Claims

1. An encoder apparatus comprising:

a plurality of frequency domain, FD, encoder tools for encoding an information signal, the information signal presenting a plurality of frames; and

an encoder bandwidth detector and controller configured to select a bandwidth for at least a subgroup of the plurality of FD encoder tools, the subgroup including less FD encoder tools than the plurality of FD encoder tools, on the basis of information signal characteristics so that at least one of the FD encoder tools of the subgroup has a different bandwidth with respect to at least one of the FD encoder tools which are not in the subgroup.

2. The encoder apparatus of claim 1, wherein:

at least one FD encoder tool of the subgroup is a temporal noise shaping, TNS, tool and/or a noise level estimator tool.

3. The encoder apparatus of claim 1 or 2, wherein:

at least one FD encoder tool which is not in the subgroup is chosen among at least on of linear predictive coding, LPC, based spectral shaper, a spectral noise shaping, SNS, tool, a spectral quantizer, and a residual coder.

4. The encoder apparatus of any of the preceding claims, wherein:

the encoder bandwidth detector and controller is configured to select the bandwidth of the at least one FD encoder tool of the subgroup between at least a first bandwidth common to at least one of the FD encoder tools which are not in the subgroup and a second bandwidth different from the bandwidth of the at least one of the FD encoder tools which are not in the subgroup.

5. The encoder apparatus of any of the preceding claims, wherein:

the encoder bandwidth detector and controller is configured to select the bandwidth of the at least one of the plurality of FD encoder tools on the basis of at least one energy estimation on the information signal.

6. The encoder apparatus of any of the preceding claims, wherein:

the encoder bandwidth detector and controller is configured to compare at least one energy estimate associated to a bandwidth of the information signal to a respective threshold to control the bandwidth for the at least one of the plurality of FD encoder tools.

7. The encoder apparatus of any of the preceding claims, wherein:

the at least one of the plurality of FD encoder tools of the subgroup comprises a TNS configured to autocorrelate a TNS input signal within the bandwidth chosen by the encoder bandwidth detector and controller.

8. The encoder apparatus of any of the preceding claims, wherein the at least one of the FD encoder tools which are not in the subgroup is configured to operate at a full bandwidth.

9. The encoder apparatus of any of the preceding claims, wherein the encoder bandwidth detector and controller is configured to select at least one bandwidth which is within the full bandwidth at which the at least one of the FD encoder tools which are not in the subgroup is configured to operate.

10. The encoder apparatus of any of the preceding claims, wherein the at least one of the remaining FD encoder tools of the plurality of FD encoder tools is configured to operate in open chain with respect to the bandwidth chosen by the encoder bandwidth detector and controller.

11. The encoder apparatus of any of the preceding claims, wherein:

the encoder bandwidth detector and controller is configured to select a bandwidth among a finite number of bandwidths and/or among a set of pre-defined bandwidths.

12. The encoder apparatus of any of the preceding claims, wherein:

the encoder bandwidth detector and controller is configured to perform a selection among at least one or a combination of the following bandwidths: a 4 KHz, 8 KHz, 12 KHz, 16 KHz, and 24 KHz, and/or NB, WB, SSWB, SWB, FB.

13. The encoder apparatus of any of the preceding claims, wherein:

the encoder bandwidth detector and controller is configured to control the signalling of the bandwidth to a decoder.

14. The encoder apparatus of any of the preceding claims, further configured to:

encode a control data field including an information regarding the chosen bandwidth.

15. The encoder apparatus of any of the preceding claims, further configured to:

encode a control data field including:

- 0 data bits corresponding to NB bandwidth;
- 1 data bit corresponding to NB, WB bandwidth;
- 2 data bits corresponding to NB, WB, SSWB bandwidth;
- 2 data bits corresponding to NB, WB, SSWB, SWB bandwidth;
- 3 data bits corresponding to NB, WB, SSWB, SWB, FB bandwidth.

16. The encoder apparatus of claim 5 or 6, wherein the at least one energy estimation is performed as:

$$E_B(n) = \sum_{k=I_{f_s}(n)}^{I_{f_s}(n+1)-1} \frac{X(k)^2}{I_{f_s}(n+1) - I_{f_s}(n)} \quad for\ n = 0 \ldots N_B - 1$$

where $X(k)$ are the MDCT or MDST or FD coefficients, N_B is the number of bands and $I_{f_s}(n)$ are the indices associated to the band.

17. The encoder apparatus of any of the preceding claims, further comprising a TNS tool configured to perform a filtering operation including the calculation of the filtering operation:

for each $k = 0..8$

$$r(k) = \begin{cases} r_0(k) & \text{, if } \prod_{s=0}^{2} e(s) = 0 \\ \sum_{s=0}^{2} \frac{\sum_{n=\text{sub_start}(f,s)}^{\text{sub_stop(f,s)-1-k}} X_s(n) X_s(n+k)}{e(s)} & \text{, otherwise} \end{cases}$$

with

$$r_0(k) = \begin{cases} 1 & , if\ k = 0 \\ 0 & , otherwise \end{cases}$$

and

$$e(s) = \sum_{n=\text{sub_start}(f,s)}^{\text{sub_stop(f,s)-1}} X_s(n)^2 \quad for\ s = 0..2$$

where $X(k)$ are the MDCT or MDST or FD coefficients, sub_start(f,s) and sub_stop(f,s) are associated to the particular bandwidth as detected by the encoder bandwidth detector and controller.

18. The encoder apparatus of any of the preceding claims, further comprising a noise estimator configured to estimate a noise level using

$$\mathrm{L_{NF}} = \frac{\sum_{\mathrm{k=0}}^{\mathrm{N_E-1}} \mathrm{I_{NF}(k)} \cdot \frac{|\mathrm{X_f(k)}|}{\mathrm{gg}}}{\sum_{\mathrm{k=0}}^{\mathrm{N_E-1}} \mathrm{I_{NF}(k)}}$$

where gg refers to the global gain, $\mathrm{I_{NF}(k)}$ to the identification of the spectral lines on which the noise level is to be estimated, and $\mathrm{X_f(k)}$ is the signal.

19. A decoder apparatus comprising a plurality of FD decoder tools for decoding an information signal encoded in a bitstream, wherein:

the FD decoder tools are divided:

- in a subgroup comprising at least one FD decoder tool;

- in remaining FD decoder tools comprising at least one FD decoder tool;

wherein the decoder apparatus is configured so that at least one of the plurality of decoder tools of the subgroup performs signal processing a different bandwidth with respect to at least one of the remaining FD decoder tools of the plurality of decoder tools.

20. The decoder apparatus of claim 19, further comprising a bandwidth controller configured to:

choose the bandwidth on the basis of the bandwidth information.

21. The decoder apparatus of claim 19 or 20, wherein:

the subgroup comprises at least one of a decoder noise filling tool and/or a temporal noise shape, TNS, decoder.

22. The decoder apparatus of any of claims claim 19-21, wherein:

the at least one of the remaining FD decoder tools is at least one of a decoder linear predictive coding, LPC, tool, a spectral noise shaping, SNS, tool, a decoder global gain tool, an MDCT or MDST shaping tool or another shaping tool based on another transformation.

23. The decoder apparatus of any of claims claim 19-22, further configured to:

control the bandwidth of the at least one of the plurality of decoder tools in the subgroup between:

at least a first bandwidth common to at least one of the remaining FD decoder tools; and

at least a second bandwidth different from the first bandwidth.

24. The decoder apparatus of any of claims 19-23, wherein the at least one of the FD remaining decoder tools is configured to operate at a full bandwidth.

25. The decoder apparatus of any of claims 19-24, wherein the at least one of the remaining FD decoder tools is configured to operate in open chain with respect to the chosen bandwidth.

26. The decoder apparatus of any of claims 19-25, further configured to:

choose a bandwidth among a finite number of bandwidths and/or among a set of pre-defined bandwidths.

27. The decoder apparatus of any of claims 19-26, further configured to:

perform a choice among at least one or a combination of: a 8 KHz, 16 KHz, 24 KHz, 32 KHz, and 48 KHz and/or NB, WB, SSWB, SWB, FB.

28. The decoder apparatus of any of claims 19-27, further comprising a noise filling tool configured to apply a noise level using indices given by

$$I_{NF}(k) = \begin{cases} 1 & \text{if } 24 \le k < bw_{stop} \; and \; \widehat{X_q}(i) == 0 \; for \; all \; i = k-3..\min(bw_{stop}, k+3) \\ 0 & \text{otherwise} \end{cases}$$

where bw_{stop} is obtained on the basis of bandwidth information in the bitstream.

29. The decoder apparatus of any of claims 19-28, further comprising a TNS decoder configured to perform:

$s^0(\text{start_freq}(0)-1) = s^1(\text{start_freq}(0)-1) = \cdots = s^7(\text{start_freq}(0)-1) = 0$

for $f = 0$ to num_tns_filters-1 do

for $n =$ start_freq(f) to stop_freq$(\mathrm{f})-1$ do

$t^{\mathrm{K}}(n) = \widehat{X_f}(n)$

for $k = 7$ to 0 do

$t^k(n) = t^{k+1}(n) - rc_q(k)s^k(n-1)$

$s^{k+1}(n) = rc_q(k)t^k(n) + s^k(n-1)$

$\widehat{X_s}(n) = s^0(n) = t^0(n)$

where $\widehat{X_s}(n)$ is the output of the TNS decoder and $\widehat{X_f}(n)$ is the intput of the TNS decoder, num_tns_filters, start_freq, stop_freq are obtained on the basis of bandwidth information (39a) in the bitstream.

30. A system comprising an encoder apparatus and a decoder apparatus, wherein the encoder apparatus is according to any of claims 1-18 and/or the decoder apparatus is according to any of claims 19-29.

31. A method for encoding an information signal according to at least a plurality of operations in the frequency domain, FD, the method comprising:

selecting a bandwidth for a subgroup of FD operations;

performing first signal processing operations at the a bandwidth for the subgroup of FD operations;

performing second signal processing operations at a different bandwidth for FD operations which are not in the subgroup.

32. A method for decoding a bitstream with an information signal and control data, the method comprising a plurality of signal processing operations in the frequency domain, FD, the method comprising:

choosing a bandwidth selection for a subgroup of FD operations on the basis of the control data;

performing first signal processing operations at the a bandwidth for the subgroup of FD operations;

performing second signal processing operations at a different bandwidth for FD operations which are not in the subgroup.