Transmission of a digital information signal having M bit PCM samples

The invention relates to a transmitter for transmitting a digital information signal having M bit PCM samples, to a receiver- for receiving a transmission signal carrying a digital information signal from a transmission medium and generating a Q bit PCM signal therefrom, said Q bit PCM signal being a representation of said digital information signal, to a record carrier obtained with the transmitter, when in the form of an apparatus for recording information on a record carrier, and to a transmission method.

Transmitters and receivers defined above are known e.g. from USP 5,479,168. Said document describes a method for signal encoding, transmitting and decoding to provide an improved reproduction of the digital information signal having M bit samples with an receiver having said decoding method, while remaining compatible with industry standardized signal receivers not incorporating the decoding features of the invention. The transmitter analyses and encodes the digital information signal so as to obtain a modified version of the digital information signal and control codes for transmission via a transmission medium. The control codes have a relationship with characteristics of the digital information signal and the operations performed for encoding the digital information signal. The control codes are used for controlling the decoding operations and reconstruction of the characteristics of the digital information signal.

The invention aims at providing transmitters and receiver having another and less complicated method of transmitting and receiving a digital information signal having M bit PCM samples, while the transmitted signal remains compatible with industry standardized signal playback apparatuses not incorporating the receiving method of the invention, said digital information signal having a higher quality than the signal reproduced by said industry standardized playback apparatuses.

The transmitter in accordance with the invention comprises

- input means for receiving the M bit PCM signal;

- splitting means for splitting the M bit PCM signal in a representation of the digital information signal having P bit PCM samples and a difference signal being the difference between the M bit PCM signal and the P bit PCM signal, in which M > P;
- first signal combination means for combining the P bit PCM signal and the difference signal so as to obtain a transmission signal for transmission via the transmission medium.

The receiver in accordance with the invention comprises

- retrieval means for retrieving the transmission signal from the transmission medium,
- demultiplex means for deriving a P bit PCM representation of the digital information signal and a difference signal from the transmission signal,
- signal combination means for combining the P bit PCM signal and the difference signal so as to obtain a Q bit PCM signal, whereby Q > P.

The invention is based on the following recognition. The transmitter in accordance with the invention splits the digital information signal having M bit PCM samples into a representation of the digital information signal having P bit PCM samples and a difference signal. The representation of the digital information signal and the difference signal are combined to obtain the transmission signal to be transmitted. The transmission signal is transmitted via the transmission medium.

In a preferred embodiment of the transmitter, the first signal combination means are adapted to obtain a transmission signal comprising an N bit PCM signal being a version of the P bit PCM signal, whereby $N \geq P$. An advantage of said embodiment is that the thus obtained transmission signal can be received and processed by prior art receivers that are capable of receiving and processing and outputting an N bit PCM signal.

The data capacity needed to carry the difference signal is generally relatively small. Data compression may even be carried out on this difference signal so as to further decrease the needed data capacity. Therefore, the transmitter is preferably provided with data compressing means so as to decrease the data capacity needed to carry the difference signal. The data compressing means comprises preferably a psycho-acoustic encoder, removing irrelevancy and redundancy in the difference signal.

The splitting may be done by splitting the M bit PCM samples of the digital information signal into P most significant bits so as to obtain the P bit PCM signal, and M-P least significant bits so as to obtain the difference signal. In the case that $P < N$, the $N - P$ least significant bits may be used to store at least a part of the difference signal, which might be data compressed.

Buried data techniques may be used to determine a buried data channel in the P bit PCM signal for carrying at least a part of the difference signal. By using buried data techniques the perceived S/N ratio of the transmitted N bit PCM signal is approximately the same as the S/N ratio of the P bit PCM signal.

Receivers in accordance with the invention are capable of retrieving the two signal components transmitted and regenerate a reproduction of the M bit PCM digital information therefrom.

These and other objects of the invention will become apparent from and elucidated further with reference to the embodiments described in the following figure description in which

figure 1 shows a first embodiment of the transmitter,

figure 2 shows a first embodiment of the receiver,

figure 3 shows a prior art receiver for receiving the transmission signal generated by the transmitter of figure 1,

figure 4 shows a first embodiment of a splitting means of the transmitter,

figure 5 shows a third embodiment of the signal combination unit in the transmitter of figure 1,

figure 6 shows a third embodiment of the demultiplex unit in the receiver of figure 2

figure 7 shows a fourth embodiment of the signal combination unit in the transmitter of figure 1,

figure 8 shows a fourth embodiment of the demultiplex unit in the receiver of figure 2

figure 9 shows a transmitter in the form of a recording apparatus, and

figure 10 shows a receiver in the form of a reproducing apparatus,

figure 11 shows another embodiment of a transmitter in the form of a recording apparatus, and

figure 12 shows another embodiment of a receiver in the form of a reproducing apparatus.

Figure 1 shows an embodiment of the transmitter. The transmitter has an input terminal 1 for receiving a digital information signal such as a digital audio signal having M bits PCM samples. This digital information could have been obtained by supplying an analog

version of the digital information signal to an input 2 of an A/D converter 4. The A/D converter 4 samples the signal applied to its input 2 and supplies the digitized M bit samples to the input terminal 1 of the transmitter. The input terminal 1 is coupled to an input 6 of a splitting unit 8. The splitting unit is adapted to split the M bit PCM signal applied to its input into a P bit PCM signal being a representation of the digital information signal having M bit PCM samples, whereby P < M, and a difference signal, which have been obtained by subtracting the P bit PCM signal from the M bit PCM signal applied to its input 6. The P bit PCM signal and the difference signal are supplied to, respectively, a first output 10 and a second output 12 of the splitting unit 8.

As an example, M could be chosen equal to 24 and P equal to 16, so that the representation could be stored in the form of an industry standardized signal on e.g. a standard CD.

An output 12 of the splitting unit 8 is coupled to a first input 14 of a data compressing unit 16. The data compressing unit is optional and not necessary for the invention. The data compressing unit compresses the difference signal received at it first input so as to obtain a data compressed difference signal to be supplied to its output 18.

The output 10 of the splitting unit 8 is coupled to a first input 22 of the signal combination unit 24. The output 18 of the data compression unit 16 is coupled to a second input 26 of the signal combination unit 24. The signal combination unit 24 combines the signals supplied to its inputs 22 and 26 into at least one serial data stream, which is suitable for transmission via a transmission medium TRM. This signal-combining step in the combination unit 24 may include a channel-encoding step, well known in the art.

The data compressing unit 16 may comprise a standard arithmetic encoder, such as a Huffmann encoder, well known in the art. The splitting unit 8 performs a quantisation step to obtain the P bit PCM signal. The quantisation noise in the P bit PCM signal results in quantisation noise in the difference signal. That's why the difference signal has an almost white frequency spectrum. To improve the data compression, the unit 16 may comprise a psycho-acoustic model, well known in the art. Therefore, the data compression unit 16 is provided with a second input 20 coupled to the input terminal 1, to receive the M bits digital information signal. The improvement can be used to decrease the data capacity to carry the difference signal or to increase the perceptual signal to noise ratio that can be obtained by a receiver having the features of the invention.

The transmitter described above functions as follows. The digital information signal is supplied to the input terminal 1. The splitting unit separates the digital information

having M bit PCM samples into a P bit PCM signal, which is a low signal quality representation of the digital information signal and a difference signal. The difference signal comprises the signal information from the M bit PCM signal needed at the receiver side to reproduce a high quality representation of the digital information signal in the form of a M bit PCM signal, by combining the P bit PCM signal and the difference signal. The P bit PCM signal and the difference signal, if so data compressed, are combined to obtain the transmission signal for transmission via the transmission medium TRM. The transmission signal carries the P bit PCM signal such that a receiver not incorporating the features of the present invention can reproduce said signal.

The transmission medium TRM can be a broadcast channel or a record carrier, such as a magnetic or an optical record carrier. The transmission signal is transmitted via the transmission medium TRM to a receiver.

Figure 2 shows an embodiment of a receiver for receiving the transmission signal and regenerating therefrom a reproduction of the original digital information signal.

The transmission signal TRM is received via the input 60 of a demultiplex unit 62. The demultiplex unit 62 is capable of retrieving the P bit PCM signal from the transmission signal and supplies said signal to a first input 68 of a signal combination unit 70.

Another output 66 of the demultiplex unit 62 is coupled to an input 72 of a data expansion unit 74. The demultiplex unit 62 is capable of retrieving the difference signal from the transmission signal and to supply the signal so retrieved to the output 66 that is coupled to a second input 76 of the signal combination unit 70. The signal combination unit 70 combines the signals received at it first and second input so as to obtain a Q bit PCM reproduction of the original digital information signal. An output 78 of the signal combination unit 70 is coupled to an output 80 of the receiver, if required via a D/A converter 82. The receiver may in addition be provided with a second D/A converter, not shown, which has an input coupled to the output 64 of the demultiplex unit 62 and an output coupled to another output terminal, not shown.

The functioning of the receiver of figure 2 is as follows. The demultiplex unit 62 retrieves the P bit PCM signal that is a lower signal quality representation of the transmitted digital information signal and supplies said signal at the output 64.

The demultiplex unit 62 is also capable of retrieving the, if so data compressed, difference signal, and supplies said signal to output 66. If necessary, the data expansion unit 74 retrieves the data compressed difference signal at the input 72, expands this signal to obtain the difference signal and supplies said difference signal to the second

input 76 of the signal combination unit 76. The difference signal relates to signals of the digital information signal below a certain level, which are not present in the P bit PCM signal representing the M bit PCM digital information signal, and the quantisation noise introduced by the splitting unit in the transmitter. The data expansion unit 84 may comprise a psycho-acoustic decoder, which is a lossy decoder, or an entropy decoder, which is a lossless decoder, such as a Huffman decoder. These decoders are well known in the art. The signal combination unit 70 combines the P bit PCM signal and the difference signal so as to obtain the Q bit PCM signal being a reproduction of the original digital information signal and supplies the Q bit PCM to its output 78. The value of Q is related to the data expansion unit 84 used. Depending on the complexity of the data expansion unit 84, the data expansion unit is able to reconstruct the signal with a higher quality. The value Q of the Q bit PCM signal generated by the signal combination unit has a relationship with the signal quality of the reconstructed difference signal received at input 76. To generate a reproduction signal with a higher signal quality than the P bit PCM signal, at least the value of Q has to be increased. Therefore, $Q > P$. The D/A converter 82, which may be present, converts the reproduction of the digital information signal into an analog signal.

Figure 4 shows an embodiment of the splitting unit in the transmitter of figure 1. The input 6 of the splitting unit 8 receives the digital information signal having M bit PCM samples. The quantizer 4.2 performs a quantisation on the M bit PCM signal so as to obtain the P bit PCM signal being a representation of the digital information signal and supplies the P bit PCM signal to the output 10 of the splitting unit 8. The quantisation step performed can be an ordinary rounding or truncation function, but any other quantisation method can be suitable as well, including the use of noise shaping and dithering. The splitting unit is further provided with a subtraction unit 4.4 for subtracting the P bit PCM signal from the M bit PCM signal so as to obtain the difference signal. The difference signal is supplied to the output 12 of the splitting unit 8.The splitting unit may also be adapted to perform the truncation function by supplying the P most significant bits of the M bit PCM samples to output 10 and supplying the M-P least significant bit to the output 12.

The transmitter is preferably compatible with the industry standardized signal reproducing apparatuses, such as CD players. Therefor the signal combination unit 24 is adapted to generate a transmission signal having an N bit PCM signal. To be compatible with the CD standard N should be equal to 16. Therefore, the splitting unit 8 supplies preferably a P bit PCM signal, whereby $P \leq N$.

A prior art receiver, shown in figure 3, is provided with a demultiplex unit 62' which is capable of retrieving the N bit PCM signal which is a representation of the P bit representation of the digital information signal, having the N bit samples, from the transmission signal transmitted via the transmission medium TRM. The receiver has a D/A converter 82', so that analog version of the representation of the digital information signal to the output 84. In a prior art receiver a D/A converter with a less dynamic range is sufficient, there $N < M$.

A first embodiment of the signal combination unit 24 may be used in the case that $P < N$. The signal combination unit receives the P bit PCM signal at the first input 22. The samples of the P bit PCM signal are used to generate the P most significant bits of the samples from the N bit PCM signal in the transmission signal. The $N - P$ bits least significant bits in the N bit PCM signal are used to carry at least a part of the difference signal, if so data compressed, received at the second input 26 of the signal combination unit 24. A prior art receiver will reproduce the N bit PCM signal having the P bit PCM signal being a lower quality reproduction of the digital information signal. N-P least significant bits in the N bit PCM signal will be reproduced as low signal noise added to P bit PCM signal. When the N bit PCM signal has a small amplitude, said low signal noise may be audible.

A first embodiment of the demultiplex unit 62 in the receiver of figure 2 is adapted to receive a transmission signal having an N bit PCM signal. The demultiplex unit extracts the P most significant bits from the N bit PCM signal so as to obtain the P bit PCM signal for supplying to the output 64. Further, the demultiplex unit extract the $N - P$ least significant bits from the N bit PCM signal so as to obtain the difference signal, if so data compressed for supplying to the output 66.

In the following embodiments of the signal combination unit 24 in the transmitter of figure 1 and the demultiplex unit 62 in the receiver of figure 2, the units are adapted to transmit, respectively, receive a transmission signal having an N bit PCM signal, whereby N is equal to P.

A second embodiment of the signal combination unit 24 in the transmitter of figure 1, makes use of buried data techniques, well known in the art, to combined the P bit PCM signal with the difference signal, if so data compressed so as to obtain the transmission signal. The signal combination unit determines a buried data channel in the P bit PCM signal. Said buried data channel is used to carry the difference signal. In a prior art receiver the transmission signal reproduces the representation of the digital signal having the buried data channel, but the data in the buried data channel is now not perceptual.

A second embodiment of the demultiplex unit 62 in the receiver of figure 2, is adapted to derive a P bit PCM signal having a buried data channel and to derive the difference signal, if so data compressed, from the buried data channel in said P bit PCM signal.

Figure 5 shows an third embodiment of the signal combination unit 24 in the transmitter of figure 1. A channel modulation unit 5.2 receives the P bit PCM signal received at the first input 22 of the signal combination unit 24 and processes the composite signal so to obtain a sequence of m-bit channel words. Preferably the channel modulation unit comprises an n – m channel modulator. A generator unit 5.4 receives the difference signal received at the second input 26 of the signal combination unit 24 and generates p merging bits in response to said remaining portion. A unit 5.6 receives the sequence of m-bit channel words and p merging bits and inserts the p merging bits between adjacent m-bit channel word so as to obtain the transmission signal and supplies for the transmission signal to the output 28 of the signal combination unit 24 for transmission via the transmission medium TRM 32. The p merging bits are normally used to prevent (d,k) constraint violations between adjacent channel words and for the additional task of DC control. When having done this, there is still room to choose one or more of those merging bits in response to the information content of the difference signal. The generator unit to generate the merging bits uses this room.
Figure 6 shows a third embodiment of the demultiplex unit 62 in the receiver of figure 2. A unit 6.2 receives the transmission signal supplied to input 60 of the demultiplex unit 62. The transmission signal comprises a sequence of m-bit channel words with p merging bits between each time adjacent m-bit channel words. The unit 6.2 separates said transmission signal into a sequence of m-bit channel words and said p merging bits. The sequence of m-bit channel words is supplied to a channel demodulator unit 6.4 arranged for preferably m – n channel modulation to obtain the representation of the digital information signal. The representation signal which is in the form of a standard digital stereo signal having P bit PCM samples is supplied to output terminal 64. The p merging bits are supplied to a processing unit 6.6. The processing unit 6.6 is arranged for processing the p merging bits so as to obtain the difference signal, if so data compressed, for supplying to output terminal 66.

Figure 7 shows a fourth embodiment of the signal combination unit 24 in the transmitter of figure 1. A processing unit 7.2 receives the P bit PCM signal received at input 22 of the signal combination unit 24 and processes the P bit PCM signal so as to obtain a sequence of q byte blocks. The processing unit can comprise a cross-interleaved Reed-Solomon encoder. The value of q is 32 for the standard CD format. A subcode encoder 7.4

receives the difference signal, if so data compressed, supplied to its input and generates an r byte subcode in response to said difference signal. The subcode in the standard CD format is essentially an auxiliary data stream. At least one bit of said r byte subcode such as the U-subcode is obtained in response to the difference signal. An unit 7.6 receives the sequence of q byte blocks and said r byte subcode and inserts the r byte subcode between adjacent m-bit channel word to obtain a signal to be written on the record carrier 32. Preferably prior to transmitting said signal on a transmission medium in the form the record carrier, the signal is channel encoded by for example an EFM encoder.

Figure 8 shows a fourth embodiment of the demultiplex unit 62 in the receiver of figure 2. A unit 8.2 receives the transmission signal supplied to input 60 of the demultiplex unit 6. The transmission signal comprises a sequence of q byte blocks with r byte subcodes between each time adjacent q byte blocks. The unit 8.2 separates said transmission signal into a sequence of q byte blocks and said r byte subcodes. The separation is based upon the physical position of q byte blocks and the subcodes in the transmission signal. The sequence of q byte blocks is supplied to a processing unit 8.4 arranged for processing the sequence of q byte blocks so as to obtain the P bit PCM signal. The processing unit 8.4 may perform the operations Reed-Solomon decoding and de-cross-interleaving. The transmission signal, which may be in the form of a standard digital stereo signal, is supplied to output terminal 64. The r byte subcodes are supplied to a processing unit 8.6. The processing unit 8.6 is arranged for processing the r byte subcodes so as to obtain the difference signal, if so data compressed, from at least one bit of the r byte subcodes. The difference signal is supplied to output terminal 66 of the demultiplex unit 62.

Figure 9 shows the transmitter in the form of an apparatus for recording the digital information signal on a record carrier. The circuit block denoted 9.2 in figure 9 replaces the circuit diagram of figure 1. The input terminal 1 of the recording apparatus of figure 9 is thus equivalent to the input terminal 1 in figure 1, and the terminal 28 in figure 9 is equivalent to the output 28 of the signal combination unit 24 in the figure 1. The recording apparatus further comprises writing means 9.4 for writing the output signal present at the terminal 28 on the record carrier 9.8. The record carrier 9.8 can be of the magnetic type. In that case, the writing means 9.4 comprise one or more magnetic heads 9.6 for writing the information in a track on the record carrier 9.8. In another embodiment, the record carrier 9.8 is an optical record carrier. The writing means 9.4 now comprise an optical write head for writing the information in a track on the optical record carrier. In general, prior to recording,

the signal to be recorded is channel encoded, depending on the embodiment of circuit block 9,2 the writing means 9.4 comprise a channel-encoding unit.

Figure 10 shows the receiver in the form of an apparatus for reproducing the digital information signal from the record carrier. The circuit block denoted 10.4 in figure 10 replaces the circuit diagram of figure 2. The terminal 60 of the reproducing apparatus of figure 10 is thus equivalent to the input 60 of the demultiplex unit 62 in figure 2, and the output terminal 80 in figure 10 is equivalent to the output terminal 80 of the receiver of figure 2. The reproducing apparatus further comprises reading means 10.2 for reading the signal recorded on the record carrier 9.8 and for supplying the signal read out to the input 60. The record carrier 9.8 can be of the magnetic type. In that case, the reading means 10.2 comprise one or more magnetic heads 10.6 for reading the information from a track on the record carrier. In another embodiment, the record carrier 9.8 is an optical record carrier. The reading means 10.2 now comprise an optical read head for reading the information from a track on the record carrier. In general, prior to further processing the said signal, the signal, read from the record carrier, is channel decoded. In dependence of the embodiment of the receiver the reading means 10.2 comprise a channel decoding unit for channel decoding the signal read from the record carrier.

Figure 11 shows another embodiment of the transmitter in the form of an apparatus for recording the digital information signal on an optical record carrier. The transmitter of figure 11 shows a large resemblance with the transmitter of figure 1. An optical record carrier replaces the transmission medium. The signal combination unit 24 in figure 1 comprises a first writing unit 11.2 and a second writing unit 11.4. The first writing unit 11.2 is adapted to receive the P bit PCM supplied by the splitting unit 8 to it input and to write the P bit PCM in a first channel of the record carrier. The record carrier thus obtained is preferably compatible with a standard audio CD whereby the P bit PCM signal can be reproduced by a conventional CD player. In that case the value of P is preferably equal to 16. The first channel is in that case formed by optical detectable marks in a track, whereby the optically detectable marks are in the form of so-called pits. The second writing unit 11.4 is adapted to receive the difference signal supplied by the splitting unit 14, eventually via the data compression unit 16, and to write the difference signal, if so data compressed, in a second channel of the record carrier CD. The second channel may be written in the form variations of optical detectable marks transverse to the track direction such as variations of the width of the marks. In USP 5,724,327 some embodiments of the second channel are disclosed. Said document discloses variation of the position of a track on the record carrier,

variations of the width or depth of pits in the track or variations of the frequency of the recovered data clock.

An advantage of this embodiment is that it produces record carriers, for example CD's that can be used in CD playback apparatuses in accordance with the current CD standard to reproduce the P bit PCM signal being a lower quality representation of the M bit PCM digital information signal. Even CD recorders, available now, are able to read the first channel only. A copy made by said CD recorders will only contain the data in the first channel and thus only the low quality representation of the M bit PCM digital information signal. The embodiment of the transmitter provides record carrier having a copy protection for copying the high-resolution M bit PCM signal.

Optionally, the first writing unit 11.2 may be adapted to insert a first portion of the difference signal, if so data compressed, in the P bit PCM signal to be written in the first channel of the record carrier. This insertion may be done by using buried data techniques. In that case, the second writing unit is adapted to write the remaining portion of the difference signal in the second channel on the record carrier. This option increases the data capacity on the record carrier for carrying the difference signal.

Figure 12 shows another embodiment of the receiver in the form of an apparatus for reproducing an M bit PCM signal written on a record carrier. The receiver of figure 12 shows a large resemblance with the receiver of figure 2. The demultiplex unit 62 comprises a first reading unit 12.2 and a second reading unit 12.4. The first reading unit 12.2 reads the data written in the first channel on a record carrier to obtain the P bit PCM signal written in the first channel and supplies said P bit PCM signal to the first input 68 of the signal combining unit 70. Said first channel is preferably in the form of a channel carrying the N bit PCM signal on a standard CD, whereby N = 16. The second reading unit 12.4 reads the data written in a second channel on the record carrier to obtain the difference signal, if so data compressed, for supplying to a second input 76 of the signal combination unit 70. If the second channel comprises a data compressed difference signal, said compressed signal is expanded prior to supplying to the second input 76 of the signal combining unit 70. Embodiments of said second channel have already been given.

Optionally, the first reading unit may be adapted to read a first portion of the difference signal, if so data compressed from the signal read from the first channel of the record carrier CD, by using e.g. buried data techniques. The second reading unit 12.4 is in that case adapted to read the remaining portion of the difference signal from the second

channel on the record carrier. The second reading unit is further adapted to combine the first portion and the remaining portion so as to obtain the difference signal, if so data compressed.

Whilst the invention is described with reference to preferred embodiments thereof, it is to be understood that these are not limitative examples. Thus various modifications may become apparent to those skilled in the art, without departing from the scope of the invention, as defined by the claims. As an example, the difference signal, if so data compressed may be split into a first portion and a remaining portion, the first portion may be stored in the buried data channel, while the remaining portion may be stored in e.g. the merging bits or the userbits. A copy protection can be realized with the invention easily. Therefore, the difference signal may be scrambled with a key. The scrambled signal may be inserted in the buried data signal and stored in the first channel on the record carrier, while the scramble key is stored in the second channel on the record carrier. By doing this the scrambled signal can be read and copied by now a days recording apparatuses, but the key cannot be read and thus not be copied. The copied record carriers carry the scrambled signal, but do not carry the scrambling key. By missing said scrambling key, a reproducing apparatus in accordance with the invention will not be able to unscramble the scrambled signal carrying the difference signal and thus not be able to reproduce a higher quality reproduction signal of the M bit PCM the digital information signal then the read P bit PCM signal.

Furthermore, the difference signal may be in the form of a scalable signal. This has the advantage that the digital information signal can be retrieved from the transmission signal by receivers having a different complexity. The complexity of the means to retrieve the difference signal determines the quality of the reproduced digital information signal. For example, if a data compressed difference signal is transmitted, some portions of said digital will not be used by a less complex decoder to generate the difference signal. This will finally result in a reproduced digital information signal having a signal quality that is lesser than the signal quality of the original M bit digital information signal.

The word 'comprising' does not exclude the presence of other elements or steps than those listed in a claim. Any reference signs do not limit the scope of the claims. The invention can be implemented by means of both hardware and software. Several “means may be represented by the same item of hardware. Further the invention lies in each and every novel feature or combination of features.

CLAIMS:

1. Transmitter for transmitting a digital information signal having M bit PCM samples via a transmission medium, the transmitter comprising
- input means for receiving the M bit PCM signal;
- splitting means for splitting the M bit PCM signal in a representation of the digital information signal having P bit PCM samples and a difference signal being the difference between the M bit PCM signal and the P bit PCM signal, in which $M > P$;
- first signal combination means for combining the P bit PCM signal and the difference signal so as to obtain a transmission signal for transmission via the transmission medium,
characterized in that data compression means are provided for data compressing the difference signal so as to obtain a data compressed difference signal, the first signal combination means being adapted to combine the P bit PCM signal and the data compressed difference signal so as to obtain said transmission signal for transmission via the transmission medium.

2. Transmitter as claimed in claim 1, characterized in that first signal combination means are adapted to obtain a transmission signal comprising an N bit PCM signal being a version of the P bit PCM signal, whereby $N \geq P$.

3. Transmitter as claimed in claim 1 or 2, characterized in that the splitting means are adapted to split the M bit PCM signal into P most significant bits (MSB) of said M bit PCM signal to obtain the P bit PCM signal and M-P least significant bits (LSB) of said M bit PCM signal to obtain the difference signal.

4. Transmitter as claimed in claim 2 or 3, in which $N > P$, characterized in that the signal combination means are adapted to insert at least a part of the difference signal (if so, data compressed) in the N-P least significant bits of the N bit PCM signal.

5. Transmitter as claimed in any of the preceding claims, characterized in that the first signal combination means are adapted to insert at least a part of the difference signal (if

so, data compressed) in a buried data channel in the P bit signal so as to obtain said transmission signal for transmission via the transmission medium.

6. Transmitter as claimed in anyone of the claims 1 to 5, characterized in that the data compression means comprise a psycho-acoustic encoder, whereby the psycho-acoustic encoder is adapted for data compressing the difference signal in dependence of the digital information signal so as to obtain the data compressed difference signal.

7. Transmitter as claimed in anyone of the claims 1 to 5, wherein the data compression means comprises entropy-encoding means.

8. Transmitter as claimed in claim 7, wherein said entropy encoding means are in the form of a Huffman encoder.

9. Transmitter as claimed in anyone of the preceding claims, the transmitter being in the form of an apparatus for recording the digital information signal on a record carrier.

10. Transmitter as claimed in anyone of the preceding claims, characterized in that the transmitter further comprises channel-encoding means for channel encoding the transmission signal prior to transmission.

11. Record carrier obtained with the transmitter as claimed in claim 9 or 10.

12. Record carrier as claimed in claim 11, wherein the record carrier is of the optical or magnetic recording type.

13. Receiver for receiving a transmission signal carrying a digital information signal from a transmission medium and generating a Q bit PCM signal therefrom, said Q bit PCM signal being a representation of said digital information signal, the receiver comprising
- retrieval means for retrieving the transmission signal from the transmission medium,
- demultiplex means for deriving P bit PCM representation of the digital information signal

and a difference signal from the transmission signal,

- signal combination means for combining the P bit PCM signal and the difference signal so as to obtain the Q bit PCM signal, whereby Q > P,

- output means for supplying the Q bit PCM signal

characterized in that the demultiplex means being adapted to retrieve a difference signal which is data compressed from the transmission signal, the receiver further being provided with data expansion means so as to obtain a difference signal which is data expanded.

14. Receiver as claimed in claim 13, characterized in that the demultiplex means are adapted to extract the P bit PCM representation from an N bit representation of the digital information signal, whereby $N \geq P$.

15. Receiver as claimed in claim 14 in which $N > P$, characterized in that the demultiplex means are adapted to extract the N-P least significant bits of N bit PCM signal so as to obtain at least a part of the difference signal (if so, data compressed).

16. Receiver as claimed in claim 13, 14 or 15, characterized in that the demultiplexing means are adapted to retrieve at least a part of the difference signal (if so, data compressed) from a buried data channel in the P bit PCM signal.

17. Receiver as claimed in anyone of the claims 13 to 16, wherein the data expansion means comprise psycho-acoustic decoding means.

18. Receiver as claimed in anyone of the claims 13 to 16, wherein the data expansion means comprise entropy-decoding means.

19. Receiver as claimed in claim 18, wherein said entropy decoding means comprise a Huffman decoder.

20. Receiver as claimed in any one of the claims 13 to 19, characterized in that it further comprises channel decoding means accommodated between the retrieval means and the demultiplex means.

21. Method of transmitting a digital information signal having M bit PCM samples via a transmission medium, the transmitter comprising the steps of
- receiving the M bit PCM signal;
- splitting the M bit PCM signal in a P bit PCM signal being a representation M bit PCM signal and a difference signal being the difference between M bit PCM signal and the P bit PCM signal, in which M > P;
- combining the P bit PCM signal and the difference signal so as to obtain a transmission signal for transmission via the transmission medium.
characterized in that that method further comprises the step of data compressing the difference signal so as to obtain a data compressed difference signal, and wherein the combining step is adapted to combine the P bit PCM signal and the data compressed difference signal so as to obtain said transmission signal for transmission via the transmission medium.

22. Method as claimed in claim 21, characterized in that the combining step obtains a transmission signal comprising an N bit PCM signal being a version of the P bit PCM signal, in which $N \geq P$.

23. Method as claimed in claim 21 or 22, characterized in that the splitting step split the M bit PCM signal into P most significant bits (MSB) of said M bit PCM signal so as to obtain the P bit PCM signal, and into M-P least significant bits (LSB) so as to obtain the difference signal.

24. Method as claimed in claim 22 or 23 in which N > P, characterized in that the combining step inserts at least a part of the difference signal (if so, data compressed) in the N-P least significant bits of the N bit PCM signal so as to obtain said transmission signal for transmission via the transmission medium.

25. Method as claimed in claim 21 to 24, characterized in that the combination step inserts at least a part of the difference signal (if so, data compressed) in a buried data channel in the P bit PCM signal so as to obtain the transmission signal.

26. Method as claimed in anyone of the claims 21 to 25, characterized in that the data compression step comprises the step of psycho-acoustic encoding the difference signal in dependence of the digital information signal so as to obtain the data compressed difference signal.