ETSI TS 138 215 V17.4.0 (2024-02)

TECHNICAL SPECIFICATION

5G;
NR;
Physical layer measurements
(3GPP TS 38.215 version 17.4.0 Release 17)

Reference
RTS/TSGR-0138215vh40

Keywords
5G

ETSI

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Foreword

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1 Scope

The present document describes the physical layer measurements for NR.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications"

[2] 3GPP TS 38.201: "NR; Physical Layer – General Description"

[3] 3GPP TS 38.211: "NR; Physical channels and modulation"

[4] 3GPP TS 38.212: "NR; Multiplexing and channel coding"

[5] 3GPP TS 38.213: "NR; Physical layer procedures for control channels"

[6] 3GPP TS 38.214: "NR; Physical layer procedures for data channels"

[7] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification"

[8] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification"

[9] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception"

[10] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification"

[11] IEEE 802.11, Part 11: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, IEEE Std."

[12] 3GPP TS 38.133: "NR; Requirements for support of radio resource management"

[13] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation"

[14] 3GPP TS 38.509: "5GS; Special conformance testing functions for User Equipment (UE)"

[15] 3GPP TS 38.901: "Study on channel model for frequencies from 0.5 to 100 GHz"

[16] 3GPP TS 38.455: "NR Positioning Protocol A (NRPPa)"

[17] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access"

[18] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN"

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

ARFCN	Absolute Radio-Frequency Channel Number
CLI	Cross Link Interference
CSI-RSRP	CSI Reference Signal Received Power
CSI-RSRQ	CSI Reference Signal Received Quality
E-UTRAN	Evolved UTRAN
GNSS	Global Navigation Satellite System
GSM	Global System for Mobile communication
LBT	Listen before Talk
SRS	Sounding Reference Signal
SS-RSRP	Synchronization Signal Reference Signal Received Power
SS-RSRQ	Synchronization Signal Reference Signal Received Quality
UTRAN	Universal Terrestrial Radio Access Network

4 Control of UE/NG-RAN measurements

In this clause the general measurement control concept of the higher layers is briefly described to provide an understanding on how L1 measurements are initiated and controlled by higher layers.

With the measurement specifications L1 provides measurement capabilities for the UE and NG-RAN. These measurements can be classified in different reported measurement types: intra-frequency, inter-frequency, inter-system, traffic volume, quality and UE internal measurements.

In the L1 measurement definitions, see clause 5, the measurements are categorised as measurements in the UE or measurements in the NG-RAN.

5 Measurement capabilities for NR

5.1 UE measurement capabilities

The structure of the table defining a UE measurement quantity is shown below.

Column field	Comment
Definition	Contains the definition of the measurement.
Applicable for	States in which state(s) it shall be possible to perform this measurement. The following terms are used in the tables: RRC_IDLE; RRC_INACTIVE; RRC_CONNECTED; Intra-frequency appended to the RRC state: Shall be possible to perform in the corresponding RRC state on an intra-frequency cell; Inter-frequency appended to the RRC state: Shall be possible to perform in the corresponding RRC state on an inter-frequency cell Inter-RAT appended to the RRC state: Shall be possible to perform in the corresponding RRC state on an inter-RAT cell. If sidelink: it shall be possible to perform this measurement on sidelink.

5.1.1 SS reference signal received power (SS-RSRP)

Definition	SS reference signal received power (SS-RSRP) is defined as the linear average over the power contributions (in [W]) of the resource elements that carry secondary synchronization signals. The measurement time resource(s) for SS-RSRP are confined within SS/PBCH Block Measurement Time Configuration (SMTC) window duration. If SS-RSRP is used for L1-RSRP as configured by reporting configurations as defined in TS 38.214 [6], the measurement time resources(s) restriction by SMTC window duration is not applicable. For SS-RSRP determination demodulation reference signals for physical broadcast channel (PBCH) and, if indicated by higher layers, CSI reference signals in addition to secondary synchronization signals may be used. SS-RSRP using demodulation reference signal for PBCH or CSI reference signal shall be measured by linear averaging over the power contributions of the resource elements that carry corresponding reference signals taking into account power scaling for the reference signals as defined in TS 38.213 [5]. If SS-RSRP is not used for L1-RSRP, the additional use of CSI reference signals for SS-RSRP determination is not applicable. SS-RSRP shall be measured only among the reference signals corresponding to SS/PBCH blocks with the same SS/PBCH block index and the same physical-layer cell identity. If SS-RSRP is not used for L1-RSRP and higher-layers indicate certain SS/PBCH blocks for performing SS-RSRP measurements, then SS-RSRP is measured only from the indicated set of SS/PBCH block(s). For frequency range 1, the reference point for the SS-RSRP shall be the antenna connector of the UE. For frequency range 2, SS-RSRP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported SS-RSRP value shall not be lower than the corresponding SS-RSRP of any of the individual receiver branches.
Applicable for	If SS-RSRP is used for L1-RSRP, RRC_CONNECTED intra-frequency. Otherwise, RRC_IDLE intra-frequency, RRC_IDLE inter-frequency, RRC_INACTIVE intra-frequency, RRC_INACTIVE inter-frequency, RRC_CONNECTED intra-frequency, RRC_CONNECTED inter-frequency

NOTE 1: The number of resource elements within the measurement period that are used by the UE to determine SS-RSRP is left up to the UE implementation with the limitation that corresponding measurement accuracy requirements have to be fulfilled.

NOTE 2: The power per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

5.1.2 CSI reference signal received power (CSI-RSRP)

Definition	CSI reference signal received power (CSI-RSRP), is defined as the linear average over the power contributions (in [W]) of the resource elements of the antenna port(s) that carry CSI reference signals configured for RSRP measurements within the considered measurement frequency bandwidth in the configured CSI-RS occasions. For CSI-RSRP determination CSI reference signals transmitted on antenna port 3000 according to TS 38.211 [4] shall be used. If CSI-RSRP is used for L1-RSRP, CSI reference signals transmitted on antenna ports 3000, 3001 can be used for CSI-RSRP determination. For intra-frequency CSI-RSRP measurements, if the measurement gap is not configured, UE is not expected to measure the CSI-RS resource(s) outside of the active downlink bandwidth part. For frequency range 1, the reference point for the CSI-RSRP shall be the antenna connector of the UE. For frequency range 2, CSI-RSRP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported CSI-RSRP value shall not be lower than the corresponding CSI-RSRP of any of the individual receiver branches.
Applicable for	If CSI-RSRP is used for L1-RSRP, RRC_CONNECTED intra-frequency. Otherwise, RRC_CONNECTED intra-frequency, RRC_CONNECTED inter-frequency

NOTE 1: The number of resource elements within the considered measurement frequency bandwidth and within the measurement period that are used by the UE to determine CSI-RSRP is left up to the UE implementation with the limitation that corresponding measurement accuracy requirements have to be fulfilled.

NOTE 2: The power per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

5.1.3 SS reference signal received quality (SS-RSRQ)

Definition	Secondary synchronization signal reference signal received quality (SS-RSRQ) is defined as the ratio of N×SS-RSRP / NR carrier RSSI, where N is the number of resource blocks in the NR carrier RSSI measurement bandwidth. The measurements in the numerator and denominator shall be made over the same set of resource blocks. NR carrier Received Signal Strength Indicator (NR carrier RSSI), comprises the linear average of the total received power (in [W]) observed only in certain OFDM symbols of measurement time resource(s), in the measurement bandwidth, over N number of resource blocks from all sources, including co-channel serving and non-serving cells, adjacent channel interference, thermal noise etc. For cell selection, according to Clause 4.1 of TS 38.211 [12], the measurement time resources(s) for NR Carrier RSSI are not constrained. Otherwise, the measurement time resource(s) for NR Carrier RSSI are confined within SS/PBCH Block Measurement Time Configuration (SMTC) window duration. If indicated by higher-layers, if measurement gap is not used, the NR Carrier RSSI is measured in slots within the SMTC window duration that are indicated by the higher layer parameter *measurementSlots* and in OFDM symbols given by Table 5.1.3-1 and, if measurement gap is used, the NR Carrier RSSI is measured in slots within the SMTC window duration that are indicated by the higher layer parameter *measurementSlots* and in OFDM symbols given by Table 5.1.3-1 that are overlapped with the measurement gap, which is defined in TS38.133 [12]. - For intra-frequency measurements, NR Carrier RSSI is measured with timing reference corresponding to the serving cell in the frequency layer - For inter-frequency measurements, NR Carrier RSSI is measured with timing reference corresponding to any cell in the target frequency layer Otherwise not indicated by higher-layers, if measurement gap is not used, NR Carrier RSSI is measured from OFDM symbols within SMTC window duration and, if measurement gap is used, NR Carrier RSSI is measured from OFDM symbols corresponding to overlapped time span between SMTC window duration and the measurement gap. If higher-layers indicate certain SS/PBCH blocks for performing SS-RSRQ measurements, then SS-RSRP is measured only from the indicated set of SS/PBCH block(s). For frequency range 1, the reference point for the SS-RSRQ shall be the antenna connector of the UE. For frequency range 2, NR Carrier RSSI shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch, where the combining for NR Carrier RSSI shall be the same as the one used for SS-RSRP measurements. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported SS-RSRQ value shall not be lower than the corresponding SS-RSRQ of any of the individual receiver branches.
Applicable for	RRC_IDLE intra-frequency, RRC_IDLE inter-frequency, RRC_INACTIVE intra-frequency, RRC_INACTIVE inter-frequency, RRC_CONNECTED intra-frequency, RRC_CONNECTED inter-frequency

Table 5.1.3-1: NR Carrier RSSI measurement symbols

OFDM signal indication *endSymbol*	Symbol indexes
0	{0,1}
1	For 480 kHz and 960 kHz {0,1,2,..,11,12}; otherwise {0,1,2,..,10,11}
2	{0,1,2,…, 5}
3	{0,1,2,…, 7}

5.1.4 CSI reference signal received quality (CSI-RSRQ)

Definition	CSI reference signal received quality (CSI-RSRQ) is defined as the ratio of N×CSI-RSRP to CSI-RSSI, where N is the number of resource blocks in the CSI-RSSI measurement bandwidth. The measurements in the numerator and denominator shall be made over the same set of resource blocks. CSI Received Signal Strength Indicator (CSI-RSSI), comprises the linear average of the total received power (in [W]) observed only in OFDM symbols of measurement time resource(s), in the measurement bandwidth, over N number of resource blocks from all sources, including co-channel serving and non-serving cells, adjacent channel interference, thermal noise etc. The measurement time resource(s) for CSI-RSSI corresponds to OFDM symbols containing configured CSI-RS occasions. For CSI-RSRQ determination CSI reference signals transmitted on antenna port 3000 according to TS 38.211 [4] shall be used. For intra-frequency CSI-RSRQ measurements, if the measurement gap is not configured, UE is not expected to measure the CSI-RS resource(s) outside of the active downlink bandwidth part. For frequency range 1, the reference point for the CSI-RSRQ shall be the antenna connector of the UE. For frequency range 2, CSI-RSSI shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch, where the combining for CSI-RSSI shall be the same as the one used for CSI-RSRP measurements. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported CSI-RSRQ value shall not be lower than the corresponding CSI-RSRQ of any of the individual receiver branches.
Applicable for	RRC_CONNECTED intra-frequency, RRC_CONNECTED inter-frequency

5.1.5 SS signal-to-noise and interference ratio (SS-SINR)

Definition	SS signal-to-noise and interference ratio (SS-SINR), is defined as the linear average over the power contribution (in [W]) of the resource elements carrying secondary synchronisation signals divided by the linear average of the noise and interference power contribution (in [W]). If SS-SINR is used for L1-SINR reporting with dedicated interference measurement resources, the interference and noise is measured over resource(s) indicated by higher layers as described in TS 38.214 [6]. Otherwise, the interference and noise are measured over the resource elements carrying secondary synchronisation signals within the same frequency bandwidth. The measurement time resource(s) for SS-SINR are confined within SS/PBCH Block Measurement Time Configuration (SMTC) window duration. If SS-SINR is used for L1-SINR as configured by reporting configurations defined in TS 38.214 [6], the measurement time resources(s) restriction by SMTC window duration is not applicable. For SS-SINR determination demodulation reference signals for physical broadcast channel (PBCH) in addition to secondary synchronization signals may be used. If SS-SINR is not used for L1-SINR and higher-layers indicate certain SS/PBCH blocks for performing SS-SINR measurements, then SS-SINR is measured only from the indicated set of SS/PBCH block(s). For frequency range 1, the reference point for the SS-SINR shall be the antenna connector of the UE. For frequency range 2, SS-SINR shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported SS-SINR value shall not be lower than the corresponding SS-SINR of any of the individual receiver branches.
Applicable for	If SS-SINR is used for L1-SINR, RRC_CONNECTED intra-frequency. Otherwise, RRC_CONNECTED intra-frequency, RRC_CONNECTED inter-frequency

5.1.6 CSI signal-to-noise and interference ratio (CSI-SINR)

Definition	CSI signal-to-noise and interference ratio (CSI-SINR), is defined as the linear average over the power contribution (in [W]) of the resource elements carrying CSI reference signals divided by the linear average of the noise and interference power contribution (in [W]). If CSI-SINR is used for L1-SINR reporting with dedicated interference measurement resources, the interference and noise is measured over resource(s) indicated by higher layers as described in TS 38.214 [6]. Otherwise, the interference and noise are measured over the resource elements carrying CSI reference signals within the same frequency bandwidth. For CSI-SINR determination CSI reference signals transmitted on antenna port 3000 according to TS 38.211 [4] shall be used. If CSI-SINR is used for L1-SINR, CSI reference signals transmitted on antenna ports 3000, 3001 can be used for CSI-SINR determination. For intra-frequency CSI-SINR measurements not used for L1-SINR reporting, if the measurement gap is not configured, UE is not expected to measure the CSI-RS resource(s) outside of the active downlink bandwidth part. For frequency range 1, the reference point for the CSI-SINR shall be the antenna connector of the UE. For frequency range 2, CSI-SINR shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported CSI-SINR value shall not be lower than the corresponding CSI-SINR of any of the individual receiver branches.
Applicable for	If CSI-SINR is used for L1-SINR, RRC_CONNECTED intra-frequency. Otherwise, RRC_CONNECTED intra-frequency, RRC_CONNECTED inter-frequency

5.1.7 Void

5.1.8 Void

5.1.9 UE GNSS Timing of Cell Frames for UE positioning for E-UTRA

Definition	The timing between E-UTRA cell j and a GNSS-specific reference time for a given GNSS (e.g., GPS/Galileo/Glonass system time). $T_{UE\text{-}GNSS}$ is defined as the time of occurrence of a specified NG-RAN event according to GNSS time for a given GNSS Id. The specified NG-RAN event is the beginning of a particular frame (identified through its SFN) in the first detected path (in time) of the cell-specific reference signals of the cell j, where cell j is a cell chosen by the UE. The reference point for $T_{UE\text{-}GNSSj}$ shall be the antenna connector of the UE.
Applicable for	RRC_CONNECTED inter-RAT

5.1.10 UE GNSS code measurements

Definition	The GNSS code phase (integer and fractional parts) of the spreading code of the i^{th} GNSS satellite signal. The reference point for the GNSS code phase shall be the antenna connector of the UE.
Applicable for	Void (this measurement is not related to NG-RAN/E-UTRAN/UTRAN/GSM signals; its applicability is therefore independent of the UE RRC state)

5.1.11 UE GNSS carrier phase measurements

Definition	The number of carrier-phase cycles (integer and fractional parts) of the i^{th} GNSS satellite signal, measured since locking onto the signal. Also called Accumulated Delta Range (ADR). The reference point for the GNSS carrier phase shall be the antenna connector of the UE.
Applicable for	Void (this measurement is not related to NG-RAN/E-UTRAN/UTRAN/GSM signals; its applicability is therefore independent of the UE RRC state)

5.1.12 IEEE 802.11 WLAN RSSI

Definition	The IEEE 802.11 WLAN RSSI as used in RRC specification [10] refers to RSSI as defined in IEEE 802.11 specification [11] , measured from Beacon, DMG Beacon or FILS discovery frames (in passive scanning mode) or from probe response frames (in active scanning mode).
Applicable for	RRC_CONNECTED inter-RAT, RRC_INACTIVE inter-RAT, RRC_IDLE inter-RAT

5.1.13 Reference signal time difference (RSTD) for E-UTRA

Definition	The relative timing difference between the E-UTRA neighbour cell j and the E-UTRA reference cell i, defined as $T_{SubframeRxj} – T_{SubframeRxi}$, where: $T_{SubframeRxj}$ is the time when the UE receives the start of one subframe from E-UTRA cell j $T_{SubframeRxi}$ is the time when the UE receives the corresponding start of one subframe from E-UTRA cell i that is closest in time to the subframe received from E-UTRA cell j. The reference point for the observed subframe time difference shall be the antenna connector of the UE.
Applicable for	RRC_CONNECTED inter-RAT

5.1.14 SFN and frame timing difference (SFTD)

Definition	The observed SFN and frame timing difference (SFTD) between an E-UTRA PCell and an NR PSCell (for EN-DC), or an NR PCell and an E-UTRA PSCell (for NE-DC), or an NR PCell and an NR PSCell (for NR-DC), or an NR PCell and NR neighbour cell (for UEs with NR PCell but no E-UTRA/NR PSCell) is defined as comprising the following two components: - SFN offset = (SFN_{PCell} - $SFN_{TRGCell}$) mod 1024, where SFN_{PCell} is the SFN of a PCell radio frame and $SFN_{TRGCell}$ is the SFN of the target cell radio frame of which the UE receives the start closest in time to the time when it receives the start of the PCell radio frame. - Frame boundary offset = $\left\lfloor \left(T_{FrameBoundaryPCell} - T_{FrameBoundaryTRGCell}\right)/5 \right\rfloor$, where $T_{FrameBoundaryPCell}$ is the time when the UE receives the start of a radio frame from the PCell, $T_{FrameBoundaryTRGCell}$ is the time when the UE receives the start of the radio frame, from the target cell, that is closest in time to the radio frame received from the PCell. The unit of ($T_{FrameBoundaryPCell}$ - $T_{FrameBoundaryTRGCell}$) is Ts.
Applicable for	RRC_CONNECTED intra-frequency for EN-DC, NE-DC, NR-DC RRC_CONNECTED inter-frequency for UEs with NR PCell but no E-UTRA/NR PSCell

5.1.15 E-UTRA RSRP

Definition	E-UTRA Reference signal received power (E-UTRA RSRP), is defined as the linear average over the power contributions (in [W]) of the resource elements that carry cell-specific reference signals within the considered measurement frequency bandwidth. For E-UTRA RSRP determination the cell-specific reference signals R0 according to TS 36.211 [3] shall be used. If the UE can reliably detect that R1 is available it may use R_1 in addition to R_0 to determine E-UTRA RSRP. If higher layers indicate measurements based on discovery signals, the UE shall measure E-UTRA RSRP in the subframes in the configured discovery signal occasions. For frame structure 1 and 2, if the UE can reliably detect that cell-specific reference signals are present in other subframes, the UE may use those subframes in addition to determine E-UTRA RSRP. The reference point for the E-UTRA RSRP shall be the antenna connector of the UE. If receiver diversity is in use by the UE, the reported value shall not be lower than the corresponding E-UTRA RSRP of any of the individual diversity branches.
Applicable for	RRC_IDLE inter-RAT, RRC_INACTIVE inter-RAT, RRC_CONNECTED inter-RAT

NOTE 1: The number of resource elements within the considered measurement frequency bandwidth and within the measurement period that are used by the UE to determine E-UTRA RSRP is left up to the UE implementation with the limitation that corresponding measurement accuracy requirements have to be fulfilled.

NOTE 2: The power per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

5.1.16 E-UTRA RSRQ

Definition	E-UTRA Reference Signal Received Quality (E-UTRA RSRQ) is defined as the ratio N×E-UTRA RSRP/(E-UTRA carrier RSSI), where N is the number of RBs of the E-UTRA carrier RSSI measurement bandwidth. The measurements in the numerator and denominator shall be made over the same set of resource blocks. E-UTRA Carrier Received Signal Strength Indicator (E-UTRA RSSI), comprises the linear average of the total received power (in [W]) observed only in certain OFDM symbols of measurement subframes, in the measurement bandwidth, over N number of resource blocks by the UE from all sources, including co-channel serving and non-serving cells, adjacent channel interference, thermal noise etc. Unless indicated otherwise by higher layers, E-UTRA RSSI is measured only from OFDM symbols containing reference symbols for antenna port 0 of measurement subframes. If higher layers indicate all OFDM symbols for performing E-UTRA RSRQ measurements, then E-UTRA RSSI is measured from all OFDM symbols of the DL part of measurement subframes. If higher-layers indicate certain subframes for performing E-UTRA RSRQ measurements, then E-UTRA RSSI is measured from all OFDM symbols of the DL part of the indicated subframes. If higher layers indicate measurements based on discovery signals, E-UTRA RSSI is measured from all OFDM symbols of the DL part of the subframes in the configured discovery signal occasions. The reference point for the E-UTRA RSRQ shall be the antenna connector of the UE. If receiver diversity is in use by the UE, the reported value shall not be lower than the corresponding E-UTRA RSRQ of any of the individual diversity branches.
Applicable for	RRC_IDLE inter-RAT, RRC_INACTIVE inter-RAT, RRC_CONNECTED inter-RAT

5.1.17 E-UTRA RS-SINR

Definition	E-UTRA reference signal-signal to noise and interference ratio (E-UTRA RS-SINR), is defined as the linear average over the power contribution (in [W]) of the resource elements carrying cell-specific reference signals divided by the linear average of the noise and interference power contribution (in [W]) over the resource elements carrying cell-specific reference signals within the same frequency bandwidth. For E-UTRA RS-SINR determination, the E-UTRA cell-specific reference signals R_0 according TS 36.211 [13] shall be used. The reference point for the E-UTRA RS-SINR shall be the antenna connector of the UE. If receiver diversity is in use by the UE, the reported value shall not be lower than the corresponding E-UTRA RS-SINR of any of the individual diversity branches. If higher-layer signalling indicates certain subframes for performing E-UTRA RS-SINR measurements, then E-UTRA RS-SINR is measured in the indicated subframes.
Applicable for	RRC_CONNECTED inter-RAT

5.1.18 SS reference signal received power per branch (SS-RSRPB)

Definition	SS reference signal received power per branch (SS-RSRPB) is defined as the linear average over the power contributions (in [W]) of the resource elements that carry secondary synchronization signals (SS). The measurement time resource(s) for SS-RSRPB are confined within SS/PBCH Block Measurement Time Configuration (SMTC) window duration. For SS-RSRPB determination demodulation reference signals for physical broadcast channel (PBCH) in addition to secondary synchronization signals may be used. SS-RSRPB using demodulation reference signal for PBCH shall be measured by linear averaging over the power contributions of the resource elements that carry corresponding reference signals taking into account power scaling for the reference signals as defined in TS 38.213 [5]. SS-RSRPB shall be measured only among the reference signals corresponding to SS/PBCH blocks with the same SS/PBCH block index and the same physical-layer cell identity. If higher-layers indicate certain SS/PBCH blocks for performing SS-RSRPB measurements, then SS-RSRPB is measured only from the indicated set of SS/PBCH block(s). For frequency range 1, SS-RSRPB shall be measured from each antenna connector of the UE. For frequency range 2, SS-RSRPB shall be measured for each receiver branch based on the combined signal from antenna elements corresponding to the receiver branch.
Applicable for	RRC_CONNECTED intra-frequency

NOTE 1: The number of resource elements within the measurement period that are used by the UE to determine SS-RSRPB is left up to the UE implementation with the limitation that corresponding measurement accuracy requirements have to be fulfilled.

NOTE 2: The power per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

NOTE 3: This UE measurement is defined only for conformance test purposes. It is described along with test control entity signalling in [14].

5.1.19 SRS reference signal received power (SRS-RSRP)

Definition	SRS reference signal received power (SRS-RSRP) is defined as linear average of the power contributions (in [W]) of the resource elements carrying sounding reference signals (SRS). SRS-RSRP shall be measured over the configured resource elements within the considered measurement frequency bandwidth in the configured measurement time occasions. For frequency range 1, the reference point for the SRS-RSRP shall be the antenna connector of the UE. For frequency range 2, SRS-RSRP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported SRS-RSRP value shall not be lower than the corresponding SRS-RSRP of any of the individual receiver branches.
Applicable for	RRC_CONNECTED intra-frequency

5.1.20 CLI Received signal strength indicator (CLI-RSSI)

Definition	CLI Received Signal Strength Indicator (CLI-RSSI), is defined as linear average of the total received power (in [W]) observed only in the configured OFDM symbols of the configured measurement time resource(s), in the configured measurement bandwidth from all sources, including co-channel serving and non-serving cells, adjacent channel interference, thermal noise etc. For frequency range 1, the reference point for the RSSI shall be the antenna connector of the UE. For frequency range 2, CLI-RSSI shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported CLI-RSSI value shall not be lower than the corresponding CLI-RSSI of any of the individual receiver branches.
Applicable for	RRC_CONNECTED intra-frequency

5.1.21 Received Signal Strength Indicator (RSSI)

Definition	Received Signal Strength Indicator (RSSI), comprises the linear average of the total received power (in [W]) observed only per configured OFDM symbol and in the measurement bandwidth indicated by higher layers or corresponding to the channel bandwidth defined in Clause 4 of TS 37.213 [17], where the channel has the center frequency configured by *ARFCN-valueNR*, by the UE from all sources, including co-channel serving and non-serving cells, adjacent channel interference, thermal noise etc. Higher layers configure the *ARFCN-valueNR*, the reference numerology and the measurement duration, i.e., which OFDM symbol(s) should be measured by the UE. For frequency range 1, the reference point for the RSSI shall be the antenna connector of the UE. For frequency range 2, RSSI shall be measured for each receiver branch based on the combined signal from antenna elements corresponding to the receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported RSSI value shall not be lower than the corresponding RSSI of any of the individual receiver branches.
Applicable for	RRC_CONNECTED intra-frequency, RRC_CONNECTED inter-frequency

5.1.22 PSBCH reference signal received power (PSBCH-RSRP)

Definition	PSBCH Reference Signal Received Power (PSBCH-RSRP) is defined as the linear average over the power contributions (in [W]) of the resource elements that carry demodulation reference signals associated with physical sidelink broadcast channel (PSBCH). For PSBCH-RSRP sidelink secondary synchronization signals in addition to demodulation reference signals for PSBCH may be used. PSBCH-RSRP using sidelink secondary synchronization signals shall be measured by linear averaging over the power contributions of the resource elements that carry corresponding reference signals. For frequency range 1, the reference point for the PSBCH RSRP shall be the antenna connector of the UE. For frequency range 2, PSBCH-RSRP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported PSBCH-RSRP value shall not be lower than the corresponding PSBCH-RSRP of any of the individual receiver branches.
Applicable for	Sidelink

NOTE 1: The number of resource elements within the considered measurement frequency bandwidth and within the measurement period that are used by the UE to determine PSBCH-RSRP is left up to the UE implementation with the limitation that corresponding measurement accuracy requirements have to be fulfilled.

NOTE 2: The power per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

NOTE 3: It is up to UE implementation to use PSBCH DMRS only or both S-SSS and PSBCH DMRS for PSBCH-RSRP.

5.1.23 PSSCH reference signal received power (PSSCH-RSRP)

Definition	PSSCH Reference Signal Received Power (PSSCH-RSRP) is defined as the linear average over the power contributions (in [W]) of the resource elements of the antenna port(s) that carry demodulation reference signals associated with physical sidelink shared channel (PSSCH), summed over the antenna ports. Demodulation reference signals transmitted on antenna ports 1000 and 1001 shall be used for PSSCH-RSRP determination if two antenna ports are indicated. For frequency range 1, the reference point for the PSSCH-RSRP shall be the antenna connector of the UE. For frequency range 2, PSSCH-RSRP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported PSSCH-RSRP value shall not be lower than the corresponding PSSCH-RSRP of any of the individual receiver branches.
Applicable for	Sidelink

NOTE 1: The power per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

5.1.24 PSCCH reference signal received power (PSCCH-RSRP)

Definition	PSCCH Reference Signal Received Power (PSCCH-RSRP) is defined as the linear average over the power contributions (in [W]) of the resource elements that carry demodulation reference signals associated with physical sidelink control channel (PSCCH). For frequency range 1, the reference point for the PSCCH-RSRP shall be the antenna connector of the UE. For frequency range 2, PSCCH-RSRP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported PSCCH-RSRP value shall not be lower than the corresponding PSCCH-RSRP of any of the individual receiver branches.
Applicable for	Sidelink

NOTE 1: The power per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

5.1.25 Sidelink received signal strength indicator (SL RSSI)

Definition	Sidelink Received Signal Strength Indicator (SL RSSI) is defined as the linear average of the total received power (in [W]) observed in the configured sub-channel in OFDM symbols of a slot configured for PSCCH and PSSCH, starting from the 2nd OFDM symbol. For frequency range 1, the reference point for the SL RSSI shall be the antenna connector of the UE. For frequency range 2, SL RSSI shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported SL RSSI value shall not be lower than the corresponding SL RSSI of any of the individual receiver branches.
Applicable for	Sidelink

5.1.26 Sidelink channel occupancy ratio (SL CR)

Definition	Sidelink Channel Occupancy Ratio (SL CR) evaluated at slot *n* is defined as the total number of sub-channels used for its transmissions in slots [*n-a*, *n-1*] and granted in slots [*n*, *n+b*] divided by the total number of configured sub-channels in the transmission pool over [*n-a*, *n+b*].
Applicable for	Sidelink

NOTE 1: *a* is a positive integer and *b* is 0 or a positive integer; *a* and *b* are determined by UE implementation with $a+b+1$ = 1000 or $1000 \cdot 2^{\mu}$ slots, according to higher layer parameter *sl-TimeWindowSizeCR*, b < (a+b+1)/2, and n+b shall not exceed the last transmission opportunity of the grant for the current transmission.

NOTE 2: SL CR is evaluated for each (re)transmission.

NOTE 3: In evaluating SL CR, the UE shall assume the transmission parameter used at slot *n* is reused according to the existing grant(s) in slot [*n+1*, *n+b*] without packet dropping.

NOTE 4: The slot index is based on physical slot index.

NOTE 5: SL CR can be computed per priority level

NOTE 6: A resource is considered granted if it is a member of a selected sidelink grant as defined in TS 38.321 [7].

5.1.27 Sidelink channel busy ratio (SL CBR)

Definition	SL Channel Busy Ratio (SL CBR) measured in slot *n* is defined as the portion of sub-channels in the resource pool whose SL RSSI measured by the UE exceed a (pre-)configured threshold provided by the higher layer parameter *sl-ThreshS-RSSI-CBR* sensed over a CBR measurement window [*n-a*, *n*-1], wherein *a* is equal to 100 or $100 \cdot 2^{\mu}$ slots, according to higher layer parameter *sl-TimeWindowSizeCBR*. When UE is configured to perform partial sensing by higher layers (including when SL DRX is configured), SL RSSI is measured in slots where the UE performs partial sensing and where the UE performs PSCCH/PSSCH reception within the CBR measurement window. The calculation of SL CBR is limited within the slots for which the SL RSSI is measured. If the number of SL RSSI measurement slots within the CBR measurement window is below a (pre-)configured threshold, a (pre-)configured SL CBR value is used.
Applicable for	Sidelink

NOTE 1: The slot index is based on physical slot index.

5.1.28 DL PRS reference signal received power (DL PRS-RSRP)

Definition	DL PRS reference signal received power (DL PRS-RSRP), is defined as the linear average over the power contributions (in [W]) of the resource elements that carry DL PRS reference signals configured for RSRP measurements within the considered measurement frequency bandwidth. For frequency range 1, the reference point for the DL PRS-RSRP shall be the antenna connector of the UE. For frequency range 2, DL PRS-RSRP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported DL PRS-RSRP value shall not be lower than the corresponding DL PRS-RSRP of any of the individual receiver branches.
Applicable for	RRC_CONNECTED, RRC_INACTIVE

5.1.29 DL reference signal time difference (DL RSTD)

Definition	DL reference signal time difference (DL RSTD) is the DL relative timing difference between the Transmission Point (TP) [18] *j* and the reference TP *i*, defined as $T_{SubframeRxj} – T_{SubframeRxi}$, Where: $T_{SubframeRxj}$ is the time when the UE receives the start of one subframe from TP *j*. $T_{SubframeRxi}$ is the time when the UE receives the corresponding start of one subframe from TP *i* that is closest in time to the subframe received from TP *j*. Multiple DL PRS resources can be used to determine the start of one subframe from a TP. For frequency range 1, the reference point for the DL RSTD shall be the antenna connector of the UE. For frequency range 2, the reference point for the DL RSTD shall be the antenna of the UE.
Applicable for	RRC_CONNECTED, RRC_INACTIVE

5.1.30 UE Rx – Tx time difference

Definition	The UE Rx – Tx time difference is defined as $T_{UE-RX} – T_{UE-TX}$ Where: T_{UE-RX} is the UE received timing of downlink subframe #*i* from a Transmission Point (TP) [18], defined by the first detected path in time. T_{UE-TX} is the UE transmit timing of uplink subframe #*j* that is closest in time to the subframe #i received from the TP. Multiple DL PRS or CSI-RS for tracking resources, as instructed by higher layers, can be used to determine the start of one subframe of the first arrival path of the TP. For frequency range 1, the reference point for T_{UE-RX} measurement shall be the Rx antenna connector of the UE and the reference point for T_{UE-TX} measurement shall be the Tx antenna connector of the UE. For frequency range 2, the reference point for T_{UE-RX} measurement shall be the Rx antenna of the UE and the reference point for T_{UE-TX} measurement shall be the Tx antenna of the UE.
Applicable for	RRC_CONNECTED, RRC_INACTIVE

5.1.31 SS reference signal antenna relative phase (SS-RSARP)

Definition	SS reference signal antenna relative phase (SS-RSARP) is defined as the difference of the average phase of the receive signals on the resource elements that carry secondary synchronization signals (SS) received by the reference individual receiver branch (Rx0) and the average phase of the receive signals on the resource elements that carry secondary synchronization signals (SS) received by one other individual receiver branch (Rx1 ... Rxn). The measurement time resource(s) for SS-RSARP are confined within SS/PBCH Block Measurement Time Configuration (SMTC) window duration. SS-RSARP shall be measured only among the reference signals corresponding to SS/PBCH blocks with the same SS/PBCH block index and the same physical-layer cell identity. If higher-layers indicate certain SS/PBCH blocks for performing SS-RSARP measurements, then SS-RSARP is measured only from the indicated set of SS/PBCH block(s). For frequency range 1, the reference point for the SS-RSARP shall be the antenna connector of the UE. For frequency range 2, SS-RSARP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch.
Applicable for	RRC_CONNECTED intra-frequency

NOTE 1: The number of resource elements within the measurement period that are used by the UE to determine SS-RSARP is left up to the UE implementation with the limitation that corresponding measurement accuracy requirements have to be fulfilled.

NOTE 2: The phase per resource element is determined from the energy received during the useful part of the symbol, excluding the CP.

NOTE 3: This UE measurement is defined only for conformance test purposes. It is described along with test control entity signalling in [14].

5.1.32 UTRA FDD CPICH RSCP

Definition	Received Signal Code Power, the received power on one code measured on the Primary CPICH. The reference point for the RSCP shall be the antenna connector of the UE. If Tx diversity is applied on the Primary CPICH the received code power from each antenna shall be separately measured and summed together in [W] to a total received code power on the Primary CPICH. If receiver diversity is in use by the UE, the reported value shall not be lower than the corresponding CPICH RSCP of any of the individual receive antenna branches.
Applicable for	RRC_CONNECTED inter-RAT

5.1.33 UTRA FDD carrier RSSI

Definition	The received wide band power, including thermal noise and noise generated in the receiver, within the bandwidth defined by the receiver pulse shaping filter. The reference point for the measurement shall be the antenna connector of the UE. If receiver diversity is in use by the UE, the reported value shall not be lower than the corresponding UTRA carrier RSSI of any of the individual receive antenna branches.
Applicable for	RRC_CONNECTED inter-RAT

NOTE: This definition does not correspond to a reported measurement. This definition is just an intermediate definition used in the definition of UTRA FDD CPICH Ec/No.

5.1.34 UTRA FDD CPICH Ec/No

Definition	The received energy per chip divided by the power density in the band. If receiver diversity is not in use by the UE, the CPICH Ec/No is identical to CPICH RSCP/UTRA Carrier RSSI. Measurement shall be performed on the Primary CPICH. The reference point for the CPICH Ec/No shall be the antenna connector of the UE. If Tx diversity is applied on the Primary CPICH the received energy per chip (Ec) from each antenna shall be separately measured and summed together in [Ws] to a total received chip energy per chip on the Primary CPICH, before calculating the Ec/No. If receiver diversity is in use by the UE, the measured CPICH Ec/No value shall not be lower than the corresponding CPICH $RSCP_i$/UTRA Carrier $RSSI_i$ of receive antenna branch *i*.
Applicable for	RRC_CONNECTED inter-RAT

5.1.35 DL PRS reference signal received path power (DL PRS-RSRPP)

Definition	DL PRS reference signal received path power (DL PRS-RSRPP), is defined as the power of the linear average of the channel response at the i-th path delay of the resource elements that carry DL PRS signal configured for the measurement, where DL PRS-RSRPP for the 1st path delay is the power contribution corresponding to the first detected path in time. For frequency range 1, the reference point for the DL PRS-RSRPP shall be the antenna connector of the UE. For frequency range 2, DL PRS-RSRPP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE for DL PRS-RSRPP measurements, the reported DL PRS-RSRPP value included in the higher layer parameter *NR-DL-AoD-MeasElement* for the first and additional measurements shall be provided for the same receiver branch(es) as applied for DL PRS-RSRP measurements.
Applicable for	RRC_CONNECTED, RRC_INACTIVE

5.2 NG-RAN measurement abilities

The structure of the table defining a NG-RAN measurement quantity is shown below.

Column field	Comment
Definition	Contains the definition of the measurement.

5.2.1 SSS transmit power

Definition	SSS transmit power is determined as the linear average over the power contributions (in [W]) of the resource elements that carry secondary synchronization signals within the secondary synchronization signal (SSS) bandwidth. For downlink reference signal transmit power determination the secondary synchronization signal according TS 38.211 [4] can be used. For frequency range 1, the reference point for the downlink reference signal power measurement shall be the transmit antenna connector.

5.2.2 UL Relative Time of Arrival ($T_{UL-RTOA}$)

Definition	The UL Relative Time of Arrival ($T_{UL-RTOA}$) is the beginning of subframe *i* containing SRS received in Reception Point (RP) [18] *j*, relative to the RTOA Reference Time [16]. The UL RTOA reference time is defined as $T_0 + t_{\mathrm{SRS}}$, where - T_0 is the nominal beginning time of SFN 0 provided by SFN Initialization Time [15, TS 38.455] - $t_{\mathrm{SRS}} = (10n_{\mathrm{f}} + n_{\mathrm{sf}}) \times 10^{-3}$, where n_{f} and n_{sf} are the system frame number and the subframe number of the SRS, respectively. Multiple SRS resources can be used to determine the beginning of one subframe containing SRS received at a RP. The reference point for $T_{UL-RTOA}$ shall be: - for type 1-C base station TS 38.104 [9]: the Rx antenna connector, - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna), - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector.

5.2.3 gNB Rx – Tx time difference

Definition	The gNB Rx – Tx time difference is defined as $T_{gNB-RX} - T_{gNB-TX}$ Where: T_{gNB-RX} is the Transmission and Reception Point (TRP) [18] received timing of uplink subframe #*i* containing SRS associated with UE, defined by the first detected path in time. T_{gNB-TX} is the TRP transmit timing of downlink subframe #*j* that is closest in time to the subframe #*i* received from the UE. Multiple SRS resources can be used to determine the start of one subframe containing SRS. The reference point for T_{gNB-RX} shall be: - for type 1-C base station TS 38.104 [9]: the Rx antenna connector, - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna), - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector. The reference point for T_{gNB-TX} shall be: - for type 1-C base station TS 38.104 [9]: the Tx antenna connector, - for type 1-O or 2-O base station TS 38.104 [9]: the Tx antenna (i.e. the centre location of the radiating region of the Tx antenna), - for type 1-H base station TS 38.104 [9]: the Tx Transceiver Array Boundary connector.

5.2.4 UL Angle of Arrival (UL AoA)

Definition	UL Angle of Arrival (UL AoA) is defined as the estimated azimuth angle (A-AoA) and vertical angle (Z-AoA) of a UE with respect to a reference direction, wherein the reference direction is defined: - In the global coordinate system (GCS), wherein estimated azimuth angle is measured relative to geographical North and is positive in a counter-clockwise direction and estimated vertical angle is measured relative to zenith and positive to horizontal direction - In the local coordinate system (LCS), wherein estimated azimuth angle is measured relative to x-axis of LCS and positive in a counter-clockwise direction and estimated vertical angle is measured relative to z-axis of LCS and positive to x-y plane direction. The bearing, downtilt and slant angles of LCS are defined according to TS 38.901 [15]. The UL-AoA is determined at the gNB antenna for an UL channel corresponding to this UE.

5.2.5 UL SRS reference signal received power (UL SRS-RSRP)

Definition	UL SRS reference signal received power (UL SRS-RSRP) is defined as linear average of the power contributions (in [W]) of the resource elements carrying sounding reference signals (SRS). UL SRS-RSRP shall be measured over the configured resource elements within the considered measurement frequency bandwidth in the configured measurement time occasions. The reference point for UL SRS-RSRP shall be: - for type 1-C base station TS 38.104 [9]: the Rx antenna connector, - for type 1-O or 2-O base station TS 38.104 [9]: based on the combined signal from antenna elements corresponding to a given receiver branch, - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector. For frequency range 1 and 2, if receiver diversity is in use by the gNB, the reported UL SRS-RSRP value shall not be lower than the corresponding UL SRS-RSRP of any of the individual receiver branches.

5.2.6 UL SRS reference signal received path power (UL SRS-RSRPP)

Definition	UL SRS reference signal received path power (UL SRS-RSRPP) is defined as the power of the linear average of the channel response at the i-th path delay of the resource elements that carry the received UL SRS signal configured for the measurement, where UL SRS-RSRPP for 1st path delay is the power contribution corresponding to the first detected path in time The reference point for UL SRS-RSRPP shall be: - for type 1-C base station TS 38.104 [9]: the Rx antenna connector, - for type 1-O or 2-O base station TS 38.104 [9]: based on the combined signal from antenna elements corresponding to a given receiver branch - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector. For frequency range 1 and 2, if receiver diversity is in use by the gNB for UL SRS-RSRPP measurements: - The reported UL SRS-RSRPP value for the first and additional paths shall be provided for the same receiver branch(es) as applied for UL SRS-RSRP measurements, or - The reported UL SRS-RSRPP value for the first path shall not be lower than the corresponding UL SRS-RSRPP for the first path of any of the individual receiver branches and the reported UL SRS-RSRPP for the additional paths shall be provided for the same receiver branch(es) as applied UL SRS-RSRPP for the first path.

5.2.7 Timing advance (T_{ADV})

Definition	Timing advance (T_{ADV}) is defined as the time difference $T_{ADV} = (T_{gNB-RX} – T_{gNB-TX})$, Where: T_{gNB-RX} is the Transmission and Reception Point (TRP) [18] received timing of uplink subframe #*i* containing PRACH transmitted from UE, defined by the first detected path in time. T_{gNB-TX} is the TRP transmit timing of downlink subframe #*j* that is closest in time to the subframe #*i* received from the UE. The detected PRACH is used to determine the start of one subframe containing that PRACH. The reference point for T_{gNB-RX} shall be: - for type 1-C base station TS 38.104 [9]: the Rx antenna connector, - for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna), - for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector. The reference point for T_{gNB-TX} shall be: - for type 1-C base station TS 38.104 [9]: the Tx antenna connector, - for type 1-O or 2-O base station TS 38.104 [9]: the Tx antenna (i.e. the centre location of the radiating region of the Tx antenna), - for type 1-H base station TS 38.104 [9]: the Tx Transceiver Array Boundary connector.

Annex A:
Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2017-05	RAN1#89	R1-1709124				Draft skeleton	0.0.0
2017-07	AH_NR2	R1-1712017				Inclusion of agreements up to and including RAN1 NR Ad-Hoc #2	0.0.1
2017-08	RAN1#90	R1-1714100				Updates according to email discussion " [NRAH2-03-215] TS 38.215	0.0.2
2017-08	RAN1#90	R1-1714660				Clean version	0.1.0
2017-08	RAN1#90	R1-1715325				Inclusion of agreements from RAN1#90	0.1.1
2017-08	RAN1#90	R1-1715333				Updates according to email discussion " [90-23-215] TS 38.215"	0.1.2
2017-09	RAN#77	RP-171999				For information to plenary	1.0.0
2017-09	AH_NR3	R1-1716931				Inclusion of agreements up to and including RAN1 NR Ad-Hoc #3	1.0.1
2017-09	RAN1#90bis	R1-1719108				Clean version	1.1.0
2017-11	RAN1#90bis	R1-1719228				Inclusion of agreements up to and including RAN1#90bis	1.1.1
2017-11	RAN1#90bis	R1-1719244				Updates according to email discussion " [90b-NR-01-38.215] "	1.1.2
2017-11	RAN1#91	R1-1721052				Clean version	1.2.0
2017-12	RAN1#91	R1-1721345				Inclusion of agreements up to and including RAN1#91	1.3.0
2017-12	RAN#78	RP-172296				Endorsed version for approval by plenary	2.0.0
2017-12	RAN#78					Approved by plenary – Rel-15 spec under change control	15.0.0
2018-03	RAN#79	RP-180200	0002	-	F	CR capturing the Jan18 ad-hoc and RAN1#92 meeting agreements	15.1.0
2018-06	RAN#80	RP-181172	0003	1	F	CR to 38.215 capturing the RAN1#92bis and RAN1#93 meeting agreements	15.2.0
2018-09	RAN#81	RP-181789	0004	-	F	CR to 38.215 capturing the RAN1#94 meetings agreements	15.3.0
2018-12	RAN#82	RP-182523	0005	3	F	Combined CR of all essential corrections to 38.215 from RAN1#94bis and RAN1#95	15.4.0
2019-06	RAN#84	RP-191278	0006	-	F	CR on SFTD measurements for NE-DC	15.5.0
2019-06	RAN#84	RP-191278	0007	-	F	Correction on SFTD measurement for NR-DC (Late drop)	15.5.0
2019-12	RAN#86	RP-192628	0010	-	F	Correction of RSTD measurement for E-UTRA	15.6.0
2019-12	RAN#86	RP-192628	0012	-	F	Corrections to SFTD measurement	15.6.0
2019-12	RAN#86	RP-192634	0008	1	B	Introduction of cross layer interference measurements	16.0.0
2019-12	RAN#86	RP-192636	0013	-	B	Introduction of NR-based access to unlicensed spectrum	16.0.0
2019-12	RAN#86	RP-192638	0014	-	B	Introduction of V2X support	16.0.0
2019-12	RAN#86	RP-192641	0015	-	B	Introduction of MIMO enhancements	16.0.0
2019-12	RAN#86	RP-192643	0016	-	B	Introduction of NR positioning support	16.0.0
2020-01						MCC clean-up fixing font issue in clauses 5.2.2/5.2.3 and 5.2.4.	16.0.1
2020-03	RAN#87-e	RP-200190	0017		F	Corrections to L1-SINR definitions	16.1.0
2020-03	RAN#87-e	RP-200192	0018		F	Corrections to NR positioning support	16.1.0
2020-03	RAN#87-e	RP-200183	0019		F	Corrections to cross layer interference measurements	16.1.0
2020-03	RAN#87-e	RP-200187	0020		F	Corrections to V2X measurement definitions	16.1.0

2020-06	RAN#88-e	RP-200707	0021	1	B	Introduction of NR ATF measurements	16.2.0
2020-06	RAN#88-e	RP-200683	0023	-	A	Correction on SS-RSRPB measurement	16.2.0
2020-06	RAN#88-e	RP-200692	0024	-	F	Corrections to CSI-SINR definition	16.2.0
2020-06	RAN#88-e	RP-200694	0025	1	F	Correction to UL Relative Time of Arrival definition	16.2.0
2020-06	RAN#88-e	RP-200687	0026	-	F	Corrections to RSSI definition for NR-U	16.2.0
2020-06	RAN#88-e	RP-200706	0027	-	B	Introduction of UE UTRAN FDD measurements for SRVCC from NR to UMTS	16.2.0
2020-06	RAN#88-e	RP-200689	0028	-	F	Corrections to V2X measurement definitions	16.2.0
2020-06	RAN#88-e	RP-200694	0029	-	F	Corrections to intra/inter-frequency measurement for NR positioning	16.2.0
2020-09	RAN#89-e	RP-201824	0030	1	F	Correction of SS-RSARP definition	16.3.0
2020-09	RAN#89-e	RP-201807	0031	-	F	Corrections to V2X measurement definitions	16.3.0
2020-09	RAN#89-e	RP-201809	0032	-	F	Corrections to CSI-SINR definition	16.3.0
2020-09	RAN#89-e	RP-201811	0033	-	F	Corrections to NR positioning measurement definitions	16.3.0
2020-12	RAN#90-e	RP-202398	0034	-	F	Alignment of RRC parameter names	16.4.0
2021-12	RAN#94-e	RP-212967	0036	-	B	Introduction of NR extensions to 71 GHz	17.0.0
2021-12	RAN#94-e	RP-212970	0037	-	B	Introduction of NR positioning enhancements	17.0.0
2021-12	RAN#94-e	RP-212968	0039	-	B	Introduction of enhanced Industrial Internet of Things (IoT) and ultra-reliable and low latency communication (URLLC) support for NR	17.0.0
2022-03	RAN#95-e	RP-220862	0038	2	B	Introduction of Timing advance (TA) PRACH based solution for NR UL E-CID [NRTADV]	17.1.0
2022-03	RAN#95-e	RP-220273	0041	-	A	CR on reference point for UL SRS-RSRP	17.1.0
2022-03	RAN#95-e	RP-220254	0042	-	F	Corrections to DL PRS-RSRPP and UL SRS-RSRPP measurement definitions	17.1.0
2022-03	RAN#95-e	RP-220251	0043	-	F	Corrections to SS-RSRQ and RSSI measurement definitions	17.1.0
2022-03	RAN#95-e	RP-220262	0044	-	F	Corrections to SL CBR measurement definition	17.1.0
2022-09	RAN#97-e	RP-222404	0045	-	F	CR on PRS RSRPP reporting for 38.215	17.2.0
2023-03	RAN#99	RP-230445	0047	-	A	Alignment CR for AOA positioning in 38.215	17.3.0
2023-12	RAN#102	RP-233723	0052	-	A	Alignment CR for AOA positioning in 38.215	17.4.0
2023-12	RAN#102	RP-233723	0055	-	A	Corrections to Applicable RRC States for Sidelink Measurements	17.4.0
2023-12	RAN#102	RP-233723	0058	-	A	CR on applicability of sidelink measurements	17.4.0

History

Document history		
V17.1.0	April 2022	Publication
V17.2.0	September 2022	Publication
V17.3.0	April 2023	Publication
V17.4.0	February 2024	Publication