

Description

The invention relates to an apparatus for reading an optically readable disc-shaped record carrier in which information comprising digital data signals and digital subcode signals is stored, the signal read from the record carrier being applied to a demodulator circuit for demodulating the information, extracting the digital data signals and the digital subcode signals, and generating a first clock signal which is locked to the channel-bit frequency of the signal being read, after which the digital data signal is applied to an error-correction circuit which comprises a buffer register into which the digital data signal is loaded with a frequency which is locked to said first clock signal and from which it is read with a frequency which is locked to a second clock signal supplied by an oscillator, said buffer register being capable of generating a filling signal which is a measure of the instantaneous degree of filling of said buffer register.

Such apparatus is the well-known Compact-Disc-Digital-Audio player, which is marketed *inter alia* by N. V. Philips' Gloeilampenfabrieken under the type no. CD 100 and which is described in the magazine "Philips Technical Review", 40, No. 6, p. 151-165 which entire issue is incorporated herewith by reference.

In this known apparatus the data signal comprises digital samples of an analog audio signal, which is recovered in the apparatus by means of a digital-to-analog converter. The subcode signal contains address information and may also contain information about the content of the data signals. The buffer register is employed for correcting time-base errors in the data signal caused by, for example, eccentricities in the record carrier, because otherwise these time-base errors may become audible in the recovered analogue audio signal, which is annoying. In order to correct these time-base errors the frequency of the second clock signal is maintained highly constant, whilst the first clock signal follows the time base of the data signal being read. The data signal as recovered by the demodulation circuit comprises the digital audio signals together with *inter alia* the parity bits for error correction. Moreover, these data signals are interleaved, so that the errors are spread and are easier to correct. This correction and the restoration of the correct sequence of said audio signals is effected in the error-correction circuit which requires a memory circuit for this purpose. In said known apparatus the buffer memory is formed by a part of this memory circuit.

A potential use of the compact-disc digital audio system is the use of the record carrier as a read-only memory (ROM), in which case the signal on which the digital data signal is based need not be an analog audio signal, but may be a digital signal which is applied to a digital processing circuit instead of to an audio chain as in the known player.

For such a use it is found to be a disadvantage

that the known apparatus generates a data signal with a corrected time base and a subcode signal with a non-corrected time base.

It is the object of the invention to provide an apparatus of the type specified in the opening paragraph, in which this problem is solved without modifying the demodulation circuit or the error-correction circuit, so that for said use the same integrated circuits may be employed for the demodulation circuit and the error-correction circuit as in an apparatus for the reproduction of audio signals.

To this end the invention is characterized in that the frequency of said oscillator is controlled by said filling signal in such a sense that variations of the degree of filling of the buffer register are counter-acted by variations of the read frequency which is dictated by the second clock signal.

The invention is based on *inter alia* the recognition of the fact that by this step the buffer memory is rendered inoperative with respect to the time-base correction of the data signal, so that the data signal remains in synchronism with the subcode signal, whereas the fact that the two signals no longer have a constant time base does not interfere with the further processing of the signals, because digital processing circuits generally accept substantially larger time base errors than those permissible in audio-signal reproduction. The step in accordance with the invention meets the said objective because the oscillator replaces a reference crystal oscillator for generating the second clock signal in the known apparatus, whilst in the known apparatus the filling signal is also externally available in order to control the speed with which the record carrier is driven. Therefore, the step in accordance with the invention does not necessitate any modification of the demodulation circuit or the error-correction circuit.

The apparatus in accordance with the invention may further be characterized in that the filling signal is applied to the oscillator *via* a low-pass filter having a bandwidth which is substantially larger than the frequency of variations in the first clock signal caused by eccentricities in the record carrier.

As a result of the step in accordance with the invention the filling signal is no longer available as error signal for controlling the record-carrier drive.

With respect to the control of the record carrier drive the apparatus in accordance with the invention may further be characterized in that the apparatus comprises a reference oscillator for supplying a reference clock signal and a comparator circuit for comparing the first clock signal with the reference clock signal for controlling the record-carrier drive.

An alternative to this apparatus may further be characterized in that the apparatus comprises a reference oscillator for supplying a reference clock signal and a comparator circuit for comparing the second clock signal with the reference

signal for controlling the record-carrier drive.

The invention will now be described in more detail, by way of example, with reference to the drawing, in which

Figure 1 shows a known apparatus, and

Figure 2 shows an apparatus in accordance with the invention,

Figure 1 schematically shows the relevant parts of the known "Compact-Disc-Digital-Audio" player as described in the afore-mentioned publication. This player comprises an optical read device 3 which employs a laser beam 4 for reading a disc-shaped record carrier 1 driven by a motor 2. The signal read is applied to an EFM-demodulator 5, in which the signal is demodulated in conformity with the compact-disc-digital-audio standard. The EFM-demodulator 5 generates a clock signal S_c which is in synchronism with the signal read and which has an average frequency of 4,3218 MHz based on 588 channel bits per frame. Moreover, the signal read is split into a subcode signal SUB, which is applied to an output 6 and a data signal DATA. This data signal DATA is applied to a circuit 7 for further processing, in which circuit this signal is error-corrected in conformity with the compact-disc-digital-audio standard, is rearranged and is applied to an output 9. For this processing the circuit 7 comprises a memory of which a part is arranged as a buffer store 8. The data signal DATA is loaded into this buffer 8 in synchronism with the clock signal S_c , a correction being applied for the fact that the clock frequency of 4,3218 MHz is based on 588 channel bits per frame whilst the DAT signal comprises a smaller number of bits per frame as a result of the extraction of the channel bits and the EFM-demodulation, and the signal is read out with a clock signal which is locked to a constant clock signal supplied by a crystal oscillator 10 and having a frequency of 4,2336 MHz, which frequency is based on a demodulated data signal which is exempt of parity bits and which exclusively comprises the bits of the digital audio signal. The actual frequency with which the buffer 8 is read out differs slightly from said frequency because this buffer has an 8-bit parallel organization and the signal in the buffer still contains parity bits. In this way the data signal is rid of time-base errors, for example those caused by eccentricities of the record carrier 1 or by irregularities in the drive by the motor 2. The buffer 8 is designed so that it generates a signal S_n which is a measure of the instantaneous degree of filling of the buffer 8 i.e. a measure of the instantaneous time error. This signal S_n is applied to the motor 2 via a low-pass filter 11 in order to control the speed in such a way that the average time error is zero. In this way a data signal with a constant time base is obtained on output 9, which is essential because in the known player the data signal comprises digitized audio information, so that time errors may become audible to an annoying extent. The subcode SUB then appears on output

6 without said time error correction, which is not annoying for audio applications.

One potential use of the compact-disc-digital audio system is the use of the record carrier as a read-only memory (ROM), the signal on which the EFM encoded signal is based not being an analog audio signal but a digital signal which is not applied to an audio chain as in the known player, but to a digital processing chain. For encoding several possibilities are available. For example, it is possible to process a digital signal as though it were an analog signal and to convert this signal by means of an analog-to-digital converter and an EFM-encoding circuit, a higher storage capacity being attainable by first converting the original digital signal into a multi-level logic signal. Alternatively, it is possible to arrange the bits of a digital signal in groups and to treat them in the same way as the output signal of an analog-to-digital converter. In the first case the digital signal is recovered after digital-to-analog conversion and in the second case it is recovered without digital-to-analog conversion.

For the said application it is found to be a problem that the subcode SUB on output 6 is no longer in synchronism with the corrected data signal on output 9. For this problem solutions are conceivable which have the disadvantage that, for example, the circuit 7 has to be modified. Since this circuit is generally an integrated circuit and it is disadvantageous to manufacture a dedicated version of this integrated circuit for the aforementioned use, it is desirable to adopt a solution which does not affect the circuit 7.

Figure 2 illustrates such a solution. In this Figure parts corresponding to those in Figure 1 bear the same reference numerals.

In the apparatus shown in Figure 2 the crystal oscillator 10 is replaced by a voltage-controlled oscillator 12. Via a low-pass filter 13 this voltage-controlled oscillator 12 is controlled by the signal S_n which is a measure of the instantaneous degree of filling of the buffer 8. As a result of this the buffer 8 is read out in such a manner that the buffer 8 is always filled substantially to a reference level or in such a manner that reading is effected at the same rate (depending on the cut-off frequency of the filter 13) as loading. As a consequence, the data signal on output 9 appears with the same irregularity as clock signal S_c , i.e. in synchronism with the subcode SUB on output 6.

In order to maintain the average rhythm with which the data is read out constant a phase comparator circuit 14 compares the clock signal S_c with the output signal of a crystal oscillator 15 which is tuned to a frequency of 4,3218 MHz. The result of this comparison is used for controlling the motor 2 via a low-pass filter 11, so that the clock signal S_c and consequently the rhythm with which the data signal is read out is stabilized with respect to the frequency of the crystal oscillator 15.

Preferably, the bandwidth of the low-pass filter 13 extends beyond the frequency corresponding to the disc eccentricity so as to enable variations

the clock signal S_c as a result of this eccentricity is tracked by the oscillator 12. This bandwidth is, for example, 500 Hz.

Since the interlock between the clock signal S_c and the oscillator 12 is fast relative to the speed control of the motor 2, it is alternatively possible to use the output signal of the oscillator 12 for the motor control instead of the clock signal S_c . The crystal oscillator 15 must then be tuned to 4,2336 MHz instead of to 4,3218 MHz.

Claims

1. An apparatus for reading an optically readable disc-shaped record carrier (1) in which information comprising digital data signals and digital sub-code signals is stored, the signal read from the record carrier being applied to a demodulator circuit (5) for demodulating the information, extracting the digital data signals (DATA) and the digital subcode signals (SUB), and generating a first clock signal (S_c) which is locked to the channel-bit frequency of the signal being read, after which the digital data signal is applied to an error-correction circuit (7) which comprises a buffer register (8) into which the digital data signal is loaded with a frequency which is locked to said first clock signal and from which it is read with a frequency which is locked to a second clock signal supplied by an oscillator, said buffer register being capable of generating a filling signal (S_n) which is a measure of the instantaneous degree of filling of said buffer register, characterized in that the frequency of said oscillator (12) is controlled by said filling signal in such a sense that variations of the degree of filling of the buffer register are counteracted by variations of the read frequency which is dictated by the second clock signal.

2. An apparatus as claimed in Claim 1, characterized in that the filling signal is applied to the oscillator via a low-pass filter (13) having a bandwidth which is substantially larger than the frequency of variations in the first clock signal caused by eccentricities in the record carrier.

3. An apparatus as claimed in Claim 1 or 2, characterized in that the apparatus comprises a reference oscillator (15) for supplying a reference clock signal and a comparator circuit (14) for comparing the first clock signal with the reference clock signal for controlling the record-carrier drive.

4. An apparatus as claimed in Claim 1 or 2, characterized in that the apparatus comprises a reference oscillator for supplying a reference clock signal and a comparator circuit for comparing the second clock signal with the reference clock signal for controlling the record-carrier drive.

Patentansprüche

1. Anordnung zum Lesen eines optisch lesbaren, scheibenförmigen Aufzeichnungsträgers (1),

in dem Information gespeichert ist, die digitale Datensignale und digitale Untercodesignale enthält, mit einem Demodulator (5) zum Demodulieren des vom Aufzeichnungsträger ausgelesenen Signals, zum Extrahieren der digitalen Datensignale (DATA) und der digitalen Untercodesignale (SUB) und zum Erzeugen eines ersten Taktsignals (S_c), das mit der Kanalbitfrequenz des ausgelesenen Signals vergekoppelt ist, wonach es an eine Fehlerkorrekturschaltung (7) mit einem Pufferregister (8) gelangt, in das das digitale Datensignal mit einer mit diesem erste Taktsignal vergekoppelten Frequenz eingeschrieben und mit einer Frequenz ausgelesen wird, die mit einem von einem Oszillator gelieferten zweiten Taktsignal vergekoppelt ist, wobei dieses Pufferregister (8) zum Erzeugen eines Füllsignals (S_n) eingerichtet ist, dass ein Mass für den momentanen Füllgrad dieses Pufferregisters ist, dadurch gekennzeichnet, dass die Frequenz des Oszillators (12) von diesem Füllsignal derart gesteuert wird, dass Änderungen des Füllgrades des Pufferregisters durch Änderungen in der vom zweiten Taktsignal bestimmten Lesefrequenz gegengekoppelt werden.

2. Anordnung nach Anspruch 1, dadurch gekennzeichnet, dass das Füllsignal über ein Tiefpassfilter (13) mit einer Bandbreite, die wesentlich grösser als die Frequenz von Änderungen im ersten Taktsignal durch Exzentrizitäten um Aufzeichnungsträger ist, dem Oszillator zugeführt wird.

3. Anordnung nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass die Anordnung einen Referenzoszillator (15) zum Erzeugen eines Referenztaktsignals und eine Vergleichsschaltung (14) zum Vergleichen des ersten Taktsignals mit dem Referenztaktsignal zum Steuern des Antriebs des Aufzeichnungsträgers enthält.

4. Anordnung nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass die Anordnung einen Referenzoszillator zum Erzeugen eines Referenztaktsignals und eine Vergleichsschaltung zum Vergleichen des zweiten Taktsignals mit dem Referenztaktsignal zum Steuern des Antriebs des Aufzeichnungsträgers enthält.

Revendications

1. Appareil pour la lecture d'un support d'enregistrement en forme de disque (1) lisible par voie optique, dans lequel est stockée de l'information contenant des signaux de données numériques et des signaux de souscode numériques, le signal lu du support d'enregistrement étant appliqué à un circuit de démodulation (5) pour la démodulation de l'information, la séparation des signaux de données numériques (DATA) et des signaux de souscode numériques (SUB), et la formation d'un premier signal d'horloge (S_c), qui est couplé à la fréquence de bit de canal du signal en lecture, après quoi le signal de données numériques est appliquée à un circuit de correction d'erreur (7), comportant un registre tampon (8) dans lequel est

the clock signal S_c as a result of this eccentricity be tracked by the oscillator 12. This bandwidth is, for example, 500 Hz.

Since the interlock between the clock signal S_c and the oscillator 12 is fast relative to the speed control of the motor 2, it is alternatively possible to use the output signal of the oscillator 12 for the motor control instead of the clock signal S_c . The crystal oscillator 15 must then be tuned to 4,2336 MHz instead of to 4,3218 MHz.

Claims

1. An apparatus for reading an optically readable disc-shaped record carrier (1) in which information comprising digital data signals and digital sub-code signals is stored, the signal read from the record carrier being applied to a demodulator circuit (5) for demodulating the information, extracting the digital data signals (DATA) and the digital subcode signals (SUB), and generating a first clock signal (S_c) which is locked to the channel-bit frequency of the signal being read, after which the digital data signal is applied to an error-correction circuit (7) which comprises a buffer register (8) into which the digital data signal is loaded with a frequency which is locked to said first clock signal and from which it is read with a frequency which is locked to a second clock signal supplied by an oscillator, said buffer register being capable of generating a filling signal (S_n) which is a measure of the instantaneous degree of filling of said buffer register, characterized in that the frequency of said oscillator (12) is controlled by said filling signal in such a sense that variations of the degree of filling of the buffer register are counteracted by variations of the read frequency which is dictated by the second clock signal.

2. An apparatus as claimed in Claim 1, characterized in that the filling signal is applied to the oscillator via a low-pass filter (13) having a bandwidth which is substantially larger than the frequency of variations in the first clock signal caused by eccentricities in the record carrier.

3. An apparatus as claimed in Claim 1 or 2, characterized in that the apparatus comprises a reference oscillator (15) for supplying a reference clock signal and a comparator circuit (14) for comparing the first clock signal with the reference clock signal for controlling the record-carrier drive.

4. An apparatus as claimed in Claim 1 or 2, characterized in that the apparatus comprises a reference oscillator for supplying a reference clock signal and a comparator circuit for comparing the second clock signal with the reference-clock signal for controlling the record-carrier drive.

Patentansprüche

1. Anordnung zum Lesen eines optisch lesbaren, scheibenförmigen Aufzeichnungsträgers (1),

in dem Information gespeichert ist, die digitale Datensignale und digitale Untercodesignale enthält, mit einem Demodulator (5) zum Demodulieren des vom Aufzeichnungsträger ausgelesenen Signals, zum Extrahieren der digitalen Datensignale (DATA) und der digitalen Untercodesignale (SUB) und zum Erzeugen eines ersten Taktsignals (S_c), das mit der Kanalbitfrequenz des ausgelesenen Signals vergekoppelt ist, wonach es an eine Fehlerkorrekturschaltung (7) mit einem Pufferregister (8) gelangt, in das das digitale Datensignal mit einer mit diesem erste Taktsignal vergekoppelten Frequenz eingeschrieben und mit einer Frequenz ausgelesen wird, die mit einem von einem Oszillator gelieferten zweiten Taktsignal vergekoppelt ist, wobei dieses Pufferregister (8) zum Erzeugen eines Füllsignals (S_n) eingerichtet ist, dass ein Mass für den momentanen Füllgrad dieses Pufferregisters ist, dadurch gekennzeichnet, dass die Frequenz des Oszillators (12) von diesem Füllsignal derart gesteuert wird, dass Änderungen des Füllgrades des Pufferregisters durch Änderungen in der vom zweiten Taktsignal bestimmten Lesefrequenz gegengekoppelt werden.

2. Anordnung nach Anspruch 1, dadurch gekennzeichnet, dass das Füllsignal über ein Tiefpassfilter (13) mit einer Bandbreite, die wesentlich grösser als die Frequenz von Änderungen im ersten Taktsignal durch Exzentrizitäten um Aufzeichnungsträger ist, dem Oszillator zugeführt wird.

3. Anordnung nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass die Anordnung einen Referenzoszillator (15) zum Erzeugen eines Referenztaktsignals und eine Vergleichsschaltung (14) zum Vergleichen des ersten Taktsignals mit dem Referenztaktsignal zum Steuern des Antriebs des Aufzeichnungsträgers enthält.

4. Anordnung nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass die Anordnung einen Referenzoszillator zum Erzeugen eines Referenztaktsignals und eine Vergleichsschaltung zum Vergleichen des zweiten Taktsignals mit dem Referenztaktsignal zum Steuern des Antriebs des Aufzeichnungsträgers enthält.

Revendications

1. Appareil pour la lecture d'un support d'enregistrement en forme de disque (1) lisible par voie optique, dans lequel est stockée de l'information contenant des signaux de données numériques et des signaux de souscode numériques, le signal lu du support d'enregistrement étant appliqué à un circuit de démodulation (5) pour la démodulation de l'information, la séparation des signaux de données numériques (DATA) et des signaux de souscode numériques (SUB), et la formation d'un premier signal d'horloge (S_c), qui est couplé à la fréquence de bit de canal du signal en lecture, après quoi le signal de données numériques est appliquée à un circuit de correction d'erreur (7), comportant un registre tampon (8) dans lequel est



chargé le signal de données numériques à une fréquence qui est couplée audit premier signal d'horloge et dans lequel il est lu à une fréquence qui est couplée à un deuxième signal d'horloge amené par un oscillateur, ledit registre tampon étant conçu pour la formation d'un signal de remplissage (Sn) qui constitue une mesure pour le degré de remplissage instantané dudit registre tampon, caractérisé en ce que la fréquence dudit oscillateur (12) est commandée par ledit signal de remplissage de façon que des variations du degré de remplissage du registre tampon soient contrecarrées par des variations de la fréquence de lecture, qui est déterminée par le deuxième signal d'horloge.

2. Appareil selon la revendication 1, caractérisé en ce que le signal de remplissage est appliqué à l'oscillateur par l'intermédiaire d'un filtre passe-bas (13) présentant une largeur de bande qui est notablement supérieure à la fréquence des varia-

tions dans le premier signal d'horloge par suite d'excentricités se produisant dans le support d'enregistrement.

3. Appareil selon la revendication 1 ou 2, caractérisé en ce que l'appareil est muni d'un oscillateur de référence (15) pour fournir un signal d'horloge de référence et d'un circuit comparateur (14) pour la comparaison du premier signal d'horloge avec le signal d'horloge de référence pour la commande de l'entraînement du support d'enregistrement.

4. Appareil selon la revendication 1 ou 2, caractérisé en ce que l'appareil est muni d'un oscillateur de référence pour fournir un signal d'horloge de référence et d'un circuit comparateur pour la comparaison du deuxième signal d'horloge avec le signal d'horloge de référence pour la commande de l'entraînement du support d'enregistrement.

20

25

30

35

40

45

50

55

60

65

5

