invention seeks to provide for an LPP signal processing method and related apparatus having advantages over known such methods and apparatus.

[0010] According to a first aspect of the present invention, there is provided a method of producing a Land Pre-Pit signal during playback of an optical disc and comprising the steps of:

obtaining an output signal from an optical detector and from which the Land Pre-Pit signal is to be derived;
scaling the said output signal responsive to a determined amplitude of a high frequency crosstalk signal arising during reading of the disc and in a manner so as to increase the said output signal when the Land Pre-Pit is identified as corresponding to a mark on the disc, and so as to decrease the output signal when the Land Pre-Pit is identified as corresponding to a space on the disc,;
characterised in that said output signal comprises a balanced push-pull signal.

[0011] The invention is advantageous in accurately boosting a small LPP signal, but alternatively attenuating the LPP signal when appropriate. The rescaling of the LPP signal based on the amplitude of the HF crosstalk signal advantageously allows for such boosting and attenuation.

[0012] The invention therefore advantageously can provide for an offset - independent re-scaling process and which serves to reduce the error rate and/or standard deviation commonly arising in the LPP signal.

[0013] Preferably, the balanced push-pull signal is derived from the difference between a high pass filtered push-pull signal from the optical detector and a high pass filtered high frequency crosstalk signal.

[0014] Advantageously, LPP waveform width changes can be compensated by means of a sample-rate-converter.

[0015] The method is further advantageous in calculating the LPP signal by means of convolution of push-pull signal along with a LPP-like wavelet.

[0016] Further, the scaling factor applied to the said output signal can be fine-tuned by means of a standard deviation step serving to calculate an error rate within the LPP signal.

[0017] According to another aspect of the present invention, there is provided a LPP signal processing apparatus arranged for producing a LPP signal during playback of an optical disc and comprising:

means for obtaining an output signal from an optical detector and from which the LPP signal is to be derived;
means for scaling the said output signal responsive to a determined amplitude of a high frequency crosstalk signal arising during reading of the disc and in a manner so as to increase the said output signal when the Land Pre-Pit is identified as corresponding to a mark on the disc, and so as to decrease the output signal when the Land Pre-Pit is identified as corresponding to a space on the disc;

characterised in that said output signal comprises a balanced push-pull signal.

[0018] Further features can advantageously be provided such that the apparatus can provide for the further advantages discussed above in relation to the discussion of the method of the present invention.

[0019] As discussed, the method and apparatus of the present invention is particular advantageous in reducing the error rate or standard deviation within the LPP signal in particular, by means of offset-irrelevant re-scaling processing and LPP-like wavelet convolution which can be provided in a particularly advantageous embodiment of the present invention.

[0020] The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a partial perspective view of a section through an optical disc arranged to produce signals for processing in accordance with the present invention;

Fig. 2 is a schematic block diagram of an arrangement for achieving the advantages of the present invention; and

Fig. 3A and 3B represent traces illustrating the advantageous LPP processing achieved by way of the present invention.

[0021] Turning now to Fig. 1, there is illustrated a section through part of an optical disc 10 to which data can be written and which comprises a spiral of grooves 12 upon which data marks 14 are written by means of an optical read/write head (not shown) and which grooves 12 are separated by spiral lands 16. As will be seen, the upper edges of the lands 16 are formed with a sinusoidal configuration which is arranged to provide for a so-called wobble signal. This signal is arranged to be detected by the optical read/write head and is employed to assist with the accurate tracking of the optical read/write head and as is well known and so is not described further here.

[0022] Within the land 16 are illustrated two Land Pre-Pits (LPP) 18,20 which comprise embossed structures provided within the land 16 and which form part of a pre-formatting addressing scheme arranged for identifying physical addresses on the disc where data blocks are to be, or have been, written.

[0023] Thus, when reading a disc, in addition to encountering the data mark 14, and the sinusoidal configurations of the upper edges of the lands 16, an output signal is also produced when the optical read/write head encounters each LPP 18,20.

[0024] It has however been identified, in particular due to HF crosstalk produced by the disc, that the signal developed from the LPP, i.e. so-called LPP signal, can prove difficult to detect particularly when the LPP is located adjacent a long data mark which will exhibit a low light-reflection characteristic. Such problems do not however arise when a LPP located adjacent a relatively long space on the disc.

[0025] Within the present invention, a method and arrangement is provided whereby the amplitude of the LPP signal when located adjacent a mark is increased. Likewise, its amplitude can be decreased through attenuation when it is identified that the LPP is located adjacent a space.

[0026] Such re-scaling of the LPP signal advantageously is based advantageously upon the amplitude of the HF crosstalk signal encountered when reading from a disc.

[0027] With regard to Fig. 2 therefore, there is illustrated an example of an arrangement for providing the advantageous LPP processing of the present invention.

[0028] The arrangement 22 comprises identical first 24, and second 26, high pass filters which are further arranged to high pass filter the high frequency cross talk signals 28 and push-pull signals 30 derived from the optical read/write head (not shown).

[0029] The output of the high pass filtered push-pull signal 30 is then delivered to the difference unit 32 arranged to produce a balanced push-pull signal 34. The balanced push-pull signal 34 is delivered to a multiplier 36 where it is combined with the high pass filtered cross talk signal 28 and delivered to an arrangement for determining a coefficient which is likewise to be applied to the high pass filtered cross talk signal 28 before delivery to the difference unit 32.

[0030] In the illustrated embodiment, the coefficient (COEF) is determined by an integrate and dump unit 38 arranged to receive the output from the multiplier 36 and to deliver a signal to a PI controller 40. However, it should be appreciated that, as an alternative, a low-pass filter could be employed in place of the integrate and dump unit 38. It is noted that the sign bit of the HF crosstalk signal 28 can be employed to simplify the aforementioned multiplication at multiplier 36.

[0031] The above-mentioned coefficient derived from the PI controller 40 is, as noted, applied to the high pass filtered crosstalk signal 28 and the result delivered to the difference unit 32 from which the balanced push-pull signal 34 is derived.

[0032] A peak and bottom detector unit 42 is arranged to receive the output from the high pass filter 24, i.e. the high pass filtered crosstalk signal 28, and so as to detect the peak, and the bottom, of the high pass filtered crosstalk signal 28. The output from this detector unit 42 is employed in turn to control the scaling factor to be applied to the balanced push-pull signal 34 by means of a scaling factor selection unit 44.

[0033] As illustrated in Fig. 2, the scaling factor selection unit 44 applies a scaling factor signal to the balanced push-pull signal 34 at a multiplier 46 and the output of the multiplier is delivered in turn to a sample rate converter 48.

[0034] The sample rate converter 48 is advantageously employed to compensate the LPP waveform with

changes that can arise in a Constant Angular Velocity (CAV) system. The signal then derived is arranged to produce the final LPP signal by means of a convolution unit 50 arranged for convolution of the rescaled balanced push-pull signal and a LPP-like wavelet W in which the wavelet W represents an ideal waveform for the LPP signal. The overall length of the wavelet illustrated by Wk is advantageously determined by the sampling rate, and recording speed, of the optical disc drive system.

[0035] As noted, the result of the convolution is output as the required LPP signal 52, which in turn is advantageously delivered to LPP detection and standard deviation unit 54. A signal can be derived from the LPP detection and standard deviation unit 54 and employed by means of a digital signal processor 56, or other appropriate digital hardware. This serves to provide for a fine tuning signal which can be applied to the scaling factor selection unit 44 so as to fine tune the scaling factor applied to the high pass filtered push-pull signal 34 at the multiplier 46. The LPP detection and standard deviation unit 54 is advantageously arranged to calculate an error rate within the LPP signal 52 so as to provide for such fine-tuning.

[0036] The scaling factor selection unit 44 operates such that the greater the amplitude of the high frequency crosstalk signal 28, the smaller the scaling factor that is applied to the balanced push-pull signal 34.

[0037] As will therefore be appreciated, in the illustrated embodiment, the balanced push-pull signal is rescaled based upon the amplitude of the HF crosstalk signal such that a relatively small LPP signal adjacent a long mark on the disc will be boosted while a relatively large LPP signal located adjacent a long space on the disc will be attenuated.

[0038] The aforementioned fine-tuning of the scaling factor enhances the flexibility of the method and arrangement and is advantageously offset-independent.

[0039] Also, the "divided by zero" problem encountered within the prior-art advantageously does not arise.

[0040] The error rate, or standard deviation, of the LPP signal is advantageously significantly reduced in accordance with the present invention.

[0041] As a further illustration of the advantageous reduction in the error rate of the LPP detection in read mode in accordance with the present invention, reference is now made to Figs. 3A and 3B.

[0042] Fig. 3A, illustrates a trace of a signal derived from an optical disc during read mode in accordance with the prior-art. The centre of the trace 58a represents the wobble signal and the signal spikes 60a and 62a represent LPP signals produced by means of the LPPs of the disc.

[0043] The readily discernable LPP signal 60a is that arising from a LPP located adjacent a long space of the disc. The LPP signal 62a of small amplitude, and which is almost lost amongst the wobble signal, is that arising when the LPP is located adjacent a relatively long mark of the disc.

[0044] Turning now to Fig. 3B, a corresponding signal derived in accordance with the present invention is illustrated and which again shows a central wobble signal 58B. However, in view of the signal boosting and signal attenuation discussed above, it will be appreciated that both LPP signals 60b and 62b are readily discernible for both the LPP that is located adjacent the relatively long mark, and that is adjacent a relatively long space on the optical disc.

[0045] In view of the manner in which it is now possible to readily differentiate the LPP signals from the wobble signal, it will be appreciated that the error rate associated with the LPP signal, particularly in read mode, is advantageously greatly reduced.

Claims

1. A method of producing a Land Pre-Pit signal during playback of an optical disc and comprising the steps of:

   obtaining an output signal from an optical detector and from which the Land Pre-Pit signal is to be derived;
   scaling the said output signal responsive to a determined amplitude of a high frequency crosstalk signal arising during reading of the disc and in a manner so as to increase the said output signal when the Land Pre-Pit is identified as adjacent to a mark on the disc, and so as to decrease the output signal when the Land Pre-Pit is identified as adjacent to a space on the disc.
   characterised in that said output signal comprises a balanced push-pull signal.

2. A method as claimed in Claim 1, wherein the balanced push-pull signal is derived from the difference between a high pass filtered push-pull signal and a high-pass filtered high frequency crosstalk signal.

3. A method as claimed in Claim 1 or 2, and including the step of compensating for LPP signal width changes.

4. A method as claimed in Claim 3, wherein the said compensation is achieved by way of a sample rate conversion step.

5. A method as claimed in any one or more of Claims 1-4, wherein the LPP signal is calculated by means of a convolution step based on the rescaled output signal.

6. A method as claimed in Claim 5, wherein the convolution step includes a LPP-like wavelet.

7. A method as claimed in any one or more of the pre-

ceding claims, including the step of calculating an error rate in the LPP signal and processing the error rate so as to fine-tune the scaling of the said output signal.

8. A method as claimed in Claim 7, wherein the calculation of the error rate is based on the standard deviation of the LPP signal.

9. An LPP signal processing apparatus arranged for producing a LPP signal during playback of an optical disc and comprising:

means for obtaining an output signal from an optical detector and from which the LPP signal is to be derived;
means for scaling the said output signal responsive to a determined amplitude of a high frequency crosstalk signal arising during reading of the disc and in a manner so as to increase the said output signal when the Land Pre-Pit is identified as corresponding to a mark on the disc, and so as to decrease the output signal when the Land Pre-Pit is identified as corresponding to a space on the disc;
characterised in that said output signal comprises a balanced push-pull signal.

10. An apparatus as claimed in Claim 9, wherein the balanced push-pull signal is derived from the difference between a high pass filtered push-pull signal and a high-pass filtered high frequency crosstalk signal.

11. An apparatus as claimed in Claims 10 or 11, and including means for compensating for LPP signal width changes.

12. An apparatus as claimed in Claim 11, wherein the said means for compensating is arranged to provide for sample rate conversation.

13. An apparatus as claimed in any one or more of Claims 9-12, and including means for calculating the LPP signal by means of a convolution step based on the rescaled output signal.

14. An apparatus as claimed in Claim 13, wherein the convolution step includes a LPP-like wavelet.

15. Ah apparatus as claimed in any one or more of the preceding claims, including means for calculating an error rate in the LPP signal and processing the error rate so as to fine-tune the scaling of the said output signal.

16. An apparatus as claimed in Claim 15, wherein the means for calculating the error rate is arranged to apply a standard deviation technique to the LPP signal.

Patentansprüche

1. Verfahren zum Erzeugen eines Flächenbereich-Prepit-Signals während der Wiedergabe einer optischen Platte, die Schritte umfassend:

Erlangen eines Ausgangssignals von einem optischen Detektor, aus dem das Flächenbereich-Prepit-Signal herzuleiten ist;
Skalieren des Ausgangssignals in Reaktion auf eine ermittelte Amplitude eines Hochfrequenz-Übersprechsignals, das während des Lesens der Platte entsteht, derart, dass das Ausgangssignal erhöht wird, wenn das Flächenbereich-Prepit als benachbart zu einer Markierung auf der Platte identifiziert wird, und das Ausgangssignal verringert wird, wenn das Flächenbereich-Prepit als zu einer Leerstelle auf der Platte benachbart identifiziert wird,
dadurch gekennzeichnet, dass das Ausgangssignal ein ausgewogenes Gegentaktsignal umfasst.

2. Verfahren nach Anspruch 1, wobei das ausgewogene Gegentaktsignal aus der Differenz zwischen einem hochpassgefilterten Gegentaktsignal und einem hochpassgefilterten Hochfrequenz-Übersprechsignal hergeleitet wird.

3. Verfahren nach Anspruch 1 oder 2, das den Schritt des Kompensierens von LPP-Signalbreiteänderungen enthält.

4. Verfahren nach Anspruch 3, wobei die Kompensation mittels eines Abtastratenkonvertierungsschritts erreicht wird.

5. Verfahren nach irgendeinem oder mehreren der Ansprüche 1 bis 4, wobei das LPP-Signal mittels eines Faltungsschrittes auf der Grundlage des neuskalierten Ausgangssignals berechnet wird.

6. Verfahren nach Anspruch 5, wobei der Faltungsschritt ein LPP-artiges Wavelet enthält.

7. Verfahren nach irgendeinem oder mehreren der vorangehenden Ansprüche, das den Schritt des Berechnens einer Fehlerrate im LPP-Signal und des Verarbeitens der Fehlerrate enthält, um somit die Skalierung des Ausgangssignals feinabzustimmen.

8. Verfahren nach Anspruch 7, wobei die Berechnung der Fehlerrate auf der Standardabweichung des LPP-Signals beruht.

9. LPP-Signal-Verarbeitungsvorrichtung, die dafür ausgelegt ist, ein LPP-Signal während der Wiedergabe einer optischen Platte zu erzeugen, umfassend:

Mittel zum Erlangen eines Ausgangssignals von einem optischen Detektor, aus dem das LPP-Signal herzuleiten ist;
Mittel zum Skalieren des Ausgangssignals in Reaktion auf eine ermittelte Amplitude eines Hochfrequenz-Übersprechsignals, das während des Lesens der Platte entsteht, derart, dass das Ausgangssignal erhöht wird, wenn das Flächenbereich-Prepit als benachbart zu einer Markierung auf der Platte identifiziert wird, und das Ausgangssignal verringert wird, wenn das Flächenbereich-Prepit zu einer Leerstelle auf der Platte zugehörig identifiziert wird;
dadurch gekennzeichnet, dass das Ausgangssignal ein ausgewogenes Gegentaktsignal umfasst.

10. Vorrichtung nach Anspruch 9, wobei das Gegentaktsignal aus der Differenz zwischen einem hochpassgefilterten Gegentaktsignal und einem hochpassgefilterten Hochfrequenz-Übersprechsignal hergeleitet wird.

11. Vorrichtung nach Anspruch 10 oder 11, die Mittel zum Kompensieren von LPP-Signalbreiteänderungen umfasst.

12. Vorrichtung nach Anspruch 11, wobei das Mittel zum Kompensieren dafür ausgelegt ist, eine Abtastratenkonvertierung zu bewirken.

13. Vorrichtung nach irgendeinem oder mehreren der Ansprüche 9 bis 12, die Mittel umfasst zum Berechnen des LPP-Signals mittels eines Faltungsschrittes auf der Grundlage des neuskalierten Ausgangssignals.

14. Vorrichtung nach Anspruch 13, wobei der Faltungsschritt ein LPP-artiges Wavelet enthält.

15. Vorrichtung nach irgendeinem oder mehreren der vorangehenden Ansprüche, die Mittel umfasst zum Berechnen einer Fehlerrate im LPP-Signal und zum Verarbeiten der Fehlerrate, um somit die Skalierung des Ausgangssignals feinabzustimmen.

16. Vorrichtung nach Anspruch 15, wobei das Mittel zum Berechnen der Fehlerrate dafür ausgelegt ist, eine Standardabweichungstechnik auf das LPP-Signal anzuwenden.

Revendications

1. Procédé de production d'un signal de Pré-Dépression d'Intersillons (LPP) pendant la lecture d'un disque optique et comportant les étapes consistant à :

obtenir un signal de sortie à partir d'un détecteur optique et à partir duquel le signal de Pré-Dépression d'Intersillons peut être déduit ;
cadrer ledit signal de sortie en réponse à une amplitude déterminée d'un signal de couplage parasite haute fréquence se produisant lors de la lecture du disque et d'une manière à augmenter ledit signal de sortie lorsque le signal de Pré-Dépression d'Intersillons (LPP) est identifié comme étant adjacent à un repère situé sur le disque, et de façon à diminuer le signal de sortie lorsque le signal de Pré-Dépression d'Intersillons est identifié comme étant adjacent à un espace sur le disque,

caractérisé en ce que ledit signal de sortie est constitué d'un signal symétrique équilibré.

2. Procédé selon la revendication 1, dans lequel le signal symétrique équilibré est déduit de la différence entre un signal symétrique filtré passe-haut et un signal de couplage parasite haute fréquence filtré passe-haut.

3. Procédé selon la revendication 1 ou 2 et comprenant l'étape de compensation des variations de largeur du signal LPP.

4. Procédé selon la revendication 3 dans lequel ladite compensation est réalisée au moyen d'une étape de conversion de cadence d'échantillonnage.

5. Procédé selon l'une quelconque ou plusieurs des revendications 1 à 4 dans lequel le signal LPP est calculé au moyen d'une étape de convolution sur la base du signal de sortie recadré.

6. Procédé selon la revendication 5 dans lequel l'étape de convolution comporte une ondelette analogue au signal LPP.

7. Procédé selon l'une quelconque ou plusieurs des revendications précédentes, comportant l'étape consistant à calculer un taux d'erreur dans le signal LPP et à traiter le taux d'erreur de façon à accorder de façon précise le cadrage dudit signal de sortie.

8. Procédé selon la revendication 7 dans lequel le calcul du taux d'erreur est fondé sur l'écart type du signal LPP.

9. Appareil de traitement de signal LPP agencé en vue

de produire un signal LPP pendant la lecture d'un disque optique et comportant:

des moyens pour obtenir un signal de sortie à partir d'un détecteur optique et à partir duquel le signal LPP doit être déduit ;
des moyens destinés à cadrer ledit signal de sortie en réponse à une amplitude déterminée d'un signal de couplage parasite à haute fréquence se produisant pendant une lecture du disque et de manière à accroître ledit signal de sortie lorsque le signal de Pré-Dépression d'Intersillons est identifié comme correspondant à un repère situé sur le disque, et de manière à diminuer le signal de sortie lorsque le signal de Pré-Dépression d'Intersillons est identifié comme correspondant à un espace sur le disque ;

caractérisé en ce que ledit signal de sortie comprend un signal symétrique équilibré.

10. Appareil selon la revendication 9, dans lequel le signal symétrique équilibré est déduit de la différence entre un signal symétrique filtré passe-haut et un signal de couplage parasite haute fréquence filtré passe-haut.

11. Appareil selon les revendications 10 ou 11 et comportant des moyens permettant de compenser des variations de largeur de signal LPP.

12. Appareil selon la revendication 11 dans lequel lesdits moyens de compensation sont agencés pour fournir une conversion de la cadence d'échantillonnage.

13. Appareil selon l'une quelconque ou plusieurs des revendications 9 à 12, et comportant des moyens pour calculer le signal LPP au moyen d'une étape de convolution sur la base du signal de sortie recadré.

14. Appareil selon la revendication 13 dans lequel l'étape de convolution comporte une ondelette analogue au signal LPP.

15. Appareil selon l'une quelconque ou plusieurs des revendications précédentes, comportant des moyens pour calculer un taux d'erreur dans le signal LPP et pour traiter le taux d'erreur de manière à accorder de façon précise le cadrage dudit signal de sortie.

16. Appareil selon la revendication 15, dans lequel les moyens pour calculer le taux d'erreur sont agencés pour appliquer une technique de l'écart type au signal LPP.

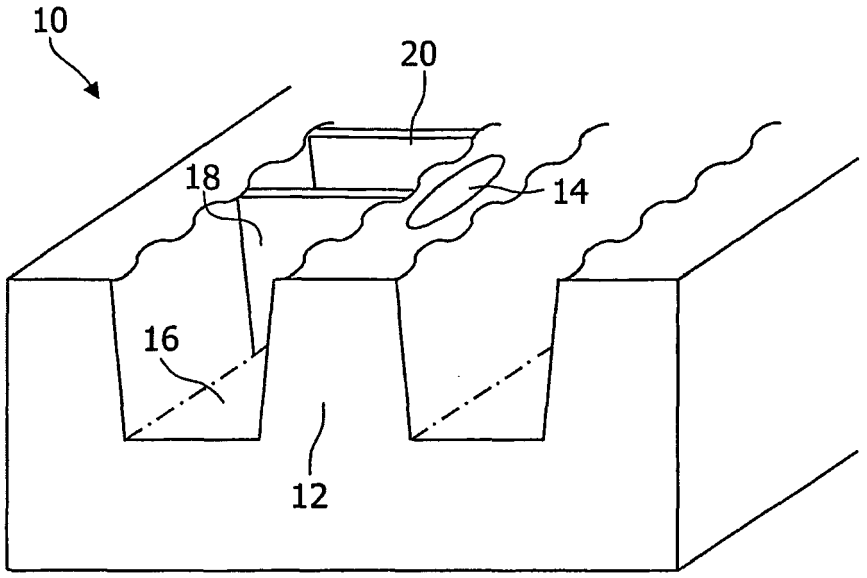
10
20
18
14
16
12

FIG. 1

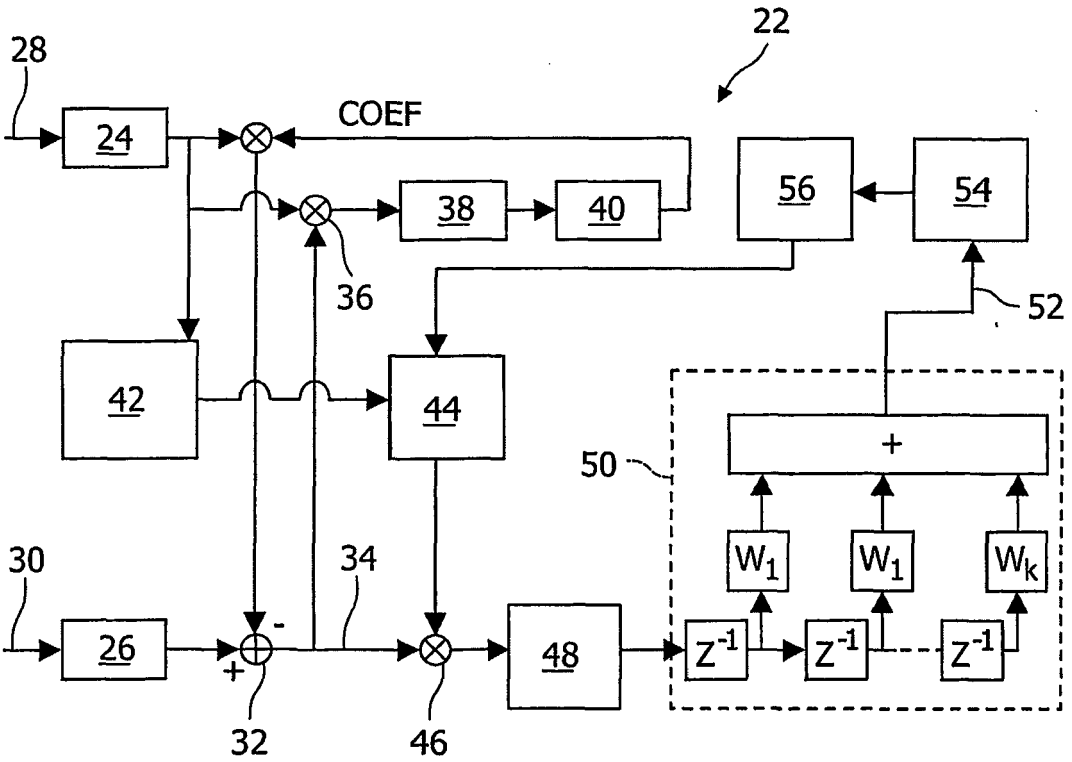
22
28
24
COEF
38
40
56
54
36
52
42
44
50
+
30
34
26
-
+
48
W_1
W_1
W_k
Z^{-1}
Z^{-1}
Z^{-1}
32
46

FIG. 2

FIG. 3A

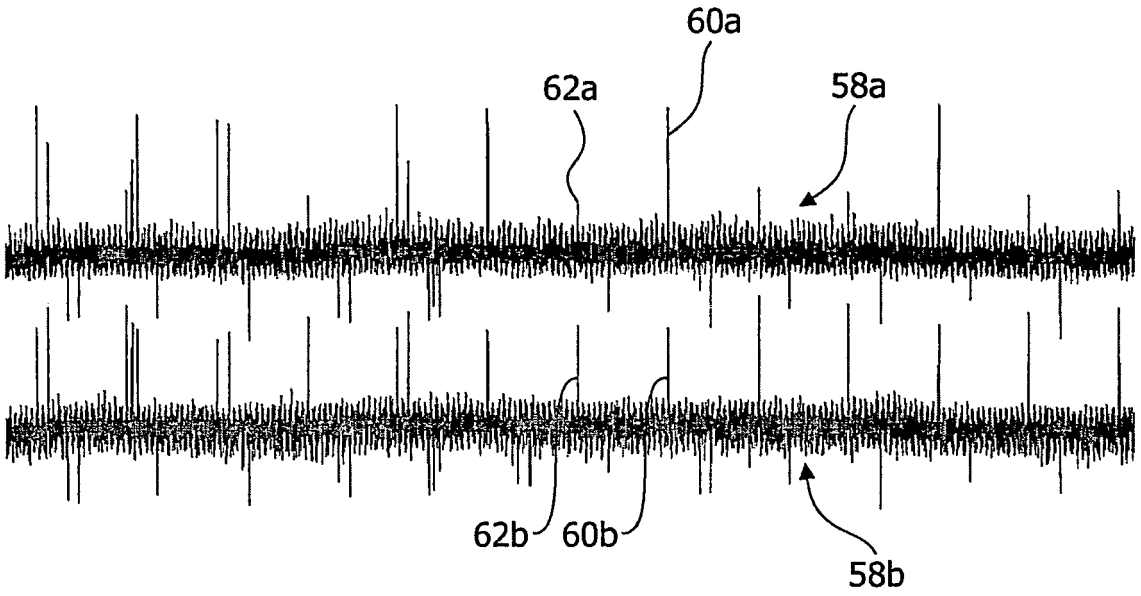

FIG. 3B

REFERENCES CITED IN THE DESCRIPTION

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