Table 5.2.2.2.3-6: Maximum allowed amplitude coefficients for restricted vectors

Bits $b_2^{(k,2(N_1x_2+x_1)+1)}b_2^{(k,2(N_1x_2+x_1))}$	Maximum Amplitude Coefficient $p_{l,i}^{(1)}$
00	0
01	$\sqrt{1/4}$
10	$\sqrt{1/2}$
11	1

5.2.2.2.4 Type II Port Selection Codebook

For 4 antenna ports {3000, 3001, …, 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 'typeII-PortSelection'

- The number of CSI-RS ports is given by $P_{\text{CSI-RS}} \in \{4,8,12,16,24,32\}$ as configured by higher layer parameter *nrofPorts*.
- The value of L is configured with the higher layer parameter *numberOfBeams* , where $L=2$ when $P_{\text{CSI-RS}} = 4$ and $L \in \{2,3,4\}$ when $P_{\text{CSI-RS}} > 4$.
- The value of d is configured with the higher layer parameter *portSelectionSamplingSize*, where $d \in \{1,2,3,4\}$ and $d \le \min\left(\frac{P_{\text{CSI-RS}}}{2}, L\right)$.
- The value of N_{PSK} is configured with the higher layer parameter *phaseAlphabetSize*, where $N_{\text{PSK}} \in \{4,8\}$.
- The UE is configured with the higher layer parameter *subbandAmplitude* set to 'true' or 'false'.
- The UE shall not report RI > 2.

The UE is also configured with the higher layer parameter *typeII-PortSelectionRI-Restriction*. The bitmap parameter *typeII-PortSelectionRI-Restriction* forms the bit sequence r_1, r_0 where r_0 is the LSB and r_1 is the MSB. When r_i is zero, $i \in \{0,1\}$, PMI and RI reporting are not allowed to correspond to any precoder associated with $\upsilon = i+1$ layers.

When $\upsilon \le 2$, where υ is the associated RI value, each PMI value corresponds to the codebook indices i_1 and i_2 where

$$i_1 = \begin{cases} \begin{bmatrix} i_{1,1} & i_{1,3,1} & i_{1,4,1} \end{bmatrix} & \upsilon = 1 \\ \begin{bmatrix} i_{1,1} & i_{1,3,1} & i_{1,4,1} & i_{1,3,2} & i_{1,4,2} \end{bmatrix} & \upsilon = 2 \end{cases}$$

$$i_2 = \begin{cases} \begin{bmatrix} i_{2,1,1} \end{bmatrix} & \textit{subbandAmplitude} = \text{'false'},\ \upsilon = 1 \\ \begin{bmatrix} i_{2,1,1} & i_{2,1,2} \end{bmatrix} & \textit{subbandAmplitude} = \text{'false'},\ \upsilon = 2 \\ \begin{bmatrix} i_{2,1,1} & i_{2,2,1} \end{bmatrix} & \textit{subbandAmplitude} = \text{'true'},\ \upsilon = 1 \\ \begin{bmatrix} i_{2,1,1} & i_{2,2,1} & i_{2,1,2} & i_{2,2,2} \end{bmatrix} & \textit{subbandAmplitude} = \text{'true'},\ \upsilon = 2 \end{cases}.$$

The L antenna ports per polarization are selected by the index $i_{1,1}$, where

$$i_{1,1} \in \left\{0,1,\ldots,\left\lceil \frac{P_{\text{CSI-RS}}}{2d} \right\rceil - 1\right\}.$$

The strongest coefficient on layer l, $l=1,\ldots,\upsilon$ is identified by $i_{1,3,l} \in \{0,1,\ldots,2L-1\}$.

The amplitude coefficient indicators $i_{1,4,l}$ and $i_{2,2,l}$ are

$$i_{1,4,l} = \left[k_{l,0}^{(1)}, k_{l,1}^{(1)}, \ldots, k_{l,2L-1}^{(1)} \right]$$
$$i_{2,2,l} = \left[k_{l,0}^{(2)}, k_{l,1}^{(2)}, \ldots, k_{l,2L-1}^{(2)} \right]$$
$$k_{l,i}^{(1)} \in \{0,1,\ldots,7\}$$
$$k_{l,i}^{(2)} \in \{0,1\}$$

for $l=1,\ldots,\upsilon$. The mapping from $k_{l,i}^{(1)}$ to the amplitude coefficient $p_{l,i}^{(1)}$ is given in Table 5.2.2.2.3-2 and the mapping from $k_{l,i}^{(2)}$ to the amplitude coefficient $p_{l,i}^{(2)}$ is given in Table 5.2.2.2.3-3. The amplitude coefficients are represented by

$$p_l^{(1)} = \left[p_{l,0}^{(1)}, p_{l,1}^{(1)}, \ldots, p_{l,2L-1}^{(1)} \right]$$
$$p_l^{(2)} = \left[p_{l,0}^{(2)}, p_{l,1}^{(2)}, \ldots, p_{l,2L-1}^{(2)} \right]$$

for $l=1,\ldots,\upsilon$.

The phase coefficient indicators are

$$i_{2,1,l} = \left[c_{l,0}, c_{l,1}, \ldots, c_{l,2L-1} \right]$$

for $l=1,\ldots,\upsilon$.

The amplitude and phase coefficient indicators are reported as follows:

- The indicators $k_{l,i_{1,3,l}}^{(1)} = 7$, $k_{l,i_{1,3,l}}^{(2)} = 1$, and $c_{l,i_{1,3,l}} = 0$ ($l=1,\ldots,\upsilon$). $k_{l,i_{1,3,l}}^{(1)}$, $k_{l,i_{1,3,l}}^{(2)}$, and $c_{l,i_{1,3,l}}$ are not reported for $l=1,\ldots,\upsilon$.

- The remaining $2L-1$ elements of $i_{1,4,l}$ ($l=1,\ldots,\upsilon$) are reported, where $k_{l,i}^{(1)} \in \{0,1,\ldots,7\}$. Let M_l ($l=1,\ldots,\upsilon$) be the number of elements of $i_{1,4,l}$ that satisfy $k_{l,i}^{(1)} > 0$.

- The remaining $2L-1$ elements of $i_{2,1,l}$ and $i_{2,2,l}$ ($l=1,\ldots,\upsilon$) are reported as follows:

  - When *subbandAmplitude* is set to 'false',

    - $k_{l,i}^{(2)} = 1$ for $l=1,\ldots,\upsilon$, and $i=0,1,\ldots,2L-1$. $i_{2,2,l}$ is not reported for $l=1,\ldots,\upsilon$.

    - For $l=1,\ldots,\upsilon$, the $M_l - 1$ elements of $i_{2,1,l}$ corresponding to the coefficients that satisfy $k_{l,i}^{(1)} > 0$, $i \neq i_{1,3,l}$, as determined by the reported elements of $i_{1,4,l}$, are reported, where $c_{l,i} \in \{0,1,\ldots,N_{\text{PSK}}-1\}$ and the remaining $2L - M_l$ elements of $i_{2,1,l}$ are not reported and are set to $c_{l,i} = 0$.

  - When *subbandAmplitude* is set to 'true',

    - For $l=1,\ldots,\upsilon$, the elements of $i_{2,2,l}$ and $i_{2,1,l}$ corresponding to the $\min\left(M_l, K^{(2)}\right)-1$ strongest coefficients (excluding the strongest coefficient indicated by $i_{1,3,l}$), as determined by the corresponding reported elements of $i_{1,4,l}$, are reported, where $k_{l,i}^{(2)} \in \{0,1\}$ and $c_{l,i} \in \{0,1,\ldots,N_{\text{PSK}}-1\}$. The values of $K^{(2)}$ are given in Table 5.2.2.2.3-4. The remaining $2L - \min\left(M_l, K^{(2)}\right)$ elements of $i_{2,2,l}$ are not

reported and are set to $k_{l,i}^{(2)}=1$. The elements of $i_{2,1,l}$ corresponding to the $M_l-\min\left(M_l,K^{(2)}\right)$ weakest non-zero coefficients are reported, where $c_{l,i}\in\{0,1,2,3\}$. The remaining $2L-M_l$ elements of $i_{2,1,l}$ are not reported and are set to $c_{l,i}=0$.

- When two elements, $k_{l,x}^{(1)}$ and $k_{l,y}^{(1)}$, of the reported elements of $i_{1,4,l}$ are identical ($k_{l,x}^{(1)}=k_{l,y}^{(1)}$), then element $\min(x,y)$ is prioritized to be included in the set of the $\min\left(M_l,K^{(2)}\right)-1$ strongest coefficients for $i_{2,1,l}$ and $i_{2,2,l}$ ($l=1,\ldots,\upsilon$) reporting.

The codebooks for 1-2 layers are given in Table 5.2.2.2.4-1, where the quantity $\varphi_{l,i}$ is given by

$$\varphi_{l,i}=\begin{cases} e^{j2\pi c_{l,i}/N_{\text{PSK}}} & \textit{subbandAmplitude} = \text{'false'} \\ e^{j2\pi c_{l,i}/N_{\text{PSK}}} & \textit{subbandAmplitude} = \text{'true'},\ \min\left(M_l,K^{(2)}\right) \text{ strongest coefficients (including } i_{1,3,l}) \text{ with } k_{l,i}^{(1)}>0 \\ e^{j2\pi c_{l,i}/4} & \textit{subbandAmplitude} = \text{'true'},\ M_l-\min\left(M_l,K^{(2)}\right) \text{ weakest coefficients with } k_{l,i}^{(1)}>0 \\ 1 & \textit{subbandAmplitude} = \text{'true'},\ 2L-M_l \text{ coefficients with } k_{l,i}^{(1)}=0 \end{cases}$$

and v_m is a $P_{\text{CSI-RS}}/2$ -element column vector containing a value of 1 in element $(m \bmod P_{\text{CSI-RS}}/2)$ and zeros elsewhere (where the first element is element 0).

Table 5.2.2.2.4-1: Codebook for 1-layer and 2-layer CSI reporting using antenna ports 3000 to 2999+$P_{\text{CSI-RS}}$

Layers	
υ=1	$W^{(1)}_{i_{1,1},p_1^{(1)},p_1^{(2)},i_{2,1,1}}=W^{1}_{i_{1,1},p_1^{(1)},p_1^{(2)},i_{2,1,1}}$
υ=2	$W^{(2)}_{i_{1,1},p_1^{(1)},p_1^{(2)},i_{2,1,1},p_2^{(1)},p_2^{(2)},i_{2,1,2}}=\frac{1}{\sqrt{2}}\left[W^{1}_{i_{1,1},p_1^{(1)},p_1^{(2)},i_{2,1,1}} \quad W^{2}_{i_{1,1},p_2^{(1)},p_2^{(2)},i_{2,1,2}}\right]$
where $W^{l}_{i_{1,1},p_l^{(1)},p_l^{(2)},i_{2,1,l}}=\frac{1}{\sqrt{\sum_{i=0}^{2L-1}\left(p_{l,i}^{(1)}p_{l,i}^{(2)}\right)^2}}\begin{bmatrix}\sum_{i=0}^{L-1}v_{i_{1,1}d+i}\,p_{l,i}^{(1)}p_{l,i}^{(2)}\varphi_{l,i}\\ \sum_{i=0}^{L-1}v_{i_{1,1}d+i}\,p_{l,i+L}^{(1)}p_{l,i+L}^{(2)}\varphi_{l,i+L}\end{bmatrix}$, $l=1,2$, and the mappings from i_1 to $i_{1,1}$, $p_1^{(1)}$, and $p_2^{(1)}$ and from i_2 to $i_{2,1,1}$, $i_{2,1,2}$, $p_1^{(2)}$, and $p_2^{(2)}$ are as described above, including the ranges of the constituent indices of i_1 and i_2.	

5.2.2.2.5 Enhanced Type II Codebook

For 4 antenna ports {3000, 3001, …, 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 UE configured with higher layer parameter *codebookType* set to ' typeII-r16'

- The values of N_1 and N_2 are configured with the higher layer parameter *n1-n2-codebookSubsetRestriction-r16*. The supported configurations of (N_1, N_2) for a given number of CSI-RS ports and the corresponding values of (O_1, O_2) are given in Table 5.2.2.2.1-2. The number of CSI-RS ports, $P_{\text{CSI-RS}}$, is $2N_1N_2$.
- The values of L, β and p_v are determined by the higher layer parameter *paramCombination-r16*, where the mapping is given in Table 5.2.2.2.5-1.
  - The UE is not expected to be configured with *paramCombination-r16* equal to
    - 3, 4, 5, 6, 7, or 8 when $P_{\text{CSI-RS}}=4$,
    - 7 or 8 when $P_{\text{CSI-RS}}<32$