Claims

1. Audio decoder for decoding a bitstream (BS) so as to produce therefrom an audio output signal (OS), the bitstream (BS) comprising at least an active phase followed by at least an inactive phase, wherein the bitstream (BS) has encoded therein at least a silence insertion descriptor frame (SI) which describes a spectrum of a background noise (SBN), the audio decoder (1) comprising:

a silence insertion descriptor decoder (3) configured to decode the silence insertion descriptor frame (SI) so as to reconstruct the spectrum (SBN) of the background noise;

a decoding device (2) configured to reconstruct the audio output signal (OS) from the bitstream during the active phase;

a spectral converter (4) configured to determine a spectrum (SAS) of the audio output signal (OS);

a noise estimator device (5) configured to determine a first spectrum (SN1) of the noise of the audio output signal (OS) based on the spectrum (SAS) of the audio output signal (OS) provided by the spectral converter (4), wherein the first spectrum (SN1) of the noise of the audio output signal (OS) has a higher spectral resolution than the spectrum (SBN) of the background noise;

a resolution converter (6) configured to establish a second spectrum (SN2) of the noise of the audio output signal (OS) based on the first spectrum (SN1) of the noise of the audio output signal (OS), wherein the second spectrum (SN2) of the noise of the audio output signal (OS) has a same spectral resolution as the spectrum (SBN) of the background noise;

a comfort noise spectrum estimation device ~~(7)~~ having a scaling factor computing device ~~(7a)~~ configured to compute scaling factors ~~(SF)~~ for a spectrum ~~(SCN)~~ for a comfort noise ~~(CN)~~ based on the spectrum ~~(SBN)~~ of the background noise as provided by the silence insertion descriptor decoder ~~(3)~~ and based on the second spectrum ~~(SN2)~~ of the noise of the audio output signal ~~(OS)~~ as provided by the resolution converter ~~(6)~~ and having a comfort noise spectrum generator ~~(7b)~~ configured to compute the spectrum ~~(SCN)~~ for a comfort noise ~~(CN)~~ based on the scaling factors ~~(SF)~~; and

a comfort noise generator ~~(8)~~ configured to produce the comfort noise ~~(CN)~~ during the inactive phase based on the spectrum ~~(SCN)~~ for the comfort noise ~~(CN)~~.

2. Audio decoder according to the preceding claim, wherein the spectral analyzer ~~(4)~~ comprises a fast Fourier transformation device ~~(4)~~.

3. Audio decoder according to one of the preceding claims, wherein the noise estimator device ~~(5)~~ comprises a converter device ~~(9)~~ configured to convert the spectrum ~~(SAS)~~ of the audio output signal ~~(OS)~~ into a converted spectrum ~~(CSA)~~ of the audio output signal ~~(OS)~~ which has same or lower spectral resolution than the spectrum ~~(SAS)~~ of the output audio signal and a higher spectral resolution than the spectrum ~~(SBN)~~ of the background noise.

4. Audio decoder according to the preceding claim, wherein the noise estimator device ~~(5)~~ comprises a noise estimator ~~(10)~~ configured to determine the first spectrum ~~(SN1)~~ of the noise of the audio output signal ~~(OS)~~ based on the converted spectrum ~~(CSA)~~ of the audio output signal ~~(OS)~~ provided by the converter device ~~(9)~~.

5. Audio decoder according to one of the preceding claims, wherein the scaling factor computing device ~~(7a)~~ is configured to compute the scaling factors ~~(SF)~~ according to the formula $\hat{S}^{LR}(i) = \frac{\hat{N}^{\mathrm{LR}}_{\mathrm{SID}}(i)}{\hat{N}^{\mathrm{LR}}_{\mathrm{dec}}(i)}$, wherein $\hat{S}^{FR}(i)$ denotes a scaling factor ~~(SF)~~ for a frequency band group i of the comfort noise ~~(CN)~~, wherein $\hat{N}^{\mathrm{LR}}_{\mathrm{SID}}(i)$ denotes a level of a frequency band group i of the spectrum ~~(SBN)~~ of the background noise, wherein $\hat{N}^{\mathrm{LR}}_{\mathrm{dec}}(i)$ denotes a level of a frequency band group i of the second spectrum ~~(SN2)~~ of the noise of the audio output signal ~~(OS)~~, wherein $i = 0, \ldots, L^{LR} - 1$, wherein L^{LR} is the number of frequency band groups of the spectrum ~~(SBN)~~ of the background noise and of the second spectrum ~~(SN2)~~ of the noise of the audio output signal ~~(OS)~~.

6. Audio decoder according to one of the preceding claims, wherein the comfort noise spectrum generator ~~(7b)~~ is configured to compute the spectrum of the comfort noise ~~(SCN)~~ based on the scaling factors ~~(SF)~~ and based on the first spectrum ~~(SN1)~~ of the noise of the audio output signal ~~(OS)~~ as provided by the noise estimation device ~~(5)~~.

7. Audio decoder according to one of the preceding claims, wherein the comfort noise spectrum generator ~~(7b)~~ is configured to compute the spectrum ~~(SCN)~~ of the comfort noise according to the formula $\hat{N}^{FR}(k) = \hat{S}^{LR}(i) \cdot \hat{N}^{\mathrm{HR}}_{\mathrm{dec}}(k)$, wherein $\hat{N}^{FR}(k)$ denotes a level of a frequency band k of the spectrum of the comfort noise ~~(SCN)~~, wherein $\hat{S}^{LR}(i)$ denotes a scaling factor ~~(SF)~~ of a frequency band group i of the spectrum ~~(SBN)~~ of the background noise and of the second spectrum ~~(SN2)~~ of the noise of the audio output signal, wherein $\hat{N}^{\mathrm{HR}}_{\mathrm{dec}}(k)$ denotes a level of a frequency band k of the first spectrum (SN1) of the noise of the audio output signal ~~(OS)~~, wherein $k = b^{LR}(i), \ldots, b^{LR}(i+1) - 1$, wherein $b^{LR}(i)$ is a first frequency band of one of the frequency band groups, wherein $i =$

in $i = 0, \ldots, L^{LR} - 1$, wherein L^{LR} is the number of frequency band groups of the spectrum ~~(SBN)~~ of the background noise and of the second spectrum ~~(SN2)~~ of the noise of the audio output signal ~~(OS)~~.

8. Audio decoder according to one of the preceding claims, wherein the resolution converter ~~(6)~~ comprises a first converter stage ~~(11)~~ configured to establish a third spectrum ~~(SN3)~~ of the noise of the audio output signal ~~(OS)~~ based on the first spectrum ~~(SN1)~~ of the noise of the audio output signal ~~(OS)~~, wherein the spectral resolution of the third spectrum ~~(SN3)~~ of the noise of the audio output signal ~~(OS)~~ is same or higher as the spectral resolution of the first spectrum ~~(SN1)~~ of the noise of the audio output signal ~~(OS)~~, and wherein the resolution converter ~~(6)~~ comprises a second converter stage ~~(12)~~ configured to establish the second spectrum ~~(SN2)~~ of the noise of the audio output signal ~~(OS)~~.

9. Audio decoder according to the preceding claim, wherein the comfort noise spectrum generator ~~(7b)~~ is configured to compute the spectrum of the comfort noise ~~(SCN)~~ based on the scaling factors ~~(SF)~~ and based on the third spectrum ~~(SN3)~~ of the noise of the audio output signal ~~(OS)~~ as provided by the first converter stage ~~(11)~~ of the resolution converter ~~(6)~~.

10. Audio decoder according to claim eight or nine, wherein the comfort noise spectrum generator ~~(7b)~~ is configured to compute the spectrum ~~(SCN)~~ of the comfort noise according to the formula $\widehat{N}^{FR}(k) = \hat{S}^{LR}(i) \,.\, \widehat{N}^{\mathrm{FR}}_{\mathrm{dec}}(k)$, wherein $\widehat{N}^{FR}(k)$ denotes a level of a frequency band k of the spectrum of the comfort noise ~~(SCN)~~, wherein $\hat{S}^{LR}(i)$ denotes a scaling factor ~~(SF)~~ of a frequency band group i of the spectrum ~~(SBN)~~ of the background noise and of the second spectrum ~~(SN2)~~ of the noise of the audio output signal, wherein $\widehat{N}^{\mathrm{FR}}_{\mathrm{dec}}(k)$ denotes a level of a frequency band k of the third spectrum ~~(SN3)~~ of the noise of the audio

output signal ~~(OS)~~, wherein $k = b^{LR}(i), \ldots, b^{LR}(i+1) - 1$, wherein $b^{LR}(i)$ is a first frequency band of a frequency band group, wherein $i =$ in $i = 0, \ldots, L^{LR} - 1$, wherein L^{LR} is the number of frequency band groups of the spectrum ~~(SBN)~~ of the background noise and of the second spectrum ~~(SN2)~~ of the noise of the audio output signal ~~(OS)~~.

11. Audio decoder according to one of the preceding claims, wherein the comfort noise generator ~~(8)~~ comprises a first fast Fourier converter ~~(15)~~ configured to adjust levels of frequency bands of the comfort noise ~~(CN)~~ in a fast Fourier transformation domain and a second fast Fourier converter ~~(16)~~ to produce at least a part of the comfort noise based on an output of the first fast Fourier converter ~~(15)~~.

12. Audio decoder according to one of the preceding claims, wherein the decoding device ~~(2)~~ comprises a core decoder ~~(17)~~ configured to produce the audio output signal ~~(OS)~~ during the active phase.

13. Audio decoder according to one of the claims 1 to 11, wherein the decoding device ~~(2)~~ comprises a core decoder ~~(17)~~ configured to produce an audio signal ~~(AS)~~ and a bandwidth extension module ~~(20)~~ configured to produce the audio output signal ~~(OS)~~ based on the audio signal ~~(AS)~~ as provided by the core decoder ~~(17)~~.

14. Audio decoder according to the preceding claim, wherein the bandwidth extension module ~~(20)~~ comprises a spectral band replication decoder ~~(21)~~, a quadrature mirror filter analyzer ~~(22)~~, and/or a quadrature mirror filter synthesizer ~~(23)~~.

15. Audio decoder according to claim 13 or 14, wherein the comfort noise ~~(CN)~~ as provided by the fast Fourier synthesizer ~~(15)~~ is fed to the bandwidth extension module ~~(17)~~.

16. Audio decoder according to one of the claims 13 to 15, wherein the comfort noise generator ~~(8)~~ comprises a quadrature mirror filter adjuster device ~~(24)~~ configured to adjust levels of frequency bands of the comfort noise ~~(CN)~~ in a quadrature mirror filter domain, wherein an output of the quadrature mirror filter synthesizer ~~(24)~~ is fed to the bandwidth extension module ~~(20)~~.

17. A system comprising a decoder ~~(1)~~ and an encoder ~~(100)~~, wherein the decoder ~~(1)~~ is designed according to one of the claims 1 to 16.

18. A method of decoding an audio bitstream ~~(BS)~~ so as to produce therefrom an audio output signal ~~(OS)~~, the bitstream ~~(BS)~~ comprising at least an active phase followed by at least an inactive phase, wherein the bitstream ~~(BS)~~ has encoded therein at least a silence insertion descriptor frame ~~(SI)~~ which describes a spectrum of a background noise ~~(SBN)~~, the method comprising the steps:

decoding the silence insertion descriptor frame ~~(SI)~~ so as to reconstruct the spectrum ~~(SBN)~~ of the background noise;

reconstructing the audio output signal ~~(OS)~~ from the bitstream during the active phase;

determining a spectrum ~~(SAS)~~ of the audio output signal ~~(OS)~~;

determining a first spectrum ~~(SN1)~~ of the noise of the audio output signal ~~(OS)~~ based on the spectrum ~~(SAS)~~ of the audio output signal ~~(OS)~~, wherein the first spectrum ~~(SN1)~~ of the noise of the audio output signal ~~(OS)~~ has a higher spectral resolution than the spectrum ~~(SBN)~~ of the background noise;

establishing a second spectrum ~~(SN2)~~ of the noise of the audio output

signal ~~(OS)~~ based on the first spectrum ~~(SN1)~~ of the noise of the audio output signal ~~(OS)~~, wherein the second spectrum ~~(SN2)~~ of the noise of the audio output signal ~~(OS)~~ has a same spectral resolution as the spectrum ~~(SBN)~~ of the background noise;

computing scaling factors for a spectrum ~~(SCN)~~ for a comfort noise ~~(CN)~~ based on the spectrum ~~(SBN)~~ of the background noise and based on the second spectrum ~~(SN2)~~ of the noise of the audio output signal ~~(OS)~~; and

producing the comfort noise ~~(CN)~~ during the inactive phase based on the spectrum ~~(SCN)~~ for the comfort noise ~~(CN)~~.

19. Computer program for performing, when running on a computer or a processor, the method of claim 18.