

APPENDIX 2: PRELIMINARY INFRINGEMENT CONTENTIONS OF U.S. PATENT NO. 9,136,924

The Accused LGE '924 Products are those that are compatible with the 5G-NR standard, and specifically with 3GPP TS 38.214, 3GPP TS 38.321, and 3GPP TS 38.331. An exemplary identification of the Accused LGE '924 Products, based on the information presently available, is set forth in Plaintiff Pantech Corporation's Patent Rule 3-1 and 3-2 Infringement Contentions, at Section A.

The Exemplary Evidence of Infringement disclosed herein establishes that asserted claims 17-19, 22-25, and 28 of U.S. Patent No. 9,136,924 are essential to mandatory sections of the 5G-NR standard (i.e., 3GPP TS 38.214, 3GPP TS 38.321, and 3GPP TS 38.331). If "a patent covers mandatory aspects of a standard," it is "enough to prove infringement by showing standard compliance." *Godofredo Kaisha IP Bridge 1 v. TCL Commun. Tech. Holdings Ltd.*, 967 F.3d 1380, 1383-84 (Fed. Cir. 2020) ("In cases involving standard essential patents, we have endorsed standard compliance as a way of proving infringement"). Based on publicly available information, the Accused LGE '924 Products comply with the 5G-NR standard, which requires compliance with 5G-NR cellular communication protocols including at least 3GPP TS 38.214, 3GPP TS 38.321, and 3GPP TS 38.331 and perform cellular communications in compliance with the aforementioned 5G-NR cellular communication standards. See Appendix 1: LGE Products Compliance with Standards.

The Exemplary Evidence of Infringement also establishes that each of the Accused LGE '924 Products contains a chipset, application processor, SoC, or system-on-chip (e.g., Qualcomm Snapdragon 865) (referred to herein as the "chipset") that incorporates a processor and/or modem. Each such chipset (and thus each accused device) complies with one or more of 5G-NR cellular communication protocols including at least 3GPP TS 38.214, 3GPP TS 38.321, and 3GPP TS 38.331 and support receiving codebook restriction information to restrict precoding matrixes of precoding matrix groups and transmit precoding matrix information indicating selecting a precoding matrix based on codebook restricting information in accordance with the 5G-NR cellular communication standard. See Appendix 1: LGE Products Components. Furthermore, each of the Accused LGE '924 Products contains an antenna or antennas, memory, and transceiver or combination of transmitter and receiver that assist with codebook restriction in accordance with the 5G-NR cellular communication standard. See Appendix 1: LGE Products Components.

Thus, Appendix 1, taken together with the showing made herein, demonstrates infringement of U.S. Patent No. 9,136,924 by the Accused LGE '924 Products.

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U.S. 9,136,924	Exemplary Evidence of Infringement
17. A communication method of a receiving device in a wireless communication system, the method comprising:	To the extent the preamble is construed as a limitation, each of the Accused LGE '924 Products is a user equipment receiving device configured to communicate in a wireless communication system. As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and supports the 5G precoding matrix codebook restriction scheme described in these technical specifications. 5.2.1.1 Reporting settings Each Reporting Setting <i>CSI-ReportConfig</i> is associated with a single downlink BWP (indicated by higher layer parameter <i>BWP-Id</i>) given in the associated <i>CSI-ResourceConfig</i> for channel measurement and contains the parameter(s) for one CSI reporting band: codebook configuration including codebook subset restriction, time-domain behavior, frequency granularity for CQI and PMI, measurement restriction configurations, and the CSI-related quantities to be reported by the UE such as the layer indicator (LI), L1-RSRP, L1-SINR, CRI, and SSBRI (SSB Resource Indicator). The time domain behavior of the <i>CSI-ReportConfig</i> is indicated by the higher layer parameter <i>reportConfigType</i> and can be set to 'aperiodic', 'semiPersistentOnPUCCH', 'semiPersistentOnPUSCH', or 'periodic'. For 'periodic' and 'semiPersistentOnPUCCH'/'semiPersistentOnPUSCH' CSI reporting, the configured periodicity and slot offset applies in the numerology of the UL BWP in which the CSI report is configured to be transmitted on. The higher layer parameter <i>reportQuantity</i> indicates the CSI-related, L1-RSRP-related or L1-SINR-related quantities to report. The <i>reportFreqConfiguration</i> indicates the reporting granularity in the frequency domain, including the CSI reporting band and if PMI/CQI reporting is wideband or sub-band. The <i>timeRestrictionForChannelMeasurements</i> parameter in <i>CSI-ReportConfig</i> can be configured to enable time domain restriction for channel measurements and <i>timeRestrictionForInterferenceMeasurements</i> can be configured to enable time domain restriction for interference measurements. The <i>CSI-ReportConfig</i> can also contain <i>CodebookConfig</i>, which contains configuration parameters for Type-I, Type II or Enhanced Type II CSI including codebook subset restriction, and configurations of group-based reporting. 3GPP TS 38.214 v16.5.0 at 50.
[17.a] receiving codebook restricting	Each of the Accused LGE '924 Products is a user equipment receiving device configured to communicate in a wireless communication system to receive codebook restricting information including at least one of a first bit

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information including at least one of a first bit sequence to restrict at least one precoding matrix from a first precoding matrix group and a second bit sequence to restrict at least one precoding matrix from a second precoding matrix group,	sequence to restrict at least one precoding matrix from a first precoding matrix group and a second bit sequence to restrict at least one precoding matrix from a second precoding matrix group. As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and supports receiving the codebook restriction information described in these technical specifications. 5.2.1.1 Reporting settings Each Reporting Setting <i>CSI-ReportConfig</i> is associated with a single downlink BWP (indicated by higher layer parameter <i>BWP-Id</i>) given in the associated <i>CSI-ResourceConfig</i> for channel measurement and contains the parameter(s) for one CSI reporting band: codebook configuration including codebook subset restriction, time-domain behavior, frequency granularity for CQI and PMI, measurement restriction configurations, and the CSI-related quantities to be reported by the UE such as the layer indicator (LI), L1-RSRP, L1-SINR, CRI, and SSBRI (SSB Resource Indicator). The time domain behavior of the <i>CSI-ReportConfig</i> is indicated by the higher layer parameter <i>reportConfigType</i> and can be set to 'aperiodic', 'semiPersistentOnPUCCH', 'semiPersistentOnPUSCH', or 'periodic'. For 'periodic' and 'semiPersistentOnPUCCH'/'semiPersistentOnPUSCH' CSI reporting, the configured periodicity and slot offset applies in the numerology of the UL BWP in which the CSI report is configured to be transmitted on. The higher layer parameter <i>reportQuantity</i> indicates the CSI-related, L1-RSRP-related or L1-SINR-related quantities to report. The <i>reportFreqConfiguration</i> indicates the reporting granularity in the frequency domain, including the CSI reporting band and if PMI/CQI reporting is wideband or sub-band. The <i>timeRestrictionForChannelMeasurements</i> parameter in <i>CSI-ReportConfig</i> can be configured to enable time domain restriction for channel measurements and <i>timeRestrictionForInterferenceMeasurements</i> can be configured to enable time domain restriction for interference measurements. The <i>CSI-ReportConfig</i> can also contain <i>CodebookConfig</i>, which contains configuration parameters for Type-I, Type II or Enhanced Type II CSI including codebook subset restriction, and configurations of group-based reporting. 3GPP TS 38.214 v16.5.0 at 50.
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5.2.2.2.1 Type I Single-Panel Codebook

For 2 antenna ports {3000, 3001} and the UE configured with higher layer parameter *codebookType* set to 'typeI-SinglePanel' each PMI value corresponds to a codebook index given in Table 5.2.2.2.1-1. The UE is configured with the higher layer parameter *twoTX-CodebookSubsetRestriction*. The bitmap parameter *twoTX-CodebookSubsetRestriction* forms the bit sequence $a_5, \dots, a_1, a_0$ where a_0 is the LSB and a_5 is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to the precoder associated with the bit. Bits 0 to 3 are associated respectively with the codebook indices 0 to 3 for $U=1$ layer, and bits 4 and 5 are associated respectively with the codebook indices 0 and 1 for $U=2$ layers.

3GPP TS 38.214 v16.5.0 at 68.

Table 5.2.2.2.1-1: Codebooks for 1-layer and 2-layer CSI reporting using antenna ports 3000 to 3001

Codebook index	Number of layers U	
	1	2
0	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$	$\frac{1}{2} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$
1	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ j \end{bmatrix}$	$\frac{1}{2} \begin{bmatrix} 1 & 1 \\ j & -j \end{bmatrix}$
2	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -1 \end{bmatrix}$	-
3	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -j \end{bmatrix}$	-

3GPP TS 38.214 v16.5.0 at 68.

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For 4 antenna ports {3000, 3001, 3002, 3003}, 8 antenna ports {3000, 3001, ..., 3007}, 12 antenna ports {3000, 3001, ..., 3011}, 16 antenna ports {3000, 3001, ..., 3015}, 24 antenna ports {3000, 3001, ..., 3023}, and 32 antenna ports {3000, 3001, ..., 3031}, and the UE configured with higher layer parameter *codebookType* set to 'type1-SinglePanel', except when the number of layers $v \in \{2, 3, 4\}$ (where v is the associated RI value), each PMI value corresponds to three codebook indices $i_{1,1}, i_{1,2}, i_{1,3}$. When the number of layers $v \in \{2, 3, 4\}$, each PMI value corresponds to four codebook indices $i_{1,1}, i_{1,2}, i_{1,3}, i_{1,4}$. The composite codebook index i_1 is defined by

$$i_1 = \begin{cases} [i_{1,1} & i_{1,2}] & v \notin \{2, 3, 4\} \\ [i_{1,1} & i_{1,2} & i_{1,3}] & v \in \{2, 3, 4\} \end{cases}$$

The codebooks for 1-8 layers are given respectively in Tables 5.2.2.2.1-5, 5.2.2.2.1-6, 5.2.2.2.1-7, 5.2.2.2.1-8, 5.2.2.2.1-9, 5.2.2.2.1-10, 5.2.2.2.1-11, and 5.2.2.2.1-12. The mapping from $i_{1,3}$ to k_1 and k_2 for 2-layer reporting is given in Table 5.2.2.2.1-3. The mapping from $i_{1,3}$ to k_1 and k_2 for 3-layer and 4-layer reporting when $P_{\text{CSI-RS}} < 16$ is given in Table 5.2.2.2.1-4. The quantities φ_n , θ_p , u_m , $v_{l,m}$, and $\tilde{v}_{l,m}$ are given by

3GPP TS 38.214 v16.5.0 at 68.

The bitmap parameter *n1-n2* forms the bit sequence $a_{A_c-1}, \dots, a_1, a_0$ where a_0 is the LSB and a_{A_c-1} is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to any precoder associated with the bit. The number of bits is given by $A_c = N_1 O_1 N_2 O_2$. Except when the number of layers $v \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32, bit $a_{N_2 O_2 l + m}$ is associated with all precoders based on the quantity $v_{l,m}$, $l = 0, \dots, N_1 O_1 - 1$, $m = 0, \dots, N_2 O_2 - 1$. When the number of layers $v \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32,

- bits $a_{(N_2 O_2 (2l-1) + m) \bmod N_1 O_1 N_2 O_2}$, $a_{N_2 O_2 (2l) + m}$, and $a_{N_2 O_2 (2l+1) + m}$ are each associated with all precoders based on the quantity $\tilde{v}_{l,m}$, $l = 0, \dots, N_1 O_1 / 2 - 1$, $m = 0, \dots, N_2 O_2 - 1$;
- if one or more of the associated bits is zero, then PMI reporting is not allowed to correspond to any precoder based on $\tilde{v}_{l,m}$.

3GPP TS 38.214 v16.5.0 at 69.

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For UE configured with higher layer parameter *reportQuantity* set to 'cri-RI-i1-CQI', the bitmap parameter *typeI-SinglePanel-codebookSubsetRestriction-i2* forms the bit sequence $b_{15}, \dots, b_1, b_0$ where b_0 is the LSB and b_{15} is the MSB. The bit b_i is associated with precoders corresponding to codebook index $i_2 = i$. When b_i is zero, the randomly selected precoder for CQI calculation is not allowed to correspond to any precoder associated with the bit b_i .

3GPP TS 38.214 v16.5.0 at 69.

— *RRCSetup*

The *RRCSetup* message is used to establish SRB1.]

Signalling radio bearer: SRB0

RLC-SAP: TM

Logical channel: CCCH

Direction: Network to UE

RRCSetup message

```
-- ASN1START
-- TAG-RRCSETUP-START

RRCSetup ::=
    rrc-TransactionIdentifier      SEQUENCE {
    criticalExtensions              RRC-TransactionIdentifier,
    rrcSetup                       CHOICE {
    criticalExtensionsFuture        RRCSetup-IEs,
                                SEQUENCE {}
    }
}

RRCSetup-IEs ::=
    radioBearerConfig              SEQUENCE {
    masterCellGroup                RadioBearerConfig,
    lateNonCriticalExtension        OCTET STRING (CONTAINING CellGroupConfig),
    nonCriticalExtension            OCTET STRING
    }
    SEQUENCE{}

-- TAG-RRCSETUP-STOP
-- ASN1STOP
```

3GPP TS 38.331 v16.5.0 at 290-291.

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5.3.5.5 Cell Group configuration

5.3.5.5.1 General

The network configures the UE with Master Cell Group (MCG), and zero or one Secondary Cell Group (SCG). In (NG)EN-DC, the MCG is configured as specified in TS 36.331 [10], and for NE-DC, the SCG is configured as specified in TS 36.331 [10]. The network provides the configuration parameters for a cell group in the *CellGroupConfig* IE.

The UE performs the following actions based on a received *CellGroupConfig* IE:

1> if the *CellGroupConfig* contains the *spCellConfig* with *reconfigurationWithSync*:

2> perform Reconfiguration with sync according to 5.3.5.5.2;

2> resume all suspended radio bearers and resume SCG transmission for all radio bearers, and resume BH RLC channels and resume SCG transmission for BH RLC channels for IAB-MT, if suspended;

1> if the *CellGroupConfig* contains the *spCellConfig*:

2> configure the SpCell as specified in 5.3.5.5.7;

1> if the *CellGroupConfig* contains the *sCellToAddModList*:

2> perform SCell addition/modification as specified in 5.3.5.5.9;

3GPP TS 38.331 v16.5.0 at 70-71.

– *CellGroupConfig*

The *CellGroupConfig* IE is used to configure a master cell group (MCG) or secondary cell group (SCG). A cell group comprises of one MAC entity, a set of logical channels with associated RLC entities and of a primary cell (SpCell) and one or more secondary cells (SCells).

CellGroupConfig information element

```
-- ASN1START
-- TAG-CELLGROUPCONFIG-START

-- Configuration of one Cell-Group:
CellGroupConfig ::= SEQUENCE {
    cellGroupId          CellGroupId,
    rlc-BearerToAddModList SEQUENCE (SIZE(1..maxLC-ID)) OF RLC-BearerConfig OPTIONAL, -- Need N
    rlc-BearerToReleaseList SEQUENCE (SIZE(1..maxLC-ID)) OF LogicalChannelIdentity OPTIONAL, -- Need N
    mac-CellGroupConfig  MAC-CellGroupConfig OPTIONAL, -- Need M
    physicalCellGroupConfig PhysicalCellGroupConfig OPTIONAL, -- Need M
    spCellConfig          SpCellConfig OPTIONAL, -- Need M
}
```

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```

sCellToAddModList      SEQUENCE (SIZE (1..maxNrofCells)) OF SCellConfig      OPTIONAL,  -- Need N
sCellToReleaseList     SEQUENCE (SIZE (1..maxNrofCells)) OF SCellIndex     OPTIONAL,  -- Need N
....

-- Serving cell specific MAC and PHY parameters for a SpCell:
SpCellConfig ::=
servCellIndex          ServCellIndex          OPTIONAL,  -- Cond SCG
reconfigurationWithSync ReconfigurationWithSync OPTIONAL,  -- Cond ReconfWithSync
rlf-TimersAndConstants SetupRelease { RLF-TimersAndConstants } OPTIONAL,  -- Need M
rlmInSyncOutOfSyncThreshold ENUMERATED {n1}   OPTIONAL,  -- Need S
spCellConfigDedicated   ServingCellConfig      OPTIONAL,  -- Need M
...
}

```

3GPP TS 38.331 v16.5.0 at 373-374.

– *ServingCellConfig*

The IE *ServingCellConfig* is used to configure (add or modify) the UE with a serving cell, which may be the SpCell or an SCell of an MCG or SCG. The parameters herein are mostly UE specific but partly also cell specific (e.g. in additionally configured bandwidth parts). Reconfiguration between a PUCCH and PUCCHless SCell is only supported using an SCell release and add.

ServingCellConfig information element

```

-- ASN1START
-- TAG-SERVINGCELLCONFIG-START

ServingCellConfig ::=
tdd-UL-DL-ConfigurationDedicated TDD-UL-DL-ConfigDedicated      OPTIONAL,  -- Cond TDD
initialDownlinkBWP              BWP-DownlinkDedicated          OPTIONAL,  -- Need M
downlinkBWP-ToReleaseList       SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Id      OPTIONAL,  -- Need N
downlinkBWP-ToAddModList        SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Downlink OPTIONAL,  -- Need N
firstActiveDownlinkBWP-Id       BWP-Id                          OPTIONAL,  -- Cond SyncAndCellAdd
bwp-InactivityTimer             ENUMERATED {ms2, ms3, ms4, ms5, ms6, ms8, ms10, ms20, ms30,
                                         ms40, ms50, ms60, ms80, ms100, ms200, ms300, ms500,
                                         ms750, ms1280, ms1920, ms2560, spare10, spare9, spare8,
                                         spare7, spare6, spare5, spare4, spare3, spare2, spare1 }
                                         OPTIONAL,  --Need R

defaultDownlinkBWP-Id           BWP-Id                          OPTIONAL,  -- Need S
uplinkConfig                    UplinkConfig                   OPTIONAL,  -- Need M
supplementaryUplink              UplinkConfig                   OPTIONAL,  -- Need M
pdcch-ServingCellConfig         SetupRelease { PDCCH-ServingCellConfig }          OPTIONAL,  -- Need M
pdsch-ServingCellConfig         SetupRelease { PDSCH-ServingCellConfig }          OPTIONAL,  -- Need M
csi-MeasConfig                  SetupRelease { CSI-MeasConfig }    OPTIONAL,  -- Need M
cellRestrictionMask             ENUMERATED {m20, m40, m80, m160, m320, m640,

```

3GPP TS 38.331 v16.5.0 at 607.

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– **CSI-MeasConfig**

The IE **CSI-MeasConfig** is used to configure CSI-RS (reference signals) belonging to the serving cell in which **CSI-MeasConfig** is included, channel state information reports to be transmitted on PUCCH on the serving cell in which **CSI-MeasConfig** is included and channel state information reports on PUSCH triggered by DCI received on the serving cell in which **CSI-MeasConfig** is included. See also TS 38.214 [19], clause 5.2.

CSI-MeasConfig information element

```
-- ASN1START
-- TAG-CSI-MEASCONFIG-START

CSI-MeasConfig ::= SEQUENCE {
    CSI-ResourceConfigToMonitor SEQUENCE (SIZE (1..maxNrofCSI-ResourceConfigurations)) OF CSI-ResourceConfig OPTIONAL, -- Need N
    CSI-ReportConfigToAddModList SEQUENCE (SIZE (1..maxNrofCSI-ReportConfigurations)) OF CSI-ReportConfig OPTIONAL, -- Need N
    CSI-ReportConfigToReleaseList SEQUENCE (SIZE (1..maxNrofCSI-ReportConfigurations)) OF CSI-ReportConfigId OPTIONAL, -- Need N
}
```

3GPP TS 38.331 v16.5.0 at 405-406.

– **CSI-ReportConfig**

The IE **CSI-ReportConfig** is used to configure a periodic or semi-persistent report sent on PUCCH on the cell in which the **CSI-ReportConfig** is included, or to configure a semi-persistent or aperiodic report sent on PUSCH triggered by DCI received on the cell in which the **CSI-ReportConfig** is included (in this case, the cell on which the report is sent is determined by the received DCI). See TS 38.214 [19], clause 5.2.1.

CSI-ReportConfig information element

```
-- ASN1START
-- TAG-CSI-REPORTCONFIG-START

CSI-ReportConfig ::= SEQUENCE {
    reportConfigId CSI-ReportConfigId,
    carrier ServCellIndex OPTIONAL, -- Need S
    resourcesForChannelMeasurement CSI-ResourceConfigId,
    csi-IM-ResourcesForInterference CSI-ResourceConfigId OPTIONAL, -- Need R
    nzp-CSI-RS-ResourcesForInterference CSI-ResourceConfigId OPTIONAL, -- Need R
    reportConfigType CHOICE {
        periodic SEQUENCE {
            reportSlotConfig CSI-ReportPeriodicityAndOffset,
            pucch-CSI-ResourceList SEQUENCE (SIZE (1..maxNrofBWPs)) OF PUCCH-CSI-Resource
        },
        semiPersistentOnPUSCH SEQUENCE {
            reportSlotConfig CSI-ReportPeriodicityAndOffset,
        }
    }
}
```

...

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```

reportFreqConfiguration      SEQUENCE {
  cqi-FormatIndicator         ENUMERATED { widebandCQI, subbandCQI }
  pmi-FormatIndicator         ENUMERATED { widebandPMI, subbandPMI }
  csi-ReportingBand           CHOICE {
    subbands3                BIT STRING(SIZE(3)),
    subbands4                BIT STRING(SIZE(4)),
    subbands5                BIT STRING(SIZE(5)),
    subbands6                BIT STRING(SIZE(6)),
    subbands7                BIT STRING(SIZE(7)),
    subbands8                BIT STRING(SIZE(8)),
    subbands9                BIT STRING(SIZE(9)),
    subbands10               BIT STRING(SIZE(10)),
    subbands11               BIT STRING(SIZE(11)),
    subbands12               BIT STRING(SIZE(12)),
    subbands13               BIT STRING(SIZE(13)),
    subbands14               BIT STRING(SIZE(14)),
    subbands15               BIT STRING(SIZE(15)),
    subbands16               BIT STRING(SIZE(16)),
    subbands17               BIT STRING(SIZE(17)),
    subbands18               BIT STRING(SIZE(18)),
    ...,
    subbands19-v1530         BIT STRING(SIZE(19))
  } OPTIONAL -- Need S
}

timeRestrictionForChannelMeasurements  ENUMERATED {configured, notConfigured},
timeRestrictionForInterferenceMeasurements  ENUMERATED {configured, notConfigured},
codebookConfig                          CodebookConfig
dummy                                  ENUMERATED {n1, n2}

```

...

CSI-ReportConfig field descriptions
carrier Indicates in which serving cell the CSI-ResourceConfig indicated below are to be found. If the field is absent, the resources are on the same serving cell as this report configuration.
codebookConfig Codebook configuration for Type-1 or Type-2 including codebook subset restriction. Network does not configure codebookConfig and codebookConfig-r16 simultaneously to a UE
cqi-FormatIndicator Indicates whether the UE shall report a single (wideband) or multiple (subband) CQI. (see TS 38.214 [19], clause 5.2.1.4)
cqi-Table Which CQI table to use for CQI calculation (see TS 38.214 [19], clause 5.2.2.1).
csi-IM-ResourcesForInterference CSI IM resources for interference measurement. <i>csi-ResourceConfigId</i> of a CSI-ResourceConfig included in the configuration of the serving cell indicated with the field "carrier" above. The CSI-ResourceConfig indicated here contains only CSI-IM resources. The <i>bwp-id</i> in that CSI-ResourceConfig is the same value as the <i>bwp-id</i> in the CSI-ResourceConfig indicated by <i>resourcesForChannelMeasurement</i>

3GPP TS 38.331 v16.5.0 at 407-410.

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– CodebookConfig

The IE *CodebookConfig* is used to configure codebooks of Type-I and Type-II (see TS 38.214 [19], clause 5.2.2.2)

CodebookConfig information element

```
-- ASN1START
-- TAG-CODEBOOKCONFIG-START

CodebookConfig ::=
  codebookType
    type1
      subType
        typeI-SinglePanel
          nrOfAntennaPorts
            two
              twoTX-CodebookSubsetRestriction
            },
            moreThanTwo
              n1-n2
                two-one-TypeI-SinglePanel-Restriction
                two-two-TypeI-SinglePanel-Restriction
                four-one-TypeI-SinglePanel-Restriction
                three-two-TypeI-SinglePanel-Restriction
                six-one-TypeI-SinglePanel-Restriction
                four-two-TypeI-SinglePanel-Restriction
                eight-one-TypeI-SinglePanel-Restriction
                four-three-TypeI-SinglePanel-Restriction
                six-two-TypeI-SinglePanel-Restriction
                twelve-one-TypeI-SinglePanel-Restriction
                four-four-TypeI-SinglePanel-Restriction
                eight-two-TypeI-SinglePanel-Restriction
                sixteen-one-TypeI-SinglePanel-Restriction
              },
              typeI-SinglePanel-codebookSubsetRestriction-i2
            },
            typeI-SinglePanel-ri-Restriction
          },
          typeI-MultiPanel
        ...
```

SEQUENCE {
 CHOICE {
 SEQUENCE {
 CHOICE {
 SEQUENCE {
 CHOICE {
 SEQUENCE {
 BIT STRING (SIZE (6))
 },
 SEQUENCE {
 CHOICE {
 BIT STRING (SIZE (8)),
 BIT STRING (SIZE (64)),
 BIT STRING (SIZE (16)),
 BIT STRING (SIZE (96)),
 BIT STRING (SIZE (24)),
 BIT STRING (SIZE (128)),
 BIT STRING (SIZE (32)),
 BIT STRING (SIZE (192)),
 BIT STRING (SIZE (192)),
 BIT STRING (SIZE (48)),
 BIT STRING (SIZE (256)),
 BIT STRING (SIZE (256)),
 BIT STRING (SIZE (64))
 },
 typeI-SinglePanel-codebookSubsetRestriction-i2 BIT STRING (SIZE (16))
 },
 typeI-SinglePanel-ri-Restriction BIT STRING (SIZE (8))
 },
 typeI-MultiPanel SEQUENCE {

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<i>CodebookConfig</i> field descriptions	
<i>codebookMode</i>	CodebookMode as specified in TS 38.214 [19], clause 5.2.2.2.2.
<i>codebookType</i>	CodebookType including possibly sub-types and the corresponding parameters for each (see TS 38.214 [19], clause 5.2.2.2).
<i>n1-n2-codebookSubsetRestriction</i>	Number of antenna ports in first (<i>n1</i>) and second (<i>n2</i>) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.2.3). Number of bits for codebook subset restriction is $\text{CEIL}(\log_2(\text{nchoosek}(\text{O1} \times \text{O2}, 4))) + 8 \times n1 \times n2$ where $\text{nchoosek}(a, b) = a! / (b!(a-b)!)$.
<i>n1-n2</i>	Number of antenna ports in first (<i>n1</i>) and second (<i>n2</i>) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.2.1).
<i>ng-n1-n2</i>	Codebook subset restriction for Type I Multi-panel codebook (see TS 38.214 [19], clause 5.2.2.2.2).
<i>numberOfBeams</i>	Number of beams, <i>L</i> , used for linear combination.
<i>numberOfPMI-SubbandsPerCQI-Subband</i>	Field indicates how PMI subbands are defined per CQI subband according to TS 38.214 [19], clause 5.2.2.2.5.
<i>paramCombination</i>	Field describes supported parameter combination (<i>L</i> , <i>p_v</i> , <i>β</i>) as specified in TS 38.214.
<i>phaseAlphabetSize</i>	The size of the PSK alphabet, QPSK or 8-PSK.
<i>portSelectionSamplingSize</i>	The size of the port selection codebook (parameter <i>d</i>), see TS 38.214 [19] clause 5.2.2.2.6.
<i>ri-Restriction</i>	Restriction for RI for <i>TypeI-MultiPanel-RI-Restriction</i> (see TS 38.214 [19], clause 5.2.2.2.2).
<i>subbandAmplitude</i>	If subband amplitude reporting is activated (<i>true</i>).
<i>twoTX-CodebookSubsetRestriction</i>	Codebook subset restriction for 2TX codebook (see TS 38.214 [19] clause 5.2.2.2.1).
<i>typeI-SinglePanel-codebookSubsetRestriction-i2</i>	i2 codebook subset restriction for Type I Single-panel codebook used when <i>reportQuantity</i> is CRI/RI/i1/CQI (see TS 38.214 [19] clause 5.2.2.2.1).
<i>typeI-SinglePanel-ri-Restriction</i>	Restriction for RI for <i>TypeI-SinglePanel-RI-Restriction</i> (see TS 38.214 [19], clause 5.2.2.2.1).
<i>typeII-PortSelectionRI-Restriction</i>	Restriction for RI for <i>TypeII-PortSelection-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.4 and 5.2.2.2.6).
<i>typeII-RI-Restriction</i>	Restriction for RI for <i>TypeII-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.3 and 5.2.2.2.5).
3GPP TS 38.331 v16.5.0 at 383-386.	

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Table 5.2.2.1-5: Codebook for 1-layer CSI reporting using antenna ports 3000 to 2999+ $P_{\text{CSI-RS}}$

codebookMode = 1			
$i_{1,1}$	$i_{1,2}$	b_2	
$0, 1, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	$0, 1, 2, 3$	$W_{i_{1,1}, i_{1,2}, b_2}^{(1)}$
where $W_{l,m,n}^{(1)} = \frac{1}{\sqrt{P_{\text{CSI-RS}}}} \begin{bmatrix} v_{l,m} \\ \phi_n v_{l,m} \end{bmatrix}$.			

codebookMode = 2, $N_2 > 1$					
$i_{1,1}$	$i_{1,2}$	b_2			
		0	1	2	3
$0, 1, \dots, \frac{N_1 O_1}{2} - 1$	$0, 1, \dots, \frac{N_2 O_2}{2} - 1$	$W_{2i_{1,1}, 2i_{1,2}, 0}^{(1)}$	$W_{2i_{1,1}, 2i_{1,2}, 1}^{(1)}$	$W_{2i_{1,1}, 2i_{1,2}, 2}^{(1)}$	$W_{2i_{1,1}, 2i_{1,2}, 3}^{(1)}$
$i_{1,1}$	$i_{1,2}$	b_2			
		4	5	6	7
$0, 1, \dots, \frac{N_1 O_1}{2} - 1$	$0, 1, \dots, \frac{N_2 O_2}{2} - 1$	$W_{2i_{1,1}+1, 2i_{1,2}, 0}^{(1)}$	$W_{2i_{1,1}+1, 2i_{1,2}, 1}^{(1)}$	$W_{2i_{1,1}+1, 2i_{1,2}, 2}^{(1)}$	$W_{2i_{1,1}+1, 2i_{1,2}, 3}^{(1)}$
$i_{1,1}$	$i_{1,2}$	b_2			
		8	9	10	11
$0, 1, \dots, \frac{N_1 O_1}{2} - 1$	$0, 1, \dots, \frac{N_2 O_2}{2} - 1$	$W_{2i_{1,1}, 2i_{1,2}+1, 0}^{(1)}$	$W_{2i_{1,1}, 2i_{1,2}+1, 1}^{(1)}$	$W_{2i_{1,1}, 2i_{1,2}+1, 2}^{(1)}$	$W_{2i_{1,1}, 2i_{1,2}+1, 3}^{(1)}$
$i_{1,1}$	$i_{1,2}$	b_2			
		12	13	14	15
$0, 1, \dots, \frac{N_1 O_1}{2} - 1$	$0, 1, \dots, \frac{N_2 O_2}{2} - 1$	$W_{2i_{1,1}+1, 2i_{1,2}+1, 0}^{(1)}$	$W_{2i_{1,1}+1, 2i_{1,2}+1, 1}^{(1)}$	$W_{2i_{1,1}+1, 2i_{1,2}+1, 2}^{(1)}$	$W_{2i_{1,1}+1, 2i_{1,2}+1, 3}^{(1)}$
where $W_{l,m,n}^{(1)} = \frac{1}{\sqrt{P_{\text{CSI-RS}}}} \begin{bmatrix} v_{l,m} \\ \phi_n v_{l,m} \end{bmatrix}$.					

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<u>codebookMode</u> = 2, $N_2 = 1$					
$i_{1,1}$	$i_{1,2}$	i_2			
		0	1	2	3
$0, 1, \dots, \frac{N_1 O_1}{2} - 1$	0	$W_{2i_{1,1}, 0, 0}^{(1)}$	$W_{2i_{1,1}, 0, 1}^{(1)}$	$W_{2i_{1,1}, 0, 2}^{(1)}$	$W_{2i_{1,1}, 0, 3}^{(1)}$
$i_{1,1}$	$i_{1,2}$	i_2			
		4	5	6	7
$0, 1, \dots, \frac{N_1 O_1}{2} - 1$	0	$W_{2i_{1,1}+1, 0, 0}^{(1)}$	$W_{2i_{1,1}+1, 0, 1}^{(1)}$	$W_{2i_{1,1}+1, 0, 2}^{(1)}$	$W_{2i_{1,1}+1, 0, 3}^{(1)}$
$i_{1,1}$	$i_{1,2}$	i_2			
		8	9	10	11
$0, 1, \dots, \frac{N_1 O_1}{2} - 1$	0	$W_{2i_{1,1}+2, 0, 0}^{(1)}$	$W_{2i_{1,1}+2, 0, 1}^{(1)}$	$W_{2i_{1,1}+2, 0, 2}^{(1)}$	$W_{2i_{1,1}+2, 0, 3}^{(1)}$
$i_{1,1}$	$i_{1,2}$	i_2			
		12	13	14	15
$0, 1, \dots, \frac{N_1 O_1}{2} - 1$	0	$W_{2i_{1,1}+3, 0, 0}^{(1)}$	$W_{2i_{1,1}+3, 0, 1}^{(1)}$	$W_{2i_{1,1}+3, 0, 2}^{(1)}$	$W_{2i_{1,1}+3, 0, 3}^{(1)}$
where $W_{i,m,n}^{(1)} = \frac{1}{\sqrt{P_{\text{CSI-RS}}}} \begin{bmatrix} v_{i,m} \\ \varphi_n v_{i,m} \end{bmatrix}$.					

3GPP TS 38.214 v16.5.0 at 70-71.

Table 5.2.2.2.1-6: Codebook for 2-layer CSI reporting using antenna ports 3000 to 2999+ $P_{\text{CSI-RS}}$

<u>codebookMode</u> = 1			
$i_{1,1}$	$i_{1,2}$	i_2	
$0, 1, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1}, i_{1,2} + \kappa_1 i_{1,2} + i_{1,2} + \kappa_2 i_{1,2}}^{(2)}$
where $W_{i_f, m, m', n}^{(2)} = \frac{1}{\sqrt{2P_{\text{CSI-RS}}}} \begin{bmatrix} v_{i_f, m} & v_{i_f, m'} \\ \varphi_n v_{i_f, m} & -\varphi_n v_{i_f, m'} \end{bmatrix}$.			
and the mapping from $i_{1,3}$ to κ_1 and κ_2 is given in Table 5.2.2.2.1-3.			

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<u>codebookMode</u> = 2, $N_2 > 1$			
$i_{1,1}$	$i_{1,2}$	k_2	
		0	1
$0, \dots, \frac{N_1 O_1}{2} - 1$	$0, \dots, \frac{N_2 O_2}{2} - 1$	$W_{2i_{1,1} + k_1, 2i_{1,2} + k_2, 0}^{(2)}$	$W_{2i_{1,1} + k_1, 2i_{1,2} + k_2, 1}^{(2)}$
$i_{1,1}$	$i_{1,2}$	k_2	
		2	3
$0, \dots, \frac{N_1 O_1}{2} - 1$	$0, \dots, \frac{N_2 O_2}{2} - 1$	$W_{2i_{1,1} + 1, 2i_{1,2} + 1 + k_1, 2i_{1,2} + k_2, 0}^{(2)}$	$W_{2i_{1,1} + 1, 2i_{1,2} + 1 + k_1, 2i_{1,2} + k_2, 1}^{(2)}$
$i_{1,1}$	$i_{1,2}$	k_2	
		4	5
$0, \dots, \frac{N_1 O_1}{2} - 1$	$0, \dots, \frac{N_2 O_2}{2} - 1$	$W_{2i_{1,1} + 2, 2i_{1,2} + 2 + k_1, 2i_{1,2} + 1 + k_2, 0}^{(2)}$	$W_{2i_{1,1} + 2, 2i_{1,2} + 2 + k_1, 2i_{1,2} + 1 + k_2, 1}^{(2)}$
$i_{1,1}$	$i_{1,2}$	k_2	
		6	7
$0, \dots, \frac{N_1 O_1}{2} - 1$	$0, \dots, \frac{N_2 O_2}{2} - 1$	$W_{2i_{1,1} + 1, 2i_{1,2} + 1 + k_1, 2i_{1,2} + 1 + k_2, 0}^{(2)}$	$W_{2i_{1,1} + 1, 2i_{1,2} + 1 + k_1, 2i_{1,2} + 1 + k_2, 1}^{(2)}$
where $W_{l', m, m', n}^{(2)} = \frac{1}{\sqrt{2P_{\text{CSI-RS}}}} \begin{bmatrix} v_{l', m} & v_{l', m'} \\ \varphi_n v_{l', m} & -\varphi_n v_{l', m'} \end{bmatrix}$. and the mapping from $i_{1,3}$ to k_1 and k_2 is given in Table 5.2.2.2.1-3.			

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<u>codebookMode</u> = 2, $N_2 = 1$					
$i_{1,1}$	$i_{1,2}$	b_2			
		0	1	2	3
$0, \dots, \frac{N_1 Q_1}{2} - 1$	0	$W_{2i_{1,1}, 2i_{1,1} + k_1, 0, 0, 0}^{(2)}$	$W_{2i_{1,1}, 2i_{1,1} + k_1, 0, 0, 1}^{(2)}$	$W_{2i_{1,1} + 1, 2i_{1,1} + 1 + k_1, 0, 0, 0}^{(2)}$	$W_{2i_{1,1} + 1, 2i_{1,1} + 1 + k_1, 0, 0, 1}^{(2)}$
$i_{1,1}$	$i_{1,2}$	b_2			
		4	5	6	7
$0, \dots, \frac{N_1 Q_1}{2} - 1$	0	$W_{2i_{1,1} + 2, 2i_{1,1} + 2 + k_1, 0, 0, 0}^{(2)}$	$W_{2i_{1,1} + 2, 2i_{1,1} + 2 + k_1, 0, 0, 1}^{(2)}$	$W_{2i_{1,1} + 3, 2i_{1,1} + 3 + k_1, 0, 0, 0}^{(2)}$	$W_{2i_{1,1} + 3, 2i_{1,1} + 3 + k_1, 0, 0, 1}^{(2)}$
where $W_{l_f', m, m', n}^{(2)} = \frac{1}{\sqrt{2P_{\text{CSI-RS}}}} \begin{bmatrix} v_{l, m} & v_{l', m'} \\ \varphi_n v_{l, m} & -\varphi_n v_{l', m'} \end{bmatrix}$.					
and the mapping from $i_{1,3}$ to k_1 is given in Table 5.2.2.2.1-3.					

3GPP TS 38.214 v16.5.0 at 71-72.

Table 5.2.2.1-7: Codebook for 3-layer CSI reporting using antenna ports 3000 to 2999+ $P_{\text{CSI-RS}}$

<u>codebookMode</u> = 1-2, $P_{\text{CSI-RS}} < 16$			
$i_{1,1}$	$i_{1,2}$	b_2	
$0, \dots, N_1 O_1 - 1$	$0, 1, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1}, i_{1,1} + k_1, i_{1,2}, i_{1,2} + k_2}^{(3)}$
where $W_{l_f', m, m', n}^{(3)} = \frac{1}{\sqrt{3P_{\text{CSI-RS}}}} \begin{bmatrix} v_{l, m} & v_{l', m'} & v_{l, m} \\ \varphi_n v_{l, m} & \varphi_n v_{l', m'} & -\varphi_n v_{l, m} \end{bmatrix}$. and the mapping from $i_{1,3}$ to k_1 and k_2 is given in Table 5.2.2.2.1-4.			

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		<u><i>codebookMode</i></u> = 1-2, $P_{\text{CSI-RS}} \geq 16$				
		$i_{1,1}$	$i_{1,2}$	$i_{1,3}$	i_2	
		$0, \dots, \frac{N_1 Q_1}{2} - 1$	$0, \dots, N_2 Q_2 - 1$	0,1,2,3	0,1	$W_{i_{1,1}, i_{1,2}, i_{1,3}, i_2}^{(3)}$
		where $W_{i,m,p,n}^{(3)} = \frac{1}{\sqrt{3P_{\text{CSI-RS}}}}$ $\begin{bmatrix} \tilde{v}_{i,m} & \tilde{v}_{i,m} & \tilde{v}_{i,m} \\ \theta_p \tilde{v}_{i,m} & -\theta_p \tilde{v}_{i,m} & \theta_p \tilde{v}_{i,m} \\ \varphi_n \tilde{v}_{i,m} & \varphi_n \tilde{v}_{i,m} & -\varphi_n \tilde{v}_{i,m} \\ \varphi_n \theta_p \tilde{v}_{i,m} & -\varphi_n \theta_p \tilde{v}_{i,m} & -\varphi_n \theta_p \tilde{v}_{i,m} \end{bmatrix}$				
		3GPP TS 38.214 v16.5.0 at 72-73.				

Table 5.2.2.2.1-8: Codebook for 4-layer CSI reporting using antenna ports 3000 to 2999+ $P_{\text{CSI-RS}}$

<u>codebookMode = 1-2, $P_{\text{CSI-RS}} < 16$</u>			
$i_{1,1}$	$i_{1,2}$	i_2	
$0, \dots, N_1 O_1 - 1$	$0, 1, \dots, N_2 O_2 - 1$	$0, 1$	$W_{i_{1,1} i_{1,2} + k_1 i_{1,2} + k_2 i_2}^{(4)}$
where $W_{i_{1,1} i_{1,2} + k_1 i_{1,2} + k_2 i_2}^{(4)} = \frac{1}{\sqrt{4P_{\text{CSI-RS}}}} \begin{bmatrix} v_{i,m} & v_{i,m'} & v_{i,m} & v_{i,m'} \\ \varphi_n v_{i,m} & \varphi_n v_{i,m'} & -\varphi_n v_{i,m} & -\varphi_n v_{i,m'} \end{bmatrix}$ and the mapping from $i_{1,3}$ to k_1 and k_2 is given in Table 5.2.2.2.1-4.			

<u>codebookMode = 1-2, $P_{\text{CSI-RS}} \geq 16$</u>				
$i_{1,1}$	$i_{1,2}$	$i_{1,3}$	i_2	
$0, \dots, \frac{N_1 O_1}{2} - 1$	$0, \dots, N_2 O_2 - 1$	$0, 1, 2, 3$	$0, 1$	$W_{i_{1,1} i_{1,2} + i_{1,3} i_2}^{(4)}$
where $W_{i_{1,1} i_{1,2} + i_{1,3} i_2}^{(4)} = \frac{1}{\sqrt{4P_{\text{CSI-RS}}}} \begin{bmatrix} \tilde{v}_{i,m} & \tilde{v}_{i,m} & \tilde{v}_{i,m} & \tilde{v}_{i,m} \\ \theta_p \tilde{v}_{i,m} & -\theta_p \tilde{v}_{i,m} & \theta_p \tilde{v}_{i,m} & -\theta_p \tilde{v}_{i,m} \\ \varphi_n \tilde{v}_{i,m} & \varphi_n \tilde{v}_{i,m} & -\varphi_n \tilde{v}_{i,m} & -\varphi_n \tilde{v}_{i,m} \\ \varphi_n \theta_p \tilde{v}_{i,m} & -\varphi_n \theta_p \tilde{v}_{i,m} & -\varphi_n \theta_p \tilde{v}_{i,m} & \varphi_n \theta_p \tilde{v}_{i,m} \end{bmatrix}$				

3GPP TS 38.214 v16.5.0 at 73.

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Table 5.2.2.1-9: Codebook for 5-layer CSI reporting using antenna ports 3000 to 2999+ $P_{\text{CSI-RS}}$

codebookMode = 1-2				
	$i_{1,1}$	$i_{1,2}$	i_2	
$N_2 > 1$	$0, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1} i_{1,2} + O_1 i_{1,1} + O_1 i_{1,2} i_{1,2} + O_2 i_2}^{(5)}$
$N_1 > 2, N_2 = 1$	$0, \dots, N_1 O_1 - 1$	0	0, 1	$W_{i_{1,1} i_{1,1} + O_1 i_{1,1} + 2 O_1 0 0 0 i_2}^{(5)}$
where $W_{i_{1,1} i_{1,2} + O_1 i_{1,1} + O_1 i_{1,2} i_{1,2} + O_2 i_2}^{(5)} = \frac{1}{\sqrt{5 P_{\text{CSI-RS}}}} \begin{bmatrix} v_{l,m} & v_{l,m} & v_{l',m'} & v_{l',m'} & v_{l'',m''} \\ \varphi_n v_{l,m} & -\varphi_n v_{l,m} & v_{l',m'} & -v_{l',m'} & v_{l'',m''} \end{bmatrix}$				

3GPP TS 38.214 v16.5.0 at 73.

Table 5.2.2.1-10: Codebook for 6-layer CSI reporting using antenna ports 3000 to 2999+ $P_{\text{CSI-RS}}$

codebookMode = 1-2				
	$i_{1,1}$	$i_{1,2}$	i_2	
$N_2 > 1$	$0, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1} i_{1,1} + O_1 i_{1,1} + O_1 i_{1,2} i_{1,2} + O_2 i_2}^{(6)}$
$N_1 > 2, N_2 = 1$	$0, \dots, N_1 O_1 - 1$	0	0, 1	$W_{i_{1,1} i_{1,1} + O_1 i_{1,1} + 2 O_1 0 0 0 i_2}^{(6)}$
where $W_{i_{1,1} i_{1,2} + O_1 i_{1,1} + O_1 i_{1,2} i_{1,2} + O_2 i_2}^{(6)} = \frac{1}{\sqrt{6 P_{\text{CSI-RS}}}} \begin{bmatrix} v_{l,m} & v_{l,m} & v_{l',m'} & v_{l',m'} & v_{l'',m''} & v_{l'',m''} \\ \varphi_n v_{l,m} & -\varphi_n v_{l,m} & \varphi_n v_{l',m'} & -\varphi_n v_{l',m'} & v_{l'',m''} & -v_{l'',m''} \end{bmatrix}$				

3GPP TS 38.214 v16.5.0 at 74.

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Table 5.2.2.1-11: Codebook for 7-layer CSI reporting using antenna ports 3000 to 2999+ $P_{\text{CSI-RS}}$

codebookMode = 1-2				
	$i_{1,1}$	$i_{1,2}$	i_2	
$N_1 = 4, N_2 = 1$	$0, \dots, \frac{N_1 O_1}{2} - 1$	0	0, 1	$W_{i_{1,1}, i_{1,2} + O_1 i_{1,1} + 2O_1 i_{1,2} + 3O_1, 0, 0, 0, 0, i_2}^{(\gamma)}$
$N_1 > 4, N_2 = 1$	$0, \dots, N_1 O_1 - 1$	0	0, 1	$W_{i_{1,1}, i_{1,2} + O_1 i_{1,1} + 2O_1 i_{1,2} + 3O_1, 0, 0, 0, 0, i_2}^{(\gamma)}$
$N_1 = 2, N_2 = 2$	$0, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1}, i_{1,2} + O_1 i_{1,1}, i_{1,2} + O_1 i_{1,2}, i_{1,2}, i_{1,2} + O_2 i_{1,2} + O_2 i_2}^{(\gamma)}$
$N_1 > 2, N_2 = 2$	$0, \dots, N_1 O_1 - 1$	$0, \dots, \frac{N_2 O_2}{2} - 1$	0, 1	$W_{i_{1,1}, i_{1,2} + O_1 i_{1,1}, i_{1,2} + O_1 i_{1,2}, i_{1,2}, i_{1,2} + O_2 i_{1,2} + O_2 i_2}^{(\gamma)}$
$N_1 > 2, N_2 > 2$	$0, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1}, i_{1,2} + O_1 i_{1,1}, i_{1,2} + O_1 i_{1,2}, i_{1,2}, i_{1,2} + O_2 i_{1,2} + O_2 i_2}^{(\gamma)}$
where $W_{i_{f'}, i_{f''}, m, m', m'', n}^{(\gamma)} = \frac{1}{\sqrt{7P_{\text{CSI-RS}}}} \begin{bmatrix} v_{i, m} & v_{i, m} & v_{i', m'} & v_{i', m'} & v_{i', m'} & v_{i'', m''} & v_{i'', m''} \\ \phi_n v_{i, m} & -\phi_n v_{i, m} & \phi_n v_{i', m'} & v_{i', m'} & -v_{i', m'} & v_{i'', m''} & -v_{i'', m''} \end{bmatrix}$				

3GPP TS 38.214 v16.5.0 at 74.

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	Table 5.2.2.1-12: Codebook for 8-layer CSI reporting using antenna ports 3000 to 2999+$P_{\text{CSI-RS}}$ <table><tr><th colspan="5">codebookMode = 1-2</th></tr><tr><th></th><th>$i_{1,1}$</th><th>$i_{1,2}$</th><th>i_2</th><th></th></tr><tr><td>$N_1 = 4, N_2 = 1$</td><td>$0, \dots, \frac{N_1 O_1}{2} - 1$</td><td>0</td><td>0, 1</td><td>$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}} + 2O_{1, i_{1,1}} + 3O_{1, 0, 0, 0, 0, i_2}$</td></tr><tr><td>$N_1 > 4, N_2 = 1$</td><td>$0, \dots, N_1 O_1 - 1$</td><td>0</td><td>0, 1</td><td>$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}} + 2O_{1, i_{1,1}} + 3O_{1, 0, 0, 0, 0, i_2}$</td></tr><tr><td>$N_1 = 2, N_2 = 2$</td><td>$0, \dots, N_1 O_1 - 1$</td><td>$0, \dots, N_2 O_2 - 1$</td><td>0, 1</td><td>$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}, i_{1,1}} + O_{1, i_{1,2}, i_{1,2}, i_{1,2}} + O_{2, i_{1,2}} + O_{2, i_2}$</td></tr><tr><td>$N_1 > 2, N_2 = 2$</td><td>$0, \dots, N_1 O_1 - 1$</td><td>$0, \dots, \frac{N_2 O_2}{2} - 1$</td><td>0, 1</td><td>$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}, i_{1,1}} + O_{1, i_{1,2}, i_{1,2}, i_{1,2}} + O_{2, i_{1,2}} + O_{2, i_2}$</td></tr><tr><td>$N_1 > 2, N_2 > 2$</td><td>$0, \dots, N_1 O_1 - 1$</td><td>$0, \dots, N_2 O_2 - 1$</td><td>0, 1</td><td>$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}, i_{1,1}} + O_{1, i_{1,2}, i_{1,2}, i_{1,2}} + O_{2, i_{1,2}} + O_{2, i_2}$</td></tr><tr><td colspan="5">where $W_{i, j}^{(8)} = \frac{1}{\sqrt{8P_{\text{CSI-RS}}}} \begin{bmatrix} v_{i, m} & v_{i, m} & v_{i', m'} & v_{i', m'} & v_{i'', m''} & v_{i'', m''} & v_{i''', m'''} & v_{i''', m'''} \\ \phi_n v_{i, m} & -\phi_n v_{i, m} & \phi_n v_{i', m'} & -\phi_n v_{i', m'} & v_{i'', m''} & -v_{i'', m''} & v_{i''', m'''} & -v_{i''', m'''} \end{bmatrix}$</td></tr></table> 3GPP TS 38.214 v16.5.0 at 74.	codebookMode = 1-2						$i_{1,1}$	$i_{1,2}$	i_2		$N_1 = 4, N_2 = 1$	$0, \dots, \frac{N_1 O_1}{2} - 1$	0	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}} + 2O_{1, i_{1,1}} + 3O_{1, 0, 0, 0, 0, i_2}$	$N_1 > 4, N_2 = 1$	$0, \dots, N_1 O_1 - 1$	0	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}} + 2O_{1, i_{1,1}} + 3O_{1, 0, 0, 0, 0, i_2}$	$N_1 = 2, N_2 = 2$	$0, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}, i_{1,1}} + O_{1, i_{1,2}, i_{1,2}, i_{1,2}} + O_{2, i_{1,2}} + O_{2, i_2}$	$N_1 > 2, N_2 = 2$	$0, \dots, N_1 O_1 - 1$	$0, \dots, \frac{N_2 O_2}{2} - 1$	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}, i_{1,1}} + O_{1, i_{1,2}, i_{1,2}, i_{1,2}} + O_{2, i_{1,2}} + O_{2, i_2}$	$N_1 > 2, N_2 > 2$	$0, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}, i_{1,1}} + O_{1, i_{1,2}, i_{1,2}, i_{1,2}} + O_{2, i_{1,2}} + O_{2, i_2}$	where $W_{i, j}^{(8)} = \frac{1}{\sqrt{8P_{\text{CSI-RS}}}} \begin{bmatrix} v_{i, m} & v_{i, m} & v_{i', m'} & v_{i', m'} & v_{i'', m''} & v_{i'', m''} & v_{i''', m'''} & v_{i''', m'''} \\ \phi_n v_{i, m} & -\phi_n v_{i, m} & \phi_n v_{i', m'} & -\phi_n v_{i', m'} & v_{i'', m''} & -v_{i'', m''} & v_{i''', m'''} & -v_{i''', m'''} \end{bmatrix}$				
codebookMode = 1-2																																									
	$i_{1,1}$	$i_{1,2}$	i_2																																						
$N_1 = 4, N_2 = 1$	$0, \dots, \frac{N_1 O_1}{2} - 1$	0	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}} + 2O_{1, i_{1,1}} + 3O_{1, 0, 0, 0, 0, i_2}$																																					
$N_1 > 4, N_2 = 1$	$0, \dots, N_1 O_1 - 1$	0	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}} + 2O_{1, i_{1,1}} + 3O_{1, 0, 0, 0, 0, i_2}$																																					
$N_1 = 2, N_2 = 2$	$0, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}, i_{1,1}} + O_{1, i_{1,2}, i_{1,2}, i_{1,2}} + O_{2, i_{1,2}} + O_{2, i_2}$																																					
$N_1 > 2, N_2 = 2$	$0, \dots, N_1 O_1 - 1$	$0, \dots, \frac{N_2 O_2}{2} - 1$	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}, i_{1,1}} + O_{1, i_{1,2}, i_{1,2}, i_{1,2}} + O_{2, i_{1,2}} + O_{2, i_2}$																																					
$N_1 > 2, N_2 > 2$	$0, \dots, N_1 O_1 - 1$	$0, \dots, N_2 O_2 - 1$	0, 1	$W_{i_{1,1}, i_{1,1}}^{(8)} + O_{1, i_{1,1}, i_{1,1}} + O_{1, i_{1,2}, i_{1,2}, i_{1,2}} + O_{2, i_{1,2}} + O_{2, i_2}$																																					
where $W_{i, j}^{(8)} = \frac{1}{\sqrt{8P_{\text{CSI-RS}}}} \begin{bmatrix} v_{i, m} & v_{i, m} & v_{i', m'} & v_{i', m'} & v_{i'', m''} & v_{i'', m''} & v_{i''', m'''} & v_{i''', m'''} \\ \phi_n v_{i, m} & -\phi_n v_{i, m} & \phi_n v_{i', m'} & -\phi_n v_{i', m'} & v_{i'', m''} & -v_{i'', m''} & v_{i''', m'''} & -v_{i''', m'''} \end{bmatrix}$																																									
[17.b] each bit of the first bit sequence corresponding to one precoding matrix of the first precoding matrix group, respectively, the at least one precoding matrix of the first precoding matrix group being restricted from being used as a precoding matrix of a first precoder,	Each of the Accused LGE '924 Products is a user equipment receiving device configured to communicate in a wireless communication system to receive codebook restricting information including each bit of the first bit sequence corresponding to one precoding matrix of the first precoding matrix group, respectively, the at least one precoding matrix of the first precoding matrix group being restricted from being used as a precoding matrix of a first precoder. As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and supports receiving the codebook restriction information described in these technical specifications.																																								

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5.2.2.2.1 Type I Single-Panel Codebook

For 2 antenna ports {3000, 3001} and the UE configured with higher layer parameter *codebookType* set to 'typeI-SinglePanel' each PMI value corresponds to a codebook index given in Table 5.2.2.2.1-1. The UE is configured with the higher layer parameter *twoTX-CodebookSubsetRestriction*. The bitmap parameter *twoTX-CodebookSubsetRestriction* forms the bit sequence $a_5, \dots, a_1, a_0$ where a_0 is the LSB and a_5 is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to the precoder associated with the bit. Bits 0 to 3 are associated respectively with the codebook indices 0 to 3 for $U=1$ layer, and bits 4 and 5 are associated respectively with the codebook indices 0 and 1 for $U=2$ layers.

3GPP TS 38.214 v16.5.0 at 68.

The codebooks for 1-8 layers are given respectively in Tables 5.2.2.2.1-5, 5.2.2.2.1-6, 5.2.2.2.1-7, 5.2.2.2.1-8, 5.2.2.2.1-9, 5.2.2.2.1-10, 5.2.2.2.1-11, and 5.2.2.2.1-12. The mapping from $i_{1,3}$ to k_1 and k_2 for 2-layer reporting is given in Table 5.2.2.2.1-3. The mapping from $i_{1,3}$ to k_1 and k_2 for 3-layer and 4-layer reporting when $P_{\text{CSI-RS}} < 16$ is given in Table 5.2.2.2.1-4. The quantities φ_n , θ_p , u_m , $v_{l,m}$, and $\tilde{v}_{l,m}$ are given by

...

The bitmap parameter *n1-n2* forms the bit sequence $a_{A_c-1}, \dots, a_1, a_0$ where a_0 is the LSB and a_{A_c-1} is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to any precoder associated with the bit. The number of bits is given by $A_c = N_1 O_1 N_2 O_2$. Except when the number of layers $v \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32, bit $a_{N_1 O_2 l + m}$ is associated with all precoders based on the quantity $v_{l,m}$, $l = 0, \dots, N_1 O_1 - 1$, $m = 0, \dots, N_2 O_2 - 1$. When the number of layers $v \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32,

- bits $a_{(N_2 O_2 (2l-1) + m) \bmod N_1 O_1 N_2 O_2}$, $a_{N_2 O_2 (2l) + m}$, and $a_{N_2 O_2 (2l+1) + m}$ are each associated with all precoders based on the quantity $\tilde{v}_{l,m}$, $l = 0, \dots, N_1 O_1 / 2 - 1$, $m = 0, \dots, N_2 O_2 - 1$;
- if one or more of the associated bits is zero, then PMI reporting is not allowed to correspond to any precoder based on $\tilde{v}_{l,m}$.

3GPP TS 38.214 v16.5.0 at 68-69.

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– CodebookConfig

The IE *CodebookConfig* is used to configure codebooks of Type-I and Type-II (see TS 38.214 [19], clause 5.2.2.2)

CodebookConfig information element

```
-- ASN1START
-- TAG-CODEBOOKCONFIG-START

CodebookConfig ::=
    codebookType
        type1
            subType
                typeI-SinglePanel
                    nrOfAntennaPorts
                        two
                            twoTX-CodebookSubsetRestriction
                        },
                        moreThanTwo
                            n1-n2
                                two-one-TypeI-SinglePanel-Restriction
                                two-two-TypeI-SinglePanel-Restriction
                                four-one-TypeI-SinglePanel-Restriction
                                three-two-TypeI-SinglePanel-Restriction
                                six-one-TypeI-SinglePanel-Restriction
                                four-two-TypeI-SinglePanel-Restriction
                                eight-one-TypeI-SinglePanel-Restriction
                                four-three-TypeI-SinglePanel-Restriction
                                six-two-TypeI-SinglePanel-Restriction
                                twelve-one-TypeI-SinglePanel-Restriction
                                four-four-TypeI-SinglePanel-Restriction
                                eight-two-TypeI-SinglePanel-Restriction
                                sixteen-one-TypeI-SinglePanel-Restriction
                            },
                            typeI-SinglePanel-codebookSubsetRestriction-i2
                        },
                    },
                typeI-SinglePanel-ri-Restriction
            },
        typeI-MultiPanel
```

...

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	<table><tr><th>CodebookConfig field descriptions</th></tr><tr><td>codebookMode CodebookMode as specified in TS 38.214 [19], clause 5.2.2.2.2.</td></tr><tr><td>codebookType CodebookType including possibly sub-types and the corresponding parameters for each (see TS 38.214 [19], clause 5.2.2.2).</td></tr><tr><td>n1-n2-codebookSubsetRestriction Number of antenna ports in first (<i>n1</i>) and second (<i>n2</i>) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.3). Number of bits for codebook subset restriction is $\text{CEIL}(\log_2(\text{nchoosek}(O1*O2,4)))+8*n1*n2$ where $\text{nchoosek}(a,b) = a!/(b!(a-b)!)$.</td></tr><tr><td>n1-n2 Number of antenna ports in first (<i>n1</i>) and second (<i>n2</i>) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.2.1).</td></tr><tr><td>ng-n1-n2 Codebook subset restriction for Type I Multi-panel codebook (see TS 38.214 [19], clause 5.2.2.2.2).</td></tr><tr><td>numberOfBeams Number of beams, <i>L</i>, used for linear combination.</td></tr><tr><td>numberOfPMI-SubbandsPerCQI-Subband Field indicates how PMI subbands are defined per CQI subband according to TS 38.214 [19], clause 5.2.2.2.5.</td></tr><tr><td>paramCombination Field describes supported parameter combination (<i>L</i>, <i>p_v</i>, <i>β</i>) as specified in TS 38.214.</td></tr><tr><td>phaseAlphabetSize The size of the PSK alphabet, QPSK or 8-PSK.</td></tr><tr><td>portSelectionSamplingSize The size of the port selection codebook (parameter <i>d</i>), see TS 38.214 [19] clause 5.2.2.2.6.</td></tr><tr><td>ri-Restriction Restriction for RI for <i>TypeI-MultiPanel-RI-Restriction</i> (see TS 38.214 [19], clause 5.2.2.2.2).</td></tr><tr><td>subbandAmplitude If subband amplitude reporting is activated (<i>true</i>).</td></tr><tr><td>twoTX-CodebookSubsetRestriction Codebook subset restriction for 2TX codebook (see TS 38.214 [19] clause 5.2.2.2.1).</td></tr><tr><td>typeI-SinglePanel-codebookSubsetRestriction-i2 <i>i2</i> codebook subset restriction for Type I Single-panel codebook used when <i>reportQuantity</i> is CRI/RI/i1/CQI (see TS 38.214 [19] clause 5.2.2.2.1).</td></tr><tr><td>typeI-SinglePanel-ri-Restriction Restriction for RI for <i>TypeI-SinglePanel-RI-Restriction</i> (see TS 38.214 [19], clause 5.2.2.2.1).</td></tr><tr><td>typeII-PortSelectionRI-Restriction Restriction for RI for <i>TypeII-PortSelection-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.4 and 5.2.2.2.6).</td></tr><tr><td>typeII-RI-Restriction Restriction for RI for <i>TypeII-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.3 and 5.2.2.2.5).</td></tr></table> 3GPP TS 38.331 v16.5.0 at 383-386.	CodebookConfig field descriptions	codebookMode CodebookMode as specified in TS 38.214 [19], clause 5.2.2.2.2.	codebookType CodebookType including possibly sub-types and the corresponding parameters for each (see TS 38.214 [19], clause 5.2.2.2).	n1-n2-codebookSubsetRestriction Number of antenna ports in first (<i>n1</i>) and second (<i>n2</i>) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.3). Number of bits for codebook subset restriction is $\text{CEIL}(\log_2(\text{nchoosek}(O1*O2,4)))+8*n1*n2$ where $\text{nchoosek}(a,b) = a!/(b!(a-b)!)$.	n1-n2 Number of antenna ports in first (<i>n1</i>) and second (<i>n2</i>) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.2.1).	ng-n1-n2 Codebook subset restriction for Type I Multi-panel codebook (see TS 38.214 [19], clause 5.2.2.2.2).	numberOfBeams Number of beams, <i>L</i> , used for linear combination.	numberOfPMI-SubbandsPerCQI-Subband Field indicates how PMI subbands are defined per CQI subband according to TS 38.214 [19], clause 5.2.2.2.5.	paramCombination Field describes supported parameter combination (<i>L</i> , <i>p_v</i> , <i>β</i>) as specified in TS 38.214.	phaseAlphabetSize The size of the PSK alphabet, QPSK or 8-PSK.	portSelectionSamplingSize The size of the port selection codebook (parameter <i>d</i>), see TS 38.214 [19] clause 5.2.2.2.6.	ri-Restriction Restriction for RI for <i>TypeI-MultiPanel-RI-Restriction</i> (see TS 38.214 [19], clause 5.2.2.2.2).	subbandAmplitude If subband amplitude reporting is activated (<i>true</i>).	twoTX-CodebookSubsetRestriction Codebook subset restriction for 2TX codebook (see TS 38.214 [19] clause 5.2.2.2.1).	typeI-SinglePanel-codebookSubsetRestriction-i2 <i>i2</i> codebook subset restriction for Type I Single-panel codebook used when <i>reportQuantity</i> is CRI/RI/i1/CQI (see TS 38.214 [19] clause 5.2.2.2.1).	typeI-SinglePanel-ri-Restriction Restriction for RI for <i>TypeI-SinglePanel-RI-Restriction</i> (see TS 38.214 [19], clause 5.2.2.2.1).	typeII-PortSelectionRI-Restriction Restriction for RI for <i>TypeII-PortSelection-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.4 and 5.2.2.2.6).	typeII-RI-Restriction Restriction for RI for <i>TypeII-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.3 and 5.2.2.2.5).
CodebookConfig field descriptions																			
codebookMode CodebookMode as specified in TS 38.214 [19], clause 5.2.2.2.2.																			
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n1-n2-codebookSubsetRestriction Number of antenna ports in first (<i>n1</i>) and second (<i>n2</i>) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.3). Number of bits for codebook subset restriction is $\text{CEIL}(\log_2(\text{nchoosek}(O1*O2,4)))+8*n1*n2$ where $\text{nchoosek}(a,b) = a!/(b!(a-b)!)$.																			
n1-n2 Number of antenna ports in first (<i>n1</i>) and second (<i>n2</i>) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.2.1).																			
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numberOfBeams Number of beams, <i>L</i> , used for linear combination.																			
numberOfPMI-SubbandsPerCQI-Subband Field indicates how PMI subbands are defined per CQI subband according to TS 38.214 [19], clause 5.2.2.2.5.																			
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typeI-SinglePanel-codebookSubsetRestriction-i2 <i>i2</i> codebook subset restriction for Type I Single-panel codebook used when <i>reportQuantity</i> is CRI/RI/i1/CQI (see TS 38.214 [19] clause 5.2.2.2.1).																			
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typeII-PortSelectionRI-Restriction Restriction for RI for <i>TypeII-PortSelection-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.4 and 5.2.2.2.6).																			
typeII-RI-Restriction Restriction for RI for <i>TypeII-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.3 and 5.2.2.2.5).																			
[17.c] each bit of the second bit sequence corresponding to one precoding matrix of the second precoding matrix group,	Each of the Accused LGE '924 Products is a user equipment receiving device configured to communicate in a wireless communication system to receive codebook restricting information including each bit of the second bit sequence corresponding to one precoding matrix of the second precoding matrix group, respectively, and the at least one precoding matrix of the second precoding matrix group being restricted from being used as a precoding matrix of a second precoder.																		

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respectively, and the at least one precoding matrix of the second precoding matrix group being restricted from being used as a precoding matrix of a second precoder; and	As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and supports receiving the codebook restriction information described in these technical specifications. 5.2.2.2.1 Type I Single-Panel Codebook For 2 antenna ports {3000, 3001} and the UE configured with higher layer parameter <i>codebookType</i> set to 'typeI-SinglePanel' each PMI value corresponds to a codebook index given in Table 5.2.2.2.1-1. The UE is configured with the higher layer parameter <i>twoTX-CodebookSubsetRestriction</i>. The bitmap parameter <i>twoTX-CodebookSubsetRestriction</i> forms the bit sequence $a_5, \dots, a_1, a_0$ where a_0 is the LSB and a_5 is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to the precoder associated with the bit. Bits 0 to 3 are associated respectively with the codebook indices 0 to 3 for $U=1$ layer, and bits 4 and 5 are associated respectively with the codebook indices 0 and 1 for $U=2$ layers. ... The codebooks for 1-8 layers are given respectively in Tables 5.2.2.2.1-5, 5.2.2.2.1-6, 5.2.2.2.1-7, 5.2.2.2.1-8, 5.2.2.2.1-9, 5.2.2.2.1-10, 5.2.2.2.1-11, and 5.2.2.2.1-12. The mapping from $i_{1,3}$ to k_1 and k_2 for 2-layer reporting is given in Table 5.2.2.2.1-3. The mapping from $i_{1,3}$ to k_1 and k_2 for 3-layer and 4-layer reporting when $P_{CSI-RS} < 16$ is given in Table 5.2.2.2.1-4. The quantities φ_n, θ_p, u_m, $v_{l,m}$, and $\tilde{v}_{l,m}$ are given by ... For UE configured with higher layer parameter <i>codebookType</i> set to 'typeI-SinglePanel', the bitmap parameter <i>typeI-SinglePanel-ri-Restriction</i> forms the bit sequence $r_7, \dots, r_1, r_0$ where r_0 is the LSB and r_7 is the MSB. When r_i is zero, $i \in \{0, 1, \dots, 7\}$, PMI and RI reporting are not allowed to correspond to any precoder associated with $U=i+1$ layers. For UE configured with higher layer parameter <i>reportQuantity</i> set to 'cri-RI-i1-CQI', the bitmap parameter <i>typeI-SinglePanel-codebookSubsetRestriction-i2</i> forms the bit sequence $b_{15}, \dots, b_1, b_0$ where b_0 is the LSB and b_{15} is the MSB. The bit b_i is associated with precoders corresponding to codebook index $i_2 = i$. When b_i is zero, the randomly selected precoder for CQI calculation is not allowed to correspond to any precoder associated with the bit b_i. 3GPP TS 38.214 v16.5.0 at 68-69.
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- *CodebookConfig*

The IE *CodebookConfig* is used to configure codebooks of Type-I and Type-II (see TS 38.214 [19], clause 5.2.2.2)

CodebookConfig information element

```

-- ASN1START
-- TAG-CODEBOOKCONFIG-START

CodebookConfig ::=
    codebookType
        type1
            subType
                typeI-SinglePanel
                    nrOfAntennaPorts
                        two
                            twoTX-CodebookSubsetRestriction
                                },
                                moreThanTwo
                                    n1-n2
                                        two-one-TypeI-SinglePanel-Restriction
                                        two-two-TypeI-SinglePanel-Restriction
                                        four-one-TypeI-SinglePanel-Restriction
                                        three-two-TypeI-SinglePanel-Restriction
                                        six-one-TypeI-SinglePanel-Restriction
                                        four-two-TypeI-SinglePanel-Restriction
                                        eight-one-TypeI-SinglePanel-Restriction
                                        four-three-TypeI-SinglePanel-Restriction
                                        six-two-TypeI-SinglePanel-Restriction
                                        twelve-one-TypeI-SinglePanel-Restriction
                                        four-four-TypeI-SinglePanel-Restriction
                                        eight-two-TypeI-SinglePanel-Restriction
                                        sixteen-one-TypeI-SinglePanel-Restriction
                                    },
                                    typeI-SinglePanel-codebookSubsetRestriction-i2
                                },
                                typeI-SinglePanel-ri-Restriction
                            },
                            typeI-MultiPanel

```

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	CodebookConfig field descriptions codebookMode CodebookMode as specified in TS 38.214 [19], clause 5.2.2.2.2. codebookType CodebookType including possibly sub-types and the corresponding parameters for each (see TS 38.214 [19], clause 5.2.2.2). n1-n2-codebookSubsetRestriction Number of antenna ports in first ($n1$) and second ($n2$) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.2.3). Number of bits for codebook subset restriction is $\text{CEIL}(\log_2(\text{nchoosek}(O1 \times O2, 4))) + 8 \times n1 \times n2$ where $\text{nchoosek}(a, b) = a! / (b!(a-b)!)$. n1-n2 Number of antenna ports in first ($n1$) and second ($n2$) dimension and codebook subset restriction (see TS 38.214 [19] clause 5.2.2.2.1). ng-n1-n2 Codebook subset restriction for Type I Multi-panel codebook (see TS 38.214 [19], clause 5.2.2.2.2). numberOfBeams Number of beams, L, used for linear combination. numberOfPMI-SubbandsPerCQI-Subband Field indicates how PMI subbands are defined per CQI subband according to TS 38.214 [19], clause 5.2.2.2.5. paramCombination Field describes supported parameter combination (L, p_v, β) as specified in TS 38.214. phaseAlphabetSize The size of the PSK alphabet, QPSK or 8-PSK. portSelectionSamplingSize The size of the port selection codebook (parameter d), see TS 38.214 [19] clause 5.2.2.2.6. ri-Restriction Restriction for RI for <i>TypeI-MultiPanel-RI-Restriction</i> (see TS 38.214 [19], clause 5.2.2.2.2). subbandAmplitude If subband amplitude reporting is activated (<i>true</i>). twoTX-CodebookSubsetRestriction Codebook subset restriction for 2TX codebook (see TS 38.214 [19] clause 5.2.2.2.1). typeI-SinglePanel-codebookSubsetRestriction-i2 $i2$ codebook subset restriction for Type I Single-panel codebook used when <i>reportQuantity</i> is CRI/RI/i1/CQI (see TS 38.214 [19] clause 5.2.2.2.1). typeI-SinglePanel-ri-Restriction Restriction for RI for <i>TypeI-SinglePanel-RI-Restriction</i> (see TS 38.214 [19], clause 5.2.2.2.1). typeII-PortSelectionRI-Restriction Restriction for RI for <i>TypeII-PortSelection-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.4 and 5.2.2.2.6). typeII-RI-Restriction Restriction for RI for <i>TypeII-RI-Restriction</i> (see TS 38.214 [19], clauses 5.2.2.2.3 and 5.2.2.2.5). 3GPP TS 38.331 v16.5.0 at 383-386.
[17.d] transmitting, to a transmitting device, 1 st channel status information indicating the precoding matrix of	Each of the Accused LGE '924 Products is a user equipment transmitting device configured to communicate in a wireless communication system to transmit, to a transmitting device, 1st channel status information indicating the precoding matrix of the first precoder. As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR

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the first precoder and	cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, 3GPP TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and supports transmitting channel status information as described in these technical specifications. 5.2 UE procedure for reporting channel state information (CSI) 5.2.1 Channel state information framework The procedures on aperiodic CSI reporting described in this clause assume that the CSI reporting is triggered by DCI format 0_1, but they equally apply to CSI reporting triggered by DCI format 0_2, by applying the higher layer parameter <i>reportTriggerSizeDCI-0-2</i> instead of <i>reportTriggerSize</i>. The time and frequency resources that can be used by the UE to report CSI are controlled by the gNB. CSI may consist of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), CSI-RS resource indicator (CRI), SS/PBCH Block Resource indicator (SSBRI), layer indicator (LI), rank indicator (RI), L1-RSRP or L1-SINR. For CQI, PMI, CRI, SSBRI, LI, RI, L1-RSRP, L1-SINR a UE is configured by higher layers with $N \geq 1$ <i>CSI-ReportConfig</i> Reporting Settings, $M \geq 1$ <i>CSI-ResourceConfig</i> Resource Settings, and one or two list(s) of trigger states (given by the higher layer parameters <i>CSI-AperiodicTriggerStateList</i> and <i>CSI-SemiPersistentOnPUSCH-TriggerStateList</i>). Each trigger state in <i>CSI-AperiodicTriggerStateList</i> contains a list of associated <i>CSI-ReportConfigs</i> indicating the Resource Set IDs for channel and optionally for interference. Each trigger state in <i>CSI-SemiPersistentOnPUSCH-TriggerStateList</i> contains one associated <i>CSI-ReportConfig</i>. 3GPP TS 38.214 v16.5.0 at 50. 5.2.1.4.2 Report Quantity Configurations A UE may be configured with a <i>CSI-ReportConfig</i> with the higher layer parameter <i>reportQuantity</i> set to either 'none', 'cri-RI-PMI-CQI', 'cri-RI-i1', 'cri-RI-i1-CQI', 'cri-RI-CQI', 'cri-RSRP', 'cri-SINR', 'ssb-Index-RSRP', 'ssb-Index-SINR' or 'cri-RI-LI-PMI-CQI'. If the UE is configured with a <i>CSI-ReportConfig</i> with the higher layer parameter <i>reportQuantity</i> set to 'none', then the UE shall not report any quantity for the <i>CSI-ReportConfig</i>. If the UE is configured with a <i>CSI-ReportConfig</i> with the higher layer parameter <i>reportQuantity</i> set to 'cri-RI-PMI-CQI', or 'cri-RI-LI-PMI-CQI', the UE shall report a preferred precoder matrix for the entire reporting band, or a preferred precoder matrix per subband, according to Clause 5.2.2.2. 3GPP TS 38.214 v16.5.0 at 55.
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	If the UE is configured with a <i>CSI-ReportConfig</i> with the higher layer parameter <i>reportQuantity</i> set to 'cri-RI-i1', - the UE expects, for that <i>CSI-ReportConfig</i>, to be configured with higher layer parameter <i>codebookType</i> set to 'typeI-SinglePanel' and <i>pmi-FormatIndicator</i> set to 'widebandPMI' and, - the UE shall report a PMI consisting of a single wideband indication (i_1 in Clause 5.2.2.2.1) for the entire CSI reporting band. 3GPP TS 38.214 v16.5.0 at 55. If the UE is configured with a <i>CSI-ReportConfig</i> with the higher layer parameter <i>reportQuantity</i> set to 'cri-RI-i1-CQI', - the UE expects, for that <i>CSI-ReportConfig</i>, to be configured with higher layer parameter <i>codebookType</i> set to 'typeI-SinglePanel' and <i>pmi-FormatIndicator</i> set to 'widebandPMI' and, - the UE shall report a PMI consisting of a single wideband indication (i_1 in Clause 5.2.2.2.1) for the entire CSI reporting band. The CQI is calculated conditioned on the reported i_1 assuming PDSCH transmission with $N_p \geq 1$ precoders (corresponding to the same i_1 but different i_2 in Clause 5.2.2.2.1), where the UE assumes that one precoder is randomly selected from the set of N_p precoders for each PRG on PDSCH, where the PRG size for CQI calculation is configured by the higher layer parameter <i>pdsch-BundleSizeForCSI</i>. 3GPP TS 38.214 v16.5.0 at 55. 8.5.3 CSI reporting The UE can be configured with one CSI reporting latency bound as indicated by the higher layer parameter <i>sl-LatencyBound-CSI-Report</i>. CSI reporting is aperiodic and is described in [10, TS 38.321]. 3GPP TS 38.214 v16.5.0 at 165.
[17.e] 2 nd channel status information indicating the	Each of the Accused LGE '924 Products is a user equipment transmitting device configured to communicate in a wireless communication system to transmit, to a transmitting device, 2 nd channel status information indicating the precoding matrix of the second precoder.

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precoding matrix of the second precoder,	As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and supports transmitting channel status information as described in these technical specifications. 5.2 UE procedure for reporting channel state information (CSI) 5.2.1 Channel state information framework The procedures on aperiodic CSI reporting described in this clause assume that the CSI reporting is triggered by DCI format 0_1, but they equally apply to CSI reporting triggered by DCI format 0_2, by applying the higher layer parameter <i>reportTriggerSizeDCI-0-2</i> instead of <i>reportTriggerSize</i>. The time and frequency resources that can be used by the UE to report CSI are controlled by the gNB. CSI may consist of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), CSI-RS resource indicator (CRI), SS/PBCH Block Resource indicator (SSBRI), layer indicator (LI), rank indicator (RI), L1-RSRP or L1-SINR. For CQI, PMI, CRI, SSBRI, LI, RI, L1-RSRP, L1-SINR a UE is configured by higher layers with $N \geq 1$ <i>CSI-ReportConfig</i> Reporting Settings, $M \geq 1$ <i>CSI-ResourceConfig</i> Resource Settings, and one or two list(s) of trigger states (given by the higher layer parameters <i>CSI-AperiodicTriggerStateList</i> and <i>CSI-SemiPersistentOnPUSCH-TriggerStateList</i>). Each trigger state in <i>CSI-AperiodicTriggerStateList</i> contains a list of associated <i>CSI-ReportConfig</i>s indicating the Resource Set IDs for channel and optionally for interference. Each trigger state in <i>CSI-SemiPersistentOnPUSCH-TriggerStateList</i> contains one associated <i>CSI-ReportConfig</i>. 3GPP TS 38.214 v16.5.0 at 50. 8.5.3 CSI reporting The UE can be configured with one CSI reporting latency bound as indicated by the higher layer parameter <i>sl-LatencyBound-CSI-Report</i>. CSI reporting is aperiodic and is described in [10, TS 38.321]. 3GPP TS 38.214 v16.5.0 at 165.
[17.f] the precoding	Each of the Accused LGE '924 Products is a user equipment transmitting device configured to select the

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matrix of the first precoder and the precoding matrix of the second precoder being selected, based on the codebook restricting information, from among precoding matrices that are not restricted,	precoding matrix of the first precoder and the precoding matrix of the second precoder being selected, based on the codebook restricting information, from among precoding matrices that are not restricted. As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and selects the precoding matrix as described in these technical specifications. 5.2.2.2.1 Type I Single-Panel Codebook For 2 antenna ports {3000, 3001} and the UE configured with higher layer parameter <i>codebookType</i> set to 'typeI-SinglePanel' each PMI value corresponds to a codebook index given in Table 5.2.2.2.1-1. The UE is configured with the higher layer parameter <i>twoTX-CodebookSubsetRestriction</i>. The bitmap parameter <i>twoTX-CodebookSubsetRestriction</i> forms the bit sequence $a_5, \dots, a_1, a_0$ where a_0 is the LSB and a_5 is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to the precoder associated with the bit. Bits 0 to 3 are associated respectively with the codebook indices 0 to 3 for $U=1$ layer, and bits 4 and 5 are associated respectively with the codebook indices 0 and 1 for $U=2$ layers. 3GPP TS 38.214 v16.5.0 at 68. The bitmap parameter <i>nI-n2</i> forms the bit sequence $a_{A_c-1}, \dots, a_1, a_0$ where a_0 is the LSB and a_{A_c-1} is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to any precoder associated with the bit. The number of bits is given by $A_c = N_1 O_1 N_2 O_2$. Except when the number of layers $v \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32, bit $a_{N_1 O_1 l + m}$ is associated with all precoders based on the quantity $\hat{v}_{l,m}$, $l = 0, \dots, N_1 O_1 - 1$, $m = 0, \dots, N_2 O_2 - 1$. When the number of layers $v \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32, - bits $a_{(N_2 O_2 (2l-1) + m) \bmod N_1 O_1 N_2 O_2}$, $a_{N_2 O_2 (2l) + m}$, and $a_{N_2 O_2 (2l+1) + m}$ are each associated with all precoders based on the quantity $\hat{v}_{l,m}$, $l = 0, \dots, N_1 O_1 / 2 - 1$, $m = 0, \dots, N_2 O_2 - 1$; - if one or more of the associated bits is zero, then PMI reporting is not allowed to correspond to any precoder based on $\hat{v}_{l,m}$. 3GPP TS 38.214 v16.5.0 at 69.
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	For UE configured with higher layer parameter <i>codebookType</i> set to 'type1-SinglePanel', the bitmap parameter <i>type1-SinglePanel-ri-Restriction</i> forms the bit sequence $r_7, \dots, r_1, r_0$ where r_0 is the LSB and r_7 is the MSB. When r_i is zero, $i \in \{0, 1, \dots, 7\}$, PMI and RI reporting are not allowed to correspond to any precoder associated with $v=i+1$ layers. For UE configured with higher layer parameter <i>reportQuantity</i> set to 'cri-RI-i1-CQI', the bitmap parameter <i>type1-SinglePanel-codebookSubsetRestriction-i2</i> forms the bit sequence $b_{15}, \dots, b_1, b_0$ where b_0 is the LSB and b_{15} is the MSB. The bit b_i is associated with precoders corresponding to codebook index $i_2 = i$. When b_i is zero, the randomly selected precoder for CQI calculation is not allowed to correspond to any precoder associated with the bit b_i. 3GPP TS 38.214 v16.5.0 at 69.
[17.g] wherein a period of transmitting the information relating to the precoding matrix of the first precoder and a period of transmitting the information relating to the precoding matrix of the second precoder are different from each other.	Each of the Accused LGE '924 Products is a user equipment transmitting device configured such that a period of transmitting the information relating to the precoding matrix of the first precoder and a period of transmitting the information relating to the precoding matrix of the second precoder are different from each other. As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and supports the period of transmission described in these technical specifications. 8.5.3 CSI reporting The UE can be configured with one CSI reporting latency bound as indicated by the higher layer parameter <i>sl-LatencyBound-CSI-Report</i>. CSI reporting is aperiodic and is described in [10, TS 38.321]. 3GPP TS 38.214 v16.5.0 at 165.

5.18.3 Aperiodic CSI Trigger State Subselection

The network may select among the configured aperiodic CSI trigger states of a Serving Cell by sending the Aperiodic CSI Trigger State Subselection MAC CE described in clause 6.1.3.13.

The MAC entity shall:

- 1> if the MAC entity receives an Aperiodic CSI trigger State Subselection MAC CE on a Serving Cell;
- 2> indicate to lower layers the information regarding Aperiodic CSI trigger State Subselection MAC CE.

3GPP TS 38.321 v16.5.0 at 80.

5.2 UE procedure for reporting channel state information (CSI)

5.2.1 Channel state information framework

The procedures on aperiodic CSI reporting described in this clause assume that the CSI reporting is triggered by DCI format 0_1, but they equally apply to CSI reporting triggered by DCI format 0_2, by applying the higher layer parameter *reportTriggerSizeDCI-0-2* instead of *reportTriggerSize*.

The time and frequency resources that can be used by the UE to report CSI are controlled by the gNB. CSI may consist of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), CSI-RS resource indicator (CRI), SS/PBCH Block Resource indicator (SSBRI), layer indicator (LI), rank indicator (RI), L1-RSRP or L1-SINR.

For CQI, PMI, CRI, SSBRI, LI, RI, L1-RSRP, L1-SINR a UE is configured by higher layers with $N \geq 1$ *CSI-ReportConfig* Reporting Settings, $M \geq 1$ *CSI-ResourceConfig* Resource Settings, and one or two list(s) of trigger states (given by the higher layer parameters *CSI-AperiodicTriggerStateList* and *CSI-SemiPersistentOnPUSCH-TriggerStateList*). Each trigger state in *CSI-AperiodicTriggerStateList* contains a list of associated *CSI-ReportConfigs* indicating the Resource Set IDs for channel and optionally for interference. Each trigger state in *CSI-SemiPersistentOnPUSCH-TriggerStateList* contains one associated *CSI-ReportConfig*.

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5.2.1.1 Reporting settings

Each Reporting Setting *CSI-ReportConfig* is associated with a single downlink BWP (indicated by higher layer parameter *BWP-Id*) given in the associated *CSI-ResourceConfig* for channel measurement and contains the parameter(s) for one CSI reporting band: codebook configuration including codebook subset restriction, time-domain behavior, frequency granularity for CQI and PMI, measurement restriction configurations, and the CSI-related quantities to be reported by the UE such as the layer indicator (LI), L1-RSRP, L1-SINR, CRI, and SSBRI (SSB Resource Indicator).

The time domain behavior of the *CSI-ReportConfig* is indicated by the higher layer parameter *reportConfigType* and can be set to 'aperiodic', 'semiPersistentOnPUCCH', 'semiPersistentOnPUSCH', or 'periodic'. For 'periodic' and 'semiPersistentOnPUCCH'/'semiPersistentOnPUSCH' CSI reporting, the configured periodicity and slot offset applies in the numerology of the UL BWP in which the CSI report is configured to be transmitted on. The higher layer parameter *reportQuantity* indicates the CSI-related, L1-RSRP-related or L1-SINR-related quantities to report. The *reportFreqConfiguration* indicates the reporting granularity in the frequency domain, including the CSI reporting band and if PMI/CQI reporting is wideband or sub-band. The *timeRestrictionForChannelMeasurements* parameter in *CSI-ReportConfig* can be configured to enable time domain restriction for channel measurements and *timeRestrictionForInterferenceMeasurements* can be configured to enable time domain restriction for interference measurements. The *CSI-ReportConfig* can also contain *CodebookConfig*, which contains configuration parameters for Type-I, Type II or Enhanced Type II CSI including codebook subset restriction, and configurations of group-based reporting.

3GPP TS 38.214 v16.5.0 at 50.

– *CSI-AperiodicTriggerStateList*

The *CSI-AperiodicTriggerStateList* IE is used to configure the UE with a list of aperiodic trigger states. Each codepoint of the DCI field "CSI request" is associated with one trigger state (see TS 38.321 [3], clause 6.1.3.13). Upon reception of the value associated with a trigger state, the UE will perform measurement of CSI-RS, CSI-IM and/or SSB (reference signals) and aperiodic reporting on L1 according to all entries in the *associatedReportConfigInfoList* for that trigger state.

CSI-AperiodicTriggerStateList information element

```
-- ASN1START
-- TAG-CSI-APERIODICTRIGGERSTATELIST-START

CSI-AperiodicTriggerStateList ::= SEQUENCE (SIZE (1..maxNrOfCSI-AperiodicTriggers)) OF CSI-AperiodicTriggerState

CSI-AperiodicTriggerState ::= SEQUENCE {
    associatedReportConfigInfoList SEQUENCE (SIZE(1..maxNrofReportConfigPerAperiodicTrigger)) OF CSI-AssociatedReportConfigInfo,
    ...
}

CSI-AssociatedReportConfigInfo ::= SEQUENCE {
    reportConfigId CSI-ReportConfigId,
    resourcesForChannel CHOICE {
        nzp-CSI-RS SEQUENCE {
            resourceSet INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig),
            qcl-info SEQUENCE (SIZE(1..maxNrofAP-CSI-RS-ResourcesPerSet)) OF TCI-StateId
        },
        csi-SSB-ResourceSet INTEGER (1..maxNrofCSI-SSB-ResourceSetsPerConfig)
    },
    csi-IM-ResourcesForInterference INTEGER(1..maxNrofCSI-IM-ResourceSetsPerConfig) OPTIONAL, -- Cond CSI-IM-ForInterference
    nzp-CSI-RS-ResourcesForInterference INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig) OPTIONAL, -- Cond NZP-CSI-RS-ForInterference
    ...
}

-- TAG-CSI-APERIODICTRIGGERSTATELIST-STOP
-- ASN1STOP
```

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	TS 38.331 v16.5.0 at 401.
18. The method of claim 17, wherein the first matrix group includes N precoding matrices, and the first bit sequence is an N-bit sequence, where N is an integer.	Each of the Accused LGE '924 Products is a user equipment transmitting device configured wherein codebook restricting information includes the first matrix group includes N precoding matrices, and the first bit sequence is an N-bit sequence, where N is an integer. As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and supports receiving the codebook restriction information described in these technical specifications. 5.2.2.2.1 Type I Single-Panel Codebook For 2 antenna ports {3000, 3001} and the UE configured with higher layer parameter <i>codebookType</i> set to 'typeI-SinglePanel' each PMI value corresponds to a codebook index given in Table 5.2.2.2.1-1. The UE is configured with the higher layer parameter <i>twoTX-CodebookSubsetRestriction</i>. The bitmap parameter <i>twoTX-CodebookSubsetRestriction</i> forms the bit sequence $a_5, \dots, a_1, a_0$ where a_0 is the LSB and a_5 is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to the precoder associated with the bit. Bits 0 to 3 are associated respectively with the codebook indices 0 to 3 for $U=1$ layer, and bits 4 and 5 are associated respectively with the codebook indices 0 and 1 for $U=2$ layers. 3GPP TS 38.214 v16.5.0 at 68.

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Table 5.2.2.1-1: Codebooks for 1-layer and 2-layer CSI reporting using antenna ports 3000 to 3001

Codebook index	Number of layers v	
	1	2
0	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$	$\frac{1}{2} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$
1	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ j \end{bmatrix}$	$\frac{1}{2} \begin{bmatrix} 1 & 1 \\ j & -j \end{bmatrix}$
2	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -1 \end{bmatrix}$	-
3	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -j \end{bmatrix}$	-

3GPP TS 38.214 v16.5.0 at 68.

The bitmap parameter $nI-n2$ forms the bit sequence $a_{A_c-1}, \dots, a_1, a_0$ where a_0 is the LSB and a_{A_c-1} is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to any precoder associated with the bit. The number of bits is given by $A_c = N_1 O_1 N_2 O_2$. Except when the number of layers $v \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32, bit $a_{N_2 O_2 l + m}$ is associated with all precoders based on the quantity $v_{l,m}$, $l = 0, \dots, N_1 O_1 - 1$, $m = 0, \dots, N_2 O_2 - 1$. When the number of layers $v \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32,

- bits $a_{(N_2 O_2 (2l-1) + m) \bmod N_1 O_1 N_2 O_2}$, $a_{N_2 O_2 (2l) + m}$, and $a_{N_2 O_2 (2l+1) + m}$ are each associated with all precoders based on the quantity $\hat{v}_{l,m}$, $l = 0, \dots, N_1 O_1 / 2 - 1$, $m = 0, \dots, N_2 O_2 - 1$;
- if one or more of the associated bits is zero, then PMI reporting is not allowed to correspond to any precoder based on $\hat{v}_{l,m}$.

3GPP TS 38.214 v16.5.0 at 69.

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19. The method of claim 17, wherein the use of precoding matrices for the second precoder that make pairs with restricted precoding matrices of the first matrix group is restricted based on the first bit sequence, and the use of precoding matrices for the first precoder that make pairs with restricted precoding matrices of the second matrix group is restricted based on the second bit sequence.	Each of the Accused LGE '924 Products is a user equipment device configured to communicate in a wireless communication system to receive codebook restricting information wherein the use of precoding matrices for the second precoder that make pairs with restricted precoding matrices of the first matrix group is restricted based on the first bit sequence, and the use of precoding matrices for the first precoder that make pairs with restricted precoding matrices of the second matrix group is restricted based on the second bit sequence. As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and supports receiving the codebook restriction information described in these technical specifications. 5.2.2.2.1 Type I Single-Panel Codebook For 2 antenna ports {3000, 3001} and the UE configured with higher layer parameter <i>codebookType</i> set to 'typeI-SinglePanel' each PMI value corresponds to a codebook index given in Table 5.2.2.2.1-1. The UE is configured with the higher layer parameter <i>twoTX-CodebookSubsetRestriction</i>. The bitmap parameter <i>twoTX-CodebookSubsetRestriction</i> forms the bit sequence $a_5, \dots, a_1, a_0$ where a_0 is the LSB and a_5 is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to the precoder associated with the bit. Bits 0 to 3 are associated respectively with the codebook indices 0 to 3 for $U=1$ layer, and bits 4 and 5 are associated respectively with the codebook indices 0 and 1 for $U=2$ layers. 3GPP TS 38.214 v16.5.0 at 68.
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Table 5.2.2.1-1: Codebooks for 1-layer and 2-layer CSI reporting using antenna ports 3000 to 3001

Codebook index	Number of layers ν	
	1	2
0	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$	$\frac{1}{2} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$
1	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ j \end{bmatrix}$	$\frac{1}{2} \begin{bmatrix} 1 & 1 \\ j & -j \end{bmatrix}$
2	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -1 \end{bmatrix}$	-
3	$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -j \end{bmatrix}$	-

3GPP TS 38.214 v16.5.0 at 68.

The bitmap parameter $n1-n2$ forms the bit sequence $a_{A_c-1}, \dots, a_1, a_0$ where a_0 is the LSB and a_{A_c-1} is the MSB and where a bit value of zero indicates that PMI reporting is not allowed to correspond to any precoder associated with the bit. The number of bits is given by $A_c = N_1 O_1 N_2 O_2$. Except when the number of layers $\nu \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32, bit $a_{N_2 O_2 l + m}$ is associated with all precoders based on the quantity $v_{l,m}$, $l = 0, \dots, N_1 O_1 - 1$, $m = 0, \dots, N_2 O_2 - 1$. When the number of layers $\nu \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32,

- bits $a_{(N_2 O_2 (2l-1) + m) \bmod N_1 O_1 N_2 O_2}$, $a_{N_2 O_2 (2l) + m}$, and $a_{N_2 O_2 (2l+1) + m}$ are each associated with all precoders based on the quantity $\bar{v}_{l,m}$, $l = 0, \dots, N_1 O_1 / 2 - 1$, $m = 0, \dots, N_2 O_2 - 1$;
- if one or more of the associated bits is zero, then PMI reporting is not allowed to correspond to any precoder based on $\bar{v}_{l,m}$.

3GPP TS 38.214 v16.5.0 at 69.

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	For UE configured with higher layer parameter <i>codebookType</i> set to 'typeI-SinglePanel', the bitmap parameter <i>typeI-SinglePanel-ri-Restriction</i> forms the bit sequence $r_7, \dots, r_1, r_0$ where r_0 is the LSB and r_7 is the MSB. When r_i is zero, $i \in \{0, 1, \dots, 7\}$, PMI and RI reporting are not allowed to correspond to any precoder associated with $v=i+1$ layers. For UE configured with higher layer parameter <i>reportQuantity</i> set to 'cri-RI-i1-CQI', the bitmap parameter <i>typeI-SinglePanel-codebookSubsetRestriction-i2</i> forms the bit sequence $b_{15}, \dots, b_1, b_0$ where b_0 is the LSB and b_{15} is the MSB. The bit b_i is associated with precoders corresponding to codebook index $i_2 = i$. When b_i is zero, the randomly selected precoder for CQI calculation is not allowed to correspond to any precoder associated with the bit b_i. 3GPP TS 38.214 v16.5.0 at 69.
22. The method of claim 17, wherein the period of transmitting the information relating to the precoding matrix of the first precoder is longer than the period of transmitting the information relating to the precoding matrix of the second precoder.	Each of the Accused LGE '924 Products is a user equipment device configured to communicate in a wireless communication system to transmit the information relating to the precoding matrix wherein the period of transmitting the information relating to the precoding matrix of the first precoder is longer than the period of transmitting the information relating to the precoding matrix of the second precoder. As shown in Appendix 1, each of the Accused LGE '924 Products incorporates a chipset, antenna or antennas, memory, and transceiver or combination of transmitter and receiver that operate in accordance with 5G-NR cellular standard. Each of the Accused LGE '924 Products complies with the 5G-NR cellular communication protocols including at least 3GPP TS 38.214 V16.5.0, TS 38.321 V16.5.0, and TS 38.331 V16.5.0, and transmitting the information relating to the precoding matrix described in these technical specifications. 8.5.3 CSI reporting The UE can be configured with one CSI reporting latency bound as indicated by the higher layer parameter <i>sl-LatencyBound-CSI-Report</i>. CSI reporting is aperiodic and is described in [10, TS 38.321]. 3GPP TS 38.214 v16.5.0 at 165.

5.18.3 Aperiodic CSI Trigger State Subselection

The network may select among the configured aperiodic CSI trigger states of a Serving Cell by sending the Aperiodic CSI Trigger State Subselection MAC CE described in clause 6.1.3.13.

The MAC entity shall:

- 1> if the MAC entity receives an Aperiodic CSI trigger State Subselection MAC CE on a Serving Cell;
- 2> indicate to lower layers the information regarding Aperiodic CSI trigger State Subselection MAC CE.

3GPP TS 38.321 v16.5.0 at 80.

5.2 UE procedure for reporting channel state information (CSI)

5.2.1 Channel state information framework

The procedures on aperiodic CSI reporting described in this clause assume that the CSI reporting is triggered by DCI format 0_1, but they equally apply to CSI reporting triggered by DCI format 0_2, by applying the higher layer parameter *reportTriggerSizeDCI-0-2* instead of *reportTriggerSize*.

The time and frequency resources that can be used by the UE to report CSI are controlled by the gNB. CSI may consist of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), CSI-RS resource indicator (CRI), SS/PBCH Block Resource indicator (SSBRI), layer indicator (LI), rank indicator (RI), L1-RSRP or L1-SINR.

For CQI, PMI, CRI, SSBRI, LI, RI, L1-RSRP, L1-SINR a UE is configured by higher layers with $N \geq 1$ *CSI-ReportConfig* Reporting Settings, $M \geq 1$ *CSI-ResourceConfig* Resource Settings, and one or two list(s) of trigger states (given by the higher layer parameters *CSI-AperiodicTriggerStateList* and *CSI-SemiPersistentOnPUSCH-TriggerStateList*). Each trigger state in *CSI-AperiodicTriggerStateList* contains a list of associated *CSI-ReportConfigs* indicating the Resource Set IDs for channel and optionally for interference. Each trigger state in *CSI-SemiPersistentOnPUSCH-TriggerStateList* contains one associated *CSI-ReportConfig*.

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5.2.1.1 Reporting settings

Each Reporting Setting *CSI-ReportConfig* is associated with a single downlink BWP (indicated by higher layer parameter *BWP-Id*) given in the associated *CSI-ResourceConfig* for channel measurement and contains the parameter(s) for one CSI reporting band: codebook configuration including codebook subset restriction, time-domain behavior, frequency granularity for CQI and PMI, measurement restriction configurations, and the CSI-related quantities to be reported by the UE such as the layer indicator (LI), L1-RSRP, L1-SINR, CRI, and SSBRI (SSB Resource Indicator).

The time domain behavior of the *CSI-ReportConfig* is indicated by the higher layer parameter *reportConfigType* and can be set to 'aperiodic', 'semiPersistentOnPUCCH', 'semiPersistentOnPUSCH', or 'periodic'. For 'periodic' and 'semiPersistentOnPUCCH'/'semiPersistentOnPUSCH' CSI reporting, the configured periodicity and slot offset applies in the numerology of the UL BWP in which the CSI report is configured to be transmitted on. The higher layer parameter *reportQuantity* indicates the CSI-related, L1-RSRP-related or L1-SINR-related quantities to report. The *reportFreqConfiguration* indicates the reporting granularity in the frequency domain, including the CSI reporting band and if PMI/CQI reporting is wideband or sub-band. The *timeRestrictionForChannelMeasurements* parameter in *CSI-ReportConfig* can be configured to enable time domain restriction for channel measurements and *timeRestrictionForInterferenceMeasurements* can be configured to enable time domain restriction for interference measurements. The *CSI-ReportConfig* can also contain *CodebookConfig*, which contains configuration parameters for Type-I, Type II or Enhanced Type II CSI including codebook subset restriction, and configurations of group-based reporting.

3GPP TS 38.214 v16.5.0 at 50.

– CSI-AperiodicTriggerStateList

The *CSI-AperiodicTriggerStateList* IE is used to configure the UE with a list of aperiodic trigger states. Each codepoint of the DCI field "CSI request" is associated with one trigger state (see TS 38.321 [3], clause 6.1.3.13). Upon reception of the value associated with a trigger state, the UE will perform measurement of CSI-RS, CSI-IM and/or SSB (reference signals) and aperiodic reporting on L1 according to all entries in the *associatedReportConfigInfoList* for that trigger state.

CSI-AperiodicTriggerStateList information element

```
-- ASN1START
-- TAG-CSI-APERIODICTRIGGERSTATELIST-START

CSI-AperiodicTriggerStateList ::= SEQUENCE (SIZE (1..maxNrOfCSI-AperiodicTriggers)) OF CSI-AperiodicTriggerState

CSI-AperiodicTriggerState ::= SEQUENCE {
    associatedReportConfigInfoList SEQUENCE (SIZE (1..maxNrOfReportConfigPerAperiodicTrigger)) OF CSI-AssociatedReportConfigInfo,
    ...
}

CSI-AssociatedReportConfigInfo ::= SEQUENCE {
    reportConfigId CSI-ReportConfigId,
    resourcesForChannel CHOICE {
        nzp-CSI-RS SEQUENCE {
            resourceSet INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig),
            qcl-info SEQUENCE (SIZE (1..maxNrofAP-CSI-RS-ResourcesPerSet)) OF TCI-StateId
        },
        csi-SSB-ResourceSet INTEGER (1..maxNrofCSI-SSB-ResourceSetsPerConfig)
    },
    csi-IM-ResourcesForInterference INTEGER (1..maxNrofCSI-IM-ResourceSetsPerConfig) OPTIONAL, -- Cond CSI-IM-ForInterference
    nzp-CSI-RS-ResourcesForInterference INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig) OPTIONAL, -- Cond NZP-CSI-RS-ForInterference
    ...
}

-- TAG-CSI-APERIODICTRIGGERSTATELIST-STOP
-- ASN1STOP
```

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	TS 38.331 v16.5.0 at 401.
23. A receiving device in a wireless communication system, the receiving device comprising:	See [17.pre] incorporated here by reference.
[23.a] an antenna array to receive, as codebook restricting information, at least one of a first bit sequence to restrict at least one precoding matrix from a first precoding matrix group and a second bit sequence to restrict at least one precoding matrix from a second precoding matrix group,	See [17.a] incorporated here by reference.
[23.b] each bit of the first bit sequence corresponding to one precoding matrix of the first precoding matrix group,	See [17.b] incorporated here by reference.

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respectively, the at least one precoding matrix of the first precoding matrix group being restricted from being used as a precoding matrix of a first precoder,	
[23.c] each bit of the second bit sequence corresponding to one precoding matrix of the second precoding matrix group, respectively, and the at least one precoding matrix of the second precoding matrix group being restricted from being used as a precoding matrix of a second precoder; and	See [17.c] incorporated here by reference.
[23.d] a channel information feedback device to transmit, to a transmitting device, information relating to the precoding matrix of the first	See [17.d] incorporated here by reference.

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precoder and	
[23.e] information relating to the precoding matrix of the second precoder,	See [17.e] incorporated here by reference.
[23.f] the precoding matrix of the first precoder and the precoding matrix of the second precoder being selected, based on the codebook restricting information, from among precoding matrices that are not restricted,	See [17.f] incorporated here by reference.
[23.g] wherein a period of transmitting the information relating to the precoding matrix of the first precoder and a period of transmitting the information relating to the precoding matrix of the second precoder are different from each	See [17.g] incorporated here by reference.

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other.	
24. The device of claim 23, wherein the first matrix group includes N precoding matrices, and the first bit sequence is an N-bit sequence, where N is an integer.	See claim 18 incorporated here by reference.
25. The device of claim 23, wherein the use of precoding matrices for the second precoder that make pairs with restricted precoding matrices of the first matrix group is restricted based on the first bit sequence, and the use of precoding matrices for the second precoder that make pairs with restricted precoding matrices of the second matrix group is restricted based on the second bit	See claim 19 incorporated here by reference.

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sequence.	
28. The device of claim 23, wherein the period of transmitting the information relating to the precoding matrix of the first precoder is longer than the period of transmitting the information relating to the precoding matrix of the second precoder.	See claim 22 incorporated here by reference.