Part 2: Test Under Dynamic Transmission Condition

Test Report No. 14809943H-C

Customer	**Panasonic Corporation of North America**
Description of EUT	**Radio Module (Tested inside of Panasonic Personal Computer FZ-40)**
Model Number of EUT	**WW21A**
FCC ID	**ACJ9TGWW21A**
Issue Date	**June 16, 2023**
Remarks	**-**

Representative test engineer	Approved by
	
Takeshi Hiyaji Engineer	Takayuki Shimada Leader

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Contents

1 Introduction

This device uses Qualcomm® Smart Transmit feature These modem(s) is enabled in Qualcomm® Smart Transmit Feature to control and manage transmitting power in real time and to ensure at all times the averaged RF exposure is in compliance with FCC requirements

This purpose of the 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 EUT.

The P_{limit} and *input.power.limit* used in this report is determined and listed in Part 0 report.

This description is an overview for STx and test results may not include both sub6 (SAR) and mmW (PD).

2 Customer information

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Telephone Number	+1-201-348-7760
Contact Person	Ben Botros

*Remarks:
Panasonic Connect Co., Ltd. is on behalf of the applicant: Panasonic Corporation of North America (Company incorporated abroad).

The information provided from the customer is as follows;
- Customer, Description of EUT, Model No. FCC ID on the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 2: Customer information
- SECTION 3: Equipment under test (EUT) other than the Receipt Date
- SECTION 10 Calculated P_{limit} and $P_{max.}$

* The laboratory is exempted from liability of any test results affected from the above information in section 3.

3 Equipment under test (EUT)

3.1 Identification of EUT

Description	Radio Module
Model Number	WW21A
Serial Number	1LTSA00106
Condition	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	May 22, 2023
Calculated Date	May 23, 2023

<Information of Host device>

Type	Personal Computer FZ-40 Intel Core i7-1185G7 (1.2 GHz, Max 4.8 GHz) 14 inch LCD (1920 x 1080)

3.2 Product description

General Specification

Rating	DC 3.0 to 3.6 V

Radio Specification

EFS version 15.

Wireless technologi+C4:C4	Dup.	Band		Mode
WCDMA	FDD	2		UMTS Rel. 99 (Data) HSDPA (Rel. 5)
	FDD	4		HSUPA (Rel. 6), HSPA+ (Rel. 7), DC-HSDPA (Rel. 8)
	FDD	5		
LTE	FDD	2		QPSK, 16QAM, 64AQM, 256QAM
	FDD	4		
	FDD	5		Dow nlink MIMO Support: Yes(2x2, 4x4)
*B42: not used in US (FCC)	FDD	7		Supported band : B2, B4, B7, B25, B38, B41, B42, B48, B66
	FDD	12		
*B48: not used in	FDD	13		Uplink MIMO Support: No
Canada(ISED)	FDD	14		Uplink transmission is limited to a single output stream.
	FDD	17		
	FDD	25		
	FDD	26		
	FDD(Rx only)	29		
	TDD	38		
	TDD	41		
	TDD	42		
	TDD(Rx only)	46		
	TDD	48		
	FDD	66		
	FDD	71		
LTE CA	Dow nlink			Uplink *B42: not used in US (FCC) / B48: not used in Canada(ISED)
	Maximum 7 carriers			Maximum 2 carriers Supported combination: <Inter-band contiguous> 7C, 41C, 42C, 48C <Inter-band> 2A-5A, 2A-12A, 2A-13A, 4A-5A, 4A-12A, 4A-13A, 5A-7A, 5A-66A, 12A-66A, 13A-66A
5G NR (FR1)	FDD	15 kHz	n2	Pi/2 BPSK (DFT-s-OFDM),
	FDD	15 kHz	n5	QPSK (CP-OFDM/DFT-s-OFDM),
*n78: not used in US (FCC)	TDD	15 kHz	n41	16QAM (CP-OFDM/DFT-s-OFDM),
	FDD	15 kHz	n66	64QAM (CP-OFDM/DFT-s-OFDM),
	FDD	15 kHz	n71	256QAM (CP-OFDM/DFT-s-OFDM)
	TDD	30 kHz	n77	Dow nlink MIMO Support: Yes(2x2, 4x4)
	TDD	30 kHz	n78	Supported band : n2, n41, n66, n77, n78
	-	-	-	Uplink MIMO Support: No
	-	-	-	Uplink transmission is limited to a single output stream.
EN-DC(LTE-FR1 Sub6)	Supported combination			*n78: not used in US (FCC)
(NSA mode only)	LTE Anchor Bands for NR band n2			LTE Band 5/12/13
	LTE Anchor Bands for NR band n5			LTE Band 2/7/66
	LTE Anchor Bands for NR band n41			LTE Band 2/25/26/66
	LTE Anchor Bands for NR band n66			LTE Band 5/12/13/14/71
	LTE Anchor Bands for NR band n71			LTE Band 2/7/66
	LTE Anchor Bands for NR band n77			LTE Band 41
	LTE Anchor Bands for NR band n78*			LTE Band 2/5/7/12/38/66

Wireless module (Tested inside of Panasonic Personal Computer FZ-40)
Model: WL20B (FCC ID ACJ9TGWL20B / ISED certification number 216H-CFWL20B)

Wireless technologies	Dup.	Band		Mode
WLAN	TDD	2.4GHz	2412-2472	802.11b
			for US	802.11g
			2412-2462	802.11n(20,40)
			for Canada	802.11ax(20,40)
	TDD	5GHz	5180-5240	802.11a
			5260-5320	802.11n(20,40)
			5500-5720	802.11ac(20,40.80.160)
			5745-5825	802.11ax(20,40.80.160)
Bluetooth	TDD	2.4GHz	2402-2480	BR/EDR/LE

Host device: Personal Computer, Model: FZ-40

Wireless technologies	Dup.	Band		Mode
5G NR (FR2)	TDD	120 kHz	n258	Pi/2 BPSK (DFT-s-OFDM), QPSK (CP-OFDM/DFT-s-OFDM)
	TDD	120 kHz	n260	16QAM (CP-OFDM/DFT-s-OFDM),
	TDD	120 kHz	n261	64QAM (CP-OFDM/DFT-s-OFDM)
	-	-	-	
	-	-	-	MIMO Support: No
EN-DC(LTE-FR2 mmW) (NSA mode only)	Supported combination			*B48: not used in Canada(ISED)
	LTE Anchor Bands for NR band n258			LTE Band 2/5/7/12/66
	LTE Anchor Bands for NR band n260			LTE Band 2/5/12/13/14/48*/66
	LTE Anchor Bands for NR band n261			LTE Band 2/5/13/48*/66

4 Location

UL Japan, Inc. Ise EMC Lab.
Shielded room for SAR testings
FCC Test Firm Registration Number: 884919
ISED SAR Lab Company Number: 2973C / CAB identifier: JP0002
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81-596-24-8999

5 References

Federal Communications Commission. (October 23, 2015). *447498 D04 Interim General RF Exposure Guidance v01.*
International Electrotechnical Commission. (2018). *IEC TR 63170:2018 .*
SPEAG. (August 2018). *5G Module V1.2 Application Note: 5G Compliance Testing.*

6 Definitions, symbols, and abbreviations

6.1 Definitions

SAR_design_target : Target value to use STx and also this shall be less than regulatory SAR limit (i.e., 1gSAR limit for FCC) after accounting for all device design related uncertainties.

SAR_design_target_extremity : SAR_design_target for limbs

Tx_power_at_SAR_design_target : Transmit level that matches SAR_design_target

Δmin : housing material influence

PD_design_target : The design target for PD compliance. It should be less than regulatory power density limit to account for all device design related uncertainties

input.power.limit : For a PD characterized wireless device, the input power level at antenna port(s) for each beam corresponding to PD_design_target.

PD char : The table that contains input.power.limit fed to antenna port(s) for all supported beams.

N beams : The mmW device supports total N beams, where M out of N are single beams and the rest of (N-M) are beam pairs (where 2 single beams are excited at the same time).

power density (PD) or S_{av} : Energy per unit time and unit area crossing a surface of area *A* characterized by the normal unit vector **n̂** and averaging time.

$$S_{\text{av}} = \frac{1}{AT}\int\int (\mathbf{E}\times\mathbf{H})\cdot\hat{\boldsymbol{n}}\,\mathrm{d}A\,\mathrm{d}T$$

Specific Absorption Rate (SAR) : The time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ), as shown in the following equation:

$$\text{SAR} = \frac{\mathrm{d}}{\mathrm{dt}}\left(\frac{\mathrm{dW}}{\mathrm{dm}}\right) = \frac{\mathrm{d}}{\mathrm{dt}}\left(\frac{\mathrm{dW}}{\rho\mathrm{dV}}\right)$$

6.2 Symbols

Symbol	Quantity	Unit	Dimensions
E	Electric field	volt per meter	V / m
f	Frequency	hertz	Hz
H	Magnetic field	ampere per meter	A / m
λ	Wavelength	meter	m
S	Local power density	watt per square meter	W / m^2
PD or S_{av}	Spatial-average power density	watt per square meter	W / m^2 (mW / cm^2)
SAR	Specific Absorption Rate	watt per kilo gram	W / kg

6.3 Abbreviations

DSI	: device state index
KDB	: knowledge data base from Federal communication committee (FCC)
BS or BSE	: base station or base station emulator
CW	: continuous wave
DUT	: device under test
NR	: new radio
PD	: power density
RF	: radio frequency
TER	: total exposure ratio
S_n	: surface number
S_{tot} or S_{total}	: total propagating power flux density into the phantom
S_n or S_{norm}	: surface normal propagating power flux density into the phantom or in normed vector space
Ant	: antenna
nG	: n generation (e.g. 3G, 4G and 5G)
☒	: applicable.
☐	: NOT applicable.

7 Qualcomm® Smart Transmit Operation Description

This description is just an overview for STx and test results may not include both sub6 (SAR) and mmW (PD).

7.1 Feature description

The regulatory 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 regulatory limit of RF exposure time-averaged over a defined time window, denoted as T_{SAR} and T_{PD} for specific absorption rate (SAR for Tx frequency < 6 GHz) and power density (PD for Tx 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 Tx power.

- Once the SAR and PD of the wireless device is characterized at a Tx 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 Tx power control and management.

The Smart Transmit algorithm embedded in Qualcomm® modems reliably controls the Tx power of the wireless device in real time to maintain the time-averaged Tx 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 (frequency < 6 GHz) and *input.power.limit* corresponding to PD design target (frequency > 6 GHz) in this report.

The wireless device with continuous Tx power at P_{limit} level or *input.power.limit* level complies with the regulatory RF exposure requirement.

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

7.2 Basic concept of the algorithm

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

- If time-averaged Tx power approaches the P_{limit}, then the modem needs to limit instantaneous Tx power to ensure the time-averaged Tx 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 regulatory RF exposure limit in any T_{SAR} or T_{PD} time window).

- The wireless device can have high Tx powers at any instant and exceed the P_{limit} or *input.power.limit* level for a short duration before limiting the power to maintain the time-averaged Tx power under P_{limit} or *input.power.limit*.

- If the wireless device is at high Tx power for a long time, then the radio link needs to be dropped to be compliant with time-averaged Tx power requirement (see Figure 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). At all times, Smart Transmit meets the below equation:

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

where, $time.avg.Tx\ power$ is the Tx power averaged between t-T_{SAR} and t time period; T_{SAR} is the time window defined by regulator for time-averaging RF exposure for Tx frequency less than 6GHz (sub6); *inst. Tx power (t)* is the instantaneous Tx 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 Tx power averaged between t-T_{PD} and t time period; T_{PD} is the time window defined by regulator for time-averaging RF exposure for mmW bands; *mmW_Tx power (t)* is the instantaneous mmW Tx power at t time instant; $input.power.limit$ is the predefined time-averaged power limit for the beam under test.

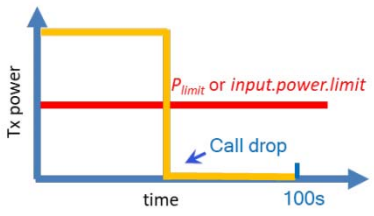
- In the case of simultaneous transmission, Smart Transmit manages all active Tx and makes sure the total exposure ratio is less than 1, i.e.,

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

or

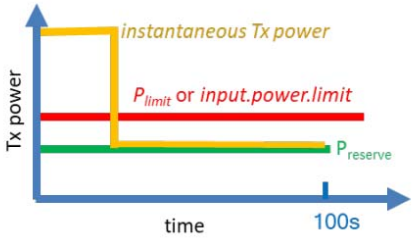
$$\sum \frac{\frac{1}{T_{SAR0}}\int_{t-T_{SAR0}}^{t} SAR0(t)dt}{Regulatory\ SAR\ limit} + \sum \frac{\frac{1}{T_{SAR1}}\int_{t-T_{SAR1}}^{t} SAR1(t)dt}{Regulatory\ SAR\ limit}\ \leq\ 1$$

where, SAR0 is primary transmitter and SAR1 is secondary transmitter.



(a)

Figure 1 High Tx power when needed and permitted



(b)

Figure 2 Tx power reduced to reserve power to support continuous transmission at a minimum power level ($P_{reserve}$)

7.3 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 Tx frequencies f<3GHz, 60 seconds for 3GHz < f < 6GHz, and 4 seconds for 24GHz < f < 42GHz. For countries adopting ICNIRP the time averaging window is 360 seconds

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

  The maximum time-averaged Tx 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 Tx power (*Preserve*):
  Preserve (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 Tx power to *P_{limit}*, in other words, the wireless device can be at continuous Tx power of *P_{limit}*, and in this case, Smart Transmit dynamic control feature is not utilized.

- *input.power.limit* (dBm) for Tx 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.

- *Regulatory body configuration:*
  Based on regulatory requirement for each countries/regions, FCC time window/limits and/or ICNIRP 1998 time window/limits can be selected and/or combined. Additionally, Time-Averaged Exposure mode or Peak Exposure mode can be selected based on MCC for Smart Transmit to operate. In Time-Averaged Exposure mode, as described in Section 7.2, the wireless device can instantaneously transmit at high transmit powers and exceed the P_{limit} for a short duration before limiting the power to maintain the time-averaged transmit power under the P_{limit}; while in Peak Exposure mode, the maximum instantaneous transmit power is limited to P_{limit}. Depending on EFS version, regulatory body configuration is different. Please refer to corresponding user guide for details.

- *force peak* for Tx transmitting frequency < 6 GHz
  The Smart Transmit feature applies time-averaging windows when the device detects an MCC that matches Time-Averaged Exposure MCCs list. For each of the MCCs under Time-Averaged Exposure MCCs list, the Smart Transmit feature can limit either maximum peak power or maximum time-average power to P_{limit} per tech/band/antenna/DSI. If force peak is set to '1' for a given tech/band/antenna/DSI in the EFS, then the Smart Transmit feature limits the maximum Tx power to P_{limit} for the selected tech/band/antenna/DSI. In other words, with force peak set to '1', under static condition (i.e., fixed tech/band/antenna/DSI) and in single active Tx scenario, Smart Transmit can guarantee Tx power level of P_{limit} at all times.

8 Tx Varying Transmission Test Cases and Test Proposal

To validate time averaging feature and demonstrate the compliance in Tx varying transmission conditions, the following transmission scenarios are covered in Part 2 test:

8.1 Transmission scenarios

1. During a time-varying Tx power transmission: To prove that the Smart Transmit feature accounts for Tx power variations in time accurately.
2. During a call disconnect and re-establish scenario: To prove that the Smart Transmit feature accounts for history of past Tx power transmissions accurately.
3. During technology/band handover: To prove that the Smart Transmit feature functions correctly during transitions in technology/band.
4. During DSI (Device State Index) change: To prove that the Smart Transmit feature functions correctly during transition from one device state (DSI) to another.
5. During antenna (or beam) switch: To prove that the Smart Transmit feature functions correctly during transitions in antenna (such as antenna diversity scenario) or beams (different antenna array
configurations).
6. SAR vs. PD exposure switching during sub-6+mmW transmission: To prove that the Smart Transmit feature functions correctly and ensures total RF exposure compliance during transitions in SAR dominant exposure, SAR+PD exposure, and PD dominant exposure scenarios.
7. During time window switch: To prove that the Smart Transmit feature correctly handles the transition from one time window to another specified by FCC, and maintains the normalized time-averaged RF exposure to be less than normalized FCC limit of 1.0 at all times.
8. SAR exposure switching between two active radios (radio1 and radio2): To prove that the Smart Transmit feature functions correctly and ensures total RF exposure compliance when exposure varies among SAR_radio1 only, SAR_radio1 + SAR_radio2, and SAR_radio2 only scenarios. As described in Part 0 report, the RF exposure is proportional to the Tx power for a SAR- and PD-characterized wireless device. Thus, feature validation in Part 2 can be effectively performed through conducted (for f < 6GHz) and radiated (for f ≥ 6GHz) power measurement.

Therefore, the compliance demonstration under dynamic transmission conditions and feature validation are required in conducted/radiated power measurement setup for transmission scenario 1 through 8.

To add confidence in the algorithm validation, the time-averaged SAR and PD measurements are also required but only performed for transmission scenario 1 to avoid the complexity in SAR and PD measurement (such as, for scenario 3 requiring change in SAR probe calibration file to accommodate different bands and/or tissue simulating liquid).

9 SAR Time Averaging Validation Test Procedures

This chapter provides the test plan and test procedure for validating Qualcomm® Smart Transmit algorithm for sub-6 transmission.

9.1 Test sequence determination for validation

Following the FCC recommendation, two test sequences having time-variation in Tx power are predefined for sub-6 (f < 6 GHz) validation:

Test sequence 1: requesting EUT to transmit at maximum power, measured P_{max} for 80s, then requesting for half of the maximum power, i.e., measured P_{max} /2, for the rest of the time.

Test sequence 2: requesting EUT to transmit at time-varying Tx power levels. This sequence is generated relative to measured P_{max}, measured P_{limit} and calculated $P_{reserve}$ (= measured P_{limit} in dBm - *Reserve_power_margin* in dB) of EUT based on measured P_{limit}.

The details for generating these two test sequences is described and listed in Appendix A.

NOTE: For test sequence generation, “measured P_{limit}” and “measured P_{max}” are used instead of the “P_{limit}” specified in EFS entry and “P_{max}” specified for the device, because Smart Transmit algorithm operates against the actual power level of the “P_{limit}” that was calibrated for the EUT. The “measured P_{limit}” accurately reflects what the algorithm is referencing to, therefore, it should be used during algorithm validation testing. The RF tune up and device-to-device variation are already considered in Part 0 report prior to determining P_{limit}.

9.2 Test configuration selection criteria for validating Smart Transmit feature

For validating Smart Transmit feature, this section provides a general guidance to select test cases. In practice, an adjustment can be made in test case selection. The justification/clarification may be provided.

Used the highest *measured* 1g_or_10g SAR at P_{limit} ($P_{limit} < P_{max}$) shown in Part 1 report and for the selected tech/band/antenna/DSI out of all radio configurations and device positions

9.2.1 Test configuration selection for time-varying Tx power transmission

The Smart Transmit time averaging feature operation is independent of bands, modes, and channels for a given technology. Hence, validation of Smart Transmit in one band/mode/channel per technology is sufficient. Two bands per technology are proposed and selected for this testing to provide high confidence in this validation.

The criteria for the selection are based on the P_{limit} values determined in Part 0 report. Select two bands[1] in each supported technology that correspond to least[2] and highest[3] P_{limit} values for validating Smart Transmit.

- If $P_{limit} > P_{max}$, the validation test with time-vary test sequences is not needed as no power enformance will be required in this condition.

Note if possible, for this selection, delta (P_{max} - P_{limit}) should be 1dB or higher.

[1] If one P_{limit} level applies to all the bands within a technology, then only one band needs to be tested. In this case, within the bands having the same P_{limit}, the radio configuration (e.g., # of RBs, channel#) and device position that correspond to the highest measured 1gSAR at P_{limit} shown in Part 1 report is selected.
[2] In case of multiple bands having the same least P_{limit} within the technology, then select the band having the highest measured 1gSAR at P_{limit}.
[3] The band having a higher P_{limit} needs to be properly selected so that the power limiting enforced by Smart Transmit can be validated using the pre-defined test sequences. If the highest P_{limit} in a technology is too high (> P_{max})where the power limiting enforcement is not needed when testing with the pre-defined test sequences, then the next highest level is checked. This process is continued within the technology until the second band for validation testing is determined.

9.2.2 Test configuration selection for change in call

The criteria to select a test configuration for call-drop measurement is:

- Select technology/band with least P_{limit} among all supported technologies/bands and $P_{limit} < P_{max}$, then select one radio configuration within the selected band for this test.
- In case of multiple bands having same least P_{limit}, then select one band/radio configuration for this test.
- Test for change in call is not required if all $P_{limit} > P_{max}$

9.2.3 Test configuration selection for change in technology/band

The selection criteria for this measurement is to have EUT switch from a technology/band with lowest (or highest) P_{limit} within the technology group to a technology/band with highest (or lowest) P_{limit} within the technology group, or vice versa. This test is performed with the EUT being requested to transmit at maximum power, the technology/band switch is performed during Tx power enforcement duration (i.e., during the time when EUT is forced to transmit at $P_{reserve}$).

- First select both technology/band configurations having $P_{limit} < P_{max}$. In case of multiple bands having the same P_{limit}, select one band/radio configuration for this test. If this cannot be found, then,
- Select at least one technology/band configuration having $P_{limit} < P_{max}$. If all $P_{limit} > P_{max}$, then, test for change in technology/band is not required.

9.2.4 Test configuration selection for change in antenna

The criteria to select a test configuration for antenna switch (between primary and diversity antennas) measurement is:

- Whenever possible and supported by the EUT, first select antenna switch configuration within the same technology/band/DSI (i.e., same technology, band and DSI combination), and having different P_{limit}, and having both $P_{limit} < P_{max}$ where possible. Otherwise, select at least one antenna having $P_{limit} < P_{max}$.
- If the EUT does not support antenna switch within the same technology/band, but has multiple transmitting antennas to support different frequency bands, then antenna switch test should be performed in combination with technology and/or band switch.
- Test for change in antenna is not required if all $P_{limit} > P_{max}$

9.2.5 Test configuration selection for change in DSI

The criteria to select a test configuration for DSI change test is

- Select a technology/band having the $P_{limit} < P_{max}$ within any technology and DSI group, and for the same technology/band having a different P_{limit} ($P_{limit} < P_{max}$) and in any other DSI group. Both the selected DSIs should have $P_{limit} < P_{max}$ where possible. Otherwise, select at least one DSI having $P_{limit} < P_{max}$. Note that the selected DSI transition need to be supported by the device.
- Test for change in device state is not required if all $P_{limit} > P_{max}$.

9.2.6 Test configuration selection for change in time window

FCC specifies different time window for time averaging based on operation frequency. The criteria to select a test configuration for validating Smart Transmit feature and demonstrating the compliance during the change in time window is

1. Select <u>any</u> technology/band that has operation frequency classified in one time window defined by FCC (such as 100s time window), and its corresponding P_{limit} is less than P_{max} if possible.
2. Select the 2nd technology/band that has operation frequency classified in a different time window defined by FCC (such as 60s time window), and its corresponding P_{limit} is less than P_{max} if possible.
3. It is preferred both P_{limit} values of two selected technology/bands are less than corresponding P_{max}, but if not possible or due to limitation of test setup, then at least one of technologies/bands has its P_{limit} less than P_{max}.
4. Else, if all $P_{limit} > P_{max}$, then,
    a. first select both technologies/bands (one is in 100s time window, another is in 60s time window) having ($P_{limit} - P_{max}$) < 2.2dB; if it is not available, then
    b. select at least one technology/band in 60s time window having ($P_{limit} - P_{max}$) < 2.2dB; if it is not available, then
    c. Test for change in time window is not required.

9.2.7 Test configuration selection for SAR exposure switching

If supported, the test configuration for SAR exposure switching should cover

1. SAR exposure switch when two active radios are in the same time window. The following radio configurations need to be covered if the device supports:

    a. LTE + sub6 NR: LTE is protected as it is anchor in NR call. However, Sub6 NR can sustain the link if LTE is at low power
    b. Interband ULCA: PCC is protected as it is primary in interband ULCA call. SCC will drop the link if SCC is requested to transmit continuously at or above P_{limit} regardless of PCC transmitting power level in devices with Smart Transmit EFS version 15 (or lower). SCC is expected to sustain the link when PCC is at low power in Smart Transmit EFS version 16 (or higher).

Note that Smart Transmit treats intraband ULCA as single Tx, so, this test is not needed for intraband ULCA.
Note that in the case of MIMO, Smart Transmit combines the individual exposures of MIMO antennas, and operates as a single Tx. So, this test is not needed for Part 2. However, the combined exposure of MIMO should be assessed in Part 1.

2. SAR exposure switch when two active radios are in different time windows. Note that one test with two active radios in any two different time windows is sufficient as Smart Transmit operation is the same for RF exposure switch in any combination of two different time windows. For device supporting LTE + mmW NR, this test (i.e., Scenario 2) is covered in SAR vs PD exposure switch validation.

The Smart Transmit time averaging operation ensures total time-averaged RF exposure compliance independent of the source of SAR exposure (for example, LTE vs. Sub6 NR). Hence, validation of Smart Transmit in any one band combination for each simultaneous SAR transmission scenario (i.e., one band combination for LTE + Sub6 NR transmission, and one band combination for interband ULCA) is sufficient, where the SAR exposure varies among SAR_{radio1} only, SAR_{radio1} + SAR_{radio2}, and SAR_{radio2} only scenarios.

The criteria to select a test configuration for validating Smart Transmit feature during SAR exposure switching scenarios is

- Following the above two test requirements, select the required configuration(s) for the EUT supported simultaneous transmission scenario(s).

- Among all supported simultaneous transmission configurations, the selection order is

    a. select one configuration where both P_{limit} of radio1 and radio2 is less than their corresponding P_{max}, preferably, with different P_{limits}. If this configuration is not available, then,
    b. select one configuration that has P_{limit} less than its P_{max} for at least one radio. If this can not be found, then,
    c. The test for SAR exposure switch when two active radios are in the same time window is not required. For SAR exposure switch when two active radios are in the different time windows, the selection order is:
        i. Select both configurations that has P_{limit} of radio1 and radio2 greater than P_{max} but having ($P_{limit} - P_{max}$) < 2.2dB. If this can not be found, then,
        ii. Select at least one configuration in 60s window that has ($P_{limit} - P_{max}$) < 2.2dB. If all ($P_{limit} - P_{max}$) > 2.2dB, then,
        iii. Test for SAR exposure switch when two active radios are in the different time windows is not required.

Test for one band combination per each simultaneous transmission technology is sufficient as the feature operation is the same.

10 Conclusion

As per section 9.2, all sub6 tests are excluded since all P_{limit} value are higher than P_{max}.
($P_{limit} > P_{max}$)

10.1 Calculated Plimit and Pmax

RAT	Band	P_{max}[dBm]	Calc. P_{limit} [dBm]	Delta P_{limt}-P_{max} [dB]
NR	n77(Block A)	24.5	26.4	**1.9**
NR	n77(Block C)	24.5	29.4	4.9

Appendix A Revision History

Original Test Report No.: 14809943H-C

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14809943H-C	June 16, 2023	-

End of Report