5.2.2.1.1 (void)

5.2.2.2 Precoding matrix indicator (PMI)

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 $a_5,...,a_1,a_0$ 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 $\upsilon=1$ layer, and bits 4 and 5 are associated respectively with the codebook indices 0 and 1 for $\upsilon=2$ layers.

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 υ	
	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	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	-

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 'typeI-SinglePanel', except when the number of layers $\upsilon \in \{2,3,4\}$ (where υ is the associated RI value), each PMI value corresponds to three codebook indices $i_{1,1}, i_{1,2}, i_2$. When the number of layers $\upsilon \in \{2,3,4\}$, each PMI value corresponds to four codebook indices $i_{1,1}, i_{1,2}, i_{1,3}, i_2$. The composite codebook index i_1 is defined by

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

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

$$\varphi_n = e^{j\pi n/2}$$

$$\theta_p = e^{j\pi p/4}$$

$$u_m = \begin{cases} \begin{bmatrix} 1 & e^{j\frac{2\pi m}{O_2 N_2}} & \cdots & e^{j\frac{2\pi m(N_2-1)}{O_2 N_2}} \end{bmatrix} & N_2 > 1 \\ 1 & N_2 = 1 \end{cases}$$

$$v_{l,m} = \begin{bmatrix} u_m & e^{j\frac{2\pi l}{O_1 N_1}} u_m & \cdots & e^{j\frac{2\pi l(N_1-1)}{O_1 N_1}} u_m \end{bmatrix}^T$$

$$\tilde{v}_{l,m} = \begin{bmatrix} u_m & e^{j\frac{4\pi l}{O_1 N_1}} u_m & \cdots & e^{j\frac{4\pi l(N_1/2-1)}{O_1 N_1}} u_m \end{bmatrix}^T$$

- The values of N_1 and N_2 are configured with the higher layer parameter *n1-n2*, respectively. 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 $2N_1N_2$.

- UE shall only use $i_{1,2} = 0$ and shall not report $i_{1,2}$ if the value of N_2 is 1.

The bitmap parameter *n1-n2* forms the bit sequence $a_{A_c-1}, ..., a_1, a_0$ 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 $A_c = N_1O_1N_2O_2$. Except when the number of layers $\upsilon \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32, bit $a_{N_2O_2l+m}$ is associated with all precoders based on the quantity $v_{l,m}$, $l = 0, \ldots, N_1O_1 - 1$, $m = 0, \ldots, N_2O_2 - 1$. When the number of layers $\upsilon \in \{3, 4\}$ and the number of antenna ports is 16, 24, or 32,

- bits $a_{(N_2O_2(2l-1)+m) \bmod N_1O_1N_2O_2}$, $a_{N_2O_2(2l)+m}$, and $a_{N_2O_2(2l+1)+m}$ are each associated with all precoders based on the quantity $\tilde{v}_{l,m}$, $l = 0, \ldots, N_1O_1/2 - 1$, $m = 0, \ldots, N_2O_2 - 1$;

- if one or more of the associated bits is zero, then PMI reporting is not allowed to correspond to any precoder based on $\tilde{v}_{l,m}$.

For UE configured with higher layer parameter *codebookType* set to 'typeI-SinglePanel', the bitmap parameter *typeI-SinglePanel-ri-Restriction* forms the bit sequence $r_7, ..., r_1, r_0$ where r_0 is the LSB and r_7 is the MSB. When r_i is zero, $i \in \{0, 1, \ldots, 7\}$, PMI and RI reporting are not allowed to correspond to any precoder associated with $\upsilon = i + 1$ layers.

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 $b_{15}, ..., b_1, b_0$ 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.

Table 5.2.2.2.1-2: Supported configurations of (N_1, N_2) and (O_1, O_2)

Number of CSI-RS antenna ports, $P_{\text{CSI-RS}}$	(N_1, N_2)	(O_1, O_2)

4	(2,1)	(4,1)
8	(2,2)	(4,4)
	(4,1)	(4,1)
12	(3,2)	(4,4)
	(6,1)	(4,1)
16	(4,2)	(4,4)
	(8,1)	(4,1)
24	(4,3)	(4,4)
	(6,2)	(4,4)
	(12,1)	(4,1)
32	(4,4)	(4,4)
	(8,2)	(4,4)
	(16,1)	(4,1)

Table 5.2.2.2.1-3: Mapping of $i_{1,3}$ to k_1 and k_2 for 2-layer CSI reporting

$i_{1,3}$	$N_1 > N_2 > 1$		$N_1 = N_2$		$N_1 = 2, N_2 = 1$		$N_1 > 2, N_2 = 1$	
	k_1	k_2	k_1	k_2	k_1	k_2	k_1	k_2
0	0	0	0	0	0	0	0	0
1	O_1	0	O_1	0	O_1	0	O_1	0
2	0	O_2	0	O_2			$2O_1$	0
3	$2O_1$	0	O_1	O_2			$3O_1$	0

Table 5.2.2.2.1-4: Mapping of $i_{1,3}$ to k_1 and k_2 for 3-layer and 4-layer CSI reporting when $P_{\text{CSI-RS}} < 16$

$i_{1,3}$	$N_1 = 2, N_2 = 1$		$N_1 = 4, N_2 = 1$		$N_1 = 6, N_2 = 1$		$N_1 = 2, N_2 = 2$		$N_1 = 3, N_2 = 2$	
	k_1	k_2	k_1	k_2	k_1	k_2	k_1	k_2	k_1	k_2
0	O_1	0	O_1	0	O_1	0	O_1	0	O_1	0
1			$2O_1$	0	$2O_1$	0	0	O_2	0	O_2
2			$3O_1$	0	$3O_1$	0	O_1	O_2	O_1	O_2
3					$4O_1$	0			$2O_1$	0

Table 5.2.2.2.1-5: Codebook for 1-layer CSI reporting using antenna ports 3000 to 2999+$P_{\text{CSI-RS}}$

***codebookMode* = 1**			
$i_{1,1}$	$i_{1,2}$	i_2	
$0,1,\ldots,N_1O_1-1$	$0,\ldots,N_2O_2-1$	0,1,2,3	$W^{(1)}_{i_{1,1},i_{1,2},i_2}$
where $W^{(1)}_{l,m,n} = \frac{1}{\sqrt{P_{\text{CSI-RS}}}} \begin{bmatrix} v_{l,m} \\ \varphi_n v_{l,m} \end{bmatrix}$.			

***codebookMode* = 2,** $N_2 > 1$					
$i_{1,1}$	$i_{1,2}$	i_2			
		0	**1**	**2**	**3**
$0,1,\ldots,\frac{N_1O_1}{2}-1$	$0,1,\ldots,\frac{N_2O_2}{2}-1$	$W^{(1)}_{2i_{1,1},2i_{1,2},0}$	$W^{(1)}_{2i_{1,1},2i_{1,2},1}$	$W^{(1)}_{2i_{1,1},2i_{1,2},2}$	$W^{(1)}_{2i_{1,1},2i_{1,2},3}$
$i_{1,1}$	$i_{1,2}$	i_2			
		4	**5**	**6**	**7**
$0,1,\ldots,\frac{N_1O_1}{2}-1$	$0,1,\ldots,\frac{N_2O_2}{2}-1$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2},0}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2},1}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2},2}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2},3}$
$i_{1,1}$	$i_{1,2}$	i_2			
		8	**9**	**10**	**11**
$0,1,\ldots,\frac{N_1O_1}{2}-1$	$0,1,\ldots,\frac{N_2O_2}{2}-1$	$W^{(1)}_{2i_{1,1},2i_{1,2}+1,0}$	$W^{(1)}_{2i_{1,1},2i_{1,2}+1,1}$	$W^{(1)}_{2i_{1,1},2i_{1,2}+1,2}$	$W^{(1)}_{2i_{1,1},2i_{1,2}+1,3}$
$i_{1,1}$	$i_{1,2}$	i_2			
		12	**13**	**14**	**15**
$0,1,\ldots,\frac{N_1O_1}{2}-1$	$0,1,\ldots,\frac{N_2O_2}{2}-1$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2}+1,0}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2}+1,1}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2}+1,2}$	$W^{(1)}_{2i_{1,1}+1,2i_{1,2}+1,3}$
where $W^{(1)}_{l,m,n} = \frac{1}{\sqrt{P_{\text{CSI-RS}}}}\begin{bmatrix} v_{l,m} \\ \varphi_n v_{l,m} \end{bmatrix}$.					

***codebookMode* = 2,** $N_2 = 1$					
$i_{1,1}$	$i_{1,2}$	i_2			
		0	**1**	**2**	**3**
$0,1,\ldots,\frac{N_1O_1}{2}-1$	0	$W^{(1)}_{2i_{1,1},0,0}$	$W^{(1)}_{2i_{1,1},0,1}$	$W^{(1)}_{2i_{1,1},0,2}$	$W^{(1)}_{2i_{1,1},0,3}$
$i_{1,1}$	$i_{1,2}$	i_2			
		4	**5**	**6**	**7**
$0,1,\ldots,\frac{N_1O_1}{2}-1$	0	$W^{(1)}_{2i_{1,1}+1,0,0}$	$W^{(1)}_{2i_{1,1}+1,0,1}$	$W^{(1)}_{2i_{1,1}+1,0,2}$	$W^{(1)}_{2i_{1,1}+1,0,3}$
$i_{1,1}$	$i_{1,2}$	i_2			
		8	**9**	**10**	**11**
$0,1,\ldots,\frac{N_1O_1}{2}-1$	0	$W^{(1)}_{2i_{1,1}+2,0,0}$	$W^{(1)}_{2i_{1,1}+2,0,1}$	$W^{(1)}_{2i_{1,1}+2,0,2}$	$W^{(1)}_{2i_{1,1}+2,0,3}$
$i_{1,1}$	$i_{1,2}$	i_2			
		12	**13**	**14**	**15**
$0,1,\ldots,\frac{N_1O_1}{2}-1$	0	$W^{(1)}_{2i_{1,1}+3,0,0}$	$W^{(1)}_{2i_{1,1}+3,0,1}$	$W^{(1)}_{2i_{1,1}+3,0,2}$	$W^{(1)}_{2i_{1,1}+3,0,3}$
where $W^{(1)}_{l,m,n} = \frac{1}{\sqrt{P_{\text{CSI-RS}}}}\begin{bmatrix} v_{l,m} \\ \varphi_n v_{l,m} \end{bmatrix}$.					

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

***codebookMode* = 1**			
$i_{1,1}$	$i_{1,2}$	i_2	
$0,1,\ldots,N_1O_1-1$	$0,\ldots,N_2O_2-1$	0,1	$W^{(2)}_{i_{1,1},i_{1,1}+k_1,i_{1,2},i_{1,2}+k_2,i_2}$
where $W^{(2)}_{l,l',m,m',n} = \frac{1}{\sqrt{2P_{\text{CSI-RS}}}}\begin{bmatrix} v_{l,m} & v_{l',m'} \\ \varphi_n v_{l,m} & -\varphi_n v_{l',m'} \end{bmatrix}$. and the mapping from $i_{1,3}$ to k_1 and k_2 is given in Table 5.2.2.2.1-3.			

***codebookMode* = 2,** $N_2 > 1$			
$i_{1,1}$	$i_{1,2}$	i_2	
		0	**1**
$0,\ldots,\frac{N_1O_1}{2}-1$	$0,\ldots,\frac{N_2O_2}{2}-1$	$W^{(2)}_{2i_{1,1},2i_{1,1}+k_1,2i_{1,2},2i_{1,2}+k_2,0}$	$W^{(2)}_{2i_{1,1},2i_{1,1}+k_1,2i_{1,2},2i_{1,2}+k_2,1}$
$i_{1,1}$	$i_{1,2}$	i_2	
		2	**3**
$0,\ldots,\frac{N_1O_1}{2}-1$	$0,\ldots,\frac{N_2O_2}{2}-1$	$W^{(2)}_{2i_{1,1}+1,2i_{1,1}+1+k_1,2i_{1,2},2i_{1,2}+k_2,0}$	$W^{(2)}_{2i_{1,1}+1,2i_{1,1}+1+k_1,2i_{1,2},2i_{1,2}+k_2,1}$
$i_{1,1}$	$i_{1,2}$	i_2	
		4	**5**
$0,\ldots,\frac{N_1O_1}{2}-1$	$0,\ldots,\frac{N_2O_2}{2}-1$	$W^{(2)}_{2i_{1,1},2i_{1,1}+k_1,2i_{1,2}+1,2i_{1,2}+1+k_2,0}$	$W^{(2)}_{2i_{1,1},2i_{1,1}+k_1,2i_{1,2}+1,2i_{1,2}+1+k_2,1}$
$i_{1,1}$	$i_{1,2}$	i_2	
		6	**7**
$0,\ldots,\frac{N_1O_1}{2}-1$	$0,\ldots,\frac{N_2O_2}{2}-1$	$W^{(2)}_{2i_{1,1}+1,2i_{1,1}+1+k_1,2i_{1,2}+1,2i_{1,2}+1+k_2,0}$	$W^{(2)}_{2i_{1,1}+1,2i_{1,1}+1+k_1,2i_{1,2}+1,2i_{1,2}+1+k_2,1}$
where $W^{(2)}_{l,l',m,m',n}=\frac{1}{\sqrt{2P_{\text{CSI-RS}}}}\begin{bmatrix} v_{l,m} & v_{l',m'} \\ \varphi_n v_{l,m} & -\varphi_n v_{l',m'} \end{bmatrix}$. and the mapping from $i_{1,3}$ to k_1 and k_2 is given in Table 5.2.2.2.1-3.			

***codebookMode* = 2,** $N_2 = 1$					
$i_{1,1}$	$i_{1,2}$	i_2			
		0	**1**	**2**	**3**
$0,\ldots,\frac{N_1O_1}{2}-1$	0	$W^{(2)}_{2i_{1,1},2i_{1,1}+k_1,0,0,0}$	$W^{(2)}_{2i_{1,1},2i_{1,1}+k_1,0,0,1}$	$W^{(2)}_{2i_{1,1}+1,2i_{1,1}+1+k_1,0,0,0}$	$W^{(2)}_{2i_{1,1}+1,2i_{1,1}+1+k_1,0,0,1}$
$i_{1,1}$	$i_{1,2}$	i_2			
		4	**5**	**6**	**7**
$0,\ldots,\frac{N_1O_1}{2}-1$	0	$W^{(2)}_{2i_{1,1}+2,2i_{1,1}+2+k_1,0,0,0}$	$W^{(2)}_{2i_{1,1}+2,2i_{1,1}+2+k_1,0,0,1}$	$W^{(2)}_{2i_{1,1}+3,2i_{1,1}+3+k_1,0,0,0}$	$W^{(2)}_{2i_{1,1}+3,2i_{1,1}+3+k_1,0,0,1}$
where $W^{(2)}_{l,l',m,m',n}=\frac{1}{\sqrt{2P_{\text{CSI-RS}}}}\begin{bmatrix} v_{l,m} & v_{l',m'} \\ \varphi_n v_{l,m} & -\varphi_n v_{l',m'} \end{bmatrix}$. and the mapping from $i_{1,3}$ to k_1 is given in Table 5.2.2.2.1-3.					

Table 5.2.2.2.1-7: Codebook for 3-layer CSI reporting using antenna ports 3000 to 2999+$P_{\text{CSI-RS}}$

***codebookMode* = 1-2,** $P_{\text{CSI-RS}} < 16$			
$i_{1,1}$	$i_{1,2}$	i_2	
$0,\ldots,N_1O_1-1$	$0,1,\ldots,N_2O_2-1$	0,1	$W^{(3)}_{i_{1,1},i_{1,1}+k_1,i_{1,2},i_{1,2}+k_2,i_2}$
where $W^{(3)}_{l,l',m,m',n}=\frac{1}{\sqrt{3P_{\text{CSI-RS}}}}\begin{bmatrix} v_{l,m} & v_{l',m'} & v_{l,m} \\ \varphi_n v_{l,m} & \varphi_n v_{l',m'} & -\varphi_n v_{l,m} \end{bmatrix}$. and the mapping from $i_{1,3}$ to k_1 and k_2 is given in Table 5.2.2.2.1-4.			

***codebookMode* = 1-2,** $P_{\text{CSI-RS}} \geq 16$				
$i_{1,1}$	$i_{1,2}$	$i_{1,3}$	i_2	
$0,\ldots,\frac{N_1O_1}{2}-1$	$0,\ldots,N_2O_2-1$	$0,1,2,3$	$0,1$	$W^{(3)}_{i_{1,1},i_{1,2},i_{1,3},i_2}$
where $W^{(3)}_{l,m,p,n}=\frac{1}{\sqrt{3P_{\text{CSI-RS}}}}\begin{bmatrix}\tilde{v}_{l,m} & \tilde{v}_{l,m} & \tilde{v}_{l,m}\\ \theta_p\tilde{v}_{l,m} & -\theta_p\tilde{v}_{l,m} & \theta_p\tilde{v}_{l,m}\\ \varphi_n\tilde{v}_{l,m} & \varphi_n\tilde{v}_{l,m} & -\varphi_n\tilde{v}_{l,m}\\ \varphi_n\theta_p\tilde{v}_{l,m} & -\varphi_n\theta_p\tilde{v}_{l,m} & -\varphi_n\theta_p\tilde{v}_{l,m}\end{bmatrix}$.				

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

***codebookMode* = 1-2,** $P_{\text{CSI-RS}} < 16$			
$i_{1,1}$	$i_{1,2}$	i_2	
$0,\ldots,N_1O_1-1$	$0,1,\ldots,N_2O_2-1$	$0,1$	$W^{(4)}_{i_{1,1},i_{1,1}+k_1,i_{1,2},i_{1,2}+k_2,i_2}$
where $W^{(4)}_{l,l',m,m',n}=\frac{1}{\sqrt{4P_{\text{CSI-RS}}}}\begin{bmatrix}v_{l,m} & v_{l',m'} & v_{l,m} & v_{l',m'}\\ \varphi_n v_{l,m} & \varphi_n v_{l',m'} & -\varphi_n v_{l,m} & -\varphi_n v_{l',m'}\end{bmatrix}$. and the mapping from $i_{1,3}$ to k_1 and k_2 is given in Table 5.2.2.2.1-4.			

***codebookMode* = 1-2,** $P_{\text{CSI-RS}} \geq 16$				
$i_{1,1}$	$i_{1,2}$	$i_{1,3}$	i_2	
$0,\ldots,\frac{N_1O_1}{2}-1$	$0,\ldots,N_2O_2-1$	$0,1,2,3$	$0,1$	$W^{(4)}_{i_{1,1},i_{1,2},i_{1,3},i_2}$
where $W^{(4)}_{l,m,p,n}=\frac{1}{\sqrt{4P_{\text{CSI-RS}}}}\begin{bmatrix}\tilde{v}_{l,m} & \tilde{v}_{l,m} & \tilde{v}_{l,m} & \tilde{v}_{l,m}\\ \theta_p\tilde{v}_{l,m} & -\theta_p\tilde{v}_{l,m} & \theta_p\tilde{v}_{l,m} & -\theta_p\tilde{v}_{l,m}\\ \varphi_n\tilde{v}_{l,m} & \varphi_n\tilde{v}_{l,m} & -\varphi_n\tilde{v}_{l,m} & -\varphi_n\tilde{v}_{l,m}\\ \varphi_n\theta_p\tilde{v}_{l,m} & -\varphi_n\theta_p\tilde{v}_{l,m} & -\varphi_n\theta_p\tilde{v}_{l,m} & \varphi_n\theta_p\tilde{v}_{l,m}\end{bmatrix}$.				

Table 5.2.2.2.1-9: 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	
$N_2>1$	$0,\ldots,N_1O_1-1$	$0,\ldots,N_2O_2-1$	$0,1$	$W^{(5)}_{i_{1,1},i_{1,1}+O_1,i_{1,1}+O_1,i_{1,2},i_{1,2},i_{1,2}+O_2,i_2}$
$N_1>2, N_2=1$	$0,\ldots,N_1O_1-1$	0	$0,1$	$W^{(5)}_{i_{1,1},i_{1,1}+O_1,i_{1,1}+2O_1,0,0,0,i_2}$
where $W^{(5)}_{l,l',l'',m,m',m'',n}=\frac{1}{\sqrt{5P_{\text{CSI-RS}}}}\begin{bmatrix}v_{l,m} & v_{l,m} & v_{l',m'} & v_{l',m'} & v_{l'',m''}\\ \varphi_n v_{l,m} & -\varphi_n v_{l,m} & v_{l',m'} & -v_{l',m'} & v_{l'',m''}\end{bmatrix}$.				

Table 5.2.2.2.1-10: 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	
$N_2 > 1$	$0,\ldots,N_1O_1-1$	$0,\ldots,N_2O_2-1$	0,1	$W^{(6)}_{i_{1,1},i_{1,1}+O_1,i_{1,1}+O_1,i_{1,2},i_{1,2}+O_2,i_2}$
$N_1 > 2, N_2 = 1$	$0,\ldots,N_1O_1-1$	0	0,1	$W^{(6)}_{i_{1,1},i_{1,1}+O_1,i_{1,1}+2O_1,0,0,0,i_2}$
where $W^{(6)}_{l,l',l'',m,m'.m'',n} = \frac{1}{\sqrt{6P_{\text{CSI-RS}}}}\begin{bmatrix} v_{l,m} & v_{l,m} & v_{l',m'} & v_{l',m'} & v_{l'',m''} & v_{l'',m''} \\ \varphi_n v_{l,m} & -\varphi_n v_{l,m} & \varphi_n v_{l',m'} & -\varphi_n v_{l',m'} & v_{l'',m''} & -v_{l'',m''} \end{bmatrix}$.				

Table 5.2.2.2.1-11: 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	
$N_1 = 4, N_2 = 1$	$0,\ldots,\frac{N_1O_1}{2}-1$	0	0,1	$W^{(7)}_{i_{1,1},i_{1,1}+O_1,i_{1,1}+2O_1,i_{1,1}+3O_1,0,0,0,0,i_2}$
$N_1 > 4, N_2 = 1$	$0,\ldots,N_1O_1-1$	0	0,1	$W^{(7)}_{i_{1,1},i_{1,1}+O_1,i_{1,1}+2O_1,i_{1,1}+3O_1,0,0,0,0,i_2}$
$N_1 = 2, N_2 = 2$	$0,\ldots,N_1O_1-1$	$0,\ldots,N_2O_2-1$	0,1	$W^{(7)}_{i_{1,1},i_{1,1}+O_1,i_{1,1},i_{1,1}+O_1,i_{1,2},i_{1,2},i_{1,2}+O_2,i_{1,2}+O_2,i_2}$
$N_1 > 2, N_2 = 2$	$0,\ldots,N_1O_1-1$	$0,\ldots,\frac{N_2O_2}{2}-1$	0,1	$W^{(7)}_{i_{1,1},i_{1,1}+O_1,i_{1,1},i_{1,1}+O_1,i_{1,2},i_{1,2},i_{1,2}+O_2,i_{1,2}+O_2,i_2}$
$N_1 > 2, N_2 > 2$	$0,\ldots,N_1O_1-1$	$0,\ldots,N_2O_2-1$	0,1	$W^{(7)}_{i_{1,1},i_{1,1}+O_1,i_{1,1},i_{1,1}+O_1,i_{1,2},i_{1,2},i_{1,2}+O_2,i_{1,2}+O_2,i_2}$
where $W^{(7)}_{l,l',l'',l''',m,m'.m'',m''',n} = \frac{1}{\sqrt{7P_{\text{CSI-RS}}}}\begin{bmatrix} v_{l,m} & v_{l,m} & v_{l',m'} & v_{l'',m''} & v_{l'',m''} & v_{l''',m'''} & v_{l''',m'''} \\ \varphi_n v_{l,m} & -\varphi_n v_{l,m} & \varphi_n v_{l',m'} & v_{l'',m''} & -v_{l'',m''} & v_{l''',m'''} & -v_{l''',m'''} \end{bmatrix}$.				

Table 5.2.2.2.1-12: Codebook for 8-layer CSI reporting using antenna ports 3000 to 2999+$P_{\text{CSI-RS}}$

***codebookMode* = 1-2**				
	$i_{1,1}$	$i_{1,2}$	i_2	
$N_1 = 4, N_2 = 1$	$0,\ldots,\frac{N_1O_1}{2}-1$	0	0,1	$W^{(8)}_{i_{1,1},i_{1,1}+O_1,i_{1,1}+2O_1,i_{1,1}+3O_1,0,0,0,0,i_2}$
$N_1 > 4, N_2 = 1$	$0,\ldots,N_1O_1-1$	0	0,1	$W^{(8)}_{i_{1,1},i_{1,1}+O_1,i_{1,1}+2O_1,i_{1,1}+3O_1,0,0,0,0,i_2}$
$N_1 = 2, N_2 = 2$	$0,\ldots,N_1O_1-1$	$0,\ldots,N_2O_2-1$	0,1	$W^{(8)}_{i_{1,1},i_{1,1}+O_1,i_{1,1},i_{1,1}+O_1,i_{1,2},i_{1,2},i_{1,2}+O_2,i_{1,2}+O_2,i_2}$
$N_1 > 2, N_2 = 2$	$0,\ldots,N_1O_1-1$	$0,\ldots,\frac{N_2O_2}{2}-1$	0,1	$W^{(8)}_{i_{1,1},i_{1,1}+O_1,i_{1,1},i_{1,1}+O_1,i_{1,2},i_{1,2},i_{1,2}+O_2,i_{1,2}+O_2,i_2}$
$N_1 > 2, N_2 > 2$	$0,\ldots,N_1O_1-1$	$0,\ldots,N_2O_2-1$	0,1	$W^{(8)}_{i_{1,1},i_{1,1}+O_1,i_{1,1},i_{1,1}+O_1,i_{1,2},i_{1,2},i_{1,2}+O_2,i_{1,2}+O_2,i_2}$
where $W^{(8)}_{l,l',l'',l''',m,m'.m'',m''',n} = \frac{1}{\sqrt{8P_{\text{CSI-RS}}}}\begin{bmatrix} v_{l,m} & v_{l,m} & v_{l',m'} & v_{l',m'} & v_{l'',m''} & v_{l'',m''} & v_{l''',m'''} & v_{l''',m'''} \\ \varphi_n v_{l,m} & -\varphi_n v_{l,m} & \varphi_n v_{l',m'} & -\varphi_n v_{l',m'} & v_{l'',m''} & -v_{l'',m''} & v_{l''',m'''} & -v_{l''',m'''} \end{bmatrix}$.				

5.2.2.2.2 Type I Multi-Panel Codebook

For 8 antenna ports {3000, 3001, …, 3007}, 16 antenna ports {3000, 3001, …, 3015}, and 32 antenna ports {3000, 3001, …, 3031}, and the UE configured with higher layer parameter *codebookType* set to 'typeI-MultiPanel',