Qualcomm Technologies, Inc.

Netgear 5G MHS Travel Router (FCC ID: PY319100441) RF Exposure Compliance Test Report

Compliance summary

80-W5669-3 Rev. B

May 14, 2019

Qualcomm Technologies, Inc.
5775 Morehouse Drive
San Diego, CA 92121
U.S.A.

Revision history

Revision	Date	Description
A	May 06, 2019	Initial release
B	May 14, 2019	Correction in SAR tables

Contents

Figures

Tables

1 Strategy for Compliance Demonstration

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 Netgear 5G MHS Travel Router (FCC ID: PY319100441), it contains:

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

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 is in compliance with FCC requirements all the time. The Section 2 provides the overview of Qualcomm Smart Transmit.

The WLAN is not enabled with Smart Transmit.

Demonstrating compliance of Netgear 5G MHS Travel Router (FCC ID: PY319100441) with Qualcomm Smart Transmit feature is completed in three parts:

0. RF Exposure Compliance Test Report Part 0: SAR Characterization and PD Characterization

   The SAR and PD Characterization determines the input power limit after accounting for device design related uncertainties, which corresponds to FCC SAR or PD limit, per each radio configuration and RF exposure usage scenario. The determined input power limits will be loaded and stored in a wireless device via the Embedded File System (EFS), and then used as inputs for Smart Transmit to operate.

   For Netgear 5G MHS Travel Router (FCC ID: PY319100441), SAR characterization is based on SAR measurement and PD characterization is based on simulation in combination with measurement as validation. The input power limit, denoted as P_{limit} for sub-6 radio, *input.power.limit* for mmW NR, represents the maximum time-averaged power level for the corresponding radio/antenna configuration.

   The SAR and PD characterization of Netgear 5G MHS Travel Router (FCC ID: PY319100441) is reported in the Part 0 report

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 in static transmission scenario at maximum allowable time-averaged power levels (i.e., P_{limit} for sub-6 radio, and *input.power.limit* for mmW NR), or maximum RF tune-up power levels if they are lower than maximum allowable time-averaged power levels. The compliance under static transmission condition is demonstrated via this Part 1 report, which includes Bureau Veritas Report No. SA181015C09: *FCC SAR Test Report*.

The RF exposure assessment for simultaneous transmission scenarios the EUT supports is also conducted in Part 1 report.

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 Netgear 5G MHS Travel Router (FCC ID: PY319100441).

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 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 RF exposure report package.
- This predefined time-averaged power limit is derived and determined in Part 0 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; *inst. Tx power (t)* is the instantaneous transmit power at t time instant; P_{limit} is the predefined time-averaged power limit.

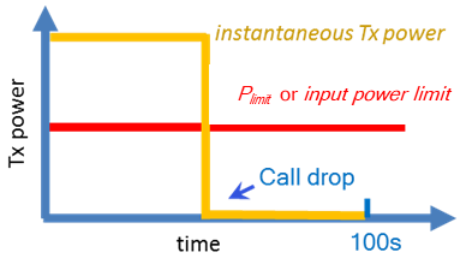

Figure 2-1 Transmit at high power when needed and permitted

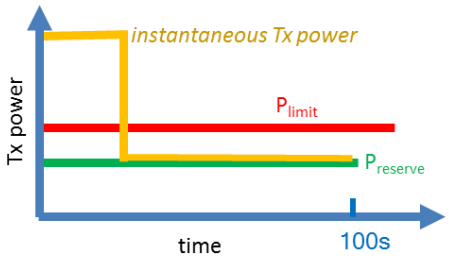

Figure 2-2 Transmit with reserve power to support continuous transmission at a minimum power level ($P_{reserve}$)

- 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_targe*t. 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 Description of Equipment Under Test

For description of the EUT, refer to Section 2 of Bureau Veritas Report No. SA181015C09: *FCC SAR Test Report*, and copied below:

EUT Type	5G MHS Travel Router
FCC ID	PY318300428
Brand Name	NETGEAR
Model Name	MR5000
Tx Frequency Bands (Unit: MHz)	LTE Band 2 : 1850.7 ~ 1909.3 (BW: 1.4M, 3M, 5M, 10M, 15M, 20M) LTE Band 4 : 1710.7 ~ 1754.3 (BW: 1.4M, 3M, 5M, 10M, 15M, 20M) LTE Band 5 : 824.7 ~ 848.3 (BW: 1.4M, 3M, 5M, 10M) LTE Band 12 : 699.7 ~ 715.3 (BW: 1.4M, 3M, 5M, 10M) LTE Band 14 : 790.5 ~ 795.5 (BW: 5M, 10M) LTE Band 29 : 717 ~ 728 (Rx only) LTE Band 30 : 2307.5 ~ 2312.5 (BW: 5M, 10M) LTE Band 46 : 5150~5925 (Rx only) LTE Band 66 : 1710.7 ~ 1779.3 (BW: 1.4M, 3M, 5M, 10M, 15M, 20M) WLAN : 2412 ~ 2462, 5180 ~ 5240, 5745 ~ 5825
Uplink Modulations	LTE : QPSK, 16QAM, 64QAM 802.11b : DSSS 802.11a/g/n/ac : OFDM
Maximum Tune-up Conducted Power (Unit: dBm)	Please refer to section 4.6.1 of this report
Antenna Type	Internal IFA Antenna
EUT Stage	Engineering Sample

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.
2. For mmW5G please refer to power density report No.SP181015C09.

List of Accessory:

Battery	**Brand Name**	NETGEAR
	Model Name	W-10a
	Power Rating	3.85Vdc, 5040mAh
	Type	Li-ion

4 Compliance Summary

In summary, all transmission scenarios that EUT supports comply with FCC time-averaged RF exposure requirement after accounting for total device related uncertainty, as shown in Table 4-1.

Table 4-1: *Reported* RF exposure level

	Reported RF Exposure Level	Notes
Highest 1g SAR at P_{limit} (W/kg)	1.16	Bureau Veritas Report No. SA181015C09: *FCC SAR Test Report*
Highest 4cm^2-avg PD at *input.power.limit* (W/m^2)	7.43	Qualcomm Document No. 80-W5669-1 Rev.A: *Netgear 5G MHS Travel Router (FCC ID: PY319100441) RF Exposure Compliance Test Report Part 1: Test Under Static Transmission Scenario*
Highest 1g SAR for simultaneous Tx (4G WWAN + WLAN)	1.28	Bureau Veritas Report No. SA181015C09: *FCC SAR Test Report*
Highest Total Exposure Ratio for simultaneous Tx (LTE+5G mmW NR + WLAN)	0.82	Qualcomm Document No. 80-W5669-1 Rev.A: *Netgear 5G MHS Travel Router (FCC ID: PY319100441) FCC Power Density Compliance Test Report, Part 1: Test Under Static Transmission Scenario*