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(73) Proprietor: **HUAWEI TECHNOLOGIES CO., LTD.**
Shenzhen, Guangdong 518129 (CN)

(72) Inventors:
- **WANG, Jianguo**
  Shenzhen, Guangdong 518129 (CN)
- **ZHOU, Yongxing**
  Shenzhen, Guangdong 518129 (CN)

(74) Representative: **Thun, Clemens**
Mitscherlich PartmbB
Patent- und Rechtsanwälte
Sonnenstraße 33
80331 München (DE)

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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of communications technologies, and in particular, to a reference signal transmission method and an apparatus.

BACKGROUND

[0002] Generally, different types of reference signals are used in a communications system, where one type of reference signal is used for channel estimation, by which coherent demodulation is performed on a received signal including control information or data, and another type of reference signal is used for channel state or channel quality measurement, by which scheduling for UE (User Equipment, user equipment) is implemented. In a 3GPP (the 3rd Generation Partnership Project, 3rd Generation Partnership Project) LTE (Long Term Evolution, Long Term Evolution) R10 (Release 10, Release 10) downlink system, a reference signal used for coherent demodulation is referred to as a DMRS (Demodulation Reference Signal, demodulation reference signal), and a reference signal used for channel state information measurement is referred to as a CSI-RS (Channel State Information Reference Signal, channel state information-reference signal). In addition, reference signals also include a CRS (Cell-specific Reference Signal, cell-specific reference signal) inherited from an R8/R9 system, where the CRS is used for UE channel estimation, which implements demodulation of a PDCCH (Physical Downlink Control Channel, physical downlink control channel) and other public channels.

[0003] In an LTE system, maximum quantities of antenna ports supported by the foregoing several types of reference signals are different. In LTE R10, the DMRS supports a maximum of eight antenna ports; in LTE R10, the CSI-RS supports a maximum of eight antenna ports, where a quantity of antenna ports may be 1, 2, 4, or 8; and in LTE R8 to R10, the CRS supports a maximum of four antenna ports, where a quantity of antenna ports may be 1, 2, or 4. In LTE R10, the DMRS supports a maximum of eight antenna ports, where a quantity of antenna ports may be 1 to 8. To improve spectral efficiency, the soon-to-be-launched LTE R12 standard has begun to consider introducing more antenna configurations, especially an antenna configuration of more than eight antenna ports based on an AAS (Active Antenna Systems, active antenna system). For example, a quantity of antenna ports may be 16, 32, or 64.

[0004] For example, CN 102 624 495 A refers to a method of processing reference signal configuration information, a base station and a terminal. The method includes: sending, by a base station, first reference signal configuration information and at least one piece of second reference signal configuration information to a terminal, such that the terminal performs detection of downlink channel state information according to the first reference signal configuration information and the at least one piece of second reference signal configuration information, wherein the first reference signal configuration information includes configuration information of a reference signal sent by antenna port(s) identified by a first number of ports, and the second reference signal configuration information includes configuration information of a reference signal sent by at least one antenna port of other antenna ports than the antenna port(s) identified by the first number of ports among the antenna ports configured by the base station.

[0005] Further, US 2012/0176939 A1 refers to a communications system and a method for performing communications. User Equipments (UEs) are provided with UE-specific configuration information, such as CSI-RS (Channel Status Indication-Reference Signal) patterns, antenna port groupings, reference signal configurations, subframe configurations, and/or scrambling codes. The UEs process the received reference signals in accordance with the received configuration information and feedback measurement information for, e.g., PMI/CQI/RI (Precoding Matrix Indicator/Channel Quality Indicator/Rank Indicator of the precoding matrix) and/or the RLM/RRM (Radio Link Monitor/Radio Resource Management).

[0006] Further, US 2010/0062783A1 refers to a coding scheme for wireless communication downlink reference signals. By way of example, a dedicated reference signal is mapped to resources of a wireless channel as a function of an identifier (ID) of a cell in which the reference signal is transmitted. The function can be similar to mapping functions employed for common reference signals, or can be distinct from such functions. As one example of the latter, a dedicated reference signal mapping function can be shifted in time or frequency with respect to the common reference signal mapping function. By employing a mapping function based on cell ID, noise caused by concurrent transmission of reference signals can be mitigated in a manner readily determined by terminals in a wireless network.

[0007] The prior art has at least the following problems: the prior-art CRS supports a maximum of four antenna ports, and direct expansion to support 16 antenna ports or more antenna ports may result in high overheads. The prior-art CSI-RS supports a maximum of eight antenna ports, and direct expansion in a PDSCH region to support 16 antenna ports or more antenna ports may result in interference to downlink data transmission of an existing system, causing performance degradation of a downlink system. If expansion is performed by using a neighboring resource block, correct CSI estimation cannot be performed by legacy (Legacy) UE. Therefore, no prior-art reference signal design solution can provide effective support for more antenna ports.

SUMMARY

[0008] A reference signal transmission method and an apparatus are provided, and can resolve a problem that prior-art reference signals do not support more than eight antenna ports, so as to improve efficiency of channel state information measurement and improve a system throughput.

[0009] This problem is solved by the subject matter of the independent claims 1, 4 and 5. Further implementation forms are provided in the dependent claims.

[0010] Compared with the prior art, in the embodiments of the present invention, user equipment receives reference signal resource configuration information sent by a base station, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index; the user equipment determines a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index; and the user equipment obtains, according to the determined reference signal configuration, positions of resource elements REs that are used to send reference signals on antenna ports in the antenna port set, and receives, according to the positions of the REs, the reference signals sent by the base station. Therefore, a problem that prior-art reference signals do not support more than eight antenna ports can be resolved, and a feasible design solution for reference signal configuration is provided for an antenna configuration including more than eight antenna ports. In addition, resource element groups used by the two antenna port subsets in two RB pairs do not have an intersection. Therefore, on one hand, an RE position occupied by a CSI RS in a legacy (Legacy) system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced. On the other hand, for multiple different reference signal configurations, because the resource element groups used in the two RB pairs do not have an intersection, inter-cell interference caused by reference signals may be reduced, that is, pilot contamination is reduced, thereby improving efficiency of channel state information measurement, and improving a system throughput.

BRIEF DESCRIPTION OF DRAWINGS

[0011] To describe the technical solutions in the embodiments of the present invention more clearly, the following briefly introduces the accompanying drawings required for describing the embodiments or the prior art. Apparently, the accompanying drawings in the following description show merely some embodiments of the present invention, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

FIG. 1 is a flowchart of a method of processing a reference signal according to the present invention;
FIG. 2 is a flowchart of a reference signal sending method according to the present invention;
FIG. 3 is a flowchart of a reference signal sending and receiving method according to the present invention;
FIG. 3a is a schematic diagram of frame structure type 1;
FIG. 3b is a schematic diagram of frame structure type 2;
FIG. 3c is a schematic structural diagram of a timeslot;
FIG. 4a is a schematic diagram of a reference signal configuration according to the present invention;
FIG. 4b is a schematic diagram of a reference signal configuration according to an example not covered by the claims;
FIG. 5a and FIG. 5b are schematic diagrams of reference signal configurations in another case according to another example not covered by the claims;
FIG. 6 is a schematic structural diagram of an apparatus according to the present invention;
FIG. 7 is a schematic structural diagram of an apparatus according to the present invention;
FIG. 8 is a schematic structural diagram of user equipment according to the present invention; and
FIG. 9 is a schematic structural diagram of a base station according to the present invention.

DESCRIPTION OF EMBODIMENTS

[0012] The following clearly and completely describes the technical solutions in the embodiments of the present invention with reference to the accompanying drawings in the embodiments of the present invention.

[0013] To make the advantages of the technical solutions in the present invention clearer, the following describes the present invention in detail with reference to the accompanying drawings and the embodiments.

[0014] As shown in FIG. 1, a method of processing a reference signal includes:

101: User equipment receives reference signal resource configuration information sent by a base station, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index.

102: The user equipment determines a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index.

[0015] The reference signal configuration is used to indicate position information of REs (Resource Element, resource element) that are used to send reference signals on antenna ports in an antenna port set, the reference signal configuration set includes at least one first reference signal configuration, and an antenna port set corresponding to the first reference signal configuration includes at least two antenna port subsets, where an RE that is used to send a reference signal on an antenna port in a first antenna port subset is located in a first RB (Resource Block, resource block) pair (Pair), an RE that is used to send a reference signal on an antenna port in a second antenna port subset is located in a second RB pair, and the first RB pair is different from the second RB pair.

[0016] The first RB pair and the second RB pair are separately located at different frequency domain positions in a same subframe or located in a same subband of different subframes.

[0017] Further, a resource element group used by the first antenna port subset in the first RB pair is REG_{i_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{i_2}, where $REG_{i_1} \in A$, $REG_{i2} \in A$, and $i_1 \neq i_2$; the set is $A = \{REG_i | i = 0, 1,...,M-1\}, M \geq 2$, where an intersection of different resource element groups in the set A is an empty set, $i_1,i_2 \in \{0,...,M\text{-}1\}$ and i_1 and i_2 are indexes of the REGs (Resource Element Group, resource element group) used in the two RB pairs respectively; and each resource element group in the set A represents a set of position triplets $(k',l',n_s \bmod 2)$ of resource elements REs in an RB pair that are used to send reference signals, relative to the RB pair in which the resource elements REs are located, where k' represents an index of a subcarrier of the resource element RE, in the RB pair in which the resource element RE is located, l' represents an index of an OFDM (Orthogonal Frequency Division Multiplexing, orthogonal frequency division multiplexing) symbol of the resource element, in the RB pair in which the resource element is located, n_s represents an index of a timeslot to which the resource element belongs, mod represents a modulo operation, and n_s mod2 represents a computed value resulting from a modulo 2 operation on n_s.

[0018] It should be noted that the symbol $\in$ indicates a belonging or subordination relationship. For example, $REG_{i_1} \in A$ indicates that REG_{i_1} is an element in the set A. $\in$ is a commonly used mathematical symbol, and is not described again herein elsewhere.

[0019] It should be pointed out that an intersection of different resource element groups in the set A is an empty set. Therefore, the resource element groups REG_{i_1} and REG_{i_2} are two different elements in the set A respectively, that is, an intersection of the two different resource element groups REG_{i_1} and REG_{i_2} is also an empty set.

[0020] Further, the reference signal configuration set includes at least one second reference signal configuration, an antenna port set corresponding to the second reference signal configuration includes at least the first antenna port subset and the second antenna port subset, a resource element group used by the first antenna port subset in the first RB pair is REG_{j_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{j_2}, where $REG_{j1} \in A$, $REG_{j_2} \in A$, $j_1 \neq j_2, j_1, j_2 \in \{0,1, ...,M-1\}$, and i_1,i_2,j_1 and j_2 meet at least one of the following relationships: $j_1 = (i_1+n) \bmod M$, $j_2 = (i_2+n) \bmod M$, or $j_1 = i_2$, $j_2 = i_1$, where n represents a shift (shift) whose value is an integer.

[0021] Specifically, different resource element groups in the set A may be different position sets of REs that are used to send CSI RSs on eight antenna ports in an LTE RIO system. In this case, the resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. In this case, for LTE RIO and R11 systems, an eNB (evolved Node B, evolved Node B) may instruct legacy (Legacy) UE to receive, at positions of REs in REG_{i_1} in the first RB pair and the second RB pair, non-zero-power CSI RSs sent on eight antenna ports, and instruct the legacy (Legacy) UE that the eNB sends zero-power CSI RSs at positions of REs in REG_{i_2} in the first RB pair and the second RB pair. For an LTE R12 system or a future system, an eNB may instruct UE to receive, at positions of REs in REG_{i_1} in the first RB pair, non-zero-power CSI RSs sent on first eight antenna ports of 16 antenna ports and to receive, at positions of REs in REG_{i_2} in the second RB pair, non-zero-power CSI RSs sent on the last eight antenna ports of the 16 antenna ports, and the eNB may notify the UE that zero-power CSI RSs are at positions of REs in REG_{i_2} in the first RB pair and at positions of REs in REG_{i_1} in the second RB pair. Both the legacy (Legacy) UE and the UE in the LTE R12 system or the future system can perform correct rate matching for a PDSCH according to the positions of non-zero-power CSI RSs and zero-power CSI RSs notified by the eNB, which avoids mapping the PDSCH to the positions of non-zero-power CSI RSs and zero-power CSI RSs, thereby avoiding interference to the PDSCH. Therefore, in the foregoing reference signal configuration, an RE position occupied by a CSI RS in the LTE RIO system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced.

[0022] In addition, in a two-cell example, an eNB instructs UE to: use the first reference signal configuration in a first cell, that is, receive non-zero-power CSI RSs in the resource element group REG_{i_1} in the first RB pair and in the resource element group REG_{i_2} in the second RB pair, and use the second reference signal configuration in a second cell, that is, receive non-zero-power CSI RSs in the resource element group REG_{j_1} in the first RB pair and in the resource element group REG_{j_2} in the second RB pair; and the eNB notifies, in the first cell, the UE that zero-power CSI RSs are in the resource element group REG_{j_1} in the first RB pair and in the resource element group REG_{j_2} in the second RB pair, and the eNB notifies, in the second cell, the UE that zero-power CSI RSs are in the resource element group REG_{i_1} in the first RB pair and in the resource element group REG_{i_2} in the second RB pair. In the two cells, the resource element groups REG_{i_1}, REG_{i_2}, REG_{j_1}, and REG_{j_2} and the indexes i_1,i_2,j_1, and j_2 are used in the two different RBs, where i_1,i_2,j_1 and j_2 meet at least one of the following relationships: $j_1 = (i_1+n)\mathrm{mod}M$, $j_2 = (i_2+n)\mathrm{mod}M$, or $j_1 = i_2$, $j_2 = i_1$, where n represents a shift (shift) whose value is an integer. Therefore, on one hand, non-zero-power CSI RSs configured by UE in each cell are staggered from, that is, have no intersection with, non-zero-power CSI RSs configured by UE in a neighboring cell, thereby effectively avoiding pilot contamination (Pilot Contamination). On the other hand, UEs in the cells can all perform correct rate matching on a PDSCH according to the positions of non-zero-power CSI RSs and zero-power CSI RSs notified by the eNB, which avoids mapping the PDSCH to the positions of non-zero-power CSI RSs and zero-power CSI RSs, and avoids interference to the PDSCH caused by CSI RSs of a neighboring cell.

[0023] According to the present invention, when a CP (Cyclic Prefix, cyclic prefix) is a normal CP (Normal CP, NCP for short), a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the following resource element groups:

$$REG_0^{NCP} = \{(9,5,0), (9,6,0), (8,5,0), (8,6,0), (3,5,0), (3,6,0), (2,5,0), (2,6,0)\} \quad (1);$$

$$REG_1^{NCP} = \{(11,2,1), (11,3,1), (10,2,1), (10,3,1), (5,2,1), (5,3,1), (4,2,1), (4,3,1)\} \quad (2);$$

$$REG_2^{NCP} = \{(9,2,1), (9,3,1), (8,2,1), (8,3,1), (3,2,1), (3,3,1), (2,2,1), (2,3,1)\} \quad (3);$$

$$REG_3^{NCP} = \{(7,2,1), (7,3,1), (6,2,1), (6,3,1), (1,2,1), (1,3,1), (0,2,1), (0,3,1)\} \quad (4);$$

and

$$REG_4^{NCP} = \{(9,5,1), (9,6,1), (8,5,1), (8,6,1), (3,5,1), (3,6,1), (2,5,1), (2,6,1)\} \quad (5).$$

[0024] The resource element group set A may apply to a subframe type being LTE frame structure type 1 (Frame Structure type 1, FS1 for short) or frame structure type 2 (Frame Structure type 2, FS2 for short).

[0025] That each resource element group includes four REs is used as an example. The resource element group set *A* includes two or more of the following resource element groups:

$$\{(9,5,0), (9,6,0), (8,5,0), (8,6,0)\} \quad (6);$$

$$\{(3,5,0), (3,6,0), (2,5,0), (2,6,0)\} \quad (7);$$

$$\{(11,2,1), (11,3,1), (10,2,1), (10,3,1)\} \quad (8);$$

$$\{(5,2,1), (5,3,1), (4,2,1), (4,3,1)\} \quad (9);$$

$$\{(9,2,1), (9,3,1), (8,2,1), (8,3,1)\} \quad (10);$$

$$\{(3,2,1), (3,3,1), (2,2,1), (2,3,1)\} \quad (11);$$

$$\{(7,2,1), (7,3,1), (6,2,1), (6,3,1)\} \quad (12);$$

$$\{(1,2,1), (1,3,1), (0,2,1), (0,3,1)\} \quad (13);$$

$$\{(9,5,1), (9,6,1), (8,5,1), (8,6,1)\} \quad (14);$$

and

$$\{(3,5,1), (3,6,1), (2,5,1), (2,6,1)\} \quad (15).$$

[0026] The resource element group set A may apply to a subframe type FS1 or FS2.

[0027] That each resource element group includes eight REs is used as an example. The resource element group set *A* may further include two or more of the following resource element groups:

$$\{(11,5,0), (11,6,0), (11,5,1), (11,6,1), (10,5,0), (10,6,0), (10,5,1), (10,6,1)\} \quad (16);$$

$$\{(6,5,0), (6,6,0), (6,5,1), (6,6,1), (5,5,0), (5,6,0), (5,5,1), (5,6,1)\} \quad (17);$$

and

$$\{(1,5,0), (1,6,0), (1,5,1), (1,6,1), (0,5,0), (0,6,0), (0,5,1), (0,6,1)\} \quad (18).$$

[0028] That each resource element group includes four REs is used as an example. The resource element group set A may further include two or more of the following resource element groups:

$$\{(11,5,0), (11,6,0), (11,5,1), (11,6,1)\} \quad (19);$$

$$\{(10,5,0), (10,6,0), (10,5,1), (10,6,1)\} \quad (20);$$

$$\{(6,5,0), (6,6,0), (6,5,1), (6,6,1)\} \quad (21);$$

$$\{(5,5,0), (5,6,0), (5,5,1), (5,6,1)\} \quad (22);$$

$$\{(1,5,0), (1,6,0), (1,5,1), (1,6,1)\} \quad (23);$$

and

$$\{(0,5,0), (0,6,0), (0,5,1), (0,6,1)\} \quad (24).$$

[0029] The resource element group set A may apply to a subframe type FS1.

[0030] In another example, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet ($k',l',n_s \bmod 2$). That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the following resource element groups:

$$REG_0^{NCP,FS2} = \{(11,1,1), (11,3,1), (10,1,1), (10,3,1), (5,1,1), (5,3,1), (4,1,1), (4,3,1)\} \quad (25);$$

$$REG_1^{NCP,FS2} = \{(9,1,1), (9,3,1), (8,1,1), (8,3,1), (3,1,1), (3,3,1), (2,1,1), (2,3,1)\} \quad (26);$$

and

$$REG_2^{NCP,FS2} = \{(7,1,1), (7,3,1), (6,1,1), (6,3,1), (1,1,1), (1,3,1), (0,1,1), (0,3,1)\} \quad (27).$$

[0031] The resource element group set A may apply to a subframe type FS2.

[0032] That each resource element group includes four REs is used as an example. The resource element group set A includes two or more of the following resource element groups:

$$\{(11,1,1), (11,3,1), (10,1,1), (10,3,1)\} \quad (28);$$

$$\{(5,1,1), (5,3,1), (4,1,1), (4,3,1)\} \quad (29);$$

$$\{(9,1,1), (9,3,1), (8,1,1), (8,3,1)\} \quad (30);$$

$$\{(3,1,1), (3,3,1), (2,1,1), (2,3,1)\} \quad (31);$$

$$\{(7,1,1), (7,3,1), (6,1,1), (6,3,1)\} \quad (32);$$

and

$$\{(1,1,1), (1,3,1), (0,1,1), (0,3,1)\} \quad (33).$$

[0033] The resource element group set A may apply to a subframe type FS2.

[0034] For LTE special subframe configurations 1, 2, 6, and 7, that each resource element group includes eight REs is used as an example. The resource element group set *A* may further include two or more of the following resource element groups:

$$\{(11,2,0), (11,3,0), (11,5,0), (11,6,0), (10,2,0), (10,3,0), (10,5,0), (10,6,0)\} \quad (34);$$

$$\{(6,2,0), (6,3,0), (6,5,0), (6,6,0), (5,2,0), (5,3,0), (5,5,0), (5,6,0)\} \quad (35);$$

and

$$\{(1,2,0), (1,3,0), (1,5,0), (1,6,0), (0,2,0), (0,3,0), (0,5,0), (0,6,0)\} \quad (36).$$

[0035] For LTE special subframe configurations 1, 2, 6, and 7, that each resource element group includes four REs is used as an example. The resource element group set *A* may further include two or more of the following resource element groups:

$$\{(11,2,0), (11,3,0), (11,5,0), (11,6,0)\} \quad (37);$$

$$\{(10,2,0), (10,3,0), (10,5,0), (10,6,0)\} \quad (38);$$

$$\{(6,2,0), (6,3,0), (6,5,0), (6,6,0)\} \quad (39);$$

$$\{(5,2,0), (5,3,0), (5,5,0), (5,6,0)\} \quad (40);$$

$$\{(1,2,0), (1,3,0), (1,5,0), (1,6,0)\} \quad (41);$$

and

$$\{(0,2,0), (0,3,0), (0,5,0), (0,6,0)\} \quad (42).$$

[0036] For LTE special subframe configurations 3, 4, 8, and 9, that each resource element group includes eight REs is used as an example. The resource element group set *A* may further include two or more of the following resource element groups:

$$\{(11,2,0), (11,3,0), (11,2,1), (11,3,1), (10,2,0), (10,3,0), (10,2,1), (10,3,1)\} \quad 43);$$

$$\{(6,2,0), (6,3,0), (6,2,1), (6,3,1), (5,2,0), (5,3,0), (5,2,1), (5,3,1)\} \quad (44);$$

and

$$\{(1,2,0), (1,3,0), (1,2,1), (1,3,1), (0,2,0), (0,3,0), (0,2,1), (0,3,1)\} \quad (45).$$

[0037] For LTE special subframe configurations 3, 4, 8, and 9, that each resource element group includes four REs is used as an example. The resource element group set *A* may further include two or more of the following resource element groups:

$$\{(11,2,0), (11,3,0), (11,2,1), (11,3,1)\} \quad (46);$$

$$\{(10,2,0), (10,3,0), (10,2,1), (10,3,1)\} \quad (47);$$

$$\{(6,2,0), (6,3,0), (6,2,1), (6,3,1)\} \quad (48);$$

$$\{(5,2,0), (5,3,0), (5,2,1), (5,3,1)\} \quad (49);$$

$$\{(1,2,0), (1,3,0), (1,2,1), (1,3,1)\} \quad (50);$$

and

$$\{(0,2,0),\ (0,3,0),\ (0,2,1),\ (0,3,1)\} \quad (51);$$

[0038] In another example, when a cyclic prefix CP is an extended CP (Extended CP, ECP for short), a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the following resource element groups:

$$REG_0^{ECP} = \{(11,4,0),\ (11,5,0),\ (8,4,0),\ (8,5,0),\ (5,4,0),\ (5,5,0),\ (2,4,0),\ (2,5,0)\} \quad (52);$$

$$REG_1^{ECP} = \{(9,4,0),\ (9,5,0),\ (6,4,0),\ (6,5,0),\ (3,4,0),\ (3,5,0),\ (0,4,0),\ (0,5,0)\} \quad (53);$$

$$REG_2^{ECP} = \{(10,4,1),\ (10,5,1),\ (7,4,1),\ (7,5,1),\ (4,4,1),\ (4,5,1),\ (1,4,1),\ (1,5,1)\} \quad (54);$$

and

$$REG_3^{ECP} = \{(9,4,1),\ (9,5,1),\ (6,4,1),\ (6,5,1),\ (3,4,1),\ (3,5,1),\ (0,4,1),\ (0,5,1)\} \quad (55).$$

[0039] The resource element group set or the resource element group may apply to a subframe type FS1 or FS2.

[0040] That each resource element group includes four REs is used as an example. The resource element group set *A* includes two or more of the following resource element groups:

$$\{(11,4,0),\ (11,5,0),\ (8,4,0),\ (8,5,0)\} \quad (56);$$

$$\{(5,4,0),\ (5,5,0),\ (2,4,0),\ (2,5,0)\} \quad (57);$$

$$\{(9,4,0),\ (9,5,0),\ (6,4,0),\ (6,5,0)\} \quad (58);$$

$$\{(3,4,0),\ (3,5,0),\ (0,4,0),\ (0,5,0)\} \quad (59);$$

$$\{(10,4,1),\ (10,5,1),\ (7,4,1),\ (7,5,1)\} \quad (60);$$

$$\{(4,4,1),\ (4,5,1),\ (1,4,1),\ (1,5,1)\} \quad (61);$$

$$\{(9,4,1),\ (9,5,1),\ (6,4,1),\ (6,5,1)\} \quad (62);$$

and

$$\{(3,4,1),\ (3,5,1),\ (0,4,1),\ (0,5,1)\} \quad (63).$$

[0041] In another example, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the following resource element groups:

$$REG_0^{ECP,FS2} = \{(11,1,1), (11,2,1), (8,1,1), (8,2,1), (5,1,1), (5,2,1), (2,1,1), (2,2,1)\} \quad (64);$$

$$REG_1^{ECP,FS2} = \{(10,1,1), (10,2,1), (7,1,1), (7,2,1), (4,1,1), (4,2,1), (1,1,1), (1,2,1)\} \quad (65);$$

and

$$REG_2^{ECP,FS2} = \{(9,1,1), (9,2,1), (6,1,1), (6,2,1), (3,1,1), (3,2,1), (0,1,1), (0,2,1)\} \quad (66).$$

[0042] The resource element group set or the resource element group may apply to a subframe type FS2.

[0043] That each resource element group includes four REs is used as an example. The resource element group set *A* includes two or more of the following resource element groups:

$$\{(11,1,1), (11,2,1), (8,1,1), (8,2,1)\} \quad (67);$$

$$\{(5,1,1), (5,2,1), (2,1,1), (2,2,1)\} \quad (68);$$

$$\{(10,1,1), (10,2,1), (7,1,1), (7,2,1)\} \quad (69);$$

$$\{(4,1,1), (4,2,1), (1,1,1), (1,2,1)\} \quad (70);$$

$$\{(9,1,1), (9,2,1), (6,1,1), (6,2,1)\} \quad (71);$$

and

$$\{(3,1,1), (3,2,1), (0,1,1), (0,2,1)\} \quad (72).$$

[0044] The resource element group set or the resource element group may apply to a subframe type FS2.

[0045] 103: The user equipment obtains, according to the determined reference signal configuration, positions of resource elements REs that are used to send reference signals on antenna ports in an antenna port set, and receives, according to the positions of the REs, reference signals sent by the base station.

[0046] In step 103, the reference signals are sent by the base station.

[0047] Compared with the prior art, user equipment receives reference signal resource configuration information sent by a base station, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index; the user equipment determines a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index; and the user equipment obtains, according to the determined reference signal configuration, positions of resource elements REs that are used to send reference signals on antenna ports in the antenna port set, and receives, according to the positions of the REs, the reference signals sent by the base station. Therefore, a problem that prior-art reference signals do not support more than eight antenna ports can be resolved, and a feasible design solution for reference signal configuration is provided for an antenna configuration including more than eight antenna ports. In addition, resource element groups used by the two antenna port subsets in two RB pairs do not have an intersection. Therefore, on one hand, an RE position occupied by a CSI RS in a legacy (Legacy) system may be reused and interference to legacy (legacy) UE in a same cell may be reduced. On the other hand, for multiple different reference signal configurations, because the resource element groups used in the two RB pairs do not have an intersection, inter-cell interference caused by reference signals may be reduced, that is, pilot contamination is reduced, thereby improving efficiency of channel state information measurement and improving a system throughput.

[0048] As shown in FIG. 2, a reference signal sending method includes:

[0049] 201: Abase station sends reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index.

[0050] The antenna port quantity information and the resource configuration index are used to indicate a reference signal configuration in a reference signal configuration set, where the reference signal configuration is used to indicate position information of resource elements REs that are used to send reference signals on antenna ports in an antenna port set, the reference signal configuration set includes at least one first reference signal configuration, and an antenna port set corresponding to the first reference signal configuration includes at least two antenna port subsets, where a resource element RE that is used to send a reference signal on an antenna port in a first antenna port subset is located in a first resource block RB pair, an RE that is used to send a reference signal on an antenna port in a second antenna port subset is located in a second RB pair, and the first RB pair is different from the second RB pair.

[0051] The first RB pair and the second RB pair are separately located at different frequency domain positions in a same subframe or located in a same subband of different subframes.

[0052] Further, a resource element group used by the first antenna port subset in the first RB pair is REG_{i_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{i_2}, where $REG_{i_1} \in A$, $REG_{i_2} \in A$, and $i_1 \neq i_2$; the set is $A = \{REG_i | i = 0,1,...,M-1\}$, $M \geq 2$, an intersection of different resource element groups in the set A is an empty set, $i_1, i_2 \in \{0,...,M-1\}, M \geq 2$, and i_1 and i_2 are indexes of the REGs used in the two RB pairs respectively; and each resource element group in the set A represents a set of position triplets $(k', l', n_s \mathrm{mod} 2)$ of resource elements REs in an RB pair that are used to send reference signals, relative to the RB pair in which the resource elements REs are located, where k' represents an index of a subcarrier of the resource element RE, in the RB pair in which the resource element RE is located, l' represents an index of an OFDM symbol of the resource element, in the RB pair in which the resource element is located, n_s represents an index of a timeslot to which the resource element belongs, mod represents a modulo operation, and n_s mod2 represents a computed value resulting from a modulo 2 operation on n_s.

[0053] Further, the reference signal configuration set includes at least one second reference signal configuration, an antenna port set corresponding to the second reference signal configuration includes at least the first antenna port subset and the second antenna port subset, a resource element group used by the first antenna port subset in the first RB pair is REG_{j_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{j_2}, where $REG_{j_1} \in A$, $REG_{j_2} \in A$, $j_1 \neq j_2, j_1, j_2 \in \{0,1,...,M-1\}$, and i_1, i_2, j_1 and j_2 meet at least one of the following relationships: $j_1 = (i_1 + n \mathrm{mod} M$, $j_2 = (i_2+n) \mathrm{mod} M$ or $j_1 = i_2$, $j_2 = i_1$, where n represents a shift (shift) whose value is an integer.

[0054] Specifically, different resource element groups in the set A may be different position sets of REs that are used to send CSI RSs on eight antenna ports in an LTE RIO system. In this case, the resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. In this case, for how an eNB instructs legacy (Legacy) UE and UE in an LTE R12 system or in a future system to receive a CSI RS and how the UE performs correct rate matching, so that in the reference signal configuration, an RE position occupied by a CSI RS in the LTE RIO system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0055] In addition, in a two-cell example, for how to instruct, in two cells, UE to use a reference signal configuration to receive CSI RSs, so as to effectively avoid pilot contamination (Pilot Contamination) and interference to a PDSCH caused by a CSI RS of a neighboring cell, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0056] According to the present invention, when a CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k', l', n_s \mathrm{mod} 2)$. That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by the expressions (1) to (5), where the resource element group set A may apply to a subframe type FS1 or FS2.

[0057] That each resource element group includes four REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by the expressions (6) to (15), where the resource element group set A may apply to a subframe type FS1 or FS2.

[0058] That each resource element group includes eight REs is used as an example. The resource element group set A may further include two or more of the resource element groups represented by the expressions (16) to (18), where the resource element group set A may apply to a subframe type FS1.

[0059] That each resource element group includes four REs is used as an example. The resource element group set *A* may further include two or more of the resource element groups represented by the expressions (19) to (24), where the resource element group set A may apply to a subframe type FS1.

[0060] Optionally, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the resource element groups represented by the expressions (25) to (27), where the resource element group set A may apply to a subframe type FS2.

[0061] That each resource element group includes four REs is used as an example. The resource element group set *A* includes two or more of the resource element groups represented by the expressions (28) to (33), where the resource element group set A may apply to a subframe type FS2.

[0062] For LTE special subframe configurations 1, 2, 6, and 7, that each resource element group includes eight REs is used as an example. The resource element group set *A* may further include two or more of the resource element groups represented by the expressions (34) to (36).

[0063] For LTE special subframe configurations 1, 2, 6, and 7, that each resource element group includes four REs is used as an example. The resource element group set *A* may further include two or more of the resource element groups represented by the expressions (37) to (42).

[0064] For LTE special subframe configurations 3, 4, 8, and 9, that each resource element group includes eight REs is used as an example. The resource element group set *A* may further include two or more of the resource element groups represented by the expressions (43) to (45).

[0065] For LTE special subframe configurations 3, 4, 8, and 9, that each resource element group includes four REs is used as an example. The resource element group set *A* may further include two or more of the resource element groups represented by the expressions (46) to (51).

[0066] Optionally, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the resource element groups represented by the expressions (52) to (55), where the resource element group set or the resource element group may apply to a subframe type FS1 or FS2.

[0067] That each resource element group includes four REs is used as an example. The resource element group set *A* includes two or more of the resource element groups represented by the expressions (56) to (63), where the resource element group set or the resource element group may apply to a subframe type FS1 or FS2.

[0068] Optionally, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the resource element groups represented by the expressions (64) to (66), where the resource element group set or the resource element group may apply to a subframe type FS2.

[0069] That each resource element group includes four REs is used as an example. The resource element group set *A* includes two or more of the resource element groups represented by the expressions (67) to (72), where the resource element group set or the resource element group may apply to a subframe type FS2.

[0070] 202: The base station determines, according to a reference signal configuration indicated by the reference signal configuration information, positions of resource elements REs that are used to send reference signals on antenna ports in an antenna port set corresponding to the reference signal configuration.

[0071] 203: The base station sends the reference signals to the user equipment at the determined positions.

[0072] Compared with the prior art, a base station sends reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index, and resource elements REs that are used to send reference signals on antenna ports in two antenna port subsets included in an antenna port set thereof are located in two different resource block RB pairs; and the base station determines, according to the sent reference signal configuration, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set, and sends reference signals to the user equipment at the positions of the resource elements RE. Therefore, a problem that prior-art reference signals do not support more than eight antenna ports can be resolved, and a feasible design solution for reference signal configuration is provided for an antenna configuration including more than eight antenna ports. In addition, resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. Therefore, on one hand, an RE position occupied by a CSI RS in a legacy (Legacy) system may be reused and interference to legacy UE in a same cell may be reduced. On the other hand, for multiple different reference signal configurations, because the resource element groups used in the two RB pairs do not have an intersection, inter-cell interference caused by reference signals may be reduced, that is, pilot contamination is reduced, thereby improving efficiency of channel state information measurement and improving a system throughput.

[0073] As shown in FIG. 3, a reference signal sending and receiving method includes:

[0074] 301: Abase station sends reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index.

[0075] Specifically, the antenna port quantity information may be a quantity of antenna ports. For example, the quantity of antenna ports may be 8, 16, 32, 64, or the like. The antenna port quantity information may be structure information of an antenna port array. For example, the antenna port array is 2 x 8 (2 rows and 8 columns), 4 x 4 (4 rows and 4 columns), or 8 x 2 (8 rows and 2 columns); it may be obtained from the information that a quantity of antenna ports is 16. For another example, an antenna port array is 4 x 8 (2 rows and 8 columns), 2 x 16 (2 rows and 16 columns), or 8 x 4 (8 rows and 4 columns); it may be obtained from the information that a quantity of antenna ports is 32.

[0076] The resource configuration index is an index of a reference signal configuration corresponding to a specific quantity of antenna ports. After the quantity of antenna ports is determined, a reference signal configuration may be determined according to the resource configuration index.

[0077] 302: The user equipment determines a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index, where an antenna port set corresponding to the reference signal configuration includes at least two antenna port subsets, and REs that are used to send reference signals on antenna ports in the two antenna port subsets are located in two different resource block RB pairs.

[0078] The reference signal configuration set includes at least one reference signal configuration, where the reference signal configuration is used to indicate position information of resource elements REs that are used to send reference signals on antenna ports in the antenna port set. The RB pairs in which the REs that are used to send reference signals on the antenna ports in the two antenna port subsets are located are separately located at different frequency domain positions in a same subframe or located in a same subband of different subframes.

[0079] The subband is one or more consecutive RBs. Specifically, a size of the subband may be a size of a precoding resource block group (Precoding Resource block Groups, PRG for short). For example, depending on system bandwidth, the subband size or PRG size (measured in RB) may be:

System bandwidth	Subband or PRG size
≤10	1
11 - 26	2
27 - 63	3
64 - 110	2

[0080] The subband size may also be equal to a subband size reported in CSI. For example, the subband size may be:

System bandwidth	Subband size
6 - 7	1
8 - 10	2
11 - 26	2
27 - 63	3
64 - 110	4

or

System bandwidth	Subband size
6 - 7	2
8 - 10	4
11 - 26	4
27 - 63	6

(continued)

System bandwidth	Subband size
64 - 110	8

[0081] Further, the resource element groups used by the two antenna port subsets in the two RB pairs are REG_{i_1} and REG_{i_2} respectively, where $REG_{i_1} \in A$, $REG_{i_2} \in A$, and $i_1 \neq i_2$; and the set is $A = \{REG_i | i = 0,1,...,M-1\}$, $M \geq 2$, where an intersection of different resource element groups in the set A is an empty set, $i_1, i_2 \in \{0,...,M-1\}$, and i_1 and i_2 are indexes of the resource element groups REGs used in the two RB pairs.

[0082] Each resource element group in the set A represents a set of position triplets (k',l',n_s mod2) of resource elements REs in an RB pair that are used to send reference signals, relative to the RB pair in which the resource elements REs are located, where k' represents an index of a subcarrier of the resource element RE, in the RB pair in which the resource element RE is located, l' represents an index of an orthogonal frequency division multiplexing OFDM symbol of the resource element, in the RB pair in which the resource element is located, n_s represents an index of a timeslot to which the resource element belongs, mod represents a modulo operation, and n_s mod2 represents a computed value resulting from a modulo 2 operation on n_s. For example, in a radio frame, a value of n_s ranges from 0 to 19; in each RB, a value of k' ranges from 0 to 11, and a value of l' ranges from 0 to 6.

[0083] For ease of understanding, the following describes a frame structure, a timeslot structure, a physical resource element and a resource block RB with reference to FIG. 3a, FIG. 3b, and FIG. 3c. In a 3GPP (3rd Generation Partnership Project, 3rd Generation Partnership Project) LTE system, uplink and downlink transmission is organized into radio frames (radio frame), where a length of each radio frame is 10 milliseconds, and each radio frame includes 10 subframes (subframe) each with a length of 1 millisecond and includes 20 timeslots (slot) each with a length of 0.5 milliseconds, where timeslot numbers are from 0 to 19. One subframe is defined as two consecutive timeslots. Two types of frame structures, type 1 and type 2, are supported and are used in the FDD system and the TDD system respectively. Frame structure type 1 (Frame Structure type 1, FS1 for short) and frame structure type 2 (FS2) are shown in FIG. 3a and FIG. 3b respectively.

[0084] A signal transmitted within each timeslot may be represented by one or more resource grids (resource grid). With a downlink system used as an example, a structure of a resource grid including $N_{RB}^{DL} N_{sc}^{RB}$ subcarriers and N_{symb}^{DL} OFDM symbols is shown in FIG. 3c, where N_{RB}^{DL} is system bandwidth measured in resource blocks (Resource Block, RB for short), N_{sc}^{RB} is a quantity of subcarriers in one RB, and N_{symb}^{DL} is a quantity of OFDM symbols within one downlink timeslot. Each element in the resource grid is referred to as a resource element (Resource Element, RE for short), and each RE may be uniquely identified by using an index pair (k, l) within a timeslot, where $k=0,...,N_{sc}^{RB}-1$ is an index of a frequency domain within the timeslot, and $l=0,...,N_{symb}^{DL}-1$ is an index of a time domain within the timeslot. N_{symb}^{DL} consecutive OFDM symbols in a time domain and N_{sc}^{RB} consecutive subcarriers in a frequency domain are defined as one resource block (Resource Block, RB for short). For a physical RB, two types of configurations, normal (Normal) cyclic prefix (cyclic prefix, CP for short) and extended (Extended) CP, may be included, and a quantity of subcarriers and a quantity of OFDM symbols of the physical RB are shown in the following table, where Δf is a subcarrier spacing.

Configuration		N_{sc}^{RB}	N_{symb}^{DL}
Normal CP	Δf = 15 kHz	12	7
Extended CP	Δf = 15 kHz		6
	Δf = 7.5 kHz	24	3

[0085] A RB pair (RB Pair) is defined as two RBs having a same RB number in one subframe. Obviously, timeslot numbers of two RBs in one RB pair are even and odd numbers respectively.

[0086] An antenna port is defined such that a channel over which a symbol on the antenna port is sent may be inferred from a channel over which another symbol on the same antenna port is sent. Each antenna port has one resource grid. In practice, each antenna port may be corresponding to a physical antenna, or may be corresponding to a virtual antenna, that is, a combination of multiple physical antennas.

[0087] Each antenna port uses one resource grid, and the base station sends a reference signal or a data channel in a time domain and a frequency domain that are corresponding to the resource grid. REs in the resource grid may be separately used to send a reference signal and a data channel such as a PDSCH. UE may estimate a channel between the UE and a corresponding antenna port by receiving the reference signal on the resource grid; according to the channel estimation value, the UE may perform channel state measurement on the channel between the UE and the corresponding antenna port or perform demodulation on the data channel.

[0088] The reference signal configuration set includes multiple reference signal configurations, where the reference signal configuration is used to indicate position information of resource elements REs that are used to send reference signals on antenna ports in an antenna port set. In a reference signal configuration, resource element groups used by two antenna port subsets may be obtained by performing, in an RB, cyclic shifting (cyclic shift) and/or interlacing (interlace) on resource element groups used by two antenna port subsets in another reference signal configuration. For example, it is defined that an antenna port set corresponding to a first reference signal configuration includes at least two antenna port subsets: a first antenna port subset and a second antenna port subset, where resource element groups used by the two antenna port subsets in the first RB pair and the second RB pair are REG_{i_1} and REG_{i_2} respectively, $i_1 \neq i_2$, and $i_1, i_2 \in \{0,1,...,M-1\}, M \geq 2$; and an antenna port set corresponding to a second reference signal configuration also includes at least the first antenna port subset and the second antenna port subset, where a resource element group used by the first antenna port subset in the first RB pair is REG_{j1}, a resource element group used by the second antenna port subset in the second RB pair is REG_{j2}, $j_1 \# j_2$, and $j_1, j_2 \in \{0,1,...,M-1\}, M \geq 2$, where $REG_{i_1} \in A$, $REG_{i_2} \in A$, $REG_{j_1} \in A$, $REG_{j2} \in A$, $A = \{REG_i | i = 0,1,...,M-1\}$, and $M \geq 2$. Based on the resource element groups used by the two antenna port subsets included in the first reference signal configuration, the resource element groups used by the two antenna port subsets included in the second reference signal configuration may be obtained by using the following relationship:

$$j_1 = (i_1 + n)\bmod M, \; j_2 = (i_2 + n)\bmod M,$$

where $j_1 = (i_1 + n)\bmod M$ indicates that j_1 is obtained by performing cyclic shifting (cyclic shift) on i_1, where a value of a shift (shift) is n, and $n \geq 1$; and $j_2 = (i_2+n)\bmod M$ indicates that j_2 is obtained by performing cyclic shifting on i_2, where a value of a shift (shift) is also n. The cyclic shift is corresponding to a sequence with a total length of M: 0, 1, 2, ..., M-1. Correspondingly, the resource element groups REG_{j_1} and REG_{j_2} used by the two antenna port subsets included in the second reference signal configuration may be obtained by performing cyclic shifting relative to a resource element group sequence $REG_0, REG_1, ..., REG_{M-1}$ by using the resource element groups REG_{i_1} and REG_{i_2} used by the two antenna port subsets included in the first reference signal configuration, where a length of the sequence is M, a shift is n resource element group positions, and $n \geq 1$.

[0089] Based on the resource element groups used by the two antenna port subsets included in the first reference signal configuration, the resource element groups used by the two antenna port subsets included in the second reference signal configuration may also be obtained by using the following relationship:

$$j_1 = i_2, \; j_2 = i_1,$$

where :

$j_1=i_2$ indicates $REG_{j_1}=REG_{i_2}$, in which case, a resource element group used by the first reference signal configuration in the first RB pair is the same as a resource element group used by the second reference signal configuration in the second RB pair; similarly, $j_2=i_1$ indicates that a resource element group used by the first reference signal configuration in the second RB pair is the same as a resource element group used by the second reference signal configuration in the first RB pair. Therefore, $j_1=i_2$, $j_2=i_1$ both holding true is equivalent that interlacing (interlace) is performed between the resource element groups used by the two antenna port subsets included in the first reference signal configuration on the two RB pairs and the resource element groups used by the two antenna port subsets included in the second reference signal configuration on the two RB pairs.

[0090] It should be noted that the foregoing method or relationships may be not limited to a scenario in which an antenna port set in a reference signal configuration includes two antenna port subsets, and may also be applicable to a scenario in which an antenna port set in a reference signal configuration includes three or more antenna port subsets. A relationship between resource element groups used in the reference signal configuration is not limited to cyclic shift or interlace either, and may further be a combination of cyclic shift and interlace. That the antenna port set in the reference signal configuration includes K antenna port subsets is used as an example. A resource element group REG_{j_k}, $k=1,..,K$

used by the K antenna port subsets included in the second reference signal configuration and a resource element group REG_{i_k}, k = 1,..,K used by the K antenna port subsets included in the first reference signal configuration meet the following relationship true:

$$j_k = (i_k + n) \bmod M, \ k = 1,2,...K, \ K \geq 2;$$

or

$$j_k = \begin{cases} i_{k+\lfloor K/2 \rfloor}, & k = 1,2,...,\lfloor K/2 \rfloor \\ i_{k-\lfloor K/2 \rfloor}, & k = \lfloor K/2 \rfloor + 1, K \end{cases}, \ K \geq 2;$$

or

$$j_k = \begin{cases} i_{k+\lceil K/2 \rceil}, & k = 1,2,...,\lceil K/2 \rceil \\ i_{k-\lceil K/2 \rceil}, & k = \lceil K/2 \rceil + 1, K \end{cases}, \ K \geq 2;$$

or

$$j_k = \begin{cases} i_{k+\lfloor K_1/2 \rfloor}, & k = 1,2,...,\lfloor K_1/2 \rfloor \\ i_{k-\lfloor K_1/2 \rfloor}, & k = \lfloor K_1/2 \rfloor + 1,...,K_1 \\ (i_k + n) \bmod M, & k = K_1 + 1,...,K \end{cases}, \ 1 \leq K_1 \leq K, \ K \geq 2.$$

[0091] Specifically, normal-CP and extended-CP reference signal configurations are separately described by using an example in which there are 16 antenna ports and in which two antenna port subsets of the 16 antenna ports are separately located in two neighboring RBs in a frequency domain. It is assumed that numbers of antenna ports in the antenna port subsets are x, x+1, ..., and x+7 and x+8, x+9, ..., and x+15 separately, where x is a start number, for example, may be x = 15, which is not limited herein. For ease of understanding, descriptions are given with examples combining tables and drawings.

[0092] For the normal CP, resource elements used in reference signal configurations and a reference signal configuration set may be shown in Table 1.

Table 1

	Reference signal configuration	Quantity of antenna ports is 16			
		Antenna port number: x to x+7		Antenna port number: x+8 to x+15	
		(k',l')	(n_{RB} mod 2, n_s mod 2)	(k',l')	(n_{RB} mod 2, n_s mod 2)
FS1 or FS2	c0	(9, 5)	(x_0, 0)	(11, 2)	(1-x_1, 1)
	c1	(11, 2)	(x_1, 1)	(9, 2)	(1-x_2, 1)
	c2	(9, 2)	(x_2, 1)	(7, 2)	(1-x_3, 1)
	c3	(7, 2)	(x_3, 1)	(9, 5)	(1-x_4, 1)
	c4	(9, 5)	(x_4, 1)	(9, 5)	(1-x_0, 0)
FS2	c20	(11, 1)	(x_{20}, 1)	(9, 1)	(1-x_{21}, 1)
	c21	(9, 1)	(X_{21}, 1)	(7, 1)	(1-x_{22}, 1)
	c22	(7, 1)	(x_{22}, 1)	(11, 1)	(1-x_{20}, 1)

[0093] When a subframe type is FS1 or FS2, a reference signal configuration set includes five reference signal configurations c0 to c4; or when a subframe type is FS2, a reference signal configuration set includes three reference signal configurations c20 to c22, where c0 to c4 and c20 to c22 are resource configuration indexes, and specific values of c0 to c4 and c20 to c22 may be 0 to 4 and 20 to 22 respectively; c0 to c4 and c20 to c22 may be coded jointly or coded independently. Depending on specific coding, the specific values of c0 to c4 and c20 to c22 are not limited herein.

[0094] n_{RB} represents an index of an RB pair in which the resource element is located, where n_{RB} may be an RB number in a system, or may be an index of an RB number relative to a specified RB number. In the table, an index of an RB pair in which a first antenna port subset (including antenna port numbers x to x+7) is located is n_{RB} mod2 = x_0, ..., x_4, or x_{20}, ..., x_{22}, and then an index of an RB pair in which a first antenna port subset (including antenna port numbers x to x+7) is n_{RB} mod2 = 1-x_0, ..., 1- x_4, or 1-x_{20}, ..., 1- x_{22}, where mod represents a modulo operation, n_{RB} mod2 represents a computed value resulting from a modulo 2 operation on n_{RB}, and values of x_0, ..., x_4, or x_{20}, ..., x_{22} are 0 or 1.

[0095] In the table, a value of a position, or triplet (k',l',n_s mod2), of the first RE (that is, the number 0 RE) in a resource element group used by each antenna port subset is given, where positions of other REs in each resource element group may be obtained based on the number 0 RE. In a same RB pair, specified offsets exist between other REs and the number 0 RE. Specifically, positions of REs in a resource element group are shown in FIG. 4a and FIG. 4b, where a horizontal direction represents a time domain and is measured in OFDM symbols, a vertical direction represents a frequency domain and is measured in subcarriers. An RB consisting of OFDM symbols 0 to 6 and 12 subcarriers is located in timeslot 0, an RB consisting of OFDM symbols 7 to 13 and 12 subcarriers is located in timeslot 1, and the two RBs have a same RB number and form an RB pair. Upper resource blocks are a first RB pair, and lower resource blocks are a second RB pair. REs marked by numbers 0 to 15 in the figures are positions of resource elements 0 to 15, where in each reference signal configuration, resource element groups used by two antenna port subsets occupy eight resource elements (RE) each.

[0096] When the subframe type is FS1 or FS2, in the first RB pair, resource element groups occupied in the reference signal configurations c0, c1, ..., and c4 are represented by the expressions (1) to (5) respectively; in the second RB pair, resource element groups occupied in the reference signal configurations c0, c1, ..., and c4 are represented by (2) to (5) and (1) respectively. Resource element groups REGs used by the two antenna port subsets in each reference signal configuration form an REG pair, which is represented by (REG_k, REG_l), and then REGs used by the two antenna port subsets in the reference signal configurations c0, c1, ..., and c4 are (REG_0,REG_1), (REG_1,REG_2), (REG_2,REG_3), (REG_3,REG_4), and (REG_4,REG_0) respectively, where REG_i,i=0,1,..,4 are represented by (1) to (5) respectively. It should be noted that an REG pair used in any one of the reference signal configurations is a cyclic shift relative to an REG pair used in another reference signal configuration. For example, a shift of (REG_1,REG_2) relative to (REG_0,REG_1) is 1, and a shift of (REG_4,REG_0) relative to (REG_0,REG_1) is 4.

[0097] When the subframe type is FS2, in the first RB pair, resource element groups occupied in the reference signal configuration c20, c21, and c22 are represented by (25) to (27) respectively; in the second RB pair, resource element groups occupied in the reference signal configuration c20, c21, and c22 are represented by (26) to (27) and (25) respectively. That is, REGs used by the two antenna port subsets in the reference signal configurations c20, c21, and c22 are (REG_0,REG_1), (REG_1,REG_2), and (REG_2,REG_0) respectively, where REG_i, i = 0,1,2 are represented by (25) to (27) respectively. It should be noted that an REG pair used in any one of the reference signal configurations is a cyclic shift relative to an REG pair used in another reference signal configuration. For example, a shift of (REG_1,REG_2) relative to (REG_0,REG_1) is 1, and a shift of (REG_2,REG_0) relative to (REG_0,REG_1) is 2.

[0098] Optionally, for the normal CP, resource elements used in reference signal configurations and a reference signal configuration set may also be shown in Table 2.

Table 2

	Reference signal configuration	Quantity of antenna ports is 16			
		Antenna port number: x to x+7		Antenna port number: x+8 to x+15	
		(k',l')	(n_{RB} mod2, n_s mod2)	(k',l')	(n_{RB} mod2,n_s mod2)
FS1 or FS2	c0	(9, 5)	(x_0, 0)	(9, 5)	(1-x_4, 1)
	c1	(11, 2)	(x_1, 1)	(9, 2)	(1-x_2, 1)
	c2	(9, 2)	(x_2, 1)	(7, 2)	(1-x_3, 1)
	c3	(7, 2)	(x_3, 1)	(11, 2)	(1-x_1, 1)
	c4	(9, 5)	(x_4, 1)	(9, 5)	(1-x_0, 0)

(continued)

	Reference signal configuration	Quantity of antenna ports is 16			
		Antenna port number: x to x+7		Antenna port number: x+8 to x+15	
		(k',l')	$(n_{RB} \bmod 2, n_s \bmod 2)$	(k',l')	$(n_{RB} \bmod 2, n_s \bmod 2)$
FS2	c20	(11, 1)	$(x_{20}, 1)$	(9, 1)	$(1-x_{21}, 1)$
	c21	(9, 1)	$(x_{21}, 1)$	(7, 1)	$(1-x_{22}, 1)$
	c22	(7, 1)	$(x_{22}, 1)$	(11, 1)	$(1-x_{20}, 1)$

[0099] Specific meanings of parameters in Table 2 are the same as or similar to those in Table 1, and are not described herein again. When a subframe type is FS1 or FS2, REGs used by two antenna port subsets in reference signal configurations c0, c1, ..., and c4 are (REG_0, REG_4), (REG_1, REG_2), (REG_2, REG_3), (REG_3, REG_1), and (REG_4, REG_0) respectively, where $PEG_i, i = 0,1,..,4$ are represented by (1) to (5) respectively. It should be noted that the REGs used in the reference signal configurations c0 and c4 are interlaced with each other, and the REGs used in the reference signal configurations c1, c2, and c3 are cyclic shifts of each other.

[0100] When a subframe type is FS2, REGs used by two antenna port subsets in reference signal configurations c20, c21, and c22 are (REG_0, REG_1), (REG_1, REG_2), and (REG_2, REG_0) respectively, where $PEG_i, i = 0,1,2$ are represented by (25) to (27) respectively. It should be noted that the REGs used in the reference signal configurations c20, c21, and c22 are cyclic shifts of each other.

[0101] Optionally, for the normal CP, resource elements used in reference signal configurations and a reference signal configuration set may also be shown in Table 3.

Table 3

	Reference signal configuration	Quantity of antenna ports is 16			
		Antenna port number: x to x+7		Antenna port number: x+8 to x+15	
		(k',l')	$(n_{RB} \bmod 2, n_s \bmod 2)$	(k',l')	$(n_{RB} \bmod 2, n_s \bmod 2)$
FS1 or FS2	c0	(9, 5)	$(x_0,0)$	(9, 5)	$(1-x_4, 1)$
	c1	(11, 2)	$(x_1,1)$	(7, 2)	$(1-x_3, 1)$
	c2	(9, 2)	$(X_2,1)$	(11, 2)	$(1-x_1, 1)$
	c3	(7, 2)	$(x_3,1)$	(9, 2)	$(1-x_2, 1)$
	c4	(9, 5)	$(x_4,1)$	(9, 5)	$(1-x_0, 0)$
FS2	c20	(11, 1)	$(x_{20},1)$	(7, 1)	$(1-x_{22}, 1)$
	c21	(9, 1)	$(x_{21},1)$	(11, 1)	$(1-x_{20}, 1)$
	c22	(7, 1)	$(x_{22},1)$	(9, 1)	$(1-x_{21}, 1)$

[0102] Specific meanings of parameters in Table 3 are the same as or similar to those in Table 1, and are not described herein again. When a subframe type is FS1 or FS2, REGs used by two antenna port subsets in reference signal configurations c0, c1, ..., and c4 are (REG_0, REG_4), (REG_1, REG_3), (REG_2, REG_1), (REG_3, REG_2), and (REG_4, REG_0) respectively, where $REG_i, i = 0,1,..,4$ are represented by (1) to (5). It should be noted that REGs used in the reference signal configurations c0 and c4 are interlaced with each other, and the REGs used in the reference signal configurations c1, c2, and c3 are cyclic shifts of each other.

[0103] When a subframe type is FS2, REGs used by two antenna port subsets in reference signal configurations c20, c21, and c22 are (REG_0, REG_2), (REG_1, REG_0), and (REG_2, REG_1) respectively, where $REG_i, i=0,1,2$ are represented by (25) to (27) respectively. It should be noted that the REGs used in the reference signal configurations c20, c21, and c22 are cyclic shifts of each other.

[0104] Optionally, for the extended CP, resource elements used in reference signal configurations and a reference signal configuration set may also be shown in Table 4.

Table 4

	Reference signal configuration	Quantity of antenna ports is 16			
		Antenna port number: x to x+7		Antenna port number: x+8 to x+15	
		(k',l')	$(n_{RB}\ \mathrm{mod}2, n_s\ \mathrm{mod}2)$	(k',l')	$(n_{RB}\ \mathrm{mod}2, n_s\ \mathrm{mod}2)$
FS1 or FS2	c0	(11, 4)	$(x_0, 0)$	(9,4)	$(1-x_1,0)$
	c1	(9, 4)	$(x_1, 0)$	(10, 4)	$(1-x_2,1)$
	c2	(10, 4)	$(x_2, 1)$	(9, 4)	$(1-x_3,1)$
	c3	(9, 4)	$(x_3, 1)$	(11, 4)	$(1-x_0,0)$
FS2	c16	(11, 1)	$(x_{16}, 1)$	(10, 1)	$(1-x_{17},1)$
	c17	(10, 1)	$(x_{17}, 1)$	(9, 1)	$(1-x_{18},1)$
	c18	(9, 1)	$(x_{18}, 1)$	(11, 1)	$(1-x_{16},1)$

[0105] When a subframe type is FS1 or FS2, a reference signal configuration set includes four reference signal configurations c0 to c3; when a subframe type is FS2, a reference signal configuration set includes three reference signal configurations c16 to c18, where c0 to c3 and c16 to c18 are resource configuration indexes, and specific values of c0 to c3 and c16 to c18 may be 0 to 3 and 16 to 18 respectively; c0 to c4 and c16 to c18 may be coded jointly or coded independently. Depending on specific coding, the specific values of c0 to c3 and c16 to c18 are not limited herein.

[0106] n_{RB} represents an index of an RB pair in which the resource element is located, where n_{RB} may be an RB number in a system, or may be an index of an RB number relative to a specified RB number. In the table, an index of an RB pair in which a first antenna port subset (including antenna port numbers x to x+7) is located is n_{RB} mod2 = x_0, ..., x_3, or x_{16}, ..., x_{18}, and then an index of an RB pair in which a first antenna port subset (including antenna port numbers x to x+7) is n_{RB} mod 2 = 1-x0, ..., 1- x_3, or 1-x_{16}, ..., 1- x_{18}. Values of x_0, ..., x_3, or x_{16}, ..., x_{18} are 0 or 1.

[0107] In the table, a value of a position, or triplet $(k',l',n_s \bmod 2)$, of a first RE (that is, the number 0 RE) in a resource element group used by each antenna port subset is given, where positions of other REs in each resource element group may be obtained based on the number 0 RE. In a same RB pair, specified offsets exist between other REs and the number 0 RE. Specifically, positions of REs in a resource element group are shown in FIG. 5a and FIG. 5b. An RB consisting of OFDM symbols 0 to 5 and 12 subcarriers is located in timeslot 0, an RB consisting of OFDM symbols 6 to 11 and 12 subcarriers is located in timeslot 1, and the two RBs have a same RB number and form an RB pair. Upper resource blocks are a first RB pair, and lower resource blocks are a second RB pair. REs marked by numbers 0 to 15 in the figures are positions of resource elements 0 to 15, where in each reference signal configuration, resource element groups used by two antenna port subsets occupy eight resource elements (RE) each.

[0108] When the subframe type is FS1 or FS2, in the first RB pair, resource element groups occupied in the configurations c0, c1, c2, and c3 are represented by (52) to (55) respectively; in the second RB pair, resource element groups occupied in the configuration c0 are represented by (53) to (55) and (52) respectively. Resource element groups REGs used by the two antenna port subsets in each reference signal configuration form an REG pair, which is represented by (REG_k,REG_l), and then REGs used by the two antenna port subsets in the reference signal configurations c0, c1, ..., and c3 are (REG_0,REG_1), (REG_1,REG_2), (REG_2,REG_3), and (REG_3,REG_0) respectively, where REG_i,i = 0,1,..,3 are represented by (52) to (55) respectively. It should be noted that the REGs used in the reference signal configurations c0 to c3 are cyclic shifts of each other.

[0109] When the subframe type is FS2, in the first RB pair, resource element groups occupied in the configurations c16, c17, and c18 are represented by (64), (65), and (66) respectively; in the second RB pair, resource element groups occupied in the configurations c16, c17, and c18 are represented by (65), (66), and (64) respectively. REGs used by the two antenna port subsets in the reference signal configurations c16, c17, and c18 are (REG_0,REG_1), (REG_1,REG_2), and (REG_2,REG_0) respectively, where REG_i, i = 0,1,2 are represented by (64) to (66) respectively. It should be noted that the REGs used in the reference signal configurations c16 to c18 are cyclic shifts of each other.

[0110] Optionally, for the extended CP, resource elements used in reference signal configurations and a reference signal configuration set may also be shown in Table 5.

Table 5

	Reference signal configuration	Quantity of antenna ports is 16			
		Antenna port number: x to x+7		Antenna port number: x+8 to x+15	
		(k',l')	$(n_{RB} \bmod 2, n_s \bmod 2)$	(k',l')	$(n_{RB} \bmod 2, n_s \bmod 2)$
FS1 or FS2	c0	(11, 4)	$(x_0, 0)$	(10, 4)	$(1-x_2, 0)$
	c1	(9, 4)	$(x_1, 0)$	(9, 4)	$(1-x_3, 1)$
	c2	(10, 4)	$(x_2, 1)$	(11, 4)	$(1-x_0, 1)$
	c3	(9, 4)	$(x_3, 1)$	(9, 4)	$(1-x_1, 0)$
FS2	c16	(11, 1)	$(x_{16}, 1)$	(10, 1)	$(1-x_{17}, 1)$
	c17	(10, 1)	$(x_{17}, 1)$	(9, 1)	$(1-x_{18}, 1)$
	c18	(9, 1)	$(x_{18}, 1)$	(11, 1)	$(1-x_{16}, 1)$

[0111] Specific meanings of parameters in Table 5 are the same as or similar to those in Table 4, and are not described herein again. When a subframe type is FS1 or FS2, REGs used by two antenna port subsets in reference signal configurations c0, c1, ..., and c3 are (REG_0,REG_2), (REG_1,REG_3), (REG_2,REG_0), and (REG_3,REG_1) respectively, where REG_i, i = 0,1,.., 3 are represented by (52) to (55) respectively. It should be noted that the REGs used in the reference signal configurations c0 to c3 are cyclic shifts of each other.

[0112] When a subframe type is FS2, REGs used by two antenna port subsets in reference signal configurations c16, c17, and c18 are (REG_0,REG_2), (REG_1,REG_2), and (REG_2,REG_0) respectively, where REG_i, i = 0,1,2 are represented by (64) to (66) respectively. It should be noted that the REGs used in the reference signal configurations c16 to c18 are cyclic shifts of each other.

[0113] Optionally, for the extended CP, resource elements used in reference signal configurations and a reference signal configuration set may also be shown in Table 6.

Table 6

	Reference signal configuration	Quantity of antenna ports is 16			
		Antenna port number: x to x+7		Antenna port number: x+8 to x+15	
		(k',l')	$(n_{RB} \bmod 2, n_s \bmod 2)$	(k',l')	$(n_{RB} \bmod 2, n_s \bmod 2)$
FS1 or FS2	c0	(11, 4)	$(x_0, 0)$	(10, 4)	$(1-x_2, 0)$
	c1	(9, 4)	$(x_1, 0)$	(9, 4)	$(1-x_3, 1)$
	c2	(10, 4)	$(x_2, 1)$	(11, 4)	$(1-x_0, 1)$
	c3	(9,4)	$(x_3, 1)$	(9,4)	$(1-x_1, 0)$
FS2	c16	(11, 1)	$(x_{16}, 1)$	(9, 1)	$(1-x_{18}, 1)$
	c17	(10, 1)	$(x_{17}, 1)$	(11, 1)	$(1-x_{16}, 1)$
	c18	(9, 1)	$(x_{18}, 1)$	(10, 1)	$(1-x_{17}, 1)$

[0114] Specific meanings of parameters in Table 6 are the same as or similar to those in Table 4, and are not described herein again. When a subframe type is FS1 or FS2, REGs used by two antenna port subsets in reference signal configurations c0, c1, ..., and c3 are (REG_0,REG_2), (REG_1,REG_3), (REG_2,REG_0), and (REG_3,REG_1) respectively, where REG_i, i = 0,1,.., 3 are represented by (52) to (55) respectively. It should be noted that the REGs used in the reference signal configurations c0 and c2 are interlaced with each other, and the REGs used in the reference signal configurations c1 and c3 are cyclic shifts of each other.

[0115] When a subframe type is FS2, REGs used by two antenna port subsets in reference signal configurations c16, c17, and c18 are (REG_0,REG_2), (REG_1,REG_0), and (REG_2,REG_1) respectively, where REG_i, i = 0,1,2 are represented by (64) to (66) respectively. It should be noted that the REGs used in the reference signal configurations c16 to c18 are cyclic shifts of each other.

[0116] Optionally, for the extended CP, resource elements used in reference signal configurations and a reference signal configuration set may also be shown in Table 7.

Table 7

	Reference signal configuration	Quantity of antenna ports is 16			
		Antenna port number: x to x+7		Antenna port number: x+8 to x+15	
		(k',l')	$(n_{RB}$ mod2,n_s mod2)	(k',l')	$(n_{RB}$ mod2,n_s mod2)
FS1 or FS2	c0	(11, 4)	$(x_0,0)$	(9,4)	$(1-x_1,0)$
	c1	(9,4)	$(x_1,0)$	(11, 4)	$(1-x_0, 1)$
	c2	(10, 4)	$(x_2,1)$	(9,4)	$(1-x_3,1)$
	c3	(9,4)	$(x_3,1)$	(10, 4)	$(1-x_2,0)$
FS2	c16	(11,1)	$(x_{16}, 1)$	(9,1)	$(1-x_{18},1)$
	c17	(10,1)	$(x_{17},1)$	(11,1)	$(1- x_{16},1)$
	c18	(9,1)	$(x_{18},1)$	(10,1)	$(1- x_{17},1)$

[0117] Specific meanings of parameters in Table 7 are the same as or similar to those in Table 4, and are not described herein again. When a subframe type is FS1 or FS2, REGs used by two antenna port subsets in reference signal configurations c0, c1, ..., and c3 are (REG_0,REG_1), (REG_1,REG_0), (REG_2,REG_3), and (REG_3,REG_2) respectively, where REG_i, i = 0,1,.., 3 are represented by (52) to (55) respectively. It should be noted that the REGs used in the reference signal configurations c0 and c1 are interlaced with each other, and the REGs used in the reference signal configurations c2 and c3 are cyclic shifts of each other.

[0118] When a subframe type is FS2, REGs used by two antenna port subsets in reference signal configurations c16, c17, and c18 are (REG_0,REG_2), (REG_1,REG_0), and (REG_2,REG_1) respectively, where REG_i, i = 0,1,2 are represented by (64) to (66) respectively. It should be noted that the REGs used in the reference signal configurations c16 to c18 are cyclic shifts of each other.

[0119] 303: The user equipment obtains, according to the determined reference signal configuration, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set.

[0120] 304: The base station sends, according to the reference signal configuration indicated by the sent reference signal configuration, reference signals to the user equipment at the positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set corresponding to the reference signal configuration.

[0121] 305: The user equipment receives the reference signals at the positions of the REs that are used by the base station to send the reference signals.

[0122] It should be noted that a CSI RS (Channel State Information Reference signal, channel state information-reference signal) is used as an example of the reference signal used in the reference signal transmission method described in this embodiment, and this embodiment imposes no limitation on a specific type of the used reference signal. For other types of reference signals, such as DMRS and CRS, a corresponding reference signal configuration or reference signal pattern (pattern) may also be obtained by using the method described in this embodiment, where the reference signal configuration or the reference signal pattern includes at least two antenna port subsets, and resource element groups used by the antenna port subsets in different RB pairs do not have an intersection; further, a resource element group used in one reference signal configuration or reference signal pattern is obtained by performing cyclic shifting or interlacing on a resource element group used in another reference signal configuration or reference signal pattern.

[0123] With the DMRS as an example, there are 16 antenna ports, where two antenna port subsets are included, and each antenna port subset includes eight antenna ports.

[0124] For a frame structure type FS1, a method similar to that in the foregoing embodiment including a CSI RS is used, and a resource element group used by each antenna port subset in a reference signal configuration or reference signal pattern of the DMRS may be obtained based on a resource element group set A. For example, the resource element group set is $A = \{REG_i | i = 0,1,2\}$, where:

$$REG_0 = \{(11,5,0), (11,6,0), (11,5,1), (11,6,1), (10,5,0), (10,6,0), (10,5,1), (10,6,1)\};$$

$$REG_1 = \{(6,5,0), (6,6,0), (6,5,1), (6,6,1), (5,5,0), (5,6,0), (5,5,1), (5,6,1)\};$$

and

$$REG_2 = \{(1,5,0), (1,6,0), (1,5,1), (1,6,1), (0,5,0), (0,6,0), (0,5,1), (0,6,1)\}.$$

[0125] For another example, for a frame structure type FS2, for LTE special subframe configurations 1, 2, 6, and 7, a resource element group used by each antenna port subset in a reference signal configuration or reference signal pattern of the DMRS may be obtained based on the following resource element group set A resource element group set $A = \{REG_i | i = 0,1,2\}$, where:

$$REG_0 = \{(11,2,0), (11,3,0), (11,5,0), (11,6,0), (10,2,0), (10,3,0), (10,5,0), (10,6,0)\};$$

$$REG_1 = \{(6,2,0), (6,3,0), (6,5,0), (6,6,0), (5,2,0), (5,3,0), (5,5,0), (5,6,0)\};$$

and

$$REG_2 = \{(1,2,0), (1,3,0), (1,5,0), (1,6,0), (0,2,0), (0,3,0), (0,5,0), (0,6,0)\}.$$

[0126] For LTE special subframe configurations 3, 4, 8, and 9, a resource element group used by each antenna port subset in a reference signal configuration or reference signal pattern of the DMRS may be obtained based on the following resource element group set A : resource element group set $A = \{REG_i | i = 0,1,2\}$, where:

$$REG_0 = \{(11,2,0), (11,3,0), (11,2,1), (11,3,1), (10,2,0), (10,3,0), (10,2,1), (10,3,1)\};$$

$$REG_1 = \{(6,2,0), (6,3,0), (6,2,1), (6,3,1), (5,2,0), (5,3,0), (5,2,1), (5,3,1)\};$$

and

$$REG_1 = \{(1,2,0), (1,3,0), (1,2,1), (1,3,1), (0,2,0), (0,3,0), (0,2,1), (0,3,1)\}.$$

[0127] For a process of obtaining, based on the foregoing resource element group set A, a reference signal configuration or reference signal pattern of each DMRS, details are not described herein again.

[0128] It should be further noted that the foregoing described RB or RB pair and the RBs in Table 1 to Table 7 may be located in a same subframe or timeslot, or may be located in different subframes or timeslots, or different combinations of subframes or timeslots and subbands.

[0129] In addition, it needs to be further pointed out that one antenna port in the antenna port subset may use one resource element in the resource element group. With an antenna port subset consisting of eight antenna ports x to x+7 as an example, assuming that a resource element group used by the antenna port subset consist of eight resource elements (RE), RE0 to RE7, REs used to send reference signals on the antenna ports x, x+1, ..., and x+7 may be RE0, RE1, RE2, ..., and RE7 respectively.

[0130] In addition, on different antenna ports in an antenna port subset, multiple resource elements in a resource element group used by the antenna port are used to send a reference signal in a code division multiplexing (Code Division Multiplexing, CDM for short) manner. In the invention, where the antenna port subset consists of eight antenna ports x to x+7, assuming that a resource element group used by the antenna port subset includes eight resource elements (RE), RE0 to RE7, in an example not covered by the claims, REs used to send a reference signal on the antenna port x are RE0 and RE1. and REs used to send a reference signal on the antenna port x+1 are also RE0 and RE1. RE0 and the RE1 are used on the two reference signals in a code division multiplexing CDM manner; for example, codes [1, 1] and [1, -1] are respectively used on the two reference signals. Similarly, RE2 and RE3 may be used on x+2 and x+3 in a code division multiplexing CDM manner; ...; and RE6 and RE7 may be used on x+6 and x+7 in a code division multiplexing CDM manner. For the claimed embodiments, RE0, RE1, RE2, and RE3 are used on the antenna ports x to x+3 in a code division multiplexing CDM manner, and RE4, RE5, RE6, and RE7 are used on the antenna ports x+4 to x+7 in a code division multiplexing CDM manner, where codes used to transmit reference signals on the antenna ports x to x+3 or x+4 to x+7 may be [1, 1, 1, 1], [1, -1, 1, -1], [1, 1, -1, -1], and [1, -1, -1, 1]. That multiple resource elements are used to transmit and receive a reference signal or data in a CDM code division multiplexing CDM manner is a prior-art technology, and details are not described herein again.

[0131] Compared with the prior art, a base station sends reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index; the user equipment determines a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index, where REs that are used to send reference signals on antenna ports in two antenna port subsets included in an antenna port set corresponding to the reference signal configuration are located in two different resource block RB pairs; the user equipment obtains, according to the determined reference signal configuration, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set; the base station sends the reference signals at the positions of the resource elements REs; and the user equipment receives, according to the positions of the REs, the reference signals sent by the base station. Therefore, a problem that prior-art reference signals do not support more than eight antenna ports can be resolved, and a feasible design solution for reference signal configuration is provided for an antenna configuration including more than eight antenna ports. In addition, resource element groups used by the two antenna port subsets in two RB pairs do not have an intersection. Therefore, on one hand, an RE position occupied by a CSI RS in a legacy (Legacy) system may be reused and interference to legacy UE in a same cell may be reduced. On the other hand, for multiple different reference signal configurations, because the resource element groups used in the two RB pairs do not have an intersection, inter-cell interference caused by reference signals may be reduced, that is, pilot contamination (Pilot Contamination) is reduced, thereby improving efficiency of channel state information measurement and data demodulation and improving a system throughput.

[0132] Another embodiment of the present invention provides user equipment 40. As shown in FIG. 6, the user equipment 40 includes:

a receiving unit 41, configured to receive reference signal resource configuration information sent by a base station, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index;

a determining unit 42, configured to determine a reference signal configuration from a reference signal configuration set according to the antenna port quantity information and the resource configuration index that are received by the receiving unit 41, where the reference signal configuration is used to indicate position information of resource elements REs that are used to send reference signals on antenna ports in an antenna port set, the reference signal configuration set includes at least one first reference signal configuration, and an antenna port set corresponding to the first reference signal configuration includes at least two antenna port subsets, where an RE that is used to send a reference signal on an antenna port in a first antenna port subset is located in a first resource block RB pair, an RE that is used to send a reference signal on an antenna port in a second antenna port subset is located in the second RB pair, and the first RB pair is different from the second RB pair; and

a position acquiring unit 43, configured to obtain, according to the reference signal configuration determined by the determining unit 42, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set, where:

the receiving unit 41 is further configured to receive the reference signals according to the positions of the REs obtained by the position acquiring unit 43.

[0133] The first RB pair and the second RB pair are separately located at different frequency domain positions in a same subframe or located in a same subband of different subframes.

[0134] A resource element group used by the first antenna port subset in the first RB pair is REG_{i_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{i_2}, where $REG_{i_1} \in A$, $REG_{i_2} \in A$, and $i_1 \neq i_2$; the set is $A = \{REG_i | i = 0,1,...,M-1\}, M \geq 2$, where an intersection of different resource element groups in the set A is an empty set, $i_1, i_2 \in \{0,...,M-1\}$, and i_1 and i_2 are indexes of the resource element groups REGs used in the two RB pairs respectively; and each resource element group in the set A represents a set of position triplets $(k', l', n_s \bmod 2)$ of resource elements REs in an RB pair that are used to send reference signals, relative to the RB pair in which the resource elements REs are located, where k' represents an index of a subcarrier of the resource element RE, in the RB pair in which the resource element RE is located, l' represents an index of an orthogonal frequency division multiplexing OFDM symbol of the resource element, in the RB pair in which the resource element is located, n_s represents an index of a timeslot to which the resource element belongs, mod represents a modulo operation, and n_s mod 2 represents a computed value resulting from a modulo 2 operation on n_s.

[0135] Further, the reference signal configuration set includes at least one second reference signal configuration, an antenna port set corresponding to the second reference signal configuration includes at least the first antenna port subset and the second antenna port subset, a resource element group used by the first antenna port subset in the first RB pair is REG_{j_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{j_2}, where $REG_{j_1} \in A$, $REG_{j_2} \in A$, $j_1 \neq j_2$, $j_1, j_2 \in \{0,1,...,M-1\}$, and i_1, i_2, j_1 and j_2 meet at least one of the following relationships: $j_1 = (i_1 + n) \bmod M$, $j_2 = (i_2 + n) \bmod M$, or $j_1 = i_2$, $j_2 = i_1$, where n represents a shift (shift) whose value is an integer.

[0136] Specifically, different resource element groups in the set A may be different position sets of REs that are used to send CSI RSs on eight antenna ports in an LTE R10 system. In this case, the resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. In this case, for how an eNB instructs legacy (Legacy) UE and UE in an LTE R12 system or in a future system to receive a CSI RS and how the UE performs correct rate matching, so that in the reference signal configuration, an RE position occupied by a CSI RS in the LTE RIO system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0137] In addition, in a two-cell example, for how to instruct, in two cells, UE to use a reference signal configuration to receive CSI RSs, so as to effectively avoid pilot contamination and interference to a PDSCH caused by a CSI RS of a neighboring cell, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0138] According to the present invention, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k', l', n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by the expressions (1) to (5), where the resource element group set A or the resource element group may apply to a subframe type FS1 or FS2.

[0139] In another example, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k', l', n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the resource element groups represented by the expressions (25) to (27), where the resource element group set A may apply to a subframe type FS2.

[0140] For LTE special subframe configurations 1, 2, 6, and 7, that each resource element group includes eight REs is used as an example. The resource element group set *A* may further include two or more of the resource element groups represented by the expressions (34) to (36).

[0141] For LTE special subframe configurations 3, 4, 8, and 9, that each resource element group includes eight REs is used as an example. The resource element group set *A* may further include two or more of the resource element groups represented by the expressions (43) to (45).

[0142] In another example, for the normal CP, a resource element group used in the reference signal configuration and a reference signal configuration set may be shown in Table 1, Table 2, or Table 3 in the foregoing embodiment. For related descriptions, refer to the foregoing embodiment, and details are not further described herein.

[0143] In another example, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k', l', n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the resource element groups represented by the expressions (52) to (55), where the resource element group set or the resource element group applies to a subframe type FS1 or FS2.

[0144] In another example, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k', l', n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set *A* includes two or more of the resource element groups represented by the expressions (64) to (66), where the resource element group set or the resource element group may apply to a subframe type FS2.

[0145] In another example, for the extended CP, a resource element group used in the reference signal configuration and a reference signal configuration set may be shown in Table 4, Table 5, Table 6, or Table 7 in the foregoing embodiment. For related descriptions, refer to the foregoing embodiment, and details are not further described herein.

[0146] Compared with the prior art, in this embodiment of the present invention, user equipment 40 receives reference signal resource configuration information sent by a base station, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index; the user equipment 40 determines a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index, where REs that are used to send reference signals on antenna ports in two antenna port subsets included in an antenna port set corresponding to the reference signal configuration are located in two different resource block RB pairs; and the user equipment 40 obtains, according to the determined reference signal configuration, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set, and receives, according to the positions of the REs, the reference signals sent by the base station. Therefore, a problem that prior-art reference signals do not support more than eight antenna ports can be resolved, and a feasible design solution for reference signal configuration is provided for an antenna configuration including more than eight antenna ports. In addition, resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. Therefore, on one hand, an RE position occupied by a CSI RS in a legacy (Legacy) system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced. On the other hand, for multiple different reference signal configurations, because the resource element groups used in the two RB pairs do not have an intersection, inter-cell interference caused by reference signals may be reduced, that is, pilot contamination is reduced, thereby improving efficiency of channel state information measurement and improving a system throughput.

[0147] Another embodiment of the present invention provides a base station 50. As shown in FIG. 7, the base station 50 includes:

a sending unit 51, configured to send reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index, and the antenna port quantity information and the resource configuration index are used to indicate a reference signal configuration in a reference signal configuration set, where the reference signal configuration is used to indicate position information of resource elements REs that are used to send reference signals on antenna ports in an antenna port set; and

the reference signal configuration set includes at least one first reference signal configuration, and an antenna port set corresponding to the first reference signal configuration includes at least two antenna port subsets, where a resource element RE that is used to send a reference signal on an antenna port in a first antenna port subset is located in a first resource block RB pair, an RE that is used to send a reference signal on an antenna port in a second antenna port subset is located in a second RB pair, and the first RB pair is different from the second RB pair; and

a determining unit 52, configured to determine, according to the reference signal configuration indicated by the reference signal configuration sent by the sending unit 51, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set corresponding to the reference signal configuration, where:

the sending unit 51 is further configured to send the reference signals to the user equipment at the positions determined by the determining unit 52.

[0148] The first RB pair and the second RB pair are separately located at different frequency domain positions in a same subframe or located in a same subband of different subframes.

[0149] A resource element group used by the first antenna port subset in the first RB pair is REG_{i_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{i_2} , where $REG_{i_1} \in A$, $REG_{i_2} \in A$, and $i_1 \neq i_2$; the set is $A = \{REG_i | i = 0,1,...,M-1\}, M \geq 2$, where an intersection of different resource element groups in the set A is an empty set, $i_1, i_2 \in \{0, ..., M-1\}$, and i_1 and i_2 are indexes of the resource element groups REGs used in the two RB pairs respectively; and

each resource element group in the set A represents a set of position triplets $(k', l', n_s \bmod 2)$ of resource elements REs in an RB pair that are used to send reference signals, relative to the RB pair in which the resource elements REs are located, where k' represents an index of a subcarrier of the resource element RE, in the RB pair in which the resource element RE is located, l' represents an index of an orthogonal frequency division multiplexing OFDM symbol of the resource element, in the RB pair in which the resource element is located, n_s represents an index of a timeslot to which the resource element belongs, mod represents a modulo operation, and n_s mod 2 represents a computed value resulting from a modulo 2 operation on n_s.

[0150] Further, the reference signal configuration set includes at least one second reference signal configuration, an antenna port set corresponding to the second reference signal configuration includes at least the first antenna port subset and the second antenna port subset, a resource element group used by the first antenna port subset in the first RB pair is REG_{j_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{j_2}, where $REG_{j_1} \in A$, $REG_{j_2} \in A$, $j_1 \neq j_2$, $j_1, j_2 \in \{0,1,...,M-1\}$, and i_1, i_2, j_1 and j_2 meet at least one of the following relationships: $j_1 = (i_1+n) \bmod M$, $j_2 = (i_2+n) \bmod M$, or $j_1 = i_2$, $j_2 = i_1$, where n represents a shift (shift) whose value is an integer.

[0151] Specifically, different resource element groups in the set A may be different position sets of REs that are used to send CSIRSs on eight antenna ports in an LTE RIO system. In this case, the resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. In this case, for how an eNB instructs legacy (Legacy) UE and UE in an LTE R12 system or in a future system to receive a CSI RS and how the UE performs correct rate matching, so that in the reference signal configuration, an RE position occupied by a CSI RS in the LTE RIO system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0152] In addition, in a two-cell example, for how to instruct, in two cells, UE to use a reference signal configuration to receive CSI RSs, so as to effectively avoid pilot contamination (Pilot Contamination) and interference to a PDSCH caused by a CSI RS of a neighboring cell, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0153] According to the present invention, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by the expressions (1) to (5), where the resource element group set A or the resource element group applies to a subframe type FS1 or FS2.

[0154] In another example, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by the expressions (25) to (27), where the resource element group set A may apply to a subframe type FS2.

[0155] For LTE special subframe configurations 1, 2, 6, and 7, that each resource element group includes eight REs is used as an example. The resource element group set A may further include two or more of the resource element groups represented by the expressions (34) to (36).

[0156] For LTE special subframe configurations 3, 4, 8, and 9, that each resource element group includes eight REs is used as an example. The resource element group set A may further include two or more of the resource element groups represented by the expressions (43) to (45).

[0157] In another example, for the normal CP, a resource element group used in the reference signal configuration and a reference signal configuration set may be shown in Table 1, Table 2, or Table 3 in the foregoing embodiment. For related descriptions, refer to the foregoing embodiment, and details are not further described herein.

[0158] In another example, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by the expressions (52) to (55), where the resource element group set or the resource element group applies to a subframe type FS1 or FS2.

[0159] In another example, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by the expressions (64) to (66), where the resource element group set or the resource element group may apply to a subframe type FS2.

[0160] In another example, for the extended CP, a resource element group used in the reference signal configuration and a reference signal configuration set may be shown in Table 4, Table 5, Table 6, or Table 7 in the foregoing embodiment. For related descriptions, refer to the foregoing embodiment, and details are not further described herein.

[0161] Compared with the prior art, in this embodiment of the present invention, an apparatus 50 sends reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index, and resource elements REs that are used to send reference signals on antenna ports in two antenna port subsets included in an antenna port set thereof are located in two different resource block RB pairs; and the apparatus 50 determines, according to the sent reference signal configuration, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set, and sends reference signals to the user equipment at the positions of the resource elements RE. Therefore, a problem that prior-art reference signals do not support more than eight antenna ports can be resolved, and a feasible design solution for reference signal configuration is provided for an antenna configuration including more than eight antenna ports, thereby improving efficiency of channel state information measurement. In addition, resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. Therefore, on one hand, an RE position occupied by a CSI RS in a legacy (Legacy) system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced. On the other hand, for multiple different reference signal configurations, because the resource element groups used in the two RB pairs do not have an intersection, inter-cell interference caused by reference signals may be reduced, that is, pilot contamination (Pilot Contamination) is reduced, thereby improving a system throughput.

[0162] Another embodiment of the present invention provides user equipment 60. As shown in FIG. 8, the user equipment 60 includes:

a receiver 61, configured to receive reference signal resource configuration information sent by a base station, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index; and a processor 62, configured to determine a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index, where the reference signal configuration is used to indicate position information of resource elements REs that are used to send reference signals on antenna ports in an antenna port set; and

the reference signal configuration set includes at least one first reference signal configuration, and an antenna port set corresponding to the first reference signal configuration includes at least two antenna port subsets, where an RE that is used to send a reference signal on an antenna port in a first antenna port subset is located in a first resource block RB pair, an RE that is used to send a reference signal on an antenna port in a second antenna port subset is located in a second RB pair, and the first RB pair is different from the second RB pair; and configured to obtain, according to the reference signal configuration determined by the determining unit, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set, where:

the receiver 61 is further configured to receive the reference signals according to the positions of the REs.

[0163] The first RB pair and the second RB pair are separately located at different frequency domain positions in a same subframe or located in a same subband of different subframes.

[0164] A resource element group used by the first antenna port subset in the first RB pair is REG_{i_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{i_2}, where $REG_{i_1} \in A$, $REG_{i_2} \in A$, and $i_1 \neq i_2$; the set is $A = \{REG_i | i = 0,1,...,M-1\}, M \geq 2$, where an intersection of different resource element groups in the set A is an empty set, $i_1, i_2 \in \{0, ..., M-1\}, M \geq 2$, and i_1 and i_2 are indexes of the resource element groups REGs used in the two RB pairs respectively; and

each resource element group in the set A represents a set of position triplets $(k', l', n_s \bmod 2)$ of resource elements REs in an RB pair that are used to send reference signals, relative to the RB pair in which the resource elements REs are located, where k' represents an index of a subcarrier of the resource element RE, in the RB pair in which the resource element RE is located, l' represents an index of an orthogonal frequency division multiplexing OFDM symbol of the resource element, in the RB pair in which the resource element is located, n_s represents an index of a timeslot to which the resource element belongs, mod represents a modulo operation, and $n_s \bmod 2$ represents a computed value resulting from a modulo 2 operation on n_s.

[0165] The reference signal configuration set includes at least one second reference signal configuration, an antenna port set corresponding to the second reference signal configuration includes at least the first antenna port subset and the second antenna port subset, a resource element group used by the first antenna port subset in the first RB pair is REG_{j_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{j_2}, where $REG_{j_1} \in A$, $REG_{j_2} \in A$, and $j_1 \neq j_2$, $j_1, j_2 \in \{0,1, ..., M-1\}$, where:

i_1, i_2, j_1 and j_2 meet at least one of the following relationships: $j_1 = (i_1+n) \bmod M$, $j_2 = (i_2+n) \bmod M$, or $j_1 = i_2$, $j_2 = i_1$, where n represents a shift (shift) whose value is an integer.

[0166] Specifically, different resource element groups in the set A may be different position sets of REs that are used to send CSI RSs on eight antenna ports in an LTE R10 system. In this case, the resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. In this case, for how an eNB instructs legacy (Legacy) UE and UE in an LTE R12 system or in a future system to receive a CSI RS and how the UE performs correct rate matching, so that in the reference signal configuration, an RE position occupied by a CSI RS in the LTE RIO system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0167] In addition, in a two-cell example, for how to instruct, in two cells, UE to use a reference signal configuration to receive CSI RSs, so as to effectively avoid pilot contamination (Pilot Contamination) and interference to a PDSCH caused by a CSI RS of a neighboring cell, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0168] According to the present invention, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k', l', n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by (1) to (5), where the resource element group set A or the resource element group may apply to a subframe type FS1 or FS2.

[0169] In another example, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k', l', n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by (25) to (27), where the resource element group set A may apply to a subframe type FS2.

[0170] For LTE special subframe configurations 1, 2, 6, and 7, that each resource element group includes eight REs is used as an example. The resource element group set A may further include two or more of the resource element groups represented by (34) to (36).

[0171] For LTE special subframe configurations 3, 4, 8, and 9, that each resource element group includes eight REs is used as an example. The resource element group set A may further include two or more of the resource element groups represented by (43) to (45).

[0172] In another example, for the normal CP, a resource element group used in the reference signal configuration and a reference signal configuration set may be shown in Table 1, Table 2, or Table 3 in the foregoing embodiment. For related descriptions, refer to the foregoing embodiment, and details are not further described herein.

[0173] In another example, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by (52) to (55), where the resource element group set or the resource element group may apply to a subframe type FS1 or FS2.

[0174] In another example, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet (k',l',n_s mod2). That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by (64) to (66), where the resource element group set or the resource element group may apply to a subframe type FS2.

[0175] In another example, for the extended CP, a resource element group used in the reference signal configuration and a reference signal configuration set may be shown in Table 4, Table 5, Table 6, or Table 7 in the foregoing embodiment. For related descriptions, refer to the foregoing embodiment, and details are not further described herein.

[0176] Compared with the prior art, in this embodiment of the present invention, user equipment 60 receives reference signal resource configuration information sent by a base station, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index; the user equipment 60 determines a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index, where REs that are used to send reference signals on antenna ports in two antenna port subsets included in an antenna port set corresponding to the reference signal configuration are located in two different resource block RB pairs; and the user equipment 60 obtains, according to the determined reference signal configuration, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set, and receives, according to the positions of the REs, the reference signals sent by the base station. Therefore, a problem that prior-art reference signals do not support more than eight antenna ports can be resolved, and a feasible design solution for reference signal configuration is provided for an antenna configuration including more than eight antenna ports. In addition, resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. Therefore, on one hand, an RE position occupied by a CSI RS in a legacy (Legacy) system may be reused and interference to legacy UE in a same cell may be reduced. On the other hand, for multiple different reference signal configurations, because the resource element groups used in the two RB pairs do not have an intersection, inter-cell interference caused by reference signals may be reduced, that is, pilot contamination is reduced, thereby improving efficiency of channel state information measurement and improving a system throughput.

[0177] Another embodiment of the present invention provides a base station 70. As shown in FIG. 9, the base station 70 includes:

a transmitter 71, configured to send reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index, and the antenna port quantity information and the resource configuration index are used to indicate a reference signal configuration in a reference signal configuration set, where the reference signal configuration is used to indicate position information of resource elements REs that are used to send reference signals on antenna ports in an antenna port set; and

the reference signal configuration set includes at least one first reference signal configuration, and an antenna port set corresponding to the first reference signal configuration includes at least two antenna port subsets, where a resource element RE that is used to send a reference signal on an antenna port in a first antenna port subset is located in a first resource block RB pair, an RE that is used to send a reference signal on an antenna port in a second antenna port subset is located in a second RB pair, and the first RB pair is different from the second RB pair; and

a processor 72, configured to determine, according to the reference signal configuration indicated by the sent reference signal configuration, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set corresponding to the reference signal configuration, where:

the transmitter 71 is further configured to send the reference signals to the user equipment at the positions determined by the processor 72.

[0178] The first RB pair and the second RB pair are separately located at different frequency domain positions in a same subframe or located in a same subband of different subframes.

[0179] A resource element group used by the first antenna port subset in the first RB pair is REG_{i_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{i_2} , where $REG_{i_1} \in A$, $REG_{i_2} \in A$, and $i_1 \neq i_2$; the set is $A = \{REG_i | i = 0,1,...,M-1\}, M \geq 2$, where an intersection of different resource element groups in the set A is an empty set, i_1, $i_2 \in \{0,...,M-1\}$, and i_1 and i_2 are indexes of the resource element groups REGs used in the two RB pairs respectively; and

each resource element group in the set A represents a set of position triplets $(k',l',n_s \bmod 2)$ of resource elements REs in an RB pair that are used to send reference signals, relative to the RB pair in which the resource elements REs are located, where k' represents an index of a subcarrier of the resource element RE, in the RB pair in which the resource element RE is located, l' represents an index of an orthogonal frequency division multiplexing OFDM symbol of the resource element, in the RB pair in which the resource element is located, n_s represents an index of a timeslot to which the resource element belongs, mod represents a modulo operation, and n_s mod2 represents a computed value resulting from a modulo 2 operation on n_s.

[0180] Further, the reference signal configuration set includes at least one second reference signal configuration, an antenna port set corresponding to the second reference signal configuration includes at least the first antenna port subset and the second antenna port subset, a resource element group used by the first antenna port subset in the first RB pair is REG_{j_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{j_2}, where $REG_{j_1} \in A$, $REG_{j_2} \in A$, and $j_1 \neq j_2, j_1, j_2 \in \{0,1,...,M-1\}$, where:

i_1, i_2, j_1 and j_2 meet at least one of the following relationships: $j_1 = (i_1+n) \bmod M$, $j_2 = (i_2+n) \bmod M$, or $j_1 = i_2$, $j_2 = i_1$, where n represents a shift (shift) whose value is an integer.

[0181] Specifically, different resource element groups in the set A may be different position sets of REs that are used to send CSIRSs on eight antenna ports in an LTE RIO system. In this case, the resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. In this case, for how an eNB instructs legacy (Legacy) UE and UE in an LTE R12 system or in a future system to receive a CSI RS and how the UE performs correct rate matching, so that in the reference signal configuration, an RE position occupied by a CSI RS in the LTE RIO system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0182] In addition, in a two-cell example, for how to instruct, in two cells, UE to use a reference signal configuration to receive CSI RSs, so as to effectively avoid pilot contamination (Pilot Contamination) and interference to a PDSCH caused by a CSI RS of a neighboring cell, refer to the descriptions in step 102 in the foregoing embodiment, and details are not further described herein.

[0183] According to the present invention, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k',l',n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by (1) to (5), where the resource element group set A or the resource element group may apply to a subframe type FS1 or FS2.

[0184] In another example, when a cyclic prefix CP is a normal CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k',l',n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by (25) to (27), where the resource element group set A may apply to a subframe type FS2.

[0185] For LTE special subframe configurations 1, 2, 6, and 7, that each resource element group includes eight REs is used as an example. The resource element group set A may further include two or more of the resource element groups represented by (34) to (36).

[0186] For LTE special subframe configurations 3, 4, 8, and 9, that each resource element group includes eight REs is used as an example. The resource element group set A may further include two or more of the resource element groups represented by (43) to (45).

[0187] In another example, for the normal CP, a resource element group used in the reference signal configuration and a reference signal configuration set may be shown in Table 1, Table 2, or Table 3 in the foregoing embodiment. For related descriptions, refer to the foregoing embodiment, and details are not further described herein.

[0188] In another example, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k',l',n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by (52) to (55), where the resource element group set or the resource element group may apply to a subframe type FS1 or FS2.

[0189] In another example, when a cyclic prefix CP is an extended CP, a position of a resource element RE relative to an RB pair in which the resource element RE is located is represented by a triplet $(k',l',n_s \bmod 2)$. That each resource element group includes eight REs is used as an example. The resource element group set A includes two or more of the resource element groups represented by (64) to (66), where the resource element group set or the resource element group may apply to a subframe type FS2.

[0190] In another example, for the extended CP, a resource element group used in the reference signal configuration and a reference signal configuration set may be shown in Table 4, Table 5, Table 6, or Table 7 in the foregoing embodiment. For related descriptions, refer to the foregoing embodiment, and details are not further described herein.

[0191] Compared with the prior art, in this embodiment of the present invention, a base station 70 sends reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index, and resource elements REs that are used to send reference signals on antenna ports in two antenna port subsets included in an antenna port set thereof are located in two different resource block RB pairs; and the base station 70 determines, according to the sent reference signal configuration, positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set, and sends reference signals to the user equipment at the positions of the resource elements RE. Therefore, a problem that prior-art reference signals do not support more than eight antenna ports can be resolved, and a feasible design solution for reference signal configuration is provided for an antenna configuration including more than eight antenna ports. In addition, resource element groups used by the two antenna port subsets in the two RB pairs do not have an intersection. Therefore, on one hand, an RE position occupied by a CSI RS in a legacy (Legacy) system may be reused and interference to legacy (Legacy) UE in a same cell may be reduced. On the other hand, for multiple different reference signal configurations, because the resource element groups used in the two RB pairs do not have an intersection, inter-cell interference caused by reference signals may be reduced, that is, pilot contamination (Pilot Contamination) is reduced, thereby improving efficiency of channel state information measurement and improving a system throughput.

[0192] The reference signal transmission apparatus provided in the embodiments of the present invention may implement the foregoing provided method embodiments; for specific function implementation, refer to the descriptions in the method embodiments, and details are not described herein again. The reference signal transmission method and an apparatus provided in the embodiments of the present invention may be applicable to sending of reference signals in an LTE system, but is not limited thereto.

[0193] A person of ordinary skill in the art may understand that all or a part of the processes of the methods in the embodiments may be implemented by a computer program instructing relevant hardware. The program may be stored in a computer readable storage medium. When the program runs, the processes of the methods in the embodiments are performed. The storage medium may include a magnetic disk, an optical disc, a read-only memory (Read-Only Memory, ROM), or a random access memory (Random Access Memory, RAM).

[0194] The foregoing descriptions are merely specific implementation manners of the present invention, but are not intended to limit the protection scope of the present invention. The protection scope of the present invention shall be subject to the protection scope of the claims.

Claims

1. A method of processing a reference signal, the method comprising:

- receiving reference signal resource configuration information sent by a base station, wherein the reference signal resource configuration information comprises antenna port quantity information and a resource configuration index (step 101/301);
- determining a reference signal configuration from a reference signal configuration set according to the antenna port quantity information and the resource configuration index, wherein the reference signal configuration is used to indicate position information of resource elements, REs, that are used to send reference signals on antenna ports in an antenna port set, the reference signal configuration set comprises at least one first reference signal configuration, and an antenna port set corresponding to the first reference signal configuration comprises at least two antenna port subsets,
  wherein:
  - an RE that is used to send a reference signal on an antenna port in a first antenna port subset is located in a first resource block RB pair, an RE that is used to send a reference signal on an antenna port in a second antenna port subset is located in a second RB pair, and the first RB pair is different from the second RB pair (step 102/302),
  - a resource element group used by the first antenna port subset in the first RB pair is REG_{i_1}, and a resource element group used by the second antenna port subset in the second RB pair is REG_{i_2}, wherein $REG_{i_1} \in A$, $REG_{i_2} \in A$, and $i_1 \neq i_2$; wherein a resource element group set is $A=\{REG_i|i=0,1,...,M-1\}, M \geq 2$, $i_1, i_2 \in \{0,...,M$

-1}, wherein i_1, and i_2 are indices of the resource element groups, REGs, used in the two RB pairs respectively, and an intersection of different resource element groups in the set A is an empty set,
◦ a cyclic prefix, CP, is a normal CP, and the resource element group set A includes two or more of the following resource element groups:

$$REG_0^{NCP} = \{(9,5,0), (9,6,0), (8,5,0), (8,6,0), (3,5,0), (3,6,0), (2,5,0), (2,6,0)\};$$

$$REG_1^{NCP} = \{(11,2,1), (11,3,1), (10,2,1), (10,3,1), (5,2,1), (5,3,1), (4,2,1), (4,3,1)\};$$

$$REG_2^{NCP} = \{(9,2,1), (9,3,1), (8,2,1), (8,3,1), (3,2,1), (3,3,1), (2,2,1), (2,3,1)\};$$

$$REG_3^{NCP} = \{(7,2,1), (7,3,1), (6,2,1), (6,3,1), (1,2,1), (1,3,1), (0,2,1), (0,3,1)\};$$

and

$$REG_4^{NCP} = \{(9,5,1), (9,6,1), (8,5,1), (8,6,1), (3,5,1), (3,6,1), (2,5,1), (2,6,1)\},$$

wherein each resource element group in the resource element group set *A* represents a set of position triplets $(k',l',n_s \bmod 2)$ of REs in an RB pair that are used to send the reference signals, relative to the RB pair in which the REs are located, wherein *k*' represents an index of a subcarrier of a RE in the RB pair in which the RE is located, *l'* represents an index of an orthogonal frequency division multiplexing, OFDM, symbol of the RE in the RB pair in which the resource element is located, n_s represents an index of a timeslot to which the RE belongs, mod represents a modulo operation, and n_s mod2 represents a computed value resulting from a modulo 2 operation on n_s,
wherein each resource element group REG_i among the resource element groups contained in the resource element group set A includes two resource element subgroups,
wherein each resource element subgroup contains four REs, the four REs being formed by two first REs and two second REs, the four REs being arranged adjacent to each other in the frequency and time domain, so that:

- the two first REs of the four REs are provided next to each other in the time domain on different adjacent OFDM symbols and are provided on a same subcarrier in the frequency domain; and
- the two second REs of the four REs are provided next to each other in the time domain on the same OFDM symbols as the two first REs and are provided on a same subcarrier with a subcarrier index reduced by one compared to a subcarrier index of the two first REs,

◦ the first and second antenna port subsets consist of eight antenna ports, and:

- for the first antenna port subset, four antenna ports among the eight antenna ports are used for:
the two first REs of a first resource element subgroup contained in REG_{i_1} and the two first REs of a second resource element subgroup contained in REG_{i_1},
and four further antenna ports among the eight antenna ports are used for:
the two second REs of the first resource element subgroup contained in REG_{i_1} and the two second

REs of the second resource element subgroup contained in REG_{i_1},
and the reference signals are code division multiplexed over the two first REs of the first resource element subgroup contained in REG_{i_1} and the two first REs of the second resource element subgroup contained in REG_{i_1} using a code of length 4, and separately from code division multiplexing the reference signals over the two first REs of the first resource element subgroup contained in REG_{i_1} and the two first REs of the second resource element subgroup contained in REG_{i_1}, the reference signals are code division multiplexed over the two second REs of the first resource element subgroup contained in REG_{i_1} and the two second REs of the second resource element subgroup contained in REG_{i_1} using a code of length 4

- for the second antenna port subset, four antenna ports among the eight antenna ports are used for:
the two first REs of a first resource element subgroup contained in REG_{i_2} and the two first REs of a second resource element subgroup contained in REG_{i_2},
and four further antenna ports among the eight antenna ports are used for:
the two second REs of the first resource element subgroup contained in REG_{i_2} and the two second REs of the second resource element subgroup contained in REG_{i_2},
and the reference signals are code division multiplexed over the two first REs of the first resource element subgroup contained in REG_{i_2} and the two first REs of the second resource element subgroup contained in REG_{i_2} using a code of length 4, and separately from code division multiplexing the reference signals over the two first REs of the first resource element subgroup contained in REG_{i_2} and the two first REs of the second resource element subgroup contained in REQ_{i_2}, the reference signals are code division multiplexed over the two second REs of the first resource element subgroup contained in REG_{i_2} and the two second REs of the second resource element subgroup contained in REG_{i_2} using a code of length 4;

• obtaining, according to the determined reference signal configuration, positions of the REs that are used to send the reference signals on the antenna ports in the antenna port set (step 103); and
• receiving the reference signals according to the positions of the REs.

2. The method according to claim 1, wherein the code division multiplexing, CDM, codes for the reference signals on the antenna ports are [1,1,1,1], [1,-1,1,-1], [1,1,-1,-1], and [1,-1,-1,1] respectively.

3. The method according to claim 1 or 2, wherein the reference signal configuration set comprises at least one second reference signal configuration, an antenna port set corresponding to the second reference signal configuration comprises at least the first antenna port subset and the second antenna port subset, a resource element group used by the first antenna port subset in the first RB pair is REG_{j_1} , and a resource element group used by the second antenna port subset in the second RB pair is REG_{j_2}, wherein $REG_{j_1} \in A$, $REG_{j_2} \in A$, $j_1 \neq j_2$, $j_{1,\ j2} \in \{0,1,...,M\text{-}1\}$, and i_1,i_2,j_1 and j_2 meet at least one of the following relationships:
$j_1 = (i_1+n)\text{mod}M$, $j_2 = (i_2 +n)\text{mod}M$, or $j_1 = i_2$, $j_2 = i_1$, wherein n represents a shift whose value is an integer.

4. An apparatus configured to perform any of the methods according to claims 1-3.

5. A computer-readable storage medium comprising instructions which, when executed by a computer, cause the computer to carry out the steps of the method of any one of the claims 1 - 3.

Patentansprüche

1. Verfahren zum Verarbeiten eines Referenzsignals, wobei das Verfahren Folgendes umfasst:

• Empfangen von Referenzsignalressourcen-Konfigurationsinformationen, die von einer Basisstation gesendet werden, wobei die Referenzsignalressourcen-Konfigurationsinformationen Antennenanschluss-Mengeninformationen und einen Ressourcenkonfigurationsindex umfassen (Schritt 101/301);
• Bestimmen einer Referenzsignalkonfiguration aus einem Referenzsignal-Konfigurationssatz gemäß den Antennenanschluss-Mengeninformationen und dem Ressourcenkonfigurationsindex, wobei die Referenzsignalkonfiguration verwendet wird, um Positionsinformationen von Ressourcenelementen, REs, anzuzeigen, welche verwendet werden, um Referenzsignale auf Antennenanschlüssen in einem Antennenanschlusssatz zu senden, wobei der Referenzsignal-Konfigurationssatz mindestens eine erste Referenzsignalkonfiguration umfasst und ein Antennenanschlusssatz, der der ersten Referenzsignalkonfiguration entspricht, mindestens zwei Antennen-

anschluss-Teil sätze umfasst,
wobei

∘ ein RE, welches verwendet wird, um ein Referenzsignal auf einem Antennenanschluss in einem ersten Antennenanschluss-Teilsatz zu senden, in einem ersten Ressourcenblock(RB)-Paar angeordnet ist, ein RE, welches verwendet wird, um ein Referenzsignal auf einem Antennenanschluss in einem zweiten Antennenanschluss-Teilsatz zu senden, in einem zweiten RB-Paar angeordnet ist und sich das erste RB-Paar von dem zweiten RB-Paar unterscheidet (Schritt 102/302);

∘ eine Ressourcenelementgruppe, die von dem ersten Antennenanschluss-Teilsatz verwendet wird, in dem ersten RB-Paar REG_{i_1} ist und eine Ressourcenelementgruppe, die von dem zweiten Antennenanschluss-Teilsatz verwendet wird, in dem zweiten RB-Paar REG_{i_2} ist, wobei $REG_{i_1} \in A$, $REG_{i_2} \in A$ und $i_l \neq i_2$ ist, wobei ein Ressourcenelement-Gruppensatz $A = \{REG_i | i=0,1,...,M-1\}$, $M \geq 2$, $i_1, i_2 \in \{0,...M-1\}$ ist, wobei i_1 und i_2 Indizes der Ressourcenelementgruppen, REGs, sind, die entsprechend in den zwei RB-Paaren verwendet werden; und eine Schnittmenge unterschiedlicher Ressourcenelementgruppen in dem Satz A ein leerer Satz ist,

∘ ein zyklisches Präfix, CP, ein normales CP ist und der Ressourcenelement-Gruppensatz A zwei oder mehr der folgenden Ressourcenelementgruppen aufweist:

REG_0^{NCP}= {(9,5,0), (9,6,0), (8,5,0), (8,6,0), (3,5,0), (3,6,0), (2,5,0), (2,6,0)};
REG_l^{NCP} = {(11,2,1), (11,3,1), (10,2,1), (10,3,1), (5,2,1), (5,3,1), (4,2,1), (4,3,1)};
REG_2^{NCP}= {(9,2,1), (9,3,1), (8,2,1), (8,3,1), (3,2,1), (3,3,1), (2,2,1), (2,3,1)};
REG_3^{NCP}= {(7,2,1), (7,3,1), (6,2,1), (6,3,1), (1,2,1), (1,3,1), (0,2,1), (0,3,1)}; und
REG_4^{NCP} = {(9,5,1), (9,6,1), (8,5,1), (8,6,1), (3,5,1), (3,6,1), (2,5,1), (2,6,1)},

wobei jede Ressourcenelementgruppe in dem Ressourcenelement-Gruppensatz *A* einen Satz von Positionstripletts (k', l', n_s mod2) von REs in einem RB-Paar, welche verwendet werden, um die Referenzsignale zu senden, relativ zu dem RB-Paar, in welchem die REs angeordnet sind, repräsentiert, wobei *k'* für einen Index eines Subträgers eines RE in dem RB-Paar steht, in welchem das RE angeordnet ist, *l'* für einen Index eines Orthogonal-Frequenzmultiplex(OFDM)-Symbols des RE in dem RB-Paar steht, in welchem das Ressourcenelement angeordnet ist, n_s für einen Index eines Zeitschlitzes steht, zu welchem das RE gehört, mod für eine Modulo-Operation steht und n_s mod2 für einen berechneten Wert steht, der aus einer Modulo-2-Operation an n_s resultiert,

wobei jede Ressourcenelementgruppe REG_i unter den in dem Ressourcenelement-Gruppensatz A enthaltenen Ressourcenelementgruppen zwei Ressourcenelement-Untergruppen aufweist,

wobei jede Ressourcenelement-Untergruppe vier REs enthält; die vier REs durch zwei erste REs und zwei zweite REs gebildet werden; und die vier REs in der Frequenz- und Zeitdomäne nebeneinander angeordnet sind, sodass

• die zwei ersten REs der vier REs in der Zeitdomäne nebeneinander an unterschiedlichen angrenzenden OFDM-Symbolen bereitgestellt und auf einem gleichen Subträger in der Frequenzdomäne bereitgestellt sind; und

• die zwei zweiten REs der vier REs in der Zeitdomäne nebeneinander an den gleichen OFDM-Symbolen wie die zwei ersten REs bereitgestellt und auf einem gleichen Subträger mit einem Subträger-Index bereitgestellt sind, der im Vergleich zu einem Subträger-Index der zwei ersten REs um eins herabgesetzt ist,

∘ der erste und der zweite Antennenanschluss-Teilsatz aus acht Antennenanschlüssen bestehen, und

• für den ersten Antennenanschluss-Teilsatz vier Antennenanschlüsse unter den acht Antennenanschlüssen verwendet werden für:

die zwei ersten REs einer in PEG_{i_1} enthaltenen ersten Ressourcenelement-Untergruppe und die zwei ersten REs einer in REG_{i_1} enthaltenen zweiten Ressourcenelement-Untergruppe,

und vier weitere Antennenanschlüsse unter den acht Antennenanschlüssen verwendet werden für:

die zwei zweiten REs der in PEG_{i_l} enthaltenen ersten Ressourcenelement-Untergruppe und die zwei zweiten REs der in REG_{i_l} enthaltenen zweiten Ressourcenelement-Untergruppe,

und die Referenzsignale über den zwei ersten REs der in REG_{i_l} enthaltenen ersten Ressourcenelement-Untergruppe und den zwei ersten REs der in PEG_{i_l} enthaltenen zweiten Ressourcenelement-Untergruppe unter Verwendung eines Codes der Länge 4 Code-gemultiplext sind; und, separat vom Code-Multiplexieren der Referenzsignale über den zwei ersten REs der in PEG_{i_l} enthaltenen ersten Ressourcenelement-Untergruppe und den zwei ersten REs der in REG_{i_l} enthaltenen zweiten Ressourcenelement-Untergruppe, die Referenzsignale über den zwei zweiten REs der in REG_{i_l} enthaltenen ersten Ressourcenelement-Untergruppe und den zwei zweiten REs der in PEG_{i_l} enthaltenen zweiten Ressourcenelement-Untergruppe unter Verwendung eines Codes der Länge 4 Code-gemultiplext sind,

• für den zweiten Antennenanschluss-Teilsatz vier Antennenanschlüsse unter den acht Antennenanschlüssen verwendet werden für:

die zwei ersten REs einer in REG_{i_2} enthaltenen ersten Ressourcenelement-Untergruppe und die zwei ersten REs einer in REG_{i_2} enthaltenen zweiten Ressourcenelement-Untergruppe,
und vier weitere Antennenanschlüsse unter den acht Antennenanschlüssen verwendet werden für:

die zwei zweiten REs der in REG_{i_2} enthaltenen ersten Ressourcenelement-Untergruppe und die zwei zweiten REs der in REG_{i_2} enthaltenen zweiten Ressourcenelement-Untergruppe,
und die Referenzsignale über den zwei ersten REs der in REG_{i_2} enthaltenen ersten Ressourcenelement-Untergruppe und den zwei ersten REs der in REG_{i_2} enthaltenen zweiten Ressourcenelement-Untergruppe unter Verwendung eines Codes der Länge 4 Code-gemultiplext sind; und, separat vom Code-Multiplexieren der Referenzsignale über den zwei ersten REs der in REG_{i_2} enthaltenen ersten Ressourcenelement-Untergruppe und den zwei ersten REs der in REG_{i_2} enthaltenen zweiten Ressourcenelement-Untergruppe, die Referenzsignale über den zwei zweiten REs der in REG_{i_2} enthaltenen ersten Ressourcenelement-Untergruppe und den zwei zweiten REs der in REG_{i_2} enthaltenen zweiten Ressourcenelement-Untergruppe unter Verwendung eines Codes der Länge 4 Code-gemultiplext sind;

• Erhalten von Positionen der REs, die verwendet werden, um die Referenzsignale auf den Antennenanschlüssen in dem Antennenanschlusssatz zu senden, gemäß der bestimmten Referenzsignalkonfiguration, (Schritt 103); und
• Empfangen der Referenzsignale gemäß den Positionen der REs.

2. Verfahren nach Anspruch 1, wobei die Codemultiplex-, CDM-, -Codes für die Referenzsignale an den Antennenanschlüssen [1,1,1,1], [1,-1,1,-1], [1,1,-1,-1] bzw. [1,-1,-1,1] sind.

3. Verfahren nach Anspruch 1 oder 2, wobei der Referenzsignal-Konfigurationssatz mindestens eine zweite Referenzsignalkonfiguration umfasst, ein Antennenanschlusssatz, der der zweiten Referenzsignalkonfiguration entspricht, mindestens den ersten Antennenanschluss-Teilsatz und den zweiten Antennenanschluss-Teilsatz umfasst; eine Ressourcenelementgruppe, die von dem ersten Antennenanschluss-Teilsatz verwendet wird, in dem ersten RB-Paar REG_{j_1} ist; und eine Ressourcenelementgruppe, die von dem zweiten Antennenanschluss-Teilsatz verwendet wird, in dem zweiten RB-Paar REG_{j_2} ist, wobei $REG_{j_1} \in A$, $REG_{j_2} \in A$, $j_1 \neq j_2$, $j_1, j_2 \in \{0,1,...,M\text{-}1\}$ und i_1, i_2, j_1 und j_2 mindestens eine der folgenden Beziehungen erfüllen:
$j_1 = (i_1 + n)\mathrm{mod}M$, $j_2 = (i_2 + n)\mathrm{mod}M$ und $j_1 = i_2$, $j_2 = i_1$, wobei n eine Verschiebung repräsentiert, deren Wert eine ganze Zahl ist.

4. Vorrichtung, ausgelegt zum Durchführen eines der Verfahren nach den Ansprüchen 1-3.

5. Rechnerlesbares Speichermedium, umfassend Anweisungen, die bei Ausführung durch einen Rechner den Rechner zum Durchführen der Schritte des Verfahrens nach einem der Ansprüche 1-3 veranlassen.

Revendications

1. Procédé de traitement d'un signal de référence, le procédé comprenant les étapes consistant à :

recevoir une information de configuration de ressource de signal de référence envoyée par une station de base, l'information de configuration de ressource de signal de référence comprenant une information de nombre de ports d'antenne et un indice de configuration de ressource (étape 101/301) ;
déterminer une configuration de signal de référence à partir d'un ensemble de configurations de signal de référence selon l'information de nombre de ports d'antenne et l'indice de configuration de ressource, la configuration de signal de référence étant utilisée pour indiquer une information de position d'éléments de ressource (RE) qui sont utilisés pour envoyer des signaux de référence sur des ports d'antenne dans un ensemble de ports d'antenne, l'ensemble de configurations de signal de référence comprenant au moins une première configuration de signal de référence, et un ensemble de ports d'antenne qui correspond à la première configuration

de signal de référence comprenant au moins deux sous-ensembles de ports d'antenne, et dans lequel :

un RE qui est utilisé pour envoyer un signal de référence sur un port d'antenne dans un premier sous-ensemble de ports d'antenne est situé dans une première paire de blocs de ressources (RB), un RE qui est utilisé pour envoyer un signal de référence sur un port d'antenne dans un second sous-ensemble de ports d'antenne est situé dans une seconde paire RB, et la première paire RB est différente de la seconde paire RB (étape 102/302),

un groupe d'éléments de ressource utilisé par le premier sous-ensemble de ports d'antenne dans la première paire RB est REG_{i_1} et un groupe d'éléments de ressource utilisé par le second sous-ensemble de ports d'antenne dans la seconde paire RB est REG_{i_2}, où $REG_{i_1} \in$ A, $REG_{i_2} \in$ A et $i_1 \neq i_2$; un ensemble de groupes d'éléments de ressource étant A = {REG_i | i=0, 1, ..., M-1}, M ≥ 2, i_1, $i_2 \in$ {0, ..., M-1}, où i_1 et i_2 sont des indices des groupes d'éléments de ressource (REG) utilisés respectivement dans les deux paires RB, et une intersection de différents groupes d'éléments de ressource dans l'ensemble A étant un ensemble vide, un préfixe cyclique (CP) est un CP normal et l'ensemble de groupes d'éléments de ressource A inclut au moins deux des groupes d'éléments de ressource suivants :

$$REG_0^{NCP} = \{(9, 5, 0), (9, 6, 0), (8, 5, 0), (8, 6, 0), (3, 5, 0), (3, 6, 0), (2, 5, 0), (2, 6, 0)\} ;$$

$$REG_1^{NCP} = \{(11, 2, 1), (11, 3, 1), (10, 2, 1), (10, 3, 1), (5, 2, 1), (5, 3, 1), (4, 2, 1), (4, 3, 1)\} ;$$

$$REG_2^{NCP} = \{(9, 2, 1), (9, 3, 1), (8, 2, 1), (8, 3, 1), (3, 2, 1), (3, 3, 1), (2, 2, 1), (2, 3, 1)\} ;$$

$$REG_3^{NCP} = \{(7, 2, 1), (7, 3, 1), (6, 2, 1), (6, 3, 1), (1, 2, 1), (1, 3, 1), (0, 2, 1), (0, 3, 1)\} ;$$

et

$$REG_4^{NCP} = \{(9, 5, 1), (9, 6, 1), (8, 5, 1), (8, 6, 1), (3, 5, 1), (3, 6, 1), (2, 5, 1), (2, 6, 1)\},$$

chaque groupe d'éléments de ressource dans l'ensemble de groupes d'éléments de ressource *A* représentant un ensemble de triplets de position (k', l', n_s mod2) de RE dans une paire RB qui sont utilisés pour envoyer les signaux de référence, par rapport à la paire RB où se trouvent les RE, où k' représente un indice d'une sous-porteuse d'un RE dans la paire RB où se trouve le RE, l' représente un indice d'un symbole de multiplexage par répartition orthogonale de la fréquence (OFDM) du RE dans la paire RB où se trouve l'élément de ressource, n_s représente un indice d'un intervalle de temps auquel appartient le RE, mod représente une opération modulo et n_s mod2 représente une valeur calculée résultant d'une opération modulo 2 sur n_s,

chaque groupe d'éléments de ressource REG_i parmi les groupes d'éléments de ressource contenus dans l'ensemble de groupes d'éléments de ressource A incluant deux sous-groupes d'éléments de ressource,

chaque sous-groupe d'éléments de ressource contenant quatre RE, les quatre RE étant formés par deux premiers RE et deux seconds RE, les quatre RE étant agencés adjacents les uns par rapport aux autres dans le domaine fréquentiel et temporel, de sorte que :

les deux premiers RE des quatre RE soient situés l'un à côté de l'autre dans le domaine temporel sur différents symboles OFDM adjacents et soient situés sur une même sous-porteuse dans le domaine fréquentiel ; et

les deux seconds RE des quatre RE soient situés l'un à côté de l'autre dans le domaine temporel sur les mêmes symboles OFDM que les deux premiers RE et soient situés sur une même sous-porteuse avec un indice de sous-porteuse diminué d'un par comparaison avec un indice de sous-porteuse des deux premiers RE,

les premier et second sous-ensembles de ports d'antenne consistent en huit ports d'antenne, et :

pour le premier sous-ensemble de ports d'antenne, quatre ports d'antenne parmi les huit ports d'antenne sont utilisés pour :

les deux premiers RE d'un premier sous-groupe d'éléments de ressource contenu dans REG_{i_1} et les deux premiers RE d'un second sous-groupe d'éléments de ressource contenu dans REG_{i_1}, et quatre autres ports d'antenne parmi les huit ports d'antenne sont utilisés pour :

les deux seconds RE du premier sous-groupe d'éléments de ressource contenu dans REG_{i_1} et les deux seconds RE du second sous-groupe d'éléments de ressource contenu dans REG_{i_1}, et les signaux de référence sont multiplexés par répartition en code sur les deux premiers RE du premier sous-groupe d'éléments de ressource contenu dans REG_{i_1} et les deux premiers RE du second sous-groupe d'éléments de ressource contenu dans REG_{i_1} au moyen d'un code de longueur 4, et séparément du multiplexage par répartition en code des signaux de référence sur les deux premiers RE du premier sous-groupe d'éléments de ressource contenu dans REG_{i_1} et les deux premiers RE du second sous-groupe d'éléments de ressource contenu dans REG_{i_1}, les signaux de référence sont multiplexés par répartition en code sur les deux seconds RE du premier sous-groupe d'éléments de ressource contenu dans REG_{i_1} et les deux seconds RE du second sous-groupe d'éléments de ressource contenu dans REG_{i_1} au moyen d'un code de longueur 4, pour le second sous-ensemble de ports d'antenne, quatre ports d'antenne parmi les huit ports d'antenne sont utilisés pour :

les deux premiers RE d'un premier sous-groupe d'éléments de ressource contenu dans REG_{i_2} et les deux premiers RE d'un second sous-groupe d'éléments de ressource contenu dans REG_{i_2}, et quatre autres ports d'antenne parmi les huit ports d'antenne sont utilisés pour :

les deux seconds RE du premier sous-groupe d'éléments de ressource contenu dans REG_{i_2} et les deux seconds RE du second sous-groupe d'éléments de ressource contenu dans REG_{i_2}, et les signaux de référence sont multiplexés par répartition en code sur les deux premiers RE du premier sous-groupe d'éléments de ressource contenu dans REG_{i_2} et les deux premiers RE du second sous-groupe d'éléments de ressource contenu dans REG_{i_2} au moyen d'un code de longueur 4, et séparément du multiplexage par répartition en code des signaux de référence sur les deux premiers RE du premier sous-groupe d'éléments de ressource contenu dans REG_{i_2} et les deux premiers RE du second sous-groupe d'éléments de ressource contenu dans REG_{i_2}, les signaux de référence sont multiplexés par répartition en code sur les deux seconds RE du premier sous-groupe d'éléments de ressource contenu dans REG_{i_2} et les deux seconds RE du second sous-groupe d'éléments de ressource contenu dans REG_{i_2} au moyen d'un code de longueur 4 ; obtenir, selon la configuration de signal de référence déterminée, des positions des RE qui sont utilisés pour envoyer les signaux de référence sur les ports d'antenne dans l'ensemble de ports d'antenne (étape 103) ; et recevoir les signaux de référence selon les positions des RE.

2. Procédé selon la revendication 1, dans lequel les codes de multiplexage par répartition en code (CDM) pour les signaux de référence sur les ports d'antenne sont respectivement [1, 1, 1, 1], [1, -1, 1, -1], [1, 1, -1, -1] et [1, -1, -1, 1].

3. Procédé selon la revendication 1 ou 2, dans lequel l'ensemble de configurations de signal de référence comprend au moins une seconde configuration de signal de référence, un ensemble de ports d'antenne correspondant à la seconde configuration de signal de référence comprend au moins le premier sous-ensemble de ports d'antenne et le second sous-ensemble de ports d'antenne, un groupe d'éléments de ressource utilisé par le premier sous-ensemble de ports d'antenne dans la première paire RB est REG_{J1} et un groupe d'éléments de ressource utilisé par le second sous-ensemble de ports d'antenne dans la seconde paire RB est REG_{j_2}, où $REG_{J_1} \in A$, $REG_{j_2} \in A$, $j_1 \neq j_2$, $j_1, j_2 \in \{0, 1, ..., M-1\}$ et i_1, i_2, j_1 et j_2 satisfont à au moins une des relations suivantes : $j_1 = (i_1 + n) \bmod M$, $j_2 = (i_2 + n) \bmod M$ et $j_1 = i_2, j_2 = i_1$, où n représente un décalage dont la valeur est un entier.

4. Appareil configuré pour réaliser l'un quelconque des procédés selon les revendications 1 à 3.

5. Support de stockage lisible par ordinateur comprenant des instructions qui, lorsqu'elles sont exécutées par un ordinateur, amènent l'ordinateur à réaliser les étapes du procédé selon l'une quelconque des revendications 1 à 3.

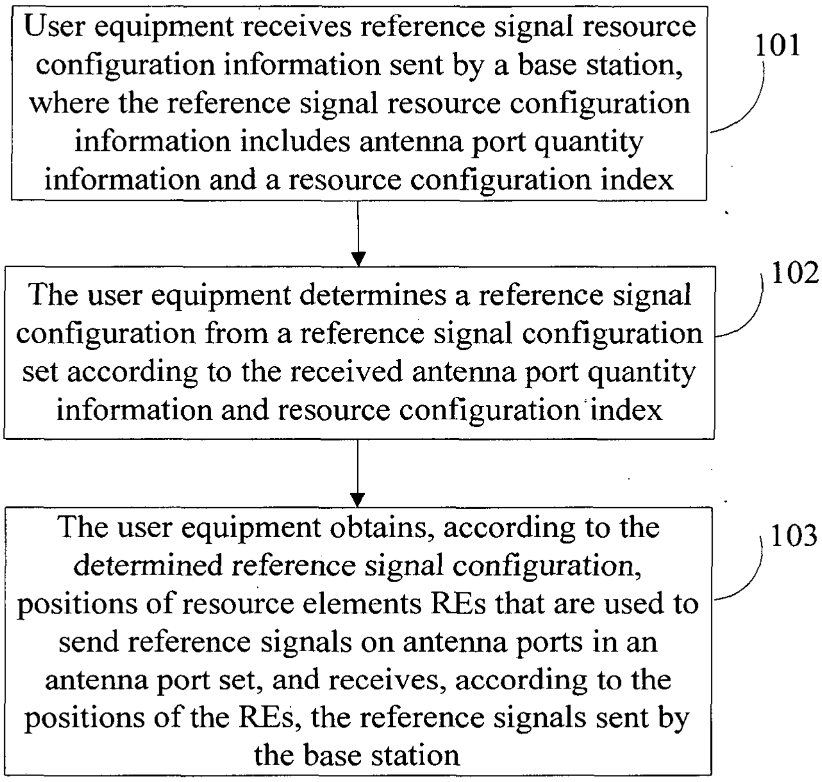

User equipment receives reference signal resource configuration information sent by a base station, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index
101
The user equipment determines a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index
102
The user equipment obtains, according to the determined reference signal configuration, positions of resource elements REs that are used to send reference signals on antenna ports in an antenna port set, and receives, according to the positions of the REs, the reference signals sent by the base station
103

FIG. 1

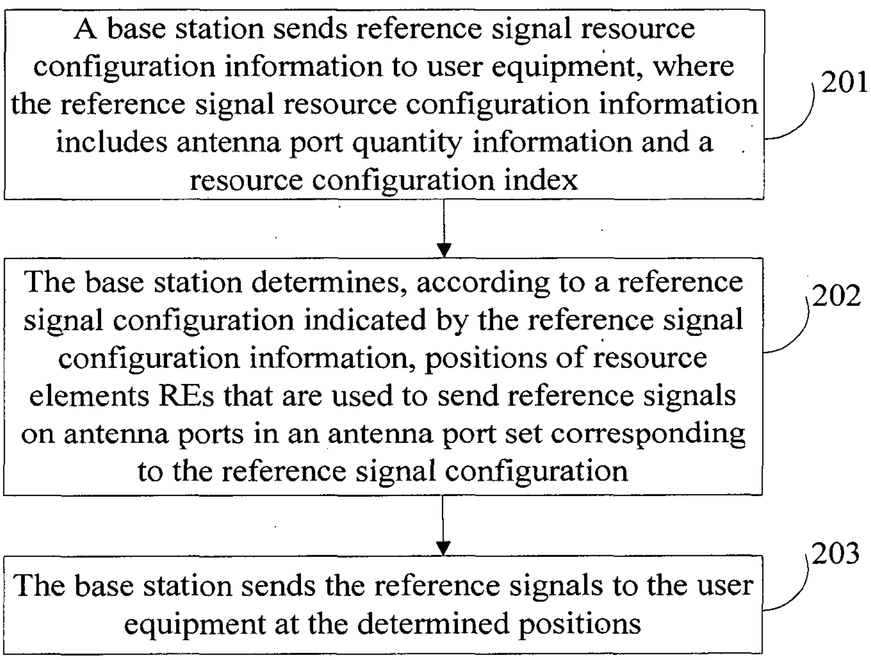

A base station sends reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index
201
The base station determines, according to a reference signal configuration indicated by the reference signal configuration information, positions of resource elements REs that are used to send reference signals on antenna ports in an antenna port set corresponding to the reference signal configuration
202
The base station sends the reference signals to the user equipment at the determined positions
203

FIG. 2

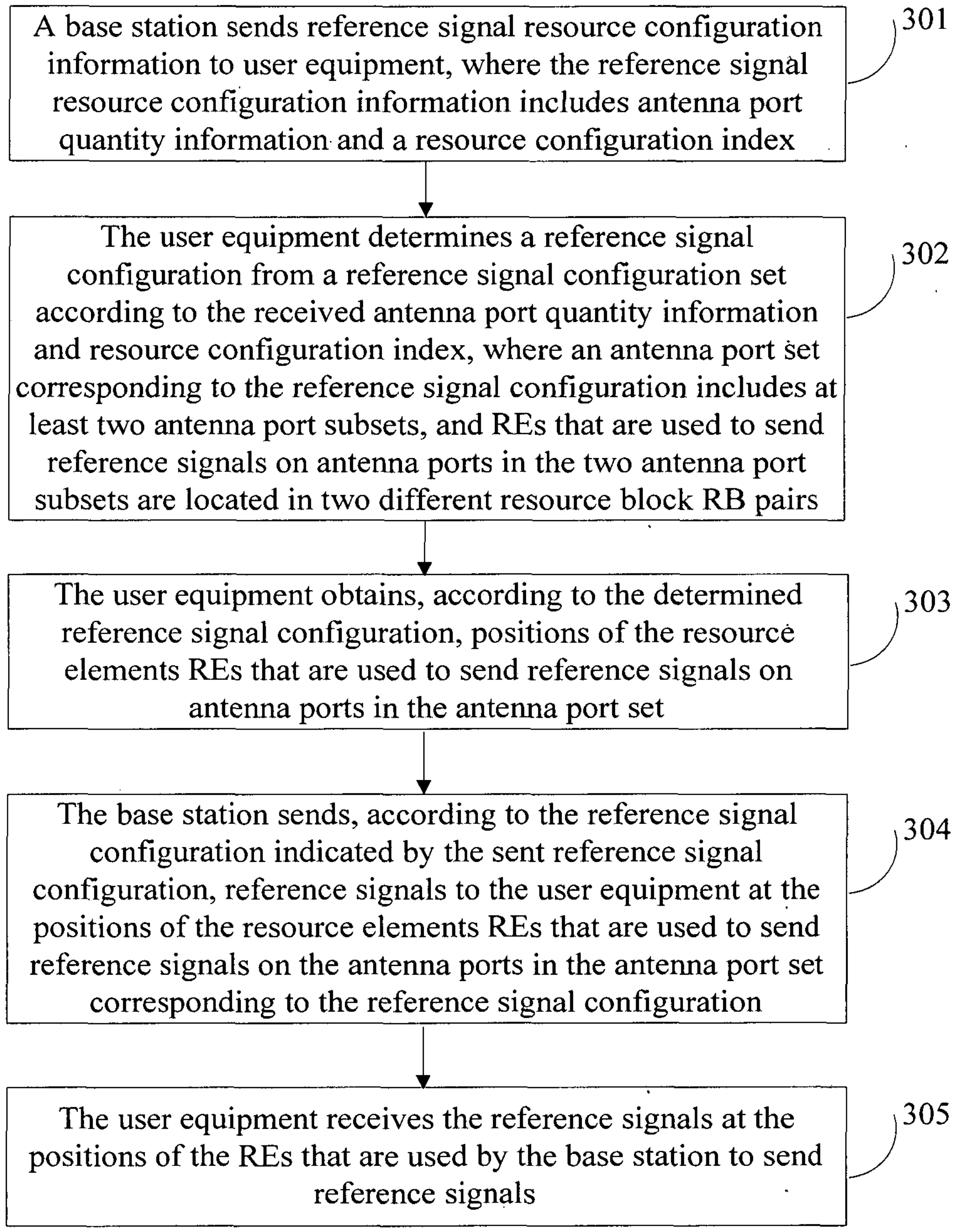
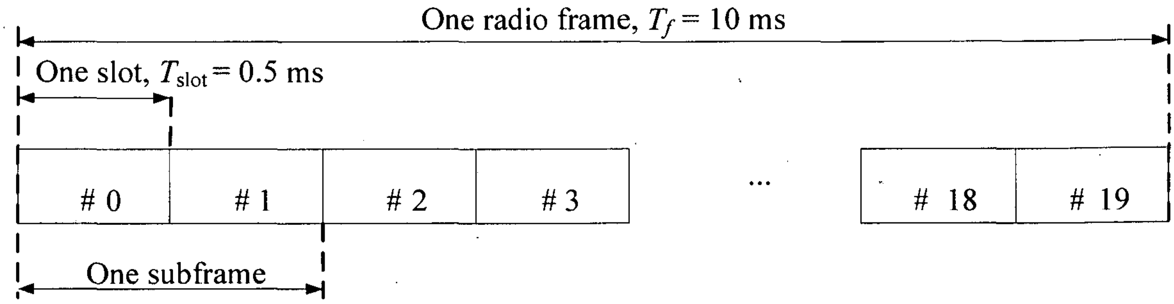
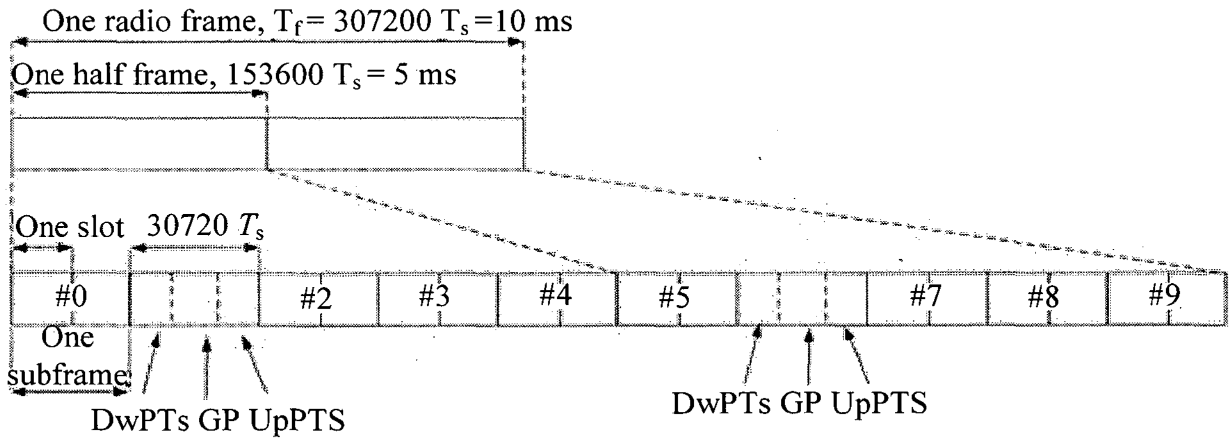

A base station sends reference signal resource configuration information to user equipment, where the reference signal resource configuration information includes antenna port quantity information and a resource configuration index
301
The user equipment determines a reference signal configuration from a reference signal configuration set according to the received antenna port quantity information and resource configuration index, where an antenna port set corresponding to the reference signal configuration includes at least two antenna port subsets, and REs that are used to send reference signals on antenna ports in the two antenna port subsets are located in two different resource block RB pairs
302
The user equipment obtains, according to the determined reference signal configuration, positions of the resource elements REs that are used to send reference signals on antenna ports in the antenna port set
303
The base station sends, according to the reference signal configuration indicated by the sent reference signal configuration, reference signals to the user equipment at the positions of the resource elements REs that are used to send reference signals on the antenna ports in the antenna port set corresponding to the reference signal configuration
304
The user equipment receives the reference signals at the positions of the REs that are used by the base station to send reference signals
305

FIG. 3



One radio frame, T_f = 10 ms
One slot, T_{slot} = 0.5 ms
0
1
2
3
...
18
19
One subframe

FIG. 3a



One radio frame, T_f = 307200 T_s =10 ms
One half frame, 153600 T_s = 5 ms
One slot 30720 T_s
#0
#2
#3
#4
#5
#7
#8
#9
One subframe
DwPTs GP UpPTS
DwPTs GP UpPTS

FIG. 3b

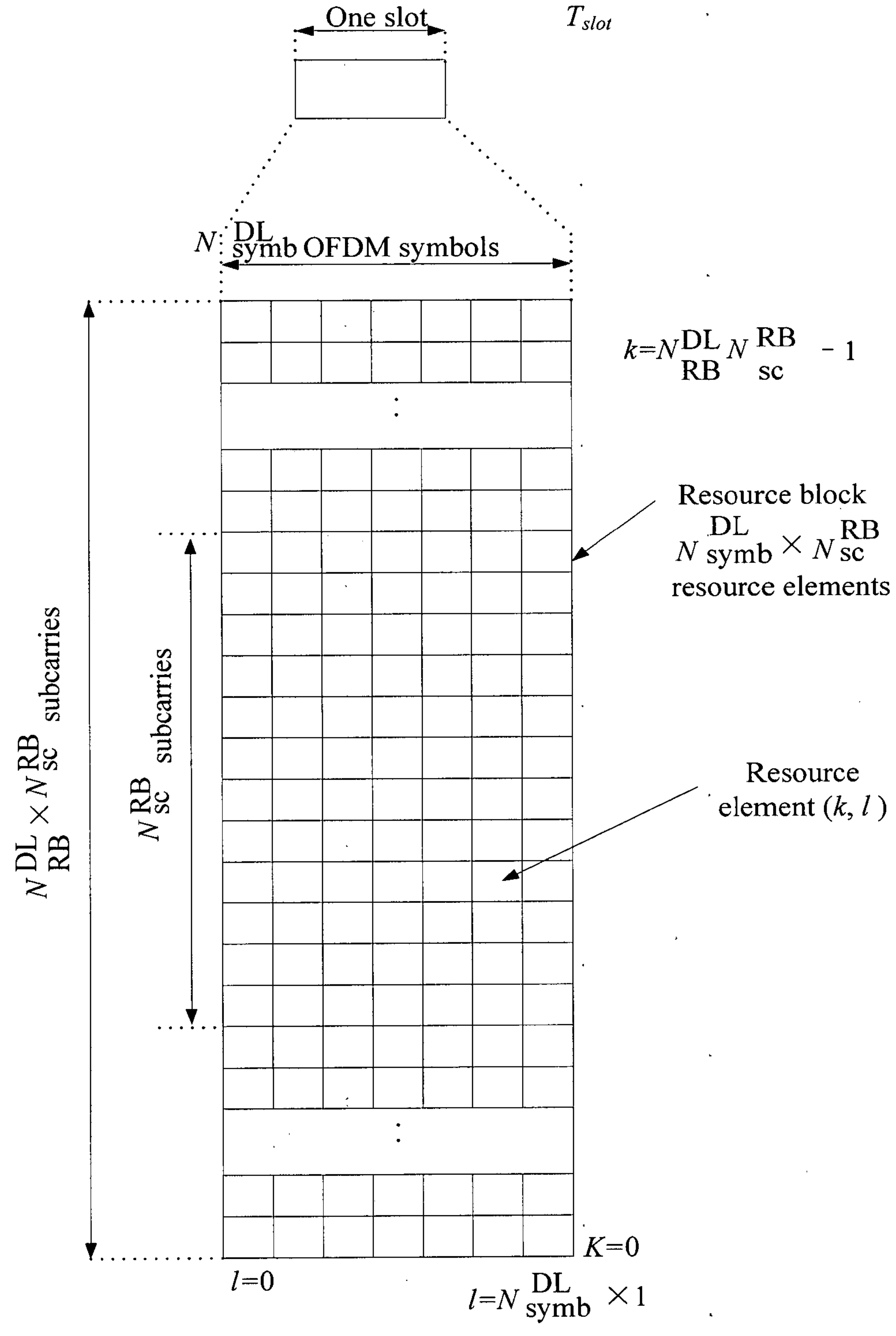

One slot
T_{slot}
N_{symb}^{DL} OFDM symbols
$k=N_{RB}^{DL}N_{sc}^{RB}-1$
Resource block
$N_{symb}^{DL}\times N_{sc}^{RB}$
resource elements
$N_{RB}^{DL}\times N_{sc}^{RB}$ subcarriers
N_{sc}^{RB} subcarriers
Resource
element (k, l)
$K=0$
$l=0$
$l=N_{symb}^{DL}\times 1$

FIG. 3c

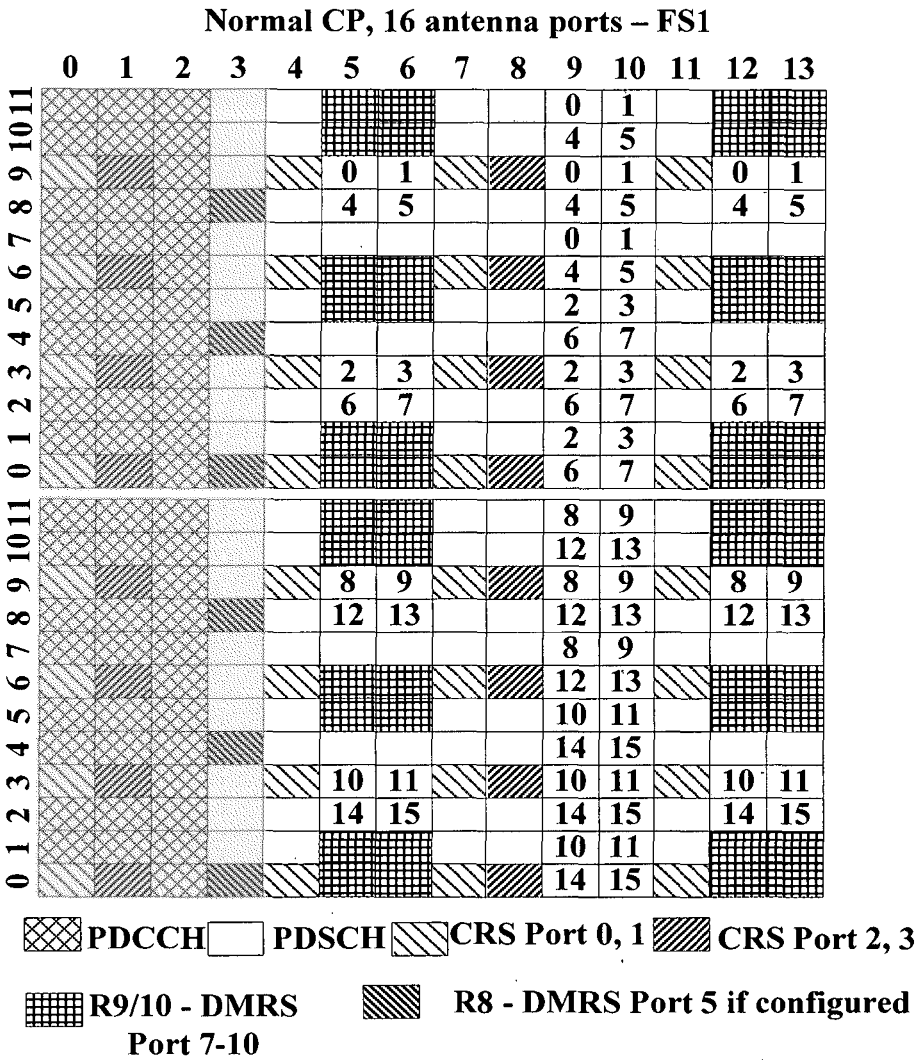

Normal CP, 16 antenna ports – FS1
0 1 2 3 4 5 6 7 8 9 10 11 12 13
PDCCH
PDSCH
CRS Port 0, 1
CRS Port 2, 3
R9/10 - DMRS Port 7-10
R8 - DMRS Port 5 if configured

FIG. 4a

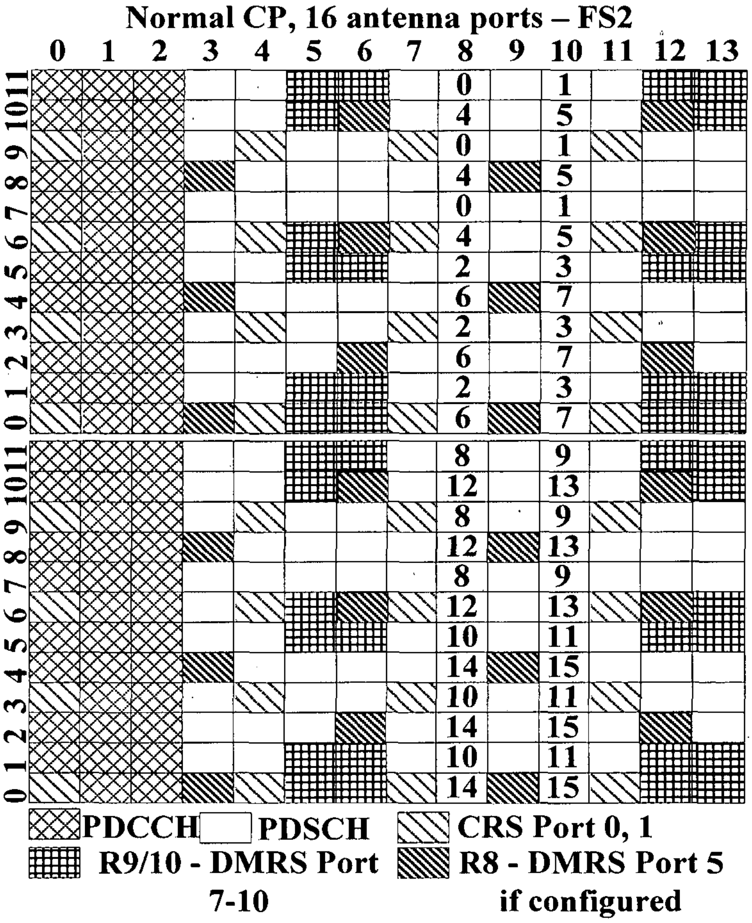

Normal CP, 16 antenna ports – FS2
PDCCH
PDSCH
CRS Port 0, 1
R9/10 - DMRS Port 7-10
R8 - DMRS Port 5 if configured

FIG. 4b

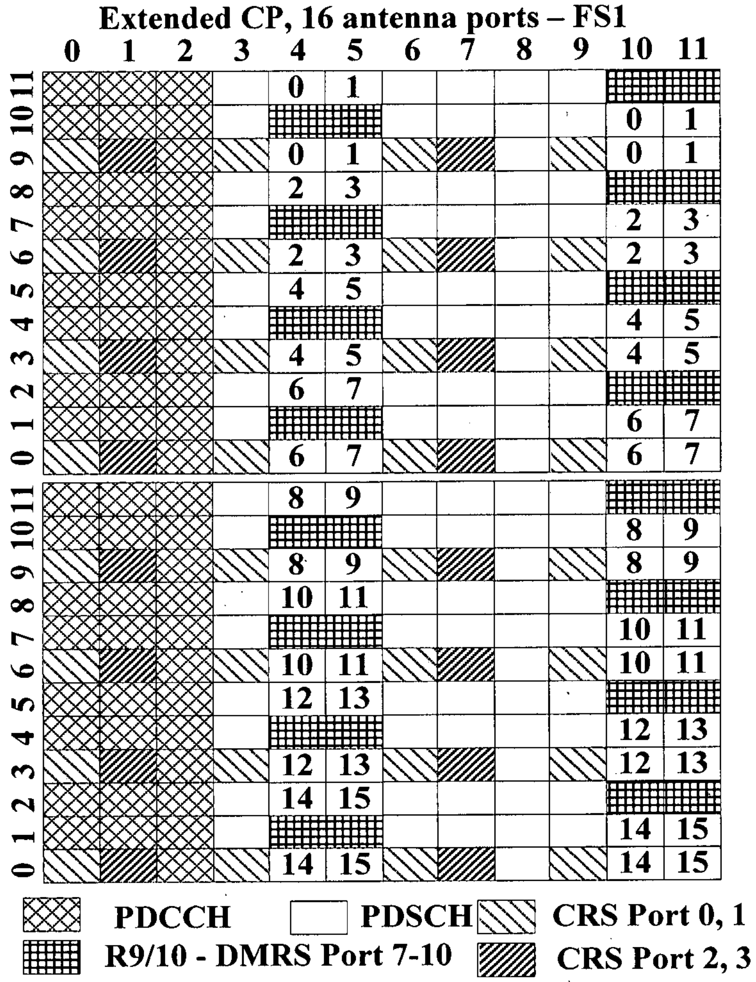

Extended CP, 16 antenna ports – FS1
0 1 2 3 4 5 6 7 8 9 10 11
PDCCH
PDSCH
CRS Port 0, 1
R9/10 - DMRS Port 7-10
CRS Port 2, 3

FIG. 5a

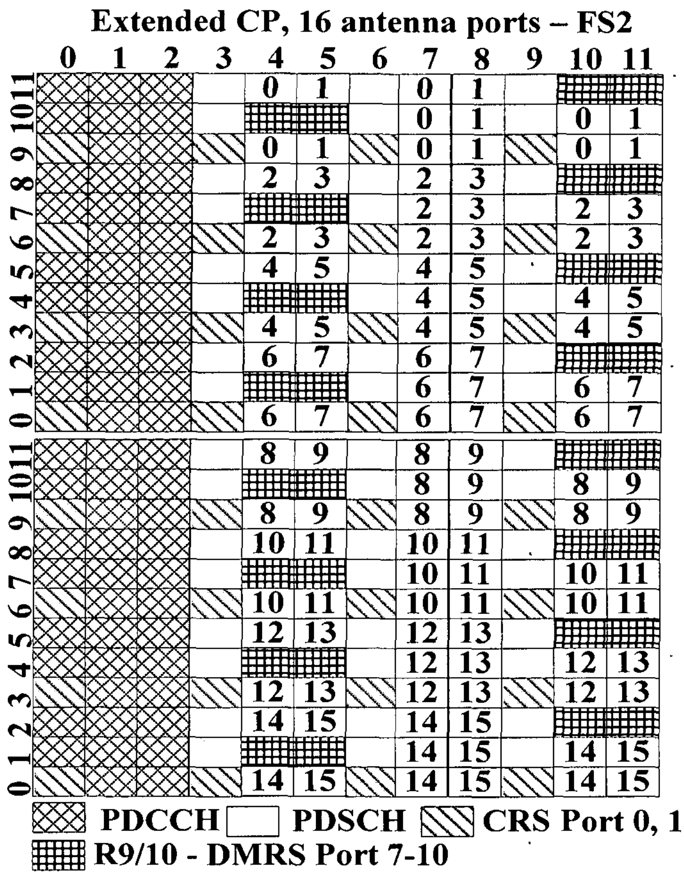

Extended CP, 16 antenna ports – FS2
PDCCH
PDSCH
CRS Port 0, 1
R9/10 - DMRS Port 7-10

FIG. 5b

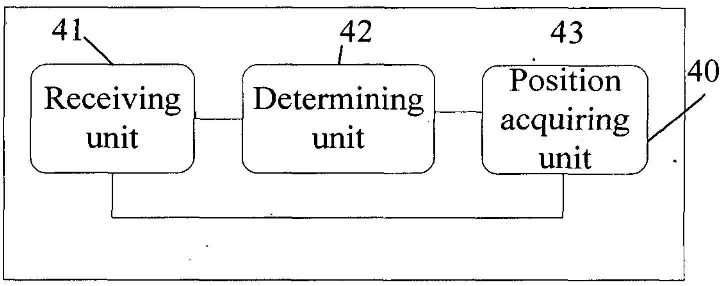

41
42
43
40
Receiving unit
Determining unit
Position acquiring unit

FIG. 6

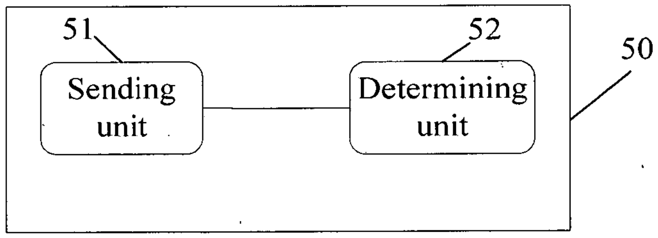


FIG. 7

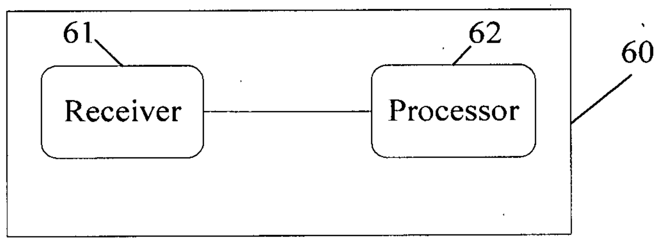


FIG. 8

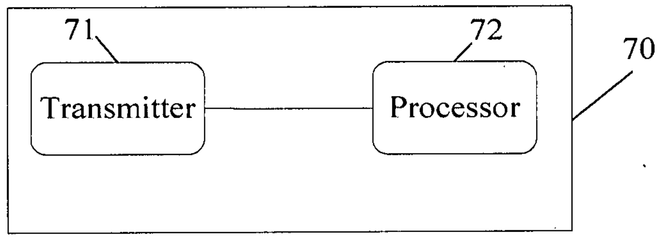


FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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- US 20100062783 A1 **[0006]**