CLAIMS

1. A method of decoding ambisonic audio data, the method comprising:

obtaining, by an audio decoding device, a decorrelated representation of ambient ambisonic coefficients that are representative of a background component of a soundfield described by a plurality of higher order ambisonic cofficients, the decorrelated representation of the ambient ambisonic coefficients being decorrelated from one or more foreground components of the soundfield, wherein at least one of a plurality of higher order ambisonic coefficients describing the soundfield is associated with a spherical basis function having an order of one or zero; and

applying, by the audio decoding device, a recorrelation transform to the decorrelated representation of the ambient ambisonic coefficients to obtain a plurality of recorrelated ambient ambisonic coefficients.

2. The method of claim **1**, wherein applying the recorrelation transform comprises applying, by the audio decoding device, an inverse phase based transform to the ambient ambisonic coefficients.

3. The method of claim **2**, wherein the inverse phase based transform has been normalized according to one of N3D (full three-D) normalization.

4. The method of claim **2**, wherein the inverse phase based transform has been normalized according to SN3D normalization (Schmidt semi-normalization).

5. The method of claim **2**, wherein the ambient ambisonic coefficients are associated with spherical basis functions having an order of zero or an order of one, and wherein applying the inverse phase based transform comprises performing, by the audio decoding device, a scalar multiplication of a phase based transform with respect to the decorrelated representation of the ambient ambisonic coefficients.

6. The method of claim **1**, further comprising obtaining, by the audio decoding device, an indication that the decorrelated representation of ambient ambisonic coefficients was decorrelated from the one or more foreground components with a decorrelation transform.

7. The method of claim **1**, further comprising:

obtaining, by the audio decoding device, one or more spatial components defining spatial characteristics of the one or more foreground components of the soundfield described by the plurality of higher order ambisonic coefficients, the spatial components defined in a spherical harmonic domain; and

combining, by the audio decoding device, the recorrelated ambient ambisonic coefficients with one or more foreground channels obtained based on the one or more spatial components.

8. A device for processing ambisonic audio data, the device comprising:

a memory device configured to store at least a portion of the ambisonic audio data to be processed; and

one or more processors coupled to the memory device, the one or more processors being configured to:

obtain, from the portion of the ambisonic audio data stored to the memory device, a decorrelated representation of ambient ambisonic coefficients that are representative of a background component of a soundfield described by a plurality of higher order ambisonic coefficients, the decorrelated representation of the ambient ambisonic coefficients being decorrelated from one or more foreground components of the soundfield described by the plurality of higher order ambisonic coefficients, wherein at least

one of the plurality of higher order ambisonic coefficients describing the soundfield is associated with a spherical basis function having an order of one or zero, and wherein the decorrelated representation of ambient ambisonic coefficients comprises four coefficient sequences $c_{AMB,2}$, $c_{AMB,3}$, and $c_{AMB,4}$; and

apply a recorrelation transform to the decorrelated representation of the ambient ambisonic coefficients to obtain a plurality of recorrelated ambient ambisonic coefficients.

9. The device of claim **8**, wherein a first coefficient sequence of the four coefficient sequences is associated with a left signal, and wherein a second coefficient sequence of the four coefficient sequences is associated with a right signal.

10. The device of claim **9**, wherein the one or more processors are configured to use the left signal as a left speaker feed and the right signal as a right speaker feed without application of the recorrelation transform to the right and left signals.

11. The device of claim **9**, the one or more processors are configured to mix the left signal and the right signal for output by a mono audio system.

12. The device of claim **8**, wherein the one or more processors are configured to combine the recorrelated ambient ambisonic coefficients with one or more foreground channels.

13. The device of claim **8**, wherein the one or more processors are further configured to determine that no foreground channels are available with which to combine the recorrelated ambient ambisonic coefficients.

14. The device of claim **8**, wherein the one or more processors are further configured to:

determine that the soundfield described by the plurality of higher order ambisonic coefficients is to be output via a mono-audio reproduction system; and

decode at least a subset of the decorrelated ambient ambisonic coefficients that include data for output by the mono-audio reproduction system.

15. The device of claim **8**, wherein the one or more processors are further configured to obtain, from the portion of the ambisonic audio data stored to the memory device, an indication that the decorrelated representation of ambient ambisonic coefficients is decorrelated from the one or more foreground components based on a decorrelation transform.

16. The device of claim **8**, wherein the one or more processors are configured to generate a speaker feed based on the plurality of recorrelated ambient ambisonic coefficients, the device further comprising a loudspeaker coupled to the one or more processors, the loudspeaker being configured to output the speaker feed generated based on the recorrelated ambient ambisonic coefficients.

17. A device for compressing audio data, the device comprising:

a memory device configured to store at least a portion of the audio data to be compressed; and

one or more processors coupled to the memory device, the one or more processors being configured to:

extract ambient ambisonic coefficients representative of a background component of a soundfield from a plurality of higher order ambisonic coefficients that describe the soundfield and are included in the audio data stored to the memory device, wherein at least one of the plurality of higher order ambisonic coefficients is associated with a spherical basis function having an order of one or zero;

apply a phase based transform to ambient ambisonic coefficients to decorrelate the extracted ambient ambisonic coefficients from one or more foreground components of the soundfield described by the plurality of higher order ambisonic coefficients to obtain a decorrelated representation of the ambient ambisonic coefficients; and

store, to the memory device, an audio signal based on the decorrelated representation of the ambient ambisonic coefficients.

18. The device of claim **17**, wherein the one or more processors are further configured to include, in the audio signal, with one or more foreground channels.

19. The device of claim **17**, wherein, the one or more processors are configured to signal the decorrelated ambient ambisonic coefficients along with one or more foreground channels in response to a determination that a target bitrate associated with the audio signal meets or exceeds a predetermined threshold.

20. The device of claim **17**, wherein the one or more processors are further configured to signal the decorrelated ambient ambisonic coefficients of the audio signal stored to the memory device without signaling any foreground channels of the audio signal stored to the memory device.

21. The device of claim **20**, wherein the one or more processors are configured to signal the decorrelated ambient ambisonic coefficients of the audio signal stored to the memory device without signaling any foreground channels of the audio signal stored to the memory device in response to a determination that a target bitrate associated with the audio signal is below a predetermined threshold.

22. The device of claim **21**, wherein the one or more processors are further configured to include, in the stored audio signal, an indication of the decorrelation transform having been applied to the ambient ambisonic coefficients.

23. The device of claim **17**, further comprising a microphone coupled to the one or more processors, the microphone being configured to capture the audio data to be compressed.

24. A device for processing ambisonic audio data, the device comprising:

a memory device configured to store at least a portion of the ambisonic audio data to be processed and a UsePhaseShiftDecorr flag; and

one or more processors coupled to the memory device, the one or more processors being configured to:

determine that a value of the UsePhaseShiftDecorr flag is equal to one (**1**);

based on the value of the UsePhaseShiftDecorr being equal to one (**1**), obtain, from the portion of the ambisonic audio data stored to the memory device, a decorrelated representation of ambient ambisonic coefficients that are representative of a background component of a soundfield described by a plurality of higher order ambisonic coefficients, the decorrelated representation of the ambient ambisonic coefficients being decorrelated from one or more foreground components of the soundfield described by the plurality of higher order ambisonic coefficients, wherein at least one of the plurality of higher order ambisonic coefficients describing the soundfield is associated with a spherical basis function having an order of one or zero; and

apply a recorrelation transform to the decorrelated representation of the ambient ambisonic coefficients to obtain a plurality of recorrelated ambient ambisonic coefficients.

25. The device of claim **24**, further comprising an interface coupled to the memory, the interface being configured to:

receive a bitstream comprising at least a portion of the ambisonic audio data; and

receive the UsePhaseShiftDecorr flag.

26. The device of claim **24**, wherein the one or more processors are configured to generate a speaker feed based on the plurality of recorrelated ambient ambisonic coefficients.

27. The device of claim **26**, further comprising a loudspeaker coupled to the one or more processors, the loudspeaker being configured to output the speaker feed generated based on the recorrelated ambient ambisonic coefficients.

28. The device of claim **24**, wherein the one or more processors are further configured to reconstruct the soundfield using the plurality of recorrelated ambient ambisonic coefficients.

29. A device for processing ambisonic audio data, the device comprising:

a memory device configured to store at least a portion of the ambisonic audio data to be processed; and

one or more processors coupled to the memory device, the one or more processors being configured to:

obtain, from the portion of the ambisonic audio data stored to the memory device, a decorrelated representation of ambient ambisonic coefficients that are representative of a background component of a soundfield described by a plurality of higher order ambisonic coefficients, the decorrelated representation of the ambient ambisonic coefficients being decorrelated from one or more foreground components of the soundfield described by the plurality of higher order ambisonic coefficients, wherein at least one of the plurality of

higher order ambisonic coefficients describing the soundfield is associated with a spherical basis function having an order of one or zero, and wherein the decorrelated representation of ambient ambisonic coefficients comprises four coefficient sequences $C_{I,AMB,1}$, $C_{I,AMB,2}$, $C_{I,AMB,3}$, and $C_{I,AMB,4}$; and

apply a recorrelation transform to the decorrelated representation of the ambient ambisonic coefficients to obtain a plurality of recorrelated ambient ambisonic coefficients, wherein to apply the recorrelation transform, the one or more processors are configured to:

generate a first phase shifted signal based on a first multiplication product of a coefficient c(**0**) of the recorrelation transform and a difference between the coefficient sequences $C_{I,AMB,1}$ and $C_{I,AMB,2}$; and

generate a second phase shifted signal based on a second multiplication product of a coefficient c(**1**) of the recorrelation transform and a sum of the coefficient sequences $C_{I,\ AMB,1}$ and $C_{I,AMB,2}$.

30. The device of claim **29**, wherein the one or more processors are further configured to:

generate a first combination based on a first phase shifted signal, a coefficient c(**3**) of the recorrelation transform, a coefficient c(**2**) of the recorrelation transform, and the coefficient sequences $c_{I,AMB,1}$ and $c_{I,AMB,2}$; and

generate a second combination based on a second phase shifted signal, a coefficient c(**5**) of the recorrelation transform, a difference between the coefficient sequences $c_{I,AMB,1}$ and $c_{I,AMB,2}$, a coefficient c(**6**) of the recorrelation transform, and the coefficient sequence $c_{I,AMB,3}$;

obtain the coefficient sequence $c_{I,AMB,4}$; and

generate a third combination based on a coefficient c(**4**) of the recorrelation transform, the coefficient sequences $c_{I,AMB,1}$ and $c_{I,AMB,2}$, and the first phase shifted signal.

31. The device of claim **30**,

wherein the recorrelation transform comprises an inverse phase based transform that is based at least in part on a set of coefficients comprising the coefficient c(**0**), the coefficient c(**1**), the coefficient c(**2**), the coefficient c(**3**), the coefficient c(**4**), the coefficient c(**5**), and the coefficient c(**6**), and

wherein each of the coefficient c(**0**), the coefficient c(**1**), the coefficient c(**2**), the coefficient c(**3**), the coefficient c(**4**), the coefficient c(**5**), and the coefficient c(**6**) has a different value.

32. The device of claim **30**, wherein the first combination is based on:

a third multiplication product of the coefficient c(**3**) and the first phase shifted signal,

a fourth multiplication product of the coefficient c(**2**) and the sum of the coefficient sequences $c_{I,AMB,1}$ and $c_{I,AMB,2}$, and

a sum of the third multiplication product and the fourth multiplication product.

33. The device of claim **30**, wherein the second combination is based on:

a third multiplication product of the coefficient c(**5**) and the difference between the coefficient sequences $c_{I,AMB,1}$ and $c_{I,AMB,2}$,

a fourth multiplication product of the coefficient c(**6**) and the coefficient sequence $c_{I,AMB,3}$, and

a sum of the third multiplication product, the fourth multiplication product, and the second phase shifted signal.

34. The device of claim **30**, wherein the third combination is based on:

a multiplication product of the coefficient c(**4**) and the sum of the coefficient sequences $c_{I,AMB,1}$ and $c_{I,AMB,2}$, and

a sum of the multiplication product and the first phase shifted signal.

35. The device of claim **29**, wherein the one or more processors are configured to generate a speaker feed based on the plurality of recorrelated ambient ambisonic coefficients.

36. The device of claim **35**, further comprising a loudspeaker coupled to the one or more processors, the loudspeaker being configured to output the speaker feed generated based on the recorrelated ambient ambisonic coefficients.

37. The device of claim **29**, wherein the one or more processors are further configured to reconstruct the soundfield using the plurality of recorrelated ambient ambisonic coefficient coefficients.

38. The method of claim **1**, further comprising generating, by the audio decoding device, a speaker feed based on the plurality of recorrelated ambient ambisonic coefficients obtained from the application of the recorrelation transform to the decorrelated representation of the ambient ambisonic coefficients.

39. The device of claim **8**, wherein the one or more processors are further configured to generate a speaker feed based on the plurality of recorrelated ambient ambisonic coefficients obtained from the application of the recorrelation transform to the decorrelated representation of the ambient ambisonic coefficients.

40. The device of claim **9**, wherein the one or more processors are configured to generate, for output by a stereo reproduction system, a left speaker feed based on the left signal and a right speaker feed based on the right signal.