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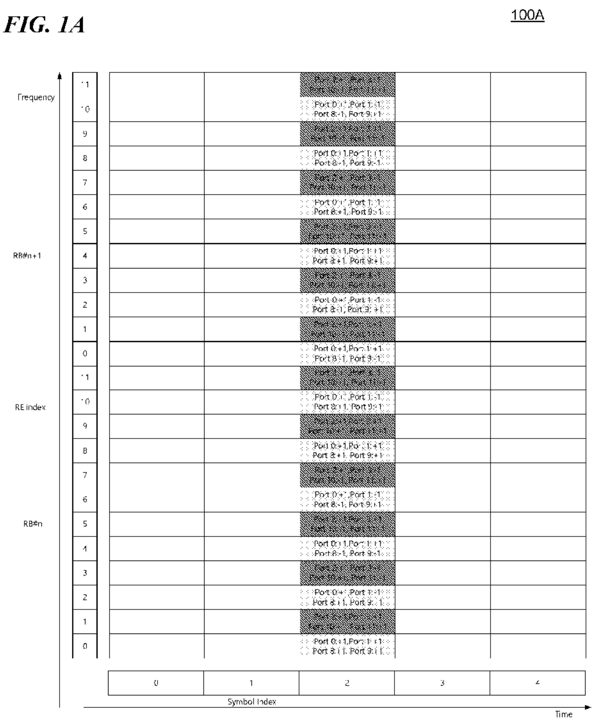
FIG. 1A



(57) Abstract: Methods and systems for demodulation reference signal (DMRS) transmission are disclosed. In some embodiments, the method includes (1) receiving, by a terminal device, configuration information of a DMRS; (2) determining, by the terminal device, a physical shared channel transmission based on the configuration information; and (3) transmitting, by the terminal device, the DMRS based on the configuration information. The configuration information indicates mapping relationships among multiple antenna ports and corresponding symbols for transmitting the DMRS, and the multiple antenna ports include more than 12 antenna ports.

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METHODS AND APPARATUS OF DEMODULATION REFERENCE SIGNAL (DMRS) TRANSMISSION

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the benefit of priority of U.S. Provisional Patent Application Serial No. 63/266,474, filed January 6, 2022, and U.S. Provisional Patent Application Serial No. 63/307,901, filed February 8, 2022, both of which are incorporated by reference herein in their entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to demodulation reference signal (DMRS) transmission. More specifically, systems and methods for enabling DMRS transmission with multiple antenna ports (e.g., up to 24 ports).

BACKGROUND

[0003] New Radio (NR) and fifth generation (5G) communication systems support DMRS for physical downlink shared channel (PDSCH) transmission and physical uplink shared channel (PUSCH) transmission. The DMRS of PDSCH can be used by a terminal device (or a user equipment, UE) to obtain a channel estimate for decoding the PDSCH. Similarly, the DMRS of PUSCH can be used by a base station (i.e., a "gNB") to obtain a channel estimate for decoding PUSCH.

[0004] In NR, two types of DMRS are supported, "DMRS Type 1" and "DMRS Type 2." "DMRS Type 1" can support up to 4 antenna ports in a single-symbol configuration and up to 8 antenna ports in a two-symbol configuration. "DMRS Type 2" can support up to 6 antenna ports in a single-symbol configuration and up to 12 antenna ports in a two-symbol configuration. The drawback of the traditional DMRS designs includes that the number of supported DMRS ports is very limited.

[0005] The traditional DMRS configurations would highly restrict the maximal number of terminal devices that can be supported in one multi-UE multiple-input-and-multiple-output (MIMO) transmission, resulting in a very limited peak throughput of the traditional NR systems. Thus, improved systems and methods that can address the foregoing issues are desirable and beneficial.

SUMMARY

[0006] Demodulation reference signals (DMRSs) can be used by terminal devices to estimate radio channels. The DMRS can be kept in a scheduled resource and can be transmitted downlink (DL) and/or uplink (UL). The present disclosure is related to systems and methods for enabling DMRS transmission with up to 24 ports. The present technology improves the capability of multi-user MIMO transmission in NR systems and thus boosts the system throughput. In some embodiments, a base station (e.g., gNB) can indicate a configuration of DMRS to a terminal device (e.g., UE). In the configuration of DMRS, the present technology provides up to 12 antenna ports in a single-symbol configuration and up to 24 antenna ports in a two-symbol configuration.

[0007] In some embodiments, the number of the antenna ports for the single-symbol configuration and the two-symbol configuration can be different. More particularly, for example, in the configuration of DMRS, the present technology can provide up to 8 antenna ports in a single-symbol configuration and up to 16 antenna ports in a two-symbol configuration.

[0008] In some embodiments, the base station indicates such a DMRS configuration for a PDSCH transmission to a terminal device. The terminal device can be requested to receive the DMRS and then the PDSCH transmission by following the provided DMRS configuration. Similarly, the base station can also indicate a DMRS configuration a PUSCH transmission and the terminal device can be requested to transmit the DMRS and the corresponding PUSCH transmission by following the provided DMRS configuration.

[0009] By the foregoing arrangement, the present technology can significantly increase the maximal number ports of DMRS to 24. Advantages of the present technology include, for example, it can improve an overall system communication capability for multi-user MIMO transmission.

[0010] In some embodiments, the present method can be implemented by a tangible, non-transitory, computer-readable medium having processor instructions stored thereon that, when executed by one or more processors, cause the one or more processors to perform one or more aspects/features of the method described herein.

In other embodiments, the present method can be implemented by a system comprising a computer processor and a non-transitory computer-readable storage medium storing instructions that when executed by the computer processor cause the computer processor to perform one or more actions of the method described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] To describe the technical solutions in the implementations of the present disclosure more clearly, the following briefly describes the accompanying drawings. The accompanying drawings show merely some aspects or implementations of the present disclosure, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

[0012] Figs. 1A-1H are schematic diagrams illustrating mapping relationships among antenna ports of DMRS and corresponding symbols in accordance with one or more implementations of the present disclosure.

[0013] Fig. 2 is a schematic diagram of a wireless communication system in accordance with one or more implementations of the present disclosure.

[0014] Fig. 3 is a schematic block diagram of a terminal device in accordance with one or more implementations of the present disclosure.

[0015] Fig. 4 is a flowchart of a method in accordance with one or more implementations of the present disclosure.

DETAILED DESCRIPTION

[0016] To describe the technical solutions in the implementations of the present disclosure more clearly, the following briefly describes the accompanying drawings. The accompanying drawings show merely some aspects or implementations of the present disclosure, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

[0017] Figs. 1A-1H are schematic diagrams illustrating mapping relationships among antenna ports for DMRS and corresponding symbols/frequencies in accordance with one or more implementations of the present disclosure. Figs. 1A-1H include tables 100A-H showing various mapping relationships in time domain (indicated by “symbol index”) and frequency domain (indicated by “resource element (RE) index”).

[0018] Referring to Fig. 1A, eight (8) antenna ports of DMRS are mapped to one symbol. Four of those 8 antenna ports (e.g., port 2, 3, 10, and 11) are mapped to odd-indexed resource elements (REs) and the other four of those 8 antenna ports (e.g., port 0, 1, 8, and 9) are mapped to even-indexed REs. For each four antenna ports mapped to the same REs, a length-4 orthogonal cover code (OCC) is applied. The length-4 OCC can be [+1,+1,+1,+1], [+1,-1,+1,-1], [+1, +1, -1,-1] and [+1,-1,-1,+1]. An example of mapping 8 DMRS antenna ports on one symbol is shown in Table 100A in Fig. 1A.

[0019] As shown in Fig. 1A, ports 0, 1, 8 and 9 are mapped all the even-numbered REs in RB #n and RB#n+1. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on “port 0” in frequency domain on the REs where port 0 is mapped. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 1 in frequency domain on the REs where port 1 is mapped. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 8 in frequency domain on the REs where port 8 is mapped, and frequency domain length-4 OCC [+1,-1,+1,-1] is applied on port 9 in frequency domain on the REs where port 9 is mapped.

[0020] Ports “2, 3, 10 and 11” are mapped all the odd-numbered REs in RB #n and RB#n+1. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 2 in frequency domain on the REs where port 2 is mapped. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 3 in frequency domain on the REs where port 3 is mapped. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 10 in frequency domain on the REs where port 10 is mapped and frequency domain length-4 OCC [+1,-1,+1,-1] is applied on port 11 in frequency domain on the REs where port 11 is mapped.

[0021] Referring to Table 100B in Fig. 1B, sixteen (6) antenna ports of DMRS are mapped to two symbols. Eight of those 16 antenna ports are mapped to even-numbered REs and the other eight of those 16 antenna ports are mapped to odd-numbered REs. For each eight antenna ports mapped to the same REs, a length-4 OCC is applied in frequency domain and a length-2 OCC is applied in time domain.

The length-4 OCC in frequency domain can be [+1,+1,+1,+1], [+1,-1,+1,-1], [+1, +1, -1,-1] and [+1,-1,-1,+1]. The length-2 OCC in time domain can be [+1,+1] and [+1, -2].

[0022] In one example, the ports 0~15 can be mapped to two symbols k and k+1 and two RBs #n and #n+1 as follows:

[0023] Ports "0, 1, 4, 5, 8, 9, 12, 13" are mapped all the even-numbered REs in RB #n and RB#n+1 on symbols k and k+1. More particularly, frequency domain length-4 OCC [+1, +1,+1,+1] is applied on port 0 on the REs where port 0 is mapped and time domain length-2 OCC [+1, +1] is applied on port 0 on symbols k and k+1. Frequency domain length-4 OCC [+1, -1,+1,-1] is applied on port 1 on the REs where port 1 is mapped and time domain length-2 OCC [+1, +1] is applied on port 1 on symbols k and k+1. Frequency domain length-4 OCC [+1, +1,-1,-1] is applied on port 8 on the REs where port 8 is mapped and time domain length-2 OCC [+1, +1] is applied on port 8 on symbols k and k+1. Frequency domain length-4 OCC [+1, -1,-1,+1] is applied on port 9 on the REs where port 9 is mapped and time domain length-2 OCC [+1, +1] is applied on port 9 on symbols k and k+1.

[0024] As also shown in Fig. 1B, frequency domain length-4 OCC [+1, +1,+1,+1] is applied on port 4 on the REs where port 4 is mapped and time domain length-2 OCC [+1, -1] is applied on port 4 on symbols k and k+1. Frequency domain length-4 OCC [+1, -1,+1,-1] is applied on port 5 on the REs where port 5 is mapped and time domain length-2 OCC [+1, -1] is applied on port 5 on symbols k and k+1. Frequency domain length-4 OCC [+1, +1,-1,-1] is applied on port 12 on the REs where port 12 is mapped and time domain length-2 OCC [+1, -1] is applied on port 12 on symbols k and k+1. Frequency domain length-4 OCC [+1, -1,-1,+1] is applied on port 13 on the REs where port 13 is mapped and time domain length-2 OCC [+1, -1] is applied on port 13 on symbols k and k+1.

[0025] Ports "2, 3, 6, 7, 10, 11, 14, 15" are mapped all the odd-numbered REs in RB #n and RB#n+1 on symbols k and k+1. Frequency domain length-4 OCC [+1, +1,+1,+1] is applied on port 2 on the REs where port 2 is mapped and time domain length-2 OCC [+1, +1] is applied on port 2 on symbols k and k+1. Frequency domain length-4 OCC [+1, -1,+1,-1] is applied on port 3 on the REs where port 3 is mapped and time domain length-2 OCC [+1, +1] is applied on port 3 on symbols k and k+1. Frequency domain length-4 OCC [+1, +1,-1,-1] is applied on port 10 on the REs where port 10 is mapped and time domain length-2 OCC [+1, +1] is applied on port 10 on symbols k and k+1.

[0026] As also shown in Fig. 1B, frequency domain length-4 OCC [+1, -1,-1,+1] is applied on port 11 on the REs where port 11 is mapped and time domain length-2 OCC [+1, +1] is applied on port 11 on symbols k and k+1. Frequency domain length-4 OCC [+1, +1,+1,+1] is applied on port 6 on the REs where port 6 is mapped and time domain length-2 OCC [+1, -1] is applied on port 6 on symbols k and k+1. Frequency domain length-4 OCC [+1, -1,+1,-1] is applied on port 7 on the REs where port 7 is mapped and time domain length-2 OCC [+1, -1] is applied on port 7 on symbols k and k+1. Frequency domain length-4 OCC [+1, +1,-1,-1] is applied on port 14 on the REs where port 14 is mapped and time domain length-2 OCC [+1, -1] is applied on port 14 on symbols k and k+1. Frequency domain length-4 OCC [+1, -1,-1,+1] is applied on port 15 on the REs where port 15 is mapped and time domain length-2 OCC [+1, -1] is applied on port 15 on symbols k and k+1.

[0027] In some embodiments, a base station can indicate a second configuration of DMRS to a terminal device. In the second configuration of DMRS, there can be up to 12 antenna ports in a single-symbol configuration and there could be up to 24 antenna ports in a two-symbol configuration. In the single-symbol configuration, those 12 ports can be partitioned into three groups. The ports in different groups can be mapped to different REs in frequency domain. Within each group, a length-4 OCC can be applied on each port in frequency domain. In the two-symbol configuration, those 24 ports can be partitioned into three groups. The ports in different groups are mapped to different REs in frequency domain. With each group, a length-4 OCC is applied on each port in frequency domain and a length-2 OCC is applied on each port in time domain.

[0028] In some embodiments, twelve (12) antenna ports of DMRS are mapped to one symbol. The 12 antenna ports are partitioned into 3 groups. The first group of antenna ports are mapped to REs “0,1,6 and 7” in a resource block (RB). The second group of antenna ports are mapped to REs “2, 3, 8 and 9” in an RB and the third group of antenna ports are mapped to REs “4, 5, 10 and 11” in an RB. On each antenna port, a length-4 OCC is applied on the REs in frequency domain. The length-4 OCC can be [+1, +1, +1, +1], [+1, -1, +1, -1], [+1, +1, -1, -1] and [+1, -1, -1, +1].

[0029] More particularly, ports “0, 1, 12 and 13” are mapped on REs “0, 1, 6 and 7” in an RB. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 0 in frequency domain on the REs where port 0 is mapped. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 1 in frequency domain on the REs where port 1 is mapped. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 12 in frequency domain on the REs where port 12 is mapped. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 13 in frequency domain on the REs where port 13 is mapped.

[0030] Ports “2, 3, 14 and 15” are mapped on REs “2, 3, 8 and 9” in an RB. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 2 in frequency domain on the REs where port 2 is mapped. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 3 in frequency domain on the REs where port 3 is mapped. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 14 in frequency domain on the REs where port 14 is mapped. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 15 in frequency domain on the REs where port 15 is mapped.

[0031] Ports “4, 5, 16 and 17” are mapped on REs “4, 5, 10 and 11” in an RB. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 4 in frequency domain on the REs where port 4 is mapped. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 5 in frequency domain on the REs where port 5 is mapped. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 16 in frequency domain on the REs where port 16 is mapped. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 17 in frequency domain on the REs where port 17 is mapped.

[0032] In some embodiments, twenty-four (24) antenna ports of DMRS can be mapped to two symbols. The 24 antenna ports are partitioned into 3 groups. The first group of antenna ports are mapped to REs “0,1,6 and 7” in an RB on both symbols. The second group of antenna ports are mapped to REs “2, 3, 8 and 9” in an RB on both symbols. The third group of antenna ports can be mapped to REs “4, 5, 10 and 11” in an RB on both symbols.

[0033] On each antenna port, a length-4 OCC is applied on the REs in frequency domain and a length-2 OCC is applied on those two symbols in time domain. The length-4 OCC can be [+1, +1, +1, +1], [+1, -1, +1, -1], [+1, +1, -1, -1] and [+1, -1, -1, +1]. The length-2 OCC can be [+1, +1] and [+1, -1]. More particularly, the ports can be arranged as follows:

[0034] Ports “0, 1, 12 and 13 and 6, 7, 18 and 19” are mapped on REs “0, 1, 6 and 7” in an RB. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 0 in frequency domain on the REs where port 0 is mapped and a length-2 OCC [+1, +1] is applied on port 0 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 1 in frequency domain on the REs where port 1 is mapped and a length-2 OCC [+1, +1] is applied on port 1 on two symbols in time domain. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 12 in frequency domain on the REs where port 12 is mapped and a length-2 OCC [+1, +1] is applied on port 12 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 13 in frequency domain on the REs where port 13 is mapped and a length-2 OCC [+1, +1] is applied on port 13 on two symbols in time domain. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 6 in frequency domain on the REs where port 6 is mapped and a length-2 OCC [+1, -1] is applied on port 6 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 7 in frequency domain on the REs where port 7 is mapped and a length-2 OCC [+1, -1] is applied on port 7 on two symbols in time domain. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 18 in frequency domain on the REs where port 18 is mapped and a length-2 OCC [+1, -1] is applied on port 18 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 19 in frequency domain on the REs where port 19 is mapped and a length-2 OCC [+1, -1] is applied on port 19 on two symbols in time domain.

[0035] Ports “2, 3, 14 and 15, 8, 9, 20 and 21” are mapped on REs “2, 3, 8 and 9” in an RB. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 2 in frequency domain on the REs where port 2 is mapped and a length-2 OCC [+1, +1] is applied on port 2 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 3 in frequency domain on the REs where port 3 is mapped and a length-2 OCC [+1, +1] is applied on port 3 on two symbols in time domain. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 14 in frequency domain on the REs where port 14 is mapped and a length-2 OCC [+1, +1] is applied on port 14 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 15 in frequency domain on the REs where port 15 is mapped and a length-2 OCC [+1, +1] is applied on port 15 on two symbols in time domain. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 8 in frequency domain on the REs where port 8 is mapped in frequency domain and a length-2 OCC [+1, -1] is applied on port 8 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 9 in frequency domain on the REs where port 9 is mapped and a length-2 OCC [+1, -1] is applied on port 9 on two symbols in time domain. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 20 in frequency domain on the REs where port 20 is mapped and a length-2 OCC [+1, -1] is applied on port 18 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 21 and a length-2 OCC [+1, -1] is applied on port 21 on two symbols in time domain.

[0036] Ports “4, 5, 16 and 17, 10, 11, 22 and 23” are mapped on REs 4, 5, 10 and 11 in an RB. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 4 in frequency domain on the REs where port 4 is mapped and a length-2 OCC [+1, +1] is applied on port 4 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 5 in frequency domain on the REs where port 5 is mapped and a length-2 OCC [+1, +1] is applied on port 5 on two symbols in time domain. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 16 in frequency domain on the REs where port 16 is mapped and a length-2 OCC [+1, +1] is applied on port 16 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 17 in frequency domain on the REs where port 17 is mapped and a length-2 OCC [+1, +1] is applied on port 17 on two symbols in time domain. Frequency domain length-4 OCC [+1, +1, +1, +1] is applied on port 10 in frequency domain on the REs where port 10 is mapped in frequency domain and a length-2 OCC [+1, -1] is applied on port 10 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 11 in frequency domain on the REs where port 11 is mapped and a length-2 OCC [+1, -1] is applied on port 11 on two symbols in time domain. Frequency domain length-4 OCC [+1, +1, -1, -1] is applied on port 22 in frequency domain on the REs where port 22 is mapped and a length-2 OCC [+1, -1] is applied on port 22 on two symbols in time domain. Frequency domain length-4 OCC [+1, -1, +1, -1] is applied on port 23 in frequency domain on the REs where port 23 is mapped and a length-2 OCC [+1, -1] is applied on port 23 on two symbols in time domain.

[0037] In some embodiments, the ports can be arranged such that one single RE corresponds to one port. Referring to Table 100C in Fig. 1C, twelve (12) antenna ports of DMRS are mapped to one symbol and those 12 antenna ports are mapped to different resource elements on the same symbol. Twenty four (24) antenna ports of DMRS can be mapped to two symbols. Each two antenna ports are mapped to one resource element on those two symbols and these two antenna ports are applied with different length-2 OCC

[0038] As shown in Table 100C, DMRS port 0 is mapped on RE #0 in one physical resource block (PRB) on one symbol. DMRS port 1 is mapped on RE #1 in one PRB on one symbol. DMRS port 2 is mapped on RE #2 in one PRB on one symbol. DMRS port 3 is mapped on RE #3 in one PRB on one symbol. DMRS port 4 is mapped on RE #4 in one PRB on one symbol. DMRS port 5 is mapped on RE #5 in one PRB on one symbol. DMRS port 6 is mapped on RE #6 in one PRB on one symbol. DMRS port 7 is mapped on RE #7 in one PRB on one symbol. DMRS port 8 is mapped on RE #8 in one PRB on one symbol. DMRS port 9 is mapped on RE #9 in one PRB on one symbol. DMRS port 10 is mapped on RE #10 in one PRB on one symbol. DMRS port 11 is mapped on RE #11 in one PRB on one symbol.

[0039] Table 100D in Fig. 1D shows examples of mapping 24 DMRS antenna ports on two symbols. As shown in Fig. 1D, DMRS ports 0 and 12 are mapped on RE #0 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 0 and OCC [+1, -1] is applied for DMRS port 12. DMRS ports 1 and 13 is mapped on RE #1 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 1 and OCC [+1, -1] is applied for DMRS port 13. DMRS ports 2 and 14 is mapped on RE #2 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 2 and OCC [+1, -1] is applied for DMRS port 14. DMRS ports 3 and 15 is mapped on RE #3 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 3 and OCC [+1, -1] is applied for DMRS port 15. DMRS ports 4 and 16 is mapped on RE #4 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 4 and OCC [+1, -1] is applied for DMRS port 16. DMRS ports 5 and 17 is mapped on RE #5 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 5 and OCC [+1, -1] is applied for DMRS port 17.

[0040] DMRS ports 6 and 18 is mapped on RE #6 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 6 and OCC [+1, -1] is applied for DMRS port 18. DMRS ports 7 and 19 is mapped on RE #7 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 7 and OCC [+1, -1] is applied for DMRS port 19. DMRS ports 8 and 20 is mapped on RE #8 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 8 and OCC [+1, -1] is applied for DMRS port 20. DMRS ports 9 and 21 is mapped on RE #9 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 9 and OCC [+1, -1] is applied for DMRS port 21. DMRS ports 10 and 22 is mapped on RE #10 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 10 and OCC [+1, -1] is applied for DMRS port 22. DMRS ports 11 and 23 is mapped on RE #11 in one PRB on two symbols. On two symbols, OCC [+1, +1] is applied for DMRS port 11 and OCC [+1, -1] is applied for DMRS port 23.

[0041] Referring to Fig. 1E, table 100E illustrates embodiments of mapping 12 DMRS antenna ports on one symbol. In the illustrated embodiments, 12 antenna ports of DMRS are mapped to one symbol and each two of those 12 antenna ports are mapped to same resource elements on the same symbol. A length-2 OCC is applied along frequency domain on each antenna port to orthogonalize those two antenna ports that are mapped on same REs. 24 antenna ports of DMRS are mapped to two symbols. Each four antenna ports are mapped to same resource elements on those two symbols and these four antenna ports are applied with different length-4 OCC along both time domain and frequency domain. In other word, for each four antenna ports that are mapped to same resource elements on those two symbols, different length-2 OCC is applied along frequency domain and different length-2 OCC is applied along time domain on each antenna port.

[0042] As shown in Fig. 1E, DMRS ports 0 and 1 are mapped on REs #0 and #1 in one PRB on one symbol. On RE#0 and RE#1, OCC [+1, +1] is applied for DMRS port 0 and OCC [+1, -1] is applied for DMRS port 1. DMRS ports 2 and 3 are mapped on REs #2 and #3 in one PRB on one symbol. On RE#2 and RE#3, OCC [+1, +1] is applied for DMRS port 2 and OCC [+1, -1] is applied for DMRS port 3. DMRS ports 4 and 5 are mapped on REs #4 and #5 in one PRB on one symbol. On RE#4 and RE#5, OCC [+1, +1] is applied for DMRS port 4 and OCC [+1, -1] is applied for DMRS port 5. DMRS ports 6 and 7 are mapped on REs #6 and #7 in one PRB on one symbol. On RE#6 and RE#7, OCC [+1, +1] is applied for DMRS port 6 and OCC [+1, -1] is applied for DMRS port 7. DMRS ports 8 and 9 are mapped on REs #8 and #9 in one PRB on one symbol. On RE#8 and RE#9, OCC [+1, +1] is applied for DMRS port 8 and OCC [+1, -1] is applied for DMRS port 9. DMRS ports 10 and 11 are mapped on REs #0 and #1 in one PRB on one symbol. On RE#10 and RE#11, OCC [+1, +1] is applied for DMRS port 10 and OCC [+1, -1] is applied for DMRS port 11.

[0043] Referring to Fig. 1F, table 100F illustrates embodiments of mapping 24 DMRS antenna ports on one symbol. As shown in table 100F, DMRS ports 0, 1, 12 and 13 are mapped on REs #0 and #1 in one PRB on two symbols. On RE#0 and RE#1 and two symbols, OCC [+1, +1, +1, +1] is applied for DMRS port 0, OCC [+1, -1, +1, -1] is applied for DMRS port 1, OCC [+1, +1, -1, -1] is applied for DMRS port 12 and OCC [+1, -1, -1, +1] is applied for DMRS port 13. In other word, OCC [+1, +1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 0, OCC [+1, -1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 1, OCC [+1, +1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 12 and OCC [+1, -1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 13.

[0044] DMRS ports “2, 3, 14 and 15” are mapped on REs #2 and #3 in one PRB on two symbols. On RE#2 and RE#3 and two symbols, OCC [+1, +1, +1, +1] is applied for DMRS port 2, OCC [+1, -1, +1, -1] is applied for DMRS port 3, OCC [+1, +1, -1, -1] is applied for DMRS port 14 and OCC [+1, -1, -1, +1] is applied for DMRS port 15. In other word, OCC [+1, +1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 2, OCC [+1, -1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 3, OCC [+1, +1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for

DMRS port 14 and OCC [+1, -1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 15.

[0045] DMRS ports “4, 5, 16 and 17” are mapped on REs #4 and #5 in one PRB on two symbols. On RE#4 and RE#5 and two symbols, OCC [+1, +1, +1, +1] is applied for DMRS port 4, OCC [+1, -1, +1, -1] is applied for DMRS port 5, OCC [+1, +1, -1, -1] is applied for DMRS port 16 and OCC [+1, -1, -1, +1] is applied for DMRS port 17. In other word, OCC [+1, +1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 4, OCC [+1, -1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 5, OCC [+1, +1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 16 and OCC [+1, -1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 17. DMRS ports 6, 7, 18 and 19 are mapped on REs #6 and #7 in one PRB on two symbols. On RE#6 and RE#7 and two symbols, OCC [+1, +1, +1, +1] is applied for DMRS port 6, OCC [+1, -1, +1, -1] is applied for DMRS port 7, OCC [+1, +1, -1, -1] is applied for DMRS port 18 and OCC [+1, -1, -1, +1] is applied for DMRS port 19. In other word, OCC [+1, +1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 6, OCC [+1, -1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 7, OCC [+1, +1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 18 and OCC [+1, -1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 19.

[0046] DMRS ports “8, 9, 20 and 21” are mapped on REs #8 and #9 in one PRB on two symbols. On RE#8 and RE#9 and two symbols, OCC [+1, +1, +1, +1] is applied for DMRS port 8, OCC [+1, -1, +1, -1] is applied for DMRS port 9, OCC [+1, +1, -1, -1] is applied for DMRS port 20 and OCC [+1, -1, -1, +1] is applied for DMRS port 21. In other word, OCC [+1, +1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 8, OCC [+1, -1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 9, OCC [+1, +1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 20 and OCC [+1, -1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 21.

[0047] DMRS ports “10, 11, 22 and 23” are mapped on REs #10 and #11 in one PRB on two symbols. On RE#10 and RE#11 and two symbols, OCC [+1, +1, +1, +1] is applied for DMRS port 10, OCC [+1, -1, +1, -1] is applied for DMRS port 11, OCC [+1, +1, -1, -1] is applied for DMRS port 22 and OCC [+1, -1, -1, +1] is applied for DMRS port 23. In other word, OCC [+1, +1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 10, OCC [+1, -1] is applied along frequency domain and OCC [+1, +1] is applied along time domain for DMRS port 11, OCC [+1, +1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 22 and OCC [+1, -1] is applied along frequency domain and OCC [+1, -1] is applied along time domain for DMRS port 23.

[0048] Referring to Fig. 1G, Table 100G illustrates embodiments of mapping 12 DMRS antenna ports on one symbol. As shown, 12 antenna ports of DMRS are mapped to one symbol and each four of those 12 antenna ports are mapped to same 4 resource elements in one PRB on one symbol. A length-4 OCC is applied along frequency domain on each antenna port to orthogonalize those four antenna ports that are mapped on same REs. 24 antenna ports of DMRS are mapped to two symbols. Each eight antenna ports are mapped to same resource elements on those two symbols and these eight antenna ports are applied with different length-4 OCC along frequency domain and different length-2 OCC along time domain.

[0049] As shown in Table 100G, DMRS ports “0, 1, 2 and 3” are mapped on REs {#0, #1, #2, #3} in one PRB on one symbol. In frequency domain, OCC [+1, +1, +1, +1] is applied on DMRS port 0, OCC [+1, -1, +1, -1] is applied for DMRS port 1, and OCC [+1, +1, -1, -1] is applied for DMRS port 2 and OCC [+1, -1, -1, -1] is applied for DMRS port 3. DMRS ports “4, 5, 6 and 7” are mapped on REs {#4, #5, #6, #7} in one PRB on one symbol. Along frequency domain, OCC [+1, +1, +1, +1] is applied on DMRS port 4, OCC [+1, -1, +1, -1] is applied for DMRS port 5, and OCC [+1, +1, -1, -1] is applied for DMRS port 6 and OCC [+1, -1, -1, -1] is applied for DMRS port 7.

[0050] DMRS ports “8, 9, 10 and 11” are mapped on REs {#8, #9, #10, #11} in one PRB on one symbol. Along frequency domain, OCC [+1, +1, +1, +1] is applied on DMRS port 8, OCC [+1, -1, +1, -1] is applied for DMRS port 9, and OCC [+1, +1, -1, -1] is applied for DMRS port 10 and OCC [+1, -1, -1, -1] is applied for DMRS port 11.

[0051] Referring to Fig. 1H, Table 100H illustrates embodiments of mapping 24 DMRS antenna ports on two symbols. As shown in Table 100H, DMRS ports "0, 1, 2, 3, 12, 13, 14 and 15" are mapped on REs {#0, #1, #2, #3} in one PRB in two symbols. Along frequency domain, OCC [+1, +1, +1, +1] is applied on DMRS ports 0 and along time domain OCC [+1, +1] is applied on DMRS port 0. Along frequency domain, OCC [+1, -1, +1, -1] is applied on DMRS ports 1 and along time domain OCC [+1, +1] is applied on DMRS port 1. Along frequency domain, OCC [+1, +1, -1, -1] is applied on DMRS ports 2 and along time domain OCC [+1, +1] is applied on DMRS port 0. Along frequency domain, OCC [+1, -1, -1, +1] is applied on DMRS ports 3 and along time domain OCC [+1, +1] is applied on DMRS port 3. Along frequency domain, OCC [+1, +1, +1, +1] is applied on DMRS ports 12 and along time domain OCC [+1, -1] is applied on DMRS port 12. Along frequency domain, OCC [+1, -1, +1, -1] is applied on DMRS ports 13 and along time domain OCC [+1, -1] is applied on DMRS port 13. Along frequency domain, OCC [+1, +1, -1, -1] is applied on DMRS ports 14 and along time domain OCC [+1, -1] is applied on DMRS port 14. Along frequency domain, OCC [+1, -1, -1, +1] is applied on DMRS ports 15 and along time domain OCC [+1, -1] is applied on DMRS port 15.

[0052] DMRS ports "4, 5, 6, 7, 16, 17, 18 and 19" are mapped on REs {#4, #5, #6, #7} in one PRB in two symbols. Along frequency domain, OCC [+1, +1, +1, +1] is applied on DMRS ports 4 and along time domain OCC [+1, +1] is applied on DMRS port 4. Along frequency domain, OCC [+1, -1, +1, -1] is applied on DMRS ports 5 and along time domain OCC [+1, +1] is applied on DMRS port 5. Along frequency domain, OCC [+1, +1, -1, -1] is applied on DMRS ports 6 and along time domain OCC [+1, +1] is applied on DMRS port 6. Along frequency domain, OCC [+1, -1, -1, +1] is applied on DMRS ports 7 and along time domain OCC [+1, +1] is applied on DMRS port 7. Along frequency domain, OCC [+1, +1, +1, +1] is applied on DMRS ports 16 and along time domain OCC [+1, -1] is applied on DMRS port 16. Along frequency domain, OCC [+1, -1, +1, -1] is applied on DMRS ports 17 and along time domain OCC [+1, -1] is applied on DMRS port 17. Along frequency domain, OCC [+1, +1, -1, -1] is applied on DMRS ports 18 and along time domain OCC [+1, -1] is applied on DMRS port 18. Along frequency domain, OCC [+1, -1, -1, +1] is applied on DMRS ports 19 and along time domain OCC [+1, -1] is applied on DMRS port 19. DMRS ports {8, 9, 10, 11, 20, 21, 22 and 23} are mapped on REs {#8, #9, #10, #11} in one PRB in two symbols. Along frequency domain, OCC [+1, +1, +1, +1] is applied on DMRS ports 8 and along time domain OCC [+1, +1] is applied on DMRS port 8. Along frequency domain, OCC [+1, -1, +1, -1] is applied on DMRS ports 9 and along time domain OCC [+1, +1] is applied on DMRS port 9. Along frequency domain, OCC [+1, +1, -1, -1] is applied on DMRS ports 10 and along time domain OCC [+1, +1] is applied on DMRS port 10. Along frequency domain, OCC [+1, -1, -1, +1] is applied on DMRS ports 11 and along time domain OCC [+1, +1] is applied on DMRS port 11. Along frequency domain, OCC [+1, +1, +1, +1] is applied on DMRS ports 20 and along time domain OCC [+1, -1] is applied on DMRS port 20. Along frequency domain, OCC [+1, -1, +1, -1] is applied on DMRS ports 21 and along time domain OCC [+1, -1] is applied on DMRS port 21. Along frequency domain, OCC [+1, +1, -1, -1] is applied on DMRS ports 22 and along time domain OCC [+1, -1] is applied on DMRS port 22. Along frequency domain, OCC [+1, -1, -1, +1] is applied on DMRS ports 23 and along time domain OCC [+1, -1] is applied on DMRS port 23.

[0053] Fig. 2 is a schematic diagram of a wireless communication system 200 in accordance with one or more implementations of the present disclosure. The wireless communication system 200 can implement the communications methods discussed herein by using the configurations of DMRS discussed with reference to Figs. 1A-1H. As shown in Fig. 2, the wireless communications system 200 includes a network device (or base station/cell) 201. Examples of the network device 201 include a base transceiver station (Base Transceiver Station, BTS), a NodeB (NodeB, NB), an evolved Node B (eNB or eNodeB), a Next Generation NodeB (gNB or gNode B), a Wireless Fidelity (Wi-Fi) access point (AP), etc. In some embodiments, the network device 201 can include a relay station, an access point, an in-vehicle device, a wearable device, and the like. The network device 201 can include wireless connection devices for communication networks such as: a Global System for Mobile Communications (GSM) network, a Code Division Multiple Access (CDMA) network, a Wideband CDMA (WCDMA) network, an LTE network, a cloud radio access network (Cloud Radio Access Network, CRAN), an Institute of Electrical and Electronics Engineers (IEEE) 802.11-based network (e.g., a Wi-Fi network), an Internet of Things (IoT) network, a device-to-device (D2D) network, a next-generation network (e.g., a

5G network), a future evolved public land mobile network (Public Land Mobile Network, PLMN), or the like. A 5G system or network can be referred to as an NR system or network.

[0054] In Fig. 2, the wireless communications system 200 also includes a terminal device 203. The terminal device 203 can be an end-user device configured to facilitate wireless communication. The terminal device 203 can be configured to wirelessly connect to the network device 201 (via, e.g., via a wireless channel 205) according to one or more corresponding communication protocols/standards.

[0055] The terminal device 203 may be mobile or fixed. The terminal device 203 can be a user equipment (UE), an access terminal, a user unit, a user station, a mobile site, a mobile station, a remote station, a remote terminal, a mobile device, a user terminal, a terminal, a wireless communications device, a user agent, or a user apparatus. Examples of the terminal device 203 include a modem, a cellular phone, a smartphone, a cordless phone, a Session Initiation Protocol (SIP) phone, a wireless local loop (WLL) station, a personal digital assistant (PDA), a handheld device having a wireless communication function, a computing device or another processing device connected to a wireless modem, an in-vehicle device, a wearable device, an Internet-of-Things (IoT) device, a device used in a 5G network, a device used in a public land mobile network, or the like. For illustrative purposes, Fig. 2 illustrates only one network device 201 and one terminal device 203 in the wireless communications system 200. However, in some instances, the wireless communications system 200 can include additional network device 201 and/or terminal device 203.

[0056] The network device 201 can indicate a DMRS configuration (e.g., those discussed with reference to Figs. 1A-1H) for a PDSCH transmission to the terminal device 203. The terminal device 203 can be requested to receive the DMRS and then the PDSCH transmission by following the provided DMRS configuration.

[0057] In some embodiments, the base station 201 can indicate a DMRS configuration a PUSCH transmission and the terminal device 203 can be requested to transmit the DMRS and the corresponding PUSCH transmission by following the provided DMRS configuration.

[0058] Fig. 3 is a schematic block diagram of a terminal device 203 (e.g., which can implement the methods discussed herein) in accordance with one or more implementations of the present disclosure. As shown, the terminal device 203 includes a processing unit 310 (e.g., a DSP, a CPU, a GPU, etc.) and a memory 320. The processing unit 310 can be configured to implement instructions that correspond to the methods discussed herein and/or other aspects of the implementations described above. It should be understood that the processor 310 in the implementations of this technology may be an integrated circuit chip and has a signal processing capability. During implementation, the steps in the foregoing method may be implemented by using an integrated logic circuit of hardware in the processor 310 or an instruction in the form of software. The processor 310 may be a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or another programmable logic device, a discrete gate or transistor logic device, and a discrete hardware component. The methods, steps, and logic block diagrams disclosed in the implementations of this technology may be implemented or performed. The general-purpose processor 310 may be a microprocessor, or the processor 310 may be alternatively any conventional processor or the like. The steps in the methods disclosed with reference to the implementations of this technology may be directly performed or completed by a decoding processor implemented as hardware or performed or completed by using a combination of hardware and software modules in a decoding processor. The software module may be located at a random-access memory, a flash memory, a read-only memory, a programmable read-only memory or an electrically erasable programmable memory, a register, or another mature storage medium in this field. The storage medium is located at a memory 320, and the processor 310 reads information in the memory 320 and completes the steps in the foregoing methods in combination with the hardware thereof.

[0059] It may be understood that the memory 320 in the implementations of this technology may be a volatile memory or a non-volatile memory, or may include both a volatile memory and a non-volatile memory. The non-volatile memory may be a read-only memory (ROM), a programmable read-only memory (PROM), an erasable programmable read-only memory (EPROM), an electrically erasable programmable read-only memory (EEPROM) or a flash memory. The volatile memory may be a random-access memory (RAM) and is used as an external cache. For exemplary rather than limitative description, many forms of RAMs can be used, and are, for example, a static random-access memory (SRAM), a dynamic random-access memory (DRAM), a synchronous dynamic random-access memory (SDRAM), a double data rate synchronous dynamic random-access memory (DDR SDRAM), an enhanced synchronous dynamic random-access memory (ESDRAM), a synchronous link dynamic random-access memory (SLDRAM), and a direct Rambus random-access memory (DR RAM). It should be noted that the memories in the systems and methods described herein are intended to include, but are not limited to, these memories and memories of any other suitable type. In some embodiments, the memory may be a non-transitory computer-readable storage medium that stores instructions capable of execution by a processor.

[0060] Fig. 4 is a flowchart of a method 400 in accordance with one or more implementations of the present disclosure. The method 400 is for performing a DMSR transmission. The method 400 can be implemented by a system (such as the wireless communications system 200). For example, the method 400 may also be implemented by the terminal device 203.

[0061] The method 400 includes, at block 401, receiving, by a terminal device, configuration information of a demodulation reference signal (DMRS). The configuration information indicates mapping relationships among multiple antenna ports and corresponding symbols for transmitting the DMRS. In some embodiments, the multiple antenna ports include more than 12 antenna ports.

[0062] At block 403, the method 400 continues by determining, by the terminal device, a physical shared channel transmission based on the configuration information. In some embodiments, the physical shared channel transmission is a physical downlink shared channel (PDSCH) transmission. In some embodiments, the physical shared channel transmission is a physical uplink shared channel (PUSCH) transmission. At block 405, the method 400 continues by transmitting, by the terminal device, the DMRS based on the configuration information.

[0063] In some embodiments, the multiple antenna ports include 24 antenna ports in a two-symbol configuration. In some embodiments, the multiple antenna ports include two sets of 12 antenna ports in a single-symbol configuration. In some embodiments, the multiple antenna ports include 16 antenna ports in a two-symbol configuration. In some embodiments, the multiple antenna ports include two sets of 8 antenna ports in a single-symbol configuration.

[0064] In some embodiments, the mapping relationships are also among the multiple antenna ports and multiple resource elements in a frequency domain. The mapping relationships can be indicative that a first set of ports of the multiple antenna ports are assigned to an odd-numbered resource element. In some embodiments, the mapping relationships can be indicative that a second set of ports of the multiple antenna ports are assigned to an even-numbered resource element.

[0065] In some embodiments, for a set of four ports of the multiple antenna ports that are mapped to a single resource element of the multiple resource elements, a length-four orthogonal cover code (OCC) is applied.

[0066] In some embodiments, for a set of two ports of the multiple antenna ports that are mapped to a single resource element of the multiple resource elements, a length-two OCC is applied.

[0067] Fig. 5 is a flowchart of a method 500 in accordance with one or more implementations of the present disclosure. The method 500 can be implemented by a system (such as the wireless communications system 200). For example, the method 500 may also be implemented by the network device 201.

[0068] The method 500 includes, at block 501, transmitting, by a base station, configuration information of a demodulation reference signal (DMRS). In some embodiments, the configuration information indicates mapping relationships among multiple antenna ports and corresponding symbols for transmitting the DMRS. In some embodiments, the multiple antenna ports include more than 12 antenna ports.

[0069] At block 503, the method 500 continues by causing, by the base station, the terminal device to transmit the DMRS based on the configuration information via a physical shared channel.

[0070] In some embodiments, the multiple antenna ports include 24 antenna ports in a two-symbol configuration. In some embodiments, the multiple antenna ports include two sets of 12 antenna ports in a single-symbol configuration. In some embodiments, the multiple antenna ports include 16 antenna ports in a two-symbol configuration. In some embodiments, the multiple antenna ports include two sets of 8 antenna ports in a single-symbol configuration.

[0071] In some embodiments, the mapping relationships are indicative that a first set of ports of the multiple antenna ports are assigned to an odd-numbered resource element. In some embodiments, the mapping relationships are indicative that a second set of ports of the multiple antenna ports are assigned to an even-numbered resource element. In some embodiments, for a set of four ports of the multiple antenna ports that are mapped to a single resource element of the multiple resource elements, a length-four orthogonal cover code (OCC) is applied. In some embodiments, for a set of two ports of the multiple antenna ports that are mapped to a single resource element of the multiple resource elements, a length-two OCC is applied.

ADDITIONAL CONSIDERATIONS

[0072] The above Detailed Description of examples of the disclosed technology is not intended to be exhaustive or to limit the disclosed technology to the precise form disclosed above. While specific examples for the disclosed technology are described above for illustrative purposes, various equivalent modifications are possible within the scope of the described technology, as those skilled in the relevant art will recognize. For example, while processes or blocks are presented in a given order, alternative implementations may perform routines having steps, or employ systems having blocks, in a different order, and some processes or blocks may be deleted, moved, added, subdivided, combined, and/or modified to provide alternative implementations or sub-combinations. Each of these processes or blocks may be implemented in a variety of different ways. Also, while processes or blocks are at times shown as being performed in series, these processes or blocks may instead be performed or implemented in parallel, or may be performed at different times. Further, any specific numbers noted herein are only examples; alternative implementations may employ differing values or ranges.

[0073] In the Detailed Description, numerous specific details are set forth to provide a thorough understanding of the presently described technology. In other implementations, the techniques introduced here can be practiced without these specific details. In other instances, well-known features, such as specific functions or routines, are not described in detail in order to avoid unnecessarily obscuring the present disclosure. References in this description to “an implementation/embodiment,” “one implementation/embodiment,” or the like mean that a particular feature, structure, material, or characteristic being described is included in at least one implementation of the described technology. Thus, the appearances of such phrases in this specification do not necessarily all refer to the same implementation/embodiment. On the other hand, such references are not necessarily mutually exclusive either. Furthermore, the particular features, structures, materials, or characteristics can be combined in any suitable manner in one or more implementations/embodiments. It is to be understood that the various implementations shown in the figures are merely illustrative representations and are not necessarily drawn to scale.

[0074] Several details describing structures or processes that are well-known and often associated with communications systems and subsystems, but that can unnecessarily obscure some significant aspects of the disclosed techniques, are not set forth herein for purposes of clarity. Moreover, although the following disclosure sets forth several implementations of different aspects of the present disclosure, several other implementations can have different configurations or different components than those described in this section. Accordingly, the disclosed techniques can have other implementations with additional elements or without several of the elements described below.

[0075] Many implementations or aspects of the technology described herein can take the form of computer- or processor-executable instructions, including routines executed by a programmable computer or processor. Those skilled in the relevant art will appreciate that the described techniques can be practiced on computer or processor systems other than those shown and described below. The techniques described herein can be implemented in a special-purpose computer or data processor that is specifically programmed, configured, or constructed to execute one or more of the computer-executable instructions described below. Accordingly, the terms “computer” and “processor” as generally used herein refer to any data processor. Information handled by these computers and processors can be presented at any suitable display medium. Instructions for executing computer- or processor-executable tasks can be stored in or on any suitable computer-readable medium, including hardware, firmware, or a combination of hardware and firmware. Instructions can be contained in any suitable memory device, including, for example, a flash drive and/or other suitable medium.

[0076] The term “and/or” in this specification is only an association relationship for describing the associated objects, and indicates that three relationships may exist, for example, A and/or B may indicate the following three cases: A exists separately, both A and B exist, and B exists separately.

[0077] These and other changes can be made to the disclosed technology in light of the above Detailed Description. While the Detailed Description describes certain examples of the disclosed technology, as well as the best mode contemplated, the disclosed technology can be practiced in many ways, no matter how detailed the above description appears in text. Details of the system may vary considerably in its specific implementation, while still being encompassed by the technology disclosed herein. As noted above, particular terminology used when describing certain features or aspects of the disclosed technology should not be taken to imply that the terminology is being redefined herein to be restricted to any specific characteristics, features, or aspects of the disclosed technology with which that terminology is associated. Accordingly, the invention is not limited, except as by the appended claims. In general, the terms used in the following claims should not be construed to limit the disclosed technology to the specific examples disclosed in the specification, unless the above Detailed Description section explicitly defines such terms.

[0078] A person of ordinary skill in the art may be aware that, in combination with the examples described in the implementations disclosed in this specification, units and algorithm steps may be implemented by electronic hardware, or a combination of computer software and electronic hardware. Whether the functions are performed by hardware or software depends on particular applications and design constraint conditions of the technical solutions. A person skilled in the art may use different methods to implement the described functions for each particular application, but it should not be considered that the implementation goes beyond the scope of this application.

[0079] Although certain aspects of the invention are presented below in certain claim forms, the applicant contemplates the various aspects of the invention in any number of claim forms. Accordingly, the applicant reserves the right to pursue additional claims after filing this application to pursue such additional claim forms, in either this application or in a continuing application.

CLAIMS

I/We claim:

1. A method comprising:

receiving, by a terminal device, configuration information of a demodulation reference signal (DMRS), wherein the configuration information indicates mapping relationships among multiple antenna ports and corresponding symbols for transmitting the DMRS, and wherein the multiple antenna ports include more than 12 antenna ports;

determining, by the terminal device, a physical shared channel transmission based on the configuration information; and

transmitting, by the terminal device, the DMRS based on the configuration information.

2. The method of claim 1, wherein the multiple antenna ports include 24 antenna ports in a two-symbol configuration.

3. The method of claim 1, wherein the multiple antenna ports include two sets of 12 antenna ports in a single-symbol configuration.

4. The method of claim 1, wherein the multiple antenna ports include 16 antenna ports in a two-symbol configuration.

5. The method of claim 1, wherein the multiple antenna ports include two sets of 8 antenna ports in a single-symbol configuration.

6. The method of claim 1, wherein the mapping relationships are also among the multiple antenna ports and multiple resource elements in a frequency domain.

7. The method of claim 6, wherein the mapping relationships are indicative that a first set of ports of the multiple antenna ports are assigned to an odd-numbered resource element.

8. The method of claim 7, wherein the mapping relationships are indicative that a second set of ports of the multiple antenna ports are assigned to an even-numbered resource element.

9. The method of claim 6, wherein for a set of four ports of the multiple antenna ports that are mapped to a single resource element of the multiple resource elements, a length-four orthogonal cover code (OCC) is applied.

10. The method of claim 6, wherein for a set of two ports of the multiple antenna ports that are mapped to a single resource element of the multiple resource elements, a length-two OCC is applied.

11. The method of claim 1, wherein the physical shared channel transmission is a physical downlink shared channel (PDSCH) transmission.

12. The method of claim 1, wherein the physical shared channel transmission is a physical uplink shared channel (PUSCH) transmission.

13. A method comprising:

transmitting, by a base station, configuration information of a demodulation reference signal (DMRS), wherein the configuration information indicates mapping relationships among multiple antenna ports and corresponding symbols for transmitting the DMRS, and wherein the multiple antenna ports include more than 12 antenna ports; and

causing, by the base station, the terminal device to transmit the DMRS based on the configuration information via a physical shared channel.

14. The method of claim 13, wherein the multiple antenna ports include 24 antenna ports in a two-symbol configuration.

15. The method of claim 13, wherein the multiple antenna ports include two sets of 12 antenna ports in a single-symbol configuration.

16. The method of claim 13, wherein the multiple antenna ports include 16 antenna ports in a two-symbol configuration.

17. The method of claim 13, wherein the multiple antenna ports include two sets of 8 antenna ports in a single-symbol configuration.

18. The method of claim 13, wherein the mapping relationships are also among the multiple antenna ports and multiple resource elements in a frequency domain.

19. The method of claim 18, wherein the mapping relationships are indicative that a first set of ports of the multiple antenna ports are assigned to an odd-numbered resource element.

20. A system comprising:

a processor; and

a memory configured to store instructions, when executed by the processor, to:

receive, by a terminal device, configuration information of a demodulation reference signal (DMRS), wherein the configuration information indicates mapping relationships among multiple antenna ports and corresponding symbols for transmitting the DMRS, and wherein the multiple antenna ports include more than 12 antenna ports;

determine, by the terminal device, a physical shared channel transmission based on the configuration information; and

transmit, by the terminal device, the DMRS based on the configuration information.

100A

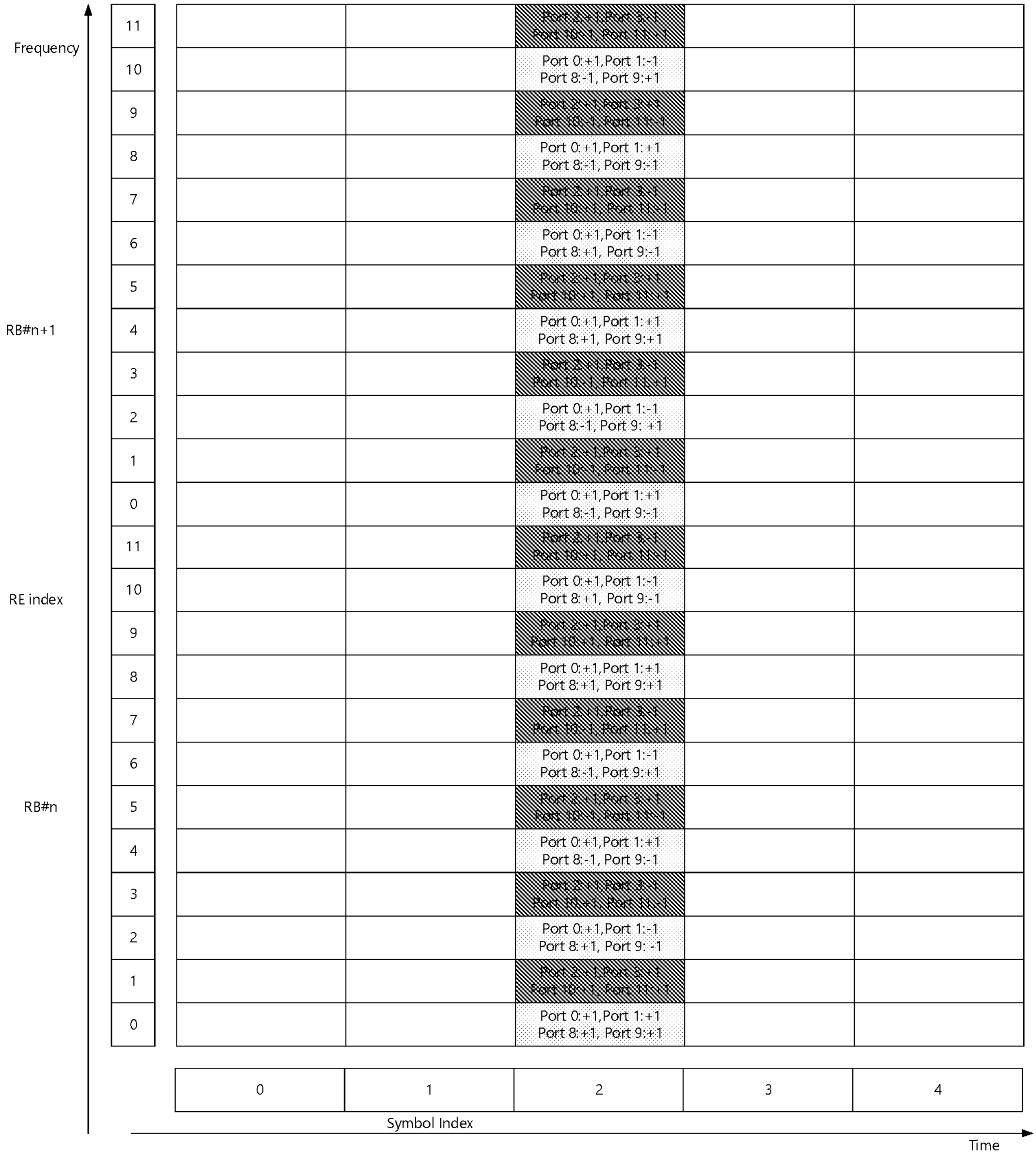
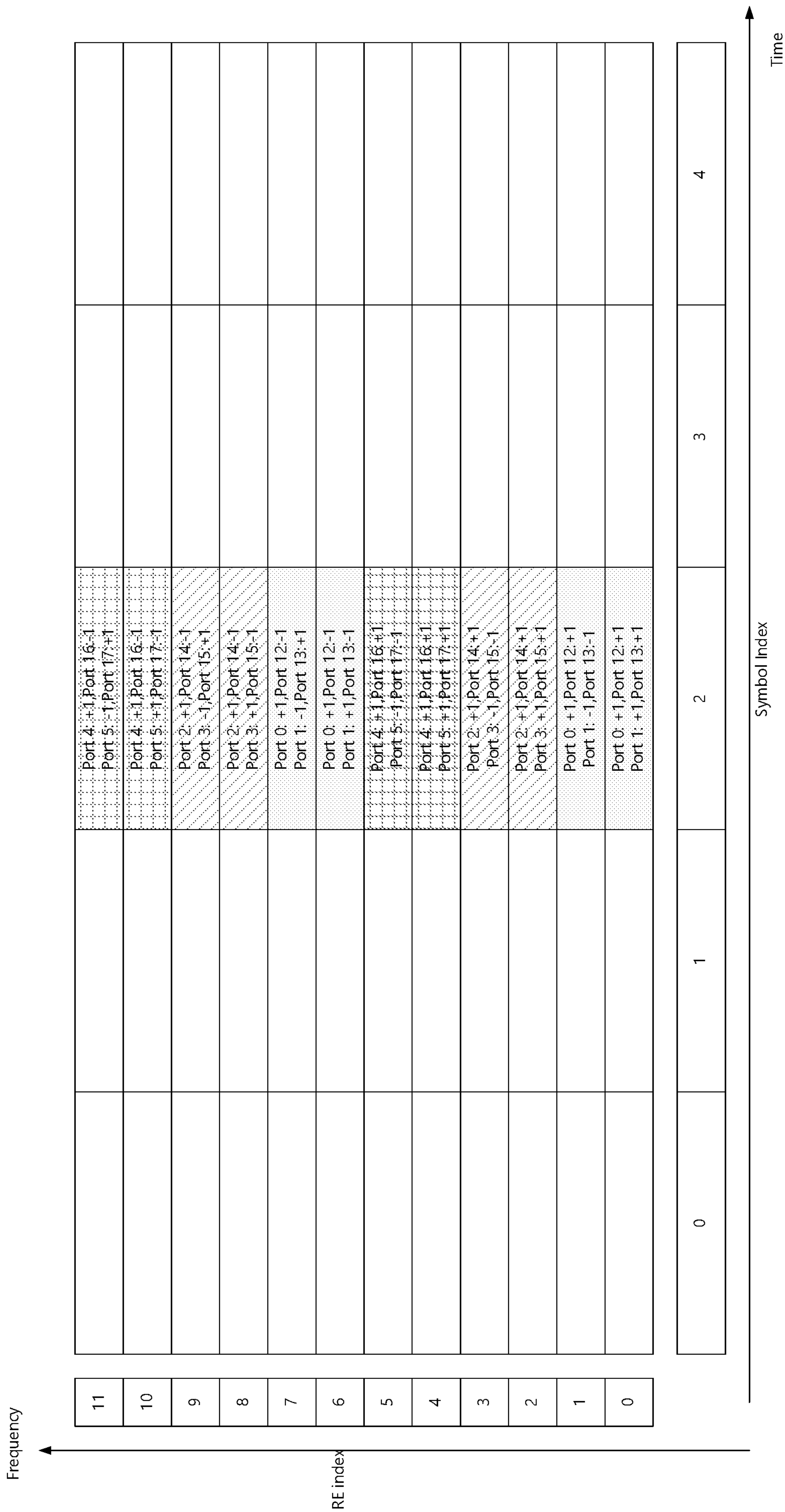

Frequency
RB#n+1
RE index
RB#n
11
10
9
8
7
6
5
4
3
2
1
0
11
10
9
8
7
6
5
4
3
2
1
0
Port 0:+1,Port 1:-1
Port 8:-1, Port 9:+1
Port 0:+1,Port 1:+1
Port 8:-1, Port 9:-1
Port 0:+1,Port 1:-1
Port 8:+1, Port 9:-1
Port 0:+1,Port 1:+1
Port 8:+1, Port 9:+1
Port 0:+1,Port 1:-1
Port 8:-1, Port 9: +1
Port 0:+1,Port 1:+1
Port 8:-1, Port 9:-1
Port 0:+1,Port 1:-1
Port 8:+1, Port 9:-1
Port 0:+1,Port 1:+1
Port 8:+1, Port 9:+1
Port 0:+1,Port 1:-1
Port 8:-1, Port 9:+1
Port 0:+1,Port 1:+1
Port 8:-1, Port 9:-1
Port 0:+1,Port 1:-1
Port 8:+1, Port 9: -1
Port 0:+1,Port 1:+1
Port 8:+1, Port 9:+1
0
1
2
3
4
Symbol Index
Time

FIG. 1A

100B


Frequency
RE index
Time
Symbol Index
0
1
2
3
4
5
6
7
8
9
10
11
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Port 5: -1,Port 17:+1
Port 4: +1,Port 16:-1
Port 5: +1,Port 17:-1
Port 2: +1,Port 14:-1
Port 3: -1,Port 15:+1
Port 2: +1,Port 14:-1
Port 3: +1,Port 15:-1
Port 0: +1,Port 12:-1
Port 1: -1,Port 13:+1
Port 0: +1,Port 12:-1
Port 1: +1,Port 13:-1
Port 4: +1,Port 16:+1
Port 5: -1,Port 17:-1
Port 4: +1,Port 16:+1
Port 5: +1,Port 17:+1
Port 2: +1,Port 14:+1
Port 3: -1,Port 15:-1
Port 2: +1,Port 14:+1
Port 3: +1,Port 15:+1
Port 0: +1,Port 12:+1
Port 1: -1,Port 13:-1
Port 0: +1,Port 12:+1
Port 1: +1,Port 13:+1

FIG. 1B

100C

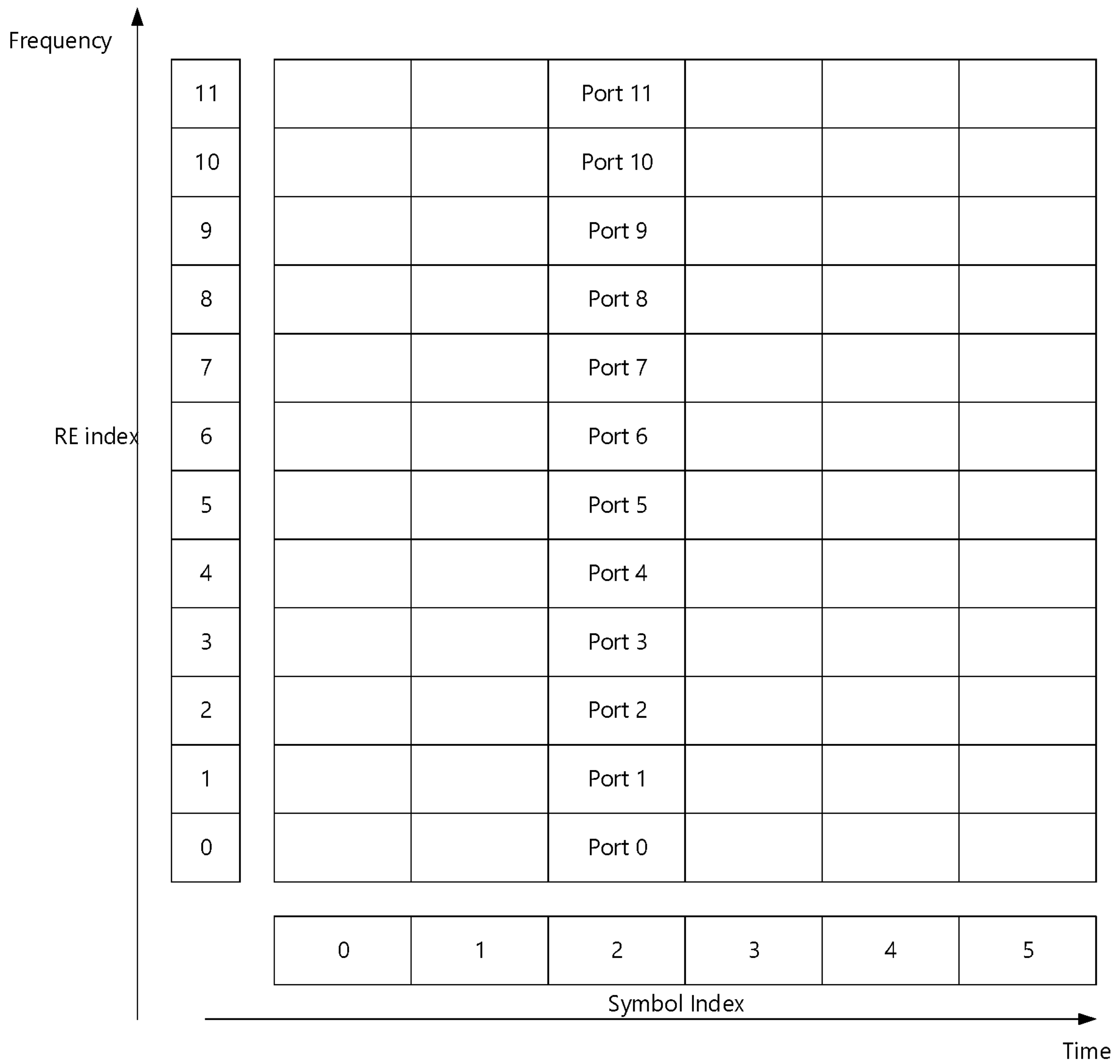
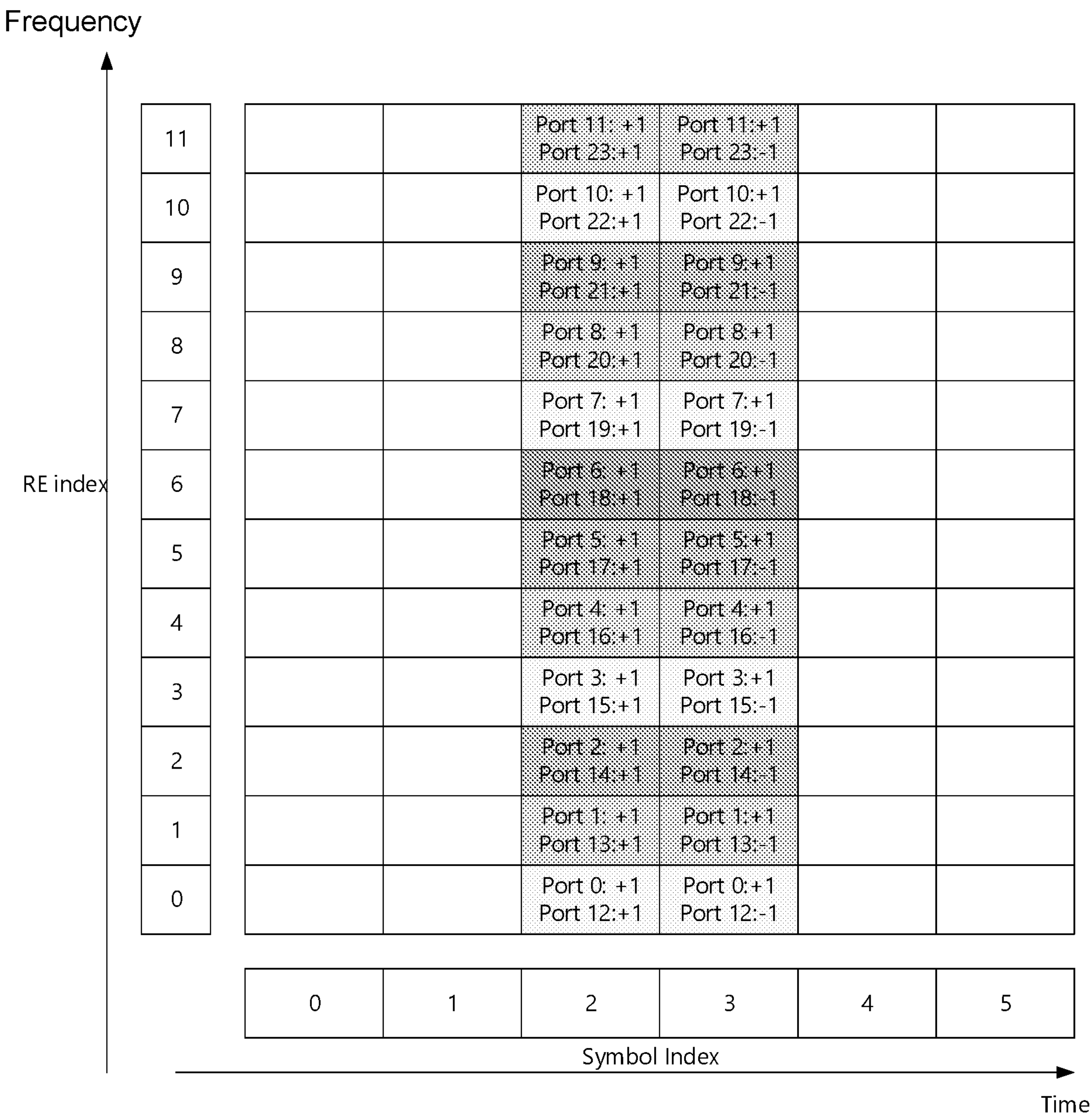

Frequency
RE index
11
10
9
8
7
6
5
4
3
2
1
0
Port 11
Port 10
Port 9
Port 8
Port 7
Port 6
Port 5
Port 4
Port 3
Port 2
Port 1
Port 0
0
1
2
3
4
5
Symbol Index
Time

FIG. 1C

100D


Frequency
RE index
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8
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6
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4
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2
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0
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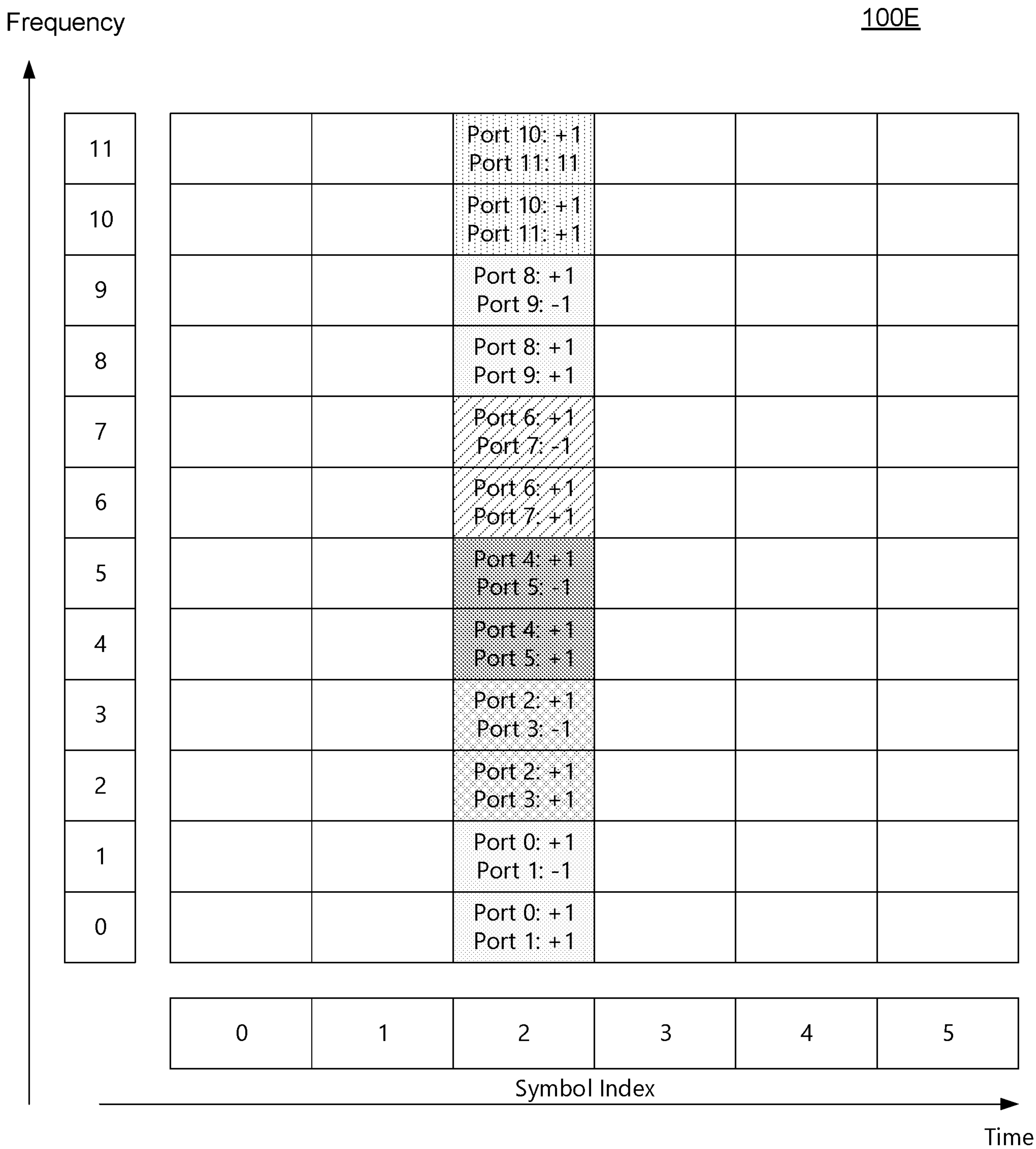
Port 23:-1
Port 10: +1
Port 22:+1
Port 10:+1
Port 22:-1
Port 9: +1
Port 21:+1
Port 9:+1
Port 21:-1
Port 8: +1
Port 20:+1
Port 8:+1
Port 20:-1
Port 7: +1
Port 19:+1
Port 7:+1
Port 19:-1
Port 6: +1
Port 18:+1
Port 6:+1
Port 18:-1
Port 5: +1
Port 17:+1
Port 5:+1
Port 17:-1
Port 4: +1
Port 16:+1
Port 4:+1
Port 16:-1
Port 3: +1
Port 15:+1
Port 3:+1
Port 15:-1
Port 2: +1
Port 14:+1
Port 2:+1
Port 14:-1
Port 1: +1
Port 13:+1
Port 1:+1
Port 13:-1
Port 0: +1
Port 12:+1
Port 0:+1
Port 12:-1
0
1
2
3
4
5
Symbol Index
Time

FIG. 1D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8
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6
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Port 6: +1
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Port 6: +1
Port 7: +1
Port 4: +1
Port 5: -1
Port 4: +1
Port 5: +1
Port 2: +1
Port 3: -1
Port 2: +1
Port 3: +1
Port 0: +1
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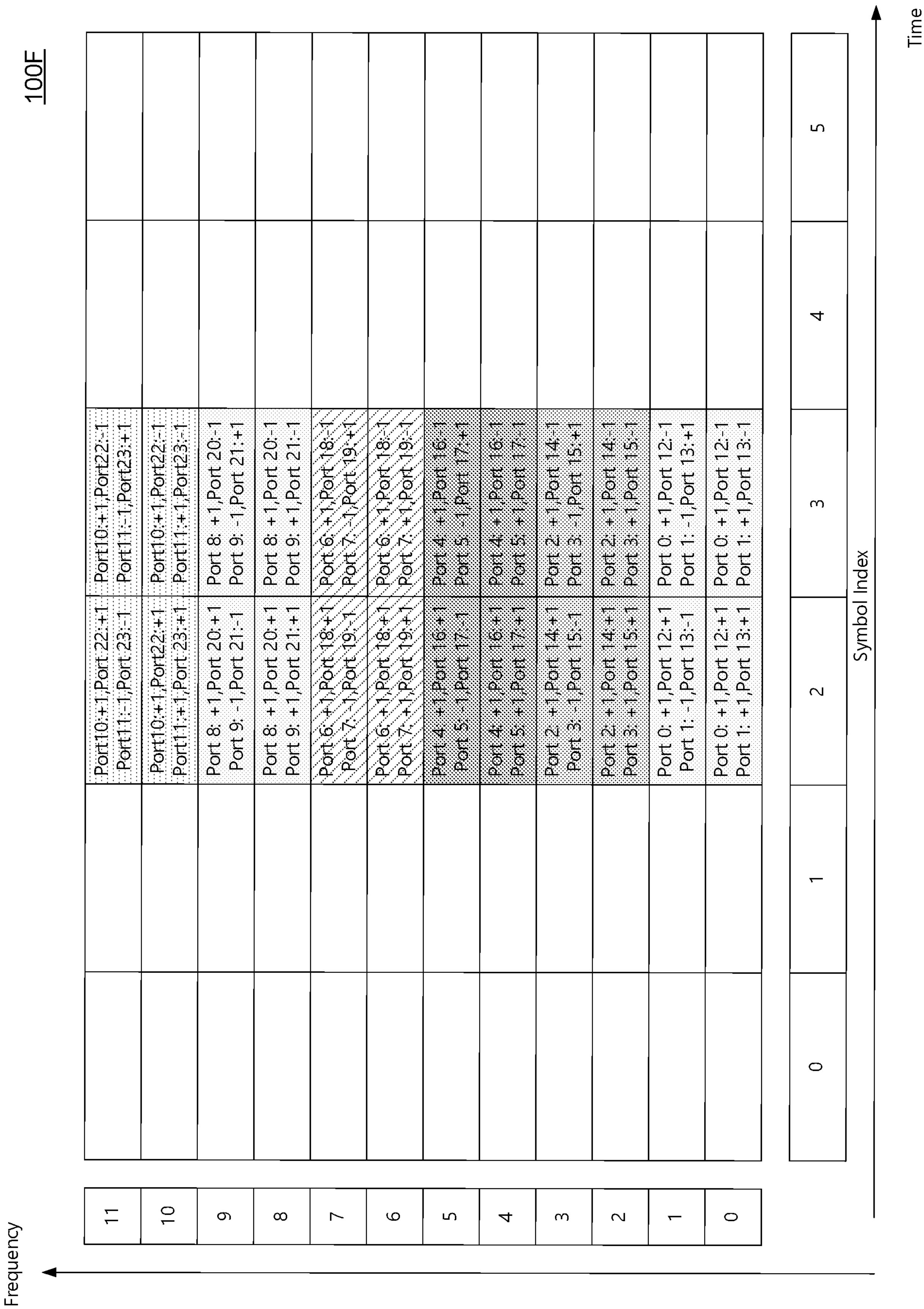
Port 0: +1
Port 1: +1
0
1
2
3
4
5
Symbol Index
Time

FIG. 1E


100F
Frequency
Time
Symbol Index
0
1
2
3
4
5
6
7
8
9
10
11
Port10:+1,Port 22:+1
Port11:-1,Port 23:-1
Port10:+1,Port22:-1
Port11:-1,Port23:+1
Port10:+1,Port22:+1
Port11:+1,Port 23:+1
Port10:+1,Port22:-1
Port11:+1,Port23:-1
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Port 9: -1,Port 21:-1
Port 8: +1,Port 20:-1
Port 9: -1,Port 21:+1
Port 8: +1,Port 20:+1
Port 9: +1,Port 21:+1
Port 8: +1,Port 20:-1
Port 9: +1,Port 21:-1
Port 6: +1,Port 18:+1
Port 7: -1,Port 19:-1
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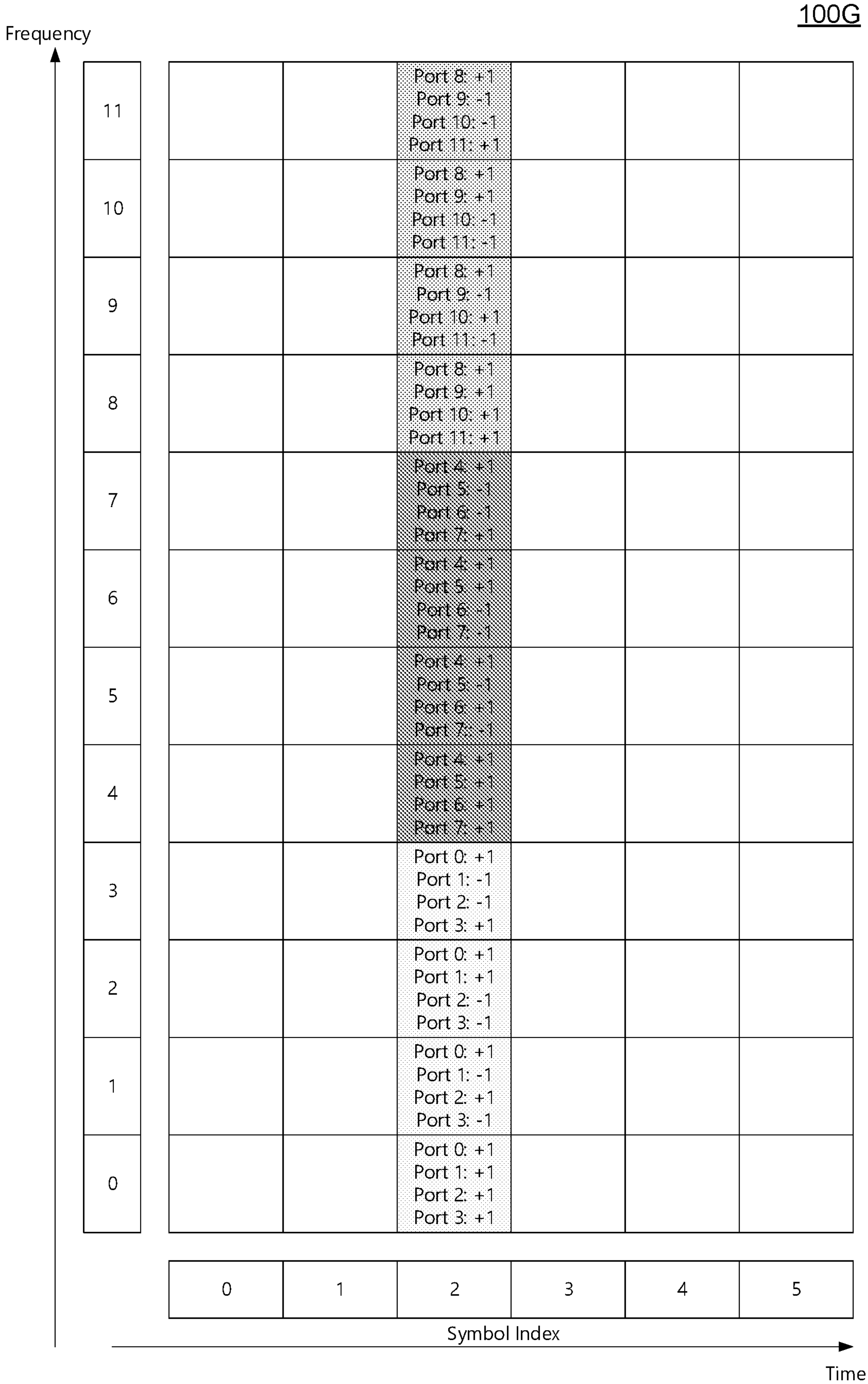
Port 1: +1,Port 13:+1
Port 0: +1,Port 12:-1
Port 1: +1,Port 13:-1

FIG. 1F


100G
Frequency
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Port 2: +1
Port 3: -1
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Port 1: +1
Port 2: +1
Port 3: +1
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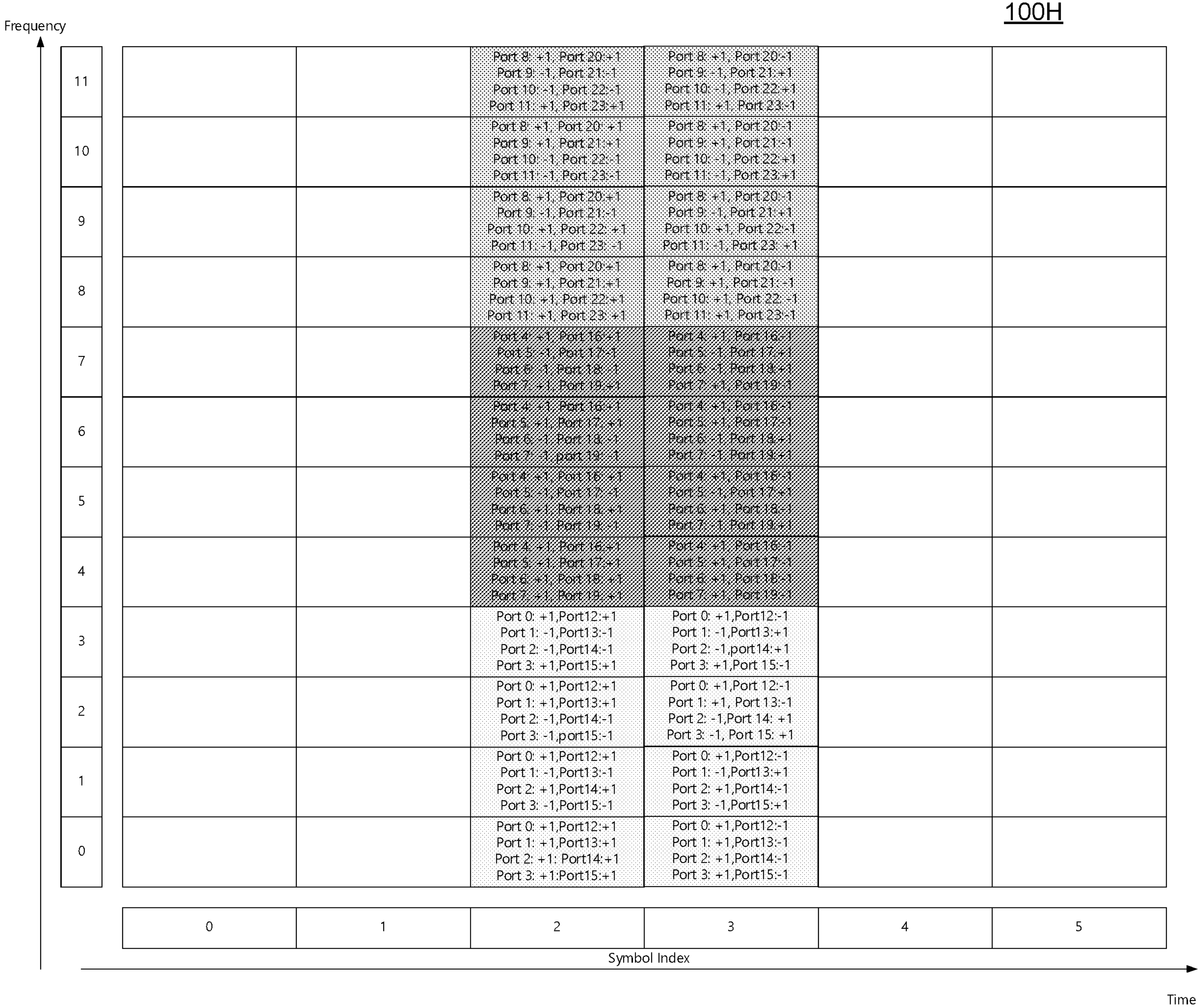
1
2
3
4
5
Symbol Index
Time

FIG. 1G

100H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Port 11: +1, Port 23:-1
Port 8: +1, Port 20: +1
Port 9: +1, Port 21:+1
Port 10: -1, Port 22:-1
Port 11: -1, Port 23:-1
Port 8: +1, Port 20:-1
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Port 10: -1, Port 22:+1
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Port 1: +1,Port13:-1
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Port 3: +1,Port15:-1
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Symbol Index
Time

FIG. 1H

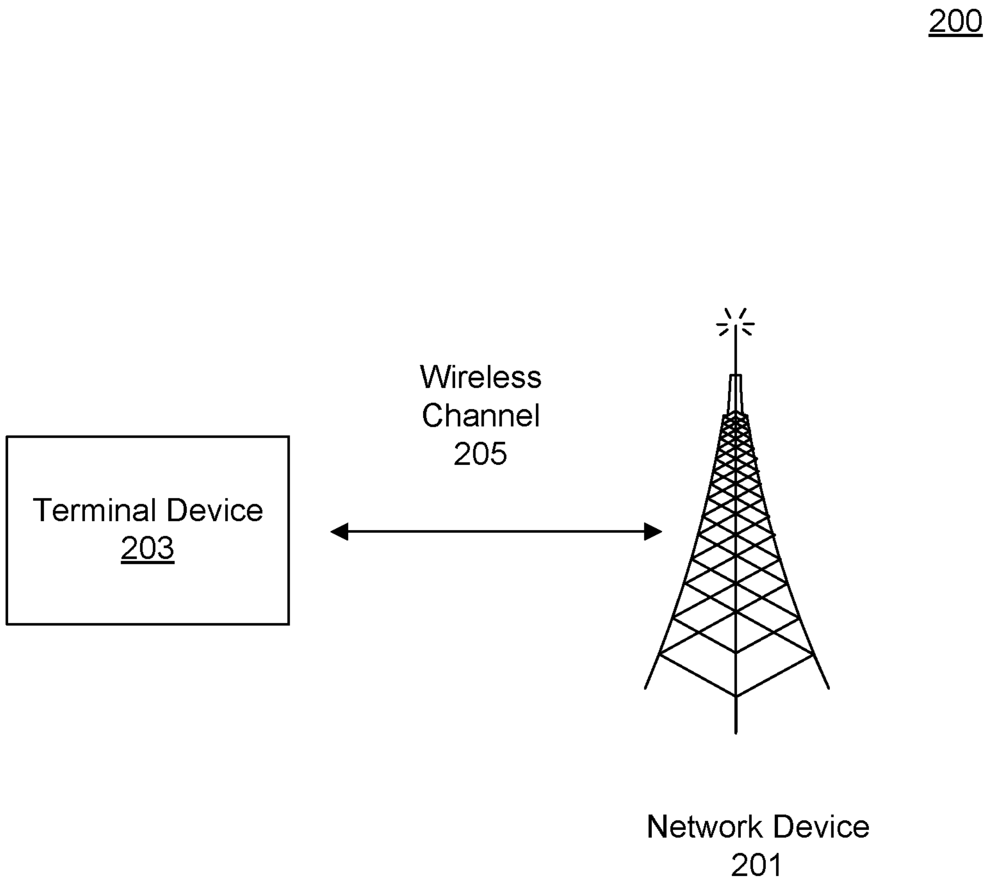
200
Wireless Channel 205
Terminal Device 203
Network Device 201

FIG. 2

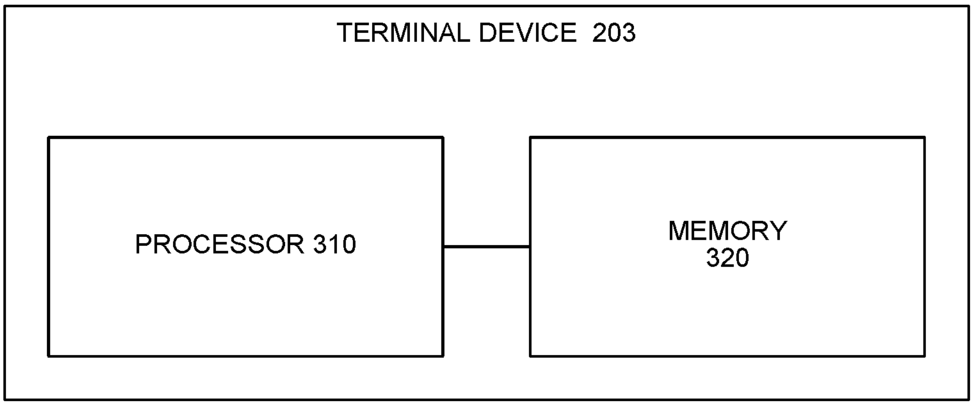

FIG. 3

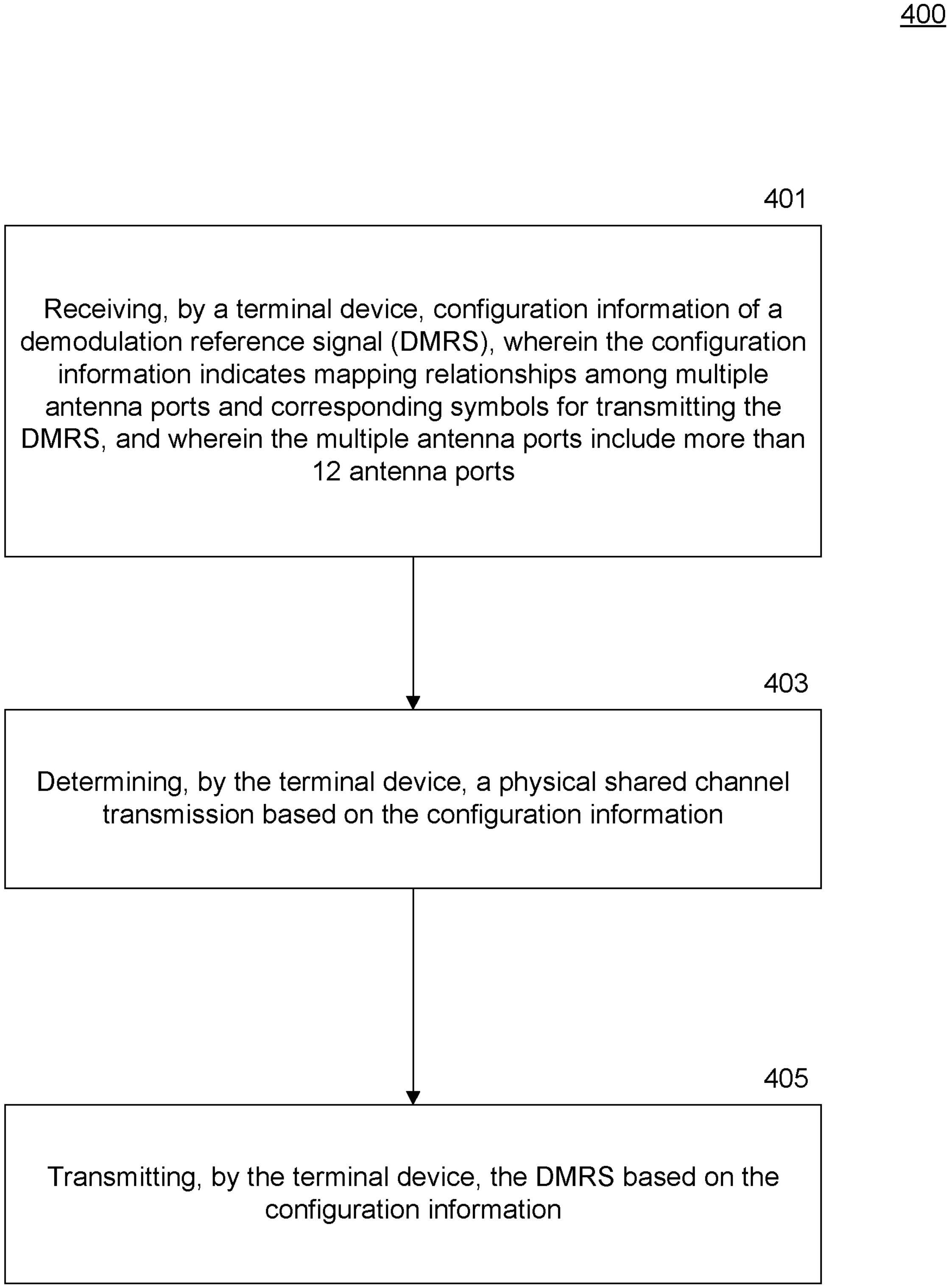
400
401
Receiving, by a terminal device, configuration information of a demodulation reference signal (DMRS), wherein the configuration information indicates mapping relationships among multiple antenna ports and corresponding symbols for transmitting the DMRS, and wherein the multiple antenna ports include more than 12 antenna ports
403
Determining, by the terminal device, a physical shared channel transmission based on the configuration information
405
Transmitting, by the terminal device, the DMRS based on the configuration information

FIG. 4

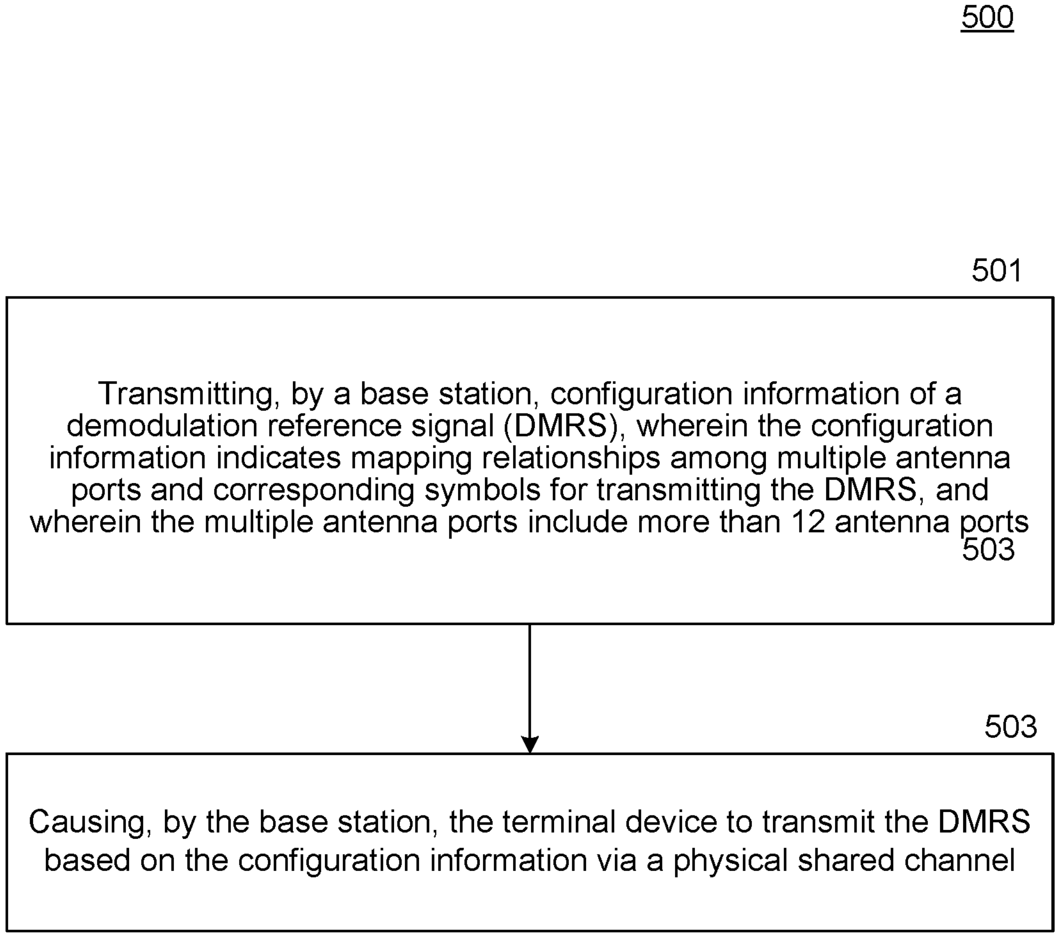
500
501
Transmitting, by a base station, configuration information of a demodulation reference signal (DMRS), wherein the configuration information indicates mapping relationships among multiple antenna ports and corresponding symbols for transmitting the DMRS, and wherein the multiple antenna ports include more than 12 antenna ports
503
503
Causing, by the base station, the terminal device to transmit the DMRS based on the configuration information via a physical shared channel

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2023/050117

A. CLASSIFICATION OF SUBJECT MATTER

H04L5/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H04L H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

3GPP,CNTXT,ENTXTC,DWPI,CNABS: configuration,demodulation reference signal, DMRS,terminal device, relationship, corresponding, antenna port, multiple antenna port, PUSCH, PDSCH, mapping

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103687042 A (ZTE CORPORATION) 26 March 2014 (2014-03-26) description, paragraphs 88-244, and claims 1-15	1-20
X	TEXAS INSTRUMENTS. "Specifying Basic Building Blocks of UL Multi-Antenna Transmission" *3GPP TSG RAN WG1 61, R1-102828,* 14 May 2010 (2010-05-14), section 2	1-20
A	CN 109391458 A (KT CORPORATION) 26 February 2019 (2019-02-26) the whole document	1-20
A	CN 109891818 A (LG ELECTRONICS INC.) 14 June 2019 (2019-06-14) the whole document	1-20
A	US 2016227521 A1 (ZTE CORPORATION) 04 August 2016 (2016-08-04) the whole document	1-20

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 April 2023	**26 April 2023**

Name and mailing address of the ISA/CN	Authorized officer
CHINA NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**YU,Feng** Telephone No. **(+86) 010-53961793**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2023/050117

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
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