CODEWORD SYNCHRONIZATION METHOD, RECEIVER, NETWORK DEVICE, AND NETWORK SYSTEM

~~This application claims priority to Chinese Patent Application No. 202010280832.9, filed on April 10, 2020 and entitled "CODEWORD SYNCHRONIZATION METHOD, RECEIVER, AND NETWORK DEVICE", and Chinese Patent Application No. 202010424884.9, filed on May 19, 2020 and entitled "CODEWORD SYNCHRONIZATION METHOD, RECEIVER, NETWORK DEVICE, AND NETWORK SYSTEM", which are incorporated herein by reference in their entireties.~~

TECHNICAL FIELD

[0001] This application relates to the communication field, and in particular, to a codeword synchronization method, a receiver, a network device, and a network system.

BACKGROUND

[0002] With improvement of a production process level, channel loss and noise have become key factors that limit a data transmission rate and distance. Emergence of forward error correction (Forward Error Correction) provides error correction protection for data in transmission, thereby increasing a data transmission rate and distance of a channel. The FEC may be classified into a block code (block code) and a convolutional code (convolutional code) based on different processing manners for information sequences. The block code may be further sub-classified into a linear block code (linear block code) and a non-linear block code (non-linear block code). Because encoding and decoding implementation of the linear block code is simple, the linear block code is widely used at a physical layer (physical layer) and a media access control (media access control) sublayer of a data link layer (data link layer) in an Open Systems Interconnection model (Open System Interconnection Model, OSI) of Ethernet.

[0003] Error detection and error correction functions of the linear block code need to be implemented based on a complete codeword (codeword). Therefore, a codeword boundary needs

CLAIMS

~~What is claimed is:~~

1. A codeword synchronization method, wherein the method comprises:

step 1: receiving a data sequence, wherein the data sequence comprises a plurality of bits;

step 2: determining a candidate bit in the data sequence, wherein the candidate bit is comprised in the plurality of bits; and

step 3: determining a synchronization position based on the candidate bit, wherein the synchronization position indicates a start position of a codeword in the data sequence.

2. The method according to claim 1, wherein step 3 comprises:

performing verification on the candidate bit, and when the verification succeeds, determining that a position of the candidate bit is the synchronization position.

3. The method according to claim 2, wherein step 3 comprises:

obtaining at least one second test data block from the data sequence through division based on the candidate bit, wherein the position of the candidate bit is a start position of the at least one second test data block; and

performing verification on a characteristic value of the at least one second test data block, and when the verification succeeds, determining that the position of the candidate bit is the synchronization position.

4. The method according to claim 3, wherein

the performing verification on a characteristic value of the at least one second test data block comprises:

sequentially accumulating a characteristic value of each of the at least one second test data block to obtain a cumulative value, wherein when the cumulative value meets a synchronization condition, the verification succeeds.

~~5. The method according to claim 4, wherein~~

~~the characteristic value is a quantity of second test data blocks determined as correct codewords, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of all-zero syndromes in syndromes, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization~~

~~threshold;~~

~~the characteristic value is a quantity of zero elements in a syndrome, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of correctable test data blocks, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold; or~~

~~the characteristic value is a quantity of test data blocks whose reconstructed parity bits are the same as received parity bits, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold, wherein~~

~~a length of the test data block is n bits, the first k bits of the test data block are information bits, the last n–k bits of the test data block are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n–k bits, and n and k are integers.~~

~~6~~5. The method according to claim 3, wherein

the performing verification on a characteristic value of the at least one second test data block comprises:

adding up characteristic values of all of the at least one second test data block to obtain a total value, wherein when the total value meets a synchronization condition, the verification succeeds.

~~7. The method according to claim 6, wherein~~

~~the characteristic value is a quantity of test data blocks that are in all the second test data blocks and that are determined as correct codewords, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of test data blocks that are in all the second test data blocks and that are determined as incorrect codewords, and the synchronization condition is that the cumulative value is less than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of all-zero syndromes in syndromes, and the synchronization condition is that the total value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of non-all-zero syndromes in syndromes, and the synchronization condition is that the total value is less than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of zero elements in a syndrome, and the synchronization condition is that the total value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of non-zero elements in a syndrome, and the synchronization condition is that the total value is less than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of correctable test data blocks, and the synchronization condition is that the total value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of uncorrectable test data blocks, and the synchronization condition is that the total value is less than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of test data blocks whose reconstructed parity bits are the same as received parity bits, and the synchronization condition is that the total value is greater than or equal to a synchronization threshold; or~~

~~the characteristic value is a quantity of test data blocks whose reconstructed parity bits are different from received parity bits, and the synchronization condition is that the total value is less than or equal to a synchronization threshold, wherein~~

~~a length of the test data block is n bits, the first k bits of the test data block are information bits, the last n-k bits of the test data block are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n-k bits, and n and k are integers.~~

~~8~~6. The method according to claim 1, wherein step 3 comprises:

using a position of the candidate bit as the synchronization position.

~~9~~7. The method according to claim 1, wherein step 2 comprises:

selecting a plurality of observed bits from the data sequence; and

selecting the candidate bit from the plurality of observed bits.

~~10~~8. The method according to claim ~~9~~7, wherein the selecting the candidate bit from the plurality of observed bits comprises:

determining a plurality of groups of first test data blocks in the data sequence based on the plurality of observed bits, wherein each of the plurality of groups of first test data blocks comprise at least one first test data block, and a position of each of the plurality of observed bits is a start position of each of the plurality of groups of first test data blocks; and

selecting one observed bit from the plurality of observed bits as the candidate bit based on characteristic values of the plurality of groups of first test data blocks.

~~11. The method according to claim 10, wherein~~

~~the selecting one observed bit from the plurality of observed bits as the candidate bit based~~

on characteristic values of the plurality of groups of first test data blocks comprises:

sequentially determining whether a characteristic value of each of the plurality of groups of first test data blocks meets a candidate condition, until it is determined that a characteristic value of a group of first test data blocks meets the candidate condition; and

using an observed bit corresponding to the group of first test data blocks that meet the candidate condition as the candidate bit.

12. The method according to claim 11, wherein

the characteristic value of the group of first test data blocks is a total quantity of first test data blocks that are in the group of first test data blocks and that are determined as correct codewords, and the candidate condition is that the cumulative value is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of first test data blocks that are in the group of first test data blocks and that are determined as correct codewords, and the candidate condition is that the cumulative value is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of all-zero syndromes in syndromes of all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of non-all-zero syndromes in syndromes of all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of zero elements in syndromes of all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of non-zero elements in syndromes of all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of correctable test data blocks in all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of uncorrectable

test data blocks in all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of test data blocks whose reconstructed parity bits are the same as received parity bits in all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of test data blocks whose reconstructed parity bits are different from received parity bits in all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a cumulative quantity of all-zero syndromes in syndromes of the first X first test data blocks in the group of first test data blocks, and the candidate condition is that the cumulative quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a cumulative quantity of zero elements in syndromes of the first X first test data blocks in the group of first test data blocks, and the candidate condition is that the cumulative quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a cumulative quantity of correctable test data blocks in the first X first test data blocks in the group of first test data blocks, and the candidate condition is that the cumulative quantity is greater than or equal to a synchronization threshold; or

the characteristic value of the group of first test data blocks is a cumulative quantity of test data blocks whose reconstructed parity bits are the same as received parity bits in the first X first test data blocks in the group of first test data blocks, and the candidate condition is that the cumulative quantity is greater than or equal to a synchronization threshold, wherein

a length of the test data block is n bits, the first k bits of the test data block are information bits, the last n−k bits of the test data block are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n−k bits, and n, k, and X are integers.

13. The method according to claim 10, wherein

the selecting one observed bit from the plurality of observed bits as the candidate bit based on characteristic values of the plurality of groups of first test data blocks comprises:

comparing characteristic values of all of the plurality of groups of first test data blocks; and using an observed bit corresponding to a group of first test data blocks whose characteristic value is an extreme value as the candidate bit.

14. The method according to claim 13, wherein

the characteristic value is a quantity of first test data blocks determined as correct codewords, and the extreme value is a maximum value;

the characteristic value is a quantity of first test data blocks determined as incorrect codewords, and the extreme value is a minimum value;

the characteristic value is a quantity of all-zero syndromes in syndromes, and the extreme value is a maximum value;

the characteristic value is a quantity of non-all-zero syndromes in syndromes, and the extreme value is a minimum value;

the characteristic value is a quantity of zero elements in a syndrome, and the extreme value is a maximum value;

the characteristic value is a quantity of non-zero elements in a syndrome, and the extreme value is a minimum value;

the characteristic value is a quantity of correctable test data blocks, and the extreme value is a maximum value;

the characteristic value is a quantity of uncorrectable test data blocks, and the extreme value is a minimum value;

the characteristic value is a quantity of test data blocks whose reconstructed parity bits are the same as received parity bits, and the extreme value is a maximum value; or

the characteristic value is a quantity of test data blocks whose reconstructed parity bits are different from received parity bits, and the extreme value is a minimum value, wherein

a length of the test data block is n bits, the first k bits of the test data block are information bits, the last n-k bits of the test data block are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n-k bits, and n and k are integers.

159. The method according to any one of claims 9 to 14claim 7 or 8, wherein

the selecting a plurality of observed bits from the data sequence comprises:

selecting one bit from the data sequence at an interval of T bits, and using the bit as the observed bit, wherein T is an integer greater than 0; or

selecting one bit from the data sequence at an interval of L×n+T bits, and using the bit as the observed bit, wherein L is a quantity of test data blocks in the interval, a length of the test data block is n bits, and L and T are integers greater than 0.

~~16~~10. The method according to claim 7 or 8~~any one of claims 9 to 14~~, wherein the data sequence is a modulated signal, and the data sequence comprises a plurality of modulated symbols; and

the selecting a plurality of observed bits from the data sequence comprises:

selecting a start bit of a modulated symbol from the data sequence at an interval of T modulated symbols, and using the start bit as the observed bit, wherein T is an integer greater than 0; or

selecting a start bit of a modulated symbol from the data sequence at an interval of L×m+T modulated symbols, and using the start bit as the observed bit, wherein L is a quantity of test data blocks in the interval, a length of the test data block is m modulated symbols, and L and T are integers greater than 0.

~~17~~11. The method according to claim 7 or 8~~any one of claims 9 to 16~~, wherein a quantity of observed bits is P, P is a positive integer, and a length of the codeword is P bits.

~~18~~12. The method according to any one of claims 3 to ~~7~~5, wherein

the determining a candidate bit in the data sequence in step 2 comprises: determining a candidate bit in a first subsequence; and the obtaining at least one second test data block from the data sequence through division based on the candidate bit in step 3 comprises: obtaining at least one second test data block from a second subsequence through division based on the candidate bit, wherein the first subsequence and the second subsequence are comprised in the data sequence, and the second subsequence is the same as, partially the same as, or different from the first subsequence.

~~19~~13. The method according to any one of claims 1 to ~~18~~12, wherein after step 3, the method further comprises:

step 4: in response to that the data sequence is in an out-of-lock state, determining an updated synchronization position of the data sequence.

~~20~~14. The method according to claim ~~19~~13, wherein the determining an updated

synchronization position of the data sequence comprises:

performing step 2 and step 3 again, and using a synchronization position determined in step 3 that is performed again as the updated synchronization position.

~~21~~15. The method according to claim ~~19 or 20~~13 or 14, wherein after step 3 and before step 4, the method further comprises:

obtaining a plurality of synchronization codewords from the data sequence through division based on the synchronization position, wherein the synchronization position is a start position of the plurality of synchronization codewords; and

performing verification on characteristic values of the plurality of synchronization codewords, and when the verification fails, determining that the data sequence is in the out-of-lock state.

~~22~~16. The method according to claim ~~21~~15, wherein

the performing verification on characteristic values of the plurality of synchronization codewords comprises:

sequentially accumulating a characteristic value of each of the plurality of synchronization codewords to obtain a cumulative value, wherein when the cumulative value meets an out-of-lock condition, the verification fails.

~~23. The method according to claim 22, wherein~~

~~the characteristic value is a quantity of synchronization codewords that are in the plurality of synchronization codewords and that are determined as incorrect codewords, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of non-all-zero syndromes in syndromes, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of non-zero elements in a syndrome, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of uncorrectable codewords, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold; or~~

~~the characteristic value is a quantity of codewords whose reconstructed parity bits are different from received parity bits, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold, wherein~~

~~a length of the codeword is n bits, the first k bits of the codeword are information bits, the last n−k bits of the codeword are the received parity bits, the reconstructed parity bits are obtained~~

~~based on the information bits, a length of the reconstructed parity bits is n-k bits, and n and k are integers.~~

~~24~~17. The method according to claim ~~21~~15, wherein

the performing verification on characteristic values of the plurality of synchronization codewords comprises:

adding up characteristic values of all of the plurality of synchronization codewords to obtain a total value, wherein when the total value meets an out-of-lock condition, the verification fails.

~~25. The method according to claim 24, wherein~~

~~the total value of the characteristic values is a total quantity of synchronization codewords that are in the plurality of synchronization codewords and that are determined as incorrect codewords, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold;~~

~~the total value of the characteristic values is a total quantity of synchronization codewords that are in the plurality of synchronization codewords and that are determined as correct codewords, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold; the characteristic value is a quantity of all-zero syndromes in syndromes, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of non-all-zero syndromes in syndromes, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of zero elements in a syndrome, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of non-zero elements in a syndrome, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of correctable codewords, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of uncorrectable codewords, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold;~~

~~the characteristic value is a quantity of codewords whose reconstructed parity bits are the same as received parity bits, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold; or~~

~~the characteristic value is a quantity of codewords whose reconstructed parity bits are~~

~~different from received parity bits, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold, wherein~~

~~a length of the codeword is n bits, the first k bits of the codeword are information bits, the last n–k bits of the codeword are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n–k bits, and n and k are integers.~~

~~26~~18. The method according to any one of claims 1 to ~~25~~17, wherein the data sequence is a linear block code.

~~27. A communication device, wherein the communication device comprises:~~

~~a receiving unit, configured to perform step 1: receiving a data sequence, wherein the data sequence comprises a plurality of bits; and~~

~~a processing unit, configured to perform step 2: determining a candidate bit in the data sequence, wherein the candidate bit is comprised in the plurality of bits; and step 3: determining a synchronization position based on the candidate bit, wherein the synchronization position indicates a start position of a codeword in the data sequence.~~

~~28. The communication device according to claim 27, wherein~~

~~the processing unit is further configured to: perform verification on the candidate bit, and when the verification succeeds, determine that a position of the candidate bit is the synchronization position.~~

~~29. The communication device according to claim 28, wherein~~

~~the processing unit is further configured to: obtain at least one second test data block from the data sequence through division based on the candidate bit, wherein the position of the candidate bit is a start position of the at least one second test data block; and perform verification on a characteristic value of the at least one second test data block, and when the verification succeeds, determine that the position of the candidate bit is the synchronization position.~~

~~30. The communication device according to claim 29, wherein~~

~~the processing unit is further configured to sequentially accumulate a characteristic value of each of the at least one second test data block to obtain a cumulative value, wherein when the cumulative value meets a synchronization condition, the verification succeeds.~~

~~31. The communication device according to claim 30, wherein~~

~~the characteristic value is a quantity of second test data blocks determined as correct~~

codewords, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of all-zero syndromes in syndromes, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of zero elements in a syndrome, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of correctable test data blocks, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold; or

the characteristic value is a quantity of test data blocks whose reconstructed parity bits are the same as received parity bits, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold, wherein

a length of the test data block is n bits, the first k bits of the test data block are information bits, the last n−k bits of the test data block are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n−k bits, and n and k are integers.

32. The communication device according to claim 29, wherein

the processing unit is further configured to add up characteristic values of all of the at least one second test data block to obtain a total value, wherein when the total value meets a synchronization condition, the verification succeeds.

33. The communication device according to claim 32, wherein

the characteristic value is a quantity of test data blocks that are in all the second test data blocks and that are determined as correct codewords, and the synchronization condition is that the cumulative value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of test data blocks that are in all the second test data blocks and that are determined as incorrect codewords, and the synchronization condition is that the cumulative value is less than or equal to a synchronization threshold;

the characteristic value is a quantity of all-zero syndromes in syndromes, and the synchronization condition is that the total value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of non-all-zero syndromes in syndromes, and the

synchronization condition is that the total value is less than or equal to a synchronization threshold;

the characteristic value is a quantity of zero elements in a syndrome, and the synchronization condition is that the total value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of non-zero elements in a syndrome, and the synchronization condition is that the total value is less than or equal to a synchronization threshold;

the characteristic value is a quantity of correctable test data blocks, and the synchronization condition is that the total value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of uncorrectable test data blocks, and the synchronization condition is that the total value is less than or equal to a synchronization threshold;

the characteristic value is a quantity of test data blocks whose reconstructed parity bits are the same as received parity bits, and the synchronization condition is that the total value is greater than or equal to a synchronization threshold; or

the characteristic value is a quantity of test data blocks whose reconstructed parity bits are different from received parity bits, and the synchronization condition is that the total value is less than or equal to a synchronization threshold, wherein

a length of the test data block is n bits, the first k bits of the test data block are information bits, the last n−k bits of the test data block are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n−k bits, and n and k are integers.

34. The communication device according to claim 27, wherein

the processing unit is further configured to use a position of the candidate bit as the synchronization position.

35. The communication device according to claim 27, wherein

the processing unit is further configured to: select a plurality of observed bits from the data sequence; and select the candidate bit from the plurality of observed bits.

36. The communication device according to claim 35, wherein

the processing unit is further configured to: determine a plurality of groups of first test data blocks in the data sequence based on the plurality of observed bits, wherein each of the plurality of groups of first test data blocks comprise at least one first test data block, and a position of each of the plurality of observed bits is a start position of each of the plurality of groups of first test data blocks; and select one observed bit from the plurality of observed bits as the candidate bit based

on characteristic values of the plurality of groups of first test data blocks.

37. The communication device according to claim 36, wherein

the processing unit is further configured to: sequentially determine whether a characteristic value of each of the plurality of groups of first test data blocks meets a candidate condition, until it is determined that a characteristic value of a group of first test data blocks meets the candidate condition; and use an observed bit corresponding to the group of first test data blocks that meet the candidate condition as the candidate bit.

38. The communication device according to claim 37, wherein

the characteristic value of the group of first test data blocks is a total quantity of first test data blocks that are in the group of first test data blocks and that are determined as correct codewords, and the candidate condition is that the cumulative value is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of first test data blocks that are in the group of first test data blocks and that are determined as correct codewords, and the candidate condition is that the cumulative value is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of all-zero syndromes in syndromes of all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of non-all-zero syndromes in syndromes of all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of zero elements in syndromes of all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of non-zero elements in syndromes of all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of correctable test data blocks in all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of uncorrectable test data blocks in all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of test data blocks whose reconstructed parity bits are the same as received parity bits in all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a total quantity of test data blocks whose reconstructed parity bits are different from received parity bits in all first test data blocks in the group of first test data blocks, and the candidate condition is that the total quantity is less than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a cumulative quantity of all-zero syndromes in syndromes of the first X first test data blocks in the group of first test data blocks, and the candidate condition is that the cumulative quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a cumulative quantity of zero elements in syndromes of the first X first test data blocks in the group of first test data blocks, and the candidate condition is that the cumulative quantity is greater than or equal to a synchronization threshold;

the characteristic value of the group of first test data blocks is a cumulative quantity of correctable test data blocks in the first X first test data blocks in the group of first test data blocks, and the candidate condition is that the cumulative quantity is greater than or equal to a synchronization threshold; or

the characteristic value of the group of first test data blocks is a cumulative quantity of test data blocks whose reconstructed parity bits are the same as received parity bits in the first X first test data blocks in the group of first test data blocks, and the candidate condition is that the cumulative quantity is greater than or equal to a synchronization threshold, wherein

a length of the test data block is n bits, the first k bits of the test data block are information bits, the last n−k bits of the test data block are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n−k bits, and n, k, and X are integers.

39. The communication device according to claim 36, wherein

the processing unit is further configured to: compare characteristic values of all of the plurality of groups of first test data blocks; and use an observed bit corresponding to a group of first test data blocks whose characteristic value is an extreme value as the candidate bit.

40. The communication device according to claim 39, wherein

the characteristic value is a quantity of first test data blocks determined as correct codewords, and the extreme value is a maximum value;

the characteristic value is a quantity of first test data blocks determined as incorrect codewords, and the extreme value is a minimum value;

the characteristic value is a quantity of all-zero syndromes in syndromes, and the extreme value is a maximum value;

the characteristic value is a quantity of non-all-zero syndromes in syndromes, and the extreme value is a minimum value;

the characteristic value is a quantity of zero elements in a syndrome, and the extreme value is a maximum value;

the characteristic value is a quantity of non-zero elements in a syndrome, and the extreme value is a minimum value;

the characteristic value is a quantity of correctable test data blocks, and the extreme value is a maximum value;

the characteristic value is a quantity of uncorrectable test data blocks, and the extreme value is a minimum value;

the characteristic value is a quantity of test data blocks whose reconstructed parity bits are the same as received parity bits, and the extreme value is a maximum value; or

the characteristic value is a quantity of test data blocks whose reconstructed parity bits are different from received parity bits, and the extreme value is a minimum value, wherein

a length of the test data block is n bits, the first k bits of the test data block are information bits, the last n−k bits of the test data block are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n−k bits, and n and k are integers.

41. The communication device according to any one of claims 35 to 40, wherein

the processing unit is further configured to: select one bit from the data sequence at an interval

~~of T bits, and use the bit as the observed bit, wherein T is an integer greater than 0; or~~

~~the processing unit is further configured to: select one bit from the data sequence at an interval of L×n+T bits, and use the bit as the observed bit, wherein L is a quantity of test data blocks in the interval, a length of the test data block is n bits, and L and T are integers greater than 0.~~

~~42. The communication device according to any one of claims 35 to 40, wherein~~

~~the processing unit is further configured to: select a start bit of a modulated symbol from the data sequence at an interval of T modulated symbols, and use the start bit as the observed bit, wherein T is an integer greater than 0; or~~

~~the processing unit is further configured to: select a start bit of a modulated symbol from the data sequence at an interval of L×m+T modulated symbols, and use the start bit as the observed bit, wherein L is a quantity of test data blocks in the interval, a length of the test data block is m modulated symbols, and L and T are integers greater than 0.~~

~~43. The communication device according to any one of claims 35 to 42, wherein a quantity of observed bits is P, P is a positive integer, and a length of the codeword is P bits.~~

~~44. The communication device according to any one of claims 29 to 33, wherein~~

~~the determining a candidate bit in the data sequence in step 2 comprises: determining a candidate bit in a first subsequence; and the obtaining at least one second test data block from the data sequence through division based on the candidate bit in step 3 comprises: obtaining at least one second test data block from a second subsequence through division based on the candidate bit, wherein the first subsequence and the second subsequence are comprised in the data sequence, and the second subsequence is the same as, partially the same as, or different from the first subsequence.~~

~~45. The communication device according to any one of claims 27 to 44, wherein~~

~~the processing unit is further configured to perform step 4: in response to that the data sequence is in an out-of-lock state, determining an updated synchronization position of the data sequence.~~

~~46. The communication device according to claim 45, wherein~~

~~the processing unit is further configured to: perform step 2 and step 3 again, and use a synchronization position determined in step 3 that is performed again as the updated synchronization position.~~

~~47. The communication device according to claim 45 or 46, wherein~~

~~the processing unit is further configured to: obtain a plurality of synchronization codewords~~

from the data sequence through division based on the synchronization position, wherein the synchronization position is a start position of the plurality of synchronization codewords; and perform verification on characteristic values of the plurality of synchronization codewords, and when the verification fails, determine that the data sequence is in the out-of-lock state.

48. The communication device according to claim 47, wherein

the processing unit is further configured to sequentially accumulate a characteristic value of each of the plurality of synchronization codewords to obtain a cumulative value, wherein when the cumulative value meets an out-of-lock condition, the verification fails.

49. The communication device according to claim 48, wherein

the cumulative value of the characteristic values is a total quantity of synchronization codewords that are in the plurality of synchronization codewords and that are determined as incorrect codewords, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of non-all-zero syndromes in syndromes, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of non-zero elements in a syndrome, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of uncorrectable codewords, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold; or

the characteristic value is a quantity of codewords whose reconstructed parity bits are different from received parity bits, and the out-of-lock condition is that the cumulative value is greater than or equal to a synchronization threshold, wherein

a length of the codeword is n bits, the first k bits of the codeword are information bits, the last n−k bits of the codeword are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n−k bits, and n and k are integers.

50. The communication device according to claim 47, wherein

the processing unit is further configured to add up characteristic values of all of the plurality of synchronization codewords to obtain a total value, wherein when the total value meets an out-of-lock condition, the verification fails.

51. The communication device according to claim 50, wherein

the total value of the characteristic values is a total quantity of synchronization codewords that are in the plurality of synchronization codewords and that are determined as correct codewords, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold;

the total value of the characteristic values is a total quantity of synchronization codewords that are in the plurality of synchronization codewords and that are determined as incorrect codewords, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of all-zero syndromes in syndromes, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold;

the characteristic value is a quantity of non-all-zero syndromes in syndromes, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of zero elements in a syndrome, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold;

the characteristic value is a quantity of non-zero elements in a syndrome, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of correctable codewords, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold;

the characteristic value is a quantity of uncorrectable codewords, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold;

the characteristic value is a quantity of codewords whose reconstructed parity bits are the same as received parity bits, and the out-of-lock condition is that the total value is less than or equal to a synchronization threshold; or

the characteristic value is a quantity of codewords whose reconstructed parity bits are different from received parity bits, and the out-of-lock condition is that the total value is greater than or equal to a synchronization threshold, wherein

a length of the codeword is n bits, the first k bits of the codeword are information bits, the last n-k bits of the codeword are the received parity bits, the reconstructed parity bits are obtained based on the information bits, a length of the reconstructed parity bits is n-k bits, and n and k are integers.

52. The communication device according to any one of claims 27 to 51, wherein the data

~~sequence is a linear block code.~~

~~53~~19. A communication device, wherein the communication device comprises a processor, a communication interface, and a memory, the memory may be configured to store program code, and the processor is configured to invoke the program code from the memory to perform the method according to any one of claims 1 to ~~26~~18.

~~54~~20. A chip, wherein the chip comprises a memory and a processor, the memory is configured to store a computer program, and the processor is configured to invoke the computer program from the memory and run the computer program, to perform the method according to any one of claims 1 to ~~26~~18.

~~55. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program; and when the computer program is run on a processor, the method according to any one of claims 1 to 26 is implemented.~~

~~56. A network system, wherein the network system comprises a sending device and a receiving device, and the receiving device is the communication device according to any one of claims 27 to 53.~~