Annex A (normative): Measurement channels

A.1 General

TBD

A.2 UL reference measurement channels

A.2.1 General

TBD

A.2.2 Void

A.2.3 Reference measurement channels for TDD

For UL RMCs defined below, TDD slot pattern defined in Table A.2.3-1 will be used for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, TDD slot patterns defined for reference sensitivity tests in Table A.3.3.1-1 will be used.

Table A.2.3-1: Additional reference channels parameters for TDD

Parameter		**Value**	
		SCS 60 kHz (μ=2)	**SCS 120 kHz (μ=3)**
TDD Slot Configuration pattern (Note 1)		DDDSUUUU	7DS8U
Special Slot Configuration (Note 2)		S=4D+6G+4U	S=12D+2G
UL-DL configuration	*referenceSubcarrierSpacing*	60 kHz	120 kHz
	dl-UL-TransmissionPeriodicity	2 ms	2 ms
	nrofDownlinkSlots	3	7
	nrofDownlinkSymbols	4	12
	nrofUplinkSlot	4	8
	nrofUplinkSymbols	4	0
	UL slot numbers	mod(slot index, 40) = {36,…,39}	mod(slot index, 80) = {72,…,79}
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.			

A.2.3.1 DFT-s-OFDM Pi/2-BPSK

Table A.2.3.1-1: Reference Channels for DFT-s-OFDM pi/2-BPSK

Parameter	Allocated resource blocks (L_{CRB})	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	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					**Bits**	**Bits**			**Bits**	
	1	11	pi/2 BPSK	0	24	16	2	1	132	132
	16	11	pi/2 BPSK	0	504	16	2	1	2112	2112
	32	11	pi/2 BPSK	0	1032	16	2	1	4224	4224
	64	11	pi/2 BPSK	0	2024	16	2	1	8448	8448
	128	11	pi/2 BPSK	0	3976	24	2	2	16896	16896
	256	11	pi/2 BPSK	0	7944	24	2	3	33792	33792

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. DM-RS symbols are not counted.
NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.
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)
NOTE 4: Indexes of active UL slots are given by Table A.2.3-1 with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, indexes of active UL slots are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.
NOTE 5: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.3.1-2: Void

A.2.3.2 DFT-s-OFDM QPSK

Table A.2.3.2-1: Reference Channels for DFT-s-OFDM QPSK

Parameter	Allocated resource blocks (L_{CRB})	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	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					**Bits**	**Bits**			**Bits**	
	1	11	QPSK	2	48	16	2	1	264	132
	16	11	QPSK	2	808	16	2	1	4224	2112
	20	11	QPSK	2	1032	16	2	1	5280	2640
	32	11	QPSK	2	1608	16	2	1	8448	4224
	64	11	QPSK	2	3240	16	2	1	16896	8448
	128	11	QPSK	2	6408	24	2	2	33792	16896
	256	11	QPSK	2	12808	24	2	4	67584	33792

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. DM-RS symbols are not counted.
NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.
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)
NOTE 4: Indexes of active UL slots are given by Table A.2.3-1 with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, indexes of active UL slots are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.
NOTE 5: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.3.2-2: Void

A.2.3.3 DFT-s-OFDM 16QAM

Table A.2.3.3-1: Reference Channels for DFT-s-OFDM 16QAM

Parameter	Allocated resource blocks (L_{CRB})	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	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					Bits	Bits			Bits	
	1	11	16QAM	10	176	16	2	1	528	132
	16	11	16QAM	10	2792	16	2	1	8448	2112
	32	11	16QAM	10	5632	24	1	1	16896	4224
	64	11	16QAM	10	11272	24	1	2	33792	8448
	128	11	16QAM	10	22536	24	1	3	67584	16896
	256	11	16QAM	10	45096	24	1	6	135168	33792

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. DM-RS symbols are not counted.
NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.
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)
NOTE 4: Indexes of active UL slots are given by Table A.2.3-1 with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, indexes of active UL slots are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.
NOTE 5: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.3.3-2: Void

A.2.3.4 DFT-s-OFDM 64QAM

Table A.2.3.4-1: Reference Channels for DFT-s-OFDM 64QAM

Parameter	Allocated resource blocks (L_{CRB})	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	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					Bits	Bits			Bits	
	1	11	64QAM	18	408	16	2	1	792	132
	16	11	64QAM	18	6400	24	1	1	12672	2112
	32	11	64QAM	18	12808	24	1	2	25344	4224
	64	11	64QAM	18	25608	24	1	4	50688	8448
	128	11	64QAM	18	51216	24	1	7	101376	16896
	256	11	64QAM	18	102416	24	1	13	202752	33792

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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 6.1.4.1-1 defined in 38.214.

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)

NOTE 4: Indexes of active UL slots are given by Table A.2.3-1 with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, indexes of active UL slots are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

NOTE 5: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.3.4-2: Void

A.2.3.5 CP-OFDM QPSK

Table A.2.3.5-1: Reference Channels for CP-OFDM QPSK

Parameter	Allocated resource blocks (L_{CRB})	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	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					Bits	Bits			Bits	
	1	11	QPSK	2	48	16	2	1	264	132
	16	11	QPSK	2	808	16	2	1	4224	2112
	32	11	QPSK	2	1608	16	2	1	8448	4224
	33	11	QPSK	2	1672	16	2	1	8712	4356
	66	11	QPSK	2	3368	16	2	1	17424	8712
	132	11	QPSK	2	6536	24	2	2	34848	17424
	264	11	QPSK	2	13064	24	2	4	69696	34848

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. DM-RS symbols are not counted.
NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.
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)
NOTE 4: Indexes of active UL slots are given by Table A.2.3-1 with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, indexes of active UL slots are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.
NOTE 5: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.3.5-2: Void

A.2.3.6 CP-OFDM 16QAM

Table A.2.3.6-1: Reference Channels for CP-OFDM 16QAM

Parameter	Allocated resource blocks (L_{CRB})	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	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					Bits	Bits			Bits	
	1	11	16QAM	10	176	16	2	1	528	132
	16	11	16QAM	10	2792	16	2	1	8448	2112
	32	11	16QAM	10	5632	24	1	1	16896	4224
	33	11	16QAM	10	5760	24	1	1	17424	4356
	66	11	16QAM	10	11528	24	1	2	34848	8712
	132	11	16QAM	10	23040	24	1	3	69696	17424
	264	11	16QAM	10	46104	24	1	6	139392	34848

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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.

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)

NOTE 4: Indexes of active UL slots are given by Table A.2.3-1 with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, indexes of active UL slots are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

NOTE 5: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.3.6-2: Void

A.2.3.7 CP-OFDM 64QAM

Table A.2.3.7-1: Reference Channels for CP-OFDM 64QAM

Parameter	Allocated resource blocks (L_{CRB})	DFT-s-OFDM Symbols per slot (Note 1)	Modulation	MCS Index (Note 2)	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					Bits	Bits			Bits	
	1	11	64QAM	19	408	16	2	1	792	132
	16	11	64QAM	19	6400	24	1	1	12672	2112
	32	11	64QAM	19	12808	24	1	2	25344	4224
	33	11	64QAM	19	13064	24	1	2	26136	4356
	66	11	64QAM	19	26120	24	1	4	52272	8712
	132	11	64QAM	19	53288	24	1	7	104544	17424
	264	11	64QAM	19	106576	24	1	13	209088	34848

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. DM-RS symbols are not counted.

NOTE 2: MCS Index is based on MCS table 5.1.3.1-1 defined in 38.214.

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)

NOTE 4: Indexes of active UL slots are given by Table A.2.3-1 with TDD UL-DL configuration specified in A2.3 for the requirements requiring at least one sub frame (1ms) for the measurement period. For other requirements, indexes of active UL slots are given by the slots satisfying mod(slot index+1, 5) = 0 with TDD UL-DL configuration specified in A.3.3.1.

NOTE 5: The RMCs apply to all channel bandwidth where $L_{CRB} \leq N_{RB}$.

Table A.2.3.7-2: Void

A.3 DL reference measurement channels

A.3.1 General

Unless otherwise stated, Tables A.3.3.2-1 and A.3.3.2-2 are applicable for measurements of the Receiver Characteristics (clause 7).

Unless otherwise stated, Tables A.3.3.2-1 and A.3.3.2-2 also apply for the modulated interferer used in Clauses 7.5 and 7.6 with test specific bandwidths.

CSI-RS configuration parameter defined in A.3.1-2 is used for verifying the beam correspondence requirement, 2 slots of CSI-RS shall be provided at each test grid point. The DL channel shall be configured for zero power on all tones except those used by CSI-RS in slots containing CSI-RS for beam refinement, and the DL and UL channel sizes shall be the same during verification.

Table A.3.1-1: Test parameters

Parameter		Unit	Value
CORESET frequency domain allocation			Full BW
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
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			2
FDM between DMRS and PDSCH			Disable
CSI-RS for tracking	First subcarrier index in the PRB used for CSI-RS (k0)		0 for CSI-RS resource 1,2
	OFDM symbols in the PRB used for CSI-RS		l0 = 8 for CSI-RS resource 1 l0 = 12 for CSI-RS resource 2
	Number of CSI-RS ports		1 for CSI-RS resource 1,2
	CDM Type		'No CDM' for CSI-RS resource 1,2
	Density (ρ)		3 for CSI-RS resource 1,2
	CSI-RS periodicity	Slots	60 kHz SCS: 80 for CSI-RS resources 1 and 2 120 kHz SCS: 160 for CSI-RS resources 1 and 2
	CSI-RS offset	Slots	60 kHz SCS: 40 for CSI-RS resources 1 and 2 120kHz SCS: 80 for CSI-RS resources 1 and 2
	Frequency Occupation		Start PRB 0 Number of PRB = BWP size
	QCL info		TCI state #0
PTRS configuration			PTRS is not configured

Table A.3.1-2: CSI-RS parameters

Resource Type	aperiodic
Resource Set Config	
repetition	on
aperiodicTriggeringOffset	Depending on UE capability
Resource Config	
nzp-CSI-RS-ResourceId	30 for resource #0
	31 for resource #1
	32 for resource #2
	33 for resource #3
	34 for resource #4
	35 for resource #5
	36 for resource #6
	37 for resource #7
powerControlOffset	0
powerControlOffsetSS	db0
nrofPorts	1
firstOFDMSymbolInTimeDomain	6 for resource #0
	7 for resource #1
	8 for resource #2
	9 for resource #3
	10 for resource #4
	11 for resource #5
	12 for resource #6
	13 for resource #7
cdm-Type	noCDM
density	3
nrofRBs	48 for channel bandwdith≥100MHz 32 for channel bandwidth=50MHz
qcl-info	Type D to SSB

The CSI-RS configuration parameter defined in Table A.3.1-3 is used for verifying the beam correspondence requirement. CSI-RS shall be provided once every 10msec.

Table A.3.1-3: CSI-RS parameters for CSI-RS based beam correspondence

Resource Type	**aperiodic**
Resource Set Config	
repetition	on
aperiodicTriggeringOffset	Depending on UE capability
Resource Config	
nzp-CSI-RS-ResourceId	30 for resource #0
	31 for resource #1
	32 for resource #2
	33 for resource #3
	…
	…
	…
	29+N for resource #(N-1), where N is *maxNumberRxBeam* in UE capability IE of *MIMO-ParametersPerBand*
powerControlOffset	0
powerControlOffsetSS	db0
nrofPorts	1
firstOFDMSymbolInTimeDomain	6 for resource #0
	7 for resource #1
	8 for resource #2
	9 for resource #3
	…
	…
	…
	5+N for resource #(N-1), where N=*maxNumberRxBeam*-1 in UE capability IE of *MIMO-ParametersPerBand*
cdm-Type	noCDM
density	3
nrofRBs	48 for channel bandwidth≥100MHz 32 for channel bandwidth=50MHz
qcl-info	Type D to SSB

A.3.2 Void

A.3.3 DL reference measurement channels for TDD

A.3.3.1 General

Table A.3.3.1-1: Additional test parameters for TDD

Parameter		**Value**	
		SCS 60 kHz (μ=2)	**SCS 120 kHz (μ=3)**
UL-DL configuration	*referenceSubcarrierSpacing*	60 kHz	120 kHz
	dl-UL-TransmissionPeriodicity	1.25 ms	0.625 ms
	nrofDownlinkSlots	3	3
	nrofDownlinkSymbols	4	10
	nrofUplinkSlot	1	1
	nrofUplinkSymbols	4	2
Number of HARQ Processes		8	8
K1 value		K1 = 4 if mod(i,5) = 0 K1 =3 if mod(i,5) = 1 K1 =7 if mod(i,5) = 2 where i is slot index per frame; i = {0,…,39}	K1 = 4 if mod(i,5) = 0 K1 =3 if mod(i,5) = 1 K1 =7 if mod(i,5) = 2 where i is slot index per frame; i = {0,…,79}

A.3.3.2 FRC for receiver requirements for QPSK

Table A.3.3.2-1: Fixed Reference Channel for Receiver Requirements (SCS 60 kHz, TDD)

Parameter	Unit	Value		
Channel bandwidth	MHz	50	100	200
Subcarrier spacing configuration μ		2	2	2
Allocated resource blocks		66	132	264
Subcarriers per resource block		12	12	12
Allocated slots per Frame (NOTE 7)		23 / 24	23 / 24	23 / 24
MCS index		4	4	4
Modulation		QPSK	QPSK	QPSK
Target Coding Rate		1/3	1/3	1/3
Maximum number of HARQ transmissions		1	1	1
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79} (NOTE 5)	Bits	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79} (NOTE 6)	Bits	4224	8456	16896
Transport block CRC	Bits	24	24	24
LDPC base graph		1	1	1
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79} (NOTE 5)	CBs	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79} (NOTE 6)	CBs	1	2	2
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79} (NOTE 5)	Bits	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79} (NOTE 6)	Bits	14256	28512	57024
Max. Throughput averaged over 1 frame (NOTE 8)	Mbps	10.138	20.294	40.550
Note 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1. Note 2: 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 3: SS/PBCH block is transmitted in slot 0 with periodicity 20 ms Note 4: Slot i is slot index per 2 frames Note 5: When this DL RMC used together with the UL RMC for the transmitter requirements requiring at least one sub frame (1ms) for the measurement period, Slot i, if mod(i, 8) = {3,4,5,6,7} for i from {0,…,79} together with the TDD UL-DL configuration specified in A2.3. Note 6: When this DL RMC used together with the UL RMC for the transmitter requirements requiring at least one sub frame (1ms) for the measurement period, Slot i, if mod(i, 8) = {0,1,2} for i from {0,…,79} together with the TDD UL-DL configuration specified in A2.3. NOTE 7: First number corresponds to the number slots allocated in the first frame of the RMC; second number corresponds to the number slots allocated in the second frame of the RMC. NOTE 8: Throughput is averaged over 2nd frame of RMC.				

Table A.3.3.2-2: Fixed Reference Channel for Receiver Requirements (SCS 120 kHz, TDD)

Parameter	Unit	Value			
Channel bandwidth	MHz	50	100	200	400
Subcarrier spacing configuration μ		3	3	3	3
Allocated resource blocks		32	66	132	264
Subcarriers per resource block		12	12	12	12
Allocated slots per Frame (NOTE 7)		47 / 48	47 / 48	47 / 48	47 / 48
MCS index		4	4	4	4
Modulation		QPSK	QPSK	QPSK	QPSK
Target Coding Rate		1/3	1/3	1/3	1/3
Maximum number of HARQ transmissions		1	1	1	1
Information Bit Payload per Slot					
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159} (NOTE 5)	Bits	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} (NOTE 6)	Bits	2088	4224	8456	16896
Transport block CRC	Bits	16	24	24	24
LDPC base graph		2	1	1	1
Number of Code Blocks per Slot					
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159} (NOTE 5)	CBs	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} (NOTE 6)	CBs	1	1	2	2
Binary Channel Bits Per Slot					
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,159} (NOTE 5)	Bits	N/A	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159} (NOTE 6)	Bits	6912	14256	28512	57024
Max. Throughput averaged over 1 frame (NOTE 8)	Mbps	10.022	20.275	40.589	81.101
Note 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1. Note 2: 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 3: SS/PBCH block is transmitted in slot 0 with periodicity 20 ms Note 4: Slot i is slot index per 2 frames Note 5: When this DL RMC used together with the UL RMC for the transmitter requirements requiring at least one sub frame (1ms) for the measurement period, Slot i, if mod(i, 16) = {7,…,15} for i from {0,…,159} together with the TDD UL-DL configuration specified in A2.3. Note 6: When this DL RMC used together with the UL RMC for the transmitter requirements requiring at least one sub frame (1ms) for the measurement period, Slot i, if mod(i, 16) = {0,…,6} for i from {0,…,159} together with the TDD UL-DL configuration specified in A2.3.					

A.3.3.3 FRC for receiver requirements for 16QAM

TBD

A.3.3.4 FRC for receiver requirements for 64QAM

Table A.3.3.4-1: Fixed Reference Channel for Receiver Requirements (SCS 60 kHz, TDD)

Parameter	Unit	Value		
Channel bandwidth	MHz	50	100	200
Subcarrier spacing configuration μ		2	2	2
Allocated resource blocks		66	132	264
Subcarriers per resource block		12	12	12
Allocated slots per Frame (NOTE 6)		23 / 24	23 / 24	23 / 24
MCS index		19	19	19
Modulation		64QAM	64QAM	64QAM
Target Coding Rate		1/2	1/2	1/2
Maximum number of HARQ transmissions		1	1	1
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79}	Bits	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2} for i from {1,…,79}	Bits	20496	40976	81976
Transport block CRC	Bits	24	24	24
LDPC base graph		1	1	1
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79}	CBs	N/A	N/A	N/A
For Slot i, if mod(i, 10) = {0,1,2} for i from {1,…,79}	CBs	3	5	10
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79}	Bits	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79}	Bits	40392	80784	161568
Max. Throughput averaged over 1 frame (NOTE 7)	Mbps	49.190	98.343	196.742
Note 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1. Note 2: 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 3: SS/PBCH block is transmitted in slot 0 with periodicity 20 ms Note 4: Slot i is slot index per 2 frames Note 5: PTRS is configured on symbols containing PDSCH with 1 port, per 2PRB in frequency domain, per symbol in time domain. Overhead for TBS calculation is assumed to be 6. NOTE 6: First number corresponds to the number slots allocated in the first frame of the RMC; second number corresponds to the number slots allocated in the second frame of the RMC. NOTE 7: Throughput is averaged over 2nd frame of RMC.				

Table A.3.3.4-2: Fixed Reference Channel for Receiver Requirements (SCS 120 kHz, TDD)

Parameter	Unit	Value			
Channel bandwidth	MHz	50	100	200	400
Subcarrier spacing configuration μ		3	3	3	3
Allocated resource blocks		32	66	132	264
Subcarriers per resource block		12	12	12	12
Allocated slots per Frame (NOTE 6)		47 / 48	47 /48	47 / 48	47 / 48
MCS index		19	19	19	19
Modulation		64QAM	64QAM	64QAM	64QAM
Target Coding Rate		1/2	1/2	1/2	1/2
Maximum number of HARQ transmissions		1	1	1	1
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	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	9992	20496	40976	81976
Transport block CRC	Bits	24	24	24	24
LDPC base graph		1	1	1	1
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	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	2	3	5	10
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	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	19584	40392	80784	161568
Max. Throughput averaged over 1 frame (NOTE 7)	Mbps	47.962	98.381	196.685	393.485

Note 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.
Note 2: 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 3: SS/PBCH block is transmitted in slot with periodicity 20 ms
Note 4: Slot i is slot index per 2 frames
Note 5: PTRS is configured on symbols containing PDSCH with 1 port, per 2PRB in frequency domain, per symbol in time domain. Overhead for TBS calculation is assumed to be 6.
NOTE 6: First number corresponds to the number slots allocated in the first frame of the RMC; second number corresponds to the number slots allocated in the second frame of the RMC.
NOTE 7: Throughput is averaged over 2nd frame of RMC.

A.3.3.5 FRC for receiver requirements for 256QAM

Table A.3.3.5-1 Fixed Reference Channel for Receiver Requirements (SCS 60 kHz, TDD)

Parameter	Unit	Value		
Channel bandwidth	MHz	50	100	200
Subcarrier spacing configuration μ		2	2	2
Allocated resource blocks		66	132	264
Subcarriers per resource block		12	12	12
Allocated slots per Frame (NOTE 6)		23 / 24	23 / 24	23 / 24
MCS index		24	24	24
Modulation		256QAM	256QAM	256QAM
Target Coding Rate		4/5	4/5	4/5
Maximum number of HARQ transmissions		1	1	1
Information Bit Payload per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79}	Bits	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79}	Bits	44040	88064	176208
Transport block CRC	Bits	24	24	24
LDPC base graph		1	1	1
Number of Code Blocks per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79}	CBs	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79}	CBs	6	11	21
Binary Channel Bits Per Slot				
For Slots 0 and Slot i, if mod(i, 5) = {3,4} for i from {0,…,79}	Bits	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,79}	Bits	53856	107712	215424
Max. Throughput averaged over 1 frame (NOTE 7)	Mbps	105.696	211.354	422.899

NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.
NOTE 2: 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 3: SS/PBCH block is transmitted in slot 0 of each frame
NOTE 4: Slot i is slot index per 2 frames
NOTE 5: PTRS is configured on symbols containing PDSCH with 1 port, per 2PRB in frequency domain, per symbol in time domain. Overhead for TBS calculation is assumed to be 6.
NOTE 6: First number corresponds to the number slots allocated in the first frame of the RMC; second number corresponds to the number slots allocated in the second frame of the RMC.
NOTE 7: Throughput is averaged over 2nd frame of RMC.

Table A.3.3.5-2 Fixed Reference Channel for Receiver Requirements (SCS 120 kHz, TDD)

Parameter	Unit	Value			
Channel bandwidth	MHz	50	100	200	400
Subcarrier spacing configuration μ		3	3	3	3
Allocated resource blocks		32	66	132	264
Subcarriers per resource block		12	12	12	12
Allocated slots per Frame (NOTE 6)		47 / 48	47 / 48	47 / 48	47 / 48
MCS index		24	24	24	24
Modulation		256QAM	256QAM	256QAM	256QAM
Target Coding Rate		4/5	4/5	4/5	4/5
Maximum number of HARQ transmissions		1	1	1	1
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	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	21504	44040	88064	176208
Transport block CRC	Bits	24	24	24	24
LDPC base graph		1	1	1	1
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	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	CBs	3	6	11	21
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	N/A	N/A	N/A
For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,159}	Bits	26112	53856	107712	215424
Max. Throughput averaged over 1 frame (NOTE 7)	Mbps	103.219	211.392	422.707	845.798

NOTE 1: Additional parameters are specified in Table A.3.1-1 and Table A.3.3.1-1.
NOTE 2: 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 3: SS/PBCH block is transmitted in slot 0 of each frame
NOTE 4: Slot i is slot index per 2 frames
NOTE 5: PTRS is configured on symbols containing PDSCH with 1 port, per 2PRB in frequency domain, per symbol in time domain. Overhead for TBS calculation is assumed to be 6.
NOTE 6: First number corresponds to the number slots allocated in the first frame of the RMC; second number corresponds to the number slots allocated in the second frame of the RMC.
NOTE 7: Throughput is averaged over 2nd frame of RMC.

A.4 Void

A.5 OFDMA Channel Noise Generator (OCNG)

A.5.1 OCNG Patterns for FDD

TBD

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 Distribution / OCNG Parameters	Control Region (Core Set)	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 in channel bandwidth.		

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.

Annex C (normative): Downlink Physical Channels

C.0 Downlink signal levels

Editor's Note : Consideration to minimize the required number of additional FR2 link is under discussion

The downlink power settings in Table C.0-1 is used unless otherwise specified in a test case.

Table C.0-1: Default Downlink power levels for NR

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/SCS	-99 for DL SCS= 60 kHz -96 for DL SCS = 120 kHz	-99 for DL SCS = 60 kHz -96 for DL SCS = 120 kHz	-99 for DL SCS = 60 kHz -96 for DL SCS = 120 kHz	-99 for DL SCS = 60 kHz -96 for DL SCS = 120 kHz
Note 1: The channel bandwidth powers are informative, based on [-99]dBm/60kHz 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.

For TRP measurement, DL signal may be supplied from RSRP based pathloss compensation link. Downlink signal level using RSRP based pathloss compensation link is specified in Table C.0-2 or Table C.0-3.

Table C.0-2: Downlink power levels for RSRP based pathloss compensation link for TRP measurement for n257, n258 and n260

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	≥ -87	≥ -84	≥ -80	N/A
120	Number of RBs		32	66	132	264
	Channel BW power	dBm	≥ -87	≥ -84	≥ -80	≥ -77
	SS/PBCH SSS EPRE	dBm/SCS	≥ -115.5 for DL SCS = 60 kHz ≥ -112.5 for DL SCS = 120 kHz	≥ -115.5 for DL SCS = 60 kHz ≥ -112.5 for DL SCS = 120 kHz	≥ -115.5 for DL SCS = 60 kHz ≥ -112.5 for DL SCS = 120 kHz	≥ -115.5 for DL SCS = 60 kHz ≥ -112.5 for DL SCS = 120 kHz
Note 1: The channel bandwidth powers are informative, based on -115.5dBm/60kHz 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 RSRP reference point as defined in TS 38.215 [24]. Note 3: DL level is applied for any of the Subcarrier Spacing configuration (μ) with the same power spectrum density of ≥ –115.5 dBm/60kHz.						

Table C.0-3: Downlink power levels for RSRP based pathloss compensation link for TRP measurement for n261

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	≥ -84	≥ -81	≥ -78	N/A
120	Number of RBs		32	66	132	264
	Channel BW power	dBm	≥ -84	≥ -81	≥ -78	≥ -75
	SS/PBCH SSS EPRE	dBm/SCS	≥ -113 for DL SCS = 60 kHz ≥ -110 for DL SCS = 120 kHz	≥ -113 for DL SCS = 60 kHz ≥ -110 for DL SCS = 120 kHz	≥ -113 for DL SCS = 60 kHz ≥ -110 for DL SCS = 120 kHz	≥ -113 for DL SCS = 60 kHz ≥ -110 for DL SCS = 120 kHz

Note 1: The channel bandwidth powers are informative, based on -113dBm/60kHz 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 RSRP reference point as defined in TS 38.215 [24].
Note 3: DL level is applied for any of the Subcarrier Spacing configuration (μ) with the same power spectrum density of ≥ –113 dBm/60kHz.

C.1 General

The following clauses describes the downlink Physical Channels that are transmitted during a connection i.e., when measurements are done.

C.2 Setup

Table C.2-1 describes the downlink Physical Channels that are required for connection set up.

Table C.2-1: Downlink Physical Channels required for connection set-up

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

As common PDSCH and PDCCH configuration parameters the parameters in Table A.3.1-1, C.2-2, C.2-3, and C.2-4 shall be used to bring up the connection setup for FR1 NR cell.

Table C.2-2: PDSCH and PDCCH configuration

Parameter	Unit	Value
Number of HARQ processes		8 (TDD)
Aggregation level	CCE	4

Table C.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.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.3 Connection

C.3.0 Measurement of Transmitter Characteristics

Unless otherwise stated, Table C.3.0-1 is applicable for measurements on the Transmitter Characteristics (clause 6).

Table C.3.0-1: Downlink Physical Channels transmitted during a connection (TDD)

Parameter	Unit	Value
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 (Note 1)	dB	-3
EPRE ratio of CSI-RS to SSS	dB	0
EPRE ratio of PTRS to PDSCH	dB	Test specific
EPRE ratio of OCNG DMRS to SSS	dB	0
EPRE ratio of OCNG to OCNG DMRS (Note 1)	dB	0
Note 1: No boosting is applied to any of the channels except PDSCH DMRS. For PDSCH DMRS, 3 dB power boosting is applied assuming DMRS Type 1 configuration when DMRS and PDSCH are TDM'ed and only half of the DMRS REs are occupied. Note 2: Number of DMRS CDM groups without data for PDSCH DMRS configuration for OCNG is set to 1.		

C.3.1 Measurement of Receiver Characteristics

Unless otherwise stated, Table C.3.1-1 is applicable for measurements on the Receiver Characteristics (clause 7). For Adjacent channel selectivity testing, Table C.3.1-2 is applied.

Table C.3.1-1: Downlink Physical Channels transmitted during a connection (TDD)

Parameter	Unit	Value
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 (Note 1)	dB	-3
EPRE ratio of CSI-RS to SSS	dB	0
EPRE ratio of PTRS to PDSCH	dB	Test specific
EPRE ratio of OCNG DMRS to SSS	dB	0
EPRE ratio of OCNG to OCNG DMRS (Note 1)	dB	0
Note 1: No boosting is applied to any of the channels except PDSCH DMRS. For PDSCH DMRS, 3 dB power boosting is applied assuming DMRS Type 1 configuration when DMRS and PDSCH are TDM'ed and only half of the DMRS REs are occupied. Note 2: Number of DMRS CDM groups without data for PDSCH DMRS configuration for OCNG is set to 1.		

Table C.3.1-2: PDCCH Aggregation Level for ACS testing

Parameter	Unit	Value	Comment
Aggregation level	CCE	4	CBW=50MHz when SCS=120kHz
		8	CBW=50MHz when SCS=60kHz CBW=100MHz when SCS=120kHz
		16	CBW>100 MHz when SCS=60kHz CBW>100 MHz when SCS=120kHz

Annex D (normative): Characteristics of the interfering signal

D.1 General

Unless otherwise stated, a modulated full bandwidth NR downlink signal, which equals to channel bandwidth of the wanted signal for Single Carrier case is used as interfering signals when RF performance requirements for NR UE receiver are defined. For intra-band contiguous CA case, a modulated NR downlink signal which equals to the aggregated channel bandwidth of the wanted signal is used.

D.2 Interference signals

Table D.2-1 describes the modulated interferer for different channel bandwidth options.

Table D.2-1: Description of modulated NR interferer

	Channel bandwidth for Single Carrier				Intra band contiguous CA
	50 MHz	100 MHz	200 MHz	400 MHz	
$BW_{Interferer}$	50 MHz	100 MHz	200 MHz	400MHz	$BW_{Channel\_CA}$
RB	NOTE1				
NOTE 1: The RB configured for interfering signal is the same as maximum RB number defined in Table 5.3.2-1 for each sub-carrier spacing.					

Annex E (normative): Global In-Channel TX-Test

NOTE: Clauses E.2.2 to E.5.9.3 are descriptions, which assume no power ramping adjacent to the measurement period.

E.1 General

The global in-channel TX test enables the measurement of all relevant parameters that describe the in-channel quality of the output signal of the TX under test in a single measurement process.

The parameters describing the in-channel quality of a transmitter, however, are not necessarily independent. The algorithm chosen for description inside this annex places particular emphasis on the exclusion of all interdependencies among the parameters.

E.2 Signals and results

E.2.1 Basic principle

The process is based on the comparison of the actual **output signal of the TX under test**, received by an ideal receiver, with a **reference signal**, that is generated by the measuring equipment and represents an ideal error free received signal. All signals are represented as equivalent (generally complex) baseband signals.

The description below uses numbers as examples. These numbers are taken from TDD with normal CP length and 100 MHz bandwidth with 60 kHz SCS. The application of the text below, however, is not restricted to this frame structure and bandwidth.

E.2.2 Output signal of the TX under test

The output signal of the TX under test is acquired by the measuring equipment and stored for further processing. It is sampled at a sampling rate of 122.88 Mbps. In the time domain it comprises at least 10 uplink subframes. The measurement period is derived by concatenating the correct number of individual uplink slots until the correct measurement period is reached. The output signal is named z(ν). Each slot is modelled as a signal with the following parameters: demodulated data content, carrier frequency, amplitude and phase for each subcarrier, timing, carrier leakage.

NOTE 1: TDD

Since the uplink subframes are not continuous, the *n* slots should be extracted from more than 1 continuous radio frame where

$$n = \begin{cases} 40, \text{for } 60 \text{ kHz SCS} \\ 80, \text{for } 120 \text{ kHz SCS} \end{cases}$$

.

E.2.3 Reference signal

Two types of reference signal are defined:

The reference signal $i_1(\nu)$ is constructed by the measuring equipment according to the relevant TX specifications, using the following parameters: demodulated data content, nominal carrier frequency, nominal amplitude and phase for each subcarrier, nominal timing, no carrier leakage. It is represented as a sequence of samples at a sampling rate of 122.88 Mbps in the time domain.

The reference signal $i_2(\nu)$ is constructed by the measuring equipment according to the relevant TX specifications, using the following parameters: restricted data content: nominal reference symbols, (all modulation symbols for user data symbols are set to 0V), nominal carrier frequency, nominal amplitude and phase for each applicable subcarrier, nominal timing, no carrier leakage. It is represented as a sequence of samples at a sampling rate of 122.88 Mbps in the time domain.

NOTE: The PUCCH is off during the time under test.

E.2.4 Measurement results

The measurement results, achieved by the global in channel TX test are the following:

- Carrier Frequency error
- EVM (Error Vector Magnitude)
- Carrier leakage
- Unwanted emissions, falling into non allocated resource blocks.
- EVM equalizer spectrum flatness

E.2.5 Measurement points

The unwanted emission falling into non-allocated RB(s) is calculated directly after the FFT as described below. In contrast to this, the EVM for the allocated RB(s) is calculated after the IDFT for DFT-s-OFDM or after the Tx-Rx chain equalizer for CP-OFDM. The samples after the TX-RX chain equalizer are used to calculate EVM equalizer spectrum flatness. Carrier frequency error and carrier leakage is calculated in the block “RF correction”.

In case the parameter 3300 or 3301 is reported from UE via *txDirectCurrentLocation* IE (as defined in TS 38.331 [6]), carrier leakage measurement in the RF correction block shall be omitted. All statements from Annex E.3 onwards shall be read assuming that no carrier leakage has been measured.

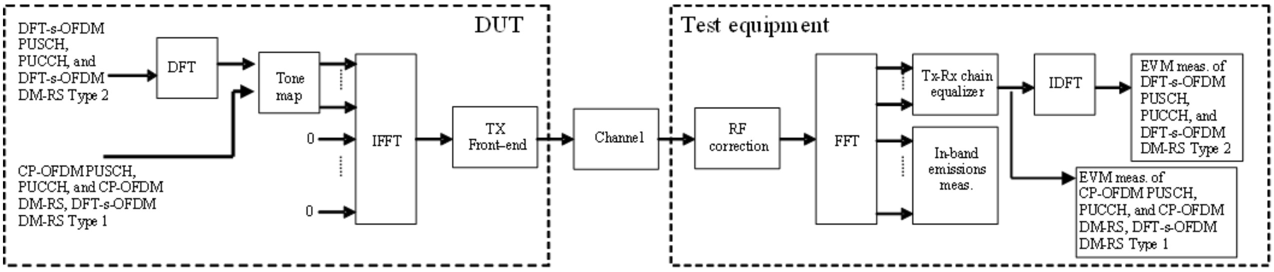


Figure E.2.5-1: EVM measurement points

E.3 Signal processing

E.3.1 Pre FFT minimization process

Before applying the pre-FFT minimization process, z(ν) and i(ν) are portioned into *n* pieces, comprising one slot each, where *n* is as defined in Annex E.2.2.

.

Each slot is processed separately. Sample timing, Carrier frequency and carrier leakage in z(ν) are jointly varied in order to minimise the difference between z(ν) and i(ν). Best fit (minimum difference) is achieved when the RMS difference value between z(ν) and i(ν) is an absolute minimum.

The carrier frequency variation and the IQ variation are the measurement results: Carrier Frequency Error and Carrier leakage.

From the acquired samples 10 carrier frequencies can be derived by averaging frequency errors for every 4 or 8 slots for 60 and 120 kHz SCS.

From the acquired samples *n* carrier frequencies and *n* carrier leakages can be derived.

NOTE 1: The minimisation process, to derive carrier leakage and RF error can be supported by Post FFT operations. However the minimisation process defined in the pre FFT domain comprises all acquired samples (i.e. it does not exclude the samples in between the FFT widths and it does not exclude the bandwidth outside the transmission bandwidth configuration

NOTE 2: The algorithm would allow deriving Carrier Frequency error and Sample Frequency error of the TX under test separately. However there are no requirements for Sample Frequency error. Hence the algorithm models the RF and the sample frequency commonly (not independently). It returns one error and does not distinguish between both.

After this process the samples z(ν) are called $z^0(\nu)$.

E.3.2 Timing of the FFT window

The FFT window length is 2048 samples per OFDM symbol. 14 FFTs (28672 samples) cover less than the acquired number of samples (30720 samples). The position in time for FFT must be determined.

In an ideal signal, the FFT may start at any instant within the cyclic prefix without causing an error. The TX filter, however, reduces the window. The EVM requirements shall be met within a window W<CP. There are three different instants for FFT:

Centre of the reduced window, called $\Delta\tilde{c}$, $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2.

The timing of the measured signal is determined in the pre FFT domain as follows, using $z^0(\nu)$ and $i_2(\nu)$:

1. The measured signal is delay spread by the TX filter. Hence the distinct boarders between the OFDM symbols and between Data and CP are also spread and the timing is not obvious.

2. In the Reference Signal $i_2(\nu)$ the timing is known.

3. Correlation between (1.) and (2.) will result in a correlation peak. The meaning of the correlation peak is approx. the “impulse response” of the TX filter. The meaning of “impulse response” assumes that the autocorrelation of the reference signal $i_2(\nu)$ is a Dirac peak and that the correlation between the reference signal $i_2(\nu)$ and the data in the measured signal is 0. The correlation peak, (the highest, or in case of more than one, the earliest) indicates the timing in the measured signal.

From the acquired samples, *n* timings can be derived.

For all calculations, except EVM, the number of samples in $z^0(\nu)$ is reduced to 14 blocks of samples, comprising 2048 samples (FFT width) and starting with $\Delta\tilde{c}$ in each OFDM symbol including the demodulation reference signal.

For the EVM calculation the output signal under test is reduced to 28 blocks of samples, comprising 2048 samples (FFT width) and starting with $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2 in each OFDM symbol including the demodulation reference signal.

The number of samples, used for FFT is reduced compared to $z^0(\nu)$. This subset of samples is called z’(ν).

The timing of the centre $\Delta\tilde{c}$ with respect to the different CP length in a slot is as follows: (TDD, normal CP length)

$\Delta\tilde{c}$ is on T_f=72 (=CP/2) within the CP of length 144 FFT samples (in OFDM symbols except 0 and 28 (=$7 \cdot 2^{\mu}$), where symbol 0 is the first symbol of each subframe) for channel bandwidth of 100 MHz and SCS = 60 kHz.

$\Delta\tilde{c}$ is on T_f=136 (=208-72) within the CP of length 208 FFT samples (in OFDM symbol 0 and 28 (=$7 \cdot 2^{\mu}$), where symbol 0 is the first symbol of each subframe) for channel bandwidth of 100 MHz and SCS = 60 kHz.

E.3.3 Post FFT equalisation

Perform 14 FFTs on z'(ν), one for each OFDM symbol in a slot using the timing $\Delta\tilde{c}$, including the demodulation reference symbol. The result is an array of samples, 14 in the time axis t times 2048 in the frequency axis f. The samples represent the data symbols (in OFDM-symbol 0,1,3,4,5,6,8,9,10,12,13 in each slot) and demodulation reference symbols (OFDM symbol 2, 7, 11 in each slot) in the allocated RBs and inband emissions in the non allocated RBs within the transmission BW.

Only the allocated resource blocks in the frequency domain are used for equalisation.

The nominal demodulation reference symbols and nominal data symbols are used to equalize the measured data symbols. (Location for equalization see Figure E.2.5-1)

NOTE: The nomenclature inside this note is local and not valid outside.

The nominal data symbols are created by a demodulation process. The location to gain the demodulated data symbols is "EVM" in Figure E.2.5-1. For CP-OFDM, the process described in Annex E.5 can be applied. A demodulation process as follows is recommended for DFT-s-OFDM:

1. Equalize the measured data symbols using the reference symbols for equalisation. Result: Equalized data symbols
2. Only for DFT-s-OFDM, iDFT transform the equalized data symbols: Result: Equalized data symbols
3. Decide for the nearest constellation point: Result: Nominal data symbols
4. Only for DFT-s-OFDM, DFT transform the nominal data symbols: Result: Nominal data symbols

At this stage we have an array of Measured data-Symbols and reference-Symbols (MS(f,t))

versus an array of Nominal data-Symbols and reference Symbols (NS(f,t))

(complex, the arrays comprise 11 data symbols and 3 demodulation reference symbol in the time axis and the number of allocated subcarriers in the frequency axis.)

MS(f,t) and NS(f,t) are processed with a least square (LS) estimator, to derive one equalizer coefficient per time slot and per allocated subcarrier. EC(f) is defined as

$$EC(f) = \frac{\sum_{t=0}^{13} NS(f,t)^{*} NS(f,t)}{\sum_{t=0}^{13} NS(f,t)^{*} MS(f,t)}.$$

With * denoting complex conjugation.

EC(f) are used to equalize the DFT-coded data symbols. The measured DFT-coded data and the references symbols are equalized by:

$$Z'(f,t) = MS(f,t) \cdot EC(f)$$

With · denoting multiplication.

Z'(f,t), restricted to the data symbol (excluding t=2,7,11) is used to calculate EVM, as described in E.4.1.

EC(f) is used in E.4.4 to calculate EVM equalizer spectral flatness.

NOTE: The post FFT minimisation process is done over 14 symbols (11 DFT-coded data symbols and 3 reference symbols).

The samples of the non allocated resource blocks within the transmission bandwidth configuration in the post FFT domain are called Y(f,t) (f covering the non allocated subcarriers within the transmission bandwidth configuration, t covering the OFDM symbols during 1 slot).

E.4 Derivation of the results

E.4.1 EVM

For EVM create two sets of Z'(f,t)., according to the timing " $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2" using the equalizer coefficients from E.3.3.

Perform the iDFTs on Z'(f,t) in the case of DFT-s-OFDM waveform. The IDFT-decoding preserves the meaning of t but transforms the variable f (representing the allocated sub carriers) into another variable g, covering the same count and representing the demodulated symbols. The samples in the post IDFT domain are called iZ'(g, t). The equivalent ideal samples are called iI(g,t). Those samples of Z'(f,t), carrying the reference symbols (=symbol 2,7,11) are not iDFT processed.

The EVM is the difference between the ideal waveform and the measured and equalized waveform for the allocated RB(s)

$$EVM = \sqrt{\frac{\sum_{t\in T}\sum_{g\in G}\left|iZ'(g,t)-iI(g,t)\right|^2}{|G|\cdot|T|\cdot P_0}},$$

where

t covers the count of demodulated symbols with the considered modulation scheme being active within the measurement period, (i.e. symbol 0,1,3,4,5,6,8,9,10,12,13 in each slot, →|T|=11)

g covers the count of demodulated symbols with the considered modulation scheme being active within the allocated bandwidth. (|G|=12* L_{CRBs} (with L_{CRBs} : number of allocated resource blocks)).

$iZ'(g,t)$ are the samples of the signal evaluated for the EVM.

$iI(g,t)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 is equal to 1.

From the acquired samples 2n EVM values can be derived, n values for the timing $\Delta\tilde{c}$ –W/2 and n values for the timing $\Delta\tilde{c}$ +W/2

E.4.2 Averaged EVM

EVM is averaged over all basic EVM measurements.

The averaging comprises n UL slots

$$\overline{EVM} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} EVM_i^2}$$

where

$$n = \begin{cases} 30, \text{ for 60 kHz SCS} \\ 60, \text{ for 120 kHz SCS} \end{cases}$$

for PUCCH, PUSCH.

The averaging is done separately for timing $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2 leading to $\overline{\mathrm{EVM}}_l$ and $\overline{\mathrm{EVM}}_h$

$EVM_{\text{final}} = \max(\overline{\mathrm{EVM}}_l, \overline{\mathrm{EVM}}_h)$ is compared against the test requirements.

E.4.3 In-band emissions measurement

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks.

Explanatory Note:

The inband emission measurement is only meaningful with allocated RB(s) next to non-allocated RB. The allocated RB(s) are necessary but not under test. The non allocated RBs are under test. The RB allocation for this test is as follows: The allocated RB(s) are at one end of the channel BW, leaving the other end unallocated. The number of allocated RB(s) is smaller than half of the number of RBs, available in the channel BW. This means that the vicinity of the carrier in the centre is unallocated.

There are 3 types of inband emissions:

1. General
2. IQ image
3. Carrier leakage

Carrier leakage are inband emissions next to the carrier.

IQ image are inband emissions symmetrically (with respect to the carrier) on the other side of the allocated RBs.

General are applied to all unallocated RBs.

For each evaluated RB, the minimum requirement is calculated as the higher of P_{RB} - 30 dB and the power sum of all limit values (General, IQ Image or Carrier leakage) that apply.

In specific the following combinations:

- Power (General)
- Power (General + Carrier leakage)
- Power (General + IQ Image)

  1 and 2 is expressed in terms of power in one non allocated RB under test, normalized to the average power of an allocated RB (unit dB).

  3 is expressed in terms of power in one non allocated RB, normalized to the power of all allocated RBs. (unit dBc).

This is the reason for two formulas $Emissions_{relative}$.

Create one set of Y(t,f) per slot according to the timing "$\Delta\tilde{c}$"

For the non-allocated RBs below the in-band emissions are calculated as follows

$$Emissions_{absolute}(\Delta_{RB}) = \begin{cases} \frac{1}{|T_s|}\sum_{t\in T_s}\sum_{\max(f_{\min},(c_l+12\cdot\Delta_{RB}*\Delta f))}^{c_l+(12\cdot\Delta_{RB}+11)*\Delta f} |Y(t,f)|^2, \Delta_{RB} < 0 \\ \frac{1}{|T_s|}\sum_{t\in T_s}\sum_{c_h+(12\cdot\Delta_{RB}-11)*\Delta f}^{\min(f_{\max},(c_h+12\cdot\Delta_{RB}*\Delta f))} |Y(t,f)|^2, \Delta_{RB} > 0 \end{cases},$$

where

the upper formula represents the in band emissions below the allocated frequency block and the lower one the in band emissions above the allocated frequency block.

T_s is a set of $|T_s|$ DFT-s-OFDM symbols with the considered modulation scheme being active within the measurement period,

Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. $\Delta_{RB} = 1$ for the first upper or $\Delta_{RB} = -1$ for the first lower adjacent RB),

$f_{\min}$ and $f_{\max}$ are the lower and upper edge of the UL transmission BW configuration,

c_l and c_h are the lower and upper edge of the allocated BW,

Δf is the SCS, and

$Y(t, f)$ is the frequency domain signal evaluated for in-band emissions as defined in clause E.3.3

The allocated RB power per RB and the total allocated RB power are given by:

$$P_{RB} = \frac{1}{|T_s| \cdot L_{CRBs}} \sum_{t\in T_S} \sum_{c_1}^{c_1+(12\cdot L_{CRBs}-1)\cdot\Delta f} |\mathrm{MS}(t,f)|^2 [\mathrm{dBm}/(12\Delta f)]$$

$$P_{All-RBs} = \frac{1}{|T_s|}\sum_{t\in T_S}\sum_{\mathrm{c_l}}^{\mathrm{c_l}+(12\cdot L_{CRBs}-1)*\Delta f} |\mathrm{MS}(t,f)|^2 \; [\mathrm{dBm}]$$

The relative in-band emissions, applicable for General and IQ image, are given by:

$$Emissions_{relative}(\Delta_{RB}) = 10 \cdot \log_{10}\left(\frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_S|\cdot L_{CRBs}}\sum_{t\in T_S}\sum_{c_l}^{c_l+(12\cdot L_{CRBs}-1)\cdot\Delta f}|\mathrm{MS}(t,f)|^2}\right)[\mathrm{dB}] =$$

$$= Emissions_{absolute}(\Delta_{RB})[\mathrm{dBm}/12\Delta f] - P_{RB}[dBm/12\Delta f]$$

where

L_{CRBs} is the number of allocated resource blocks,

and

$\mathrm{MS}(t, f)$ is the frequency domain samples for the allocated bandwidth, as defined in clause E.3.3.

The relative in-band emissions, applicable for carrier leakage, is given by:

$$Emissions_{relative} = 10 \cdot \log_{10}\left(\frac{Emissions_{absolute}(RBnextDC)}{\frac{1}{|T_s|}\sum_{t\in T_s}\sum_{c_l}^{c_l+(12\cdot L_{CRBs}-1)\cdot\Delta f}|\mathrm{MS}(t,f)|^2}\right)[\mathrm{dBc}]$$
$$= Emissions_{absolute}(RBnextDC)[\mathrm{dBm}/12\Delta f] - P_{All\ RBs}[\mathrm{dBm}]$$

where RBnextDC means: Resource Block next to the carrier.

This can be one RB or one pair of RBs, depending whether the DC carrier is inside an RB or in-between two RBs.

Although an exclusion period may be applicable in the time domain, when evaluating EVM, the inband emissions measurement interval is defined over one complete slot in the time domain.

From the acquired samples *n* functions for general in band emissions and IQ image inband emissions can be derived. n values or n pairs of carrier leakage inband emissions can be derived. They are compared against different limits.

The in-band emissions are averaged over the *n* samples (equivalent to 10 UL subframes):

$$\overline{Emissions}_{absolute}(\Delta_{RB}) = \frac{1}{n}\sum_{i=1}^{n} Emissions_{absolute,i}(\Delta_{RB})$$

$$\overline{Emissions}_{relative}(\Delta_{RB}) = 10*\log_{10}\left(\frac{1}{n}\sum_{i=1}^{n}10^{Emissions_{relative,i}(\Delta_{RB})/10}\right) \quad [dB]$$

$$\overline{Emissions}_{relative} = 10*\log_{10}\left(\frac{1}{n}\sum_{i=1}^{n}10^{Emissions_{relative,i}/10}\right) \quad [dBc]$$

E.4.4 EVM equalizer spectrum flatness

For EVM equalizer spectrum flatness use EC(f) as defined in E.3.3. Note, EC(f) represents equalizer coefficient $f \in F$, f is the allocated subcarriers within the transmission bandwidth (($|F|=12* L_{CRBs}$)

From the acquired samples n functions EC(f) can be derived.

EC(f) is broken down to 2 functions:

$$\mathrm{EC}_1(\mathrm{f}),\ f \in Range\ \ 1$$

$$\mathrm{EC}_2(\mathrm{f}),\ f \in Range\ \ 2$$

Where Range 1 and Range 2 are as defined in Table 6.5.2.4.5-1 for normal condition and Table 6.5.2.4.5-2 for extreme condition

The following peak to peak ripple is calculated:

$\mathrm{RP}_1 = 20*\log(\max(|\mathrm{EC}_1(\mathrm{f})|)/\min(|\mathrm{EC}_1(\mathrm{f})|))$,which denote the maximum ripple in Range 1

$\mathrm{RP}_2 = 20*\log(\max(|\mathrm{EC}_2(\mathrm{f})|)/\min(|\mathrm{EC}_2(\mathrm{f})|))$,which denote the maximum ripple in Range 2

$RP_{12} = 20 * \log(\max(|EC_1(f)|)/\min(|EC_2(f)|))$,which denote the maximum ripple between the upper side of Range 1 and lower side of Range 2

$RP_{21} = 20 * \log(\max(|EC_2(f)|)/\min(|EC_1(f)|))$,which denote the maximum ripple between the upper side of Range 2 and lower side of Range 1

E.4.5 Frequency error and Carrier leakage

See E.3.1.

E.4.6 EVM of Demodulation reference symbols (EVM$_{DMRS}$)

For the purpose of EVM $_{DMRS}$, the steps E.2.2 to E.4.2 are repeated 6 times, constituting 6 EVM $_{DMRS}$ sub-periods. The only purpose of the repetition is to cover the longer gross measurement period of EVM $_{DMRS}$ ($6 \cdot n$ time slots) and to derive the FFT window timing per sub-period.

The bigger of the EVM results in one n TS period corresponding to the timing¦ $\Delta\tilde{c}$ –W/2 or $\Delta\tilde{c}$ +W/2 is compared against the limit. (Clause E.4.2) This timing is re-used for EVM $_{DMRS}$ in the equivalent EVM $_{DMRS}$ sub-period.

For EVM the demodulation reference symbols are excluded, while the data symbols are used. For EVM$_{DMRS}$ the data symbols are excluded, while the demodulation references symbols are used. This is illustrated in figure E.4.6-1

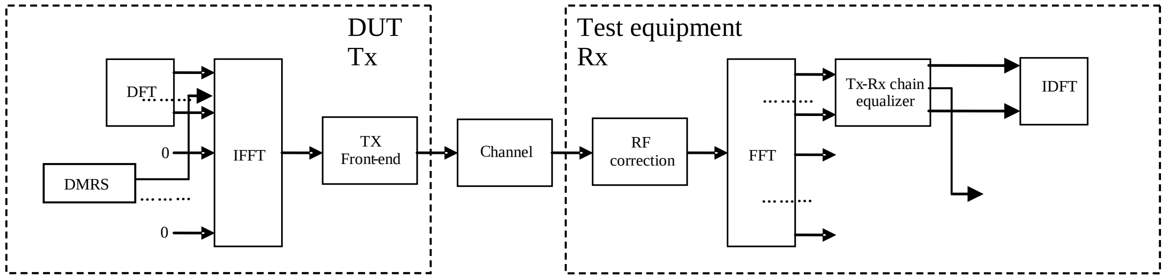


Figure E.4.6-1: EVM$_{DMRS}$ measurement points

Re-use the following formula from E.3.3:

$$Z'(f,t) = MS(f,t) \cdot EC(f)$$

To calculate EVM$_{DMRS}$, the data symbol (t=0,1,3,4,5,6,8,9,10,12,13) in Z'(f,t) are excluded and only the reference symbols (t=2,7,11) is used.

The EVM $_{DMRS}$ is the difference between the ideal waveform and the measured and equalized waveform for the allocated RB(s)

$$EVM_{DMRS} = \sqrt{\frac{\sum_{t \in T} \sum_{f \in F} \left| Z'(f,t) - I(f,t) \right|^2}{|T| \cdot P_0 \cdot |F|}},$$

where

t covers the count of demodulation reference symbols (i.e. symbols 2,7,11 in each slot, so count=3)

f covers the count of demodulation reference symbols within the allocated bandwidth. (|F|=12* L_{CRBs} (with L_{CRBs} : number of allocated resource blocks)).

$Z'(f,t)$ are the samples of the signal evaluated for the EVM $_{DMRS}$

$I(f,t)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 is equal to 1.

n such results are generated per measurement sub-period.

E.4.6.1 1st average for EVM $_{DMRS}$

EVM $_{DMRS}$ is averaged over all basic EVM $_{DMRS}$ measurements in one sub-period

The averaging comprises n UL slots

$$1stEVM_{DMRS} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(EVM_{DMRS,i}\right)^2}$$

The timing is taken from the EVM for the data. 6 of those results are achieved from the samples. In general the timing is not the same for each result.

E.4.6.2 Final average for EVM $_{DMRS}$

$$finalEVM_{DMRS} = \sqrt{\frac{1}{6}\sum_{i=1}^{6}\left(1stEVM_{DMRS,i}\right)^2}$$

E.5 EVM and inband emissions for PUCCH

For the purpose of worst case testing, the PUCCH shall be located on the edges of the Transmission Bandwidth Configuration (6,15,25,50,75,100 RBs).

The EVM for PUCCH (EVM_{PUCCH}) is averaged over *n* slots, where

$$n = \begin{cases} 30, \text{ for 60 kHz SCS} \\ 60, \text{ for 120 kHz SCS} \end{cases}.$$

At least *n* TSs shall be transmitted by the UE without power change. SRS multiplexing shall be avoided during this period. The following transition periods are applicable: One OFDM symbol on each side of the slot border (instant of band edge alternation).

The description below is generic in the sense that all 5 PUCCH formats are covered. Although the number of OFDM symbols in one slot can be different from 7 (depending on the format, configuration and cyclic prefix length), the text below uses 7 without excluding the others.

E.5.1 Basic principle

The basic principle is the same as described in E.2.1

E.5.2 Output signal of the TX under test

The output signal of the TX under test is processed same as described in E.2.2

E.5.3 Reference signal

The reference signal is defined same as in E.2.3. Same as in E.2.3, $i_1(\nu)$ is the ideal reference for EVM_{PUCCH} and $i_2(\nu)$ is used to estimate the FFT window timing.

Note PUSCH is off during the PUCCH measurement period.

E.5.4 Measurement results

The measurement results are:

- EVM_{PUCCH}
- Inband emissions with the sub-results: General in-band emission, IQ image (according to: 38.101. Annex F.4, Clause starting with: “At this stage the ….”)

E.5.5 Measurement points

The measurement points are illustrated in the Figure E.2.5-1.

E.5.6 Pre FFT minimization process

The pre FFT minimisation process is the same as describes in clause E.3.1.

NOTE: although an exclusion period for EVM_{PUCCH} is applicable in E.5.9.1, the pre FFT minimisation process is done over the complete slot.

RF error, and carrier leakage are necessary for best fit of the measured signal towards the ideal signal in the pre FFT domain. However they are not used to compare them against the limits.

E.5.7 Timing of the FFT window

Timing of the FFT window is estimated with the same method as described in E.3.2.

E.5.8 Post FFT equalisation

The post FFT equalisation is described separately without reference to E.3.3:

Perform 14 FFTs on z’(ν), one for each OFDM symbol in a slot using the timing $\Delta\tilde{c}$, including the demodulation reference symbol. The result is an array of samples, 14 in the time axis t times 2048 in the frequency axis f. The samples represent the OFDM symbols (data and reference symbols) in the allocated RBs and inband emissions in the non allocated RBs within the transmission BW.

Only the allocated resource blocks in the frequency domain are used for equalisation.

The nominal reference symbols and **nominal** OFDM data symbols are used to equalize the measured data symbols.

Note: (The nomenclature inside this note is local and not valid outside)

The nominal OFDM data symbols are created by a demodulation process. A demodulation process as follows is recommended:

1. Equalize the measured OFDM data symbols using the reference symbols for equalisation. Result: Equalized OFDM data symbols
2. Decide for the nearest constellation point, however not independent for each subcarrier in the RB. 12 constellation points are decided dependent, using the applicable CAZAC sequence. Result: Nominal OFDM data symbols

At this stage we have an array of Measured data-Symbols and reference-Symbols (MS(f,t))

versus an array of Nominal data-Symbols and reference Symbols (NS(f,t))

The arrays comprise in sum 7 data and reference symbols, depending on the PUCCH format, in the time axis and the number of allocated sub-carriers in the frequency axis.

MS(f,t) and NS(f,t) are processed with a least square (LS) estimator, to derive one equalizer coefficient per time slot and per allocated subcarrier. EC(f)

$$EC(f)=\frac{\sum_{t=0}^{6} NS(f,t)^{*}\,NS(f,t)}{\sum_{t=0}^{6} MS(f,t)^{*}\,NS(f,t)}$$

With * denoting complex conjugation.

EC(f) are used to equalize the OFDM data together with the demodulation reference symbols by:

$$Z'(f,t) = MS(f,t) \cdot EC(f)$$

With · denoting multiplication.

Z'(f,t) is used to calculate EVM_{PUCCH}, as described in E.5.9 1

NOTE: although an exclusion period for EVM_{PUCCH} is applicable in E.5.9.1, the post FFT minimisation process is done over 7 OFDM symbols.

The samples of the non allocated resource blocks within the transmission bandwidth configuration in the post FFT domain are called Y(f,t) (f covering the non allocated subcarriers within the transmission bandwidth configuration, t covering the OFDM symbols during 1 slot).

E.5.9 Derivation of the results

E.5.9.1 EVM_{PUCCH}

For EVM_{PUCCH} create two sets of Z'(f,t)., according to the timing " $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2" using the equalizer coefficients from E.5.8

The EVM_{PUCCH} is the difference between the ideal waveform and the measured and equalized waveform for the allocated RB(s)

$$EVM_{PUCCH}=\sqrt{\frac{\sum_{t\in T}\sum_{f\in F}\left|Z'(f,t)-I(f,t)\right|^{2}}{|T|\cdot P_0\cdot|F|}},$$

where

the OFDM symbols next to transition boarders (instant of PUCCH frequency hopping) are excluded:

t covers less than the count of demodulated symbols in the slot (|T|= 5)

f covers the count of subcarriers within the allocated bandwidth. (|F|=12)

$Z'(f,t)$ are the samples of the signal evaluated for the EVM_{PUCCH}

$I(f,t)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 is equal to 1.

From the acquired samples 2*n* EVM_{PUCCH} value can be derived, *n* values for the timing $\Delta\tilde{c}$ –W/2 and *n* values for the timing $\Delta\tilde{c}$ +W/2

E.5.9.2 Averaged EVM_{PUCCH}

EVM_{PUCCH} is averaged over all basic EVM_{PUCCH} measurements

The averaging comprises *n* UL slots

$$\overline{EVM}_{PUCCH} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(EVM_{PUCCH,i}\right)^2}$$

The averaging is done separately for timing $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2 leading to $\overline{EVM}_{PUCCH,low}$ and $\overline{EVM}_{PUCCH,high}$

$EVM_{PUCCH,final} = \max(\overline{EVM}_{PUCCH,low}, \overline{EVM}_{PUCCH,high})$ is compared against the test requirements.

E.5.9.3 In-band emissions measurement

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks

Create one set of Y(t,f) per slot according to the timing "$\Delta\tilde{c}$"

For the non-allocated RBs the in-band emissions are calculated as follows

$$Emissions_{absolute}(\Delta_{RB}) = \begin{cases} \dfrac{1}{|T_s|}\displaystyle\sum_{t\in T_s}\sum_{\max(f_{\min},(c_l+12\cdot\Delta_{RB}*\Delta f))}^{c_l+(12\cdot\Delta_{RB}+11)*\Delta f}|Y(t,f)|^2, \Delta_{RB}<0 \\ \dfrac{1}{|T_s|}\displaystyle\sum_{t\in T_s}\sum_{c_h+(12\cdot\Delta_{RB}-11)*\Delta f}^{\min(f_{\max},(c_h+12\cdot\Delta_{RB}*\Delta f))}|Y(t,f)|^2, \Delta_{RB}>0 \end{cases},$$

where

the upper formula represents the inband emissions below the allocated frequency block and the lower one the inband emissions above the allocated frequency block.

T_s is a set of $|T_s|$ OFDM symbols in the measurement period,

Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. $\Delta_{RB} = 1$ for the first upper or $\Delta_{RB} = -1$ for the first lower adjacent RB),

$f_{\min}$ and $f_{\max}$ are the lower and upper edge of the UL system BW,

c_l and c_h are the lower and upper edge of the allocated BW,

Δf is the SCS, and

$Y(t,f)$ is the frequency domain signal evaluated for in-band emissions as defined in the subsection E.5.8

The relative in-band emissions are, given by

$$Emissions_{relative}(\Delta_{RB}) = 10*\log_{10} \frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_s| \cdot L_{CRBs}} \sum_{t \in T_s} \sum_{c_1}^{c_1+(12 \cdot L_{CRBs}-1)*\Delta f} |MS(t,f)|^2} [dB]$$

where

L_{CRBs} is the number of allocated RBs,

and $MS(t, f)$ is the frequency domain samples for the allocated bandwidth, as defined in the subsection E.5.8

Although an exclusion period for EVM is applicable in E.5.9.1, the inband emissions measurement interval is defined over one complete slot in the time domain.

From the acquired samples *n* functions for inband emissions can be derived.

The in-band emissions are averaged over the *n* samples (equivalent to 10 UL subframes) with the same PUCCH position to prevent averaging of allocated and non-allocated RBs due to PUCCH frequency hopping:

$$\overline{Emissions}_{absolute}(\Delta_{RB}) = \frac{1}{n}\sum_{i=1}^{n} Emissions_{absolute,i}(\Delta_{RB})$$

$$\overline{Emissions}_{relative}(\Delta_{RB}) = 10*\log_{10}\left(\frac{1}{n}\sum_{i=1}^{n} 10^{Emissions_{relative,i}(\Delta_{RB})/10}\right) \quad [dB]$$

Since the PUCCH allocation is always on the upper or lower band-edge, the opposite of the allocated one represents the IQ image, and the remaining inner RBs represent the general inband emissions. They are compared against different limits.

E.6 EVM for PRACH

The description below is generic in the sense that all PRACH formats are covered. The numbers, used in the text below are taken from PRACH format B4 without excluding the other formats. The sampling rate for the PUSCH, 122.88 Mbps in the time domain, is re-used for the PRACH. The carrier spacing of the PUSCH is up to 48 times higher than that of PRACH depending on the PRACH format and SCS. This results in an oversampling factor *ovf* of up to 48, when acquiring the time samples for the PRACH. The pre-FFT algorithms (clauses E.6.6 and E.6.7) use all time samples, although oversampled. For the FFT the time samples are decimated by the *ovf*, resulting in the same FFT size as for the other transmit modulation tests. Decimation requires a decision, which samples are used and which ones are rejected. The algorithm in E.6.6, Timing of the FFT window, can also be used to decide about the used samples.

E.6.1 Basic principle

The basic principle is the same as described in E.2.1

E.6.2 Output signal of the TX under test

The output signal of the TX under test is processed same as described in E.2.2

The measurement period is different since 2 PRACH preambles are recorded for long preamble formats as defined in Table 6.3.3.1-1 in [9] and 10 preambles are recorded for short preamble formats as defined in Table 6.3.3.1-2 in [9].

E.6.3 Reference signal

The test description in 6.4.2.1.4.1 is based on non-contention based access:

- PRACH configuration index (responsible for Preamble format, System frame number and subframe number)
- Preamble ID
- Preamble power

signalled to the UE, defines the reference signal unambiguously, such that no demodulation process is necessary to gain the reference signal.

The reference signal i(v) is constructed by the measuring equipment according to the relevant TX specifications, using the following parameters: the applicable Zadoff Chu sequence, nominal carrier frequency, nominal amplitude and phase for each subcarrier, nominal timing, no carrier leakage. It is represented as a sequence of samples at a sampling rate of 122.88 Mbps in the time domain.

E.6.4 Measurement results

The measurement result is:

- EVMPRACH

E.6.5 Measurement points

The measurement points are illustrated in the figure below:

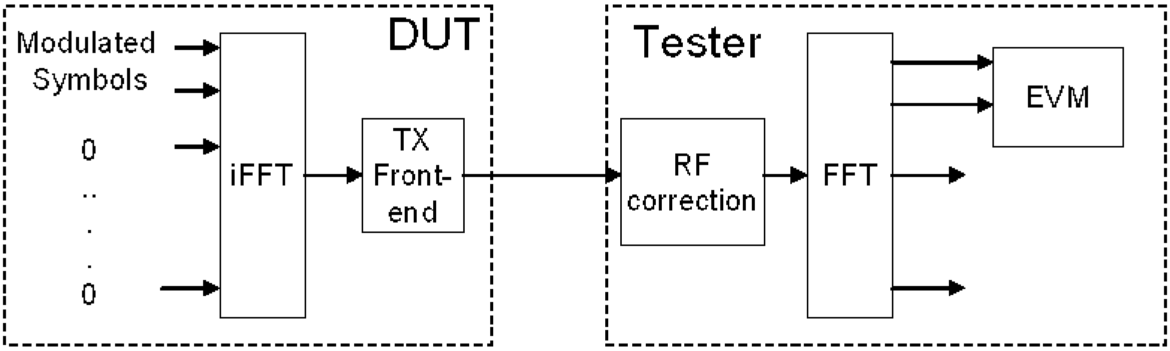


Figure E.6.5-1: Measurement points

E.6.6 Pre FFT minimization process

The pre-FFT minimization process is applied to each PRACH preamble separately. The time period for the pre- FFT minimisation process includes the complete CP and Zadoff-Chu sequence (in other words, the power transition period is per definition outside of this time period) Sample timing, Carrier frequency and carrier leakage in z(v) are jointly varied in order to minimise the difference between z(v) and i(v). Best fit (minimum difference) is achieved when the RMS difference value between z(v) and i(v) is an absolute minimum.

After this process the samples z(v) are called $z^0(v)$.

RF error, and carrier leakage are necessary for best fit of the measured signal towards the ideal signal in the pre FFT domain. However they are not used to compare them against the limits.

E.6.7 Timing of the FFT window

The FFT window length is $8192 \cdot 2^{-\mu}$ samples for preamble format B4, however in the measurement period at least $11936 \cdot 2^{-\mu}$ samples are taken where $\mu \in \{2,3\}$. The position in time for FFT must be determined.

In an ideal signal, the FFT may start at any instant within the cyclic prefix without causing an error. The TX filter, however, reduces the window. The EVM requirements shall be met within a window W<CP.

The reference instant for the FFT start is the centre of the reduced window, called $\Delta\tilde{c}$,

EVM is measured at the following two instants: $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2.

The timing of the measured signal $z^0(\nu)$ with respect to the ideal signal i(ν) is determined in the pre FFT domain as follows:

Correlation between $z^0(\nu)$ and i(ν) will result in a correlation peak. The meaning of the correlation peak is approx. the “impulse response” of the TX filter. The correlation peak, (the highest, or in case of more than one, the earliest) indicates the timing in the measured signal with respect to the ideal signal.

W is different for different preamble formats and shown in Table E.6.7-1 for $L_{\mathrm{RA}} = 139$ and $\Delta f^{\mathrm{RA}} = 15 \cdot 2^{\mu}$ kHz where $\mu \in \{2,3\}$.

Table E.6.7-1 EVM window length for PRACH formats for $L_{\mathrm{RA}} = 139$

Preamble format	Cyclic prefix length N_{cp}	Nominal FFT size[1]	EVM window length *W* in FFT samples	Ratio of *W* to CP*
A1	$1152 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$576 \cdot 2^{-\mu}$	50.0%
A2	$2304 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$1728 \cdot 2^{-\mu}$	75.0%
A3	$3456 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$2880 \cdot 2^{-\mu}$	83.3%
B1	$864 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$288 \cdot 2^{-\mu}$	33.3%
B2	$1440 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$864 \cdot 2^{-\mu}$	60.0%
B3	$2016 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$1440 \cdot 2^{-\mu}$	71.4%
B4	$3744 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$3168 \cdot 2^{-\mu}$	84.6%
C0	$4960 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$4384 \cdot 2^{-\mu}$	88.4%
C2	$8192 \cdot 2^{-\mu}$	$8192 \cdot 2^{-\mu}$	$7616 \cdot 2^{-\mu}$	93.0%
Note 1: The use of other FFT sizes is possible as long as appropriate scaling of the window length is applied. Note 2: These percentages are informative.				

The number of samples, used for FFT is reduced compared to $z^0(\nu)$. This subset of samples is called z’’(ν).

The sample frequency 122.88 MHz is oversampled with respect to the PRACH-subcarrier spacing of $\Delta f^{\mathrm{RA}} = 15 \cdot 2^{\mu}$ kHz . EVM is based on $8192 \cdot 2^{-\mu}$ samples per PRACH preamble and requires decimation of the time samples by the factor of $12 \cdot 2^{\mu}$. The final number of samples per PRACH preamble, used for FFT is reduced compared to z’’(ν) by the same factor. This subset of samples is called z’(ν).

E.6.8 Post FFT equalisation

Equalisation is not applicable for the PRACH.

E.6.9 Derivation of the results

E.6.9.1 $\mathrm{EVM}_{\mathrm{PRACH}}$

Perform FFT on z’(ν) and i(ν) using the FFT timing $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2.

For format B4 the first and the repeated preamble sequence are FFT-converted separately using the standard FFT length of 8192.

The $\mathrm{EVM}_{\mathrm{PRACH}}$ is the difference between the ideal waveform and the measured and equalized waveform for the allocated RB(s).

$$EVM_{PRACH} = \sqrt{\frac{\sum_{t \in T} \sum_{f \in F} \left| Z'(f,t) - I(f,t) \right|^2}{|T| \cdot P_0 \cdot |F|}}$$

where

t covers the count of demodulated symbols in the slot.

f covers the count of demodulated symbols within the allocated bandwidth.

$Z'(f,t)$ are the samples of the signal evaluated for the EVM_{PRACH}

$I(f,t)$ is the ideal signal reconstructed by the measurement equipment, and

P_0 is the average power of the ideal signal. For normalized modulation symbols P_0 is equal to 1.

From the acquired samples 2*m* EVM_{PRACH} values can be derived, *m* values for the timing $\Delta\tilde{c}$ –W/2 and *m* values for the timing $\Delta\tilde{c}$ +W/2.

E.6.9.2 Averaged EVM$_{PRACH}$

The PRACH EVM, EVM_{PRACH}, is averaged over *m* preamble sequence measurements.

$$\overline{EVM}_{\text{PRACH}} = \sqrt{\frac{1}{m}\sum_{i=1}^{m}\left(EVM_{\text{PRACH},i}\right)^2}$$

where *m* is the number of recorded preambles as defined in Annex E.6.2.

The averaging is done separately for timing $\Delta\tilde{c}$ –W/2 and $\Delta\tilde{c}$ +W/2 leading to $\overline{EVM}_{PRACH,\Delta\tilde{c}-W/2}$ and $\overline{EVM}_{PRACH,\Delta\tilde{c}+W/2}$

$\overline{EVM}_{PRACH,final} = \max(\overline{EVM}_{PRACH,\Delta\tilde{c}-W/2}, \overline{EVM}_{PRACH,\Delta\tilde{c}+W/2})$ is compared against the test requirements.

Annex F (normative): Measurement uncertainties and Test Tolerances

F.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.1.1 Measurement of test environments

Editor's note: Various measurement accuracies for UE test environments, e.g., pressure, relative humidity, DC&AC voltage, vibration, and vibration frequency, are FFS:

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

- Temperature ±4 degrees.

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.1.2 Measurement of transmitter

Table F.1.2-1: Maximum Test System Uncertainty (MTSU) for transmitter tests

Sub clause	Maximum Test System Uncertainty	Derivation of MTSU
6.2.1.1 UE maximum output power (EIRP)	PC3 Minimum peak EIRP, Max EIRP Max Device size ≤ 30 cm ±4.89 dB (FR2a, NTC testing) ±5.09 dB (FR2b, NTC testing) ±5.17 dB (FR2a, ETC testing) ±5.37 dB (FR2b, ETC testing) PC1 Minimum peak EIRP, Max EIRP Max Device size ≤ 30 cm ±[5.33] dB (FR2a, NTC testing) ±TBD dB (FR2b, NTC testing) ±TBD dB (FR2a, ETC testing) ±TBD dB (FR2b, ETC testing)	MTSU = 1.00 x MU (from Table B.3-1 in TR 38.903)
6.2.1.1 UE maximum output power (TRP)	PC3 Max TRP Max Device size ≤ 30 cm ±4.42 dB (FR2a, NTC testing) ±4.62 dB (FR2b, NTC testing) ±4.70 dB (FR2a, ETC testing) ±4.90 dB (FR2b, ETC testing) PC1 Max TRP Max Device size ≤ 30 cm ±[4.64] dB (FR2a, NTC testing) ± TBD dB (FR2b, NTC testing) ± TBD dB (FR2a, ETC testing) ± TBD dB (FR2b, ETC testing)	MTSU = 1.00 x MU (from Table B.3-2 in TR 38.903)
6.2.1.1_1 UE maximum output power – EIRP (Rel-16 and forward)	Same as 6.2.1.1	
6.2.1.2 UE maximum output power (Spherical coverage)	PC3 Max Device size ≤ 30 cm ±4.60 dB (FR2a) ±5.20 dB (FR2b) PC1 Max Device size ≤ 30 cm TBD	MTSU = 1.00 x MU (from Table B.3-3 in TR 38.903)
6.2.1.2_1 UE maximum output power – Spherical coverage (Rel16 and forward)	Same as 6.2.1.2	
6.2.2 UE maximum output power reduction	PC3 Max Device size ≤ 30 cm ±4.92 dB (FR2a), NTC testing ±5.10 dB (FR2b), NTC testing ±5.20 dB (FR2a, ETC testing) ±5.38 dB (FR2b, ETC testing)	MTSU = 1.00 x MU (from Table B.4-1 in TR 38.903)
6.2.2_1 UE maximum output power reduction enhancements	Same as 6.2.2	
6.2.3 UE maximum output power with additional requirements	Same as 6.2.2	
6.2.4 Configured transmitted power	TBD	
6.2.4_1 Configured transmitted power with Power Boost	Same as 6.2.1.1	

6.2A.1.1.1 UE maximum output power - EIRP and TRP for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.1.1.2 UE maximum output power - EIRP and TRP for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.1.1.3 UE maximum output power - EIRP and TRP for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.1.1.4 UE maximum output power - EIRP and TRP for CA (5UL CA)	Intra-band contiguous CA TBD	
6.2A.1.1.5 UE maximum output power - EIRP and TRP for CA (6UL CA)	Intra-band contiguous CA TBD	
6.2A.1.1.6 UE maximum output power - EIRP and TRP for CA (7UL CA)	Intra-band contiguous CA TBD	
6.2A.1.1.7 UE maximum output power - EIRP and TRP for CA (8UL CA)	Intra-band contiguous CA TBD	
6.2A.1.2.1 Spherical coverage for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.1.2.2 Spherical coverage for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.1.2.3 Spherical coverage for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.1.2.4 Spherical coverage for CA (5UL CA)	Intra-band contiguous CA TBD	

6.2A.1.2.5 Spherical coverage for CA (6UL CA)	Intra-band contiguous CA TBD	
6.2A.1.2.6 Spherical coverage for CA (7UL CA)	Intra-band contiguous CA TBD	
6.2A.1.2.7 Spherical coverage for CA (8UL CA)	Intra-band contiguous CA TBD	
6.2A.2.1 UE maximum output power reduction for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	MTSU = 1.00 x MU (from Table B.4-1 in TR 38.903)
6.2A.2.2 UE maximum output power reduction for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.2.3 UE maximum output power reduction for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.2.4 UE maximum output power reduction for CA (5UL CA)	Intra-band contiguous CA TBD	
6.2A.2.5 UE maximum output power reduction for CA (6UL CA)	Intra-band contiguous CA TBD	
6.2A.2.6 UE maximum output power reduction for CA (7UL CA)	Intra-band contiguous CA TBD	
6.2A.2.7 UE maximum output power reduction for CA (8UL CA)	Intra-band contiguous CA TBD	
6.2D.2 UE maximum output power reduction for UL MIMO	Same as 6.2.2	
6.2D.3 UE maximum output power with additional requirements for UL MIMO	Same as 6.2.3	
6.3.1 Minimum output power	PC1 Minimum peak EIRP, Max EIRP Max Device size ≤ 30 cm FFS (FR2a) FFS dB (FR2b) PC3 Minimum peak EIRP, Max EIRP Max Device size ≤ 30 cm ±6.15 dB (FR2a & FR2b, NTC testing ±6.41 dB (FR2a & FR2b, ETC testing))	MTSU = 1.00 x MU (from Table B.7-1 in TR 38.903)
6.3.2 Transmit OFF power	PC3: Max Device size ≤ 30 cm ±5.67 dB (FR2a) PC1: Max Device size ≤ 30 cm ±[5.67] dB (FR2a)	MTSU = 1.00 x MU (from Table B.8-1 in TR 38.903)

6.3.3.2 General ON/OFF time mask	ON power: Same as 6.2.1.1 (EIRP) for the respective power class OFF power: Same as 6.3.1 for the respective power class	
6.3.3.4 PRACH time mask	PC3: PRACH power: TBD OFF power: Max Device size ≤ 30 cm ±6.15 dB (FR2a & FR2b, NTC testing) ±6.41 dB (FR2a & FR2b, ETC testing)	
6.3.3.6 SRS time mask	TBD	
6.3.4.2 Absolute power tolerance	PC3 Max Device size ≤ 30 cm ±8.05 dB (FR2a & FR2b, NTC testing) ±8.42 dB (FR2a & FR2b, ETC testing)	MTSU = SQRT (UL Meas Uncer^2 + DL Meas Uncer^2) UL Meas Uncer: Same as 6.3.1 DL Meas Uncer: Same as 7.3.2
6.3.4.3 Relative power tolerance	PC3 Max Device size ≤ 30 cm [±1.7 dB] (FR2a) [±1.7 dB] (FR2b)	MTSU = 1.00 x MU (from Table B.9a.2.2-2 in TR 38.903)
6.3.4.4 Aggregate power tolerance	PC3 Max Device size ≤ 30 cm ±1.4 dB (FR2a) ±1.4 dB (FR2b)	MTSU = 1.00 x MU (from Table B.9a.3.2-2 in TR 38.903)
6.3A.1.1 Minimum output power for CA (2UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 for each CC For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.2 Minimum output power for CA (3UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 for each CC For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.3 Minimum output power for CA (4UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 for each CC For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.4 Minimum output power for CA (5UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 for each CC For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.5 Minimum output power for CA (6UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 for each CC For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.6 Minimum output power for CA (7UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 for each CC For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.7 Minimum output power for CA (8UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 for each CC For UL CA aggregated BW > 800 MHz: TBD	
6.3A.3.1.1 General ON/OFF time mask for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.3 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	

6.3A.3.1.2 General ON/OFF time mask for CA (3UL CA)	<u>Intra-band contiguous CA</u> Maximum aggregated BW ≤ 400MHz Same as 6.3.3 Maximum aggregated BW > 400MHz TBD <u>Intra-band non-contiguous, Inter-band CA</u> TBD	
6.3A.3.1.3 General ON/OFF time mask for CA (4UL CA)	<u>Intra-band contiguous CA</u> Maximum aggregated BW ≤ 400MHz Same as 6.3.3 Maximum aggregated BW > 400MHz TBD <u>Intra-band non-contiguous, Inter-band CA</u> TBD	
6.3A.3.1.4 General ON/OFF time mask for CA (5UL CA)	<u>Intra-band contiguous CA</u> TBD	
6.3A.3.1.5 General ON/OFF time mask for CA (6UL CA)	<u>Intra-band contiguous CA</u> TBD	
6.3A.3.1.6 General ON/OFF time mask for CA (7UL CA)	<u>Intra-band contiguous CA</u> TBD	
6.3A.3.1.7 General ON/OFF time mask for CA (8UL CA)	<u>Intra-band contiguous CA</u> TBD	
6.3A.4.2.1 Absolute power tolerance for CA (2UL CA)	<u>Intra-band contiguous CA</u> Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD <u>Intra-band non-contiguous, Inter-band CA</u> TBD	
6.3A.4.2.2 Absolute power tolerance for CA (3UL CA)	<u>Intra-band contiguous CA</u> Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD <u>Intra-band non-contiguous, Inter-band CA</u> TBD	
6.3A.4.2.3 Absolute power tolerance for CA (4UL CA)	<u>Intra-band contiguous CA</u> Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD <u>Intra-band non-contiguous, Inter-band CA</u> TBD	
6.3A.4.2.4 Absolute power tolerance for CA (5UL CA)	<u>Intra-band contiguous CA</u> Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD <u>Intra-band non-contiguous, Inter-band CA</u> TBD	

6.3A.4.2.5 Absolute power tolerance for CA (6UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.2.6 Absolute power tolerance for CA (7UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.2.7 Absolute power tolerance for CA (8UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.3.1 Relative power tolerance for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz TBD Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.3.2 Relative power tolerance for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz TBD Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.3.3 Relative power tolerance for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz TBD Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.3.4 Relative power tolerance for CA (5UL CA)	Intra-band contiguous CA TBD	
6.3A.4.3.5 Relative power tolerance for CA (6UL CA)	Intra-band contiguous CA TBD	
6.3A.4.3.6 Relative power tolerance for CA (7UL CA)	Intra-band contiguous CA TBD	
6.3A.4.3.7 Relative power tolerance for CA (8UL CA)	Intra-band contiguous CA TBD	

6.3A.4.4.1 Aggregate power tolerance for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.4 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.4.2 Aggregate power tolerance for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.4 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.4.3 Aggregate power tolerance for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.4 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.4.4 Aggregate power tolerance for CA (5UL CA)	Intra-band contiguous CA TBD	
6.3A.4.4.5 Aggregate power tolerance for CA (6UL CA)	Intra-band contiguous CA TBD	
6.3A.4.4.6 Aggregate power tolerance for CA (7UL CA)	Intra-band contiguous CA TBD	
6.3A.4.4.7 Aggregate power tolerance for CA (8UL CA)	Intra-band contiguous CA TBD	
6.3D.3.1 General ON/OFF time mask for UL MIMO	PC3: OFF Power Max Device size ≤ 30cm ± 6.15 dB (FR2a) ± 6.15 dB (FR2b) ON Power Quiet Zone size ≤ 30cm TBD (FR2a) TBD (FR2b)	OFF Power MTSU = 1.00 x MU (from Table B.8-2-4 in TR 38.903) ON Power TBD
6.3D.3.4 SRS time mask for UL MIMO	PC3: OFF Power Max Device size ≤ 30cm ± 6.15 dB (FR2a) ± 6.15 dB (FR2b) ON Power Quiet Zone size ≤ 30cm TBD (FR2a) TBD (FR2b)	OFF Power MTSU = 1.00 x MU (from Table B.8-2-4 in TR 38.903) ON Power TBD
6.4.1 Frequency error	± 0.01 ppm (NTC & ETC testing)	MTSU = 1.00 x MU (from B.10.1 and B.10.2 in TR 38.903)
6.4.2.1 Error vector magnitude	PUSCH, PC3, FR2a: As defined in Table F.1.2-2. PUSCH, PC3, FR2b: As defined in Table F.1.2-3. Otherwise: TBD	

6.4.2.2 Carrier leakage	PC3 Max Device size ≤ 30 cm ±5.44 dB (FR2a) ±5.57 dB (FR2b) uplink absolute power measurement uncertainty: 6.15 dB (FR2a & FR2b, NTC testing) uplink relative power measurement uncertainty: 1.4 dB (FR2a & FR2b, NTC testing)	MTSU = 1.00 x MU (from Table B.11-1 in TR 38.903)
6.4.2.3 In-band emissions	TBD	
6.4.2.4 EVM equalizer spectrum flatness	TBD	
6.4.2.5 EVM equalizer spectrum flatness for BPSK modulation	TBD	
6.4A.1.1 Frequency error for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.4.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.4A.1.2 Frequency error for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.4.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.4A.1.3 Frequency error for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.4.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.4A.1.4 Frequency error for CA (5UL CA)	Intra-band contiguous CA TBD	
6.4A.1.5 Frequency error for CA (6UL CA)	Intra-band contiguous CA TBD	
6.4A.1.6 Frequency error for CA (7UL CA)	Intra-band contiguous CA TBD	
6.4A.1.7 Frequency error for CA (8UL CA)	Intra-band contiguous CA TBD	
6.4A.2.1.1 Error Vector magnitude for CA (2UL CA)	TBD	
6.4A.2.1.2 Error Vector magnitude for CA (3UL CA)	TBD	
6.4A.2.1.3 Error Vector magnitude for CA (4UL CA)	TBD	
6.4A.2.1.4 Error Vector magnitude for CA (5UL CA)	TBD	
6.4A.2.1.5 Error Vector magnitude for CA (6UL CA)	TBD	
6.4A.2.1.6 Error Vector magnitude for CA (7UL CA)	TBD	
6.4A.2.1.7 Error Vector magnitude for CA (8UL CA)	TBD	

6.4A.2.2.1 Carrier leakage for CA (2UL CA)	TBD	
6.4A.2.2.2 Carrier leakage for CA (3UL CA)	TBD	
6.4A.2.2.3 Carrier leakage for CA (4UL CA)	TBD	
6.4A.2.2.4 Carrier leakage for CA (5UL CA)	TBD	
6.4A.2.2.5 Carrier leakage for CA (6UL CA)	TBD	
6.4A.2.2.6 Carrier leakage for CA (7UL CA)	TBD	
6.4A.2.2.7 Carrier leakage for CA (8UL CA)	TBD	
6.4A.2.3.1 In-band emissions for CA (2UL CA)	TBD	
6.4A.2.3.2 In-band emissions for CA (3UL CA)	TBD	
6.4A.2.3.3 In-band emissions for CA (4UL CA)	TBD	
6.4A.2.3.4 In-band emissions for CA (5UL CA)	TBD	
6.4A.2.3.5 In-band emissions for CA (6UL CA)	TBD	
6.4A.2.3.6 In-band emissions for CA (7UL CA)	TBD	
6.4A.2.3.7 In-band emissions for CA (8UL CA)	TBD	
6.5.1 Occupied bandwidth	Max Device size ≤ 30cm PC3: FR2a: ±0.4 [%CBW] (BW 50MHz) ±0.4 [%CBW] (BW 100MHz) ±1.2 [%CBW] (BW 200MHz) ±1.2 [%CBW] (BW 400MHz) FR2b: ±0.4 [%CBW] (BW 50MHz) ±0.4 [%CBW] (BW 100MHz) ±1.3 [%CBW] (BW 200MHz) ±1.3 [%CBW] (BW 400MHz) FR2c: TBD	
6.5.2.1 Spectrum Emission Mask	Max Device size ≤ 30 cm ±4.94 dB (FR2a) ±5.32 dB (FR2b)	MTSU = 1.00 x MU (from Table B.16-1 in TR 38.903)
6.5.2.3 Adjacent Channel Leakage Ratio	Max Device size ≤ 30cm FR2a, NTC & ETC testing: ±5.63 dB (BW ≤ 50MHz) ±6.09 dB (50MHz < BW ≤ 100MHz) ±6.09 dB (100MHz < BW ≤ 200MHz) ±6.09 dB (200MHz < BW ≤ 400MHz) FR2b, NTC & ETC testing: ±6.09 dB (BW ≤ 50MHz) ±6.09 dB (50MHz < BW ≤ 100MHz) ±6.09 dB (100MHz < BW ≤ 200MHz) ±6.09 dB (200MHz < BW ≤ 400MHz)	MTSU = 1.00 x MU (from Table B.17-1B in TR 38.903)

6.5.3.1 Transmitter Spurious emissions	Max Device size ≤ 30 cm Maximum in-band BW ≤ 400MHz ±5.14 dB (6GHz ≤ f ≤ 12.75GHz) ±5.11 dB (12.75GHz < f ≤ 23.45GHz) ±5.41 dB (23.45GHz < f < 40.8GHz) ±7.42 dB (40.8GHz ≤ f ≤ 66GHz) ±7.72 dB (66GHz ≤ f ≤ 80GHz)	MTSU = 1.00 x MU (from Table B.18-1 in TR 38.903)
6.5.3.2 Spurious emission band UE co-existence	Max Device size ≤ 30 cm Maximum in-band BW ≤ 400MHz Protected band n260, n261, n257: ±6.00 dB Protected frequency 23.6 GHz ≤ f ≤ 24.0 GHz:±6.00 dB Protected frequency 57 GHz ≤ f ≤ 66GHz: ±8.01 dB Protected frequency 36 GHz ≤ f ≤ 37GHz: ±6.00 dB	MTSU = 1.00 x MU (from Table B.18-1a in TR 38.903)
6.5.3.3 Additional Spurious emission	Max Device size ≤ 30 cm Maximum in-band BW ≤ 400MHz ±5.14 dB (6GHz ≤ f ≤ 12.75GHz), NS_202 ±5.70 dB (12.75GHz < f ≤ 23.45GHz), NS_202 ±6.00 dB (23.45GHz < f < 40.8GHz), NS_202, NS_203 ±8.01 dB (40.8GHz ≤ f ≤ 2nd harmonic of the upper frequency edge of the UL operating band), NS_202	MTSU = 1.00 x MU (from Table B.18-1b in TR 38.903)
6.5A.1.1 Occupied bandwidth for CA (2UL CA)	<u>Intra-band contiguous CA</u> Maximum aggregated BW ≤ 400MHz Max Device size ≤ 30cm PC3: FR2a: TBD FR2b: TBD FR2c: TBD Maximum aggregated BW > 400MHz TBD <u>Intra-band non-contiguous, Inter-band CA</u> TBD	
6.5A.1.2 Occupied bandwidth for CA (3UL CA)	<u>Intra-band contiguous CA</u> Maximum aggregated BW ≤ 400MHz Same as 6.5A.1.1 Maximum aggregated BW > 400MHz TBD <u>Intra-band non-contiguous, Inter-band CA</u> TBD	

6.5A.1.3 Occupied bandwidth for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5A.1.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.1.4 Occupied bandwidth for CA (5UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5A.1.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.1.5 Occupied bandwidth for CA (6UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5A.1.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.1.6 Occupied bandwidth for CA (7UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5A.1.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.1.7 Occupied bandwidth for CA (8UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5A.1.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.2.1.1 Spectrum Emission Mask for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.2.1.2 Spectrum Emission Mask for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	

6.5A.2.1.3 Spectrum Emission Mask for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.2.1.4 Spectrum Emission Mask for CA (5UL CA)	TBD	
6.5A.2.1.5 Spectrum Emission Mask for CA (6UL CA)	TBD	
6.5A.2.1.6 Spectrum Emission Mask for CA (7UL CA)	TBD	
6.5A.2.1.7 Spectrum Emission Mask for CA (8UL CA)	TBD	
6.5A.2.2.1 Adjacent channel leakage ratio for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.3 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	MTSU = 1.00 x MU (from Table B.17-1B in TR 38.309)
6.5A.2.2.2 Adjacent channel leakage ratio for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.3 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.2.2.3 Adjacent channel leakage ratio for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.3 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.2.2.4 Adjacent channel leakage ratio for CA (5UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	
6.5A.2.2.5 Adjacent channel leakage ratio for CA (6UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	
6.5A.2.2.6 Adjacent channel leakage ratio for CA (7UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	
6.5A.2.2.7 Adjacent channel leakage ratio for CA (8UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	

6.5A.3.1.1 Transmitter Spurious emissions for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.3.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.3.1.2 Transmitter Spurious emissions for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.3.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.3.1.3 Transmitter Spurious emissions for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.3.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.3.1.4 Transmitter Spurious emissions for CA (5UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	
6.5A.3.1.5 Transmitter Spurious emissions for CA (6UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	
6.5A.3.1.6 Transmitter Spurious emissions for CA (7UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	
6.5A.3.1.7 Transmitter Spurious emissions for CA (8UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	
6.5A.3.2.1 Spurious emission band UE co-existence for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.3.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.3.2.2 Spurious emission band UE co-existence for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.3.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	

6.5A.3.2.3 Spurious emission band UE co-existence for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.3.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.3.2.4 Spurious emission band UE co-existence for CA (5UL CA)	TBD	
6.5A.3.2.5 Spurious emission band UE co-existence for CA (6UL CA)	TBD	
6.5A.3.2.6 Spurious emission band UE co-existence for CA (7UL CA)	TBD	
6.5A.3.2.7 Spurious emission band UE co-existence for CA (8UL CA)	TBD	
6.5A.3.3.1 Additional spurious emissions for CA (2UL CA)	TBD	
6.5A.3.3.2 Additional spurious emissions for CA (3UL CA)	TBD	
6.5A.3.3.3 Additional spurious emissions for CA (4UL CA)	TBD	
6.5A.3.3.4 Additional spurious emissions for CA (5UL CA)	TBD	
6.5A.3.3.5 Additional spurious emissions for CA (6UL CA)	TBD	
6.5A.3.3.6 Additional spurious emissions for CA (7UL CA)	TBD	
6.5A.3.3.7 Additional spurious emissions for CA (8UL CA)	TBD	
6.5D.2.1 Spectrum Emission Mask for UL MIMO	Same as 6.5.2.1	
6.5D.2.2 Adjacent channel leakage ratio for UL MIMO	Same as 6.5.2.3	
6.6.1 Beam correspondence – EIRP	PC3 Max Device size ≤ 30 cm 2.67 dB (FR2a, NTC testing) 3.80 dB (FR2b, NTC testing)	MTSU = 1.00 x MU (from Table B.18a.2-2 in TR 38.309)
6.6.2 Enhanced Beam correspondence - EIRP	Same as 6.6.1	
NOTE 1: FR2a: 23.45GHz ≤ f ≤ 32.125GHz FR2b: 32.125GHz ≤ f ≤ 40.8GHz FR2c: 40.8GHz ≤ f ≤ 44.3GHz		

Table F.1.2-2: EVM Measurement Uncertainty (MU) for PUSCH, PC3, FR2a (23.45GHz <= f <= 32.125GHz)

Test ID	Modulation	RB alloc.	50MHz	100MHz	200MHz	400MHz
1	DFT-s-OFDM PI/2 BPSK	Inner_Full	2.78%	3.85%	5.44%	7.69%
2	DFT-s-OFDM PI/2 BPSK	Outer_Full	3.10%	4.16%	5.88%	8.99%
3	DFT-s-OFDM QPSK	Inner_Full	2.78%	3.85%	5.44%	7.69%
4	DFT-s-OFDM QPSK	Outer_Full	3.10%	4.16%	5.88%	8.99%
5	DFT-s-OFDM 16 QAM	Inner_Full	3.31%	4.50%	6.36%	11.21%
6	DFT-s-OFDM 16 QAM	Outer_Full	3.60%	4.73%	6.68%	11.21%
7	DFT-s-OFDM 64 QAM	Inner_Full	4.26%	5.96%	8.41%	15.84%
8	DFT-s-OFDM 64 QAM	Outer_Full	5.01%	7.08%	9.99%	15.84%
9	CP-OFDM QPSK	Inner_Full	3.60%	4.73%	6.68%	11.89%

10	CP-OFDM QPSK	Outer_Full	3.71%	4.99%	7.07%	11.89%
11	CP-OFDM 16 QAM	Inner_Full	4.26%	5.96%	8.41%	15.84%
12	CP-OFDM 16 QAM	Outer_Full	4.26%	5.96%	8.41%	15.84%
13	CP-OFDM 64 QAM	Inner_Full	6.31%	8.91%	12.59%	21.13%
14	CP-OFDM 64 QAM	Outer_Full	6.31%	8.91%	12.59%	21.13%

Table F.1.2-3: EVM Measurement Uncertainty (MU) for PUSCH, PC3, FR2b (32.125GHz < f <= 40.8GHz)

Test ID	Modulation	RB alloc.	50MHz	100MHz	200MHz	400MHz
1	DFT-s-OFDM PI/2 BPSK	Inner_Full	3.56%	4.83%	6.91%	9.65%
2	DFT-s-OFDM PI/2 BPSK	Outer_Full	4.15%	5.69%	8.11%	12.50%
3	DFT-s-OFDM QPSK	Inner_Full	3.56%	4.83%	6.91%	9.65%
4	DFT-s-OFDM QPSK	Outer_Full	4.15%	5.69%	8.11%	12.50%
5	DFT-s-OFDM 16 QAM	Inner_Full	4.54%	6.26%	8.91%	18.06%
6	DFT-s-OFDM 16 QAM	Outer_Full	5.09%	7.19%	10.15%	18.06%
7	DFT-s-OFDM 64 QAM	Inner_Full	6.78%	9.58%	13.54%	25.50%
8	DFT-s-OFDM 64 QAM	Outer_Full	8.06%	11.38%	16.09%	25.50%
9	CP-OFDM QPSK	Inner_Full	5.09%	7.19%	10.15%	19.13%
10	CP-OFDM QPSK	Outer_Full	5.39%	7.61%	10.75%	19.13%
11	CP-OFDM 16 QAM	Inner_Full	6.78%	9.58%	13.54%	25.50%
12	CP-OFDM 16 QAM	Outer_Full	6.78%	9.58%	13.54%	25.50%
13	CP-OFDM 64 QAM	Inner_Full	10.14%	14.33%	20.25%	34.01%
14	CP-OFDM 64 QAM	Outer_Full	10.14%	14.33%	20.25%	34.01%

F.1.3 Measurement of receiver

Table F.1.3-1: Maximum Test System Uncertainty (MTSU) for receiver tests

Sub clause	Maximum Test System Uncertainty	Derivation of MTSU
7.3.2 Reference sensitivity power level	PC3 Max Device size ≤ 30 cm ±5.19 dB (FR2a, FR2b, NTC testing) ±5.45 dB (FR2a, FR2b, ETC testing) PC1 Max Device size ≤ 30 cm ±[5.58] dB (FR2a, NTC testing) ± TBD dB (FR2a, ETC testing)	MTSU = 1.00 x MU (from Table B.19-1 in TR 38.903)
7.3.4 EIS spherical coverage	PC3 ±4.90 dB (Max Device size ≤ 30 cm, FR2a, FR2b) PC1 TBD	MTSU = 1.00 x MU (from Table B.19-2 in TR 38.903)
7.3A.2.1 Reference sensitivity power level for CA (2DL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 7.3.2 for each component carrier Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
7.3A.2.2 Reference sensitivity power level for CA (3DL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 7.3.2 for each component carrier Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
7.3A.2.3 Reference sensitivity power level for CA (4DL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 7.3.2 for each component carrier Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
7.3A.2.4 Reference sensitivity power level for CA (5DL CA)	TBD	
7.3A.2.5 Reference sensitivity power level for CA (6DL CA)	TBD	
7.3A.2.6 Reference sensitivity power level for CA (7DL CA)	TBD	
7.3A.2.7 Reference sensitivity power level for CA (8DL CA)	TBD	
7.3A.3.1 EIS spherical coverage for CA (2DL CA)	TBD	
7.3A.3.2 EIS spherical coverage for CA (3DL CA)	TBD	
7.3A.3.3 EIS spherical coverage for CA (4DL CA)	TBD	
7.3A.3.4 EIS spherical coverage for CA (5DL CA)	TBD	
7.3A.3.5 EIS spherical coverage for CA (6DL CA)	TBD	
7.3A.3.6 EIS spherical coverage for CA (7DL CA)	TBD	

7.3A.3.7 EIS spherical coverage for CA (8DL CA)	TBD	
7.4 Maximum input level	TBD	
7.4A.1 Maximum input level for CA (2DL CA)	TBD	
7.4A.2 Maximum input level for CA (3DL CA)	TBD	
7.4A.3 Maximum input level for CA (4DL CA)	TBD	
7.4A.4 Maximum input level for CA (5DL CA)	TBD	
7.4A.5 Maximum input level for CA (6DL CA)	TBD	
7.4A.6 Maximum input level for CA (7DL CA)	TBD	
7.4A.7 Maximum input level for CA ((DL CA)	TBD	
7.5 Adjacent channel selectivity	PC3 ±7.84 dB (Max Device size ≤ 30 cm, FR2a, FR2b) PC1 ±[8.31] dB (Max Device size ≤ 30 cm, FR2a)	MTSU = 1.00 x MU (from Table B.21-1 in TR 38.903)
7.5A.1 Adjacent channel selectivity for CA (2UL CA)	TBD	
7.5A.2 Adjacent channel selectivity for CA (3UL CA)	TBD	
7.5A.3 Adjacent channel selectivity for CA (4UL CA)	TBD	
7.5A.4 Adjacent channel selectivity for CA (5UL CA)	TBD	
7.5A.5 Adjacent channel selectivity for CA (6UL CA)	TBD	
7.5A.6 Adjacent channel selectivity for CA (7UL CA)	TBD	
7.5A.7 Adjacent channel selectivity for CA (8UL CA)	TBD	
7.6.2 In-band blocking	Same as 7.5	
7.6A.2.1 In-band blocking for CA (2UL CA)	TBD	
7.6A.2.2 In-band blocking for CA (3UL CA)	TBD	
7.6A.2.3 In-band blocking for CA (4UL CA)	TBD	
7.6A.2.4 In-band blocking for CA (5UL CA)	TBD	
7.6A.2.5 In-band blocking for CA (6UL CA)	TBD	
7.6A.2.6 In-band blocking for CA (7UL CA)	TBD	
7.6A.2.7 In-band blocking for CA (8UL CA)	TBD	
7.9 Spurious emissions	Max Device size ≤ 30 cm Maximum in-band BW ≤ 400MHz For Band n257, n258, n260, n261: ±5.50dB (6GHz ≤ f ≤ 12.75GHz) ±5.46dB (12.75GHz < f ≤ 23.45GHz) ±6.11dB (23.45GHz < f < 40.8GHz) ±7.65dB (40.8GHz ≤ f ≤ 66GHz) ±7.95 dB (66GHz ≤ f ≤ 80GHz)	MTSU = 1.00 x MU (from Table B.25-1 in TR 38.903)
NOTE 1: FR2a, FR2b and FR2c are specified in Table F.1.2-1.		

F.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.3 Test Tolerance and Derivation of Test Requirements (informative)

TBD

F.3.1 Measurement of test environments

TBD

F.3.2 Measurement of transmitter

Editor's note: This clause is incomplete. The following aspects are either missing or not yet determined:

- Influence of noise is subtracted from MTSU before calculating the TT for lower limit Tx test cases.

Table F.3.2-1: Derivation of Test Requirements (Transmitter tests)

Sub clause	Test Tolerance (TT)	Formula for test requirement
6.2.1.1 UE maximum output power (EIRP)	PC3 Minimum peak EIRP IFF (Max Device size ≤ 30 cm) 2.87 dB (FR2a, NTC) 2.87 dB (FR2b, NTC) 3.04 dB (FR2a, ETC) 3.04 dB (FR2b, ETC) PC1 Minimum peak EIRP IFF (Max Device size ≤ 30 cm) [3.12] dB (FR2a, NTC) TBD dB (FR2b, NTC) TBD dB (FR2a, ETC) TBD dB (FR2b, ETC) Max EIRP 0 dB	PC3 Minimum peak EIRP TT = 0.60 x ($MTSU_{IFF}$ - 0.1) (FR2a) TT = 0.60 x ($MTSU_{IFF}$ - 0.3) (FR2b) PC1 Minimum peak EIRP TT = 0.60 x (MTSUIFF – [0.13]) (FR2a) TT = TBD (FR2b)
6.2.1.1 UE maximum output power (TRP)	PC3 Max TRP IFF (Max Device size ≤ 30 cm) 2.65 dB (FR2a, NTC) 2.77 dB (FR2b, NTC) 2.82 dB (FR2a, ETC) 2.94 dB (FR2b, ETC) PC1 Max TRP IFF (Max Device size ≤ 30 cm) [2.78] dB (FR2a, NTC) TBD dB (FR2b, NTC) TBD dB (FR2a, ETC) TBD dB (FR2b, ETC)	Max TRP TT = 0.60 x $MTSU_{IFF}$
6.2.1.1_1 UE maximum output power – EIRP (Rel-16 and forward)	Same as 6.2.1.1	
6.2.1.2 UE maximum output power (Spherical coverage)	PC1 TBD PC2 TBD PC3 IFF (Max Device size ≤ 30 cm) 2.58 dB (FR2a) 2.58 dB (FR2b) PC4 TBD	PC3 TT = 0.60 x ($MTSU_{IFF}$ - 0.3) (FR2a) TT = 0.60 x ($MTSU_{IFF}$ - 0.9) (FR2b) PC1 TBD
6.2.1.2_1 UE maximum output power – Spherical coverage (Rel16 and forward)	Same as 6.2.1.2	
6.2.2 UE maximum output power reduction	PC3 Minimum peak EIRP IFF (Max Device size ≤ 30 cm) 3.11 dB (FR2a, NTC) 3.11 dB (FR2b, NTC) 3.30 dB (FR2a, ETC) 3.30 dB (FR2b, ETC)	Minimum peak EIRP TT = 0.65 x ($MTSU_{IFF}$ - 0.13) (FR2a) TT = 0.65 x ($MTSU_{IFF}$ - 0.31) (FR2b)
6.2.2_1 UE maximum output power reduction enhancements	Same as 6.2.2	

6.2.3 UE maximum output power with additional requirements	Same as 6.2.2	
6.2.4 Configured transmitted power	TBD	
6.2.4_1 Configured transmitted power with Power Boost	Same as 6.2.1.1	
6.2A.1.1.1 UE maximum output power - EIRP and TRP for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous TBD	
6.2A.1.1.2 UE maximum output power - EIRP and TRP for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous TBD	
6.2A.1.1.3 UE maximum output power - EIRP and TRP for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous TBD	
6.2A.1.1.4 UE maximum output power - EIRP and TRP for CA (5UL CA)	Intra-band contiguous CA, Intra-band non-contiguous CA TBD	
6.2A.1.1.5 UE maximum output power - EIRP and TRP for CA (6UL CA)	Intra-band contiguous CA, Intra-band non-contiguous CA TBD	
6.2A.1.1.6 UE maximum output power - EIRP and TRP for CA (7UL CA)	Intra-band contiguous CA, Intra-band non-contiguous CA TBD	
6.2A.1.1.7 UE maximum output power - EIRP and TRP for CA (8UL CA)	Intra-band contiguous CA TBD	
6.2A.1.2.1 Spherical coverage for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.1.2.2 Spherical coverage for CA (3UL CA)	Maximum aggregated BW ≤ 400MHz Same as 6.2.1.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.1.2.3 Spherical coverage for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.1.2	

	Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	

6.2A.1.2.4 Spherical coverage for CA (5UL CA)	Intra-band contiguous CA TBD	
6.2A.1.2.5 Spherical coverage for CA (6UL CA)	Intra-band contiguous CA TBD	
6.2A.1.2.6 Spherical coverage for CA (7UL CA)	Intra-band contiguous CA TBD	
6.2A.1.2.7 Spherical coverage for CA (8UL CA)	Intra-band contiguous CA TBD	
6.2A.2.1 UE maximum output power reduction for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.2.2 UE maximum output power reduction for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.2.3 UE maximum output power reduction for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.2.2 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.2A.2.4 UE maximum output power reduction for CA (5UL CA)	Intra-band contiguous CA TBD	
6.2A.2.5 UE maximum output power reduction for CA (6UL CA)	Intra-band contiguous CA TBD	
6.2A.2.6 UE maximum output power reduction for CA (7UL CA)	Intra-band contiguous CA TBD	
6.2A.2.7 UE maximum output power reduction for CA (8UL CA)	Intra-band contiguous CA TBD	
6.2D.2 UE maximum output power reduction for UL MIMO	Same as 6.2.2	
6.2D.3 UE maximum output power with additional requirements for UL MIMO	Same as 6.2.3	
6.3.1 Minimum output power	PC3 Minimum EIRP IFF (Max Device size ≤ 30 cm) NTC 4.21 dB (FR2a 50 MHz) 2.52 dB (FR2a 100 MHz) 0.66 dB (FR2a 200 MHz) 0 dB (FR2a 400 MHz) 1.17 dB (FR2b 50 MHz) 0 dB (FR2b 100 MHz) 0 dB (FR2b 200 MHz) 0 dB (FR2b 400 MHz) ETC 4.37 dB (FR2a 50 MHz)	Minimum EIRP TT = max(R, ΔSNR_{mr} + 0.65 x ($MTSU_{IFF}$ – 1.0)) -R R: Relaxation needed to limit influence of TE noise to 1 dB (specified in clause 6.3.1.5) ΔSNR_{mr}: Systematic offset due to noise when measuring at minimum requirement level (-13 dBm) FR2a 50 MHz: ΔSNR_{mr} = 0.86 dB FR2a 100 MHz: ΔSNR_{mr} = 1.57 dB FR2a 200 MHz: ΔSNR_{mr} = 2.71 dB

	2.68 dB (FR2a 100 MHz) 0.82 dB (FR2a 200 MHz) 0 dB (FR2a 400 MHz) 1.33 dB (FR2b 50 MHz) 0 dB (FR2b 100 MHz) 0 dB (FR2b 200 MHz) 0 dB (FR2b 400 MHz)	FR2a 400 MHz: ΔSNR_{mr} = 4.35 dB FR2b 50 MHz: ΔSNR_{mr} = 2.32 dB FR2b 100 MHz: ΔSNR_{mr} = 3.82 dB FR2b 200 MHz: ΔSNR_{mr} = 5.82 dB FR2b 400 MHz: ΔSNR_{mr} = 8.21 dB
6.3.2 Transmit OFF power	0 dB	
6.3.3.2 General ON/OFF time mask	PC3: ON Power Same as 6.2.1.1 (EIRP) OFF Power 0 dB	ON Power: Same as 6.2.1.1 (EIRP) OFF Power: Same as 6.3.1
6.3.3.4 PRACH time mask	PC3: OFF Power Max Device size ≤ 30cm 0 dB ON Power Max Device size ≤ 30cm TBD (FR2a) TBD (FR2b)TBD	ON Power TBD
6.3.4.2 Absolute power tolerance	PC3 Max Device size ≤ 30 cm ±8.05 dB (FR2a & FR2b, NTC testing) ±8.42 dB (FR2a & FR2b, ETC testing)	TT = MTSU
6.3.4.3 Relative power tolerance	PC3 IFF (Max Device size ≤ 30 cm) [0.46 dB] (FR2a) [0.46 dB] (FR2b)	PC3 TT = 0.65 x ($MTSU_{IFF}$ – 1.0) (FR2a) TT = 0.65 x ($MTSU_{IFF}$ – 1.0) (FR2b) (assuming a power step ΔP = 1 dB)
6.3.4.4 Aggregate power tolerance	PC3 IFF (Max Device size ≤ 30 cm) 0.26 dB (FR2a) 0.26 dB (FR2b)	PC3 TT = 0.65 x ($MTSU_{IFF}$ – 1.0) (FR2a) TT = 0.65 x ($MTSU_{IFF}$ – 1.0) (FR2b) (assuming a power step ΔP = 1 dB)
6.3A.1.1 Minimum output power for CA (2UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.2 Minimum output power for CA (3UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.3 Minimum output power for CA (4UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.4 Minimum output power for CA (5UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.5 Minimum output power for CA (6UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.6 Minimum output power for CA (7UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 For UL CA aggregated BW > 800 MHz: TBD	
6.3A.1.7 Minimum output power for CA (8UL CA)	For UL CA aggregated BW ≤ 800 MHz: Same as 6.3.1 For UL CA aggregated BW > 800 MHz: TBD	
6.3A.3.1.1 General ON/OFF time mask for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.3	

	Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.3.1.2 General ON/OFF time mask for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.3 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.3.1.3 General ON/OFF time mask for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.3 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.3.1.4 General ON/OFF time mask for CA (5UL CA)	Intra-band contiguous CA TBD	
6.3A.3.1.5 General ON/OFF time mask for CA (6UL CA)	Intra-band contiguous CA TBD	
6.3A.3.1.6 General ON/OFF time mask for CA (7UL CA)	Intra-band contiguous CA TBD	
6.3A.3.1.7 General ON/OFF time mask for CA (8UL CA)	Intra-band contiguous CA TBD	
6.3D.3.1 General ON/OFF time mask for UL MIMO	PC3: OFF Power Max Device size ≤ 30cm 0 dB ON Power Max Device size ≤ 30cm TBD (FR2a) TBD (FR2b)	ON Power TBD
6.3D.3.4 SRS time mask for UL MIMO	PC3: OFF Power Max Device size ≤ 30cm 0 dB ON Power Max Device size ≤ 30cm TBD (FR2a) TBD (FR2b)	ON Power TBD
6.3A.4.2.1 Absolute power tolerance for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.2.2 Absolute power tolerance for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA	

	TBD	
6.3A.4.2.3 Absolute power tolerance for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.2.4 Absolute power tolerance for CA (5UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.2.5 Absolute power tolerance for CA (6UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.2.6 Absolute power tolerance for CA (7UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.2.7 Absolute power tolerance for CA (8UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.2 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.3.1 Relative power tolerance for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz TBD Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.3.2 Relative power tolerance for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz TBD Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.3.3 Relative power tolerance for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz TBD Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	

6.3A.4.3.4 Relative power tolerance for CA (5UL CA)	Intra-band contiguous CA TBD	
6.3A.4.3.5 Relative power tolerance for CA (6UL CA)	Intra-band contiguous CA TBD	
6.3A.4.3.6 Relative power tolerance for CA (7UL CA)	Intra-band contiguous CA TBD	
6.3A.4.3.7 Relative power tolerance for CA (8UL CA)	Intra-band contiguous CA TBD	
6.3A.4.4.1 Aggregate power tolerance for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.4 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.4.2 Aggregate power tolerance for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.4 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.4.3 Aggregate power tolerance for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.3.4.4 for each CC. Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.3A.4.4.4 Aggregate power tolerance for CA (5UL CA)	Intra-band contiguous CA TBD	
6.3A.4.4.5 Aggregate power tolerance for CA (6UL CA)	Intra-band contiguous CA TBD	
6.3A.4.4.6 Aggregate power tolerance for CA (7UL CA)	Intra-band contiguous CA TBD	
6.3A.4.4.7 Aggregate power tolerance for CA (8UL CA)	Intra-band contiguous CA TBD	
6.4.1 Frequency error	0.005 ppm (NTC & ETC testing)	TT = 0.5 x MTSU

6.4.2.1 Error vector magnitude	PUSCH, PC3, FR2a:
	As defined in Table 6.4.2.1.5-2.
	
	PUSCH, PC3, FR2b:
	As defined in Table 6.4.2.1.5-3.
		Minimum requirement + TT
		
		EVM_meas_Increase = sqrt(Minimum requirement^2 + MTSU^2) - Minimum requirement; it is the increase of measured EVM due to test equipment uncertainty.
		
		EVM_meas_Increase_Relative = EVM_meas_Increase / Minimum requirement [%]
		
		If (EVM_meas_Increase_Relative < 7.5%)
		TT = 0%
		Else if (7.5% ≤ EVM_meas_Increase_Relative ≤ 50%)
		TT = EVM_meas_Increase
		Else
		Skip the test as not testable.

6.4.2.2 Carrier leakage	IFF (Max Device size ≤ 30 cm) FR2a: ±3.54 dB (BW ≤ 400MHz) FR2b: ±3.62 dB (BW ≤ 400MHz)	TT = 0.65 x $MTSU_{IFF}$
6.4.2.3 In-band emissions	TBD	
6.4.2.4 EVM equalizer spectrum flatness	TBD	
6.4.2.5 EVM equalizer spectrum flatness for BPSK modulation	TBD	
6.4A.1.1 Frequency error for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.4.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.4A.1.2 Frequency error for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.4.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.4A.1.3 Frequency error for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.4.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.4A.1.4 Frequency error for CA (5UL CA)	Intra-band contiguous CA TBD	
6.4A.1.5 Frequency error for CA (6UL CA)	Intra-band contiguous CA TBD	
6.4A.1.6 Frequency error for CA (7UL CA)	Intra-band contiguous CA TBD	
6.4A.1.7 Frequency error for CA (8UL CA)	Intra-band contiguous CA TBD	
6.4A.2.1.1 Error Vector magnitude for CA (2UL CA)	TBD	
6.4A.2.1.2 Error Vector magnitude for CA (3UL CA)	TBD	
6.4A.2.1.3 Error Vector magnitude for CA (4UL CA)	TBD	
6.4A.2.1.4 Error Vector magnitude for CA (5UL CA)	TBD	
6.4A.2.1.5 Error Vector magnitude for CA (6UL CA)	TBD	
6.4A.2.1.6 Error Vector magnitude for CA (7UL CA)	TBD	
6.4A.2.1.7 Error Vector magnitude for CA (8UL CA)	TBD	
6.4A.2.2.1 Carrier leakage for CA (2UL CA)	TBD	
6.4A.2.2.2 Carrier leakage for CA (3UL CA)	TBD	
6.4A.2.2.3 Carrier leakage for CA (4UL CA)	TBD	

6.4A.2.2.4 Carrier leakage for CA (5UL CA)	TBD	
6.4A.2.2.5 Carrier leakage for CA (6UL CA)	TBD	
6.4A.2.2.6 Carrier leakage for CA (7UL CA)	TBD	
6.4A.2.2.7 Carrier leakage for CA (8UL CA)	TBD	
6.4A.2.3.1 In-band emissions for CA (2UL CA)	TBD	
6.4A.2.3.2 In-band emissions for CA (3UL CA)	TBD	
6.4A.2.3.3 In-band emissions for CA (4UL CA)	TBD	
6.4A.2.3.4 In-band emissions for CA (5UL CA)	TBD	
6.4A.2.3.5 In-band emissions for CA (6UL CA)	TBD	
6.4A.2.3.6 In-band emissions for CA (7UL CA)	TBD	
6.4A.2.3.7 In-band emissions for CA (8UL CA)	TBD	
6.5.1 Occupied bandwidth	0 kHz	Minimum requirement + TT
6.5.2.1 Spectrum Emission Mask	IFF (Max Device size ≤ 30 cm) 3.21 dB (FR2a) 3.46 dB (FR2b)	TT = 0.65 x $MTSU_{IFF}$
6.5.2.3 Adjacent Channel Leakage Ratio	Absolute requirement 0 dB Relative requirement IFF (Max Device size ≤ 30 cm) FR2a: ±4.66 dB (BW ≤ 50MHz) ±4.96 dB (50MHz < BW ≤ 100MHz) ±4.96 dB (100MHz < BW ≤ 200MHz) ±4.96 dB (200MHz < BW ≤ 400MHz) FR2b: ±4.96 dB (BW ≤ 50MHz) ±4.96 dB (50MHz < BW ≤ 100MHz) ±4.96 dB (100MHz < BW ≤ 200MHz) ±4.96 dB (200MHz < BW ≤ 400MHz)	TT = max(R, ΔSNR_{mr}+0.65 x ($MTSU_{IFF}$-1.0)) -R + TT due to metric change TT due to metric change : 1.0 dB R: Relaxation needed to limit influence of TE noise to 1 dB (specified in clause 6.5.2.3.5) $\Delta SNR_{mr:}$ Systematic offset due to noise when measuring ACP at minimum requirement level
6.5.3.1 Transmitter Spurious emissions	0 dB	Minimum requirement + TT
6.5.3.2 Spurious emission band UE co-existence	0 dB	Minimum requirement + TT
6.5.3.3 Additional spurious emission	0 dB	Minimum requirement + TT
6.5A.1.1 Occupied bandwidth for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.1.2 Occupied bandwidth for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	

6.5A.1.3 Occupied bandwidth for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.1.4 Occupied bandwidth for CA (5UL CA)	TBD	
6.5A.1.5 Occupied bandwidth for CA (6UL CA)	TBD	
6.5A.1.6 Occupied bandwidth for CA (7UL CA)	TBD	
6.5A.1.7 Occupied bandwidth for CA (8UL CA)	TBD	
6.5A.2.1.1 Spectrum Emission Mask for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.2.1.2 Spectrum Emission Mask for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.2.1.3 Spectrum Emission Mask for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.2.1.4 Spectrum Emission Mask for CA (5UL CA)	TBD	
6.5A.2.1.5 Spectrum Emission Mask for CA (6UL CA)	TBD	
6.5A.2.1.6 Spectrum Emission Mask for CA (7UL CA)	TBD	
6.5A.2.1.7 Spectrum Emission Mask for CA (8UL CA)	TBD	
6.5A.2.2.1 Adjacent channel leakage ratio for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.3 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	TT = 0.65 x $MTSU_{IFF}$ + TT due to metric change TT due to metric change : 1.0 dB
6.5A.2.2.2 Adjacent channel leakage ratio for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.3	TT = 0.65 x $MTSU_{IFF}$ + TT due to metric change

	Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	TT due to metric change : 1.0 dB
6.5A.2.2.3 Adjacent channel leakage ratio for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.2.3 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	TT = 0.65 x $MTSU_{IFF}$ + TT due to metric change TT due to metric change : 1.0 dB
6.5A.2.2.4 Adjacent channel leakage ratio for CA (5UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	TBD
6.5A.2.2.5 Adjacent channel leakage ratio for CA (6UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	TBD
6.5A.2.2.6 Adjacent channel leakage ratio for CA (7UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	TBD
6.5A.2.2.7 Adjacent channel leakage ratio for CA (8UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	TBD
6.5A.3.1.1 Transmitter Spurious emissions for CA (2UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.3.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.3.1.2 Transmitter Spurious emissions for CA (3UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.3.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.3.1.3 Transmitter Spurious emissions for CA (4UL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 6.5.3.1 Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
6.5A.3.1.4 Transmitter Spurious emissions for CA (5UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	TBD
6.5A.3.1.5 Transmitter Spurious emissions for CA (6UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	TBD
6.5A.3.1.6 Transmitter Spurious emissions for CA	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz	TBD

(7UL CA)	Intra-band non-contiguous CA TBD	
6.5A.3.1.7 Transmitter Spurious emissions for CA (8UL CA)	Intra-band contiguous CA 400 MHz < aggregated BW ≤ TBD MHz Intra-band non-contiguous CA TBD	TBD
6.5D.2.1 Spectrum Emission Mask for UL MIMO	Same as 6.5.2.1	
6.5D.2.2 Adjacent channel leakage ratio for UL MIMO	Same as 6.5.2.3	
6.6.1 Beam correspondence - EIRP	PC3 1.26 dB (FR2a, FR2b)	PC3 TT = 0.60 x ($MTSU_{IFF}$ - ΔSNR_{mr}) $\Delta SNR_{mr:}$ Systematic offset due to noise when measuring at minimum requirement level
6.6.2 Enhanced Beam correspondence - EIRP	Same as 6.6.1	
NOTE 1: FR2a: 23.45GHz ≤ f ≤ 32.125GHz FR2b: 32.125GHz ≤ f ≤ 40.8GHz FR2c: 40.8GHz ≤ f ≤ 44.3GHz		

F.3.3 Measurement of receiver

Table F.3.3-1: Derivation of Test Requirements (Receiver tests)

Sub clause	Test Tolerance (TT)	Formula for test requirement
7.3.2 Reference sensitivity power level	PC3 IFF (Max Device size ≤ 30 cm) 2.34 dB (FR2a, FR2b, NTC) 2.45 dB (FR2a, FR2b, ETC) PC1 IFF (Max Device size ≤ 30 cm) [2.51] dB (FR2a, NTC) TBD dB (FR2a, ETC)	TT = 0.45 x $MTSU_{IFF}$
7.3.4 EIS spherical coverage	PC3 IFF (Max Device size ≤ 30 cm, FR2a, FR2b) 2.21 dB PC1 TBD	TT = 0.45 x $MTSU_{IFF}$
7.3A.2.1 Reference sensitivity power level for CA (2DL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 7.3.2 for each component carrier Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
7.3A.2.2 Reference sensitivity power level for CA (3DL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 7.3.2 for each component carrier Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
7.3A.2.3 Reference sensitivity power level for CA (4DL CA)	Intra-band contiguous CA Maximum aggregated BW ≤ 400MHz Same as 7.3.2 for each component carrier Maximum aggregated BW > 400MHz TBD Intra-band non-contiguous, Inter-band CA TBD	
7.3A.2.4 Reference sensitivity power level for CA (5DL CA)	Intra-band contiguous CA TBD	
7.3A.2.5 Reference sensitivity power level for CA (6DL CA)	Intra-band contiguous CA TBD	
7.3A.2.6 Reference sensitivity power level for CA (7DL CA)	Intra-band contiguous CA TBD	
7.3A.2.7 Reference sensitivity power level for CA (8DL CA)	Intra-band contiguous CA TBD	
7.3A.3.1 EIS spherical coverage for CA (2DL CA)	TBD	
7.3A.3.2 EIS spherical coverage for CA (3DL CA)	TBD	
7.3A.3.3 EIS spherical coverage for CA (4DL CA)	TBD	
7.3A.3.4 EIS spherical coverage for CA (5DL CA)	TBD	
7.3A.3.5 EIS spherical coverage for CA (6DL CA)	TBD	
7.3A.3.6 EIS spherical coverage for CA (7DL CA)	TBD	

7.3A.3.7 EIS spherical coverage for CA (8DL CA)	TBD	
7.4 Maximum input level	TBD	
7.4A.1 Maximum input level for CA (2DL CA)	TBD	
7.4A.2 Maximum input level for CA (3DL CA)	TBD	
7.4A.3 Maximum input level for CA (4DL CA)	TBD	
7.4A.4 Maximum input level for CA (5DL CA)	TBD	
7.4A.5 Maximum input level for CA (6DL CA)	TBD	
7.4A.6 Maximum input level for CA (7DL CA)	TBD	
7.4A.7 Maximum input level for CA ((DL CA)	TBD	
7.5 Adjacent channel selectivity	0 dB	Wanted signal power + TT T-put limit unchanged
7.5A.1 Adjacent channel selectivity for CA (2UL CA)	TBD	
7.5A.2 Adjacent channel selectivity for CA (3UL CA)	TBD	
7.5A.3 Adjacent channel selectivity for CA (4UL CA)	TBD	
7.5A.4 Adjacent channel selectivity for CA (5UL CA)	TBD	
7.5A.5 Adjacent channel selectivity for CA (6UL CA)	TBD	
7.5A.6 Adjacent channel selectivity for CA (7UL CA)	TBD	
7.5A.7 Adjacent channel selectivity for CA (8UL CA)	TBD	
7.6.2 In-band blocking	0 dB	Wanted signal power + TT T-put limit unchanged
7.6A.2.1 In-band blocking for CA (2UL CA)	TBD	
7.6A.2.2 In-band blocking for CA (3UL CA)	TBD	
7.6A.2.3 In-band blocking for CA (4UL CA)	TBD	
7.6A.2.4 In-band blocking for CA (5UL CA)	TBD	
7.6A.2.5 In-band blocking for CA (6UL CA)	TBD	
7.6A.2.6 In-band blocking for CA (7UL CA)	TBD	
7.6A.2.7 In-band blocking for CA (8UL CA)	TBD	
7.9 Spurious emissions	0 dB	Minimum requirement + TT T-put limit unchanged
NOTE 1: FR2a, FR2b and FR2c are specified in Table F.3.2-1.		

F.4 Uplink power window

F.4.1 Introduction

A number of Tx and Rx Test cases set the UE uplink power to be within a defined window to ensure the test is carried out in the intended conditions. This clause gives the method for calculating the uplink power window used in Tx test cases and Rx Test cases.

F.4.2 Setting the power window above a requirement

The method used to derive the uplink power window for NR FR2 is defined in TS 38.521-3 [14] clause F.4.2.2.

F.4.3 Setting the power window below a requirement

The method used to derive the uplink power window for NR FR2 is defined in TS 38.521-3 [14] clause F.4.3.2.

F.4.4 Setting the power window centred on a target value

The method used to derive the uplink power window for NR FR2 is defined in TS 38.521-3 [14] clause F.4.4.2.

Annex G (normative): Uplink Physical Channels

G.0 Uplink Signal Levels

Please refer to Annex G.0 in TS 38.521-1 [13].

G.1 General

Please refer to Annex G.1 in TS 38.521-1 [13].

G.2 Set-up

Please refer to Annex G.2 in TS 38.521-1 [13].

G.3 Connection

Please refer to Annex G.3 in TS 38.521-1 [13].

G.3.0 Measurement of Transmitter Characteristics

Please refer to Annex G.3.0 in TS 38.521-1 [13].

G.3.1 Measurement of Receiver Characteristics

Please refer to Annex G.3.1 in TS 38.521-1 [13].

Annex H (normative): Statistical Testing

Editor's Note: Further investigate the technical details behind this statistical method to ensure that this is applicable for FR2 radiated test cases.

H.1 General

This annex specifies mapping throughput to error ratio, pass fail limits and pass fail decision rules that are needed for measuring average throughput for a duration sufficient to achieve statistical significance for testing receiver characteristics.

H.2 Statistical testing of receiver characteristics

H.2.1 General

The test of receiver 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 all receiver tests is >95% of the maximum throughput.

All receiver tests are performed in static propagation conditions. No fading conditions are applied.

H.2.2 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.

H.2.3 Design of the test

The test is defined by the following design principles (see clause H.x, 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

The test is defined by the following parameters:

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

H.2.4 Numerical definition of the pass fail limits

Table H.2.4-1: pass fail limits

ne	ns_p	ns_f	ne	ns_p	ns_f	ne	ns_p	ns_f	ne	ns_p	ns_f
0	67	NA	39	763	500	78	1366	1148	117	1951	1828
1	95	NA	40	778	516	79	1381	1166	118	1965	1845
2	119	NA	41	794	532	80	1396	1183	119	1980	1863
3	141	NA	42	810	548	81	1412	1200	120	1995	1881
4	162	NA	43	826	564	82	1427	1217	121	2010	1899
5	183	NA	44	842	580	83	1442	1234	122	2025	1916
6	202	NA	45	858	596	84	1457	1252	123	2039	1934
7	222	NA	46	873	612	85	1472	1269	124	2054	1952
8	241	NA	47	889	629	86	1487	1286	125	2069	1969
9	259	NA	48	905	645	87	1502	1303	126	2084	1987
10	278	76	49	920	661	88	1517	1321	127	2099	2005
11	296	88	50	936	678	89	1532	1338	128	2113	2023
12	314	100	51	952	694	90	1547	1355	129	2128	2040
13	332	113	52	967	711	91	1562	1373	130	2143	2058
14	349	126	53	983	727	92	1577	1390	131	2158	2076
15	367	140	54	998	744	93	1592	1407	132	2172	2094
16	384	153	55	1014	760	94	1607	1425	133	2187	2111
17	401	167	56	1029	777	95	1623	1442	134	2202	2129
18	418	181	57	1045	793	96	1637	1459	135	2217	2147
19	435	195	58	1060	810	97	1652	1477	136	2231	2165
20	452	209	59	1076	827	98	1667	1494	137	2246	2183
21	469	224	60	1091	844	99	1682	1512	138	2261	2201
22	486	238	61	1106	860	100	1697	1529	139	2275	2218
23	503	253	62	1122	877	101	1712	1547	140	2290	2236
24	519	268	63	1137	894	102	1727	1564	141	2305	2254
25	536	283	64	1153	911	103	1742	1582	142	2320	2272
26	552	298	65	1168	928	104	1757	1599	143	2334	2290
27	569	313	66	1183	944	105	1772	1617	144	2349	2308
28	585	328	67	1199	961	106	1787	1634	145	2364	2326
29	602	343	68	1214	978	107	1802	1652	146	2378	2344
30	618	359	69	1229	995	108	1817	1669	147	2393	2361
31	634	374	70	1244	1012	109	1832	1687	148	2408	2379
32	650	389	71	1260	1029	110	1847	1704	149	2422	2397
33	667	405	72	1275	1046	111	1861	1722	150	2437	2415
34	683	421	73	1290	1063	112	1876	1740	151	2452	2433
35	699	436	74	1305	1080	113	1891	1757	152	2466	2451
36	715	452	75	1321	1097	114	1906	1775	153*)	NA	2469
37	731	468	76	1336	1114	115	1921	1793			
38	747	484	77	1351	1131	116	1936	1810	*) note 2 in H.2.5		

NOTE 1: The first column is the number of errors (ne = number of NACK + statDTX)

NOTE 2: The second column is the number of samples for the pass limit (ns_p, ns=Number of Samples= number of `NACK + statDTX + ACK`)

NOTE 3: The third column is the number of samples for the fail limit (ns_f)

H.2.5 Pass fail decision rules

The pass fail decision rules apply for a single test, comprising one component in the test vector. The overall Pass /Fail conditions are defined in clause H.2.6and H.2A.6

Having observed 0 errors, pass the test at 67+ samples, otherwise continue

Having observed 1 error, pass the test at 95+ otherwise continue

Having observed 2 errors, pass the test at 119+ samples, fail the test at 2- samples, otherwise continue

Etc. etc.

Having observed 151 errors, pass the test at 2452+ samples, fail the test at 2433- samples, otherwise continue

Having observed 152 errors, pass the test at 2466+ samples, fail the test at 2451- samples.

Where x+ means: x or more, x- means x or less

NOTE 1: an ideal DUT passes after 67 samples. The maximum test time is 2466 samples.

NOTE 2: It is allowed to deviate from the early decision concept by postponing the decision (pass/fail or continue). Postponing the decision to or beyond the end of Table H.2.4-1 requires a pass fail decision against the test limit: pass the DUT for ER<0.0618, otherwise fail.

Annex I:Void

Annex J (normative): Test applicability per permitted test method

This annex describes, per test requirement, the permitted test methodologies as a function of DUT antenna configuration.

Table J-1: Test metric applicability per permitted test method

Test Metric	No DUT antenna configuration declaration	DUT antenna configuration declaration		
		Configuration 1 (one antenna panel with D ≤ 5 cm active at any one time)	Configuration 2 (More than one antenna panel D ≤ 5 cm without phase coherency between panels active at any one time)	Configuration 3 (Any phase coherent antenna panel of any size)
EIRP, TRP	IFF, Enhanced IFF, DFF+IFF (Note 1)	DFF, DFF simplification, IFF, Enhanced IFF, DFF+IFF (Note 2), NFTF	DFF, DFF simplification, IFF, Enhanced IFF, DFF+IFF (Note 2), NFTF	IFF, Enhanced IFF, DFF+IFF (Note 1)
EIS, Frequency Error, EVM, Carrier Leakage, In-Band Emission, EVM SF, OBW	IFF, Enhanced IFF, DFF+IFF (Note 1)	DFF, DFF simplification, IFF, Enhanced IFF, DFF+IFF (Note 2)	DFF, DFF simplification, IFF, Enhanced IFF, DFF+IFF (Note 2)	IFF, Enhanced IFF, DFF+IFF (Note 1)
NOTE: D = DUT radiating aperture declared by UE vendor. Note 1: Only the IFF probe(s) are applicable Note 2: Either DFF or IFF probe(s) are applicable				

Annex K (normative): EIRP, TRP, and EIS measurement procedures

Annex K defines the EIRP, TRP, and EIS measurement procedures which includes Tx and Rx beam peak direction search, spherical coverage procedures and TRP procedures for the permitted testing methodologies defined in [5].

The default value for BEAM_SELECT_WAIT_TIME = 3 sec for all applicable Tx and Rx test cases. The BEAM_SELECT_WAIT_TIME represents a default minimum wait time period required to complete beam selection process at a single position before start of measurement. For a particular EUT, if it is known/determined that a lower wait time than default value is enough to complete beam selection process, then such a lower value may be used by the Test system to achieve test time optimization.

K.1 Direct far field (DFF)

K.1.1 TX beam peak direction search

This Tx beam peak search procedure applies to DUTs with and without support of *beamCorrespondenceWithoutUL-BeamSweeping*. The TX beam peak direction is found with a 3D EIRP scan (separately for each orthogonal downlink polarization). The TX beam peak direction search grid points for this single grid approach are defined in Annex M.2.1. Alternatively, a coarse and fine grid approach could be used according to the definition in Annex M.2.2.

The beam peak searches shall be performed for every test frequency range by default unless the device manufacturer explicitly declares that the beam peak at the mid test frequency range is applicable for the remaining (low, high) test frequency ranges. Beam peak search results cannot be re-used across different bands that do not overlap. Beam peak search results can be re-used from bands that completely contain the target bands if explicitly declared with a declaration.

A beam peak search shall be performed for every intra-band contiguous combination and CA BW class by default unless the device manufacturer explicitly declares that the beam peak for a reference (frequency band, CBW) or (frequency band combination, CA BW class) is applicable for a group of other intra-band contiguous combinations and CA BW classes.

The beam peak searches shall be performed for every modulation by default unless the device manufacturer explicitly declares that the beam peak at the QPSK modulation is applicable for the remaining 16QAM and 64QAM modulations.

The beam peak searches shall be performed for every waveform by default unless the device manufacturer explicitly declares that the beam peak from one waveform is applicable for the other waveform.

The beam peak searches shall be performed separately for NTC (Normal), ETC (TL), and ETC (TH).

The beam peak search results from single carrier can be re-used for UL MIMO testing.

The measurement procedure includes the following steps:

1) Select any of the three Alignment Options (1, 2, or 3) from Tables N.2-1 through N.2-7 [3] to mount the DUT inside the QZ.

2) Position the DUT in DUT Orientation 1 from Tables N.2-1 through N.2-7 [3].

3) Connect the SS (System Simulator) with the DUT through the measurement antenna with Pol_{Link}=θ polarization to form the TX beam towards the measurement antenna. Allow at least BEAM_SELECT_WAIT_TIME for the UE TX beam selection to complete.

4) Send continuously uplink power control "up" commands in every uplink scheduling information to the UE; allow at least 200 msec starting from the first TPC Command in this step for the UE to reach P_{UMAX} level. Allow at least BEAM_SELECT_WAIT_TIME for the UE Tx beam selection to complete.

5) Through its beam correspondence procedure, DUT refines its TX beam toward that direction depending on DUT’s beam correspondence capability which shall match OEM declaration:

   - If the DUT’s beam correspondence capability *beamCorrespondenceWithoutUL-BeamSweeping* is supported, then DUT autonomously chooses the corresponding TX beam for PUSCH transmission using downlink reference signals to transmit in the direction of the incoming DL signal, which is based on beam correspondence without relying on UL beam sweeping;

   - If the DUT’s beam correspondence capability *beamCorrespondenceWithoutUL-BeamSweeping* is not present, then DUT chooses the TX beam for PUSCH transmission which is based on beam correspondence with relying on both DL measurements on downlink reference signals and network-assisted uplink beam sweeping (NOTE 3).

6) SS activates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.2 using condition Tx only.

7) Measure the mean power P_{meas} (Pol_{Meas}=θ, Pol_{Link}=θ) of the modulated signal arriving at the power measurement equipment (such as a spectrum analyser, power meter, or gNB emulator).

8) Calculate EIRP (Pol_{Meas}=θ, Pol_{Link}=θ) by adding the composite loss of the entire transmission path for utilized signal path, $L_{EIRP,\theta}$, and frequency to the measured power P_{meas}(Pol_{Meas}=θ, Pol_{Link}=θ).

9) Measure the mean power P_{meas} (Pol_{Meas}=ϕ, Pol_{Link}=θ) of the modulated signal arriving at the power measurement equipment.

10) Calculate EIRP (Pol_{Meas}=ϕ, Pol_{Link}=θ) by adding the composite losses of the entire transmission path for utilized signal path, $L_{EIRP,\varphi}$, and frequency to the measured power P_{meas} (Pol_{Meas}=ϕ, Pol_{Link}=θ).

11) Calculate total EIRP(Pol_{Link}=θ) = EIRP(Pol_{Meas}=θ, Pol_{Link}=θ) + EIRP(Pol_{Meas}=ϕ, Pol_{Link}=θ).

12) SS deactivates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.3.

13) Connect the SS (System Simulator) with the DUT through the measurement antenna with Pol_{Link}=ϕ polarization to form the TX beam towards the measurement antenna. Allow at least BEAM_SELECT_WAIT_TIME for the UE TX beam selection to complete.

14) Repeat steps 4 through 12 and get the result of total EIRP(Pol_{Link}=ϕ) = EIRP(Pol_{Meas}=θ, Pol_{Link}=ϕ) + EIRP(Pol_{Meas}=ϕ, Pol_{Link}=ϕ)

15) Advance to the next grid point and repeat steps 3 through 14 until measurements within zenith range $0^o \le \theta \le 90^o$ have been completed

16) After the measurements within zenith range $0^o \le \theta \le 90^o$ have been completed and

   a) if the re-positioning concept is applied to the TX test cases, position the device in DUT Orientation 2 (either Options 1 or 2) from Tables N.2-1 through N.2-7 [3] for the Alignment Option selected in Step 1. For the TX beam peak search in the second hemisphere, perform steps 3 through 15 for the range of zenith angles $90^o > \theta \ge 0^o$.

   b) if the re-positioning concept is not applied to the TX test cases, continue steps 3 through 15 for the range of zenith angles $90^o < \theta \le 180^o$

If the beam correspondence capability *beamCorrespondenceWithoutUL-BeamSweeping* is not present, the above step 5) can be further clarified as following sub-steps:

5.1) DUT uses downlink reference signals to select proper RX beam and uses autonomous beam correspondence to select the TX beam.

5.2) SS configures M=8 SRS resources to DUT, with the field *spatialRelationInfo* omitted and the field *usage* set as ‘beamManagement’. In case DUT supports less than 8 SRS resources, SS configures the number of SRS resources according to the maximum number of SRS resources indicated by UE capability signalling. Additionally, for codebook based PUSCH transmission, SS configures a semi-persistent SRS resource set with the field *usage* as 'codebook'.

5.3) Based on the TX beam autonomously selected by DUT, DUT chooses TX beams to transmit SRS-resources configured by SS.

5.4) Based on measurement of the received *beamManagement* SRS, SS chooses the best SRS beam and, if needed, updates the spatial relation information between the semi-persistent *codebook* SRS resources and the SS selected *beamManagement* SRS resource in the activation MAC CE of the semi-persistent SRS resource. The SS indicates in the SRS Resource Indicator (SRI) field in the scheduling grant for PUSCH, if present, the SRS resource within the semi-persistent SRS resource set whose spatial relation is linked to the best detected SRS beam.

5.5) DUT transmits PUSCH corresponding to the SRS resource indicated by the SRI.

The TX beam peak direction is where the maximum total component of EIRP(Pol_{Link}=θ) or EIRP(Pol_{Link}=ϕ) is found. Whenever this TX beam peak direction is used, if the UE does not support *beamCorrespondenceWithoutUL-BeamSweeping*, the side conditions for SSB-based and CSI-RS based L1-RSRP measurements are applied as per Table 6.6.1.3.3.1.1-1 and Table 6.6.1.3.3.1.1-2 respectively just before setting TX beam peak direction.

NOTE 1: Void.

NOTE 2: VOID.

NOTE 3:

In order to allow the UE to carry out its Rel 15 beam correspondence procedure, the side conditions for SSB based and CSI-RS based L1-RSRP measurements are configured as per Table 6.6.1.3.3.1.1-1 and Table 6.6.1.3.3.1.1-2 respectively.

For Release 16 and forward UEs: unless otherwise stated within the test case, the following side conditions are applied for the enhanced beam correspondence procedure, depending on the UE capability

a. If *beamCorrespondenceWithoutUL-BeamSweeping* is NOT supported and *beamCorrespondenceSSB-based-r16* is supported: use side conditions defined in Table 6.6.1.3.3.1.1-1
b. If *beamCorrespondenceWithoutUL-BeamSweeping* is NOT supported, and *beamCorrespondenceCSI-RS-based-r16* is supported: use side conditions defined in Table 6.6.2.3.3-1
c. If *beamCorrespondenceWithoutUL-BeamSweeping* is NOT supported and *beamCorrespondenceSSB-based-r16* and *beamCorrespondenceCSI-RS-based-r16 are* supported: use side conditions defined in Table 6.6.1.3.3.1.1-1.
d. If *beamCorrespondenceWithoutUL-BeamSweeping* is NOT supported and *beamCorrespondenceSSB-based-r16* and *beamCorrespondenceCSI-RS-based-r16 are* NOT supported: use side conditions defined in Table 6.6.1.3.3.1.1-1 and Table 6.6.1.3.3.1.1-2.
e. *If beamCorrespondenceWithoutUL-BeamSweeping is supported and beamCorrespondenceSSB-based-r16 is supported: use side conditions defined in Table 6.6.1.3.3.1.1-1*
f. *If beamCorrespondenceWithoutUL-BeamSweeping is supported, and beamCorrespondenceCSI-RS-based-r16 is supported: use side conditions defined in Table 6.6.2.3.3-1*
g. If *beamCorrespondenceWithoutUL-BeamSweeping* is supported and *beamCorrespondenceSSB-based-r16* and *beamCorrespondenceCSI-RS-based-r16 are* supported: use side conditions defined in Table 6.6.1.3.3.1.1-1.
h. If *beamCorrespondenceWithoutUL-BeamSweeping* is supported and *beamCorrespondenceSSB-based-r16* and *beamCorrespondenceCSI-RS-based-r16 are* NOT supported: use side conditions defined in Table 6.6.1.3.3.1.1-1 and Table 6.6.1.3.3.1.1-2.

K.1.2 RX beam peak direction search

Editor's note: The following aspects are either missing or not yet determined:

- The Rx beam peak direction search for intra-band DL CA configurations with frequency separations larger than 800 MHz is currently FFS.

The RX beam peak direction is found with a 3D EIS scan (separately for each orthogonal downlink polarization). The RX beam peak direction search grid points for this single grid approach are defined in Annex M.2.1. Alternatively, a coarse and fine grid approach could be used according to the definition in Annex M.2.4.

The beam peak searches shall be performed for every test frequency range by default unless the device manufacturer explicitly declares that the beam peak at the mid test frequency range is applicable for the remaining (low, high) test frequency ranges. Beam peak search results cannot be re-used across different bands that do not overlap. Beam peak search results can be re-used from bands that completely contain the target bands if explicitly declared with a declaration.

A beam peak search shall be performed for every intra-band contiguous combination and CA BW class by default unless the device manufacturer explicitly declares that the beam peak for a reference (frequency band, CBW) or (frequency band combination, CA BW class) is applicable for a group of other intra-band contiguous combinations and CA BW classes.

The beam peak searches shall be performed for every modulation by default unless the device manufacturer explicitly declares that the beam peak at the QPSK modulation is applicable for the remaining 16QAM and 64QAM modulations.

The beam peak searches shall be performed separately for NTC (Normal), ETC (TL), and ETC (TH).

The single carrier measurement procedure includes the following steps:

1) Select any of the three Alignment Options (1, 2, or 3) from Tables N.2-1 through N.2-7 [3] to mount the DUT inside the QZ.

2) Position the DUT in DUT Orientation 1 from Tables N.2-1 through N.2-7 [3].

3) Connect the SS (System Simulator) with the DUT through the measurement antenna with $Pol_{Link}=\theta$ polarization to form the RX beam towards the DUT. Allow at least BEAM_SELECT_WAIT_TIME for the UE RX beam selection to complete.

4) Determine EIS($Pol_{Meas}=\theta$, $Pol_{Link}=\theta$) for θ-polarization, i.e., by sweeping the power level for the θ-polarization, at which the throughput exceeds the requirements for the specified reference measurement channel. The downlink power step size shall be no more than 0.2 dB when the RF power level is near the sensitivity level (coarse and fine searches are not precluded as long as the fine search is using the 0.2dB step size near the sensitivity level).

5) Connect the SS (System Simulator) with the DUT through the measurement antenna with $Pol_{Link}=\phi$ polarization to form the RX beam towards the DUT. Allow at least BEAM_SELECT_WAIT_TIME for the UE RX beam selection to complete.

6) Determine EIS($Pol_{Meas}=\phi$, $Pol_{Link}=\phi$) for φ-polarization, i.e., by sweeping the power level for the φ-polarization, at which the throughput exceeds the requirements for the specified reference measurement channel. The downlink power step size shall be no more than 0.2 dB when the RF power level is near the sensitivity level (coarse and fine searches are not precluded as long as the fine search is using the 0.2dB step size near the sensitivity level).

7) Advance to the next grid point and repeat steps 3 through 6 until measurements within zenith range $0^o \leq \theta \leq 90^o$ have been completed

8) After the measurements within zenith range $0^o \leq \theta \leq 90^o$ have been completed and

   a) if the re-positioning concept is applied to the RX test cases, position the device in DUT Orientation 2 (either Options 1 or 2) from Tables N.2-1 through N.2-7 [3] for the Alignment Option selected in Step 1. For the RX beam peak search in the second hemisphere, perform steps 3 through 6 for the range of zenith angles $90^o > \theta \geq 0^o$.

   b) If the re-positioning concept is not applied to the RX test cases, continue steps 3 through 6 for the range of zenith angles $90^o < \theta \leq 180^o$

9) Calculate the resulting "averaged EIS" as:

$$\text{averaged EIS} = 2*[1/EIS(Pol_{Meas}=\theta, Pol_{Link}=\theta) + 1/EIS(Pol_{Meas}=\phi, Pol_{Link}=\phi)]^{-1}$$

The RX beam peak direction is where the minimum "averaged EIS" is found.

Alternatively, the RX beam peak direction for single carrier could be determined following the procedure described in Annex K.1.11.

For intra-band DL CA configurations with a frequency separation up to 800 MHz, if for single carrier test the Rx beam peak direction has been found for any frequency within the CA bandwidth, such direction shall be used. Otherwise, the single carrier measurement procedure is performed only on the PCC and the RX beam peak direction for the DL CA configuration is the direction of the PCC Rx beam peak direction.

For intra-band DL CA configurations with a frequency separation up to 800 MHz, if UE vendor provides a Beam Peak Search Declaration with respect to test frequency range for single CC for a given band, see 38.508-2 [4] table A.4.3.9-5, such declaration will also apply to PCC in DL CA configurations for that band.

For intra-band DL CA configurations with a frequency separation larger than 800 MHz the beam peak direction search procedure is FFS.

K.1.3 Peak EIRP measurement procedure

This section describes EIRP measurement procedure for a chosen Pol_{Link} of θ or ϕ

The TX beam peak direction is where the maximum total component of EIRP is found, including the respective polarization of the measurement antenna used to form the TX beam, according to K.1.1.

The measurement procedure includes the following steps:

1) Select any of the three Alignment Options (1, 2, or 3) from Tables N.2-1 through N.2-7 [3] to mount the DUT inside the QZ.

2) If the re-positioning concept is not applied to the TX test cases, position the device in DUT Orientation 1. If the re-positioning concept is applied to the TX test cases,

   a) position the device in DUT Orientation 1 from Tables N.2-1 through N.2-7 [3] if the maximum beam peak direction is within zenith angular range $0^o \leq \theta \leq 90^o$ for the alignment option selected in step 1

   b) position the device in DUT Orientation 2 (either Options 1 or 2) from Tables N.2-1 through N.2-7 [3] if the maximum beam peak direction is within zenith angular range $90^o < \theta \leq 180^o$ for DUT Orientation 1 for the alignment option selected in step 1.

3) Connect the SS (System Simulator) with the DUT through the measurement antenna with polarization reference Pol_{Link} to form the TX beam towards the TX beam peak direction and respective polarization. Allow at least BEAM_SELECT_WAIT_TIME for the UE TX beam selection to complete.

4) SS activates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.2 using condition Tx only.

5) Measure the mean power P_{meas} (Pol_{Meas}=θ, Pol_{Link}) of the modulated signal arriving at the power measurement equipment (such as a spectrum analyser, power meter, or gNB emulator).

6) Calculate EIRP(Pol_{Meas}=θ, Pol_{Link}) by adding the composite loss of the entire transmission path for utilized signal path, $L_{EIRP,\theta}$, and frequency to the measured power P_{meas} (Pol_{Meas}=θ, Pol_{Link}).

7) Measure the mean power P_{meas} (Pol_{Meas}=ϕ, Pol_{Link}) of the modulated signal arriving at the power measurement equipment.

8) Calculate EIRP(Pol_{Meas}=ϕ, Pol_{Link}) by adding the composite losses of the entire transmission path for utilized signal path, $L_{EIRP,\varphi}$ and frequency to the measured power P_{meas} (Pol_{Meas}=ϕ, Pol_{Link})

9) Calculate the resulting "total EIRP(Pol_{Link})", for the chosen Pol_{Link} of θ or ϕ as follows:

$$\text{total EIRP } (Pol_{Link}) = \text{EIRP}(Pol_{Meas}=\theta, Pol_{Link}) + \text{EIRP}(Pol_{Meas}=\phi, Pol_{Link})$$

10) SS deactivates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.3.

K.1.4 Peak EIS measurement procedure

This section describes EIS measurement procedure. The RX beam peak direction is where the minimum EIS is found according to K.1.2.

The measurement procedure includes the following steps:

1) Select any of the three Alignment Options (1, 2, or 3) from Tables N.2-1 through N.2-7 [3] to mount the DUT inside the QZ.

2) If the re-positioning concept is not applied to the RX test cases, position the device in DUT Orientation 1. If the re-positioning concept is applied to the RX test cases

   a) position the device in DUT Orientation 1 from Tables N.2-1 through N.2-7 [3] if the maximum beam peak direction is within zenith angular range $0^o \leq \theta \leq 90^o$ for the alignment option selected in step 1

   b) position the device in DUT Orientation 2 (either Options 1 or 2) from Tables N.2-1 through N.2-7 [3] if the maximum beam peak direction is within zenith angular range $90^o < \theta \leq 180^o$ for DUT Orientation 1 for the alignment option selected in step 1.

3) Connect the SS (System Simulator) with the DUT through the measurement antenna with $Pol_{Link}=\theta$ polarization to form the RX beam towards the RX beam peak direction. Allow at least BEAM_SELECT_WAIT_TIME for the UE RX beam selection to complete.

4) Determine EIS($Pol_{Meas}=\theta$, $Pol_{Link}=\theta$) for θ-polarization, i.e., the power level for the θ-polarization at which the throughput exceeds the requirements for the specified reference measurement channel. The downlink power step size shall be no more than 0.2 dB when the RF power level is near the sensitivity level.

5) Connect the SS (System Simulator) with the DUT through the measurement antenna with $Pol_{Link}=\phi$ polarization to form the RX beam towards the RX beam peak direction. Allow at least BEAM_SELECT_WAIT_TIME for the UE RX beam selection to complete.

6) Determine EIS($Pol_{Meas}=\phi$, $Pol_{Link}=\phi$) for φ-polarization, i.e., the power level for the ϕ-polarization at which the throughput exceeds the requirements for the specified reference measurement channel. The downlink power step size shall be no more than 0.2 dB when the RF power level is near the sensitivity level.

7) Calculate the resulting averaged EIS as:

$$EIS = 2*[1/EIS(Pol_{Mes}=\theta, Pol_{Link}=\theta) + 1/EIS(Pol_{Meas}=\phi, Pol_{Link}=\phi)]^{-1}$$

K.1.5 EIRP spherical coverage

The EIRP results from the TX beam peak search procedures of K.1.1, using the minimum number of grid points as described in Annex M.2.1 can be re-used for EIRP spherical coverage.

In case a coarse beam peak grid is used for TX beam peak search, using the minimum number of grid points defined in Annex M.3.1.1, the EIRP results can be re-used for EIRP spherical coverage.

K.1.5.0 Tx Spherical Coverage Method

In case a separate test is performed for EIRP spherical coverage, the procedure as per K.1.3 should be followed using the minimum number of grid points defined in Annex M.3.1.1 for spherical coverage.

The $EIRP_{target\text{-}CDF}$ is then obtained from the Cumulative Distribution Function (CDF) computed using maximum(EIRP($Pol_{Link}=\theta$), EIRP($Pol_{Link}=\phi$)) for all grid points. When using constant step size measurement grids, a theta-dependent correction shall be applied, i.e., the PDF probability contribution for each measurement point is scaled by sin(θ) or the normalized Clenshaw-Curtis weights $W(\theta)/W(90^o)$, introduced in Section M.4.2.1, to account for the denser grid point distribution near the poles. In case of Clenshaw-Curtis weights, when just a single measurement at the poles is performed, the PDF probability contributions need to be scaled by $M*W(\theta)/W(\theta=90°)$ to account for the M longitudes at those two grid points. When using constant density grids, these corrections are not needed.

K.1.5.1 Tx Fast Spherical Coverage Method

K.1.5.1.1 Introduction

The Fast Spherical Coverage Method is a test method providing an optimized test time for Tx spherical coverage measurements. This method is applicable to constant density and constant step size grid type. Instead of measuring all grid points as per Annex M, as required by the test procedure defined in Annex K.1.5, this method requires only a reduced number of grid points to be measured.

K.1.5.1.2 Description

To use this method, apply the following steps

1) During the EIRP Spherical coverage measurements, calculate the EIRP result for the grid point as $EIRP_{spherical}$ = Max(EIRP(Pol_{Link}= θ), EIRP(Pol_{Link}= ϕ)) starting with $N_{grid, meas, PASS}$ =0. If the $EIRP_{spherical}$ value is above the Min EIRP spherical coverage limit increase $N_{grid, meas, PASS}$ by 1.

2) Calculate the percentage of total grid points measured thus far above the EIRP spherical coverage requirement limit $N_{grid, meas, PASS}$ compared to the total number of grid points on the measurement grid $N_{grid,total}$.

3) If the percentage calculated in step 2) is equal to or higher than (100 - n^{th} percentile for EIRP spherical coverage)%, pass the device, otherwise continue to step 4. If all grid points have been measured, calculate the CDF for all grid points and pass the UE if the derived %-tile EIRP in measurement distribution exceeds the requirement. Otherwise fail the UE.

4) Advance to the next grid point and repeat the steps until measurements within zenith range 0º≤ θ ≤[90]º have been completed

NOTE 1: For test systems where the device repositioning approach outlined in Annex N is applied, the grid points of up to a zenith of [90]° are allowed to be measured in the first hemisphere before the device needs to be placed in the second orientation.

K.1.5.1.3 Measurement uncertainties

Same as when test procedure described in clause K.1.5.0 is used.

K.1.6 EIS spherical coverage

The EIS results from the RX beam peak search procedures of K.1.2, using the minimum number of grid points as described in Annex M.2.2 can be re-used for EIS spherical coverage.

In case a coarse beam peak grid is used for RX beam peak search with an EIS metric, using the minimum number of grid points defined in Annex M.3.2.1, the EIS results can be re-used for EIS spherical coverage.

K.1.6.0 Rx Spherical Coverage Method

In case a separate test is performed for spherical coverage, the procedure K.1.4 should be followed using the minimum number of grid points defined in Annex M.3.2.1 for spherical coverage.

The $EIS_{target-CDF}$ is then obtained from the Cumulative Distribution Function (CDF) computed using averaged EIS for all grid points. When using constant step size measurement grids, a theta-dependent correction shall be applied, i.e., the PDF probability contribution for each measurement point is scaled by sin(θ) or the normalized Clenshaw-Curtis weights W(θ)/W(90º), introduced in Section M.4.2.1, to account for the denser grid point distribution near the poles. In case of Clenshaw-Curtis weights, when just a single measurement at the poles is performed, the PDF probability contributions need to be scaled by M*W(θ)/W(θ=90°) to account for the M longitudes at those two grid points. When using constant density grids, these corrections are not needed.

K.1.6.1 Rx Fast Spherical Coverage Method

K.1.6.1.1 Introduction

Same as Annex K.1.5.1.2 except that this sub-clause is applicable to Rx measurements in Annex K.1.6.

K.1.6.1.2 Description

To use this method, apply the following steps

1) During the EIS Spherical coverage measurements, calculate the averaged EIS as: EIS = $2*[1/EIS(Pol_{Meas}= \theta\ Pol_{Link}= \theta) +1/EIS(Pol_{Meas}= \phi\ Pol_{Link}= \phi)]^{-1}$ at each grid point starting with $N_{grid,\ meas,\ PASS}$ =0. If the EIS value is below the EIS spherical coverage limit increase $N_{grid,\ meas,\ PASS}$ by 1.

2) Calculate the percentage of total grid points measured thus far above the EIS spherical coverage requirement limit $N_{grid,\ meas,\ PASS}$ compared to the total number of grid points on the measurement grid $N_{grid,total}$.

3) If the percentage calculated in step 2) is equal to or higher than (100 - n^{th} percentile for EIS spherical coverage)%, pass the device, otherwise continue to step 4. If all grid points have been measured, calculate the CDF for all grid points and pass the UE if the derived %-tile EIRP in measurement distribution exceeds the requirement. Otherwise fail the UE.

4) Advance to the next grid point and repeat the steps until measurements within zenith range $0^o \leq \theta \leq [90]^o$ have been completed.

NOTE 1: Same as NOTE 1 in Annex K.1.5.1.2.

K.1.6.1.3 Measurement uncertainties

Same as when test procedure described in clause K.1.6.0 is used.

K.1.7 TRP measurement procedure

The minimum number of measurement points for TRP measurement grid is outlined in Annex M.4.

The measurement procedure includes the following steps:

1) Select any of the three Alignment Options (1, 2, or 3) from Tables N.2-1 through N.2-7 [3] to mount the DUT inside the QZ.

2) If the re-positioning concept is not applied to the TX test cases, position the device in DUT Orientation 1. If the re-positioning concept is applied to the TX test cases

   a) position the device in DUT Orientation 1 from Tables N.2-1 through N.2-7 [3] if the maximum beam peak direction is within zenith angular range $0^o \leq \theta \leq 90^o$ for the alignment option selected in step 1

   b) Position de device in DUT Orientation 2 (either Options 1 or 2) from Tables N.2-1 through N.2-7 [3] if the maximum beam peak direction is within zenith angular range $90^o < \theta \leq 180^o$ for DUT Orientation 1 for the alignment option selected in step 1.

3) Connect the SS with the DUT through the measurement antenna with desired polarization reference Pol_{Link} to form the TX beam towards the desired TX beam direction and respective polarization. Allow at least BEAM_SELECT_WAIT_TIME for the UE TX beam selection to complete.

4) SS activates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.2 using condition Tx only.

5) For each measurement grid point, measure $P_{meas}(Pol_{Meas}=\theta, Pol_{Link})$ and $P_{meas}(Pol_{Meas}=\phi, Pol_{Link})$. The angle between the measurement antenna and the DUT (θ_{Meas}, φ_{Meas}) is achieved by rotating the measurement antenna and the DUT (based on system architecture).

6) Calculate EIRP(Pol_{Meas}=θ, Pol_{Link}) and EIRP(Pol_{Meas}=ϕ, Pol_{Link}) by adding the composite loss of the entire transmission path for utilized signal paths, $L_{EIRP,θ}$, $L_{EIRP,φ}$ and frequency to the respective measured powers P_{meas}.

7) The TRP value for the uniform measurement grid is calculated using the TRP integration approaches outlined in Annex M.4.2. The TRP value for the constant density grid is calculated using the TRP integration formula in Annex M.4.3.

8) SS deactivates the UE Beamlock Function (UBF) by performing the procedure as specified in TS 38.508-1 [10] clause 4.9.3.

K.1.8 Blocking measurement procedure

The RX beam peak direction is where the minimum EIS is found according to K.1.2.

The measurement procedure includes the following steps:

1) Select any of the three Alignment Options (1, 2, or 3) from Tables N.2-1 through N.2-7 to mount the DUT inside the QZ.

2) If the re-positioning concept is not applied to the RX test cases, position the device in DUT Orientation 1. If the re-positioning concept is applied to the RX test cases

   a) position the device in DUT Orientation 1 from Tables N.2-1 through N.2-7 [3] if the maximum beam peak direction is within zenith angular range 0º≤θ≤90º for the alignment option selected in step 1

   b) position the device in DUT Orientation 2 (either Options 1 or 2) from Tables N.2-1 through N.2-7 [3] if the maximum beam peak direction is within zenith angular range 90º<θ≤180º for DUT Orientation 1 for the alignment option selected in step 1.

3) Establish a connection between the DUT and the SS with the downlink signal applied to the θ-polarization of the measurement antenna

4) Position the UE so that the beam is formed towards the measurement antenna in the RX beam peak direction.

5) Apply a signal with the specified reference measurement channel on the θ-polarization, setting the power level of the signal 3dB below the EIS level stated in the requirement.

6) Apply the blocking signal with the same polarization and coming from the same direction as the downlink signal. Set the power level of the blocking signal 3dB below the level stated in the requirement.

7) Measure the throughput of the downlink signal on the θ-polarization.

8) Switch the downlink and blocking signal to the φ-polarization of the measurement antenna.

9) Repeat steps 3 to 7 on the φ-polarization.

10) Compare the results for both the θ-polarization and φ-polarization against the requirement. If both results meet the requirements, pass the UE.

K.1.9 Beam Correspondence tolerance procedure

This beam correspondence tolerance procedure applies to the DUT with beam correspondence capability *beamCorrespondenceWithoutUL-BeamSweeping* not present (which shall match OEM declaration), such that DUT relies on uplink beam sweeping to fulfil the minimum peak EIRP and spherical coverage requirements.

The measurement procedure includes the following steps for each of the points in the grid:

1) Follow the test procedures specified in subclause K.1.5 with uplink beam sweeping disabled, obtain total $EIRP_1$(Pol_{Link}=θ) and total $EIRP_1$(Pol_{Link}=ϕ). $EIRP_1$ is calculated by $EIRP_1$ = maximum($EIRP_1$(Pol_{Link}=θ), $EIRP_1$(Pol_{Link}=ϕ)).

2) Follow the test procedures specified in subclause K.1.5, with uplink beam sweeping enabled (SS does not configure the *spatialRelationInfo* to DUT) during DUT TX beam refinement, obtain total $EIRP_2(Pol_{Link}=\theta)$ and total $EIRP_2(Pol_{Link}=\phi)$. $EIRP_2$ is calculated by $EIRP_2$ = maximum($EIRP_2(Pol_{Link}=\theta)$, $EIRP_2(Pol_{Link}=\phi)$).

3) Calculate the $\Delta EIRP_{BC} = EIRP_2 – EIRP_1$.

The $\Delta EIRP_{target\text{-}CDF}$ is then obtained from the Cumulative Distribution Function (CDF) computed using $\Delta EIRP_{BC}$ for each of all top N^{th} percentile of the $EIRP_2$ measurement points in the grid. When using constant step size measurement grids, a theta-dependent correction shall be applied, i.e., the PDF probability contribution for each measurement point is scaled by sin(θ) or the normalized Clenshaw-Curtis weights W(θ)/W(90°), introduced in Section M.4.2.1.

NOTE: $\Delta EIRP_{BC}$ is introduced for beam correspondence tolerance based on two EIRP measurements ($EIRP_1$ and $EIRP_2$). $EIRP_1$ is the measured total EIRP based on the beam which DUT chooses autonomously (corresponding beam) to transmit in the direction of the incoming DL signal, which is based on beam correspondence without relying on UL beam sweeping. $EIRP_2$ is the measured total EIRP based on the beam yielding highest EIRP in a given direction, which is based on beam correspondence with relying on UL beam sweeping. $\Delta EIRP_{BC}$ shall be calculated over the link angles spanning a subset of the spherical coverage grid points which are corresponding to the top N^{th} percentile of the $EIRP_2$ measurement points in the grid, where the value of N is according to EIRP spherical coverage requirement of DUT's power class defined in TS 38.101-2 [3] clause 6.2.1, e.g., N=50 for power class 3 DUT.

K.1.11 RSRP(B) based RX beam peak search

Editor's Note: This clause is incomplete. The following aspects are not determined.

- Feasibility and Applicability of this RSRP-B based Rx beam peak search is FFS
- Additional analysis of side conditions to be applied is FFS
- Analysis of MU impact is FFS
- Additional optimization of the method for use in scenarios such as Carrier Aggregation and EN-DC is still FFS

RSRP(B)-based RX beam peak search approach is applicable to find the beam peak, the beam peak search time can be reduced significantly.

K.1.11.1 Test procedure

The RX beam peak direction is found with a 3D RSRP(B) scan (separately for each orthogonal downlink polarization). The RX beam peak direction is where the maximum total component of RSRP is found. The RX beam peak direction search grid points for this single grid approach are defined in Annex M,2.

The measurement procedure includes the following steps:

1) Select any of the three Alignment Options (1, 2, or 3) from Tables N.2-1 through N.2-3 [3] to mount the DUT inside the QZ.

2) Position the DUT in DUT Orientation 1 or 2 from Tables N.2-1 through N.2-3 [3].

3) Connect the SS (System Simulator) with the DUT through the measurement antenna with $Pol_{Link}=\theta$ polarization to form the RX beam towards the measurement antenna.

4) Adjust the DL power of the SS to obtain the NR DL signal level as per Table C.0-1 at the centre of QZ. Determine RSRP or RSRPBs (one per receiver branch) at $Pol_{Meas}=Pol_{Link}=\theta$ condition reported by UE.

5) Connect the SS (System Simulator) with the DUT through the measurement antenna with $Pol_{Link}=\phi$ polarization to form the RX beam towards the measurement antenna.

6) Set the same DL power as the one in step 4. Determine RSRP or RSRPBs (one per receiver branch) at $Pol_{Meas}=Pol_{Link}=\phi$ condition reported by UE.

7) Advance to the next grid point and repeat steps 3 through 6 until measurements within the full 3D scan have been completed.

8) Data processing the linear sum of four reported RSRPBs. How to calculate the reported RSRPs is FFS.

To guarantee RSRP(B) accuracy, SNR side condition configuration can refer to the minimum SSB_RP specified for beam correspondence defined in Table K.1.11-1 (from TS 38.101-2 [3] Table 6.6.4.3.1-1):

Table K.1.11.1-1: Conditions for SSB based L1-RSRP measurements for beam correspondence

Angle of arrival	NR operating bands	Minimum SSB_RP Note 2	SSB Ês/Iot
		dBm / SCS_{SSB}	dB
		SCS_{SSB} = 120 kHz	
All angles Note 1	n257	-96.2	≥6
	n258	-96.2	
	n259	-90.7	
	n260	-91.9	
	n261	-96.2	
	n262	-88.5	
NOTE 1: For UEs that support multiple FR2 bands, the Minimum SSB_RP values for all angles are increased by $\Delta MB_{S,n}$, the UE multi-band relaxation factor in dB specified in clause 6.2.1. NOTE 2: Values specified at the radiated requirements reference point to give minimum SSB Ês/Iot, with no applied noise.			

K.1.12 Enhanced test method for EIRP measurements

Editor's Note: This clause is incomplete. The following aspects are not determined.

- Applicability of this enhanced method is FFS
- Additional analysis of how this method can be used within existing tests is FFS
- Additional optimization of the method for use in scenarios such as Carrier Aggregation and EN-DC is still FFS

Transmitted Matrix Precoding Indicator (TPMI) is the basis of codebook based transmission enabling multi-port antenna transmission. TPMI method is identified as applicable method to enhance EIRP measurement, which is able to activate dual polarization transmission in EIRP measurement. The applicability of this method is defined in Clause K.1.12.1.

For FR2 UEs support the TPMI method, the precoding matrix W is given by Table K.1.12-1 (same as Table 6.3.1.5-1 in TS 38.211 [9]). 2Tx TPMI index 2-5 can force UE single-layer transmission using two antenna ports. Among them, only TPMI index 2 is selected for EIRP measurement.

Table K.1.12-1-1: Precoding matrix W for single-layer transmission using two antenna ports

TPMI index	W (ordered from left to right in increasing order of TPMI index)							
0 – 5	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\0\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}0\\1\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\1\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-1\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\j\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	-	-

The permitted test methods (i.e. DFF, IFF and NFTF) in [5] are all applicable for TPMI method with the additional procedure that the UE should be configured with TPMI index and working at single-layer transmission using two antenna ports, before performing EIRP-based test procedures in Clause 5.2.1.3 in TR38.810 [5].:

- Peak EIRP Measurement Procedure
- TRP Measurement Procedure
- TX Beam Peak direction search and EIRP Spherical Coverage

K.1.12.1 Applicability of TPMI side condition method

TPMI is applicable for one layer transmission with multi-port antenna. In FR2, dual polarization can be regarded as dual antenna ports, so it is natural to activate dual polarization transmission with TPMI side condition in EIRP measurement procedure. However, for TPMI supporting dual antenna ports, the number of SRS ports (*nrofSRS-Ports*) is configured as 2 for both one layer transmission with 'full power transmission' and two layers transmission with regular UL MIMO, as specified in clause 6.1 of TS 38.101-2 [3]:

> For a UE that supports 'UL full power transmission' and is configured to transmit a single layer with *nrofSRS-Ports* = 2, the requirements for UL MIMO operation apply only when it is configured for any of its declared full power modes in IE *FullPowerTransmission-r16* (as defined in TS 38.331[19]).
>
> For a UE configured to transmit 2 layers, transmitter requirements for UL MIMO operation apply when the UE transmits on 2 ports on the same CDM group. The UE may use higher MPR values outside this limitation.

Thus, TPMI method is applicable for the following FR2 UEs:

- Rel-15 Coherent UE (UE capability *pusch-TransCoherence* = *fullCoherent* with network configuration *codebookSubset= FullyAndPartialAndNonCoherent*).
- Rel-16 and onwards Coherent UE (UE capability *pusch-TransCoherence* = *fullCoherent* with network configuration *codebookSubset= FullyAndPartialAndNonCoherent*).
- Rel-16 and onwards UE supporting UL full power transmission mode1 (UE capability *ul-FullPwrMode1-r16= supported* with network configuration *ul-FullPowerTransmission* = *fullpowerMode1*).

Other UEs are not applicable for TPMI based test method.

K.1.12.2 TPMI side condition method Measurement uncertainties impact

TPMI side condition method has no impact on measurement uncertainties.

K.2 Direct far field (DFF) simplification

K.2.1 TX beam peak direction search

Same measurement procedure as in clause K.1.1.

K.2.2 RX beam peak direction search

Same measurement procedure as in clause K.1.2.

K.2.3 Peak EIRP measurement procedure

Same measurement procedure as in clause K.1.3.

K.2.4 Peak EIS measurement procedure

Same measurement procedure as in clause K.1.4.

K.2.5 EIRP spherical coverage

Same measurement procedure as in clause K.1.5.

K.2.6 EIS spherical coverage

Same measurement procedure as in clause K.1.6.

K.2.7 TRP measurement procedure

Same measurement procedure as in clause K.1.7.

K.2.8 Blocking measurement procedure

Same measurement procedure as in clause K.1.8.

K.3 Indirect far field (IFF)

K.3.1 TX beam peak direction search

Same measurement procedure as in clause K.1.1.

K.3.2 RX beam peak direction search

Same measurement procedure as in clause K.1.2.

K.3.3 Peak EIRP measurement procedure

Same measurement procedure as in clause K.1.3.

K.3.4 Peak EIS measurement procedure

Same measurement procedure as in clause K.1.4.

K.3.5 EIRP spherical coverage

Same measurement procedure as in clause K.1.5.

K.3.6 EIS spherical coverage

Same measurement procedure as in clause K.1.6.

K.3.7 TRP measurement procedure

Same measurement procedure as in clause K.1.7.

K.3.8 Blocking measurement procedure

Same measurement procedure as in clause K.1.8.

K.4 Near field to far field transform (NFTF)

K.4.1 TX beam peak direction search

The TX beam peak direction is found with a 3D EIRP scan (separately for each orthogonal polarization) with a grid that is TBD. The TX beam peak direction is where the maximum total component of EIRP is found.

FFS

K.4.2 RX beam peak direction search

Not applicable for NFTF method.

K.4.3 Peak EIRP measurement procedure

1) Connect the SS (System Simulator) to the DUT through the measurement antenna with polarization reference Pol_{Meas} to form the TX beam towards the previously determined TX beam peak direction and respective polarization.

2) Lock the beam toward that direction for the entire duration of the test.

3) Perform a 3D pattern measurement (amplitude and phase) with the DUT sending a modulated signal.

4) Determine the EIRP for both polarization towards the TX beam peak direction by using a Near Field to Far Field transform.

5) Calculate total EIRP = $EIRP_{\theta}$ + $EIRP_{\phi}$

K.4.4 Peak EIS measurement procedure

Not applicable for NFTF method.

K.4.5 EIRP spherical coverage

Same measurement procedure as in clause K.1.5.

K.4.6 EIS spherical coverage

Not applicable for NFTF method.

K.4.7 TRP measurement procedure

The minimum number of measurement points for TRP measurement grid is outlined in Annex M.4.

The measurement procedure includes the following steps:

1) Connect the SS to the DUT through the measurement antenna with polarization reference Pol_{Meas} to form the TX beam towards the previously determined TX beam peak direction and respective polarization.

2) Lock the beam toward that direction for the entire duration of the test.

3) Perform a 3D pattern measurement (amplitude and phase) with the DUT sending a modulated signal.

4) For each measurement point on the grid, determine the EIRP for both polarization by using a Near Field to Far Field transform.

5) The TRP value for the constant step size measurement grids are calculated using the TRP integration approaches outlined in Annex M.4.2. The TRP value for the constant density grid is calculated using the TRP integration formula in Annex M.4.3.

K.4.8 Blocking measurement procedure

Not applicable for NFTF method.

Annex L (normative): Void

Annex M:(normative) Measurement grids

This appendix describes the assumptions and definition of the minimum number of measurement grid points for various grid types. Further details can be found in [5].

A total of three measurement grids are considered:

- Beam Peak Search Grid: using this grid, the TX and RX beam peak direction will be determined. 3D EIRP scans are used to determine the TX beam peak direction and 3D Throughput/RSRP/EIS scans for RX beam peak directions.

- Spherical Coverage Grid: using this grid, the CDF of the EIRP/EIS distribution in 3D is calculated to determine the spherical coverage performance.

- TRP Measurement Grid: using this grid, the total power radiated by the DUT in the TX beam peak direction is determined by integrating the EIRP measurements taken on the sampling grid.

M.1 Grid Types

Two different measurement grid types are considered:

- The constant step size grid type has the azimuth and elevation angles uniformly distributed as in the examples illustrated in Figures M.1-1 in 2D and M.1-2 in 3D.

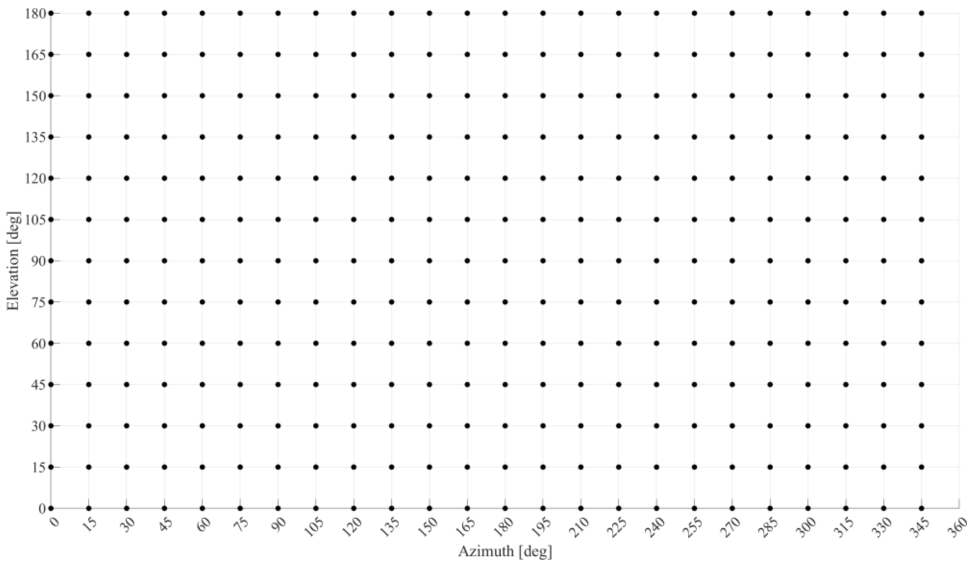


Figure M.1-1: Distribution of measurement grid points in 2D for a constant step size grid with Δθ=Δϕ=15º (266 unique measurement points)

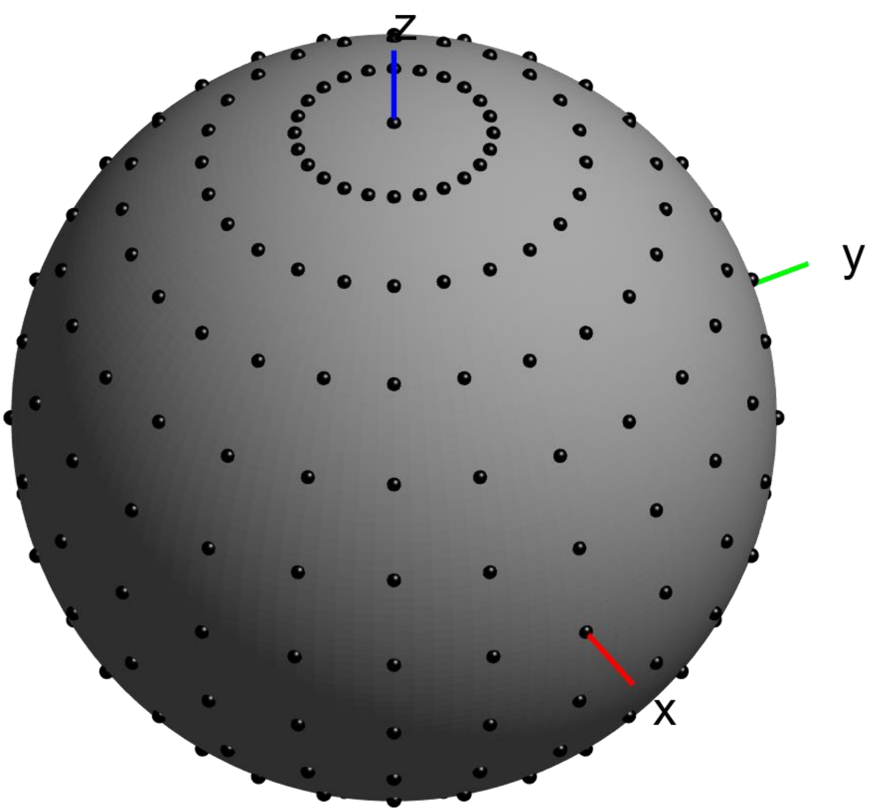


Figure M.1-2: Distribution of measurement grid points in 3D for a constant step size grid with Δθ=Δϕ=15º (266 unique measurement points)

- Constant density grid types have measurement points that are evenly distributed on the surface of the sphere with a constant density as in the example illustrated in Figures M.1-3 in 2D and M.1-4 in 3D.

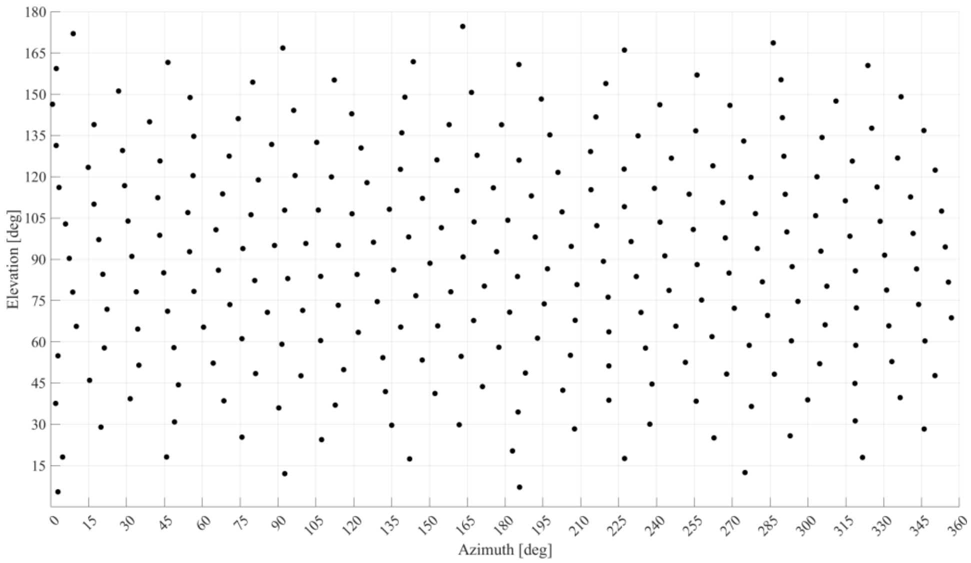


Figure M.1-3: Distribution of measurement grid points in 2D for a constant density grid with 266 unique measurement points

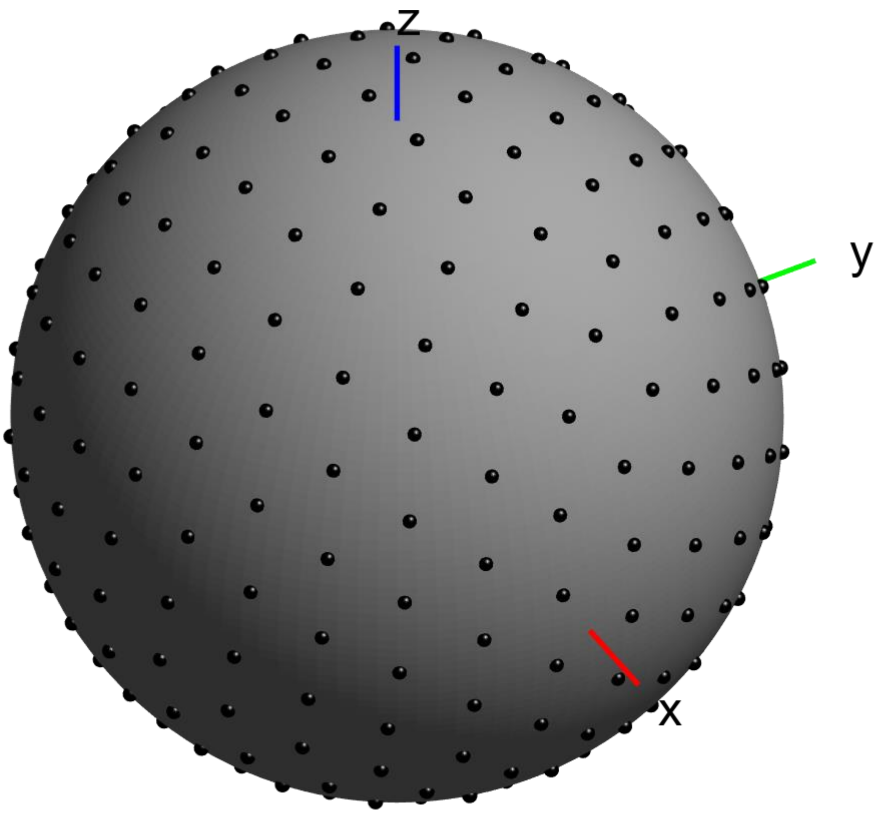


Figure M.1-4: Distribution of measurement grid points in 3D for a constant density grid type with 266 unique measurement points

M.2 Beam Peak Search Grid

Editor's note: Other implementations are not precluded as far as the respective analysis are presented and included in this TS

M.2.1 UE Power classes

M.2.1.1 Power class 1 devices

In order to make a reasonable trade-off with measurement uncertainties, it is recommended to use for beam peak search the following measurement grids leading to a systematic error of "Beam Peak Search" of 0.7 dB:

- Constant density grid (using the charged particle implementation) with at least 3000 grid points.
- Constant step size grid with at least 4902 grid points, corresponding to an angular step size of 3.6º.

For better measurement uncertainties, finer measurement grids as shown in Table M.2.1.1-1 may be used. Choice of grids among these 2 types of grids is up to test system implementation.

Table M.2.1.1-1: Minimum number of unique grid points for sample systematic errors

Systematic Error of 'Beam Peak Search': Offset from Beam Peak at which CDF is 5%	Minimum Number of Unique Grid Points for Constant Step Size Grid	Minimum Number of Unique Grid Points for Constant Density Grid
0.3dB	10226 (2.5° step size)	7000
0.4dB	N/A	5000
0.5dB	7082 (3°step size)	4500
0.6dB	N/A	3500
0.7dB	4902 (3.6° step size)	3000

M.2.1.2 Power class 2 devices

TBD

M.2.1.3 Power class 3 devices

In order to make a reasonable trade-off between measurement uncertainties, at least 800(constant density grid with charged particle implementation) or 1106 (constant step size grid) measurement grid points shall be used for beam peak search procedures. For better measurement uncertainties, finer measurement grids as shown below may be used. Choice of grids among these 2 types of grids is up to test system implementation.

Table M.2.1.3-1: Minimum number of unique grid points for sample systematic errors (non-sparse antenna arrays)

Systematic Error of 'Beam Peak Search': Offset from Beam Peak at which CDF is 5%	Minimum Number of Unique Grid Points for Constant Step Size Grid	Minimum Number of Unique Grid Points for Constant Density Grid (charged particle implementation)
0.2dB	2522 (5° step size)	2000
0.3dB	1742 (6° step size)	1500
0.4dB	N/A	1000
0.5dB	1106 (7.5°step size)	800

Based on an optional vendor declaration with respect to the antenna array configuration, devices with an M x N ($M \geq N$) configuration with $M \leq 4$ and $N \leq 2$ can utilize either of the following minimum number of grid points with the same systematic error of 'Beam Peak Search' of 0.5dB for beam peak search procedures:

- 310 (constant density grid with charged particle implementation) measurement grid points.
- 422 (constant step size grid with $\Delta\theta=\Delta\phi=12.0^{o}$) measurement grid points.

M.2.1.4 Power class 4 devices

TBD

M.2.2 Coarse and fine measurement grids

The baseline beam peak search is based on a single and fine beam peak search grid to determine the TX/RX beam peak of the DUT in any given direction. This means that even in sectors where poor EIRP/EIS performance is observed, a very fine grid is used to search for the TX/RX beam peak.

An optimized approach, based on an initial coarse search followed by a subsequent fine search could reduce the number of beam peak search grid points significantly. The basis for this approach is to use a coarse grid with fewer number of points than the ones described in section M.2.1 in the first stage to identify candidate regions that contain the global beam peak and search for the global beam peak with the fine grid in the second stage with a minimum number of points described in section M.2.1.

As an example, Figure M.2.2-1 illustrates the coarse and fine measurement grid approach applied to TX beam search; while this illustration is for EIRP, it can easily be extended to RX beam peak search using EIS or throughput metrics For simplification purposes, 2D coarse and fine searches are illustrated but the concept can be extended to 3D easily. The UE is assumed to form a total of six beams in the 2D plane as illustrated on the left of Figure M.2.2-1. In the centre of Figure M.2.2-1, the 36 coarse beam peak search grid points in the 2D plane are illustrated. On the right, the grey circles on the respective antenna patterns illustrate the measured EIRP values towards each coarse grid point direction based on the respective beam steering directions. This illustration shows that the EIRP beam peak of the coarse search, $EIRP_{CSBP}$, is found to be the peak of the orange beam while the global TX beam peak (red beam) was not identified due to the coarse sampling of the grid points.

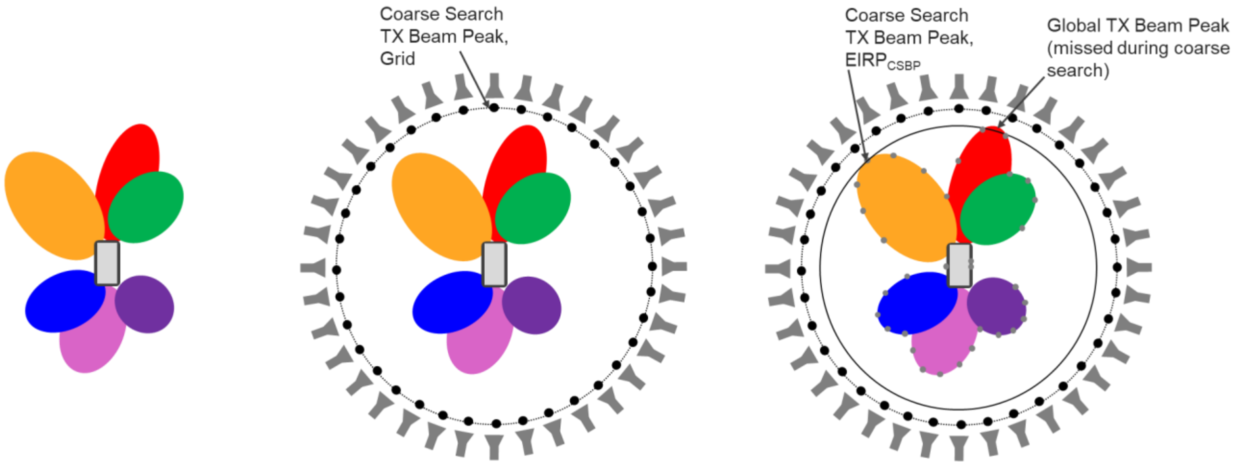


Figure M.2.2-1: Illustration of the Coarse Search Approach for TX Beam Peak Search. Left: Antenna Pattern assumptions in 2D, Centre: Coarse beam peak search grid points/discrete antenna measurement positions, Right: TX beam EIRP measurements per grid point

The proposed fine search approach is illustrated further in Figure M.2.2-2. A fine search region starting from the beam peak identified in the coarse search, $EIRP_{CSBP}$, over a range of Δ_{FS} is used to identify the regions that need to be investigated more closely with the fine search algorithm. The fine search range Δ_{FS} is a function of the angular spacing of the coarse beam peak search grid as well as the beam width of the reference antenna pattern considered for smartphone UEs.

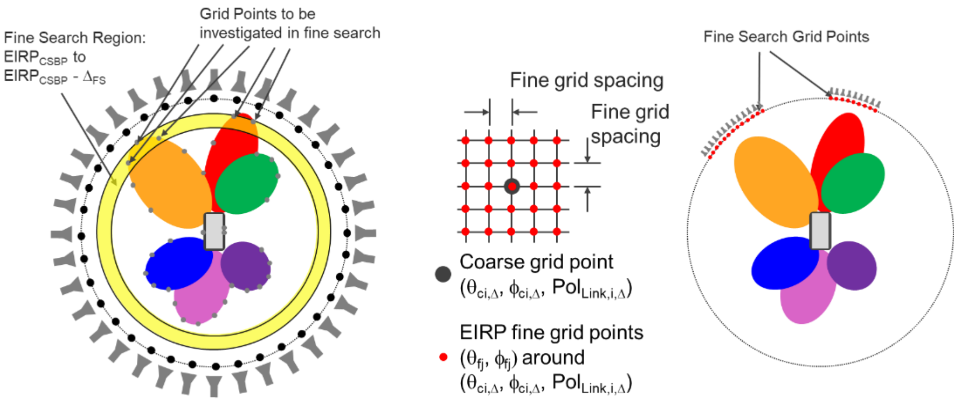


Figure M.2.2-2: Illustration of the fine beam peak search grid. Left: identify the measurement grid points that yielded EIRP values within the fine search region, right: placement of fine beam peak search grid points

Figure M.2.2-3 illustrates coarse and fine grids for constant step size measurement grids while Figure M.2.2-4 illustrates the same for constant density grid.

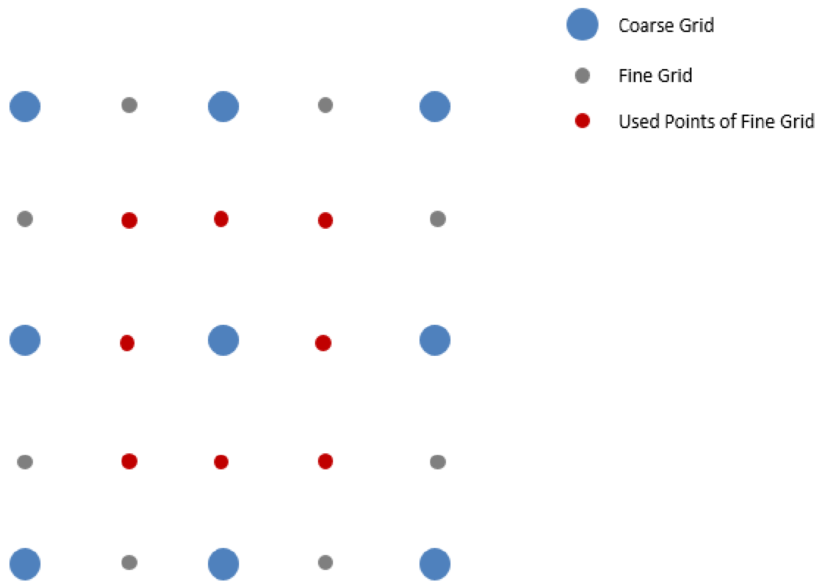


Figure M.2.2-3: Illustration: Coarse & Fine Constant Step Size Grids

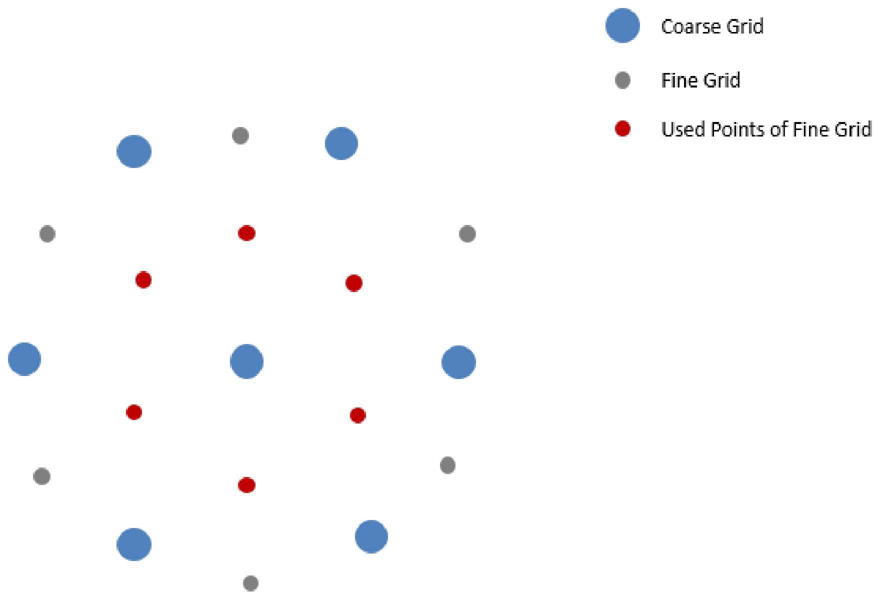


Figure M.2.2-4: Illustration: Coarse & Fine Constant Density Grids

The metric using a coarse & fine grid approach for the TX beam peak search is EIRP for both grids. For RX beam peak search either EIS or Throughput could be used for coarse grids while only EIS for fine grid,

M.3 Spherical Coverage Grid

Editor's note: Other implementations are not precluded as far as the respective analysis are presented and included in this TS

M.3.1 EIRP spherical coverage

M.3.1.1 UE Power classes

M.3.1.1.1 Power class 1 devices

In order to make a reasonable trade-off with measurement uncertainties, it is recommended to use the following recommendation in terms of min. number of grid points, standard deviation, and mean error for spherical coverage grids:

- constant density grid (using the charged particle implementation) with at least 200 grid points: standard deviation (MU element 'Influence of spherical coverage grid') of 0.13dB and 0.04dB Mean Error

- constant step size grid with at least 266 grid points: standard deviation (MU element 'Influence of spherical coverage grid') of 0.12dB and 0.06dB Mean Error

For better measurement uncertainties, finer measurement grids as shown in Tables M.3.1.1.1-1 and M.3.1.1.1-2 may be used. Choice of grids among these 2 types of grids is up to test system implementation.

There is no need to have the Tx beam peak placed on a measurement grid point.

For constant step size measurement grids, the CDF analyses require the PDFs to be scaled by sin(theta) or the normalized Clenshaw-Curtis weights W(θ)/W(90º), introduced in Section M.4.2.1.

Table M.3.1.1.1-1: Statistical results of $EIRP_{85\%CDF}$ for the 12x12 antenna array for constant step size measurement grids and the beam peak oriented in completely random orientations.

Step Size [º]	Number of unique grid points	Std. Dev [dB]	|Mean Error| [dB]
12	422	0.10	0.03
15	266	0.12	0.06
20	146	0.23	0.05

Table M.3.1.1.1-2: Statistical results of $EIRP_{50\%CDF}$ for the 12x12 antenna array for constant density measurement grids and the beam peak oriented in completely random orientations.

Number of unique grid points	Std. Dev [dB]	|Mean Error| [dB]
150	0.15	0.06
175	0.13	0.04
200	0.13	0.04

M.3.1.1.2 Power class 2 devices

TBD

M.3.1.1.3 Power class 3 devices

In order to make a reasonable trade-off between measurement uncertainties, at least 200 (constant density grid with charged particle implementation) or 266 (constant step size grid) measurement grid points shall be used for EIRP spherical coverage procedure. For better measurement uncertainties, finer measurement grids as shown below may be used. Choice of grids among these 2 types of grids is up to test system implementation.

There is no need to have the Tx beam peak placed on a measurement grid point.

For constant step size measurement grids, the CDF analyses require the PDFs to be scaled by sin(theta) or the normalized Clenshaw-Curtis weights W(θ)/W(90º), introduced in Section M.4.2.1.

Table M.3.1.1.3-1: Statistical results of EIRP50%CDF for the 8x2 antenna array for constant density measurement grids (with charged particle implementation) and the beam peak oriented in completely random orientations errors (non-sparse antenna arrays)

Number of unique grid points	STD [dB]	|Mean Error| [dB]
200	0.11	0.02
300	0.08	0.01
400	0.07	0.01
500	0.06	0.01

Table M.3.1.1.3-2: Statistical results of EIRP50%CDF for the 8x2 antenna array for constant step size measurement grids and the beam peak oriented in completely random orientations errors (non-sparse antenna arrays)

Step Size [º]	Number of unique grid points	STD [dB]	|Mean Error| [dB]
9	762	0.05	0.00
10	614	0.06	0.00
12	422	0.07	0.01
15	266	0.12	0.01

Based on an optional vendor declaration with respect to the antenna array configuration, devices with an M x N ($M \geq N$) configuration with $M \leq 4$ and $N \leq 2$ can utilize either of the following minimum number of grid points for spherical coverage procedures:

- 180 (constant density grid with charged particle implementation) measurement grid points with std. deviation of 0.12dB.
- 266 (constant step size grid with $\Delta\theta=\Delta\phi=15.0^{o}$) measurement grid points with std. deviation of 0.11dB.

M.3.1.1.4 Power class 4 devices

TBD

M.3.2 EIS spherical coverage

M.3.2.1 UE Power classes

M.3.2.1.1 Power class 1 devices

In order to make a reasonable trade-off with measurement uncertainties, it is recommended to use the following recommendation in terms of min. number of grid points, standard deviation, and mean error for spherical coverage grids:

- constant density grid (using the charged particle implementation) with at least 200 grid points: standard deviation (MU element 'Influence of spherical coverage grid') of 0.13dB and 0.04dB Mean Error
- constant step size grid with at least 266 grid points: standard deviation (MU element 'Influence of spherical coverage grid') of 0.12dB and 0.06dB Mean Error
- the MU element 'Systematic error related to EIS spherical coverage' is the DL step size, i.e., 0.2dB.

Choice of grids among these 2 types of grids is up to test system implementation.

There is no need to have the Rx beam peak placed on a measurement grid point.

For constant step size measurement grids, the CCDF analyses require the PDFs to be scaled by sin(theta) or the normalized Clenshaw-Curtis weights W(θ)/W(90º), introduced in Section M.4.2.1.

M.3.2.1.2 Power class 2 devices

TBD

M.3.2.1.3 Power class 3 devices

In order to make a reasonable trade-off between measurement uncertainties, at least 200 (constant density grid with charged particle implementation) or 266 (constant step size grid) measurement grid points shall be used for EIS spherical coverage procedure. For better measurement uncertainties, finer measurement grids as shown below may be used. Choice of grid(s) among these 2 types of grids is up to test system implementation.

There is no need to have the Rx beam peak placed on a measurement grid point.

For constant step size measurement grids, the CCDF analyses require the PDFs to be scaled by sin(theta) or the normalized Clenshaw-Curtis weights W(θ)/W(90º), introduced in Section M.4.2.1.

Table M.3.2.1.3-1: Statistical results of EIS50%CDF for the 8x2 antenna array for constant step size measurement grids and the beam peak oriented in completely random orientations errors (non-sparse antenna arrays)

		DL Power Step Size: infinitesimal		DL Power Step Size: 0.1dB		DL Power Step Size: 0.5dB		DL Power Step Size: 1dB	
Step Size [º]	Number of unique grid points	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]
6.0	1742	0.03	0.00	0.03	0.10	0.03	0.50	0.02	1.02
9.0	762	0.05	0.00	0.05	0.10	0.05	0.50	0.04	1.02
10.0	614	0.06	0.00	0.06	0.10	0.06	0.50	0.05	1.02
12.0	422	0.08	0.01	0.07	0.10	0.07	0.50	0.07	1.02
15.0	266	0.12	0.02	0.12	0.10	0.11	0.50	0.10	1.02

Table M.3.2.1.3-2: Statistical results of EIS50%CDF for the 8x2 antenna array for constant density measurement grids (with charged particle implementation) and the beam peak oriented in completely random orientations errors (non-sparse antenna arrays)

	DL Power Step Size: infinitesimal		DL Power Step Size: 0.1dB		DL Power Step Size: 0.5dB		DL Power Step Size: 1dB	
Number of unique grid points	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]	STD [dB]	|Mean Error| [dB]
200	0.10	0.02	0.10	0.10	0.10	0.50	0.09	1.01
300	0.08	0.01	0.08	0.10	0.08	0.50	0.07	1.01
400	0.06	0.01	0.06	0.10	0.06	0.50	0.05	1.01
500	0.06	0.01	0.06	0.10	0.06	0.50	0.05	1.01

Based on an optional vendor declaration with respect to the antenna array configuration, devices with an M x N ($M \geq N$) configuration with $M \leq 4$ and $N \leq 2$ can utilize either of the following minimum number of grid points for spherical coverage procedures:

- 180 (constant density grid with charged particle implementation) measurement grid points with std. deviation of 0.12dB.
- 266 (constant step size grid with $\Delta\theta=\Delta\phi=15.0^o$) measurement grid points with std. deviation of 0.11dB.

M.3.2.1.4 Power class 4 devices

TBD

M.4 TRP Measurement Grid

Editor's note: Other implementations are not precluded as far as the respective analysis are presented and included in this TS

M.4.1 UE Power Classes

M.4.1.1 Power class 1 devices

In order to make a reasonable trade-off between measurement uncertainties, at least the following number of points shall be included in the measurement grid for TRP measurements PC1 UEs based on the assumption that the standard deviation does not exceed 0.25dB. If the re-positioning concept is not applied to TRP test cases:

- 500 measurement grid points for constant density grid – Charged Particle implementation, with standard deviation of 0.25 dB
- 25 latitudes and 48 longitudes (1106 unique grid points) for constant step size grid – sin (theta) weights integration approach, with standard deviation of 0.10dB with the allowance to skip and interpolate measurements at the pole at $\theta=180^o$, see Annex M.4.4
- 25 latitudes and 48 longitudes (1106 unique grid points) for constant step size grid – Clenshaw Curtis weights integration approach, with standard deviation of 0.07dB with the allowance to skip and interpolate measurements at the pole at $\theta=180^o$, see Annex M.4.4

If the re-positioning concept is applied to TRP test cases:

- 500 measurement grid points for constant density grid – Charged Particle implementation, with standard deviation of 0.25 dB with the allowance to skip and interpolate measurements for $\theta\geq150^o$, see Annex M.4.4
- 25 latitudes and 48 longitudes (1106 unique grid points) for constant step size grid – sin (theta) weights integration approach, with standard deviation of 0.09dB with the allowance to skip and interpolate measurements for $\theta\geq157.5^o$, see Annex M.4.4
- 25 latitudes and 48 longitudes (1106 unique grid points) for constant step size grid – Clenshaw-Curtis weights integration approach, with standard deviation of 0.03dB with the allowance to skip and interpolate measurements for $\theta\geq157.5^o$, see Annex M.4.4
- 21 latitudes and 40 longitudes (762 unique grid points) for constant step size grid – Clenshaw Curtis weights integration approach, with standard deviation of 0.24 dB with the allowance to skip and interpolate measurements for $\theta\geq153^o$, see Annex M.4.4

M.4.1.2 Power class 2 devices

TBD

M.4.1.3 Power class 3 devices

In order to make a reasonable trade-off between measurement uncertainties, at least the following number of points should be included in the measurement grid for TRP measurements for non-sparse antenna arrays case. If the re-positioning concept is not applied to TRP test cases:

- 135 measurement grid points for constant density grid – Charged Particle implementation, with standard deviation of 0.23 dB.
- 12 latitudes and 19 longitudes for constant step size grid – sin (theta) weights integration approach, with standard deviation of 0.25dB with the allowance to skip and interpolate measurements at the pole at θ=180º.
- 12 latitudes and 19 longitudes for constant step size grid – Clenshaw Curtis weights integration approach, with standard deviation of 0.20 dB with the allowance to skip and interpolate measurements at the pole at θ=180º.

If the re-positioning concept is applied to TRP test cases:

- 135 measurement grid points for constant density grid – Charged Particle implementation, with standard deviation of 0.23 dB with the allowance to skip and interpolate measurements for θ≥165º, see Annex M.4.4
- 150 measurement grid points for constant density grid – Charged Particle implementation, with standard deviation of 0.25 dB with the allowance to skip and interpolate measurements for θ≥150º, see Annex M.4.4
- 12 latitudes and 19 longitudes for constant step size grid – sin (theta) weights integration approach, with standard deviation of 0.25dB with the allowance to skip and interpolate measurements the at pole at θ=180º, see Annex M.4.4
- 12 latitudes and 19 longitudes for constant step size grid – Clenshaw Curtis weights integration approach, with standard deviation of 0.20 dB with the allowance to skip and interpolate measurements the at pole at θ=180º, see Annex M.4.4
- 13 latitudes and 24 longitudes for constant step size grid – sin (theta) weights integration approach, with standard deviation of 0.21dB with the allowance to skip and interpolate measurements for θ≥165º, see Annex M.4.4
- 13 latitudes and 24 longitudes for constant step size grid – Clenshaw Curtis weights integration approach, with standard deviation of 0.15 dB with the allowance to skip and interpolate measurements for θ≥165º, see Annex M.4.4.

Choice of grid(s) among above 3 types of grids is up to test system implementation.

Based on an optional vendor declaration with respect to the antenna array configuration, devices with an M x N ($M \geq N$) configuration with $M \leq 4$ and $N \leq 2$ can utilize either of the following minimum number of grid points for TRP procedures without the repositioning approach:

- 50 measurement grid points for constant density grid – Charged Particle implementation, with standard deviation of 0.14 dB.
- 80 measurement grid points for constant density grid – Charged Particle implementation, with standard deviation of 0.23 dB. with the allowance to skip and interpolate measurements for θ≥165º, see Annex M.4.4.
- 8 latitudes and 14 longitudes (84 unique number of grid points) for constant step size grid – sin (theta) weights integration approach, with standard deviation of 0.25dB with the allowance to skip and interpolate measurements at the pole at θ=180º.
- 8 latitudes and 14 longitudes (84 unique number of grid points) for constant step size grid – Clenshaw Curtis weights integration approach, with standard deviation of 0.20 dB with the allowance to skip and interpolate measurements at the pole at θ=180º.

Either of the following minimum number of grid points for TRP procedures apply if the re-positioning is applied:

- 50 measurement grid points for constant density grid – Charged Particle implementation, with standard deviation of 0.14 dB with the allowance to skip and interpolate measurements for θ≥150º, see Annex M.4.4.
- 7 latitudes and 12 longitudes (62 unique number of grid points) for constant step size grid – Clenshaw Curtis weights integration approach, with standard deviation of 0.20 dB with the allowance to skip and interpolate measurements the at pole at θ=180º, see Annex M.4.4.

- 8 latitudes and 14 longitudes (86 unique number of grid points) for constant step size grid – sin (theta) weights integration approach, with standard deviation of 0.25dB with the allowance to skip and interpolate measurements for θ≥154.29°, see Annex M.4.4.

- 8 latitudes and 14 longitudes (86 unique number of grid points) for constant step size grid – Clenshaw Curtis weights integration approach, with standard deviation of 0.09 dB with the allowance to skip and interpolate measurements for θ≥128.58°, see Annex M.4.4.

Choice of grid(s) among above 3 types of grids is up to test system implementation.

M.4.1.4 Power class 4 devices

TBD

M.4.2 TRP Integration for Constant Step Size Grid Type

Different approaches to perform the TRP integration from the respective EIRP measurements are outlined in the next sub clauses for the constant step size grid type.

M.4.2.1 TRP Integration using Weights

In many engineering disciplines, the integral of a function needs to be solved using numerical integration techniques, commonly referred to as "quadrature". Here, the approximation of the integral of a function is usually stated as a weighted sum of function values at specified points within the domain of integration. The derivation from the closed surface TRP integral

$$TRP = \oint\!\!\!\oint_S \frac{EIRP(\theta,\phi)}{4\pi} \cdot \sin\theta \cdot d\theta\, d\phi$$

to the classical discretized summation equation used for OTA

$$TRP \approx \frac{\pi}{2\,NM}\sum_{i=1}^{N-1}\sum_{j=0}^{M-1}\left[EIRP_\theta(\theta_i,\phi_j) + EIRP_\phi(\theta_i,\phi_j)\right]\sin(\theta_i)$$

The weights for this integral are based on the sinθ·Δθ weights. More accurate implementations are based on the Clenshaw-Curtis quadrature integral approximation based on an expansion of the integrand in terms of Chebyshev polynomials. This implementation does not ignore the measurement points at the poles (θ=0° and 180°) where sinθ = 0. The discretized TRP can be expressed as

$$TRP \approx \frac{1}{2\,M}\sum_{i=0}^{N}\sum_{j=0}^{M-1}\left[EIRP_\theta(\theta_i,\phi_j) + EIRP_\phi(\theta_i,\phi_j)\right]\mathrm{W}(\theta_i)$$

which the sinθ·Δθ weights replaced by a weight function W(θ) and extends the sum over I to include the poles. There is no simple closed-form expression for the Clenshaw-Curtis weights; however, a numerical straightforward approach is available, i.e.,

$$W(\theta_i) = \frac{c_i}{N}\left[1 - \sum_{j=1}^{\mathrm{int}\left(\frac{N}{2}\right)} \frac{b_j}{4j^2-1}\cos(2j\theta_i)\right]$$

with

$$b_j = \begin{cases} 1, & 2j = N \\ 2, & otherwise \end{cases}$$

and

$$c_i = \begin{cases} 1, & i = 0 \text{ or } N \\ 2, & otherwise \end{cases}$$

The Clenshaw-Curtis weights are compared to the classical sin θ·Δθ weights in Tables M.4.2.1-1 and M.4.2.1-2 for two different numbers of latitudes. The TRP measurement grid consists of N+1 latitudes and M longitudes with

$$\theta_i = i\Delta\theta \text{ where } \Delta\theta = \frac{\pi}{N}$$

and

$$\phi_j = j\Delta\phi \text{ where } \Delta\phi = \frac{2\pi}{M}$$

Table M.4.2.1-1: Samples and weights for the classical sin θ·Δθ weighting and Clenshaw-Curtis quadratures with 12 latitudes (Δθ=16.4°)

Classical sinθ·Δθ		Clenshaw-Curtis	
θ [deg]	Weights	θ [deg]	Weights
0	0	0	0.008
16.4	0.08	16.4	0.079
32.7	0.154	32.7	0.155
49.1	0.216	49.1	0.216
65.5	0.26	65.5	0.26
81.8	0.283	81.8	0.283
98.2	0.283	98.2	0.283
114.6	0.26	114.6	0.26
130.9	0.216	130.9	0.216
147.3	0.154	147.3	0.155
163.6	0.08	163.6	0.079
180	0	180	0.008

Table M.4.2.1-2: Samples and weights for the classical sin θ·Δθ weighting and Clenshaw-Curtis quadratures with 13 latitudes (Δθ=15º)

Classical sinθ·Δθ		Clenshaw-Curtis	
θ [deg]	Weights	θ [deg]	Weights
0	0	0	0.007
15	0.0678	15	0.0661
30	0.1309	30	0.1315
45	0.1851	45	0.1848
60	0.2267	60	0.227
75	0.2529	75	0.2527
90	0.2618	90	0.262
105	0.2529	105	0.2527
120	0.2267	120	0.227
135	0.1851	135	0.1848
150	0.1309	150	0.1315
165	0.0678	165	0.0661
180	0	180	0.007

M.4.3 TRP Integration for Constant Density Grid Types

For constant density grid types, the TRP integration should ideally take into account the area of the Voronoi region surrounding each grid point. Assuming an ideal constant density configuration of the grid points, the TRP can be approximated using

$$TRP \approx \frac{1}{N}\sum_{i=0}^{N-1}\left[EIRP_{\theta}(\theta_i,\phi_i) + EIRP_{\phi}(\theta_i,\phi_i)\right]$$

where N is the number of grid points of the constant density grid type.

M.4.4 Interpolation at or near the Pole

As illustrated in Figure M.4.4-1, for systems that either do not allow measurements at the pole (θ=180º), e.g., using distributed-axes positioners, or systems that have the positioners/support structures block the radiation towards the pole (θ=180º), e.g., combined-axes positioners, measurements beyond 150º in θ can be skipped and interpolated instead for measurement grids defined in Annex M.4.1.

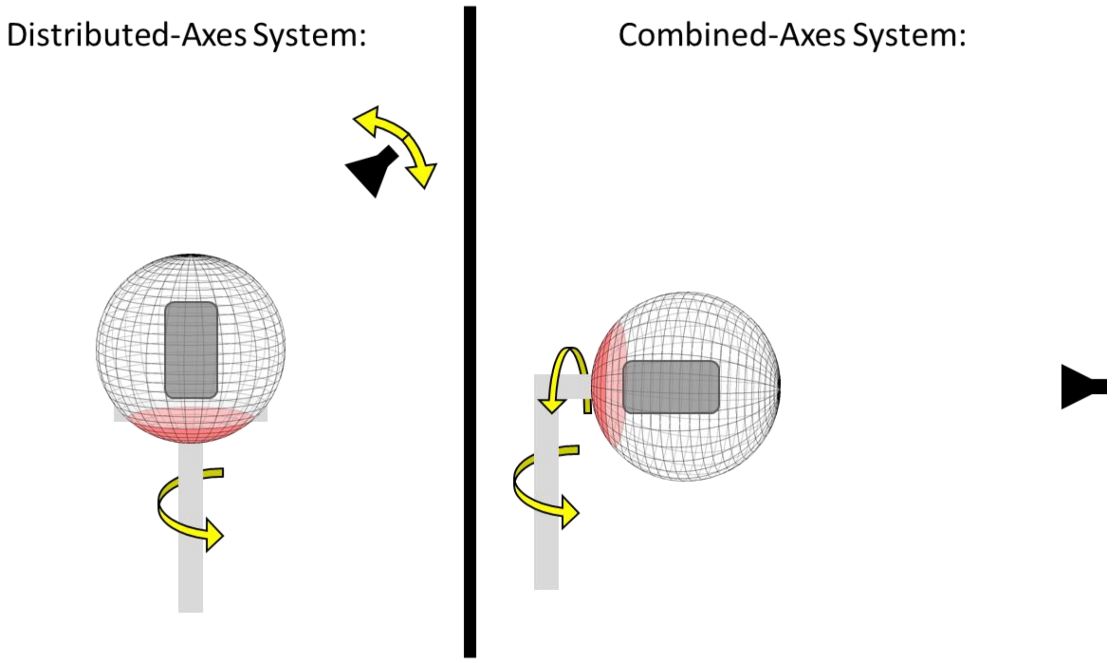


Figure M.4.4-1: Illustration of areas around the pole that either cannot be reached by the measurement antenna or are blocked by the positioner

M.4.5 TRP Grids for Spurious Emissions

The worst antenna array assumptions for the MU simulations are outlined in Tables M.4.5-1 and M.4.5-2.

Table M.4.5-1: Single Antenna Element Radiation Pattern for spurious emission measurements

Antenna element horizontal radiation pattern	$A_{E,H}(\varphi) = -\min\left[12\left(\frac{\varphi}{\varphi_{3dB}}\right)^2, A_m\right] dB$, A_m =30 dB
Horizontal half-power beam width of single element	260º
Antenna element vertical radiation pattern	$A_{E,V}(\theta) = -\min\left[12\left(\frac{\theta-90}{\theta_{3dB}}\right)^2, SLA_v\right]$, SLA_v =30 dB
Vertical half-power beam width of single array element	130º
Array element radiation pattern	$A_E(\varphi,\theta) = G_{E,\max} - \min\left\{-\left[A_{E,H}(\varphi) + A_{E,V}(\theta)\right], A_m\right\}$
Element gain without antenna losses	$G_{E,max}$ = 1.5 dBi

Table M.4.5-2: Composite Antenna Array Radiation Pattern for spurious emission measurements

Composite array radiation pattern in dB $A_A(\theta,\varphi)$	$A_{A,Beami}(\theta,\varphi) = A_E(\theta,\varphi) + 10\log_{10}\left(\left\|\sum_{m=1}^{N_H}\sum_{n=1}^{N_V} w_{i,n,m}\cdot v_{n,m}\right\|^2\right)$ the super position vector is given by: $v_{n,m} = \exp\left(i\cdot 2\pi\left((n-1)\cdot\frac{d_V}{\lambda}\cdot\cos(\theta) + (m-1)\cdot\frac{d_H}{\lambda}\cdot\sin(\theta)\cdot\sin(\varphi)\right)\right),$ $n = 1,2,\ldots N_V;\ m = 1,2,\ldots N_H;$ the weighting is given by: $w_{i,n,m} = \frac{1}{\sqrt{N_H N_V}}\exp\left(i\cdot 2\pi\left((n-1)\cdot\frac{d_V}{\lambda}\cdot\sin(\theta_{i,etilt}) - (m-1)\cdot\frac{d_H}{\lambda}\cdot\cos(\theta_{i,etilt})\cdot\sin(\varphi_{i,escan})\right)\right)$
Antenna array configuration (Row×Column)	8 x 2
Horizontal radiating element spacing, d_h/λ	1
Vertical radiating element spacing, d_v/λ	1

The TRP measurement grid selection for spurious emissions is up to test system implementation but shall meet the criteria shown in Table M.4.5-3.

Table M.4.5-3: TRP measurement grid requirement for spurious emission measurements

Level of Grid	Grid Type	Standard Deviation of MU Element 'Influence of TRP Measurement'	Systematic error due to TRP calculation/quadrature	Number of unique grid points
Coarse	Constant Density	N/A	N/A	35
	Constant-Step Size	N/A	N/A	62 (Δθ=Δϕ=30º)
Fine	Constant Density	0.32dB	0dB	135
	Constant-Step Size	0.31dB	0dB	266 (Δθ=Δϕ=15º)

For spurious emissions, TRP measurements with measurement antennas displaced up to 10º from the focal point (based on electrical switching) in an IFF (based on CATR) test system, alternate TRP approaches for constant-step size grids are allowed for the coarse and fine grids:

interpolation to the non-offset system coordinate system that allows the use of Clenshaw-Curtis or classical sin(θ) quadratures

use of the advanced Jacobian matrix quadrature approach that uses triangulations of the sphere

Annex N (normative): UE coordinate system

N.1 Reference coordinate system

This annex defines the measurement coordinate system for the NR UE. The reference coordinate system as defined in IEEE Std 149 [27] is provided in Figure N.1-1 below while Figure N.1.-2 shows an example DUT in the default alignment, i.e., the DUT and the reference coordinate systems are aligned with α = 0º and β = 0º and γ = 0º where α, β, and γ describe the relative angles between the two coordinate systems.

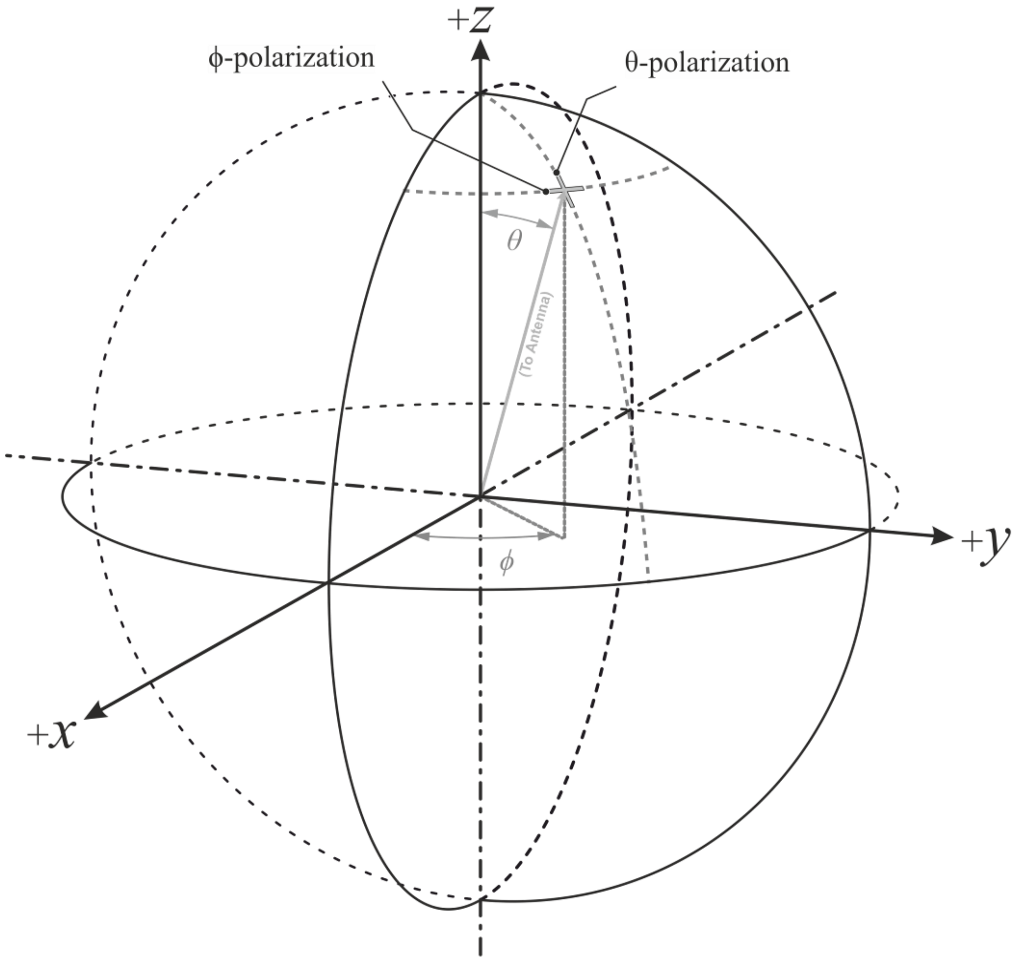


Figure N.1-1: Reference coordinate system

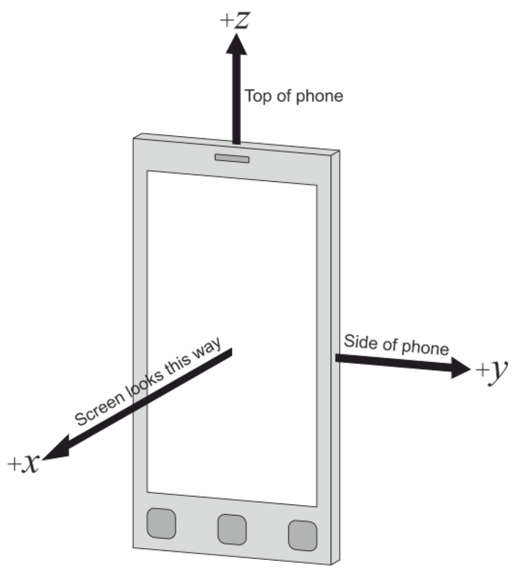


Figure N.1-2: Example of DUT default alignment to coordinate system

The following aspects are necessary:

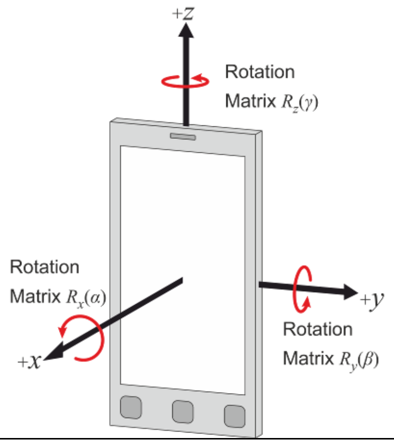
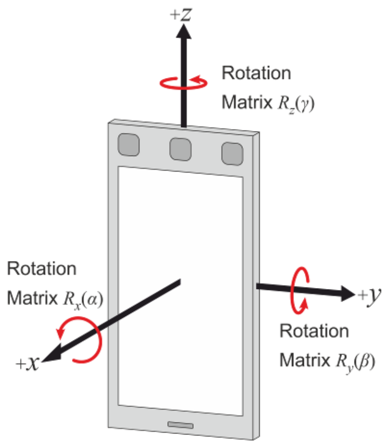
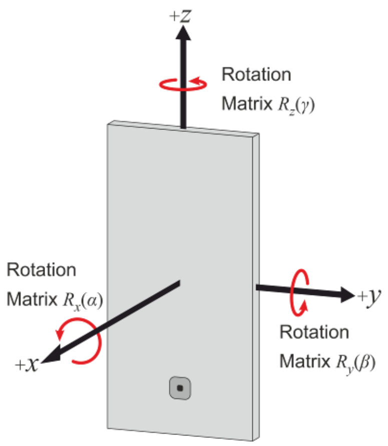
- A basic understanding of the top and bottom of the device is needed in order to define unambiguous DUT positioning requirements for the test, e.g., in the drawings used in this annex, the three buttons are on the bottom of the device (front) and the camera is on the top of the device (back).

- An understanding of the origin and alignment the coordinate system inside the test system i.e. the directions in which the x, y, z -axes points inside the test chamber is needed in order to define unambiguous DUT orientation, DUT beam, signal, interference, and measurement angles

N.2 Test conditions and angle definitions

Tables N.2-1 through N.2-3 below provides the test conditions and angle definitions for three permitted device alignment for smartphones and tablets for the default test condition, DUT orientation 1, and two different options for each permitted device alignment to re-position the device for DUT Orientation 2 as outlined in Figures N.2-1 and N.2-3.

Table N.2-1: Test conditions and angle definitions for smartphones and tablets for Alignment Option 1

Test condition	DUT orientation	Link angle	Measurement angle	Diagram
Free space DUT Orientation 1 (default)	α = 0°; β = 0°; γ = 0°	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 1 (based on re-positioning approach)	α = 180°; β = 0°; γ = 0°	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 2 (based on re-positioning approach)	α = 0°; β = 180°; γ = 0°	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	

NOTE 1: A polarization reference, as defined in relation to the reference coordinate system in N.1-1, is maintained for each signal angle, link or interferer angle, and measurement angle.

NOTE 2: The combination of rotations is captured by matrix $M=R_z(\gamma)\cdot R_y(\beta)\cdot R_x(\alpha)$

Table N.2-2: Test conditions and angle definitions for smartphones and tablets for Alignment Option 2

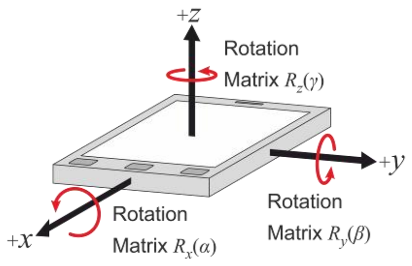
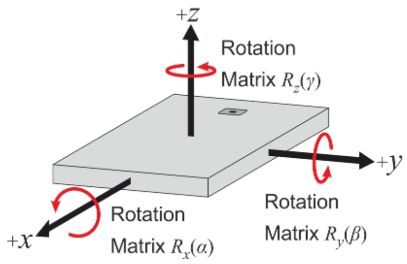
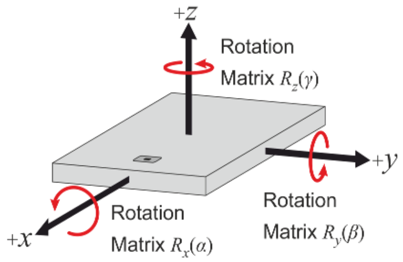
Test condition	DUT orientation	Link angle	Measurement angle	Diagram
Free space DUT Orientation 1 (default)	α = 0º; β = -90º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 1 (based on re-positioning approach)	α = 180º; β = 90º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 2 (based on re-positioning approach)	α = 0º; β = 90º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
NOTE 1: A polarization reference, as defined in relation to the reference coordinate system in N.1-1, is maintained for each signal angle, link or interferer angle, and measurement angle. NOTE 2: The combination of rotations is captured by matrix $M=R_z(\gamma)\bullet R_y(\beta)\bullet R_x(\alpha)$				

Table N.2-3: Test conditions and angle definitions for smartphones and tablets for Alignment Option 3

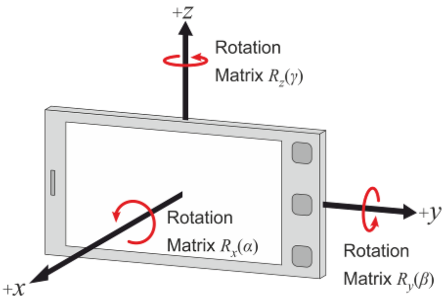
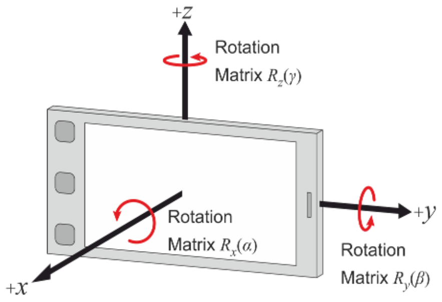
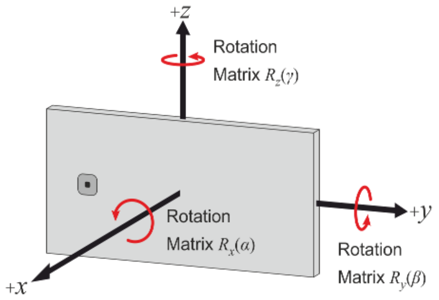
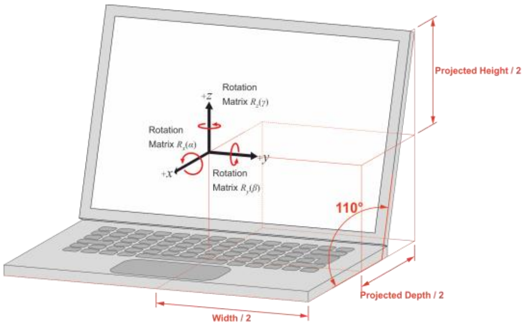
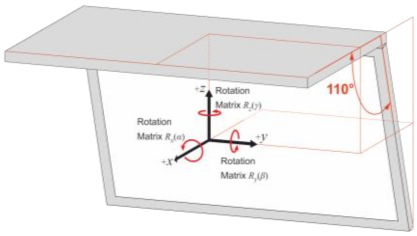
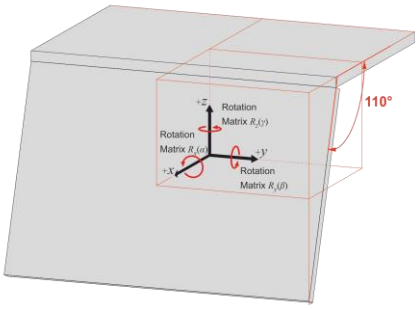
Test condition	DUT orientation	Link angle	Measurement angle	Diagram
Free space DUT Orientation 1 (default)	α = 90º; β = 0º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 1 (based on re-positioning approach)	α = -90º; β = 0º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 2 (based on re-positioning approach)	α = 90º; β = 180º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
NOTE 1: A polarization reference, as defined in relation to the reference coordinate system in N.1-1, is maintained for each signal angle, link or interferer angle, and measurement angle. NOTE 2: The combination of rotations is captured by matrix $M=R_z(\gamma)\bullet R_y(\beta)\bullet R_x(\alpha)$				

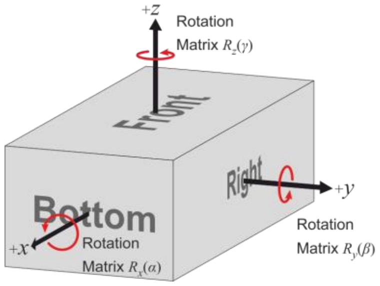
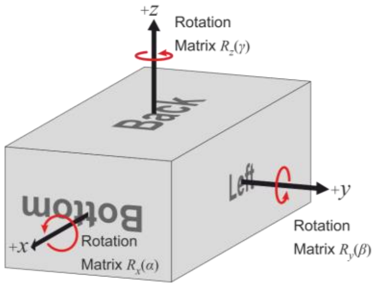
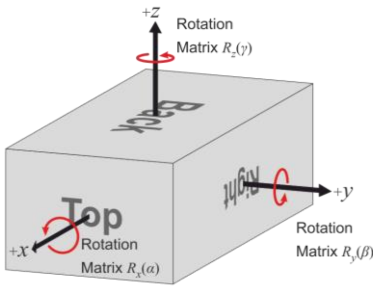
Table N.2-4 below provides the test conditions and angle definitions for the permitted device alignment for laptops for the default test condition, DUT orientation 1, and two different options for each permitted device alignment to re-position the device for DUT Orientation 2 as outlined in Figures N.3-1 and N.3-2. The display is open at a lid angle of 110º ± 5º, where lid angle is defined as the angle between the front of the display to the levelled base, and the full projected volume is centred inside the test volume.

Table N.2-4: Test conditions and angle definitions for laptops

Test condition	DUT orientation	Link angle	Measurement angle	Diagram
Free space DUT Orientation (default)	α = 0º; β = 0º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 1 (based on re-positioning approach)	α = 180º; β = 0º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 2 (based on re-positioning approach)	α = 0º; β = 180º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
NOTE 1: A polarization reference, as defined in relation to the reference coordinate system in N.1-1, is maintained for each signal angle, link or interferer angle, and measurement angle. NOTE 2: The combination of rotations is captured by matrix $M = R_z(\gamma) \cdot R_y(\beta) \cdot R_x(\alpha)$				

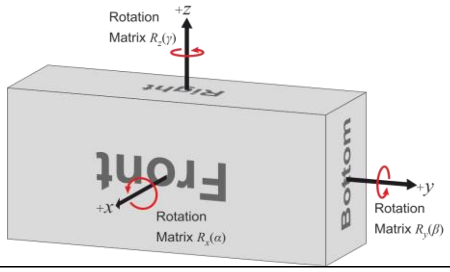
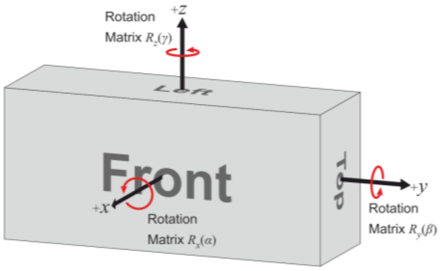
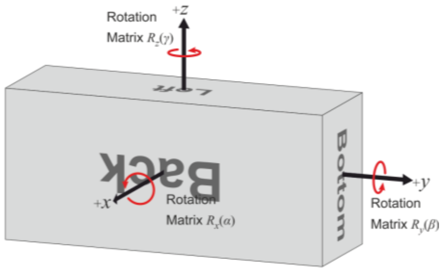
Tables N.2-5 through N.2-7 below provides the test conditions and angle definitions for the three permitted device alignment options for Fixed Wireless Access (FWA) for the default test condition, DUT orientation 1, and two different options for each permitted device alignment to re-position the device for DUT Orientation 2 as outlined in Figures N.3-1 and N.3-2. Due to changes in DUT orientations α, β, and γ for the alignment options for FWA proposed in Tables N.2-6 through N.2-7 when compared to those in Tables N.2-2 through N.2-3, new alignment options, i.e., Options 4 and 5, were introduced.

Table N.2-5: Test conditions and angle definitions for FWA for Alignment Option 1

Test condition	DUT orientation	Link angle	Measurement angle	Diagram
Free space DUT Orientation 1 (default)	α = 0º; β = 0º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 1 (based on re-positioning approach)	α = 180º; β = 0º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 2 (based on re-positioning approach)	α = 0º; β = 180º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	

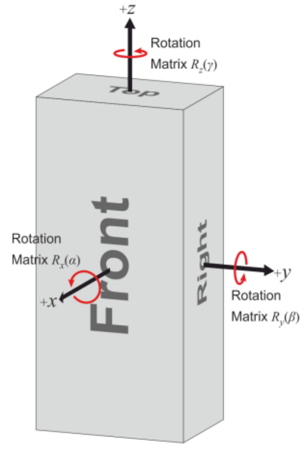
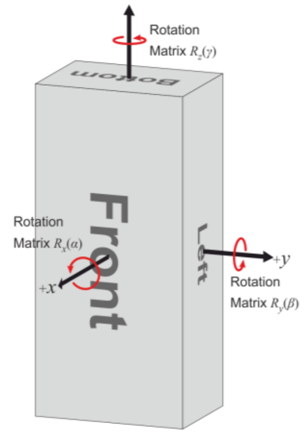
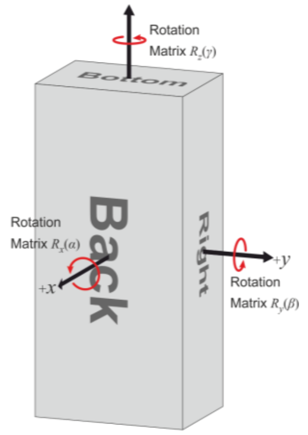
NOTE 1: A polarization reference, as defined in relation to the reference coordinate system in N.1-1, is maintained for each signal angle, link or interferer angle, and measurement angle.
NOTE 2: The combination of rotations is captured by matrix $M=R_z(\gamma)\bullet R_y(\beta)\bullet R_x(\alpha)$

Table N.2-6: Test conditions and angle definitions for FWA for Alignment Option 4

Test condition	DUT orientation	Link angle	Measurement angle	Diagram
Free space DUT Orientation 1 (default)	α = 90º; β = 0º; γ = 90º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 1 (based on re-positioning approach)	α = -90º; β = 0º; γ = -90º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 2 (based on re-positioning approach)	α = -90º; β = 0º; γ = 90º	θLink; ϕLink with polarization reference PolLink = θ or ϕ	θMeas; ϕMeas with polarization reference PolMeas = θ or ϕ	

NOTE 1: A polarization reference, as defined in relation to the reference coordinate system in N.1-1, is maintained for each signal angle, link or interferer angle, and measurement angle.
NOTE 2: The combination of rotations is captured by matrix $M=R_z(\gamma)\bullet R_y(\beta)\bullet R_x(\alpha)$

Table N.2-7: Test conditions and angle definitions for FWA for Alignment Option 5

Test condition	DUT orientation	Link angle	Measurement angle	Diagram
Free space DUT Orientation 1 (default)	α = 0º; β = 90º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 1 (based on re-positioning approach)	α = 180º; β = -90º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
Free space DUT Orientation 2 – Option 2 (based on re-positioning approach)	α = 0º; β = -90º; γ = 0º	θ_{Link}; ϕ_{Link} with polarization reference Pol_{Link} = θ or ϕ	θ_{Meas}; ϕ_{Meas} with polarization reference Pol_{Meas} = θ or ϕ	
NOTE 1: A polarization reference, as defined in relation to the reference coordinate system in N.1-1, is maintained for each signal angle, link or interferer angle, and measurement angle. NOTE 2: The combination of rotations is captured by matrix $M=R_z(\gamma)\cdot R_y(\beta)\cdot R_x(\alpha)$				

For each UE requirement and test case, each of the parameters in Table N.2-1 through N.2-7 need to be recorded, such that DUT positioning, DUT beam direction, and angles of the signal, link/interferer, and measurement are specified in terms of the fixed coordinate system.

Due to the non-commutative nature of rotations, the order of rotations is important and needs to be defined when multiple DUT orientations are tested.

The rotations around the x, y, and z axes can be defined with the following rotation matrices

$$R_x(\alpha) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\alpha & -\sin\alpha & 0 \\ 0 & \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_y(\beta) = \begin{bmatrix} \cos\beta & 0 & \sin\beta & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\beta & 0 & \cos\beta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

and

$$R_z(\gamma) = \begin{bmatrix} \cos\gamma & -\sin\gamma & 0 & 0 \\ \sin\gamma & \cos\gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

with the respective angles of rotation, α, β, γ, and

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = R \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

Additionally, any translation of the DUT can be defined with the translation matrix

$$T(t_x, t_y, t_z) = \begin{bmatrix} 1 & 0 & 0 & t_x \\ 0 & 1 & 0 & t_y \\ 0 & 0 & 1 & t_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

with offsets t_x, t_y, t_z in x, y, and z, respectively and with

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = T \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

The combination of rotations and translation is captured by the multiplication of rotation and translation matrices.

For instance, the matrix M

$$M = T(t_x, t_y, t_z) \cdot R_z(\gamma) \cdot R_y(\beta) \cdot R_x(\alpha)$$

describes an initial rotation of the DUT around the x axis with angle α, a subsequent rotation around the y axis with angle β, and a final rotation around the z axis with angle γ. After those rotations, the DUT is translated by t_x, t_y, t_z in x, y, and z, respectively.

N.3 DUT positioning guidelines

Near-field coupling effects between the antenna and the pedestals/positioners/fixtures generally cause increased signal ripples. Re-positioning the DUT by directing the beam peak away from those areas can reduce the effect of signal ripple on EIRP/EIS measurements. Figure N.3-1 and N.3-2 illustrate how to reposition the DUT in distributed axes and combined axes system, when the beam peak is directed to the DUTs upper hemisphere (DUT orientation 1) or the DUTs lower hemisphere (DUT orientation 2). While these figures are examples of different positioning systems and other implementations are not precluded, the relative orientation of the coordinate system with respect to the antennas/reflectors and the axes of rotation shall apply to any measurement setup.

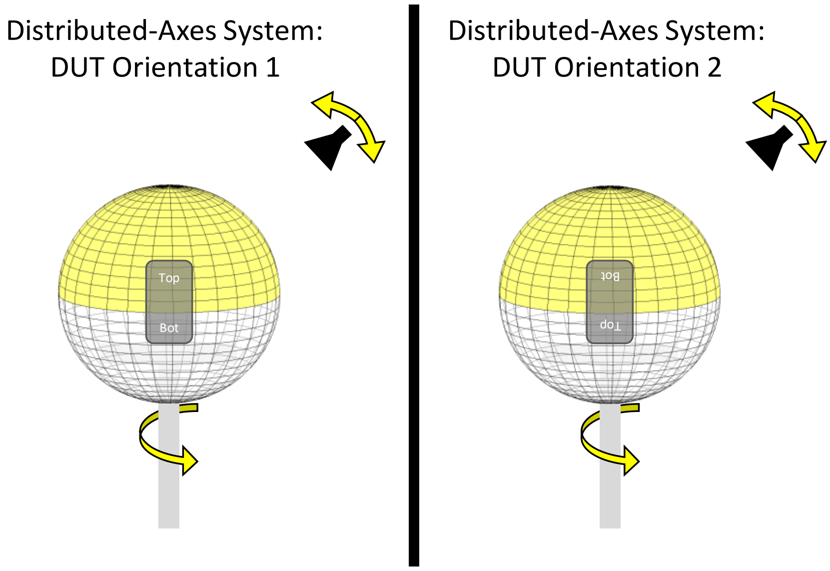


Figure N.3-1: DUT re-positioning for an example of distributed-axes system

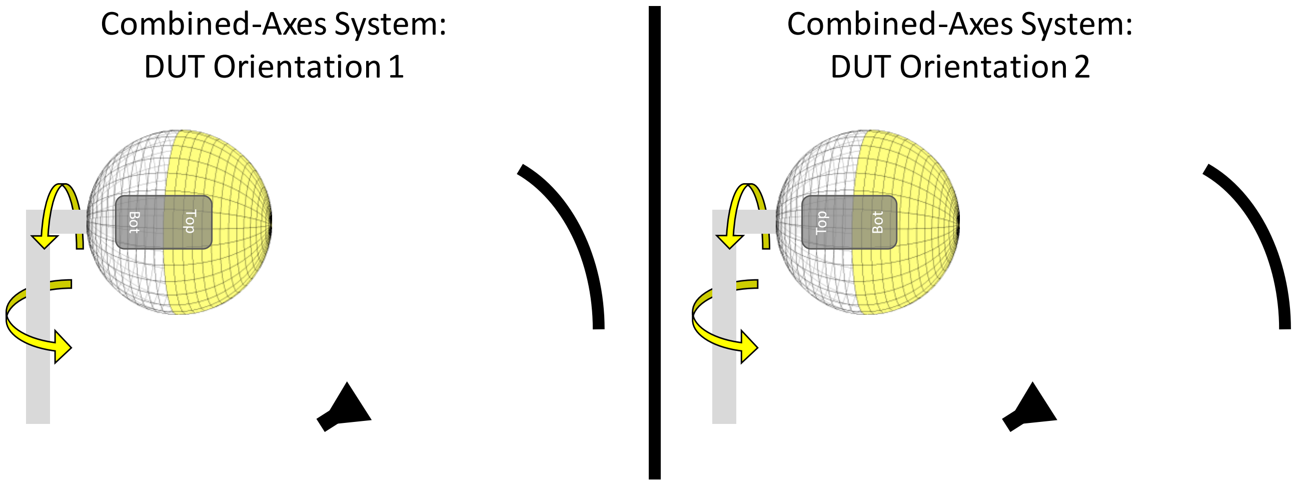


Figure N.3-2: DUT re-positioning for an example of combined-axes system

For EIRP/EIS measurements, re-positioning the DUT makes sure the pedestal is not obstructing the beam path and that the pedestal is not in closer proximity to the measurement antenna/reflector than the DUT. For TRP measurements, re-positioning the DUT makes sure that the beam peak direction is not obstructed by the pedestal and the pedestal is in the measurement path only when measuring the back-hemisphere. No re-positioning during the TRP measurement is required.

The radiating portions of the device have to be fully enclosed within the quiet zone, but the non-radiating portions of the device can be located/placed outside the quiet zone if a vendor declaration with positioning reference points and the minimum QZ required to contain all active antennas within the quiet zone (per band) is provided. This grey-box testing approach where the declared reference point is aligned with the centre of the QZ is further illustrated in Figure N.3-3.

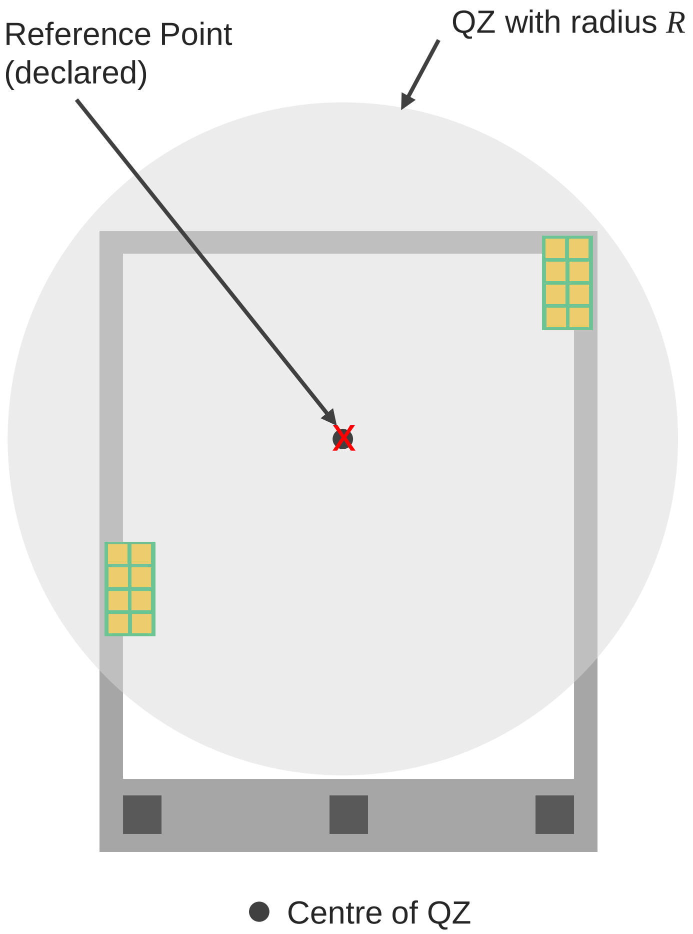


Figure N.3-3: Grey-box test approach

In the absence of a vendor declaration, the geometric centre of the DUT shall be aligned with the centre of the QZ and the DUT shall be fully contained within the QZ. This black-box testing approach is further illustrated in Figure N.3-4.

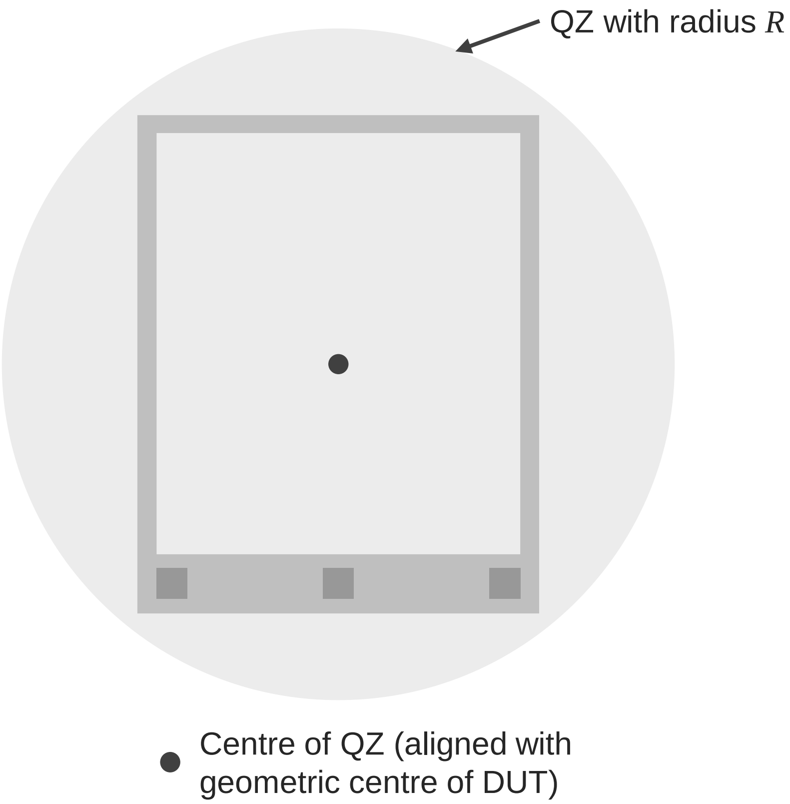


Figure N.3-4: Black-box test approach

Annex O: Quality of the quiet zone validation

O.1 General

This annex describes the procedures for validating the quality of the quiet zone for the permitted far-field methods outlined in Annex B.2.2 (DFF), B.2.3 (simplified DFF), and in B.2.4 (IFF based on CATR) in [10]. Annex O.2 focuses on the procedure for in-band and OOB test cases while Annex O.3 focuses on the procedure for spurious emissions test cases. These procedures are applicable to PC1 and PC3 UEs.

O.2 Procedure to characterize the quality of the quiet zone for in-band/OOB for the permitted far field methods

This procedure is mandatory before the test system is commissioned for certification tests and characterizes the quiet zone performance of the anechoic chamber, specifically the effect of reflections within the anechoic chamber including any positioners and support structures. Additionally, it includes the effect of offsetting the directive antenna array inside a DUT from the centre of the quiet zone, i.e., the centre of rotation of the DUT and measurement antenna positioning systems as well as the directivity MU, i.e., the variation of antenna gains in the different direct line-of-sight links.

The quiet zone is illustrated in Figure O.2-1 which includes the definitions of centre of quiet zone range, i.e., the geometric centre of the positioning systems, and the range length, i.e., the distance between the centre of the quiet zone and the aperture of the measurement antenna.

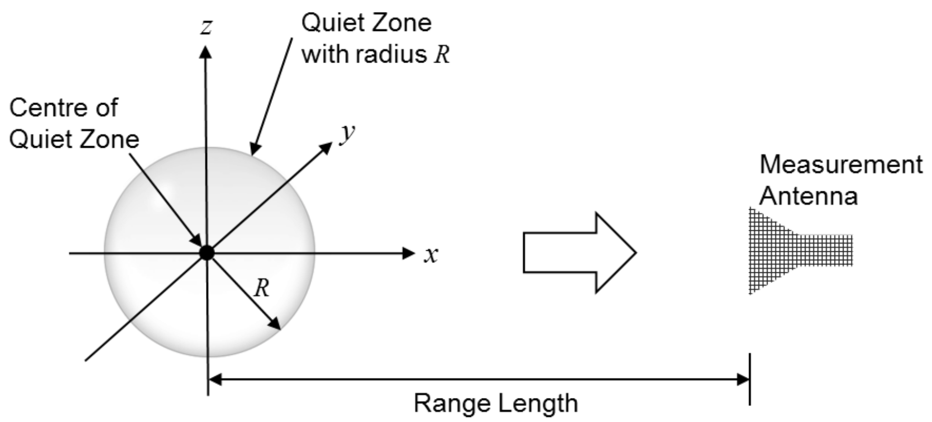


Figure O.2-1: Quiet Zone Illustration

The outcome of the procedures can be used to predict the

- variation of the TRP measurements, spherical surface integrals of EIRP/EIS, when the DUT is placed anywhere within the quiet zone and with the beam formed in any arbitrary direction inside the chamber
- variation of the EIRP/EIS measurements when the DUT is placed anywhere within the quiet zone and with the beam formed in any arbitrary direction inside the chamber

The reference coordinate system defined in Annex N applies to this procedure.

O.2.1 Equipment used

The reference antenna under test (AUT) that is placed at various locations within the quiet zone shall be a directive antenna with similar properties of typical antenna arrays integrated in DUTs. The characteristics in terms of Directivity and Half Power Beamwidth (HPBW) of the reference AUT are shown in Figure O.2.1-1, O.2.1-2, and O.2.1-3.

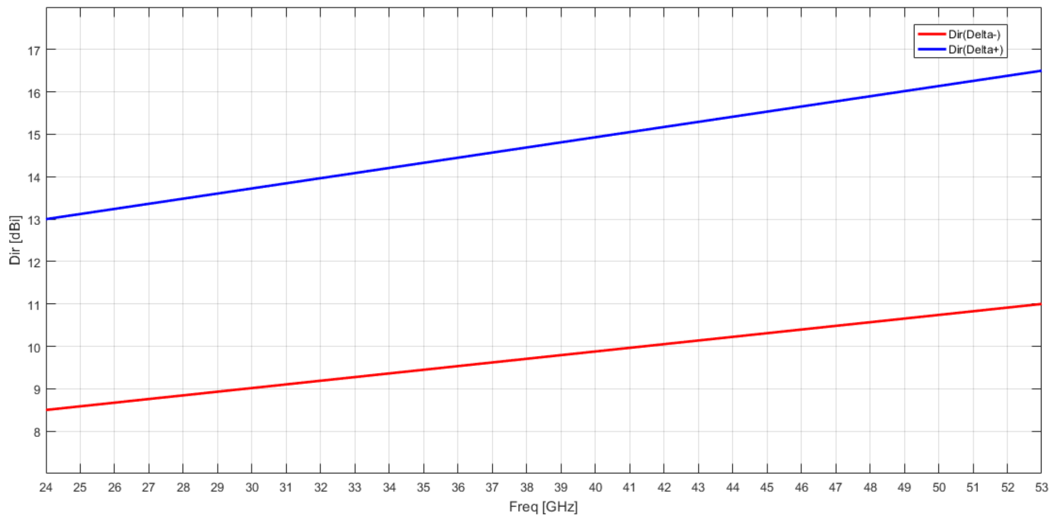


Figure O.2.1-1: Directivity mask

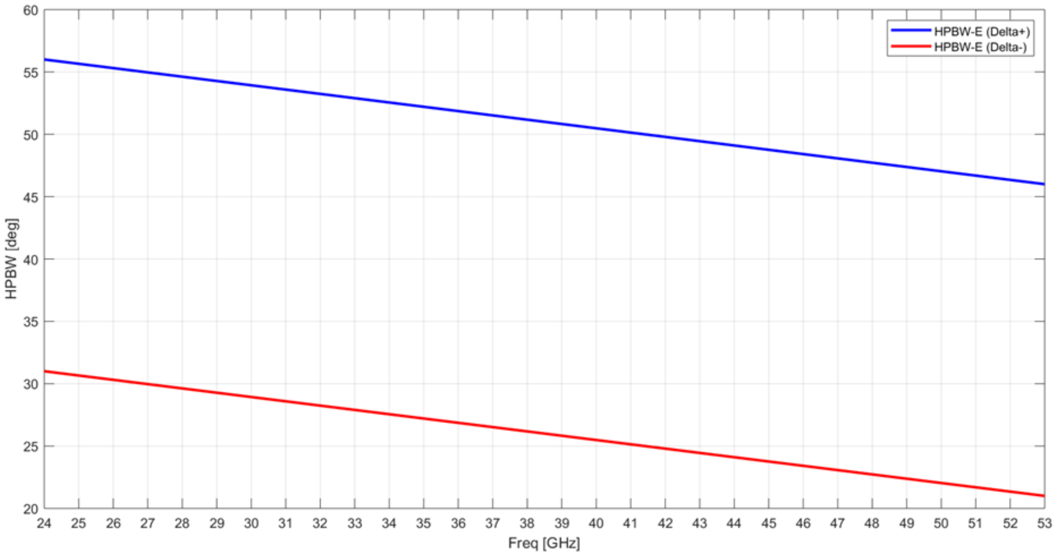


Figure O.2.1-2: 2xHPBW-E mask

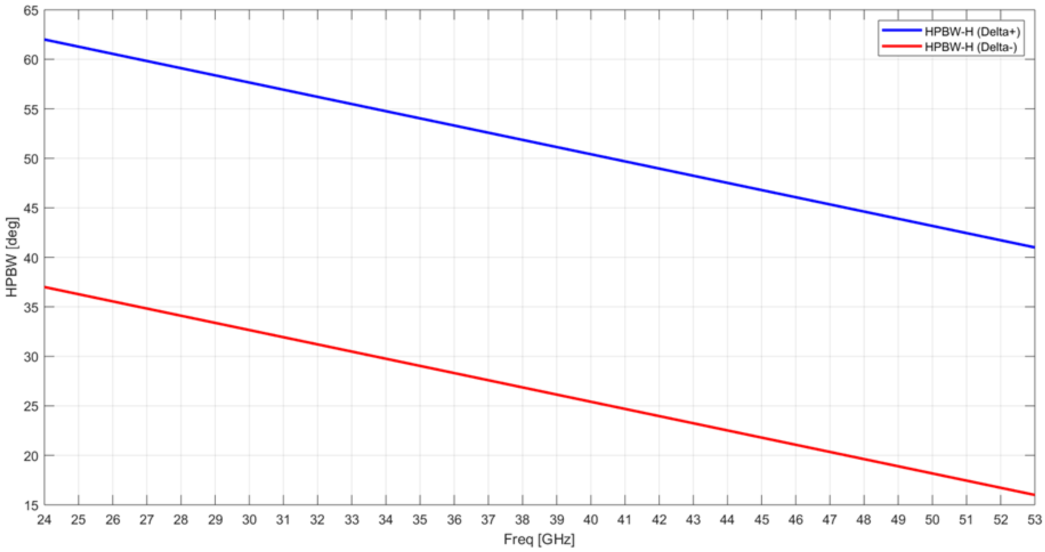


Figure O.2.1-3: 2xHPBW-H mask

AUT shall be symmetric on E and H planes.

The above masks for the reference antenna are met based on antenna vendors' calibration report.

For the measurement, a combination of signal generator and spectrum analyser or a network analyser can be used. The multi-port (with three ports) network analyser is most suitable to reduce test time as both polarizations of the measurement antenna can be measured simultaneously, and multiple frequencies can be measured in a sweep.

O.2.2 Test frequencies

The frequencies to be used to characterize the quality of the quiet zone are 23.45 GHz, 32.125 GHz, 40.8 GHz, 44.3 GHz, and 49 GHz. The quiet zone validation analysis is performed for each frequency individually.

O.2.3 Reference measurements

The quality of the quiet measurements for integrated RF parameters such as TRP shall use 3D pattern measurements of the reference antenna patterns as they most closely resemble the 3D/spherical surface measurements/integrals of EIRP or EIS. Therefore, the quality of the quiet zone measurements for TRP metrics shall be based on efficiency measurements. On the other hand, the quality of the quiet zone measurements for single-directional EIRP and EIS metrics shall be based on gain measurements of the direct line-of-sight link between the reference AUT and the measurement antenna.

The grid types for the TRP measurements shall match those outlined in M.1 and the minimum number of grid points (including quadratures for constant step size grids and implementation of constant density grids) shall meet the 0.25 dB maximum standard uncertainty summarized in M.4.

O.2.4 Size of the quiet zone

The size of the quiet zone within which the variations of measurements are evaluated depends on the size of the DUT. For smartphones, the quiet zone shall be considered a sphere with radius of R=10cm. For larger smartphones and tablet type devices, the quiet zone shall be considered a sphere with radius of R=15cm. For even larger device, e.g., larger tablets and laptops, quiet zones of radius *R*=20cm and *R*=27.5cm shall be considered. Alternate quiet zone sizes can be defined for even larger DUTs.

The quality of quiet zone procedure for systems supporting multiple quiet zone sizes can be performed for the largest quiet zone radius only and the results can be applied to the smaller quiet zone radii if the same chamber components affecting QoQZ, i.e., reflector, feed probes, etc, are used. Performing separate sets of quality of quiet zone measurements for different radii is not precluded.

O.2.5 Reference AUT positions

The reference AUT shall be positioned in a total of 7 different reference positions, shown in Figure O.2.5.1-1 and O.2.5.2-1

While position 1, P1, is the centre of the quiet zone, the remaining positions, 2 through 7, are off-centre positions each displaced by the radius of the quiet zone, R. The coordinates of the respective test points are shown in Table O.2.5-1.

Table O.2.5-1: Reference AUT Measurement Coordinates

Position	*x*	*y*	*z*
P1	0	0	0
P2	*R*	0	0
P3	-*R*	0	0
P4	0	*R*	0
P5	0	-*R*	0
P6	0	0	*R*
P7	0	0	-*R*

For quiet zones exceeding 30cm in diameter, i.e., *R*=20cm and *R*=27.5cm, an alternate set of reference points can be selected for the quality of quiet zone evaluation, summarized in Table O.2.5-2

Table O.2.5-2: Alternate Reference AUT Measurement Coordinates for *R*=20cm and *R*=27.5cm Quiet Zones

Position	*x*	*y*	*z*
P1	0	0	0
P2	*R*	*0*	*0*
P3	*-R*	*0*	*0*
P4	*0*	*R*	*0*
P5	*0*	*-R*	*0*
P6	*0*	*0*	z_6
P7	0	0	$-z_7$
Note:	z_6 and z_7 are the maximum declared DUT heights in ±z defined in the chamber specification and are bound to a minimum of 15cm. The DUT antennas (grey-box approach)/the DUT (black box approach) cannot extend past these heights within the QZ (in z) when installed in the system.		

O.2.5.1 Distributed-axes system

The reference AUT shall be positioned in a total of 7 different reference positions, shown in Figure O.2.5.1-1.

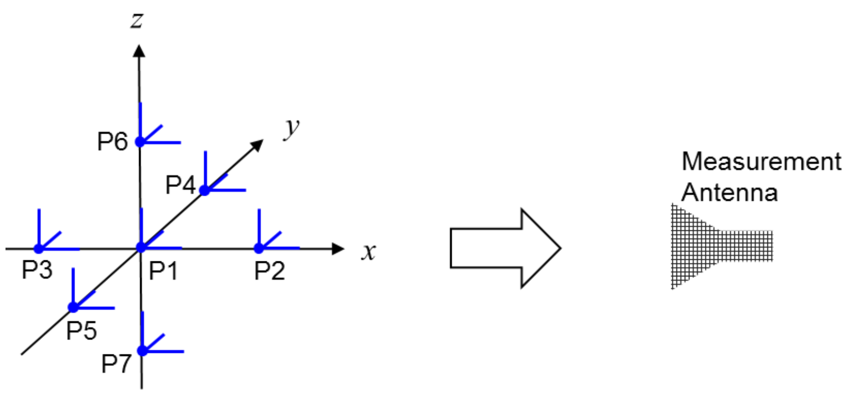


Figure O.2.5.1-1: Reference AUT Measurement Positions for distributed-axes system

The reference AUT positions inside a typical distributed-axes system are shown in Figure O.2.5.1-2.

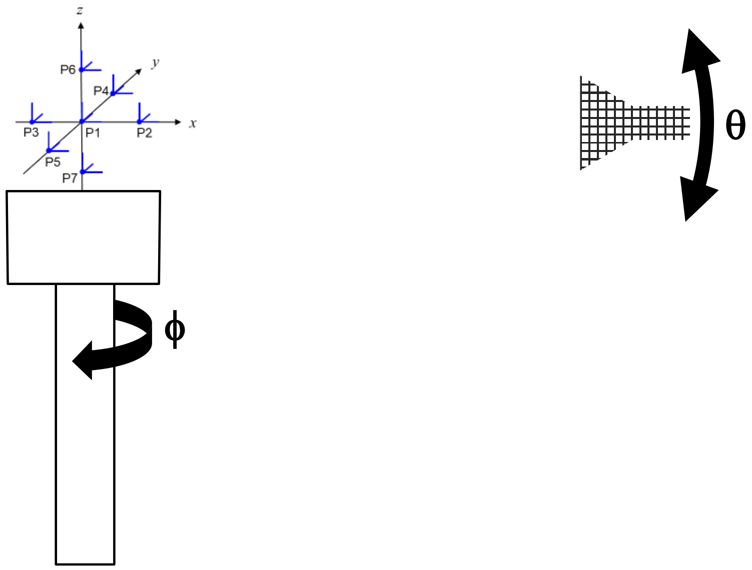


Figure O.2.5.1-2: Reference AUT Measurement Positions for distributed-axes system

O.2.5.2 Combined-axes system

The reference AUT shall be positioned in a total of 7 different reference positions, shown in Figure O.2.5.2-1.

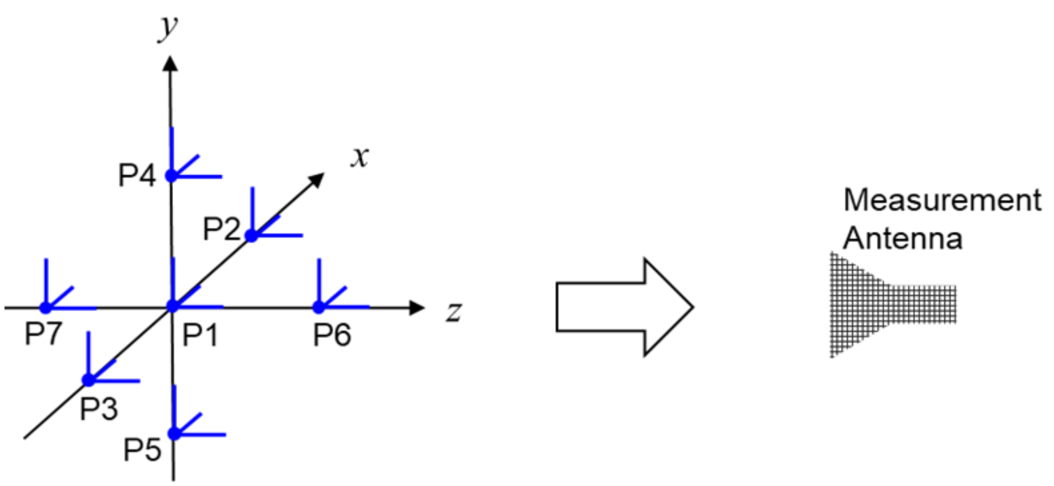


Figure O.2.5.2-1: Reference AUT Measurement Positions for combined-axes system

The reference AUT positions inside a typical combined-axes system are shown in Figure O.2.5.2-2.

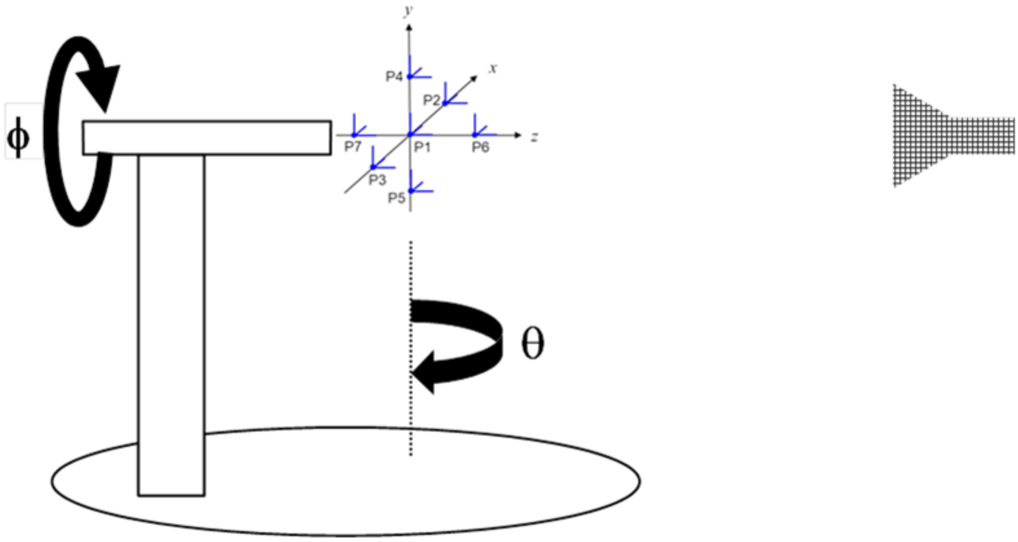


Figure O.2.5.2-2: Reference AUT Measurement Positions for combined-axes system

O.2.6 Reference AUT orientations

As different areas within the chamber could yield variations in the field uniformity inside the quiet zone caused by reflections, it is important to characterize the electromagnetic fields with the reference antennas uniformly illuminating the anechoic chamber.

O.2.6.1 Distributed-axes system

In order to keep the quality of the quiet zone characterization manageable in terms of test times, it is suggested to perform the reference measurements for the reference AUT placed at the 7 antenna positions with the antenna rotated around the y axis with 5 different angles β, i.e., $\beta = 0^o$, 45º, 90º, 135º, and 180º, and rotated around the z axis with 8 different γ = 0º, 45º, 90º, 135º, 180º, 225º, 270º, and 315º. A graphical illustration of the some sample reference AUT orientations is shown in Figure O.2.6.1-1 with a reference AUT placed at position 6, P6, for reference antenna polarization $\gamma_{pol} = 0^o$; Figure O.2.6.1-2 illustrates the reference AUT orientations for the reference polarization γ_{pol} = 90º.

The matrix operation for the rotations and translation is defined as

$$M = T(t_x, t_y, t_z) \cdot R_z(\gamma) \cdot R_y(\beta) \cdot R_{z,pol}(\gamma_{pol})$$

for the distributed-axes system.

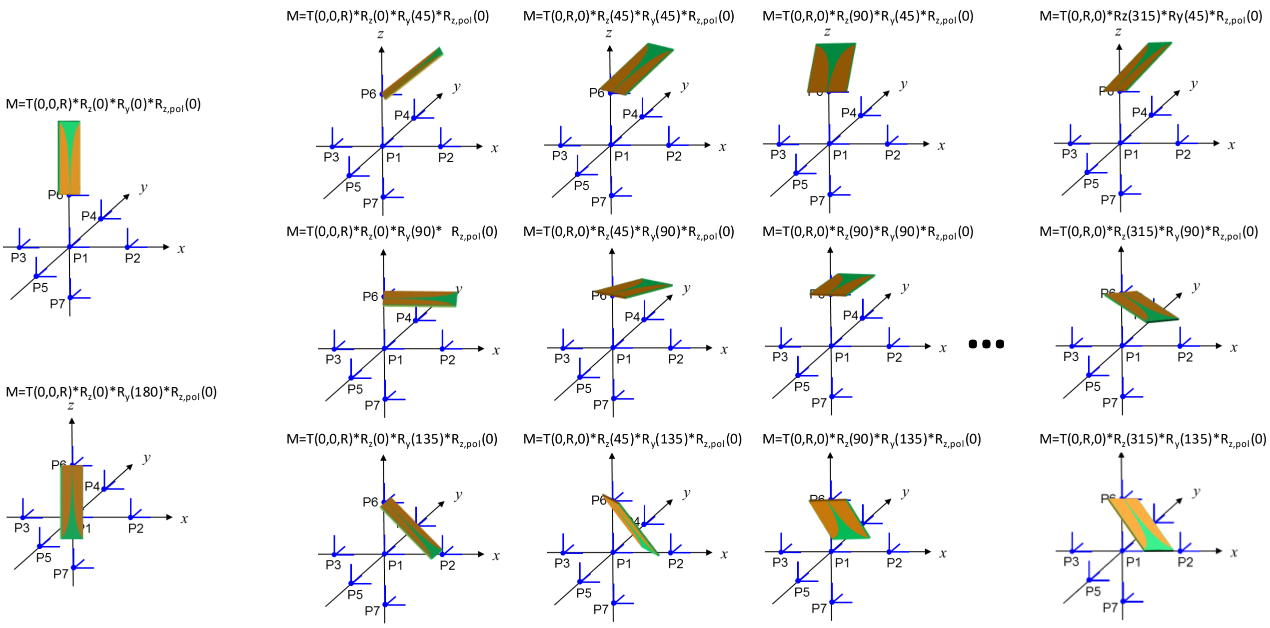


Figure O.2.6.1-1: Sample reference AUT orientations for position 6, P6 for reference antenna polarization γ_{pol} = 0°

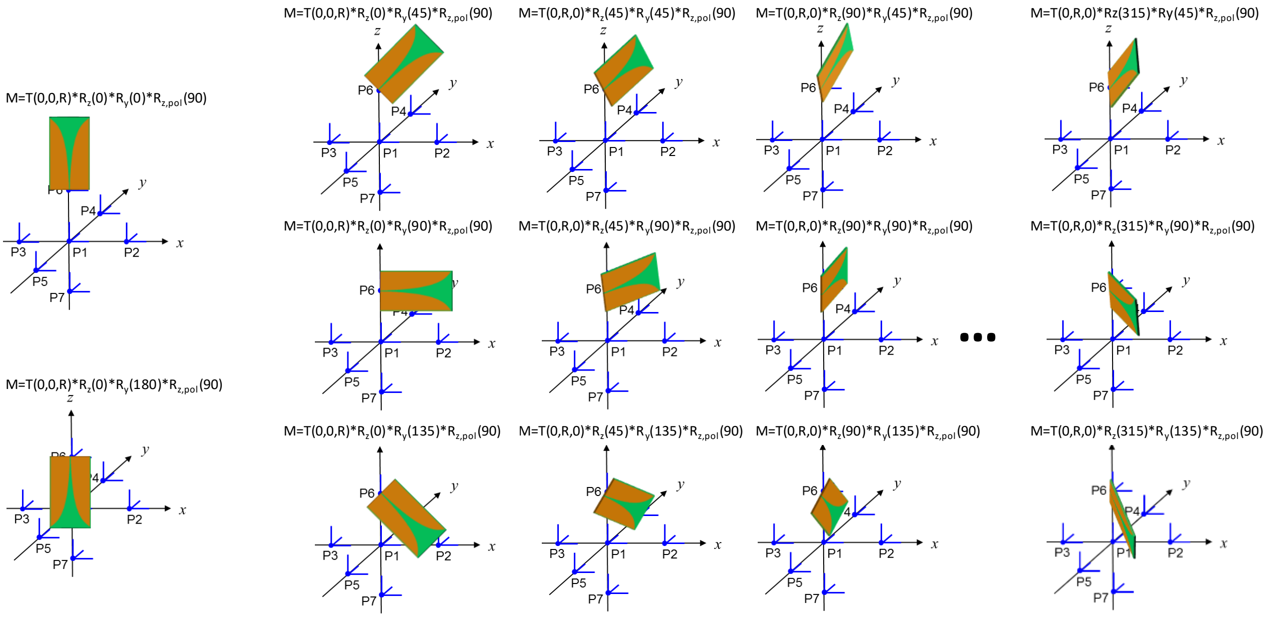


Figure O.2.6.1-2: Sample reference AUT orientations for position 6, P6, for reference antenna polarization γ_{pol} = 90°

When facing the z-axis, β = 0° and β = 180°, the antenna does not need to be evaluated for the 8 different rotations around the z axis. A single orientation is sufficient since those orientations are unique. Due to the pedestal, distributed-axes systems are not able to measure towards the β =180° direction; for those systems, the reference measurements at this reference AUT orientation can be skipped.

If the device re-positioning approach outlined in Annex N is adopted for the EIRP/EIS/TRP based conformance test cases, the quality of quiet zone analysis is sufficient only for β = 0°, 45°, 90°.

The positioner relative coordinates/orientations with respect to the measurement antenna/reflector in the initial position shall remain the same for each reference antenna orientation, e.g., in the sample distributed-axes system shown in

Figure O.2.5.1-2 the reference antenna shall be pointed towards the positioner for β = 135° for the initial position of (θ,ϕ) of (0,0).

O.2.6.2 Combined-axes system

In order to keep the quality of the quiet zone characterization manageable in terms of test times, it is suggested to perform the reference measurements for the reference AUT placed at the 7 antenna positions with the antenna rotated around the x axis with 5 different angles α, i.e., α = -90°, -45°, 0°, 45°, and 90° and rotated around the y axis with 8 different angles β = 0°, 45°, 90°, 135°, 180°, 225°, 270°, and 315°. A graphical illustration of some sample reference AUT orientations is shown in Figure O.2.6.2-1 with a reference AUT placed at position 4, P4, for reference antenna polarization γ_{pol} = 0°; Figure O.2.6.2-2 illustrates the reference AUT orientations for the reference polarization γ_{pol} = 90°.

The matrix operation for the rotations and translation is defined as

$$M = T(t_x, t_y, t_z) \cdot R_y(\beta) \cdot R_x(\alpha) \cdot R_{z,pol}(\gamma_{pol})$$

for the combined-axes system.

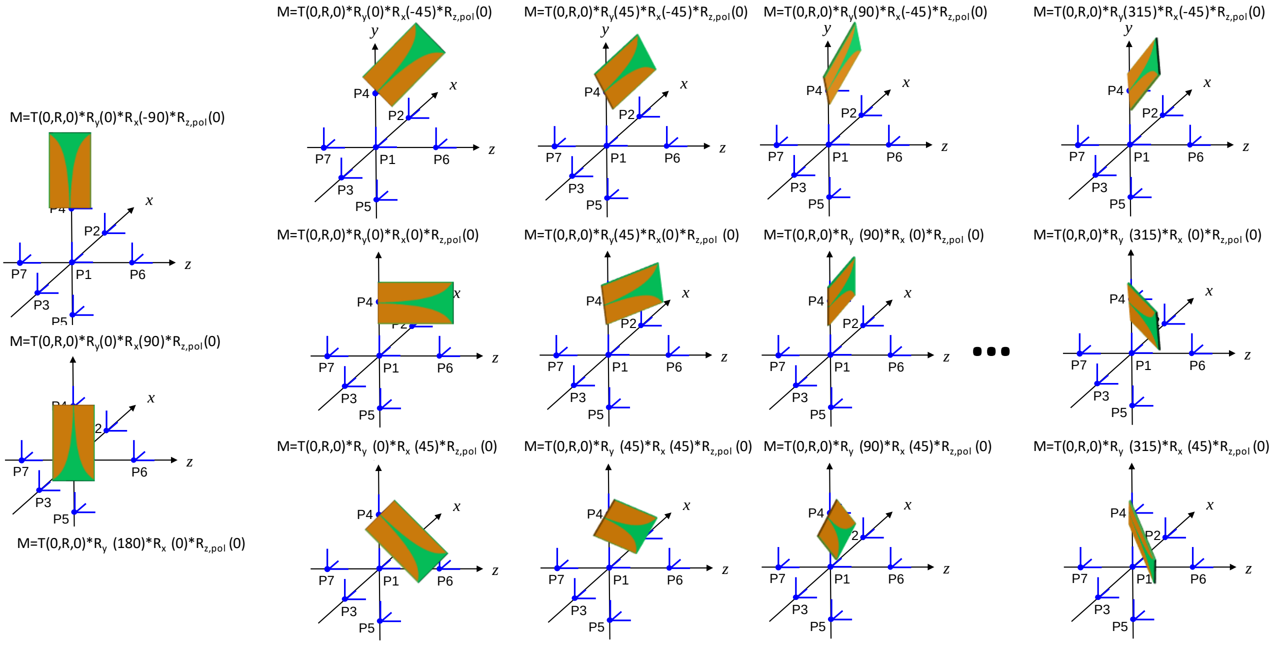


Figure O.2.6.2-1: Sample reference AUT orientations for position 4, P4, for reference antenna polarization γ_{pol} = 0°

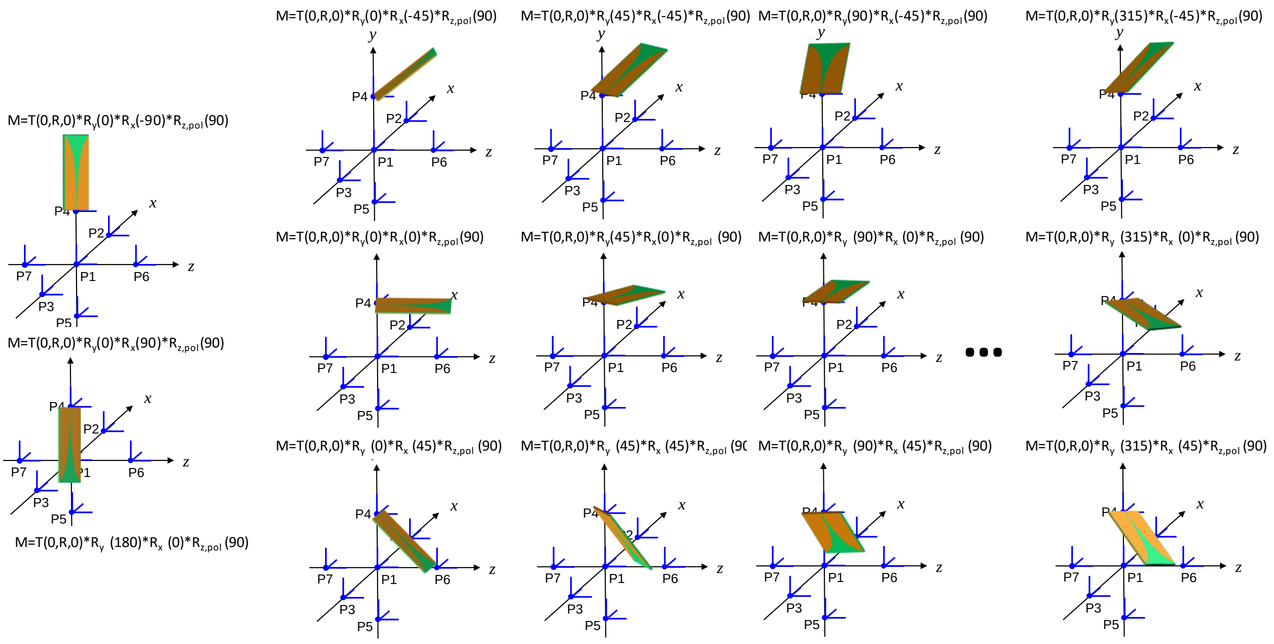


Figure O.2.6.2-2: Sample reference AUT orientations for position 4, P4, for reference antenna polarization γ_{pol} = 90°

When facing the y axis, α = 90° and α = -90°, the antenna does not need to be evaluated for the 8 different rotations around the y axis. A single rotation is sufficient since those orientations are unique. Due to the pedestal of the 2-axis positioner, combined-axes systems are not able to measure towards the β = 180° direction; for those systems, the reference measurements at this reference AUT orientation can be skipped.

If the device re-positioning approach outlined in Annex N is adopted for all EIRP/EIS/TRP based conformance test cases, the quality of quiet zone analysis is sufficient only for β = 0°, 45°, 90°, 270°, and 315°.

The positioner relative coordinates/orientations with respect to the measurement antenna/reflector shall remain the same for each reference antenna orientation, e.g., in the sample combined-axes system shown in O.2.5.2-2 the reference antenna shall be pointed towards the positioner for β = 135° and 225° for the initial position of (θ,ϕ) of (0,0).

O.2.7 Quality of quiet zone measurement uncertainty calculations for TRP

The combined MU element related to the quality of the quiet zone for TRP and offset between UE antenna array and centre of quiet zone is the standard deviation of the various efficiency measurement results that are based on the 7 different reference AUT positions, the respective reference AUT orientations, and the two reference AUT polarization orientations.

O.2.8 Quality of quiet zone measurement uncertainty for EIRP/EIS

The MU for the quality of the quiet zone for EIRP/EIS includes the additional MU element of the directivity of the DUT and measurement antennas as shown in Figure O.2.9-1. The EIRP/EIS measurements are taking the peak gains of the respective antennas into account with the reference AUT placed in the centre of the quiet zone. Once the antenna is displaced in directions other than the measurement antenna, the direct line-of-sight link is taking reduced antenna gains into account. The type of reference AUT should therefore have similar pattern properties as typical UE antennas. For systems with very large range lengths, the directivity MU will be insignificant.

The combined MU element related to the quality of the quiet zone for EIRP/EIS, offset between UE antenna array and centre of quiet zone, and directivity is the standard deviation of the single-point gain measurement results that are based on the 7 different reference AUT positions, the respective reference AUT orientations, and the two reference AUT polarization orientations.

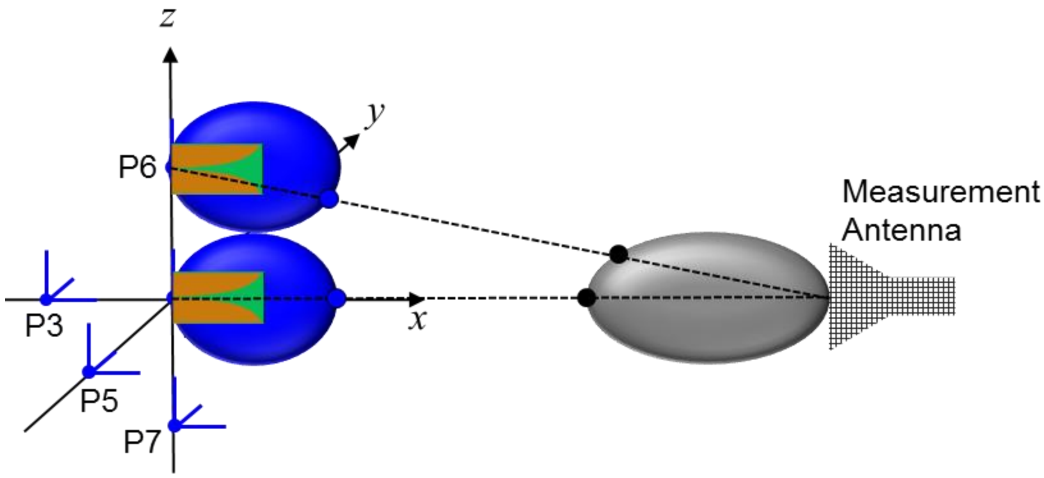


Figure O.2.9-1: Illustration of the Directivity MU Element

O.3 Procedure to characterize the spurious emissions quality of the quiet zone for the permitted far field methods

This procedure is mandatory before the spurious emissions test system is commissioned for certification tests and characterizes the quiet zone performance of the anechoic chamber, specifically the effect of reflections within the anechoic chamber including any positioners and support structures. Additionally, it includes the effect of offsetting the directive antenna array inside a DUT from the centre of the quiet zone, i.e., the centre of rotation of the DUT and measurement antenna positioning systems.

The quiet zone is illustrated in Figure O.2-1 which includes the definitions of centre of quiet zone range, i.e., the geometric centre of the positioning systems, and the range length, i.e., the distance between the centre of the quiet zone and the aperture of the measurement antenna.

The outcome of the procedures can be used to predict the variation of the TRP measurements, spherical surface integrals of EIRP, when the DUT is placed anywhere within the quiet zone and with the beam formed in any arbitrary direction inside the chamber

The reference coordinate system defined in Annex N applies to this procedure.

O.3.1 Equipment used

The reference antenna under test (AUT) that is placed at various locations within the quiet zone shall be a directive antenna with a half-power beam width (HPBW) of ≥ 20° in E-Plane and H-Plane. The HPBWs met based on antenna vendors' calibration report or datasheet.

For the measurement, a combination of signal generator and spectrum analyser or a network analyser can be used. The multi-port (with three ports) network analyser is most suitable to reduce test time as both polarizations of the measurement antenna can be measured simultaneously, and multiple frequencies can be measured in a sweep.

O.3.2 Test frequencies

Editor Note: Another test frequency of [TBD] GHz will be added as soon as FR2 bands >49 GHz are introduced.

The frequencies to characterize the quality of the quiet zone shall be 6, 12.75, 23.45, 40.8, 49.0, 66, and 80 GHz. The quiet zone validation analysis is performed for each frequency individually.

The measurements from the 23.45, 40.8, and 49.0 GHz in-band QoQZ validation can be re-used provided that the reference antenna position and orientation as well as the measurement frequency and measurement antenna are identical in both cases.

O.3.3 Reference measurements

The spurious emissions quality of the quiet zone measurements shall use 3D pattern measurements of the reference antenna patterns as they most closely resemble the 3D/spherical surface measurements/integrals of EIRP. Therefore, the quality of the quiet zone measurements for TRP metrics shall be based on efficiency measurements.

The grid types for the TRP measurements shall meet the 0.25 dB maximum standard uncertainty. The min number of grid points for the two grid types are:

- 192 grid points for the constant step-size measurement grids
- 100 grid points for the constant density measurement grids (charged particle implementation)

O.3.4 Size of the quiet zone

The size of the quiet zone within which the variations of measurements are evaluated depends on the size of the DUT. For smartphones, the quiet zone shall be considered a sphere with radius of R=10cm. For larger smartphones and tablet type devices, the quiet zone shall be considered a sphere with radius of R=15cm. Alternate quiet zone sizes can be defined for even larger DUTs.

The quality of quiet zone procedure for systems supporting larger quiet zone sizes can be performed for the largest quiet zone radius only and the results can be applied to the smaller quiet zone radius. Performing separate sets of quality of quiet zone measurements for different radii is not precluded.

O.3.5 Reference AUT positions

The reference AUT shall be positioned in a total of 7 different reference positions, shown in Figure O.2.5.1-1 and O.2.5.2-1

While position 1, P1, is the centre of the quiet zone, the remaining positions, 2 through 7, are off-centre positions each displaced by the radius of the quiet zone, *R*. The coordinates of the respective test points are shown in Table O.2.5-1.

O.3.5.1 Distributed-axes system

The reference AUT shall be positioned in a total of 7 different reference positions, shown in Figure O.2.5.1-1 for distributed-axes systems.

The reference AUT positions inside a typical distributed-axes system are shown in Figure O.2.5.1-2.

O.3.5.2 Combined-axes system

The reference AUT shall be positioned in a total of 7 different reference positions, shown in Figure O.2.5.2-1 for combined-axes systems.

The reference AUT positions inside a typical combined-axes system are shown in Figure O.2.5.2-2.

O.3.6 Reference AUT orientations

As different areas within the chamber could yield variations in the field uniformity inside the quiet zone caused by reflections, it is important to characterize the electromagnetic fields with the reference antennas uniformly illuminating the anechoic chamber. However, in order to keep the spurious emissions quality of the quiet zone characterization manageable in terms of test time, the number of orientations for the spurious emissions quality of quiet zone validation is limited when compared to the number of orientations for the in-band quality of quiet zone validation.

O.3.6.1 Distributed-axes system

The reference measurements for the reference AUT placed at the 7 antenna positions shall be rotated around the y axis with 2 different angles β, i.e., $\beta = 0^o$ and 180^o and fixed $\gamma = 0^o$. A graphical illustration of the reference AUT orientations is shown in Figure O.3.6.1-1 with a reference AUT placed at position 6, P6, for reference antenna polarization γ_{pol} = 0°; Figure O.3.6.1-2 illustrates the reference AUT orientations for the reference polarization γ_{pol} = 90°.

The matrix operation for the rotations and translation is defined as

$$M = T(t_x, t_y, t_z) \cdot R_z(\gamma) \cdot R_y(\beta) \cdot R_{z,pol}(\gamma_{pol})$$

for the distributed-axes system. The matrices are defined in Annex J.2 of TS 38.101-2.

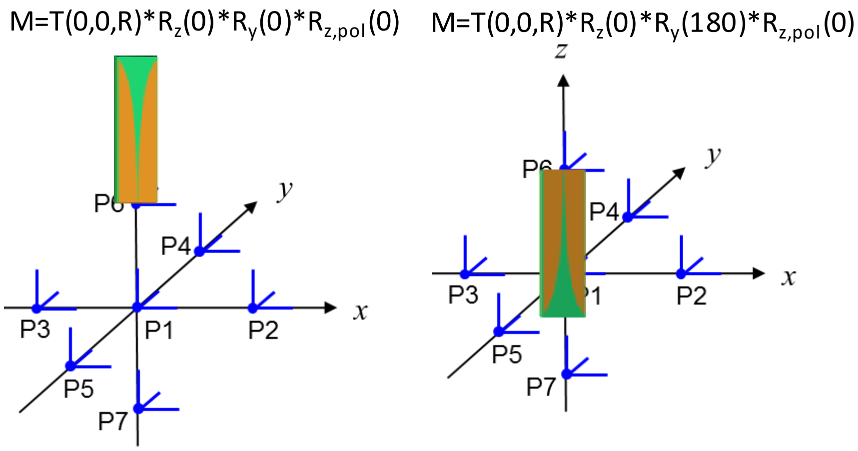


Figure O.3.6.1-1: Reference AUT orientations for position 6, P6 for reference antenna polarization γ_{pol} = 0°

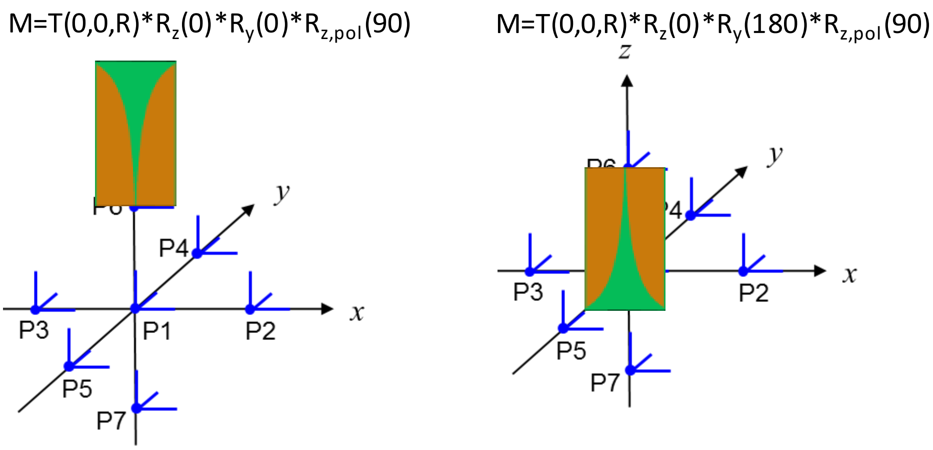


Figure O.3.6.1-2: Reference AUT orientations for position 6, P6, for reference antenna polarization γ_{pol} = 90°

If the device re-positioning approach is adopted for the spurious emissions test cases, i.e., two hemispheres are measured separately which involves the DUT, while connected to the gNB emulator, to be rotated by 180° around its axis halfway through the test, the quality of quiet zone analysis is sufficient only for β = 0°.

The positioner relative coordinates/orientations with respect to the measurement antenna/reflector in the initial position shall remain the same for each reference antenna orientation, e.g., in the sample distributed-axes system shown in Figure O.2.5.1-2 the reference antenna shall be pointed at the positioner for β = 180° for the initial position of (θ,ϕ) of (0,0).

O.3.6.2 Combined-axes system

The reference measurements for the reference AUT placed at the 7 antenna positions shall be rotated around the *x* axis with 2 different angles β, i.e., β = 0° and 180° and fixed α = 0°. A graphical illustration of the sample reference AUT orientations is shown in Figure O.3.6.2-1 with a reference AUT placed at position 4, P4, for reference antenna polarization γ_{pol} = 0°; Figure O.3.6.2-2 illustrates the reference AUT orientations for the reference polarization γ_{pol} = 90°.

The matrix operation for the rotations and translation is defined as

$$M = T(t_x, t_y, t_z) \cdot R_y(\beta) \cdot R_x(\alpha) \cdot R_{z,pol}(\gamma_{pol})$$

for the combined-axes system. The matrices are defined in Annex J.2 of TS 38.101-2.

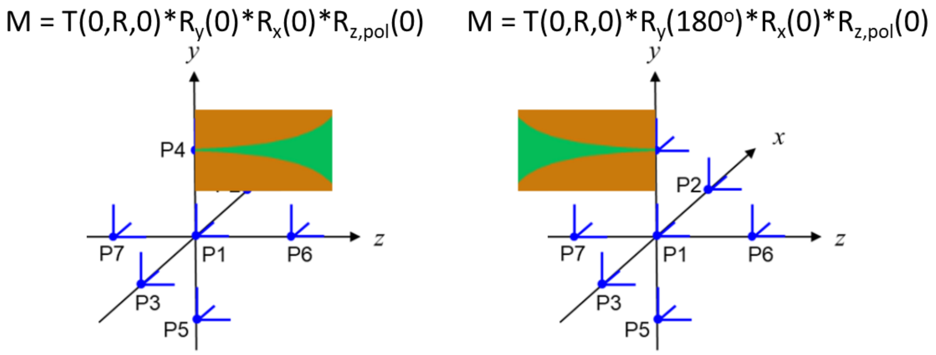


Figure O.3.6.2-1: Reference AUT orientations for position 4, P4, for reference antenna polarization γ_{pol} = 0°.

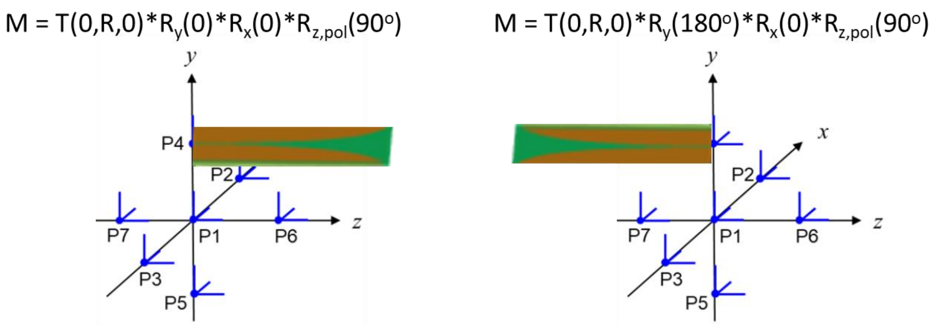


Figure O.3.6.2-2: Reference AUT orientations for position 4, P4, for reference antenna polarization γ_{pol} = 90°

If the device re-positioning approach is adopted for the spurious emissions test cases, i.e., two hemispheres are measured separately which involves the DUT, while connected to the gNB emulator, to be rotated by 180° around its axis halfway through the test, the quality of quiet zone analysis is sufficient only for β = 0°.

The positioner relative coordinates/orientations with respect to the measurement antenna/reflector shall remain the same for each reference antenna orientation, e.g., in the sample combined-axes system shown in O.2.5.2-2 the reference antenna shall be pointed at the positioner for β = 180° for the initial position of (θ,ϕ) of (0,0).

O.3.7 Quality of quiet zone measurement uncertainty calculations for TRP

The combined MU element related to the spurious emissions quality of the quiet zone for TRP and offset between UE antenna array and centre of quiet zone is the standard deviation of the various efficiency measurement results that are based on the 7 different reference AUT positions, the respective reference AUT orientations, and the two reference AUT polarization orientations.

Annex P (normative): Modified MPR behaviour

P.1 Indication of modified MPR behaviour

This annex contains the definitions of the bits in the field *modifiedMPR-Behavior* indicated per supported NR band in the IE *RF-Parameters* [19] by a UE supporting an MPR or A-MPR modified in a given version of this specification. A modified MPR or A-MPR behaviour can apply to a supported NR band in stand-alone operation (including CA and NN-DC operation) or in non-standalone operation with the said NR band as part of an EN-DC or NE-DC band combination. Moreover, the bits in the field can explicitly indicate NS value(s) supported by a UE.

NOTE 1: In the present release, the *modifiedMPR-Behavior* is indicated [19] by an 8-bit bitmap per supported NR band.

Table P.1-1: Definitions of the bits in the field *modifiedMPRbehavior*

NR Band	**Index of field** (bit number)	**Definition** (description of the supported functionality if indicator set to one)	**Notes**
n257	0 (leftmost bit)	- FR2 power class 3 MPR as defined in clause 6.2.2.3 of 38.101-2 v16.2.0	- This bit may be set to 1 by a UE supporting n257
n258	0 (leftmost bit)	- FR2 power class 3 MPR as defined in clause 6.2.2.3 of 38.101-2 v16.2.0	- This bit may be set to 1 by a UE supporting n258
	1	Void	
	2	- NS_203 as defined in clause 6.5.3.2.4 or both NS_203 and CA_NS_203 as defined in clause 6.5A.3.2.4 of 38.101-2 v15.11.0	- This bit shall be set to 1 by a UE supporting n258 or both n258 and CA_n258
n260	0 (leftmost bit)	- FR2 power class 3 MPR as defined in clause 6.2.2.3 of 38.101-2 v16.2.0	- This bit may be set to 1 by a UE supporting n260
n261	0 (leftmost bit)	- FR2 power class 3 MPR as defined in clause 6.2.2.3 of 38.101-2 v16.2.0	- This bit may be set to 1 by a UE supporting n261

Annex Q (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2017-08	RAN5 #76	R5-174709	-	-	-	Draft skeleton	0.0.1
2018-01	RAN5#1-5G-NR Adhoc	R5-180002	-	-	-	Add references	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180103	-	-	-	Add definitions, symbols and abbreviations	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180104	-	-	-	Introduction of Operating bands and Channel arrangement	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180094	-	-	-	Introduction of new test case 6.3.2 Transmit OFF power	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180095	-	-	-	TP to add skeleton of 6.5.1 Occupied bandwidth to 38.521-2	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180096	-	-	-	TP to add skeleton of 6.5.2.1 SEM to 38.521-2	0.1.0
2018-01	RAN5#1-5G-NR Adhoc	R5-180097	-	-	-	TP to add skeleton of 6.5.2.3 ACLR to 38.521-2	0.1.0
2018-03	RAN5 #78	R5-181508	-	-	-	Updated 38.521-2 to extend Annex with additional testing information	0.2.0
2018-03	RAN5 #78	R5-181680	-	-	-	TP to skeleton of 7.6.1 Inband blocking to 38.521-2	0.2.0
2018-03	RAN5 #78	R5-181681	-	-	-	5G-NR: Text Proposal to add spurious emissions test case to 38.521-2	0.2.0
2018-04	RAN5#2-5G-NR Adhoc	R5-181978	-	-	-	Update TS 38.521-2 further to align with the latest TS 38.101-2 spec structure.	0.3.1
2018-04	RAN5#2-5G-NR Adhoc	R5-182027	-	-	-	5G-NR Text Proposal to update spurious emissions test case to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182041	-	-	-	5G-NR Text Proposal to add REFSENS test case to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182009	-	-	-	General section updated to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182048	-	-	-	Addition of FR2 test case 6.3.1 Minimum Output Power	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182049	-	-	-	Addition of FR2 test case 6.3.3.2 General ON/OFF time mask	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-181839	-	-	-	Definitions and abbreviations updated to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-181840	-	-	-	Operating bands and Channel arrangement updated to 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182008	-	-	-	Introduction of new test case 7.4 Maximum input level	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182010	-	-	-	Common uplink configuration table for Tx test cases for TS 38.521-2 non-CA	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182011	-	-	-	TP for 6.5.1 Occupied Bandwidth in TS 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182029	-	-	-	TP for 6.5.2.1 Spectrum Emission Mask in TS 38.521-2	0.4.0
2018-04	RAN5#2-	R5-182031	-	-	-	TP for 6.5.2.3 Adjacent Channel Leakage Ratio in TS 38.521-2	0.4.0

	5G-NR Adhoc						
2018-04	RAN5#2-5G-NR Adhoc	R5-182043	-	-	-	TP for 7.6.2 InBand Blocking in TS 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-182046	-	-	-	TP for 7.5 Adjacent channel selectivity in TS 38.521-2	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-181844	-	-	-	Add Annex G (normative): Measurement uncertainties and Test Tolerances	0.4.0
2018-04	RAN5#2-5G-NR Adhoc	R5-181844	-	-	-	Add clause 4.4 Test point analysis	0.4.0
2018-05	RAN5 #79	R5-183908	-	-	-	Introduction of New FR2 test case 6.3.3.4 PRACH time mask	0.5.0
2018-05	RAN5 #79	R5-182769	-	-	-	General section updated to 38.521-2	0.5.0
2018-05	RAN5 #79	R5-183914	-	-	-	TP for FR2 spurious test procedure (38.521-2)	0.5.0
2018-05	RAN5 #79	R5-183925	-	-	-	Update of Refsens test procedure for FR2	0.5.0
2018-05	RAN5 #79	R5-182883	-	-	-	Definitions, symbols and abbreviations updated to 38.521-2	0.5.0
2018-05	RAN5 #79	R5-182884	-	-	-	Operating bands and Channel arrangement updated to 38.521-2	0.5.0
2018-05	RAN5 #79	R5-182890	-	-	-	Update minimum conformance requirements and test requirement for 6.3.2 Transmit OFF power	0.5.0
2018-05	RAN5 #79	R5-183926	-	-	-	Annex for test case applicability per permitted test method	0.5.0
2018-05	RAN5 #79	R5-183712	-	-	-	Corrections annexes for EIRP and TRP metric definition	0.5.0
2018-05	RAN5 #79	R5-183927	-	-	-	Clean up TBD from Occupied Bandwidth, SEM and ACLR test cases	0.5.0
2018-05	RAN5 #79	R5-183928	-	-	-	Clean up TBD from ACS and Inband Blocking test cases	0.5.0
2018-05	RAN5 #79	R5-183948	-	-	-	Statistical Testing Annex for 38.521-2	0.5.0
2018-08	RAN5 #80	R5-185348	-	-	-	Correction to FR2 Spurious TC and introduction of TRP measurement grid requirement	1.0.0
2018-08	RAN5 #80	R5-185350	-	-	-	Addition of Frequency Error test case to TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185490	-	-	-	FR2_TxSpurious_TestConfig_38.521-2	1.0.0
2018-08	RAN5 #80	R5-185562	-	-	-	FR2_StoreTxRxBeamPeakCoordinates_38.521-2	1.0.0
2018-08	RAN5 #80	R5-184742	-	-	-	Update of FR2 test case 6.3.1	1.0.0
2018-08	RAN5 #80	R5-184743	-	-	-	Update of FR2 test case 6.3.3.2	1.0.0
2018-08	RAN5 #80	R5-184856	-	-	-	General sections updated to 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185519	-	-	-	Updates of FR2 TRx MU and TT in Annex	1.0.0
2018-08	RAN5 #80	R5-185555	-	-	-	FR2_UE_BeamlockInvoke_38.521-2	1.0.0
2018-08	RAN5 #80	R5-185191	-	-	-	Update to Occupied Bandwidth, SEM and ACLR test cases in TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185192	-	-	-	Update to ACS and inband blocking test cases in TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185187	-	-	-	FR2_RefSens_TestConfig_38.521-2	1.0.0
2018-08	RAN5 #80	R5-185188	-	-	-	DL and UL RMC updated for FR2 tests	1.0.0
2018-08	RAN5 #80	R5-185189	-	-	-	Downlink physical channel updated for FR2 tests	1.0.0
2018-08	RAN5 #80	R5-185190	-	-	-	OCNG Patterns updated for FR2 tests	1.0.0
2018-08	RAN5 #80	R5-185194	-	-	-	Update to Test frequencies for SEM in TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185196	-	-	-	Addition of Carrier Leakage test case to TS 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185193	-	-	-	Addition of Annex Global In-Channel TX-Test to 38.521-2	1.0.0
2018-08	RAN5 #80	R5-185197	-	-	-	Introduction of maximum output power test cases	1.0.0
2018-08	RAN5 #80	R5-185195	-	-	-	Addition of EVM test case to TS 38.521-2	1.0.0
2018-09	RAN #81	-	-	-	-	raised to v15.0.0 with editorial changes only	15.0.0
2018-12	RAN #82	R5-186504	0021	-	F	FR2 RefSens test case updates	15.1.0
2018-12	RAN #82	R5-186505	0022	-	F	Update Text on Store Beam Peak Coordinate	15.1.0
2018-12	RAN #82	R5-186510	0023	-	F	Structure updates to Annex C and G	15.1.0
2018-12	RAN #82	R5-186675	0026	-	F	Updating test case 6.2.3 maximum output power with additional requirements	15.1.0
2018-12	RAN #82	R5-187151	0034	-	F	Updated to Annexes for FR2 tests	15.1.0
2018-12	RAN #82	R5-187152	0035	-	F	General Information updated for TS38.521-2	15.1.0
2018-12	RAN #82	R5-187561	0042	-	F	Update to Table 5.3.5-1 in TS 38.521-2	15.1.0
2018-12	RAN #82	R5-187619	0050	-	F	Update of Section 6.3.3.1 General	15.1.0
2018-12	RAN #82	R5-187838	0045	1	F	Update of transmit signal quality test cases in 38.521-2	15.1.0
2018-12	RAN #82	R5-187839	0046	1	F	Addition of In-band Emissions test case to TS 38.521-2	15.1.0
2018-12	RAN #82	R5-187840	0047	1	F	Addition of EVM equalizer spectral flatness test cases 6.4.2.4 and 6.4.2.5 to TS 38.521-2	15.1.0
2018-12	RAN #82	R5-187841	0048	1	F	Update of Common Uplink Configuration for FR2	15.1.0
2018-12	RAN #82	R5-187842	0029	1	F	General sections updated to 38.521-2	15.1.0
2018-12	RAN #82	R5-187843	0044	1	F	Update of Global In-channel Tx Test Annex in 38.521-2	15.1.0
2018-12	RAN #82	R5-187886	0020	1	F	FR2 Spurious Emission test case updates	15.1.0
2018-12	RAN #82	R5-187912	0038	1	F	Addition of notes to clarify test point selection into general section of TS 38.521-2	15.1.0
2018-12	RAN #82	R5-188037	0032	1	F	Removing the Editor's notes of SA messages and procedures for all FR2 test cases	15.1.0
2018-12	RAN #82	R5-188038	0036	1	F	FR2 downlink signal level(38.521-2)	15.1.0

2018-12	RAN #82	R5-188063	0027	1	F	Update of FR2 6.3.2 Transmit OFF power	15.1.0
2018-12	RAN #82	R5-188212	0040	2	F	Updates to maximum output power test cases	15.1.0
2018-12	RAN #82	R5-188213	0028	1	F	Update of FR2 test case 7.4	15.1.0
2018-12	RAN #82	R5-188214	0025	1	F	Updates of TT in TS 38.521-2 Annex F during RAN5#81	15.1.0
2018-12	RAN #82	R5-188215	0031	1	F	TDD configuration for UE Tx test in FR2	15.1.0
2018-12	RAN #82	R5-188216	0039	1	F	Core alignment CR to capture TS 38.101-2 updates during RAN4#89	15.1.0
2018-12	RAN #82	R5-188217	0041	2	F	On measurement grids	15.1.0
2018-12	RAN #82	R5-188218	0043	1	F	Update to Annex K	15.1.0
2018-12	RAN #82	RP-182736	0024	2	F	Updates of MU Annex F	15.1.0
2019-03	RAN #83	R5-191091	0083	-	F	Updates of TT in TS38.521-2 Annex F during RAN5#NR4	15.2.0
2019-03	RAN #83	R5-191092	0084	-	F	Editorial correction of core alignment in TS 38.521-2	15.2.0
2019-03	RAN #83	R5-191093	0085	-	F	Editorial cleaning up of test configuration tables in TS 38.521-2	15.2.0
2019-03	RAN #83	R5-191246	0086	-	F	Update TRP measurement procedure Annex in TS38.521-2	15.2.0
2019-03	RAN #83	R5-191247	0087	-	F	Update Annex K and Annex M in TS38.521-2	15.2.0
2019-03	RAN #83	R5-191259	0088	-	F	Update to FR2 test case 6.3.3.4 PRACH time mask	15.2.0
2019-03	RAN #83	R5-191507	0090	-	F	Shared Risk clarification in TS 38.521-2	15.2.0
2019-03	RAN #83	R5-191609	0093	-	F	CR to TS 38.521-2 to add text proposal for Annex F.1	15.2.0
2019-03	RAN #83	R5-191676	0094	-	F	Addition of FR2 6.2.4 Configured transmitted power	15.2.0
2019-03	RAN #83	R5-191677	0095	-	F	Update of FR2 6.3.1 Minimum Output Power	15.2.0
2019-03	RAN #83	R5-191679	0096	-	F	Addition of FR2 6.3.4.2 Absolute power tolerance	15.2.0
2019-03	RAN #83	R5-191680	0097	-	F	Update of FR2 6.3.3.2 General ON/OFF time mask	15.2.0
2019-03	RAN #83	R5-191793	0098	-	F	Introduction of Minimum output power for 2UL CA	15.2.0
2019-03	RAN #83	R5-191809	0099	-	F	OBW test procedure update for 38.521-2	15.2.0
2019-03	RAN #83	R5-191812	0100	-	F	FR2 Spurious Emission test case updates	15.2.0
2019-03	RAN #83	R5-191824	0102	-	F	Update to Annex K and Annex L	15.2.0
2019-03	RAN #83	R5-191986	0107	-	F	Introduction of Annex on Characteristics of the Interfering Signal FR2	15.2.0
2019-03	RAN #83	R5-192092	0110	-	F	Test mode and test loop function activation in SA Tx RF test cases in TS 38.521-2	15.2.0
2019-03	RAN #83	R5-192095	0111	-	F	Test mode and test loop function activation in SA Rx RF test cases in TS 38.521-2	15.2.0
2019-03	RAN #83	R5-192122	0112	-	F	Update of Global In-channel Tx Test Annex for FR2	15.2.0
2019-03	RAN #83	R5-192450	0089	1	F	Update of test case 6.3.4.3, Relative power tolerance in 38.521-2	15.2.0
2019-03	RAN #83	R5-192451	0082	1	F	Updates of test environment for frequency error	15.2.0
2019-03	RAN #83	R5-192452	0105	1	F	FR2 SA Spurious Emission Coexistence test case	15.2.0
2019-03	RAN #83	R5-192648	0106	1	F	Introduction of Aggregate power tolerance in NR SA FR2	15.2.0
2019-03	RAN #83	R5-192649	0117	1	F	CR to add UL RMC for 60kHz SCS in Annex A.2.3	15.2.0
2019-03	RAN #83	R5-192650	0113	1	F	Update of transmit signal quality test cases for FR2	15.2.0
2019-03	RAN #83	R5-192651	0114	1	F	Update OBW test case in TS 38.521-2	15.2.0
2019-03	RAN #83	R5-192652	0115	1	F	Update SEM test case in TS 38.521-2	15.2.0
2019-03	RAN #83	R5-192653	0116	1	F	Update ACLR test case in TS 38.521-2	15.2.0
2019-03	RAN #83	R5-192654	0101	1	F	FR2 Reference Sensitivity test case updates	15.2.0
2019-03	RAN #83	R5-192655	0104	1	F	FR2 Reference Sensitivity EIS spherical coverage	15.2.0
2019-03	RAN #83	R5-192667	0108	1	F	Update of Annex F.2	15.2.0
2019-03	RAN #83	R5-192849	0080	2	F	Updates of MU in TS38.521-2 Annex F during RAN5#82	15.2.0
2019-03	RAN #83	R5-192843	0081	2	F	Updates of TT in TS38.521-2 Annex F during RAN5#82	15.2.0
2019-03	RAN #83	R5-192680	0103	1	F	38.521-2 Editor's Note Updates	15.2.0
2019-03	RAN #83	RP-190746	0118	4	F	Updates to maximum output power test cases	15.2.0
2019-03	RAN#83	-	-	-	-	Editorial correction of references to TS 38.508-1 clause 4.6 tables	15.2.0
2019-06	RAN#84	R5-193541	0137	-	F	Alignment of scheduling of DL RMC with scheduling of UL RMC	15.3.0
2019-06	RAN#84	R5-193552	0138	-	F	Core alignment of RAN4 pending issues in TS 38.521-2	15.3.0
2019-06	RAN#84	R5-193575	0143	-	F	Correction of 38.521-2 7.4	15.3.0
2019-06	RAN#84	R5-193749	0151	-	F	Updates of ACLR test procedure	15.3.0
2019-06	RAN#84	R5-193820	0152	-	F	Correction of 38.521-2 clause 2 to 5	15.3.0
2019-06	RAN#84	R5-194009	0153	-	F	FR2 Reference Sensitivity test case updates	15.3.0
2019-06	RAN#84	R5-194243	0161	-	F	Addition FR2 blocking measurement procedure in Annex K	15.3.0
2019-06	RAN#84	R5-194264	0163	-	F	Correction to FR2 EIRP test configurations	15.3.0
2019-06	RAN#84	R5-194265	0164	-	F	Correction to FR2 EIS test configurations	15.3.0
2019-06	RAN#84	R5-194269	0165	-	F	Update FR2 ACS and Inband blocking test cases	15.3.0
2019-06	RAN#84	R5-194461	0170	-	F	Update to 6.2.3 A-MPR FR2	15.3.0
2019-06	RAN#84	R5-194618	0171	-	F	Update of Global In-channel Tx Test Annex for FR2	15.3.0
2019-06	RAN#84	R5-194958	0139	1	F	Updates of MU and TT in TS 38.521-2 Annex F during RAN5#NR5	15.3.0
2019-06	RAN#84	R5-194968	0167	1	F	Update of TC 6.3A.1.1 Minimum output power for 2UL CA	15.3.0
2019-06	RAN#84	R5-194969	0166	1	F	Clean up FR2 SA test cases	15.3.0
2019-06	RAN#84	R5-194970	0160	1	F	Introduction of beam correspondence	15.3.0
2019-06	RAN#84	R5-194971	0162	1	F	Introduction of beam correspondence for CA	15.3.0
2019-06	RAN#84	R5-194976	0173	1	F	Update of Frequency Error Test Case for FR2	15.3.0
2019-06	RAN#84	R5-194977	0175	1	F	Editorial corrections for 6.2.1 UE maximum output power	15.3.0
2019-06	RAN#84	R5-195080	0176	-	F	Update of FR2 ON_ON time mask test cases	15.3.0
2019-06	RAN#84	R5-195147	0141	1	F	Addition of new SA FR2 RF test case 6.2.2	15.3.0

2019-06	RAN#84	R5-195149	0142	1	F	Correction of 38.521-2 6.3.2	15.3.0
2019-06	RAN#84	R5-195151	0144	1	F	Introduction of MOP (SA UL CA)	15.3.0
2019-06	RAN#84	R5-195152	0145	1	F	Introduction of OFF power (SA UL CA)	15.3.0
2019-06	RAN#84	R5-195153	0146	1	F	Introduction of Frequency error (SA UL CA)	15.3.0
2019-06	RAN#84	R5-195154	0148	1	F	Introduction of SEM (SA UL CA)	15.3.0
2019-06	RAN#84	R5-195155	0149	1	F	Introduction of ACLR (SA UL CA)	15.3.0
2019-06	RAN#84	R5-195156	0150	1	F	Introduction of General Spurious (SA UL CA)	15.3.0
2019-06	RAN#84	R5-195157	0157	1	F	Introduction of New test case 6.5A.1.1 Occupied bandwidth for CA (2UL CA)	15.3.0
2019-06	RAN#84	R5-195158	0156	1	F	Update Out of band emission test cases in TS 38.521-2	15.3.0
2019-06	RAN#84	R5-195160	0159	1	F	Introduction of SRS time mask for UL-MIMO	15.3.0
2019-06	RAN#84	R5-195404	0172	1	F	Update of transmit signal quality test cases for FR2	15.3.0
2019-06	RAN#84	R5-195417	0154	1	F	38.521-2 implementation of FR2 UL demod OTA tests using single pol Rx TE	15.3.0
2019-06	RAN#84	R5-195432	0168	2	F	Update to 6.2.1.1 UE maximum output power - EIRP and TRP	15.3.0
2019-06	RAN#84	R5-195433	0169	2	F	Update to 6.2.1.2 UE maximum output power - Spherical coverage	15.3.0
2019-06	RAN#84	R5-195434	0140	1	F	Updates of MU and TT in TS 38.521-2	15.3.0
2019-06	RAN#84	R5-195435	0155	1	F	Core alignment with TS 38.101-2	15.3.0
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	R5-195695	0178	-	F	Change of TS 38.521-2 UL CA MOP Minimum conformance requirements	16.1.0
2019-09	RAN#85	R5-196069	0194	-	F	Introduction of absolute power tolerance for CA test cases	16.1.0
2019-09	RAN#85	R5-196165	0198	-	F	Correction of wrong spec reference numbers for TS 38.508-1	16.1.0
2019-09	RAN#85	R5-196236	0202	-	F	Correction to test procedure of TC 6.4.2.2 Carrier Leakage	16.1.0
2019-09	RAN#85	R5-196240	0206	-	F	Clarification on EVM test requirement for PUCCH and PRACH	16.1.0
2019-09	RAN#85	R5-196427	0208	-	F	Update of FR2 6.2.4 Configured transmitted power	16.1.0
2019-09	RAN#85	R5-196428	0209	-	F	Update of FR2 6.3.3.2 General ON_OFF time mask	16.1.0
2019-09	RAN#85	R5-196431	0211	-	F	Addition of FR2 6.2A.4 Configured transmitted power for 2UL CA	16.1.0
2019-09	RAN#85	R5-196433	0213	-	F	Addition of FR2 6.2D.4 Configured transmitted power for UL MIMO	16.1.0
2019-09	RAN#85	R5-196434	0214	-	F	Addition of FR2 6.3D.1 Minimum output power for UL MIMO	16.1.0
2019-09	RAN#85	R5-196594	0220	-	F	Addition of new test case 6.4A.2.1.2 Error vector magnitude for 3UL CA in FR2	16.1.0
2019-09	RAN#85	R5-196595	0221	-	F	Addition of new test case 6.4A.2.1.3 Error vector magnitude for 4UL CA in FR2	16.1.0
2019-09	RAN#85	R5-196650	0225	-	F	Update of Minimum conformance requirements and test configurations in TC 6.2.2	16.1.0
2019-09	RAN#85	R5-196810	0229	-	F	Update to TRP measurement grid section in TS 38.521-2	16.1.0
2019-09	RAN#85	R5-196950	0239	-	F	Corrections on clause 2 and 3 in 38.521-2	16.1.0
2019-09	RAN#85	R5-197384	0197	1	F	Update UL-MIMO to UL MIMO to align with RAN4 terminology in FR2	16.1.0
2019-09	RAN#85	R5-197385	0238	1	F	Update OBW FR2 test case	16.1.0
2019-09	RAN#85	R5-197386	0200	1	F	Alignment of clause 2 to 5 with the core spec	16.1.0
2019-09	RAN#85	R5-197387	0242	-	F	Integrating the QoQZ Procedures into 38.521-2	16.1.0
2019-09	RAN#85	R5-197388	0219	1	F	Addition of new test case 6.4A.2.1.1 Error vector magnitude for 2UL CA in FR2	16.1.0
2019-09	RAN#85	R5-197389	0222	1	F	Update of TC 6.3A.1.1 Minimum output power for 2UL CA	16.1.0
2019-09	RAN#85	R5-197390	0223	1	F	Addition of new test case 6.3A.1.2 Minimum output power for 3UL CA in FR2	16.1.0
2019-09	RAN#85	R5-197391	0224	1	F	Addition of new test case 6.3A.1.3 Minimum output power for 4UL CA in FR2	16.1.0
2019-09	RAN#85	R5-197392	0227	1	F	Update of Common Uplink Configuration table for PC3	16.1.0
2019-09	RAN#85	R5-197393	0212	1	F	Addition of FR2 6.3A.3 ON_OFF time mask for 2 UL CA	16.1.0
2019-09	RAN#85	R5-197394	0215	1	F	Addition of FR2 6.3D.3 General ON_OFF power for UL MIMO	16.1.0
2019-09	RAN#85	R5-197395	0199	1	F	Addition of new Annex N (normative): UE coordinate system	16.1.0
2019-09	RAN#85	R5-197500	0231	1	F	Update of Spurious Emissions TRP test procedure	16.1.0
2019-09	RAN#85	R5-197501	0233	1	F	Update of FR2 MUs in TS 38.521-2	16.1.0
2019-09	RAN#85	R5-197503	0230	1	F	Update of TRP measurement grids for spurious emissions	16.1.0
2019-09	RAN#85	R5-197529	0180	1	F	New Introduction of TC 6.2A.1.2.1 UE Maximum output power Spherical coverage 2UL CA	16.1.0
2019-09	RAN#85	R5-197530	0181	1	F	New Introduction of TC 6.2A.1.2.2 UE Maximum output power Spherical coverage 3UL CA	16.1.0
2019-09	RAN#85	R5-197531	0182	1	F	New Introduction of TC 6.2A.1.2.3 UE Maximum output power Spherical coverage 4UL CA	16.1.0
2019-09	RAN#85	R5-197532	0183	1	F	New Introduction of TC 6.4A.2.2.1 Carrier leakage 2UL CA	16.1.0
2019-09	RAN#85	R5-197533	0184	1	F	New Introduction of TC 6.4A.2.2.2 Carrier leakage 3UL CA	16.1.0
2019-09	RAN#85	R5-197534	0185	1	F	New Introduction of TC 6.4A.2.2.3 Carrier leakage 4UL CA	16.1.0
2019-09	RAN#85	R5-197535	0189	1	F	Rel-16_NR_38.521-2_Addition of new TC 6.2A.1.1.1	16.1.0
2019-09	RAN#85	R5-197536	0193	1	F	Additions to the SRS time mask for UL-MIMO test case	16.1.0
2019-09	RAN#85	R5-197537	0195	1	F	Additions to the beam correspondence test case	16.1.0
2019-09	RAN#85	R5-197538	0203	1	F	Correction to RB allocation in 6.2.2 UE maximum output power	16.1.0

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2019-09	RAN#85	R5-197539	0204	1	F	Correction to number of measurements of 6.4.2.3 In-band emissions	16.1.0
2019-09	RAN#85	R5-197540	0205	1	F	Correction to UBF in transmit modulation quality test cases	16.1.0
2019-09	RAN#85	R5-197541	0226	1	F	Update of FR2 A-MPR test case	16.1.0
2019-09	RAN#85	R5-197543	0190	1	F	Refsens test case updates	16.1.0
2019-09	RAN#85	R5-197544	0196	1	F	Introduction of beam correspondence to direct far field (DFF)	16.1.0
2019-09	RAN#85	R5-197545	0216	1	F	Updated to Annex A for RF FR2 tests	16.1.0
2019-09	RAN#85	R5-197546	0232	1	F	Integrating the Re-Positioning Concept into Annex K	16.1.0
2019-09	RAN#85	R5-197614	0191	1	F	Spurious test case updates	16.1.0
2019-09	RAN#85	R5-197642	0201	1	F	Correction to 6.5.2.1 SEM and 6.5.2.3 ACLR to consider MPR values	16.1.0
2019-09	RAN#85	R5-197643	0210	2	F	Addition of FR2 6.2A.2 MPR for 2 UL CA	16.1.0
2019-09	RAN#85	R5-197644	0177	2	F	Updates of MU and TT in TS 38.521-2	16.1.0
2019-09	RAN#85	R5-197645	0234	2	F	Addition of the connection setup in TS 38.521-2	16.1.0
2019-12	RAN#86	R5-198072	0247	-	F	Introduction of 4 New test cases 6.5A.1 Occupied bandwidth for CA	16.2.0
2019-12	RAN#86	R5-198073	0248	-	F	Introduction of 4 New test cases 6.5A.2.1 Spectrum Emission Mask for CA	16.2.0
2019-12	RAN#86	R5-198075	0249	-	F	Introduction of 4 New test cases 6.5A.2.2 Adjacent channel leakage ratio for CA	16.2.0
2019-12	RAN#86	R5-198078	0250	-	F	New Introduction of TC 6.2A.1.2.4 UE maximum output power - Spherical coverage 5UL CA	16.2.0
2019-12	RAN#86	R5-198079	0251	-	F	New Introduction of TC 6.2A.1.2.5 UE maximum output power - Spherical coverage 6UL CA	16.2.0
2019-12	RAN#86	R5-198080	0252	-	F	New Introduction of TC 6.2A.1.2.6 UE maximum output power - Spherical coverage 7UL CA	16.2.0
2019-12	RAN#86	R5-198081	0253	-	F	New Introduction of TC 6.2A.1.2.7 UE maximum output power - Spherical coverage 8UL CA	16.2.0
2019-12	RAN#86	R5-198210	0260	-	F	Addition of Common Uplink Configuration for PC1 in SA FR2 6.1	16.2.0
2019-12	RAN#86	R5-198381	0267	-	F	Introduction of beam correspondence side conditions	16.2.0
2019-12	RAN#86	R5-198385	0269	-	F	Update of minimum conformance requirements for SA FR2 7.4	16.2.0
2019-12	RAN#86	R5-198636	0276	-	F	General clause updated for FR2 spec	16.2.0
2019-12	RAN#86	R5-198730	0278	-	F	Correction of test requirements	16.2.0
2019-12	RAN#86	R5-199086	0262	1	F	CR to 38.521-2 on Measurement Grids for PC1 UEs	16.2.0
2019-12	RAN#86	R5-199087	0243	2	F	Updates of MU and TT in TS 38.521-2	16.2.0
2019-12	RAN#86	R5-199356	0245	1	F	Update of FR2 6.3.3.2 ON-OFF time mask	16.2.0
2019-12	RAN#86	R5-199357	0244	1	F	Update of FR2 6.3.1 minimum output power	16.2.0
2019-12	RAN#86	R5-199358	0263	1	F	CR to 38.521-2 on optimized search procedure for REFSENS	16.2.0
2019-12	RAN#86	R5-199359	0264	1	F	CR to 38.521-2 on optimized search procedure for RX Beam Peak Search	16.2.0
2019-12	RAN#86	R5-199360	0254	1	F	Updating incorrect note in test procedure	16.2.0
2019-12	RAN#86	R5-199361	0256	1	F	Spurious UL MIMO test case updates	16.2.0
2019-12	RAN#86	R5-199373	0265	1	F	Introduction of New TC 6.4A.2.3.1 In-band emissions for 2UL CA	16.2.0
2019-12	RAN#86	R5-199374	0266	1	F	Update to test case 6.3.3.4 PRACH time mask in FR2	16.2.0
2019-12	RAN#86	R5-199375	0257	1	F	Ref Sens UL MIMO test case updates	16.2.0
2019-12	RAN#86	R5-199376	0258	1	F	Alignment of clause 3 to 5 with the core spec	16.2.0
2019-12	RAN#86	R5-199461	0271	2	F	Further updates to the SRS time mask for UL-MIMO test case	16.2.0
2019-12	RAN#86	R5-199473	0282	-	F	Update to UE maximum output power - Spherical coverage	16.2.0
2019-12	RAN#86	R5-199483	0277	1	F	Update of applicability for Spherical coverage and Beam Correspondence test cases	16.2.0
2019-12	RAN#86	R5-199494	0281	1	F	Add section 4.5 Applicability and test coverage rules	16.2.0
2019-12	RAN#86	R5-199495	0246	1	F	Update of FR2 6.3.4.2 absolute power tolerance	16.2.0
2019-12	RAN#86	R5-199496	0270	1	F	Further updates to the absolute power tolerance for CA test cases	16.2.0
2019-12	RAN#86	R5-199504	0259	1	F	Addition of test requirements and update of minimum conformance requirements and test configurations for SA FR2 6.2.2	16.2.0
2019-12	RAN#86	R5-199548	0268	1	F	Updates to the beam correspondence TC	16.2.0
2019-12	RAN#86	R5-199579	0279	1	F	Update of quality of quiet zone validation procedure	16.2.0
2019-12	RAN#86	R5-199586	0275	1	F	Update on FR2 Spurious Test in 38.521-2	16.2.0
2020-03	RAN#87	R5-200319	0288		F	CR to 38.521-2 on CDF/PDF Scaling Factor	16.3.0
2020-03	RAN#87	R5-200320	0289		F	CR to 38.521-2: Correction to TRP grid	16.3.0
2020-03	RAN#87	R5-200368	0292		F	Addition of new test case 6.3A.1.4 Minimum output power for 5UL CA in FR2	16.3.0
2020-03	RAN#87	R5-200369	0293		F	Addition of new test case 6.3A.1.5 Minimum output power for 6UL CA in FR2	16.3.0
2020-03	RAN#87	R5-200372	0294		F	Addition of new test case 6.3A.1.6 Minimum output power for 7UL CA in FR2	16.3.0
2020-03	RAN#87	R5-200374	0295		F	Addition of new test case 6.3A.1.7 Minimum output power for 8UL CA in FR2	16.3.0
2020-03	RAN#87	R5-200375	0296		F	Addition of new test case 6.4A.2.1.4 Error vector magnitude for 5UL CA in FR2	16.3.0
2020-03	RAN#87	R5-200376	0297		F	Addition of new test case 6.4A.2.1.5 Error vector magnitude for 6UL CA in FR2	16.3.0
2020-03	RAN#87	R5-200377	0298		F	Addition of new test case 6.4A.2.1.6 Error vector magnitude for 7UL	16.3.0

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2020-03	RAN#87	R5-200382	0300		F	Addition of new test case 6.4A.2.1.7 Error vector magnitude for 8UL CA in FR2	16.3.0
2020-03	RAN#87	R5-200383	0301		F	Update of test cases for Error vector magnitude for CA in FR2	16.3.0
2020-03	RAN#87	R5-200418	0302		F	Update of Operating bands and Channel arrangement of SA FR2 R15	16.3.0
2020-03	RAN#87	R5-200444	0303		F	Clarification of measurement interval of frequency error in FR2	16.3.0
2020-03	RAN#87	R5-200557	0309		F	Clarify absolute power tolerance for CA TP3	16.3.0
2020-03	RAN#87	R5-200602	0312		F	Updates to reference sensitivity test case	16.3.0
2020-03	RAN#87	R5-200656	0317		F	Correction of Editor's note of 6.2.2 and 6.3.2 of SA FR2 R15	16.3.0
2020-03	RAN#87	R5-201248	0318	1	F	Alignment of Table A.3.1-1 in 38.521-2 to core spec 38.101-2	16.3.0
2020-03	RAN#87	R5-200800	0319		F	Update of Standalone FR2 A-MPR test case	16.3.0
2020-03	RAN#87	R5-200894	0286	1	F	Correction to TC 6.3.4.4 Aggregate power tolerance	16.3.0
2020-03	RAN#87	R5-200910	0310	1	F	Beam correspondence TC message contents clarifications	16.3.0
2020-03	RAN#87	R5-200911	0285	1	F	Update of Clause 4 in TS 38.521-2	16.3.0
2020-03	RAN#87	R5-200980	0284	1	F	Correction of reference numbers in TS 38.521-2	16.3.0
2020-03	RAN#87	R5-200992	0291	1	F	Updates of MU and TT in TS 38.521-2 for Rel-16	16.3.0
2020-03	RAN#87	R5-201059	0305	1	F	Update of rx beampeak search	16.3.0
2020-03	RAN#87	R5-201060	0307	1	F	Update of absolute power tolerance for test point 3	16.3.0
2020-03	RAN#87	R5-201161	0313	1	F	Updates to test case relative power tolerance 6.3.4.3	16.3.0
2020-03	RAN#87	R5-201192	0283	1	F	Updates of MU and TT in TS 38.521-2	16.3.0
2020-03	RAN#87	R5-201244	0311	3	F	Correction of the FR2 RMC slot patterns for MOP test cases	16.3.0
2020-06	RAN#88	R5-201328	0321	-	F	Add n261 to FR2 ACLR requirements	16.4.0
2020-06	RAN#88	R5-201330	0323	-	F	Update to UBF command implementation for Relative power sub tests	16.4.0
2020-06	RAN#88	R5-201795	0325	-	F	Introduction of New TC 6.4A.2.2.4 Carrier leakage for 5UL CA	16.4.0
2020-06	RAN#88	R5-201796	0326	-	F	Introduction of New TC 6.4A.2.2.5 Carrier leakage for 6UL CA	16.4.0
2020-06	RAN#88	R5-201797	0327	-	F	Introduction of New TC 6.4A.2.2.6 Carrier leakage for 7UL CA	16.4.0
2020-06	RAN#88	R5-201811	0328	-	F	Introduction of New TC 6.4A.2.2.7 Carrier leakage for 8UL CA	16.4.0
2020-06	RAN#88	R5-201812	0329	-	F	Introduction of New TC 6.4A.2.3.2 In-band emissions for 3UL CA	16.4.0
2020-06	RAN#88	R5-201813	0330	-	F	Introduction of New TC 6.4A.2.3.3 In-band emissions for 4UL CA	16.4.0
2020-06	RAN#88	R5-201814	0331	-	F	Introduction of New TC 6.4A.2.3.4 In-band emissions for 5UL CA	16.4.0
2020-06	RAN#88	R5-201815	0332	-	F	Introduction of New TC 6.4A.2.3.5 In-band emissions for 6UL CA	16.4.0
2020-06	RAN#88	R5-201835	0333	-	F	Correction of FR2 PUCCH EVM definition	16.4.0
2020-06	RAN#88	R5-201849	0334	-	F	Updating common uplink allocation for PC1	16.4.0
2020-06	RAN#88	R5-201850	0335	-	F	Cleaning up references to common uplink configuration	16.4.0
2020-06	RAN#88	R5-201851	0336	-	F	Updating test requirements of 6.2.3 AMPR for NS_201	16.4.0
2020-06	RAN#88	R5-202045	0342	-	F	Correction of test metric in minimum conformance requirements and some test style in 6.3.2 of SA FR2 R15	16.4.0
2020-06	RAN#88	R5-202046	0343	-	F	Correction of uplink configuration table number in minimum conformance requirements and test requirement table of 7.4 of SA FR2 R15	16.4.0
2020-06	RAN#88	R5-202120	0346	-	F	CR to 38.521-2 to correct Clenshaw-Curtis Weight Equations	16.4.0
2020-06	RAN#88	R5-202122	0348	-	F	CR to 38.521-2 to clarify the applicability of QoQZ validation	16.4.0
2020-06	RAN#88	R5-202135	0354	-	F	Update to 6 test cases 6.5A.2.1.x Spectrum Emission Mask for 3 to 8 UL CA	16.4.0
2020-06	RAN#88	R5-202137	0356	-	F	Update to 6 test cases 6.5A.2.2.x Adjacent channel leakage ratio for 3 to 8 UL CA	16.4.0
2020-06	RAN#88	R5-202447	0367	-	F	Editorial correction to the test requirement of in-band blocking	16.4.0
2020-06	RAN#88	R5-202450	0368	-	F	Correction of Spectrum Emission Mask CA test cases	16.4.0
2020-06	RAN#88	R5-202504	0372	-	F	CR on EVM Window Centre Timing Definition in FR2	16.4.0
2020-06	RAN#88	R5-202720	0345	1	F	CR to 38.521-2 to correct Clenshaw-Curtis Weights at the Poles for CDF/CCDF	16.4.0
2020-06	RAN#88	R5-202722	0364	1	F	Additions to Initial Conditions and Messages for SRS time mask with UL MIMO	16.4.0
2020-06	RAN#88	R5-202723	0337	1	F	Aligning test procedure for Rx beam peak direction	16.4.0
2020-06	RAN#88	R5-202724	0341	1	F	Alignment of section 3 and 5 with core spec of SA FR2 R15	16.4.0
2020-06	RAN#88	R5-202808	0365	1	F	Receiver characteristics testing update to 38.521-2	16.4.0
2020-06	RAN#88	R5-202824	0351	1	F	Update to test case 6.5A.1.1 Occupied bandwidth for 2UL CA	16.4.0
2020-06	RAN#88	R5-202825	0353	1	F	Update to test case 6.5A.2.1.1 Spectrum Emission Mask for 2UL CA	16.4.0
2020-06	RAN#88	R5-202826	0355	1	F	Update to test case 6.5A.2.2.1 Adjacent channel leakage ratio for 2UL CA	16.4.0
2020-06	RAN#88	R5-202827	0371	1	F	Update to 6 test cases 6.5A.1.x Occupied bandwidth for 3 to 8 UL CA	16.4.0
2020-06	RAN#88	R5-202828	0338	1	F	Updating SRS config table in test case 6.3D.3.4	16.4.0
2020-06	RAN#88	R5-202885	0322	1	F	Add NS 202 requirements to FR2 additional spurious emission test case	16.4.0
2020-06	RAN#88	R5-202893	0349	1	F	Editorial correction of test case 6.5.1 Occupied bandwidth to align with core spec	16.4.0
2020-06	RAN#88	R5-202894	0350	1	F	Editorial correction of Tx test cases for Out of band emission to align with core spec	16.4.0
2020-06	RAN#88	R5-202895	0357	1	F	Clarification of disabling Tx diversity for FR2 UE for SA FR2 testing	16.4.0

2020-06	RAN#88	R5-202896	0358	1	F	Updates of Test Points of Tx CA test cases	16.4.0
2020-06	RAN#88	R5-202897	0360	1	F	Correction on txDirectCurrentLocation in FR2 SA tests	16.4.0
2020-06	RAN#88	R5-202898	0370	1	F	Update on transmit modulation quality test cases	16.4.0
2020-06	RAN#88	R5-202899	0361	1	F	Update to SA FR2 Receiver Spurious Emission Test Case	16.4.0
2020-06	RAN#88	R5-202943	0363	1	F	CR to 38.521-2: On the order of test steps for output power dynamics test cases	16.4.0
2020-06	RAN#88	R5-202968	0359	1	F	Core spec alignment of k1 value for RF test cases	16.4.0
2020-06	RAN#88	R5-202990	0362	2	F	Updates of FR2 MU and TT in TS 38.521-2	16.4.0
2020-06	RAN#88	R5-203117	0347	2	F	CR to 38.521-2 to properly define Link and Meas Angles	16.4.0
2020-09	RAN#89	R5-203292	0373	-	F	Clarification of Interferer frequency selection in FR2 IBB test case 7.6.2	16.5.0
2020-09	RAN#89	R5-203875	0392	-	F	Alignment of general sections with core spec of SA FR2 R15	16.5.0
2020-09	RAN#89	R5-203969	0394	-	F	Updating beam correspondence capability	16.5.0
2020-09	RAN#89	R5-204264	0412	-	F	Editorial correction of ACLR CA test cases	16.5.0
2020-09	RAN#89	R5-204265	0413	-	F	Editorial correction of Annex C.3 Connection	16.5.0
2020-09	RAN#89	R5-204266	0414	-	F	Update of FR2 OBW test case	16.5.0
2020-09	RAN#89	R5-204713	0382	1	F	Correction to test configuration for Carrier leakage for CA	16.5.0
2020-09	RAN#89	R5-204714	0383	1	F	Correction to TC 6.4A.2.3.1 In-band emissions for 2UL CA	16.5.0
2020-09	RAN#89	R5-204715	0384	1	F	Correction to test cases 6.4A.2.3.x In-band emissions for 3 to 6 UL CA	16.5.0
2020-09	RAN#89	R5-204716	0385	1	F	Introduction of New TC 6.4A.2.3.6 In-band emissions for 7UL CA	16.5.0
2020-09	RAN#89	R5-204717	0386	1	F	Introduction of New TC 6.4A.2.3.7 In-band emissions for 8UL CA	16.5.0
2020-09	RAN#89	R5-204763	0393	1	F	Miscellaneous corrections due to core spec alignment	16.5.0
2020-09	RAN#89	R5-204764	0415	1	F	Update of Tx signal quality test cases	16.5.0
2020-09	RAN#89	R5-204765	0395	1	F	Addition of UL power setting for Rx test cases	16.5.0
2020-09	RAN#89	R5-204856	0403	1	F	CR to update MU and TT in 38.521-2	16.5.0
2020-09	RAN#89	R5-204857	0380	1	F	Beam correspondence - SRS configuration corrections in section 6.6.1	16.5.0
2020-09	RAN#89	R5-204858	0397	1	F	CR to 38.521-2 to update Absolute Power Tolerance for CA on the order of test steps	16.5.0
2020-09	RAN#89	R5-204859	0401	1	F	CR to TS 38.521-2: Correction to MB relaxation minimum requirements	16.5.0
2020-09	RAN#89	R5-204860	0406	1	F	CR to 38.521-2 to adjust the test step sequences	16.5.0
2020-09	RAN#89	R5-204861	0407	1	F	CR to 38.521-2 to allow vendor declarations related to beam peak searches	16.5.0
2020-09	RAN#89	R5-204862	0408	1	F	CR to 38.521-2 on QoQZ Verification Clarification	16.5.0
2020-09	RAN#89	R5-204863	0411	1	F	FR2 Minimum output power MU updates	16.5.0
2020-09	RAN#89	R5-204864	0417	1	F	FR2 EIRP OFF power MU updates	16.5.0
2020-09	RAN#89	R5-204865	0379	1	F	Beam correspondence - SRS configuration corrections in annex K.1.1	16.5.0
2020-09	RAN#89	R5-204914	0388	1	F	Updates to test case 6.3.4.3, relative power tolerance	16.5.0
2020-09	RAN#89	R5-204915	0398	1	F	CR to 38.521-2 to update Transmit OFF Power	16.5.0
2020-09	RAN#89	R5-204916	0399	1	F	CR to TS 38.521-2: Correction to time mask requirements	16.5.0
2020-09	RAN#89	R5-204917	0402	1	F	Clean up complete status for FR2 SA test cases	16.5.0
2020-09	RAN#89	R5-204918	0404	1	F	Update to UE maximum output power for CA	16.5.0
2020-09	RAN#89	R5-204919	0410	1	F	FR2 Minimum output power measurement period definition	16.5.0
2020-09	RAN#89	R5-204920	0389	1	F	FR2 RefSens and EIS spherical PC3 MBR table update	16.5.0
2020-09	RAN#89	R5-204921	0396	1	F	Addition of modified MPR behaviour	16.5.0
2020-09	RAN#89	R5-204922	0400	1	F	CR to TS 38.521-2: Annex F EIRP OFF Power	16.5.0
2020-09	RAN#89	R5-204923	0409	1	F	CR to TS 38.521-2 on DUT alignment options	16.5.0
2020-09	RAN#89	RP-201671	0418	-	F	Adding FR2 PDCCH Aggregation Level in Annex C.3	16.5.0
2020-12	RAN#90	R5-205259	0420	-	F	Addition of new test case 6.4D.3 Time alignment error for UL MIMO in FR2	16.6.0
2020-12	RAN#90	R5-205260	0421	-	F	Addition of new test case 6.5D.1 Occupied bandwidth for UL MIMO in FR2	16.6.0
2020-12	RAN#90	R5-205496	0422	-	F	Alignment of general sections with core spec	16.6.0
2020-12	RAN#90	R5-205497	0423	-	F	Correction of minimum conformance requirements for 6.2.2 MPR	16.6.0
2020-12	RAN#90	R5-205536	0427	-	F	Aligning tested subframe numbers with defined RMC in test case 6.3.4.3	16.6.0
2020-12	RAN#90	R5-205573	0428	-	F	Adding a new note in test configuration table for ACLR and SEM test case	16.6.0
2020-12	RAN#90	R5-205711	0431	-	F	FR2 EIS editor's note clean up	16.6.0
2020-12	RAN#90	R5-205811	0433	-	F	Correction to Carrier leakage for CA	16.6.0
2020-12	RAN#90	R5-205812	0434	-	F	Correction to In-band emissions for CA	16.6.0
2020-12	RAN#90	R5-205854	0438	-	F	Correction of transmission gap for relative power tolerance TC 6.3.4.3	16.6.0
2020-12	RAN#90	R5-206009	0439	-	F	Update of in-band emission and carrier leakage test cases	16.6.0
2020-12	RAN#90	R5-206206	0448	-	F	Update of occupied bandwidth test case	16.6.0
2020-12	RAN#90	R5-206210	0449	-	F	Correction of Annex F for absolute power tolerance for CA	16.6.0
2020-12	RAN#90	R5-206644	0437	1	F	Correction of MBW for output power dynamics TCs 6.3.x and ACLR TC 6.5.2.3	16.6.0
2020-12	RAN#90	R5-206645	0440	1	F	Correction of 6.2.3.3.1 for UE additional maximum power reduction	16.6.0

2020-12	RAN#90	R5-206646	0419	1	F	Forgotten change extending Table range to N.2-7	16.6.0
2020-12	RAN#90	R5-206647	0430	1	F	CR to update DMRS position in UL RMC for FR2	16.6.0
2020-12	RAN#90	R5-206821	0442	1	F	CR to 38.521-2 on ETC Testing	16.6.0
2020-12	RAN#90	R5-206822	0445	1	F	Minimum output power updates	16.6.0
2020-12	RAN#90	R5-206823	0446	1	F	FR2 time masks updates	16.6.0
2020-12	RAN#90	R5-206824	0443	1	F	Update FR2 TRx MU and TT in 38.521-2	16.6.0
2020-12	RAN#90	R5-206825	0444	1	F	Minimum output power measurement uncertainties and test tolerances	16.6.0
2020-12	RAN#90	R5-206826	0447	1	F	FR2 Time masks updates	16.6.0
2020-12	RAN#90	R5-206865	0429	1	F	Update on Test points of FR2 Transmit OFF power for CA	16.6.0
2020-12	RAN#90	R5-206866	0432	1	F	Adding NS202 and NS203 to MOP and Spurious	16.6.0
2020-12	RAN#90	R5-206867	0435	1	F	Addition of 6.5D.2.1 Spectrum Emission Mask for UL MIMO in FR2	16.6.0
2020-12	RAN#90	R5-206868	0436	1	F	Addition of 6.5D.2.2 Adjacent channel leakage ratio for UL MIMO in FR2	16.6.0
2021-03	RAN#91	R5-210489	0457	-	F	Correction of test purpose for 6.3.2 Transmit OFF power	16.7.0
2021-03	RAN#91	R5-210490	0458	-	F	Addition of new test case 6.3D.2 Transmit OFF power for UL MIMO	16.7.0
2021-03	RAN#91	R5-210491	0459	-	F	Correction of test applicability and test description for 7.4 Maximum input level	16.7.0
2021-03	RAN#91	R5-210492	0460	-	F	Addition of new test cases for 7.4A Maximum input level for CA	16.7.0
2021-03	RAN#91	R5-210494	0462	-	F	Removal of brackets for MU of EIS spherical coverage	16.7.0
2021-03	RAN#91	R5-210495	0463	-	F	Correction of Annex P for Modified MPR behaviour	16.7.0
2021-03	RAN#91	R5-210496	0464	-	F	Correction of definition for EIS	16.7.0
2021-03	RAN#91	R5-210565	0467	-	F	Update of waveform to be used during Rx peam peak search in Annex K.1.2	16.7.0
2021-03	RAN#91	R5-210724	0468	-	F	Omitting of FR2 Rx cases with UL-MIMO on TDD bands	16.7.0
2021-03	RAN#91	R5-210729	0471	-	F	Removing test condition of extreme voltage	16.7.0
2021-03	RAN#91	R5-210731	0473	-	F	Adding definition of FR2a, FR2b and FR2c in general section	16.7.0
2021-03	RAN#91	R5-210732	0474	-	F	Cleaning up of Annex K	16.7.0
2021-03	RAN#91	R5-211094	0481	-	F	Correction to assumption of aggregated channel bandwidth in TC 6.5A.2.2	16.7.0
2021-03	RAN#91	R5-211097	0484	-	F	Definition of relaxation value of spurious emissions UE co-existence in TC 6.5.3.2	16.7.0
2021-03	RAN#91	R5-211110	0486	-	F	Corrections to subclauses in 38.521-2 with appropriate subclause level and heading styles	16.7.0
2021-03	RAN#91	R5-211126	0488	-	F	Update of 5.5A.2 for corrections to configurations for intra-band non-contiguous CA	16.7.0
2021-03	RAN#91	R5-211683	0456	1	F	Editorial corrections in Occupied bandwidth test procedure	16.7.0
2021-03	RAN#91	R5-211684	0465	1	F	FR2 UL CA Frequency error test cases update	16.7.0
2021-03	RAN#91	R5-211685	0469	1	F	Addition of Inner_partial allocation in general section and a few test cases	16.7.0
2021-03	RAN#91	R5-211686	0470	1	F	Correction of parameter configuration for open loop power control	16.7.0
2021-03	RAN#91	R5-211688	0476	1	F	Addition of new test case 6.2A.1.1.4 UE maximum output power - EIRP and TRP for 5UL CA	16.7.0
2021-03	RAN#91	R5-211689	0477	1	F	Addition of new test case 6.2A.1.1.5 UE maximum output power - EIRP and TRP for 6UL CA	16.7.0
2021-03	RAN#91	R5-211690	0478	1	F	Addition of new test case 6.2A.1.1.6 UE maximum output power - EIRP and TRP for 7UL CA	16.7.0
2021-03	RAN#91	R5-211691	0479	1	F	Addition of new test case 6.2A.1.1.7 UE maximum output power - EIRP and TRP for 8UL CA	16.7.0
2021-03	RAN#91	R5-211692	0487	1	F	Corrections to reference figures for transmission bandwidth configuration in FR2	16.7.0
2021-03	RAN#91	R5-211693	0493	1	F	Update of Annex F for test case 7.3.4	16.7.0
2021-03	RAN#91	R5-211863	0466	1	F	FR2 MPR, ACLR and SEM test cases update as per TP analysis update	16.7.0
2021-03	RAN#91	R5-211864	0472	1	F	Cleaning up of FR2 test specification	16.7.0
2021-03	RAN#91	R5-211865	0475	1	F	Update of TX Test Cases for UL MIMO in FR2	16.7.0
2021-03	RAN#91	R5-211866	0482	1	F	Correction to definition of power control window size in FR2 relative power tolerance in TC 6.3.4.3	16.7.0
2021-03	RAN#91	R5-211867	0491	1	F	FR2 Tx additional spurious emission test case updates	16.7.0
2021-03	RAN#91	R5-211868	0453	1	F	ACS FR2 test case update	16.7.0
2021-03	RAN#91	R5-211869	0454	1	F	IBB FR2 test case update	16.7.0
2021-03	RAN#91	R5-211919	0451	1	F	Introduction of FR2 DL 256QAM	16.7.0
2021-03	RAN#91	R5-211921	0480	1	F	Correction to ACLR relaxation value in TC 6.5.2.3	16.7.0
2021-03	RAN#91	R5-211922	0455	1	F	MU and TT definition for REFSENS FR2 CA test cases	16.7.0
2021-03	RAN#91	R5-211923	0485	1	F	Update FR2 MU and TT in 38.521-2	16.7.0
2021-03	RAN#91	R5-211924	0490	1	F	CR to 38.521-2 on PC1 Measurement Grid MUs	16.7.0
2021-03	RAN#91	R5-211925	0492	1	F	Update of ETC MTSU	16.7.0
2021-06	RAN#92	R5-212225	0496	-	F	Configured transmitter power for UL power boosting	16.8.0
2021-06	RAN#92	R5-212226	0497	-	F	In-band emissions for UL power boosting	16.8.0
2021-06	RAN#92	R5-212227	0498	-	F	Output power dynamics for CA	16.8.0
2021-06	RAN#92	R5-212229	0500	-	F	Occupied bandwidth for CA	16.8.0
2021-06	RAN#92	R5-212230	0501	-	F	Spectrum emission mask for CA	16.8.0

2021-06	RAN#92	R5-212231	0502	-	F	Adjacent channel leakage ratio for CA	16.8.0
2021-06	RAN#92	R5-212233	0504	-	F	Spurious emission band UE co-existence for CA	16.8.0
2021-06	RAN#92	R5-212341	0505	-	F	FR2 MPR - Test configuration correction	16.8.0
2021-06	RAN#92	R5-212342	0506	-	F	Removal of requirement for EIRP measurement in the transmitter spurious emission test cases	16.8.0
2021-06	RAN#92	R5-212343	0507	-	F	Test limits update for MOP spherical coverage test case 6.2.1.2	16.8.0
2021-06	RAN#92	R5-212351	0508	-	F	ACS and IBB - FR2 MU definition in 38.521-2	16.8.0
2021-06	RAN#92	R5-212523	0510	-	F	Update of the test configuration for 6.5D.1 Occupied Bandwidth for UL MIMO test case	16.8.0
2021-06	RAN#92	R5-212814	0515	-	F	Updated CA NS 201 202 203 for additional spurious emission	16.8.0
2021-06	RAN#92	R5-212815	0516	-	F	Align CA spurious emission UE coex requirements with core spec	16.8.0
2021-06	RAN#92	R5-212829	0519	-	F	Correction of 7.6 for test of blocking characteristics	16.8.0
2021-06	RAN#92	R5-212858	0521	-	F	Removal of brackets for the Configured transmitted power requirements	16.8.0
2021-06	RAN#92	R5-212859	0522	-	F	Removal of test cases in 6.3A.2	16.8.0
2021-06	RAN#92	R5-212861	0524	-	F	Correction of definition for bit 1 of modifiedMPRbehavior field of n28	16.8.0
2021-06	RAN#92	R5-212975	0531	-	F	Updating H.2.2 for NR SA FR2 testing	16.8.0
2021-06	RAN#92	R5-213309	0545	-	F	Update of output power dynamic test cases	16.8.0
2021-06	RAN#92	R5-213319	0546	-	F	Update of Spectrum Emission Mask for UL MIMO test case	16.8.0
2021-06	RAN#92	R5-213325	0549	-	F	Editorial Correction to FR2 frequency sub-group definitions	16.8.0
2021-06	RAN#92	R5-213329	0552	-	F	EIS Requirements update for Rel.16 Inter-band CA	16.8.0
2021-06	RAN#92	R5-213333	0555	-	F	Align MBR requirements table with current core spec	16.8.0
2021-06	RAN#92	R5-213836	0511	1	F	Correction of power control in 38.521-2	16.8.0
2021-06	RAN#92	R5-213837	0540	1	F	FR2 Carrier Aggregation Minimum Output power updates	16.8.0
2021-06	RAN#92	R5-213838	0548	1	F	Implementation of PCC Prio test procedure updates in UL-CA tests	16.8.0
2021-06	RAN#92	R5-213839	0535	1	F	CR to 38.521-2 on Optional 4x2 PC3 Antenna Array Configuration	16.8.0
2021-06	RAN#92	R5-213840	0536	1	F	CR to 38.521-2 on larger quiet zone with grey-box approach	16.8.0
2021-06	RAN#92	R5-213841	0537	1	F	CR to 38.521-2 to clarify BP Searches for NTC and ETC	16.8.0
2021-06	RAN#92	R5-213842	0539	1	F	Measurement uncertainties and test tolerances for FR2 Relative and aggregate power tolerance	16.8.0
2021-06	RAN#92	R5-213895	0509	1	F	Update of the test configuration for 6.4A.2.1 EVM CA test cases	16.8.0
2021-06	RAN#92	R5-213896	0514	1	F	Update to FR2 test case title in clause 6	16.8.0
2021-06	RAN#92	R5-213897	0518	1	F	Correction of 6.2.3 for mapping of network signalling label	16.8.0
2021-06	RAN#92	R5-213898	0523	1	F	Correction of Test applicability of 6.4.2.5	16.8.0
2021-06	RAN#92	R5-213899	0526	1	F	Correction of subclause titles with appropriate styles	16.8.0
2021-06	RAN#92	R5-213900	0529	1	F	Editorial correction of AMPR and Additional spurious emission	16.8.0
2021-06	RAN#92	R5-213901	0530	1	F	Clean up of CA sub-titles	16.8.0
2021-06	RAN#92	R5-213902	0541	1	F	Clarifications on UE beamlock function applicability	16.8.0
2021-06	RAN#92	R5-213903	0538	1	F	CR to 38.521-2 on Temperature Tolerance for FR2 Testing	16.8.0
2021-06	RAN#92	R5-213904	0542	1	F	Annex C: Clarifications to downlink signal levels	16.8.0
2021-06	RAN#92	R5-213984	0550	1	F	Add n259 definition in common section	16.8.0
2021-06	RAN#92	R5-214011	0495	1	F	Introduction of FR2 DL 256QAM to Maximum input level for CA	16.8.0
2021-06	RAN#92	R5-214028	0503	1	F	Spurious emissions for CA	16.8.0
2021-06	RAN#92	R5-214029	0551	1	F	Update with Rel16 Beam Correspondence requirements	16.8.0
2021-06	RAN#92	R5-214048	0512	1	F	Correction of ON OFF time mask in 38.521-2	16.8.0
2021-06	RAN#92	R5-214049	0525	1	F	Removal of for further study notes about ETC testing	16.8.0
2021-06	RAN#92	R5-214050	0554	1	F	Addition of missing clauses for SA FR2 UL-CA scenarios	16.8.0
2021-06	RAN#92	R5-214051	0534	1	F	Measurement Uncertainties updates for FR2 Extreme Testing Conditions	16.8.0
2021-06	RAN#92	R5-214078	0517	1	F	Updated spurious emission CA test configuration table	16.8.0
2021-06	RAN#92	R5-214104	0499	1	F	Transmit signal quality for CA	16.8.0
2021-09	RAN#93	R5-214605	0572	-	F	Removal of empty cells in the test configuration table	16.9.0
2021-09	RAN#93	R5-214606	0573	-	F	Removal of brackets from the Minimum Conformance Requirements of Reference sensitivity power level for Intra-band non-contiguous CA	16.9.0
2021-09	RAN#93	R5-214608	0575	-	F	Move the definition of cumulative aggregated channel bandwidth to the Definitions section	16.9.0
2021-09	RAN#93	R5-214910	0582	-	F	Editorial correction to Reference sensitivity power level for Inter-band CA	16.9.0
2021-09	RAN#93	R5-214914	0586	-	F	Transmit ON/OFF time mask test configuration for non-contiguous CA	16.9.0
2021-09	RAN#93	R5-214915	0587	-	F	Frequency error for non-contiguous CA	16.9.0
2021-09	RAN#93	R5-215056	0590	-	F	Update to time mask for FR2 UL-MIMO	16.9.0
2021-09	RAN#93	R5-215329	0598	-	F	Correction to MU and TT for spurious emission band UE co-existence	16.9.0
2021-09	RAN#93	R5-215473	0605	-	F	Clarification of PCC for FR2 DL CA	16.9.0
2021-09	RAN#93	R5-215474	0606	-	F	Correction of common UL configuration	16.9.0
2021-09	RAN#93	R5-215517	0609	-	F	Minor correction on UL additional reference channels parameters for TDD 60kHz SCS	16.9.0
2021-09	RAN#93	R5-215583	0618	-	F	MTSU and TT mapping related to Max Device Size	16.9.0
2021-09	RAN#93	R5-215584	0619	-	F	MTSU and TT mapping related to Max Device Size	16.9.0
2021-09	RAN#93	R5-215585	0620	-	F	MTSU and TT mapping related to Max Device Size	16.9.0

2021-09	RAN#93	R5-215618	0622	-	F	EIS spherical coverage for inter-band CA	16.9.0
2021-09	RAN#93	R5-215636	0628	-	F	Updates to CSI-RS based beam correspondence minimum requirements	16.9.0
2021-09	RAN#93	R5-215637	0629	-	F	Updates to SSB based beam correspondence minimum requirements	16.9.0
2021-09	RAN#93	R5-215641	0630	-	F	Text correction to section clarifying leverage from NSA test coverage	16.9.0
2021-09	RAN#93	R5-215830	0612	1	F	FR2 SA UL MIMO measurement uncertainties and test tolerances updates	16.9.0
2021-09	RAN#93	R5-215831	0614	1	F	Editorial correction for Receiver Spurious Emissions Measurement Uncertainty	16.9.0
2021-09	RAN#93	R5-215848	0558	1	F	Introduction of new clause 6.3A.4.4 and Minimum conformance requirements	16.9.0
2021-09	RAN#93	R5-215849	0565	1	F	Introduction of new TC 6.3A.4.4.1 Aggregate power tolerance for CA (2UL CA)	16.9.0
2021-09	RAN#93	R5-215850	0566	1	F	Introduction of new TC 6.3A.4.4.2 Aggregate power tolerance for CA (3UL CA)	16.9.0
2021-09	RAN#93	R5-215851	0567	1	F	Introduction of new TC 6.3A.4.4.3 Aggregate power tolerance for CA (4UL CA)	16.9.0
2021-09	RAN#93	R5-215852	0568	1	F	Introduction of new TC 6.3A.4.4.4 Aggregate power tolerance for CA (5UL CA)	16.9.0
2021-09	RAN#93	R5-215853	0569	1	F	Introduction of new TC 6.3A.4.4.5 Aggregate power tolerance for CA (6UL CA)	16.9.0
2021-09	RAN#93	R5-215854	0570	1	F	Introduction of new TC 6.3A.4.4.6 Aggregate power tolerance for CA (7UL CA)	16.9.0
2021-09	RAN#93	R5-215855	0571	1	F	Introduction of new TC 6.3A.4.4.7 Aggregate power tolerance for CA (8UL CA)	16.9.0
2021-09	RAN#93	R5-215856	0580	1	F	Addition of new test case 6.4D.1 Frequency error for UL MIMO in FR2	16.9.0
2021-09	RAN#93	R5-215857	0581	1	F	Update of test case 6.4D.3 Time alignment error for UL MIMO in FR2	16.9.0
2021-09	RAN#93	R5-215858	0591	1	F	Cleaning up the specification skeleton	16.9.0
2021-09	RAN#93	R5-215859	0593	1	F	Editorial corrections for various test cases	16.9.0
2021-09	RAN#93	R5-215860	0595	1	F	Correction of FR2 Carrier Leakage Test Case	16.9.0
2021-09	RAN#93	R5-215861	0599	1	F	Editors note correction to reference sensitivity for CA	16.9.0
2021-09	RAN#93	R5-215862	0589	1	F	Update of FR2 UL RMCs	16.9.0
2021-09	RAN#93	R5-215925	0603	1	F	Correct the abbreviations for network signalling value in 38.521-2	16.9.0
2021-09	RAN#93	R5-215975	0588	1	F	Transmit modulation quality for non-contiguous CA	16.9.0
2021-09	RAN#93	R5-215976	0576	1	F	Update Minimum conformance requirement clause 7.4A.0 for Rel-16 Enhancement	16.9.0
2021-09	RAN#93	R5-215977	0577	1	F	Addition of clause 7.5A.0 minimum conformance requirement for Rel-16 Enhancement WP	16.9.0
2021-09	RAN#93	R5-215978	0578	1	F	Addition of clause 7.6A.2.0 minimum conformance requirement for Rel-16 Enhancement WP	16.9.0
2021-09	RAN#93	R5-215979	0623	1	F	DL CA BW Enhancement and CA REFSENS	16.9.0
2021-09	RAN#93	R5-215980	0627	1	F	Common clause updates to cover Rel.16 FR2 changes	16.9.0
2021-09	RAN#93	R5-216036	0611	1	F	FR2 SA UL MIMO Out-of-band emissions initial conditions updates	16.9.0
2021-09	RAN#93	R5-216037	0613	1	F	FR2 SA UL MIMO Maximum Power Reduction update	16.9.0
2021-09	RAN#93	R5-216063	0602	1	F	Update of 5.5A.1 for intra-band contiguous CA configuration table	16.9.0
2021-09	RAN#93	R5-216081	0626	1	F	Updates to Rel.16 enhanced Beam Correspondence test	16.9.0
2021-09	RAN#93	R5-216087	0556	1	F	Update to FR2 minimum output power test case	16.9.0
2021-09	RAN#93	R5-216088	0557	1	F	Update to FR2 ACLR test case	16.9.0
2021-09	RAN#93	R5-216089	0592	1	F	Add missing LO retrieval step in ULCA carrier leakage test procedure	16.9.0
2021-09	RAN#93	R5-216090	0594	1	F	FR2 Spur emissions test config table updates and editor notes clean up	16.9.0
2021-09	RAN#93	R5-216091	0596	1	F	Correction of power control in 38.521-2	16.9.0
2021-09	RAN#93	R5-216092	0625	1	F	38.521-2 CR FR2 ETC MU & TT updates	16.9.0
2021-09	RAN#93	R5-216111	0621	1	F	UE maximum output power for UL-MIMO	16.9.0
2021-12	RAN#94	R5-216546	0631	-	F	Addition of test configuration for FR2 DL 256QAM to Maximum input level	16.10.0
2021-12	RAN#94	R5-217092	0636	-	F	Update Rx beam peak direction search	16.10.0
2021-12	RAN#94	R5-217093	0637	-	F	Update of Reference Sensitivity Test Cases for CA	16.10.0
2021-12	RAN#94	R5-217113	0638	-	F	FR2 Refsens correction for power class 2	16.10.0
2021-12	RAN#94	R5-217114	0639	-	F	FR2 EIS spherical coverage correction for power class 2	16.10.0
2021-12	RAN#94	R5-217248	0645	-	F	Correction of note for BEAM_SELECT_WAIT_TIME	16.10.0
2021-12	RAN#94	R5-217249	0646	-	F	Correction of subclause style, number and position	16.10.0
2021-12	RAN#94	R5-217250	0647	-	F	Correction of Table 6.2.2.4.1-9 for Test Frequency	16.10.0
2021-12	RAN#94	R5-217331	0651	-	F	Correction to test requirements of 6.2D.2 MPR for UL-MIMO	16.10.0
2021-12	RAN#94	R5-217333	0653	-	F	Removing 6.3D.3.4.5 SRS time mask for MIMO	16.10.0
2021-12	RAN#94	R5-217341	0654	-	F	Correction of 3.2 and 3.3 for symbols and abbreviations	16.10.0
2021-12	RAN#94	R5-217419	0658	-	F	Correction of test configuration table in 6.3.4.2	16.10.0
2021-12	RAN#94	R5-217420	0659	-	F	Correction of aggregate power tolerance	16.10.0

2021-12	RAN#94	R5-217421	0660	-	F	Correction of core requirement of aggregate power tolerance	16.10.0
2021-12	RAN#94	R5-217614	0665	-	F	Update to FR2 Tx test cases for n260	16.10.0
2021-12	RAN#94	R5-217708	0671	-	F	FR2 Extreme Temperature Conditions applicability for ACLR	16.10.0
2021-12	RAN#94	R5-217709	0672	-	F	Minimum Output Power Editor notes review	16.10.0
2021-12	RAN#94	R5-217710	0673	-	F	38.521-2 FR2 Extreme Temperature Conditions applicability for UL-MIMO	16.10.0
2021-12	RAN#94	R5-218234	0644	1	F	Correction of exception of message contents for DFT-s-OFDM modulation	16.10.0
2021-12	RAN#94	R5-218235	0650	1	F	Global correction of test cases except those having impact on ETSI EN 301 908 25	16.10.0
2021-12	RAN#94	R5-218236	0652	1	F	Correction to testability statement of 6.5.2.3 ACLR	16.10.0
2021-12	RAN#94	R5-218237	0656	1	F	Correction of 6.2.4 for configured transmitted power	16.10.0
2021-12	RAN#94	R5-218238	0664	1	F	Correction to FR2 Rx test cases	16.10.0
2021-12	RAN#94	R5-218239	0669	1	F	Clarification on reference sensitivity power level	16.10.0
2021-12	RAN#94	R5-218240	0635	1	F	Handling of fallbacks for FR2 CA	16.10.0
2021-12	RAN#94	R5-218241	0655	1	F	Correction of 4.1 and 4.2 for minimum requirements and test requirements	16.10.0
2021-12	RAN#94	R5-218366	0678	1	F	Updates to CSI-RS based beam correspondence minimum requirements	16.10.0
2021-12	RAN#94	R5-218367	0679	1	F	Updates to SSB based beam correspondence minimum requirements	16.10.0
2021-12	RAN#94	R5-218368	0633	1	F	MTSUs for Rel-16 RF Enhancement for FR2	16.10.0
2021-12	RAN#94	R5-218369	0634	1	F	TTs for Rel-16 RF Enhancement for FR2	16.10.0
2021-12	RAN#94	R5-218401	0662	1	F	Update of transmit modulation quality test cases	16.10.0
2021-12	RAN#94	R5-218407	0670	1	F	38.521-2 Beam correspondence Measurement Uncertainties	16.10.0
2021-12	RAN#94	R5-218425	0640	1	F	Spur emissions coex test config update and editor notes clean up	16.10.0
2021-12	RAN#94	R5-218426	0641	1	F	Clarify DL CC config for UL CA test	16.10.0
2021-12	RAN#94	R5-218427	0642	1	F	Update Minimum Output Power requirement	16.10.0
2021-12	RAN#94	R5-218428	0643	1	F	Alignment of the description for initial set up of downlink and uplink signals	16.10.0
2021-12	RAN#94	R5-218429	0648	1	F	Correction of test cases having impact on ETSI EN 301 908 25	16.10.0
2021-12	RAN#94	R5-218430	0649	1	F	Correction of test configuration for CA test cases	16.10.0
2021-12	RAN#94	R5-218431	0667	1	F	Update of test case 6.2.3 A-MPR	16.10.0
2021-12	RAN#94	R5-218432	0668	1	F	Update of test case 6.5.3.3 A-Spurious	16.10.0
2021-12	RAN#94	R5-218474	0676	1	F	Enhanced Beam Correspondence test updates	16.10.0
2021-12	RAN#94	R5-218475	0677	1	F	Common clause updates to cover Rel.16 FR2 changes	16.10.0
2021-12	RAN#94	R5-218484	0675	1	F	Rel.15 Beam Correspondence Updates and clarifications	16.10.0
2022-03	RAN#95	R5-220256	0684	-	F	FR2 Frequency error tests - unify requirements per polarization	16.11.0
2022-03	RAN#95	R5-220257	0685	-	F	Test limit correction in FR2 MPR test case	16.11.0
2022-03	RAN#95	R5-220258	0686	-	F	RX beam peak direction search procedure update in case of intra-band DL CA	16.11.0
2022-03	RAN#95	R5-220259	0687	-	F	Updated reference to FR2 connection diagram in tests using modulated interferer	16.11.0
2022-03	RAN#95	R5-220274	0688	-	F	Clarifications on 5G NR connectivity options for RF FR2	16.11.0
2022-03	RAN#95	R5-220791	0693	-	F	Update to 6.2D.1 for ULFPTx	16.11.0
2022-03	RAN#95	R5-220792	0694	-	F	Update to 6.2D.2 for ULFPTx	16.11.0
2022-03	RAN#95	R5-220793	0695	-	F	Update to 6.2D.4 for ULFPTx	16.11.0
2022-03	RAN#95	R5-220908	0698	-	F	Correction to test procedure of 6.4A.1.1	16.11.0
2022-03	RAN#95	R5-221060	0699	-	F	Update of 6.2A.1 for UE maximum output power	16.11.0
2022-03	RAN#95	R5-221061	0700	-	F	Update of 6.2.3 for UE maximum output power with additional requirements	16.11.0
2022-03	RAN#95	R5-221063	0702	-	F	Update of 6.2A.4 for configured transmitted power for CA	16.11.0
2022-03	RAN#95	R5-221111	0704	-	F	Editorial correction to titles of FR2 test cases	16.11.0
2022-03	RAN#95	R5-221112	0705	-	F	Update to test applicability to FR2 test cases	16.11.0
2022-03	RAN#95	R5-221269	0706	-	F	Correction of ON OFF time mask test cases for FR2	16.11.0
2022-03	RAN#95	R5-221334	0709	-	F	Removing TP analysis editor note for FR2 Tx spur emission UL MIMO test case	16.11.0
2022-03	RAN#95	R5-221338	0710	-	F	Update to Clause 7.6 Blocking Characteristics	16.11.0
2022-03	RAN#95	R5-221341	0712	-	F	Update to Intra-band non-contiguous CA	16.11.0
2022-03	RAN#95	R5-221354	0716	-	F	Update reference to intra-band non-contiguous UL-CA FR2 RF tests in Annex	16.11.0
2022-03	RAN#95	R5-221355	0717	-	F	Editorial correction in intra-band non-contiguous configurations table	16.11.0
2022-03	RAN#95	R5-221356	0718	-	F	Add correct test case structure to Beam Correspondence CA test case	16.11.0
2022-03	RAN#95	R5-221357	0719	-	F	Introduce EIS test cases to incorporate Rel.16 inter-band CA	16.11.0
2022-03	RAN#95	R5-221657	0707	2	F	38.521-2 Beam correspondence Measurement Uncertainties and test tolerances	16.11.0
2022-03	RAN#95	R5-221685	0683	1	F	Correction of test config tables of non-CA test cases for consistency with CA test cases on without RB allocation case	16.11.0
2022-03	RAN#95	R5-221686	0689	1	F	FR2 SA EVM test case update based on MU and TT analysis	16.11.0
2022-03	RAN#95	R5-221687	0696	1	F	Correction of general ON OFF time mask	16.11.0
2022-03	RAN#95	R5-221688	0697	1	F	Correction to FR2 absolute power tolerance MU and TT	16.11.0

2022-03	RAN#95	R5-221689	0681	1	F	Removal of empty lines in Table 7.3.2.3.2-1 and Table 7.3.2.5-2	16.11.0
2022-03	RAN#95	R5-221690	0703	1	F	Correction to PDCCH DCI format for FR2 test cases	16.11.0
2022-03	RAN#95	R5-221691	0711	1	F	Update to Clause 7.5 Adjacent channel selectivity	16.11.0
2022-03	RAN#95	R5-221692	0682	1	F	Correction of the table title style of Table 5.5A.3-1	16.11.0
2022-03	RAN#95	R5-221766	0701	1	F	Update of 6.2A.2 for UE maximum output power reduction for CA	16.11.0
2022-03	RAN#95	R5-221792	0708	1	F	ETC for FR2 RF CA	16.11.0
2022-03	RAN#95	R5-221889	0714	1	F	FR2 Enhanced Beam Correspondence test updates	16.11.0
2022-03	RAN#95	R5-221890	0715	1	F	Minimum Conformance Requirements updates to enhanced beam correspondence	16.11.0
2022-06	RAN#96	R5-222198	0720	-	F	Correction of table numbers in 6.2D.2.5	16.12.0
2022-06	RAN#96	R5-222199	0721	-	F	Correction of Test Environment for UL MIMO MPR test case	16.12.0
2022-06	RAN#96	R5-222342	0723	-	F	Beam peak search - re-positioning formula correction	16.12.0
2022-06	RAN#96	R5-222488	0731	-	F	Editorial correction for Tx test cases	16.12.0
2022-06	RAN#96	R5-222544	0733	-	F	Update of A-MPR and A-SE test cases	16.12.0
2022-06	RAN#96	R5-222879	0736	-	F	Update to FR2 6.2.3 A-MPR	16.12.0
2022-06	RAN#96	R5-223122	0749	-	F	Addition of FR2 6.2D.3 for ULFPTx	16.12.0
2022-06	RAN#96	R5-223258	0752	-	F	Correction of FR2 MOP and beam correspondence test cases	16.12.0
2022-06	RAN#96	R5-223617	0728	1	F	Update FR2 TRx MU in 38.521-2	16.12.0
2022-06	RAN#96	R5-223749	0726	1	F	Common Uplink Configuration updates for NR RF requirement enhancements for FR2	16.12.0
2022-06	RAN#96	R5-223750	0740	1	F	FR2 Enhanced Beam Correspondence test updates	16.12.0
2022-06	RAN#96	R5-223751	0742	1	F	Updates across Spherical Coverage test cases to incorporate Rel.16 requirements	16.12.0
2022-06	RAN#96	R5-223752	0748	1	F	Test case updates in Max Input Level FR2 CA tests	16.12.0
2022-06	RAN#96	R5-223814	0724	1	F	Rel-15 MPR updates	16.12.0
2022-06	RAN#96	R5-223815	0725	1	F	Common Uplink Configuration updates for Rel-15 FR2	16.12.0
2022-06	RAN#96	R5-223816	0732	1	F	Correction to DCI format in signal quality TCs	16.12.0
2022-06	RAN#96	R5-223817	0739	1	F	Implement test function approach to limit Pcell Power in FR2 UL-CA tests	16.12.0
2022-06	RAN#96	R5-223818	0750	1	F	Correction to 6.2.1.1 for multi-band relaxation factors for PC3 UE	16.12.0
2022-06	RAN#96	R5-223819	0755	1	F	Clarification on Configured transmitted power	16.12.0
2022-06	RAN#96	R5-223820	0757	1	F	Implementation of FR2 single carrier Tx beam peak applicability for UL MIMO Tx tests	16.12.0
2022-06	RAN#96	R5-223821	0761	1	F	Editorial correction to test requirement of FR2 test cases	16.12.0
2022-06	RAN#96	R5-223822	0754	1	F	Clarification on Adjacent channel selectivity	16.12.0
2022-06	RAN#96	R5-223823	0758	1	F	Clarification on In-band blocking	16.12.0
2022-06	RAN#96	R5-223824	0730	1	F	Editorial correction in Annex	16.12.0
2022-06	RAN#96	R5-223825	0734	1	F	Correction of TRP Measurement Grids	16.12.0
2022-06	RAN#96	R5-223826	0735	1	F	CR on applicability per permitted test method	16.12.0
2022-06	RAN#96	R5-223827	0743	1	F	Correction to FR2 DL RMCs	16.12.0
2022-06	RAN#96	R5-223828	0744	1	F	Initial introduction of fast spherical coverage test method	16.12.0
2022-06	RAN#96	R5-223829	0745	1	F	Initial introduction of RSRP-B based Rx Peak Beam Search	16.12.0
2022-06	RAN#96	R5-223830	0746	1	F	Initial introduction of Enhanced EIRP measurement method	16.12.0
2022-06	RAN#96	R5-223831	0751	1	F	Correction to A.2.3 and A.3.3 for UL and DL RMCs	16.12.0
2022-06	RAN#96	R5-223832	0760	1	F	Clarification on UE Channel bandwidth per operating band for CA	16.12.0
2022-09	RAN#97	R5-224247	0772	-	F	Correction of the SCS value in Table 5.3.5-1 for n259	16.13.0
2022-09	RAN#97	R5-224248	0773	-	F	Correction of the clause numbers and table numbers in 7.3A.3	16.13.0
2022-09	RAN#97	R5-224303	0775	-	F	PUCCH format correction to test DFT-s-OFDM in FR2	16.13.0
2022-09	RAN#97	R5-224305	0777	-	F	FR2 SA EVM test case update based on TT analysis	16.13.0
2022-09	RAN#97	R5-224907	0787	-	F	Reference sensitivity power level for CA, editor notes update on ETC	16.13.0
2022-09	RAN#97	R5-225107	0794	-	F	Update of spurious emissions test cases	16.13.0
2022-09	RAN#97	R5-225205	0797	-	F	CR to update validation test frequencies and sub-ranges	16.13.0
2022-09	RAN#97	R5-225607	0798	1	F	Addition of new test case 6.2.2_1 for FR2 MPR enhancements	16.13.0
2022-09	RAN#97	R5-225658	0762	1	F	New test case addition: 6.2.4_1 Configured transmitted power with Power Boost	16.13.0
2022-09	RAN#97	R5-225659	0765	1	F	Enhanced Beam correspondence Measurement Uncertainties and test tolerances	16.13.0
2022-09	RAN#97	R5-225660	0764	1	F	Measurement uncertainties and test tolerances for test case 6.2.4_1 Configured transmitted power with Power Boost	16.13.0
2022-09	RAN#97	R5-225664	0776	1	F	PC1 - MU and TT definition for MOP in 38.521-2	16.13.0
2022-09	RAN#97	R5-225665	0778	1	F	PC1 - MU and TT definition for REFSENS in 38.521-2	16.13.0
2022-09	RAN#97	R5-225666	0767	1	F	Updates to Spherical Coverage annexes	16.13.0
2022-09	RAN#97	R5-225667	0780	1	F	Definition of PC1 MU and relaxation	16.13.0
2022-09	RAN#97	R5-225679	0779	1	F	Update of FR2 5 to 8UL CA Test Cases	16.13.0
2022-09	RAN#97	R5-225680	0766	1	F	Updates related to TPMI test methods	16.13.0
2022-09	RAN#97	R5-225719	0774	1	F	Applicable NR-ARFCN correction for n259	16.13.0
2022-09	RAN#97	R5-225743	0763	1	F	In-band emissions minimum conformance requirements update	16.13.0
2022-09	RAN#97	R5-225744	0786	1	F	Reference sensitivity power level for CA, update on intra-band non-continuous CA	16.13.0
2022-09	RAN#97	R5-225771	0788	1	F	HST FR2 6.2.3 UE maximum output power with additional requirements	16.13.0
2022-09	RAN#97	R5-225772	0789	1	F	HST FR2 6.2D.1.1 adding Release-17 FR2 PC6 UE maximum	16.13.0

						output power for UL MIMO	
2022-09	RAN#97	R5-225773	0790	1	F	HST FR2 6.3.1 adding Release-17 FR2 PC6 Minimum output power	16.13.0
2022-09	RAN#97	R5-225774	0791	1	F	HST FR2 6.4.2.2 adding Release-17 FR2 PC6 Carrier leakage	16.13.0
2022-09	RAN#97	R5-225775	0792	1	F	HST FR2 6.4.2.3 adding Release-17 FR2 PC6 In-band emissions	16.13.0
2022-09	RAN#97	R5-225792	0768	1	F	Tx Fast Spherical Coverage test cases integration	16.13.0
2022-09	RAN#97	R5-225793	0771	1	F	FR2 Tx Signal Quality UL MIMO Test Case Updates	16.13.0
2022-09	RAN#97	R5-225794	0795	1	F	Correction of spurious emissions test case	16.13.0
2022-09	RAN#97	R5-225795	0800	1	F	Updated Test points in FR2 CA MPR test case	16.13.0
2022-09	RAN#97	R5-225796	0769	1	F	Rx Fast Spherical Coverage test cases integration	16.13.0
2022-09	RAN#97	R5-225797	0785	1	F	Correction to interfere offset in 7.6.2	16.13.0
2022-09	RAN#97	R5-225798	0770	1	F	Annex updates related to RSRP-B Rx Beam peak search	16.13.0
2022-09	RAN#97	R5-225843	0796	1	F	Update to FR2 CA MPR test case 6.2A.2.1 to prevent SCell drop by using UE PHR	16.13.0
2022-09	RAN#97	R5-225844	0799	1	F	Extension of test function approach to limit Pcell Power in some FR2 UL CA tests	16.13.0
2022-09	RAN#97	R5-225845	0784	1	F	Correction to test procedure of minimum output power	16.13.0
2022-09	RAN#97	R5-225870	0782	1	F	Correction to EVM measurement point for DFTs-OFDM DM-RS Type 2	16.13.0