CLAIMS

1. A method of polar coding, comprising:

generating a puncturing pattern comprising a plurality of punctured bit locations for puncturing corresponding coded bit locations in a polar codeword;

calculating a first log likelihood ratio (LLR) sum for an unknown-bit puncturing scheme by considering the coded bit locations corresponding to the punctured bit locations as comprising unknown bits;

calculating a second LLR sum for a known-bit puncturing scheme by considering the coded bit locations corresponding to the punctured bit locations as comprising known bits;

selecting between the unknown-bit puncturing scheme and the known bit puncturing scheme according to a greater LLR sum between the first LLR sum and the second LLR sum;

polar coding an information block to produce the polar codeword; and

puncturing the polar codeword using the puncturing pattern and based on the selected puncturing scheme to produce a punctured codeword comprising a codeword length other than a power of two.

2. The method of claim 1, further comprising:

performing bit-reversal permutation on the puncturing pattern to produce a final puncturing pattern comprising final punctured bit locations different than the punctured bit locations.

3. The method of claim 2, wherein the final puncturing pattern comprises a uniform puncturing pattern.

4. The method of claim 1, wherein calculating the first LLR sum for the unknown-bit puncturing scheme comprises:

setting a respective unknown-bit LLR for each coded bit location corresponding to one of the punctured bit locations to zero; and

determining a respective first coded bit LLR for remaining ones of the coded bit locations.

5. The method of claim 4, wherein the information block comprises a plurality of

original bit locations, and wherein calculating the first LLR sum for the unknown-bit puncturing scheme further comprises:

calculating respective first LLRs for each original bit location of the information block from the respective first coded bit LLRs and the respective unknown-bit LLRs by performing density evolution or Gaussian approximation; and

calculating the first LLR sum based on the first LLRs.

6. The method of claim 5, wherein each of the coded bit locations corresponds to a sub-channel and the polar codeword comprises an original codeword length of N, and further comprising:

sorting the sub-channels based on the first LLRs;

selecting K best sub-channels in accordance with the first LLRs;

setting original bits of the information block corresponding to the K best sub-channels as information bits; and

setting original bits of the information block corresponding to N-K sub-channels as frozen bits.

7. The method of claim 1, wherein calculating the second LLR sum over the coded bit locations for the known-bit puncturing scheme comprises:

setting a respective known-bit LLR for each coded bit location corresponding to one of the punctured bit locations to infinity; and

determining a respective second coded bit LLR for remaining ones of the coded bit locations.

8. The method of claim 7, wherein the information block comprises a plurality of original bit locations, and wherein calculating the second LLR sum for the known-bit puncturing scheme further comprises:

calculating respective second LLRs for each original bit location of the information block from the respective second coded bit LLRs and the respective known-bit LLRs by performing density evolution or Gaussian approximation; and

calculating the second LLR sum based on the second LLRs.

9. The method of claim 8, wherein each of the coded bit locations corresponds to a

sub-channel, the polar codeword comprises an original codeword length of *N*, and the punctured codeword comprises the codeword length of *M*, and further comprising:

sorting the sub-channels based on the second LLRs;

selecting *K* best sub-channels, excluding the sub-channels corresponding to the punctured bit locations, in accordance with the second LLRs;

setting original bits of the information block corresponding to the *K* best sub-channels as information bits;

setting original bits of the information block corresponding to the sub-channels corresponding to the punctured bit locations as frozen bits; and

setting original bits of the information block corresponding to a remaining number of sub-channels as frozen bits, wherein the remaining number of sub-channels is equal to a difference between *N*-*K* and *N*-*M* sub-channels.

10. The method of claim 1, further comprising:

transmitting an explicit indication of the selected puncturing scheme; and

transmitting the punctured polar codeword.

11. The method of claim 1, wherein puncturing the polar codeword is performed during the polar coding the information block.

12. The method of claim 1, wherein generating the puncturing pattern further comprises:

generating the puncturing pattern with the plurality of punctured bit locations at an end of the initial puncturing pattern.

13. The method of claim 12, wherein the polar codeword comprises an original codeword length of *N*, and the punctured codeword comprises the codeword length of *M*, and further comprising:

setting a last *N*-*M* original bits of the information block to zero.

14. A method of polar decoding, comprising:

receiving a polar codeword;

determining whether punctured bits in the polar codeword are considered known bits or

unknown bits;

setting an initial log likelihood ratio (LLR) of each of the punctured bits to a first value if the punctured bits are considered unknown bits, or to a second value if the punctured bits are considered known bits, the second value being larger than the first value; and

performing decoding of the received polar codeword.

15. The method of claim 14, wherein determining whether the punctured bits are considered known bits or unknown bits comprises:

receiving an explicit indication of a utilized puncturing scheme selected from an unknown-bit puncturing scheme and a known bit puncturing scheme.

16. The method of claim 14, wherein determining whether the punctured bits are considered known bits or unknown bits comprises:

receiving one or more parameters corresponding to channel coding of the polar codeword; and

deriving whether the punctured bits are considered known bits or unknown bits in accordance with the one or more parameters.

17. The method of claim 16, wherein the one or more parameters comprise a coding rate, and wherein the deriving whether the punctured bits are considered known bits or unknown bits comprises determining that the punctured bits are considered known bits if the coding rate is greater than a coding rate threshold, and determining that the punctured bits are considered unknown bits if the coding rate is not greater than the coding rate threshold.

18. The method of claim 17, wherein the coding rate threshold is ½.

19. The method of claim 14, wherein performing decoding of the polar codeword further comprises:

using successive cancellation decoding to decode the polar codeword.

20. An apparatus configured for polar coding, the apparatus comprising:

a processor;

a memory communicatively coupled to the processor; and

a transceiver communicatively coupled to the processor,

wherein the processor is configured to:

generate a puncturing pattern comprising a plurality of punctured bit locations for puncturing corresponding coded bit locations in a polar codeword;

calculate a first log likelihood ratio (LLR) sum for an unknown-bit puncturing scheme by considering the coded bit locations corresponding to the punctured bit locations as comprising unknown bits;

calculate a second LLR sum for a known-bit puncturing scheme by considering the coded bit locations corresponding to the punctured bit locations as comprising known bits;

select between the unknown-bit puncturing scheme and the known bit puncturing scheme according to a greater LLR sum between the first LLR sum and the second LLR sum;

polar code an information block to produce the polar codeword; and

puncture the polar codeword using the puncturing pattern and based on the selected puncturing scheme to produce a punctured codeword comprising a codeword length other than a power of two.

21. The apparatus of claim 20, wherein the processor is further configured to perform bit-reversal permutation on the puncturing pattern to produce a final puncturing pattern comprising final punctured bit locations different than the punctured bit locations.

22. The apparatus of claim 20, wherein the processor is further configured to calculate the first LLR sum over the coded bit locations for the unknown-bit puncturing scheme by:

setting a respective unknown-bit LLR for each coded bit location corresponding to one of the punctured bit locations to zero; and

determining a respective first coded bit LLR for remaining ones of the coded bit locations.

23. The apparatus of claim 22, wherein the information block comprises a plurality of original bit locations, and wherein the processor is further configured to calculate the first LLR sum for the unknown-bit puncturing scheme by:

calculating respective first LLRs for each original bit location of the information block from the respective first coded bit LLRs and the respective unknown-bit LLRs by performing density evolution or Gaussian approximation; and

calculating the first LLR sum based on the first LLRs.

24. The apparatus of claim 20, wherein the processor is further configured to calculate the second LLR sum over the coded bit locations for the known-bit puncturing scheme by:

setting a respective known-bit LLR for each coded bit location corresponding to one of the punctured bit locations to infinity; and

determining a respective second coded bit LLR for remaining ones of the coded bit locations.

25. The apparatus of claim 24, wherein the information block comprises a plurality of original bit locations, and wherein the processor is further configured to calculate the first LLR sum for the known-bit puncturing scheme by:

calculating respective second LLRs for each original bit location of the information block from the respective second coded bit LLRs and the respective known-bit LLRs by performing density evolution or Gaussian approximation; and

calculating the second LLR sum based on the second LLRs.

26. The apparatus of claim 20, wherein the processor is further configured to:

transmit an explicit indication of the selected puncturing scheme via the transceiver; and

transmit the punctured polar codeword via the transceiver.

27. An apparatus configured for polar decoding, comprising:

a processor;

a memory communicatively coupled to the processor; and

a transceiver communicatively coupled to the processor,

wherein the processor is configured to:

receive a polar codeword;

determine whether punctured bits in the polar codeword are considered known bits or unknown bits;

set an initial log likelihood ratio (LLR) of each of the punctured bits to a first value if the punctured bits are considered unknown bits, or to a second value if the punctured bits are considered known bits, the second value being larger than the first value; and

perform decoding of the received polar codeword.

28. The apparatus of claim 27, wherein the processor is further configured to determine whether the punctured bits are considered known bits or unknown bits by receiving an explicit indication of a utilized puncturing scheme selected from an unknown-bit puncturing scheme and a known bit puncturing scheme.

29. The apparatus of claim 27, wherein the processor is further configured to determine whether the punctured bits are considered known bits or unknown bits by:

receiving one or more parameters corresponding to channel coding of the polar codeword; and

deriving whether the punctured bits are considered known bits or unknown bits in accordance with the one or more parameters.

30. The apparatus of claim 29, wherein the one or more parameters comprise a coding rate, and wherein the processor is further configured to derive whether the punctured bits are considered known bits or unknown bits by determining that the punctured bits are considered known bits if the coding rate is greater than a coding rate threshold, and determining that the punctured bits are considered unknown bits if the coding rate is not greater than the coding rate threshold.

31. The method of claim 14 wherein the first value is zero and the second value is one.

32. The method of claim 14 wherein the first value is zero and the second value is infinity.