Qualcomm Technologies, Inc.

LGE portable handset (FCC ID: ZNFV450VM) RF Exposure Compliance Test Report

(Part 2: Test Under Dynamic Transmission Scenario)

80-W5668-1 Rev. D

June 5, 2019

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Revision history

Revision	Date	Description
A	May 2019	Initial release of ‘Regular’ distribution version of 80-W5665-4
B	May 2019	Updated MPE report number
C	May 2019	Editorial changes based on FCC/TCB comments
D	June 2019	Corrected typos in Bibliography and Appendix A.2.2

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1 Introduction on Compliance Demonstration with Qualcomm® Smart Transmit Algorithm

The FCC RF exposure limits, i.e., SAR limit and Power Density (PD) limit, are defined based on time-averaged RF exposure. Therefore, to demonstrate the compliance, the maximum time-averaged exposure needs to be below the corresponding limits.

The equipment under test (EUT) is LGE portable handset (FCC ID: ZNFV450VM), it contains:

1. Qualcomm® SM8150 modem supporting 2G/3G/4G WWAN technologies
2. Qualcomm® SDX50 modem supporting 5G mmW NR 28GHz and 39GHz bands.
3. WLAN/BT

Both of Qualcomm® SM8150 and SDX50 modems are enabled with Qualcomm® Smart Transmit feature. This feature performs time averaging algorithm in real time to control and manage transmitting power and ensure the time-averaged RF exposure in compliance with FCC requirements all the time. The following section provides the overview of Qualcomm® Smart Transmit.

The WLAN/BT is not enabled with Smart Transmit.

Demonstrating compliance of LGE portable handset (FCC ID: ZNFV450VM) with Qualcomm Smart Transmit feature is completed in two parts:

1. **RF Exposure Compliance Test Report Part 1: Test in Static Transmission Scenario**

   The purpose of Part 1 test is to demonstrate that the EUT meets FCC SAR and PD limits when transmitting at maximum allowable time-averaged power levels, or maximum RF tune-up power levels if the maximum allowable time-averaged power levels are higher than the maximum RF tune-up power levels (as is the case for this EUT) in static transmission scenario. The compliance under static transmission condition is demonstrated via PCTEST reports [B1, B2]*.

2. **RF Exposure Compliance Test Report Part 2: Test in Dynamic Transmission Scenario**

   The purpose of this Part 2 report is to demonstrate the EUT complies with FCC RF exposure requirement under Tx varying transmission scenarios, thereby validity of Qualcomm Smart Transmit feature for FCC equipment authorization of LGE portable handset (FCC ID: ZNFV450VM).

*Refer to PCTEST reports listed in Bibliography for device description.

2 Overview of Qualcomm® Smart Transmit

2.1 Algorithm description

The FCC RF exposure limit is defined based on time-averaged RF exposure. When running in a wireless device, Qualcomm Smart Transmit algorithm enables *more elegant* power control mechanisms for RF exposure management. It ensures at all times the wireless device is in compliance with the FCC limit of RF exposure time-averaged over a defined time window, denoted as T_{SAR} and T_{PD} for specific absorption rate (SAR for transmit frequency < 6 GHz) and power density (PD for transmit frequency > 6 GHz) time windows, respectively.

The Smart Transmit algorithm not only ensures the wireless device complies with RF exposure requirement, but also improves the user experience and network performance.

For a given wireless device, RF exposure is proportional to the transmitting power.

- Once the SAR and PD of the wireless device is characterized at a transmit power level, RF exposure at a different power level for the characterized configurations can be scaled by the change in the corresponding power level.
- Therefore, for a characterized device, RF exposure compliance can be achieved through transmit power control and management.

The Smart Transmit algorithm embedded in Qualcomm modems reliably controls the transmit power of the wireless device in real time to maintain the time-averaged transmit power, in turn, time-averaged RF exposure, below the predefined time-averaged power limit for each characterized technology and band.

- This predefined time-averaged power limit is derived and determined in Part 1 PCTEST reports (i.e., [B1] & [B2]).
- This predefined time-averaged power limit is denoted as P_{limit} corresponding to *SAR_design_target* (< FCC SAR limit, SAR_{limit}, for frequency < 6 GHz) and *input.power.limit* corresponding *PD_design_target* (<FCC PD limit, PD_{limit}, for frequency > 6 GHz) in this report.
- The wireless device continuously transmitting at P_{limit} level or *input.power.limit* level complies with the FCC RF exposure requirement.

In a simultaneous transmission scenario, the algorithm manages all active transmitters and make sure the total exposure ratio from each transmitter does not exceed 1.

2.2 Basic concept of the algorithm

The Smart Transmit algorithm controls and manages the instantaneous transmit power (Tx) to maintain the time-averaged Tx power (in turn, time-averaged RF exposure) in compliance with FCC limits.

- If time-averaged transmit power approaches the P_{limit}, then the modem needs to limit instantaneous transmit power to ensure the time-averaged transmit power does not exceed the

P_{limit} or *input.power.limit* in any T_{SAR} and T_{PD} time windows (i.e., the time-averaged RF exposure complies with the FCC RF exposure limit in any T_{SAR} or T_{PD} time window).

- The wireless device can instantaneously transmit at high transmit powers and exceed the P_{limit} or *input.power.limit* level for a short duration before limiting the power to maintain the time-averaged transmit power under P_{limit} or *input.power.limit*.
- If the wireless device transmits at high power for a long time, then the radio link needs to be dropped to be compliant with time-averaged Tx power requirement (see Figure 2-1).
- To avoid dropping the radio link, Smart Transmit algorithm starts the power limiting enforcement earlier in time to back off the Tx power to a reserve level (denoted as $P_{reserve}$), so the wireless device can maintain the radio link at a minimum reserve power level for as long as needed, and at the same time ensure the time-averaged Tx power over any defined time window is less than P_{limit} at all times (see Figure 2-2). At all times, Smart Transmit meets the below equation:

$$time.avg.Tx\ power = \frac{1}{T_{SAR}} \int_{t-T_{SAR}}^{t} inst.Tx\ power(t)\, dt \leq P_{limit}$$

where, $time.avg.Tx\ power$ is the transmit power averaged between t-T_{SAR} and t time period; T_{SAR} is the time window defined by FCC for time-averaging RF exposure for Tx frequency less than 6GHz (sub6); *inst. Tx power (t)* is the instantaneous transmit power at t time instant; P_{limit} is the predefined time-averaged power limit. Similarly, Smart Transmit meets the below equation for mmW transmission:

$$mmW\_time.avg.Tx\ power = \frac{1}{T_{PD}} \int_{t-T_{PD}}^{t} mmW\_Tx\ power(t)\, dt \leq input.power.limit$$

where, $mmW\_time.avg.Tx\ power$ is the mmW transmit power averaged between t-T_{PD} and t time period; T_{PD} is the time window defined by FCC for time-averaging RF exposure for mmW bands; *mmW_Tx power (t)* is the instantaneous mmW transmit power at t time instant; $input.power.limit$ is the predefined time-averaged power limit for the beam under test.

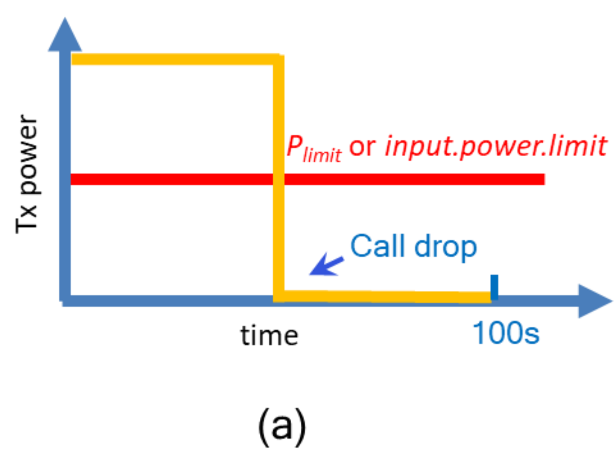
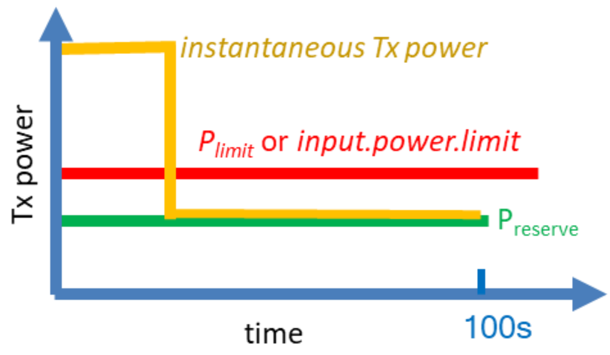


Figure 2-1 Transmit at high power when needed and permitted



(b)

Figure 2-2 Transmit with reserve power to support continuous transmission at a minimum power level ($P_{reserve}$)

- In the case of simultaneous transmission, Smart Transmit manages all active transmitters and make sure the total exposure ratio is less than 1, i.e.,

$$\sum \frac{\frac{1}{T_{SAR}}\int_{t-T_{SAR}}^{t} SAR(t)\,dt}{FCC\ SAR\ limit} + \sum \frac{\frac{1}{T_{PD}}\int_{t-T_{PD}}^{t} 4cm^2 PD(t)\,dt}{FCC\ PD\ limit} \leq 1$$

2.3 Configurable parameters

The following input parameters are required for functionality of Qualcomm Smart Transmit algorithm. These parameters cannot be accessed by the end user, because at the factory they are entered through the embedded file system (EFS) entries by the OEM

- Regulatory body

  The *regulatory body* entry should be filled out with either 0 or "1" to correspond to the FCC or ICNIRP requirement, so that Smart Transmit algorithm can select the appropriate averaging time windows. For FCC, Smart Transmit uses 100 seconds averaging window for transmit frequencies f<3GHz, 60 seconds for 3GHz < f < 6GHz, and 4 seconds for 24GHz < f < 42GHz.

- *Tx_power_at_SAR_design_target* (P_{limit} in dBm) for Tx transmitting frequency < 6GHz

  The maximum time-averaged transmit power, in dBm, at which this radio configuration (i.e., band and technology) reaches the *SAR_design_target*. This *SAR_design_target* is pre-determined for the specific device and it shall be less than regulatory SAR limit after accounting for all design related tolerances. The time-averaged SAR is assessed against this *SAR_design_target* in real time to determine the compliance. The P_{limit} could vary with technology, band and DSI (device state index), therefore it has the unique value for each technology, band and DSI.

- *Reserve_power_margin* (dB)

  The margin, in dB, below the P_{limit} to reserve for future transmission with a minimum transmit power ($P_{reserve}$):

  $P_{reserve}$ (dBm) = P_{limit} (dBm) – *Reserve_power_margin* (dB)

When the *Reserve_power_margin* is set to zero dB, Smart Transmit effectively limits the upper bound of wireless device transmit power to P_{limit}, in other words, the wireless device transmits continuously at P_{limit}, and in this case, Smart Transmit dynamic control feature is not utilized.

- *input.power.limit* (dBm) for Tx transmitting frequency ≥ 6GHz

  The maximum time-averaged power at the input of antenna element port, in dBm, at which each antenna configuration (i.e., each beam) meets the *PD_design_target* that is less than the regulatory power density limit after accounting for all design related tolerances.

3 Qualcomm® Smart Transmit Parameters

For LGE portable handset (FCC ID: ZNFV450VM), the *SAR_design_target* is 1.3 W/kg after accounting for 0.7dB of total design-related uncertainty for sub-6 radio; *PD_design_target* is 5 W/m2 after accounting for 2.8dB of total design-related uncertainty for 5G mmW NR. The *reserve_power_margin* is 3dB.

3.1 Qualcomm Smart Transmit parameters for the 4G modem

The following input parameters (*regulatory body*, P_{limit} and *Reserve_power_margin*) are populated via the EFS entry for this EUT and cannot be accessed by the end user. The P_{limit} levels are derived and extracted from PCTEST SAR report [B1].

Table 3-1 Smart Transmit EFS entries for sub-6 WWAN bands

Regulatory requirement:	FCC		max RF tune-up power (not part of Smart Tranmsit settings)	
Reserve_power_margin (dB):	3			
DSI:	0	1	0	1
Tech/Band, Antenna	***Plimit* (dBm)**		***Pmax* (dBm)**	
LTE B13, Ant 1	26.5	26.5	25.5	25.5
LTE B5, Ant 1	26.5	26.5	25.5	25.5
LTE B4, Ant 2	26.5	24.8	25.2	23.7
LTE B66, Ant 2	26.5	24.8	25.2	23.7
LTE B2, Ant 2	25.9	25.3	25.2	23.7
LTE B48, Ant 8	22.7	22.7	21.7	21.7
GSM850 Ant 1	25.5	25.5	24.5 (GSM); 24.5 (GMSK 1-slot); 23.3 (GMSK 2-slot); 17.8 (8-PSK 1-slot); 20.8 (8-PSK 2-slot)	
GSM1900 Ant 2	23.0	23.0	22.0 (GSM); 22.0 (GMSK 1-slot); 21.3 (GMSK 2-slot); 16.8 (8-PSK 1-slot); 19.8 (8-PSK 2-slot)	
WCDMA V (850), Ant 1	26.5	26.5	25.5	25.5
WCDMA II (1900), Ant 2	26.2	25.6	25.2	23.7

Notes:

1. For LTE TDD and GSM technologies, the P_{max} power listed in Table 3-1 is in terms of averaged power.
2. As can be observed from above table, $P_{limit} \geq P_{max}$ (i.e., *SAR_design_target* ≥ SAR @ P_{max}) for all the supported 2G/3G/4G WWAN technologies/bands, therefore, in this particular scenario, transmitting at P_{max} will correspond to SAR level that is lower than

SAR_design_target threshold. Thus, power limiting is not triggered in Smart Transmit operation due to SAR-below-threshold when only 2G/3G/4G radio is active.

3. The highest *reported* SAR listed in PCTEST SAR report [B1] is 1.07mW/g. It can be calculated that all P_{limit} values in Smart Transmit EFS entries, as shown in Table 3-1, correspond to 1.07mW/g or less.
   a. DSI=0: corresponds to head SAR, body-worn SAR, hotspot SAR and extremity SAR at larger separation distances that do not trigger the proximity sensor. Minimum P_{limit} out of all these scenarios is used as input in the EFS.
   b. DSI=1: corresponds to proximity sensor being triggered, i.e., extremity SAR at 0mm. The corresponding P_{limit} is used as input in the EFS.

3.2 Qualcomm Smart Transmit parameters for the 5G modem

The *input.power.limit* parameter for 5G mmW NR radio are populated via EFS entry into the EUT, and cannot be accessed by the end user. The *input.power.limit* is derived and extracted from PCTEST Power Density report [B2].

Table 3-2 Smart Transmit EFS entries for mmW WWAN bands

n260 mmW band				n261 mmW band		
Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)		Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
	0	-0.2			0	0.2
	1	-0.2			1	0.2
	2	-0.2			2	0.2
	3	-0.2			3	0.2
	4	-0.2			4	0.2
	5	-0.2			5	0.2
	6	-0.2			6	0.2
	7	-0.2			7	0.2
	8	-0.2			8	0.2
	9	-0.2			9	0.2
	10	-0.2			10	0.2
	11	-0.2			11	0.2
	12	-0.2			12	0.2
	13	-0.2			13	0.2
	14	-0.2			14	0.2
	15	-0.2			15	0.2
	16	-0.2			16	0.2
	17	-0.2			17	0.2
	18	-0.2			18	0.2
	19	-0.2			19	0.2
	20	-0.2			20	0.2
	21	-0.2			21	0.2
	22	-0.2			22	0.2
	23	-0.2			23	0.2
	24	-0.2			24	0.2
	25	-0.2			25	0.2
	26	-0.2			26	0.2
	27	-0.2			27	0.2
	28	-0.2			28	0.2
	29	-0.2			29	0.2
	128	-0.2			128	0.2

n260 mmW band		
Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
	129	-0.2
	130	-0.2
	131	-0.2
	132	-0.2
	133	-0.2
	134	-0.2
	135	-0.2
	136	-0.2
	137	-0.2
	138	-0.2
	139	-0.2
	140	-0.2
	141	-0.2
	142	-0.2
	143	-0.2
	144	-0.2
	145	-0.2
	146	-0.2
	147	-0.2
	148	-0.2
	149	-0.2
	150	-0.2
	151	-0.2
	152	-0.2
	153	-0.2
	154	-0.2
	155	-0.2
	156	-0.2
	157	-0.2
128	0	-0.2
129	1	-0.2
130	2	-0.2

n261 mmW band		
Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
	129	0.2
	130	0.2
	131	0.2
	132	0.2
	133	0.2
	134	0.2
	135	0.2
	136	0.2
	137	0.2
	138	0.2
	139	0.2
	140	0.2
	141	0.2
	142	0.2
	143	0.2
	144	0.2
	145	0.2
	146	0.2
	147	0.2
	148	0.2
	149	0.2
	150	0.2
	151	0.2
	152	0.2
	153	0.2
	154	0.2
	155	0.2
	156	0.2
	157	0.2
128	0	0.2
129	1	0.2
132	2	0.2

n260 mmW band				n261 mmW band		
Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)		Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
131	3	-0.2		131	3	0.2
132	4	-0.2		130	4	0.2
134	5	-0.2		133	5	0.2
133	6	-0.2		134	6	0.2
135	7	-0.2		135	7	0.2
137	8	-0.2		137	8	0.2
136	9	-0.2		136	9	0.2
139	10	-0.2		138	10	0.2
138	11	-0.2		139	11	0.2
140	12	-0.2		144	12	0.2
141	13	-0.2		142	13	0.2
142	14	-0.2		141	14	0.2
144	15	-0.2		140	15	0.2
143	16	-0.2		143	16	0.2
146	17	-0.2		145	17	0.2
147	18	-0.2		147	18	0.2
145	19	-0.2		148	19	0.2
149	20	-0.2		149	20	0.2
148	21	-0.2		146	21	0.2
150	22	-0.2		153	22	0.2
151	23	-0.2		151	23	0.2
153	24	-0.2		150	24	0.2
152	25	-0.2		152	25	0.2
154	26	-0.2		154	26	0.2
156	27	-0.2		156	27	0.2
155	28	-0.2		157	28	0.2
157	29	-0.2		155	29	0.2

Note the above table lists all the single beams and all the beam-pairs that the EUT supports. These beams are pre-defined for this EUT, i.e., in the field, EUT will pick one of these beams (either single beam or beam-pair) from this table that provides the best radio link.

4 Tx Varying Transmission Test Cases and Test Proposal

In general, to validate power enforcement by Smart Transmit and demonstrate the compliance in Tx varying transmission conditions, the following test cases are proposed and agreed by FCC:

1. During a time-varying Tx power transmission: To prove that the Smart Transmit algorithm accounts for Tx power variations in time accurately.
2. During a call disconnect and reestablish scenario in 2G/3G/4G technology: To prove that the Smart Transmit algorithm accounts for history of past Tx power transmissions accurately.
3. During technology/band handover within 2G/3G/4G technology: To prove that the Smart Transmit algorithm functions correctly during transitions in technology/band.
4. During antenna (or beam) switch: To prove that the Smart Transmit algorithm functions correctly during transitions in antenna (such as AsDiv scenario) or beams (different antenna array configurations).
5. SAR vs. PD exposure switching during sub-6+mmW transmission: To prove that the Smart Transmit algorithm functions correctly and ensures total RF exposure compliance during transitions in SAR only exposure, SAR+PD exposure, and PD only exposure scenarios.

As shown in Table 3-1, since maximum time-averaged power level $P_{limit} \geq P_{max}$ (maximum RF tune-up output power) for all supported 2G/3G/4G WWAN technologies/bands for this EUT, there is no power limiting required. Hence, the validation for 2G/3G/4G WWAN radio is not required as Smart Transmit will not perform any power enforcement when only 2G/3G/4G WWAN radio is active.

The test case 1, 4 and 5 are performed in this Part 2 report for both 5G mmW NR band 260 and band 261 with LTE as anchor.

For a SAR-and PD-characterized wireless device, RF exposure is proportional to the Tx power. Thus, algorithm validation in Part 2 can be effectively performed through conducted (for f < 6GHz) and radiated (for f ≥ 6GHz) power measurement. Therefore, the validation is done in power measurement setup for test cases 1, 4 and 5.

To add confidence in the algorithm validation, the time-averaged SAR and PD measurements are also performed but only performed for test case 1 to avoid the complexity in SAR/PD measurement.

The strategy for testing in Tx varying transmission condition is outlined as follows:

- Demonstrate the total RF exposure averaged over FCC defined time windows does not exceed FCC's SAR and PD limits, through time-averaged power measurements
  - Measure conducted Tx power (for f < 6GHz) versus time, and radiated Tx power (EIRP for f > 6GHz) versus time.
  - Convert it into RF exposure and divide by respective FCC limits to get normalized exposure versus time.

- Perform running time-averaging over FCC defined time windows.
- Demonstrate that the total normalized time-averaged RF exposure is less than 1 for all transmission scenarios (i.e., test case 1, 4, and 5) at all times.

  Mathematical expression:

  For LTE+mmW transmission:

$$1g\_or\_10gSAR(t) = \frac{conducted\_Tx\_power(t)}{conducted\_Tx\_power\_P_{limit}} * 1g\_or\_10gSAR\_P_{limit} \quad (1a)$$

$$4cm^2PD(t) = \frac{radiated\_Tx\_power(t)}{radiated\_Tx\_power\_input.power.limit} * 4cm^2PD\_input.power.limit \quad (1b)$$

$$\frac{\frac{1}{T_{SAR}}\int_{t-T_{SAR}}^{t} 1g\_or\_10gSAR(t)dt}{FCC\ SAR\ limit} + \frac{\frac{1}{T_{PD}}\int_{t-T_{PD}}^{t} 4cm^2PD(t)dt}{FCC\ 4cm^2PD\ limit} \leq 1 \quad (1c)$$

  where, $conducted\_Tx\_power(t)$, $conducted\_Tx\_power\_P_{limit}$, and $1g\_or\_10gSAR\_P_{limit}$ correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at P_{limit}, and measured *1gSAR or 10gSAR* values at P_{limit}. Similarly, $radiated\_Tx\_power(t)$, $radiated\_Tx\_power\_input.power.limit$, and $4cm^2PD\_input.power.limit$ correspond to the measured instantaneous radiated Tx power, radiated Tx power at *input.power.limit* (i.e., radiated power limit), and $4cm^2$PD value at *input.power.limit*. Both P_{limit} and *input.power.limit* are the parameters pre-defined in Section 3 and entered through EFS. T_{SAR} is the time window for sub-6 radio defined by FCC; T_{PD} is the time window for mmW radio defined by FCC.

- Demonstrate the total RF exposure averaged over predefined time windows does not exceed FCC's SAR and PD limits, through time-averaged PD measurements. Note as mentioned earlier, this measurement is performed for test case 1 only.
  - For LTE + mmW transmission, measure instantaneous E-field versus time for mmW radio and instantaneous conducted power versus time for LTE radio.
  - Convert it into RF exposure and divide by respective FCC limits to get normalized exposure versus time.
  - Perform time averaging over FCC defined time windows.
  - Demonstrate that the total normalized time-averaged RF exposure is less than 1 for test case 1 at all times.

    Mathematical expression:

    For LTE+mmW transmission:

$$1g\_or\_10gSAR(t) = \frac{conducted\_Tx\_power(t)}{conducted\_Tx\_power\_P_{limit}} * 1g\_or\_10gSAR\_P_{limit} \quad (2a)$$

$$4cm^2PD(t) = \frac{[pointE(t)]^2}{[pointE\_input.power.limit]^2} * 4cm^2PD\_input.power.limit \quad (2b)$$

$$\frac{\frac{1}{T_{SAR}}\int_{t-T_{SAR}}^{t} 1g\_or\_10gSAR(t)dt}{FCC\ SAR\ limit} + \frac{\frac{1}{T_{PD}}\int_{t-T_{PD}}^{t} 4cm^2PD(t)dt}{FCC\ 4cm^2PD\ limit} \leq 1 \qquad (2c)$$

where, $pointSAR(t)$, $pointSAR\_P_{limit}$, and $1g\_or\_10gSAR\_P_{limit}$ correspond to the measured instantaneous point SAR, measured point SAR at P_{limit}, and measured *1gSAR* or 10gSAR values at P_{limit}. Similarly, $pointE(t)$, $pointE\_input.power.limit$, and $4cm^2PD\_input.power.limit$ correspond to the measured instantaneous E-field, E-field at *input.power.limit*, and $4cm^2$PD value at *input.power.limit*.

5 PD Time Averaging Validation Test Procedures

This section provides the test plan and test procedures for validating Qualcomm Smart Transmit algorithm for mmW transmission. For this EUT, millimeter wave (mmW) transmission is only in non-standalone mode, i.e., it requires a sub-6 LTE link as anchor.

5.1 Test sequence for validation in mmW NR transmission

In 5G mmW NR transmission, the test sequence for validation is with the callbox requesting EUT to transmit in 5G mmW NR at maximum power all the time.

5.2 Test configuration selection criteria for validating smart transmit algorithm

5.2.1 Test configuration selection for time-varying Tx power transmission

The Smart Transmit time averaging algorithm operation is independent of bands, modes, channels, and antenna configurations (beams) for a given technology. Hence, validation of Smart Transmit in any one band/mode/channel/beam per technology is sufficient. Two mmW bands are tested in this report to provide high confidence in this validation.

5.2.2 Test configuration selection for change in antenna configuration (beam)

The Smart Transmit time averaging algorithm operation is independent of bands, modes, channels, and antenna configurations (beams) for a given technology. Hence, validation of Smart Transmit with beam switch between any two beams is sufficient. Beam switch is performed in two mmW bands in this report to provide high confidence in this validation.

5.2.3 Test configuration selection for SAR vs. PD exposure switch during transmission

The Smart Transmit time averaging algorithm operation is independent of the nature of exposure (SAR vs. PD) and ensures total time-averaged RF exposure compliance. Hence, validation of Smart Transmit in any one band/mode/channel/beam for mmW + sub-6 (LTE) transmission is sufficient, where the exposure varies among SAR dominant scenario, SAR+PD scenario, and PD dominant scenario. Change in nature of exposure (SAR vs. PD) is performed in two mmW bands in this report to provide high confidence in this validation.

5.3 Test procedures for mmW radiated power measurements

Perform conducted power measurement (for f < 6GHz) and radiated power measurement (for f > 6GHz) for LTE + mmW transmission to validate Smart Transmit time averaging algorithm in the various transmission scenarios described in Section 4.

5.3.1 Time-varying Tx power scenario

The purpose of the test is to demonstrate the effectiveness of power limiting enforcement and that the time-averaged transmit power when converted into RF exposure values does not exceed the FCC limit at all times (see Eq. (1a), (1b) & (1c) in Section 4).

Test procedure:

1. Measure conducted Tx power corresponding to P_{limit} for LTE in selected band, and measure radiated Tx power corresponding to *input.power.limit* in desired mmW band/channel/beam. Test condition to measure conducted P_{limit} and radiated *input.power.limit* is:
   a. Measure radiated power corresponding to mmW *input.power.limit* by setting up the EUT to transmit in desired band/channel/beam at *input.power.limit* in Factory Test Mode (FTM). This test is performed in a calibrated anechoic chamber. Rotate the EUT to obtain maximum radiated Tx power, keep the EUT in this position and do not disturb the position of the EUT inside the anechoic chamber for the rest of this test.
   b. Reset EUT to place in online mode and establish radio link in LTE, measure conducted Tx power corresponding to LTE P_{limit} with Smart Transmit enabled and *Reserve_power_margin* set to 0 dB, callbox set to request maximum power.
2. Set *Reserve_power_margin* to actual value (i.e., 3dB as shown in Table 3-1) and reset power on EUT to enable Smart Transmit. With EUT setup for a mmW NR call in the desired/selected LTE band and mmW NR band, perform the following steps:
   a. Establish LTE (sub-6) and mmW NR connection. As soon as the mmW connection is established, immediately request all-down bits on LTE link. With callbox requesting EUT to transmit at maximum mmW power to test predominantly PD exposure scenario (as SAR exposure is less when LTE transmits at low power).
   b. After 120s, request LTE to go all-up bits for at least 100s. SAR exposure is dominant. There are two scenarios:
      i If $P_{limit} < P_{max}$, then the RF exposure margin (to mmW NR) gradually run out of (due to high SAR exposure), the 5G NR mmW transmission power should be gradually reduced accordingly and eventually seized when LTE goes to $P_{reserve}$ level.
      ii If $P_{limit} \geq P_{max}$, then the 5G NR mmW transmission averaged power should gradually reduce but the mmW NR connection can sustain all the time (assuming TxAGC uncertainty = 0dB).
   c. Record the conducted Tx power of LTE and radiated Tx power of mmW for the full duration of this test of ~ 300s.

3. Once the measurement is done, extract instantaneous Tx power versus time for both LTE and mmW links. Convert the conducted Tx power for LTE into 1g or 10gSAR value using Eq. (1a) and P_{limit} measured in Step 1.b, and then divide by FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR to obtain instantaneous normalized 1gSAR or 10gSAR versus time. Perform 100s running average to determine normalized 100s-averaged 1g or 10gSAR versus time as illustrated in Figure 5-1.

   NOTE: In Eq.(1a), instantaneous Tx power is converted into instantaneous 1gSAR value by applying the worst-case 1gSAR value at P_{limit} for the corresponding technology/band/antenna/DSI reported in Part 1 SAR report [B1].

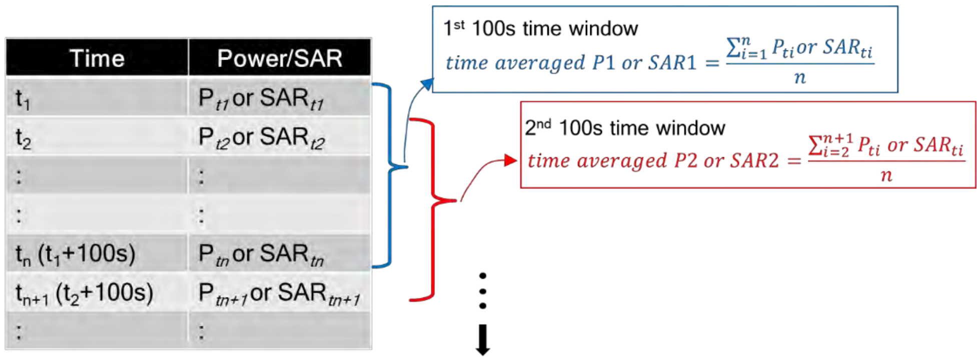


Figure 5-1: Running time averaging illustration

4. Similarly, convert the radiated Tx power for mmW into $4cm^2$PD value using Eq. (1b) and the radiated Tx power limit (i.e., radiated Tx power at *input.power.limit*) measured in Step 1.a, then divide by FCC $4cm^2$PD limit of $10W/m^2$ to obtain instantaneous normalized $4cm^2$PD versus time. Perform 4s running average to determine normalized 4s-averaged $4cm^2$PD versus time.

   NOTE: In Eq.(1b), instantaneous radiated Tx power is converted into instantaneous $4cm^2$PD by applying the worst-case $4cm^2$PD value measured at *input.power.limit* for the selected band/beam in Section 7.

5. Make one plot containing: (a) instantaneous conducted Tx power for LTE versus time, and (b) instantaneous radiated Tx power for mmW versus time, as measured in Step 2.
6. Make another plot containing: (a) computed normalized 100s-averaged 1gSAR or 10gSAR versus time determined in Step 3, (b) computed normalized 4s-averaged $4cm^2$PD versus time determined in Step 4, and (c) corresponding total normalized time-averaged RF exposure (sum of steps (6.a) and (6.b)) versus time.

The validation criteria is, at all times, the total normalized time-averaged RF exposure versus time determined in Step 6.c shall not exceed the normalized limit of 1.0 of FCC requirement (i.e., Eq. (1c)).

5.3.2 Switch in SAR vs. PD exposure during transmission

This test is to demonstrate that Smart Transmit algorithm is independent of the nature of exposure (SAR vs. PD), accurately accounts for switching in exposures among SAR only, SAR+PD, and PD only scenarios, and ensures total time-averaged RF exposure compliance.

Test procedure:

1. Measure conducted Tx power corresponding to P_{limit} for LTE in selected band/channel/DSI, and measure radiated Tx power corresponding to *input.power.limit* in desired mmW band/channel/beam. Test condition to measure conducted P_{limit} and radiated *input.power.limit* is:
    a. Measure radiated power corresponding to mmW *input.power.limit* by setting up the EUT to transmit in desired band/channel/beam at *input.power.limit* in FTM. This test is performed in a calibrated anechoic chamber. Rotate the EUT to obtain maximum radiated Tx power, keep the EUT in this position and do not disturb the position of the EUT inside the anechoic chamber for the rest of this test.
    b. Reset EUT to place in online mode and establish radio link in LTE, measure conducted Tx power corresponding to LTE P_{limit} with Smart Transmit enabled and *Reserve_power_margin* set to 0 dB, callbox set to request maximum power.
2. Set *Reserve_power_margin* to actual value (i.e., 3dB as shown in Table 3-1) and reset power in EUT, With EUT setup for LTE (sub-6) + mmW call, perform the following steps:
    a. Establish LTE (sub-6) and mmW NR connection with callbox.
    b. As soon as the mmW connection is established, immediately request all-down bits on LTE link. Continue LTE (all-down bits) + mmW transmission for more than 100s duration to test predominantly PD exposure scenario (as SAR exposure is negligible from all-down bits in LTE).
    c. After 120s, request LTE to go all-up bits, mmW transmission should gradually run out of RF exposure margin if $P_{limit} < P_{max}$ and seize mmW transmission (SAR only scenario); or mmW transmission should gradually reduce in Tx power if $P_{limit} > P_{max}$ and will sustain the connection, which is for this EUT, in this case there will be no SAR exposure only scenario when in EN-DC mode for this EUT.
    d. After 75s, request LTE to go all-down bits, mmW transmission should start getting RF exposure margin and gradually transmit at high averaged power again.
    e. Record the conducted Tx power of LTE and radiated Tx power of mmW for the entire duration of this test of ~300s.
3. Once the measurement is done, extract instantaneous Tx power versus time for both LTE and mmW links. Convert the conducted Tx power for LTE into 1gSAR or 10gSAR value using Eq. (1a) and P_{limit} measured in Step 1.b, and then divide by FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR to obtain instantaneous normalized 1gSAR or 10gSAR versus time. Perform 100s running average to determine normalized 100s-averaged 1gSAR or 10gSAR versus time.

    NOTE: In Eq.(1a), instantaneous Tx power is converted into instantaneous 1gSAR or 10gSAR value by applying the worst-case 1gSAR or 10gSAR value at P_{limit} for the corresponding technology/band/antenna/DSI reported in Part 1 SAR report [B1].

4. Similarly, convert the radiated Tx power for mmW into $4cm^2$PD value using Eq. (1b) and the radiated Tx power limit (i.e., radiated Tx power at *input.power.limit*) measured in Step 1.a, then divide this by FCC $4cm^2$PD limit of $10W/m^2$ to obtain instantaneous normalized $4cm^2$PD versus time. Perform 4s running average to determine normalized 4s-averaged $4cm^2$PD versus time.

NOTE: In Eq.(2b), instantaneous radiated Tx power is converted into instantaneous $4cm^2$PD by applying the worst-case $4cm^2$PD value measured at *input.power.limit* for the selected band/beam in Section 7.

5. Make one plot containing: (a) instantaneous conducted Tx power for LTE versus time, and (b) instantaneous radiated Tx power for mmW versus time, as measured in Step 2.
6. Make another plot containing: (a) computed normalized 100s-averaged 1gSAR or 10gSAR versus time determined in Step 3, (b) computed normalized 4s-averaged $4cm^2$PD versus time determined in Step 4, and (c) corresponding total normalized time-averaged RF exposure (sum of steps (6.a) and (6.b)) versus time.

The validation criteria is, at all times, the total normalized time-averaged RF exposure versus time determined in Step 6.c shall not exceed the normalized limit of 1.0 of FCC requirement (i.e., Eq. (1c)).

5.3.3 Change in antenna configuration (beam)

This test is to demonstrate the correct power control by Smart Transmit during changes in antenna configuration (beam). Since the *input.power.limit* varies with beam, the Eq. (1a), (1b) and (1c) in Section 4 are written as below for transmission scenario having change in beam,

$$1g\_or\_10gSAR(t) = \frac{conducted\_Tx\_power(t)}{conducted\_Tx\_power\_P_{limit}} * 1g\_or\_10gSAR\_P_{limit} \quad (3a)$$

$$4cm^2PD_1(t) = \frac{radiated\_Tx\_power\_1(t)}{radiated\_Tx\_power\_input.power.limit\_1} * 4cm^2PD\_input.power.limit\_1 \quad (3b)$$

$$4cm^2PD_2(t) = \frac{radiated\_Tx\_power\_2(t)}{radiated\_Tx\_power\_input.power.limit\_2} * 4cm^2PD\_input.power.limit\_2 \quad (3c)$$

$$\frac{\frac{1}{T_{SAR}}\int_{t-T_{SAR}}^{t} 1g\_or\_10gSAR(t)dt}{FCC\ SAR\ limit} + \frac{\frac{1}{T_{PD}}\left[\int_{t-T_{PD}}^{t_1} 4cm^2\text{PD}_1(t)dt + \int_{t_1}^{t} 4cm^2\text{PD}_2(t)dt\right]}{FCC\ 4cm^2PD\ limit} \leq 1 \quad (3d)$$

where, *radiated_Tx_power_1(t)*, *radiated_Tx_power_input.power.limit_1*, and *$4cm^2$PD_input.power.limit_1* correspond to the instantaneous radiated Tx power, radiated Tx power at *input.power.limit*, and *$4cm^2$PD* value at *input.power.limit* of beam1; *radiated_Tx_power_2(t)*, *radiated_Tx_power_input.power.limit_2*, and *$4cm^2$PD_input.power.limit_2* correspond to the instantaneous radiated Tx power, radiated Tx power at *input.power.limit*, and *$4cm^2$PD* value at *input.power.limit* of beam2.

Test procedure:

1. Measure conducted Tx power corresponding to P_{limit} for LTE in selected band/channel/DSI, and measure radiated Tx power corresponding to *input.power.limit* in desired mmW band/channel/beam. Test condition to measure conducted P_{limit} and radiated *input.power.limit* is:

a. Measure radiated power corresponding to mmW *input.power.limit* by setting up the EUT to transmit in desired band/channel for beam1 at *input.power.limit* in FTM. Do not disturb the position of the EUT inside the anechoic chamber for the rest of this test. Repeat this Step 1.a for beam2.

b. Reset EUT to place in online mode and establish radio link in LTE, measure conducted Tx power corresponding to LTE P_{limit} with Smart Transmit enabled and *Reserve_power_margin* set to 0 dB, callbox set to request maximum power.

2. Set *Reserve_power_margin* to actual value (i.e., 3dB as shown in Table 3-1) and reset power in EUT, With EUT setup for LTE (sub-6) + mmW connection, perform the following steps:
   a. Establish LTE (sub-6) and mmW NR connection in beam1. As soon as the mmW connection is established, immediately request all-down bits on LTE link with the callbox requesting EUT to transmit at maximum mmW power.
   b. After beam 1 transmits for at least 20s, request the EUT to change from beam 1 to beam 2, and continue transmitting with beam 2 for at least 20s.
   c. Record the conducted Tx power of LTE and radiated Tx power of mmW for the entire duration of this test.
3. Once the measurement is done, extract instantaneous Tx power versus time for both LTE and mmW links. Convert the conducted Tx power for LTE into 1gSAR or 10gSAR value using the similar approach described in Step 3 of Section 5.3.2. Perform 100s running average to determine normalized 100s-averaged 1gSAR or 10gSAR versus time.
4. Similarly, convert the radiated Tx power for mmW NR into $4cm^2$PD value using Eq. (3b), (3c) and the radiated Tx power limits (i.e., radiated Tx power at *input.power.limit*) measured in Step 1.a for beam 1 and beam 2, respectively, and then divide the resulted PD values by FCC $4cm^2$PD limit of $10W/m^2$ to obtain instantaneous normalized $4cm^2$PD versus time for beam 1 and beam 2. Perform 4s running average to determine normalized 4s-averaged $4cm^2$PD versus time.

NOTE: In Eq.(3b) and (3c), instantaneous radiated Tx power of beam 1 and beam 2 is converted into instantaneous $4cm^2$PD by applying the worst-case $4cm^2$PD value measured at the *input.power.limit* of beam 1 and beam 2 in Section 7.

5. Since the measured radiated powers for beam1 and beam2 in Step 1.a were performed at an arbitrary rotation of EUT in anechoic chamber, repeat Step 1.a of this procedure by rotating the EUT to determine maximum radiated power at *input.power.limit* in FTM mode for both beams separately. Re-scale the measured instantaneous radiated power in Step 2.c by the delta in radiated powers in (Step 5 – Step 1.a) for plotting purposes in next Step. In other words, this step essentially converts measured instantaneous radiated power during this test into maximum instantaneous radiated power for both beams.
6. Make one plot containing: (a) instantaneous conducted Tx power for LTE versus time as measured in Step 2, and (b) instantaneous radiated Tx power for mmW versus time as scaled in Step 5.
7. Make another plot containing: (a) computed normalized 100s-averaged 1gSAR or 10gSAR versus time determined in Step 3, (b) computed normalized 4s-averaged $4cm^2$PD versus time determined in Step 4, and (c) corresponding total normalized time-averaged RF exposure (sum of steps (7.a) and (7.b)) versus time.

The validation criteria is, at all times, the total normalized time-averaged RF exposure versus time determined in Step 7.c shall not exceed the normalized limit of 1.0 of FCC requirement (i.e., Eq. (3d)).

5.4 Test procedure for PD measurements

The following steps are used to perform the validation through PD measurement for test case 1 described in Section 4:

1. Place the EUT on the DASY platform to perform PD measurement in the worst-case position/surface for the selected mmW band/beam/DSI. In PD measurement, the callbox is set to request maximum mmW Tx power from EUT all the time. Hence, “path loss” calibration between callbox antenna and EUT is not needed in this test.
2. Time averaging algorithm validation:
    a. Measure conducted Tx power corresponding to P_{limit} for LTE in selected band/channel/DSI, and measure point E-field corresponding to *input.power.limit* in desired mmW band/channel/beam. Test condition to measure conducted P_{limit} and PD (i.e., E-field) at *input.power.limit* is:
        i. Measure conducted Tx power corresponding to LTE P_{limit} with Smart Transmit enabled and *Reserve_power_margin* set to 0 dB, callbox set to request maximum power.
        ii. Measure point E-field at peak location of fast area scan corresponding to *input.power.limit* by setting up the EUT to transmit in desired mmW band/channel/beam at *input.power.limit* in FTM Mode. Do not disturb the position of EUT and mmW DASY probe.
    b. Set *Reserve_power_margin* to actual value (i.e., 3dB as shown in Table 3-1) and reset power on EUT, place EUT in online mode. With EUT setup for LTE (sub-6) + mmW call, as soon as the mmW connection is established, request all-down bits on LTE link. Continue LTE (all-down bits) + mmW transmission for more than 100s duration to test predominantly PD exposure scenario. After 120s, request LTE to go all-up bits, mmW transmission should gradually reduce but sustain the mmW connection for this EUT. Record the conducted Tx power of LTE and point E-field of mmW at peak location identified in Step 2.a.ii for the entire duration of this test of ~300s.
    c. Once the measurement is done, extract instantaneous Tx power versus time for LTE and point E-field versus time from DASY system for mmW. Convert the conducted Tx power for LTE into 1gSAR value using Eq. (2a) and P_{limit} measured in Step 2.a.i, and then divide this by FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR to obtain instantaneous normalized 1gSAR or 10gSAR versus time. Perform 100s running average to determine normalized 100s-averaged 1gSAR or 10gSAR versus time.

        NOTE: In Eq.(2a), instantaneous Tx power is converted into instantaneous 1gSAR or 10gSAR value by applying the worst-case 1gSAR or 10gSAR value at P_{limit} for the corresponding technology/band reported in Part 1 SAR report [B1].

    d. Similarly, convert the point E-field for mmW into $4cm^2$PD value using Eq. (2b) and radiated power limit measured in Step 2.a.ii, and then divide this by FCC $4cm^2$PD limit of $10W/m^2$ to obtain instantaneous normalized $4cm^2$PD versus time. Perform 4s running average to determine normalized 4s-averaged $4cm^2$PD versus time.

e. Make one plot containing: (i) computed normalized 100s-averaged 1gSAR or 10gSAR versus time determined in Step 2.c, (ii) computed normalized 4s-averaged $4cm^2$PD versus time determined in Step 2.d, and (iii) corresponding total normalized time-averaged RF exposure (sum of steps (2.e.i) and (2.e.ii)) versus time.

The validation criteria is, at all times, the total normalized time-averaged RF exposure versus time determined in Step 2.e.iii shall not exceed the normalized limit of 1.0 of FCC requirement (i.e., Eq. (2c)).

6 Test Configurations

6.1 LTE + mmW NR transmission

Based on the selection criteria described in Section 5.2, the selections for LTE and mmW NR validation test are listed in Table 6-1. The radio configurations used in this test is listed in Table 6-2.

Table 6-1 Selections for LTE + mmW NR validation measurements

Transmission Scenario	Test	Technology and Band	mmW Beam
Time-varying Tx power test	Cond. & Rad. Power meas. PD meas.	LTE Band 2 and n261	Beam ID 23
		LTE Band 2 and n260	Beam ID 23
Switch in SAR vs. PD	Cond. & Rad. Power meas.	LTE Band 2 and n261	Beam ID 23
		LTE Band 2 and n260	Beam ID 23
Beam switch test	Cond. & Rad. Power meas.	LTE Band 2 and n261	Beam ID 4 to Beam ID 0
		LTE Band 2 and n260	Beam ID 3 to Beam ID 0

Table 6-2: Test configuration for LTE + mmW NR validation

Tech	Band	DSI	Channel	RB/offset	Freq (MHz)	Mode	UL Duty Cycle
LTE	B2	1	18900	50	1880	QPSK	100%
mmW NR	n261	--	2072498	28	27600	CP-OFDM, QPSK	75.6%
	n260	--	2254147	28	38499	CP-OFDM, QPSK	75.6%

7 Radiated Power Test Results for mmW Smart Transmit Algorithm Validation

7.1 WWAN (sub-6) transmission

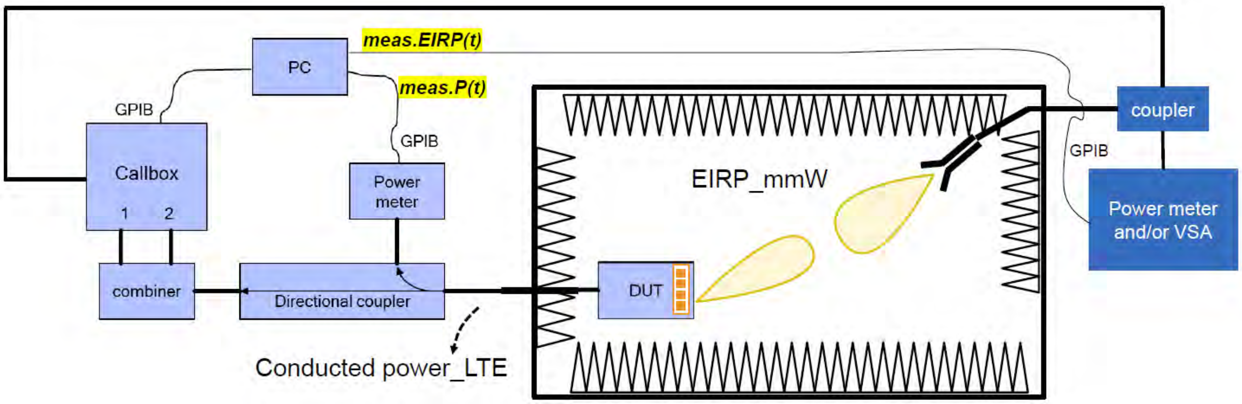
As discussed in Section 4, since maximum time-averaged power level $P_{limit} \geq P_{max}$ (maximum RF tune-up output power) for all supported 2G/3G/4G WWAN technologies/bands/DSI for this EUT, there is no power limiting required if only 2G/3G/4G radio is active. Hence, the Tx varying transmission scenario tests listed in Section 4 are performed for mmW NR + LTE radio only in this Part 2 report for LGE portable handset (FCC ID: ZNFV450VM).

7.2 Measurement setup

The Keysight Technologies E7515B UXM callbox is used in this test. The test setup is shown in Figure 7-1a and the schematic of the setup is shown in Figure 7-1b. The UXM callbox has two RF radio heads to up/down convert IF to mmW frequencies, which in turn are connected to two horn antennas for V- and H-polarizations for downlink communication. In the uplink, a directional coupler is used in the path of one of the horn antennas to measure and record radiated power using a Rohde & Schwarz NR50S power sensor and NRP2 power meter. Note that since the measurements performed in this validation are all relative, measurement of EUT's radiated power in one polarization is sufficient. The EUT is placed inside an anechoic chamber with V- and H-pol horn antennas to establish the radio link as shown in Figure 7-1. The callbox's LTE port is directly connected to the EUT's RF port via a directional coupler to measure the EUT's conducted Tx power using a Rohde & Schwarz NR8S power sensor and NRP2 power meter. Additionally, EUT is connected to the PC via USB connection for sending beam switch command. Care is taken to route the USB cable and RF cable (for LTE connection) away from the EUT's mmW antenna modules.

Setup in Figure 7-1 is used for the test scenario 1, 4 and 5 described in Section 4. The test procedures described in Section 5 are followed. The path losses from the EUT to the power meters are calibrated and used as offset in the power meter.

(a)



(b)

Figure 7-1 Radiated power measurement setup

Both the callbox and power meters are connected to the PC using USB cables. Test scripts are custom made for automation of establishing LTE + mmW call, conducted Tx power recording for LTE and radiated Tx power recording for mmW. These tests are manually stopped after desired time duration. Immediately after the mmW link is established, test script is programmed to set LTE Tx power to all-down bits on the callbox, and programmed to set toggle between all-up and all-down bits depending on the transmission scenario being evaluated. Similarly, test script is also programmed to send beam switch command manually to the EUT via USB connection. For all the tests, the callbox is set to request maximum Tx power in mmW NR radio from EUT all the time.

Power meter readings are periodically recorded every 10ms on both NR8S and NR50S power sensors. A running average of this measured conducted Tx power over 100 seconds (i.e., 10,000 data points collected with 10ms sampling rate) is performed in the post-data processing to determine the 100s-time averaged power for LTE. Similarly, a running average of radiated Tx power over 4 seconds (i.e., 400 data points collected with 10ms sampling rate) is performed in the post-data processing to determine the 4s-time averaged power for mmW NR.

7.3 mmW radiated power test results

To demonstrate the compliance, the conducted Tx power of LTE B2 is converted to extremity exposure 10gSAR by applying the worst-case 10gSAR value of 2.242W/kg @ 23.7dBm for LTE B2 at P_{limit} in DSI=1 as reported in Part 1 SAR report [B1].

Similarly, radiated Tx power of mmW Band n261 and n260 is converted by applying the corresponding worst-case 4cm^{2}PD values by following Step 4 in Section 5.3.1.

Both worst-case 10gSAR and 4cm^{2}PD values are listed in Table 7-1.

NOTE: Since the beams used in the validation were not tested at PCTEST (Document S/N 1M1901150005-15.ZNF: *ZNFV450VM Power Density Report revB*), additional PD measurements were performed at Qualcomm lab and the measured results are provided in Table 7-1 below.

NOTE: Qualcomm® Smart Transmit algorithm operates based on average transmit power reported on a per symbol based, which is independent of modulation, channel and bandwidth (RBs). Therefore, PD measurements in Table 7-1 were conducted with the EUT in FTM mode, with CW modulation and in mid channel, with EUT transmitting at *input.power.limit* (listed in Table 3-2) corresponding to the tested beams. Additionally, the current DASY6 EUmmWv2 probe used for PD measurements is only calibrated for CW modulation.

Table 7-1: Worst-case 10gSAR, 4cm^2 avg. PD and EIRP measured at *input.power.limit* of the selected configurations for Part 2 validation test via conducted and radiated power measurement

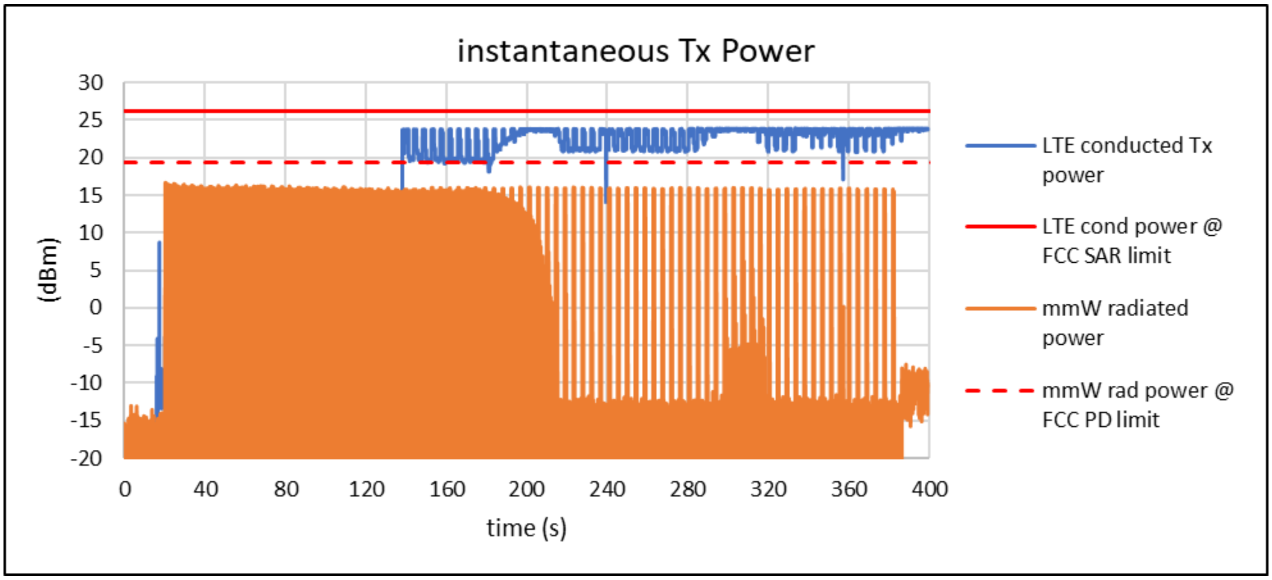
					meas. 4cm2PD		
Tech	Band	Module ID	Beam ID	input.power.limit (dBm)	at input.power.limit (W/m2)	configuration	meas. EIRP at input.power.limit (dBm)
mmW NR	n261	1: ANT 11	23	0.2	1.186	right	11.2
		1: ANT 11	4	0.2	0.447	right	7.6
		1: ANT 11	0	0.2	0.443	right	2.2
	n260	1: ANT 11	23	-0.2	1.224	right	13.1
		1: ANT 11	3	-0.2	0.635	right	8.7
		1: ANT 11	0	-0.2	0.349	right	3.9

					10g SAR		
			DSI	Plimit (dBm)	at Pmax (W/kg)	configuration	Pmax max. tune-up power (dBm)
LTE	B2	--	1	25.3	2.242	bottom/phablet	23.7

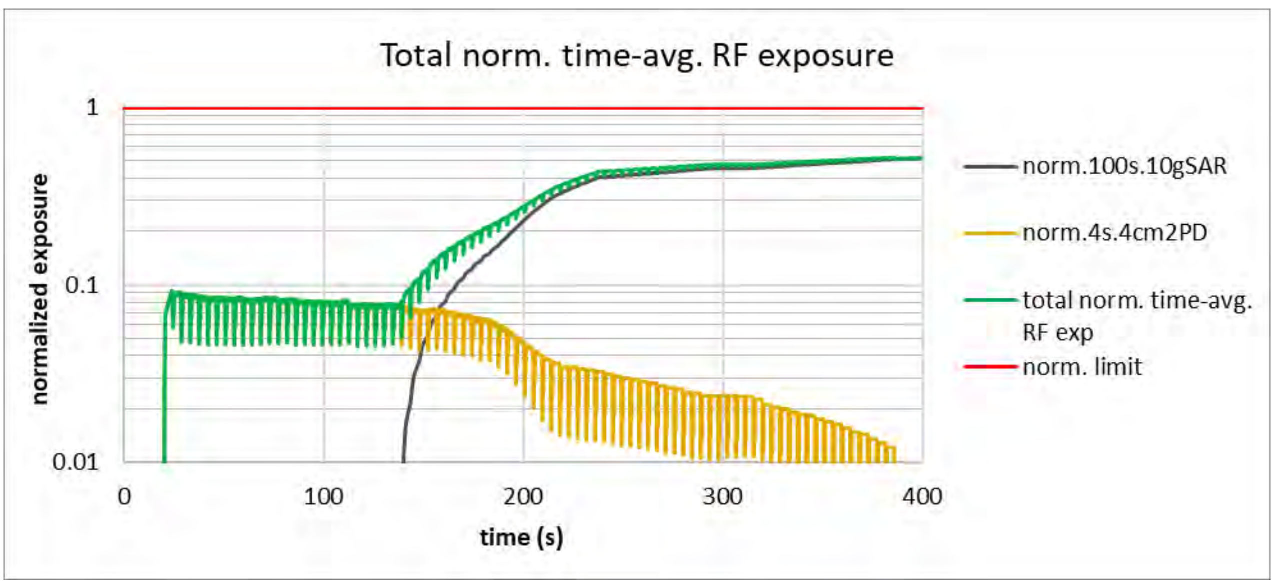
7.3.1 Maximum transmit power test results for n261

This test was measured with LTE B2 (DSI = 1) and mmW Band n261 Beam ID 23, by following the detailed test procedure described in Section 5.3.1.

Instantaneous conducted LTE Tx power and instantaneous radiated mmW Tx power versus time:



Above instantaneous conducted Tx power for LTE B2 is converted into instantaneous 10gSAR using Equation (1a)), which is divided by FCC extremity exposure 10gSAR limit of 4.0 W/kg to obtain normalized SAR exposure versus time. Similarly, instantaneous radiated Tx power for 5G mmW NR is converted into instantaneous $4cm^2$PD using Equation (1b), which is divided by FCC $4cm^2$PD limit of 10 W/m^2 to obtain normalized PD exposure versus time. Time-averaged normalized exposures versus time are obtained using Equation (1c). Below plot shows (a) normalized time-averaged 10gSAR versus time, (b) normalized time-averaged 4cm2-avg.PD versus time, (c) sum of normalized time-averaged 10gSAR and normalized time-averaged $4cm^2$-avg.PD (Eq. (1c)) as shown below to demonstrate that the total time-averaged exposure versus time does not exceed the normalized FCC limit of 1.0 at all times.



FCC requirement for total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure (green curve)	0.525
Validated	

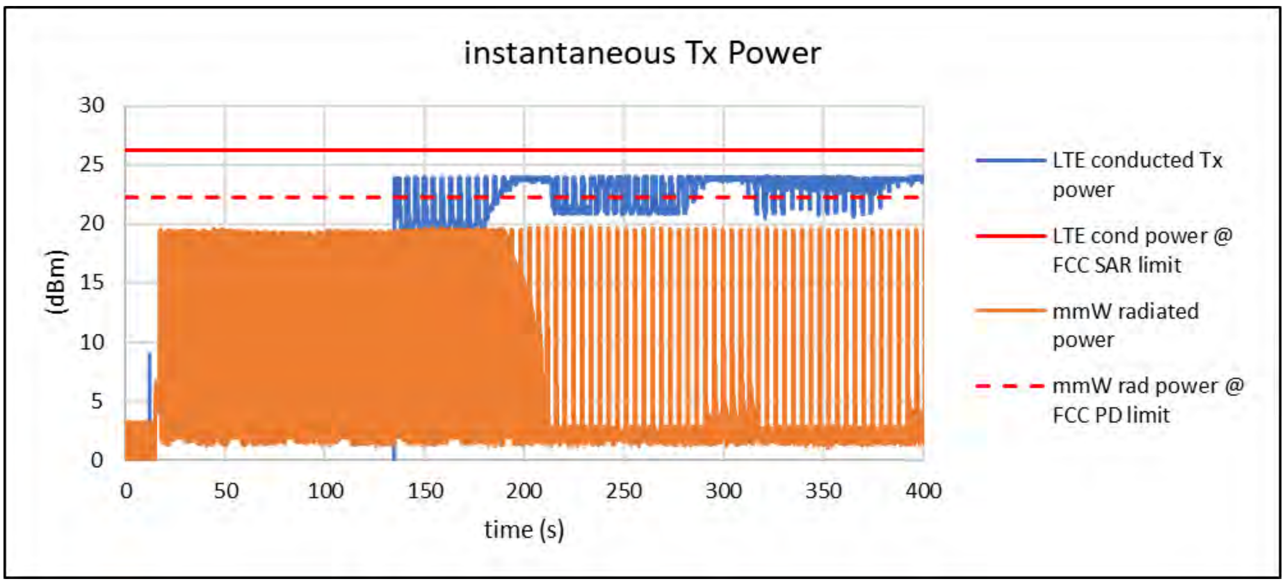
Plot notes: 5G mmW NR call was established at ~20s time mark and LTE was placed in all-down bits immediately after 5G mmW NR call was established. Between 20s~140s, mmW exposure is the dominant contributor. Here, Smart Transmit algorithm allocates a maximum of 75% for mmW (i.e., at least 25% is allocated to 4G LTE anchor to maintain the link) based on the reserve settings in Table 3-1. From Table 7-1, this corresponds to a normalized $4cm^2$PD exposure value for Beam ID 23 of (75% * 1.186 W/m^2)/(10 W/m^2) = 8.9% ± 2.8dB device related uncertainty (see green and orange curve between 20s~140s). At 140s time mark, LTE is set to all-up bits, taking away margin from mmW exposure gradually. Towards the end of test, LTE is the dominant contributor towards RF exposure, i.e., corresponding normalized 10gSAR exposure value of (100% * 2.242 W/kg)/(4.0 W/kg) = 56% ± 0.7dB design related uncertainty (see green and black curves approaching this level towards end of the test).

As can be seen, the power limiting enforcement is effective and the total normalized time-averaged RF exposure does not exceed 1.0. Therefore, Qualcomm® Smart Transmit time averaging algorithm is validated.

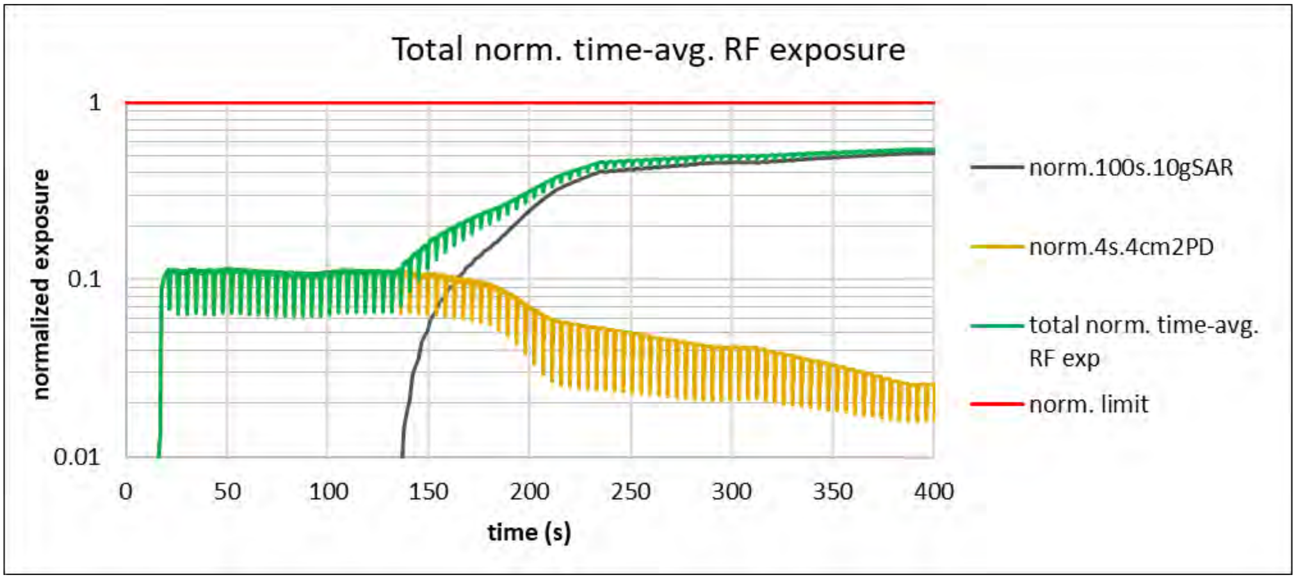
7.3.2 Maximum transmit power test results for n260

This test was measured with LTE B2 (DSI = 1) and mmW Band n260 Beam ID 23, by following the detailed test procedure described in Section 5.3.1.

Instantaneous conducted LTE Tx power and instantaneous radiated mmW Tx power versus time:



Similar to Section 7.3.1, the normalized time-averaged exposures for LTE (10gSAR) and mmW NR ($4cm^2$PD), as well as total normalized time-averaged exposure versus time were determined:



FCC requirement for total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure (green curve)	0.543
Validated	

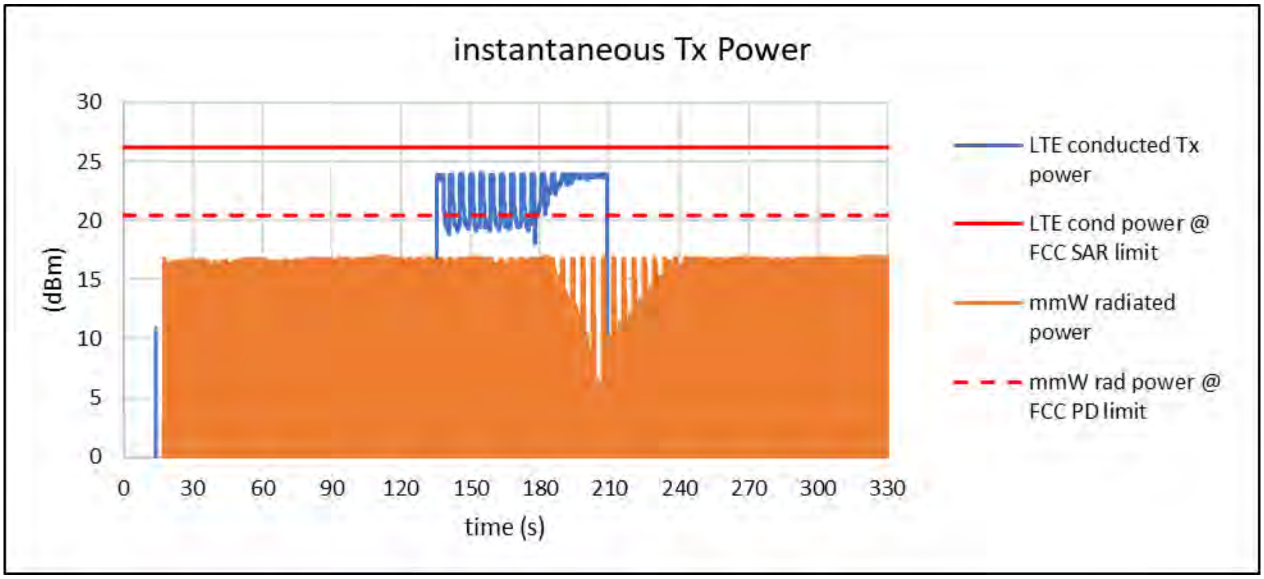
Plot notes: 5G mmW NR call was established at ~20s time mark and LTE was placed in all-down bits immediately after 5G mmW NR call was established. Between 20s~140s, mmW exposure is the dominant contributor. Here, Smart Transmit algorithm allocates a maximum of 75% for mmW (i.e., at least 25% is allocated to 4G LTE anchor to maintain the link) based on the reserve settings in Table 3-1. From Table 7-1, this corresponds to a normalized 4cm^{2}PD exposure value for Beam ID 23 of (75% * 1.224 W/m^2)/(10 W/m^2) = 9.2% ± 2.8dB device related uncertainty (see green and orange curve between 20s~140s). At 140s time mark, LTE is set to all-up bits, taking away margin from mmW exposure gradually. Towards the end of the test, LTE is the dominant contributor towards RF exposure, i.e., corresponding normalized 10gSAR exposure value of (100% * 2.242 W/kg)/(4.0 W/kg) = 56% ± 0.7dB design related uncertainty (see green and black curves approaching this level towards end of the test).

As can be seen, the power limiting enforcement is effective and the total normalized time-averaged RF exposure does not exceed 1.0. Therefore, Qualcomm® Smart Transmit time averaging algorithm is validated.

7.3.3 Switch in SAR vs. PD exposure test results for n261

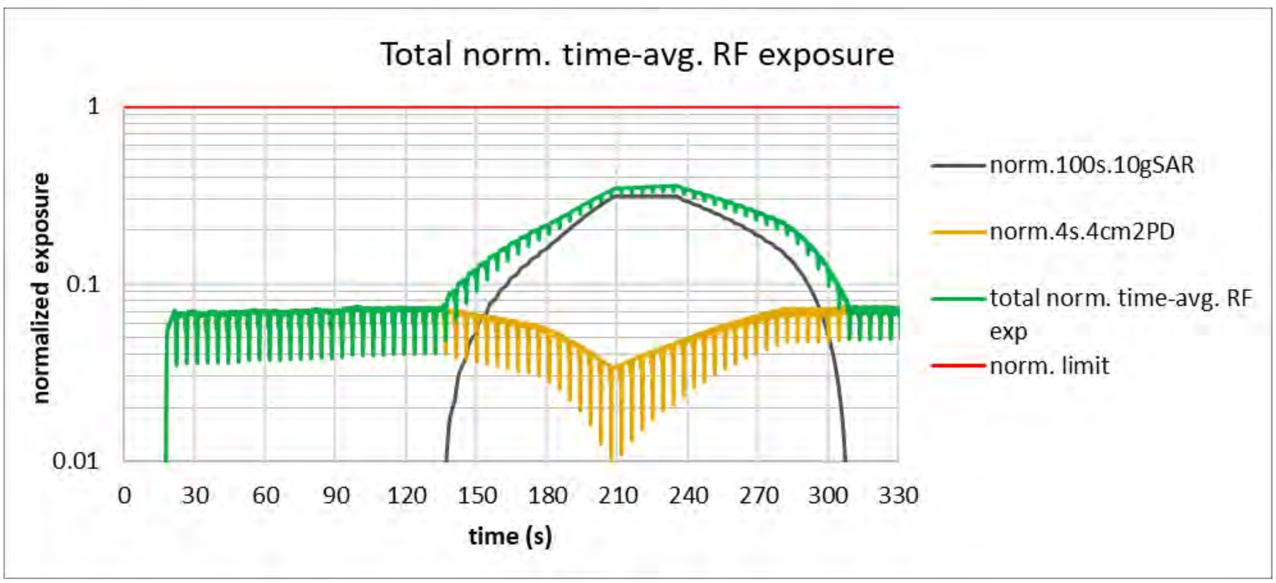
This test was measured with LTE Band 2 (DSI = 1) and mmW Band n261 Beam ID 23, by following the detailed test procedure is described in Section 5.3.2.

Instantaneous conducted LTE Tx power and instantaneous radiated mmW Tx power versus time:



From the above plot, it can be seen that between 15s ~ 135s, it is predominantly instantaneous PD exposure, between 135s ~ 210s, it is instantaneous SAR+PD exposure, above 210s, it is predominantly instantaneous PD exposure.

Normalized time-averaged exposures for LTE (10gSAR) and mmW (4cm^{2}PD), as well as total normalized time-averaged exposure versus time:



FCC requirement for total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure (green curve)	0.359
Validated	

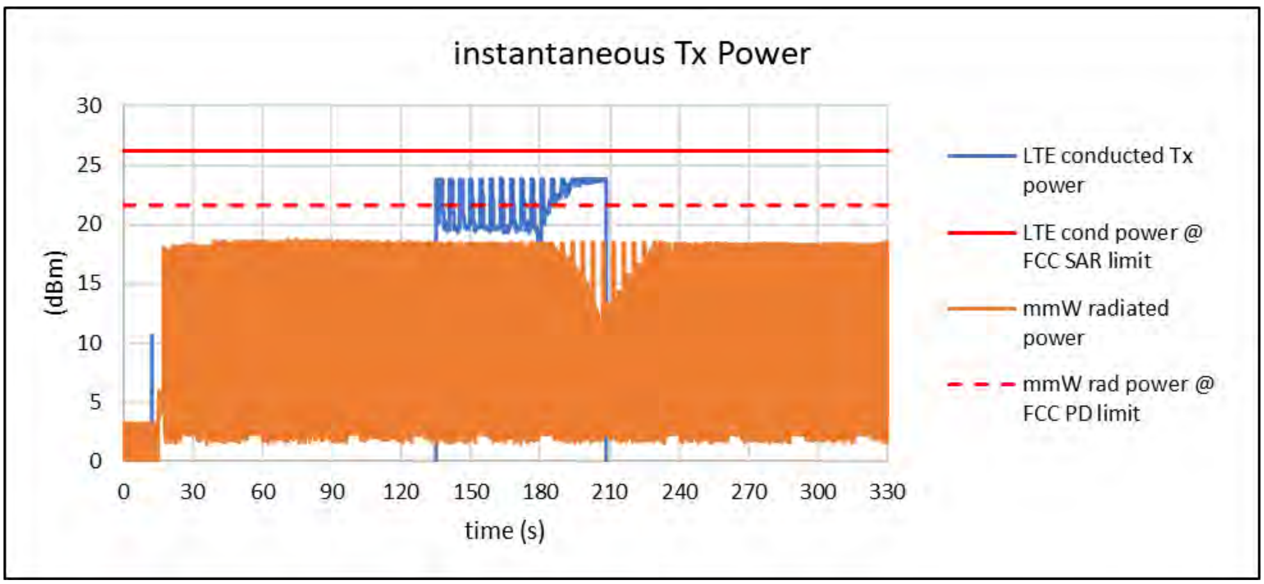
Plot notes: 5G mmW NR call was established at ~15s time mark and LTE was placed in all-down bits immediately after 5G mmW NR call was established. Between 15s~135s, mmW exposure is the dominant contributor. Here, Smart Transmit algorithm allocates a maximum of 75% for mmW (i.e., at least 25% is allocated to 4G LTE anchor to maintain the link) based on the reserve settings in Table 3-1. From Table 7-1, this corresponds to a normalized 4cm^{2}PD exposure value for Beam ID 23 of (75% * 1.186 W/m^2)/(10 W/m^2) = 8.9% ± 2.8dB device related uncertainty (see green and orange curve between 15s~135s). At 135s time mark, LTE is set to all-up bits, taking away margin from mmW exposure gradually (orange curve for mmW exposure goes down while black curve for LTE exposure goes up). At 210s time mark, LTE is set to all-down bits, which results in mmW getting back RF margin slowly as seen by gradual increase in mmW exposure (orange curve for mmW exposure goes up while black curve for LTE exposure goes down). The calculated maximum RF exposure from LTE corresponds to normalized 10gSAR exposure value of (100% * 2.242 W/kg)/(4.0 W/kg) = 56% ± 0.7dB design related uncertainty (note that this level will be achieved by green and black curves if LTE remains in all-up bits for longer time duration which was already demonstrated in maximum transmit power test in Section 7.3.2). Total normalized time-averaged exposure (green curve) for this test should be within the calculated range between 8.9% ± 2.8dB device related uncertainty (only PD exposure) and 56% ± 0.7dB design related uncertainty (only SAR exposure).

As can be seen, the power limiting enforcement is effective during transmission when SAR and PD exposures are switched, and the total normalized time-averaged RF exposure does not exceed 1.0. Therefore, Qualcomm® Smart Transmit time averaging algorithm is validated.

7.3.4 Switch in SAR vs. PD exposure test results for n260

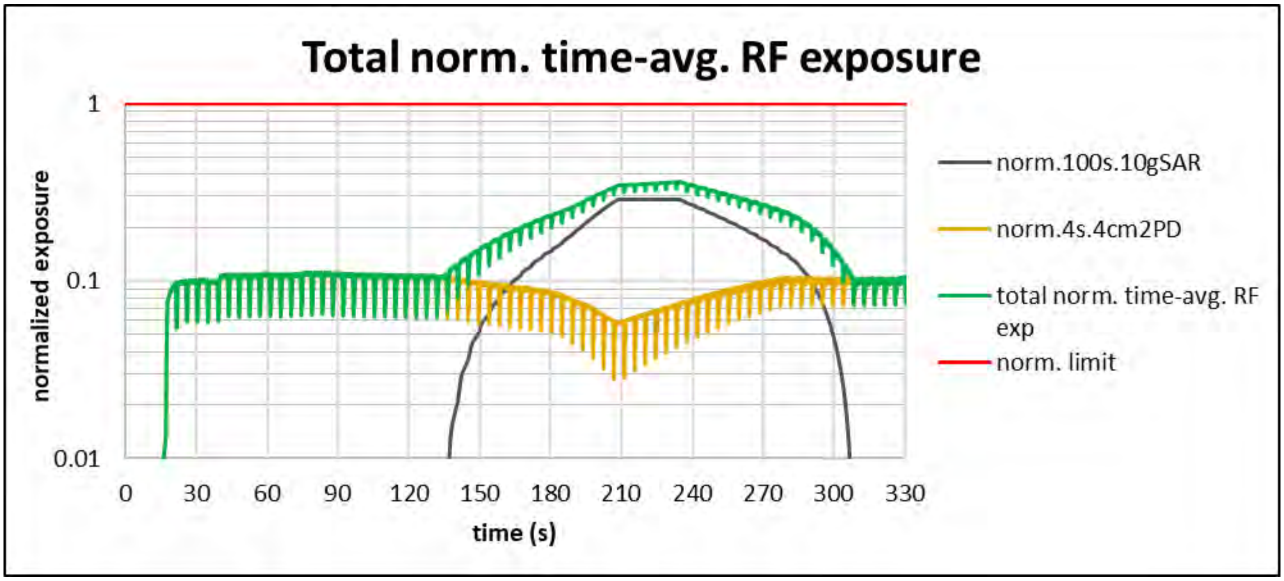
This test was measured with LTE Band 2 (DSI = 1) and mmW Band n260 Beam ID 23, by following the detailed test procedure is described in Section 5.3.2.

Instantaneous conducted LTE Tx power and instantaneous radiated mmW Tx power versus time:



From the above plot, it can be seen that between 25s ~ 130s, it is predominantly instantaneous PD exposure, between 130s ~ 210s, it is instantaneous SAR+PD exposure, and above 210s, it is predominantly instantaneous PD exposure.

Normalized time-averaged exposures for LTE (10gSAR) and mmW (4cm^{2}PD), as well as total normalized time-averaged exposure versus time:



FCC requirement for total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure (green curve)	0.364
Validated	

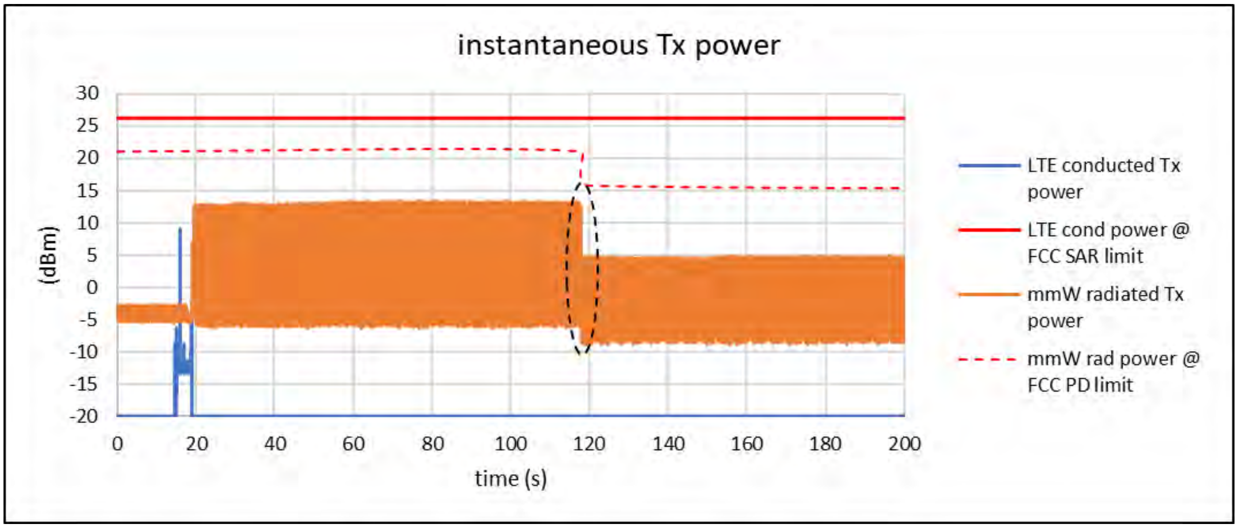
Plot notes: 5G mmW NR call was established at ~15s time mark and LTE was placed in all-down bits immediately after 5G mmW NR call was established. Between 15s~135s, mmW exposure is the dominant contributor. Here, Smart Transmit algorithm allocates a maximum of 75% for mmW (i.e., at least 25% is allocated to 4G LTE anchor to maintain the link) based on the reserve settings in Table 3-1. From Table 7-1, this corresponds to a normalized $4cm^2$PD exposure value for Beam ID 23 of (75% * 1.224 W/m^2)/(10 W/m^2) = 9.2% ± 2.8dB device related uncertainty (see green and orange curve between 15s~135s). At 135s time mark, LTE is set to all-up bits, taking away margin from mmW exposure gradually (orange curve for mmW exposure goes down while black curve for LTE exposure goes up). At 210s time mark, LTE is set to all-down bits, which results in mmW getting back RF margin slowly as seen by gradual increase in mmW exposure (orange curve for mmW exposure goes up while black curve for LTE exposure goes down). The calculated maximum RF exposure from LTE corresponds to normalized 10gSAR exposure value of (100% * 2.242 W/kg)/(4.0 W/kg) = 56% ± 0.7dB design related uncertainty (note that this level will be achieved by green and black curves if LTE remains in all-up bits for longer time duration which was already demonstrated in maximum transmit power test in Section 7.3.2). Total normalized time-averaged exposure (green curve) for this test should be within the calculated range between 9.2% ± 2.8dB device related uncertainty (only PD exposure) and 56% ± 0.7dB design related uncertainty (only SAR exposure).

As can be seen, the power limiting enforcement is effective during transmission when SAR and PD exposures are switched, and the total normalized time-averaged RF exposure does not exceed 1.0. Therefore, Qualcomm® Smart Transmit time averaging algorithm is validated

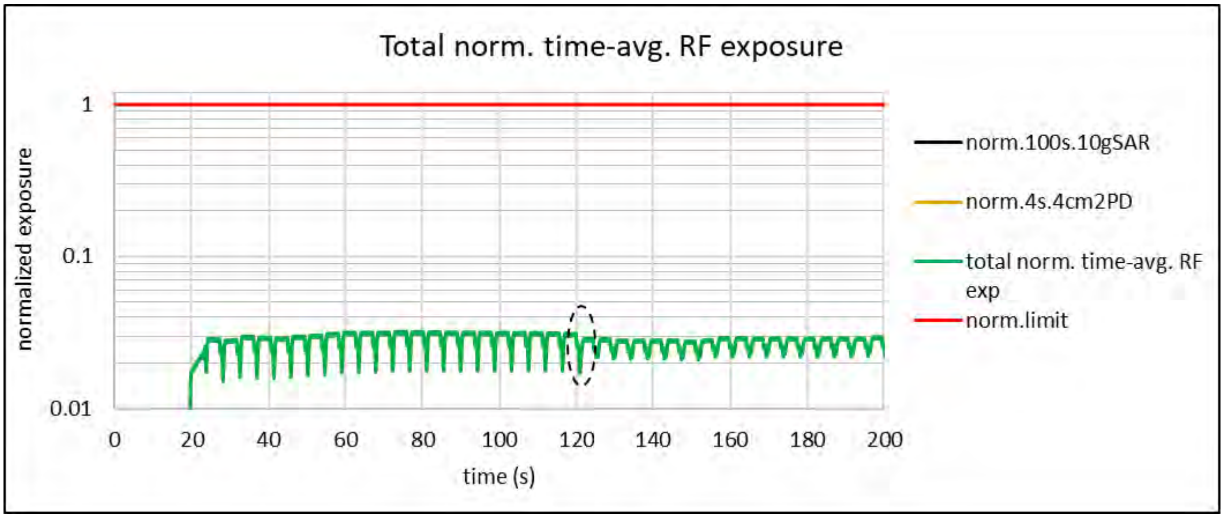
7.3.5 Change in Beam test results for n261

This test was measured with LTE Band 2 (DSI = 1) and mmW Band n261, with beam switch from Beam ID 4 to Beam ID 0, by following the test procedure is described in Section 5.3.3.

Instantaneous conducted LTE Tx power and instantaneous radiated mmW Tx power versus time:



Normalized time-averaged exposures for LTE and mmW ($4cm^2$PD), as well as total normalized time-averaged exposure versus time:



FCC requirement for total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure (green curve)	0.032
Validated	

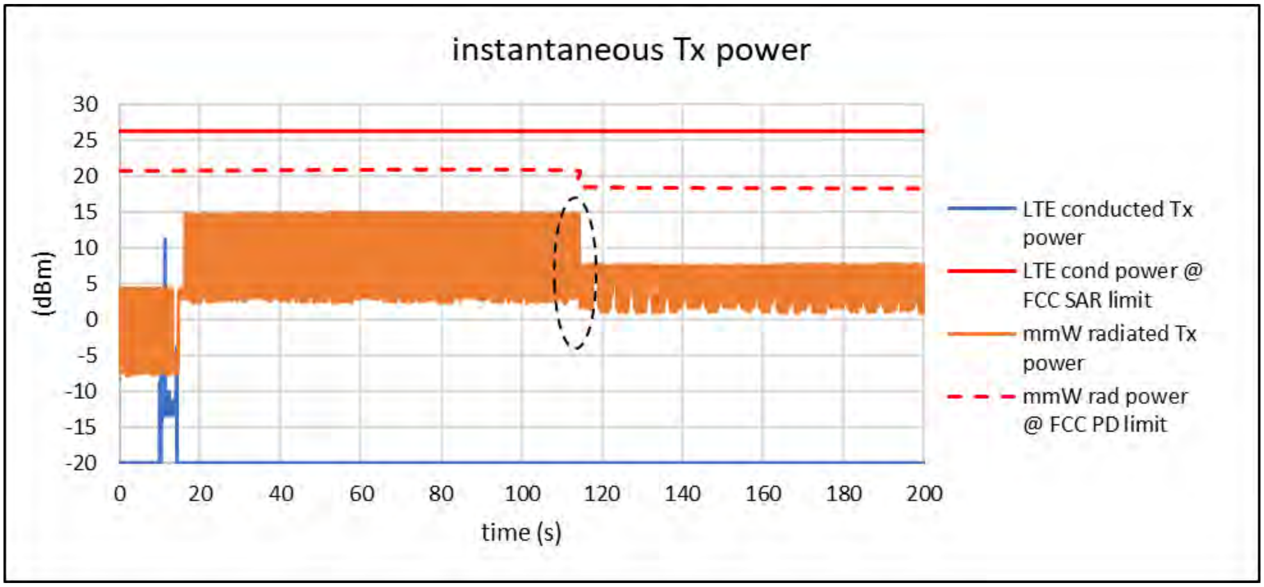
Plot notes: 5G mmW NR call was established at ~20s time mark and LTE was placed in all-down bits immediately after 5G mmW NR call was established. For the rest of this test, mmW exposure is the dominant contributor as LTE is left in all-down bits. Here, Smart Transmit algorithm allocates a maximum of 75% for mmW (i.e., at least 25% is allocated to 4G LTE anchor to maintain the link) based on the reserve settings in Table 3-1. From Table 7-1, exposure between 20s ~120s corresponds to a normalized $4cm^2$PD exposure value for Beam ID 4 of (75% * 0.447 W/m^2)/(10 W/m^2) = 3.4% ± 2.8dB device related uncertainty (see green and orange curve between 20s~120s). At ~120s time mark (shown in black dotted ellipse), beam is switched to Beam ID 0 resulting in a normalized $4cm^2$PD exposure value of (75% * 0.443 W/m^2)/(10 W/m^2) = 3.3% ± 2.8dB device related uncertainty (see green and orange curve >~120s). Additionally, during the switch, the ratio between the peak radiated powers of the two beams should correspond to the ratio of EIRPs (within ±2.8dB device uncertainty) for these beams listed in Table 7-1.

As can be seen, the power limiting enforcement is effective during beam switches and the total normalized time-averaged RF exposure does not exceed 1.0. Therefore, Qualcomm® Smart Transmit time averaging algorithm is validated.

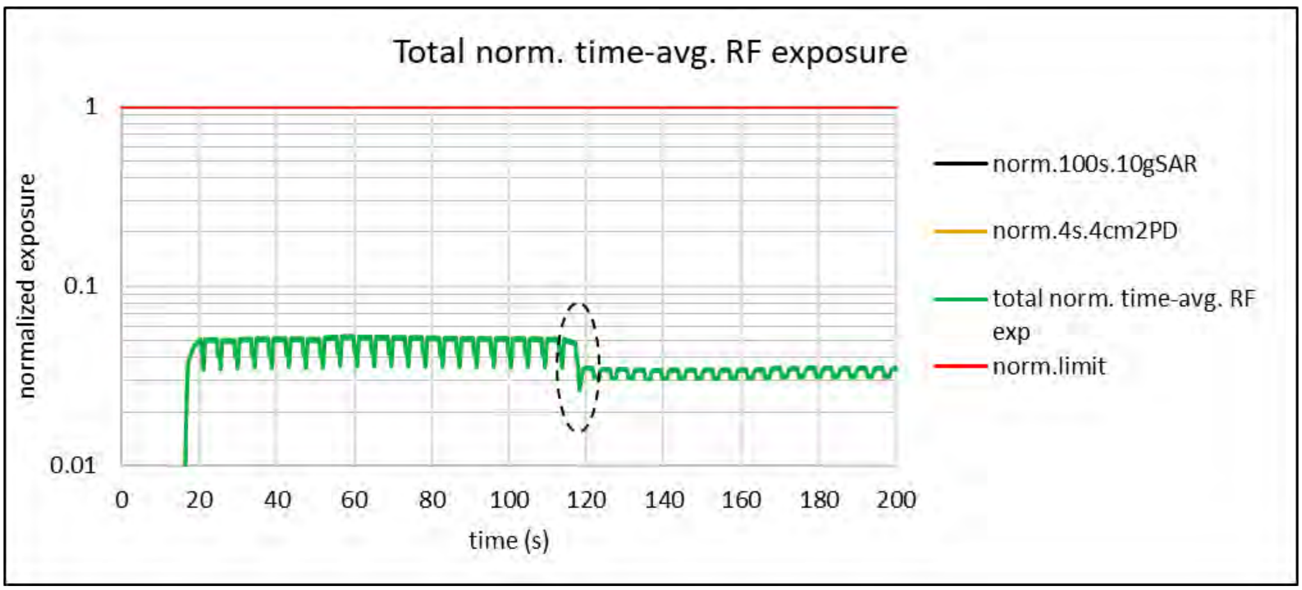
7.3.6 Change in Beam test results for n260

This test was measured with LTE Band 2 (DSI = 1) and mmW Band n260, with beam switch from Beam ID 3 to Beam ID 0, by following the test procedure is described in Section 5.3.3.

Instantaneous conducted LTE Tx power and instantaneous radiated mmW Tx power versus time:



Normalized time-averaged exposures for LTE (10gSAR) and mmW (4cm^{2}PD), as well as total normalized time-averaged exposure versus time:



FCC requirement for total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure (green curve)	0.053
Validated	

Plot notes: 5G mmW NR call was established at ~20s time mark and LTE was placed in all-down bits immediately after 5G mmW NR call was established. For the rest of this test, mmW exposure is the dominant contributor as LTE is left in all-down bits. Here, Smart Transmit algorithm allocates a maximum of 75% for mmW (i.e., at least 25% is allocated to 4G LTE anchor to maintain the link) based on the reserve settings in Table 3-1. From Table 7-1, exposure between 20s ~120s corresponds to a normalized $4cm^2$PD exposure value for Beam ID 3 of (75% * 0.635 W/m^2)/(10 W/m^2) = 4.8% ± 2.8dB device related uncertainty (see green and orange curve between 20s~120s). At ~120s time mark (shown in black dotted ellipse), beam is switched to Beam ID 0 resulting in a normalized $4cm^2$PD exposure value of (75% * 0.349 W/m^2)/(10 W/m^2) = 2.6% ± 2.8dB device related uncertainty (see green and orange curve >~120s). Additionally, during the switch, the ratio between the peak radiated powers of the two beams should correspond to the ratio of EIRPs (within ±2.8dB device uncertainty) for these beams listed in Table 7-1.

As can be seen, the power limiting enforcement is effective during beam switches and the total normalized time-averaged RF exposure does not exceed 1.0. Therefore, Qualcomm® Smart Transmit time averaging algorithm is validated.

8 PD Test Results for mmW Smart Transmit Algorithm Validation

8.1 Measurement setup

The measurement setup is similar to normal PD measurements, the EUT is positioned on DASY platform, and is connected with the callbox (conducted for LTE and wirelessly for mmW). Keysight UXM callbox is set to request maximum mmW Tx power from EUT all the time. Hence, “path loss” calibration between callbox antenna and EUT is not needed in this test. The callbox’s LTE port is directly connected to the EUT’s RF port via a directional coupler to measure the EUT’s conducted Tx power using a Rohde & Schwarz NR8S power sensor and NRP2 power meter. Additionally, EUT is connected to the PC via USB connection for toggling between FTM and online mode with Smart Transmit enabled following the test procedures described Section 5.4.

Worst-surface of EUT (for the mmW beam being tested) is positioned facing up for PD measurement with DASY mmW probe as shown in Figure 8-1. Figure 8-2 shows the schematic of this measurement setup.

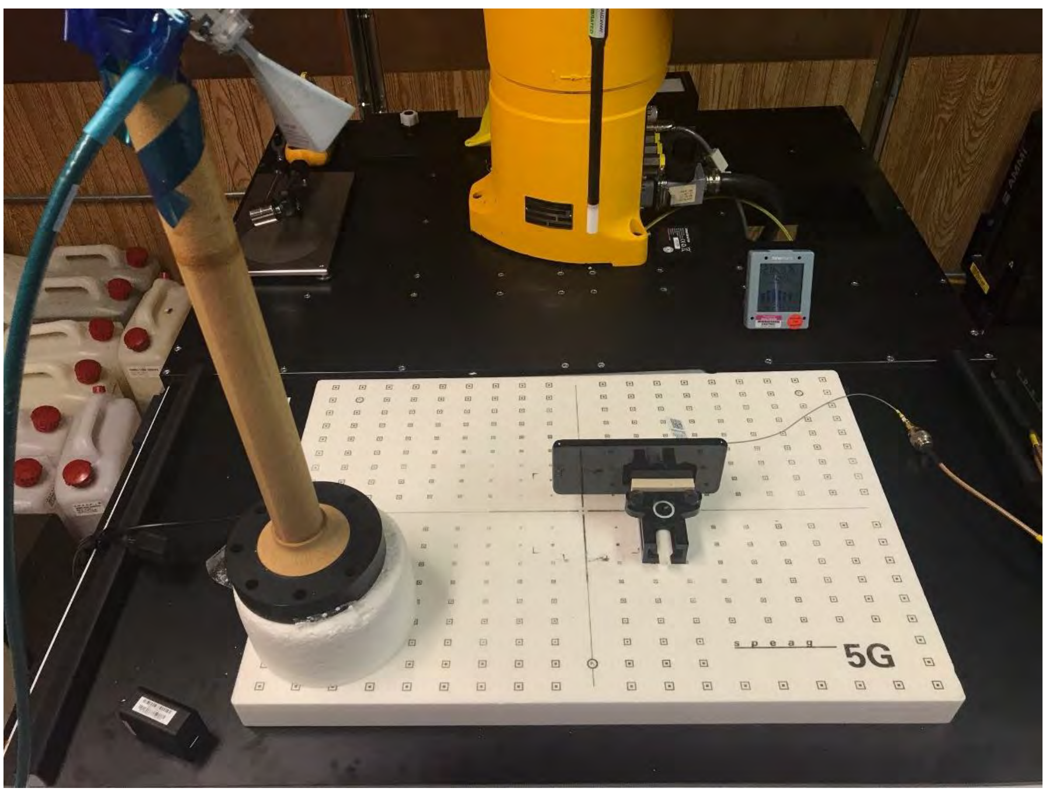


Figure 8-1 Worst-surface of EUT positioned facing up for the mmW beam being tested

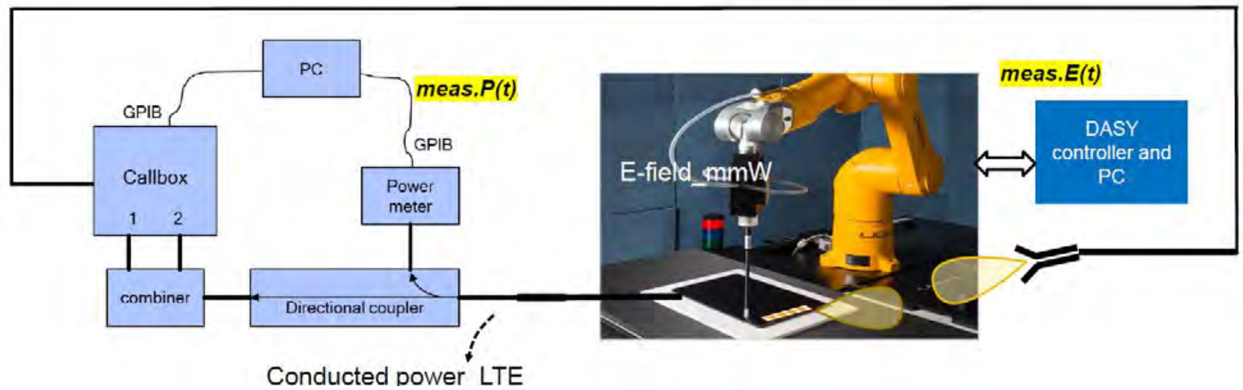


Figure 8-2 PD measurement setup

Both the callbox and power meters are connected to the PC using USB cables. Test scripts are custom made for automation of establishing LTE + mmW call, conducted Tx power recording for LTE. These tests are manually stopped after desired time duration. Once the mmW link is established, LTE Tx power is programmed to toggle between all-up and all-down bits on the callbox. For all the tests, the callbox is set to request maximum Tx power in mmW NR radio from EUT all the time. Therefore, the calibration for the pathloss between the EUT and the horn antenna connected to the remote radio head of the callbox is not required.

Power meter readings are periodically recorded every 10ms on NR8S power sensor for LTE conduced power. Time-averaged E-field measurements are performed using EUmmWV2 mmW probe at peak location of fast area scan. The distance between EUmmWV2 mmW probe tip to EUT surface is ~0.5 mm, and the distance between EUmmWV2 mmW probe sensor to probe tip is 1.5 mm. Appendix B furthermore detailed the steps for performing time-averaged E-field measurements using cDASY6 measurement system used for this validation. cDASY6 records relative point E-field values at mmW frequencies periodically every 0.1s seconds. Running average is performed on the extracted data during post-processing.

8.2 PD measurement results for maximum power transmission scenario

The following configurations were measured by following the detailed test procedure is described in Section 5.4:

1. LTE Band 2 (DSI =1) and mmW Band n261 Beam ID 23
2. LTE Band 2 (DSI =1) and mmW Band n260 Beam ID 23

Similar to the maximum transmit power test described in Section 7.3.1 and Section 7.3.2, by applying LTE 10gSAR value and 4cm^{2}PD levels at *input.power.limit* of mmW listed in Table 7-1, the measured conducted Tx power of LTE is converted into the *10gSAR(t)* and ratio of $\frac{[pointE(t)]^2}{[pointE\_input.power.limit]^2}$ of mmW is converted into *4cm^{2}PD(t)* value, respectively, using Eq. (2a) and (2b), rewritten below:

$$1g\_or\_10gSAR(t) = \frac{conducted\_Tx\_power(t)}{conducted\_Tx\_power\_P_{limit}} * 1g\_or\_10gSAR\_P_{limit} \qquad (2a)$$

$$4cm^2PD(t) = \frac{[pointE(t)]^2}{[pointE\_input.power.limit]^2} * 4cm^2PD\_input.power.limit \quad (2b)$$

$$\frac{\frac{1}{T_{SAR}}\int_{t-T_{SAR}}^{t} 1g\_or\_10gSAR(t)dt}{FCC\ SAR\ limit} + \frac{\frac{1}{T_{PD}}\int_{t-T_{PD}}^{t} 4cm^2PD(t)dt}{FCC\ 4cm^2PD_{limit}\ of\ 10W/m^2} \leq 1 \quad (2c)$$

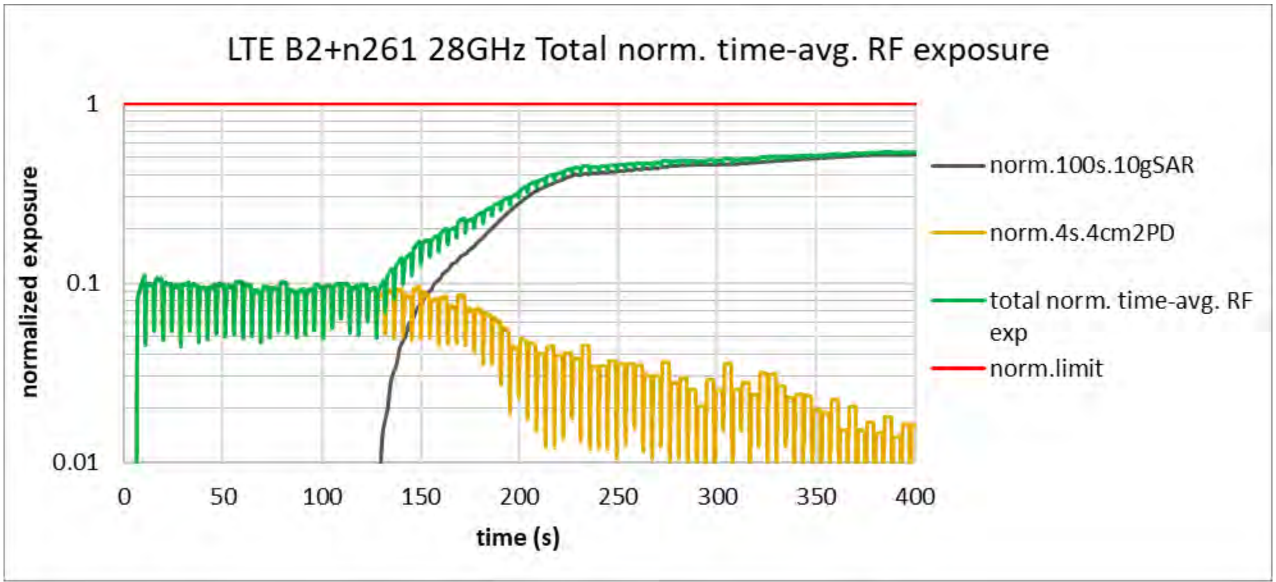
Where, $conducted\_Tx\_power(t)$, $conducted\_Tx\_power\_P_{limit}$, and $1g\_or\_10gSAR\_P_{limit}$ correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at P_{limit}, and measured 1gSAR or 10gSAR values at P_{limit}. Similarly, $pointE(t)$, $pointE\_input.power.limit$, and $4cm^2PD@input.power.limit$ correspond to the measured instantaneous E-field, E-field at *input.power.limit*, and $4cm^2$PD value at *input.power.limit*.

NOTE: If $P_{limit} \geq P_{max}$, 1gSAR or 10gSAR measured at P_{limit} shall be replaced with 1gSAR or 10gSAR measured at P_{max}.

NOTE: cDASY6 system measures relative E-field, and provides ratio of $\frac{[pointE(t)]^2}{[pointE\_input.power.limit]^2}$ versus time. See Appendix B for time-averaged PD measurement details.

8.2.1 PD test results for n261

Step 2.e plot (in Section 5.4) for normalized time-averaged exposures for LTE and mmW n261 beam 23:



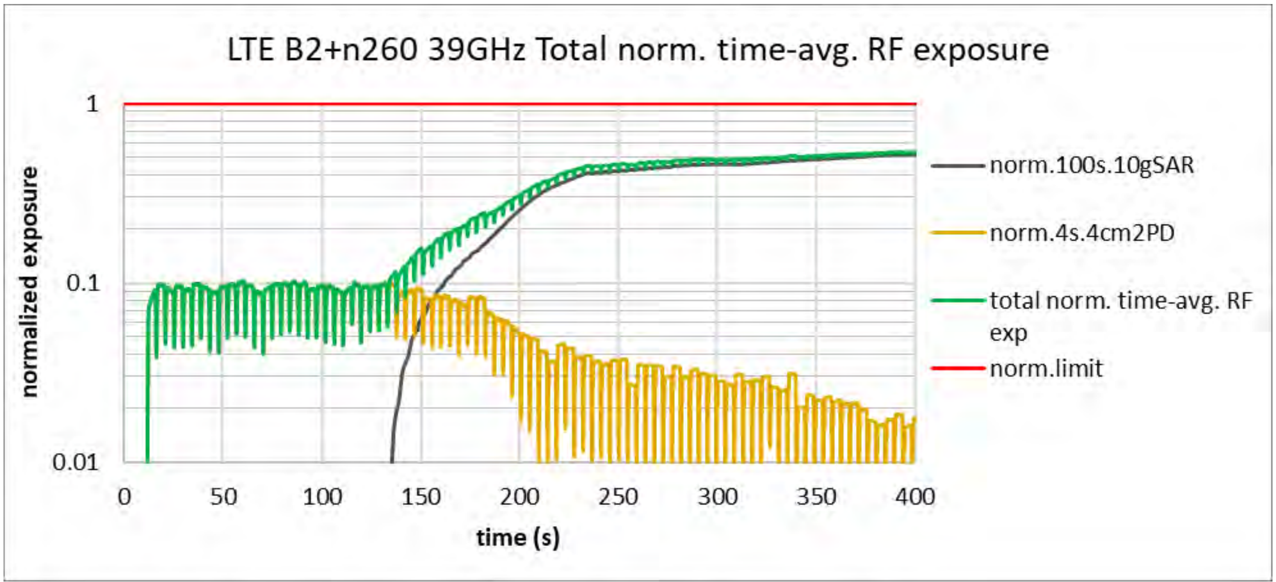
FCC limit for total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure (green curve)	0.537
Validated	

Plot notes: LTE was placed in all-down bits immediately after 5G mmW NR call was established. Between 10s~130s, mmW exposure is the dominant contributor. Here, Smart Transmit algorithm allocates a maximum of 75% for mmW (i.e., at least 25% is allocated to 4G LTE anchor to maintain the link) based on the reserve settings in Table 3-1. From Table 7-1, this corresponds to a normalized $4cm^2$PD exposure value for Beam ID 23 of (75% * 1.186 W/m^2)/(10 W/m^2) = 8.9% ± 2.8dB device related uncertainty (see green and orange curve between 10s~130s). Around 130s time mark, LTE is set to all-up bits, taking away margin from mmW exposure gradually. Towards the end of the test, LTE is the dominant contributor towards RF exposure, i.e., corresponding normalized 10gSAR exposure value of (100% * 2.242 W/kg)/(4.0 W/kg) = 56% ± 0.7dB design related uncertainty (see green and black curves approaching this level towards end of the test).

As can be seen, the power limiting enforcement is effective and the total normalized time-averaged RF exposure does not exceed 1.0. Therefore, Qualcomm® Smart Transmit time averaging algorithm is validated.

8.2.2 PD test results for n260

Step 2.e plot (in Section 5.4) for normalized time-averaged exposures for LTE and mmW n260 beam 23:



FCC limit for total RF exposure	1.0
Max total normalized time-averaged RF exposure (green curve)	0.536
Validated	

Plot notes: LTE was placed in all-down bits immediately after 5G mmW NR call was established. Between 20s~140s, mmW exposure is the dominant contributor. Here, Smart Transmit algorithm allocates a maximum of 75% for mmW (i.e., at least 25% is allocated to 4G LTE anchor to maintain the link) based on the reserve settings in Table 3-1. From Table 7-1, this corresponds to a normalized $4cm^2$PD exposure value for Beam ID 23 of (75% * 1.224 W/m^2)/(10 W/m^2) = 9.2% ± 2.8dB device related uncertainty (see green and orange curve between 20s~140s). Around 140s time mark, LTE is set to all-up bits, taking away margin from mmW exposure gradually. Towards the end of the test, LTE is the dominant contributor towards RF exposure, i.e., corresponding normalized 10gSAR exposure value of (100% * 2.242 W/kg)/(4.0 W/kg) = 56% ± 0.7dB design related uncertainty (see green and black curves approaching this level towards end of the test).

As can be seen, the power limiting enforcement is effective and the total normalized time-averaged RF exposure does not exceed 1.0. Therefore, Qualcomm® Smart Transmit time averaging algorithm is validated.

9 Conclusions

Qualcomm Smart Transmit feature for managing time-averaging of RF exposure, employed in LGE portable handset (FCC ID: ZNFV450VM) has been validated through the conducted/radiated power measurement (as demonstrated in Section 7), as well as PD measurement (as demonstrated in Section 8).

As demonstrated in this report, the power limiting enforcement is effective and the total normalized time-averaged RF exposure does not exceed 1.0 for all the transmission scenarios described in Section 4.

Furthermore, with Qualcomm Smart Transmit feature enabled, the simultaneous analysis has been re-evaluated (see Appendix C).

In conclusion, all transmission scenarios that EUT supports comply with FCC time-averaged RF exposure requirement after accounting for total device related uncertainty.

Table 9-1: *Reported* RF exposure level

	Reported RF Exposure Level	Notes
Highest 1g SAR at P_{limit} (W/kg)	1.07	[B1]
Highest 10g SAR at P_{limit} (W/kg)	2.51	[B1]
Highest 4cm^2-avg PD at *input.power.limit* (W/m^2)	7.12	Appendix C
Highest 1g SAR for simultaneous Tx (2G/3G/4G WWAN + WLAN + BT)	1.58	[B1]
Highest 10g SAR for simultaneous Tx (2G/3G/4G WWAN + WLAN + BT)	3.94	[B1]
Highest Total Exposure Ratio for simultaneous Tx (LTE+5G mmW NR + WLAN + BT)	0.92	Appendix C

10 Bibliography

[B1] Document S/N 1M1901150005-01-R3.ZNF: *ZNFV450VM SAR Evaluation Report*

[B2] Document S/N 1M1901150005-15_R3.ZNF: *ZNFV450VM Near Field Power Density Evaluation Report*

A Appendix A: PD Measurement System Validation

A.1 Test environment

Test location	Qualcomm Incorporated, Inc. 5775 Morehouse Dr., San Diego, CA 92121
Ambient temperature	22±2^{0}C
Tissue simulating liquid	22±2^{0}C
Humidity range	30% ~ 49%

A.2 Power density measurement system

Table A-1 provides the list of calibrated equipment.

Table A-1 List of calibrated equipment

Equipment Manufacturer and Type	Serial number	Last Calibrated	Next Calibration
Rohde & Schwarz NR8S Power Sensor	105485	1/17/2019	1/17/2020
Rohde & Schwarz NR50S Power Sensor	101086	2/18/2019	2/18/2021
Keysight UXM 5G Wireless Test Platform	MY57510551	2/2/2018	N/A
Keysight Input E7770A	GB57330038	11/16/2018	N/A
Keysight mmWave transceiver M1740A	US58230232	12/11/2018	N/A
Keysight mmWave transceiver M1740A	US58230215	12/14/2018	N/A

Appendix D lists the calibration certificates for the measurement equipment used in this report.

The PD measurement system is operated within a shielded screen room manufactured by Lindgren RF Enclosures to provide isolation from external EM fields. The phantom bench is placed on two ferrite panels measuring 2 ft^2 each to minimize reflected energy that would otherwise re-enter the phantom and combine constructively or destructively with the desired results

The power density measurement system is constructed based on the DASY6 platform by SPEAG (see Figure A-1). The DASY6 with EUmmWv2 and 5G software module can measure the electromagnetic exposure (electromagnetic and power density) up to 110GHz as close as 2mm from any transmitter.

Figure A-1 Power density measurement system

A.2.1 Power density probe

The novel EUmmWV2 probe is used in the power density measurement. It is designed for precise near-field measurements in the mm-wave range by Schmid & Partner Engineering AG of Zurich, Switzerland. The specifications are:

- Frequency range: 0.75 ~ 110 GHz
- Dynamic range: <50 – 3000 V/m (up to 10000 V/m with additional PRE-10 voltage divider)
- Linearity: < ± 0.2 dB
- Supports sensor model calibration (SMC)
- ISO17025 accredited calibration

A.2.2 Power density measurement system verification

The power density system verification is performed using the SPEAG verification device. It consists of a ka-band horn antenna with a corresponding gun oscillator packaged with a cube-shaped housing (see Figure A-2).

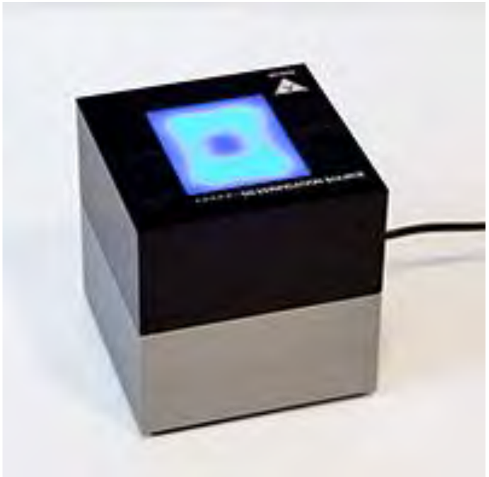


Figure A-2 Ka-band verification device

The specification of the verification device is

- Calibrated frequency: 30 GHz at 10 mm from the case surface
- Frequency accuracy: ± 100 MHz
- E-field polarization: linear
- Harmonics: -20 dBc (typ)
- Total radiated power: 14 dBm (typ)
- Power stability: 0.05 dB
- Power consumption: 5 W (max)
- Size: 100 × 100 × 100 mm
- Weight: 1 kg

Table A-2 shows the verification test results. The measured power density (PD) value is within 0.5dB of target level. Note that the uncertainty of 5G verification source is 1.4dB (k=2).

Table A-2 System validation results

Validation kit	S/N	Frequency (GHz)	14dBm Target PD (W/m^2)	14dBm Meas. PD (W/m^2)	Deviation (%)	Date
Ka-band source	1012	30	47.9 ($4cm^2$)	43.2($4cm^2$)	-0.45dB ($4cm^2$)	4/5/2019

Scan Setup

Scan Type	5G Scan
Grid Extents [mm]	60 x 60
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	5.55

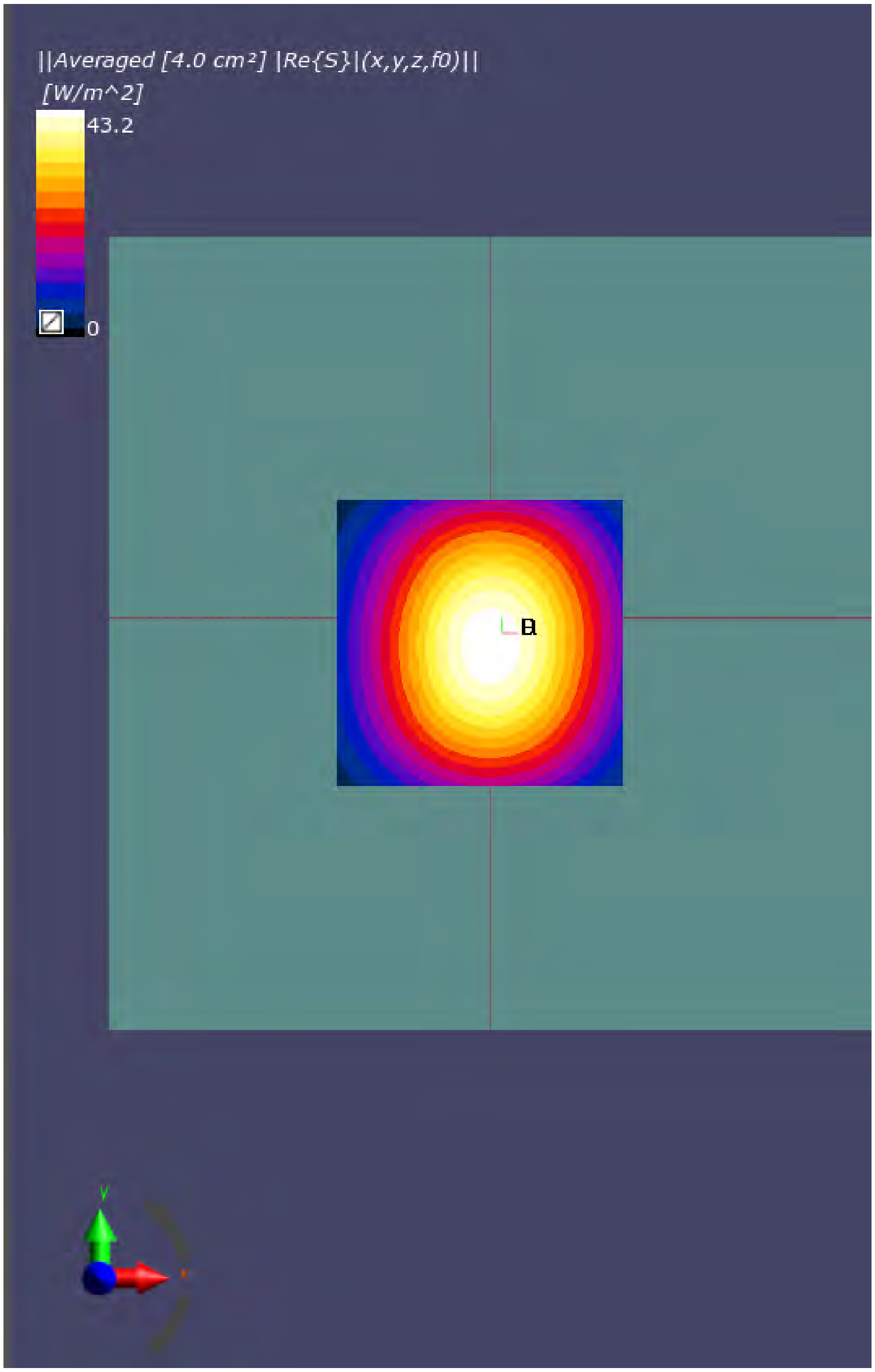
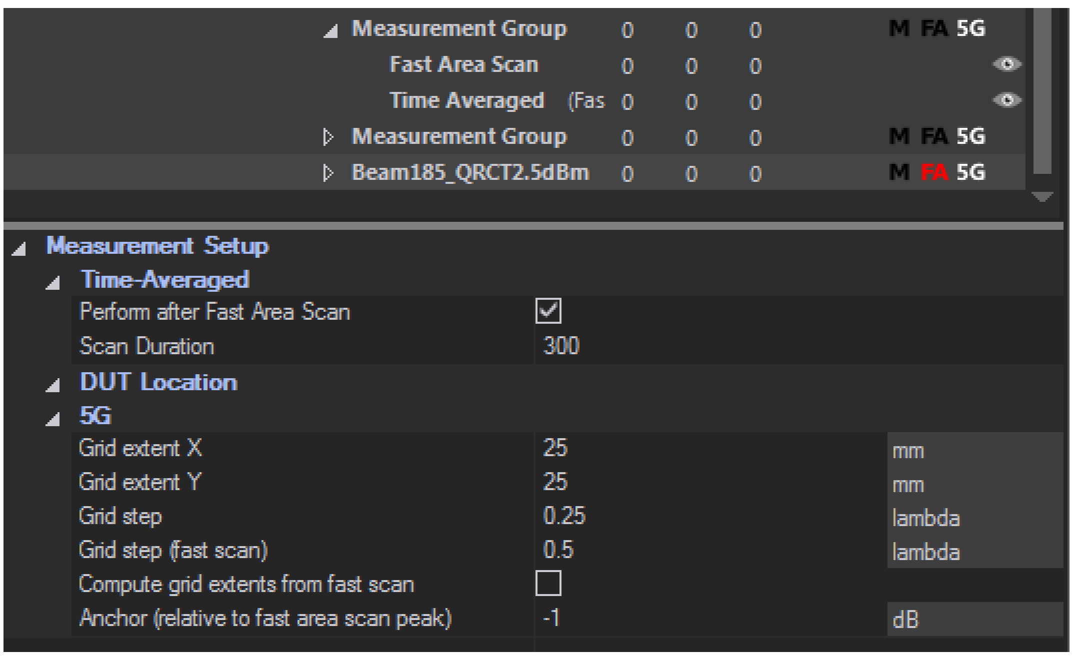


Figure A-1 ***4cm²PD*** **for source validation on 4/5/2019**

B Test Procedure for Time-Averaged PD Measurement Using cDASY6

Test procedures for time-averaged PD measurement with cDASY6 system:

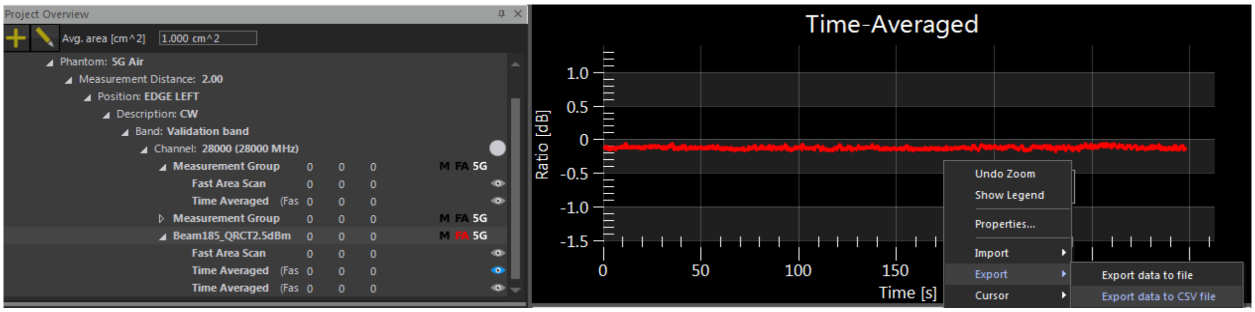
1. Setup the EUT to transmit in the desired band, channel and beam configuration at *input.power.limit*.
2. In cDASY6, enable checkbox for time-averaged measurement option after Fast Area Scan in Measurement Setup settings (see screen capture below), and set the duration of the scan to 300s. Fast area scan quickly scans the area to identify the hotspot location with highest E-field along the polarization of the sensor inside the mmW probe.



3. For tests where the callbox requesting EUT to transmit at maximum power at all times, mmW path loss between EUT and the callbox need not be calibrated.
4. Setup EUT to transmit at *input.power.limit* via Factory Test Mode (FTM) and perform the fast area scan with time-average scan enabled. After the fast area scan, cDASY6 will pause for time-average measurement at the peak location of fast area scan.
5. To measure time-average PD for maximum power test sequences: place EUT in online mode without disturbing the wireless device position relative to the mmW probe. Start the cDASY6 time-averaged measurement with EUT in mmW call and the callbox requesting maximum

power in mmW link at all times. After this step, user should click 'no' on the prompt for an additional cDASY time-averaged measurements.

6. Extract recorded data in dB scale (i.e., point E-field data versus time normalized to the E-field at peak location from fast area scan in Step 4) from time-averaged measurement as shown below by first viewing the data in field viewer, and then right-click on the plot to export data in csv format.



7. Exported data is in dB scale, *rel_dB(t)*, indicates the PD value versus time is relative to the 4cm2.PD measured at *input.power.limit* in Table 7-1, as given by below equation, i.e.,

$$4cm2PD(t) = 10^{[rel\_dB(t)/10]} * 4cm2PD\_P_{limit}$$

8. The above equation is represented as equation (2b) in this report re-written below:

$$4cm^2PD(t) = \frac{[pointE(t)]^2}{[pointE\_input.power.limit]^2} * 4cm^2PD\_input.power.limit \qquad (2b)$$

where, $\frac{[pointE(t)]^2}{[pointE_{input}.power.limit]^2}$ is a ratio between E-field for time-varying mmW Tx power and E-field measured at *input.power.limit*, which is also represented by $10^{[rel\_dB(t)/10]}$.

C Simultaneous Transmission Analysis

The EUT supports simultaneous transmission of multiple radios. RF exposure compliance in simultaneous transmission scenarios is evaluated in this section.

It must be noted here that Qualcomm® Smart Transmit time-averaging algorithm was applied to only WWAN (2G/3G/4G/5G mmW NR) on this device, where the time-averaged power level is controlled so that RF exposure is ≤ *SAR_design_target* (corresponding *to* P_{limit}) for 2G/3G/4G WWAN and ≤ *PD_design_target* (corresponding to *input.power.limit*) for 5G mmW NR. Since there is total design-related uncertainty arising from TxAGC, device-to-device variation, and time-averaging algorithm, therefore, the worst-case RF exposure can be determined by adding this uncertainty, i.e.,

Table C-1 Worst-case time-averaged RF exposure for WWAN

	WWAN	
	2G/3G/4G	5G mmW NR
Maximum time-averaged power level	P_{limit}	*input.power.limit*
Design-related uncertainty	*0.7 dB*	*2.8 dB*
Worst-case time-averaged RF exposure	*reported* SAR† =1.07W/kg (1gSAR), 2.51W/kg (10gSAR)	*reported PD* = =75% × *meas.PD**+2.8dB = 7.12 W/m^2

† Highest SAR value obtained from PCTEST SAR report at P_{max}[B1]. For this EUT, (P_{limit}+0.7dB uncertainty) ≥ P_{max} (maximum RF tune-up output power). Therefore, time-averaged SAR exposure from Smart Transmit enabled EUT (at P_{limit}) cannot exceed *reported* SAR corresponding to P_{max}.

* It is determined as sum of maximum time-averaged 4cm^2 PD, i.e., PD measured at *input.power.limit*, and total design-related uncertainty of mmW NR, given by

$$reported\ PD = measured\ PD\ at\ input.power.limit + total\ uncertainty$$

For this EUT, the value of highest measured PD at *input.power.limit*, 4.98 W/m^2, is obtained from PCTEST Power Density report [B2]. Smart Transmit allows only 75% of maximum PD exposure for this EUT. See below for details.

For WLAN and BT that do not employ time-averaging in this device, 1gSAR & 10gSAR measurements were conducted for WLAN and BT at the maximum power following current FCC test procedures to determine *reported* SAR values for all required test configurations. Refer to PCTEST SAR report [B1] for WLAN and BT SAR data.

C.1 Analysis

RF exposure compliance with WWAN+WLAN+BT simultaneous transmission scenarios is demonstrated for various radio configurations using below equation:

Total norm. RF exposure = norm. RF exposure from Smart Transmit enabled WWAN (norm. SAR from 2G/3G/4G + norm. PD from 5G mmW NR) + norm. SAR from WLAN + norm. SAR from BT ≤ 1.0 normalized limit (1)

Smart Transmit algorithm in WWAN adds directly the time-averaged RF exposure from 2G/3G/4G and time-averaged RF exposure from 5G mmW NR. The compliance demonstration is shown in Section 7, i.e.,

norm. RF exposure from Smart Transmit enabled WWAN: (normalized SAR exposure from 2G/3G/4G) + (normalized PD exposure from 5G mmW NR) ≤ 1.0 normalized limit (2)

In other words, Smart Transmit algorithm controls the total RF exposure from both 2G/3G/4G radio and 5G mmW NR to not exceed FCC limit. Smart transmit algorithm assumes hotspots are collocated (i.e., ignoring spatial distribution of hotspots) and directly adds normalized RF exposures from 2G/3G/4G and from 5G mmW NR, i.e.,

If *A = max normalized time-averaged SAR exposure from 2G/3G/4G*,

B = max normalized time-averaged PD exposure from 5G mmW NR,

then, equation (2) can be re-written as below because Smart Transmit assumes 2G/3G/4G hotspots are collocated with 5G mmW NR hotspot:

*Smart Transmit enabled WWAN: x(t) * A + (1-x(t)) * B ≤ 1.0 normalized limit* (3)

Here, "*x(t)*A*" represents percentage of normalized time-averaged RF exposure from 2G/3G/4G, and *x(t)* ranges between [0,1]; "*(1-x(t))*B*" is remaining percentage of RF exposure contribution from 5G mmW NR. Smart Transmit controls '*x*' in real time such that the sum of these exposures never exceeds 1.0 normalized limit.

Note that mathematically,

$x(t) * A + (1-x(t)) * B \leq max(A,B) \leq 1.0\, normalized\ limit$, for $x(t) \in [0,1]$ (4)

Therefore, if below equations (5a) and (5b) are proven,

$A + norm.SAR\ from\ WLAN + norm.SAR\ from\ BT \leq 1.0\, norm.limit$ (5a),

and

$B + norm.SAR\ from\ WLAN + norm.SAR\ from\ BT \leq 1.0\, norm.limit$ (5b),

Then, based on equation (4), below condition is also proved:

$[x(t) * A + (1-x(t)) * B\ ] + norm.SAR\ from\ WLAN + norm.SAR\ from\ BT \leq 1.0\, norm.limit$ (5c),

which is same as equation (1), to demonstrate compliance for simultaneous transmission.

Additionally, it should be noted that in the absence of 5G mmW NR, Smart Transmit limits the maximum RF exposure contributed from 2G/3G/4G to 100% normalized exposure (i.e., x=1.0 in equation 3), while with 5G mmW NR active, Smart Transmit limits the maximum RF exposure contributed from 5G mmW NR to 75% normalized exposure to guarantee at least 25% margin allocated to 4G LTE anchor to maintain the link (i.e., x=0.25 in equation 3). Therefore,

Smart Transmit enabled WWAN: A=max (normalized SAR exposure from 2G/3G/4G) ≤ 1.0 normalized limit (6a)

Smart Transmit enabled WWAN: B=max (normalized PD exposure from 5G mmW NR) ≤ 0.75 normalized limit (6b)

Thus, for compliance demonstration given by equation (1), below equation (7) obtained by combining equations (5a & 5b) and (6a & 6b), should be proven to guarantee simultaneous transmission compliance:

Total normalized RF exposure = norm. SAR from 2G/3G/4G WWAN + norm. SAR from WLAN + norm. SAR from BT < 1.0 normalized FCC limit (7a)

*Total normalized RF exposure = 0.75*norm. PD from 5G mmW NR WWAN + norm. SAR from WLAN + norm. SAR from BT < 1.0 normalized FCC limit* (7b)

Based on PCTEST Power Density report [B2], and Table C-1, the reported PD for the worst-case time-averaged PD exposure is listed in Table C-2, which will be used for simultaneous transmission analysis in the following sections.

Table C-2 Worst-case time-averaged 5G mmW NR exposure from Smart Transmit-enabled WWAN

Band	Beam	exposure surface (at 2mm)	meas. PD (W/m2)	***Smart Transmit*** *reported* PD =0.75*meas. PD+ 2.8dB (W/m2)
n261	(14,141)	Back	1.65	2.36
		Front	1.87	2.67
		Top*	4.52	6.46
		Right	4.52	6.46
		Left	4.19	5.99
n260	(12,140)	Back	1.26	1.80
		Front	1.65	2.36
		Top*	4.98	7.12
		Right	4.98	7.12
		Left	4.42	6.32

* PD data for worst-case Right surface is used for Top surface

The compliance for simultaneous transmission scenarios of WWAN (2G/3G/4G/5G mmW NR) radio enabled with Smart Transmit and WLAN/BT without Smart Transmit is re-evaluated in this appendix for all transmission scenarios supported by this EUT as listed in Table 1-2 of PCTEST SAR report [B1].

Note as described in equation (7), simultaneous transmission analysis for WWAN + WLAN + BT is performed in two parts:

a. 2G/3G/4G WWAN + WLAN + BT (i.e., Eq. (7a) with compliance demonstration in Appendix C.2)

b. 5G mmW NR WWAN + WLAN + BT (i.e., Eq. (7b) with compliance demonstration in Appendix C.3)

By combining above a. and b., the FCC requirement expressed in Eq. (1), re-written below, is met

Total norm. RF exposure = norm. RF exposure from Smart Transmit enabled WWAN (norm. SAR from 2G/3G/4G + norm. PD from 5G mmW NR) + norm. SAR from WLAN + norm. SAR from BT ≤ 1.0 normalized limit (1)

C.2 Simultaneous Transmission Compliance demonstration for 2G/3G/4G WWAN + WLAN + BT

For this EUT in all the supported 2G/3G/4G WWAN technologies, bands, antennas and DSIs, P_{limit} is ≥ P_{max} (maximum RF tune-up power). Therefore, simultaneous transmission analysis is performed at P_{max}, which is shown in Section 12 of PCTEST SAR report [B1].

C.3 Simultaneous Transmission Compliance demonstration for 5G mmW NR WWAN + WLAN + BT

Simultaneous transmission analysis performed in PCTEST SAR report [B1] is being re-evaluated in this section using worst-case PD values listed in Table C-2 for compliance demonstration of 5G mmW NR WWAN + WLAN + BT, along with all worst-case *reported* SAR values for WLAN and BT extracted from PCTEST SAR report [B1].

Note that since this EUT is enabled with Qualcomm Smart Transmit feature, the simultaneous transmission analysis in this section supersedes Appendix A of PCTEST Power Density report [B2].

Simultaneous transmission analysis on all 5G mmW NR WWAN + WLAN + BT scenarios supported by this EUT are listed below:

Table C-3 Simultaneous transmission analysis scenarios for 5G mmW NR WWAN + WLAN + BT

1	2.4GHz WLAN Ant1 + 2.4GHz WLAN Ant 2 + 5G mmW NR
2	2.4GHz WLAN Ant1 + 5GHz WLAN Ant 2 + 5G mmW NR
3	5GHz WLAN Ant1 + 5GHz WLAN Ant 2 + 5G mmW NR
4	5GHz MIMO WLAN + BT + 5G mmW NR

The total exposure ratio (TER) is calculated using the equation below:

$$TER = \sum_{n=1}^{N} \frac{\mathrm{SAR}_n}{\mathrm{SAR}_{n,limit}} + \sum_{m=1}^{M} \frac{S_{m,avg}}{S_{m,limit}} < 1$$

(*) For test positions that were not required to be evaluated for WLAN SAR per FCC KDB publication 248227, the worst-case WLAN SAR result for the applicable exposure conditions was used for simultaneous transmission analysis.

Table C-4 TER for 2.4GHz WLAN Ant1 + 2.4GHz WLAN Ant2 + 5G mmW NR n261

Exposure condition	Configuration	2.4GHz WLAN Ant 1 SAR (W/kg)	2.4GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	SAR/1.6	S† (W/m2)	S/10	TER
Head SAR	Front	0.528	0.229	0.757	0.473	2.67	0.267	0.740
Body-worn SAR	Back	0.08	0.154	0.234	0.146	2.67	0.267	0.413
Hotspot SAR	Back	0.08	0.154	0.234	0.146	2.36	0.236	0.382
	Front	0.142*	0.08*	0.222	0.139	2.67	0.267	0.406
	Top	0.206	0.026*	0.232	0.145	6.46	0.646	**0.791**
	Bottom	0.000	0.000	0.000	0.000	0.00	0.000	0.000
	Right	0.028	0.147	0.175	0.109	6.46	0.646	0.755
	Left	0.000	0.000	0.000	0.000	5.99	0.599	0.599

† Note: Front side power density at 2mm were used for head TER analysis. Worst-case back side power density at 2mm was used for body-worn TER analysis. Worst-case back, front, left, right and top edge power density were used for hotspot TER analysis.

Note: NR Band n261 was evaluated using MIMO (H+V) polarization

*Note 'peak SAR of area scan' was used for conservative TER analysis

Note: Per FCC guidance, the device edges that are not required to be evaludated are indicated 0 for TER analysis.

Table C-5 TER for 2.4GHz WLAN Ant1 + 2.4GHz WLAN Ant2 + 5G mmW NR n260

Exposure condition	Configuration	2.4GHz WLAN Ant 1 SAR (W/kg)	2.4GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	SAR/1.6	S† (W/m2)	S/10	TER
Head SAR	Front	0.528	0.229	0.757	0.473	2.36	0.236	0.709
Body-worn SAR	Back	0.08	0.154	0.234	0.146	2.36	0.236	0.382
Hotspot SAR	Back	0.08	0.154	0.234	0.146	1.80	0.180	0.326
	Front	0.142*	0.08*	0.222	0.139	2.36	0.236	0.375
	Top	0.206	0.026*	0.232	0.145	7.12	0.712	**0.857**
	Bottom	0.000	0.000	0.000	0.000	0.00	0.000	0.000
	Right	0.028	0.147	0.175	0.109	7.12	0.712	0.821
	Left	0.000	0.000	0.000	0.000	6.32	0.632	0.632

† Note: Front side power density at 2mm were used for head TER analysis. Worst-case back side power density at 2mm was used for body-worn TER analysis. Worst-case back, front, left, right and top edge power density were used for hotspot TER analysis.
Note: Due to SW and HW limitations, NR Band n260 was evaluated using SISO H polarization and SISO V polarization
*Note 'peak SAR of area scan' was used for conservative TER analysis
Note: Per FCC guidance, the device edges that are not required to be evaludated are indicated 0 for TER analysis.

Table C-6 TER for 2.4GHz WLAN Ant1 + 5GHz WLAN Ant2 + 5G mmW NR n261

Exposure condition	Configuration	2.4GHz WLAN Ant 1 SAR (W/kg)	5GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	SAR/1.6	S† (W/m2)	S/10	TER
Head SAR	Front	0.528	0.165	0.693	0.433	2.67	0.267	0.700
Body-worn SAR	Back	0.08	0.121	0.201	0.126	2.67	0.267	0.393
Hotspot SAR	Back	0.08	0.121	0.201	0.126	2.36	0.236	0.361
	Front	0.142*	0.032*	0.174	0.109	2.67	0.267	0.376
	Top	0.206	0.036*	0.242	0.151	6.46	0.646	**0.797**
	Bottom	0.000	0.000	0.000	0.000	0.00	0.000	0.000
	Right	0.028	0.039	0.067	0.042	6.46	0.646	0.688
	Left	0.000	0.000	0.000	0.000	5.99	0.599	0.599

† Note: Front side power density at 2mm were used for head TER analysis. Worst-case back side power density at 2mm was used for body-worn TER analysis. Worst-case back, front, left, right and top edge power density were used for hotspot TER analysis.
Note: NR Band n261 was evaluated using MIMO (H+V) polarization
*Note 'peak SAR of area scan' was used for conservative TER analysis
Note: Per FCC guidance, the device edges that are not required to be evaludated are indicated 0 for TER analysis.

Table C-7 TER for 2.4GHz WLAN Ant1 + 5GHz WLAN Ant2 + 5G mmW NR n260

Exposure condition	Configuration	2.4GHz WLAN Ant 1 SAR (W/kg)	5GHz WLAN Ant 2 SAR (W/kg)	Σ SAR (W/kg)	SAR/1.6	S† (W/m2)	S/10	TER
Head SAR	Front	0.528	0.165	0.693	0.433	2.36	0.236	0.669
Body-worn SAR	Back	0.08	0.121	0.201	0.126	2.36	0.236	0.362
Hotspot SAR	Back	0.08	0.121	0.201	0.126	1.80	0.180	0.306
	Front	0.142*	0.032*	0.174	0.109	2.36	0.236	0.345
	Top	0.206	0.036*	0.242	0.151	7.12	0.712	**0.863**
	Bottom	0.000	0.000	0.000	0.000	0.00	0.000	0.000
	Right	0.028	0.039	0.067	0.042	7.12	0.712	0.754
	Left	0.000	0.000	0.000	0.000	6.32	0.632	0.632

† Note: Front side power density at 2mm were used for head TER analysis. Worst-case back side power density at 2mm was used for body-worn TER analysis. Worst-case back, front, left, right and top edge power density were used for hotspot TER analysis.

Note: Due to SW and HW limitations, NR Band n260 was evaluated using SISO H polarization and SISO V polarization

*Note 'peak SAR of area scan' was used for conservative TER analysis

Note: Per FCC guidance, the device edges that are not required to be evaludated are indicated 0 for TER analysis.

Table C-8 TER for 5GHz WLAN Ant1 + 5GHz WLAN Ant2 + 5G mmW NR n261

Exposure condition	Configuration	5GHz WLAN Ant 1 SAR (W/kg)	5GHz WLAN Ant 2 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	SAR/1.6	S† (W/m2)	S/10	TER
Head SAR	Front	0.368	0.165	0.217	0.75	0.469	2.67	0.267	0.736
Body-worn SAR	Back	0.104	0.121	0.041	0.266	0.166	2.67	0.267	0.433
Hotspot SAR	Back	0.095	0.121	0.041	0.257	0.161	2.36	0.236	0.396
	Front	0.158*	0.032*	0.028	0.218	0.136	2.67	0.267	0.403
	Top	0.247*	0.036*	0.047	0.33	0.206	6.46	0.646	**0.852**
	Bottom	0.000	0.000	0.000	0.000	0.000	0.00	0.000	0.000
	Right	0.04	0.039	0.011	0.09	0.056	6.46	0.646	0.702
	Left	0.000	0.000	0.000	0.000	0.000	5.99	0.599	0.599

† Note: Front side power density at 2mm were used for head TER analysis. Worst-case back side power density at 2mm was used for body-worn TER analysis. Worst-case back, front, left, right and top edge power density were used for hotspot TER analysis.

Note: NR Band n261 was evaluated using MIMO (H+V) polarization

*Note 'peak SAR of area scan' was used for conservative TER analysis

Note: Per FCC guidance, the device edges that are not required to be evaludated are indicated 0 for TER analysis.

Table C-9 TER for 5GHz WLAN Ant1 + 5GHz WLAN Ant2 + 5G mmW NR n260

Exposure condition	Configuration	5GHz WLAN Ant 1 SAR (W/kg)	5GHz WLAN Ant 2 SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	SAR/1.6	S† (W/m2)	S/10	TER
Head SAR	Front	0.368	0.165	0.217	0.75	0.469	2.36	0.236	0.705
Body-worn SAR	Back	0.104	0.121	0.041	0.266	0.166	2.36	0.236	0.402
Hotspot SAR	Back	0.095	0.121	0.041	0.257	0.161	1.80	0.180	0.341
	Front	0.158*	0.032*	0.028	0.218	0.136	2.36	0.236	0.372
	Top	0.247*	0.036*	0.047	0.33	0.206	7.12	0.712	**0.918**
	Bottom	0.000	0.000	0.000	0.000	0.000	0.00	0.000	0.000
	Right	0.04	0.039	0.011	0.09	0.056	7.12	0.712	0.768
	Left	0.000	0.000	0.000	0.000	0.000	6.32	0.632	0.632

† Note: Front side power density at 2mm were used for head TER analysis. Worst-case back side power density at 2mm was used for body-worn TER analysis. Worst-case back, front, left, right and top edge power density were used for hotspot TER analysis.

Note: Due to SW and HW limitations, NR Band n260 was evaluated using SISO H polarization and SISO V polarization

*Note 'peak SAR of area scan' was used for conservative TER analysis

Note: Per FCC guidance, the device edges that are not required to be evaludated are indicated 0 for TER analysis.

Table C-10 TER for 5GHz MIMO WLAN + Bluetooth + 5G mmW NR n261

Exposure condition	Configuration	5GHz WLAN MIMO SAR (W/kg)	SAR/4	S (W/m2)	S/10	TER
Phablet SAR	Back	0.915	0.229	2.36	0.236	0.465
	Front	0.242	0.061	2.67	0.267	0.328
	Top	0.242*	0.061	6.46	0.646	0.706
	Bottom	0.000	0.000	0.00	0.000	0.000
	Right	0.290	0.073	6.46	0.646	**0.718**
	Left	0.000	0.000	5.99	0.599	0.599

*Note: WLAN SAR data for Front surface is used for conservative analysis, as its peak SAR is higher than Top surface

Note: Per FCC guidance, the device edges that are not required to be evaludated are indicated 0 for TER analysis.

Note: Per FCC guidance, the bands/modes that are not required to be evaluated for phablet SAR are not considered for TER analysis.

Note: Per FCC guidance, power density measurements at 2mm was used for phablet configuration due to probe restraints.

Note: NR Band n261 was evaluated using MIMO (H+V) polarization

Table C-11 TER for 5GHz MIMO WLAN + Bluetooth + 5G mmW NR n260

Exposure condition	Configuration	5GHz WLAN MIMO SAR (W/kg)	SAR/4	S (W/m2)	S/10	TER
Phablet SAR	Back	0.915	0.229	1.80	0.180	0.409
	Front	0.242	0.061	2.36	0.236	0.296
	Top*	0.242*	0.061	7.12	0.712	0.772
	Bottom	0.000	0.000	0.00	0.000	0.000
	Right	0.290	0.073	7.12	0.712	**0.784**
	Left	0.000	0.000	6.32	0.632	0.632

*Note: WLAN SAR data for Front surface is used for conservative analysis, as its peak SAR is higher than Top surface

Note: Per FCC guidance, the device edges that are not required to be evaludated are indicated 0 for TER analysis.

Note: Per FCC guidance, the bands/modes that are not required to be evaluated for phablet SAR are not considered for TER analysis.

Note: Per FCC guidance, power density measurements at 2mm was used for phablet configuration due to probe restraints.

Note: Due to SW and HW limitations, NR Band n260 was evaluated using SISO H polarization and SISO V polarization

C.4 Simultaneous Transmission Conclusion

The above numerical summed total exposure ratio (TER) results in Section C.3 for all the worst-case simultaneous transmission conditions were below the normalized limit of 1.0. Therefore, the above combined analysis of Section C.3 and Section C.2 (i.e., Section 12 of [B1]) is sufficient to determine that simultaneous transmission cases for this EUT are RF exposure compliant.

D DASY mmW Probe and Verification Source Certificates

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Qualcomm USA**

Certificate No: **EUmmWV3-9367_Sep18**

CALIBRATION CERTIFICATE

Object	EUmmWV3 - SN:9367
Calibration procedure(s)	QA CAL-02.v8, QA CAL-25.v6, QA CAL-42.v2 Calibration procedure for E-field probes optimized for close near field evaluations in air
Calibration date:	September 26, 2018

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-18 (No. 217-02682)	Apr-19
Reference Probe ER3DV6	SN: 2328	10-Oct-17 (No. ER3-2328_Oct17)	Oct-18
DAE4	SN: 789	7-Aug-18 (No. DAE4-789_Aug18)	Aug-19
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-17)	In house check: Oct-18

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 29, 2018

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

NORMx,y,z	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system
Sensor Angles	sensor deviation from the probe axis, used to calculate the field orientation and polarization
k	is the wave propagation direction

Calibration is Performed According to the Following Standards:

a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 for XY sensors and ϑ = 90 for Z sensor (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). For frequencies > 6 GHz, the far field in front of waveguide horn antennas is measured for a set of frequencies in various waveguide bands up to 110 GHz.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- The frequency sensor model parameters are determined prior to calibration based on a frequency sweep (sensor model involving resistors R, R_p, inductance L and capacitors C, C_p).
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *Sensor Offset:* The sensor offset corresponds to the mechanical from the probe tip (on probe axis). No tolerance required.
- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).
- *Equivalent Sensor Angle:* The two probe sensors are mounted in the same plane at different angles. The angles are assessed using the information gained by determining the *NORMx* (no uncertainty required).
- *Spherical isotropy (3D deviation from isotropy):* in a locally homogeneous field realized using an open waveguide / horn setup.

DASY - Parameters of Probe: EUmmWV3 - SN:9367

Basic Calibration Parameters (750 MHz – 3 GHz)

	Sensor X	Sensor Y	Unc (k=2)
Norm (μV/(V/m)^2)	0.02171	0.02498	± 10.1 %
DCP (mV)[B]	118.0	99.0	
Equivalent Sensor Angle	-56.8	29.9	

Calibration results for Frequency Response (6 – 110 GHz)

Frequency GHz	Target E-Field V/m	Deviation Sensor X dB	Deviation Sensor Y dB	Unc (k=2) dB
6.6	40.04	-0.09	0.01	± 0.98 dB
8	48.41	-0.38	-0.39	± 0.98 dB
10	54.41	-0.24	-0.14	± 0.98 dB
15	75.04	0.50	0.19	± 0.98 dB
18	85.30	0.13	0.26	± 0.98 dB
26.6	96.89	0.15	0.28	± 0.98 dB
30	92.55	0.26	0.27	± 0.98 dB
35	93.71	-0.12	0.08	± 0.98 dB
40	91.46	-0.05	-0.25	± 0.98 dB
50	19.62	0.33	0.36	± 0.98 dB
55	22.38	0.58	0.36	± 0.98 dB
60	23.03	0.07	-0.03	± 0.98 dB
65	27.40	-0.02	-0.11	± 0.98 dB
70	23.95	-0.08	-0.26	± 0.98 dB
75	19.61	-0.55	-0.48	± 0.98 dB
75	14.11	-0.34	-0.13	± 0.98 dB
80	21.51	-0.14	-0.02	± 0.98 dB
85	22.75	0.18	0.16	± 0.98 dB
90	23.84	0.15	0.25	± 0.98 dB
92	23.93	0.07	0.07	± 0.98 dB
95	20.55	0.03	0.02	± 0.98 dB
97	24.41	0.17	0.02	± 0.98 dB
100	22.61	0.03	0.03	± 0.98 dB
105	22.75	-0.06	-0.02	± 0.98 dB
110	18.85	-0.26	-0.25	± 0.98 dB

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	124.4	± 3.5 %	± 4.7 %
		Y	0.0	0.0	1.0		55.2		

Note: For details on UID parameters see Appendix

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[B] Numerical linearization parameter: uncertainty not required.

[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY - Parameters of Probe: EUmmWV3 - SN:9367

Sensor Frequency Model Parameters

	Sensor X	Sensor Y
R (Ω)	39.03	41.96
R_p (Ω)	95.81	91.97
L (nH)	0.03214	0.03396
C (pF)	0.2228	0.2427
C_p (pF)	0.1243	0.1132

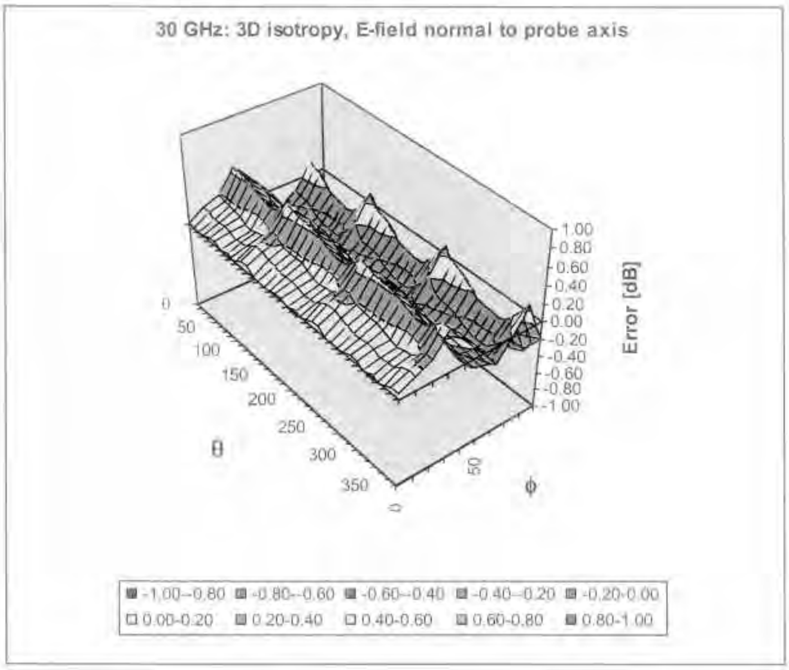
Sensor Model Parameters

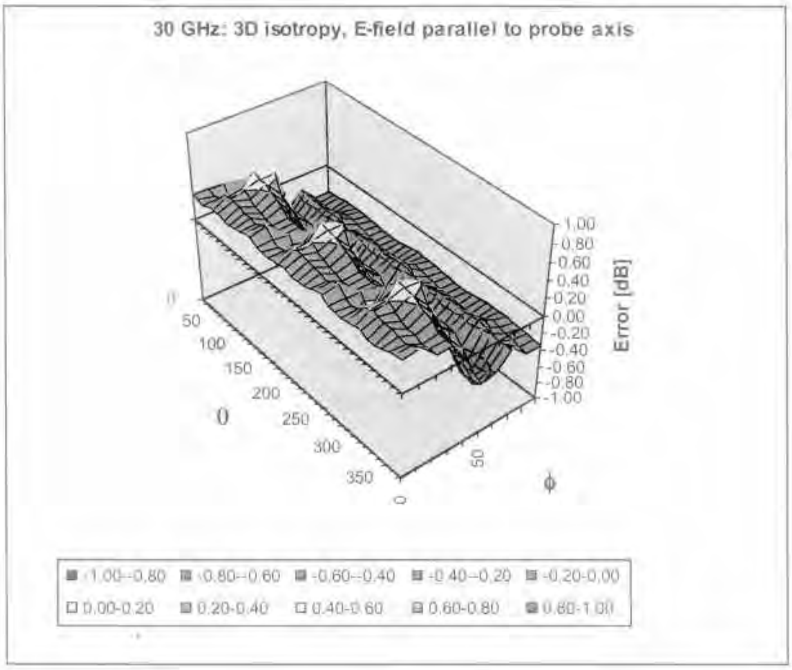
	C1 fF	C2 fF	α V^{-1}	T1 $ms.V^{-2}$	T2 $ms.V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
X	7.329	49.74	30.07	0.916	1.785	4.911	0.449	0.442	0.997
Y	5.629	40.96	33.97	0.916	1.643	4.965	0.000	0.577	1.001

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	15.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	320 mm
Probe Body Diameter	8 mm
Tip Length	23 mm
Tip Diameter	8.0 mm
Probe Tip to Sensor X Calibration Point	1.5 mm
Probe Tip to Sensor Y Calibration Point	1.5 mm

Deviation from Isotropy in Air
f = 30 GHz





Probe isotropy for E_{tot}: probe rotated φ = 0° to 360°, tilted from field propagation direction $\vec{k}$
Parallel to the field propagation (ψ =0° - 90°): deviation within ± 0.47 dB
Normal to field orientation (ϑ =0° - 90°): deviation within ± 0.52 dB

Appendix: Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max Unc[E] (k=2)
0	CW	X	0.00	0.00	1.00	0.00	124.4	± 3.5 %
		Y	0.00	0.00	1.00		55.2	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	57.17	110.11	28.37	10.00	6.0	± 9.6 %
		Y	100.00	121.14	31.54		6.0	
10011-CAB	UMTS-FDD (WCDMA)	X	1.18	74.35	16.27	0.00	34.0	± 9.6 %
		Y	100.00	112.17	22.27		34.0	
10012-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	1.19	65.34	14.52	0.41	42.0	± 9.6 %
		Y	1.22	67.89	15.47		42.0	
10013-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	X	3.61	67.29	15.27	1.46	10.0	± 9.6 %
		Y	3.33	67.43	14.81		10.0	
10021-DAC	GSM-FDD (TDMA, GMSK)	X	100.00	122.88	33.10	9.39	7.0	± 9.6 %
		Y	100.00	128.25	35.53		7.0	
10023-DAC	GPRS-FDD (TDMA, GMSK, TN 0)	X	27.12	100.32	26.71	9.57	7.0	± 9.6 %
		Y	100.00	123.50	33.23		7.0	
10024-DAC	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	100.00	124.22	32.04	6.56	13.0	± 9.6 %
		Y	100.00	132.43	35.63		13.0	
10025-DAC	EDGE-FDD (TDMA, 8PSK, TN 0)	X	4.25	60.00	17.14	12.57	4.0	± 9.6 %
		Y	6.14	60.00	16.41		4.0	
10026-DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1)	X	5.39	75.57	24.87	9.56	7.0	± 9.6 %
		Y	5.65	78.73	27.46		7.0	
10027-DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	100.00	131.38	34.17	4.80	19.0	± 9.6 %
		Y	100.00	148.40	41.51		19.0	
10028-DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	100.00	142.28	38.03	3.55	25.0	± 9.6 %
		Y	100.00	175.07	51.90		25.0	
10029-DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2)	X	4.10	71.51	22.38	7.80	11.0	± 9.6 %
		Y	4.32	74.58	25.07		11.0	
10030-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH1)	X	4.76	80.44	18.61	5.30	17.0	± 9.6 %
		Y	100.00	122.53	30.12		17.0	
10031-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH3)	X	0.95	73.14	17.08	1.88	37.0	± 9.6 %
		Y	100.00	148.27	38.03		37.0	
10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	0.47	67.89	16.02	1.17	43.0	± 9.6 %
		Y	1.53	96.08	28.26		43.0	
10033-CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH1)	X	2.61	69.39	12.90	5.30	11.0	± 9.6 %
		Y	3.08	72.58	13.99		11.0	
10034-CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH3)	X	0.42	60.00	5.63	1.88	23.0	± 9.6 %
		Y	0.32	60.00	4.14		23.0	
10035-CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH5)	X	0.29	60.00	4.93	1.17	27.0	± 9.6 %
		Y	13.58	61.19	1.83		27.0	
10036-CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH1)	X	2.81	70.25	13.28	5.30	11.0	± 9.6 %
		Y	3.96	75.33	15.02		11.0	

10072-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 12 Mbps)	X	3.74	67.41	15.65	2.30	9.0	± 9.6 %
		Y	3.58	68.13	15.62		9.0	
10073-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 18 Mbps)	X	3.83	67.55	15.98	2.83	9.0	± 9.6 %
		Y	3.72	68.51	16.15		9.0	
10074-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 24 Mbps)	X	3.95	67.80	16.38	3.30	8.0	± 9.6 %
		Y	3.86	68.90	16.72		8.0	
10075-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 36 Mbps)	X	4.10	68.17	16.78	3.82	7.0	± 9.6 %
		Y	4.06	69.48	17.30		7.0	
10076-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 48 Mbps)	X	4.26	68.38	17.08	4.15	7.0	± 9.6 %
		Y	4.26	69.92	17.74		7.0	
10077-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	X	4.30	68.44	17.23	4.30	7.0	± 9.6 %
		Y	4.31	70.02	17.93		7.0	
10081-CAB	CDMA2000 (1xRTT, RC3)	X	1.31	206.00	28.61	0.00	27.0	± 9.6 %
		Y	0.00	82.49	50.30		27.0	
10082-CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Fullrate)	X	0.74	60.00	7.05	4.77	19.0	± 9.6 %
		Y	0.66	60.00	6.81		19.0	
10090-DAC	GPRS-FDD (TDMA, GMSK, TN 0-4)	X	100.00	124.08	31.99	6.56	13.0	± 9.6 %
		Y	100.00	132.24	35.56		13.0	
10097-CAB	UMTS-FDD (HSDPA)	X	0.85	65.52	10.13	0.00	28.0	± 9.6 %
		Y	0.33	60.00	4.41		28.0	
10098-CAB	UMTS-FDD (HSUPA, Subtest 2)	X	0.91	66.27	10.57	0.00	28.0	± 9.6 %
		Y	0.32	60.00	4.51		28.0	
10099-DAC	EDGE-FDD (TDMA, 8PSK, TN 0-4)	X	5.41	75.59	24.86	9.56	7.0	± 9.6 %
		Y	5.67	78.77	27.47		7.0	
10100-CAE	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	2.25	69.92	16.86	0.00	21.0	± 9.6 %
		Y	2.38	72.94	18.23		21.0	
10101-CAE	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM)	X	2.54	68.39	15.68	0.00	18.0	± 9.6 %
		Y	2.49	69.77	15.99		18.0	
10102-CAE	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM)	X	2.64	68.74	15.86	0.00	17.0	± 9.6 %
		Y	2.60	70.10	16.13		17.0	
10103-CAG	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	1.92	60.00	12.77	3.98	9.0	± 9.6 %
		Y	1.57	60.00	13.62		9.0	
10104-CAG	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM)	X	4.20	69.09	16.60	3.98	8.0	± 9.6 %
		Y	4.03	69.89	16.88		8.0	
10105-CAG	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM)	X	2.27	60.00	12.74	3.98	8.0	± 9.6 %
		Y	1.62	60.00	13.58		8.0	
10108-CAG	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	1.90	70.63	16.34	0.00	20.0	± 9.6 %
		Y	2.20	74.69	17.17		20.0	
10109-CAG	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM)	X	2.04	68.49	14.22	0.00	18.0	± 9.6 %
		Y	1.47	65.63	11.46		18.0	
10110-CAG	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	1.19	67.25	12.29	0.00	20.0	± 9.6 %
		Y	0.49	60.00	6.18		20.0	

10153-CAG	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 64-QAM)	X	3.55	68.04	14.65	3.98	8.0	± 9.6 %
		Y	3.02	66.90	13.32		8.0	
10154-CAG	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	1.23	67.73	12.55	0.00	20.0	± 9.6 %
		Y	0.49	60.00	6.21		20.0	
10155-CAG	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)	X	0.85	61.67	7.83	0.00	18.0	± 9.6 %
		Y	0.51	60.00	4.52		18.0	
10156-CAG	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, QPSK)	X	0.32	60.00	4.11	0.00	20.0	± 9.6 %
		Y	0.00	196.85	109.01		20.0	
10157-CAG	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)	X	36.97	364.62	40.10	0.00	17.0	± 9.6 %
		Y	0.00	60.00	0.00		17.0	
10158-CAG	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)	X	0.83	61.03	7.31	0.00	17.0	± 9.6 %
		Y	0.53	60.00	4.36		17.0	
10159-CAG	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)	X	13.62	348.94	45.07	0.00	17.0	± 9.6 %
		Y	0.00	60.00	0.00		17.0	
10160-CAE	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	1.91	70.04	14.69	0.00	20.0	± 9.6 %
		Y	4.24	75.46	13.93		20.0	
10161-CAE	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, 16-QAM)	X	1.61	65.90	11.74	0.00	18.0	± 9.6 %
		Y	0.81	60.00	6.62		18.0	
10162-CAE	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, 64-QAM)	X	1.62	65.79	11.61	0.00	17.0	± 9.6 %
		Y	0.81	60.00	6.52		17.0	
10166-CAF	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK)	X	2.42	65.17	16.76	3.01	20.0	± 9.6 %
		Y	2.45	66.04	17.90		20.0	
10167-CAF	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM)	X	2.57	66.73	16.74	3.01	17.0	± 9.6 %
		Y	2.63	67.74	17.88		17.0	
10168-CAF	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 64-QAM)	X	2.84	69.22	18.51	3.01	16.0	± 9.6 %
		Y	3.03	71.36	20.28		16.0	
10169-CAE	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	2.67	66.42	17.05	3.01	19.0	± 9.6 %
		Y	2.75	67.37	18.16		19.0	
10170-CAE	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	X	3.38	71.11	19.11	3.01	16.0	± 9.6 %
		Y	3.65	73.21	20.78		16.0	
10171-AAE	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM)	X	2.80	67.22	16.29	3.01	16.0	± 9.6 %
		Y	2.88	68.04	17.25		16.0	
10172-CAG	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	1.95	60.00	13.40	6.02	9.0	± 9.6 %
		Y	1.85	60.00	14.69		9.0	
10173-CAG	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	X	3.46	70.67	17.50	6.02	8.0	± 9.6 %
		Y	4.05	74.71	20.25		8.0	
10174-CAG	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM)	X	2.38	60.00	11.40	6.02	7.0	± 9.6 %
		Y	2.06	60.00	12.97		7.0	
10175-CAG	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	2.64	66.15	16.81	3.01	19.0	± 9.6 %
		Y	2.71	67.02	17.88		19.0	
10176-CAG	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	X	3.39	71.12	19.12	3.01	16.0	± 9.6 %
		Y	3.66	73.23	20.79		16.0	

10221-CAC	IEEE 802.11n (HT Mixed, 72.2 Mbps, 64-QAM)	X	3.44	68.40	15.41	0.00	13.0	± 9.6 %
		Y	3.04	67.91	14.49		13.0	
10222-CAC	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	X	4.06	67.80	16.25	0.00	13.0	± 9.6 %
		Y	3.91	68.39	16.55		13.0	
10223-CAC	IEEE 802.11n (HT Mixed, 90 Mbps, 16-QAM)	X	4.20	68.26	16.29	0.00	12.0	± 9.6 %
		Y	4.02	68.89	16.53		12.0	
10224-CAC	IEEE 802.11n (HT Mixed, 150 Mbps, 64-QAM)	X	4.07	68.07	16.28	0.00	13.0	± 9.6 %
		Y	3.90	68.66	16.55		13.0	
10225-CAB	UMTS-FDD (HSPA+)	X	0.82	60.00	5.52	0.00	20.0	± 9.6 %
		Y	27.79	61.46	1.96		20.0	
10226-CAA	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM)	X	3.52	71.06	17.74	6.02	8.0	± 9.6 %
		Y	4.19	75.46	20.65		8.0	
10227-CAA	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, 64-QAM)	X	3.35	70.20	16.96	6.02	7.0	± 9.6 %
		Y	3.95	74.33	19.74		7.0	
10228-CAA	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)	X	3.01	69.62	18.46	6.02	9.0	± 9.6 %
		Y	3.32	73.03	21.14		9.0	
10229-CAC	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM)	X	3.46	70.71	17.52	6.02	8.0	± 9.6 %
		Y	4.06	74.80	20.29		8.0	
10230-CAC	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, 64-QAM)	X	3.29	69.86	16.75	6.02	7.0	± 9.6 %
		Y	3.83	73.70	19.41		7.0	
10231-CAC	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, QPSK)	X	2.97	69.31	18.24	6.02	9.0	± 9.6 %
		Y	3.25	72.50	20.81		9.0	
10232-CAF	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)	X	3.46	70.70	17.52	6.02	8.0	± 9.6 %
		Y	4.06	74.79	20.29		8.0	
10233-CAF	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)	X	3.29	69.86	16.76	6.02	7.0	± 9.6 %
		Y	3.83	73.69	19.41		7.0	
10234-CAF	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, QPSK)	X	2.92	69.00	18.01	6.02	9.0	± 9.6 %
		Y	3.18	72.00	20.48		9.0	
10235-CAF	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	X	3.46	70.70	17.52	6.02	8.0	± 9.6 %
		Y	4.06	74.76	20.28		8.0	
10236-CAF	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)	X	3.30	69.88	16.77	6.02	7.0	± 9.6 %
		Y	3.84	73.71	19.41		7.0	
10237-CAF	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	2.96	69.27	18.23	6.02	9.0	± 9.6 %
		Y	3.24	72.43	20.78		9.0	
10238-CAF	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)	X	3.46	70.70	17.51	6.02	8.0	± 9.6 %
		Y	4.06	74.76	20.28		8.0	
10239-CAF	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, 64-QAM)	X	3.29	69.85	16.75	6.02	7.0	± 9.6 %
		Y	3.83	73.66	19.40		7.0	
10240-CAF	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	2.96	69.27	18.22	6.02	9.0	± 9.6 %
		Y	3.24	72.42	20.78		9.0	
10241-CAA	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM)	X	3.84	69.71	19.46	6.98	8.0	± 9.6 %
		Y	3.92	71.21	21.12		8.0	

10263-CAF	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)	X	2.06	62.34	8.98	3.98	8.0	± 9.6 %
		Y	1.44	60.00	6.42		8.0	
10264-CAF	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	2.36	66.27	12.47	3.98	9.0	± 9.6 %
		Y	1.76	63.84	10.17		9.0	
10265-CAF	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM)	X	3.26	66.84	13.75	3.98	8.0	± 9.6 %
		Y	2.73	65.59	12.36		8.0	
10266-CAF	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM)	X	3.54	68.02	14.63	3.98	8.0	± 9.6 %
		Y	3.01	66.87	13.30		8.0	
10267-CAF	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	3.45	70.23	16.21	3.98	9.0	± 9.6 %
		Y	3.38	71.54	16.42		9.0	
10268-CAF	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, 16-QAM)	X	4.24	69.26	16.38	3.98	8.0	± 9.6 %
		Y	3.99	69.75	16.28		8.0	
10269-CAF	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, 64-QAM)	X	4.26	69.08	16.21	3.98	8.0	± 9.6 %
		Y	3.96	69.37	15.98		8.0	
10270-CAF	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	4.15	71.27	17.55	3.98	9.0	± 9.6 %
		Y	4.27	73.65	18.59		9.0	
10274-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	X	0.71	60.00	5.82	0.00	24.0	± 9.6 %
		Y	19.23	61.11	1.86		24.0	
10275-CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	X	1.10	69.49	12.87	0.00	28.0	± 9.6 %
		Y	0.32	60.00	5.48		28.0	
10277-CAA	PHS (QPSK)	X	2.72	63.48	9.26	9.03	5.0	± 9.6 %
		Y	2.33	62.43	8.42		5.0	
10278-CAA	PHS (QPSK, BW 884MHz, Rolloff 0.5)	X	3.11	64.17	9.63	9.03	5.0	± 9.6 %
		Y	2.60	63.07	8.76		5.0	
10279-CAA	PHS (QPSK, BW 884MHz, Rolloff 0.38)	X	3.09	63.99	9.49	9.03	4.0	± 9.6 %
		Y	2.57	62.85	8.59		4.0	
10290-AAB	CDMA2000, RC1, SO55, Full Rate	X	4.02	216.28	19.34	0.00	28.0	± 9.6 %
		Y	0.00	114.07	76.74		28.0	
10291-AAB	CDMA2000, RC3, SO55, Full Rate	X	1.35	206.02	28.20	0.00	30.0	± 9.6 %
		Y	0.00	81.66	49.62		30.0	
10292-AAB	CDMA2000, RC3, SO32, Full Rate	X	20.09	270.51	35.93	0.00	31.0	± 9.6 %
		Y	0.00	91.74	58.80		31.0	
10293-AAB	CDMA2000, RC3, SO3, Full Rate	X	0.10	60.00	3.71	0.00	30.0	± 9.6 %
		Y	0.00	99.41	78.41		30.0	
10295-AAB	CDMA2000, RC1, SO3, 1/8th Rate 25 fr	X	100.00	106.27	25.03	9.03	4.0	± 9.6 %
		Y	2243.57	133.00	28.68		4.0	
10297-AAD	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	1.93	70.93	16.51	0.00	20.0	± 9.6 %
		Y	2.32	75.49	17.52		20.0	
10298-AAD	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, QPSK)	X	0.09	230.80	12.81	0.00	20.0	± 9.6 %
		Y	0.00	60.00	0.00		20.0	
10299-AAD	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM)	X	4.50	347.37	43.23	0.00	17.0	± 9.6 %
		Y	0.00	60.00	0.00		17.0	

10404-AAB	CDMA2000 (1xEV-DO, Rev. A)	X	4.02	216.28	19.34	0.00	29.0	± 9.6 %
		Y	0.00	114.07	76.74		29.0	
10406-AAB	CDMA2000, RC3, SO32, SCH0, Full Rate	X	12.28	89.29	18.44	0.00	22.0	± 9.6 %
		Y	100.00	115.54	25.55		22.0	
10410-AAF	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9, Subframe Conf=4)	X	1.53	66.69	13.20	3.23	12.0	± 9.6 %
		Y	2.31	74.20	17.45		12.0	
10415-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle)	X	1.11	66.03	14.92	0.00	45.0	± 9.6 %
		Y	1.16	69.18	15.97		45.0	
10416-AAA	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle)	X	3.35	68.29	15.22	0.00	13.0	± 9.6 %
		Y	2.92	67.61	14.12		13.0	
10417-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle)	X	3.35	68.29	15.22	0.00	13.0	± 9.6 %
		Y	2.92	67.61	14.12		13.0	
10418-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 99pc duty cycle, Long preambule)	X	3.28	68.32	15.26	0.00	13.0	± 9.6 %
		Y	2.86	67.69	14.18		13.0	
10419-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 99pc duty cycle, Short preambule)	X	3.31	68.30	15.23	0.00	13.0	± 9.6 %
		Y	2.88	67.61	14.11		13.0	
10422-AAB	IEEE 802.11n (HT Greenfield, 7.2 Mbps, BPSK)	X	3.42	68.31	15.36	0.00	13.0	± 9.6 %
		Y	3.03	67.88	14.46		13.0	
10423-AAB	IEEE 802.11n (HT Greenfield, 43.3 Mbps, 16-QAM)	X	3.42	68.32	15.31	0.00	12.0	± 9.6 %
		Y	3.00	67.74	14.32		12.0	
10424-AAB	IEEE 802.11n (HT Greenfield, 72.2 Mbps, 64-QAM)	X	3.41	68.32	15.33	0.00	12.0	± 9.6 %
		Y	3.01	67.85	14.40		12.0	
10425-AAB	IEEE 802.11n (HT Greenfield, 15 Mbps, BPSK)	X	4.18	68.13	16.29	0.00	12.0	± 9.6 %
		Y	4.03	68.80	16.56		12.0	
10426-AAB	IEEE 802.11n (HT Greenfield, 90 Mbps, 16-QAM)	X	4.17	68.14	16.29	0.00	12.0	± 9.6 %
		Y	3.99	68.72	16.52		12.0	
10427-AAB	IEEE 802.11n (HT Greenfield, 150 Mbps, 64-QAM)	X	4.20	68.17	16.30	0.00	12.0	± 9.6 %
		Y	4.02	68.77	16.54		12.0	
10430-AAD	LTE-FDD (OFDMA, 5 MHz, E-TM 3.1)	X	0.89	60.00	5.80	0.00	12.0	± 9.6 %
		Y	97.73	61.49	1.75		12.0	
10431-AAD	LTE-FDD (OFDMA, 10 MHz, E-TM 3.1)	X	2.10	64.67	11.21	0.00	12.0	± 9.6 %
		Y	1.27	60.33	7.13		12.0	
10432-AAC	LTE-FDD (OFDMA, 15 MHz, E-TM 3.1)	X	2.99	67.69	14.30	0.00	12.0	± 9.6 %
		Y	2.33	65.52	12.13		12.0	
10433-AAC	LTE-FDD (OFDMA, 20 MHz, E-TM 3.1)	X	3.43	68.37	15.40	0.00	12.0	± 9.6 %
		Y	3.04	67.92	14.49		12.0	
10434-AAA	W-CDMA (BS Test Model 1, 64 DPCH)	X	0.72	60.00	4.64	0.00	11.0	± 9.6 %
		Y	755.27	62.45	1.82		11.0	
10435-AAF	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	1.52	66.58	13.11	3.23	12.0	± 9.6 %
		Y	2.26	73.83	17.26		12.0	

10472-AAE	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	0.89	60.00	7.60	3.23	10.0	± 9.6 %
		Y	0.86	60.00	8.16		10.0	
10473-AAE	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	0.91	61.14	10.79	3.23	12.0	± 9.6 %
		Y	1.47	68.89	15.51		12.0	
10474-AAE	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	0.90	60.00	8.10	3.23	11.0	± 9.6 %
		Y	0.90	60.37	8.91		11.0	
10475-AAE	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	0.89	60.00	7.60	3.23	10.0	± 9.6 %
		Y	0.85	60.00	8.16		10.0	
10477-AAF	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	0.90	60.00	8.08	3.23	11.0	± 9.6 %
		Y	0.90	60.28	8.84		11.0	
10478-AAF	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	0.89	60.00	7.59	3.23	10.0	± 9.6 %
		Y	0.86	60.00	8.15		10.0	
10479-AAA	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	0.91	61.51	11.56	3.23	12.0	± 9.6 %
		Y	1.48	70.43	16.93		12.0	
10480-AAA	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	0.83	60.00	8.57	3.23	11.0	± 9.6 %
		Y	0.92	61.92	10.16		11.0	
10481-AAA	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	0.82	60.00	8.10	3.23	11.0	± 9.6 %
		Y	0.77	60.00	8.61		11.0	
10482-AAB	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	14.45	197.77	17.14	2.23	13.0	± 9.6 %
		Y	0.00	118.41	58.10		13.0	
10483-AAB	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	3.22	153.07	4.55	2.23	11.0	± 9.6 %
		Y	0.00	60.00	0.00		11.0	
10484-AAB	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	3.00	155.87	4.23	2.23	11.0	± 9.6 %
		Y	0.00	123.20	68.98		11.0	
10485-AAE	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	0.35	53.98	2.00	2.23	13.0	± 9.6 %
		Y	4.91	222.19	33.77		13.0	
10486-AAE	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	44.74	195.39	2.43	2.23	11.0	± 9.6 %
		Y	0.00	60.00	0.00		11.0	
10487-AAE	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	47.80	197.91	0.92	2.23	11.0	± 9.6 %
		Y	0.00	132.76	57.95		11.0	
10488-AAE	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	1.12	61.45	9.84	2.23	13.0	± 9.6 %
		Y	0.80	60.00	7.64		13.0	
10489-AAE	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	1.10	60.00	7.68	2.23	12.0	± 9.6 %
		Y	0.98	60.00	5.77		12.0	
10490-AAE	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	1.12	60.00	7.54	2.23	11.0	± 9.6 %
		Y	1.03	60.00	5.58		11.0	
10491-AAE	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	1.62	63.65	12.21	2.23	13.0	± 9.6 %
		Y	1.36	63.23	11.02		13.0	
10492-AAE	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	1.57	61.37	10.03	2.23	11.0	± 9.6 %
		Y	1.18	60.00	7.98		11.0	

10512-AAF	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	2.36	65.91	15.08	2.23	13.0	± 9.6 %
		Y	2.66	69.78	17.11		13.0	
10513-AAF	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	2.71	65.34	14.62	2.23	12.0	± 9.6 %
		Y	2.85	67.76	15.69		12.0	
10514-AAF	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	2.78	65.34	14.59	2.23	11.0	± 9.6 %
		Y	2.89	67.55	15.52		11.0	
10515-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps, 99pc duty cycle)	X	1.07	66.24	15.01	0.00	45.0	± 9.6 %
		Y	1.15	69.91	16.24		45.0	
10516-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps, 99pc duty cycle)	X	0.73	70.31	18.04	0.00	43.0	± 9.6 %
		Y	4.12	105.93	31.04		43.0	
10517-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps, 99pc duty cycle)	X	0.93	67.85	16.02	0.00	44.0	± 9.6 %
		Y	1.48	78.23	20.16		44.0	
10518-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps, 99pc duty cycle)	X	3.33	68.46	15.30	0.00	13.0	± 9.6 %
		Y	2.89	67.77	14.22		13.0	
10519-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps, 99pc duty cycle)	X	3.32	68.26	15.18	0.00	12.0	± 9.6 %
		Y	2.86	67.43	13.99		12.0	
10520-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps, 99pc duty cycle)	X	3.29	68.41	15.25	0.00	13.0	± 9.6 %
		Y	2.86	67.73	14.15		13.0	
10521-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps, 99pc duty cycle)	X	3.27	68.36	15.17	0.00	13.0	± 9.6 %
		Y	2.85	67.70	14.05		13.0	
10522-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps, 99pc duty cycle)	X	3.31	68.57	15.27	0.00	12.0	± 9.6 %
		Y	2.86	67.81	14.15		12.0	
10523-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps, 99pc duty cycle)	X	3.22	68.45	15.25	0.00	13.0	± 9.6 %
		Y	2.81	67.79	14.15		13.0	
10524-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps, 99pc duty cycle)	X	3.19	68.08	15.10	0.00	13.0	± 9.6 %
		Y	2.82	67.58	14.08		13.0	
10525-AAB	IEEE 802.11ac WiFi (20MHz, MCS0, 99pc duty cycle)	X	3.34	67.87	15.19	0.00	12.0	± 9.6 %
		Y	2.97	67.53	14.34		12.0	
10526-AAB	IEEE 802.11ac WiFi (20MHz, MCS1, 99pc duty cycle)	X	3.38	68.00	15.25	0.00	12.0	± 9.6 %
		Y	2.99	67.63	14.39		12.0	
10527-AAB	IEEE 802.11ac WiFi (20MHz, MCS2, 99pc duty cycle)	X	3.31	67.87	15.16	0.00	13.0	± 9.6 %
		Y	2.93	67.49	14.28		13.0	
10528-AAB	IEEE 802.11ac WiFi (20MHz, MCS3, 99pc duty cycle)	X	3.33	67.88	15.15	0.00	12.0	± 9.6 %
		Y	2.95	67.48	14.26		12.0	
10529-AAB	IEEE 802.11ac WiFi (20MHz, MCS4, 99pc duty cycle)	X	3.33	67.88	15.15	0.00	12.0	± 9.6 %
		Y	2.95	67.48	14.26		12.0	
10531-AAB	IEEE 802.11ac WiFi (20MHz, MCS6, 99pc duty cycle)	X	3.32	67.97	15.19	0.00	12.0	± 9.6 %
		Y	2.96	67.71	14.37		12.0	
10532-AAB	IEEE 802.11ac WiFi (20MHz, MCS7, 99pc duty cycle)	X	3.25	67.76	15.08	0.00	13.0	± 9.6 %
		Y	2.91	67.54	14.27		13.0	

10556-AAC	IEEE 802.11ac WiFi (160MHz, MCS2, 99pc duty cycle)	X	4.98	66.69	15.79	0.00	12.0	± 9.6 %
		Y	4.80	66.56	15.95		12.0	
10557-AAC	IEEE 802.11ac WiFi (160MHz, MCS3, 99pc duty cycle)	X	4.96	66.67	15.80	0.00	12.0	± 9.6 %
		Y	4.77	66.51	15.94		12.0	
10558-AAC	IEEE 802.11ac WiFi (160MHz, MCS4, 99pc duty cycle)	X	4.97	66.70	15.82	0.00	12.0	± 9.6 %
		Y	4.81	66.63	16.00		12.0	
10560-AAC	IEEE 802.11ac WiFi (160MHz, MCS6, 99pc duty cycle)	X	4.99	66.67	15.82	0.00	12.0	± 9.6 %
		Y	4.82	66.55	15.98		12.0	
10561-AAC	IEEE 802.11ac WiFi (160MHz, MCS7, 99pc duty cycle)	X	4.94	66.63	15.81	0.00	12.0	± 9.6 %
		Y	4.76	66.50	15.96		12.0	
10562-AAC	IEEE 802.11ac WiFi (160MHz, MCS8, 99pc duty cycle)	X	4.97	66.70	15.85	0.00	12.0	± 9.6 %
		Y	4.79	66.56	15.99		12.0	
10563-AAC	IEEE 802.11ac WiFi (160MHz, MCS9, 99pc duty cycle)	X	5.10	66.99	15.98	0.00	12.0	± 9.6 %
		Y	4.95	67.00	16.19		12.0	
10564-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 9 Mbps, 99pc duty cycle)	X	3.56	68.05	15.42	0.46	13.0	± 9.6 %
		Y	3.20	67.88	14.80		13.0	
10565-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 12 Mbps, 99pc duty cycle)	X	3.70	68.63	15.85	0.46	12.0	± 9.6 %
		Y	3.37	68.67	15.33		12.0	
10566-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 18 Mbps, 99pc duty cycle)	X	3.58	68.33	15.61	0.46	13.0	± 9.6 %
		Y	3.25	68.30	15.06		13.0	
10567-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 24 Mbps, 99pc duty cycle)	X	3.86	69.82	16.58	0.46	13.0	± 9.6 %
		Y	3.68	70.59	16.43		13.0	
10568-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 36 Mbps, 99pc duty cycle)	X	3.38	67.36	14.83	0.46	12.0	± 9.6 %
		Y	3.00	67.00	14.10		12.0	
10569-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 48 Mbps, 99pc duty cycle)	X	3.88	70.26	16.90	0.46	13.0	± 9.6 %
		Y	3.77	71.33	16.92		13.0	
10570-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 54 Mbps, 99pc duty cycle)	X	3.72	69.25	16.34	0.46	13.0	± 9.6 %
		Y	3.54	69.94	16.15		13.0	
10571-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 90pc duty cycle)	X	1.16	65.27	14.31	0.46	41.0	± 9.6 %
		Y	1.18	67.79	15.16		41.0	
10572-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps, 90pc duty cycle)	X	1.17	65.93	14.78	0.46	41.0	± 9.6 %
		Y	1.27	69.53	16.18		41.0	
10573-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps, 90pc duty cycle)	X	0.95	71.34	18.12	0.46	39.0	± 9.6 %
		Y	6.59	108.79	31.39		39.0	
10574-AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps, 90pc duty cycle)	X	1.36	71.90	18.41	0.46	40.0	± 9.6 %
		Y	11.21	110.87	31.54		40.0	
10575-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 90pc duty cycle)	X	3.32	67.35	14.74	0.46	12.0	± 9.6 %
		Y	2.91	66.78	13.74		12.0	
10576-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 9 Mbps, 90pc duty cycle)	X	3.38	67.89	15.11	0.46	12.0	± 9.6 %
		Y	3.00	67.49	14.24		12.0	
10577-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 12 Mbps, 90pc duty cycle)	X	3.41	67.91	15.14	0.46	12.0	± 9.6 %
		Y	3.01	67.41	14.19		12.0	

10599-AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS0, 90pc duty cycle)	X	4.34	68.03	16.34	0.46	11.0	± 9.6 %
		Y	4.28	69.06	16.80		11.0	
10600-AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS1, 90pc duty cycle)	X	4.23	67.66	16.10	0.46	11.0	± 9.6 %
		Y	4.08	68.32	16.40		11.0	
10601-AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS2, 90pc duty cycle)	X	4.21	67.66	16.16	0.46	11.0	± 9.6 %
		Y	4.06	68.35	16.49		11.0	
10602-AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS3, 90pc duty cycle)	X	4.19	67.33	15.90	0.46	11.0	± 9.6 %
		Y	4.07	68.09	16.26		11.0	
10603-AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS4, 90pc duty cycle)	X	4.31	67.93	16.39	0.46	11.0	± 9.6 %
		Y	4.27	69.04	16.91		11.0	
10604-AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS5, 90pc duty cycle)	X	4.26	67.61	16.18	0.46	12.0	± 9.6 %
		Y	4.11	68.27	16.51		12.0	
10605-AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS6, 90pc duty cycle)	X	4.19	67.30	16.00	0.46	11.0	± 9.6 %
		Y	4.05	67.95	16.30		11.0	
10606-AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS7, 90pc duty cycle)	X	4.08	66.88	15.60	0.46	11.0	± 9.6 %
		Y	3.96	67.56	15.90		11.0	
10607-AAB	IEEE 802.11ac WiFi (20MHz, MCS0, 90pc duty cycle)	X	3.37	67.19	14.95	0.46	12.0	± 9.6 %
		Y	3.04	67.08	14.28		12.0	
10608-AAB	IEEE 802.11ac WiFi (20MHz, MCS1, 90pc duty cycle)	X	3.42	67.38	15.06	0.46	11.0	± 9.6 %
		Y	3.09	67.28	14.40		11.0	
10609-AAB	IEEE 802.11ac WiFi (20MHz, MCS2, 90pc duty cycle)	X	3.27	66.84	14.67	0.46	12.0	± 9.6 %
		Y	2.92	66.57	13.91		12.0	
10610-AAB	IEEE 802.11ac WiFi (20MHz, MCS3, 90pc duty cycle)	X	3.39	67.34	15.01	0.46	11.0	± 9.6 %
		Y	3.06	67.25	14.33		11.0	
10611-AAB	IEEE 802.11ac WiFi (20MHz, MCS4, 90pc duty cycle)	X	3.29	67.00	14.77	0.46	11.0	± 9.6 %
		Y	2.96	66.89	14.09		11.0	
10612-AAB	IEEE 802.11ac WiFi (20MHz, MCS5, 90pc duty cycle)	X	3.20	66.67	14.51	0.46	11.0	± 9.6 %
		Y	2.84	66.34	13.70		11.0	
10613-AAB	IEEE 802.11ac WiFi (20MHz, MCS6, 90pc duty cycle)	X	3.20	66.51	14.40	0.46	11.0	± 9.6 %
		Y	2.85	66.22	13.63		11.0	
10614-AAB	IEEE 802.11ac WiFi (20MHz, MCS7, 90pc duty cycle)	X	3.35	67.46	15.09	0.46	12.0	± 9.6 %
		Y	3.08	67.62	14.55		12.0	
10615-AAB	IEEE 802.11ac WiFi (20MHz, MCS8, 90pc duty cycle)	X	3.08	65.96	14.02	0.46	11.0	± 9.6 %
		Y	2.70	65.45	13.11		11.0	
10616-AAB	IEEE 802.11ac WiFi (40MHz, MCS0, 90pc duty cycle)	X	4.12	67.14	15.92	0.46	11.0	± 9.6 %
		Y	3.99	67.92	16.30		11.0	
10617-AAB	IEEE 802.11ac WiFi (40MHz, MCS1, 90pc duty cycle)	X	4.09	67.01	15.83	0.46	11.0	± 9.6 %
		Y	3.95	67.73	16.18		11.0	
10618-AAB	IEEE 802.11ac WiFi (40MHz, MCS2, 90pc duty cycle)	X	4.06	67.18	15.96	0.46	12.0	± 9.6 %
		Y	3.93	67.95	16.35		12.0	
10619-AAB	IEEE 802.11ac WiFi (40MHz, MCS3, 90pc duty cycle)	X	4.03	66.82	15.71	0.46	11.0	± 9.6 %
		Y	3.86	67.42	16.01		11.0	

10641-AAC	IEEE 802.11ac WiFi (160MHz, MCS5, 90pc duty cycle)	X	5.08	66.33	15.71	0.46	11.0	± 9.6 %
		Y	5.01	66.59	16.07		11.0	
10642-AAC	IEEE 802.11ac WiFi (160MHz, MCS6, 90pc duty cycle)	X	5.16	66.75	16.13	0.46	11.0	± 9.6 %
		Y	5.02	66.82	16.42		11.0	
10643-AAC	IEEE 802.11ac WiFi (160MHz, MCS7, 90pc duty cycle)	X	4.98	66.20	15.67	0.46	11.0	± 9.6 %
		Y	4.83	66.19	15.90		11.0	
10644-AAC	IEEE 802.11ac WiFi (160MHz, MCS8, 90pc duty cycle)	X	5.03	66.36	15.78	0.46	11.0	± 9.6 %
		Y	4.88	66.33	16.00		11.0	
10645-AAC	IEEE 802.11ac WiFi (160MHz, MCS9, 90pc duty cycle)	X	5.20	66.76	15.96	0.46	11.0	± 9.6 %
		Y	5.08	66.90	16.26		11.0	
10646-AAF	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, QPSK, UL Subframe=2,7)	X	4.08	72.32	21.51	9.30	5.0	± 9.6 %
		Y	4.20	74.65	23.67		5.0	
10647-AAF	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK, UL Subframe=2,7)	X	3.79	71.39	21.20	9.30	5.0	± 9.6 %
		Y	3.88	73.51	23.29		5.0	
10648-AAA	CDMA2000 (1x Advanced)	X	1.87	268.09	27.53	0.00	30.0	± 9.6 %
		Y	0.00	62.43	33.47		30.0	
10652-AAD	LTE-TDD (OFDMA, 5 MHz, E-TM 3.1, Clipping 44%)	X	1.30	60.02	8.52	2.23	80.0	± 9.6 %
		Y	1.06	60.00	7.04		80.0	
10653-AAD	LTE-TDD (OFDMA, 10 MHz, E-TM 3.1, Clipping 44%)	X	2.61	64.60	13.08	2.23	80.0	± 9.6 %
		Y	2.15	63.55	11.71		80.0	
10654-AAD	LTE-TDD (OFDMA, 15 MHz, E-TM 3.1, Clipping 44%)	X	3.06	65.52	14.49	2.23	80.0	± 9.6 %
		Y	2.98	66.68	14.63		80.0	
10655-AAE	LTE-TDD (OFDMA, 20 MHz, E-TM 3.1, Clipping 44%)	X	3.32	65.59	15.06	2.23	80.0	± 9.6 %
		Y	3.33	67.14	15.68		80.0	
10658-AAA	Pulse Waveform (200Hz, 10%)	X	7.24	77.24	18.30	10.00	6.0	± 9.6 %
		Y	10.50	83.67	20.67		6.0	
10659-AAA	Pulse Waveform (200Hz, 20%)	X	6.38	79.94	18.40	6.99	12.0	± 9.6 %
		Y	49.00	107.93	26.55		12.0	
10660-AAA	Pulse Waveform (200Hz, 40%)	X	4.20	81.74	18.71	3.98	23.0	± 9.6 %
		Y	100.00	123.95	29.84		23.0	
10661-AAA	Pulse Waveform (200Hz, 60%)	X	1.71	78.31	18.38	2.22	27.0	± 9.6 %
		Y	100.00	137.06	33.92		27.0	
10662-AAA	Pulse Waveform (200Hz, 80%)	X	0.45	68.60	16.52	0.97	44.0	± 9.6 %
		Y	3.38	112.44	33.12		44.0	
10670-AAA	Bluetooth Low Energy	X	1.31	75.76	18.10	2.19	43.0	± 9.6 %
		Y	100.00	145.88	37.62		43.0	

[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

10620-AAB	IEEE 802.11ac WiFi (40MHz, MCS4, 90pc duty cycle)	X	4.08	66.85	15.72	0.46	11.0	± 9.6 %
		Y	3.92	67.48	16.02		11.0	
10621-AAB	IEEE 802.11ac WiFi (40MHz, MCS5, 90pc duty cycle)	X	4.22	67.50	16.25	0.46	12.0	± 9.6 %
		Y	4.11	68.42	16.73		12.0	
10622-AAB	IEEE 802.11ac WiFi (40MHz, MCS6, 90pc duty cycle)	X	4.18	67.43	16.22	0.46	12.0	± 9.6 %
		Y	4.07	68.32	16.68		12.0	
10623-AAB	IEEE 802.11ac WiFi (40MHz, MCS7, 90pc duty cycle)	X	4.05	66.77	15.64	0.46	11.0	± 9.6 %
		Y	3.91	67.49	15.99		11.0	
10624-AAB	IEEE 802.11ac WiFi (40MHz, MCS8, 90pc duty cycle)	X	4.20	67.18	15.95	0.46	11.0	± 9.6 %
		Y	4.06	67.94	16.33		11.0	
10625-AAB	IEEE 802.11ac WiFi (40MHz, MCS9, 90pc duty cycle)	X	4.29	67.40	16.14	0.46	11.0	± 9.6 %
		Y	4.18	68.28	16.58		11.0	
10626-AAB	IEEE 802.11ac WiFi (80MHz, MCS0, 90pc duty cycle)	X	4.56	66.41	15.78	0.46	11.0	± 9.6 %
		Y	4.38	66.59	16.04		11.0	
10627-AAB	IEEE 802.11ac WiFi (80MHz, MCS1, 90pc duty cycle)	X	4.58	66.51	15.83	0.46	11.0	± 9.6 %
		Y	4.42	66.77	16.12		11.0	
10628-AAB	IEEE 802.11ac WiFi (80MHz, MCS2, 90pc duty cycle)	X	4.50	66.21	15.55	0.46	12.0	± 9.6 %
		Y	4.33	66.39	15.81		12.0	
10629-AAB	IEEE 802.11ac WiFi (80MHz, MCS3, 90pc duty cycle)	X	4.50	66.14	15.52	0.46	11.0	± 9.6 %
		Y	4.36	66.42	15.82		11.0	
10630-AAB	IEEE 802.11ac WiFi (80MHz, MCS4, 90pc duty cycle)	X	4.52	66.43	15.68	0.46	12.0	± 9.6 %
		Y	4.43	66.93	16.09		12.0	
10631-AAB	IEEE 802.11ac WiFi (80MHz, MCS5, 90pc duty cycle)	X	4.67	67.25	16.37	0.46	11.0	± 9.6 %
		Y	4.55	67.68	16.77		11.0	
10632-AAB	IEEE 802.11ac WiFi (80MHz, MCS6, 90pc duty cycle)	X	4.62	66.95	16.21	0.46	12.0	± 9.6 %
		Y	4.49	67.32	16.55		12.0	
10633-AAB	IEEE 802.11ac WiFi (80MHz, MCS7, 90pc duty cycle)	X	4.54	66.48	15.76	0.46	11.0	± 9.6 %
		Y	4.40	66.81	16.09		11.0	
10634-AAB	IEEE 802.11ac WiFi (80MHz, MCS8, 90pc duty cycle)	X	4.53	66.65	15.88	0.46	11.0	± 9.6 %
		Y	4.37	66.89	16.16		11.0	
10635-AAB	IEEE 802.11ac WiFi (80MHz, MCS9, 90pc duty cycle)	X	4.32	65.56	14.91	0.46	11.0	± 9.6 %
		Y	4.12	65.62	15.06		11.0	
10636-AAC	IEEE 802.11ac WiFi (160MHz, MCS0, 90pc duty cycle)	X	5.06	66.39	15.79	0.46	11.0	± 9.6 %
		Y	4.92	66.42	16.06		11.0	
10637-AAC	IEEE 802.11ac WiFi (160MHz, MCS1, 90pc duty cycle)	X	5.07	66.45	15.83	0.46	12.0	± 9.6 %
		Y	4.94	66.49	16.10		12.0	
10638-AAC	IEEE 802.11ac WiFi (160MHz, MCS2, 90pc duty cycle)	X	5.05	66.39	15.77	0.46	11.0	± 9.6 %
		Y	4.91	66.41	16.03		11.0	
10639-AAC	IEEE 802.11ac WiFi (160MHz, MCS3, 90pc duty cycle)	X	5.06	66.46	15.85	0.46	11.0	± 9.6 %
		Y	4.90	66.44	16.10		11.0	
10640-AAC	IEEE 802.11ac WiFi (160MHz, MCS4, 90pc duty cycle)	X	5.01	66.28	15.67	0.46	11.0	± 9.6 %
		Y	4.89	66.35	15.95		11.0	

10578-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 18 Mbps, 90pc duty cycle)	X	3.51	68.73	15.68	0.46	12.0	± 9.6 %
		Y	3.18	68.64	14.97		12.0	
10579-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 24 Mbps, 90pc duty cycle)	X	3.05	66.28	13.86	0.46	12.0	± 9.6 %
		Y	2.64	65.54	12.74		12.0	
10580-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 36 Mbps, 90pc duty cycle)	X	3.05	66.24	13.79	0.46	11.0	± 9.6 %
		Y	2.62	65.43	12.65		11.0	
10581-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 48 Mbps, 90pc duty cycle)	X	3.41	68.57	15.54	0.46	12.0	± 9.6 %
		Y	3.09	68.47	14.81		12.0	
10582-AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 54 Mbps, 90pc duty cycle)	X	2.87	65.36	13.24	0.46	11.0	± 9.6 %
		Y	2.48	64.62	12.11		11.0	
10583-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 90pc duty cycle)	X	3.32	67.35	14.74	0.46	12.0	± 9.6 %
		Y	2.91	66.78	13.74		12.0	
10584-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps, 90pc duty cycle)	X	3.38	67.89	15.11	0.46	12.0	± 9.6 %
		Y	3.00	67.49	14.24		12.0	
10585-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps, 90pc duty cycle)	X	3.41	67.91	15.14	0.46	12.0	± 9.6 %
		Y	3.01	67.41	14.19		12.0	
10586-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps, 90pc duty cycle)	X	3.51	68.73	15.68	0.46	12.0	± 9.6 %
		Y	3.18	68.64	14.97		12.0	
10587-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps, 90pc duty cycle)	X	3.05	66.28	13.86	0.46	12.0	± 9.6 %
		Y	2.64	65.54	12.74		12.0	
10588-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps, 90pc duty cycle)	X	3.05	66.24	13.79	0.46	11.0	± 9.6 %
		Y	2.62	65.43	12.65		11.0	
10589-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps, 90pc duty cycle)	X	3.41	68.57	15.54	0.46	12.0	± 9.6 %
		Y	3.09	68.47	14.81		12.0	
10590-AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps, 90pc duty cycle)	X	2.87	65.36	13.24	0.46	11.0	± 9.6 %
		Y	2.48	64.62	12.11		11.0	
10591-AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS0, 90pc duty cycle)	X	3.52	67.81	15.23	0.46	12.0	± 9.6 %
		Y	3.17	67.61	14.51		12.0	
10592-AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS1, 90pc duty cycle)	X	3.55	67.95	15.32	0.46	11.0	± 9.6 %
		Y	3.19	67.75	14.60		11.0	
10593-AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS2, 90pc duty cycle)	X	3.43	67.57	15.03	0.46	12.0	± 9.6 %
		Y	3.06	67.23	14.23		12.0	
10594-AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS3, 90pc duty cycle)	X	3.54	68.00	15.35	0.46	11.0	± 9.6 %
		Y	3.20	67.86	14.66		11.0	
10595-AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS4, 90pc duty cycle)	X	3.46	67.83	15.17	0.46	11.0	± 9.6 %
		Y	3.12	67.69	14.48		11.0	
10596-AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS5, 90pc duty cycle)	X	3.37	67.46	14.96	0.46	11.0	± 9.6 %
		Y	3.02	67.16	14.16		11.0	
10597-AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS6, 90pc duty cycle)	X	3.36	67.47	14.89	0.46	11.0	± 9.6 %
		Y	2.99	67.14	14.12		11.0	
10598-AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS7, 90pc duty cycle)	X	3.51	68.32	15.54	0.46	12.0	± 9.6 %
		Y	3.23	68.47	15.01		12.0	

10533-AAB	IEEE 802.11ac WiFi (20MHz, MCS8, 99pc duty cycle)	X	3.26	67.81	15.09	0.00	12.0	± 9.6 %
		Y	2.88	67.40	14.18		12.0	
10534-AAB	IEEE 802.11ac WiFi (40MHz, MCS0, 99pc duty cycle)	X	4.06	67.56	16.01	0.00	12.0	± 9.6 %
		Y	3.90	68.23	16.30		12.0	
10535-AAB	IEEE 802.11ac WiFi (40MHz, MCS1, 99pc duty cycle)	X	4.05	67.55	16.01	0.00	12.0	± 9.6 %
		Y	3.90	68.22	16.30		12.0	
10536-AAB	IEEE 802.11ac WiFi (40MHz, MCS2, 99pc duty cycle)	X	3.98	67.51	15.98	0.00	13.0	± 9.6 %
		Y	3.82	68.15	16.26		13.0	
10537-AAB	IEEE 802.11ac WiFi (40MHz, MCS3, 99pc duty cycle)	X	4.03	67.56	16.04	0.00	12.0	± 9.6 %
		Y	3.85	68.15	16.31		12.0	
10538-AAB	IEEE 802.11ac WiFi (40MHz, MCS4, 99pc duty cycle)	X	4.07	67.53	16.01	0.00	12.0	± 9.6 %
		Y	3.90	68.13	16.27		12.0	
10540-AAB	IEEE 802.11ac WiFi (40MHz, MCS6, 99pc duty cycle)	X	4.04	67.49	16.04	0.00	12.0	± 9.6 %
		Y	3.88	68.11	16.32		12.0	
10541-AAB	IEEE 802.11ac WiFi (40MHz, MCS7, 99pc duty cycle)	X	4.06	67.57	16.03	0.00	12.0	± 9.6 %
		Y	3.92	68.30	16.35		12.0	
10542-AAB	IEEE 802.11ac WiFi (40MHz, MCS8, 99pc duty cycle)	X	4.15	67.69	16.11	0.00	12.0	± 9.6 %
		Y	3.98	68.34	16.40		12.0	
10543-AAB	IEEE 802.11ac WiFi (40MHz, MCS9, 99pc duty cycle)	X	4.18	67.64	16.11	0.00	12.0	± 9.6 %
		Y	4.03	68.32	16.42		12.0	
10544-AAB	IEEE 802.11ac WiFi (80MHz, MCS0, 99pc duty cycle)	X	4.48	66.72	15.80	0.00	12.0	± 9.6 %
		Y	4.28	66.77	15.97		12.0	
10545-AAB	IEEE 802.11ac WiFi (80MHz, MCS1, 99pc duty cycle)	X	4.48	66.74	15.79	0.00	12.0	± 9.6 %
		Y	4.30	66.85	15.99		12.0	
10546-AAB	IEEE 802.11ac WiFi (80MHz, MCS2, 99pc duty cycle)	X	4.49	66.79	15.81	0.00	13.0	± 9.6 %
		Y	4.29	66.87	15.99		13.0	
10547-AAB	IEEE 802.11ac WiFi (80MHz, MCS3, 99pc duty cycle)	X	4.48	66.72	15.78	0.00	12.0	± 9.6 %
		Y	4.30	66.86	15.98		12.0	
10548-AAB	IEEE 802.11ac WiFi (80MHz, MCS4, 99pc duty cycle)	X	4.47	66.87	15.83	0.00	13.0	± 9.6 %
		Y	4.33	67.17	16.11		13.0	
10550-AAB	IEEE 802.11ac WiFi (80MHz, MCS6, 99pc duty cycle)	X	4.42	66.69	15.76	0.00	13.0	± 9.6 %
		Y	4.23	66.78	15.92		13.0	
10551-AAB	IEEE 802.11ac WiFi (80MHz, MCS7, 99pc duty cycle)	X	4.46	66.81	15.82	0.00	12.0	± 9.6 %
		Y	4.28	66.97	16.03		12.0	
10552-AAB	IEEE 802.11ac WiFi (80MHz, MCS8, 99pc duty cycle)	X	4.42	66.77	15.75	0.00	12.0	± 9.6 %
		Y	4.23	66.88	15.92		12.0	
10553-AAB	IEEE 802.11ac WiFi (80MHz, MCS9, 99pc duty cycle)	X	4.48	66.90	15.82	0.00	12.0	± 9.6 %
		Y	4.27	66.99	15.98		12.0	
10554-AAC	IEEE 802.11ac WiFi (160MHz, MCS0, 99pc duty cycle)	X	4.97	66.64	15.77	0.00	12.0	± 9.6 %
		Y	4.80	66.53	15.94		12.0	
10555-AAC	IEEE 802.11ac WiFi (160MHz, MCS1, 99pc duty cycle)	X	4.98	66.66	15.79	0.00	12.0	± 9.6 %
		Y	4.80	66.55	15.96		12.0	

10493-AAE	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	1.55	61.05	9.75	2.23	11.0	± 9.6 %
		Y	1.19	60.00	7.85		11.0	
10494-AAF	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	1.86	65.14	13.80	2.23	13.0	± 9.6 %
		Y	2.15	69.05	15.12		13.0	
10495-AAF	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	2.02	63.92	12.40	2.23	12.0	± 9.6 %
		Y	1.66	63.02	11.05		12.0	
10496-AAF	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	2.04	63.71	12.22	2.23	11.0	± 9.6 %
		Y	1.62	62.39	10.62		11.0	
10497-AAA	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	0.55	139.19	8.53	2.23	13.0	± 9.6 %
		Y	0.00	60.00	0.00		13.0	
10498-AAA	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	0.00	60.00	0.00	2.23	11.0	± 9.6 %
		Y	0.00	66.91	33.03		11.0	
10499-AAA	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	0.00	60.00	0.00	2.23	10.0	± 9.6 %
		Y	0.00	60.00	0.00		10.0	
10500-AAB	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	0.77	60.00	6.69	2.23	13.0	± 9.6 %
		Y	32.58	60.11	2.40		13.0	
10501-AAB	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	1.32	60.00	4.33	2.23	11.0	± 9.6 %
		Y	238.34	58.17	1.25		11.0	
10502-AAB	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	1.57	60.00	4.05	2.23	11.0	± 9.6 %
		Y	160.61	57.70	1.09		11.0	
10503-AAE	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	1.10	61.31	9.75	2.23	13.0	± 9.6 %
		Y	0.80	60.00	7.61		13.0	
10504-AAE	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	1.10	60.00	7.65	2.23	12.0	± 9.6 %
		Y	0.99	60.00	5.73		12.0	
10505-AAE	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	1.12	60.00	7.52	2.23	11.0	± 9.6 %
		Y	1.04	60.00	5.54		11.0	
10506-AAE	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	1.84	65.02	13.72	2.23	13.0	± 9.6 %
		Y	2.10	68.71	14.95		13.0	
10507-AAE	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	2.00	63.83	12.33	2.23	12.0	± 9.6 %
		Y	1.64	62.88	10.96		12.0	
10508-AAE	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	2.03	63.61	12.15	2.23	11.0	± 9.6 %
		Y	1.60	62.25	10.53		11.0	
10509-AAE	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	2.34	65.78	14.85	2.23	12.0	± 9.6 %
		Y	2.58	69.31	16.48		12.0	
10510-AAE	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	2.66	65.30	14.24	2.23	11.0	± 9.6 %
		Y	2.67	67.01	14.70		11.0	
10511-AAE	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	2.71	65.24	14.15	2.23	11.0	± 9.6 %
		Y	2.66	66.62	14.41		11.0	

10447-AAD	LTE-FDD (OFDMA, 5 MHz, E-TM 3.1, Clipping 44%)	X	0.82	60.00	5.09	0.00	14.0	± 9.6 %
		Y	22.51	346.38	34.52		14.0	
10448-AAD	LTE-FDD (OFDMA, 10 MHz, E-TM 3.1, Clippin 44%)	X	2.09	64.80	11.32	0.00	15.0	± 9.6 %
		Y	1.27	60.43	7.23		15.0	
10449-AAC	LTE-FDD (OFDMA, 15 MHz, E-TM 3.1, Cliping 44%)	X	2.97	67.85	14.44	0.00	15.0	± 9.6 %
		Y	2.35	65.84	12.37		15.0	
10450-AAC	LTE-FDD (OFDMA, 20 MHz, E-TM 3.1, Clipping 44%)	X	3.37	68.30	15.38	0.00	15.0	± 9.6 %
		Y	3.01	67.99	14.57		15.0	
10451-AAA	W-CDMA (BS Test Model 1, 64 DPCH, Clipping 44%)	X	0.70	60.00	3.63	0.00	14.0	± 9.6 %
		Y	5.58	640.23	29.21		14.0	
10456-AAB	IEEE 802.11ac WiFi (160MHz, 64-QAM, 99pc duty cycle)	X	5.20	67.47	16.22	0.00	12.0	± 9.6 %
		Y	5.02	67.38	16.39		12.0	
10457-AAA	UMTS-FDD (DC-HSDPA)	X	2.88	66.98	14.32	0.00	18.0	± 9.6 %
		Y	2.23	64.51	11.75		18.0	
10458-AAA	CDMA2000 (1xEV-DO, Rev. B, 2 carriers)	X	158.67	59.71	0.97	0.00	17.0	± 9.6 %
		Y	0.00	60.00	0.00		17.0	
10459-AAA	CDMA2000 (1xEV-DO, Rev. B, 3 carriers)	X	0.00	60.00	0.00	0.00	13.0	± 9.6 %
		Y	7.70	153.43	9.94		13.0	
10460-AAA	UMTS-FDD (WCDMA, AMR)	X	1.95	84.09	20.87	0.00	37.0	± 9.6 %
		Y	100.00	129.32	29.12		37.0	
10461-AAA	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	0.99	61.72	11.44	3.29	12.0	± 9.6 %
		Y	1.70	70.75	16.73		12.0	
10462-AAA	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	0.90	60.00	8.11	3.23	11.0	± 9.6 %
		Y	0.92	60.65	9.08		11.0	
10463-AAA	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	0.88	60.00	7.63	3.23	10.0	± 9.6 %
		Y	0.85	60.00	8.20		10.0	
10464-AAB	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	0.91	61.06	10.70	3.23	12.0	± 9.6 %
		Y	1.44	68.59	15.32		12.0	
10465-AAB	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	0.90	60.00	8.06	3.23	11.0	± 9.6 %
		Y	0.88	60.17	8.76		11.0	
10466-AAB	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	0.89	60.00	7.57	3.23	10.0	± 9.6 %
		Y	0.85	60.00	8.13		10.0	
10467-AAE	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	0.91	61.16	10.80	3.23	12.0	± 9.6 %
		Y	1.49	69.02	15.56		12.0	
10468-AAE	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	0.90	60.00	8.09	3.23	11.0	± 9.6 %
		Y	0.90	60.36	8.90		11.0	
10469-AAE	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	X	0.89	60.00	7.59	3.23	10.0	± 9.6 %
		Y	0.85	60.00	8.15		10.0	
10470-AAE	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	X	0.91	61.15	10.80	3.23	12.0	± 9.6 %
		Y	1.48	68.93	15.53		12.0	
10471-AAE	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	X	0.90	60.00	8.10	3.23	11.0	± 9.6 %
		Y	0.90	60.37	8.91		11.0	

10300-AAD	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, 64-QAM)	X	0.29	246.13	28.07	0.00	16.0	± 9.6 %
		Y	0.00	154.14	85.80		16.0	
10301-AAA	IEEE 802.16e WiMAX (29:18, 5ms, 10MHz, QPSK, PUSC)	X	4.90	60.00	9.21	4.17	5.0	± 9.6 %
		Y	0.00	121.04	59.87		5.0	
10302-AAA	IEEE 802.16e WiMAX (29:18, 5ms, 10MHz, QPSK, PUSC, 3 CTRL symbols)	X	4.60	68.85	15.36	4.96	5.0	± 9.6 %
		Y	3.42	64.55	11.75		5.0	
10303-AAA	IEEE 802.16e WiMAX (31:15, 5ms, 10MHz, 64QAM, PUSC)	X	4.59	68.76	14.65	4.96	5.0	± 9.6 %
		Y	2.95	62.77	10.03		5.0	
10304-AAA	IEEE 802.16e WiMAX (29:18, 5ms, 10MHz, 64QAM, PUSC)	X	3.95	67.44	13.75	4.17	6.0	± 9.6 %
		Y	2.43	61.44	9.07		6.0	
10305-AAA	IEEE 802.16e WiMAX (31:15, 10ms, 10MHz, 64QAM, PUSC, 15 symbols)	X	1.19	56.30	5.51	6.02	3.0	± 9.6 %
		Y	0.69	55.42	3.31		3.0	
10306-AAA	IEEE 802.16e WiMAX (29:18, 10ms, 10MHz, 64QAM, PUSC, 18 symbols)	X	3.61	63.97	10.49	6.02	3.0	± 9.6 %
		Y	1.17	55.25	4.20		3.0	
10307-AAA	IEEE 802.16e WiMAX (29:18, 10ms, 10MHz, QPSK, PUSC, 18 symbols)	X	3.61	64.02	10.36	6.02	3.0	± 9.6 %
		Y	1.13	54.96	3.81		3.0	
10308-AAA	IEEE 802.16e WiMAX (29:18, 10ms, 10MHz, 16QAM, PUSC)	X	3.70	64.44	10.65	6.02	3.0	± 9.6 %
		Y	1.11	55.18	4.15		3.0	
10309-AAA	IEEE 802.16e WiMAX (29:18, 10ms, 10MHz, 16QAM, AMC 2x3, 18 symbols)	X	3.75	64.56	10.96	6.02	3.0	± 9.6 %
		Y	1.19	55.61	4.73		3.0	
10310-AAA	IEEE 802.16e WiMAX (29:18, 10ms, 10MHz, QPSK, AMC 2x3, 18 symbols)	X	3.78	64.66	10.92	6.02	3.0	± 9.6 %
		Y	1.16	55.52	4.60		3.0	
10311-AAD	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	X	2.17	69.27	16.41	0.00	19.0	± 9.6 %
		Y	2.36	72.80	17.72		19.0	
10313-AAA	iDEN 1:3	X	8.30	89.76	24.82	6.99	6.0	± 9.6 %
		Y	100.00	141.20	40.66		6.0	
10314-AAA	iDEN 1:6	X	100.00	135.23	39.56	10.00	3.0	± 9.6 %
		Y	100.00	148.27	45.62		3.0	
10315-AAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	X	1.15	66.11	14.93	0.17	43.0	± 9.6 %
		Y	1.24	69.61	16.20		43.0	
10316-AAB	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 96pc duty cycle)	X	3.28	67.52	14.71	0.17	12.0	± 9.6 %
		Y	2.88	66.96	13.71		12.0	
10317-AAC	IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle)	X	3.28	67.52	14.71	0.17	12.0	± 9.6 %
		Y	2.88	66.96	13.71		12.0	
10400-AAD	IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle)	X	3.28	67.83	14.97	0.00	12.0	± 9.6 %
		Y	2.86	67.21	13.93		12.0	
10401-AAD	IEEE 802.11ac WiFi (40MHz, 64-QAM, 99pc duty cycle)	X	4.12	67.56	15.93	0.00	12.0	± 9.6 %
		Y	3.90	67.91	16.05		12.0	
10402-AAD	IEEE 802.11ac WiFi (80MHz, 64-QAM, 99pc duty cycle)	X	4.53	67.45	16.08	0.00	12.0	± 9.6 %
		Y	4.33	67.54	16.24		12.0	
10403-AAB	CDMA2000 (1xEV-DO, Rev. 0)	X	4.02	216.28	19.34	0.00	29.0	± 9.6 %
		Y	0.00	114.07	76.74		29.0	

10242-CAA	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, 64-QAM)	X	2.39	60.00	14.37	6.98	8.0	± 9.6 %
		Y	2.27	60.00	15.51		8.0	
10243-CAA	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK)	X	2.52	60.00	14.89	6.98	8.0	± 9.6 %
		Y	2.50	60.00	15.82		8.0	
10244-CAC	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM)	X	0.96	60.00	4.33	3.98	8.0	± 9.6 %
		Y	57.58	61.57	1.88		8.0	
10245-CAC	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, 64-QAM)	X	0.96	60.00	4.22	3.98	8.0	± 9.6 %
		Y	58.12	61.16	1.69		8.0	
10246-CAC	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, QPSK)	X	0.89	60.00	5.33	3.98	9.0	± 9.6 %
		Y	0.67	60.00	4.06		9.0	
10247-CAF	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)	X	1.12	60.00	5.28	3.98	8.0	± 9.6 %
		Y	0.92	59.96	3.49		8.0	
10248-CAF	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)	X	1.54	56.57	2.02	3.98	8.0	± 9.6 %
		Y	1.37	60.46	3.10		8.0	
10249-CAF	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, QPSK)	X	1.21	60.65	6.85	3.98	9.0	± 9.6 %
		Y	0.87	60.00	5.42		9.0	
10250-CAF	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)	X	2.27	63.89	10.35	3.98	8.0	± 9.6 %
		Y	1.52	60.68	7.30		8.0	
10251-CAF	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)	X	2.07	62.35	8.99	3.98	8.0	± 9.6 %
		Y	1.44	60.00	6.43		8.0	
10252-CAF	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	2.38	66.40	12.56	3.98	9.0	± 9.6 %
		Y	1.78	63.98	10.27		9.0	
10253-CAF	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, 16-QAM)	X	2.86	65.11	11.92	3.98	8.0	± 9.6 %
		Y	2.15	62.72	9.56		8.0	
10254-CAF	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, 64-QAM)	X	3.06	65.96	12.56	3.98	8.0	± 9.6 %
		Y	2.30	63.39	10.13		8.0	
10255-CAF	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	3.10	68.59	14.69	3.98	9.0	± 9.6 %
		Y	2.63	67.57	13.44		9.0	
10256-CAA	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM)	X	4.16	61.93	3.04	3.98	8.0	± 9.6 %
		Y	6.85	153.44	11.41		8.0	
10257-CAA	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, 64-QAM)	X	68.07	60.01	1.14	3.98	8.0	± 9.6 %
		Y	14.88	61.07	1.89		8.0	
10258-CAA	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK)	X	0.73	60.00	4.45	3.98	9.0	± 9.6 %
		Y	15.68	61.11	1.92		9.0	
10259-CAC	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)	X	1.31	60.00	6.00	3.98	8.0	± 9.6 %
		Y	0.98	60.00	4.89		8.0	
10260-CAC	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, 64-QAM)	X	1.33	60.00	5.95	3.98	8.0	± 9.6 %
		Y	46.28	60.34	1.26		8.0	
10261-CAC	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, QPSK)	X	1.50	61.91	8.25	3.98	9.0	± 9.6 %
		Y	1.02	60.00	6.01		9.0	
10262-CAF	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)	X	2.26	63.82	10.29	3.98	8.0	± 9.6 %
		Y	1.51	60.62	7.24		8.0	

10177-CAI	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK)	X	2.65	66.18	16.83	3.01	19.0	± 9.6 %
		Y	2.71	67.05	17.90		19.0	
10178-CAG	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)	X	3.38	71.09	19.11	3.01	16.0	± 9.6 %
		Y	3.65	73.20	20.77		16.0	
10179-CAG	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)	X	3.03	68.89	17.51	3.01	16.0	± 9.6 %
		Y	3.17	70.18	18.74		16.0	
10180-CAG	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)	X	2.80	67.22	16.29	3.01	16.0	± 9.6 %
		Y	2.89	68.06	17.26		16.0	
10181-CAE	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	2.65	66.18	16.83	3.01	19.0	± 9.6 %
		Y	2.71	67.05	17.90		19.0	
10182-CAE	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)	X	3.38	71.06	19.09	3.01	16.0	± 9.6 %
		Y	3.65	73.16	20.75		16.0	
10183-AAD	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 64-QAM)	X	2.80	67.21	16.28	3.01	16.0	± 9.6 %
		Y	2.88	68.04	17.25		16.0	
10184-CAE	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, QPSK)	X	2.65	66.20	16.84	3.01	19.0	± 9.6 %
		Y	2.72	67.07	17.91		19.0	
10185-CAE	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM)	X	3.39	71.13	19.13	3.01	16.0	± 9.6 %
		Y	3.66	73.26	20.80		16.0	
10186-AAE	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 64-QAM)	X	2.80	67.24	16.30	3.01	16.0	± 9.6 %
		Y	2.89	68.08	17.28		16.0	
10187-CAF	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)	X	2.67	66.37	16.99	3.01	19.0	± 9.6 %
		Y	2.74	67.30	18.10		19.0	
10188-CAF	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM)	X	3.47	71.64	19.45	3.01	16.0	± 9.6 %
		Y	3.78	74.01	21.25		16.0	
10189-AAF	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 64-QAM)	X	2.84	67.50	16.50	3.01	16.0	± 9.6 %
		Y	2.93	68.40	17.51		16.0	
10193-CAC	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	3.32	68.25	15.21	0.00	13.0	± 9.6 %
		Y	2.90	67.61	14.18		13.0	
10194-CAC	IEEE 802.11n (HT Greenfield, 39 Mbps, 16-QAM)	X	3.44	68.48	15.44	0.00	13.0	± 9.6 %
		Y	3.07	68.21	14.64		13.0	
10195-CAC	IEEE 802.11n (HT Greenfield, 65 Mbps, 64-QAM)	X	3.45	68.45	15.43	0.00	13.0	± 9.6 %
		Y	3.05	68.05	14.56		13.0	
10196-CAC	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	3.33	68.34	15.23	0.00	13.0	± 9.6 %
		Y	2.91	67.75	14.24		13.0	
10197-CAC	IEEE 802.11n (HT Mixed, 39 Mbps, 16-QAM)	X	3.43	68.45	15.43	0.00	13.0	± 9.6 %
		Y	3.06	68.17	14.63		13.0	
10198-CAC	IEEE 802.11n (HT Mixed, 65 Mbps, 64-QAM)	X	3.42	68.35	15.38	0.00	13.0	± 9.6 %
		Y	3.03	67.92	14.49		13.0	
10219-CAC	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	X	3.27	68.35	15.26	0.00	13.0	± 9.6 %
		Y	2.87	67.77	14.28		13.0	
10220-CAC	IEEE 802.11n (HT Mixed, 43.3 Mbps, 16-QAM)	X	3.44	68.47	15.44	0.00	13.0	± 9.6 %
		Y	3.06	68.17	14.62		13.0	

10111-CAG	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)	X	0.84	61.57	7.75	0.00	18.0	± 9.6 %
		Y	0.50	60.00	4.50		18.0	
10112-CAG	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM)	X	2.09	68.44	14.11	0.00	17.0	± 9.6 %
		Y	1.44	64.99	11.01		17.0	
10113-CAG	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)	X	0.82	60.97	7.25	0.00	17.0	± 9.6 %
		Y	0.53	60.00	4.34		17.0	
10114-CAC	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	4.07	67.80	16.25	0.00	13.0	± 9.6 %
		Y	3.91	68.39	16.55		13.0	
10115-CAC	IEEE 802.11n (HT Greenfield, 81 Mbps, 16-QAM)	X	4.26	68.35	16.36	0.00	12.0	± 9.6 %
		Y	4.06	68.95	16.61		12.0	
10116-CAC	IEEE 802.11n (HT Greenfield, 135 Mbps, 64-QAM)	X	4.10	68.15	16.31	0.00	13.0	± 9.6 %
		Y	3.93	68.76	16.59		13.0	
10117-CAC	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	4.07	67.75	16.25	0.00	13.0	± 9.6 %
		Y	3.91	68.34	16.55		13.0	
10118-CAC	IEEE 802.11n (HT Mixed, 81 Mbps, 16-QAM)	X	4.28	68.40	16.38	0.00	12.0	± 9.6 %
		Y	4.09	69.01	16.64		12.0	
10119-CAC	IEEE 802.11n (HT Mixed, 135 Mbps, 64-QAM)	X	4.10	68.11	16.30	0.00	13.0	± 9.6 %
		Y	3.93	68.72	16.57		13.0	
10140-CAE	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 16-QAM)	X	2.52	68.59	15.40	0.00	18.0	± 9.6 %
		Y	2.34	69.16	15.01		18.0	
10141-CAE	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 64-QAM)	X	2.70	69.46	15.86	0.00	18.0	± 9.6 %
		Y	2.55	70.20	15.51		18.0	
10142-CAE	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, QPSK)	X	0.41	60.00	5.54	0.00	20.0	± 9.6 %
		Y	13.92	300.78	36.01		20.0	
10143-CAE	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)	X	0.49	60.00	3.24	0.00	18.0	± 9.6 %
		Y	0.00	60.00	0.00		18.0	
10144-CAE	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 64-QAM)	X	9.44	240.24	29.15	0.00	17.0	± 9.6 %
		Y	0.00	215.39	78.82		17.0	
10145-CAF	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK)	X	0.00	130.96	75.70	0.00	19.0	± 9.6 %
		Y	0.00	60.00	0.00		19.0	
10146-CAF	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM)	X	0.00	60.00	0.00	0.00	17.0	± 9.6 %
		Y	0.00	60.00	0.00		17.0	
10147-CAF	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 64-QAM)	X	0.00	60.00	0.00	0.00	16.0	± 9.6 %
		Y	0.00	60.00	0.00		16.0	
10149-CAE	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM)	X	2.07	68.71	14.34	0.00	18.0	± 9.6 %
		Y	1.50	65.85	11.59		18.0	
10150-CAE	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, 64-QAM)	X	2.12	68.65	14.23	0.00	17.0	± 9.6 %
		Y	1.46	65.17	11.13		17.0	
10151-CAG	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	3.45	70.26	16.24	3.98	9.0	± 9.6 %
		Y	3.38	71.60	16.46		9.0	
10152-CAG	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM)	X	3.25	66.83	13.75	3.98	8.0	± 9.6 %
		Y	2.73	65.58	12.35		8.0	

10037-CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH3)	X	0.42	60.00	5.48	1.88	22.0	± 9.6 %
		Y	0.33	60.00	3.83		22.0	
10038-CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH5)	X	0.30	60.00	4.90	1.17	26.0	± 9.6 %
		Y	42.36	61.73	1.86		26.0	
10039-CAB	CDMA2000 (1xRTT, RC1)	X	1.54	347.79	17.25	0.00	25.0	± 9.6 %
		Y	0.00	114.74	79.18		25.0	
10042-CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Halfrate)	X	100.00	120.51	30.81	7.78	10.0	± 9.6 %
		Y	100.00	124.67	32.56		10.0	
10044-CAA	IS-91/EIA/TIA-553 FDD (FDMA, FM)	X	0.16	60.00	16.19	0.00	55.0	± 9.6 %
		Y	0.09	60.00	21.88		55.0	
10048-CAA	DECT (TDD, TDMA/FDM, GFSK, Full Slot, 24)	X	11.40	81.10	21.59	13.80	3.0	± 9.6 %
		Y	50.42	106.50	29.62		3.0	
10049-CAA	DECT (TDD, TDMA/FDM, GFSK, Double Slot, 12)	X	13.32	87.26	22.77	10.79	5.0	± 9.6 %
		Y	100.00	120.83	32.49		5.0	
10056-CAA	UMTS-TDD (TD-SCDMA, 1.28 Mcps)	X	6.89	77.34	18.17	9.03	5.0	± 9.6 %
		Y	20.76	95.01	24.27		5.0	
10058-DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2-3)	X	3.48	69.52	21.01	6.55	14.0	± 9.6 %
		Y	3.69	72.63	23.80		14.0	
10059-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps)	X	1.18	65.41	14.42	0.61	39.0	± 9.6 %
		Y	1.24	68.32	15.52		39.0	
10060-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps)	X	1.20	70.49	16.65	1.30	32.0	± 9.6 %
		Y	3.85	91.61	24.76		32.0	
10061-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	X	1.45	67.51	14.97	2.04	28.0	± 9.6 %
		Y	1.91	73.64	17.67		28.0	
10062-CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	X	3.40	67.59	14.92	0.49	12.0	± 9.6 %
		Y	3.02	67.19	14.03		12.0	
10063-CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps)	X	3.43	67.68	15.07	0.72	12.0	± 9.6 %
		Y	3.10	67.54	14.39		12.0	
10064-CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps)	X	3.47	67.41	14.93	0.86	11.0	± 9.6 %
		Y	3.08	67.00	14.07		11.0	
10065-CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps)	X	3.49	67.34	15.01	1.21	11.0	± 9.6 %
		Y	3.17	67.24	14.36		11.0	
10066-CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps)	X	3.50	67.08	14.84	1.46	10.0	± 9.6 %
		Y	3.17	66.92	14.12		10.0	
10067-CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps)	X	3.72	67.20	15.14	2.04	8.0	± 9.6 %
		Y	3.42	67.23	14.60		8.0	
10068-CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps)	X	3.77	67.06	15.36	2.55	8.0	± 9.6 %
		Y	3.52	67.21	14.93		8.0	
10069-CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	X	3.79	66.83	15.26	2.67	8.0	± 9.6 %
		Y	3.52	66.91	14.76		8.0	
10071-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 9 Mbps)	X	3.75	67.35	15.58	1.99	9.0	± 9.6 %
		Y	3.53	67.80	15.38		9.0	

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client Qualcomm USA

Certificate No: **5G-Veri30-1006_Apr18**

CALIBRATION CERTIFICATE

Object	5G Verification Source 30 GHz – SN: 1006
Calibration procedure(s)	QA CAL-45.v1 Calibration procedure for 5G Verification and Validation Sources
Calibration date:	April 06, 2018

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Reference Probe EUmmWV2	SN: 9374	23-Mar-18 (No. EUmmWV2-9374_Mar18)	Mar-19
DAE4	SN: 1215	26-Feb-18 (No. DAE4-1215_Feb18)	Feb-19

Secondary Standards	ID #	Check Date (in house)	Scheduled Check

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	[signature]
Approved by:	Katja Pokovic	Technical Manager	[signature]

Issued: April 12, 2018

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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Glossary

CW Continuous wave

Calibration is Performed According to the Following Standards

- Internal procedure QA CAL-45-5Gsources
- IEC TR-63170 ED1, "Measurement procedure for the evaluation of power density related to human exposure to radio frequency fields from wireless communication devices operating between 6 GHz and 100 GHz", November 2017
- DASY6 Handbook

Methods Applied and Interpretation of Parameters

- *Coordinate System:* z-axis in the waveguide horn boresight, x-axis is in the direction of the E-field, y-axis normal to the others in the field scanning plane parallel to the horn flare and horn flange.
- *Measurement Conditions: (1) 10 GHz:* The forward power to the horn antenna is measured prior and after the measurement with a power sensor. During the measurements, the horn is directly mounted to the waveguide source and the reflected power is monitored and adjusted. (2) 30, 60 and 90 GHz: The verification sources are switched on for at least 30 minutes. Absorbers are used around the probe cup to minimize reflections.
- *Horn Positioning:* The waveguide horn is mounted vertically on the flange of the waveguide source to allow vertical positioning of the EUmmW probe during the scan. The plane is parallel to the phantom surface (plane height defined by teaching the point at the surface of the flare of the horn).
- *E- field distribution:* E field is measured in four x-y-planes (10mm, 10mm + λ/4, 150mm; 150mm+ λ/4) with a vectorial E-field probe. The results at 150 mm are used to derive radiated power P_{rad} using numerically determined values. The E-field value stated as calibration value represents the E-field-maxima and the averaged (1cm^2 and 4cm^2) power density values at 10mm in front of the horn.
- *E-field polarization:* Above the open horn, linear polarization of the field is expected.

Calibrated Quantity

- Local peak E-field and spatial-averaged power density S (1 cm^2 and 4cm^2) at 10, 30, 60 or 90 GHz.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	cDASY6 5G module	V1.0.0.12565
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm and 150 mm	
XY Scan Resolution	dx, dy = λ/4	
Number of measured planes	4 (10mm, 10mm + λ/4, 150mm; 150mm+ λ/4)	
Frequency	30 GHz ± 10 MHz	

Calibration Parameters, 30 GHz

Distance Horn Aperture to Measured Plane	P_{rad}[1] *(dBm)*	**Max E-field (V/m)**	Uncertainty E (k = 2)	Avg Power Density (W/m^2)		Uncertainty S (k = 2)
				1 cm^2	4 cm^2	
10 mm	15.7	**140.0**	1.2 dB	**43.3**	**37.9**	1.4 dB
150 mm	15.7	**53.8**	1.2 dB	**7.26**	**6.94**	1.4 dB

[1] derived from far-field E-field data