Annex A (normative): Measurement channels

A.1 General

A.1.1 Throughput definition

The throughput values defined in the measurement channels specified in Annex A, are calculated and are valid per codeword. For multi-codeword transmissions, the throughput referenced in the minimum requirements is the sum of throughputs of all codewords.

A.1.2 TDD UL-DL configurations for FR1

TDD UL-DL configurations for performance requirements are provided in Tables A.1.2-1, A.1.2-2, and A.1.2-3.

Table A.1.2-1: TDD UL-DL configuration for SCS 15 kHz

Parameter		Unit	UL-DL pattern
			FR1.15-1
TDD Slot Configuration pattern (Note 1)			DDDSU
Special Slot Configuration (Note 2)			10D+2G+2U
referenceSubcarrierSpacing		kHz	15
pattern1	*dl-UL-TransmissionPeriodicity*	ms	5
	nrofDownlinkSlots		3
	nrofDownlinkSymbols		10
	nrofUplinkSlot		1
	nrofUplinkSymbols		2
The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3)			4 if mod(i,5) = 0 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,9}.			

Table A.1.2-2: TDD UL-DL configuration for SCS 30 kHz

Parameter		Unit	UL-DL pattern					
			FR1.30-1	FR1.30-2	FR1.30-3	FR1.30-4	FR1.30-5	FR1.30-6
TDD Slot Configuration pattern (Note 1)			7DS2U	DDDSU	DDDSUDDSUU	DDDSUUDDDD	DSUU	DS_1S_2U
Special Slot Configuration (Note 2)			6D+4G+4U	10D+2G+2U	10D+2G+2U	6D+4G+4U	12D+2G	S1: 10D+2G+2U S2: 12D+2G+0U
referenceSubcarrierSpacing		kHz	30	30	30	30	30	30
pattern1								
	dl-UL-TransmissionPeriodicity	ms	5	2.5	2.5	3	2	1
	nrofDownlinkSlots		7	3	3	3	1	1
	nrofDownlinkSymbols		6	10	10	6	12	10
	nrofUplinkSlot		2	1	1	2	2	0
	nrofUplinkSymbols		4	2	2	4	0	2
pattern2								
	dl-UL-TransmissionPeriodicity	ms	N/A	N/A	2.5	2	N/A	1
	nrofDownlinkSlots		N/A	N/A	2	4	N/A	0
	nrofDownlinkSymbols		N/A	N/A	10	0	N/A	12
	nrofUplinkSlot		N/A	N/A	2	0	N/A	1
	nrofUplinkSymbols		N/A	N/A	2	0	N/A	0
The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3)			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if	4 if mod(i,5) = 0 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3	4 if mod(i,10) = 0 3 if mod(i,10) = 1 2 if mod(i,10) = 2 5 if mod(i,10) = 3 3 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7	5 if mod(i,10) = 0 4 if mod(i,10) = 1 3 if mod(i,10) = 2 2 if mod(i,10) = 3 8 if mod(i,10) = 6 7 if mod(i,10) = 7 6 if mod(i,10) = 8 5 if mod(i,10) = 9	3 if mod(i,4) = 0 2 if mod(i,4) = 1	3 if mod(i,4) = 0 2 if mod(i,4) = 1 3 if mod(i,4) = 2

		mod(i,10) = 7					
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,19}							

Table A.1.2-2a: TDD UL-DL configuration for SCS 30 kHz for DCI-based dynamic UL/DL detection

Parameter		Unit	UL-DL pattern
			FR1.30-1A
TDD Slot Configuration pattern (Note 1)			7DS2U
Special Slot Configuration (Note 2)			6D+4G+4U
referenceSubcarrierSpacing		kHz	N/A
pattern1 (Note 4)			
	dl-UL-TransmissionPeriodicity	ms	N/A
	nrofDownlinkSlots		N/A
	nrofDownlinkSymbols		N/A
	nrofUplinkSlot		N/A
	nrofUplinkSymbols		N/A
PDCCH DCI Configuration	DCI Format		1-1 for slot indices with mod(i,10) = 0,1,2,3,4,5,6,7
	Scheduled Grant		Symbol 2-13 for slot indices with mod(i,10) = 0,1,2,3,4,5,6 and Symbol 2-5 for slot indices with mod(i,10) = 7
The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3) (PDSCH-to-HARQ-timing-indicator)			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G and U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,19} Note 4: Do not configure *tdd-UL-DL-ConfigurationCommon* using RRC configuration.			

A.1.3 TDD UL-DL configurations for FR2

TDD UL-DL configurations for performance requirements are provided in Tables A.1.3-1, A.1.3-2.

Table A.1.3-1: TDD UL-DL configuration for SCS 60 kHz

Parameter		Unit	UL-DL pattern
			FR2.60-1
TDD Slot Configuration pattern (Note 1)			DDSU
Special Slot Configuration (Note 2)			11D+3G+0U
referenceSubcarrierSpacing		kHz	60
pattern1	*dl-UL-TransmissionPeriodicity*	ms	1
	nrofDownlinkSlots		2
	nrofDownlinkSymbols		11
	nrofUplinkSlot		1
	nrofUplinkSymbols		0

The number of slots between PDSCH and corresponding HARQ-ACK information (Note 3)		3 if mod(i,4) = 0 2 if mod(i,4) = 1 5 if mod(i,4) = 2
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,39}		

Table A.1.3-2: TDD UL-DL configuration for SCS 120 kHz

Parameter		Unit	UL-DL pattern	
			FR2.120-1	**FR2.120-2**
TDD Slot Configuration pattern (Note 1)			DDDSU	DDSU
Special Slot Configuration (Note 2)			10D+2G+2U	11D+3G+0U
referenceSubcarrierSpacing		kHz	120	120
pattern1	*dl-UL-TransmissionPeriodicity*	ms	0.625	0.5
	nrofDownlinkSlots		3	2
	nrofDownlinkSymbols		10	11
	nrofUplinkSlot		1	1
	nrofUplinkSymbols		2	0
The number of slots between PDSCH and corresponding HARQ-ACK information(Note 3)			4 if mod(i,5) = 0 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3	3 if mod(i,4) = 0 2 if mod(i,4) = 1 5 if mod(i,4) = 2
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,79}				

Table A.1.3-2a: TDD UL-DL configuration for SCS 120 kHz for DCI-based dynamic UL/DL detection

Parameter		Unit	UL-DL pattern
			FR2.120-1A
TDD Slot Configuration pattern (Note 1)			DDDSU
Special Slot Configuration (Note 2)			10D+2G+2U
referenceSubcarrierSpacing		kHz	N/A
pattern1 (Note 4)	*dl-UL-TransmissionPeriodicity*	ms	N/A
	nrofDownlinkSlots		N/A
	nrofDownlinkSymbols		N/A
	nrofUplinkSlot		N/A
	nrofUplinkSymbols		N/A
PDCCH DCI Configuration	DCI Format		1-1 for slot indices with mod(i,5) = 0,1,2,3
	Scheduled Grant		Symbol 1-13 for slot indices with mod(i,5) = 0,1,2 and Symbol 1-9 for slot indices with mod(i,5) = 3
The number of slots between PDSCH and corresponding HARQ-ACK information(Note 3)			4 if mod(i,5) = 0 3 if mod(i,5) = 1 2 if mod(i,5) = 2 6 if mod(i,5) = 3
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G and U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,79} Note 4: Do not configure *tdd-UL-DL-ConfigurationCommon* using RRC configuration.			

A.2 UL Reference measurement channels

A.2.1 General

The measurement channels in the following subclauses are defined to test the performance requirements where PUSCH is required. The measurement channels represent example configurations of physical channels for different data rates.

A.2.2 Reference measurement channels for FDD

A.2.2.1 RMC for Sustained downlink data rate

A.2.2.1.1 CP-OFDM 64QAM

Table A.2.2.1.1-1: Reference Channels for CP-OFDM 64QAM for 15kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size	Transport block CRC	LDPC Base Graph	Number of code blocks per slot (Note 3)	Total number of bits per slot	Total modulated symbols per slot
Unit	MHz	KHz						Bits	Bits			Bits	
	5	15	25	11	64QAM	19	1/2	9992	24	1	2	19800	3300
	10	15	52	11	64QAM	19	1/2	21000	24	1	3	41184	6864
	15	15	79	11	64QAM	19	1/2	31752	24	1	4	62568	10428
	20	15	106	11	64QAM	19	1/2	42016	24	1	5	83952	13992
	25	15	133	11	64QAM	19	1/2	53288	24	1	7	105336	17556
	30	15	160	11	64QAM	19	1/2	63528	24	1	8	126720	21120
	40	15	216	11	64QAM	19	1/2	86040	24	1	11	171072	28512
	50	15	270	11	64QAM	19	1/2	108552	24	1	13	213840	35640

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [12].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

Table A.2.2.1.1-2: Reference Channels for CP-OFDM 64QAM for 30kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size	Transport block CRC	LDPC Base Graph	Number of code blocks per slot (Note 3)	Total number of bits per slot	Total modulated symbols per slot
Unit	MHz	KHz						Bits	Bits			Bits	
	5	30	11	11	64QAM	19	1/2	4352	24	1	1	8712	1452
	10	30	24	11	64QAM	19	1/2	9480	24	1	2	19008	3168
	15	30	38	11	64QAM	19	1/2	15112	24	1	2	30096	5016
	20	30	51	11	64QAM	19	1/2	20496	24	1	3	40392	6732
	25	30	65	11	64QAM	19	1/2	26120	24	1	4	51480	8580
	30	30	78	11	64QAM	19	1/2	31240	24	1	4	61776	10296
	40	30	106	11	64QAM	19	1/2	42016	24	1	5	83952	13992
	50	30	133	11	64QAM	19	1/2	53288	24	1	7	105336	17556
	60	30	162	11	64QAM	19	1/2	64552	24	1	8	128304	21384
	80	30	217	11	64QAM	19	1/2	86040	24	1	11	171864	28644
	90	30	245	11	64QAM	19	1/2	98376	24	1	12	194040	32340
	100	30	273	11	64QAM	19	1/2	108552	24	1	13	216216	36036

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [12].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

A.2.3 Reference measurement channels for TDD

A.2.3.1 RMC for Sustained downlink data rate

A.2.3.1.1 CP-OFDM 16QAM

Table A.2.3.1.1-1: Reference Channels for CP-OFDM 16QAM for 15kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots 4 and 9	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for slots 4 and 9 (Note 3)	Total number of bits per slot for slots 4 and 9	Total modulated symbols per slot for slots 4 and 9
Unit	MHz	KHz						Bits	Bits			Bits	
	5-50	15	1	11	16QAM	10	1/3	176	16	2	1	528	132
	5	15	13	11	16QAM	10	1/3	2280	16	2	1	6864	1716
	5	15	25	11	16QAM	10	1/3	4352	24	1	1	13200	3300
	10	15	26	11	16QAM	10	1/3	4480	24	1	1	13728	3432
	10	15	52	11	16QAM	10	1/3	9224	24	1	2	27456	6864
	15	15	40	11	16QAM	10	1/3	7040	24	1	1	21120	5280
	15	15	79	11	16QAM	10	1/3	13832	24	1	2	41712	10428
	20	15	53	11	16QAM	10	1/3	9224	24	1	2	27984	6996
	20	15	106	11	16QAM	10	1/3	18432	24	1	3	55968	13992
	25	15	67	11	16QAM	10	1/3	11784	24	1	2	35376	8844
	25	15	133	11	16QAM	10	1/3	23040	24	1	3	70224	17556
	30	15	80	11	16QAM	10	1/3	14088	24	1	2	42240	10560
	30	15	160	11	16QAM	10	1/3	28168	24	1	4	84480	21120
	40	15	108	11	16QAM	10	1/3	18960	24	1	3	57024	14256
	40	15	216	11	16QAM	10	1/3	37896	24	1	5	114048	28512
	50	15	135	11	16QAM	10	1/3	23568	24	1	3	71280	17820
	50	15	270	11	16QAM	10	1/3	47112	24	1	6	142560	35640

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [12].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

Table A.2.3.1.1-2: Reference Channels for CP-OFDM 16QAM for 30kHz SCS

Parameter	Channel bandwidth	Subcarrier Spacing	Allocated resource blocks	CP-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	Target Coding Rate	Payload size for slots 8, 9, 18 and 19	Transport block CRC	LDPC Base Graph	Number of code blocks per slot for slots 8, 9, 18 and 19 (Note 3)	Total number of bits per slot for slots 8, 9, 18 and 19	Total modulated symbols per slot for slots 8, 9, 18 and 19
Unit	MHz	KHz						Bits	Bits			Bits	
	5-50	30	1	11	16QAM	10	1/3	176	16	2	1	528	132
	5	30	6	11	16QAM	10	1/3	1064	16	2	1	3168	792
	5	30	11	11	16QAM	10	1/3	1928	16	2	1	5808	1452
	10	30	12	11	16QAM	10	1/3	2088	16	2	1	6336	1584
	10	30	24	11	16QAM	10	1/3	4224	24	1	1	12672	3168
	15	30	19	11	16QAM	10	1/3	3368	16	2	1	10032	2508
	15	30	38	11	16QAM	10	1/3	6656	24	1	1	20064	5016
	20	30	26	11	16QAM	10	1/3	4480	24	1	1	13728	3432
	20	30	51	11	16QAM	10	1/3	8968	24	1	2	26928	6732
	25	30	33	11	16QAM	10	1/3	5760	24	1	1	17424	4356
	25	30	65	11	16QAM	10	1/3	11272	24	1	2	34320	8580
	30	30	39	11	16QAM	10	1/3	6784	24	1	1	20592	5148
	30	30	78	11	16QAM	10	1/3	13576	24	1	2	41184	10296
	40	30	53	11	16QAM	10	1/3	9224	24	1	2	27984	6996
	40	30	106	11	16QAM	10	1/3	18432	24	1	3	55968	13992
	50	30	67	11	16QAM	10	1/3	11784	24	1	2	35376	8844
	50	30	133	11	16QAM	10	1/3	23040	24	1	3	70224	17556
	60	30	81	11	16QAM	10	1/3	14088	24	1	2	42768	10692
	60	30	162	11	16QAM	10	1/3	28168	24	1	4	85536	21384
	80	30	109	11	16QAM	10	1/3	18960	24	1	3	57552	14388
	80	30	217	11	16QAM	10	1/3	37896	24	1	5	114576	28644
	90	30	123	11	16QAM	10	1/3	21504	24	1	3	64944	16236
	90	30	245	11	16QAM	10	1/3	43032	24	1	6	129360	32340
	100	30	137	11	16QAM	10	1/3	24072	24	1	3	72336	18084
	100	30	273	11	16QAM	10	1/3	48168	24	1	6	144144	36036

Note 1: PUSCH mapping Type-A and single-symbol DM-RS configuration Type-1 with 2 additional DM-RS symbols, such that the DM-RS positions are set to symbols 2, 7, 11. DMRS is [TDM'ed] with PUSCH data.
Note 2: MCS Index is based on MCS table 5.1.3.1-1 defined in TS 38.214 [12].
Note 3: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

A.3 DL reference measurement channels

A.3.1 General

The transport block size (TBS) determination procedure is described in clause 5.1.3.2 of TS 38.214 [12].

Unless otherwise stated, no user data is scheduled on slot #0 within 20 ms in order to avoid SSB and PDSCH transmissions in one slot and simplify test configuration.

A.3.2 Reference measurement channels for PDSCH performance requirements

For PDSCH reference channels if more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).

A.3.2.1 FDD

A.3.2.1.1 Reference measurement channels for SCS 15 kHz FR1

Table A.3.2.1.1-1: PDSCH Reference Channel for FDD (QPSK)

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-1.1 FDD	R.PDSCH.1-1.2 FDD	R.PDSCH.1-1.3 FDD	R.PDSCH.1-1.4 FDD	
Channel bandwidth	MHz	10	10	10	10	
Subcarrier spacing	kHz	15	15	15	15	
Number of allocated resource blocks	PRBs	52	6	52	52	
Number of consecutive PDSCH symbols		12	12	7	12	
Allocated slots per 2 frames	Slots	19	19	19	19	
MCS table		64QAM	64QAM	64QAM	64QAMLowSE	
MCS index		4	4	4	14	
Modulation		QPSK	QPSK	QPSK	QPSK	
Target Coding Rate		0.30	0.30	0.30	0.59	
Number of MIMO layers		1	1	1	1	
Number of DMRS REs		18	12	12	12	
Overhead for TBS determination		0	0	0	0	
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	Bits	3904	480	2280	8064	
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	Bits	24	16	16	24	
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	CBs	1	1	1	1	
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 10, 11	Bits	12480	1512	6864	13104	
For Slots i = 1,…, 9, 12, …, 19	Bits	13104	1584	7488	13728	
Max. Throughput averaged over 2 frames	Mbps	3.709	0.456	2.166	7.661	
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.1.1-2: PDSCH Reference Channel for FDD (16QAM)

Parameter	Unit	Value					
Reference channel		R.PDSCH.1-2.1 FDD	R.PDSCH.1-2.2 FDD	R.PDSCH.1-2.3 FDD	R.PDSCH.1-2.4 FDD	R.PDSCH.1-2.5 FDD	R.PDSCH.1-2.6 FDD
Channel bandwidth	MHz	10	10	10	10	10	10
Subcarrier spacing	kHz	15	15	15	15	15	15
Number of allocated resource blocks	PRBs	52	52	52	52	52	52
Number of consecutive PDSCH symbols		12	12	12	12	12	12
Allocated slots per 2 frames	Slots	19	19	19	19	19	19
MCS table		64QAM	64QAM	64QAM	64QAM	64QAMLowSE	64QAM
MCS index		13	13	13	13	19	16
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.54	0.64
Number of MIMO layers		1	2	3	4	2	1
Number of DMRS REs		12	12	24	24	12	12
Overhead for TBS determination		0	0	0	0	0	0
Information Bit Payload per Slot							
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	13064	26120	35856	48168	29704	17424
Transport block CRC per Slot							
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	Bits	24	24	24	24	24	24
Number of Code Blocks per Slot							
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,…, 19	CBs	2	4	5	6	4	3
Binary Channel Bits Per Slot							
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	N/A	N/A
For Slots i = 10, 11	Bits	26208	52416	71136	94848	49920	26208
For Slots i = 1,…, 9, 12, …, 19	Bits	27456	54912	74880	99840	54912	27456
Max. Throughput averaged over 2 frames	Mbps	12.411	24.814	34.063	45.760	28.219	16.553
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.							

Table A.3.2.1.1-3: PDSCH Reference Channel for FDD (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-3.1 FDD	R.PDSCH.1-3.2 FDD	R.PDSCH.1-3.3 FDD	R.PDSCH.1-3.4 FDD	
Channel bandwidth	MHz	10	10	10	10	
Subcarrier spacing	kHz	15	15	15	15	
Number of allocated resource blocks	PRBs	52	52	26 (Note 3)	26 (Note 4)	
Number of consecutive PDSCH symbols		12	12	12	12	
Allocated slots per 2 frames	Slots	19	19	19	19	
MCS table		64QAM	64QAM	64QAM	64QAM	
MCS index		19	19	19	19	
Modulation		64QAM	64QAM	64QAM	64QAM	
Target Coding Rate		0.51	0.51	0.51	0.51	
Number of MIMO layers		2	2	2	2	
Number of DMRS REs		12	24	24	24	
Overhead for TBS determination		0	0	0	0	
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	Bits	42016	37896	18960	18960	
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	Bits	24	24	24	24	
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	CBs	5	5	3	3	
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 10, 11	Bits	78624	67392	33696	33696	
For Slots i = 1,…, 9, 12, …, 19	Bits	82368	74880	37440	37440	
Max. Throughput averaged over 2 frames	Mbps	39.915	36.001	18.012	18.012	
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames. Note 3: PDSCH is scheduled in PRB numbers from 0 to 25. Note 4: PDSCH is scheduled in PRB numbers from 26 to 51.						

Table A.3.2.1.1-4: PDSCH Reference Channel for FDD (256QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-4.1 FDD				
Channel bandwidth	MHz	10				
Subcarrier spacing	kHz	15				
Number of allocated resource blocks	PRBs	52				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames	Slots	19				
MCS table		256QAM				
MCS index		24				
Modulation		256QAM				
Target Coding Rate		0.82				
Number of MIMO layers		1				
Number of DMRS REs		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	45096				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	24				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slots i = 1,…, 19	CBs	6				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 10, 11	Bits	52416				
For Slots i = 1,…, 9, 12, …, 19	Bits	54912				
Max. Throughput averaged over 2 frames	Mbps	42.841				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.1.1-5: PDSCH Reference Channel for FDD and CSI-RS overlapped with PDSCH

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-5.1 FDD				
Channel bandwidth	MHz	10				
Subcarrier spacing	kHz	15				
Number of allocated resource blocks	PRBs	52				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames	Slots	19				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		2				
Number of DMRS REs		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	26120				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	24				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slots i = 1,…, 19	CBs	4				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 5, 15	Bits	50752				
For Slots i = 10	Bits	48256				
For Slots i = 11	Bits	52416				
For Slots i = 1,…,4,6,…, 9,12,…14,16,…,19	Bits	54912				
Max. Throughput averaged over 2 frames	Mbps	24.814				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.1.1-6: PDSCH Reference Channel for FDD PMI reporting requirements

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-6.1 FDD	R.PDSCH.1-6.2 FDD	R.PDSCH.1-6.3 FDD		
Channel bandwidth	MHz	10	10	10		
Subcarrier spacing	kHz	15	15	15		
Number of allocated resource blocks	PRBs	52	52	52		
Number of consecutive PDSCH symbols		12	12	12		
Allocated slots per 2 frames	Slots	15	15	15		
MCS table		64QAM	64QAM	64QAM		
MCS index		13	13	20		
Modulation		16QAM	16QAM	64QAM		
Target Coding Rate		0.48	0.48	0.55		
Number of MIMO layer		1	2	2		
Number of DMRS REs (Note 3)		24	24	24		
Overhead for TBS determination		0	0	0		
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A		
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A	N/A	N/A		
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..19}	Bits	12040	24072	40976		
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A		
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A	N/A	N/A		
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..19}	Bits	24	24	24		
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A		
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A	N/A	N/A		
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..,19}	CBs	2	3	5		
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A		
For CSI Slots i, if mod (i,5) =1, i={0,…,19}		N/A	N/A	N/A		
For Slots i = 10	Bits	23712	47424	71136		
For Non CSI-RS Slot i, if mod (i,5) ={0,2,3,4}, i={1,..9,11,…,19}	Bits	24960	49920	74880		
Max. Throughput averaged over 2 frames	Mbps	9.030	18.054	30.732		

Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms.
Note 2: Slot i is slot index per 2 frames.
Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data.

Table A.3.2.1.1-7: PDSCH Reference Channel for FDD LTE-NR coexistence scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-7.1 FDD	R.PDSCH.1-7.2 FDD			
Channel bandwidth	MHz	10	10			
Subcarrier spacing	kHz	15	15			
Number of allocated resource blocks	PRBs	52	52			
Number of consecutive PDSCH symbols		9	11			
Allocated slots per 2 frames	Slots	16	16			
MCS table		64QAM	64QAM			
MCS index		4	4			
Modulation		QPSK	QPSK			
Target Coding Rate		0.30	0.30			
Number of MIMO layers		1	1			
Number of DMRS REs		12	12			
Overhead for TBS determination		18	18			
Information Bit Payload per Slot						
For Slots i = 0,5,10,15	Bits	N/A	N/A			
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19}	Bits	2472	3240			
Transport block CRC per Slot						
For Slots i = 0,5,10,15	Bits	N/A	N/A			
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19}	Bits	16	16			
Number of Code Blocks per Slot						
For Slots i = 0,5,10,15	CBs	N/A	N/A			
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {0,…,19}	CBs	1	1			
Binary Channel Bits Per Slot						
For Slots i = 0,5,10,15	Bits	N/A	N/A			
For Slots i = 11	Bits	7760	10256			
For Slots i, if mod(i, 5) = {1,2,3,4} for i from {1,…, 9, 12, …, 19}	Bits	8384	10880			
Max. Throughput averaged over 2 frames	Mbps	1.978	2.592			
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: No user data is scheduled on slots with LTE PBCH/PSS/SSS						

Table A.3.2.1.1-8: PDSCH Reference Channel for FDD HST scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-8.1 FDD	R.PDSCH.1-8.2 FDD	R.PDSCH.1-8.3 FDD	R.PDSCH.1-8.4 FDD	
Channel bandwidth	MHz	10	10	10	10	
Subcarrier spacing	kHz	15	15	15	15	
Number of allocated resource blocks	PRBs	52	52	52	52	
Number of consecutive PDSCH symbols		12	12	12	12	
Allocated slots per 2 frames	Slots	19	19	19	19	
MCS table		64QAM	64QAM	64QAM	64QAM	
MCS index		13	17	13	17	
Modulation		16QAM	64QAM	16QAM	64QAM	
Target Coding Rate		0.48	0.43	0.48	0.43	
Number of MIMO layers		1	1	2	2	
Number of DMRS REs		18	18	18	18	
Overhead for TBS determination		0	0	0	0	
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	Bits	12552	16896	25104	28680	
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	Bits	24	24	24	24	
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A	N/A	N/A	N/A	
For Slots i = 1,…, 19	CBs	2	3	3	4	
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A	N/A	N/A	N/A	
For Slots i = 1,2,11,12	Bits	24960	37440	51168	76752	
For Slots i = 3,…, 10, 13, …, 19	Bits	26208	39312	52416	78624	
Max. Throughput averaged over 2 frames	Mbps	11.924	16.0512	23.8488	27.246	
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

Table A.3.2.1.1-9: PDSCH Reference Channel for FDD CC and CA scenario

FFS

Table A.3.2.1.1-10: PDSCH Reference Channel for FDD CC and CA scenario

FFS

Table A.3.2.1.1-11: PDSCH Reference Channel for FDD

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-11.1 FDD	R.PDSCH.1-11.2 FDD			
Channel bandwidth	MHz	10	10			
Subcarrier spacing	kHz	15	15			
Number of allocated resource blocks	PRBs	52	52			
Number of consecutive PDSCH symbols		12	12			
Allocated slots per 2 frames	Slots	18	18			
MCS table		64QAMLowSE	64QAMLowSE			
MCS index		19	19			
Modulation		16QAM	16QAM			
Target Coding Rate		0.54	0.54			
Number of MIMO layers		1	1			
Number of DMRS REs		12	12			
Overhead for TBS determination		0	0			
Information Bit Payload per Slot						
For Slot i = 0,1	Bits	N/A	N/A			
For Slots i = 2,…, 19	Bits	14856	14856			
Transport block CRC per Slot						
For Slot i = 0,1	Bits	N/A	N/A			
For Slots i = 2,…, 19	Bits	24	24			
Number of Code Blocks per Slot						
For Slot i = 0,1	CBs	N/A	N/A			
For Slots i = 2,…, 19	CBs	2	2			
Binary Channel Bits Per Slot						
For Slot i = 0,1	Bits	N/A	N/A			
For Slots i = 10, 11	Bits	26208	24960			
For Slots i =2,…, 9, 12, …, 19	Bits	27456	27456			
Max. Throughput averaged over 2 frames	Mbps	6.685 (NOTE 3)	6.685 (NOTE 4)			
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: Throughput is calculated under assumption of aggregation factor 2. Note 4: Throughput is calculated under assumption of repetition number 2.						

Table A.3.2.1.1-12: PDSCH Reference Channel for FDD

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-12.1 FDD				
Channel bandwidth	MHz	10				
Subcarrier spacing	kHz	15				
Number of allocated resource blocks	PRBs	52				
Number of consecutive PDSCH symbols		2				
Allocated slots per 2 frames	Slots	19				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.3				
Number of MIMO layers		1				
Number of DMRS REs		6				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	576				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 19	Bits	16				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slots i = 1,…, 19	CBs	1				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 10, 11	Bits	1872				
For Slots i =1,…, 9, 12, …, 19	Bits	1872				
Max. Throughput averaged over 2 frames	Mbps	0.547				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

A.3.2.1.2 Reference measurement channels for SCS 30 kHz FR1

Table A.3.2.1.2-1: PDSCH Reference Channel for FDD (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-1.1 FDD				
Channel bandwidth	MHz	20				
Subcarrier spacing	kHz	30				
Number of allocated resource blocks	PRBs	51				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames	Slots	39				
MCS table		64QAM				
MCS index		19				
Modulation		64QAM				
Target Coding Rate		0.51				
Number of MIMO layers		2				
Number of DMRS REs		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 39	Bits	40976				
Transport block CRC per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 1,…, 39	Bits	24				
Number of Code Blocks per Slot						
For Slot i = 0	CBs	N/A				
For Slots i = 1,…, 39	CBs	5				
Binary Channel Bits Per Slot						
For Slot i = 0	Bits	N/A				
For Slots i = 20, 21	Bits	77112				
For Slots i = 1,…, 19, 22, …, 39	Bits	80784				
Max. Throughput averaged over 2 frames	Mbps	79.903				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

A.3.2.1.3 Reference measurement channels for SCS 60 kHz FR1

A.3.2.1.4 Reference measurement channels for E-UTRA

Table A.3.2.1.4-1: PDSCH Reference Channel for sustained data-rate test (64QAM, 2 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-1.1 FDD	R.PDSCH.4-1.2 FDD	R.PDSCH.4-1.3 FDD	R.PDSCH.4-1.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		9	10	10	10
Modulation		64QAM	64QAM	64QAM	64QAM
Coding Rate					
For Sub-Frames 1,2,3,4,6,7,8,9,		0.85	0.85	0.85	0.88
For Sub-Frame 5		N/A	0.89	0.91	0.87
For Sub-Frame 0		0.83	0.90	0.88	0.90
Information Bit Payload (Note 3)					
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	18336	36696	55056	75376
For Sub-Frame 5	Bits	N/A	35160	52752	71112
For Sub-Frame 0	Bits	15840	36696	55056	75376
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 1,2,3,4,6,7,8,9	CBs	3	6	9	13
For Sub-Frame 5	CBs	N/A	6	9	12
For Sub-Frame 0	CBs	3	6	9	13
Binary Channel Bits (Note 3)					
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	21600	43200	64800	86400
For Sub-Frame 5	Bits	N/A	39744	60480	82080
For Sub-Frame 0	Bits	19152	40752	62352	83952
Number of layers		2	2	2	2
Max. Throughput averaged over 1 frame (Note 3)	Mbps	16.253	36.542	54.826	74.950

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: Given per component carrier per codeword.
Note 4: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 5: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks n_{PRB} = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-2: PDSCH Reference Channel for sustained data-rate test (64QAM, 4 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-2.1 FDD	R.PDSCH.4-2.2 FDD	R.PDSCH.4-2.3 FDD	R.PDSCH.4-2.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		9	10	10	10
Modulation		64QAM	64QAM	64QAM	64QAM
Coding Rate					
For Sub-Frames 1,2,3,4,6,7,8,9,		0.78	0.78	0.77	0.79
For Sub-Frame 5		N/A	0.80	0.79	0.81
For Sub-Frame 0		0.85	0.83	0.8	0.81
Information Bit Payload (Note 3)					
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	31704	63776	93800	128496
For Sub-Frame 5	Bits	N/A	59256	90816	124464
For Sub-Frame 0	Bits	30576	63776	93800	128496
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 1,2,3,4,6,7,8,9	CBs	6	11	16	21
For Sub-Frame 5	CBs	N/A	10	15	21
For Sub-Frame 0	CBs	5	11	16	21
Binary Channel Bits (Note 3)					
For Sub-Frames 1,2,3,4,6,7,8,9	Bits	40800	81600	122400	163200
For Sub-Frame 5	Bits	N/A	74976	114144	154944
For Sub-Frame 0	Bits	36192	76992	117792	158592
Number of layers		4	4	4	4
Max. Throughput averaged over 1 frame (Note 3)	Mbps	28.421	63.324	93.502	128.093

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: Given per component carrier per codeword.
Note 4: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 5: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks n_{PRB} = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-3: PDSCH Reference Channel for sustained data-rate test (256QAM, 2 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-3.1 FDD	R.PDSCH.4-3.2 FDD	R.PDSCH.4-3.3 FDD	R.PDSCH.4-3.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		10	10	10	10
Modulation		256QAM	256QAM	256QAM	256QAM
Coding Rate					
For Sub-Frames 3,4,8,9		0.85	0.85	0.88	0.85
For Sub-Frames 1,2,6,7		0.77	0.74	0.74	0.74
For Sub-Frame 5		0.79	0.77	0.77	0.75
For Sub-Frame 0		0.84	0.78	0.77	0.76
Information Bit Payload (Note 3)					
For Sub-Frames 3,4,8,9	Bits	24496	48936	75376	97896
For Sub-Frames 1,2,6,7	Bits	21384	42368	63776	84760
For Sub-Frame 5	Bits	19848	40576	61664	81176
For Sub-Frame 0	Bits	21384	42368	63776	84760
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 3,4,8,9	CBs	4	8	13	16
For Sub-Frames 1,2,6,7	CBs	4	7	11	14
For Sub-Frame 5	CBs	4	7	11	14
For Sub-Frame 0	CBs	4	7	11	14
Binary Channel Bits (Note 3)					
For Sub-Frames 3,4,8,9	Bits	28800	57600	86400	115200
For Sub-Frames 1,2,6,7	Bits	28800	57600	86400	115200
For Sub-Frame 5	Bits	25344	52992	80640	109440
For Sub-Frame 0	Bits	25536	54336	83136	111936
Number of layers		2	2	2	2
Max. Throughput averaged over 1 frame (Note 3)	Mbps	22.475	44.816	68.205	89.656

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: Given per component carrier per codeword.
Note 4: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 5: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks n_{PRB} = 2..24 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-4: PDSCH Reference Channel for sustained data-rate test (256QAM, 4 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-4.1 FDD	R.PDSCH.4-4.2 FDD	R.PDSCH.4-4.3 FDD	R.PDSCH.4-4.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		10	10	10	10
Modulation		256QAM	256QAM	256QAM	256QAM
Coding Rate					
For Sub-Frames 3,4,8,9		0.85	0.78	0.79	0.78
For Sub-Frames 1,2,6,7		0.77	0.78	0.79	0.78
For Sub-Frame 5		0.79	0.82	0.82	0.786
For Sub-Frame 0		0.84	0.83	0.82	0.80
Information Bit Payload (Note 3)					
For Sub-Frames 3,4,8,9	Bits	42368	84760	128496	169544
For Sub-Frames 1,2,6,7	Bits	42368	84760	128496	169544
For Sub-Frame 5	Bits	39232	81176	124464	161760
For Sub-Frame 0	Bits	39232	84760	128496	169544
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 3,4,8,9	CBs	7	14	21	28
For Sub-Frames 1,2,6,7	CBs	7	14	21	28
For Sub-Frame 5	CBs	7	14	21	27
For Sub-Frame 0	CBs	7	14	21	28
Binary Channel Bits (Note 3)					
For Sub-Frames 3,4,8,9	Bits	54400	108800	163200	217600
For Sub-Frames 1,2,6,7	Bits	54400	108800	163200	217600
For Sub-Frame 5	Bits	47744	99968	152192	206592
For Sub-Frame 0	Bits	48256	102656	157056	211456
Number of layers		4	4	4	4
Max. Throughput averaged over 1 frame (Note 3)	Mbps	41.741	84.4016	128.093	168.766

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: Given per component carrier per codeword.
Note 4: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 5: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks n_{PRB} = 2..24 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-5: PDSCH Reference Channel for sustained data-rate test (1024QAM, 2 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-5.1 FDD	R.PDSCH.4-5.2 FDD	R.PDSCH.4-5.3 FDD	R.PDSCH.4-5.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		10	10	10	10
Modulation		1024QAM	1024QAM	1024QAM	1024QAM
Coding Rate					
For Sub-Frames 3,4,8,9		0.76	0.73	0.75	0.76
For Sub-Frames 1,2,6,7		0.76	0.73	0.75	0.76
For Sub-Frame 5		0.80	0.77	0.78	0.77
For Sub-Frame 0		0.86	0.78	0.78	0.79
Information Bit Payload (Note 3)					
For Sub-Frames 3,4,8,9	Bits	27376	52752	81176	110136
For Sub-Frames 1,2,6,7	Bits	27376	52752	81176	110136
For Sub-Frame 5	Bits	25456	51024	78704	105528
For Sub-Frame 0	Bits	27376	52752	81176	110136
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 3,4,8,9	CBs	5	9	14	18
For Sub-Frames 1,2,6,7	CBs	5	9	14	18
For Sub-Frame 5	CBs	5	9	13	18
For Sub-Frame 0	CBs	5	9	14	18
Binary Channel Bits (Note 3)					
For Sub-Frames 3,4,8,9	Bits	36000	72000	108000	144000
For Sub-Frames 1,2,6,7	Bits	36000	72000	108000	144000
For Sub-Frame 5	Bits	31680	66240	100800	136800
For Sub-Frame 0	Bits	31920	67920	103920	139920
Number of layers		2	2	2	2
Max. Throughput averaged over 1 frame (Note 3)	Mbps	27.18	52.58	80.93	109.68

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: Given per component carrier per codeword.
Note 4: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 5: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks n_{PRB} = 2..24 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

Table A.3.2.1.4-6: PDSCH Reference Channel for sustained data-rate test (1024QAM, 4 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.4-6.1 FDD	R.PDSCH.4-6.2 FDD	R.PDSCH.4-6.3 FDD	R.PDSCH.4-6.4 FDD
Channel bandwidth	MHz	5	10	15	20
Allocated resource blocks		Note 6	Note 7	Note 8	Note 9
Allocated subframes per Radio Frame		10	10	10	10
Modulation		1024QAM	1024QAM	1024QAM	1024QAM
Coding Rate					
For Sub-Frames 3,4,8,9		0.78	0.81	0.79	0.81
For Sub-Frames 1,2,6,7		0.78	0.81	0.79	0.81
For Sub-Frame 5		0.82	0.81	0.83	0.82
For Sub-Frame 0		0.87	0.86	0.82	0.83
Information Bit Payload (Note 3)					
For Sub-Frames 3,4,8,9	Bits	52752	110136	161760	220296
For Sub-Frames 1,2,6,7	Bits	52752	110136	161760	220296
For Sub-Frame 5	Bits	48936	101840	157432	211936
For Sub-Frame 0	Bits	52752	110136	161760	220296
Number of Code Blocks (Notes 3 and 4)					
For Sub-Frames 3,4,8,9	CBs	9	18	27	36
For Sub-Frames 1,2,6,7	CBs	9	18	27	36
For Sub-Frame 5	CBs	8	17	26	35
For Sub-Frame 0	CBs	9	18	27	36
Binary Channel Bits (Note 3)					
For Sub-Frames 3,4,8,9	Bits	68000	136000	204000	272000
For Sub-Frames 1,2,6,7	Bits	68000	136000	204000	272000
For Sub-Frame 5	Bits	59680	124960	190240	258240
For Sub-Frame 0	Bits	60320	128320	196320	264320
Number of layers		4	4	4	4
Max. Throughput averaged over 1 frame (Note 3)	Mbps	52.37	109.31	161.33	219.46

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: Given per component carrier per codeword.
Note 4: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 5: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 6: Resource blocks n_{PRB} = 2..24 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..24 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 8: Resource blocks nPRB = 4..74 are allocated for the user data in sub-frame 5, and resource blocks nPRB = 0..74 in sub-frames 0,1,2,3,4,6,7,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,1,2,3,4,6,7,8,9.

A.3.2.2 TDD

A.3.2.2.1 Reference measurement channels for SCS 15 kHz FR1

Table A.3.2.2.1-1: PDSCH Reference Channel for TDD UL-DL pattern FR1.15-1 and LTE-NR coexistence scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.1-1.1 TDD	R.PDSCH.1-1.2 TDD			
Channel bandwidth	MHz	10	10			
Subcarrier spacing	kHz	15	15			
Allocated resource blocks	PRBs	52	52			
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		N/A	N/A			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		9	11			
Allocated slots per 2 frames		7	7			
MCS table		64QAM	64QAM			
MCS index		4	4			
Modulation		QPSK	QPSK			
Target Coding Rate		0.30	0.30			
Number of MIMO layers		1	1			
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 5) = 3 for i from {0,…,19}		N/A	N/A			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19}		12	12			
Overhead for TBS determination		18	18			
Information Bit Payload per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	Bits	N/A	N/A			
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}	Bits	2472	3240			
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	Bits	N/A	N/A			
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}	Bits	16	16			
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	CBs	N/A	N/A			
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,19}	CBs	1	1			
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 5) = {2,3,4} for i from {0,…,19}	Bits	N/A	N/A			
For Slots i = 10, 11	Bits	7760	10256			
For Slot i, if mod(i, 5) = {0,1} for i from {1,…,9,12,…,19}	Bits	8384	10880			
Max. Throughput averaged over 2 frames	Mbps	0.865	1.134			
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: No user data is scheduled on slots with LTE PBCH/PSS/SSS						

A.3.2.2.2 Reference measurement channels for SCS 30 kHz FR1

Table A.3.2.2.2-1: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and FR1.30-1A (QPSK)

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-1.1 TDD	R.PDSCH. 2-1.2 TDD	R.PDSCH. 2-1.3 TDD	R.PDSCH. 2-1.4 TDD	
Channel bandwidth	MHz	40	40	40	40	
Subcarrier spacing	kHz	30	30	30	30	
Allocated resource blocks	PRBs	106	6	106	106	
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	4	N/A	N/A	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	7	12	
Allocated slots per 2 frames		31	31	27	27	
MCS table		64QAM	64QAM	64QAM	64QAMLow SE	
MCS index		4	4	4	14	
Modulation		QPSK	QPSK	QPSK	QPSK	
Target Coding Rate		0.30	0.30	0.30	0.59	
Number of MIMO layers		1	1	1	1	
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	N/A	N/A	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18	12	12	12	
Overhead for TBS determination		0	0	0	0	
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	2664	144	N/A	N/A	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	8064	480	4608	16392	
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	16	16	N/A	N/A	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	24	16	24	24	
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	1	1	N/A	N/A	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	1	1	1	2	
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	
For Slots i = 20, 21	Bits	25440	1512	13992	26712	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	8904	504	N/A	N/A	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	26712	1584	15264	27984	
Max. Throughput averaged over 2 frames	Mbps	11.419	0.677	6.221	22.129	
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.2-2: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (16QAM)

Parameter	Unit	Value					
Reference channel		R.PDSCH.2-2.1 TDD	R.PDSCH.2-2.2 TDD	R.PDSCH.2-2.3 TDD	R.PDSCH.2-2.4 TDD	R.PDSCH.2-2.5 TDD	R.PDSCH.2-2.6 TDD
Channel bandwidth	MHz	40	40	40	40	40	40
Subcarrier spacing	kHz	30	30	30	30	30	30
Allocated resource blocks	PRBs	106	106	106	106	106	106
Number of consecutive PDSCH symbols							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	4	4	4	4	4
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	12	12	12	12
Allocated slots per 2 frames		31	31	31	31	31	31
MCS table		64QAM	64QAM	64QAM	64QAM	64QAMLowSE	64QAM
MCS index		13	13	13	13	19	16
Modulation		16QAM	16QAM	16QAM	16QAM	16QAM	16QAM
Target Coding Rate		0.48	0.48	0.48	0.48	0.54	0.64
Number of MIMO layers		1	2	3	4	2	1
Number of DMRS REs							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6	12	12	6	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	24	24	12	12
Overhead for TBS determination		0	0	0	0	0	0
Information Bit Payload per Slot							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	8456	16896	22032	29192	19464	11528
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	26632	53288	73776	98376	60456	35856
Transport block CRC per Slot							
For Slots 0 and	Bits	N/A	N/A	N/A	N/A	N/A	N/A

Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}							
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	24	24	24	24	24
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6}for i from {1,…,39}	Bits	24	24	24	24	24	24
Number of Code Blocks per Slot							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	2	3	3	4	3	2
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	4	7	9	12	8	5
Binary Channel Bits Per Slot							
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A	N/A
For Slots i = 20, 21	Bits	53424	106848	144008	193344	101760	53424
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	17808	35616	45792	61056	35616	17808
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39 }	Bits	55968	111936	152640	203520	111936	55968
Max. Throughput averaged over 2 frames	Mbps	37.644	75.318	104.004	138.646	85.508	50.711
NOTE 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. NOTE 2: Slot i is slot index per 2 frames.							

Table A.3.2.2.2-3: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-3.1 TDD	R.PDSCH. 2-3.2 TDD	R.PDSCH. 2-3.3 TDD	R.PDSCH. 2-3.4 TDD	
Channel bandwidth	MHz	40	40	40	40	
Subcarrier spacing	kHz	30	30	30	30	
Allocated resource blocks	PRBs	106	106	53 (Note 3)	53 (Note 4)	
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	4	4	4	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	12	12	
Allocated slots per 2 frames		31	31	31	31	
MCS table		64QAM	64QAM	64QAM	64QAM	
MCS index		19	19	R.PDSCH. 2-3.3 TDD	R.PDSCH. 2-3.4 TDD	
Modulation		64QAM	64QAM	40	40	
Target Coding Rate		0.51	0.51	30	30	
Number of MIMO layers		2	2	53 (Note 3)	53 (Note 4)	
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	12	4	4	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	24	12	12	
Overhead for TBS determination		0	0	31	31	
Information Bit Payload per Slot				64QAM	64QAM	
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	27144	23040	11528	11528	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	83976	77896	38936	38936	
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	24	24	24	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	24	24	24	24	
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	4	3	2	2	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	10	10	5	5	
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	
For Slots i = 20, 21	Bits	160272	137376	68688	68688	
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	53424	45792	22896	22896	
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	167904	152640	76320	76320	
Max. Throughput averaged over 2 frames	Mbps	118.796	109.768	54.869	54.869	
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames. Note 3: PDSCH is scheduled in PRB numbers from 0 to 52. Note 4: PDSCH is scheduled in PRB numbers from 53 to 105.						

Table A.3.2.2.2-4: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (256QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-4.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12				
Allocated slots per 2 frames		31				
MCS table		256QAM				
MCS index		24				
Modulation		256QAM				
Target Coding Rate		0.82				
Number of MIMO layers		1				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	29192				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	92200				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	4				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	11				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slots i = 20, 21	Bits	106848				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	35616				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	111936				
Max. Throughput averaged over 2 frames	Mbps	130.308				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.2-5: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-2

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-5.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39}		N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}		8				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}		12				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39}		N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}		12				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	Bits	5376				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	Bits	8456				
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	CBs	1				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	CBs	2				
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,39}	Bits	N/A				
For Slot i = 20, 21	Bits	26712				
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	Bits	17808				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19,22,…,39}	Bits	27984				
Max. Throughput averaged over 2 frames	Mbps	11.875				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.2-6: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-3

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-6.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}		8				
For Slot i, if mod(i, 10) = {0,1,2,5,6} for i from {1,…,39}		12				
Allocated slots per 2 frames		27				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}		12				
For Slot i, if mod(i, 10) = {0,1,2,5,6} for i from {1,…,39}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}	Bits	5376				
For Slot i, if mod(i, 10) = {0,1,2,5,6} for i from {1,…,39}	Bits	8456				
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 10) = {0,1,2,5,6} for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}	CBs	1				
For Slot i, if mod(i, 10) = {0,1,2,5,6} for i from {1,…,39}	CBs	2				
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 10) = {4,8,9} for i from {0,…,39}	Bits	N/A				
For Slot i = 20, 21	Bits	26712				
For Slot i, if mod(i, 10) = {3,7} for i from {0,…,39}	Bits	17808				
For Slot i, if mod(i, 10) = {0,1,2,5,6} for i from {1,…,19,22,…,39}	Bits	27984				
Max. Throughput averaged over 2 frames	Mbps	10.184				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.2-7: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and CSI-RS overlapped with PDSCH

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-7.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	16896				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	53288				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	3				
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	7				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = {0,5} for i from {1,…,19,22,…,39}	Bits	103456				
For Slots i = 20	Bits	98368				
For Slots i = 21	Bits	106848				
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	35616				
For Slot i, if mod(i, 10) = {1,2,3,4,6} for i from {1,…,19,22,…,39}	Bits	111936				
Max. Throughput averaged over 2 frames	Mbps	75.318				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.2-8: PDSCH Reference Channel for TDD PMI reporting requirements with UL-DL pattern FR1.30-1 (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH. 2-8.1 TDD	R.PDSCH. 2-8.2 TDD	R.PDSCH. 2-8.3 TDD		
Channel bandwidth	MHz	40	40	40		
Subcarrier spacing	kHz	30	30	30		
Allocated resource blocks	PRBs	106	106	106		
Number of consecutive PDSCH symbols		12	12	12		
Allocated slots per 2 frames		23	23	23		
MCS table		64QAM	64QAM	64QAM		
MCS index		13	13	20		
Modulation		16QAM	16QAM	64QAM		
Target Coding Rate		0.48	0.48	0.55		
Number of MIMO layers		1	2	2		
Number of DMRS REs (Note 3)		24	24	24		
Overhead for TBS determination		0	0	0		
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A		
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	Bits	N/A	N/A	N/A		
For Slot i = 20	Bits	24576	49176	83976		
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	24576	49176	83976		
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A		
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	Bits	N/A	N/A	N/A		
For Slot i = 20	Bits	24	24	24		
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	24	24	24		
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39}	CBs	N/A	N/A	N/A		
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	CBs	N/A	N/A	N/A		
For Slot i = 20	CBs	3	6	10		
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	CBs	3	6	10		
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A		
For CSI-RS Slot i, if mod(i,10) =1 for i from {0,…,39}	Bits	N/A	N/A	N/A		
For Slot i = 20	Bits	48336	96672	145008		
For Slot i, if mod(i, 10) = {0,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	50880	101760	152640		
Max. Throughput averaged over 2 frames	Mbps	28.2624	56.5524	96.5724		
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames. Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data.						

Table A.3.2.2.2-9: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-4 (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-9.1 TDD				
Channel bandwidth	MHz	20				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	51				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}		4				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}		12				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		19				
Modulation		64QAM				
Target Coding Rate		0.51				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}		6				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}		12				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}	Bits	13064				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}	Bits	40976				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}	CBs	2				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,39}	CBs	5				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {4,5} for i from {0,…,39}	Bits	N/A				
For Slots i = 20, 21	Bits	77112				
For Slot i, if mod(i, 10) = 3 for i from {0,…,39}	Bits	25704				
For Slot i, if mod(i, 10) = {0,1,2,6,7,8,9} for i from {1,…,19,22,…,39}	Bits	80784				
Max. Throughput averaged over 2 frames	Mbps	57.930				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

Table A.3.2.2.2-10: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 and HST scenario

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-10.1 TDD	R.PDSCH.2-10.2 TDD	R.PDSCH.2-10.3 TDD	R.PDSCH.2-10.4 TDD	R.PDSCH.2-10.5 TDD
Channel bandwidth	MHz	40	40	40	40	40
Subcarrier spacing	kHz	30	30	30	30	30
Allocated resource blocks	PRBs	106	106	106	106	106
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	N/A	4	N/A	4
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12	12	12	12
Allocated slots per 2 frames		31	27	31	27	31
MCS table		64QAM	64QAM	64QAM	64QAM	64QAM
MCS index		13	13	17	13	17
Modulation		16QAM	16QAM	64QAM	16QAM	64QAM
Target Coding Rate		0.48	0.48	0.43	0.48	0.43
Number of MIMO layers		1	1	1	2	2
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}		N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	N/A	6	N/A	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		18	18	18	18	18
Overhead for TBS determination		0	0	0	0	0
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	8456	N/A	11528	N/A	19464
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	25608	25608	33816	51216	58384
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	24	N/A	24	N/A	24
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	Bits	24	24	24	24	24
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	2	N/A	2	N/A	3
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}	CBs	4	4	5	7	7
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A	N/A	N/A	N/A
For Slots i = 1,2,21,22	Bits	52176	50880	76320	104304	156456
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	17808	N/A	26712	N/A	53424
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {3,…,20,23,…,39}	Bits	53424	53424	80136	106848	160272
Max. Throughput averaged over 2 frames	Mbps	36.262	34.5708	47.9572	69.1416	82.7112
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

Table A.3.2.2.2-11: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-5

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-11.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}		12				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}		10				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}		N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}		18				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}		18				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	Bits	8064				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	Bits	6528				
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	Bits	24				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	CBs	1				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	CBs	1				
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,39}	Bits	N/A				
For Slot i = 20	Bits	25440				
For Slot i = 21	Bits	20352				
For Slot i, if mod(i, 4) = 0 for i from {1,…,19,22,…,39}	Bits	26712				
For Slot i, if mod(i, 4) = 1 for i from {0,…,19,22,…,39}	Bits	21624				
Max. Throughput averaged over 2 frames	Mbps	6.893				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

Table A.3.2.2.2-12: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-6

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-12.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}		N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}		12				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}		8				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}		10				
Allocated slots per 2 frames		31				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}		N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}		18				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}		18				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}		18				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	Bits	8064				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	Bits	4992				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}	Bits	6528				
Transport block CRC per Slot						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}	Bits	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	Bits	24				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	Bits	24				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}	Bits	24				
Number of Code Blocks per Slot						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}	CBs	N/A				
For Slot i, if mod(i, 4) = 0 for i from {1,…,39}	CBs	1				
For Slot i, if mod(i, 4) = 1 for i from {0,…,39}	CBs	1				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}	CBs	1				
Binary Channel Bits Per Slot						
For Slot 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,39}	Bits	N/A				
For Slot i = 20	Bits	25440				
For Slot i = 21	Bits	15264				
For Slot i, if mod(i, 4) = 0 for i from	Bits	26712				

{1,…,19,22,…,39}						
For Slot i, if mod(i, 4) = 1 for i from {1,…,19,22,…,39}	Bits	16536				
For Slot i, if mod(i, 4) = 2 for i from {0,…,39}	Bits	21624				
Max. Throughput averaged over 2 frames	Mbps	9.389				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

Table A.3.2.2.2-13: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario

FFS

Table A.3.2.2.2-14: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario

FFS

Table A.3.2.2.2-15: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario

FFS

Table A.3.2.2.2-16: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-16.1 TDD	R.PDSCH.2-16.2 TDD			
Channel bandwidth	MHz	40	40			
Subcarrier spacing	kHz	30	30			
Allocated resource blocks	PRBs	106	106			
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 10) = {0, 7} for i from {0,…,39}		N/A	N/A			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39}		12	12			
Allocated slots per 2 frames		24	24			
MCS table		64QAMLowSE	64QAMLowSE			
MCS index		19	19			
Modulation		16QAM	16QAM			
Target Coding Rate		0.54	0.54			
Number of MIMO layers		1	1			
Number of DMRS REs						
For Slot i, if mod(i, 10) = {0, 7} for i from {0,…,39}		N/A	N/A			
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39}		12	12			
Overhead for TBS determination		0	0			
Information Bit Payload per Slot						
For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39}	Bits	N/A	N/A			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39}	Bits	30216	30216			
Transport block CRC per Slot						
For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39}	Bits	N/A	N/A			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39}	Bits	24	24			
Number of Code Blocks per Slot						
For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39}	CBs	N/A	N/A			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39}	CBs	2	4			
Binary Channel Bits Per Slot						
For Slot i, if mod(i, 10) = {0,7,8,9} for i from {0,…,39}	Bits	N/A	N/A			
For Slot i = 21	Bits	53424	50880			
For Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,19,22,…,39}	Bits	55968	55968			
Max. Throughput averaged over 2 frames	Mbps	18.130 (NOTE 3)	18.130 (NOTE 3)			
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: Throughput is calculated under assumption of aggregation factor 2. Note 4: Throughput is calculated under assumption of repetition number 2.						

Table A.3.2.2.2-17: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-2

Parameter	Unit	Value				
Reference channel		R.PDSCH.2-17.1 TDD				
Channel bandwidth	MHz	40				
Subcarrier spacing	kHz	30				
Allocated resource blocks	PRBs	106				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}		2				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}		N/A				
Allocated slots per 2 frames		8				
MCS table						
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.3				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}		6				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}		N/A				
Overhead for TBS determination		0				
Information Bit Payload per Slot						
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	Bits	1160				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	Bits	N/A				
Transport block CRC per Slot						
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	Bits	16				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	Bits	N/A				
Number of Code Blocks per Slot						
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	CBs	1				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	CBs	N/A				
Binary Channel Bits Per Slot						
For Slot i, if mod(i, 5) = 3 for i from {0,…,39}	Bits	3816				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,39}	Bits	N/A				
Max. Throughput averaged over 2 frames	Mbps	0.464				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

A.3.2.2.3 Reference measurement channels for SCS 60 kHz FR1

A.3.2.2.4 Reference measurement channels for SCS 60 kHz FR2

Table A.3.2.2.4-1: PDSCH Reference Channel for TDD UL-DL pattern FR2.60-1 (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.4-1.1 TDD				
Channel bandwidth	MHz	50				
Subcarrier spacing	kHz	60				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}		N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}		10				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}		13				
Allocated slots per 2 frames		59				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}		N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}		12				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}	Bits	25608				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}	Bits	34816				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}	Bits	24				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}	CBs	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 79}	CBs	4				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79}	CBs	5				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,79}	Bits	N/A				
For Slot i = 40, 41	Bits	69960				
For Slot i, if mod(i, 4) = 2 for i from {4,…, 79}	Bits	54912				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,39,42,…,79}	Bits	73128				
Max. Throughput averaged over 2 frames	Mbps	93.499				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

A.3.2.2.5 Reference measurement channels for SCS 120 kHz FR2

Table A.3.2.2.5-1: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 and FR2.120-1A (QPSK)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-1.1 TDD	R.PDSCH.5-1.2 TDD			
Channel bandwidth	MHz	100	100			
Subcarrier spacing	kHz	120	120			
Allocated resource blocks	PRBs	66	66			
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}		9	2			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		13	2			
Allocated slots per 2 frames		127	127			
MCS table		64QAM	64QAM			
MCS index		4	4			
Modulation		QPSK	QPSK			
Target Coding Rate		0.30	0.30			
Number of MIMO layers		1	1			
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}		12	6			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		12	6			
Overhead for TBS determination		6	0			
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}	Bits	3624	736			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	5504	736			
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}	Bits	16	16			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	24	16			
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	CBs	N/A	N/A			
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}	CBs	1	1			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	1	1			
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A			
For Slots i = 80, 81	Bits	17490	2310			
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}	Bits	12210	2310			
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,82,…,159}	Bits	18282	2310			
Max. Throughput averaged over 2 frames	Mbps	31.942	4.673			
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.5-2: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-2.1 TDD	R.PDSCH.5-2.2 TDD	R.PDSCH.5-2.3 TDD		
Channel bandwidth	MHz	100	100	200		
Subcarrier spacing	kHz	120	120	120		
Allocated resource blocks	PRBs	66	66	132		
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}		9	9	9		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		13	13	13		
Allocated slots per 2 frames		127	127	127		
MCS table		64QAM	64QAM	64QAM		
MCS index		13	13	13		
Modulation		16QAM	16QAM	16QAM		
Target Coding Rate		0.48	0.48	0.48		
Number of MIMO layers		1	2	2		
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}		12	12	12		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		12	12	12		
Overhead for TBS determination		6	6	6		
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}	Bits	11272	22536	45096		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	17424	34816	69672		
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}	Bits	24	24	24		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	24	24	24		
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	CBs	N/A	N/A	N/A		
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}	CBs	2	3	6		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	3	5	9		
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A	N/A		
For Slots i = 80, 81	Bits	36564	69960	139920		
For Slots i = 82, 83	Bits	34980	73128	146256		
For Slot i, if mod(i, 5) = 3 for i from {0,…,159}	Bits	24420	48840	97680		
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,84,…,159}	Bits	36564	73128	146256		
Max. Throughput averaged over 2 frames	Mbps	100.799	201.434	403.096		
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.5-3: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-3.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		9				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		13				
Allocated slots per 2 frames		127				
MCS table		64QAM				
MCS index		18				
Modulation		64QAM				
Target Coding Rate		0.46				
Number of MIMO layers		1				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		12				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	16136				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	25104				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	24				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	2				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	3				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slots i = 80, 81	Bits	52470				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	36630				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,82,…,159}	Bits	54846				
Max. Throughput averaged over 2 frames	Mbps	145.062				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.5-4: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-2 (QPSK)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-4.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	6				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}		10				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}		13				
Allocated slots per 2 frames		119				
MCS table		64QAM				
MCS index		4				
Modulation		QPSK				
Target Coding Rate		0.30				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}		12				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	736				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	Bits	1032				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	16				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	Bits	16				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	CBs	1				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	CBs	1				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i = 80, 81	Bits	3180				
For Slot i, if mod(i, 4) = 2 for i from {4,…, 159}	Bits	2496				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79,82,…,159}	Bits	3324				
Max. Throughput averaged over 2 frames	Mbps	5.548				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.5-5: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-2 (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-5.1 TDD	R.PDSCH. 5-5.2 TDD			
Channel bandwidth	MHz	100	50			
Subcarrier spacing	kHz	120	120			
Allocated resource blocks	PRBs	66	32			
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A	N/A			
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}		10	10			
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}		13	13			
Allocated slots per 2 frames		119	119			
MCS table		64QAM	64QAM			
MCS index		13	13			
Modulation		16QAM	16QAM			
Target Coding Rate		0.48	0.48			
Number of MIMO layers		2	2			
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A	N/A			
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}		12	12			
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}		12	12			
Overhead for TBS determination		6	6			
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A	N/A			
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	25608	12552			
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	Bits	34816	16896			
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A	N/A			
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	24	24			
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	Bits	24	24			
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	CBs	N/A	N/A			
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	CBs	4	2			
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	CBs	5	3			
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A	N/A			
For Slot i = 80, 81	Bits	69960	33920			
For Slot i, if mod(i, 4) = 2 for i from {4,…, 159}	Bits	54912	26624			
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79,82,…,159}	Bits	73128	35456			
Max. Throughput averaged over 2 frames	Mbps	188.739	91.843			
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.5-6: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-2 (64QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-6.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}		10				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}		13				
Allocated slots per 2 frames		119				
MCS table		64QAM				
MCS index		17				
Modulation		64QAM				
Target Coding Rate		0.43				
Number of MIMO layers		2				
Number of DMRS REs						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}		N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}		12				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	34816				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	Bits	47112				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	Bits	24				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 4) = 2 for i from {1,…, 159}	CBs	5				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,159}	CBs	6				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = 3 for i from {0,…,159}	Bits	N/A				
For Slot i = 80, 81	Bits	114940				
For Slot i, if mod(i, 4) = 2 for i from {4,…, 159}	Bits	82368				
For Slot i, if mod(i, 4) = {0,1} for i from {1,…,79,82,…,159}	Bits	109692				
Max. Throughput averaged over 2 frames	Mbps	255.724				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.						

Table A.3.2.2.5-7: PDSCH Reference Channel for TDD PMI reporting requirements with UL-DL pattern FR2.120-1 (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-7.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames		63				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs (Note 3)		24				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i,5) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	14344				
For Slot i, if mod(i, 5) = {0,2} for i from {1,…, 79,82,…,159}	Bits	14344				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i, 5) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	24				
For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159}	CBs	N/A				
For CSI-RS Slot i, if mod(i, 5) =1 for i from {0,…,159}	CBs	N/A				
For Slot i = 80	CBs	2				
For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159}	CBs	2				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i, 5) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	28776				
For Slot i, if mod(i, 5) = {0,2} for i from {1,…,79,82,…,159}	Bits	30360				
Max. Throughput averaged over 2 frames	Mbps	45.1836				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames. Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data.						

Table A.3.2.2.5-8: PDSCH Reference Channel for TDD PMI reporting requirements with UL-DL pattern FR2.120-2 (16QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-8.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols		12				
Allocated slots per 2 frames		59				
MCS table		64QAM				
MCS index		13				
Modulation		16QAM				
Target Coding Rate		0.48				
Number of MIMO layers		1				
Number of DMRS REs (Note 3)		24				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i, 8) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	14344				
For Slot i, if mod(i, 8) = {0,4,5} for i from {1,…,79,82,…,159}	Bits	14344				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i, 8) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	24				
For Slot i, if mod(i, 8) = {0,4,5,} for i from {1,…,79,82,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	CBs	N/A				
For CSI-RS Slot i, if mod(i, 8) =1 for i from {0,…,159}	CBs	N/A				
For Slot i = 80	CBs	2				
For Slot i, if mod(i, 8) = {0,4,5} for i from {1,…,79,82,…,159}	CBs	2				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A				
For CSI-RS Slot i, if mod(i, 8) =1 for i from {0,…,159}	Bits	N/A				
For Slot i = 80	Bits	28776				
For Slot i, if mod(i, 8) = {0,4,5}for i from {1,…,79,82,…,159}	Bits	30360				
Max. Throughput averaged over 2 frames	Mbps	42.3148				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames. Note 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data.						

Table A.3.2.2.5-9: PDSCH Reference Channel for TDD CC with UL-DL pattern FR2.120-1 and CA scenario

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Table A.3.2.2.5-10: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-1 (256QAM)

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-10.1 TDD				
Channel bandwidth	MHz	50				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	32				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		9				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		13				
Allocated slots per 2 frames		127				
MCS table		256QAM				
MCS index		20				
Modulation		256QAM				
Target Coding Rate		0.67				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		12				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	15368				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	23568				
Transport block CRC per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	24				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	2				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	3				
Binary Channel Bits Per Slot						
For Slots 0 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A				
For Slots i = 80, 81	Bits	33920				
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	23680				
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79,82,…,159}	Bits	35456				
Max. Throughput averaged over 2 frames	Mbps	136.537				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames						

Table A.3.2.2.5-11: PDSCH Reference Channel for TDD UL-DL pattern FR2.120-2

Parameter	Unit	Value				
Reference channel		R.PDSCH.5-11.1 TDD				
Channel bandwidth	MHz	100				
Subcarrier spacing	kHz	120				
Allocated resource blocks	PRBs	66				
Number of consecutive PDSCH symbols						
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}		13				
Allocated slots per 2 frames		78				
MCS table		64QAMLowSE				
MCS index		16				
Modulation		16QAM				
Target Coding Rate		0.37				
Number of MIMO layers		1				
Number of DMRS REs						
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}		12				
Overhead for TBS determination		6				
Information Bit Payload per Slot						
For Slots 0, 1 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}	Bits	13320				
Transport block CRC per Slot						
For Slots 0, 1 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	Bits	N/A				
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}	Bits	24				
Number of Code Blocks per Slot						
For Slots 0, 1 and Slot i, if mod(i, 4) = {2,3} for i from {0,…,159}	CBs	N/A				
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}	CBs	2				
Binary Channel Bits Per Slot						
For Slots 0,1 and Slot i, if mod(i, 4) = {2, 3} for i from {0,…,159}	Bits	N/A				
For Slot i = 80, 81	Bits	34980				
For Slot i, if mod(i, 4) = {0,1} for i from {2,…,159}	Bits	36564				
Max. Throughput averaged over 2 frames	Mbps	25.974 (Note 3)				
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms Note 2: Slot i is slot index per 2 frames Note 3: Throughput is calculated under assumption of aggregation factor 2.						

A.3.2.2.6 Reference measurement channels for E-UTRA

Table A.3.2.2.6-1: PDSCH Reference Channel for sustained data-rate test (64QAM, 2 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-1.1 TDD	R.PDSCH.6-1.2 TDD	R.PDSCH.6-1.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		64QAM	64QAM	64QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4,8,9		0.85	0.85	0.88	
For Sub-Frame 5		0.88	0.87	0.87	
For Sub-Frame 0		0.90	0.88	0.90	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4,8,9	Bits	36696	55056	75376	
For Sub-Frame 5	Bits	35160	52752	71112	
For Sub-Frame 0	Bits	36696	55056	75376	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4,8,9	CBs	6	9	13	
For Sub-Frame 5	CBs	6	9	12	
For Sub-Frame 0	CBs	6	9	13	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4,8,9	Bits	43200	64800	86400	
For Sub-Frame 5	Bits	40176	60912	82512	
For Sub-Frame 0	Bits	41184	62784	84384	
Number of layers		2	2	2	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	21.864	32.803	44.799	

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 6: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,3,4,8,9.

Table A.3.2.2.6-2: PDSCH Reference Channel for sustained data-rate test (64QAM, 4 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-2.1 TDD	R.PDSCH.6-2.2 TDD	R.PDSCH.6-2.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		64QAM	64QAM	64QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4,8,9		0.78	0.77	0.79	
For Sub-Frame 5		0.79	0.79	0.80	
For Sub-Frame 0		0.82	0.79	0.81	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4,8,9	Bits	63776	93800	128496	
For Sub-Frame 5	Bits	59256	90816	124464	
For Sub-Frame 0	Bits	63776	93800	128496	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4,8,9	CBs	11	16	21	
For Sub-Frame 5	CBs	10	15	21	
For Sub-Frame 0	CBs	11	16	21	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4,8,9	Bits	81600	122400	163200	
For Sub-Frame 5	Bits	75840	115008	155808	
For Sub-Frame 0	Bits	77856	118656	159456	
Number of layers		4	4	4	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	37.813	55.981	76.694	

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 6: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,3,4,8,9.

Table A.3.2.2.6-3: PDSCH Reference Channel for sustained data-rate test (256QAM, 2 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-3.1 TDD	R.PDSCH.6-3.2 TDD	R.PDSCH.6-3.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		256QAM	256QAM	256QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4		0.74	0.79	0.74	
For Sub-Frames 8,9		0.85	0.88	0.85	
For Sub-Frame 5		0.76	0.76	0.74	
For Sub-Frame 0		0.78	0.77	0.76	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	42368	63776	84760	
For Sub-Frames 8,9	Bits	48936	75376	97896	
For Sub-Frame 5	Bits	40576	61664	81176	
For Sub-Frame 0	Bits	42368	63776	84760	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4	CBs	7	11	14	
For Sub-Frames 8,9	CBs	8	13	16	
For Sub-Frame 5	CBs	7	11	14	
For Sub-Frame 0	CBs	7	11	14	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	57600	86400	115200	
For Sub-Frames 8,9	Bits	57600	86400	115200	
For Sub-Frame 5	Bits	53568	81216	110016	
For Sub-Frame 0	Bits	54912	83712	112512	
Number of layers		2	2	2	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	26.555	40.374	53.125	

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 6: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,3,4,8,9.

Table A.3.2.2.6-4: PDSCH Reference Channel for sustained data-rate test (256QAM, 4 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-4.1 TDD	R.PDSCH.6-4.2 TDD	R.PDSCH.6-4.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		256QAM	256QAM	256QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4		0.78	0.79	0.78	
For Sub-Frames 8,9		0.78	0.79	0.78	
For Sub-Frame 5		0.81	0.82	0.78	
For Sub-Frame 0		0.82	0.82	0.80	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	84760	128496	169544	
For Sub-Frames 8,9	Bits	84760	128496	169544	
For Sub-Frame 5	Bits	81176	124464	161760	
For Sub-Frame 0	Bits	84760	128496	169544	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4	CBs	14	21	28	
For Sub-Frames 8,9	CBs	14	21	28	
For Sub-Frame 5	CBs	14	21	27	
For Sub-Frame 0	CBs	14	21	28	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	108800	163200	217600	
For Sub-Frames 8,9	Bits	108800	163200	217600	
For Sub-Frame 5	Bits	101120	153344	207744	
For Sub-Frame 0	Bits	103808	158208	212608	
Number of layers		4	4	4	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	50.498	76.694	100.948	

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 6: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,3,4,8,9.

Table A.3.2.2.6-5: PDSCH Reference Channel for sustained data-rate test (1024QAM, 2 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-5.1 TDD	R.PDSCH.6-5.2 TDD	R.PDSCH.6-5.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		1024QAM	1024QAM	1024QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4		0.76	0.75	0.76	
For Sub-Frames 8,9		0.76	0.75	0.76	
For Sub-Frame 5		0.76	0.78	0.77	
For Sub-Frame 0		0.80	0.78	0.78	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	55056	81176	110136	
For Sub-Frames 8,9	Bits	55056	81176	110136	
For Sub-Frame 5	Bits	51024	78704	105528	
For Sub-Frame 0	Bits	55056	81176	110136	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4	CBs	9	14	18	
For Sub-Frames 8,9	CBs	9	14	18	
For Sub-Frame 5	CBs	9	13	18	
For Sub-Frame 0	CBs	9	14	18	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	72000	108000	144000	
For Sub-Frames 8,9	Bits	72000	108000	144000	
For Sub-Frame 5	Bits	66960	101520	137520	
For Sub-Frame 0	Bits	68640	104640	140640	
Number of layers		2	2	2	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	32.630	48.458	65.621	

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 6: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,3,4,8,9.

Table A.3.2.2.6-6: PDSCH Reference Channel for sustained data-rate test (1024QAM, 4 MIMO layers)

Parameter	Unit	Value			
Reference channel		R.PDSCH.6-6.1 TDD	R.PDSCH.6-6.2 TDD	R.PDSCH.6-6.3 TDD	
Channel bandwidth	MHz	10	15	20	
Allocated resource blocks		Note 7	Note 8	Note 9	
Uplink-Downlink Configuration (Note 3)		2	2	2	
Number of HARQ Processes per component carrier		10	10	10	
Allocated subframes per Radio Frame (D+S)		6	6	6	
Modulation		1024QAM	1024QAM	1024QAM	
Coding Rate					
For Sub-Frames 1,2,6,7		N/A	N/A	N/A	
For Sub-Frames 3,4		0.81	0.79	0.81	
For Sub-Frames 8,9		0.81	0.79	0.81	
For Sub-Frame 5		0.81	0.82	0.82	
For Sub-Frame 0		0.85	0.82	0.83	
Information Bit Payload (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	110136	161760	220296	
For Sub-Frames 8,9	Bits	110136	161760	220296	
For Sub-Frame 5	Bits	101840	157432	211936	
For Sub-Frame 0	Bits	110136	161760	220296	
Number of Code Blocks (Notes 4 and 5)					
For Sub-Frames 1,2,6,7	CBs	N/A	N/A	N/A	
For Sub-Frames 3,4	CBs	18	27	36	
For Sub-Frames 8,9	CBs	18	27	36	
For Sub-Frame 5	CBs	17	26	35	
For Sub-Frame 0	CBs	18	27	36	
Binary Channel Bits (Note 4)					
For Sub-Frames 1,2,6,7	Bits	N/A	N/A	N/A	
For Sub-Frames 3,4	Bits	136000	204000	272000	
For Sub-Frames 8,9	Bits	136000	204000	272000	
For Sub-Frame 5	Bits	126400	191680	259680	
For Sub-Frame 0	Bits	129760	197760	265760	
Number of layers		2	2	2	
Max. Throughput averaged over 1 frame (Note 4)	Mbps	65.252	96.623	131.342	

Note 1: 1 symbol allocated to PDCCH for all tests.
Note 2: Reference signal, synchronization signals and PBCH allocated as per TS 36.211 [17].
Note 3: As per Table 4.2-2 in TS 36.211 [15].
Note 4: Given per component carrier per codeword.
Note 5: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit).
Note 6: Resource blocks n_{PRB} = 0..2 are allocated for SIB transmissions in sub-frame 5 for all bandwidths.
Note 7: Resource blocks n_{PRB} = 3..49 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..49 in sub-frames 0,3,4,8,9.
Note 8: Resource blocks n_{PRB} = 4..74 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..74 in sub-frames 0,3,4,8,9.
Note 9: Resource blocks n_{PRB} = 4..99 are allocated for the user data in sub-frame 5, and resource blocks n_{PRB} = 0..99 in sub-frames 0,3,4,8,9.

A.3.2_1 Reference measurement channels for Sustained downlink data rate performance requirements

A.3.2_1.1 FDD

A.3.2_1.1.1 Reference measurement channels for SCS 15 kHz FR1

Table A.3.2_1.1.1-1: Sustained Downlink Data Rate Reference Channel for FDD 15kHz SCS FR1 (64QAM)

eter	Channel bandwidth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots (Note 1)	Number of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Binary Channel Bits per Slot for allocated full DL slots (Note 1)	M Throu aver ov fra
	MHz	kHz	PRBs	Symbols						Bits	Bits	CBs	Bits	MI
	10	15	52	13	18	64QAM	0.46	1	1	20496	24	3	44928	17
	20	15	106	13	18	64QAM	0.46	1	1	42016	24	5	91584	35
	10	15	52	13	22	64QAM	0.65	1	1	29192	24	4	44928	24
	20	15	106	13	22	64QAM	0.65	1	1	59432	24	8	91584	50
	10	15	52	13	23	64QAM	0.7	1	1	31752	24	4	44928	26
	20	15	106	13	23	64QAM	0.7	1	1	64552	24	8	91584	54
	10	15	52	13	27	64QAM	0.89	1	1	39936	24	5	44928	33
	20	15	106	13	27	64QAM	0.89	1	1	81976	24	10	91584	69
	10	15	52	13	18	64QAM	0.46	2	1	40976	24	5	89856	34
	20	15	106	13	18	64QAM	0.46	2	1	83976	24	10	183168	71
	10	15	52	13	22	64QAM	0.65	2	1	58384	24	7	89856	49
	20	15	106	13	22	64QAM	0.65	2	1	118896	24	15	183168	101
	10	15	52	13	23	64QAM	0.7	2	1	63528	24	8	89856	53
	20	15	106	13	23	64QAM	0.7	2	1	129128	24	16	183168	109
	10	15	52	13	27	64QAM	0.89	2	1	79896	24	10	89856	67
	20	15	106	13	27	64QAM	0.89	2	1	163976	24	20	183168	13
	10	15	52	13	19	64QAM	0.5	4	1	83976	24	10	164736	71
	20	15	106	13	19	64QAM	0.5	4	1	167976	24	20	335808	14
	10	15	52	13	23	64QAM	0.7	4	1	114776	24	14	164736	97
	20	15	106	13	23	64QAM	0.7	4	1	237776	24	29	335808	20
	10	15	52	13	24	64QAM	0.75	4	1	125016	24	15	164736	106
	20	15	106	13	24	64QAM	0.75	4	1	254176	24	31	335808	21
	10	15	52	13	27	64QAM	0.89	4	1	147576	24	18	164736	12
	20	15	106	13	27	64QAM	0.89	4	1	295176	24	36	335808	25

Allocated full DL slots are with slot index i, if i is not in {0,10,11} for i = 0,1,...,19. So total number of allocated slots per 2 frames is 17.
MCS Index is based on MCS Table defined in TS38.214 when 256QAM is not enabled. MCS 18 and 19 are equivalent to MCS 11 and 12 in 256QAM
tively.
Number of DMRS REs per RB = 12,12,24,24 for number of MIMO layers = 1,2,3,4, respectively
SS/PBCH block is transmitted in slot #0 with periodicity 20 ms.
Overhead parameter for TBS determination is 0.

If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

Table A.3.2_1.1.1-2: Sustained Downlink Data Rate Reference Channel for FDD 15kHz SCS FR1 (256QAM)

nel idth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots (Note 1)	Number of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Bin Cha Bits Slo allo ful sl (No
z	kHz	PRBs	Symbols						Bits	Bits	CBs	B
	15	52	13	20	256QAM	0.67	1	1	39936	24	5	59
	15	106	13	20	256QAM	0.67	1	1	81976	24	10	122
	15	52	13	21	256QAM	0.69	1	1	42016	24	5	59
	15	106	13	21	256QAM	0.69	1	1	83976	24	10	122
	15	52	13	26	256QAM	0.9	1	1	53288	24	7	59
	15	106	13	26	256QAM	0.9	1	1	108552	24	13	122
	15	52	13	20	256QAM	0.67	2	1	79896	24	10	119
	15	106	13	20	256QAM	0.67	2	1	163976	24	20	244
	15	52	13	21	256QAM	0.69	2	1	83976	24	10	119
	15	106	13	21	256QAM	0.69	2	1	167976	24	20	244
	15	133	13	21	256QAM	0.69	2	1	213176	24	26	306
	15	52	13	26	256QAM	0.9	2	1	106576	24	13	119
	15	106	13	26	256QAM	0.9	2	1	217128	24	26	244
	15	52	13	22	256QAM	0.74	4	1	159880	24	19	219
	15	106	13	22	256QAM	0.74	4	1	327888	24	39	447
	15	52	13	23	256QAM	0.78	4	1	172176	24	21	219
	15	106	13	23	256QAM	0.78	4	1	352440	24	42	447
	15	133	13	23	256QAM	0.78	4	1	434280	24	52	561
	15	52	13	26	256QAM	0.9	4	1	196776	24	24	219
	15	106	13	26	256QAM	0.9	4	1	401640	24	48	447

DL slots are with slot index i, if i is not in {0,10,11} for i = 0,1,...,19. So total number of allocated slots per 2 frames is 17.
s based on MCS Table defined in TS38.214 when 256QAM is enabled.
MRS REs per RB = 12,12,24,24 for number of MIMO layers = 1,2,3,4, respectively
ock is transmitted in slot #0 with periodicity 20 ms.
rameter for TBS determination is 0.
one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

A.3.2_1.2 TDD

A.3.2_1.2.1 Reference measurement channels for SCS 30 kHz FR1

Table A.3.2_1.2.1-1: Sustained Downlink Data Rate Reference Channel for TDD 30kHz SCS FR1 (64QAM)

eter	Channel	Subcarrier	Allocated	Number of	MCS	Modulation	Target	Number	LDPC	Information	Transport	Number	Binary	M

bandwidth	spacing	resource blocks	consecutive PDSCH symbols for allocated full DL slots (Note 1)	Index (Note 2)		Coding Rate	of MIMO layers	Base Graph	Bit Payload per Slot for allocated full DL slots (Note 1)	block CRC per Slot for allocated full DL slots (Note 1)	of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Channel Bits per Slot for allocated full DL slots (Note 1)	Throu aver ov fra
MHz	kHz	PRBs	Symbols						Bits	Bits	CBs	Bits	Ml
20	30	51	13	18	64QAM	0.46	1	1	19968	24	3	44064	24
100	30	273	13	18	64QAM	0.46	1	1	106576	24	13	235872	13
20	30	51	13	22	64QAM	0.65	1	1	28680	24	4	44064	35
100	30	273	13	22	64QAM	0.65	1	1	151608	24	18	235872	18
20	30	51	13	23	64QAM	0.7	1	1	30728	24	4	44064	38
100	30	273	13	23	64QAM	0.7	1	1	163976	24	20	235872	20
20	30	51	13	27	64QAM	0.89	1	1	38936	24	5	44064	48
100	30	273	13	27	64QAM	0.89	1	1	208976	24	25	235872	26
20	30	51	13	18	64QAM	0.46	2	1	39936	24	5	88128	49
100	30	273	13	18	64QAM	0.46	2	1	213176	24	26	471744	26
20	30	51	13	22	64QAM	0.65	2	1	57376	24	7	88128	71
100	30	273	13	22	64QAM	0.65	2	1	303240	24	36	471744	37
20	30	51	13	23	64QAM	0.7	2	1	61480	24	8	88128	76
100	30	273	13	23	64QAM	0.7	2	1	327888	24	39	471744	40
20	30	51	13	27	64QAM	0.89	2	1	77896	24	10	88128	97
100	30	273	13	27	64QAM	0.89	2	1	417976	24	50	471744	52
20	30	51	13	19	64QAM	0.5	4	1	81976	24	10	161568	10
100	30	273	13	19	64QAM	0.5	4	1	434280	24	52	864864	54
20	30	51	13	23	64QAM	0.7	4	1	112648	24	14	161568	14
100	30	273	13	23	64QAM	0.7	4	1	606504	24	72	864864	75
20	30	51	13	24	64QAM	0.75	4	1	120936	24	15	161568	15
100	30	273	13	24	64QAM	0.75	4	1	655800	24	78	864864	81
20	30	51	13	27	64QAM	0.89	4	1	143400	24	18	161568	17
100	30	273	13	27	64QAM	0.89	4	1	770568	24	92	864864	96

Allocated full DL slots are with slot index i, if mod(i,10) = 0,1,2,3,4,5,6 and i is not in {0,20,21} for i = 0,1,...,39. So total number of allocated slots per 2
is 25.
MCS Index is based on MCS Table defined in TS38.214 when 256QAM is not enabled. MCS 18 and 19 are equivalent to MCS 11 and 12 in 256QAM
tively.
Number of DMRS REs per RB = 12,12,24,24 for number of MIMO layers = 1,2,3,4, respectively
SS/PBCH block is transmitted in slot #0 with periodicity 20 ms.
Overhead parameter for TBS determination is 0.
If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

Table A.3.2_1.2.1-2: Sustained Downlink Data Rate Reference Channel for TDD 30kHz SCS FR1(256QAM)

eter	Channel bandwidth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots	Number of Code Blocks per Slot for allocated full DL	Binary Channel Bits per Slot for allocated full DL slots	M Throu aver ov fra

											(Note 1)	**slots (Note 1, 6)**	**(Note 1)**	
	MHz	**kHz**	**PRBs**	**Symbols**						**Bits**	**Bits**	**CBs**	**Bits**	**M**
	20	30	51	13	20	256QAM	0.67	1	1	38936	24	5	58752	48
	100	30	273	13	20	256QAM	0.67	1	1	208976	24	25	314496	26
	20	30	51	13	21	256QAM	0.69	1	1	40976	24	5	58752	51
	100	30	273	13	21	256QAM	0.69	1	1	217128	24	26	314496	27
	20	30	51	13	26	256QAM	0.9	1	1	52224	24	7	58752	65
	100	30	273	13	26	256QAM	0.9	1	1	278776	24	34	314496	34
	20	30	51	13	20	256QAM	0.67	2	1	77896	24	10	117504	97
	100	30	273	13	20	256QAM	0.67	2	1	417976	24	50	628992	52
	20	30	51	13	21	256QAM	0.69	2	1	81976	24	10	117504	10
	100	30	273	13	21	256QAM	0.69	2	1	434280	24	52	628992	54
	20	30	51	13	26	256QAM	0.9	2	1	104496	24	13	117504	13
	100	30	273	13	26	256QAM	0.9	2	1	557416	24	67	628992	69
	20	30	51	13	22	256QAM	0.74	4	1	159880	24	19	215424	19
	100	30	273	13	22	256QAM	0.74	4	1	852696	24	102	1153152	106
	20	30	51	13	23	256QAM	0.78	4	1	167976	24	20	215424	20
	100	30	273	13	23	256QAM	0.78	4	1	901344	24	107	1153152	112
	20	30	51	13	26	256QAM	0.9	4	1	192624	24	23	215424	24
	100	30	273	13	26	256QAM	0.9	4	1	1032192	24	123	1153152	129

Allocated full DL slots are with slot index i, if mod(i,10) = 0,1,2,3,4,5,6 and i is not in {0,20,21} for i = 0,1,...,39. So total number of allocated slots per 2
is 25.
MCS Index is based on MCS Table defined in TS38.214 when 256QAM is enabled.
Number of DMRS REs per RB = 12,12,24,24 for number of MIMO layers = 1,2,3,4, respectively
SS/PBCH block is transmitted in slot #0 with periodicity 20 ms.
Overhead parameter for TBS determination is 0.
If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

Table A.3.2_1.2.1-3: Sustained Downlink Data Rate Reference Channel for TDD 120kHz SCS FR2 (QPSK)

nel idth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots (Note 1)	Number of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Bi Cha Bits Slo allo ful sl (No
z	kHz	PRBs	Symbols						Bits	Bits	CBs	B
	120	32	13	9	QPSK	0.66	1	1	5888	24	1	88
)	120	66	13	9	QPSK	0.66	1	1	12040	24	2	18
)	120	132	13	9	QPSK	0.66	1	1	24072	24	3	36
	120	32	13	9	QPSK	0.66	2	1	11784	24	2	17
)	120	66	13	9	QPSK	0.66	2	1	24072	24	3	36
)	120	132	13	9	QPSK	0.66	2	1	48168	24	6	72

DL slots are with slot index i, if mod(i,5) = 0,1,2 and i is not in {0,80,81} for i = 0,1,...,159. So total number of allocated slots per 2 frames is 93.
s based on MCS Table defined in TS38.214 when 256QAM is not enabled.
MRS REs per RB is 12.
ock is transmitted in slot #0 with periodicity 20 ms.
rameter for TBS determination is 6.
one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

Table A.3.2_1.2.1-4: Sustained Downlink Data Rate Reference Channel for TDD 120kHz SCS FR2 (16QAM)

nel idth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots (Note 1)	Number of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Bi Cha Bits Slo allo ful sl (No
z	kHz	PRBs	Symbols						Bits	Bits	CBs	B
	120	32	13	16	16QAM	0.64	1	1	11272	24	2	17
)	120	66	13	16	16QAM	0.64	1	1	23568	24	3	36
)	120	132	13	16	16QAM	0.64	1	1	47112	24	6	72
	120	32	13	16	16QAM	0.64	2	1	22536	24	3	35
)	120	66	13	16	16QAM	0.64	2	1	47112	24	6	72
)	120	132	13	16	16QAM	0.64	2	1	94248	24	12	145

DL slots are with slot index i, if mod(i,5) = 0,1,2 and i is not in {0,80,81} for i = 0,1,...,159. So total number of allocated slots per 2 frames is 93.
s based on MCS Table defined in TS38.214 when 256QAM is not enabled.
MRS REs per RB is 12.
ock is transmitted in slot #0 with periodicity 20 ms.
rameter for TBS determination is 6.
one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

Table A.3.2_1.2.1-5: Sustained Downlink Data Rate Reference Channel for TDD 120kHz SCS FR2 (64QAM)

nel idth	Subcarrier spacing	Allocated resource blocks	Number of consecutive PDSCH symbols for allocated full DL slots (Note 1)	MCS Index (Note 2)	Modulation	Target Coding Rate	Number of MIMO layers	LDPC Base Graph	Information Bit Payload per Slot for allocated full DL slots (Note 1)	Transport block CRC per Slot for allocated full DL slots (Note 1)	Number of Code Blocks per Slot for allocated full DL slots (Note 1, 6)	Bi Cha Bits Slo allo full sl (No
z	KHz	PRBs	Symbols						Bits	Bits	CBs	B
	120	32	13	27	64QAM	0.89	1	1	23568	24	3	26
)	120	66	13	27	64QAM	0.89	1	1	48168	24	6	54
)	120	132	13	27	64QAM	0.89	1	1	96264	24	12	108
	120	32	13	27	64QAM	0.89	2	1	47112	24	6	52
)	120	66	13	27	64QAM	0.89	2	1	96264	24	12	108
)	120	132	13	27	64QAM	0.89	2	1	192624	24	23	217

DL slots are with slot index i, if mod(i,5) = 0,1,2 and i is not in {0,80,81} for i = 0,1,...,159. So total number of allocated slots per 2 frames is 93.
s based on MCS Table defined in TS38.214 when 256QAM is not enabled.
MRS REs per RB is 12.
ock is transmitted in slot #0 with periodicity 20 ms.
rameter for TBS determination is 6.
one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)

A.3.3 Reference measurement channels for PDCCH performance requirements

A.3.3.1 FDD

A.3.3.1.1 Reference measurement channels for SCS 15 kHz FR1

Table A.3.3.1.1-1: PDCCH Reference Channels (Time domain allocation 1 symbol)

Parameter	Unit	Value					
Reference channel		R.PDCCH.1-1.1 FDD	R.PDCCH.1-1.2 FDD	R.PDCCH.1-1.3 FDD			
Subcarrier spacing	kHz	15	15	15			
CORESET frequency domain allocation		48	48	48			
CORESET time domain allocation		1	1	1			
Aggregation level		4	4	8			
DCI Format		1_0	1_1	1_1			
Payload (without CRC)	Bits	39	52	52			

Table A.3.3.1.1-2: PDCCH Reference Channel (Time domain allocation 2 symbols)

Parameter	Unit	Value						
Reference channel		R.PDCCH.1-2.1 FDD	R.PDCCH.1-2.2 FDD	R.PDCCH.1-2.3 FDD	R.PDCCH.1-2.4 FDD	R.PDCCH.1-2.5 FDD	R.PDCCH.1-2.6 FDD	R.PDCCH.1-2.7 FDD
Subcarrier spacing	kHz	15	15	15	15	15	15	15
CORESET frequency domain allocation		24	24	24	48	48	48	48
CORESET time domain allocation		2	2	2	2	2	2	2
Aggregation level		2	4	2	4	8	16	8
DCI Format		1_0	1_0	1_1	1_1	1_1	1_0	2_6
Payload (without CRC)	Bits	39	39	52	52	52	39	12

Table A.3.3.1.1-3: Additional PDSCH Reference Channel FDD

Parameter	Unit	Value	
DCI Format		1_0	1_1
Channel bandwidth	MHz	10	10
Subcarrier spacing	kHz	15	15
Number of allocated resource blocks	PRBs	52	52
Number of consecutive PDSCH symbols		12	12
Allocated slots per 2 frames	Slots	19	19
MCS table		64QAM	64QAM
MCS index		4	4
Modulation		QPSK	QPSK
Target Coding Rate		0.30	0.30
Number of MIMO layers		1	1
Number of DMRS REs		12	12
Overhead for TBS determination		0	0
Information Bit Payload per Slot			
For Slot i = 0	Bits	N/A	N/A
For Slots i = 1,…, 19	Bits	3368	4096
Transport block CRC per Slot			
For Slot i = 0	Bits	N/A	N/A
For Slots i = 1,…, 19	Bits	16	24
Number of Code Blocks per Slot			
For Slot i = 0	CBs	N/A	N/A
For Slots i = 1,…, 19	CBs	1	1
Binary Channel Bits Per Slot			
For Slot i = 0	Bits	N/A	N/A
For Slots i = 10, 11	Bits	9984	13104
For Slots i = 1,…, 9, 12, …, 19	Bits	11232	13728
Max. Throughput averaged over 2 frames	Mbps	3.1996	3.8912
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames.			

A.3.3.1.2 Reference measurement channels for SCS 30 kHz FR1

Table A.3.3.1.2-1: PDCCH Reference Channels (Time domain allocation 1 symbol)

Parameter	Unit	Value					
Reference channel		R.PDCCH.2-1.1 FDD	R.PDCCH.2-1.2 FDD	R.PDCCH.2-1.3 FDD			
Subcarrier spacing	kHz	30	30	30			
CORESET frequency domain allocation		102	102	90			
CORESET time domain allocation		1	1	1			
Aggregation level		2	4	8			
DCI Format		1_0	1_1	1_1			
Payload (without CRC)	Bits	41	53	53			

Table A.3.3.1.2-2: PDCCH Reference Channel (Time domain allocation 2 symbols)

Parameter	Unit	Value					
Reference channel		R.PDCCH.2-2.1 FDD					
Subcarrier spacing	kHz	30					
CORESET frequency domain allocation		48					
CORESET time domain allocation		2					
Aggregation level		16					
DCI Format		1_0					
Payload (without CRC)	Bits	41					

A.3.3.2 TDD

A.3.3.2.1 Reference measurement channels for SCS 15 kHz FR1

Table A.3.3.2.1-1: PDCCH Reference Channels (Time domain allocation 1 symbol)

Parameter	Unit	Value					
Reference channel		R.PDCCH.1-1.1 TDD	R.PDCCH.1-1.2 TDD	R.PDCCH.1-1.3 TDD			
Subcarrier spacing	kHz	15	15	15			
CORESET frequency domain allocation		48	48	48			
CORESET time domain allocation		1	1	1			
Aggregation level		4	4	8			
DCI Format		1_0	1_1	1_1			
Payload (without CRC)	Bits	39	52	52			

Table A.3.3.2.1-2: PDCCH Reference Channel (Time domain allocation 2 symbols)

Parameter	Unit	Value					
Reference channel		R.PDCCH.1-2.1 TDD	R.PDCCH.1-2.2 TDD	R.PDCCH.1-2.3 TDD	R.PDCCH.1-2.4 TDD	R.PDCCH.1-2.5 TDD	R.PDCCH.1-2.6 TDD
Subcarrier spacing	kHz	15	15	15	15	15	15
CORESET frequency domain allocation		24	24	24	48	48	48
CORESET time domain allocation		2	2	2	2	2	2
Aggregation level		2	4	2	4	8	16
DCI Format		1_0	1_0	1_1	1_1	1_1	1_0
Payload (without CRC)	Bits	39	39	52	52	52	39

A.3.3.2.2 Reference measurement channels for SCS 30 kHz FR1

Table A.3.3.2.2-1: PDCCH Reference Channels (Time domain allocation 1 symbol)

Parameter	Unit	Value					
Reference channel		R.PDCCH.2-1.1 TDD	R.PDCCH.2-1.2 TDD	R.PDCCH.2-1.3 TDD	R.PDCCH.2-1.4 TDD		
Subcarrier spacing	kHz	30	30	30	30		
CORESET frequency domain allocation		102	102	90	102		
CORESET time domain allocation		1	1	1	1		
Aggregation level		2	4	8	8		
DCI Format		1_0	1_1	1_1	2_6		
Payload (without CRC)	Bits	41	53	53	12		

Table A.3.3.2.2-2: PDCCH Reference Channel (Time domain allocation 2 symbols)

Parameter	Unit	Value					
Reference channel		R.PDCCH.2-2.1 TDD					
Subcarrier spacing	kHz	30					
CORESET frequency domain allocation		48					
CORESET time domain allocation		2					
Aggregation level		16					
DCI Format		1_0					
Payload (without CRC)	Bits	41					

Table A.3.3.2.2-3: Additional PDSCH Reference Channel TDD

Parameter	Unit	Value	
DCI Format		1-0	1-1
TDD UL/DL pattern		FR1.30-1	FR1.30-1
Channel bandwidth	MHz	40	40
Subcarrier spacing	kHz	30	30
Allocated resource blocks	PRBs	106	106
Number of consecutive PDSCH symbols			
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		4	4
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}		12	12
Allocated slots per 2 frames		31	31
MCS table		64QAM	64QAM
MCS index		4	4
Modulation		QPSK	QPSK
Target Coding Rate		0.30	0.3
Number of MIMO layers		1	1
Number of DMRS rEs			
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}		6	6
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}		12	12
Overhead for TBS determination		0	0
Information Bit Payload per Slot			
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	2280	2664
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	6912	8456
Transport block CRC per Slot			
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	16	16
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	24	24
Number of Code Blocks per Slot			
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	CBs	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	CBs	1	1
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	CBs	1	2
Binary Channel Bits Per Slot			
For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39}	Bits	N/A	N/A
For Slot i, if mod(i, 10) = 7 for i from {0,…,39}	Bits	7488	8904
For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6) for i from {1,…,39}	Bits	22896	27984
Max. Throughput averaged over 2 frames	Mbps	9.78	11.94

A.3.3.2.3 Reference measurement channels for SCS 60 kHz FR1

A.3.3.2.4 Reference measurement channels for SCS 60 kHz FR2

A.3.3.2.5 Reference measurement channels for SCS 120 kHz FR2

Table A.3.3.2.5-1: PDCCH Reference Channels (Time domain allocation 1 symbol)

Parameter	Unit	Value					
Reference channel		R.PDCCH.5-1.1 TDD	R.PDCCH.5-1.2 TDD	R.PDCCH.5-1.3 TDD	R.PDCCH.5-1.4 TDD		
Subcarrier spacing	kHz	120	120	120	120		
CORESET frequency domain allocation		60	60	60	60		
CORESET time domain allocation		1	1	1	1		
Aggregation level		2	4	8	8		
DCI Format		1_0	1_1	1_1	2_6		
Payload (without CRC)	Bits	40	56	56	12		

Table A.3.3.2.5-2: PDCCH Reference Channel (Time domain allocation 2 symbols)

Parameter	Unit	Value					
Reference channel		R.PDCCH.5-2.1 TDD					
Subcarrier spacing	kHz	120					
CORESET frequency domain allocation		60					
CORESET time domain allocation		2					
Aggregation level		16					
DCI Format		1_0					
Payload (without CRC)	Bits	40					

Table A.3.3.2.5-3: Additional PDSCH Reference Channel TDD

Parameter	Unit	Value	
DCI format		DCI 1_0	DCI 1_1
TDD UL/DL pattern			
Channel bandwidth	MHz	100	100
Subcarrier spacing	kHz	120	120
Allocated resource blocks	PRBs	66	66
Number of consecutive PDSCH symbols			
For Slots 0, 5 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		9	9
For Slot i, if mod(i, 5) = {1,2} for i from {1,…,159}		13	13
For Slot i, if mod(i, 5) = {0} for i from {6,…,159}		13	13
Allocated slots per 2 frames		126	126
MCS table		64QAM	64QAM
MCS index		4	4
Modulation		QPSK	QPSK
Target Coding Rate		0.30	0.30
Number of MIMO layers		1	1
Number of DMRS REs			
For Slots 0, 5 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}		N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}		12	12
For Slot i, if mod(i, 5) = {1,2} for i from {1,…,159}		12	12
For Slot i, if mod(i, 5) = {0} for i from {6,…,159}		12	12
Overhead for TBS determination		6	6
Information Bit Payload per Slot			
For Slots 0, 5 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	3104	3624
For Slot i, if mod(i, 5) = {1,2} for i from {1,…,159}	Bits	4480	5504
For Slot i, if mod(i, 5) = {0} for i from {6,…,159}		4480	5504
Transport block CRC per Slot			
For Slots 0, 5 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	16	16
For Slot i, if mod(i, 5) = {1,2} for i from {1,…,159}	Bits	24	24
For Slot i, if mod(i, 5) = {0} for i from {6,…,159}		24	24
Number of Code Blocks per Slot			
For Slots 0, 5 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	CBs	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	CBs	1	1
For Slot i, if mod(i, 5) = {1,2} for i from {1,…,159}	CBs	1	1
For Slot i, if mod(i, 5) = {0} for i from {6,…,159}		1	1
Binary Channel Bits Per Slot			
For Slots 0, 5 and Slot i, if mod(i, 5) = 4 for i from {0,…,159}	Bits	N/A	N/A
For Slot i, if mod(i, 5) = 3 for i from {0,…, 159}	Bits	10296	11880
For Slot i, if mod(i, 5) = {1,2} for i from {1,…,159}	Bits	15048	18216
For Slot i, if mod(i, 5) = {0} for i from {6,…,159}		15048	18216
Max. Throughput averaged over 2 frames	Mbps	26,022	31.667
Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms. Note 2: Slot i is slot index per 2 frames			

A.3.4 Reference measurement channels for PBCH demodulation requirements

A.3.4.1 Reference measurement channels for FR1

Table A.3.4.1-1: PBCH Reference Channel

Parameter	Unit	Value	
Reference channel		R.PBCH.1	R.PBCH.2
SS/PBCH block subcarrier spacing	kHz	15	30
Modulation		QPSK	QPSK
Target coding rate		56/864	56/864
Payload (without CRC and timing related PBCH payload bits)	bits	24	24

A.3.4.2 Reference measurement channels for FR2

Table A.3.4.2-1: PBCH Reference Channel

Parameter	Unit	Value	
Reference channels		R.PBCH.5	R.PBCH.6
SS/PBCH block subcarrier spacing	kHz	120	240
Modulation		QPSK	QPSK
Target coding rate		56/864	56/864
Payload (without CRC and timing related PBCH payload bits)	bits	24	24

A.4 CSI reference measurement channels

This section defines the DL signal applicable to the reporting of channel status information (Clause X).

Tables in this section specifies the mapping of CQI index to Information Bit payload, which complies with the CQI definition specified in clause 5.2.2.1 of TS 38.214 [12] and with MCS definition specified in clause 5.1.3 of TS 38.214 [12]

Table A.4-1: Mapping of CQI Index to Information Bit payload (CQI table 1)

TBS Scheme				TBS.1-1	TBS.1-2				
MCS table				64QAM					
Number of allocated PDSCH resource blocks				66	66				
Number of consecutive PDSCH symbols				12	12				
Number of PDSCH MIMO layers				1	2				
Number of DMRS REs (Note 1)				24	24				
Overhead for TBS determination				6	6				
Available RE-s				7920	7920				
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot					
0	OOR	OOR	OOR	N/A	N/A				
1	0.2344	0	QPSK	1800	3624				
2	0.2344	0		1800	3624				
3	0.3770	2		2856	5640				
4	0.6016	4		4480	8968				
5	0.8770	6		6528	13064				
6	1.1758	8		8712	17928				
7	1.4766	11	16QAM	11016	22032				
8	1.9141	13		14343	28680				
9	2.4063	15		17928	35856				
10	2.7305	18	64QAM	20496	40976				
11	3.3223	20		25104	50184				
12	3.9023	22		29192	58384				
13	4.5234	24		33816	67584				
14	5.1152	26		38936	77896				
15	5.5547	28		42016	83976				
Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data Note 2: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-1 of TS 38.214 [12]									

Table A.4-2: Mapping of CQI Index to Information Bit payload (CQI table 2)

TBS Scheme				TBS.2-1	TBS.2-2	TBS.2-3	TBS.2-4	TBS.2-5	TBS.2-6	TBS.2-7
MCS table				256QAM						
Number of allocated PDSCH resource blocks				52	52	106	106	8	16	32
Number of consecutive PDSCH symbols				12	12	12	12	12	12	12
Number of PDSCH MIMO layers				1	2	1	2	1	1	1
Number of DMRS REs (Note 1)				24	24	24	24	24	24	24
Overhead for TBS determination				0	0	0	0	0	0	6
Available RE-s for PDSCH				6240	6240	12720	12720	960	1920	3680
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot						
0	OOR	OOR	OOR	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	0.2344	0	QPSK	1480	2976	2976	5896	224	456	848
2	0.3770	1		2408	4744	4744	9480	368	736	1416
3	0.8770	3		5504	11016	11016	22536	848	1736	3240
4	1.4766	5	16QAM	9224	18432	18960	37896	1416	2856	5376
5	1.9141	7		12040	24072	24576	49176	1864	3752	6912
6	2.4063	9		15112	30216	30728	61480	2408	4608	8712
7	2.7305	11	64QAM	16896	33816	34816	69672	2600	5248	9992
8	3.3223	13		20496	40976	42016	83976	3240	6400	12040
9	3.9023	15		24576	49176	49176	98376	3752	7424	14344
10	4.5234	17		28168	56368	57376	114776	4352	8712	16392
11	5.1152	19		31752	63528	65576	131176	4864	9736	18432
12	5.5547	21	256QAM	34816	69672	69672	139376	5248	10760	20496
13	6.2266	23		38936	77896	79896	159880	6016	12040	22536
14	6.9141	25		43032	86040	88064	176208	6656	13320	25104
15	7.4063	27		46104	92200	94248	188576	7040	14088	27144

Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data
Note 2: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL
Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity
Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-2 of TS 38.214 [12]

Table A.4-3: Mapping of CQI Index to Information Bit payload (CQI table 2, Rank 3 and Rank 4)

TBS Scheme				TBS.3-1	TBS.3-2	TBS.3-3	TBS.3-4		
MCS table				256QAM					
Number of allocated PDSCH resource blocks				52	52	106	106		
Number of consecutive PDSCH symbols				12	12	12	12		
Number of PDSCH MIMO layers				3	4	3	4		
Number of DMRS REs (Note 1)				24	24	24	24		
Overhead for TBS determination				0	0	0	0		
Available RE-s for PDSCH				6240	6240	12720	12720		
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot					
0	OOR	OOR	OOR	N/A	N/A	N/A	N/A		
1	0.2344	0	QPSK	4360	5896	8976	11784		
2	0.3770	1		7048	9480	14344	18976		
3	0.8770	3		16392	22032	33816	45096		
4	1.4766	5	16QAM	27656	36896	56368	75792		
5	1.9141	7		35856	48168	73776	98376		
6	2.4063	9		45096	60456	92200	122976		
7	2.7305	11	64QAM	51216	67584	104496	139376		
8	3.3223	13		62504	81976	127080	167976		
9	3.9023	15		73776	98376	147576	196776		
10	4.5234	17		83976	112648	172176	229576		
11	5.1152	19		96264	127080	196776	262376		
12	5.5547	21	256QAM	104496	139376	213176	278776		
13	6.2266	23		116792	155776	237776	319784		
14	6.9141	25		129128	172176	262376	352440		
15	7.4063	27		139376	184424	278776	376896		
Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data Note 2: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity Note 4: Spectral efficiency is based on MCS Table defined in Table 5.1.3.1-2 of TS 38.214 [12]									

Table A.4-4: Mapping of CQI Index to Information Bit payload (CQI table 3)

TBS Scheme				TBS.4-1	TBS.4-2				
MCS table				64QAMLowSE					
Number of allocated PDSCH resource blocks				52	106				
Number of consecutive PDSCH symbols				12	12				
Number of PDSCH MIMO layers				1	1				
Number of DMRS REs (Note 1)				24	24				
Overhead for TBS determination				0	0				
Available RE-s for PDSCH				6240	12720				
CQI index	Spectral efficiency	MCS index	Modulation	Information Bit Payload per Slot					
0	OOR	OOR	OOR	N/A	N/A				
1	0.0586	0	QPSK	368	768				
2	0.0977	2		608	1256				
3	0.1523	4		984	2024				
4	0.2344	6		1480	2976				
5	0.3770	8		2408	4744				
6	0.6016	10		3752	7680				
7	0.8770	12		5504	11016				
8	1.1758	14		7296	14856				
9	1.4766	16	16QAM	9224	18960				
10	1.9141	18		12040	24576				
11	2.4063	20		15112	30728				
12	2.7305	22	64QAM	16896	34816				
13	3.3223	24		20496	42016				
14	3.9023	26		24576	49176				
15	4.5234	28		28168	57376				
Note 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data. Note 2: PDSCH is not scheduled on slots containing CSI-RS or slots which are not full DL. Note 3: PDSCH is not scheduled on slots containing PBCH, i.e. slot#0 per 20ms periodicity.									

A.5 OFDMA Channel Noise Generator (OCNG)

A.5.1 OCNG Patterns for FDD

A.5.1.1 OCNG FDD pattern 1: Generic OCNG FDD Pattern for all unused REs

Table A.5.1.1-1: OP.1 FDD: Generic OCNG FDD Pattern for all unused REs

OCNG Appliance / OCNG Parameters	Control Region (CORESET)	Data Region
Resources allocated	All unused REs (Note 1)	All unused REs (Note 2)
Structure	PDCCH	PDSCH
Content	Uncorrelated pseudo random QPSK modulated data	Uncorrelated pseudo random QPSK modulated data
Transmission scheme for multiple antennas ports transmission	Single Tx port transmission	Spatial multiplexing using any precoding matrix with dimensions same as the precoding matrix for PDSCH
Subcarrier Spacing	Same as for RMC PDCCH in the active BWP	Same as for RMC PDSCH in the active BWP
Power Level	Same as for RMC PDCCH	Same as for RMC PDSCH
Note 1: All unused REs in the active CORESETS appointed by the search spaces in use. Note 2: Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals, and excluding REs in all the available PDSCH DMRS CDM groups, in channel bandwidth.		

A.5.2 OCNG Patterns for TDD

A.5.2.1 OCNG TDD pattern 1: Generic OCNG TDD Pattern for all unused REs

Table A.5.2.1-1: OP.1 TDD: Generic OCNG TDD Pattern for all unused REs

OCNG Appliance / OCNG Parameters	Control Region (CORESET)	Data Region
Resources allocated	All unused REs (Note 1)	All unused REs (Note 2)
Structure	PDCCH	PDSCH
Content	Uncorrelated pseudo random QPSK modulated data	Uncorrelated pseudo random QPSK modulated data
Transmission scheme for multiple antennas ports transmission	Single Tx port transmission	Spatial multiplexing using any precoding matrix with dimensions same as the precoding matrix for PDSCH
Subcarrier Spacing	Same as for RMC PDCCH in the active BWP	Same as for RMC PDSCH in the active BWP
Power Level	Same as for RMC PDCCH	Same as for RMC PDSCH
Note 1: All unused REs in the active CORESETS appointed by the search spaces in use. Note 2: Unused available REs refer to REs in PRBs not allocated for any physical channels, CORESETs, synchronization signals or reference signals, and excluding REs in all the available PDSCH DMRS CDM groups, in channel bandwidth.		

A.6 SL reference measurement channels

A.6.1 General

The transport block size (TBS) determination procedure is described in clause 8.1.3 of TS 38.214 [12].

A.6.2 Reference measurement channels for PSSCH performance requirements

A.6.2.1 Reference measurement channels for SCS 15 kHz FR1

FFS

A.6.2.2 Reference measurement channels for SCS 30 kHz FR1

Table A.6.2.2-1: PSSCH Reference Channel

Parameter		Unit	Value				
Reference channel			R.PSSCH. 2-1.1	R.PSSCH. 2-1.2	R.PSSCH. 2-1.3	R.PSSCH. 2-1.4	R.PSSCH. 2-1.5
Channel bandwidth		MHz	20	20	20	20	20
Subcarrier spacing		kHz	30	30	30	30	30
Allocated resource blocks		RB	20	20	10	10	10
CP-OFDM symbols for slot with PSFCH(Note 1)			9	9	9	9	9
CP-OFDM symbols for slot without PSFCH			12	12	12	12	-
Modulation order			QPSK	16QAM	64QAM	QPSK	64QAM
MCS index			4	11	17	4	27
Number of MIMO layers			1	1	1	1	1
Number of DMRS REs			21	15	12	15	12
Number of REs for SCI format 1-A			240	240	240	240	240
2nd stage SCI format 2-A configuration	Payloads	Bits	35	35	35	35	35
	α		1	1	1	1	1
	β_{offset}		3.5	5	5	3.5	2.5
Overhead for TBS determination			0	0	0	0	0
Transport Block Size for slot with PSFCH		Bits	704	1800	984	208	3496
Transport Block Size for slot without PSFCH		Bits	1128	2856	1928	432	-
Transport block CRC		Bits	24	24	24	24	16
Maximum number of HARQ transmissions			1	1	1	1	2
Binary Channel Bits for slots with PSFCH			2304	4848	2232	744	3816
Binary Channel Bits for slots without PSFCH		Bits	3744	7728	4392	1464	-
Note 1: OFDM symbols is for PSCCH/PSSCH transmission not including first symbol (AGC), PSFCH symbols, and guard symbols.							

A.6.3 Reference measurement channels for PSCCH performance requirements

A.6.3.1 Reference measurement channels for SCS 15 kHz FR1

FFS

A.6.3.2 Reference measurement channels for SCS 30 kHz FR1

Table A.6.3.2-1: PSCCH Reference Channel

Parameter	Unit	Value
Reference channel		R.PSCCH.2-1.1
Allocated resource blocks	PRBs	10
OFDM Symbols per slot (Note 2)	Symbols	2
Modulation		QPSK
Payload (without CRC)	Bits	26
CRC	Bits	24
SCI Format		1-A
Binary Channel Bits	Bits	180
NOTE 1: The first OFDM symbol of a PSSCH and its associated PSCCH is duplicated as described in clauses 8.3.1.5 and 8.3.2.3 of TS 38.211 [9]. This symbol is used for AGC and not used for demodulation. NOTE 2: First OFDM symbol is not included.		

A.6.4 Reference measurement for PSBCH performance requirements

A.6.4.1 Reference measurement channels for SCS 15 kHz FR1

FFS

A.6.4.2 Reference measurement channels for SCS 30 kHz FR1

Table A.6.4.2-1: PSBCH Reference Channel

Parameter	Unit	Value
Reference channel		R.PSBCH.2-1
Channel bandwidth	MHz	20
Allocated resource blocks	PRBs	11
CP-OFDM Symbols per slot (see Note 1)	Symbols	8
Modulation		QPSK
Transport Block Size (without CRC)	Bits	32
Transport block CRC	Bits	24
Binary Channel Bits	Bits	1782
Note 1: PSBCH transmissions are rate-matched for 9 CP-OFDM symbols per slot. The first symbol is used for AGC and the last symbol is gap and shall not be used for PSBCH transmission as per TS 38.211 [9].		

Annex B (normative): Propagation conditions

B.0 No interference

The downlink connection between the System Simulator and the UE is without Additive White Gaussian Noise, and has no fading or multipath effects.

B.1 Static propagation condition

B.1.1 UE Receiver with 2Rx

For 1 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}.$$

For 2 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{pmatrix} 1 & j \\ 1 & -j \end{pmatrix}.$$

For 4 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & j & j \\ 1 & 1 & -j & -j \end{bmatrix}$$

For 8 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & 1 & 1 & j & j & j & j \\ 1 & 1 & 1 & 1 & -j & -j & -j & -j \end{bmatrix}$$

B.1.2 UE Receiver with 4Rx

For 1 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}.$$

For 2 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{bmatrix} 1 & j \\ 1 & -j \\ 1 & j \\ 1 & -j \end{bmatrix}.$$

For 4 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & j & j \\ 1 & 1 & -j & -j \\ 1 & -1 & j & -j \\ 1 & -1 & -j & j \end{bmatrix}.$$

For 8 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & 1 & 1 & j & j & j & j \\ 1 & 1 & 1 & 1 & -j & -j & -j & -j \\ 1 & 1 & -1 & -1 & j & j & -j & -j \\ 1 & 1 & -1 & -1 & -j & -j & j & j \end{bmatrix}$$

B.2 Multi-path fading propagation conditions

The multipath propagation conditions consist of several parts:

- A delay profile in the form of a "tapped delay-lin", characterized by a number of taps at fixed positions on a sampling grid. The profile can be further characterized by the r.m.s. delay spread and the maximum delay spanned by the taps.
- A combination of channel model parameters that include the Delay profile and the Doppler spectrum that is characterized by a classical spectrum shape and a maximum Doppler frequency.
- Different models are used for FR1 and FR2.

Initial channel matrix for LOS component of TDL-D channel model is equal to channel matrix of Static propagation conditions in Clause B.1.

B.2.1 Delay profiles

The delay profiles are simplified from the TR 38.901 [15] TDL models. The simplification steps are shown below for information. These steps are only used when new delay profiles are created. Otherwise, the delay profiles specified in B.2.1.1 and B.2.1.2 can be used as such.

Step 1: Use the original TDL model from TR38.901 [15].

Step 2: Re-order the taps in ascending delays

Step 3: Perform delay scaling according to the procedure described in subclause 7.7.3 in TR 38.901 [15].

Step 4: Apply the quantization to the delay resolution 5 ns. This is done simply by rounding the tap delays to the nearest multiple of the delay resolution.

Step 5: If multiple taps are rounded to the same delay bin, merge them by calculating their linear power sum.

Step 6: If there are more than 12 taps in the quantized model, merge the taps as follows:

- Find the weakest tap from all taps (both merged and unmerged taps are considered)
  - If there are two or more taps having the same value and are the weakest, select the tap with the smallest delay as the weakest tap.
- When the weakest tap is the first delay tap, merge taps as follows:
  - Update the power of the first delay tap as the linear power sum of the weakest tap and the second delay tap.
  - Remove the second delay tap.
- When the weakest tap is the last delay tap, merge taps as follows:
  - Update the power of the last delay tap as the linear power sum of the second-to-last tap and the last tap.
  - Remove the second-to-last tap.
- Otherwise

- For each side of the weakest tap, identify the neighbour tap that has the smaller delay difference to the weakest tap.
  - When the delay difference between the weakest tap and the identified neighbour tap on one side equals the delay difference between the weakest tap and the identified neighbour tap on the other side.
    - Select the neighbour tap that is weaker in power for merging.
  - Otherwise, select the neighbour tap that has smaller delay difference for merging.
- To merge, the power of the merged tap is the linear sum of the power of the weakest tap and the selected tap.
- When the selected tap is the first tap, the location of the merged tap is the location of the first tap. The weakest tap is removed.
- When the selected tap is the last tap, the location of the merged tap is the location of the last tap. The weakest tap is removed.
- Otherwise, the location of the merged tap is based on the average delay of the weakest tap and selected tap. If the average delay is on the sampling grid, the location of the merged tap is the average delay. Merge two parallel taps with different delays (average delay, sum power) starting from the weakest ones. Otherwise, the location of the merged tap is rounded towards the direction of the selected tap (e.g. 10 ns & 20 ns → 15 ns, 10 ns & 25 ns → 20 ns, if 25 ns had higher or equal power; 15 ns, if 10 ns had higher power). The weakest tap and the selected tap are removed.

- Repeat step 6 until the final number of taps is 12.

Step 7: Round the amplitudes of taps to one decimal (e.g. -8.78 dB → -8.8 dB)

Step 8: If the delay spread has slightly changed due to the tap merge, adjust the final delay spread by increasing or decreasing the power of the last tap so that the delay spread is corrected.

Step 9: Re-normalize tap powers such that the strongest tap is at 0dB.

Note 1: Some values of the delay profile created by the simplification steps may differ from the values in tables B.2.1.1-2, B.2.1.1-3, B.2.1.1-4, B.2.1.2-2, and B.2.1.1-3 for the corresponding model.

Note 2: For Step 5 and Step 6, the power values are expressed in the linear domain using 6 digits of precision. The operations are in the linear domain.

Note 3: Delay profile for TDLD30 is generated under assumption that Steps 1-8 are applied for taps with Rayleigh distribution.

B.2.1.1 Delay profiles for FR1

The delay profiles for FR1 are selected to be representative of low, medium and high delay spread environment. The resulting model parameters are specified in B.2.1.1-1 and the tapped delay line models are specified in Tables B.2.1.1-2 ~ Table B.2.1.1-4.

Table B.2.1.1-1: Delay profiles for NR channel models

Model	Number of channel taps	Delay spread (r.m.s.)	Maximum excess tap delay (span)	Delay resolution
TDLA30	12	30 ns	290 ns	5 ns
TDLB100	12	100 ns	480 ns	5 ns
TDLC300	12	300 ns	2595 ns	5 ns

Table B.2.1.1-2: TDLA30 (DS = 30 ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	-15.5	Rayleigh
2	10	0	Rayleigh
3	15	-5.1	Rayleigh
4	20	-5.1	Rayleigh
5	25	-9.6	Rayleigh
6	50	-8.2	Rayleigh
7	65	-13.1	Rayleigh
8	75	-11.5	Rayleigh
9	105	-11.0	Rayleigh
10	135	-16.2	Rayleigh
11	150	-16.6	Rayleigh
12	290	-26.2	Rayleigh

Table B.2.1.1-3: TDLB100 (DS = 100ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	0	Rayleigh
2	10	-2.2	Rayleigh
3	20	-0.6	Rayleigh
4	30	-0.6	Rayleigh
5	35	-0.3	Rayleigh
6	45	-1.2	Rayleigh
7	55	-5.9	Rayleigh
8	120	-2.2	Rayleigh
9	170	-0.8	Rayleigh
10	245	-6.3	Rayleigh
11	330	-7.5	Rayleigh
12	480	-7.1	Rayleigh

Table B.2.1.1-4: TDLC300 (DS = 300 ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	-6.9	Rayleigh
2	65	0	Rayleigh
3	70	-7.7	Rayleigh
4	190	-2.5	Rayleigh
5	195	-2.4	Rayleigh
6	200	-9.9	Rayleigh
7	240	-8.0	Rayleigh
8	325	-6.6	Rayleigh
9	520	-7.1	Rayleigh
10	1045	-13.0	Rayleigh
11	1510	-14.2	Rayleigh
12	2595	-16.0	Rayleigh

B.2.1.2 Delay profiles for FR2

The delay profiles for FR2 are specified in B.2.1.2-1 and the tapped delay line models are specified in Tables B.2.1.2-2 and B.2.1.2-3.

Table B.2.1.2-1: Delay profiles for NR channel models

Model	Number of channel taps	Delay spread (r.m.s.)	Maximum excess tap delay (span)	Delay resolution
TDLA30	12	30 ns	290 ns	5 ns
TDLC60	12	60 ns	520 ns	5 ns
TDLD30	10	30 ns	375 ns	5 ns

Table B.2.1.2-2: TDLA30 (DS = 30 ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	-15.5	Rayleigh
2	10	0	Rayleigh
3	15	-5.1	Rayleigh
4	20	-5.1	Rayleigh
5	25	-9.6	Rayleigh
6	50	-8.2	Rayleigh
7	65	-13.1	Rayleigh
8	75	-11.5	Rayleigh
9	105	-11.0	Rayleigh
10	135	-16.2	Rayleigh
11	150	-16.6	Rayleigh
12	290	-26.2	Rayleigh

Table B.2.1.2-3: TDLC60 (DS = 60 ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	-7.8	Rayleigh
2	15	-0.3	Rayleigh
3	40	0	Rayleigh
4	50	-8.9	Rayleigh
5	55	-14.5	Rayleigh
6	75	-8.5	Rayleigh
7	80	-10.2	Rayleigh
8	130	-12.1	Rayleigh
9	210	-13.9	Rayleigh
10	300	-15.2	Rayleigh
11	360	-16.9	Rayleigh
12	520	-19.4	Rayleigh

Table B.2.1.2-4: TDLD30 (DS = 30 ns)

Tap #	Delay [ns]	Power [dB]	Fading distribution
1	0	-0.2	LOS path
	0	-12.4	Rayleigh
2	20	-21	Rayleigh
3	40	-16.7	Rayleigh
4	55	-18.3	Rayleigh
5	80	-21.9	Rayleigh
6	120	-27.8	Rayleigh
7	240	-23.6	Rayleigh
8	285	-24.8	Rayleigh
9	290	-30.0	Rayleigh
10	375	-27.6	Rayleigh
Note 1: Tap #1 follows a Ricean distribution.			

B.2.2 Combinations of channel model parameters

The propagation conditions used for the performance measurements in multi-path fading environment are indicated as a combination of a channel model name and a maximum Doppler frequency, i.e. TDLA<DS>-<Doppler>, TDLB<DS>-<Doppler> or TDLC<DS>-<Doppler> where '<DS>' indicates the desired delay spread and '<Doppler>' indicates the maximum Doppler frequency (Hz).

Table B.2.2-1 and Table B.2.2-2 show the propagation conditions that are used for the performance measurements in multi-path fading environment for low, medium and high Doppler frequencies for FR1 and FR2, respectively.

Table B.2.2-1: Channel model parameters for FR1

Combination name	Model	Maximum Doppler frequency
TDLA30-5	TDLA30	5 Hz
TDLA30-10	TDLA30	10 Hz
TDLB100-400	TDLB100	400 Hz
TDLC300-100	TDLC300	100 Hz
TDLC300-600	TDLC300	600 Hz
TDLC300-1200	TDLC300	1200 Hz

Table B.2.2-2: Channel model parameters for FR2

Combination name	Model	Maximum Doppler frequency
TDLA30-35	TDLA30	35 Hz
TDLA30-75	TDLA30	75 Hz
TDLA30-300	TDLA30	300 Hz
TDLC60-300	TDLC60	300 Hz
TDLD30-75	TDLD30	75 Hz

B.2.3 MIMO Channel Correlation Matrices

The MIMO channel correlation matrices defined in B.2.3 apply for the antenna configuration using uniform linear arrays at both gNB and UE and for the antenna configuration using cross polarized antennas.

B.2.3.1 MIMO Correlation Matrices using Uniform Linear Array (ULA)

The MIMO channel correlation matrices defined in B.2.3.1 apply for the antenna configuration using uniform linear array (ULA) at both gNB and UE.

B.2.3.1.1 Definition of MIMO Correlation Matrices

Table B.2.3.1.1-1 defines the correlation matrix for the gNB.

Table B.2.3.1.1-1: gNB correlation matrix

	One antenna	Two antennas	Four antennas
gNB Correlation	$R_{gNB} = 1$	$R_{gNB} = \begin{pmatrix} 1 & \alpha \\ \alpha^* & 1 \end{pmatrix}$	$R_{gNB} = \begin{pmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9*} & \alpha^{1/9*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9*} & \alpha^{1/9*} & 1 \end{pmatrix}$

Table B.2.3.1.1-2 defines the correlation matrix for the UE:

Table B.2.3.1.1-2 UE correlation matrix

	One antenna	Two antennas	Four antennas
UE Correlation	$R_{UE} = 1$	$R_{UE} = \begin{pmatrix} 1 & \beta \\ \beta^* & \mathbf{1} \end{pmatrix}$	$R_{UE} = \begin{pmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9^*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9^*} & \beta^{1/9^*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9^*} & \beta^{1/9^*} & 1 \end{pmatrix}$

Table B.2.3.1.1-3 defines the channel spatial correlation matrix R_{spat} . The parameters, α and β in Table B.2.3.1-3 defines the spatial correlation between the antennas at the gNB and UE.

Table B.2.3.1.1-3: R_{spat} correlation matrices

1x2 case	$R_{spat} = R_{UE} = \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix}$
1x4 case	$R_{spat} = R_{UE} = \begin{pmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9^*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9^*} & \beta^{1/9^*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9^*} & \beta^{1/9^*} & 1 \end{pmatrix}$
2x1 case	$R_{spat} = R_{gNB} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix}$
2x2 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix} = \begin{bmatrix} 1 & \beta & \alpha & \alpha\beta \\ \beta^* & 1 & \alpha\beta^* & \alpha \\ \alpha^* & \alpha^*\beta & 1 & \beta \\ \alpha^*\beta^* & \alpha^* & \beta^* & 1 \end{bmatrix}$
2x4 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9^*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9^*} & \beta^{1/9^*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9^*} & \beta^{1/9^*} & 1 \end{bmatrix}$
4x1 case	$R_{spat} = R_{gNB} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9^*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9^*} & \alpha^{1/9^*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9^*} & \alpha^{1/9^*} & 1 \end{bmatrix}$
4x2 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9^*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9^*} & \alpha^{1/9^*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9^*} & \alpha^{1/9^*} & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix}$
4x4 case	$R_{spat} = R_{gNB} \otimes R_{UE} = \begin{bmatrix} 1 & \alpha^{1/9} & \alpha^{4/9} & \alpha \\ \alpha^{1/9^*} & 1 & \alpha^{1/9} & \alpha^{4/9} \\ \alpha^{4/9^*} & \alpha^{1/9^*} & 1 & \alpha^{1/9} \\ \alpha^* & \alpha^{4/9^*} & \alpha^{1/9^*} & 1 \end{bmatrix} \otimes \begin{pmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9^*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9^*} & \beta^{1/9^*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9^*} & \beta^{1/9^*} & 1 \end{pmatrix}$

For cases with more antennas at either gNB or UE or both, the channel spatial correlation matrix can still be expressed as the Kronecker product of R_{gNB} and R_{UE} according to $R_{spat} = R_{gNB} \otimes R_{UE}$.

B.2.3.1.2 MIMO Correlation Matrices at High, Medium and Low Level

The α and β for different correlation types are given in Table B.2.3.1.2-1.

Table B.2.3.1.2-1: The α and β parameters for ULA MIMO correlation matrices

Correlation Model	α	β
Low correlation	0	0
Medium Correlation	0.3	0.9
Medium Correlation A	0.3	0.3874
High Correlation	0.9	0.9

The correlation matrices for high, medium, medium A and low correlation are defined in Tables B.2.3.1.2-2, B.2.3.1.2-3, B.2.3.1.2-4 and B.2.3.1.2-5 as below.

The values in Table B.2.3.1.2-2 have been adjusted for the 4x2 and 4x4 high correlation cases to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision. This is done using the equation:

$$R_{high} = [R_{spat} + aI_n]/(1 + a)$$

Where the value "a" is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 4x2 high correlation case, a=0.00010. For the 4x4 high correlation case, a=0.00012.

The same method is used to adjust the 2x4 and 4x4 medium correlation matrix in Table B.2.3.1.2-3 to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision with a = 0.00010 and a = 0.00012.

Table B.2.3.1.2-2: MIMO correlation matrices for high correlation

1x2 case	$R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$
2x1 case	$R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$
2x2 case	$R_{high} = \begin{pmatrix} 1 & 0.9 & 0.9 & 0.81 \\ 0.9 & 1 & 0.81 & 0.9 \\ 0.9 & 0.81 & 1 & 0.9 \\ 0.81 & 0.9 & 0.9 & 1 \end{pmatrix}$
4x2 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 & 0.8999 & 0.8099 \\ 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 & 0.8099 & 0.8999 \\ 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 & 0.9542 & 0.8587 \\ 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 & 0.8587 & 0.9542 \\ 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 & 0.9883 & 0.8894 \\ 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 & 0.8894 & 0.9883 \\ 0.8999 & 0.8099 & 0.9542 & 0.8587 & 0.9883 & 0.8894 & 1.0000 & 0.8999 \\ 0.8099 & 0.8999 & 0.8587 & 0.9542 & 0.8894 & 0.9883 & 0.8999 & 1.0000 \end{bmatrix}$
4x4 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.8999 & 0.8894 & 0.8587 & 0.8099 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.8894 & 0.8999 & 0.8894 & 0.8587 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.8587 & 0.8894 & 0.8999 & 0.8894 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8099 & 0.8587 & 0.8894 & 0.8999 \\ 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 0.9541 & 0.9430 & 0.9105 & 0.8587 \\ 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9430 & 0.9541 & 0.9430 & 0.9105 \\ 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9105 & 0.9430 & 0.9541 & 0.9430 \\ 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8587 & 0.9105 & 0.9430 & 0.9541 \\ 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.9882 & 0.9767 & 0.9430 & 0.8894 \\ 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.9767 & 0.9882 & 0.9767 & 0.9430 \\ 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.9430 & 0.9767 & 0.9882 & 0.9767 \\ 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.8894 & 0.9430 & 0.9767 & 0.9882 \\ 0.8999 & 0.8894 & 0.8587 & 0.8099 & 0.9541 & 0.9430 & 0.9105 & 0.8587 & 0.9882 & 0.9767 & 0.9430 & 0.8894 & 1.0000 & 0.9882 & 0.9541 & 0.8999 \\ 0.8894 & 0.8999 & 0.8894 & 0.8587 & 0.9430 & 0.9541 & 0.9430 & 0.9105 & 0.9767 & 0.9882 & 0.9767 & 0.9430 & 0.9882 & 1.0000 & 0.9882 & 0.9541 \\ 0.8587 & 0.8894 & 0.8999 & 0.8894 & 0.9105 & 0.9430 & 0.9541 & 0.9430 & 0.9430 & 0.9767 & 0.9882 & 0.9767 & 0.9541 & 0.9882 & 1.0000 & 0.9882 \\ 0.8099 & 0.8587 & 0.8894 & 0.8999 & 0.8587 & 0.9105 & 0.9430 & 0.9541 & 0.8894 & 0.9430 & 0.9767 & 0.9882 & 0.8999 & 0.9541 & 0.9882 & 1.0000 \end{bmatrix}$

Table B.2.3.1.2-3: MIMO correlation matrices for medium correlation

1x2 case	N/A
2x1 case	N/A
2x2 case	$R_{medium} = \begin{pmatrix} 1 & 0.9 & 0.3 & 0.27 \\ 0.9 & 1 & 0.27 & 0.3 \\ 0.3 & 0.27 & 1 & 0.9 \\ 0.27 & 0.3 & 0.9 & 1 \end{pmatrix}$
2x4 case	$R_{medium} = \begin{pmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.3000 & 0.2965 & 0.2862 & 0.2700 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.2965 & 0.3000 & 0.2965 & 0.2862 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.2862 & 0.2965 & 0.3000 & 0.2965 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.2700 & 0.2862 & 0.2965 & 0.3000 \\ 0.3000 & 0.2965 & 0.2862 & 0.2700 & 1.0000 & 0.9882 & 0.9541 & 0.8999 \\ 0.2965 & 0.3000 & 0.2965 & 0.2862 & 0.9882 & 1.0000 & 0.9882 & 0.9541 \\ 0.2862 & 0.2965 & 0.3000 & 0.2965 & 0.9541 & 0.9882 & 1.0000 & 0.9882 \\ 0.2700 & 0.2862 & 0.2965 & 0.3000 & 0.8999 & 0.9541 & 0.9882 & 1.0000 \end{pmatrix}$
4x2 case	$R_{medium} = \begin{pmatrix} 1.0000 & 0.9000 & 0.8748 & 0.7873 & 0.5856 & 0.5271 & 0.3000 & 0.2700 \\ 0.9000 & 1.0000 & 0.7873 & 0.8748 & 0.5271 & 0.5856 & 0.2700 & 0.3000 \\ 0.8748 & 0.7873 & 1.0000 & 0.9000 & 0.8748 & 0.7873 & 0.5856 & 0.5271 \\ 0.7873 & 0.8748 & 0.9000 & 1.0000 & 0.7873 & 0.8748 & 0.5271 & 0.5856 \\ 0.5856 & 0.5271 & 0.8748 & 0.7873 & 1.0000 & 0.9000 & 0.8748 & 0.7873 \\ 0.5271 & 0.5856 & 0.7873 & 0.8748 & 0.9000 & 1.0000 & 0.7873 & 0.8748 \\ 0.3000 & 0.2700 & 0.5856 & 0.5271 & 0.8748 & 0.7873 & 1.0000 & 0.9000 \\ 0.2700 & 0.3000 & 0.5271 & 0.5856 & 0.7873 & 0.8748 & 0.9000 & 1.0000 \end{pmatrix}$
4x4 case	$R_{medium} = \begin{pmatrix} 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 0.5855 & 0.5787 & 0.5588 & 0.5270 & 0.3000 & 0.2965 & 0.2862 & 0.2700 \\ 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.5787 & 0.5855 & 0.5787 & 0.5588 & 0.2965 & 0.3000 & 0.2965 & 0.2862 \\ 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.5588 & 0.5787 & 0.5855 & 0.5787 & 0.2862 & 0.2965 & 0.3000 & 0.2965 \\ 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.5270 & 0.5588 & 0.5787 & 0.5855 & 0.2700 & 0.2862 & 0.2965 & 0.3000 \\ 0.8747 & 0.8645 & 0.8347 & 0.7872 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 0.5855 & 0.5787 & 0.5588 & 0.5270 \\ 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.5787 & 0.5855 & 0.5787 & 0.5588 \\ 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.5588 & 0.5787 & 0.5855 & 0.5787 \\ 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.5270 & 0.5588 & 0.5787 & 0.5855 \\ 0.5855 & 0.5787 & 0.5588 & 0.5270 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 1.0000 & 0.9882 & 0.9541 & 0.8999 & 0.8747 & 0.8645 & 0.8347 & 0.7872 \\ 0.5787 & 0.5855 & 0.5787 & 0.5588 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.9882 & 1.0000 & 0.9882 & 0.9541 & 0.8645 & 0.8747 & 0.8645 & 0.8347 \\ 0.5588 & 0.5787 & 0.5855 & 0.5787 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.9541 & 0.9882 & 1.0000 & 0.9882 & 0.8347 & 0.8645 & 0.8747 & 0.8645 \\ 0.5270 & 0.5588 & 0.5787 & 0.5855 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.8999 & 0.9541 & 0.9882 & 1.0000 & 0.7872 & 0.8347 & 0.8645 & 0.8747 \\ 0.3000 & 0.2965 & 0.2862 & 0.2700 & 0.5855 & 0.5787 & 0.5588 & 0.5270 & 0.8747 & 0.8645 & 0.8347 & 0.7872 & 1.0000 & 0.9882 & 0.9541 & 0.8999 \\ 0.2965 & 0.3000 & 0.2965 & 0.2862 & 0.5787 & 0.5855 & 0.5787 & 0.5588 & 0.8645 & 0.8747 & 0.8645 & 0.8347 & 0.9882 & 1.0000 & 0.9882 & 0.9541 \\ 0.2862 & 0.2965 & 0.3000 & 0.2965 & 0.5588 & 0.5787 & 0.5855 & 0.5787 & 0.8347 & 0.8645 & 0.8747 & 0.8645 & 0.9541 & 0.9882 & 1.0000 & 0.9882 \\ 0.2700 & 0.2862 & 0.2965 & 0.3000 & 0.5270 & 0.5588 & 0.5787 & 0.5855 & 0.7872 & 0.8347 & 0.8645 & 0.8747 & 0.8999 & 0.9541 & 0.9882 & 1.0000 \end{pmatrix}$

Table B.2.3.1.2-4: MIMO correlation matrices for medium correlation A

2x4 case	$R_{medium\ A} = \begin{pmatrix} 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.3000 & 0.2700 & 0.1968 & 0.1162 \\ 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.2700 & 0.3000 & 0.2700 & 0.1968 \\ 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.1968 & 0.2700 & 0.3000 & 0.2700 \\ 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.1162 & 0.1968 & 0.2700 & 0.3000 \\ 0.3000 & 0.2700 & 0.1968 & 0.1162 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \\ 0.1968 & 0.2700 & 0.3000 & 0.2700 & 0.6561 & 0.9000 & 1.0000 & 0.9000 \\ 0.1162 & 0.1968 & 0.2700 & 0.3000 & 0.3874 & 0.6561 & 0.9000 & 1.0000 \end{pmatrix}$
4x4 case	$R_{medium\ A} = \begin{pmatrix} 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 0.5856 & 0.5270 & 0.3842 & 0.2269 & 0.3000 & 0.2700 & 0.1968 & 0.1162 \\ 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.5270 & 0.5856 & 0.5270 & 0.3842 & 0.2700 & 0.3000 & 0.2700 & 0.1968 \\ 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.3842 & 0.5270 & 0.5856 & 0.5270 & 0.1968 & 0.2700 & 0.3000 & 0.2700 \\ 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.1162 & 0.1968 & 0.2700 & 0.3000 \\ 0.8748 & 0.7873 & 0.5739 & 0.3389 & 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 0.5856 & 0.5270 & 0.3842 & 0.2269 \\ 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.5270 & 0.5856 & 0.5270 & 0.3842 \\ 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.3842 & 0.5270 & 0.5856 & 0.5270 \\ 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.2269 & 0.3842 & 0.5270 & 0.5856 \\ 0.5856 & 0.5270 & 0.3842 & 0.2269 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 1.0000 & 0.9000 & 0.6561 & 0.3874 & 0.8748 & 0.7873 & 0.5739 & 0.3389 \\ 0.5270 & 0.5856 & 0.5270 & 0.3842 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.9000 & 1.0000 & 0.9000 & 0.6561 & 0.7873 & 0.8748 & 0.7873 & 0.5739 \\ 0.3842 & 0.5270 & 0.5856 & 0.5270 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.6561 & 0.9000 & 1.0000 & 0.9000 & 0.5739 & 0.7873 & 0.8748 & 0.7873 \\ 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 & 0.3389 & 0.5739 & 0.7873 & 0.8748 \\ 0.3000 & 0.2700 & 0.1968 & 0.1162 & 0.5856 & 0.5270 & 0.3842 & 0.2269 & 0.8748 & 0.7873 & 0.5739 & 0.3389 & 1.0000 & 0.9000 & 0.6561 & 0.3874 \\ 0.2700 & 0.3000 & 0.2700 & 0.1968 & 0.5270 & 0.5856 & 0.5270 & 0.3842 & 0.7873 & 0.8748 & 0.7873 & 0.5739 & 0.9000 & 1.0000 & 0.9000 & 0.6561 \\ 0.1968 & 0.2700 & 0.3000 & 0.2700 & 0.3842 & 0.5270 & 0.5856 & 0.5270 & 0.5739 & 0.7873 & 0.8748 & 0.7873 & 0.6561 & 0.9000 & 1.0000 & 0.9000 \\ 0.1162 & 0.1968 & 0.2700 & 0.3000 & 0.2269 & 0.3842 & 0.5270 & 0.5856 & 0.3389 & 0.5739 & 0.7873 & 0.8748 & 0.3874 & 0.6561 & 0.9000 & 1.0000 \end{pmatrix}$

Table B.2.3.1.2-5: MIMO correlation matrices for low correlation

1x2 case	$R_{low} = \mathbf{I}_2$
1x4 case	$R_{low} = \mathbf{I}_4$
2x1 case	$R_{low} = \mathbf{I}_2$
2x2 case	$R_{low} = \mathbf{I}_4$
2x4 case	$R_{low} = \mathbf{I}_8$
4x1 case	$R_{low} = \mathbf{I}_4$
4x2 case	$R_{low} = \mathbf{I}_8$
4x4 case	$R_{low} = \mathbf{I}_{16}$

In Table B.2.3.1.2-5, $\mathbf{I}_d$ is the $d \times d$ identity matrix.

B.2.3.2 MIMO Correlation Matrices using Cross Polarized Antennas (X-pol)

The MIMO channel correlation matrices defined in B.2.3.2 apply for the antenna configuration using cross polarized (XP/X-pol) antennas at both gNB and UE. The cross-polarized antenna elements with +/-45 degrees polarization slant angles are deployed at gNB and cross-polarized antenna elements with +90/0 degrees polarization slant angles are deployed at UE.

For the 2D cross-polarized antenna array at eNodeB, the *N* antennas are indexed by (N_1, N_2, P), and total number of antennas is $N = P \cdot N_1 \cdot N_2$, where

- N_1 is the number of antenna elements in first dimension with same polarization,
- N_2 is the number of antenna elements in second dimension with same polarization, and
- P is the number of polarization groups.

For the 2D cross-polarized antennas at gNB, the *N* antennas are labelled such that antennas shall be in increasing order of the second dimension firstly, then the first dimension, and finally the polarization group. For a specific antenna element at *p*-th polarization, n_1-th row, and n_2-th column within the 2D antenna array, the following index number is used for antenna labelling:

$$Index(p,n_1,n_2) = p \cdot N_1 \cdot N_2 + n_1 \cdot N_2 + n_2 + 1; \qquad p = 0,1;\ \ n_1 = 0,\cdots,N_1 - 1;\ \ n_2 = 0,\cdots,N_2 - 1.$$

where *N* is the number of transmit antennas, *p* is the polarization group index, n_1 is the row index, and n_2 is the column index of the antenna element.

For the linear (single dimension, 1D) cross-polarized antenna, the *N* antennas are labelled following the above equations with N_2=1.

B.2.3.2.1 Definition of MIMO Correlation Matrices using cross polarized antennas

For the channel spatial correlation matrix, the following is used:

$$R_{spat} = P\left(R_{gNB} \otimes \Gamma \otimes R_{UE}\right)P^T$$

where

- R_{UE} is the spatial correlation matrix at the UE with same polarization,
- R_{gNB} is the spatial correlation matrix at the gNB with same polarization,
- Γ is a polarization correlation matrix, and
- $(\bullet)^T$ denotes transpose.

The matrix Γ is defined as:

$$\Gamma = \begin{bmatrix} 1 & 0 & -\gamma & 0 \\ 0 & 1 & 0 & \gamma \\ -\gamma & 0 & 1 & 0 \\ 0 & \gamma & 0 & 1 \end{bmatrix}$$

A permutation matrix P elements are defined as:

$$P(a,b) = \begin{cases} 1 & for \quad a = (j-1)Nr + i \quad and \quad b = 2(j-1)Nr + i, \qquad i = 1,\cdots,Nr,\ j = 1,\cdots Nt/2 \\ 1 & for \quad a = (j-1)Nr + i \quad and \quad b = 2(j - Nt/2)Nr - Nr + i, \quad i = 1,\cdots,Nr,\ j = Nt/2+1,\cdots,Nt \\ 0 & otherwise \end{cases}.$$

where *Nt* and *Nr* is the number of transmitter and receiver respectively. This is used to map the spatial correlation coefficients in accordance with the antenna element labelling system described in B.2.3.2.

For the 2D cross-polarized antenna array at gNB, the spatial correlation matrix at the gNB is further expressed as following for 2D cross-polarized antenna array at gNB:

$$R_{gNB} = R_{gNB\_Dim,1} \otimes R_{gNB\_Dim,2}$$

where

- $R_{gNB\_Dim,1}$ is the correlation matrix of antenna elements in first dimension with same polarization, and
- $R_{gNB\_Dim,2}$ is the correlation matrix of antenna elements in second dimension with same polarization.

For the 2D cross polarized antenna array at gNB side, the spatial correlation matrices in one direction of antenna array are as follows:

- For 1 antenna element with the same polarization in one direction,

$$R_{gNB\_Dim,i} = 1.$$

- For 2 antenna elements with the same polarization in one direction,

$$R_{gNB\_Dim,i} = \begin{pmatrix} 1 & \alpha_i \\ \alpha_i^* & 1 \end{pmatrix}.$$

- For 3 antenna elements with the same polarization in one direction,

$$R_{gNB\_Dim,i} = \begin{pmatrix} 1 & \alpha_i^{1/4} & \alpha_i \\ \alpha_i^{1/4*} & 1 & \alpha_i^{1/4} \\ \alpha_i^* & \alpha_i^{1/4*} & 1 \end{pmatrix}.$$

- For 4 antenna elements with the same polarization in one direction,

$$R_{gNB\_Dim,i} = \begin{pmatrix} 1 & \alpha_i^{1/9} & \alpha_i^{4/9} & \alpha_i \\ \alpha_i^{1/9*} & 1 & \alpha_i^{1/9} & \alpha_i^{4/9} \\ \alpha_i^{4/9*} & \alpha_i^{1/9*} & 1 & \alpha_i^{1/9} \\ \alpha_i^* & \alpha_i^{4/9*} & \alpha_i^{1/9*} & 1 \end{pmatrix}.$$

where the index i = 1,2 stands for first dimension and second dimension respectively.

For the 1D cross-polarized antenna array at gNB, the matrix of R_{gNB} is determined by follow the equations for 2D cross-polarized antenna array and letting $R_{gNB\_Dim,2} = 1$, i.e.

$$R_{gNB} = R_{gNB\_Dim,1}$$

The spatial correlation matrices at UE side are as follows:

- For 1 antenna element with the same polarization,

$$R_{UE} = 1.$$

- For 2 antenna elements with the same polarization,

$$R_{UE} = \begin{pmatrix} 1 & \beta \\ \beta^* & 1 \end{pmatrix}.$$

B.2.3.2.2 MIMO Correlation Matrices using cross polarized antennas

The values for parameters α_1, α_2. β and γ for the cross polarized antenna models are given in Table B.2.3.2.2-1.

Table B.2.3.2.2-1: The α and β parameters for cross-polarized MIMO correlation matrices

Correlation Model	α_1	α_2	β	γ
Medium Correlation	0.3	0.3	0.6	0.2
High Correlation	0.9	0.9	0.9	0.3
NOTE 1: Value of α_1 applies when more than one pair of cross-polarized antenna elements in first dimension at gNB side. NOTE 2: Value of α_2 applies when more than one pair of cross-polarized antenna elements in second dimension at gNB side. NOTE 3: Value of β applies when more than one pair of cross-polarized antenna elements at UE side.				

For the 1D cross polarized antenna array at gNB side, the correlation matrices for high spatial correlation and medium correlation are defined in Table B.2.3.2.2-2 and Table B.2.3.2.2-3 as below.

The values in Table B.2.3.2.2-2 have been adjusted to ensure the correlation matrix is positive semi-definite after round-off to 4 digit precision. This is done using the equation:

$$R_{high} = [R_{spat} + aI_n]/(1+a) \text{ or } R_{medium} = [R_{spat} + aI_n]/(1+a)$$

Where the value "a" is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 8(4,1,2)x2 high spatial correlation case, a=0.00010.

Table B.2.3.2.2-2: MIMO correlation matrices for high spatial correlation

4(2,1,2)x 2 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.0000 & 0.9000 & 0.0000 & -0.3000 & 0.0000 & -0.2700 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.9000 & 0.0000 & 0.3000 & 0.0000 & 0.2700 \\ 0.9000 & 0.0000 & 1.0000 & 0.0000 & -0.2700 & 0.0000 & -0.3000 & 0.0000 \\ 0.0000 & 0.9000 & 0.0000 & 1.0000 & 0.0000 & 0.2700 & 0.0000 & 0.3000 \\ -0.3000 & 0.0000 & -0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9000 & 0.0000 \\ 0.0000 & 0.3000 & 0.0000 & 0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9000 \\ -0.2700 & 0.0000 & -0.3000 & 0.0000 & 0.9000 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2700 & 0.0000 & 0.3000 & 0.0000 & 0.9000 & 0.0000 & 1.0000 \end{bmatrix}$
2(1,1,2)x 4 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.9000 & 0.0000 & 0.0000 & -0.3000 & -0.2700 & 0.0000 & 0.0000 \\ 0.9000 & 1.0000 & 0.0000 & 0.0000 & -0.2700 & -0.3000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.3000 & 0.2700 \\ 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.2700 & 0.3000 \\ -0.3000 & -0.2700 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 \\ -0.2700 & -0.3000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.3000 & 0.2700 & 0.0000 & 0.0000 & 1.0000 & 0.9000 \\ 0.0000 & 0.0000 & 0.2700 & 0.3000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 \end{bmatrix}$
4(2,1,2)x 4 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & -0.3000 & -0.2700 & 0.0000 & 0.0000 & -0.2700 & -0.2430 & 0.0000 & 0.0000 \\ 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & -0.2700 & -0.3000 & 0.0000 & 0.0000 & -0.2430 & -0.2700 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & 0.3000 & 0.2700 & 0.0000 & 0.0000 & 0.2700 & 0.2430 \\ 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.2700 & 0.3000 & 0.0000 & 0.0000 & 0.2430 & 0.2700 \\ 0.9000 & 0.8100 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & -0.2700 & -0.2430 & 0.0000 & 0.0000 & -0.3000 & -0.2700 & 0.0000 & 0.0000 \\ 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & -0.2430 & -0.2700 & 0.0000 & 0.0000 & -0.2700 & -0.3000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.2700 & 0.2430 & 0.0000 & 0.0000 & 0.3000 & 0.2700 \\ 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.2430 & 0.2700 & 0.0000 & 0.0000 & 0.2700 & 0.3000 \\ -0.3000 & -0.2700 & 0.0000 & 0.0000 & -0.2700 & -0.2430 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 \\ -0.2700 & -0.3000 & 0.0000 & 0.0000 & -0.2430 & -0.2700 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.3000 & 0.2700 & 0.0000 & 0.0000 & 0.2700 & 0.2430 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 0.8100 \\ 0.0000 & 0.0000 & 0.2700 & 0.3000 & 0.0000 & 0.0000 & 0.2430 & 0.2700 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 \\ -0.2700 & -0.2430 & 0.0000 & 0.0000 & -0.3000 & -0.2700 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & 1.0000 & 0.9000 & 0.0000 & 0.0000 \\ -0.2430 & -0.2700 & 0.0000 & 0.0000 & -0.2700 & -0.3000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.2700 & 0.2430 & 0.0000 & 0.0000 & 0.3000 & 0.2700 & 0.0000 & 0.0000 & 0.9000 & 0.8100 & 0.0000 & 0.0000 & 1.0000 & 0.9000 \\ 0.0000 & 0.0000 & 0.2430 & 0.2700 & 0.0000 & 0.0000 & 0.2700 & 0.3000 & 0.0000 & 0.0000 & 0.8100 & 0.9000 & 0.0000 & 0.0000 & 0.9000 & 1.0000 \end{bmatrix}$
8(4,1,2)x 2 case	$R_{high} = \begin{bmatrix} 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 & -0.2700 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 & 0.0000 & 0.2700 \\ 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 \\ 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 \\ 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 \\ 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 \\ 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & -0.2700 & 0.0000 & -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 \\ 0.0000 & 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.2700 & 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 \\ -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 & -0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 & 0.0000 \\ 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 & 0.0000 & 0.2700 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 & 0.8999 \\ -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & -0.2862 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 & 0.0000 \\ 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.2862 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 & 0.9542 \\ -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & -0.2965 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 & 0.0000 \\ 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.2965 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 & 0.9883 \\ -0.2700 & 0.0000 & -0.2862 & 0.0000 & -0.2965 & 0.0000 & -0.3000 & 0.0000 & 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2700 & 0.0000 & 0.2862 & 0.0000 & 0.2965 & 0.0000 & 0.3000 & 0.0000 & 0.8999 & 0.0000 & 0.9542 & 0.0000 & 0.9883 & 0.0000 & 1.0000 \end{bmatrix}$

Table B.2.3.2.2-3: MIMO correlation matrices for medium spatial correlation

2(1,1,2)x2 case	$R_{medium} = \begin{bmatrix} 1.0000 & 0.0000 & -0.2000 & 0.0000 \\ 0.0000 & 1.0000 & 0.0000 & 0.2000 \\ -0.2000 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.2000 & 0.0000 & 1.0000 \end{bmatrix}$

B.2.3.2.3 Beam steering approach

For the 2D cross-polarized antenna array at gNB, given the channel spatial correlation matrix in B.2.3.2.1 and B.2.3.2.2, the corresponding random channel matrix *H* can be calculated. The signal model for the *k*-th slot is denoted as:

$$y = HD_{\theta_{k,1},\theta_{k,2}}Wx + n$$

And the steering matrix is further expressed as following:

$$D_{\theta_{k,1},\theta_{k,2}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes \left(D_{\theta_{k,1}}(N_1) \otimes D_{\theta_{k,2}}(N_2) \right)$$

Where:

- H is the $Nr \times Nt$ channel matrix per subcarrier.
- $D_{\theta_{k,1},\theta_{k,2}}$ is the steering matrix,
- $D_{\theta_{k,1}}(N_1)$ is the steering matrix in first dimension with same polarization,
- $D_{\theta_{k,2}}(N_2)$ is the steering matrix in second dimension with same polarization,
- N_1 is the number of antenna elements in first dimension with same polarization,
- N_2 is the number of antenna elements in second dimension with same polarization,

For antenna array with only one direction, number of antenna element in second direction N_2 equals 1.

For 1 antenna element with the same polarization in one direction,

$$D_{\theta_{k,i}}(1) = 1.$$

For 2 antenna elements with the same polarization in one direction,

$$D_{\theta_{k,i}}(2) = \begin{bmatrix} 1 & 0 \\ 0 & e^{j3\theta_{k,i}} \end{bmatrix}.$$

For 3 antenna elements with the same polarization in one direction,

$$D_{\theta_{k,i}}(3) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & e^{j1.5\theta_{k,i}} & 0 \\ 0 & 0 & e^{j3\theta_{k,i}} \end{bmatrix}.$$

For 4 antenna elements with the same polarization in one direction,

$$D_{\theta_{k,i}}(4) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & e^{j\theta_{k,i}} & 0 & 0 \\ 0 & 0 & e^{j2\theta_{k,i}} & 0 \\ 0 & 0 & 0 & e^{j3\theta_{k,i}} \end{bmatrix}.$$

where the index $i = 1,2$ stands for first dimension and second dimension respectively.

$\theta_{k,i}$ controls the phase variation in first dimension and second dimension respectively, and the phase for k-th subframe is denoted by $\theta_{k,i} = \theta_{0,i} + \Delta\theta \cdot k$, where $\theta_{0,i}$ is the random start value with the uniform distribution, i.e. $\theta_{0,i} \in [0,2\pi]$, $\Delta\theta$ is the step of phase variation, which is defined in Table B.2.3.2.2.3-1, and k is the linear increment of $2^{-\mu}$ for every slot throughout the simulation, the index $i = 1,2$ stands for first dimension and second dimension respectively.

- W is the precoding matrix for Nt transmission antennas,
- *y* is the received signal, *x* is the transmitted signal, and *n* is AWGN.
- μ corresponds to subcarrier spacing configuration, $\Delta f = 2^{\mu} \cdot 15\,[\mathrm{kHz}]$

For the 1D cross-polarized antenna array at gNB, the corresponding random channel matrix *H* can be calculated by letting N_2=1, i.e.

$$D_{\theta_{k,1}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes D_{\theta_{k,1}}(N_1)$$

Table B.2.3.2.2.3-1: The step of phase variation

Variation Step	Value (rad/ms)
$\Delta\theta$	1.2566×10^{-3}

B.2.3.2.3A Beam steering approach with dual cluster beams

For the 2D cross-polarized antenna array at gNB, given the channel spatial correlation matrix in B.2.3.2.1 and B.2.3.2.2, the corresponding random channel matrix *H* can be calculated. The signal model for the *k*-th slot is denoted as

$$y = \left[\sqrt{\frac{1}{1+p^2}} H_m D^{(m)}_{\theta_{k,1},\theta_{k,2}} + \sqrt{\frac{p^2}{1+p^2}} H_s D^{(s)}_{\theta_{k,1},\theta_{k,2}} \right] Wx + n$$

And the steering matrix is further expressed as following:

$$D_{\theta_{k,1},\theta_{k,2}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes \left(D_{\theta_{k,1}}(N_1) \otimes D_{\theta_{k,2}}(N_2) \right)$$

where

- H_m, H_s are independent channels for the first beam and second beam with the Nr xNt channel matrix per subcarrier.
- $D^{(m)}_{\theta_{k,1},\theta_{k,2}}$, $D^{(s)}_{\theta_{k,1},\theta_{k,2}}$ are the steering matrix for first beam and second beam
- $D_{\theta_{k,1}}(N_1)$ is the steering matrix in first dimension with same polarization,
- $D_{\theta_{k,2}}(N_2)$ is the steering matrix in second dimension with same polarization,
- N_1 is the number of antenna elements in first dimension with same polarization,
- N_2 is the number of antenna elements in second dimension with same polarization,
- For antenna array with only one direction, number of antenna element in second direction N_2 equals 1，
- p is the relative power ratio of the second beam to the first beam, the value of p is specific to a test case,

For 1 antenna element of the same polarization in one direction, $D_{\theta_{k,i}}(1) = 1$.

For 2 antenna elements of the same polarization in one direction, $D_{\theta_{k,i}}(2) = \begin{bmatrix} 1 & 0 \\ 0 & e^{j3\theta_{k,i}} \end{bmatrix}$.

For 3 antenna elements of the same polarization in one direction, $D_{\theta_{k,i}}(3) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & e^{j1.5\theta_{k,i}} & 0 \\ 0 & 0 & e^{j3\theta_{k,i}} \end{bmatrix}$.

For 4 antenna elements of the same polarization in one direction, $D_{\theta_{k,i}}(4) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & e^{j\theta_{k,i}} & 0 & 0 \\ 0 & 0 & e^{j2\theta_{k,i}} & 0 \\ 0 & 0 & 0 & e^{j3\theta_{k,i}} \end{bmatrix}$.

where the index $i = 1,2$ stands for first dimension and second dimension respectively.

- $\theta_{k,i}$ controls the phase variation in first dimension and second dimension respectively, and the phase for k-th subframe is denoted by $\theta_{k,i} = \theta_{0,i} + \Delta\theta \cdot k$, where $\theta_{0,i}$ is the random start value with the uniform distribution, i.e., $\theta_{0,i} \in [0, 2\pi]$, $\Delta\theta$ is the step of phase variation, which is defined in Table B.2.3.2.3A-1, and k is the linear increment of $2^{-\mu}$ for every slot throughout the simulation, the index $i = 1,2$ stands for first dimension and second dimension respectively.
- W is the precoding matrix for Nt transmission antennas,
- *y* is the received signal, *x* is the transmitted signal, and *n* is AWGN.
- μ corresponds to subcarrier spacing configuration, $\Delta f = 2^{\mu} \cdot 15\,[\text{kHz}]$

For the 1D cross-polarized antenna array at gNB, the corresponding random channel matrix *H* can be calculated by letting N_2=1, i.e.,

$$D_{\theta_{k,1}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes D_{\theta_{k,1}}(N_1)$$

Table B.2.3.2.3A-1: The step of phase variation

Variation Step	Value (rad/subframe)
$\Delta\theta^{(m)}$	1.2566×10^{-3}
$\Delta\theta^{(s)}$	2.5132×10^{-3}

B.2.4 Two-tap propagation conditions for CQI tests

For Channel Quality Indication (CQI) tests, the following additional multi-path profile is used:

$$h(t,\tau) = \delta(\tau) + a\exp(-i2\pi f_D t)\delta(\tau - \tau_d)$$

in continuous time (t,τ) representation, with τ_d the delay, a constant value of *a* and f_D the Doppler frequency. The same $h(t,\tau)$ is used to describe the fading channel between every pair of Tx and Rx.

B.3 High Speed Train Scenario

B.3.1 Single Tap Channel Profile

The high speed train condition for the test of the baseband performance is a non-fading propagation channel with one tap. Doppler shift is given by

$$f_s(t) = f_d \cos\theta(t) \qquad \text{(B.3.1.1)}$$

where $f_s(t)$ is the Doppler shift and f_d is the maximum Doppler frequency. The cosine of angle $\theta(t)$ is given by

$$\cos\theta(t) = \frac{D_s/2 - vt}{\sqrt{D_{\min}{}^2 + (D_s/2 - vt)^2}}, \; 0 \le t \le D_s/v \qquad \text{(B.3.1.2)}$$

$$\cos\theta(t) = \frac{-1.5D_s + vt}{\sqrt{D_{\min}{}^2 + (-1.5D_s + vt)^2}}, \; D_s/v < t \le 2D_s/v \qquad \text{(B.3.1.3)}$$

$$\cos\theta(t) = \cos\theta(t \mod (2D_s/v)), \; t > 2D_s/v \qquad \text{(B.3.1.4)}$$

where $D_s/2$ is the initial distance of the train from gNB, and $D_{\min}$ is gNB Railway track distance, both in meters; v is the velocity of the train in m/s, t is time in seconds.

Doppler shift and cosine angle are given by equation B.3.1.1 and B.3.1.2-B.3.1.4 respectively, where the required input parameters listed in table B.3.1-1 and the resulting Doppler shift shown in Figures B.3.1-1, B.3.1-2, B.3.1-3, B.3.1-4 are applied for all frequency bands.

Table B.3.1-1: High speed train scenario

Parameter	Value			
	HST-750	HST-972	HST-1000	HST-1667
D_s	300 m	300 m	300 m	300 m
$D_{\min}$	2 m	2 m	2 m	2 m
v	300 km/h	500 km/h	300 km/h	500 km/h
f_d	750 Hz for 15 kHz SCS test	972 Hz for 15 kHz SCS test	1000 Hz for 30 kHz SCS test	1667 Hz for 30 kHz SCS test

Note 1: Parameters for HST conditions in table B.3.1-1 including f_d and Doppler shift trajectories presented on figures B.3.1-1 for 750 Hz and B.3.1-3 for 972 Hz for 15 kHz SCS and figures B.3.1-2 for 1000 Hz and B.3.1-4 for 1667 Hz for 30 kHz SCS are applied for performance verification in all frequency bands.

Note 2: The propagation conditions used for the performance requirements under high speed train condition are indicated as a combination of "HST" and Doppler shift f_d, i.e. HST-<Doppler shift>, where '<Doppler shift>'indicates the maximum Doppler shift (Hz).

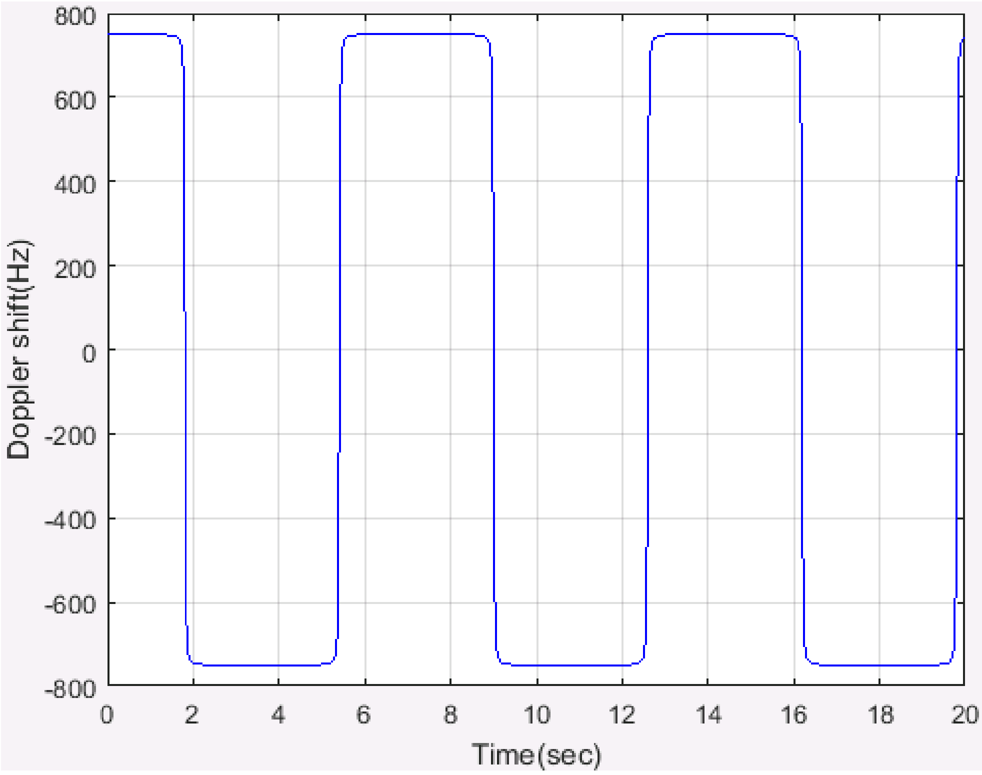

Figure B.3.1-1: Doppler shift trajectory (f_d = 750 Hz)

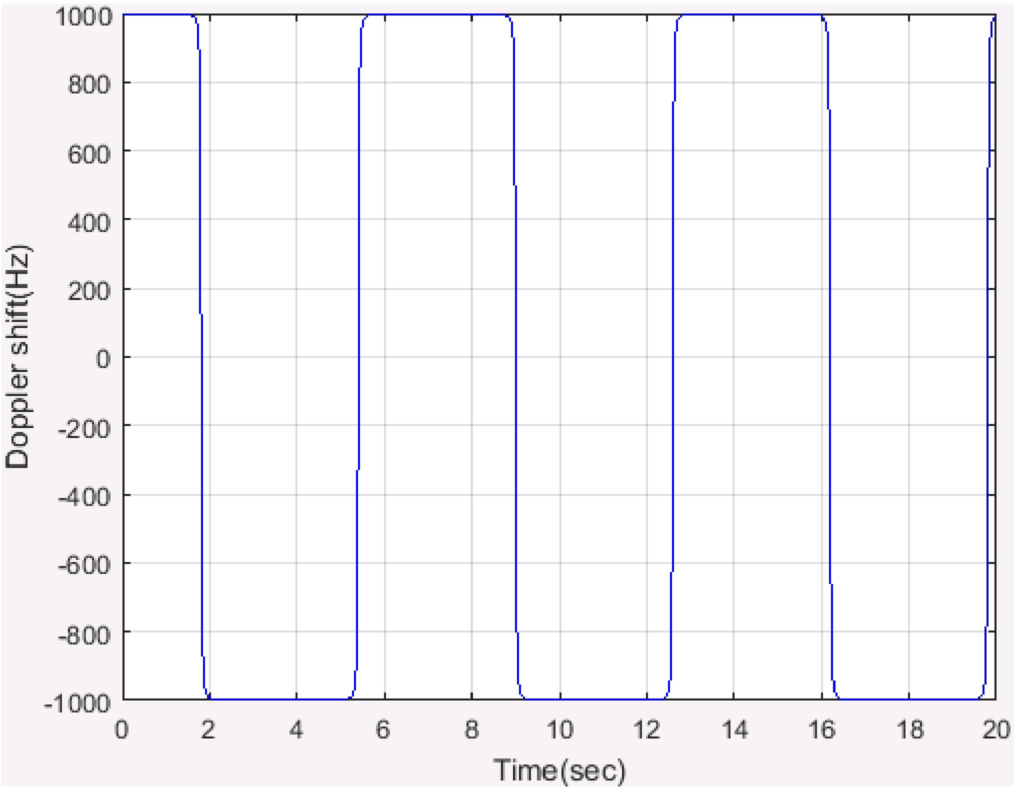

Figure B.3.1-2: Doppler shift trajectory (f_d = 1000 Hz)

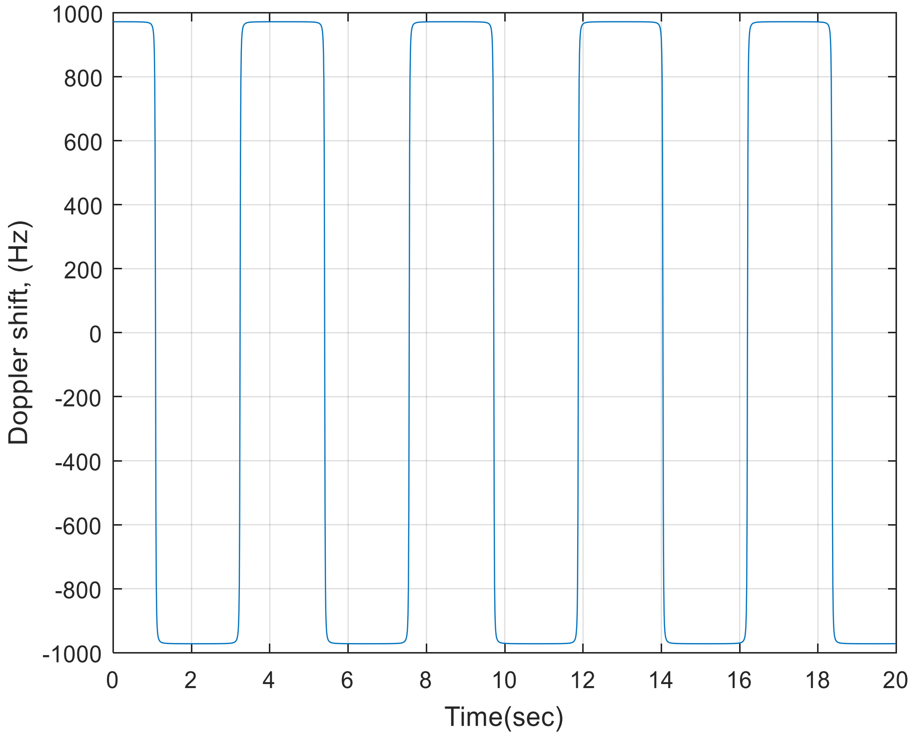

Figure B.3.1-3: Doppler shift trajectory (f_d = 972 Hz)

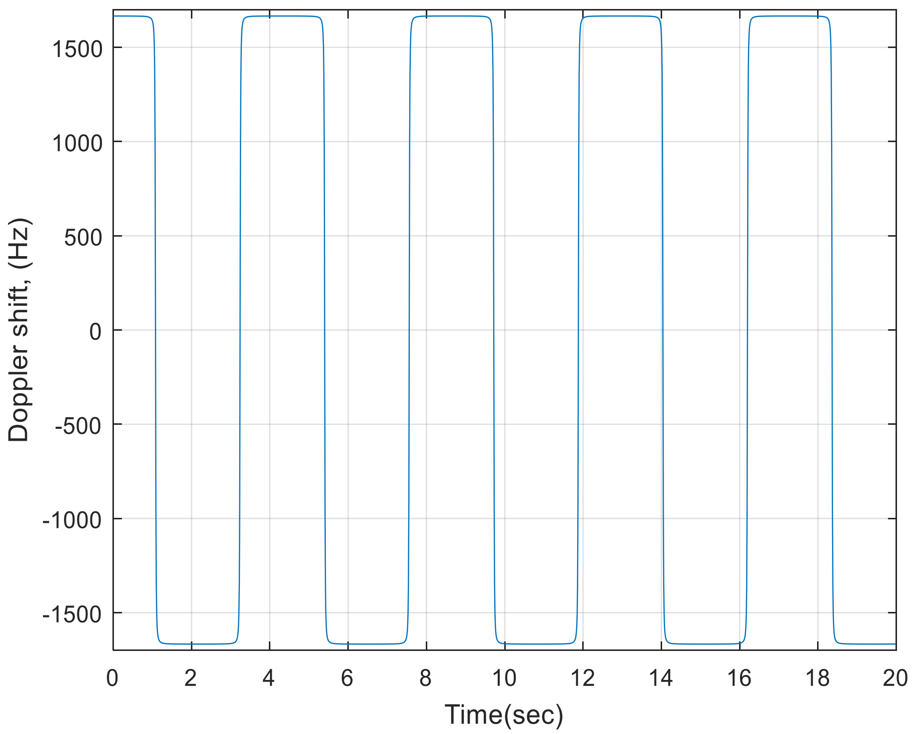

Figure B.3.1-4: Doppler shift trajectory (f_d = 1667 Hz)

For 1x2 antenna configuration, the same $h(t,\tau)$ is used to describe the channel between every pair of Tx and Rx.

For 1x4 antenna configuration, the same $h(t,\tau)$ is used to describe the channel between every pair of Tx and Rx.

B.3.2 HST-SFN Channel Profile

There is an infinite number of RRHs distributed equidistantly along the track with the same Cell ID as depicted in figure B.3.2-1.

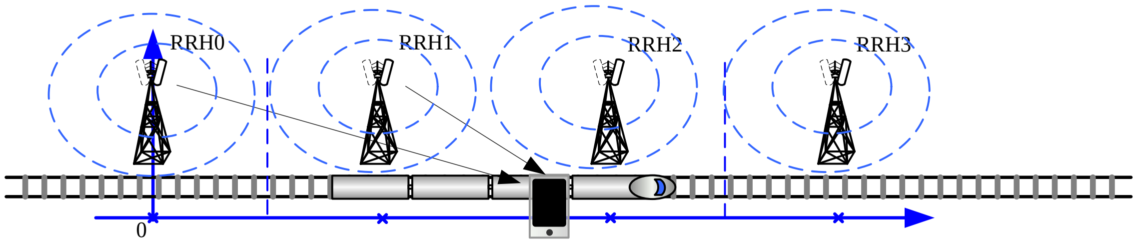

Figure B.3.2-1: Deployment of HST-SFN

The location of RRH k is given as:

$$x_k = k * D_s + j * D_{\min} \quad \text{(B.3.2.1)}$$

where: $k \in [-\infty, \infty]$, $j = sqrt(-1)$ and $D_{\min}$ is the distance between the RRHs and railway track, while D_s is the distance of two RRHs, both in meters.

The train location is denoted as:

$$y = a + j * 0 \quad \text{(B.3.2.2)}$$

where: $a \in [0, \infty]$ and a means distance in meters, which means the train is right on the track.

The HST-SFN scenario for the test of the baseband performance is a non-fading propagation channel with four taps, namely the four nearest RRHs. Thus, RRH k is visible for the train only in the range:

$$k * D_s - 2 * D_s \le a < k * D_s + 2 * D_s \quad \text{(B.3.2.3)}$$

Power level P_k (dB) for the signal from k^{th} RRH, normalized to the total power received from all visible RRHs, is given by:

$$P_k = -20\lg\left(\left|y - x_k\right|\right) - 10\lg\left(\sum_{i \in \{i | i*D_S - 2*D_S \le a < i*D_S + 2*D_S\}} \frac{1}{\left|y - x_i\right|^2}\right) \text{ for } k * D_s - 2 * D_s \le a < k * D_s + 2 * D_s$$

(B.3.2.4)

Doppler shift $F_{D,k}$ (Hz) from k^{th} RRH is given by:

$$F_{D,k} = f_C \times real\left[-v \times \frac{y - x_k}{\left|y - x_k\right| \times C}\right] \text{ for } k * D_s - 2 * D_s \le a < k * D_s + 2 * D_s \quad \text{(B.3.2.5)}$$

The relative delay T_k (s) for the signal from k^{th} RRH can be derived as:

$$T_k = \frac{|y - x_k|}{C} \text{ for } k*D_s - 2*D_s \le a < k*D_s + 2*D_s \qquad \text{(B.3.2.6)}$$

In the above v (m/s) is the moving speed of the train, f_C (Hz) is the centre frequency, and C (m/s) is the velocity of light.

Power level, Doppler shift and relative delay are given by equations B.3.2.4 ~ B.3.2.6 respectively, where the required input parameters listed in table B.3.2-1 and the resulting Doppler shift shown in Figures B.3.2-3 and B.3.2-4 are applied for all frequency bands.

Table B.3.2-1: HST-SFN scenario

Parameter	Value
D_s	700 m
D_{min}	150 m
v	500 km/h
f_d	870 Hz for 15 kHz SCS test; 1667 Hz for 30 kHz SCS test

NOTE 1: The trajectories of relative power, Doppler shifts and absolute delays presented in Figures B.3.2-2, B.3.2-3, B.3.2-4 and B.3.2-5 are derived from the equations B.3.2.4 ~ B.3.2.6 respectively.

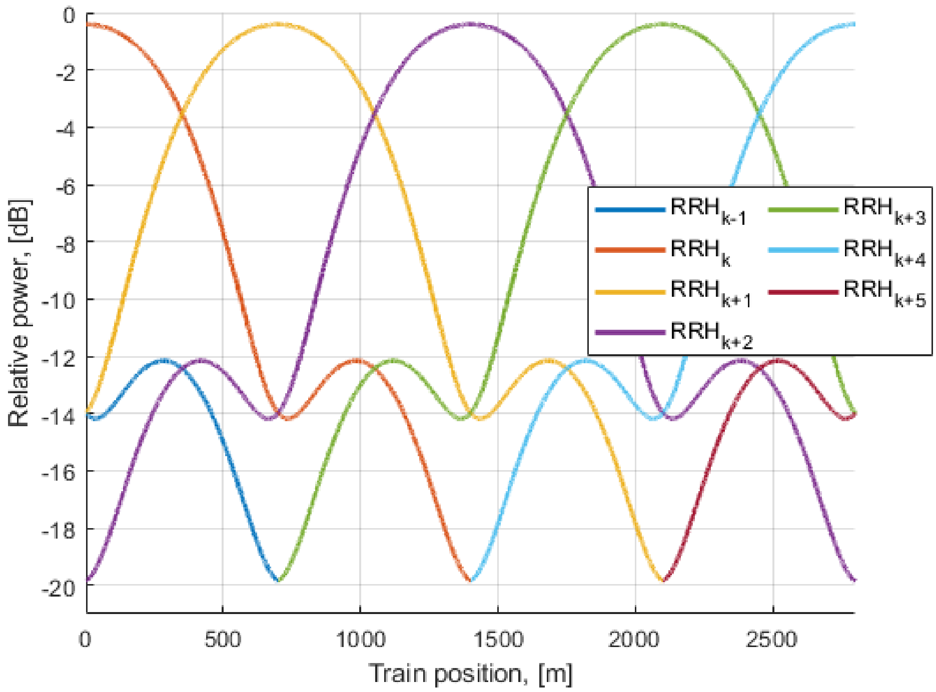

Figure B.3.2-2 Relative power level trajectories

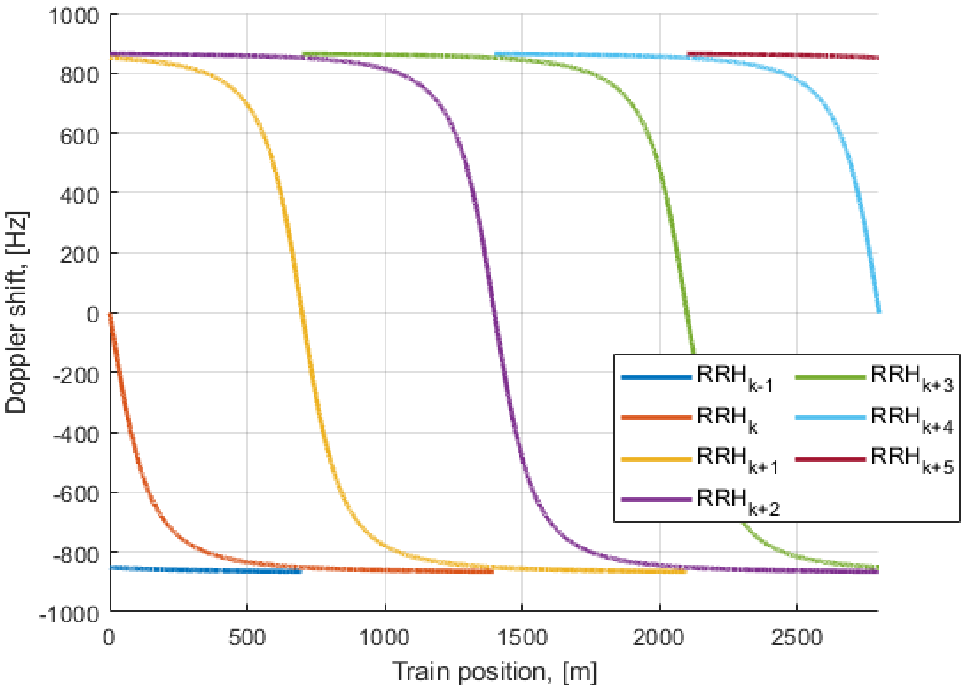

Figure B.3.2-3 Doppler shift trajectories (f_d = 870 Hz)

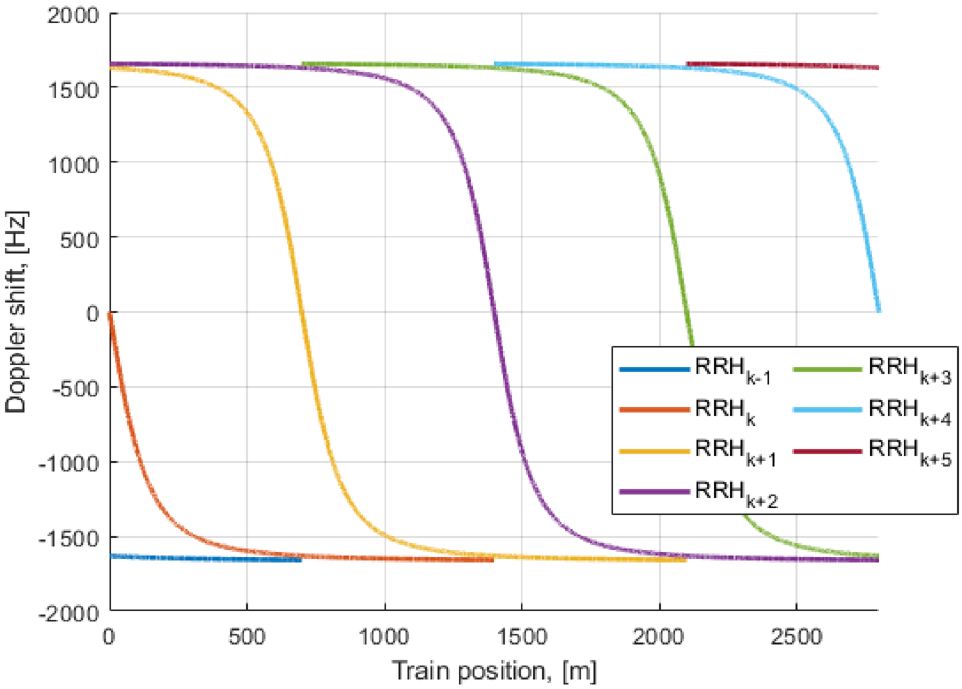

Figure B.3.2-4 Doppler shift trajectories (f_d = 1667 Hz)

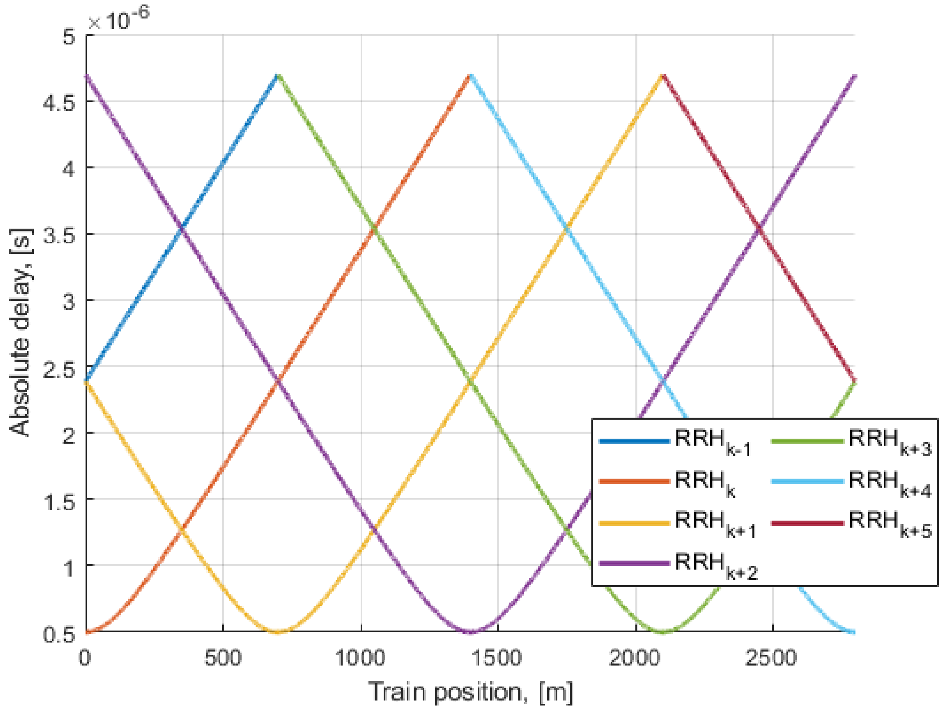

Figure B.3.2-5 Absolute delay trajectories

Static channel matrix will be used as defined in Annex B.1.

B.3.3 HST-DPS Channel Profile

There is an infinite number of RRHs distributed equidistantly along the railway track with the same Cell ID as illustrated in Figure B.3.3-1.

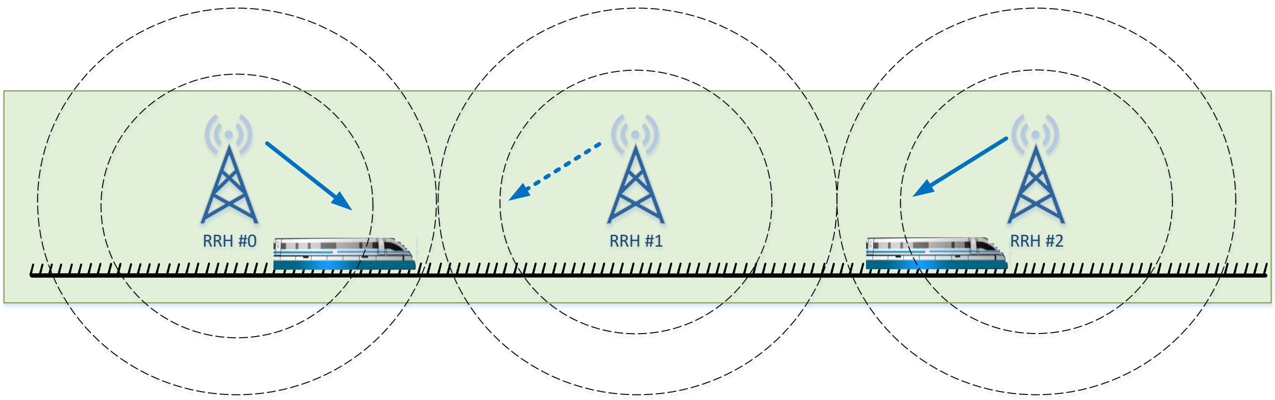

Figure B.3.3-1: Deployment of HST-DPS

The location of RRH *k* is given as:

$$x_k = k * D_s + j * D_{\min} \quad \text{(B.3.3.1)}$$

where: $k \in [-\infty, \infty]$, $j = sqrt(-1)$ and $D_{\min}$ is the distance between the RRHs and railway track, while D_s is the distance of two RRHs, both in meters.

The train location is denoted as:

$$y = a + j * 0 \quad \text{(B.3.3.2)}$$

where: $a \in [0, \infty]$ and *a* means distance in meters, which means the train is right on the track.

The HST DPS multi-RRH scenario for the test of the baseband performance is a single tap propagation channel at each time with switching of transmission point in the middle point between two RRHs. Thus, RRH *k* is visible for the train only in the range:

$$k * D_s - \frac{D_s}{2} \le a < k * D_s + \frac{D_s}{2} \qquad \text{(B.3.3.3)}$$

Power level P_k (dB) for the signal from k^{th} RRH equals to 0. Doppler shift $F_{D,k}$ (Hz) from k^{th} RRH is given by:

$$F_{D,k} = f_C \times real\left[-v \times \frac{y - x_k}{|y - x_k| \times C} \right] \text{ for } k * D_s - \frac{D_s}{2} \le a < k * D_s + \frac{D_s}{2} \qquad \text{(B.3.3.4)}$$

In the above v (m/s) is the moving speed of the train, f_C (Hz) is the centre frequency, and C (m/s) is the velocity of light.

Doppler shift is given by equation B.3.3.4, where the required input parameters listed in table B.3.3-1 and the resulting Doppler shift shown in Figures B.3.3-2 and B.3.3-3 are applied for all frequency bands.

Table B.3.3-1: HST-DPS scenario

Parameter	Value
D_s	700 m
D_{min}	150 m
v	500 km/h
f_d	870 Hz for 15 kHz SCS test; 1667 Hz for 30 kHz SCS test

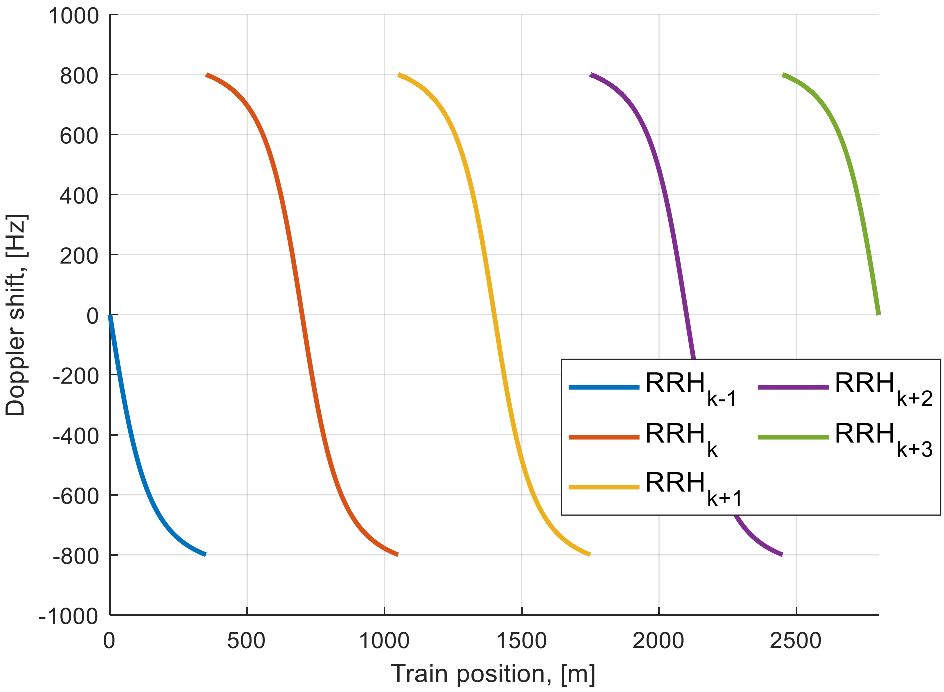

Figure B.3.3-2 Doppler shift trajectory (f_d = 870 Hz)

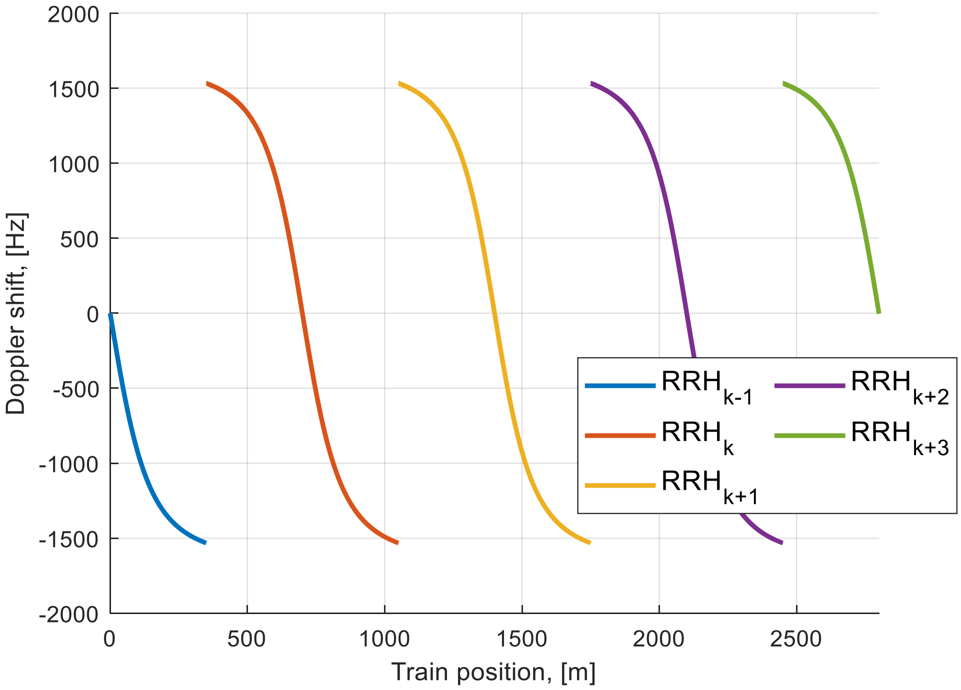

Figure B.3.3-3 Doppler shift trajectory (f_d = 1667 Hz)

Static channel matrix will be used as defined in Annex B.1.

B.4 Physical signals, channels mapping and precoding

B.4.1 General

Unless otherwise stated, the transmission on antenna port(s) $p = p_0, p_0 + 1, \ldots, p_0 + N_p - 1$ is defined by using a precoder matrix $W(i)$ of size $N_{ANT} \times N_p$, where N_{ANT} is the number of physical transmit antenna elements configured per test , N_p is the number of ports for a reference signal or physical channel configured per test, and p_0 is the first port for that reference signal or physical channel as defined in clauses 7.3 and 7.4 in TS 38.211 [9]. This precoder takes as an input a block of signals for antenna port(s) $p = p_0, p_0 + 1, \ldots, p_0 + N_p - 1$, $y^{(p)}(i) = \left[y^{(p_0)}(i) \;\; y^{(p_0+1)}(i) \;\; \ldots \;\; y^{(p_0+N_p-1)}(i)\right]^T$, $i = 0,1,\ldots,M_{\text{symb}}^{\text{ap}} - 1$, with $M_{\text{symb}}^{\text{ap}}$ being the number of modulation symbols per antenna port including the reference signal symbols, and generates a block of signals $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i) \;\; y_{bf}^{(1)}(i) \;\; \ldots \;\; y_{bf}^{(N_{ANT}-1)}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair (k,l) as per the test configuration but transmitted on different physical antenna elements:

$$y_{bf}^{(q)}(i) = W(i)y^{(p)}(i)$$

For Clause 6 and 8, the transmission of PDCCH and PDCCH DMRS on antenna port $p = p_0$ is defined by using a precoder matrix $W(i)$ of size 2x1. This precoder takes as an input a block of signals for antenna port(s) $p = p_0$, $y^{(p)}(i) = y^{(p_0)}(i)$ and generates a block of signals $y_{bf}^{(q)}(i) = \left[y_{bf}^{(0)}(i) \;\; y_{bf}^{\left(\frac{N_{ANT}}{2}\right)}(i)\right]^T$ the elements of which are to be mapped onto the frequency-time index pair (k,l) as per the test configuration but transmitted on different physical antenna elements:

$$y_{bf}^{(q)}(i) = W(i)y^{(p)}(i)$$

The precoder matrix $W(i)$ is specific to the test case configuration $W(i)$ is defined in Clause 5.2.2.2 of TS 38.214 [12].

The transmission on PT-RS antenna port is associated (using same precoder) with the lowest indexed DM-RS antenna port among the DM-RS antenna ports assigned for the PDSCH.

The physical antenna elements are identified by indices $j = 0,1,\ldots,N_{ANT} - 1$, where N_{ANT} is the number of physical antenna elements configured per test.

Modulation symbols $y^{(p)}(i)$ with $p \in \{4000\}$ (i.e. PSS, SSS, PBCH and DM-RS for PBCH) are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}$ for CSI-RS resources which configured for tracking with one port are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}$ for CSI-RS resources which configured for beam refinement with one port are directly mapped to first physical antenna element.

Modulation symbols $a_{k,l}^{(p)}$ for NZP CSI-RS which configured for CSI acquisition with $p \in \{p_0, p_0 + 1,\ldots, p_0 + N_{CSI} - 1\}$ are mapped to the physical antenna index $j = p - p_0$ where N_{CSI} is the number of NZP CSI-RS ports configured per test.

Annex C (normative): Downlink physical channels

C.0 Downlink signal levels

Downlink power settings to be configured for connection setup has been defined in this clause covering both FR1 and FR2.

C.0.1 FR1 Downlink Signal Levels (Conducted)

The downlink power settings in Table C.0.1-1 is used for FR1 conducted unless otherwise specified in a test case.

If the UE has more than one Rx antenna, the downlink signal is applied to each one. All UE Rx antennas shall be connected.

Table C.0.1-1: Default Downlink power levels for NR FR1

SCS (kHz)		Unit	Channel bandwidth											
			5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz
15	Number of RBs		25	50	75	100	128	160	215	270	N/A	N/A	N/A	N/A
	Channel BW power	dBm	-60	-57	-55	-54	-53	-52	-51	-50	N/A	N/A	N/A	N/A
30	Number of RBs		10	24	36	50	64	75	100	128	162	216	243	270
	Channel BW power	dBm	-61	-57	-55	-54	-53	-52	-51	-50	-49	-48	-47	-47
60	Number of RBs		N/A	10	18	24	30	36	50	64	75	100	120	135
	Channel BW power	dBm	N/A	-58	-56	-54	-53	-52	-51	-50	-49	-48	-47	-47
	SSS EPRE	dBm/ 15 kHz	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85
	NOTE 1: The channel bandwidth powers are informative, based on -85dBm/15kHz SS/PBCH SSS EPRE, then scaled according to the number of RBs and rounded to the nearest integer dBm value. Full RE allocation with no boost or deboost is assumed. NOTE 2: The power level is specified at each UE Rx antenna. NOTE 3: DL level is applied for any of the Subcarrier Spacing configuration ( ) with the same power spectrum density of -85 dBm/15 kHz.													

The default signal level uncertainty is [+/-3] dB at each test port, for any level specified. If the uncertainty value is critical for the test purpose, a tighter uncertainty is specified for the related test case in [Annex F]

C.0.2 FR2 Downlink Signal Levels (Radiated)

The downlink power settings in Table C.0.2-1 is used unless otherwise specified in a test case.

Table C.0.2-1: Default Downlink power levels for NR FR2

SCS (kHz)		Unit	Channel Bandwidth			
			50 MHz	100 MHz	200 MHz	400 MHz
60	Number of RBs		66	132	264	N/A
	Channel BW power	dBm	-70	-67	-64	N/A
120	Number of RBs		32	66	132	264
	Channel BW power	dBm	-70	-67	-64	-61
	SS/PBCH SSS EPRE	dBm/60 kHz	[-99]	[-99]	[-99]	[-99]

NOTE 1: The channel bandwidth powers are informative, based on [-99] dBm/60 kHz SS/PBCH SSS EPRE, then scaled according to the number of RBs and rounded to the nearest integer dBm value. Full RE allocation with no boost or deboost is assumed.
NOTE 2: The power level is specified at the centre of quiet zone.
NOTE 3: DL level is applied for any of the Subcarrier Spacing configuration (μ) with the same power spectrum density of [-99]dBm/60kHz.

The default downlink signal level uncertainty is +/- TBD dB, for any level specified. If the uncertainty value is critical for the test purpose, a tighter uncertainty is specified for the related test case in Annex F.

C.1 Setup

The following clause describes the downlink Physical Channels that are transmitted during connection setup.

C.1.1 FR1 Setup

Table C.1.1-1 describes the downlink Physical Channels that are required for FR1 connection set up.

Table C.1.1-1: Downlink Physical Channels required for FR1 connection setup

Physical Channel
PBCH
SSS
PSS
PDCCH
PDSCH
PBCH DMRS
PDCCH DMRS
PDSCH DMRS
CSI-RS

The following common PDSCH and PDCCH configuration parameters shall be used to bring up the connection setup for FR1 NR cell.

Table C.1.1-2: Common reference channel parameters for FR1

Parameter	Unit	Value
CORESET frequency domain allocation		Full BW,number of RB's to be in multiple of 6
CORESET time domain allocation		2 OFDM symbols at the begin of each slot
PDSCH mapping type		Type A
PDSCH start symbol index (S)		2
Number of consecutive PDSCH symbols (L)		12
PDSCH PRB bundling	PRBs	2
Dynamic PRB bundling		false
Overhead value for TBS determination		0
First DMRS position for Type A PDSCH mapping		2
DMRS type		Type 1
Number of additional DMRS		1
FDM between DMRS and PDSCH		Enable
TRS configuration		2 slots, periodicity 20 ms, offset 10
PTRS configuration		PTRS is not configured
Num of HARQ processes		8 (TDD)
Aggregation level	CCE	4

Table C.1.1-3: Additional reference channels parameters for FDD

Parameter	Unit	Value
Number of HARQ Processes		4
K1 value		2 for all slots

Table C.1.1-4: TDD UL-DL pattern for SCS 15 KHz

Parameter		Unit	UL-DL pattern
			FR1.15-1
TDD Slot Configuration pattern (Note 1)			DDDSU
Special Slot Configuration (Note 2)			10D+2G+2U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	15
	dl-UL-TransmissionPeriodicity	ms	5
	nrofDownlinkSlots		3
	nrofDownlinkSymbols		10
	nrofUplinkSlot		1
	nrofUplinkSymbols		2
K1 value (PDSCH-to-HARQ-timing-indicator)			[4] if mod(I,5) = 0 [3] if mod(i,5) = 1 [2] if mod(i,5) = 2 [6] if mod(i,5) = 3
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,9}			

Table C.1.1-5: TDD UL-DL pattern for SCS 30 KHz

Parameter		Unit	UL-DL Pattern
TDD Slot Configuration pattern (Note 1)			7DS2U
Special Slot Configuration (Note 2)			6D+4G+4U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	30	kHz
	dl-UL-TransmissionPeriodicity	5	
	nrofDownlinkSlots	7	
	nrofDownlinkSymbols	6	
	nrofUplinkSlot	2	
	nrofUplinkSymbols	4	
UL-DL configuration2 (*tdd-UL-DL-ConfigurationCommon2*)	*referenceSubcarrierSpacing*	N/A	
	dl-UL-TransmissionPeriodicity	N/A	
	nrofDownlinkSlots	N/A	
	nrofDownlinkSymbols	N/A	
	nrofUplinkSlot	N/A	
	nrofUplinkSymbols	N/A	
K1 value (PDSCH-to-HARQ-timing-indicator)			8 if mod(i,10) = 0 7 if mod(i,10) = 1 6 if mod(i,10) = 2 5 if mod(i,10) = 3 5 if mod(i,10) = 4 4 if mod(i,10) = 5 3 if mod(i,10) = 6 2 if mod(i,10) = 7
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,19}			

Table C.1.1-6: PDCCH Aggregation level for NR-LTE coexistence test cases

Parameter	Unit	Value
Aggregation level	CCE	2

C.1.2 FR2 Setup

Table C.1.2-1 describes the downlink Physical Channels that are required for FR2 connection set up.

Table C.1.2-1: Downlink Physical Channels required for FR2 connection set-up

Physical Channel
PBCH
SSS
PSS
PDCCH
PDSCH
PBCH DMRS
PDCCH DMRS
PDSCH DMRS
CSI-RS
PTRS

The following common PDSCH and PDCCH configuration parameters shall be used to bring up the connection setup for FR2 NR cell.

Table C.1.2-2: Common reference channel parameters for FR2

Parameter	Unit	Value
CORESET frequency domain allocation		Full BW, number of RB's to be in multiple of 6
CORESET time domain allocation		1 OFDM symbols at the begin of each slot
PDSCH mapping type		Type A
PDSCH start symbol index (S)		1
Number of consecutive PDSCH symbols (L)		13
PDSCH PRB bundling	PRBs	2
Dynamic PRB bundling		false
MCS table for TBS determination		64QAM
Overhead value for TBS determination		0
First DMRS position for Type A PDSCH mapping		2
DMRS type		Type 1
Number of additional DMRS		1
FDM between DMRS and PDSCH		Enable
TRS configuration		2 slots, periodicity 20 ms, offset 10
PTRS configuration		Single port, every other RB, every symbol (K=2, L=1)
Num of HARQ processes		8

Table C.1.2-3: Additional test parameters for TDD for SCS 60 KHz

Parameter		Unit	UL-DL pattern
TDD Slot Configuration pattern (Note 1)			DDSU
Special Slot Configuration (Note 2)			11D+3G+0U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	60
	dl-UL-TransmissionPeriodicity	ms	1
	nrofDownlinkSlots		2
	nrofDownlinkSymbols		11
	nrofUplinkSlot		1
	nrofUplinkSymbols		0
K1 value (PDSCH-to-HARQ-timing-indicator)			K1 = 3 if mod(i,4) = 0 K1 = 2 if mod(i,4) = 1 K1 = 5 if mod(i,4) = 2
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,39}			

Table C.1.2-4: Additional test parameters for TDD for SCS 120 KHz

Parameter		Unit	UL-DL pattern
TDD Slot Configuration pattern (Note 1)			DDDSU
Special Slot Configuration (Note 2)			10D+2G+2U
UL-DL configuration (*tdd-UL-DL-ConfigurationCommon*)	*referenceSubcarrierSpacing*	kHz	120
	dl-UL-TransmissionPeriodicity	ms	0.625
	nrofDownlinkSlots		3
	nrofDownlinkSymbols		10
	nrofUplinkSlot		1
	nrofUplinkSymbols		2
K1 value (PDSCH-to-HARQ-timing-indicator)			K1 = [4] if mod(i,5) = 0 K1 = [3] if mod(i,5) = 1 K1 = [2] if mod(i,5) = 2 K1 = [6] if mod(i,5) = 3
Note 1: D denotes a slot with all DL symbols; S denotes a slot with a mix of DL, UL and guard symbols; U denotes a slot with all UL symbols. The field is for information. Note 2: D, G, U denote DL, guard and UL symbols, respectively. The field is for information. Note 3: i is the slot index per frame; i = {0,…,79}			

C.2 Connection

C.2.1 FR1 Measurement of Performance Characteristics

Unless otherwise stated, Table C.2.1-1 is applicable for measurements in which uniform RS-to-EPRE boosting for all downlink physical channels is used.

Table C.2.1-1: Downlink Physical Channels transmitted during a connection (FDD and TDD) for FR1

Parameter	Unit	Value (NOTE 2)
SSS transmit power	W	Test specific
EPRE ratio of PSS to SSS	dB	0
EPRE ratio of PBCH to SSS	dB	0
EPRE ratio of PBCH to PBCH DMRS	dB	0
EPRE ratio of PDCCH to SSS	dB	0
EPRE ratio of PDCCH to PDCCH DMRS	dB	0
EPRE ratio of PDSCH to SSS	dB	0
EPRE ratio of PDSCH to PDSCH DMRS	dB	Test specific (Note 1)
EPRE ratio of NZP CSI-RS to SSS	dB	-10*log10(L) (Note 3)
EPRE ratio of PDSCH OCNG to SSS	dB	0
EPRE ratio of PDCCH OCNG to SSS	dB	0
EPRE ratio of LTE CRS to NR SSS	dB	0 (Note 4)
NOTE 1: Value is derived from Table 4.1-1 in TS 38.214 [X] based on “Number of DM-RS CDM groups without data” and “DMRS Type” parameters specified for each test. NOTE 2: The value is the energy of per RE for a single antenna port before pre-coding. NOTE 3: $L \in \{1,2,4,8\}$ is the CDM group size of NZP CSI-RS specified for each test. NOTE 4: It is only applicable to LTE-NR coexistence tests.		

C.2.2 FR2 Measurement of Performance Characteristics

Unless otherwise stated, Table C.2.2-1 is applicable for measurements on the Performance Characteristics.

Table C.2.2-1: Downlink Physical Channels transmitted during a connection (TDD) for FR2

Parameter	Unit	Value (Note 2)
SSS transmit power	W	Test specific
EPRE ratio of PSS to SSS	dB	0
EPRE ratio of PBCH to SSS	dB	0
EPRE ratio of PBCH to PBCH DMRS	dB	0
EPRE ratio of PDCCH to SSS	dB	0
EPRE ratio of PDCCH to PDCCH DMRS	dB	0
EPRE ratio of PDSCH to SSS	dB	0
EPRE ratio of PDSCH to PDSCH DMRS	dB	Test specific (Note 1)
EPRE ratio of NZP CSI-RS to SSS	dB	-10*log10(L) (Note 3)
EPRE ratio of PTRS to PDSCH	dB	Test specific (Note 4)
EPRE ratio of PDSCH OCNG to SSS	dB	0
EPRE ratio of PDCCH OCNG to SSS	dB	0
Note 1: Value is derived from Table 4.1-1 in TS 38.214 [12] based on "Number of DM-RS CDM groups without data" and "DMRS Type" parameters specified for each test Note 2: The value is the energy of per RE for a single antenna port before pre-coding. Note 3: $L \in \{1,2,4,8\}$ is the CDM group size of NZP CSI-RS specified for each test. Note 4: Value is derived from Table 4.1-2 in TS 38.214 [12] based on “The number of PDSCH layers” and “*epre-Ratio*” parameters specified for each test.		

Annex D (normative): E-UTRA link setup config for NSA testing

D.0 General

Below clauses define the E-UTRA link setup config for NSA Demodulation and CSI tests cases unless otherwise specified within the main test case.

D.1 E-UTRA test parameters

Below are the common test parameters to be configured for E-UTRA link.

Table D.1-1: Common Test Parameters (FDD)

Parameter	Unit	Value	Comments
Inter-TTI Distance		1	
Number of HARQ processes	Processes	8	For FDD, 8 HARQ processes in the DL, as specified in TS 36.213 [10] clause 7. All 8 HARQ processes are used.
Scheduling of retransmissions			1. Retransmissions use the same Transport Block Size (TBS) as the initial transmission. 2. HARQ processes are scheduled consecutively, independent of the fact, whether retransmissions (for negatively acknowledged HARQ processes) or new transmissions (for positively acknowledged HARQ processes) occur.
Maximum number of HARQ transmission		4	It is always 4 for FDD, as specified in TS 36.213 [10] clause 8
Redundancy version coding sequence		{0,1,2,3} for QPSK	
Number of OFDM symbols for PDCCH	OFDM symbols	3 for 5 MHz bandwidths, 2 for 10 MHz, 20MHz	The PCFICH carries information about the number of OFDM symbols used for transmission of PDCCHs in a subframe, as specified in TS 36.211 [8] clause 6.7
Cyclic Prefix		Normal	CP consist of the following physical resource blocks (RBs) parameters: 12 consecutive subcarriers at a 15 kHz spacing and 7 OFDM symbols, as specified in TS 36.211 [8] clause 6.2.3
Cell ID		0 (Note 1)	The Cell ID is uniquely defined by a number in the range of 0 to 503, representing the physical-layer cell identity, as specified in TS 36.211 [8] clause 6.11.
DCI format for PDSCH	Format 1A		
DCI format for PUSCH	Format 0		

Table D.1-2: Common Test Parameters (TDD)

Parameter	Unit	Value	Comments
Uplink downlink configuration (Note 1)		2	
Special subframe configuration (Note 2)		5	
Inter-TTI Distance		1	
Number of HARQ processes	Processes	7	For TDD, 7 HARQ processes in the DL, as specified in TS 36.213 [10] clause 7. All 7 HARQ processes are used.
Scheduling of retransmissions			1. Retransmissions use the same Transport Block Size (TBS) as the initial transmission. 2. HARQ processes are scheduled consecutively, independent of the fact, whether retransmissions (for negatively acknowledged HARQ processes) or new transmissions (for positively acknowledged HARQ processes) occur. 3. In case when the initial transmission and the retransmissions are scheduled in subframes with a different N_{PRB} (in terms of TS 36.213 [10] subclause 7.1.7) $29 \le I_{MCS} \le 31$ according to TS 36.213 [10] subclause 7.1.7.2 and the appropriate modulation is used.
Maximum number of HARQ transmission		4	It is always 4 for TDD, as specified in TS 36.213 [10] clause 8
Redundancy version coding sequence		{0,1,2,3} for QPSK	
Number of OFDM symbols for PDCCH	OFDM symbols	3 for 5 MHz bandwidths, 2 for 10 MHz	The PCFICH carries information about the number of OFDM symbols used for transmission of PDCCHs in a subframe, as specified in TS 36.211 [8] clause 6.7
Cyclic Prefix		Normal	CP consist of the following physical resource blocks (RBs) parameters: 12 consecutive subcarriers at a 15 kHz spacing and 7 OFDM symbols, as specified in TS 36.211 [8] clause 6.2.3
Cell ID		0 (Note 3)	The Cell ID is uniquely defined by a number in the range of 0 to 503, representing the physical-layer cell identity, as specified in TS 36.211 [8] clause 6.11.
DCI format for PDSCH	Format 1A		
DCI format for PUSCH	Format 0		
NOTE 1: as specified in Table 4.2-2 in TS 36.211 [8]. NOTE 2: as specified in Table 4.2-1 in TS 36.211 [8]. NOTE 3: For CA tests, Cell ID = 0 applies only to P-Cell. For (n)*th* S-Cell, Cell ID = n is used.			

D.2 E-UTRA configuration

This clause defines the E-UTRA link settings for the test cases defined in clauses 5 and 6. The LTE link is supposed to be a functional link. The configuration defined in this clause ensures establishment of LTE link. Unless otherwise stated, ensure the UE is in state 3A-RF on the E-UTRA cell as defined in TS 36.508 [19].

Table D.2-1: E-UTRA configuration for EN-DC tests

Parameter	Value	Comments
Test Frequency during and after connection setup	Mid	As defined in TS 36.508 [19] for inter band test cases and as defined in TS 38.508-1 [6] clause 4.3.1 for intra band test cases, with NR SCS as per the test case for the LTE band under test
Bandwidth during and after connection setup	5 MHz (Note 1)	Supported by all LTE bands
PDSCH transmission mode and antenna config	TM1 1x2	
OCNG pattern	OP.1 for FDD OP.1 for TDD	These physical resource blocks are assigned to an arbitrary number of virtual UE' s with one PDSCH per virtual UE; the data transmitted over the OCNG PDSCHs shall be uncorrelated pseudo random data, which is QPSK modulated.
DL RMC	According to table A.3.2-1 in TS 36.521-1 [16] for FDD According to table A.3.1.1-1 in TS 38.521-3 [21] for TDD	Note 1
DL RB allocation	25	Full RB allocation assuming 5 MHz ChBW. 100 RB for 20 MHz ChBW as applicable
UL Signal levels during connection setup	PUSCH Power	Attained by enabling open loop power control and setting up UL signal levels according to Annexes H.0, H.2 and H.3 of TS 36.521-1 [16]
TA adjustments	*TimeAlignmentTimerDedicated* IE to be set to infinity	*TimeAlignmentTimerDedicated* IE to be set to infinity to ensure UE doesn't look for TA adjustments (See Table D.2-4)
CQI reports and SRS after connection setup	Disabled (See Table D.2-2 and D.2-3)	Disable periodic and aperiodic CQI reports to ensure none of these transmissions occur on the LTE uplink.
NOTE 1: If none of the UE supported EN-DC band combos support 5MHz E-UTRA carrier, configure 20 MHz channel BW.		

Table D.2-2: *CQI-ReportConfig-DEFAULT:* Additional E-UTRA Anchor Configuration

Derivation Path: TS 36.508 [7] clause 4.6.3, Table 4.6.3-2 CQI-ReportConfig-DEFAULT			
Information Element	**Value/remark**	**Comment**	**Condition**
CQI-ReportConfig-DEFAULT ::= SEQUENCE {			
cqi-ReportModeAperiodic	NOT PRESENT		
cqi-ReportPeriodic	NOT PRESENT		
}			

Table D.2-3: *PhysicalConfigDedicated-DEFAULT:* Additional E-UTRA Anchor Configuration

Derivation Path: TS 36.508 [7] clause 4.8.2, Table 4.8.2.1.6-1 PhysicalConfigDedicated-DEFAULT			
Information Element	**Value/remark**	**Comment**	**Condition**
PhysicalConfigDedicated-DEFAULT ::= SEQUENCE {			
soundingRS-UL-ConfigDedicated	Not present		RBC
}			

Table D.2-4: *MAC-MainConfig-RBC*: Additional E-UTRA Anchor Configuration

Derivation Path: TS 36.508 [7] clause 4.8.2.1.5, Table 4.8.2.1.5-1 MAC-MainConfig-RBC			
Information Element	**Value/remark**	**Comment**	**Condition**
timeAlignmentTimerDedicated	Infinity		

D.3 E-UTRA link common physical channel setup

Table D.3-1 describes the downlink Physical Channels that are required for E-UTRA connection set up.

Table D.3-1: Downlink Physical Channels required for E-UTRA connection set-up

Physical Channel	EPRE Ratio	Note
PBCH	PBCH_RA = 0 dB	
	PBCH_RB = 0 dB	
PSS	PSS_RA = 0 dB	
SSS	SSS_RA = 0 dB	
PCFICH	PCFICH_RB = 0 dB	
PDCCH	PDCCH_RA = 0 dB	
	PDCCH_RB = 0 dB	
PDSCH	PDSCH_RA = 0 dB	
	PDSCH_RB = 0 dB	
PHICH	PHICH_RA = 0 dB	
	PHICH_RB = 0 dB	
NOTE 1: $P_B = 0$. NOTE 2: PHICH group power, i.e. the total power of all active PHICH sequences within a PHICH group.		

D.4 E-UTRA power level

D.4.1 E-UTRA power level (conducted)

Table D.4.1-1: DL power level for E-UTRA (conducted)

Parameter	Value	Comments
DL signal level	RS EPRE -85.0 dBm/15 kHz	The power level is specified at each UE Rx antenna

D.4.2 E-UTRA power level (radiated)

Table D.4.2-1: Downlink power levels for E-UTRA (radiated)

Parameter	Value	Comments
DL signal level	RS EPRE -100 dBm/15 kHz	The power level is specified at each UE Rx antenna

Annex E (normative): Environmental conditions

FFS

Annex F (normative): Measurement uncertainties and test tolerances

The requirements of this clause apply to all tests in the present document.

F.1 Measurement uncertainties and test tolerances for FR1

F.1.1 Acceptable uncertainty of test system (normative)

The maximum acceptable uncertainty of the Test System is specified below for each test, where appropriate. The Test System shall enable the stimulus signals in the test case to be adjusted to within the specified range, and the equipment under test to be measured with an uncertainty not exceeding the specified values. All ranges and uncertainties are absolute values, and are valid for a confidence level of 95 %, unless otherwise stated.

A confidence level of 95 % is the measurement uncertainty tolerance interval for a specific measurement that contains 95 % of the performance of a population of test equipment.

For RF tests it should be noted that the uncertainties in clause F.1 apply to the Test System operating into a nominal 50 ohm load and do not include system effects due to mismatch between the DUT and the Test System.

The downlink signal uncertainties apply at each receiver antenna connector.

F.1.1.1 Measurement of test environments

The measurement accuracy of the UE test environments defined in TS 38.508-1 [5] subclause 4.1, Test environments shall be

- Pressure ±5 kPa.
- Temperature ±2 degrees.
- Relative Humidity ±5 %.
- DC Voltage ±1,0 %.
- AC Voltage ±1,5 %.
- Vibration 10 %.
- Vibration frequency 0,1 Hz.

The above values shall apply unless the test environment is otherwise controlled and the specification for the control of the test environment specifies the uncertainty for the parameter.

F.1.1.2 Measurement of Demod Performance requirements

This clause defines the maximum test system uncertainty for Demod Performance requirements. The maximum test system uncertainty allowed for the measurement uncertainty contributors are defined in Table F.1.1.2-1.

Table F.1.1.2-1: Maximum measurement uncertainty values for the test system for FR1 (up to 6 GHz) and Channel BW ≤ 40 MHz

MU contributor	Unit	Value	Comment
AWGN flatness and signal flatness, max deviation for any Resource Block, relative to average over BW_{config}	dB	±2.0	Same as in LTE
Signal to noise ratio uncertainty	dB	±0.3	Same as in LTE
Signal to noise ratio variation	dB	±0.5	Same as in LTE
Fading profile power uncertainty for 1Tx	dB	±0.5	Same as in LTE
Fading profile power uncertainty for 2Tx	dB	±0.7	Same as in LTE
Fading profile power uncertainty for 4Tx	dB	±0.7	Same as in LTE

The maximum test system uncertainty for test cases defined in section 5 is defined in Table F.1.1.2-2.

Table F.1.1.2-2: Maximum test system uncertainty for FR1 demodulation performance test cases

Subclause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
5.2.2.1.1_1 2Rx FDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA	± 0.9 dB for > 10Hz doppler ± 1 dB for 10Hz doppler ± 0.6 dB for test 1-6 ± 0.9 dB for test 1-7	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2}) + SNR uncertainty due to finite test time^2 Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.7 dB for 2Tx AWGN flatness and signal flatness ±2.0 dB SNR uncertainty due to finite test time ±0.3 dB for 10Hz Doppler, otherwise ±0.0 dB For test point 1-6, Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2} + SNR uncertainty due to finite test time^2) = 0.6 dB For test point 1-7, Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2} + SNR uncertainty due to finite test time^2) = 0.9 dB
5.2.2.1.1_2 2Rx FDD FR1 PDSCH Mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.2_1 2Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.3_1 2Rx FDD FR1 PDSCH mapping Type B performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.4_1 2Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1

5.2.2.1.5_1 2Rx FDD FR1 PDSCH 0.001% BLER performance - 1x2 MIMO with baseline receiver for both SA and NSA	[± 0.6 dB]	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty 2. Effect of AWGN flatness and signal flatness Items 1 and 2 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2}) Signal-to-noise ratio uncertainty ±0.3 dB AWGN flatness and signal flatness ±2.0 dB
5.2.2.1.6_1 2Rx FDD FR1 PDSCH repetitions over multiple slots performance - 2x2 MIMO with baseline receiver for both SA and NSA	[0.7dB]	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty 2. Effect of AWGN flatness and signal flatness 3. SNR uncertainty due to finite test time Items 1, 2 and 3 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2}+ SNR uncertainty due to finite test time^2) Signal-to-noise ratio uncertainty ±0.3 dB AWGN flatness and signal flatness ±2.0 dB SNR uncertainty due to finite test time ±[0.4] dB for 1% residual BLER
5.2.2.1.7_1 2Rx FDD FR1 PDSCH Mapping Type B and UE processing capability 2 performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.8_1 2Rx FDD FR1 PDSCH pre-emption performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.9_1 2Rx FDD FR1 HST-SFN performance - 2x2 MIMO with baseline receiver for both SA and NSA	± 0.6 dB	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty, ±0.3 dB 2. Effect of AWGN flatness and signal flatness, ±2.0 dB 3. SNR uncertainty due to finite test time, ±0.0 dB for >10Hz Doppler. Items 1, 2, 3 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2} + SNR uncertainty due to finite test time^2) = 0.6 dB

5.2.2.1.10_1 2Rx FDD FR1 HST-DPS performance - 2x2 MIMO with baseline receiver for both SA and NSA	± 0.6 dB	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty, ±0.3 dB 2. Effect of AWGN flatness and signal flatness, ±2.0 dB 3. SNR uncertainty due to finite test time, ±0.0 dB for >10Hz Doppler. Items 1, 2, 3 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2} + SNR uncertainty due to finite test time^2) = 0.6 dB
5.2.2.1.11_1 2Rx FDD FR1 PDSCH Single-DCI based SDM scheme performance - 2x2 MIMO for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.12_1 2Rx FDD FR1 PDSCH Multiple-DCI based transmission scheme performance - 2x2 MIMO for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.13_1 2Rx FDD FR1 PDSCH Single-DCI based FDM scheme A performance - 2x2 MIMO for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.1.14_1 2Rx FDD FR1 PDSCH Single-DCI based Inter-slot TDM scheme performance - 2x2 MIMO for both SA and NSA	Same as 5.2.2.1.6_1	Same as 5.2.2.1.6_1
5.2.2.2.1_1 2Rx TDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA	± 0.9 dB for test 1-10 ± 0.6 dB for test 1-11 For other TPs, same as 5.2.2.1.1_1	For test point 1-10, Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2} + SNR uncertainty due to finite test time^2) = 0.9 dB For test point 1-11, Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2} + SNR uncertainty due to finite test time^2) = 0.6 dB For other TPs, same as 5.2.2.1.1_1
5.2.2.2.1_2 2Rx TDD FR1 PDSCH Mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.2_1 2Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.3_1 2Rx TDD FR1 PDSCH mapping Type B performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.4_1 2Rx TDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1

5.2.2.2.5_1 2Rx TDD FR1 PDSCH 0.001% BLER performance - 1x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.5_1	Same as 5.2.2.1.5_1
5.2.2.2.6_1 2Rx TDD FR1 PDSCH repetitions over multiple slots performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.6_1	Same as 5.2.2.1.6_1
5.2.2.2.7_1 2Rx TDD FR1 PDSCH Mapping Type B and UE processing capability 2 performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.8_1 2Rx TDD FR1 PDSCH pre-emption performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.9_1 2Rx TDD FR1 HST-SFN performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.9_1	Same as 5.2.2.1.9_1
5.2.2.2.10_1 2Rx TDD FR1 HST-DPS performance - 2x2 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.10_1	Same as 5.2.2.1.10_1
5.2.2.2.11_1 2Rx TDD FR1 PDSCH Single-DCI based SDM scheme performance - 2x2 MIMO for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.12_1 2Rx TDD FR1 PDSCH Multiple-DCI based transmission scheme performance - 2x2 MIMO for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.13_1 2Rx TDD FR1 PDSCH Single-DCI based FDM scheme A performance - 2x2 MIMO for both SA and NSA	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2.2.2.14_1 2Rx TDD FR1 PDSCH Single-DCI based Inter-slot TDM scheme performance - 2x2 MIMO for both SA and NSA	Same as 5.2.2.1.6_1	Same as 5.2.2.1.6_1
5.2.3.1.1_1 4Rx FDD FR1 PDSCH mapping Type A performance - 2x4 MIMO with baseline receiver for both SA and NSA	± 0.9 dB for > 10Hz doppler ± 1.0 dB for 10Hz doppler	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2} + SNR uncertainty due to finite test time ^{2}) Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.7 dB for 2Tx AWGN flatness and signal flatness ±2.0 dB SNR uncertainty due to finite test time ±0.3 dB for 10Hz Doppler, otherwise ±0.0 dB
5.2.3.1.1_2 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1

5.2.3.1.1_4 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with enhanced receiver type 1 for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.2_1 4Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 4x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.3_1 4Rx FDD FR1 PDSCH mapping Type B performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.4_1 4Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.5_1 4Rx FDD FR1 PDSCH 0.001% BLER performance - 1x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.5_1	Same as 5.2.2.1.5_1
5.2.3.1.6_1 4Rx FDD FR1 PDSCH repetitions over multiple slots performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.6_1	Same as 5.2.2.1.6_1
5.2.3.1.7_1 4Rx FDD FR1 PDSCH Mapping Type B and UE processing capability 2 performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.8_1 4Rx FDD FR1 PDSCH pre-emption performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.9_1 4Rx FDD FR1 HST-SFN performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.9_1	Same as 5.2.2.1.9_1
5.2.3.1.10_1 4Rx FDD FR1 HST-DPS performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.10_1	Same as 5.2.2.1.10_1
5.2.3.1.11_1 4Rx FDD FR1 PDSCH Single-DCI based SDM scheme performance - 2x4 MIMO for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.12_1 4Rx FDD FR1 PDSCH Multiple-DCI based transmission scheme performance - 2x4 MIMO for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.13_1 4Rx FDD FR1 PDSCH Single-DCI based FDM scheme A performance - 2x4 MIMO for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.1.14_1 4Rx FDD FR1 PDSCH Single-DCI based Inter-slot TDM scheme performance - 2x4 MIMO for both SA and NSA	Same as 5.2.3.1.6_1	Same as 5.2.3.1.6_1
5.2.3.2.1_1 4Rx TDD FR1 PDSCH mapping Type A performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.2.1_2 4Rx TDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.2.1_4 4Rx TDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with enhanced receiver type 1 for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1

5.2.3.2.2_1 4Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.2.3_1 4Rx TDD FR1 PDSCH mapping Type B performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.2.4_1 4Rx TDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.2.5_1 4Rx TDD FR1 PDSCH 0.001% BLER performance - 1x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.5_1	Same as 5.2.2.1.5_1
5.2.3.2.6_1 4Rx TDD FR1 PDSCH repetitions over multiple slots performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.2.1.6_1	Same as 5.2.2.1.6_1
5.2.3.2.7_1 4Rx TDD FR1 PDSCH Mapping Type B and UE processing capability 2 performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.2.9_1 4Rx TDD FR1 HST-SFN performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.9_1	Same as 5.2.3.1.9_1
5.2.3.2.10_1 4Rx TDD FR1 HST DPS performance - 2x4 MIMO with baseline receiver for both SA and NSA	Same as 5.2.3.1.10_1	5.2.3.1.10_1
5.2.3.2.11_1 4Rx TDD FR1 PDSCH Single-DCI based SDM scheme performance - 2x2 MIMO for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.2.12_1 4Rx TDD FR1 PDSCH Multiple-DCI based transmission scheme performance - 2x2 MIMO for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.2.13_1 4Rx TDD FR1 PDSCH Single-DCI based FDM scheme A performance - 2x2 MIMO for both SA and NSA	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2.3.2.14_1 4Rx TDD FR1 PDSCH Single-DCI based Inter-slot TDM scheme performance - 2x2 MIMO for both SA and NSA	Same as 5.2.3.1.6_1	Same as 5.2.3.1.6_1
5.2A.2.1.1 2Rx Normal PDSCH Demodulation Performance for CA (2DL CA)	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2A.2.1.2 2Rx Normal PDSCH Demodulation Performance for CA (3DL CA)	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2A.2.1.3 2Rx Normal PDSCH Demodulation Performance for CA (4DL CA)	Same as 5.2.2.1.1_1	Same as 5.2.2.1.1_1
5.2A.2.2.1 2Rx PDSCH Demodulation Performance for CA with power imbalance (2DL CA)	±0.7 dB, f ≤ 3.0GHz ±1.0 dB, 3.0GHz < f ≤ 4.2GHz ±1.5 dB, 4.2GHz < f ≤ 6GHz Downlink EVM ≤ 6%	6% EVM is equivalent to a Test system downlink SNR of 24.4dB. The noise from the Test system is then sufficiently below that required for the UE to demodulate the signal with the required % success rate. Under these conditions the UE throughput is limited by the Reference measurement channel and the UE capability, and not by the Test system EVM.

5.2A.2.5.1 2RX PDSCH Demodulation Performance for HST-DPS CA	Same as 5.2.2.1.10_1	Same as 5.2.2.1.10_1
5.2A.3.1.1 4Rx Normal PDSCH Demodulation Performance for CA (2DL CA)	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2A.3.1.2 4Rx Normal PDSCH Demodulation Performance for CA (3DL CA)	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2A.3.1.3 4Rx Normal PDSCH Demodulation Performance for CA (4DL CA)	Same as 5.2.3.1.1_1	Same as 5.2.3.1.1_1
5.2A.3A.1.1 2Rx-4Rx Normal PDSCH Demodulation Performance for CA (2DL CA)	Same as 5.2.2.1.1_1 for 2Rx CC and 5.2.3.1.1_1 for 4Rx CC	Same as 5.2.2.1.1_1 for 2Rx CC and 5.2.3.1.1_1 for 4Rx CC
5.2A.3A.1.2 2Rx-4Rx Normal PDSCH Demodulation Performance for CA (3DL CA)	Same as 5.2.2.1.1_1 for 2Rx CC and 5.2.3.1.1_1 for 4Rx CC	Same as 5.2.2.1.1_1 for 2Rx CC and 5.2.3.1.1_1 for 4Rx CC
5.2A.3A.1.3 2Rx-4Rx Normal PDSCH Demodulation Performance for CA (3DL CA)	Same as 5.2.2.1.1_1 for 2Rx CC and 5.2.3.1.1_1 for 4Rx CC	Same as 5.2.2.1.1_1 for 2Rx CC and 5.2.3.1.1_1 for 4Rx CC
5.3.2.1.1 2Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	± 0.9 dB	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2}+ SNR uncertainty due to finite test time^2) Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.5 dB for 1Tx AWGN flatness and signal flatness ±2.0 dB SNR uncertainty due to finite test time ±0.4 dB

5.3.2.1.2 2Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	± 1.0 dB	Overall system uncertainty for fading conditions comprises four quantities: 1. Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2}+ SNR uncertainty due to finite test time^2) Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.7 dB for 2 Tx AWGN flatness and signal flatness ±2.0 dB SNR uncertainty due to finite test time ±0.4 dB
5.3.2.1.3 2Rx FDD FR1 PDCCH 1 Tx antenna performance for power saving	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.3.2.2.1 2Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.3.2.2.2 2Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.2	Same as 5.3.2.1.2
5.3.2.2.3 2Rx TDD FR1 PDCCH 1 Tx antenna performance for power saving	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.3.3.1.1 4Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.3.3.1.2 4Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.2	Same as 5.3.2.1.2
5.3.3.1.3 4Rx FDD FR1 PDCCH 1 Tx antenna performance for power saving	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.3.3.2.1 4Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.3.3.2.2 4Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	Same as 5.3.2.1.2	Same as 5.3.2.1.2
5.3.3.2.3 4Rx TDD FR1 PDCCH 1 Tx antenna performance for power saving	Same as 5.3.2.1.1	Same as 5.3.2.1.1
5.5.1 FR1 Sustained downlink data rate performance for single carrier	±0.7 dB, f ≤ 3.0GHz ±1.0 dB, 3.0GHz < f ≤ 4.2GHz ±1.5 dB, 4.2GHz < f ≤ 6GHz Downlink EVM ≤ 3%	3% EVM is equivalent to a Test system downlink SNR of 30.5dB. The noise from the Test system is then sufficiently below that required for the UE to demodulate the signal with the required % success rate. Under these conditions the UE throughput is limited by the Reference measurement channel and the UE capability, and not by the Test system EVM.
9.4B.1.1 Sustained downlink data rate performance for EN-DC within FR1	E-UTRA CC: ±0.7 dB, f ≤ 3.0GHz ±1.0 dB, 3.0GHz < f ≤ 4.2GHz NR CC: Same as 5.5.1	Same as 5.5.1

11.1.2.1.1_1 2Rx FR1 PSSCH performance - single active PSSCH link	± 0.8 dB	Overall system uncertainty for fading conditions comprises three quantities: 1. Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness Items 1, 2 and 3 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty 2 + Fading profile power uncertainty 2 + (0.25 x AWGN flatness and signal flatness) 2) Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.5 dB for single Tx AWGN flatness and signal flatness ±2.0 dB
11.1.3.1.1_1 2Rx FR1 PSCCH performance - single active PSSCH link	Same as 11.1.2.1.1_1	Same as 11.1.2.1.1_1
11.1.5.1.1_1 2Rx FR1 PSCCH performance - single active PSSCH link	Same as 11.1.2.1.1_1	Same as 11.1.2.1.1_1
11.1.6.1.1_1 2Rx FR1 Power imbalance performance - two active PSSCH link	± 0.6 dB	Overall system uncertainty for fading conditions comprises two quantities: 1. Signal-to-noise ratio uncertainty 2. Effect of AWGN flatness and signal flatness Items 1, and 2 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty 2 + (0.25 x AWGN flatness and signal flatness) 2) Signal-to-noise ratio uncertainty ±0.3 dB AWGN flatness and signal flatness ±2.0 dB
11.1.7.1.1_1 2Rx FR1 HARQ buffer soft combining performance - maximum number of HARQ processes	Same as 11.1.2.1.1_1	Same as 11.1.2.1.1_1
11.1.8.1.1_1 2Rx FR1 PSCCH decoding capability - maximum number of received PSCCHs	Downlink absolute power uncertainty, averaged over BWConfig ±1.0 dB Downlink EVM ≤ 3%	3% EVM is equivalent to a Test system downlink SNR of 30.5dB. The noise from the Test system is then sufficiently below that required for the UE to demodulate the signal with the required % success rate. Under these conditions the UE throughput is limited by the Reference measurement channel and the UE capability, and not by the Test system EVM.
11.1.9.1.1_1 2Rx FR1 PSFCH decoding capability - maximum number of received PSFCHs	Same as 11.1.8.1.1_1	Same as 11.1.8.1.1_1

F.1.1.3 Measurement of Channel State Information reporting

This clause defines the maximum test system uncertainty for channel state information reporting requirements. The maximum test system uncertainty allowed for the measurement uncertainty contributors are defined in Table F.1.1.3-1.

Table F.1.1.3-1: Maximum measurement uncertainty values for the test system for FR1 (up to 6 GHz) and Channel BW ≤ 40 MHz

MU contributor	Unit	Value	Comment
AWGN flatness and signal flatness, max deviation for any Resource Block, relative to average over BW_{config}	dB	Same as in table F.1.1.2-1	
Signal to noise ratio uncertainty	dB	Same as in table F.1.1.2-1	
Signal to noise ratio variation	dB	Same as in table F.1.1.2-1	
Fading profile power uncertainty for 1Tx	dB	Same as in table F.1.1.2-1	
Fading profile power uncertainty for 2Tx	dB	Same as in table F.1.1.2-1	

The maximum test system uncertainty for test cases defined in section 6 is defined in Table F.1.1.3-2.

Table F.1.1.3-2: Maximum test system uncertainty for FR1 channel state information reporting test cases

Subclause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
6.2.2.1.1.1 2Rx FDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	+/- 0.3 dB	Overall system uncertainty for AWGN conditions comprises: Signal-to-noise ratio uncertainty ±0.3 dB *AWGN flatness and signal flatness ±2.0 dB not expected to have any significant effect*
6.2.2.1.1.22Rx FDD FR1 periodic CQI reporting with Table 3 under AWGN conditions for both SA and NSA	Same as 6.2.2.1.1.1	Same as 6.2.2.1.1.1
6.2.2.1.2.12Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	+/- 0.8 dB	Overall system uncertainty for fading conditions comprises two quantities: 1. Signal-to-noise ratio uncertainty ±0.3 dB 2. Fading profile power uncertainty for 2Tx ±0.7 dB Items 1 and 2 are assumed to be uncorrelated so can be root sum squared: Test System uncertainty = SQRT (Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2}) *AWGN flatness and signal flatness ±2.0 dB not expected to have any significant effect*
6.2.2.1.2.22Rx FDD FR1 aperiodic subband CQI reporting under fading conditions for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.2.2.2.1.1 2Rx TDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	Same as 6.2.2.1.1.1	Same as 6.2.2.1.1.1
6.2.2.2.1.22Rx TDD FR1 periodic CQI reporting with Table 3 under AWGN conditions for both SA and NSA	Same as 6.2.2.1.1.1	Same as 6.2.2.1.1.1
6.2.2.2.2.12Rx TDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.2.2.2.2.22Rx TDD FR1 aperiodic subband CQI reporting under fading conditions for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.2.3.1.1.1 4Rx FDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	Same as 6.2.2.1.1.1	Same as 6.2.2.1.1.1
6.2.3.1.1.24Rx FDD FR1 periodic CQI reporting with Table 3 under AWGN conditions for both SA and NSA	Same as 6.2.2.1.1.1	Same as 6.2.2.1.1.1
6.2.3.1.2.14Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.2.3.1.2.24Rx FDD FR1 aperiodic subband CQI reporting under fading conditions for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.2.3.2.1.1 4Rx TDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	Same as 6.2.2.1.1.1	Same as 6.2.2.1.1.1
6.2.3.2.2.14Rx TDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.2.3.2.2.24Rx TDD FR1 aperiodic subband CQI reporting under fading conditions for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1

6.2A.3.1.1 2Rx CQI reporting accuracy under AWGN conditions for CA (2DL CA)	Same as 6.2.2.1.1.1 for each CC	Same as 6.2.2.1.1.1
6.2A.3.1.2 2Rx CQI reporting accuracy under AWGN conditions for CA (3DL CA)	Same as 6.2.2.1.1.1 for each CC	Same as 6.2.2.1.1.1
6.2A.3.1.3 2Rx CQI reporting accuracy under AWGN conditions for CA (4DL CA)	Same as 6.2.2.1.1.1 for each CC	Same as 6.2.2.1.1.1
6.3.2.1.1 2Rx FDD FR1 Single PMI with 4Tx Type I- SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.2.1.2 2Rx FDD FR1 Single PMI with 8Tx Type I – SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.2.1.3 2Rx FDD FR1 Multiple PMI with 16Tx Type I – SinglePanel Codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.2.1.4 2Rx FDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.2.1.5 2Rx FDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.2.1.6 2Rx FDD FR1 Multiple PMI with 16Tx Enhanced TypeII codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.2.3.2.1.24Rx TDD FR1 periodic CQI reporting with Table 3 under AWGN conditions for both SA and NSA	Same as 6.2.2.1.1.1	Same as 6.2.2.1.1.1
6.3.2.2.1 2Rx TDD FR1 Single PMI with 4Tx TypeI – SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.2.2.2 2Rx TDD FR1 Single PMI with 8Tx TypeI – SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.2.2.3 2Rx TDD FR1 Single PMI with 16Tx Type1 – SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.2.2.4 2Rx TDD FR1 Single PMI with 32Tx Type1 – SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.2.2.6 2Rx TDD FR1 Multiple PMI with 16Tx Enhanced TypeII codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook– SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook– SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.1.3 4Rx FDD FR1 Multiple PMI with 16Tx Type I – SinglePanel Codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.1.4 4Rx FDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.1.5 4Rx FDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.1.6 4Rx FDD FR1 Multiple PMI with 16Tx Enhanced TypeII codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.2.1 4Rx TDD FR1 Single PMI with 4Tx Type1 - SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1

6.3.2.2.5 2Rx TDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.2.2 4Rx TDD FR1 Single PMI with 8Tx Type1 - SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.2.3 4Rx TDD FR1 Single PMI with 16Tx Type1 - SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.2.4 4Rx TDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.2.5 4Rx TDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.3.3.2.6 4Rx TDD FR1 Multiple PMI with 16Tx Enhanced TypeII codebook for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.4.2.1_1 2Rx FDD FR1 RI reporting for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.4.2.2_1 2Rx TDD FR1 RI reporting for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.4.3.1_1 4Rx FDD FR1 RI reporting for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1
6.4.3.2_1 4Rx TDD FR1 RI reporting for both SA and NSA	Same as 6.2.2.1.2.1	Same as 6.2.2.1.2.1

F.1.2 Interpretation of measurement results (normative)

The measurement results returned by the Test System are compared – without any modification – against the Test Requirements as defined by the shared risk principle.

The Shared Risk principle is defined in ETR 273-1-2 clause 6.5.

The actual measurement uncertainty of the Test System for the measurement of each parameter shall be included in the test report.

The recorded value for the Test System uncertainty shall be, for each measurement, equal to or lower than the appropriate figure in clause F.1 of the present document.

If the Test System for a test is known to have a measurement uncertainty greater than that specified in clause F.1, it is still permitted to use this apparatus provided that an adjustment is made value as follows:

Any additional uncertainty in the Test System over and above that specified in clause F.1 shall be used to tighten the Test Requirement, making the test harder to pass. For some tests, for example receiver tests, this may require modification of stimulus signals. This procedure will ensure that a Test System not compliant with clause F.1does not increase the chance of passing a device under test where that device would otherwise have failed the test if a Test System compliant with clause F.1 had been used.

F.1.3 Test Tolerance and Derivation of Test Requirements (informative)

The Test Requirements in the present document have been calculated by relaxing the Minimum Requirements of the core specification using the Test Tolerances defined in this clause. When the Test Tolerance is zero, the Test Requirement will be the same as the Minimum Requirement. When the Test Tolerance is non-zero, the Test Requirements will differ from the Minimum Requirements, and the formula used for the relaxation is given in this clause.

The Test Tolerances are derived from Test System uncertainties, regulatory requirements and criticality to system performance. As a result, the Test Tolerances may sometimes be set to zero.

The test tolerances should not be modified for any reason e.g. to take account of commonly known test system errors (such as mismatch, cable loss, etc.).

The downlink Test Tolerances apply at each receiver antenna connector.

F.1.3.1 Measurement of test environments

The UE test environments are set to the values defined in TS 36.508 subclause 4.1, without any relaxation. The applied Test Tolerance is therefore zero.

F.1.3.2 Measurement of Demod Performance requirements

The derivation of the test requirements for the test cases in section 5 is defined in Table F.1.3.2-1.

Table F.1.3.2-1: Derivation of Test Requirements (FR1 demodulation performance tests)

Test	Minimum Requirement in TS 38.101-4	Test Tolerance (TT)	Test Requirement in TS 38.521-4
5.2.2.1.1_1 2Rx FDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler 0.6 dB for test 1-6 0.9 dB for test 1-7	Formula: SNR + TT T-put limit unchanged
5.2.2.1.1_2 2Rx FDD FR1 PDSCH Mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.2_1 2Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.3_1 2Rx FDD FR1 PDSCH mapping Type B performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.4_1 2Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.5_1 2Rx FDD FR1 PDSCH 0.001% BLER performance - 1x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2.2.1.6_1 2Rx FDD FR1 PDSCH repetitions over multiple slots performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	[0.7]	Formula: SNR + TT
5.2.2.1.7 2Rx FDD FR1 PDSCH Mapping Type B and UE processing capability 2 performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.8_1 2Rx FDD FR1 PDSCH pre-emption performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.9_1 2Rx FDD FR1 HST-SFN performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2.2.1.10_1 2Rx FDD FR1 HST-DPS performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2.2.1.11_1 2Rx FDD FR1 PDSCH Single-DCI based SDM scheme performance - 2x2 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.12_1 2Rx FDD FR1 PDSCH Multiple-DCI based transmission scheme performance - 2x2 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.13_1 2Rx FDD FR1 PDSCH Single-DCI based FDM scheme A performance - 2x2 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.1.14_1 2Rx FDD FR1 PDSCH Single-DCI based Inter-slot TDM scheme performance - 2x2 MIMO for both SA and NSA	SNRs as specified	[0.7]	Formula: SNR + TT T-put limit unchanged

5.2.2.2.1_1 2Rx TDD FR1 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler 0.9 dB for test 1-10 0.6 dB for test 1-11	Formula: SNR + TT T-put limit unchanged
5.2.2.2.1_2 2Rx TDD FR1 PDSCH Mapping Type A performance - 2x2 MIMO with enhanced receiver type X for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.2_1 2Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.3_1 2Rx TDD FR1 PDSCH mapping Type B performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.4_1 2Rx TDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.5_1 2Rx FDD FR1 PDSCH 0.001% BLER performance - 1x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	[0.6 dB]	Formula: SNR + TT T-put limit unchanged
5.2.2.2.6_1 2Rx TDD FR1 PDSCH repetitions over multiple slots performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	[0.6 dB]	Formula: SNR + TT
5.2.2.2.7_1 2Rx TDD FR1 PDSCH Mapping Type B and UE processing capability 2 performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.8_1 2Rx TDD FR1 PDSCH pre-emption performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.9_1 2Rx TDD FR1 HST-SFN performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2.2.2.10_1 2Rx TDD FR1 HST-DPS performance - 2x2 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2.2.2.11_1 2Rx TDD FR1 PDSCH Single-DCI based SDM scheme performance - 2x2 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.12_1 2Rx TDD FR1 PDSCH Multiple-DCI based transmission scheme performance - 2x2 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.13_1 2Rx TDD FR1 PDSCH Single-DCI based FDM scheme A performance - 2x2 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.2.2.14_1 2Rx TDD FR1 PDSCH Single-DCI based Inter-slot TDM scheme performance - 2x2 MIMO for both SA and NSA	SNRs as specified	[0.7dB]	Formula: SNR + TT T-put limit unchanged
5.2.3.1.1_1 4Rx FDD FR1 PDSCH mapping Type A performance - 2x4 MIMO baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged

5.2.3.1.1_2 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.1_4 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with enhanced receiver type 1 for both SA and NSA	SNRs as specified	0.9 dB for > 10Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.2_1 4Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 4x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.1.3_1 4Rx FDD FR1 PDSCH mapping Type B performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.1.4_1 4Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB for > 10 Hz doppler 1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.5_1 4Rx FDD FR1 PDSCH 0.001% BLER performance - 1x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	[0.6 dB]	Formula: SNR + TT T-put limit unchanged
5.2.3.1.6_1 4Rx FDD FR1 PDSCH repetitions over multiple slots performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	[0.7dB]	Formula: SNR + TT
5.2.3.1.7_1 4Rx FDD FR1 PDSCH Mapping Type B and UE processing capability 2 performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.8_1 4Rx FDD FR1 PDSCH pre-emption performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.9_1 4Rx FDD FR1 HST-SFN performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.1.10_1 4Rx FDD FR1 HST-DPS performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.1.11_1 4Rx FDD FR1 PDSCH Single-DCI based SDM scheme performance - 2x4 MIMO for both SA and NSA	SNRs as specified	1.0 dB for > 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.12_1 4Rx FDD FR1 PDSCH Multiple-DCI based transmission scheme performance - 2x4 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.13_1 4Rx FDD FR1 PDSCH Single-DCI based FDM scheme A performance - 2x4 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.1.14_1 4Rx FDD FR1 PDSCH Single-DCI based Inter-slot TDM scheme performance - 2x4 MIMO for both SA and NSA	SNRs as specified	[0.7dB]	Formula: SNR + TT T-put limit unchanged
5.2.3.2.2_1 4Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.2.3_1 4Rx TDD FR1 PDSCH mapping Type B performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.2.4_1 4Rx TDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.2.5_1 4Rx TDD FR1 PDSCH 0.001% BLER performance - 1x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	[0.6 dB]	Formula: SNR + TT T-put limit unchanged

5.2.3.2.6_1 4Rx TDD FR1 PDSCH repetitions over multiple slots performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	[0.7dB]	Formula: SNR + TT
5.2.3.2.7_1 4Rx TDD FR1 PDSCH Mapping Type B and UE processing capability 2 performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.2.8_1 4Rx TDD FR1 PDSCH pre-emption performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.2.9_1 4Rx TDD FR1 HST-SFN performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.2.10_1, 4Rx TDD FR1 HST DPS performance - 2x4 MIMO with baseline receiver for both SA and NSA	SNRs as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2.3.2.11_1 4Rx TDD FR1 PDSCH Single-DCI based SDM scheme performance - 2x2 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.2.12_1 4Rx TDD FR1 PDSCH Multiple-DCI based transmission scheme performance - 2x2 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.2.13_1 4Rx TDD FR1 PDSCH Single-DCI based FDM scheme A performance - 2x2 MIMO for both SA and NSA	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2.3.2.14_1 4Rx TDD FR1 PDSCH Single-DCI based Inter-slot TDM scheme performance - 2x2 MIMO for both SA and NSA	SNRs as specified	[0.7dB]	Formula: SNR + TT T-put limit unchanged
5.2A.2.1.1 2Rx Normal PDSCH Demodulation Performance for CA (2DL CA)	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2A.2.1.2 2Rx Normal PDSCH Demodulation Performance for CA (3DL CA)	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2A.2.1.3 2Rx Normal PDSCH Demodulation Performance for CA (4DL CA)	SNRs as specified	1.0 dB for 10Hz doppler	Formula: SNR + TT T-put limit unchanged
5.2A.2.2.1 2Rx PDSCH Demodulation Performance for CA with power imbalance (2DL CA)	Power level as specified	No TT added	T-put limit unchanged
5.2A.2.5.1 2RX PDSCH Demodulation Performance for HST-DPS CA	SNR as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
5.2A.3.1.1 4Rx Normal PDSCH Demodulation Performance for CA (2DL CA)	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.2A.3.1.2 4Rx Normal PDSCH Demodulation Performance for CA (3DL CA)	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.2A.3.1.3 4Rx Normal PDSCH Demodulation Performance for CA (4DL CA)	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.2A.3A.1.1 2Rx-4Rx Normal PDSCH Demodulation Performance for CA (2DL CA)	SNRs as specified	2Rx CC: 1.0 dB for 10Hz doppler 4Rx CC: 0.9dB	Formula: SNR + TT T-put limit unchanged
5.2A.3A.1.2 2Rx-4Rx Normal PDSCH Demodulation Performance for CA (3DL CA)	SNRs as specified	2Rx CC: 1.0 dB for 10Hz doppler 4Rx CC: 0.9dB	Formula: SNR + TT T-put limit unchanged
5.2A.3A.1.3 2Rx-4Rx Normal PDSCH Demodulation Performance for CA (3DL CA)	SNRs as specified	2Rx CC: 1.0 dB for 10Hz doppler 4Rx CC: 0.9dB	Formula: SNR + TT T-put limit unchanged

11.1.2.1.1_1 2Rx FR1 PSSCH performance - single active PSSCH link	SNR as specified	0.8 dB	Formula: SNR + TT T-put limit unchanged
11.1.3.1.1_1 2Rx FR1 PSCCH performance - single active PSSCH link	SNR as specified	0.8 dB	Formula: SNR + TT missing detection probability limit unchanged
11.1.5.1.1_1 2Rx FR1 PSCCH performance - single active PSSCH link	SNR as specified	0.8 dB	Formula: SNR + TT missing detection probability limit unchanged
11.1.6.1.1_1 2Rx FR1 Power imbalance performance - two active PSSCH link	SNR as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
11.1.7.1.1_1 2Rx FR1 HARQ buffer soft combining performance - maximum number of HARQ processes	SNR as specified	0.6 dB	Formula: SNR + TT T-put limit unchanged
11.1.8.1.1_1 2Rx FR1 PSCCH decoding capability - maximum number of received PSCCHs	sidelink power	0 dB	sidelink power unchanged missing detection probability limit unchanged
11.1.9.1.1_1 2Rx FR1 PSFCH decoding capability - maximum number of received PSFCHs	sidelink power	0 dB	sidelink power unchanged missing detection probability limit unchanged
5.3.2.1.1 2Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.2.1.2 2Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged
5.3.2.1.3 2Rx FDD FR1 PDCCH 1 Tx antenna performance for power saving	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.2.2.1 2Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.2.2.2 2Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged
5.3.2.2.3 2Rx TDD FR1 PDCCH 1 Tx antenna performance for power saving	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.3.1.1 4Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.3.1.2 4Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged
5.3.3.1.3 4Rx FDD FR1 PDCCH 1 Tx antenna performance power saving	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.3.2.1 4Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	SNRs as specified	0.9 dB	Formula: SNR + TT T-put limit unchanged
5.3.3.2.2 4Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	SNRs as specified	1.0 dB	Formula: SNR + TT T-put limit unchanged

F.1.3.3 Measurement of Channel State Information reporting

The derivation of the test requirements for the test cases in section 6 is defined in Table F.1.3.3-1.

Table F.1.3.3-1: Derivation of Test Requirements (FR1 channel state information reporting tests)

Test	Minimum Requirement in TS 38.101-4	Test Tolerance (TT)	Test Requirement in TS 38.521-4
6.2.2.1.1.12Rx FDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	SNR unchanged
6.2.2.1.1.22Rx FDD FR1 periodic CQI reporting with Table 3 under AWGN conditions for both SA and NSA	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	SNR unchanged
6.2.2.1.2.12Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α 20% γ 1.05 BLER 0.02	SNR 0 dB α 0% γ *0.01* BLER 0	SNR unchanged α unchanged γ 1.04 BLER limit unchanged
6.2.2.1.2.22Rx FDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α 2% β 55% γ 1.05 BLER 0.02	SNR 0 dB α 0% β 0% γ 0.01 BLER 0	SNR unchanged α limit unchanged β limit unchanged γ 1.04 BLER limit unchanged
6.2.2.2.1.12Rx TDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	SNR unchanged
6.2.2.2.1.22Rx TDD FR1 periodic CQI reporting with Table 3 under AWGN conditions for both SA and NSA	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	SNR unchanged
6.2.2.2.2.12Rx TDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α 20% γ 1.05 BLER 0.02	SNR 0 dB α 0% γ *0.01* BLER 0	SNR unchanged α unchanged γ 1.04 BLER limit unchanged
6.2.2.2.2.22Rx TDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α 2% β 55% γ 1.05 BLER 0.02	SNR 0 dB α 0% β 0% γ *0.01* BLER 0	SNR unchanged α limit unchanged β limit unchanged γ 1.04 BLER limit unchanged
6.2.3.1.1.14Rx FDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	SNR unchanged
6.2.3.1.1.24Rx FDD FR1 periodic CQI reporting with Table 3 under AWGN conditions for both SA and NSA	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	SNR unchanged
6.2.3.1.2.14Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α 5% γ 1.05 BLER 0.02	SNR 0 dB α 0% γ *0.01* BLER 0	SNR unchanged α unchanged γ 1.04 BLER limit unchanged
6.2.3.1.2.24Rx FDD FR1 aperiodic subband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α 2% β 55% γ 1.05 BLER 0.02	SNR 0 dB α 0% β 0% γ 0.01 BLER 0	SNR unchanged α limit unchanged β limit unchanged γ 1.04 BLER limit unchanged
6.2.3.2.1.14Rx TDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	SNR unchanged
6.2.3.2.1.24Rx TDD FR1 periodic CQI reporting with Table 3 under AWGN conditions for both SA and NSA	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	SNR unchanged
6.2.3.2.2.14Rx TDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α 5% γ 1.05 BLER 0.02	SNR 0 dB α 0% γ *0.01* BLER 0	SNR unchanged α unchanged γ 1.04 BLER limit unchanged

6.2.3.2.2.24Rx TDD FR1 aperiodic subband CQI reporting under fading conditions for both SA and NSA	SNRs as specified α 2% β 55% γ 1.05 BLER 0.02	SNR 0 dB α 0% β 0% γ 0.01 BLER 0	SNR unchanged α limit unchanged β limit unchanged γ 1.04 BLER limit unchanged
6.2A.3.1.1 2Rx CQI reporting accuracy under AWGN conditions for CA (2DL CA)	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	Test requirement unchanged
6.2A.3.1.2 2Rx CQI reporting accuracy under AWGN conditions for CA (3DL CA)	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	Test requirement unchanged
6.2A.3.1.3 2Rx CQI reporting accuracy under AWGN conditions for CA (4DL CA)	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	Test requirement unchanged
6.3.2.1.1 2Rx FDD FR1 Single PMI with 4Tx Type I- SinglePanel codebook for both SA and NSA	SNRs as specified γ 1.30	SNR 0 dB γ 0.01	SNR unchanged γ 1.29
6.3.2.1.2 2Rx FDD FR1 Single PMI with 8Tx Type I – SinglePanel codebook for both SA and NSA	SNRs as specified γ 1.50	SNR 0 dB γ 0.01	SNR unchanged γ 1.49
6.3.2.1.3 2Rx FDD FR1 Multiple PMI with 16Tx Type I – SinglePanel Codebook for both SA and NSA	SNRs as specified γ 2.50	SNR 0 dB γ 0.01	SNR unchanged γ 2.49
6.3.2.1.4 2Rx FDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	SNRs as specified γ 5.0	SNR 0 dB γ 0.01	SNR unchanged γ 4.99
6.3.2.1.5 2Rx FDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	SNRs as specified γ 1.9	SNR 0 dB γ 0.01	SNR unchanged γ 1.89
6.3.2.1.6 2Rx FDD FR1 Multiple PMI with 16Tx Enhanced TypeII codebook for both SA and NSA	SNRs as specified γ 2.2	SNR 0 dB γ 0.01	SNR unchanged γ 2.19
6.3.2.2.1 2Rx TDD FR1 Single PMI with 4Tx TypeI - SinglePanel codebook for both SA and NSA	SNRs as specified γ 1.30	SNR 0 dB γ 0.01	SNR unchanged γ 1.29
6.3.2.2.2 2Rx TDD FR1 Single PMI with 8Tx TypeI - SinglePanel codebook for both SA and NSA	SNRs as specified γ 1.50	SNR 0 dB γ 0.01	SNR unchanged γ 1.49
6.3.2.2.3 2Rx TDD FR1 Single PMI with 16Tx Type1 - SinglePanel codebook for both SA and NSA	SNRs as specified γ 2.50	SNR 0 dB γ 0.01	SNR unchanged γ 2.49
6.3.2.2.4 2Rx TDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	SNRs as specified γ 5.0	SNR 0 dB γ 0.01	SNR unchanged γ 4.99
6.3.2.2.5 2Rx TDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	SNRs as specified γ 1.9	SNR 0 dB γ 0.01	SNR unchanged γ 1.89
6.3.2.2.6 2Rx TDD FR1 Multiple PMI with 16Tx Enhanced TypeII codebook for both SA and NSA	SNRs as specified γ 2.2	SNR 0 dB γ 0.01	SNR unchanged γ 2.19
6.3.3.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook– SinglePanel codebook for both SA and NSA	SNRs as specified γ 1.30	SNR 0 dB γ 0.01	SNR unchanged γ 1.29

6.3.3.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook– SinglePanel codebook for both SA and NSA	SNRs as specified γ 1.50	SNR 0 dB γ *0.01*	SNR unchanged γ 1.49
6.3.3.1.3 4Rx FDD FR1 Multiple PMI with 16Tx Type I – SinglePanel Codebook for both SA and NSA	SNRs as specified γ 3.00	SNR 0 dB γ *0.01*	SNR unchanged γ 2.99
6.3.3.1.4 4Rx FDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	SNRs as specified γ *7*.0	SNR 0 dB γ *0.01*	SNR unchanged γ 6.99
6.3.3.1.5 4Rx FDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	SNRs as specified γ *1.9*	SNR 0 dB γ *0.01*	SNR unchanged γ 1.89
6.3.3.1.6 4Rx FDD FR1 Multiple PMI with 16Tx Enhanced TypeII codebook for both SA and NSA	SNRs as specified γ 2.2	SNR 0 dB γ *0.01*	SNR unchanged γ 2.19
6.3.3.2.1 4Rx TDD FR1 Single PMI with 4Tx Type1 - SinglePanel codebook for both SA and NSA	SNRs as specified γ 1.30	SNR 0 dB γ *0.01*	SNR unchanged γ 1.29
6.3.3.2.2 4Rx TDD FR1 Single PMI with 8Tx Type1 - SinglePanel codebook for both SA and NSA	SNRs as specified γ 1.50	SNR 0 dB γ *0.01*	SNR unchanged γ 1.49
6.3.3.2.3 4Rx TDD FR1 Single PMI with 16Tx Type1 - SinglePanel codebook for both SA and NSA	SNRs as specified γ *3*.0	SNR 0 dB γ *0.01*	SNR unchanged γ 2.99
6.3.3.2.4 4Rx TDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	SNRs as specified γ *7*.0	SNR 0 dB γ *0.01*	SNR unchanged γ 6.99
6.3.3.2.5 4Rx TDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	SNRs as specified γ 1.8	SNR 0 dB γ *0.01*	SNR unchanged γ 1.79
6.3.3.2.6 4Rx TDD FR1 Multiple PMI with 16Tx Enhanced TypeII codebook for both SA and NSA	SNRs as specified γ 2.2	SNR 0 dB γ *0.01*	SNR unchanged γ 2.19
6.4.2.1_1 2Rx FDD FR1 RI reporting for both SA and NSA	SNRs as specified γ_2 1.00 for Test 1 γ_1 1.05 for Test 2 γ_1 0.90 for Test 3	SNR 0 dB γ_2 *0.01 for Test 1* γ_1 *0.01 for Test 2* γ_1 *0.01 for Test 3*	SNR unchanged γ_2 0.99 for Test 1 γ_1 1.04 for Test 2 γ_1 0.89 for Test 3
6.4.2.2_1 2Rx TDD FR1 RI reporting for both SA and NSA	SNRs as specified γ_2 1.00 for Test 1 γ_1 1.05 for Test 2 γ_1 0.90 for Test 3	SNR 0 dB γ_2 *0.01 for Test 1* γ_1 *0.01 for Test 2* γ_1 *0.01 for Test 3*	SNR unchanged γ_2 0.99 for Test 1 γ_1 1.04 for Test 2 γ_1 0.89 for Test 3
6.4.3.1_1 4Rx FDD FR1 RI reporting for both SA and NSA	SNRs as specified γ_2 0.90 for Test 1 γ_1 1.05 for Test 2 γ_1 0.90 for Test 3 γ_2 0.90 for Test 4	SNR 0 dB γ_2 *0.01 for Test 1* γ_1 *0.01 for Test 2* γ_1 *0.01 for Test 3* γ_2 *0.01 for Test 4*	SNR unchanged γ_2 0.89 for Test 1 γ_1 1.04 for Test 2 γ_1 0.89 for Test 3 γ_2 0.89 for Test 4
6.4.3.2_1 4Rx TDD FR1 RI reporting for both SA and NSA	SNRs as specified γ_2 0.90 for Test 1 γ_1 1.05 for Test 2 γ_1 0.90 for Test 3 γ_2 0.90 for Test 4	SNR 0 dB γ_2 *0.01 for Test 1* γ_1 *0.01 for Test 2* γ_1 *0.01 for Test 3* γ_2 *0.01 for Test 4*	SNR unchanged γ_2 0.89 for Test 1 as per Table G.3.4 γ_1 1.04 for Test 2 as per Table G.3.4 γ_1 0.89 for Test 3 as per Table G.3.4 γ_2 0.89 for Test 4 as per Table G.3.4

F.2 Measurement uncertainties and test tolerances for FR2

F.2.1 Acceptable uncertainty of test system (normative)

The maximum acceptable uncertainty of the Test System is specified below for each test, where appropriate. The Test System shall enable the stimulus signals in the test case to be adjusted to within the specified range, and the equipment under test to be measured with an uncertainty not exceeding the specified values. Care should be taken to ensure that each conformance test implementation including the OTA chamber aspects meets the specified measurement uncertainty for each test case by requiring the test laboratory to maintain a detailed measurement uncertainty test report showing compliance to all the measurement uncertainty requirements. The detailed measurement uncertainty report would contain the justification for each measurement uncertainty component and its value and distribution. The derivation of these values is based on the minimum conformance requirements plus relaxation, i.e., test tolerance is not to be considered. All ranges and uncertainties are absolute values, and are valid for a confidence level of 95 %, unless otherwise stated.

A confidence level of 95 % is the measurement uncertainty tolerance interval for a specific measurement that contains 95 % of the performance of a population of test equipment.

The downlink signal uncertainties apply at the defined quiet zone with the UE properly positioned in the quiet zone. The uplink signal uncertainties apply at the measurement equipment with the UE positioned properly in the quiet zone.

F.2.1.1 Measurement of test environments

TBD

F.2.1.2 Measurement of Demod Performance requirements

This clause defines the maximum test system uncertainty for Demod Performance requirements. The maximum test system uncertainty allowed for the measurement uncertainty contributors are defined in Table F.2.1.2-1.

Table F.2.1.2-1: Maximum measurement uncertainty values for the test system for FR2 (up to 40 GHz) and Channel BW ≤ 400 MHz

MU contributor	Unit	Value	Comment
AWGN flatness and signal flatness, max deviation for any Resource Block, relative to average over BW_{config}	dB	±3.6	
gNB emulator Signal to noise ratio uncertainty	dB	±0.3	
Impact on non-ideal isolation between branches for the wireless cable mode	dB	0.60 for Rank1 0.45 for Rank2	Systematic uncertainty
Fading profile power uncertainty	dB	±0.5 for 1Tx ±0.7 for 2Tx	
SNR uncertainty due to finite test time	dB	±0.3 for PDSCH and doppler < 100Hz 0.0 for PDSCH and doppler ≥ ±0.4 for PDCCH	

The maximum test system uncertainty for test cases defined in section 7 is defined in Table F.2.1.2-2.

Table F.2.1.2-2: Maximum test system uncertainty for FR2 demodulation performance test cases

Subclause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
7.2.2.2.1_1 2Rx TDD FR2 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for SA and NSA	2Tx, Rank 1: ± 1.82 dB for Doppler < 100 Hz ± 1.78 dB for Doppler ≥100 Hz 2Tx, Rank 2: ± 1.67 dB for Doppler < 100Hz ± 1.63 dB for Doppler ≥100 Hz	Overall system uncertainty for fading conditions comprises four quantities: 1. gNB emulator Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time 5. Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator SNR Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (gNB emulator Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2} + SNR uncertainty due to finite test time^2) + Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.7 dB AWGN flatness and signal flatness ±3.6 dB SNR uncertainty due to finite test time ±0.3 dB for doppler < 100Hz, otherwise 0 dB Impact on non-ideal isolation between branches for the wireless cable mode 0.60 dB for Rank1, 0.45 dB for Rank2
7.2.2.2.1_2 2Rx TDD FR2 PDSCH mapping Type A performance - 2x2 MIMO with enhanced type 1 receiver for SA and NSA	2Tx, Rank 2: ± 1.67 dB for Doppler < 100Hz ± 1.63 dB for Doppler ≥ 100Hz	Same as 7.2.2.2.1_1
7.2.2.2.1_3 2Rx TDD FR2 PDSCH mapping Type A performance - 2x2 MIMO with 256QAM for SA and NSA (Rel-16 and forward)	2Tx, Rank 1: ± 1.82 dB for Doppler < 100 Hz	Same as 7.2.2.2.1_1
7.2.2.2.2_1 2Rx TDD FR2 PDSCH repetitions over multiple slots	FFS	FFS
7.2.2.2.3_1 2Rx TDD FR2 PDSCH Mapping Type B	2Tx, Rank 1: ± 1.82 dB for Doppler < 100 Hz	Same as 7.2.2.2.1_1

7.2A.2.1 2Rx TDD FR2 CA requirements for normal PDSCH Demodulation Performance for both SA and NSA (2DLCA)	2Tx, Rank 2: ± 1.67 dB for Doppler < 100Hz	Overall system uncertainty for fading conditions comprises four quantities: 1. gNB emulator Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time 5. Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator SNR Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (gNB emulator Signal-to-noise ratio uncertainty ^{2} + Fading profile power uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2} + SNR uncertainty due to finite test time^2) + Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.7 dB AWGN flatness and signal flatness ±3.6 dB SNR uncertainty due to finite test time ±0.3 dB for doppler < 100Hz, otherwise 0 dB Impact on non-ideal isolation between branches for the wireless cable mode 0.45 dB for Rank2
7.2A.2.2 2Rx TDD FR2 CA requirements for normal PDSCH Demodulation Performance for both SA and NSA (3DLCA)	Same as 7.2A.2.1	Same as 7.2A.2.1

7.3.2.2.1 2Rx TDD FR2 PDCCH 1 Tx antenna performance for both SA and NSA	1Tx, rank1: ± 1.74 dB	Overall system uncertainty for fading conditions comprises four quantities: 1. gNB emulator Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time 5. Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator SNR Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (gNB emulator Signal-to-noise ratio uncertainty 2 + Fading profile power uncertainty 2 + (0.25 x AWGN flatness and signal flatness) 2 + SNR uncertainty due to finite test time2) + Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.5 dB for 1Tx, ±0.7 dB for 2Tx AWGN flatness and signal flatness ±3.6 dB SNR uncertainty due to finite test time ±0.4 dB Impact on non-ideal isolation between branches for the wireless cable mode 0.6 for Rank1 and 0.45 for rank2
7.3.2.2.2 2Rx TDD FR2 PDCCH 2 Tx antenna performance for both SA and NSA	2Tx, rank1: ± 1.84 dB	Same as 7.3.2.2.1
7.3.2.2.3 2Rx TDD FR2 PDCCH 1 Tx antenna performance for power saving	1Tx, rank1: ± 1.74 dB	Same as 7.3.2.2.1
7.5.1 FR2 Sustained downlink data rate performance for single carrier	Downlink absolute power uncertainty (including beam peak search , averaged over BW_{Config} ± 5.19 dB	Downlink absolute power uncertainty (including beam peak search error) is one of the factors used to determine the max testable SNR for a given Test System as listed in sheet “Mode2 100MHz” in 38.521-4 Spreadsheet - Demod SNR range calculator V3.xlsx of TR 38.903
7.5A.1.1 FR2 SDR performance for CA	Maximum aggregated BW ≤ 400MHz, same as 7.5.1 Maximum aggregated BW > 400MHz, TBD	Same as 7.5.1
9.4B.1.2 Sustained downlink data rate performance for EN-DC including FR2 NR carrier	Downlink absolute power uncertainty (including beam peak search , averaged over BW_{Config} ± 5.19 dB	Downlink absolute power uncertainty (including beam peak search error) is one of the factors used to determine the max testable SNR for a given Test System as listed in sheet “Mode2 100MHz” in 38.521-4 Spreadsheet - Demod SNR range calculator V3.xlsx of TR 38.903

F.2.1.3 Measurement of Channel State Information reporting

This clause defines the maximum test system uncertainty for channel state information reporting requirements. The maximum test system uncertainty allowed for the measurement uncertainty contributors are defined in Table F.2.1.3-1.

Table F.2.1.3-1: Maximum measurement uncertainty values for the test system for FR2 (up to 40 GHz) and Channel BW ≤ 400 MHz

MU contributor	Unit	Value	Comment
AWGN flatness and signal flatness, max deviation for any Resource Block, relative to average over BW_{config}	dB	Same as in table F.2.1.2-1	
Signal to noise ratio uncertainty	dB	Same as in table F.2.1.2-1	
Impact on non-ideal isolation between branches for the wireless cable mode	dB	Same as in table F.2.1.2-1	
Fading profile power uncertainty	dB	Same as in table F.2.1.2-1	

The maximum test system uncertainty for test cases defined in section 8 is defined in Table F.2.1.3-2.

Table F.2.1.3-2: Maximum test system uncertainty for FR2 channel state information reporting test cases

Subclause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
8.2.2.2.1.12 Rx TDD FR2 periodic wideband CQI reporting under AWGN performance for both SA and NSA	± 1.40 dB	Overall system uncertainty under AWGN conditions comprises three quantities: 1. gNB emulator Signal-to-noise ratio uncertainty 2. Effect of AWGN flatness and signal flatness 3. Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator SNR Items 1 and 2 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x [0.25] effect on the required SNR, so use sensitivity factor of x [0.25] for the uncertainty contribution. Test System uncertainty = SQRT (gNB emulator Signal-to-noise ratio uncertainty ^{2} + (0.25 x AWGN flatness and signal flatness) ^{2}) + Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator Signal-to-noise ratio uncertainty ±0.3 dB AWGN flatness and signal flatness ±3.6 dB Impact on non-ideal isolation between branches for the wireless cable mode 0.45 dB for Rank2 and 0.6 for Rank1

8.2.2.2.2.12 Rx TDD FR2 aperiodic wideband CQI reporting under fading performance for both SA and NSA	± 1.82 dB for Doppler < 100Hz	Overall system uncertainty for fading conditions comprises five quantities: 1. gNB emulator Signal-to-noise ratio uncertainty 2. Fading profile power uncertainty 3. Effect of AWGN flatness and signal flatness 4. SNR uncertainty due to finite test time 5. Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator SNR Items 1, 2, 3 and 4 are assumed to be uncorrelated so can be root sum squared: AWGN flatness and signal flatness has x 0.25 effect on the required SNR, so use sensitivity factor of x 0.25 for the uncertainty contribution. Test System uncertainty = SQRT (gNB emulator Signal-to-noise ratio uncertainty 2 + Fading profile power uncertainty 2 + (0.25 x AWGN flatness and signal flatness) 2 + SNR uncertainty due to finite test time2) + Impact on non-ideal isolation between branches for the wireless cable mode gNB emulator Signal-to-noise ratio uncertainty ±0.3 dB Fading profile power uncertainty ±0.7 dB for 2Tx AWGN flatness and signal flatness ±3.6 dB SNR uncertainty due to finite test time ±0.3 dB Impact on non-ideal isolation between branches for the wireless cable mode 0.6 for Rank1 and 0.45 for Rank2
8.2.2.2.2.1_1 2Rx TDD FR2 aperiodic wideband CQI reporting under fading performance for both SA and NSA – 256QAM (Rel-16 and forward)	Same as 8.2.2.2.2.1	Same as 8.2.2.2.2.1
8.2A.3.1.1 2Rx CQI reporting accuracy under AWGN conditions for CA (2DL CA)	Same as 8.2.2.2.1.1 on each CC.	Same as 8.2.2.2.1.1
8.2A.3.1.2 2Rx CQI reporting accuracy under AWGN conditions for CA (3DL CA)	Same as 8.2.2.2.1.1 on each CC.	Same as 8.2.2.2.1.1
8.2A.3.1.3 2Rx CQI reporting accuracy under AWGN conditions for CA (4DL CA)	Same as 8.2.2.2.1.1 on each CC.	Same as 8.2.2.2.1.1
8.3.2.2.1 2Rx TDD FR2 Single PMI with 2TX TypeI-SinglePanel codebook for both SA and NSA	Same as 8.2.2.2.2.1	Same as 8.2.2.2.2.1
8.4.2.2.1 2Rx TDD FR2 RI reporting for both SA and NSA	Same as 8.2.2.2.2.1	Same as 8.2.2.2.2.1

F.2.2 Interpretation of measurement results (normative)

The actual measurement uncertainty of the Test System for the measurement of each parameter shall be included in the test report.

The recorded value for the Test System uncertainty shall be, for each measurement, equal to or lower than the appropriate figure in clause F.1 of the present document.

If the Test System using one of the permitted test methods defined in TR38.903 [20] for a test is known to have a measurement uncertainty greater than that specified in clause F.1, it is still permitted to use this apparatus provided that an adjustment is made value as follows:

Any additional uncertainty in the Test System over and above that specified in clause F.1 shall be used to tighten the Test Requirement, making the test harder to pass. For some tests, for example receiver tests, this may require modification of stimulus signals. This procedure will ensure that a Test System not compliant with clause F.1does not increase the chance of passing a device under test where that device would otherwise have failed the test if a Test System compliant with clause F.1 had been used.

F.2.3 Test Tolerance and Derivation of Test Requirements (informative)

TBD

F.2.3.1 Measurement of test environments

TBD

F.2.3.2 Measurement of Demod Performance requirements

The derivation of the test requirements for the test cases in section 7 is defined in Table F.2.3.2-1.

Table F.2.3.2-1: Derivation of Test Requirements (FR2 demodulation performance tests)

Test	Minimum Requirement in TS 38.101-4	Test Tolerance (TT)	Test Requirement in TS 38.521-4
7.2.2.2.1_1 2Rx TDD FR2 PDSCH mapping Type A performance - 2x2 MIMO with baseline receiver for SA and NSA	SNRs as specified	2Tx, Rank 1: 1.8 dB 2Tx, Rank 2: 1.7 dB for doppler < 100Hz 1.6 dB otherwise	Formula: SNR + TT T-put limit unchanged
7.2.2.2.1_2 2Rx TDD FR2 PDSCH mapping Type A performance - 2x2 MIMO with enhanced type 1 receiver for SA and NSA	SNRs as specified	2Tx, Rank 2: 1.7 dB for doppler < 100Hz 1.6 dB otherwise	Formula: SNR + TT T-put limit unchanged
7.2.2.2.1_3 2Rx TDD FR2 PDSCH mapping Type A performance - 2x2 MIMO with 256QAM for SA and NSA (Rel-16 and forward)	SNRs as specified	2Tx, Rank 1: 1.8 dB	Formula: SNR + TT T-put limit unchanged
7.2.2.2.2_1 2Rx TDD FR2 PDSCH repetitions over multiple slots	SNRs as specified	FFS	FFS
7.2.2.2.3_1 2Rx TDD FR2 PDSCH Mapping Type B	SNRs as specified	2Tx, Rank 1: 1.8 dB	T-put limit unchanged
7.2A.2.1 2Rx TDD FR2 CA requirements for normal PDSCH Demodulation Performance for both SA and NSA (2DLCA)	SNRs as specified	2Tx, Rank 2: 1.7 dB	Formula: SNR + TT T-put limit unchanged
7.2A.2.2 2Rx TDD FR2 CA requirements for normal PDSCH Demodulation Performance for both SA and NSA (3DLCA)	Same as 7.2A.2.1	Same as 7.2A.2.1	Same as 7.2A.2.1
7.3.2.2.1 2Rx TDD FR2 PDCCH 1 Tx antenna performance for both SA and NSA	SNRs as specified	1Tx, rank1: 1.7 dB	Formula: SNR + TT T-put limit unchanged
7.3.2.2.2 2Rx TDD FR2 PDCCH 2 Tx antenna performance for both SA and NSA	SNRs as specified	2Tx, rank1: 1.8 dB	Formula: SNR + TT T-put limit unchanged
7.3.2.2.3 2Rx TDD FR2 PDCCH 1 Tx antenna performance for power saving	SNRs as specified	1Tx, rank1: 1.7 dB	Formula: SNR + TT T-put limit unchanged
7.5.1 FR2 Sustained downlink data rate performance for single carrier	Power level as applied in the test procedure	No test tolerance applied	T-put limit unchanged
7.5A.1.1 FR2 SDR performance for CA	Same as 7.5.1	Same as 7.5.1	Same as 7.5.1

9.4B.1.2 Sustained downlink data rate performance for EN-DC including FR2 NR carrier	Indirect far field (IFF) with 30cm QZ, PC3, 100MHz CHBW Downlink power n257, n261: -79.5 dBm/120 kHz n258: -79.2 dBm/120 kHz	No test tolerance applied	T-put limit unchanged

F.2.3.3 Measurement of Channel State Information reporting

The derivation of the test requirements for the test cases in section 8 is defined in Table F.2.3.3-1.

Table F.2.3.3-1: Derivation of Test Requirements (FR2 channel state information reporting tests)

Test	Minimum Requirement in TS 38.101-4	Test Tolerance (TT)	Test Requirement in TS 38.521-4
8.2.2.2.1.12 Rx TDD FR2 periodic wideband CQI reporting under AWGN performance for both SA and NSA	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	SNR unchanged
8.2.2.2.2.12 Rx TDD FR2 aperiodic wideband CQI reporting under fading performance for both SA and NSA	SNRs as specified α 2% γ 1.05 BLER 0.02	SNR 0 dB α 0% γ *0.01* BLER 0	SNR unchanged α unchanged γ 1.04 BLER limit unchanged
8.2.2.2.2.1_1 2Rx TDD FR2 aperiodic wideband CQI reporting under fading performance for both SA and NSA	SNRs as specified α 2% γ 1.05 BLER 0.02	SNR 0 dB α 0% γ *0.01* BLER 0	SNR unchanged α unchanged γ 1.04 BLER limit unchanged
8.2A.3.1.1 2Rx CQI reporting accuracy under AWGN conditions for CA (2DL CA)	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	Test requirement unchanged
8.2A.3.1.2 2Rx CQI reporting accuracy under AWGN conditions for CA (3DL CA)	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	Test requirement unchanged
8.2A.3.1.3 2Rx CQI reporting accuracy under AWGN conditions for CA (4DL CA)	SNRs as specified Limits as in the Test Procedure	No test tolerances applied	Test requirement unchanged
8.3.2.2.1 2Rx TDD FR2 Single PMI with 2TX TypeI-SinglePanel codebook for both SA and NSA	SNRs as specified γ 1.05 for Test 1 γ 1.05 for Test 2	SNR 0 dB γ *0.01 for Test 1* γ *0.01 for Test 2*	SNR unchanged γ 1.04 for Test 1 γ 1.04 for Test 2
8.4.2.2.1 2Rx TDD FR2 RI reporting for both SA and NSA	SNRs as specified γ_2 1.00 for Test 1 γ_1 1.05 for Test 2 γ_1 1.05 for Test 3	SNR 0 dB γ_2 *0.01 for Test 1* γ_1 *0.01 for Test 2* γ_1 *0.01 for Test 3*	SNR unchanged γ_2 0.99 for Test 1 γ_1 1.04 for Test 2 γ_1 1.04 for Test 3

Annex G (normative): Statistical Testing

G.1 Statistical testing of Performance Requirements with throughput

G.1.1 General

The test of receiver performance characteristics is twofold.

1. A signal or a combination of signals is offered to the RX port(s) of the receiver.
2. The ability of the receiver to demodulate /decode this signal is verified by measuring the throughput.

In (2) is the statistical aspect of the test and is treated here.

The minimum requirement for most receiver performance tests is either 70 % or 30 % of the maximum throughput.

All receiver performance tests are performed in fading conditions. In addition to the statistical considerations, this requires the definition of a minimum test time.

G.1.2 Mapping throughput to error ratio

a) The measured information bit throughput R is defined as the sum (in kilobits) of the information bit payloads successfully received during the test interval, divided by the duration of the test interval (in seconds).

b) In measurement practice the UE indicates successfully received information bit payload by signalling an ACK to the SS.
If payload is received, but damaged and cannot be decoded, the UE signals a NACK.

c) Only the ACK and NACK signals, not the data bits received, are accessible to the SS.
The number of bits is known in the SS from knowledge of what payload was sent.

d) For the reference measurement channel, applied for testing, the number of bits is different in different slots, however in a radio frame it is fixed during one test.

e) The time in the measurement interval is composed of successfully received slots (ACK), unsuccessfully received slots (NACK) and no reception at all (DTX-slots).

f) DTX-slots may occur regularly according the applicable reference measurement channel (regDTX).
In real live networks this is the time when other UEs are served. In TDD these are the UL and special slots.
regDTX vary from test to test but are fixed within the test.

g) Additional DTX-slots occur statistically when the UE is not responding ACK or NACK where it should. (statDTX)
This may happen when the UE was not expecting data or decided that the data were not intended for it.

The pass / fail decision is done by observing the:

- number of NACKs
- number of ACKs and
- number of statDTXs (regDTX is implicitly known to the SS)

The ratio `(NACK + statDTX)/(NACK+ statDTX + ACK)` is the Error Ratio (ER). Taking into account the time consumed by the ACK, NACK, and DTX-TTIs (regular and statistical), ER can be mapped unambiguously to throughput for any single reference measurement channel test.

G.1.3 Design of the test

The test is defined by the following design principles (see clause G.2, Theory):

1. The standard concept is applied. (not the early decision concept)
2. A second limit is introduced: The second limit is different, whether 30 % or 70 % throughput is tested.
3. To decide the test pass:

   Supplier risk is applied based on the Bad DUT quality

   To decide the test fail:

   Customer Risk is applied based on the specified DUT quality

The test is defined by the following parameters:

1a) Limit Error Ratio = 0.3 (in case 70 % Throughput is tested) or

1b) Limit Throughput = 0.3 (in case 30 % Throughput is tested) or

1c) Limit Error Ratio = 0.01 (in case 1% BLER is tested)

2a) Bad DUT factor M=1.378 (selectivity)

2b) Bad DUT factor m=0.692 (selectivity)

2c) Bad DUT facor M=1.5 (selectivity)

justification see: TS 34.121 Clause F.6.3.3

3) Confidence level CL = 95 % (for specified DUT and Bad DUT-quality)

G.1.4 Pass Fail limit

Testing Throughput = 30 %, then the test limit is

Number of successes (ACK) / number of samples ≥ 59 / 233

Testing Throughput = 70 % then the test limit is

Number of fails (NACK and statDTX) / number of samples ≤ 66 / 184

Testing BLER = 1% then the test limit is

Number of fails (NACK and statDTX) / number of samples ≤ 163 / 13135

There are 3 distinct cases:

a) The duration for the number of samples (233, 184 or 13135) is greater than the minimum test time:

Then the number of samples (233, 184 or 13135) is predefined and the decision is done according to the number of events (59 successes, 66 fails or 163 fails)

b) Since subframe 0 and 5 contain less bits than the remaining subframes, it is allowed to predefine a number of samples contained in an integer number of frames. In this case test-limit-ratio applies.

c) The minimum test time is greater than the duration for the number of samples:

The minimum test time is predefined and the decision is done comparing the measured ratio at that instant against the test-limit-ratio.

NOTE: The test time for most of the tests is governed by the Minimum Test Time.

G.1.5 Minimum Test time

Editor's Note: Simulation method to derive minimum test time for FR2 needs to be evaluated.

If a pass fail decision in clause G.1.4 can be achieved earlier than the minimum test time, then the test shall not be decided, but continued until the minimum test time is elapsed.

The tables below contain the minimum number of slots for FDD and TDD.

By simulations the minimum number of active subframes (carrying DL payload) was derived (MNAS), then adding inactive subframes to the active ones. (for TDD additional subframes contain no DL payload), then rounding up to full thousand.

Simulation method to derive minimum test time:

With a level, corresponding a throughput at the test limit (here 30 % or 70 % of the max. throughput) the preliminary throughput versus time converges towards the final throughput. The allowance of ± 0.2 dB around the above mentioned level is predefined by RAN5 to find the minimum test time. The allowance of ±0.2 dB maps through the function "final throughput versus level" into a throughput corridor. The minimum test time is achieved when the preliminary throughput escapes the corridor the last time. The two functions "final throughput versus level" and "preliminary throughput versus time" are simulation results, which are done individual for each demodulation scenario.

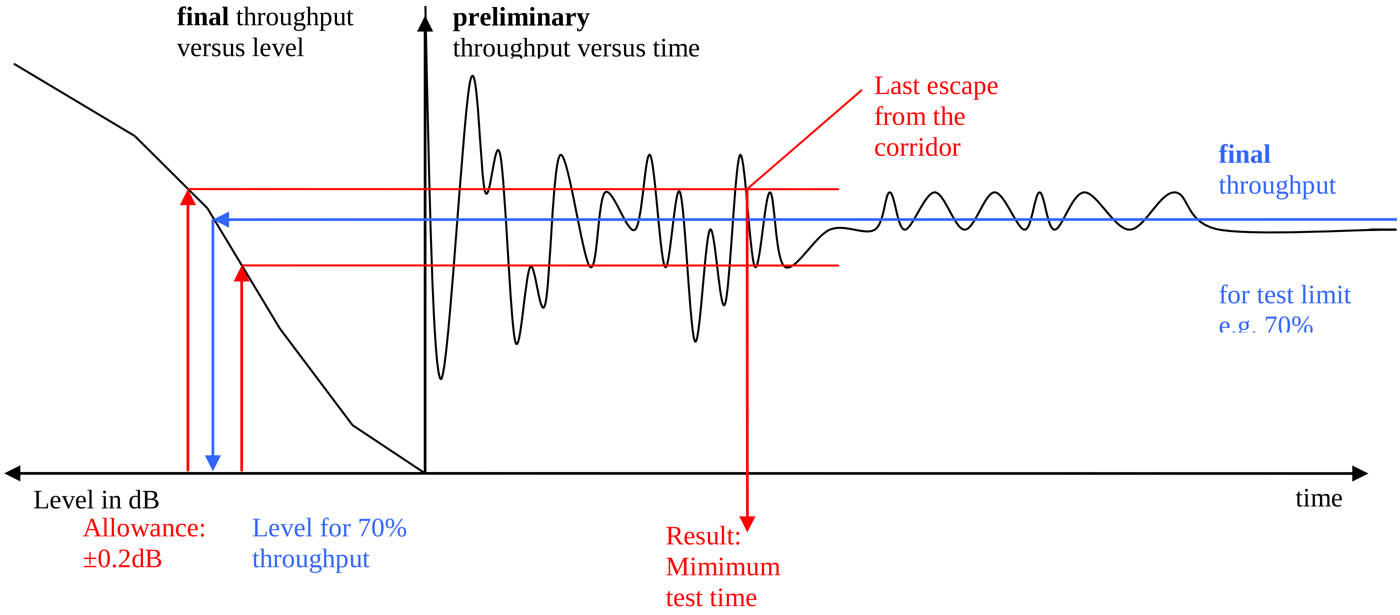

Figure G.1.5-1: Simulation method to derive minimum test time

Table G.1.5-1: Minimum Test time for PDSCH demodulation

TDD UL-DL pattern	Reference Channel	Propagation condition	Demodulation scenario (doppler speed)	Minimum number of active subframes (MNAS)	MNAS to MNS Scaling factor (Note 3)	Minimum Number of Subframes (MNS) after rounding up to nearest thousand MNS= $1000*\left\lceil \frac{MNS}{1000} \right\rceil$
NA	R.PDSCH.1-8.1 FDD	HST-750	750 Hz	6000 (Note 1)	1.0526	6400
NA	R.PDSCH.1-8.2 FDD	HST-972	972 Hz	6000 (Note 1)	1.0526	6400
NA	R.PDSCH.1-8.1 FDD	TDLC300-600	600 Hz	8000 (Note 1)	1.0526	9000
NA	R.PDSCH.1-1.1 FDD	TDLB100-400	400 Hz	10000 (Note 1)	1.0526	11000
NA	R.PDSCH.1-1.2 FDD, R.PDSCH.1-2.1 FDD, R.PDSCH.1-5.1 FDD	TDLC300-100	100 Hz	20000 (Note 1)	1.0526	22000
NA	R.PDSCH.1-1.3 FDD, R.PDSCH.1-2.2 FDD, R.PDSCH.1-2.3 FDD, R.PDSCH.1-2.4 FDD, R.PDSCH.1-2.5 FDD, R.PDSCH.1-3.1 FDD, R.PDSCH.1-3.2 FDD, R.PDSCH.1-3.3 FDD, R.PDSCH.1-3.4 FDD, R.PDSCH.1-4.1 FDD, R.PDSCH.1-12.1 FDD, R.PDSCH.2-1.1 FDD	TDLA30-10	10 Hz	75000 (Note 1)	1.0526	79000
NA	R.PDSCH.1-7.1 FDD, R.PDSCH.1-7.2 FDD	TDLA30-10	10 Hz	75000 (Note 1)	1.25	94000
NA	R.PDSCH.1-8.3 FDD, R.PDSCH.1-13.1 FDD, R.PDSCH.1-13.2 FDD, R.PDSCH.1-13.3 FDD, R.PDSCH.1-13.4 FDD, R.PDSCH.1-13.5 FDD, R.PDSCH.1-14.1 FDD, R.PDSCH.1-14.2 FDD, R.PDSCH.1-14.3 FDD, R.PDSCH.1-14.4 FDD	HST-SFN	870 Hz	30000 (Note 1)	1.0526	32000
NA	R.PDSCH.1-8.4 FDD, R.PDSCH.1-15.1 FDD, R.PDSCH.1-15.2 FDD, R.PDSCH.1-15.3 FDD, R.PDSCH.1-15.4 FDD, R.PDSCH.1-15.5 FDD, R.PDSCH.1-16.1 FDD, R.PDSCH.1-16.2 FDD, R.PDSCH.1-16.3 FDD, R.PDSCH.1-16.4 FDD	HST-DPS	870 Hz	30000 (Note 1)	1.0526	32000
FR1.15-1	R.PDSCH.1-1.1 TDD, R.PDSCH.1-1.2 TDD	TDLA30-10	10Hz	75000 (Note 1)	2.8571	215000
FR1.30-1A	R.PDSCH.2-1.1 TDD	TDLB100-400	400 Hz	10000 (Note 1)	1.2903	13000
FR1.30-1	R.PDSCH.2-1.2 TDD, R.PDSCH.2-2.1 TDD, R.PDSCH.2-7.1 TDD	TDLC300-100	100 Hz	20000 (Note 1)	1.2903	26000
FR1.30-1	R.PDSCH.2-2.2 TDD, R.PDSCH.2-2.3 TDD, R.PDSCH.2-2.4 TDD, R.PDSCH.2-2.5 TDD, R.PDSCH.2-3.1 TDD, R.PDSCH.2-3.2 TDD, R.PDSCH.2-3.3 TDD, R.PDSCH.2-3.4 TDD, R.PDSCH.2-4.1 TDD	TDLA30-10	10 Hz	75000 (Note 1)	1.2903	97000
FR1.30-1	R.PDSCH.2-1.3 TDD	TDLA30-10	10 Hz	75000 (Note 1)	1.4815	112000
FR1.30-2	R.PDSCH.2-5.1 TDD	TDLA30-10	10 Hz	75000 (Note 1)	1.2903	97000
FR1.30-2	R.PDSCH.2-17.1 TDD	TDLA30-10	10 Hz	75000 (Note 1)	5	375000
FR1.30-3	R.PDSCH.2-6.1 TDD	TDLA30-10	10 Hz	75000 (Note 1)	1.4815	112000

FR1.30-4	R.PDSCH.2-9.1 TDD	TDLA30-10	10 Hz	75000 (Note 1)	1.2903	97000
FR1.30-5	R.PDSCH.2-11.1 TDD	TDLB100-400	400Hz	10000 (Note 1)	1.2903	13000
FR1.30-6	R.PDSCH.2-12.1 TDD	TDLB100-400	400Hz	10000 (Note 1)	1.2903	13000
FR1.30-1	R.PDSCH.2-10.1 TDD	HST-1000	1000 Hz	15000 (Note 1)	1.4815	23000
FR1.30-1	R.PDSCH.2-10.1 TDD	HST-1667	1667 Hz	15000 (Note 1)	1.4815	23000
FR1.30-1	R.PDSCH.2-10.4 TDD, R.PDSCH.2-19.1 TDD, R.PDSCH.2-19.2 TDD, R.PDSCH.2-19.3 TDD, R.PDSCH.2-19.4 TDD, R.PDSCH.2-19.5 TDD, R.PDSCH.2-20.1 TDD, R.PDSCH.2-20.2 TDD, R.PDSCH.2-20.3 TDD, R.PDSCH.2-20.4 TDD, R.PDSCH.2-20.5 TDD, R.PDSCH.2-21.1 TDD	HST-SFN	1667 Hz	30000 (Note 1)	1.4815	45000
FR1.30-1	R.PDSCH.2-10.5 TDD, R.PDSCH.2-22.1 TDD, R.PDSCH.2-22.2 TDD, R.PDSCH.2-22.3 TDD, R.PDSCH.2-22.4 TDD, R.PDSCH.2-22.5 TDD, R.PDSCH.2-23.1 TDD, R.PDSCH.2-23.2 TDD, R.PDSCH.2-23.3 TDD, R.PDSCH.2-23.4 TDD, R.PDSCH.2-23.5 TDD, R.PDSCH.2-24.1 TDD	HST-DPS	1667 Hz	30000 (Note 1)	1.4815	45000
FR2.60-1	R.PDSCH.4-1.1 TDD	TDLA30-75	75 Hz	20000 (Note 2)	1.33	27000
FR2.120-1A	R.PDSCH.5-1.1 TDD	TDLC60-300	300 Hz	10000 (Note 2)	1.25	13000
FR2.120-1	R.PDSCH.5-2.1 TDD, R.PDSCH.5-2.2 TDD, R.PDSCH.5-2.3 TDD, R.PDSCH.5-3.1 TDD	TDLA30-300	300 Hz	10000 (Note 2)	1.25	13000
FR2.120-1	R.PDSCH.5-1.2 TDD	TDLA30-75	75 Hz	20000 (Note 2)	1.25	25000
FR2.120-2	R.PDSCH.5-4.1 TDD, R.PDSCH.5-5.1 TDD, R.PDSCH.5-5.2 TDD, R.PDSCH.5-6.1 TDD	TDLA30-75	75 Hz	20000 (Note 2)	1.33	27000
FR2.120-1	R.PDSCH.5-10.1 TDD	TDLD30-75	75 Hz	20000 (Note 2)	1.26	26000

Note 1: MNAS determined by simulations.
Note 2: For cases where MNS is not determined by simulations, use same MNAS as the similar case simulated (same doppler speed)
Note 3: MNS/MNAS ratio decided by scheduling pattern and is ratio of all slots to DL slots.

Table G.1.5-1a: Minimum Test time for PDSCH demodulation with 1% BLER

TDD UL-DL pattern	Reference Channel	Propagation condition	Demodulation scenario (doppler speed)	Minimum number of active subframes (MNAS)	MNAS to MNS Scaling factor (Note 3)	Minimum Number of Subframes (MNS) after rounding up to nearest thousand MNS= $1000*\left\lceil \frac{MNS}{1000} \right\rceil$
NA	R.PDSCH.1-11.1 FDD R.PDSCH.1-11.2 FDD	TDLA30-10	10 Hz	[200000] (Note 1)	1.1111	[223000]
FR1.30-1	R.PDSCH.2-16.1 TDD R.PDSCH.2-16.2 TDD	TDLA30-10	10 Hz	[200000] (Note 1)	1.6667	[334000]

Note 1: MNAS determined by simulations.
Note 2: For cases where MNS is not determined by simulations, use same MNAS as the similar case simulated (same doppler speed).
Note 3: MNS/MNAS ratio decided by scheduling pattern (how much time is required to collect required number of active DL SFs).

Table G.1.5-2: Minimum Test time for PDCCH demodulation

Reference Channel	Demodulation scenario (doppler speed)	Minimum number of active subframes (MNAS)	MNAS to MNS Scaling factor (Note 3)	Minimum Number of Subframes (MNS) after rounding up to nearest thousand MNS=$1000*\left\lceil \frac{MNS}{1000} \right\rceil$
R.PDCCH 1-1.1 FDD, R.PDCCH.1-1.3 FDD, R.PDCCH.1-2.1 FDD, R.PDCCH.1-2.2 FDD, R.PDCCH.1-2.3 FDD, R.PDCCH.1-2.4 FDD, R.PDCCH.1-2.5 FDD, R.PDCCH.1-2.6 FDD	10, 100, 400 Hz	100000 (Note 1)	1.0526	106000
R.PDCCH.2-1.1 TDD, R.PDCCH.2-1.2 TDD, R.PDCCH.2-2.1 TDD, R.PDCCH.2-1.3 TDD	10, 100, 400 Hz	100000 (Note 1)	1.2903	130000
R.PDCCH.5-1.1 TDD, R.PDCCH.5-1.2 TDD, R.PDCCH.5-1.3 TDD, R.PDCCH.5-2.1 TDD	75, 300 Hz	100000 (Note 2)	1.25	130000
Note 1: MNAS determined by simulations. Note 2: For cases where MNS is not determined by simulations, use same MNAS as the similar case simulated (same doppler speed) Note 3: MNS/MNAS ratio decided by scheduling pattern and is ratio of all slots to DL slots.				

G.2 Theory to derive the numbers for statistical testing (informative)

Editor's note: This clause of the Annex G is for information only and it described the background theory and information for statistical testing.

G.2.1 Error Ratio (ER)

The Error Ratio (ER) is defined as the ratio of number of errors (ne) to all results, number of samples (ns).

(1-ER is the success ratio).

G.2.2 Test Design

A statistical test is characterized by:

Test-time, Selectivity and Confidence level.

G.2.3 Confidence level

The outcome of a statistical test is a decision. This decision may be correct or in-correct. The Confidence Level CL describes the probability that the decision is a correct one. The complement is the wrong decision probability (risk) D = 1-CL.

G.2.4 Introduction: Supplier Risk versus Customer Risk

There are two targets of decision:

(a) A measurement on the pass-limit shows, that the DUT has the specified quality or is better with probability CL (CL e.g.95 %). This shall lead to a "pass decision".

The pass-limit is on the good side of the specified DUT-quality. A more stringent CL (CL e.g.99 %) shifts the pass-limit farer into the good direction. Given the quality of the DUTs is distributed, a greater CL passes less and better DUTs.

A measurement on the bad side of the pass-limit is simply "not pass" (undecided or artificial fail).

(aa) Complementary:

A measurement on the fail-limit shows, that the DUT is worse than the specified quality with probability CL.

The fail-limit is on the bad side of the specified DUT-quality. A more stringent CL shifts the fail-limit farer into the bad direction. Given the quality of the DUTs is distributed, a greater CL fails less and worse DUTs.

A measurement on the good side of the fail-limit is simply "not fail".

(b) A DUT, known to have the specified quality, shall be measured and decided pass with probability CL. This leads to the test limit.

For CL e.g. 95 %, the test limit is on the bad side of the specified DUT-quality. CL e.g.99 % shifts the pass-limit farer into the bad direction. Given the DUT-quality is distributed, a greater CL passes more and worse DUTs.

(bb) A DUT, known to be an (ε→0) beyond the specified quality, shall be measured and decided fail with probability CL.

For CL e.g.95 %, the test limit is on the good side of the specified DUT-quality.

NOTE 1: The different sense for CL in (a), (aa) versus (b), (bb).

NOTE 2: For constant CL in all 4 bullets (a) is equivalent to (bb) and (aa) is equivalent to (b).

G.2.5 Supplier Risk versus Customer Risk

The table below summarizes the different targets of decision.

Table G.2.5-1: Equivalent statements

	Equivalent statements, using different cause-to-effect-directions, and assuming CL = constant >1/2	
cause-to-effect-directions	Known measurement result → estimation of the DUT's quality	Known DUT's quality → estimation of the measurement's outcome
Supplier Risk	A measurement on the pass-limit shows, that the DUT has the specified quality or is better (a)	A DUT, known to have an (ε→0) beyond the specified DUT-quality, shall be measured and decided fail (bb)
Customer Risk	A measurement on the fail-limit shall shows, that the DUT is worse than the specified quality (aa)	A DUT, known to have the specified quality, shall be measured and decided pass (b)

The shaded area shown the direct interpretation of Supplier Risk and Customer Risk.

The same statements can be based on other DUT-quality-definitions.

G.2.6 Introduction: Standard test versus early decision concept

In standard statistical tests, a certain number of results (ns) is predefined in advance to the test. After ns results the number of bad results (ne) is counted and the error ratio (ER) is calculated by ne/ns.

Applying statistical theory, a decision limit can be designed, against which the calculated ER is compared to derive the decision. Such a limit is one decision point and is characterized by:

- D: the wrong decision probability (a predefined parameter)
- ns: the number of results (a fixed predefined parameter)
- ne: the number of bad results (the limit based on just ns)

In the formula for the limit, D and ns can be understood as variable parameter and variable. However the standard test execution requires fixed ns and D. The property of such a test is: It discriminates between two states only, depending on the test design:

- pass (with CL) / undecided (undecided in the sense: finally undecided)
- fail (with CL) / undecided (undecided in the sense: finally undecided)
- pass(with CL) / fail (with CL) (however against two limits).

In contrast to the standard statistical tests, the early decision concept predefines a set of (ne,ns) co-ordinates, representing the limit-curve for decision. After each result a preliminary ER is calculated and compared against the limit-curve. After each result one may make the decision or not (undecided for later decision). The parameters and variables in the limit-curve for the early decision concept have a similar but not equal meaning:

- D: the wrong decision probability (a predefined parameter)
- ns: the number of results (a variable parameter)
- ne: the number of bad results (the limit. It varies together with ns)

To avoid a "final undecided" in the standard test, a second limit shall be introduced and the single decision co-ordinate (ne,ns) needs a high ne, leading to a fixed (high) test time. In the early decision concept, having the same selectivity and the same confidence level an "undecided" need not to be avoided, as it can be decided later. A perfect DUT will hit the decision coordinate (ne,ns) with ne=0. This test time is short.

G.2.7 Standard test versus early decision concept

For Supplier Risk:

The wrong decision probability D in the standard test is the probability, to decide a DUT in-correct in the single decision point. In the early decision concept there is a probability of in-correct decisions d at each point of the limit-curve. The sum of all those wrong decision probabilities accumulate to D. Hence $d<D$.

For Customer Risk:

The correct decision probability CL in the standard test is the probability, to decide a DUT correct in the single decision point. In the early decision concept there is a probability of correct decisions cl at each point of the limit-curve. The sum of all those correct decision probabilities accumulate to CL. Hence $cl<CL$ or $d>D$.

G.2.8 Selectivity

There is no statistical test which can discriminate between a limit DUT and a DUT which is an ($\varepsilon \rightarrow 0$) apart from the limit in finite time and high confidence level CL. Either the test discriminates against one limit with the results pass (with CL)/undecided or fail (with CL)/undecided, or the test ends in a result pass (with CL)/fail (with CL) but this requires a second limit.

For $CL>1/2$, a (measurement-result = specified-DUT-quality), generates undecided in test "supplier risk against pass limit" (a, from above) and also in the test "customer risk against the fail limit " (aa)

For $CL>1/2$, a DUT, known to be on the limit, will be decided pass for the test "customer risk against pass limit" (b) and also "supplier risk against fail limit" (bb).

This overlap or undecided area is not a fault or a contradiction, however it can be avoided by introducing a Bad or a Good DUT quality according to:

- Bad DUT quality: specified DUT-quality * M (M>1)
- Good DUT quality: specified DUT-quality * m (m<1)

Using e.g. M>1 and CL=95 % the test for different DUT qualities yield different pass probabilities:

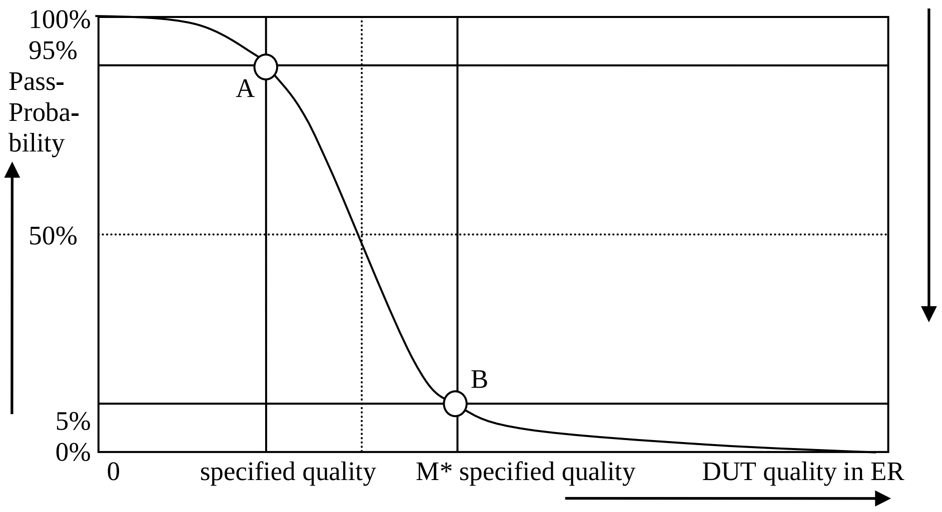

Figure G.2.8-1: Pass probability versus DUT quality

G.2.9 Design of the test

The receiver characteristic test are defined by the following design principles:

1. The early decision concept is applied.
2. A second limit is introduced: Bad DUT factor M>1
3. To decide the test pass:

    Supplier risk is applied based on the Bad DUT quality

    To decide the test fail

    Customer Risk is applied based on the specified DUT quality

The receiver characteristic test are defined by the following parameters:

1. Limit ER = 0.05
2. Bad DUT factor M=1.5 (selectivity)
3. Confidence level CL = 95 % (for specified DUT and Bad DUT-quality)

This has the following consequences:

1. A measurement on the fail limit is connected with 2 equivalent statements:

A measurement on the fail-limit shows, that the DUT is worse than the specified DUT-quality	A DUT, known have the specified quality, shall be measured and decided pass

2. A measurement on the pass limit is connected with the complementary statements:

A measurement on the pass limit shows, that the DUT is better than the Bad DUT-quality.	A DUT, known to have the Bad DUT quality, shall be measured and decided fail

The left column is used to decide the measurement.

The right column is used to verify the design of the test by simulation.

The simulation is based on the two fulcrums A and B only in Figure G.2.8-1

3. Test time

The minimum and maximum test time is fixed.

The average test time is a function of the DUT's quality.

The individual test time is not predictable.

4. The number of decision co-ordinates (ne,ns) in the early decision concept is responsible for the selectivity of the test and the maximum test time. Having fixed the number of decision co-ordinates there is still freedom to select the individual decision co-ordinates in many combinations, all leading to the same confidence level.

G.2.10 Simulation to derive the pass fail limits

There is freedom to design the decision co-ordinates (ne,ns).

The binomial distribution and its inverse is used to design the pass and fail limits. Note that this method is not unique and that other methods exist.

$$\mathrm{fail}(ne, d_f) := \frac{ne}{(ne + \mathrm{qnbinom}(d_f, ne, ER))}$$

$$\mathrm{pass}(ne, cl_p, M) := \frac{ne}{(ne + \mathrm{qnbinom}(cl_p, ne, ER \cdot M))}$$

Where

- fail(..) is the error ratio for the fail limit
- pass(..) is the error ratio for the pass limit
- ER is the specified error ratio 0.05
- ne is the number of bad results. This is the variable in both equations
- M is the Bad DUT factor M=1.5
- d_f is the wrong decision probability of a single (ne,ns) co-ordinate for the fail limit. It is found by simulation to be $d_f = 0.004$
- cl_p is the confidence level of a single (ne,ns) co-ordinate for the pass limit. It is found by simulation to be $cl_p = 0.9975$
- qnbinom(..): The inverse cumulative function of the negative binomial distribution

The simulation works as follows:

- A large population of limit DUTs with true ER = 0.05 is decided against the pass and fail limits.
- cl_p and d_f are tuned such that CL (95 %) of the population passes and D (5 %) of the population fails.
- A population of Bad DUTs with true ER = M*0.05 is decided against the same pass and fail limits.
- cl_p and d_f are tuned such that CL (95 %) of the population fails and D (5 %) of the population passes.
- This procedure and the relationship to the measurement is justified in clause G.2.9. The number of DUTs decrease during the simulation, as the decided DUTs leave the population. That number decreases with an approximately exponential characteristics. After 169 bad results all DUTs of the population are decided.

NOTE: The exponential decrease of the population is an optimal design goal for the decision co-ordinates (ne,ns), which can be achieved with other formulas or methods as well.

G.3 Measuring throughput ratio

G.3.1 General

Annex G.3 is applicable for clauses 6.2, 6,3 and 6.4. Common to those clauses is, that a throughput ratio γ of the form $\gamma = \frac{t_{Numerator}}{t_{Denominator}}$ is measured. These clauses are tested exclusively with "slow" multipath fading profiles. Hence the test time is governed by test time due to fading, and number of samples due to statistical significance is not applicable.

The test requirement in clause 6.3 is a ratio of 2 throughput tests γ. In either numerator or denominator (depending on test case) a target throughput is desired, which is established by an approach resulting in the throughput and the reference SNR that is defined in G.3.2. This SNR is then reused when measuring the throughput of the other factor of the formula. The formulas for calculation of γ are defined directly under sections 6.3.

The test requirements in clauses 6.2 and 6.4 are a ratio of 2 throughput tests γ, where numerator and denominator are ordinary throughput tests. The formulas for calculation of γ are defined in sections 6.2 and 6.4 respectively

G.3.2 Establishing SNR

Adjust SNR such that the measured throughput is within 2% of target value (TBD% depending on test case). The approach, leading to target throughput and reference SNR is not specified.

The resulting SNR is the reference SNR to use when measuring throughput in the other factor (numerator or denominator) of γ.

To achieve statistical significance the final throughput measurement must be done with MNS samples, given table G.3.4-1

G.3.3 Measuring T-put

To achieve statistical significance the final throughput measurement must be done with MNS samples, given in table G.3.4 -1. Number of samples due to statistical significance is not applicable.

For measuring $t_{ue,follow1,follow2}$ and $t_{ue,rnd1,rnd2}$, the SS collects ACK, NACK and statDTX from the UE and records the time, elapsed from the beginning of the test. The payload size, received by the UE and acknowledged towards the SS, is constant. Throughput can be calculated in the SS by multiplying the payload size with the number of ACKs and dividing the accumulated payload in kilobits by the time in seconds, elapsed from the beginning of the test, being associated to the following ratio: ACK/ (ACK+NACK + DTX).

G.3.4 Number of samples for throughput ratios

Table G.3.4-1: Test time for testing throughput ratios

Demodulation scenario (doppler speed)	Minimum number of active subframes (MNAS)	Scheduling pattern	MNAS to MNS Scaling factor (Note 2)	Minimum Number of Subframes (MNS) after rounding up to nearest thousand MNS= $1000*\left\lceil \frac{MNS}{1000} \right\rceil$
5Hz	100000	FDD	1.0526	106000
5Hz	100000	TDD FR1.30-1	1.2903	130000
35Hz	100000	TDD FR2.120-1	1.2598	126000
35Hz	100000	TDD FR2.120-2	1.3445	135000
Note 1: MNAS determined by theoretical estimations inherited from LTE based on R5-106393. All slots in active subframe is assumed to be DL slots. Note 2: MNS/MNAS ratio decided by scheduling pattern and is ratio of all slots to DL slots Note 3: MNS apply for both denominator and numerator measurement				

G.4 Statistical testing of Performance Requirements with BLER limit

G.4.1 General

The test of receiver performance characteristics is twofold.

1. A signal or a combination of signals is offered to the RX port(s) of the receiver.
2. The ability of the receiver to demodulate /decode this signal is verified by measuring the throughput.

In (2) is the statistical aspect of the test and is treated here.

The minimum requirement for several receiver performance test cases is specified in regards of BLER: 0.001%.

G.4.2 Design of the test

The test is defined by the following design principles (see clause G.2, Theory):

1. The early decision concept is applied.
2. A second limit is introduced: Bad DUT factor M>1.
3. To decide the test pass:

   Supplier risk is applied based on the Bad DUT quality

   To decide the test fail:

   Customer Risk is applied based on the specified DUT quality

G.4.3 Numerical definition of the pass fail limits for 0.001% BLER

The numerical pass/fail limit is derived by the following parameters:

1a) Limit Error Ratio = 0.001%

2a) Bad DUT factor M=1.5 (selectivity)

justification see: TS 34.121 Clause F.6.3.3

3) Confidence level CL = 99.999%

Table G.4.3-1: Pass fail limits

ne	ns_p	ns_f	ne	ns_p	ns_f	ne	ns_p	ns_f
0	1074532	1067	215	20006574	14871394	430	36441701	33298651
1	1074532	1067	216	20085020	14954177	431	36516711	33386452
2	1274645	1067	217	20163439	15036999	432	36591711	33474268
3	1444583	1067	218	20241831	15119861	433	36666702	33562097
4	1599072	4727	219	20320196	15202761	434	36741683	33649940
5	1743641	12160	220	20398535	15285701	435	36816654	33737797
6	1881111	23683	221	20476847	15368679	436	36891616	33825668
7	2013164	39190	222	20555133	15451695	437	36966568	33913553
8	2140902	58403	223	20633393	15534749	438	37041511	34001452
9	2265092	81000	224	20711628	15617841	439	37116445	34089364
10	2386297	106667	225	20789836	15700971	440	37191369	34177291
11	2504945	135116	226	20868019	15784137	441	37266283	34265231
12	2621369	166089	227	20946177	15867341	442	37341189	34353184
13	2735834	199360	228	21024309	15950581	443	37416085	34441151
14	2848557	234730	229	21102417	16033858	444	37490972	34529132
15	2959718	272025	230	21180499	16117172	445	37565849	34617126
16	3069467	311091	231	21258557	16200521	446	37640718	34705134
17	3177931	351792	232	21336590	16283906	447	37715577	34793155
18	3285220	394009	233	21414599	16367326	448	37790427	34881189
19	3391428	437636	234	21492584	16450782	449	37865268	34969237
20	3496637	482577	235	21570545	16534273	450	37940100	35057298
21	3600921	528746	236	21648482	16617799	451	38014923	35145372
22	3704343	576068	237	21726395	16701360	452	38089737	35233459
23	3806960	624473	238	21804284	16784955	453	38164542	35321560
24	3908823	673898	239	21882150	16868585	454	38239338	35409673
25	4009977	724286	240	21959993	16952248	455	38314125	35497800
26	4110465	775585	241	22037812	17035945	456	38388903	35585939
27	4210324	827748	242	22115608	17119676	457	38463672	35674092
28	4309587	880730	243	22193382	17203440	458	38538432	35762258
29	4408285	934492	244	22271133	17287238	459	38613184	35850436
30	4506448	988997	245	22348861	17371068	460	38687927	35938627
31	4604101	1044211	246	22426567	17454931	461	38762661	36026831
32	4701268	1100101	247	22504250	17538827	462	38837386	36115048
33	4797972	1156638	248	22581911	17622755	463	38912102	36203278
34	4894232	1213795	249	22659550	17706716	464	38986810	36291520
35	4990069	1271547	250	22737168	17790708	465	39061510	36379774
36	5085500	1329869	251	22814763	17874733	466	39136200	36468042
37	5180542	1388740	252	22892337	17958789	467	39210882	36556322
38	5275209	1448137	253	22969889	18042876	468	39285556	36644614
39	5369517	1508043	254	23047420	18126994	469	39360221	36732919
40	5463478	1568438	255	23124929	18211144	470	39434877	36821237
41	5557107	1629304	256	23202418	18295325	471	39509525	36909566
42	5650414	1690627	257	23279885	18379536	472	39584165	36997908
43	5743410	1752389	258	23357331	18463778	473	39658796	37086263
44	5836108	1814577	259	23434757	18548050	474	39733419	37174629
45	5928516	1877177	260	23512162	18632353	475	39808033	37263008
46	6020643	1940175	261	23589546	18716685	476	39882639	37351399
47	6112500	2003560	262	23666910	18801047	477	39957237	37439803
48	6204094	2067319	263	23744254	18885439	478	40031826	37528218
49	6295434	2131442	264	23821577	18969861	479	40106407	37616645
50	6386526	2195916	265	23898880	19054311	480	40180980	37705085

51	6477380	2260734	266	23976164	19138791	481	40255545	37793536
52	6568000	2325884	267	24053427	19223300	482	40330102	37882000
53	6658395	2391358	268	24130671	19307838	483	40404650	37970475
54	6748569	2457146	269	24207895	19392404	484	40479190	38058963
55	6838530	2523241	270	24285099	19476999	485	40553722	38147462
56	6928283	2589634	271	24362284	19561623	486	40628246	38235973
57	7017834	2656318	272	24439450	19646274	487	40702762	38324496
58	7107187	2723285	273	24516597	19730954	488	40777270	38413030
59	7196348	2790528	274	24593724	19815662	489	40851770	38501576
60	7285321	2858041	275	24670832	19900397	490	40926262	38590134
61	7374112	2925816	276	24747922	19985160	491	41000746	38678704
62	7462724	2993848	277	24824993	20069950	492	41075222	38767285
63	7551162	3062130	278	24902045	20154768	493	41149690	38855878
64	7639430	3130657	279	24979078	20239613	494	41224150	38944482
65	7727532	3199424	280	25056093	20324485	495	41298602	39033098
66	7815471	3268424	281	25133089	20409383	496	41373047	39121725
67	7903252	3337653	282	25210068	20494309	497	41447483	39210364
68	7990878	3407105	283	25287028	20579261	498	41521912	39299014
69	8078352	3476777	284	25363970	20664239	499	41596333	39387675
70	8165677	3546663	285	25440893	20749244	500	41670746	39476348
71	8252857	3616759	286	25517799	20834275	501	41745152	39565032
72	8339894	3687060	287	25594687	20919332	502	41819550	39653727
73	8426792	3757563	288	25671558	21004415	503	41893940	39742434
74	8513553	3828263	289	25748411	21089524	504	41968323	39831151
75	8600181	3899156	290	25825246	21174658	505	42042698	39919880
76	8686677	3970239	291	25902063	21259818	506	42117065	40008620
77	8773044	4041508	292	25978864	21345003	507	42191424	40097371
78	8859286	4112960	293	26055647	21430213	508	42265777	40186133
79	8945403	4184590	294	26132413	21515449	509	42340121	40274907
80	9031399	4256396	295	26209162	21600709	510	42414458	40363691
81	9117276	4328375	296	26285893	21685995	511	42488788	40452486
82	9203035	4400523	297	26362608	21771305	512	42563110	40541292
83	9288680	4472838	298	26439306	21856639	513	42637425	40630109
84	9374212	4545316	299	26515987	21941999	514	42711732	40718937
85	9459633	4617954	300	26592652	22027382	515	42786032	40807776
86	9544944	4690751	301	26669300	22112790	516	42860324	40896625
87	9630149	4763702	302	26745931	22198222	517	42934609	40985485
88	9715249	4836806	303	26822546	22283678	518	43008887	41074356
89	9800245	4910060	304	26899145	22369157	519	43083157	41163238
90	9885139	4983461	305	26975727	22454661	520	43157420	41252131
91	9969933	5057007	306	27052293	22540188	521	43231676	41341034
92	10054629	5130696	307	27128843	22625739	522	43305924	41429947
93	10139228	5204526	308	27205377	22711313	523	43380165	41518872
94	10223731	5278493	309	27281895	22796910	524	43454399	41607806
95	10308141	5352597	310	27358398	22882531	525	43528626	41696752
96	10392459	5426835	311	27434884	22968175	526	43602846	41785708
97	10476685	5501204	312	27511355	23053842	527	43677058	41874674
98	10560822	5575703	313	27587810	23139531	528	43751263	41963651
99	10644871	5650331	314	27664249	23225243	529	43825462	42052638
100	10728833	5725084	315	27740673	23310978	530	43899653	42141635
101	10812709	5799961	316	27817081	23396736	531	43973837	42230643
102	10896501	5874961	317	27893475	23482516	532	44048014	42319662
103	10980210	5950082	318	27969852	23568318	533	44122183	42408690

104	11063837	6025321	319	28046215	23654143	534	44196346	42497729
105	11147384	6100677	320	28122563	23739989	535	44270502	42586778
106	11230851	6176149	321	28198895	23825858	536	44344651	42675837
107	11314239	6251735	322	28275212	23911748	537	44418793	42764907
108	11397550	6327434	323	28351515	23997661	538	44492928	42853986
109	11480785	6403243	324	28427803	24083595	539	44567056	42943076
110	11563945	6479161	325	28504075	24169550	540	44641177	43032176
111	11647030	6555187	326	28580333	24255527	541	44715291	43121286
112	11730042	6631320	327	28656577	24341526	542	44789399	43210406
113	11812982	6707558	328	28732806	24427546	543	44863499	43299535
114	11895850	6783899	329	28809020	24513587	544	44937593	43388675
115	11978648	6860343	330	28885220	24599649	545	45011680	43477825
116	12061377	6936887	331	28961405	24685732	546	45085760	43566985
117	12144037	7013532	332	29037577	24771836	547	45159833	43656155
118	12226629	7090274	333	29113734	24857961	548	45233900	43745334
119	12309155	7167114	334	29189876	24944107	549	45307960	43834523
120	12391614	7244050	335	29266005	25030273	550	45382013	43923723
121	12474008	7321081	336	29342119	25116460	551	45456059	44012932
122	12556338	7398206	337	29418220	25202668	552	45530099	44102150
123	12638604	7475422	338	29494306	25288896	553	45604132	44191379
124	12720808	7552731	339	29570379	25375144	554	45678159	44280617
125	12802949	7630129	340	29646438	25461412	555	45752178	44369865
126	12885029	7707617	341	29722483	25547700	556	45826192	44459123
127	12967048	7785194	342	29798514	25634009	557	45900198	44548390
128	13049007	7862857	343	29874532	25720337	558	45974198	44637667
129	13130907	7940606	344	29950536	25806685	559	46048192	44726953
130	13212749	8018441	345	30026527	25893053	560	46122179	44816249
131	13294533	8096360	346	30102504	25979441	561	46196159	44905555
132	13376259	8174362	347	30178468	26065848	562	46270133	44994870
133	13457929	8252446	348	30254418	26152274	563	46344100	45084194
134	13539543	8330612	349	30330355	26238721	564	46418061	45173528
135	13621102	8408859	350	30406279	26325186	565	46492016	45262871
136	13702605	8487185	351	30482190	26411671	566	46565964	45352224
137	13784055	8565589	352	30558087	26498174	567	46639906	45441586
138	13865452	8644072	353	30633972	26584697	568	46713841	45530958
139	13946795	8722632	354	30709843	26671239	569	46787770	45620339
140	14028086	8801268	355	30785702	26757800	570	46861692	45709729
141	14109325	8879979	356	30861547	26844380	571	46935608	45799128
142	14190513	8958765	357	30937380	26930979	572	47009518	45888537
143	14271650	9037625	358	31013200	27017596	573	47083422	45977955
144	14352737	9116558	359	31089007	27104232	574	47157319	46067382
145	14433775	9195563	360	31164802	27190886	575	47231210	46156818
146	14514763	9274640	361	31240584	27277559	576	47305094	46246264
147	14595702	9353788	362	31316353	27364250	577	47378973	46335719
148	14676593	9433006	363	31392110	27450959	578	47452845	46425182
149	14757437	9512294	364	31467854	27537687	579	47526711	46514655
150	14838233	9591650	365	31543586	27624433	580	47600570	46604137
151	14918983	9671074	366	31619306	27711197	581	47674424	46693628
152	14999686	9750566	367	31695013	27797979	582	47748271	46783128
153	15080344	9830124	368	31770708	27884779	583	47822113	46872637
154	15160956	9909749	369	31846390	27971597	584	47895948	46962155
155	15241523	9989439	370	31922061	28058432	585	47969777	47051682
156	15322045	10069194	371	31997719	28145286	586	48043599	47141218

157	15402524	10149014	372	32073365	28232157	587	48117416	47230762
158	15482959	10228896	373	32149000	28319045	588	48191227	47320316
159	15563350	10308842	374	32224622	28405951	589	48265031	47409879
160	15643699	10388851	375	32300232	28492875	590	48338830	47499450
161	15724005	10468921	376	32375831	28579815	591	48412622	47589030
162	15804270	10549052	377	32451417	28666774	592	48486409	47678619
163	15884492	10629245	378	32526992	28753749	593	48560190	47768217
164	15964673	10709497	379	32602555	28840741	594	48633964	47857823
165	16044814	10789809	380	32678107	28927751	595	48707733	47947438
166	16124913	10870180	381	32753646	29014778	596	48781495	48037062
167	16204973	10950610	382	32829175	29101821	597	48855252	48126695
168	16284993	11031098	383	32904691	29188882	598	48929003	48216336
169	16364973	11111643	384	32980196	29275959	599	49002747	48305986
170	16444914	11192245	385	33055690	29363053	600	49076486	48395644
171	16524817	11272904	386	33131172	29450164	601	49150219	48485312
172	16604680	11353619	387	33206643	29537291	602	49223946	48574987
173	16684506	11434390	388	33282102	29624435	603	49297668	48664671
174	16764294	11515215	389	33357550	29711596	604	49371383	48754364
175	16844045	11596095	390	33432987	29798773	605	49445093	48844065
176	16923758	11677030	391	33508413	29885966	606	49518797	48933775
177	17003435	11758018	392	33583827	29973176	607	49592495	49023493
178	17083075	11839059	393	33659230	30060402	608	49666187	49113220
179	17162679	11920153	394	33734623	30147644	609	49739874	49202955
180	17242247	12001299	395	33810004	30234902	610	49813554	49292699
181	17321779	12082497	396	33885374	30322176	611	49887229	49382451
182	17401276	12163747	397	33960734	30409467	612	49960899	49472211
183	17480738	12245048	398	34036082	30496773	613	50034562	49561980
184	17560165	12326400	399	34111419	30584095	614	50108220	49651757
185	17639558	12407801	400	34186746	30671433	615	50181872	49741542
186	17718917	12489253	401	34262062	30758787	616	50255519	49831335
187	17798241	12570754	402	34337367	30846156	617	50329160	49921137
188	17877532	12652304	403	34412662	30933541	618	50402795	50010947
189	17956790	12733903	404	34487945	31020942	619	50476425	50100765
190	18036015	12815550	405	34563218	31108358	620	50550049	50190592
191	18115206	12897245	406	34638481	31195790	621	50623667	50280427
192	18194366	12978988	407	34713733	31283237	622	50697280	50370270
193	18273492	13060777	408	34788974	31370699	623	50770887	50460120
194	18352587	13142614	409	34864205	31458177	624	50844489	50549980
195	18431650	13224497	410	34939426	31545670	625	50918085	50639847
196	18510681	13306426	411	35014636	31633178	626	50991676	50729722
197	18589681	13388401	412	35089836	31720702	627	51065261	50819605
198	18668650	13470421	413	35165025	31808240	628	51138840	50909497
199	18747588	13552486	414	35240204	31895794	629	51212414	50999396
200	18826495	13634596	415	35315373	31983362	630	51285983	51089304
201	18905372	13716750	416	35390532	32070946	631	51359546	51179219
202	18984219	13798949	417	35465680	32158544	632	51433104	51269143
203	19063035	13881191	418	35540819	32246157	633	51506656	51359074
204	19141822	13963476	419	35615947	32333785	634	51580203	51449013
205	19220579	14045805	420	35691065	32421428	635	51653744	51538961
206	19299307	14128176	421	35766173	32509085	636	51727280	51628916
207	19378006	14210590	422	35841272	32596757	637	51800811	51718879
208	19456676	14293046	423	35916360	32684443	638	51874336	51808850
209	19535318	14375544	424	35991438	32772144	639	51947856	51898828

210	19613930	14458083	425	36066507	32859859	640	52021370	51988815
211	19692515	14540664	426	36141565	32947589	641	52094880	52078809
212	19771071	14623286	427	36216614	33035333	642	52168384	52168811
213	19849600	14705948	428	36291653	33123092			
214	19928101	14788651	429	36366682	33210864			

NOTE 1: The first column is the number of errors (ne = number of NACK).
NOTE 2: The second column is the number of samples for the pass limit (ns_p, ns=Number of Samples= number of NACK + ACK).
NOTE 3: The third column is the number of samples for the fail limit (ns_f).
NOTE 4: An ideal DUT passes after 1074532 samples. The maximum test time is 52171625 samples. A DUT passes, if the maximum number of samples is reached and it did not fail before.

G.4.4 Simulation to derive the pass-fail limits for 0.001% BLER

The binomial distribution and its inverse are used to design the pass and fail limits. Note that this method is not unique and that other methods exist.

$$\text{fail}(ne,d_f) := \frac{ne}{ns_f} = \frac{ne}{(ne + \text{qnbinom}(d_f, ne, ER))}$$

$$\text{pass}(ne,cl_p,M) := \frac{ne}{ns_p} = \frac{ne}{(ne + \text{qnbinom}(cl_p, ne, ER \cdot M))}$$

Where

- fail(..) is the error ratio for the fail limit.
- pass(..) is the error ratio for the pass limit.
- ER is the specified error ratio 1e-5.
- ne is the number of bad results. This is the variable in both equations.
- M is the Bad DUT factor M=1.5.
- d_f is the wrong decision probability of a single (ne, ns) co-ordinate for the fail limit.
  It is found by simulation to be d_f = 2e-7.
- cl_p is the confidence level of a single (ne, ns) co-ordinate for the pass limit.
  It is found by simulation to be cl_p = 0.9999999.
- qnbinom(..): The inverse cumulative function of the negative binomial distribution.

The simulation works as follows:

- A large population of limit DUTs with true ER = 1e-5 is decided against the pass and fail limits.
- cl_p and d_f are tuned such that CL (99.999 %) of the population passes and D (0.001 %) of the population fails.
- A population of Bad DUTs with true ER = M*1e-5 is decided against the same pass and fail limits.
- cl_p and d_f are tuned such that CL (99.999 %) of the population fails and D (0.001 %) of the population passes.
- The number of DUTs decrease during the simulation, as the decided DUTs leave the population. That number decreases with an approximately exponential characteristics. After 642 bad results all DUTs of the population are decided.

NOTE: The exponential decrease of the population is an optimal design goal for the decision co-ordinates (ne, ns), which can be achieved with other formulas or methods as well.

G.5 Statistical Testing of NR sidelink Performance Requirements – Non concurrent

G.5.1 General

To test PSCCH or PSSCH performance requirements the UE under test is required to send sidelink HARQ feedback on PSFCH based on corresponding PSSCH reception when PSFCH is configured in resource pool and sidelink HARQ function is enabled. The SS can use the PSFCH sent by the UE under test to determine a Pass or Fail decision. See G.5.2 for more details.

To test PSFCH performance requirements. PSFCH should be configured in resource pool and sidelink HARQ function should be enabled. The UE under test is required to keep sending PSSCH transport blocks when test loop function mode E (transmit mode) is activated as specified in TS 38.509 [22]. The SS shall sends appropriate sidelink HARQ feedback on PSFCH corresponds to each PSSCH. The UE shall retransmit PSSCH if it receives NACK on corresponding PSFCH. The SS can use the re-transmission sent by the UE under test to determine a Pass or Fail decision. See G.5.3 for more details.

The system simulator (SS) sends NR sidelink packets or PSFCH to the UE under test. The number of packets or PSFCH sent by the SS is predefined by the test time in G.5.4, G.5.5 and G.5.6 for requirements with PSSCH throughput, PSCCH miss-detection probability, and PSFCH miss-detection probability, respectively.

G.5.2 Test method for PSCCH/PSSCH performance using sidelink HARQ feedback

Test method described in this subclause applies to the UE supporting *psfch-FormatZeroSidelink-r16*.

Figure G.5.2-1 descriptively represents the course of a test based in two metrics: the noise-normalized test SNR and the performance session, represented in terms of fractional throughput. The SS counts the sidelink HARQ feedback samples sent by the UE under test during performance session and calculate the performance metrics based on them. This effectively results on the discard of early sidelink HARQ feedback that might take place between their initialization at State 4-A and the stabilized performance session. The test method is as follows:

1) The UE is set on state 4-A with generic procedure parameters Test Loop Function = *On* according to TS 38.508-1 [6] clause 4.4A.2. The UE is configured as the receiving UE.

2) Once the UE is operating on state 4-A, the SNR is set to the test SNR level and the scheduling of sidelink packets starts. This takes place during the test procedure stage. The SS receives every sidelink HARQ feedback sent by the UE under test and starts to count the number of ACK/NACK/DTX (for ACK/NACK HARQ) or NACK/DTX (for NACK-only HARQ).

3) Once the scheduling of sidelink packets starts, the SS shall wait for a stability window of T=10 seconds before recoding the number of sidelink HARQ feedback sent by the UE under test.

4) Upon expiration of the stability window, the SS shall recode the number of ACK/NACK/DTX (for ACK/NACK HARQ) or NACK/DTX (for NACK-only HARQ) sent by the UE under test (Time Point A in Figure G.5.2-1). Then the performance session starts.

5) During the performance session the SS shall record the number of transmitted sidelink packets (PSCCH, PSSCH carrying SDAP SDU) starting in Time Point A and ending in Time Point B and keep counting the number of ACK/NACK/DTX (for ACK/NACK HARQ) or NACK/DTX (for NACK-only HARQ) sent by the UE under test. The performance session lasts for the Test Time defined in sections G.5.4 and G.5.5 for throughput and PSCCH miss-detection probability, respectively.

6) Once the Test Time is completed the SS shall recode the number of ACK/NACK/DTX (for ACK/NACK HARQ) or NACK/DTX (for NACK-only HARQ) sent by the UE under test (Time Point B in Figure G.5.2-1)

and then stop counting. The SS shall use the retrieved counter values at Time Point A and Time Point B, as well as the recorded number of transmitted sidelink packets (PSCCH, PSSCH and/or SDAP SDU) between Time Point A and Time Point B, to calculate the PSCCH probability of miss-detection, the PSSCH BLER and the SDAP SDU loss, respectively.

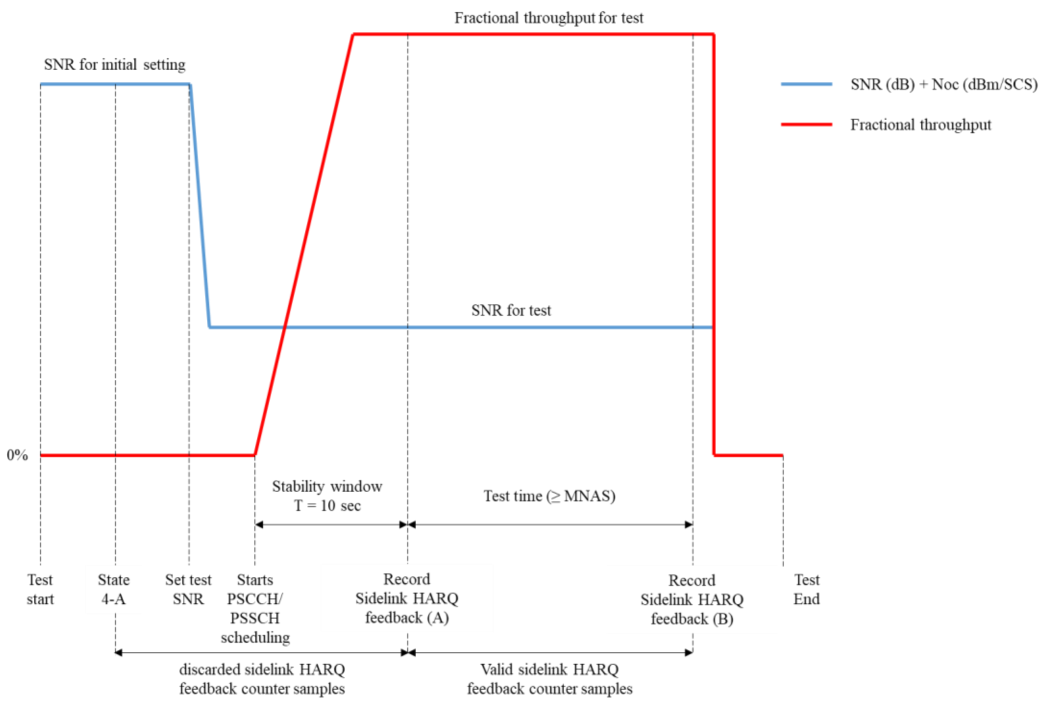

Figure G.5.2-1: Proposed Test Method for PSCCH/PSSCH performance using sidelink HARQ feedback

According to both the test method described in this section and Figure G.5.2-1, the PSCCH probability of miss-detection can be defined as follows when ACK/NACK HARQ or NACK-only HARQ is applied, respectively.

$$P^{MD}_{PSCCH,ACK-NACK} = \frac{NACK_{Counter}(B) + DTX_{Counter}(B) - NACK_{Counter}(A) - DTX_{Counter}(A)}{PSCCH_{Transmitted}}$$

$$P^{MD}_{PSCCH,NACK-only} = \frac{NACK_{Counter}(B) - NACK_{Counter}(A)}{PSCCH_{Transmitted}}$$

Similarly, we can define the PSSCH BLER as follows:

$$BLER_{PSSCH,ACK-NACK} = 1 - \frac{NACK_{Counter}(B) + DTX_{Counter}(B) - NACK_{Counter}(A) - DTX_{Counter}(A)}{PSSCH_{Transmitted}}$$

$$BLER_{PSSCH,NACK-only} = 1 - \frac{NACK_{Counter}(B) - NACK_{Counter}(A)}{PSSCH_{Transmitted}}$$

Finally, we can define the SDAP SDU loss as follows:

$$Loss_{SDAP\_SDU} = 1 - \left[\frac{SDAP\_SDU_{Counter}(B) - SDAP\_SDU_{Counter}(A)}{SDAP\_SDU_{Transmitted}}\right]$$

Where:

P^{MD} = Probability of Miss-Detection

BLER = Block Error Rate

$Loss_{SDAP\_SDU}$ = SDAP SDU Loss rate

$NACK_{Counter}$ = number of NACK feedback recorded by the SS

$DTX_{Counter}$ = number of DTX observed by the SS

$SDAP\_SDU_{Counter}$ = number of SDAP SDUs all of whose corresponding PSSCHs are correctly received (i.e. the SS receives positive acknowledgements on all corresponding PSFCHs)

T = 10 seconds stability window

$PSCCH_{Transmitted}$ = Transmitted number of PSCCH transport blocks counted by the SS

$PSSCH_{Transmitted}$ = Transmitted number of PSSCH transport blocks counted by the SS

$STCH\_SDU_{Transmitted}$ = Transmitted number of STCH PDCP SDUs counted by the SS

MNAS = Minimum Number of Active Subframes, as per Table G.5.4-1 and Table G.5.5-1 for performance tests with throughput and probability of miss-detection, respectively

G.5.3 Test method for PSFCH performance

Figure G.5.2-1 descriptively represents the course of a test based in two metrics: the noise-normalized test SNR and the performance session, represented in terms of fractional throughput. The SS counts the re-transmissions samples sent by the UE under test during performance session and calculate the performance metrics based on them. This effectively results on the discard of early re-transmission that might take place between their initialization at State 4-A and the stabilized performance session. The test method is as follows:

1) The UE is set on state 4-A with generic procedure parameters Test Loop Function = *On* according to TS 38.508-1 [6] clause 4.4A.2. The UE is configured as the transmitting UE.

2) Once the UE is operating on state 4-A, the SNR is set to the test SNR level. This takes place during the test procedure stage. The SS receives and counts every PSCCH/PSSCH sent by the UE under test, then send ACK/NACK/DTX on corresponding PSFCH according to setting in test case.

3) Once the test SNR level is set, the SS shall wait for a stability window of T=10 seconds before recoding the number of sidelink HARQ feedback sent by the UE under test.

4) Upon expiration of the stability window, the SS shall recode the number of re-transmissions sent by the UE under test (Time Point A in Figure G.5.2-1). Then the performance session starts.

5) During the performance session the SS shall record the number of transmitted sidelink HARQ feedback (ACK, NACK and DTX) starting in Time Point A and ending in Time Point B and keep counting the number of re-transmission sent by the UE under test. The performance session lasts for the Test Time defined in sections G.5.6 for PSFCH miss-detection probability, respectively.

6) Once the Test Time is completed the SS shall recode the number of re-transmissions sent by the UE under test (Time Point B in Figure G.5.2-1) and then stop counting. The SS shall use the retrieved counter values at Time Point A and Time Point B, as well as the recorded number of transmitted sidelink HARQ feedbacks (ACK, NACK and DTX) between Time Point A and Time Point B, to calculate the PSFCH probability of miss-detection.

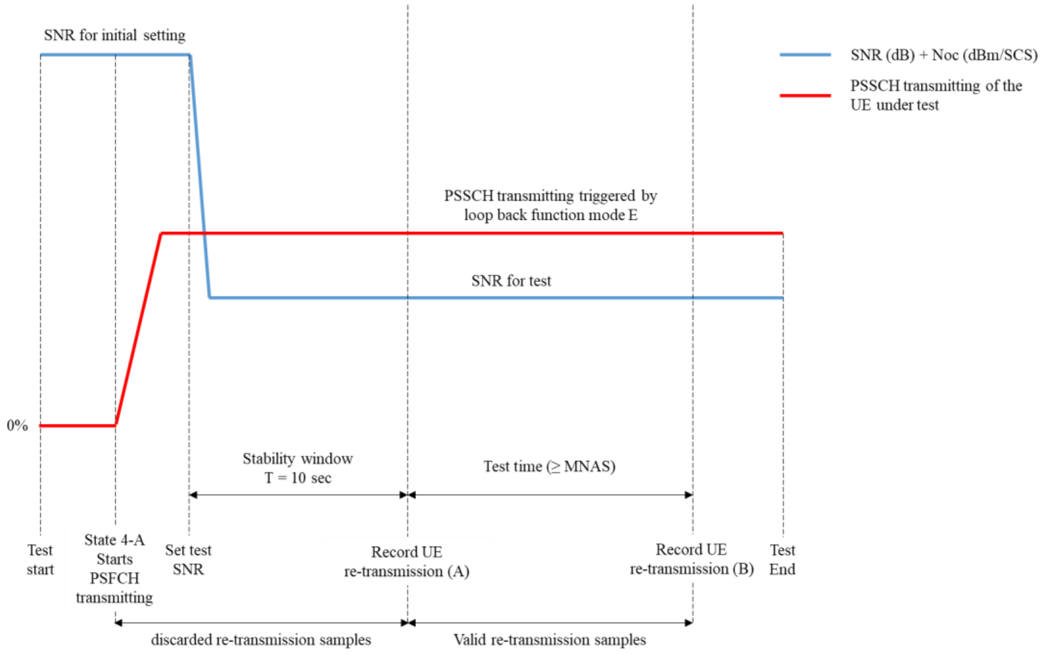

Figure G.5.3-1: Proposed Test Method for PSFCH performance

According to both the test method described in this section and Figure G.5.3-1, the PSFCH probability of miss-detection can be defined as follows when ACK/NACK HARQ or NACK-only HARQ is applied, respectively.

$$P^{MD}_{PSFCH,ACK-NACK} = 1 - \frac{ReTx_{NACK}(B) + ReTx_{DTX}(B) - ReTx_{NACK}(A) - ReTx_{DTX}(A)}{NACK_{Counter} + DTX_{Counter}}$$

$$P^{MD}_{PSCCH,NACK-only} = 1 - \frac{ReTx_{NACK}(B) - ReTx_{NACK}(A)}{NACK_{Counter}}$$

When NACK-only HARQ is applied, the DTX to NACK probability defined in TS 38.101-4 [5] clause 11.1.5.1.1.2 can be defined as follows:

$$Prob(PSFCH\ DTX \rightarrow NACK) = \frac{ReTx_{DTX}(B) - ReTx_{DTX}(A)}{DTX_{Counter}}$$

When ACK/NACK HARQ is applied, the success detection probability of ACK can be defined as follows:

$$P^{SD}_{PSFCH\ ACK} = 1 - \frac{ReTx_{ACK}(B) - ReTx_{ACK}(A)}{ACK_{Counter}}$$

And the success detection probability of NACK/DTX can be defined as follows:

$$P^{SD}_{PSFCH\ NACK/DTX} = 1 - P^{MD}_{PSFCH,ACK-NACK}$$

Where:

P^{MD} = Probability of Miss-Detection

P^{SD} = Probability of success detection

$ReTx_{ACK}$ = number of re-transmissions corresponding to the ACK sent by the SS.

$ReTx_{NACK}$ = number of re-transmissions corresponding to the NACK sent by the SS.

$ReTx_{DTX}$ = number of re-transmissions corresponding to the DTX sent by the SS.

$NACK_{Counter}$ = number of ACK feedback sent by the SS

$NACK_{Counter}$ = number of NACK feedback sent by the SS

$DTX_{Counter}$ = number of PSFCH occasions on which SS chooses to send nothing

T = 10 seconds stability window

MNAS = Minimum Number of Active Subframes, as per Table G.5.6-1 for PSFCH probability of miss-detection.

G.5.4 Test time for PSSCH performance requirements with throughput

The throughput requirements are tested in terms of PSSCH BLER. The maximum BLER requirement for all tests is 10%. The tests are performed in a variety of AWGN and fading propagation models. For each test in Table G.5.4-1 the test time (in subframes) is to be applied to the test method described in section G.5.2

Table G.5.4-1: Minimum test time for PSSCH performance requirements with throughput

Test num.	Performance Scenario	Minimum Number of Active Subframes (MNAS)	Minimum Number of Subframes (MNS)(Note 1)	Test Time in Subframes (Note 2)
11.1.2-1	R.PSSCH.2-1.1 1x2 Low TDLA30-2700	FFS	FFS	FFS
11.1.2-2	R.PSSCH.2-1.2 1x2 Low TDLA30-1400	FFS	FFS	FFS
11.1.2-3	R.PSSCH.2-1.3 1x2 Low TDLA30-180	FFS	FFS	FFS
11.1.6-1	R.PSSCH.2-1.4 1x2 Low AWGN 2 PSSCH transmissions	FFS	FFS	FFS
11.1.7-1	R.PSSCH.2-1.5 1x2 Low AWGN Number of PSSCH transmissions depends on UE capability	FFS	FFS	FFS
Note 1: The Minimum Number of Subframes is the total minimum number of subframes (active and inactive) required for this demodulation scenario and is derived from the MNAS, according to the resource pool configuration defined for each test case. Note 2: The Test Time is based on the Minimum Number of Subframes (MNS) according to the formula: Test Time in Subframes = 1000*CEIL(MNS/1000).				

G.5.5 Test time for PSCCH performance requirements with miss-detection probability

The probability of miss-detection requirements are tested in terms of Probability of PSCCH miss-detection. The maximum Probability of PSCCH miss-detection for all tests is 1%. The tests are performed in a variety of Static, AWGN and fading propagation models. For each test in Table G.5.5-1 the Test Time in Subframes is to be applied to the test method described in section G.5.2.

Table G.5.5-1: Minimum Test Time for PSCCH Performance Requirements with Probability of Miss-Detection

Test num.	Performance Scenario	Minimum Number of Active Subframes (MNAS)	Minimum Number of Subframes (MNS)(Note 1)	Test Time in Subframes (Note 2)
11.1.3-1	R.PSCCH.2-1.1 20 / 30 1x2 Low TDLA30-1400	FFS	FFS	FFS
11.1.8-1	R.PSCCH.2-1.1 40 / 30 1x2 Low Static	FFS	FFS	FFS
Note 1: The Minimum Number of Subframes is the total minimum number of subframes (active and inactive) required for this demodulation scenario and is derived from the MNAS, according to the resource pool configuration defined for each test case. Note 2: The Test Time is based on the Minimum Number of Subframes (MNS) according to the formula: Test Time in Subframes = 1000*CEIL(MNS/1000).				

G.5.6 Test time for PSFCH performance requirements with miss-detection probability

The probability of miss-detection requirements are tested in terms of Probability of PSFCH miss-detection. The maximum Probability of PSFCH miss-detection for all tests is 1%. The tests are performed in a variety of Static, AWGN and fading propagation models. For each test in Table G.5.6-1 the Test Time in Subframes is to be applied to the test method described in section G.5.3.

Table G.5.6-1: Minimum Test Time for PSFCH Performance Requirements with Probability of Miss-Detection

Test num.	Performance Scenario	Minimum Number of Active Subframes (MNAS)	Minimum Number of Subframes (MNS)(Note 1)	Test Time in Subframes (Note 2)
11.1.5-1	20 / 30 1x2 Low TDLA30-180	FFS	FFS	FFS
11.1.9-1	40 / 30 1x2 Low Static	FFS	FFS	FFS
Note 1: The Minimum Number of Subframes is the total minimum number of subframes (active and inactive) required for this demodulation scenario and is derived from the MNAS, according to the resource pool configuration defined for each test case. Note 2: The Test Time is based on the Minimum Number of Subframes (MNS) according to the formula: Test Time in Subframes = 1000*CEIL(MNS/1000).				

Annex H: Approach for finding UE direction for FR2 Demod and CSI Testing

H.0 Normative criteria for determining UE direction for Demod and CSI

Following 3 criteria shall be satisfied for a given UE direction. Procedure for finding the UE direction is captured in Annex H.1

1. UE shall pass the REFSENS test as per TC 7.3.2 of TS 38.521-2 [8].
2. Minimum isolation requirement of 12 dB between the 2 TE polarization branches shall be met.
3. UE reported rank shall be higher or same as intended rank for a given test.

H.1 Procedure for finding UE direction

This section provides example approaches for finding the UE direction for Demod and CSI tests. Other approaches satisfying the normative criteria listed in H.0 are not precluded.

Default approach is as defined in H.1.2.

H.1.1 Using Rx beam peak direction search

1. For Rx beam peak direction search, please refer to procedure defined in Annex K.1.2/K.3.2 of TS 38.521-2 [8].
2. Run wireless cable mode isolation procedure as defined in H.2.
3. Ensure UE reported rank is higher or same as intended rank for a given test.

H.1.2 RSRPB based scan with fallback option to Rx beam peak direction search

1. Enable periodic RSRPB reporting from the UE.
2. Set of grid points for the UE scan can be user defined set or entire sphere.
3. For each grid point, record RSRPB first by connecting SS to the DUT through the measurement antenna with $Pol_{Link}= \theta$ polarization to form the Rx beam towards the measurement antenna and similarly for $Pol_{Link}= \phi$ polarization.
4. Wait for BEAM_SELECT_WAIT_TIME before recording the RSRPB reports.
5. Once the grid points scan is completed, sort the grid points based on the linear sum of 4 RSRPB values (2 each for θ and ϕ polarization).
6. For the top [10] grid points, run the REFSENS throughput test as per the test condition defined in 38.521-2 clause 7.3.2
7. Grid points that pass the REFSENS throughput test are the potential UE direction to be used for running the tests.
8. If no grid points found in step 7, fall back to using H.1.1.
9. For running rank1 tests,

a. Pick any of the grid points obtained in step 7.

b. Run the wireless cable isolation procedure defined in H.2.

c. Exit the procedure.

10. For running rank2 tests,

a. Pick a grid point obtained in step 7.

b. Run the wireless cable mode isolation procedure defined in H.2.

c. If the grid point satisfies the minimum isolation, proceed to RI check.

Enable RI reporting from UE. If the UE reported rank = 2, exit the procedure.

If UE reported rank is not equal to 2, move to the next grid from step 7 and run step 10.

d. If no grid point meets the criteria in step 7 and step 10c, fallback to using H.1.1.

H.1.3 Isolation based scan with fallback option to Rx beam peak direction search

1. Enable periodic RSRPB reporting from the UE.

2. Set of grid points for the UE scan can be user defined set or entire sphere.

3. For each grid point, record RSRPB first by connecting SS to the DUT through the measurement antenna with Pol_{Link}= θ polarization to form the Rx beam towards the measurement antenna and similarly for Pol_{Link}= ϕ polarization.

4. Wait for BEAM_SELECT_WAIT_TIME before recording the RSRPB reports.

5. Once the grid points scan is completed, sort the grid points based on the highest $ISO_{\theta,B1}$ and $ISO_{\phi,B2}$ or $ISO_{\theta,B2}$ and $ISO_{\phi,B1}$ ($ISO_{\theta,B1}$, $ISO_{\phi,B2}$, $ISO_{\theta,B2}$ and $ISO_{\phi,B1}$ are explained in H.2).

6. For the top [10] grid points, run the REFSENS throughput test as per the test condition defined in 38.521-2 clause 7.3.2

7. Grid points that pass the REFSENS throughput test are the potential UE direction to be used for running the tests.

8. If no grid points found in step 7, fall back to using H.1.1.

9. For running rank1 tests,

a. Pick any of the grid points obtained in step 7.

b. If the grid point satisfies the minimum isolation, exit the procedure.

10. For running rank2 tests,

a. Pick a grid point obtained in step 7.

b. If the grid point satisfies the minimum isolation, proceed to RI check.

Enable RI reporting from UE. If the UE reported rank = 2, exit the procedure.

If UE reported rank is not equal to 2, move to the next grid from step 7 and run step 10.

d. If no grid point meets the criteria in step 7 and step 10b, fallback to using H.1.1.

H.2 Wireless cable mode isolation procedure

The following procedure shall be used to verify the wireless cable mode has been established and that the minimum isolation has been achieved

1. Select any of the three Alignment Options (1, 2, or 3) to mount the DUT inside the QZ.
2. If the re-positioning concept is applied to demodulation test cases, position the DUT in DUT Orientation 1 if the RX beam peak is within $0^o \leq \theta \leq 90^o$. Otherwise, position the DUT in DUT Orientation 2 (Option 1 or 2). If the re-positioning concept is not applied to demodulation test cases, position the DUT in DUT Orientation 1
3. Connect the SS (System Simulator) using static propagation conditions with the DUT through the measurement antenna with $Pol_{Link}=\theta$ polarization to form the RX beam towards the desired test direction. Allow at least BEAM_SELECT_WAIT_TIME for the UE RX beam selection to complete.
4. Adjust the DL power of the SS to obtain P_{DL} defined in Table C.0.2-1 at the centre of QZ
5. Perform the isolation of the branches to achieve the wireless cable mode. The inverse channel matrix approach in [4] is one suitable approach. Alternate approaches are not precluded.
6. To verify the wireless cable mode and thus the min. isolation between branches
    a) Query SS-RSRPB($Pol_{Meas}=Pol_{Link}=\theta$) from the DUT for the θ-polarization and convert the two measurements in dBm, i.e., $SS\text{-}RSRPB_{B1}$ and $SS\text{-}RSRPB_{B2}$
    b) Calculate the isolation from θ-polarization into Branch 1, i.e., $ISO_{\theta,B1} = SS\text{-}RSRPB_{B1} - SS\text{-}RSRPB_{B2}$ and the isolation into Branch 2, i.e., $ISO_{\theta,B2} = SS\text{-}RSRPB_{B2} - SS\text{-}RSRPB_{B1}$
    c) Connect the SS (System Simulator) using static propagation conditions with the DUT through the measurement antenna with $Pol_{Link}=\phi$ polarization to form the RX beam towards desired test direction. Allow at least BEAM_SELECT_WAIT_TIME for the UE RX beam selection to complete.
    d) Adjust the DL power of the SS to obtain P_{DL} defined in Table C.0.2-1 at the centre of QZ
    e) Query SS-RSRPB($Pol_{Meas}=Pol_{Link}=\phi$) from the DUT for ϕ-polarization and convert the two measurements in dBm, i.e., $SS\text{-}RSRPB_{B1}$ and $SS\text{-}RSRPB_{B2}$
    f) Calculate the isolation from ϕ-polarization into Branch 2, i.e., $ISO_{\phi,B2} = SS\text{-}RSRPB_{B2} - SS\text{-}RSRPB_{B1}$ and the isolation into Branch 1, i.e., $ISO_{\phi,B1} = SS\text{-}RSRPB_{B1} - SS\text{-}RSRPB_{B2}$

If either of the isolations pairs, $ISO_{\theta,B1}$ and $ISO_{\phi,B2}$ or $ISO_{\theta,B2}$ and $ISO_{\phi,B1}$ exceed 12dB, the wireless cable mode has been achieved.

Annex I (informative): Change history

Change history							
Date	Meeting	Tdoc	CR	Rev	Cat	Subject/Comment	New version
2018-01		R5-180064				Skeleton for NR Demod spec	0.0.1
2018-04-13		R5-182036				Added the test procedure for FR2 Demod testing in Annex	0.1.0
2018-10-12		R5-185903				Added the demod spec test case section titles to be in line with RAN4 approved skeleton for 38.101-4	0.1.1
2018-11-20	RAN5 #81	R5-188006				new TC for PDSCH FR1 demod	0.2.0
2018-11-20	RAN5 #81	R5-188008				new TC for PDSCH FR2 demod	0.2.0
2018-11-20	RAN5 #81	R5-187573				section 3 of 38.521-4 spec	0.2.0
2018-11-20	RAN5 #81	R5-187845				section 4 of 38.521-4 spec	0.2.0
2018-11-20	RAN5 #81	R5-188009				pCR for new TC addition for FR1 FDD PDSCH Demod	0.2.0
2018-11-20	RAN5 #81	R5-188010				pCR for new TC addition for FR1 FDD PDCCH Demod	0.2.0
2019-01-25	RAN5 5G-NR AH#4	R5-190054				update to 2Rx TDD FR1 PDSCH mapping Type A performance test case	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190926				pCR for new TC addition for FR1 4Rx FDD PDSCH Demodulation performance (2x4)	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190927				pCR for new TC addition for FR1 4Rx FDD PDSCH Demodulation performance (4x4)	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190928				pCR for new TC addition for FR1 4Rx FDD PDSCH Demodulation performance with enhanced receiver type X (4x4)	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190291				Updated to Annex A Measurement Channels for Performance tests	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190292				Updated to Annex B Propagation conditions for Performance tests	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190458				update to 2Rx TDD FR2 PDSCH mapping Type A performance test case	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190461				2Rx TDD FR2 PDCCH performance test case	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190929				LTE link setup details for demod test cases	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190930				Annex for statistical tput calculation for demod test cases	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190931				pCR for TC addition of FR1 TDD 4Rx PDSCH	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190932				pCR for modification of FDD 2Rx FR1 PDSCH Demod	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190933				Annex for DL and UL Signal Setup	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190934				pCR for modification of FDD FR1 PDCCH Demod	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190935				PDSCH and PDCCH Config before measurement	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190986				38.521-4 Common Section updates to clarify leverage across architecture options	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190552				Addition of 2Rx TDD FR1 Single PMI tests for both SA and NSA	0.3.0
2019-01-25	RAN5 5G-NR AH#4	R5-190553				Addition of 2Rx TDD FR1 RI reporting for both SA and NSA	0.3.0
2019-03-01	RAN5 #82	R5-191183				Adding relevant references to 38.521-4	0.4.0
2019-03-01	RAN5 #82	R5-192461				Adding of test case 6.2.2.1.2.1.2, Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192672				Introduction of New test case 5.3.2.2.1 2Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192463				Introduction of New test case 5.3.2.2.2 2Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192462				Introduction of New test case 5.3.3.1.1 4Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192464				Introduction of New test case 5.3.3.1.2 4Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192465				Introduction of New test case 5.3.3.2.1 4Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192465				Introduction of New test case 5.3.3.2.2 4Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	0.4.0

2019-03-01	RAN5 #82	R5-192474				Introduction of TS 38.521-4 test case 6.3.2.1.1	0.4.0
2019-03-01	RAN5 #82	R5-192475				Introduction of TS 38.521-4 test case 6.3.2.1.2	0.4.0
2019-03-01	RAN5 #82	R5-192467				Introduction of test case 5.2.2.1.2_1, 2Rx FDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - 2x2 MIMO with baseline receiver for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192840				Demod spec section 4 update	0.4.0
2019-03-01	RAN5 #82	R5-192673				Update to TDD FR1 2Rx PDSCH Type A test case	0.4.0
2019-03-01	RAN5 #82	R5-192103				addition of 2Rx TDD FR1 periodic CQI reporting test case	0.4.0
2019-03-01	RAN5 #82	R5-192468				pCR for addition of 2Rx TDD FR1 TypeA and CSI-RS overlapped TC	0.4.0
2019-03-01	RAN5 #82	R5-192866				pCR for modification of PDSCH and PDCCH Config before measurement	0.4.0
2019-03-01	RAN5 #82	R5-192470				pCR for modification of FDD FR1 PDCCH Demod	0.4.0
2019-03-01	RAN5 #82	R5-192471				pCR for modification of FDD 2Rx FR1 PDSCH Demod	0.4.0
2019-03-01	RAN5 #82	R5-192472				Update to 2Rx TDD FR1 RI reporting for both SA and NSA	0.4.0
2019-03-01	RAN5 #82	R5-192460				Minimum test time update for FR1 Demod test case	0.4.0
2019-03-01	RAN5 #82	R5-192473				Addition of Annex F for Demod spec	0.4.0
2019-03	RAN#83	RP-190222	-	-	-	Presented to the RAN#83 plenary for 1-step approval	1.0.0
2019-03	RAN#83	-	-	-	-	raised to v15.0.0 with editorial changes only	15.0.0
2019-06	RAN5#83	R5-193544	0030	-	F	Updates to test case 6.2.2.1.2.1, 2Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-193943	0035	-	F	Adding test case 6.2.2.2.2.2, 2Rx TDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194159	0048	-	F	Alignment of Annex C with core specification	15.1.0
2019-06	RAN5#83	R5-194466	0056	-	F	Introduction of FR1 CQI test case 6.2.2.2.2.1	15.1.0
2019-06	RAN5#83	R5-194622	0057	-	F	Corrections TDD UL-DL configurations	15.1.0
2019-06	RAN5#83	R5-194680	0066	-	F	Demod section 5 general update	15.1.0
2019-06	RAN5#83	R5-194689	0073	-	F	Addition of text for FR1 PBCH demodulation test case	15.1.0
2019-06	RAN5#83	R5-194690	0074	-	F	Update to 2Rx TDD FR2 PDSCH Type A test case	15.1.0
2019-06	RAN5#83	R5-194691	0075	-	F	Update to FR2 PDCCH config param	15.1.0
2019-06	RAN5#83	R5-194692	0076	-	F	Addition of text for FR2 PBCH demodulation test case	15.1.0
2019-06	RAN5#83	R5-194693	0077	-	F	Update to section 8 CSI reporting	15.1.0
2019-06	RAN5#83	R5-194979	0063	1	F	Further updates to 2Rx TDD FR1 PDSCH mapping Type A test case	15.1.0
2019-06	RAN5#83	R5-194980	0032	1	F	Introduction of TC 6.4.3.2_1 4Rx TDD FR1 RI reporting for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194981	0034	1	F	Adding test case 6.2.2.1.2.2, 2Rx FDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194982	0053	1	F	Update to 4Rx FDD FR1 PDSCH mapping Type A performance 4x4 MIMO with baseline Rx	15.1.0
2019-06	RAN5#83	R5-194983	0054	1	F	Update to 4Rx FDD FR1 PDSCH mapping Type A performance 4x4 MIMO with enhanced Rx	15.1.0
2019-06	RAN5#83	R5-194984	0037	1	F	Editorial changes to TS 38.521-4 test case 6.3.2.1.2	15.1.0
2019-06	RAN5#83	R5-194985	0038	1	F	Introduction to TS 38.521-4 test case 6.3.3.1.1	15.1.0
2019-06	RAN5#83	R5-194986	0039	1	F	Introduction to TS 38.521-4 test case 6.3.3.1.2	15.1.0
2019-06	RAN5#83	R5-194987	0040	1	F	Introduction to TS 38.521-4 test case 6.3.3.2.1	15.1.0
2019-06	RAN5#83	R5-194988	0041	1	F	Introduction to TS 38.521-4 test case 6.3.3.2.2	15.1.0
2019-06	RAN5#83	R5-194989	0059	1	F	Modification of 2Rx FDD FR1 PDSCH mapping Type A performance - enhanced Rx	15.1.0
2019-06	RAN5#83	R5-194990	0060	1	F	Modification of 2Rx TDD FR1 PDSCH mapping Type A and CSI-RS overlapped with PDSCH performance - baseline Rx	15.1.0
2019-06	RAN5#83	R5-194991	0061	1	F	Modification of 2Rx FDD FR1 PDCCH 1 Tx	15.1.0
2019-06	RAN5#83	R5-194992	0062	1	F	Modification of 2Rx FDD FR1 PDCCH 2 Tx	15.1.0
2019-06	RAN5#83	R5-194993	0042	1	F	Update to test case 5.3.2.2.1 2Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194994	0043	1	F	Update to test case 5.3.2.2.2 2Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194995	0044	1	F	Update to test case 5.3.3.1.1 4Rx FDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194996	0045	1	F	Update to test case 5.3.3.1.2 4Rx FDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194997	0046	1	F	Update to test case 5.3.3.2.1 4Rx TDD FR1 PDCCH 1 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194998	0047	1	F	Update to test case 5.3.3.2.2 4Rx TDD FR1 PDCCH 2 Tx antenna performance for both SA and NSA	15.1.0
2019-06	RAN5#83	R5-194999	0055	1	F	Update to FR1 demod test case 5.2.2.1.2_1	15.1.0
2019-06	RAN5#83	R5-195000	0078	1	F	Update to RI Reporting Accuracy test	15.1.0
2019-06	RAN5#83	R5-195001	0049	1	F	Updated to Annexes for performance tests	15.1.0
2019-06	RAN5#83	R5-195002	0068	1	F	Demod section 2-4 update	15.1.0

2019-06	RAN5#83	R5-195003	0058	1	F	Modification of 2Rx FDD FR1 PDSCH mapping Type A performance - baseline Rx	15.1.0
2019-06	RAN5#83	R5-195088	0029	1	F	Editorial Aligning CSI common test parameters with core specification	15.1.0
2019-06	RAN5#83	R5-195089	0031	1	F	Updating of E-UTRA test frequency for DEMOD test cases	15.1.0
2019-06	RAN5#83	R5-195098	0079	-	F	Performance implementation of FR2 UL demod OTA tests using single pol Rx TE	15.1.0
2019-06	RAN5#83	R5-195170	0052	1	F	Update to 4Rx FDD FR1 PDSCH mapping Type A performance 2x4 MIMO with baseline Rx	15.1.0
2019-06	RAN5#83	R5-195171	0033	1	F	Introducing MU and TT clauses in annex F for Channel State Information reporting test cases	15.1.0
2019-06	RAN5#83	R5-195172	0069	1	F	Annex update for PDSCH PDCCH minimum test time	15.1.0
2019-06	RAN5#83	R5-195413	0067	1	F	Update to section 9 and 10 of Demod spec	15.1.0
2019-06	RAN5#83	R5-195438	0050	2	F	Introducing 5.2.2.1.4_1 2Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance	15.1.0
2019-06	RAN5#83	R5-195439	0051	2	F	Introducing 5.2.3.1.4_1 4Rx FDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance	15.1.0
2019-06	RAN5#83	R5-195440	0064	1	F	Addition of new test case for 2Rx FDD FR1 periodic CQI reporting under AWGN	15.1.0
2019-06	RAN5#83	R5-195441	0065	1	F	Update to 2Rx TDD FR1 periodic CQI reporting under AWGN	15.1.0
2019-06	RAN5#83	R5-195442	0070	1	F	Addition of SDR test case for single carrier in SA mode	15.1.0
2019-06	RAN5#83	R5-195443	0072	1	F	Addition of FR1 SDR test case for CA in NSA mode	15.1.0
2019-06	RAN#84	-	-	-	-	Administrative release upgrade to match the release of 3GPP TS 38.508-1 and TS 38.521-1 which were upgraded at RAN#84 to Rel-16 due to Rel-16 relevant CR(s)	16.0.0
2019-09	RAN#85	R5-195558	0080	-	F	Correction to 5.2.2.1.4_1 2Rx FR1 PDSCH LTE-NR coexistence performance	16.1.0
2019-09	RAN#85	R5-196245	0090	-	F	Correction to 2Rx TDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	16.1.0
2019-09	RAN#85	R5-196247	0092	-	F	Correction to 5.3.2.2.1 and 5.3.3.2.1 TDD FR1 PDCCH 1Tx performance	16.1.0
2019-09	RAN#85	R5-196495	0097	-	F	Updated to Annex A for performance tests	16.1.0
2019-09	RAN#85	R5-196496	0098	-	F	Updated to Annex B for performance tests	16.1.0
2019-09	RAN#85	R5-196498	0100	-	F	Updated to General clauses for Demod and CSI requirements	16.1.0
2019-09	RAN#85	R5-196857	0119	-	F	Corrections to PDSCH demod TCs	16.1.0
2019-09	RAN#85	R5-197370	0086	1	F	Updates to 6.2.2.1.2.1, 2Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	16.1.0
2019-09	RAN#85	R5-197371	0087	1	F	Updates to 6.2.2.2.2.1, 2Rx TDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	16.1.0
2019-09	RAN#85	R5-197372	0125	1	F	Modification of 4Rx FDD FR1 PDSCH mapping Type A performance - 2x4 MIMO with baseline receiver for both SA and NSA	16.1.0
2019-09	RAN#85	R5-197373	0084	1	F	Clean up test cases 5.3.3.1.1, 5.3.3.1.2, 5.3.3.2.1 and 5.3.3.2.2 for 4Rx PDCCH	16.1.0
2019-09	RAN#85	R5-197374	0099	1	F	Updated to General clauses for performance tests	16.1.0
2019-09	RAN#85	R5-197375	0123	1	F	Modification of FDD FR1 2Rx TypeA baseline and TypeX Rxvr	16.1.0
2019-09	RAN#85	R5-197376	0083	1	F	Clean up test cases 5.3.2.2.1 and 5.3.2.2.2 for 2Rx PDCCH	16.1.0
2019-09	RAN#85	R5-197377	0093	1	F	Correction to FR1 FDD PDSCH mapping Type A performance test cases	16.1.0
2019-09	RAN#85	R5-197378	0095	1	F	Correction to MU and TT for FR1 demodulation test cases	16.1.0
2019-09	RAN#85	R5-197379	0096	1	F	Update to 4Rx FDD FR1 PDSCH mapping Type A performance	16.1.0
2019-09	RAN#85	R5-197380	0117	1	F	Update of Annex F to add new CSI test cases	16.1.0
2019-09	RAN#85	R5-197512	0101	1	F	Update to SA SDR test case	16.1.0
2019-09	RAN#85	R5-197513	0102	1	F	Update to NSA SDR test case	16.1.0
2019-09	RAN#85	R5-197566	0127	1	F	Modification on 2Rx TDD FR1 Single PMI with 4Tx Type1 - SinglePanel codebook for both SA and NSA	16.1.0
2019-09	RAN#85	R5-197567	0128	1	F	Introduce 2Rx TDD FR1 Single PMI with 8Tx Type1 - SinglePanel codebook for both SA and NSA	16.1.0
2019-09	RAN#85	R5-197572	0126	1	F	Modification of 4Rx FDD FR1 PDSCH mapping Type A performance - 4x4 MIMO with baseline receiver for both SA and NSA	16.1.0
2019-09	RAN#85	R5-197573	0091	1	F	Correction to 2Rx TDD FR1 PDSCH mapping Type A performance	16.1.0
2019-09	RAN#85	R5-197574	0105	1	F	Update to TDD FR1 2Rx TypeA Baseline and Type X receiver Demod test cases	16.1.0
2019-09	RAN#85	R5-197575	0107	1	F	Editorial and updates to TS 38.521-4 test case 6.3.2.1.1	16.1.0
2019-09	RAN#85	R5-197576	0108	1	F	Updates to TS 38.521-4 test case 6.3.2.1.2	16.1.0
2019-09	RAN#85	R5-197577	0109	1	F	Updates to TS 38.521-4 test case 6.3.3.1.1	16.1.0
2019-09	RAN#85	R5-197578	0110	1	F	Update to TS 38.521-4 test case 6.3.3.1.2	16.1.0
2019-09	RAN#85	R5-197579	0111	1	F	Editorial and update to TS 38.521-4 test case 6.3.3.2.1	16.1.0
2019-09	RAN#85	R5-197580	0112	1	F	Editorial and update to TS 38.521-4 test case 6.3.3.2.2	16.1.0
2019-09	RAN#85	R5-197581	0120	1	F	Correction of PRACH-ConfigurationIndex for TC 5.2.2.2.1_1	16.1.0
2019-09	RAN#85	R5-197582	0122	1	F	Update to RI Reporting Accuracy test	16.1.0

2019-09	RAN#85	R5-197615	0088	1	F	Updates to 6.2.2.1.2.2, 2Rx FDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	16.1.0
2019-09	RAN#85	R5-197616	0089	1	F	Updates to 6.2.2.2.2.2, 2Rx TDD FR1 periodic subband CQI reporting under fading conditions for both SA and NSA	16.1.0
2019-09	RAN#85	R5-197648	0115	2	F	Update to Annex G to restructure minimum test time tables for Demodulation test cases	16.1.0
2019-09	RAN#85	R5-197649	0116	2	F	Update to Annex G to add minimum test time for CSI test cases	16.1.0
2019-12	RAN#86	R5-198248	0141	-	F	Updates to Annex F	16.2.0
2019-12	RAN#86	R5-198281	0142	-	F	Update to FR1 4Rx FDD PDSCH Type A Demodulation performance	16.2.0
2019-12	RAN#86	R5-198395	0151	-	F	Corrections to E-UTRA configurations for EN-DC test cases	16.2.0
2019-12	RAN#86	R5-198407	0152	-	F	Correction to 2Rx FDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	16.2.0
2019-12	RAN#86	R5-198408	0153	-	F	Correction to 2Rx and 4Rx TDD FR1 Single PMI with 4Tx Type1 - SinglePanel codebook for both SA and NSA	16.2.0
2019-12	RAN#86	R5-198409	0154	-	F	Correction to Sections 5.2 and 5.3	16.2.0
2019-12	RAN#86	R5-198560	0157	-	F	Updated to Annex A and B for performance tests	16.2.0
2019-12	RAN#86	R5-198679	0161	-	F	Correction of SchedulingRequestResourceConfig periodicityAndOffset for TC 7.2.2.2.1_1	16.2.0
2019-12	RAN#86	R5-198680	0162	-	F	Include PDSCH RMC for PDCCH demod FR1 test cases	16.2.0
2019-12	RAN#86	R5-199079	0137	2	F	Adding new test case 6.2.3.1.2.1, 4Rx FDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	16.2.0
2019-12	RAN#86	R5-199382	0129	1	F	Addition of 5.2.2.1.3_1 2Rx FDD PDSCH mapping Type B	16.2.0
2019-12	RAN#86	R5-199383	0130	1	F	Addition of NR test case 5.2.3.1.2_1-FDD type A CSI-RS overlap 4x4 MIMO	16.2.0
2019-12	RAN#86	R5-199384	0134	1	F	Addition of NR test case 6.2.3.1.1.1-FDD periodical CQI	16.2.0
2019-12	RAN#86	R5-199385	0136	1	F	Addition of NR test case 6.4.2.1_1-FDD RI reporting	16.2.0
2019-12	RAN#86	R5-199387	0149	1	F	Update to starting MCS index for CQI reporting test cases	16.2.0
2019-12	RAN#86	R5-199388	0145	1	F	Update to Annex G for minimum test time for FR2 Demod test cases	16.2.0
2019-12	RAN#86	R5-199414	0131	1	F	Addition of NR test case 5.2.3.1.3_1-FDD type B 2x4 MIMO	16.2.0
2019-12	RAN#86	R5-199415	0132	1	F	Addition of NR test case 5.2.3.2.2_1-TDD type A CSI-RS overlap 2x4 MIMO	16.2.0
2019-12	RAN#86	R5-199416	0133	1	F	Addition of NR test case 5.2.3.2.3_1-TDD type B 2x4 MIMO	16.2.0
2019-12	RAN#86	R5-199417	0135	1	F	Addition of NR test case 6.2.3.2.1.1-TDD periodical CQI	16.2.0
2019-12	RAN#86	R5-199418	0138	1	F	Adding new test case 6.2.3.1.2.2, 4Rx FDD FR1 aperiodic subband CQI reporting under fading conditions for both SA and NSA	16.2.0
2019-12	RAN#86	R5-199419	0139	1	F	Adding new test case 6.2.3.2.2.1, 4Rx TDD FR1 periodic wideband CQI reporting under fading conditions for both SA and NSA	16.2.0
2019-12	RAN#86	R5-199420	0140	1	F	Adding new test case 6.2.3.2.2.2, 4Rx TDD FR1 aperiodic subband CQI reporting under fading conditions for both SA and NSA	16.2.0
2019-12	RAN#86	R5-199421	0155	1	F	Correction to chapter 5 and 6 to be aligned with core spec	16.2.0
2019-12	RAN#86	R5-199422	0156	1	F	Editorial correction to CSI reporting tests	16.2.0
2019-12	RAN#86	R5-199425	0146	1	F	Update to FR2 2Rx PDSCH Type A enhanced type X receiver test case	16.2.0
2019-12	RAN#86	R5-199516	0160	1	F	Update PrachConfigIndex in 5.2.3.2.1_1 test case	16.2.0
2019-12	RAN#86	R5-199525	0148	1	F	Clarification on PDCP SDU size for SDR SA Demod test case	16.2.0
2019-12	RAN#86	R5-199526	0147	1	F	Clarification on PDCP SDU size for SDR NSA Demod test case	16.2.0
2019-12	RAN#86	R5-199527	0143	1	F	Update to FR2 2Rx PDSCH Type A baseline receiver test case	16.2.0
2019-12	RAN#86	R5-199531	0144	1	F	Annex update for UE positioning procedure for Demod test cases	16.2.0
2019-12	RAN#86	R5-199532	0150	1	F	Update to FR2 PDCCH Demod test case	16.2.0
2019-12	RAN#86	R5-199570	0158	1	F	Introduction of FR2 CQI test cases	16.2.0
2020-03	RAN#87	R5-200271	0165	-	F	Update to Demod TC 5.2.3.2.1_1	16.3.0
2020-03	RAN#87	R5-200322	0166	-	F	CR to 38.521-4 to introduce isolation procedure	16.3.0
2020-03	RAN#87	R5-200450	0168	-	F	Addition of message exceptions for Type2 QCL information	16.3.0
2020-03	RAN#87	R5-201245	0170	1	F	Core alignment to 4Rx PDCCH Demod Test Cases	16.3.0
2020-03	RAN#87	R5-200453	0171	-	F	Correction to FR1 2Rx PDSCH demodulation test cases	16.3.0
2020-03	RAN#87	R5-200454	0172	-	F	Correction to FR1 4Rx PDSCH demodulation test cases	16.3.0
2020-03	RAN#87	R5-200455	0173	-	F	Correction to measurement uncertainty and test tolerance for CQI test cases	16.3.0
2020-03	RAN#87	R5-200456	0174	-	F	Correction to PDCCH demod TCs	16.3.0
2020-03	RAN#87	R5-200660	0175	-	F	Correcting CQI value in test procedure	16.3.0
2020-03	RAN#87	R5-200672	0178	-	F	Updated to Annex A and B for performance tests	16.3.0
2020-03	RAN#87	R5-200682	0179	-	F	Correction to Applicability rules for Performance tests	16.3.0
2020-03	RAN#87	R5-200710	0180	-	F	Update of TC 5.2.2.1.3_1 2Rx FDD PDSCH mapping Type B	16.3.0
2020-03	RAN#87	R5-200711	0181	-	F	Update of TC 5.2.3.1.2_1 4Rx FDD PDSCH mapping Type A and CSI-RS overlapped	16.3.0
2020-03	RAN#87	R5-200712	0182	-	F	Update of TC 5.2.3.1.3_1 4Rx FDD PDSCH mapping Type B	16.3.0

2020-03	RAN#87	R5-200713	0183	-	F	Update of TC 5.2.3.2.2_1 4Rx TDD PDSCH mapping Type A and CSI-RS overlapped	16.3.0
2020-03	RAN#87	R5-200714	0184	-	F	Update of TC 5.2.3.2.3_1 4Rx TDD PDSCH mapping Type B	16.3.0
2020-03	RAN#87	R5-200718	0188	-	F	Update of Test Tolerance in Annex F	16.3.0
2020-03	RAN#87	R5-200729	0189	-	F	Core spec alignment for FR1 4Rx FDD PDSCH Type A Demodulation performance	16.3.0
2020-03	RAN#87	R5-200914	0176	1	F	Correction to test case 8.2.2.2.1.1 2 Rx, TDD FR2 periodic CQI reporting under AWGN performance for both SA and NSA	16.3.0
2020-03	RAN#87	R5-200915	0164	1	F	Update of Clause 4 in TS 38.521-4	16.3.0
2020-03	RAN#87	R5-200985	0169	1	F	Core alignment for FR2 demod test case	16.3.0
2020-03	RAN#87	R5-201068	0187	1	F	Update of TC 6.4.2.1_1 2Rx FDD RI reporting	16.3.0
2020-03	RAN#87	R5-201090	0177	1	F	Replacing derivation paths to 38.331	16.3.0
2020-03	RAN#87	R5-201180	0167	1	F	Addition of FR2 Demod sustained data rate test case	16.3.0
2020-06	RAN#88	R5-201816	0190	-	F	Correction to TC 5.2.3.1.1_4 4Rx FDD FR1 PDSCH mapping Type A performance	16.4.0
2020-06	RAN#88	R5-201945	0191	-	F	Updated to Annex A and B for performance tests	16.4.0
2020-06	RAN#88	R5-202242	0195	-	F	Clarification of propagation condition for Demod test cases during call setup	16.4.0
2020-06	RAN#88	R5-202297	0198	-	F	Correction to 4Rx FDD FR1 periodic CQI reporting under AWGN conditions for both SA and NSA	16.4.0
2020-06	RAN#88	R5-202980	0201	1	F	Correction to CSI reporting test cases missing MIMO correlation matrixes	16.4.0
2020-06	RAN#88	R5-202304	0205	-	F	Correction to FR2 PDCCH demodulation tests	16.4.0
2020-06	RAN#88	R5-202307	0208	-	F	Editorial correction on the table numbers for Minimum Test Time	16.4.0
2020-06	RAN#88	R5-202308	0209	-	F	Editorial correction to 4x4 MIMO PDSCH demodulation tests	16.4.0
2020-06	RAN#88	R5-202736	0197	1	F	Message exception correction for Demod test cases	16.4.0
2020-06	RAN#88	R5-202737	0202	1	F	Correction to FR1 aperiodic subband CQI reporting under fading conditions	16.4.0
2020-06	RAN#88	R5-202738	0203	1	F	Correction to FR1 Single PMI with 8Tx TypeI - SinglePanel codebook for both SA and NSA	16.4.0
2020-06	RAN#88	R5-202739	0207	1	F	Correction to message exception and test description in RI tests	16.4.0
2020-06	RAN#88	R5-202740	0196	1	F	Update to FR2 PDSCH Demod test case	16.4.0
2020-06	RAN#88	R5-202741	0211	1	F	Introduction of 8.4.2.2.1 2Rx TDD FR2 RI reporting for both SA and NSA	16.4.0
2020-06	RAN#88	R5-202742	0210	1	F	Editorial correction to Annex C.2	16.4.0
2020-06	RAN#88	R5-202743	0213	1	F	Update Wireless isolation procedure	16.4.0
2020-06	RAN#88	R5-202766	0212	1	F	Updates of FR2 MU and TT in TS 38.521-4	16.4.0
2020-06	RAN#88	R5-202832	0214	1	F	Addition of message exceptions for PDSCH test cases	16.4.0
2020-06	RAN#88	R5-202908	0193	1	F	Clarification of disabling Tx diversity for FR2 UE for FR2 Demod testing	16.4.0
2020-06	RAN#88	R5-202979	0199	2	F	Correction to 4Rx TDD FR1 RI reporting	16.4.0
2020-06	RAN#88	R5-202981	0204	1	F	Correction to FR2 CQI reporting tests	16.4.0
2020-06	RAN#88	R5-202989	0192	1	F	Updates to 8.2.2.2.2.1, 2Rx TDD FR2 aperiodic CQI reporting under fading performance for both SA and NSA	16.4.0
2020-09	RAN#89	R5-203298	0215	-	F	Activate Test Mode in NSA Demod Test Cases	16.5.0
2020-09	RAN#89	R5-203670	0217	-	F	message contents correction for TC 5.2.3.1.2_1	16.5.0
2020-09	RAN#89	R5-203717	0219	-	F	Correction to TC 5.2.3.1.1_1 4Rx FDD FR1 PDSCH mapping Type A performance	16.5.0
2020-09	RAN#89	R5-203756	0220	-	F	Removing unnecessary IE rbg-Size from message exceptions	16.5.0
2020-09	RAN#89	R5-203902	0221	-	F	Correction to Annex G minimum test time table	16.5.0
2020-09	RAN#89	R5-204062	0226	-	F	Correction to PDSCH reference channel	16.5.0
2020-09	RAN#89	R5-204063	0227	-	F	Correction to 2Rx FDD FR1 periodic wideband CQI reporting under fading conditions	16.5.0
2020-09	RAN#89	R5-204064	0228	-	F	Correction to LTE-NR coexistence performance	16.5.0
2020-09	RAN#89	R5-204100	0232	-	F	Update to common test parameters and channel mappings	16.5.0
2020-09	RAN#89	R5-204101	0233	-	F	Update E-UTRA cell configuration for NSA	16.5.0
2020-09	RAN#89	R5-204261	0235	-	F	Editorial correction of message exceptions	16.5.0
2020-09	RAN#89	R5-204774	0223	1	F	Test applicability update for all PDSCH mapping type B test cases	16.5.0
2020-09	RAN#89	R5-204870	0222	1	F	Addition of FR1 2Rx TDD PDSCH mapping type B test case	16.5.0
2020-09	RAN#89	R5-204871	0224	1	F	Addition of 4Rx FDD FR1 RI reporting test case	16.5.0
2020-09	RAN#89	R5-204933	0229	1	F	CR to update MU and TT in 38.521-4	16.5.0
2020-09	RAN#89	R5-204934	0225	1	F	Correction to frequencyDomainAllocation	16.5.0
2020-09	RAN#89	R5-204935	0230	1	F	Correction to MU and TT for FR1 PMI and RI tests	16.5.0
2020-09	RAN#89	R5-204936	0218	1	F	Update to FR2 PDSCH test case	16.5.0
2020-09	RAN#89	R5-204937	0216	1	F	Annex F Update of MU and TT for FR2 PDSCH and PDCCH Demodulation scenario	16.5.0
2020-09	RAN#89	R5-204938	0236	1	F	Update of AWGN flatness in TS 38.521-4	16.5.0
2020-12	RAN#90	R5-205920	0243	-	F	Introduction of new test case for FR2 CA PDSCH Demodulation	16.6.0
2020-12	RAN#90	R5-205925	0247	-	F	Update to FDD LTE-NR coexistence test case	16.6.0
2020-12	RAN#90	R5-206090	0248	-	F	Correction to 5.2.2.1.4_1 LTE NR coexistence performance	16.6.0
2020-12	RAN#90	R5-206091	0249	-	F	Correction to 9.4B.1.1 Sustained downlink data rate performance for EN-DC within FR1	16.6.0

2020-12	RAN#90	R5-206092	0250	-	F	Core alignment to FR1 and FR2 CSI test cases	16.6.0
2020-12	RAN#90	R5-206093	0251	-	F	Clean up on FR2 CQI and RI test cases	16.6.0
2020-12	RAN#90	R5-206094	0252	-	F	Clean up on FR1 RI test cases	16.6.0
2020-12	RAN#90	R5-206097	0255	-	F	Correction to incorrect parameter settings for subband CQI tests	16.6.0
2020-12	RAN#90	R5-206098	0256	-	F	Correction to Message contents for Sustained downlink data rate tests	16.6.0
2020-12	RAN#90	R5-206163	0259	-	F	Correction in message content of 5.2.2.2.1_1, 5.2.3.2.1_1 test cases	16.6.0
2020-12	RAN#90	R5-206165	0260	-	F	Update on TB success rate definition in Sustain data rate test cases	16.6.0
2020-12	RAN#90	R5-206208	0262	-	F	Editorial update of uplink signals	16.6.0
2020-12	RAN#90	R5-206666	0237	1	F	Update of LTE-NR coexistence performance test case 5.2.2.1.4	16.6.0
2020-12	RAN#90	R5-206667	0238	1	F	Update of LTE-NR coexistence performance test case 5.2.3.1.4	16.6.0
2020-12	RAN#90	R5-206668	0253	1	F	Correction to number of CQI and HARQ in CQI TCs under fading	16.6.0
2020-12	RAN#90	R5-206669	0254	1	F	Correction to FR1 periodic wideband CQI reporting under fading conditions	16.6.0
2020-12	RAN#90	R5-206670	0258	1	F	Correction of CSI-IM periodicity and offset in 4RX FDD wideband CQI under fading condition	16.6.0
2020-12	RAN#90	R5-206671	0240	1	F	Update to OCNG definition in DEMOD spec	16.6.0
2020-12	RAN#90	R5-206775	0239	1	F	Addition of test case 5.2.2.2.4_1 2Rx TDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x2 MIMO with baseline receiver for both SA and NSA	16.6.0
2020-12	RAN#90	R5-206776	0241	1	F	Applicability rules for section 5 CA Demodulation requirements	16.6.0
2020-12	RAN#90	R5-206777	0242	1	F	Applicability rules for section 7 CA Demodulation requirements	16.6.0
2020-12	RAN#90	R5-206829	0263	1	F	Update of Annex F	16.6.0
2020-12	RAN#90	R5-206830	0244	1	F	Update to FR2 PDSCH Demodulation test case	16.6.0
2020-12	RAN#90	R5-206831	0245	1	F	Update to FR2 PDCCH Demodulation test case	16.6.0
2020-12	RAN#90	R5-206832	0246	1	F	Update to FR2 CQI reporting under AWGN test case	16.6.0
2020-12	RAN#90	R5-206833	0261	1	F	CR on MU and testability limit for FR2 demod test case	16.6.0
2021-03	RAN#91	R5-210520	0275	-	F	Correction to SR config for TDD PDSCH Type A performance test cases	16.7.0
2021-03	RAN#91	R5-210521	0276	-	F	Correction to test applicability for LTE-NR coexistence performance test cases	16.7.0
2021-03	RAN#91	R5-210522	0277	-	F	Correction to wideband CQI reporting under fading test cases	16.7.0
2021-03	RAN#91	R5-210523	0278	-	F	Addition of 8.3.2.2.1 2Rx TDD FR2 Single PMI with 2TX TypeI-SinglePanel Codebook	16.7.0
2021-03	RAN#91	R5-210770	0282	-	F	Update message content in test case 7.3.2.2.2	16.7.0
2021-03	RAN#91	R5-210773	0283	-	F	Correction in 6.4.2.1_1 test requirements	16.7.0
2021-03	RAN#91	R5-210868	0284	-	F	Correction to Table F.1.1.2-2 for FR1 test cases	16.7.0
2021-03	RAN#91	R5-210869	0285	-	F	Correction to Test Purpose of PDCCH test cases	16.7.0
2021-03	RAN#91	R5-210993	0288	-	F	Editorial, cleanup of some references in 38.521-4	16.7.0
2021-03	RAN#91	R5-211050	0289	-	F	Updating applicability in test case 5.2.2.2.4_1	16.7.0
2021-03	RAN#91	R5-211081	0293	-	F	Update to downlink physical channel EPRE level for LTE-NR coex scenario	16.7.0
2021-03	RAN#91	R5-211086	0296	-	F	Adding new CSI test cases to annex F	16.7.0
2021-03	RAN#91	R5-211658	0297	1	F	Addition of new test case 6.3.2.1.3 2Rx FDD FR1 Multiple PMI with 16Tx Type1 - SinglePanel codebook for both SA and NSA	16.7.0
2021-03	RAN#91	R5-211659	0298	1	F	Addition of new test case 6.3.3.1.3 4Rx FDD FR1 Multiple PMI with 16Tx Type1 - SinglePanel codebook for both SA and NSA	16.7.0
2021-03	RAN#91	R5-211716	0280	1	F	Correction to DCI bit size for PDSCH Type B performance and LTE coexistence tests	16.7.0
2021-03	RAN#91	R5-211717	0281	1	F	Correction to LB setup DRB in CLOSE UE TEST LOOP message	16.7.0
2021-03	RAN#91	R5-211718	0286	1	F	Correction to NR test case 6.2.2.1.2.1	16.7.0
2021-03	RAN#91	R5-211719	0273	1	F	Correction to E-UTRA link setup for NSA testing	16.7.0
2021-03	RAN#91	R5-211813	0290	1	F	Adding new test case 6.3.2.2.3, 2Rx TDD FR1 Single PMI with 16Tx Type1 - SinglePanel codebook for both SA and NSA	16.7.0
2021-03	RAN#91	R5-211814	0292	1	F	Adding new test case 6.3.3.2.3, 4Rx TDD FR1 Single PMI with 16Tx Type1 - SinglePanel codebook for both SA and NSA	16.7.0
2021-03	RAN#91	R5-211816	0274	1	F	Update of minimum conformance requirements for 4Rx FDD FR1 PDSCH in TC 5.2.3.1.1_1	16.7.0
2021-03	RAN#91	R5-211817	0265	1	F	Addition of Applicability of different requirements for R16 NR HST in 5.1.1.7	16.7.0
2021-03	RAN#91	R5-211818	0268	1	F	Update of Applicability of requirements for mandatory UE features with capability signalling for R16 NR HST in 5.1.1.4	16.7.0
2021-03	RAN#91	R5-211819	0269	1	F	Update of Applicability of requirements for optional UE features for R16 NR HST in 5.1.1.3	16.7.0
2021-03	RAN#91	R5-211820	0264	1	F	Addition of Abbreviations and References for R16 NR HST in 3.3 and References	16.7.0
2021-03	RAN#91	R5-211821	0266	1	F	Addition of HST-DPS Channel Profile in B.3.3	16.7.0
2021-03	RAN#91	R5-211822	0267	1	F	Addition of HST-SFN Channel Profile in B.3.2	16.7.0
2021-03	RAN#91	R5-211823	0270	1	F	Update of Combinations of channel model parameters for R16 NR HST in B.2.2	16.7.0

2021-03	RAN#91	R5-211824	0271	1	F	Update of Reference measurement channels for PDSCH performance requirements for R16 NR HST in A.3.2	16.7.0
2021-03	RAN#91	R5-211825	0272	1	F	Update of Single Tap Channel Profile for R16 NR HST in B.3.1	16.7.0
2021-03	RAN#91	R5-211916	0291	1	F	Adding new test case 6.3.2.2.4, 2Rx TDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	16.7.0
2021-03	RAN#91	R5-211929	0299	1	F	Update of FR2 demod test cases	16.7.0
2021-06	RAN#92	R5-212063	0301	-	F	Addition of test applicability rules for UE supporting FR2 DL 256QAM	16.8.0
2021-06	RAN#92	R5-212064	0302	-	F	Updating on annexes for FR2 DL 256QAM test cases	16.8.0
2021-06	RAN#92	R5-212067	0303	-	F	Addition of new test case 6.3.2.1.4 2Rx FDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	16.8.0
2021-06	RAN#92	R5-212068	0304	-	F	Addition of new test case 6.3.3.1.4 4Rx FDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	16.8.0
2021-06	RAN#92	R5-212254	0308	-	F	Update MU and TT for 8.4.2.2.1	16.8.0
2021-06	RAN#92	R5-212632	0311	-	F	Correction of E-UTRA link settings	16.8.0
2021-06	RAN#92	R5-212635	0312	-	F	Correction of DL RMC for TC 5.2.3.1.4_1	16.8.0
2021-06	RAN#92	R5-212743	0314	-	F	Update to Demod test cases title	16.8.0
2021-06	RAN#92	R5-212933	0315	-	F	Addition of eMIMO demod test case 5.2.2.1.11	16.8.0
2021-06	RAN#92	R5-212934	0316	-	F	Addition of eMIMO demod test case 5.2.2.2.11	16.8.0
2021-06	RAN#92	R5-212935	0317	-	F	Addition of eMIMO demod test case 5.2.3.1.11	16.8.0
2021-06	RAN#92	R5-212936	0318	-	F	Addition of eMIMO demod test case 5.2.3.2.11	16.8.0
2021-06	RAN#92	R5-212937	0319	-	F	Adding FRC for eMIMO demod test cases	16.8.0
2021-06	RAN#92	R5-212977	0327	-	F	Updating G.1.2 for performance testing	16.8.0
2021-06	RAN#92	R5-213306	0328	-	F	Introduction of additional PDSCH RMC for FDD	16.8.0
2021-06	RAN#92	R5-213308	0329	-	F	Update of message exceptions in FR2 demod test cases	16.8.0
2021-06	RAN#92	R5-213341	0330	-	F	Message content update in 5.2.2.2.1_1 and 5.2.3.2.1_1 test 1-9	16.8.0
2021-06	RAN#92	R5-213342	0331	-	F	Message content update in SA LTE-NR coexistence test cases	16.8.0
2021-06	RAN#92	R5-213358	0334	-	F	Addition of FR1 PDSCH Demodulation CA with power imbalance test case	16.8.0
2021-06	RAN#92	R5-213919	0313	1	F	Correction of derivation paths to 38.508-1	16.8.0
2021-06	RAN#92	R5-213920	0332	1	F	TT update to FR2 CQI reporting under fading test case	16.8.0
2021-06	RAN#92	R5-214012	0326	1	F	Adding 256QAM into CQI reporting test case	16.8.0
2021-06	RAN#92	R5-214016	0325	1	F	Adding FRC for URLLC demod test cases	16.8.0
2021-06	RAN#92	R5-214058	0300	1	F	Update of FR2 demod test cases	16.8.0
2021-06	RAN#92	R5-214059	0310	1	F	Correction to TC 9.4B.1.1-SDR performance	16.8.0
2021-06	RAN#92	R5-214088	0307	1	F	Update to minimum test time	16.8.0
2021-06	RAN#92	R5-214098	0333	1	F	Addition of FR1 normal PDSCH demodulation CA test case for 2CC	16.8.0
2021-06	RAN#92	R5-214099	0320	1	F	Addition of URLLC demod test case 5.2.2.1.5	16.8.0
2021-06	RAN#92	R5-214100	0321	1	F	Addition of URLLC demod test case 5.2.2.2.5	16.8.0
2021-06	RAN#92	R5-214101	0322	1	F	Addition of URLLC demod test case 5.2.3.1.5	16.8.0
2021-06	RAN#92	R5-214102	0323	1	F	Addition of URLLC demod test case 5.2.3.2.5	16.8.0
2021-06	RAN#92	R5-214103	0324	1	F	Adding MU and TT for URLLC demod test cases	16.8.0
2021-06	RAN#92	R5-214112	0306	1	F	Core alignment of common test parameters for PDCCH demodulation tests	16.8.0
2021-09	RAN#93	R5-214533	0338	-	F	Updates on FRC for FR2 DL 256QAM	16.9.0
2021-09	RAN#93	R5-215065	0353	-	F	Core spec alignment of RMC	16.9.0
2021-09	RAN#93	R5-215084	0357	-	F	Addition of eMIMO demod test case 5.2.2.2.12	16.9.0
2021-09	RAN#93	R5-215085	0358	-	F	Addition of eMIMO demod test case 5.2.2.2.13	16.9.0
2021-09	RAN#93	R5-215090	0363	-	F	Addition of eMIMO demod test case 5.2.3.2.12	16.9.0
2021-09	RAN#93	R5-215091	0364	-	F	Addition of eMIMO demod test case 5.2.3.2.13	16.9.0
2021-09	RAN#93	R5-215092	0365	-	F	Addition of eMIMO demod test case 5.2.3.2.14	16.9.0
2021-09	RAN#93	R5-215093	0366	-	F	Adding FRC for eMIMO demod test cases	16.9.0
2021-09	RAN#93	R5-215094	0367	-	F	Adding MU and TT for eMIMO demod test cases	16.9.0
2021-09	RAN#93	R5-215103	0372	-	F	Addition of URLLC demod test case 5.2.3.2.7	16.9.0
2021-09	RAN#93	R5-215342	0380	-	F	Correction to reporting granularity for single PMI TCs	16.9.0
2021-09	RAN#93	R5-215343	0381	-	F	Correction to test time for measuring CQI in Sub-band CQI TCs	16.9.0
2021-09	RAN#93	R5-215345	0383	-	F	Correction to DCI bitlength for test 1-5 and 1-6 in TC 5.2.2.2.1_1 and 5.2.3.2.1_1	16.9.0
2021-09	RAN#93	R5-215470	0387	-	F	Correction of message exceptions in PDCCH test cases	16.9.0
2021-09	RAN#93	R5-215609	0390	-	F	MTSU and TT mapping related to Max Device Size in TS 38.521-4	16.9.0
2021-09	RAN#93	R5-215610	0391	-	F	Update 9.4B.1.1 message content	16.9.0
2021-09	RAN#93	R5-215663	0394	-	F	Updates to FR1 2DLCA PDSCH demodulation with power imbalance test case	16.9.0
2021-09	RAN#93	R5-215665	0396	-	F	Editorial correction to the section 6.2.2.2.2 title	16.9.0
2021-09	RAN#93	R5-215666	0397	-	F	Update to test coverage across 5G NR architecture options for Demod scenarios	16.9.0
2021-09	RAN#93	R5-215901	0346	1	F	Update FR2 RI test configuration update for TS 38.521-4	16.9.0
2021-09	RAN#93	R5-215902	0382	1	F	Editorial error correction in Section 7 and 8	16.9.0
2021-09	RAN#93	R5-215934	0360	1	F	Addition of eMIMO demod test case 5.2.3.1.12	16.9.0
2021-09	RAN#93	R5-215937	0343	1	F	Update of Annex F for test cases of demodulation for power	16.9.0

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2021-09	RAN#93	R5-215942	0339	1	F	Updates to PDSCH Demodulation Performance for 2DL CA	16.9.0
2021-09	RAN#93	R5-215944	0345	1	F	Update Applicability of requirement for HST-DPS and multi-TRxP test cases	16.9.0
2021-09	RAN#93	R5-215946	0350	1	F	Addition of NR HST Demod TC 5.2.2.1.9 - HST SFN	16.9.0
2021-09	RAN#93	R5-215947	0351	1	F	Addition of NR HST Demod TC 5.2.2.1.10 - HST DPS	16.9.0
2021-09	RAN#93	R5-215950	0368	1	F	Completing CQI reporting test case with 256QAM	16.9.0
2021-09	RAN#93	R5-215952	0369	1	F	Addition of URLLC demod test case 5.2.2.1.7	16.9.0
2021-09	RAN#93	R5-215953	0370	1	F	Addition of URLLC demod test case 5.2.2.2.7	16.9.0
2021-09	RAN#93	R5-215954	0374	1	F	Addition of 5.2.2.1.6 2Rx FDD FR1 PDSCH repetitions over multiple slots performance	16.9.0
2021-09	RAN#93	R5-215955	0375	1	F	Addition of 5.2.2.1.8 2Rx FDD FR1 PDSCH pre-emption performance	16.9.0
2021-09	RAN#93	R5-215956	0376	1	F	Addition of 5.2.2.2.6 2Rx TDD FR1 PDSCH repetitions over multiple slots performance	16.9.0
2021-09	RAN#93	R5-215957	0377	1	F	Addition of 5.2.2.2.8 2Rx TDD FR1 PDSCH pre-emption performance	16.9.0
2021-09	RAN#93	R5-215958	0378	1	F	Addition of 5.2.3.1.6 4Rx FDD FR1 PDSCH repetitions over multiple slots performance	16.9.0
2021-09	RAN#93	R5-215959	0379	1	F	Addition of 5.2.3.2.6 4Rx TDD FR1 PDSCH repetitions over multiple slots performance	16.9.0
2021-09	RAN#93	R5-216021	0385	1	F	Clean-up of parameter settings and message contents in 8.4.2.2.1	16.9.0
2021-09	RAN#93	R5-216040	0384	1	F	Correction to dedicated CORESET ID setting in PDCCH-Config for Standalone	16.9.0
2021-09	RAN#93	R5-216041	0388	1	F	Update of message exceptions	16.9.0
2021-09	RAN#93	R5-216071	0359	1	F	Addition of eMIMO demod test case 5.2.2.2.14	16.9.0
2021-09	RAN#93	R5-216072	0340	1	F	Addition of 2Rx TDD FR1 PDCCH 1 Tx antenna performance for power saving test case	16.9.0
2021-09	RAN#93	R5-216073	0341	1	F	Addition of 4Rx TDD FR1 PDCCH 1 Tx antenna performance for power saving test case	16.9.0
2021-09	RAN#93	R5-216074	0342	1	F	Addition of 2Rx TDD FR2 PDCCH 1 Tx antenna performance for power saving test case	16.9.0
2021-09	RAN#93	R5-216075	0395	1	F	Updates to FR2 2DLCA PDSCH demodulation test case	16.9.0
2021-09	RAN#93	R5-216076	0337	1	F	Addition of FR2 DL 256QAM demodulation test case	16.9.0
2021-09	RAN#93	R5-216078	0371	1	F	Addition of URLLC demod test case 5.2.3.1.7	16.9.0
2021-09	RAN#93	R5-216096	0336	1	F	Update of FR2 demod test cases	16.9.0
2021-09	RAN#93	R5-216112	0347	1	F	Addition of NR PS Demod TC 5.3.2.1.3-FR1 FDD 2Rx	16.9.0
2021-09	RAN#93	R5-216113	0348	1	F	Addition of NR PS Demod TC 5.3.3.1.3-FR1 FDD 4Rx	16.9.0
2021-09	RAN#93	R5-216118	0392	1	F	Update to FR2 NSA SDR TC 9.4B.1.2	16.9.0
2021-09	RAN#93	R5-216126	0354	1	F	Addition of eMIMO demod test case 5.2.2.1.12	16.9.0
2021-09	RAN#93	R5-216127	0355	1	F	Addition of eMIMO demod test case 5.2.2.1.13	16.9.0
2021-09	RAN#93	R5-216128	0356	1	F	Addition of eMIMO demod test case 5.2.2.1.14	16.9.0
2021-09	RAN#93	R5-216129	0361	1	F	Addition of eMIMO demod test case 5.2.3.1.13	16.9.0
2021-09	RAN#93	R5-216130	0362	1	F	Addition of eMIMO demod test case 5.2.3.1.14	16.9.0
2021-12	RAN#94	R5-216786	0403	-	F	Addition of applicability of different requirements with Multi-TRxP	16.10.0
2021-12	RAN#94	R5-216787	0404	-	F	Update Applicability of requirements for optional UE features	16.10.0
2021-12	RAN#94	R5-216908	0407	-	F	Addition of NR HST Demod TC 5.2.2.1.1_1 - 2Rx FDD type A	16.10.0
2021-12	RAN#94	R5-216909	0408	-	F	Addition of NR HST Demod TC 5.2.2.2.1_1 - 2Rx TDD type A	16.10.0
2021-12	RAN#94	R5-216910	0409	-	F	Correction to NR HST Demod TC 5.2.2.1.9_1 - HST-SFN	16.10.0
2021-12	RAN#94	R5-217059	0412	-	F	Correction to NR TC 5.3.2.1.1-2Rx FDD FR1 PDCCH 1 Tx antenna performance	16.10.0
2021-12	RAN#94	R5-217060	0413	-	F	Correction to NR TC 5.3.3.2.1-PDCCH 1 Tx antenna performance	16.10.0
2021-12	RAN#94	R5-217363	0430	-	F	Addition of RMC in Annex A for eMIMO enhanced typeII CSI reporting	16.10.0
2021-12	RAN#94	R5-217364	0431	-	F	Addition of B.2.3.2.3A Beam steering approach with dual cluster beams	16.10.0
2021-12	RAN#94	R5-217370	0434	-	F	Updating 5.2.x.y.7 PDSCH with UE processing capability 2	16.10.0
2021-12	RAN#94	R5-217375	0439	-	F	Update to Annex F for URLLC test cases	16.10.0
2021-12	RAN#94	R5-217377	0441	-	F	Update to applicability of optional features for URLLC test cases	16.10.0
2021-12	RAN#94	R5-217378	0442	-	F	Update to URLLC RMC for demodulation testing in Annex A	16.10.0
2021-12	RAN#94	R5-217437	0443	-	F	Correction to frequencyDomainResources in PDCCHConfigCommon message exception	16.10.0
2021-12	RAN#94	R5-217522	0446	-	F	Addition of DL and UL RMC for FR2 SDR test case	16.10.0
2021-12	RAN#94	R5-217525	0449	-	F	Updates to FR1 normal PDSCH CA test cases	16.10.0
2021-12	RAN#94	R5-217526	0450	-	F	Updates to FR2 normal PDSCH CA test cases	16.10.0
2021-12	RAN#94	R5-218248	0424	1	F	Updating minimum test time in Annex G	16.10.0
2021-12	RAN#94	R5-218308	0425	1	F	Addition of 6.3.2.1.6 2Rx FDD FR1 Multiple PMI with 16Tx Enhanced Type II codebook	16.10.0
2021-12	RAN#94	R5-218309	0426	1	F	Addition of 6.3.2.2.6 2Rx TDD FR1 Multiple PMI with 16Tx Enhanced Type II codebook	16.10.0
2021-12	RAN#94	R5-218310	0427	1	F	Addition of 6.3.3.1.6 4Rx FDD FR1 Multiple PMI with 16Tx	16.10.0

						Enhanced Type II codebook	
2021-12	RAN#94	R5-218311	0428	1	F	Addition of 6.3.3.2.6 4Rx TDD FR1 Multiple PMI with 16Tx Enhanced Type II codebook	16.10.0
2021-12	RAN#94	R5-218312	0429	1	F	Addition of applicability of optional features in 6.1.1.3	16.10.0
2021-12	RAN#94	R5-218328	0405	1	F	Correction to PS Demod TC 5.3.2.1.3 - 2Rx	16.10.0
2021-12	RAN#94	R5-218329	0406	1	F	Correction to PS Demod TC 5.3.3.1.3 - 4Rx	16.10.0
2021-12	RAN#94	R5-218339	0420	1	F	Addition of new test case 6.3.2.1.5 2Rx FDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	16.10.0
2021-12	RAN#94	R5-218340	0421	1	F	Addition of new test case 6.3.2.2.5 2Rx TDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	16.10.0
2021-12	RAN#94	R5-218341	0422	1	F	Addition of new test case 6.3.3.1.5 4Rx FDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	16.10.0
2021-12	RAN#94	R5-218342	0423	1	F	Addition of new test case 6.3.3.2.5 4Rx TDD FR1 Multiple PMI with 16Tx TypeII codebook for both SA and NSA	16.10.0
2021-12	RAN#94	R5-218343	0444	1	F	Correction to TC 5.2.2.2.4_1 and editorial corrections	16.10.0
2021-12	RAN#94	R5-218344	0447	1	F	Addition of NE-DC SDR test case	16.10.0
2021-12	RAN#94	R5-218345	0399	1	F	Addition of new test case 5.2.3.1.9_1 for NR HST	16.10.0
2021-12	RAN#94	R5-218346	0400	1	F	Addition of new test case 5.2.3.1.10_1 for NR HST	16.10.0
2021-12	RAN#94	R5-218347	0414	1	F	Addition of test case 5.2.2.2.9_1, 2Rx TDD FR1 HST-SFN performance - 2x2 MIMO with baseline receiver for both SA and NSA	16.10.0
2021-12	RAN#94	R5-218348	0415	1	F	Addition of test case 5.2.2.2.10_1, 2Rx TDD FR1 HST-DPS performance - 2x2 MIMO with baseline receiver for both SA and NSA	16.10.0
2021-12	RAN#94	R5-218349	0416	1	F	Addition of test case 5.2.3.2.9_1, 4Rx TDD FR1 HST-SFN performance - 2x4 MIMO with baseline receiver for both SA and NSA	16.10.0
2021-12	RAN#94	R5-218350	0418	1	F	Addition of test cases 5.2.2.2.9_1, 5.2.2.2.10_1, 5.2.3.2.9_1 to annex F	16.10.0
2021-12	RAN#94	R5-218357	0419	1	F	Update of URLLC demodulation Test Cases	16.10.0
2021-12	RAN#94	R5-218358	0433	1	F	Updating 5.2.x.y.5 PDSCH with 1e-5 BLER	16.10.0
2021-12	RAN#94	R5-218359	0435	1	F	Addition of 6.2.2.1.1.2 URLLC 2RX FDD CQI reporting test case	16.10.0
2021-12	RAN#94	R5-218360	0440	1	F	Addition of statistical testing limit for URLLC test cases in Annex G	16.10.0
2021-12	RAN#94	R5-218436	0453	1	F	Update to LTE-NR coex test case message exception	16.10.0
2021-12	RAN#94	R5-218462	0432	1	F	Addition of MU and TT in Annex F for enhanced typeII CSI reporting	16.10.0
2021-12	RAN#94	R5-218465	0401	1	F	Addition of PDCCH Search Space Ext configuration for power saving test case	16.10.0
2021-12	RAN#94	R5-218466	0417	1	F	Update of test case 5.2.3.2.1_1, 4Rx TDD FR1 PDSCH mapping Type A performance - 2x4 MIMO with baseline receiver for both SA and NSA	16.10.0
2021-12	RAN#94	R5-218467	0436	1	F	Addition of 6.2.2.2.1.2 URLLC 2RX TDD CQI reporting test case	16.10.0
2021-12	RAN#94	R5-218468	0437	1	F	Addition of 6.2.3.1.1.2 URLLC 4RX FDD CQI reporting test case	16.10.0
2021-12	RAN#94	R5-218469	0438	1	F	Addition of 6.2.3.2.1.2 URLLC 4RX TDD CQI reporting test case	16.10.0
2021-12	RAN#94	R5-218486	0445	1	F	Clarification on cl 4.6 test coverage across 5G NR architecture options for Demod	16.10.0
2022-03	RAN#95	R5-220276	0454	-	F	Clarifications on 5G NR connectivity options for Demod	16.11.0
2022-03	RAN#95	R5-220629	0460	-	F	Correction to demod TC 5.2.2.1.4_1	16.11.0
2022-03	RAN#95	R5-220630	0461	-	F	Correction to demod TC 5.2.3.2.1_1	16.11.0
2022-03	RAN#95	R5-220634	0463	-	F	Updates to HST test case 5.2.3.1.9_1	16.11.0
2022-03	RAN#95	R5-220635	0464	-	F	Updates to HST test case 5.2.3.1.10_1	16.11.0
2022-03	RAN#95	R5-220638	0467	-	F	Addition of fading profile power uncertainty for 4Tx, FR1	16.11.0
2022-03	RAN#95	R5-220651	0468	-	F	Editorial correction for test case title in Annex F	16.11.0
2022-03	RAN#95	R5-220664	0469	-	F	Editorial change for the position of clause 5.2.3.1.9 and 5.2.3.1.10	16.11.0
2022-03	RAN#95	R5-220678	0471	-	F	Correcting applicability part of HST test cases in 38.521-4	16.11.0
2022-03	RAN#95	R5-220684	0473	-	F	Addition of new RMCs to Annex	16.11.0
2022-03	RAN#95	R5-220686	0475	-	F	Correcting test applicability for EN-DC, rel-16 to rel-15	16.11.0
2022-03	RAN#95	R5-220751	0476	-	F	Correction to PS Demod TC 5.3.2.1.3	16.11.0
2022-03	RAN#95	R5-220764	0477	-	F	Updating test case 6.3.2.2.3, 2Rx TDD FR1 Single PMI with 16Tx Type1 - SinglePanel codebook for both SA and NSA	16.11.0
2022-03	RAN#95	R5-220796	0478	-	F	Update to eMIMO demod test cases	16.11.0
2022-03	RAN#95	R5-220820	0487	-	F	Adding testability description of 7.2.2.2.2 and 7.2.2.2.3	16.11.0
2022-03	RAN#95	R5-220936	0493	-	F	Editorial correction to 5.3.3.1.3 and 5.3.3.2.3	16.11.0
2022-03	RAN#95	R5-221153	0494	-	F	Update to FR1 CA normal PDSCH test cases	16.11.0
2022-03	RAN#95	R5-221154	0495	-	F	Update to FR1 CA power imbalance test cases	16.11.0
2022-03	RAN#95	R5-221155	0496	-	F	Update to FR2 CA normal PDSCH test cases	16.11.0
2022-03	RAN#95	R5-221707	0499	1	F	Editorial update to PBCH demod requirements section	16.11.0
2022-03	RAN#95	R5-221708	0500	1	F	Update to testability of test requirements due to achievable SNR improvements	16.11.0
2022-03	RAN#95	R5-221709	0501	1	F	FR1 NSA SDR message contents update	16.11.0
2022-03	RAN#95	R5-221710	0491	1	F	Correction to Annex H.1.2	16.11.0

2022-03	RAN#95	R5-221842	0455	1	F	Correction on Type I PMI test cases	16.11.0
2022-03	RAN#95	R5-221843	0456	1	F	Addition of FR1 CA CQI test cases	16.11.0
2022-03	RAN#95	R5-221844	0457	1	F	Addition of applicability for FR1 CA CQI test requirements	16.11.0
2022-03	RAN#95	R5-221845	0474	1	F	Addition of test case 5.2.3.2.4_1, 4Rx TDD FR1 PDSCH Mapping Type A and LTE-NR coexistence performance - 4x4 MIMO with baseline receiver for both SA and NSA	16.11.0
2022-03	RAN#95	R5-221846	0497	1	F	Introduction of FR1 CA SDR test case	16.11.0
2022-03	RAN#95	R5-221847	0458	1	F	Addition of FR2 CA CQI test cases	16.11.0
2022-03	RAN#95	R5-221848	0459	1	F	Addition of applicability for FR2 CA CQI test requirements	16.11.0
2022-03	RAN#95	R5-221854	0470	1	F	Addition of test case 5.2.3.2.10_1, 4Rx TDD FR1 HST DPS performance - 2x4 MIMO with baseline receiver for both SA and NSA	16.11.0
2022-03	RAN#95	R5-221855	0502	1	F	Update to HST Demod test cases	16.11.0
2022-03	RAN#95	R5-221856	0465	1	F	Addition of HST test case 5.2.3.1.9_1 to annex F	16.11.0
2022-03	RAN#95	R5-221857	0466	1	F	Addition of HST test case 5.2.3.1.10_1 to annex F	16.11.0
2022-03	RAN#95	R5-221860	0480	1	F	Update to 5.2.x.y.5 PDSCH with 1e-5 BLER	16.11.0
2022-03	RAN#95	R5-221861	0481	1	F	Update to 5.2.x.y.6 PDSCH with repetitions over multiple slots	16.11.0
2022-03	RAN#95	R5-221862	0483	1	F	Update to 5.2.2.y.8 PDSCH pre-emption	16.11.0
2022-03	RAN#95	R5-221863	0484	1	F	Addition of 5.2.3.1.8 PDSCH pre-emption 4Rx FDD	16.11.0
2022-03	RAN#95	R5-221864	0485	1	F	Addition of 5.2.3.2.8 PDSCH pre-emption 4Rx TDD	16.11.0
2022-03	RAN#95	R5-221865	0488	1	F	Addition of 7.2.2.2.2 FR2 PDSCH repetition	16.11.0
2022-03	RAN#95	R5-221866	0489	1	F	Addition of 7.2.2.2.3 FR2 PDSCH mapping Type B	16.11.0
2022-03	RAN#95	R5-221867	0479	1	F	Addition of minimum test time for 1% residual BLER	16.11.0
2022-03	RAN#95	R5-221868	0486	1	F	Update to Annex F for URLLC test cases	16.11.0
2022-06	RAN#96	R5-222231	0503	-	F	Update of Demod TC 5.2.2.1.9_1 2Rx FDD FR1 HST-SFN performance	16.12.0
2022-06	RAN#96	R5-222232	0504	-	F	Update of Demod TC 5.2.3.1.1_1 4Rx FDD FR1 PDSCH mapping Type A perf for NR HST	16.12.0
2022-06	RAN#96	R5-222233	0505	-	F	Update of Demod TC 5.2.3.1.9_1 4Rx FDD FR1 HST-SFN performance	16.12.0
2022-06	RAN#96	R5-222234	0506	-	F	Update of Demod TC 5.2.3.1.10_1 4Rx FDD FR1 HST-DPS performance	16.12.0
2022-06	RAN#96	R5-222498	0509	-	F	Correction to k0 value description	16.12.0
2022-06	RAN#96	R5-222499	0510	-	F	Correction to coreset RB in 5.3.2.1.3 and 5.3.3.1.3	16.12.0
2022-06	RAN#96	R5-222585	0519	-	F	Update to FR1 CA SDR test case	16.12.0
2022-06	RAN#96	R5-222595	0524	-	F	Correction to demod test case procedure	16.12.0
2022-06	RAN#96	R5-222619	0525	-	F	Addition of NR SL Demod TC 11.1.2 - PSSCH	16.12.0
2022-06	RAN#96	R5-222620	0526	-	F	Addition of NR SL Demod TC 11.1.3 - PSCCH	16.12.0
2022-06	RAN#96	R5-222621	0527	-	F	Addition of NR SL Demod TC 11.1.4 - PSBCH	16.12.0
2022-06	RAN#96	R5-222622	0528	-	F	Addition of NR SL Demod TC 11.1.5 - PSFCH	16.12.0
2022-06	RAN#96	R5-222623	0529	-	F	Addition of NR SL Demod TC 11.1.6 - imbalance	16.12.0
2022-06	RAN#96	R5-222624	0530	-	F	Addition of NR SL Demod TC 11.1.7 - soft buffer	16.12.0
2022-06	RAN#96	R5-222625	0531	-	F	Addition of NR SL Demod TC 11.1.8 - PSCCH capability	16.12.0
2022-06	RAN#96	R5-222627	0533	-	F	Correction to references for NR SL Demod	16.12.0
2022-06	RAN#96	R5-222628	0534	-	F	Addition of NR SL Demod RMCs in Annex A	16.12.0
2022-06	RAN#96	R5-222629	0535	-	F	Addition of test tolerance for NR SL Demod in Annex F	16.12.0
2022-06	RAN#96	R5-222630	0536	-	F	Addition of test method for NR SL Demod in Annex G	16.12.0
2022-06	RAN#96	R5-222895	0540	-	F	Update to URLLC test cases 5.2.x.y.7	16.12.0
2022-06	RAN#96	R5-222898	0543	-	F	Update to URLLC test case 7.2.2.2.3	16.12.0
2022-06	RAN#96	R5-223024	0547	-	F	Update of FR1 RI reporting test cases	16.12.0
2022-06	RAN#96	R5-223048	0548	-	F	Removal of duplicate clauses from the Demod spec	16.12.0
2022-06	RAN#96	R5-223049	0549	-	F	Addition of test case 6.3.3.2.4, 4Rx TDD FR1 Single PMI with 32Tx Type1 - SinglePanel codebook for both SA and NSA	16.12.0
2022-06	RAN#96	R5-223107	0551	-	F	Correction in performance enhancement test cases 6.3.2.2.3, 6.3.2.2.4 and 6.3.3.2.3	16.12.0
2022-06	RAN#96	R5-223119	0552	-	F	Solving editor notes for Type I PMI test cases	16.12.0
2022-06	RAN#96	R5-223120	0553	-	F	Solving editor notes for Type II PMI test cases	16.12.0
2022-06	RAN#96	R5-223153	0554	-	F	Solve duplicated information in Annex	16.12.0
2022-06	RAN#96	R5-223275	0555	-	F	Update of FR2 CQI CA test cases	16.12.0
2022-06	RAN#96	R5-223704	0532	1	F	Addition of NR SL Demod TC 11.1.9 - PSFCH capability	16.12.0
2022-06	RAN#96	R5-223714	0508	1	F	Correction to PDCCH parameters in 5.2.2.1.4 and 5.2.2.2.4	16.12.0
2022-06	RAN#96	R5-223715	0516	1	F	Update to FR1 CA normal PDSCH test cases	16.12.0
2022-06	RAN#96	R5-223716	0517	1	F	Update to FR1 CA power imbalance test cases	16.12.0
2022-06	RAN#96	R5-223717	0520	1	F	Update to FR1 CA CQI reporting test case	16.12.0
2022-06	RAN#96	R5-223718	0518	1	F	Update to FR2 CA normal PDSCH test cases	16.12.0
2022-06	RAN#96	R5-223719	0521	1	F	Introduction of FR2 CA SDR test case	16.12.0
2022-06	RAN#96	R5-223722	0544	1	F	Editorial, removal of editors note in test case 5.2.2.2.10_1	16.12.0
2022-06	RAN#96	R5-223723	0545	1	F	Adding TT and removal of editors note in test case 5.2.3.2.9_1	16.12.0
2022-06	RAN#96	R5-223724	0546	1	F	Adding TT and removal of editors note in test case 5.2.3.2.10_1	16.12.0
2022-06	RAN#96	R5-223726	0539	1	F	Update to URLLC test cases 5.2.x.y.6	16.12.0
2022-06	RAN#96	R5-223727	0537	1	F	Update to Annex G for minimum test time	16.12.0
2022-06	RAN#96	R5-223728	0538	1	F	Update to Annex F for URLLC test cases	16.12.0

2022-06	RAN#96	R5-223837	0512	1	F	Correction to the reference of test frequency	16.12.0
2022-06	RAN#96	R5-223838	0513	1	F	Clarification of UL RMC in FR1 PMI test cases	16.12.0
2022-06	RAN#96	R5-223839	0515	1	F	Update of LTE-NR coexistence test cases	16.12.0
2022-06	RAN#96	R5-223840	0514	1	F	Update of FR2 test cases	16.12.0
2022-06	RAN#96	R5-223841	0522	1	F	Introduction of FR2 SDR test case	16.12.0
2022-06	RAN#96	R5-223871	0511	1	F	Correction to CSI-Report periodicity and offset in 6.2A.3.1	16.12.0
2022-09	RAN#97	R5-224502	0556	-	F	Re-organization of NR SL Demod test cases	16.13.0
2022-09	RAN#97	R5-224503	0557	-	F	Correction to Annex F for NR SL Demod TCs	16.13.0
2022-09	RAN#97	R5-224633	0559	-	F	Core alignment and editorial corrections for FR1 Demodulation CA test cases	16.13.0
2022-09	RAN#97	R5-224642	0560	-	F	Correction to CQI-RI-PMI delay in 6.2A.3.1	16.13.0
2022-09	RAN#97	R5-224643	0561	-	F	Correction to DCI bit size in 5.2.2.2.4_1	16.13.0
2022-09	RAN#97	R5-224644	0562	-	F	Correction to message exception in 5.2.3.2.10_1	16.13.0
2022-09	RAN#97	R5-224655	0563	-	F	Addition of missing message exceptions for CQI tests	16.13.0
2022-09	RAN#97	R5-224657	0565	-	F	Update of FR2 PDCCH TCs	16.13.0
2022-09	RAN#97	R5-225004	0569	-	F	Editorial correction to sub-clause ID for test requirement to TC5.2.3.2.1_x	16.13.0
2022-09	RAN#97	R5-225110	0573	-	F	Correction of aperiodicTriggeringOffset	16.13.0
2022-09	RAN#97	R5-225118	0575	-	F	Correction of CQI reporting test cases	16.13.0
2022-09	RAN#97	R5-225121	0577	-	F	Update of minimum test time	16.13.0
2022-09	RAN#97	R5-225208	0578	-	F	Update CQI report periodicity for TDD FR1 periodic wideband CQI reporting under fading conditions	16.13.0
2022-09	RAN#97	R5-225670	0566	1	F	FR2 demod testability update	16.13.0
2022-09	RAN#97	R5-225726	0579	1	F	Corrections for FDD Power Saving test cases	16.13.0
2022-09	RAN#97	R5-225727	0580	1	F	Corrections for TDD Power Saving test cases	16.13.0
2022-09	RAN#97	R5-225809	0558	1	F	Core alignment and editorial corrections for FR1 CSI CA test cases	16.13.0
2022-09	RAN#97	R5-225810	0572	1	F	Removal of brackets for DCI format in clause 5	16.13.0
2022-09	RAN#97	R5-225811	0574	1	F	Correction of NR-LTE coexistence test cases	16.13.0
2022-09	RAN#97	R5-225812	0576	1	F	Clarification of UL RMC in FR1 aperiodic CQI reporting tests	16.13.0
2022-09	RAN#97	R5-225813	0564	1	F	Addition of missing RMC for PDCCH tests	16.13.0
2022-09	RAN#97	R5-225024	0570	-	F	Addition of test case 5.2A.2.4.1, 2Rx Normal Demodulation Performance for HST-SFN CA	17.0.0
2022-09	RAN#97	R5-225769	0571	1	F	Addition of test case 5.2A.2.5.1, 2RX PDSCH Demodulation Performance for HST-DPS CA	17.0.0
2022-09	RAN#97	R5-225770	0567	1	F	Minimum test time for new HST enhancement RMCs	17.0.0