

Encoding of a plurality of information signals.

Various prior art transmission systems have been described in which a multi channel information signal, such as a multi channel audio signal, is transmitted via a transmission medium. Generally, use is made of matrixing in order to obtain first and second composite audio signals that can be retrieved upon reception and reproduced as a stereo audio signal. Reference is made in this respect to EP 678,226 A1, which is document (8) in the list of related documents.

The present invention, however, is not restricted to a transmission of multi channel information signals in matrixed form.

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Upon encoding, the various information signals of the multi channel information signal are data compressed and combined into one serial datastream and subsequently transmitted via the transmission medium. Upon reception of the transmitted data, the various data compressed information signals are retrieved and data expanded so as to obtain replicas of the original information signals.

Compression means for bit rate reducing a signal has been described in published European patent applications 457,390A1 (PHN 13.328) and 457,391A1 (PHN 13.329), the documents (7a) and (7b) respectively in the list of references. Further, reference is made to two ISO/IEC standard documents, the documents (9) and (10) in the list of related documents, referred to as MPEG-1 and MPEG-2 standard documents.

The documents cited above generally relate to data compression based on subband coding. The invention is however not restricted to data compression based on subband coding. Other data compression techniques, such as transform coding, are equally well applicable.

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The invention aims at providing further improvements to an encoder apparatus for encoding a plurality of information signals.

In accordance with the invention, the apparatus for encoding a plurality of

- digital information signals, having at least
- first input means for receiving a first digital information signal,
 - second input means for receiving a second digital information signal,
 - first signal combination means for combining at least the first and second digital
- 5 information signal and being adapted to generate a first combination signal,
- first and second data compression means for data compressing the first and second digital information signal so as to obtain first and second data reduced digital information signals,
 - first, second and third masked threshold determining means for determining first, second and third masked thresholds respectively from the first, second digital information signals
- 10 and the first combination signal respectively,
- first selection means for deriving one masked threshold from at least the first and third masked threshold so as to obtain a first selected masked threshold, the first data compression means being adapted to carry out a data compression step on the first digital information signal in response to said first selected masked threshold,
- 15 - formatting means for combining the first and second data reduced digital information signals into a transmission signal suitable for transmission via a transmission medium.

The invention is based on the following recognition. The invention resides in the objective to provide a multi channel encoding apparatus which enables an undistorted decoding in a corresponding decoding apparatus. The encoder apparatus encodes the multi

20 channel signals and the encoded multi channel signals will be received in the decoder apparatus. This decoder apparatus may generally be capable of carrying out a matrixing procedure so as to obtain at least one combination signal. In a 2-channel decoding apparatus, matrixing results in the generation of two combination signals that can be reproduced as a stereo signal via two loudspeakers positioned in a stereo setup. Experiments revealed that

25 during decoding sometimes a noise component became audible. Investigations resulted in the recognition that those noise components became apparent because of the matrixing process. More specifically, the noise components originated from quantisation noise that was masked before the matrixing step could not be masked thereafter. By selecting another masked threshold, this problem could be solved. More specifically, during encoding an

30 information signal, a choice is made for the masked threshold with which the information signal in question must be data reduced. The choice is made between at least two masked thresholds, one of which is the masked threshold derived from the information signal itself and one of which is the masked threshold derived from another signal, such as that combination signal that includes the information signal in question.

The problems identified above occur in various transmission systems, such as in transmitting a stereo audio signal. The left hand signal component (L) and the right hand signal component (R) of the stereo audio signal are data compressed and subsequently transmitted. Upon reception, the data compressed left and right hand signal components are data expanded and combined so as to obtain a mono signal. Quantisation noise may become audible in the mono signal without applying the measure in accordance with the invention.

In a 3-channel encoding apparatus, a left hand signal component (L), a right hand signal component (R) and a centre signal component (C) of the 3-channel audio signal are data compressed and subsequently transmitted. Upon reception, the data compressed left and right hand signal components and the centre signal component are data expanded. The left hand signal component and the centre signal component are subsequently combined so as to obtain a composite left signal component and the right hand signal component and the centre signal component are combined so as to obtain a composite right hand signal component. Quantisation noise may become audible in both composite signal components without applying the measure in accordance with the invention.

In a 4-channel encoding apparatus, a left hand signal component (L), a right hand signal component (R), a centre signal component (C) and a surround signal component (S) of the 4-channel audio signal are data compressed and subsequently transmitted. Upon reception, the data compressed left and right hand signal components, the centre signal component and the surround signal component are data expanded. The left hand signal component, the centre signal component and the surround signal component are subsequently combined so as to obtain a composite left signal component and the right hand signal component, the centre signal component and the surround signal component are combined so as to obtain a composite right hand signal component. Quantisation noise may become audible in both composite signal components without applying the measure in accordance with the invention.

In a 5-channel encoding apparatus, a left hand signal component (L), a right hand signal component (R), a centre signal component (C), a surround left signal component (S_l) and a surround right signal component (S_r) of the 5-channel audio signal are data compressed and subsequently transmitted. Upon reception, the data compressed left and right hand signal components, the centre signal component and the surround left and right signal components are data expanded. The left hand signal component, the centre signal component and the surround left signal component are subsequently combined so as to obtain a composite left signal component and the right hand signal component, the centre signal

component and the surround right signal component are combined so as to obtain a composite right hand signal component. Quantisation noise may become audible in both composite signal components without applying the measure in accordance with the invention.

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

figure 1 shows part of a first embodiment of the encoder apparatus for encoding
10 a first and a second digital information signal,

figure 2 shows another part of the encoder apparatus of figure 1, and a corresponding decoder apparatus for decoding the first and second data reduced digital information signals,

figure 3 shows part of a second embodiment of the encoder apparatus in
15 accordance with the invention, for encoding a first, second and a third digital information signal,

figure 4 shows another part of the embodiment of figure 3, and a corresponding decoder apparatus,

figure 5 shows part of a third embodiment of the encoder apparatus, for
20 encoding four digital information signals,

figure 6 shows another part of the encoder apparatus of figure 5, and a corresponding decoder apparatus,

figure 7 shows part of a fourth embodiment of the encoder apparatus, for encoding five digital information signals,

25 figure 8 shows another part of the encoder apparatus of figure 7, and a corresponding decoder apparatus, and

figure 9 shows the encoder apparatus included in a recording arrangement.

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Figure 1 shows a portion of a first embodiment of the encoder apparatus and figure 2 shows another portion of the encoder apparatus of figure 1. The encoder has a first input terminal 1 for receiving a first digital information signal, such as the left signal component L of a stereo audio signal, and a second input terminal 2 for receiving a second digital information signal, such as the right signal component R of the stereo audio signal.

The input terminal 1 is coupled to inputs of a first data compressor unit 12.1 and a first masked threshold determining unit 14.1 and to an input of a signal combination unit 10. The input terminal 2 is coupled to inputs of a second data compressor unit 12.2 and a second masked threshold determining unit 14.2 and to another input of the signal combining unit 10. An output of the signal combining unit 10 is coupled to a third masked threshold determining unit 14.3.

Outputs of the data compressor units 12.1 and 12.2 are coupled to corresponding inputs of a signal combining unit 18. The encoder apparatus is further provided with selection units 16.1 and 16.2. The selection unit 16.1 has inputs coupled to the outputs of the masked threshold determining units 14.1 and 14.3 and the selection unit 16.2 has inputs coupled to the outputs of the masked threshold determining units 14.2 and 14.3.

The encoder apparatus functions as follows. In the present embodiment, the signal combination unit 10 combines the signals L and R by adding them in order to obtain a combination signal M, that is:

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$$M = L + R. \quad (\text{Eq.1})$$

The masked threshold determining units 14.1, 14.2 and 14.3 generate a masked threshold mt_1 , mt_2 and mt_3 respectively, from the signals L, R and M respectively, applied to their respective inputs. The masked thresholds are required to enable a data compression step to be carried out on the two information signals in the data compression units 12.1 and 12.2. The generation of a masked threshold from an information signal is well known in the art and needs no further explanation. For a further description, reference is made to various prior art documents.

One data compression technique for realizing a data compression on the two information signals is the subband coding data compression technique, as applied in MPEG-1 and MPEG-2 and DAB. Documents describing the subband coding data compression technique are the documents (3), (4), (6), (7a), (7b), (9) and (10). In this data compression technique, signal components in the information signal lying below a masked threshold are left out.

In accordance with the prior art, the masked threshold derived from the first digital information signal L, that is the masked threshold mt_1 derived in the masked threshold determining unit 14.1, is used for data compressing this first digital information signal L, and the masked threshold derived from the second digital information signal R, that is the

masked threshold mt_2 derived in the masked threshold determining unit 14.2, is used for data compressing this second digital information signal. In accordance with the present invention, however, a selection is made between two masked thresholds for each of the two information signals L and R, for the reason explained hereafter.

5 Figure 2 shows not only a portion of the encoder apparatus, but also a corresponding decoder apparatus. The decoder apparatus comprises a demultiplexer unit 30 for receiving the transmission signal transmitted via the transmission medium TRM. The demultiplexer unit 30 retrieves the data compressed first and second digital signals from the transmission signal and supplies the data compressed digital signals to respective data
10 expander units 32.1 and 32.2. In the data expander units 32.1 and 32.2, the data compressed digital information signals are expanded so as to obtain replicas L' and R' respectively, of the original digital information signals L and R. The decoder apparatus further comprises a signal combination unit 34 for combining the replicas L' and R' so as to obtain a combination signal M', in accordance with

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$$M' = L' + R'. \quad (\text{Eq.2})$$

Let us assume for the moment that the signals L and R have been data compressed on the basis of mt_1 and mt_2 respectively. Actually, however, the following
20 relationship exists:

$$M' = L + N_L + R + N_R. \quad (\text{Eq.3})$$

where N_L is the quantisation noise introduced by data compressing the signal L using the
25 masked threshold mt_1 and N_R is the quantisation noise introduced by data compressing the signal R using the masked threshold mt_2 . Generally, the noise component N_L is masked by the signal L and the noise component N_R is masked by the signal R, so that the quantisation noise is inaudible. Suppose however that R and L are roughly of the same amplitude, but of opposite phase. As a result of this, the signal component $L+R$ is small. As N_L and N_R are
30 uncorrelated to each other, they add up, and the noise components N_L+N_R will become audible.

In order to overcome this, the selection units 16.1 and 16.2 are provided. The selection unit 16.1 determines which of the masked thresholds mt_1 and mt_2 supplied to its inputs is the smallest and supplies the smallest masked threshold to the data compression unit

12.1. In the same way, the selection unit 16.2 determines which of the masked thresholds mt_2 and mt_3 supplied to its inputs is the smallest and supplies the smallest masked threshold to the data compression unit 12.2.

By supplying the smallest of the masked thresholds mt_1 and mt_3 to a data compressor unit 12.1, it is guaranteed that upon reception and decoding both replicas L' and M' will maintain their audio quality as their original ones. With respect to the replica L' , this is obvious as, if the masked threshold mt_1 is used, this is the masked threshold of L , so that it masks the quantization noise in L' . When the masked threshold mt_3 had been chosen, because this masked threshold was lower than mt_1 , this masked threshold will also mask the quantization noise in L' . More specifically, an extra margin is introduced between the level of audibility and the actual noise level of L' .

With respect to the replica M' , the following reasoning applies. Suppose that the masked threshold mt_3 of the signal M is lower than the other two masked thresholds, mt_1 and mt_2 . That means that L and R are compressed under the influence of the masked threshold mt_3 and the quantization noise in M' is masked by the masked threshold mt_3 . Suppose now that either mt_1 , or mt_2 or both were lower than mt_3 . This again results in an extra margin between audibility and the actual noise level in the signal M' so that noise components remain inaudible.

With respect to the replica R' , the same reasoning applies as given above for the replica L' .

A better look at eq. (3) shows that, depending on the actual used masked thresholds and the actual applied compression, a noise component can result which is twice the level of the given masked threshold induced by M . This situation occurs if the levels of both N_L and N_R reach the level of masked threshold induced by M . In fact, if N_L and N_R are also fully correlated, the total level may be four times the allowed masked threshold induced by M . Usually, N_L and N_R will be uncorrelated and thus a realistic worst case overshoot of $10 \cdot \log 2$, which is roughly 3 dB, may occur.

To circumvent this problem, the two selection units check each others selection results. If both selection units select mt_3 as the selected masked threshold, they may be capable of both applying an extra decrease of a predetermined number of dB to the masked threshold mt_3 and supply the masked threshold thus obtained as the selected masked threshold to their outputs. This predetermined number could be chosen to be value lying in the range from 0 dB to 3 dB.

It should be remarked that the spread in accuracy in measuring human hearing

capabilities is generally larger than the 3 dB mentioned above. As a consequence, this above introduced decrease of the masked threshold might be omitted in practical realisations.

Alternatively, the decrease can be applied as a kind of safety margin.

The masked threshold is used in a data compression unit, such as the data
5 compression units 12.1 and 12.2, to realize the data compression. From prior art documents it can be understood that bitallocation information can be derived from the masked threshold supplied to a data compression unit. The bitallocation information is an indication by how many bits per sample, the samples in a subband or transform signal are quantized. It will be clear that this bitallocation information can be transmitted as well via the transmission
10 medium as instruction signal so as to instruct the data expansion units 32.1 and 32.2 to carry out their data expansion steps in a correct way so as to regenerate the replicas of the two information signals L' and R'.

The encoder apparatus may further comprise a user interface 21 for generating an enable control signal in response to a user actuating the user interface. The enable control
15 signal is supplied to the selection units 16.1 and 16.2 and enables the selection units so that they carry out their functioning as described above. When disabled, the selection unit 16.1 supplies the masked threshold signal mt_1 to its output and the selection unit 16.2 supplies the masked threshold mt_2 to its output. The enable control signal is also supplied as a flag signal to the combination unit 18, for combining the flag signal into the transmission signal for
20 transmission via the transmission medium TRM.

A correspondingly equipped decoder apparatus is capable of retrieving the flag signal from the transmission medium. When present in the transmission signal, the flag signal is an indication that the encoding took place in the way as described above, including the selection of the masked thresholds. The decoder now knows that it can generate the
25 combination signal M, without the risk of artifacts in the signal M. When the flag is absent, this is an indication that no selection of masked thresholds took place upon encoding. The decoding apparatus may issue a warning signal, indicating that, if the combination signal is to be generated, such combination signal may be affected with artifacts.

Figure 3 shows part of a second embodiment of the encoder apparatus, where
30 figure 4 shows another part of the encoder apparatus and a corresponding decoder apparatus for decoding the encoded information signals. The encoder has a first input terminal 1 for receiving a first digital information signal, such as the left signal component L of a three channel digital audio signal, a second input terminal 2 for receiving a second digital information signal, such as the centre signal component of the three channel audio signal,

and a third input terminal 3 for receiving a third digital information signal, such as the right signal component R of the three channel audio signal. The input terminal 1 is coupled to inputs of a first data compressor unit 12.1 and a first masked threshold determining unit 14.1 and to an input of a first signal combination unit 10.1. The input terminal 2 is coupled to
 5 inputs of a second data compressor unit 12.2 and a second masked threshold determining unit 14.2, to another input of the first signal combining unit 10.1 and to an input of a second signal combination unit 10.2. The input terminal 3 is coupled to inputs of a third data compressor unit 12.3 and a masked threshold determining unit 14.4 and to another input of the second signal combining unit 10.2. An output of the signal combining unit 10.1 is
 10 coupled to a third masked threshold determining unit 14.3 and an output of the signal combining unit 10.2 is coupled to a fifth masked threshold determining unit 14.5

Outputs of the data compressor units 12.1, 12.2 and 12.3 are coupled to corresponding inputs of a signal combining unit 18.1. The encoder apparatus is further provided with selection units 16.1, 16.2 and 16.3. The selection unit 16.1 has inputs coupled
 15 to the outputs of the masked threshold determining units 14.1 and 14.3, the selection unit 16.2 has inputs coupled to the outputs of the masked threshold determining units 14.2, 14.3 and 14.5 and the selection unit 16.3 has inputs coupled to the outputs of the masked threshold determining units 14.4 and 14.5.

The encoder apparatus functions as follows. In the present embodiment, the
 20 signal combination unit 10.1 combines the signals L and C in order to obtain a first combination signal L_0 , that satisfies the following equation:

$$L_0 = L + C. \quad (\text{Eq.4a})$$

25 Further, the signal combination unit 10.2 combines the signals R and C in order to obtain a second combination signal R_0 , that satisfies the following equation:

$$R_0 = R + C. \quad (\text{Eq.4b})$$

30 The masked threshold determining units 14.1, 14.2, 14.3, 14.4 and 14.5 generate a masked threshold mt_1 , mt_2 , mt_4 , mt_3 and mt_5 respectively, from the signals L, C, L_0 , R and R_0 respectively, applied to their respective inputs. The masked thresholds are required to enable a data compression step to be carried out on the three information signals in the data compression units 12.1, 12.2 and 12.3. The generation of a masked threshold

from an information signal is well known in the art as explained above.

In accordance with the prior art, the masked threshold derived from the first digital information signal L, that is the masked threshold mt_1 derived in the masked threshold determining unit 14.1, is used for data compressing this first digital information signal L. In a similar way, the masked threshold derived from the second digital information signal C, that is the masked threshold mt_2 derived in the masked threshold determining unit 14.2, is used for data compressing this second digital information signal. Further, the masked threshold derived from the third digital information signal R, that is the masked threshold mt_4 derived in the masked threshold determining unit 14.4, is used for data compressing this second digital information signal R.

In accordance with the present invention, however, a selection is made between masked thresholds in the selection units 16.1, 16.2 and 16.3. More specifically, the selection unit 16.1 selects between the masked thresholds mt_1 and mt_3 , the selection unit 16.2 selects between the masked thresholds mt_2 , mt_3 and mt_5 and the selection unit 16.3 selects between the masked thresholds mt_4 and mt_5 , for the reason explained hereafter.

Figure 4 shows not only a portion of the encoder apparatus, but also a corresponding decoder apparatus. The decoder apparatus comprises a demultiplexer unit 30.1 for receiving the transmission signal transmitted via the transmission medium TRM. The demultiplexer unit 30.1 retrieves the data compressed first, second and third digital signals from the transmission signal and supplies the data compressed digital signals to respective data expander units 32.1, 32.2 and 32.3. In the data expander units 32.1, 32.2 and 32.3, the data compressed digital information signals are expanded so as to obtain replicas L', R' and C' respectively, of the original digital information signals L, R and C, respectively. The decoder apparatus further comprises a signal combination unit 34.1 for combining the replicas L' and C' so as to obtain a combination signal L_0' , in accordance with

$$L_0' = L' + C'. \quad (\text{Eq.5})$$

Let us assume for the moment that the signals L and C have been data compressed on the basis of mt_1 and mt_2 respectively. Actually, however, the following relationship exists:

$$L_0' = L + N_L + C + N_C. \quad (\text{Eq.6})$$

where N_L is the quantisation noise introduced by data compressing the signal L using the masked threshold mt_1 and N_C is the quantisation noise introduced by data compressing the signal C using the masked threshold mt_2 . Generally, the noise component N_L is masked by the signal L and the noise component N_C is masked by the signal C , so that the quantisation noise is inaudible. Suppose however that L and C are roughly of the same amplitude, but of opposite phase. As a result of this, the signal component $L+C$ is small and the noise components N_L+N_C may become audible.

In order to overcome this, the selection unit 16.1 determines which of the masked thresholds mt_1 and mt_3 supplied to its inputs is the smallest and supplies the smallest masked threshold to the data compression unit 12.1. Further, the selection unit 16.3 determines which of the masked thresholds mt_4 and mt_5 supplied to its inputs is the smallest and supplies the smallest masked threshold to the data compression unit 12.3 for data compressing R .

The selection unit 16.2 determines which of the masked thresholds mt_2 , mt_3 and mt_5 supplied to its inputs is the smallest and supplies the smallest masked threshold to the data compression unit 12.2 for data compressing C , for the following reasoning. The signal C appears in both equations (4a) and (4b). The minimum of the masked thresholds of L_0 and C should be used according to eq. (4a), whilst eq. (4b) requires that the smallest of the masked thresholds of R_0 and C should be used. Consequently, the smallest of the masked thresholds of L_0 , R_0 and C should be used for compressing C .

The masked threshold is used in a data compression unit, such as the data compression units 12.1, 12.2 and 12.3, to realize the data compression. As has been argued above, bitallocation information can be derived from the masked threshold supplied to a data compression unit. The bitallocation information is an indication by how many bits per sample, the samples in a subband signal are quantized. It will be clear that this bitallocation information can be transmitted as well via the transmission medium as instruction signal so as to instruct the data expansion units 32.1, 32.2 and 32.3 to carry out their data expansion steps in a correct way so as to regenerate the replicas of the information signals L' , C' and R' .

In a further elaborated version of the encoder apparatus of figure 3 and 4, the signal combination unit 10.1 combines the signals L and C in order to obtain a first combination signal L_0 , that satisfies the following equation:

$$L_0 = L + a.C. \quad (\text{Eq. 7a})$$

Further, the signal combination unit 10.2 combines the signals R and C in order to obtain a second combination signal R_0 , that satisfies the following equation:

$$R_0 = R \pm a.C, \quad (\text{Eq. 7b})$$

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where a may be negative.

In this version of the encoder apparatus, the masked threshold determining unit 14.2 is adapted to generate a masked threshold mt_2' which is the masked threshold for the signal a.C. One could obtain the masked threshold mt_2' in another way, namely by
10 multiplying mt_2 (which is considered to be the masked threshold of the signal C) by $|a|$, where flag|a| is the absolute value of a. The masked threshold mt_2' is supplied by the determining unit 14.2 to the selection unit 16.2 and the selection unit 16.2 compares the masked thresholds mt_2' , mt_3 and mt_5 with each other.

Selection is realized in the following manner. Suppose that mt_2' is the smallest
15 masked threshold of the masked thresholds supplied to the selection unit 16.2. In that situation, the masked threshold mt_2 is used for data compressing C. If mt_3 is the smallest masked threshold, the masking effect of the signal L_0 is used for data compressing C in the following way: the masked threshold of the signal L_0 divided by $|a|$ is determined and used for data compressing C. Alternatively, mt_3 divided by $|a|$ is used as the masked threshold
20 for data compressing C.

If mt_5 is the smallest masked threshold, the masking effect of the signal R_0 is used for data compressing C in the following way: the masked threshold of the signal R_0 divided by $|a|$ is determined and used for data compressing C. Alternatively, mt_5 divided by $|a|$ is used as the masked threshold for data compressing C.

25 The selection units 16.1 to 16.3 may further be adapted to subtract a predetermined number of dB, in the case that two of them select the same masked threshold, as described above with reference to the embodiment of the figures 1 and 2.

The encoder apparatus of the figures 3 and 4 may further be provided with the user interface 21 (not shown in the figures 3 and 4) described in figure 1 for generating the
30 enable control signal and may be adapted to transmit the flag signal so as to indicate that the signal transmitted was encoded in the way in accordance with the invention (including the selection of the masked thresholds), which means that the flag is present in the transmitted signal, or so as to indicate that no such selection took place (flag absent).

Figure 5 shows part of a third embodiment of the encoder apparatus, where

figure 6 shows another part of the encoder apparatus of figure 5 and further shows a corresponding decoder apparatus for decoding the encoded information signals. The encoder of the figures 5 and 6 shows a large resemblance with the encoder apparatus of the figures 3 and 4. Compared with the encoder apparatus of the figures 3 and 4, the encoder apparatus of the figures 5 and 6 further comprise a fourth input 4 for receiving a fourth digital information signal S, which is the surround signal component of a four channel surround audio signal.

The input terminal 4 is coupled to inputs of a fourth data compressor unit 12.4 and a sixth masked threshold determining unit 14.6. The input terminal 4 is also coupled to additional inputs of the first and second signal combination units 10.3 and 10.4 respectively. An output of the masked threshold determining unit 14.6 is coupled an input of a fourth selection unit 16.4. The selection unit 16.4 has two further inputs coupled to the outputs of the masked threshold determining units 14.3 and 14.4. Further, the output of the data compression unit 12.4 is coupled to a further input of the signal combining unit 18.2.

The encoder apparatus functions as follows. In the present embodiment, the signal combination unit 10.3 combines the signals L, C and S in order to obtain a first combination signal L_0 , that satisfies the following equation:

$$L_0 = L + C + S. \quad (\text{Eq. 8a})$$

Further, the signal combination unit 10.4 combines the signals R, C and S in order to obtain a second combination signal R_0 , that satisfies the following equation:

$$R_0 = R + C + S. \quad (\text{Eq. 8b})$$

The masked threshold determining units 14.1, 14.2, 14.3, 14.4 and 14.5 again generate a masked threshold mt_1 , mt_2 , mt_3 , mt_4 and mt_5 respectively, from the signals L, C, L_0 , R and R_0 respectively, applied to their respective inputs. Further, the unit 14.6 generates a masked threshold mt_6 from the signal S applied to its input.

The selection of the masked thresholds in the selection units 16.1, 16.2 and 16.3 is the same as explained above in the description with reference to the figures 3 and 4. The selection of the masked threshold in the selection unit 16.4 is such that it selects the smallest one of the masked thresholds mt_3 , mt_5 and mt_6 applied by the determining units 14.3, 14.5 and 14.6 respectively.

Figure 6 shows not only a portion of the encoder apparatus of figure 5, but also a corresponding decoder apparatus. The decoder apparatus shows large resemblances with the decoder apparatus of figure 4. The demultiplexer unit 30.2 also retrieves the data compressed fourth digital signals from the transmission signal and supplies the data compressed digital
 5 signal to a corresponding data expander unit 32.4. In the data expander unit 32.4, the fourth data compressed digital information signal is expanded so as to obtain a replica S' of the fourth digital information signal S. The signal combination unit 34.3 combines the replicas L', C' and S' so as to obtain a combination signal L₀'', in accordance with

$$10 \quad L_0'' = L' + C' + S'. \quad (\text{Eq.9a})$$

The signal combination unit 34.4 combines the replicas R', C' and S' so as to obtain a combination signal R₀'', in accordance with

$$15 \quad R_0'' = R' + C' + S'. \quad (\text{Eq.9b})$$

Where necessary, bitallocation information derived from the masked thresholds selected can be supplied to the signal combining unit 18.2 and transmitted.

In a further elaborated version of the encoder apparatus of figure 5 and 6, the
 20 signal combination unit 10.3 combines the signals L, C and S in order to obtain a first combination signal L₀, that satisfies the following equation:

$$L_0 = L + a.C + b.S. \quad (\text{Eq.10a})$$

25 Further, the signal combination unit 10.4 combines the signals R, C and S in order to obtain a second combination signal R₀, that satisfies the following equation:

$$R_0 = R + a.C \pm b.S. \quad (\text{Eq.10b})$$

30 a and b are positive or negative integers.

In this version of the encoder apparatus, the masked threshold determining units 14.2 and 14.6 function differently. The determining unit 14.2 generates a masked threshold mt₂'. The masked threshold mt₂' is the masked threshold for the signal a.C. One could obtain the masked threshold mt₂' in another way, namely by multiplying mt₂ (which is the

masked threshold of the signal C) by $|a|$, where $|a|$ is the absolute value of a . The selection unit 16.2 now compares the masked thresholds mt_2' , mt_3 and mt_5 with each other and generates a selected masked threshold in the following way.

Suppose that mt_2' is the smallest masked threshold. In that situation, the masked threshold mt_2 is used for data compressing C. If mt_3 is the smallest masked threshold, the masking effect of the signal L_0 is used

for data compressing C in the following way: the masked threshold of the signal L_0 divided by $|a|$ is determined and used for data compressing C. Alternatively, mt_3 divided by $|a|$ is used as the masked threshold for data compressing C.

If mt_5 is the smallest masked threshold, the masking effect of the signal R_0 is used for data compressing C in the following way: the masked threshold of the signal R_0 divided by $|a|$ is determined and used for data compressing C. Alternatively, mt_5 divided by $|a|$ is used as the masked threshold for data compressing C.

The determining unit 14.6 generates a masked threshold mt_6' . The masked threshold mt_6' is the masked threshold for the signal $b.S$. One could obtain the masked threshold mt_6' in another way, namely by multiplying mt_6 by $|b|$. The selection unit 16.4 now compares the masked thresholds mt_6' , mt_4 and mt_5 with each other.

Selection is realized in the following manner. Suppose that mt_6' is the smallest masked threshold. In that situation, the masked threshold mt_6 is used for data compressing S. If mt_3 is the smallest masked threshold, the masking effect of the signal L_0 is used for data compressing S in the following way: the masked threshold of the signal $L_0/|b|$ is determined and used for data compressing S. Alternatively, $mt_3/|b|$ is used as the masked threshold for data compressing S.

If mt_5 is the smallest masked threshold, the masking effect of the signal R_0 is used for data compressing S in the following way: the masked threshold of the signal $R_0/|b|$ is determined and used for data compressing S. Alternatively, $mt_5/|b|$ is used as the masked threshold for data compressing S.

The selection units 16.1 to 16.4 may further be adapted to subtract a predetermined number of dB, in the case that two of them select the same masked threshold, as described above with reference to the embodiment of the figures 1 and 2. Further, if three of them select the same masked threshold, the selection units may be adapted to subtract an even larger number of dB from the masked threshold selected. More specifically, roughly 5 dB ($=10\log 3$) is subtracted.

The encoder apparatus of the figures 5 and 6 may further be provided with the

user interface 21 (not shown in the figures 5 and 6) described in figure 1 for generating the enable control signal and may be adapted to transmit the flag signal so as to indicate that the signal transmitted was encoded in the way in accordance with the invention (including the selection of the masked thresholds), which means that the flag is present in the transmitted signal, or so as to indicate that no such selection took place (flag absent).

Figure 7 shows part of a fourth embodiment of the encoder apparatus, where figure 8 shows another part of the encoder apparatus of figure 7 and further shows a corresponding decoder apparatus for decoding the encoded information signals. The encoder of the figures 7 and 8 shows a large resemblance with the encoder apparatus of the figures 3 and 4. Compared with the encoder apparatus of the figures 3 and 4, the encoder apparatus of the figures 7 and 8 further comprise a fourth input 4 for receiving a fourth digital information signal S_l , which is the left surround signal component of a five channel surround audio signal and a fifth input 5 for receiving a fifth digital information signal S_r , which is the right surround signal component of a five channel surround audio signal.

The input terminal 4 is coupled to inputs of a fourth data compressor unit 12.4 and a sixth masked threshold determining unit 14.6. The input terminal 4 is also coupled to an additional input of the first signal combination unit 10.1. An output of the masked threshold determining unit 14.6 is coupled an input of a fourth selection unit 16.4. The selection unit 16.4 has one further input coupled to the output of the masked threshold determining unit 14.3. Further, the output of the data compression unit 12.4 is coupled to a further input of the signal combining unit 18.3.

The input terminal 5 is coupled to inputs of a fifth data compressor unit 12.5 and a seventh masked threshold determining unit 14.7. The input terminal 5 is also coupled to an additional input of the second signal combination unit 10.2. An output of the masked threshold determining unit 14.7 is coupled an input of a fifth selection unit 16.5. The selection unit 16.5 has one further input coupled to the output of the masked threshold determining unit 14.5. Further, the output of the data compression unit 12.5 is coupled to a further input of the signal combining unit 18.3.

The encoder apparatus functions as follows. In the present embodiment, the signal combination unit 10.1 combines the signals L , C and S_l in order to obtain a first combination signal L_0 , that satisfies the following equation:

$$L_0 = L + C + S_l. \quad (\text{Eq. 11a})$$

Further, the signal combination unit 10.2 combines the signals R, C and S_r in order to obtain a second combination signal R_0 , that satisfies the following equation:

$$R_0 = R + C + S_r. \quad (\text{Eq.11b})$$

5

The masked threshold determining units 14.1, 14.2, 14.3, 14.4 and 14.5 again generate a masked threshold mt_1 , mt_2 , mt_3 , mt_4 and mt_5 respectively, from the signals L, C, L_0 , R and R_0 respectively, applied to their respective inputs. Further, the units 14.6 and 14.7 generate masked thresholds mt_6 and mt_7 respectively from the signals S_l and S_r respectively, applied to their inputs.

The selection of the masked thresholds in the selection units 16.1, 16.2 and 16.3 is the same as explained above in the description with reference to the figures 3 and 4. The selection of the masked threshold in the selection unit 16.4 is such that it selects the smallest one of the masked thresholds mt_3 and mt_6 applied by the determining units 14.3 and 14.6 respectively. The selection of the masked threshold in the selection unit 16.5 is such that it selects the smallest one of the masked thresholds mt_5 and mt_7 applied by the determining units 14.5 and 14.7 respectively.

Figure 8 shows not only a portion of the encoder apparatus of figure 7, but also a corresponding decoder apparatus. The decoder apparatus shows large resemblances with the decoder apparatus of figure 4. The demultiplexer unit 30.3 also retrieves the data compressed fourth and fifth digital signals from the transmission signal and supplies the data compressed digital signals to corresponding data expander units 32.4 and 32.5. In the data expander unit 32.4, the fourth data compressed digital information signal is expanded so as to obtain a replica S_l' of the fourth digital information signal S_l . The signal combination unit 34.3 combines the replicas L' , C' and S_l' so as to obtain a combination signal L_0''' , in accordance with

$$L_0''' = L' + C' + S_l'. \quad (\text{Eq.12a})$$

30

In the data expander unit 32.5, the fifth data compressed digital information signal is expanded so as to obtain a replica S_r' of the fifth digital information signal S_r . The signal combination unit 34.4 combines the replicas R' , C' and S_r' so as to obtain a combination signal R_0''' in accordance with

$$R_0''' = R' + C' + S_r'. \quad (\text{Eq. 12b})$$

Where necessary, bitallocation information derived from the masked thresholds selected can be supplied to the signal combining unit 18.3 and transmitted.

5 In a further elaborated version of the encoder apparatus of figure 7 and 8, the signal combination unit 10.1 combines the signals L , C and S_l in order to obtain a first combination signal L_0 , that satisfies the following equation:

$$L_0 = L + a.C + b.S_l. \quad (\text{Eq. 13a})$$

10

Further, the signal combination unit 10.2 combines the signals R , C and S_r in order to obtain a second combination signal R_0 , that satisfies the following equation:

$$R_0 = R + a.C + d.S_r. \quad (\text{Eq. 13b})$$

15

In this version of the encoder apparatus, the masked threshold determining unit 14.2 and the selection unit 16.2 function in the way already described above with reference to the figures 3, 4, 5 and 6.

A further explanation of the selection in the selection units 16.4 and 16.5 will
20 now be given.

The determining unit 14.6 generates a masked threshold mt_6' . The masked threshold mt_6' is the masked threshold for the signal $b.S_l$. One could obtain the masked threshold mt_6' in another way, namely by multiplying mt_6 by $|b|$. The selection unit 16.4 now compares the masked thresholds mt_6' and mt_3 with each other.

25 Selection is realized in the following manner. Suppose that mt_6' is the smallest masked threshold. In that situation, the masked threshold mt_6 is used for data compressing S_l . If mt_3 is the smallest masked threshold, the masking effect of the signal L_0 is used for data compressing S_l in the following way: the masked threshold of the signal $L_0/|b|$ is determined and used for data compressing S_l . Alternatively, $mt_3/|b|$ is used as the masked
30 threshold for data compressing S_l .

The determining unit 14.7 generates a masked threshold mt_7' . The masked threshold mt_7' is the masked threshold for the signal $d.S_r$. One could obtain the masked threshold mt_7' in another way, namely by multiplying mt_7 by $|d|$. The selection unit 16.5 now compares the masked thresholds mt_7' and mt_5 with each other.

Selection is realized in the following manner. Suppose that mt_7 is the smallest masked threshold. In that situation, the masked threshold mt_7 is used for data compressing S_r . If mt_5 is the smallest masked threshold, the masking effect of the signal R_0 is used for data compressing S_r in the following way: the masked threshold of the signal $R_0/|d|$ is determined and used for data compressing S_r . Alternatively, $mt_5/|d|$ is used as the masked threshold for data compressing S_r .

The selection units 16.1 to 16.5 may further be adapted to subtract a predetermined number of dB, in the case that two of them select the same masked threshold, as described above with reference to the embodiment of the figures 1 and 2. Further, if three of them select the same masked threshold, the selection units may be adapted to subtract an even larger number of dB from the masked threshold selected. More specifically, roughly 5 dB ($=10\log 3$) is subtracted.

The encoder apparatus of the figures 7 and 8 may further be provided with the user interface 21 (not shown in the figures 7 and 8) described in figure 1 for generating the enable control signal and may be adapted to transmit the flag signal so as to indicate that the signal transmitted was encoded in the way in accordance with the invention (including the selection of the masked thresholds), which means that the flag is present in the transmitted signal, or so as to indicate that no such selection took place (flag absent).

The encoder apparatus can be used in an arrangement for storing the signal supplied by the encoder apparatus on a storage medium, such as a record carrier. Figure 9 schematically shows such a storage arrangement in the form of a recording arrangement. The block denoted by 190 is the encoder apparatus described above. The block denoted by 191 can be a channel encoder, if the channel encoder is not incorporated in the combining unit 18, 18.1, 18.2 or 18.3. In the channel encoder, the signal applied to its input 192 is encoded in, as an example a Reed-Solomon encoder, and an interleaver, so as to enable an error correction to be carried out in the receiver. Further, again as an example, an 8-to-10 modulation well known in the art, see document (5) in the list of references, is carried out. The signal thus obtained is recorded in one track or a multiplicity of tracks on a record carrier 193, such as a magnetic or optical record carrier, by means of writing means 194, such as a magnetic or optical head 195. The storage medium may alternatively be a solid state memory.

Whilst the present invention has been described with respect 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

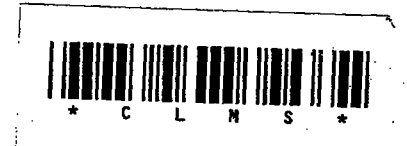
from the scope of the invention, as defined by the claims.

More specifically, the encoder apparatus encodes the multi channel signals without matrixing. As a result, unmatrixed encoded information signals will be received in the decoder apparatus. This decoder apparatus must be capable of carrying out a matrixing
5 procedure so as to obtain at least the two composite information signals that can be reproduced as a stereo signal via two loudspeakers positioned in a stereo setup. During decoding a noise component may become audible. Investigations resulted in the recognition that those noise components became apparent because of the matrixing process. More specifically, the noise components originated from quantisation noise that could not be
10 masked any more. By selecting another masked threshold, this problem could be solved. More specifically, during encoding an information signal, a choice is made for the masked threshold with which the information signal in question must be data reduced. The choice is made between at least two masked thresholds, one of which is the masked threshold derived from the information signal itself and one is the masked threshold derived from another
15 signal. This may be the masked threshold derived from that combination signal that includes the information signal in question.

Further, the invention lies in each and every novel feature or combination of features as herein disclosed.

List of related documents

- (1a) J.A.E.S., Vol. 40, No. 5, May 1992, pp. 376-382.
- (1b) 'Matrixing of bitrate reduced audio signals' by W.R.Th. ten Kate et al, in Proc. of the ICASSP, 1992, March 23-26, San Francisco. Vol.2, pp. II-205 to II-208.
- (2) US Patent application ser. no. 08/427,646 (PHQ 93-002)
- 5 (3) European Patent Application no. 402,973 (PHN 13.241).
- (4) European patent application no. 497,413A1 (PHN 13.581)
- (5) US patent spec. no. 4,620,311 (PHN 11.117).
- (6) European Patent Application no. 400.755 (PHQ 89.018A).
- (7a) European Patent Application no. 457,390 (PHN 13.328).
- 10 (7b) European Patent Application no. 457,391 (PHN 13.329).
- (8) EP 678,226-A1 and US ser. no. 08/328,999 (PHN 14.615)
- (9) ISO/IEC international standard IS 11172-3, Information technology - coding of moving pictures and associated audio for digital storage media up to about 1.5 Mbit/s, Part 3: audio.
- 15 (10) ISO/IEC international standard IS 13818-3, Information technology - coding of moving pictures and associated audio, Part 3: audio.

CLAIMS:

1. Apparatus for encoding a plurality of digital information signals, having at least
 - first input means for receiving a first digital information signal,
 - second input means for receiving a second digital information signal,
 - first signal combination means for combining at least the first and second digital
- 5 information signal and being adapted to generate a first combination signal,
 - first and second data compression means for data compressing the first and second digital information signal so as to obtain first and second data reduced digital information signals,
 - first, second and third masked threshold determining means for determining first, second and third masked thresholds respectively from the first, second digital information signals
- 10 and the first combination signal respectively,
 - first selection means for deriving one masked threshold from at least the first and third masked threshold so as to obtain a first selected masked threshold, the first data compression means being adapted to carry out a data compression step on the first digital information signal in response to said first selected masked threshold,
- 15 - formatting means for combining the first and second data reduced digital information signals into a transmission signal suitable for transmission via a transmission medium.
2. Apparatus as claimed in claim 1, wherein said first selected masked threshold is derived from the smallest of the masked thresholds supplied to the first selection means.
3. Apparatus as claimed in claim 1 or 2, further provided with second selection
- 20 means for deriving one masked threshold from at least the second and third masked threshold so as to obtain a second selected masked threshold, the second data compression means being adapted to carry out a data compression step on the second digital information signal in response to said second selected masked threshold.
4. Apparatus as claimed in claim 3, wherein said second selected masked threshold
- 25 is derived from the smallest of the masked thresholds supplied to the second selection means.
5. Apparatus as claimed in claim 1 or 2, further provided with
 - third input means for receiving a third digital information signal,
 - second signal combination means for combining at least the second and third digital information signal and being adapted to generate a second combination signal,



- third data compression means for data compressing the third digital information signal so as to obtain a third data reduced digital information signal.
 - fourth and fifth masked threshold determining means for determining fourth and fifth masked thresholds respectively from the third digital information signal and the second combination signal respectively,
 - 5 - second selection means for deriving one masked threshold from at least the second, third and fifth masked thresholds so as to obtain a second selected masked threshold, the second data compression means being adapted to carry out a data compression step on the second digital information signal in response to said second selected masked threshold,
 - 10 - third selection means for deriving one masked threshold from at least the fourth and fifth masked threshold so as to obtain a third selected masked threshold, the third data compression means being adapted to carry out a data compression step on the third digital information signal in response to said third selected masked threshold.
 - the formatting means being further adapted to combine the third data reduced digital information signal into said transmission signal suitable for transmission via said transmission medium.
 - 15
6. Apparatus as claimed in claim 5, wherein said second selected masked threshold is the smallest of the masked thresholds supplied to the second selection means, and said third selected masked threshold is the smallest of the masked thresholds supplied to the third selection means.
- 20
7. Apparatus as claimed in claim 5 or 6, further provided with
- fourth input means for receiving a fourth digital information signal,
 - the first mentioned signal combination means being adapted to combine the first, second and fourth digital information signal so as to generate said first combination signal,
 - 25 - the second signal combination means being adapted to combine the second, third and fourth digital information signal so as to generate said second combination signal,
 - fourth data compression means for data compressing the fourth digital information signal so as to obtain a fourth data reduced digital information signal,
 - sixth masked threshold determining means for determining a sixth masked threshold from the fourth digital information signal,
 - 30 - fourth selection means for deriving one masked threshold from the third, fifth and sixth masked thresholds so as to obtain a fourth selected masked threshold, the fourth data compression means being adapted to carry out a data compression step on the fourth digital information signal in response to said fourth selected masked threshold.



- the formatting means being further adapted to combine the fourth data reduced digital information signal into said transmission signal suitable for transmission via said transmission medium.
- 8. Apparatus as claimed in claim 7, wherein said fourth selected masked threshold
5 is the smallest of the masked thresholds supplied to the fourth selection means.
- 9. Apparatus as claimed in claim 5 or 6, further provided with
 - fourth input means for receiving a fourth digital information signal,
 - fifth input means for receiving a fifth digital information signal,
 - the first mentioned signal combination means being adapted to combine the first, second
10 and fourth digital information signal so as to generate said first combination signal,
 - the second signal combination means being adapted to combine the second, third and fifth digital information signal so as to generate said second combination signal,
 - fourth data compression means for data compressing the fourth digital information signal so as to obtain a fourth data compressed digital information signal,
 - 15 - fifth data compression means for data compressing the fifth digital information signal so as to obtain a fifth data compressed digital information signal,
 - sixth masked threshold determining means for determining a sixth masked threshold from the fourth digital information signal,
 - seventh masked threshold determining means for determining a seventh masked threshold
20 from the fifth digital information signal,
 - fourth selection means for deriving one masked threshold from the third and sixth masked thresholds so as to obtain a fourth selected masked threshold, the fourth data compression means being adapted to carry out a data compression step on the fourth digital information signal in response to said fourth selected masked threshold,
 - 25 - fifth selection means for deriving one masked threshold from the fifth and seventh masked thresholds so as to obtain a fifth selected masked threshold, the fifth data compression means being adapted to carry out a data compression step on the fifth digital information signal in response to said fifth selected masked threshold,
 - the formatting means being further adapted to combine the fourth and fifth data reduced
30 digital information signals into said transmission signal suitable for transmission via said transmission medium.
- 10. Apparatus as claimed in claim 9, wherein said fourth selected masked threshold is the smallest of the masked thresholds supplied to the fourth selection means, and said fifth selected masked threshold is the smallest of the masked thresholds supplied to the fifth



selection means.

11. Apparatus as claimed in anyone of the preceding claims, wherein the formatter means is further adapted to combine an instruction signal having a relationship with a selected masked threshold into the transmission signal.

5 12. Apparatus as claimed in anyone of the preceding claims, comprising user controlled means for enabling and disabling the selection means, the apparatus further comprising a flag signal generator means for generating a flag signal in response to an enabling of the selection means by the user, the formatting means being further adapted to combine the flag signal into said transmission signal for transmission via said transmission
10 medium.

13. Apparatus as claimed in anyone of the preceding claims, wherein a signal combination means is adapted to multiply a first input signal received via a first input with a first multiplication value, to multiply a second input signal received via a second input with a second multiplication value and to add the multiplied versions of the first and second input
15 signals.

14. Apparatus as claimed in anyone of the claims 5 to 10, wherein the first signal combination means are adapted to multiply the second digital information signal with a first constant and to add the multiplied second digital information signal to the first digital information signal so as to obtain said first combination signal, the second signal combination
20 means are adapted to multiply the second digital information signal with a second constant and to add or subtract the multiplied second digital information signal to/from the third digital information signal so as to obtain said second combination signal, the second selection means being further adapted to select a masked threshold corresponding to the masked threshold of said first combination signal, divided by the absolute value of said first constant,
25 if the third masked threshold is smaller than the fifth masked threshold and also smaller than the second masked threshold.

15. Apparatus as claimed in anyone of the claims 3 to 14, wherein, if at least two of the selection means have selected the same masked threshold as the selected masked threshold, such at least two selection means are further adapted to subtract a certain number
30 of decibels from the selected masked threshold and supply the masked threshold thus obtained as the selected masked threshold.

16. Apparatus for encoding a plurality of n digital information signals, having n input means for receiving the n digital information signals respectively at least one signal combination means for combining at least two of the n digital information signals and being



adapted to generate at least a first combination signal, n data compression means for each data compressing one of the n digital information signals so as to obtain each one of n data reduced digital information signals, at least $n+1$ masked threshold determining means for determining at least $n+1$ masked thresholds respectively from the n digital information
5 signals and the at least first combination signal respectively, selection means for deriving n selected masked thresholds from the at least $n+1$ masked thresholds, the n data compression means being each adapted to carry out a data compression step on one the n digital information signals in response to one of said n selected masked thresholds respectively, formatting means for combining the n data reduced digital information signals into a
10 transmission signal suitable for transmission via a transmission medium, n being an integer larger than 1.

17. Apparatus as claimed in claim 16, wherein a selected masked threshold is selected from a subgroup of the at least $n+1$ masked thresholds such that said selected masked threshold is the smallest of the masked thresholds in said subgroup.

15 18. Apparatus for encoding a plurality of n digital information signals, having input means for receiving the n digital information signals, signal combination means for combining at least two of the n digital information signals and being adapted to generate at least a first combination signal, data compression means for data compressing the n digital information signals so as to obtain n data reduced digital information signals, masked
20 threshold determining means for determining at least $n+1$ masked thresholds from the n digital information signals and the at least first combination signal, selection means for deriving n selected masked thresholds from the at least $n+1$ masked thresholds, a selected masked threshold being selected from a subgroup of at least two masked thresholds from the at least $n+1$ masked thresholds, the n subgroups for the selection of the n selected masked
25 threshold being different from each other, the data compression means being each adapted to carry out a data compression step on each of the n digital information signals in response to one of said n selected masked thresholds respectively, formatting means for combining the n data reduced digital information signals into a transmission signal suitable for transmission via a transmission medium, n being an integer larger than 1.

30 19. Apparatus as claimed in claim 18, wherein a selected masked threshold is selected from a subgroup of at least two masked thresholds from the at least $n+1$ masked thresholds such that said selected masked threshold is the smallest of the masked thresholds in said subgroup.

20. Apparatus as claimed in anyone of the preceding claims, further provided with



writing means for writing the transmission signal into a storage medium, such as a record carrier.

21. Method of encoding a plurality of digital information signals, the method comprising the steps of

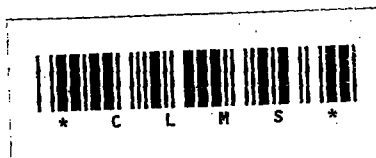
- 5 - receiving a first digital information signal,
- receiving a second digital information signal,
- combining the first and second digital information signal so as to generate a first combination signal,
- data compressing the first and second digital information signal so as to obtain first and
- 10 second data reduced digital information signals,
- determining first, second and third masked thresholds respectively from the first, second digital information signals and the combination signal respectively,
- deriving one masked threshold from the first and third masked threshold so as to obtain a first selected masked threshold, the data compression step carrying out data compression on
- 15 the first digital information signal in response to said first selected masked threshold,
- combining the first and second data reduced digital information signals into a transmission signal suitable for transmission via a transmission medium.

22. Method as claimed in claim 21, further comprising the step of writing the transmission signal into a storage medium, such as a record carrier.

23. Apparatus for encoding a plurality of n digital information signals, having n input means for receiving the n digital information signals respectively, n data compression means for each data compressing one of the n digital information signals so as to obtain each one of n data reduced digital information signals, at least n masked threshold determining means for determining at least n masked thresholds from the n digital information signals respectively, selection means for deriving n selected masked thresholds from the at least $n+1$ masked thresholds, such that at least one selected masked threshold is obtained from a selection of at least two of the at least n masked thresholds, the n data compression means being each adapted to carry out a data compression step on one the n digital information signals in response to one of said n selected masked thresholds respectively, formatting means for combining the n data reduced digital information signals into a transmission signal suitable for transmission via a transmission medium, n being an integer larger than 1.

24. Method of encoding a plurality of digital information signals, the method comprising the steps of

- receiving a first digital information signal,



- receiving a second digital information signal,
- data compressing the first and second digital information signal so as to obtain first and second data reduced digital information signals,
- determining first and second masked thresholds from the first and second digital information signals respectively,
- deriving one masked threshold from the first and second masked threshold so as to obtain a first selected masked threshold, the data compression step carrying out data compression on the first digital information signal in response to said first selected masked threshold,
- combining the first and second data reduced digital information signals into a transmission signal suitable for transmission via a transmission medium.