FastConnect_TAS_Time Varying Validation Report

FCC ID	:	**E2K-QCNCM825**
Equipment	:	**WiFi 7/BT Combo module**
Brand Name	:	**DELL**
Model Name	:	**QCNCM825**
Applicant	:	**Dell Inc. One Dell Way, Round Rock, TX 78682, USA**
Standard	:	**FCC 47 CFR Part 2 (2.1093)**

We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. Laboratory, the test report shall not be reproduced except in full.

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Appendix A. Test Setup Photos

History of this test report

Report No.	Version	Description	Issued Date
FA3D0452C	01	Initial issue of report	Mar. 19, 2024

1. Introduction

FastConnect TAS for Qualcomm WLAN technologies controls and manages transmit power in real time to always ensure the time averaged RF exposure is in compliance with regulatory requirements. The purpose of this report is to demonstrate the Qualcomm® FastConnect™ time averaged SAR (TAS) feature RF exposure compliance under dynamic transmission scenarios.

This test report provides reference to test results and plots using parameters is determined from for static SAR test and configurate in FastConnect TAS BDF for validating the FastConnect TAS feature.

Test Lab Information

Test Firm Name	Sporton International Inc. Wensan Laboratory
Test Firm Information	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan
Date of Start during the Test	01/01/2024
Date of End during the Test	1/10/2024
Test Engineers	Aaron Chen
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2. FastConnect TAS Operation

2.1 Background

Regulatory RF exposure limits are defined with respect to time-averaged RF exposure. Qualcomm FastConnect TAS algorithm performs transmit power control to ensures at all times the wireless device is in compliance with the configured limit of RF exposure averaged over a defined time window denoted as TSAR for SAR and PD

For FCC. Wi-Fi 6E operates in the 6GHz ~ 7GHz band. The Interim RF Exposure Test Procedures for U-NII 6-7GHz Portable Devices requires RF exposure assessment with SAR and incident PD (total) using mmW near-field probe and total-field/power-density reconstruction method.

For ISED. An APD evaluation should be used to address the RF exposure for operating at a frequency greater than 6 GHz.

The FastConnect TAS supports maximum time-averaging windows (denoted as TSAR) as defined by the FCC and ISED that:

- For FCC, a 30 second time-averaging window is used by FastConnect TAS for WLAN operation in 2.4GHz, 5GHz, and 6GHz WLAN bands
- For ICNIRP 1998, the time-averaging window for radios operating <10GHz is 360 seconds. FastConnect TAS uses a 360s window for regions outside the U.S (e.g., ISED Canada).

2.2 Basic concept of the feature

FastConnect TAS manages the instantaneous transmit power to maintain the time-averaged power and associated RF exposure is below the regulatory compliance limit.

- If the time-averaged transmit power approaches the SAR compliance power, then the instantaneous transmit power is limited to ensure the time-averaged transmit power does not exceed the SAR compliance power in any TSAR time window (i.e., the time-averaged RF exposure complies with the FCC or ICNIRP RF exposure limit in any time window).
- The wireless device can instantaneously transmit at high transmit powers for a short time durations before limiting the power to maintain time-averaged SAR compliance.

2.3 Supported WLAN operations

- IEEE 802.11 – Operation in 2GHz, 5GHz, and 6GHz U-NII frequencies.
- SISO – Operation using a single antenna. The transmit chain may switch during operation. While using a single antenna, a design may support transmitting WLAN packets in 2GHz, 5GHz, or 6GHz channels.
- MIMO – Operation using two antennas with one or more spatial streams.
- Dual band simultaneous (DBS) and/or High Band simultaneous (HBS) – Packets are transmitted in separate frequencies at the same time. A device may operate in DBS using MIMO or SISO.

NOTE:
1. SISO operation depends on implementation in software. SISO mode may not be supported when software enables cyclic delay diversity (CDD). In this case WLAN always transmits in MIMO mode.
2. DBS operation support depends on implementation in software.

2.4 Configurable parameters

This section defines the key parameters required for FastConnect TAS Validation.
The following inputs are key parameters required for functionality of the FastConnect TAS feature.

NOTE:
The OEM must configure these parameters in the board data file (BDF).

- Time-Averaged Exposure Mode (FCC or ICNIRP) or Peak exposure mode, configurable for a given region/country: When enabled in Peak Exposure mode, FastConnect TAS limits instantaneous Tx power not to exceed Plim in both simultaneous and single antenna case.
- Plim per WLAN band/ant/DSI/regulatory limit (FCC or ICNIRP limit). Either FCC or ICNIRP limits can be chosen for a given region/country.
- Antenna group (AG) table: Optional feature to group transmit antennas such that the antennas in each group have RF exposure that is mutually exclusive (either have sum of SAR less than regulatory limit or meet SPLSR criteria) with antennas belonging to a different group.
- Reserve margin (in dB).

Dynamic inputs:
- Country of operation (location-based awareness).
- Device state index (DSI).

Non-configurable parameters (fixed entries):
- Pmax values per each WLAN operating state.

2.4.1 Plim

Plim (in dBm) is the power corresponding to the SARtarget for FastConnect WLAN. In other words, Plim is the maximum time-average transmit power setting for FastConnect TAS, at which this radio configuration (i.e., antenna, band and DSI state) reaches the SARtarget. The Fast Connect TAS algorithm uses Plim to and the real time transmit power to ensure the real time-averaged SAR is below the SARtarget in real time and thus ensure device RF Exposure compliance.

2.4.2 Pmax

Pmax for FastConnect WLAN represents the maximum WLAN transmit power from other power setting in board data file. The Pmax value could be identified by compare the target power (Rateto-Power) and compliance transmit (CTL) and other power limit.
Pmax = min {CTL, Regdomain, TPE/TPC, Rate-to-Power}

2.4.3 Reserve margin

FastConnect TAS allows minimum reserve power Preserve (= Plim - reserve margin) for WLAN radio to transmit, which can be used to maintain the link. The reserve margin is a global parameter, meaning it applies to all the radio configurations. When the reserve margin is set to zero dB, the FastConnect TAS effectively allows minimum transmit power Preserve = Plim at all times, in other words, the EUT transmits continuously at Plim.
The value is chosen by the OEM and stored in the board data file (BDF). It is in 0.1 dB increments. A single value is applied to all bands and modes.

3. Compliance Assessment Methodology

3.1 Overall strategy

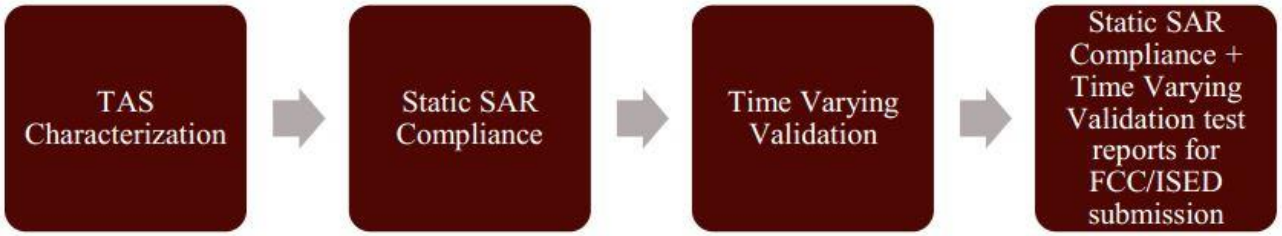
To demonstrate the compliance of FastConnect TAS. Three parts of assessment should be completed, and Static SAR compliance test report and Time Varying Validation test report should be created for certification approval:

Qualcomm_FastConnect_TAS _Characterization – OEM must perform SAR/PD characterization at the device level to determine Plim for RF exposure test.

Qualcomm_FastConnect_TAS_Static_SAR_Compliance – OEM must perform Static SAR testing for all supported WLAN band/antenna/DSI. The maximum time average Tx power levels are determined from the SAR characterization and test in static transmission (e.g., FTM mode) to validate and demonstrate RF exposure meets the design target.

Qualcomm_FastConnect_TAS_Time_Varying_Validation – Test with pre-defined test sequence for each validation scenario to demonstrate RF Exposure compliance is achieved by FastConnect TAS. Qualcomm releases a test tool that can be used for the validation scenarios and also provides installation and test guides to OEMs manufactures. OEM manufactures should determine the appropriate test mode/channel and complete the TAS Time Varying Validation Report and submit in FCC and ISED certification submissions.

High-level procedure for FastConnect TAS product approval process is shown in below Figure.



3.2 Validation strategy

The following scenarios cover validation tests to prove FastConnect TAS accounts for the history of transmission power accuracy at all times including before, during, and after transition in each scenario. Since RF exposure is proportional to the Tx power for a SAR wireless device, time-averaging algorithm validation can be effectively performed through conducted power measurements is outlined as specified in Section 4.5 to all validation scenarios.

Also, to have high confidence in validation, but also be practical, the strategy for the TimeVarying Test Sequence including both conducted power measurement and RF exposure measurement is outlined as specified in Section 4.5 Section 4.6.

In addition, since FastConnect TAS feature operates at the same averaged algorithm to all WLAN bands (2.4GHz, 5GHz, and 6GHz), 2.4GHz and 5.1 GHz are selected to demonstrate FastConnect TAS functions correctly in this validation test report. OEMs should follow the test selection criteria described in Section 4.5.1 for Time Varying Validation to the product.

3.2.1 Time-Varying Test Sequence

This test proves the FastConnect TAS accounts for Tx power variations in time accurately.

- Two bands to be selected for this test as possible and one antenna/DSI from each band should be selected and tested to prove the FastConnect TAS feature accounts for Tx power variations in time accurately using the conducted power measurement approach. This test sequence is also used for pointSAR measurement to demonstrate FastConnect TAS feature in radiated test setup.

In addition, this test is performed to capture the maximum time-averaged results in at least two time-averaging windows duration

3.2.2 Change in antenna (applicable when the software supports SISO diversity operation)

This test is to prove that FastConnect functions correctly during transitions in Plim (at different antennas) within the same WLAN band and same Antenna Group. If device supports SISO and transmission diversity between an Antenna to another antenna, then this test is applicable. If WLAN MIMO CDD is implemented, then device is always under MIMO transmission, in this case, this test is NOT applicable.

- One band/DSI and two antenna ports should be selected for conducted power measurement.

3.2.3 Change in device state (DSI) (applicable when the device supports multiple DSI)

This is to prove that FastConnect TAS performs power enforcements to maintain compliance during transitions in the device state.

- One antenna/band and two DSIs should be selected for conducted measurement.

3.2.4 Change in WLAN band

This is to prove that the FastConnect TAS functions correctly during transitions in radios and bands.

- One antenna/DSI and two bands should be selected for conducted power measurement.

3.2.5 Simultaneous Transmission

This is to prove that the FastConnect TAS functions in transition from 1 st standalone WLAN radio to simultaneous WLAN radios and back to 2nd standalone WLAN radio.

- Select two bands per simultaneous transmissions feature implemented to FastConnect TAS device for this test. One antenna/DSI and two bands should be selected for conducted power measurement.

3.3 Conducted power measurement

This section provides general procedures to perform conducted power measurement under dynamic transmission scenarios and apply to all test scenarios described in section 3.2.

1. Measure conducted power.
2. Convert it into RF exposure and divide by respective limits to get normalized exposure use equation as described in this section.
3. Perform time-averaging over predefined time windows.
4. Demonstrate that the total normalized time-averaged RF exposure is <1 for all transmission scenarios.

For frequency below 6GHz or if regulator requires SAR for WLAN 6GHz band.

$$1g\_or\_10gSAR(t) = \frac{Conducted\_Tx\_power\ (t)}{Conducted\_Tx\_power\_Plim} * 1g\_or\_10gSAR\_Plim \quad (1a)$$

$$\frac{\frac{1}{TSAR}\int_{t-TSAR}^{t} 1g\_or\_10gSAR(t)\,dt}{FCC\ or\ ICNIRP\ SAR\ limit} \leq 1 \quad (1b)$$

For frequency greater than 6GHz if regulator requires APD. (Applicable for ISED)

$$4cm^2\ PD(t) = \frac{Conducted\_Tx\_power\ (t)}{Conducted\_Tx\_power\_Plim} * 4cm^2\ PD\_Plim \quad (1c)$$

$$\frac{\frac{1}{TSAR}\int_{t-TSAR}^{t} 4cm2\ PD(t)\,dt}{APD\ 4cm^2 PD\ limit} \leq 1 \quad (1d)$$

Where, conducted_Tx_power(t), conducted_Tx_power_Plim and 1g or 10g SAR_Plim correspond to the measured instantaneous conducted Tx power and conducted Tx power at Plim of DUT, and 1g or 10g SAR values at Plim for the worst-case radio configuration within the tested band/Antenna/DSI. Similarly, 4cm^2 PD_Plim correspond to the APD values at Plim for the worst-case radio configuration within the tested band (greater than 6GHz)/Antenna/DSI.
The equations (1a) & (1b) are applicable if SAR is required by regulator to address RF exposure for the band greater than 6GHz.

NOTE:
The ratio circled in red square is obtained from the measurement on the radio configuration is selected for validation test while the 1g or 10g SAR_Plim and 4cm^2 PD_Plim must be from the SAR value in the worst-case radio configuration within the tested band/Antenna/DSI in static SAR report and scale to the conducted_Tx_power_Plim level is measured from DUT used in validation test.

3.4 RF exposure measurement

This section provides the general procedure to demonstrate the FastConnect TAS comply SAR limit in radiated test setup. Through pointSAR measurement for only test scenario Time-Varying Test Sequence (section 3.2.1) to add confidence in the FastConnect TAS feature validation, while avoiding the complexity in SAR measurement.

1. Choose worst case EUT orientation of SAR measurement per according to Static SAR test report and perform pointSAR measurement use cDASY6
2. Measure instantaneous SAR versus time and demonstrate total normalized time-averaged RF exposure is <1.0 at all times.

For frequency below 6GHz or if regulator requires SAR for WLAN 6GHz band.

$$1g\_or\_10gSAR(t) = \frac{pointSAR\ (t)}{pointSAR\_Plim} * 1g\_or\_10gSAR\_Plim \qquad (2a)$$

$$\frac{\frac{1}{TSAR}\int_{t-TSAR}^{t} 1g\_or\_10gSAR(t)\,dt}{FCC\ or\ ICNIRP\ SAR\ limit} \leq 1 \qquad (2b)$$

For frequency greater than 6GHz if regulator requires APD. (Applicable for ISED)

$$4cm^2\ PD(t) = \frac{pointSAR\ (t)}{pointSAR\_Plim} * 4cm^2\ PD\_Plim \qquad (2c)$$

$$\frac{\frac{1}{TSAR}\int_{t-TSAR}^{t} 4cm2\ PD(t)\,dt}{APD\ 4cm^2 PD\ limit} \leq 1 \qquad (2d)$$

where, pointSAR(t), pointSAR_Plim, and 1g or 10g SAR_Plim correspond to the measured instantaneous point SAR and point SAR at Plim of DUT, and 1g or 10g SAR values at Plim for the worst-case radio configuration within the tested band/Antenna/DSI. Similarly, 4cm^2 PD_Plim is the APD values at Plim for the worst-case radio configuration within the tested band (greater than 6GHz)/Antenna/DSI.The equations (2a) & (2b) are applicable if SAR is required by regulator to address RF exposure for the band greater than 6GHz.

Note:
The ratio circled in red square is obtained from the measurement on the radio configuration is selected for validation test while the 1g or 10g SAR_Plim and 4cm2 PD_Plim must be from the SAR value in the worst-case radio configuration within the tested band/Antenna/DSI in static SAR report and scale to the conducted_Tx_power_Plim level is measured from DUT used in validation test.

4. Test Setup Information

4.1 DUT FastConnect TAS Configured Parameters

The DUT has FastConnect TAS parameters configured in Board Data File for test in this test report. See Annex B for the detail of parameters configured.

4.2 Test equipment list

The test equipment used in this FastConnect TAS Time varying test report is listed in Table below

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Data Acquisition Electronics	DAE4	656	Jan. 23, 2023	Jan. 22, 2024
SPEAG	Dosimetric E-Field Probe	EX3DV4	7625	Jan. 26, 2023	Jan. 25, 2024
SPEAG	2450MHz System Validation Kit	D2450V2	929	Nov. 21, 2022	Nov. 20, 2023
SPEAG	5GHz System Validation Kit	D5GHzV2	1128	Nov. 23, 2022	Nov. 22, 2023
R&S	Base Station	CMW500	115793	Nov. 20, 2023	Nov. 19, 2024
R&S	Power Sensor	NRP50S	100983	Nov. 14, 2023	Nov. 13, 2024
R&S	Power Sensor	NRP8S	109687	Sep. 26, 2023	Sep. 25, 2024
Testo	Hygro meter	608-H1	45196600	Nov. 02, 2023	Nov. 01, 2024
Warison	10-50 GHz Directional Coupler	WCOU-10-50S-10	WR889BMC481	N/A	
ATM	500M-18GHz Dual Directional Coupler	C122H-10	P610410z-02	N/A	
Wainwright Instruments	2.4GHz Band Filter	WLK10-4630-5093-11000-40SS	N/A	N/A	
Wainwright Instruments	5GHz Band Filter	WHKX12-2700-3000-18000-60ST	N/A	N/A	
Woken	Power Divider	0120A02058001M	N/A	N/A	

4.3 Validation test setup

4.3.1 Conductive test setup

This section provides the setup diagram that is performed in this test report. Depends on the test mode selection. The test setup instruction is provided in Qualcomm® FastConnect™ User Guide (80-39282-2) Qualcomm document.

Figure 4-1 SISO (Time-Varying Test Sequence, Change in DSI) – Validation test setup

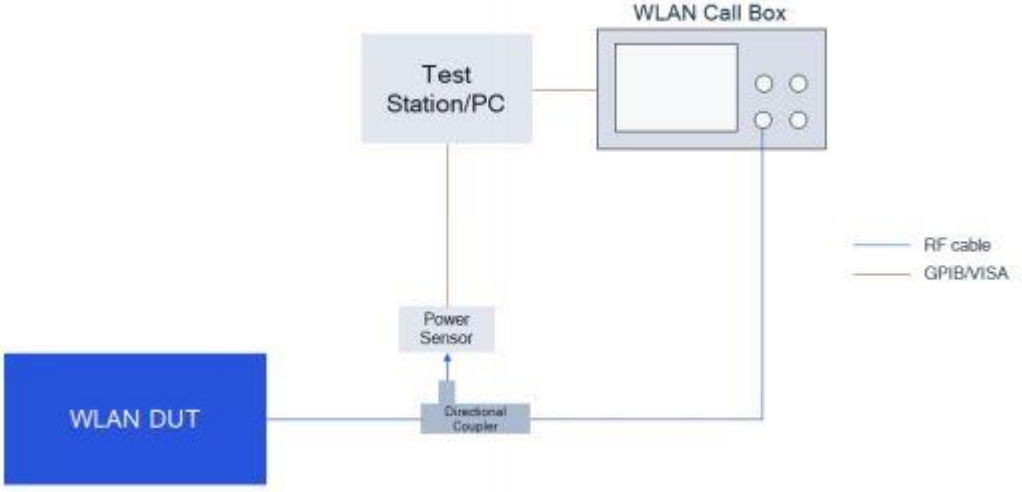


Figure 4-2 SISO (Change in Antenna) – Validation test setup

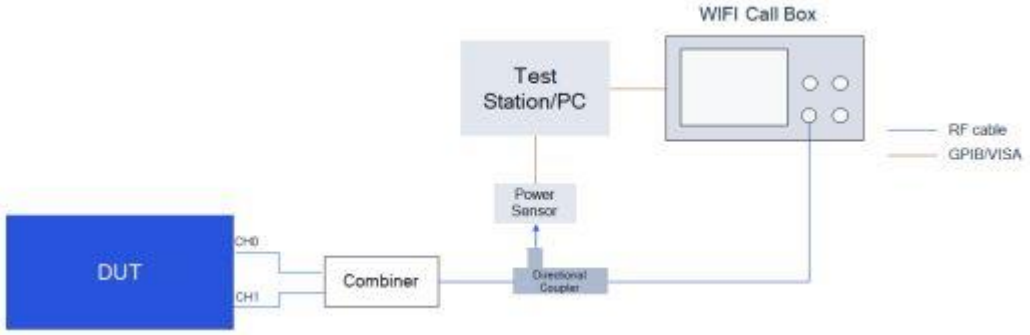


Figure 4-3 MIMO (Change in WLAN band) – Validation test setup

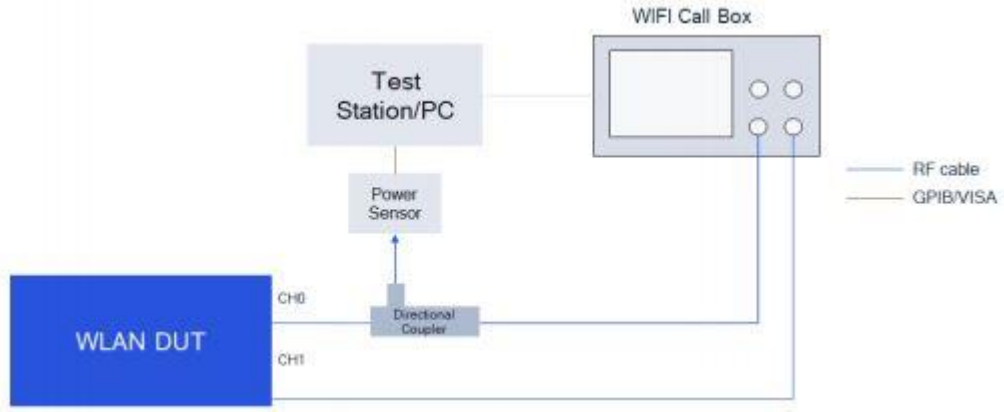
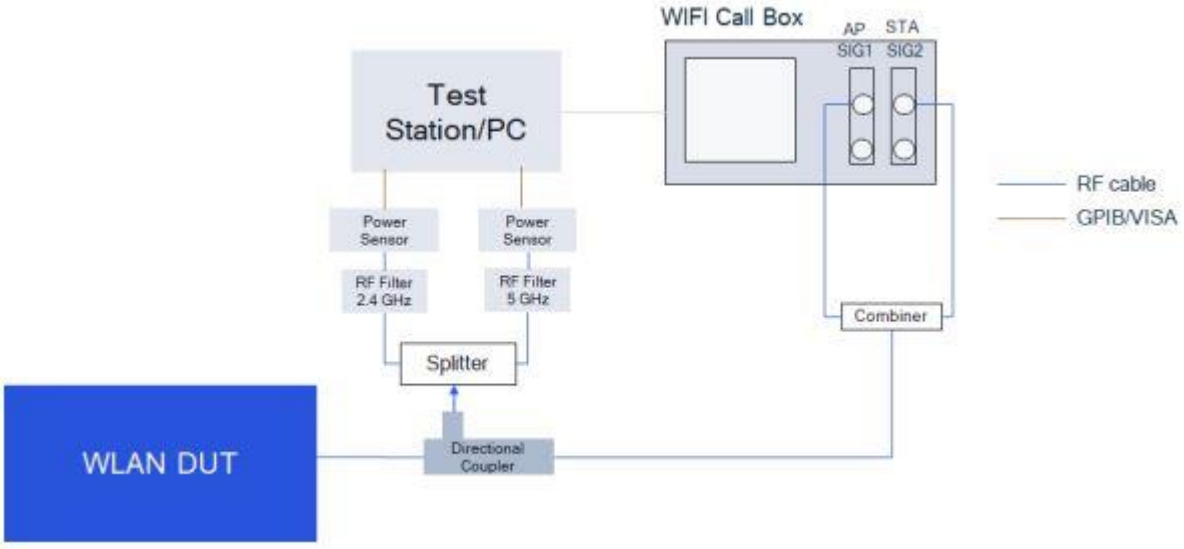


Figure 4-4 SISO (Simultaneous Transmission) – Validation test setup



4.3.2 Conductive test setup

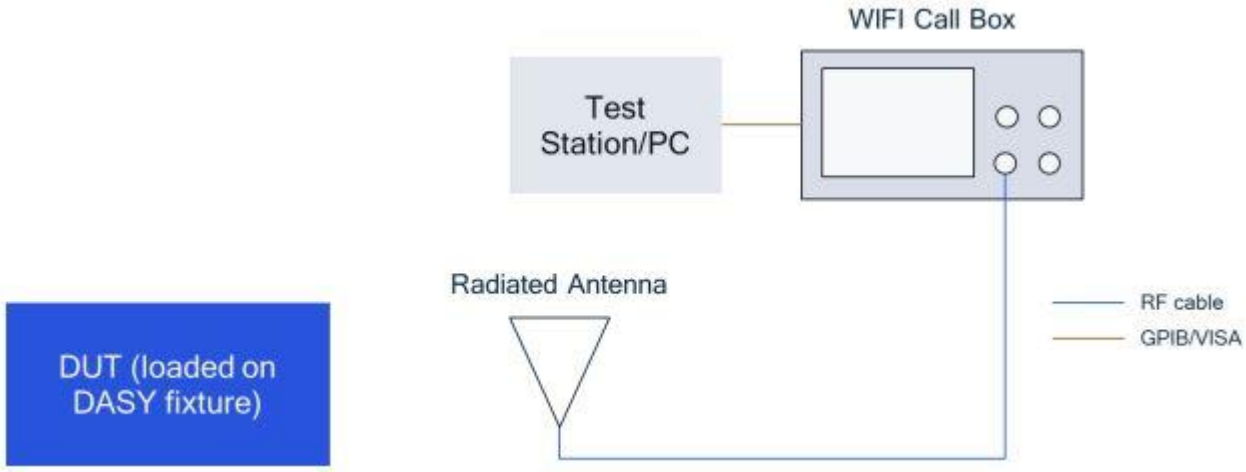
To provide higher confidence in the validation test, the FastConnect TAS Validation test plan includes radiated measurements.

In this test, the measurement setup is similar to the normal SAR measurements:

- The EUT is positioned against the flat section of the SAM Twin phantom and wirelessly connected with the callbox.
- The EUT is placed in worst-case position as determined from the static SAR test report.

The same test script from Time-Varying Test Sequence is also used here for SAR measurements.

Figure 4-5 cDASY6 System Measurement setup



4.4 Conducted Power Measurement

4.4.1 Test selection criteria

The conducted power measurement method is used for all validation test scenarios. These tests demonstrate the power enforcement by FastConnect TAS where Plim could vary before and after transition.

4.4.1.1 Test selection criteria

Select one representative test channel from all the available radio configurations (band/ant(s)/DSI) that has Pmax > Plim + device uncertainty.

If Pmax < Plim + device uncertainty for all radio configurations, then select radio configuration with largest (Pmax dBm – Plim dBm) value.

If Pmax > Plim + device uncertainty for more than one radio configuration. Then, order of preference is given by:

- If multiple radio configurations (band/ant(s)/DSI) meet this criteria, then SISO is preferred over MIMO due to simplified test setup.
- After determining SISO vs. MIMO configuration, then select the configuration that has largest (Pmax dBm – Plim dBm) dB delta.

Test to be performed at two bands for Time-Varying Test sequence test. If only one band within a configuration has Pmax > Plim and Plim > Pmax in all other configurations, then only one band needs to be tested.

Test is not required if Plim > Pmax for all radio configurations.

NOTE:
The same selection criteria are applicable for both conducted & radiated tests.

4.4.1.2 Test selection for Change in Antenna

This test scenario does not apply if SISO mode diversity is not supported. (e.g., CDD is enabled and always use MIMO). The criteria to select test configuration for Change in Antenna measurement is:

The antennas selected for this test should be in the same antenna group.

Whenever possible and supported by the EUT, first select antenna switch configuration within the same band/DSI (i.e., same band and DSI combination), and having different Plim, and having both Pmax > Plim + device uncertainty where possible. Otherwise, select at least one antenna having Pmax > Plim + device uncertainty.

- If multiple radio configurations (band/DSI) meet Pmax > Plim + device uncertainty, then select the configuration that has largest (Pmax dBm – Plim dBm) dB delta.
- If Pmax < Plim + device uncertainty for all radio configurations, then select radio configuration with largest (Pmax dBm – Plim dBm) value.

If the EUT does not support antenna switch within the same band, but has multiple transmitting antennas to support different frequency bands, then antenna switch test should be performed in combination with Change in WLAN band test scenario.

Test for Change in Antenna is not required if all Plim > Pmax for all radio configurations.

4.4.1.3 Test selection for Change in device state index (DSI)

This test scenario does not apply if multiple DSIs is not supported in the device. The criteria to select test configuration for Change in DSI measurement is:

Select a band/antenna having the Pmax > Plim + device uncertainty within any DSI, and for the same band/antenna(s) having a different Plim in any other DSI. Both the selected DSIs should have Pmax > Plim + device uncertainty where possible. Otherwise, select at least one DSI having Pmax > Plim + device uncertainty.

If Pmax < Plim + device uncertainty for all band/antenna(s), then select radio configuration with largest (Pmax dBm – Plim dBm) value.

If Pmax > Plim + device uncertainty for more than one radio configuration, then order of preference is given by:

- If multiple radio configurations (band/ant(s)/DSI) meet this criteria and if device support SISO. Then SISO is preferred over MIMO due to simplified test setup.
- After determining SISO vs. MIMO configuration, then select the configuration that has largest (Pmax dBm – Plim dBm) dB delta.

Test for Change in DSI is not required if all Plim > Pmax for all radio configurations.

4.4.1.4 Test selection for Change in WLAN band

The criteria to select test configuration for Change in WLAN band measurement is:

First select both bands in a DSI having Pmax > Plim + device uncertainty where possible. Otherwise, select at least one band having Pmax > Plim + device uncertainty.

If Pmax < Plim + device uncertainty for all radio configurations, then select radio configuration with largest (Pmax dBm – Plim dBm) value.

If Pmax > Plim + device uncertainty for more than one radio configuration. Then, order of preference is given by:

- If multiple radio configurations (band/ant(s)/DSI) meet this criteria and if device support SISO. Then SISO is preferred over MIMO due to simplified test setup.
- After determining SISO vs. MIMO configuration, then select the configuration that has largest (Pmax dBm – Plim dBm) dB delta.

The antennas corresponding to the selected bands should be in the same antenna group.

Test for Change in WLAN band is not required if all Plim > Pmax for all radio configurations.

4.4.1.5 Test selection for Simultaneous Transmission

This test scenario does not apply if simultaneous transmission within WLAN bands is not supported in the device. The criteria to select test configuration for Simultaneous Transmission measurement is:

The bands must be selected from supported Simultaneous Transmission configuration. (e.g., WLAN DBS and/or HBS)

First select both bands in a DSI having Pmax > Plim + device uncertainty where possible. Otherwise, select at least one band having Pmax > Plim + device
uncertainty.
If Pmax < Plim + device uncertainty for all radio configurations, then select radio configuration with largest (Pmax dBm – Plim dBm) value.

If Pmax > Plim + device uncertainty for more than one radio configuration. Then, order of preference is given by:

- If multiple radio configurations (band/ant(s)/DSI) meet this criteria and if device support SISO. Then SISO is preferred over MIMO due to simplified test setup.
- After determining SISO vs. MIMO configuration, then select the configuration that has largest (Pmax dBm – Plim dBm) dB delta.

The antennas corresponding to the selected bands should be in the same antenna group.

Even if a device has Plim > Pmax for all radio configurations, then “Simultaneous Transmission” test scenario should still be performed for validation of FastConnect TAS device.

NOTE:
For all above test selection. Pmax = min (CTL, Regdomain, TPE/TPC, Rate-toPower) of the selected channel//rate/band. Since FastConnect TAS supports the same Plim for all modulations in same antenna/band/DSI, the selection of test modulation/channel chooses the highest Pmax modulation.

4.4.2 Test Procedure

1. Measure Plim for modes at validation antenna ports, bands and/or DSIs with FastConnect TAS Peak Exposure Mode enabled with callbox to establish the chosen mode for test. Denote this measured power value as Conducted_Tx_power_Plim.

NOTE: The measurement of Peak Exposure Mode should be performed with 70% or higher WLAN duty cycle (for example, using iPerf to generate UL traffic).

2. Set EUT to the intended FastConnect TAS mode.

3. Establish radio link with the callbox in the selected band.

NOTE:
For the purpose of collecting repeatable time averaged power data, it is recommended to include a section of 30s at the beginning of every test with the device WLAN connection disconnected or turned off or transmitting at a very low duty cycle.

4. Request EUT to transmit in following Transition sequence:

a. **Time-Varying Test Sequence** – Request EUT to transmit maximum power for at least 30s with 100% duty cycle and 50% duty cycle for 60s to determine timeaveraged 1gSAR versus time

Time duration (seconds)	Duty Cycle (%)
30	100%
60	50%

b. **Change in antenna** – EUT operates at Antenna 1 (e.g., Main antenna port) and requests to transmit at maximum power for at least 60s. Then switch to operation on Antenna 2 (e.g., Aux antenna port), followed by at least 120s of observation.

c. **Change in device state (DSI)** – EUT operates at DSI 1 and requests to transmit at maximum power for at least 60s. Then switch to operation on DSI 2, followed by at least 120s of observation (observation period includes transition time).

d. **Change in WLAN band** – EUT operates at Band 1 and requests to transmit at maximum power for at least 60s. Then it switches to Band 2 using the same antenna port and observes another 120s (observation period includes transition time).

e. **Simultaneous Transmissions**: First establish WLAN connection with the callbox in radio2 configuration and request radio2 configuration to transmit at maximum duty cycle for at least 120s to test predominantly radio2 SAR exposure scenario. Then add radio1 configuration to the existing radio2 configuration call, and request both radio1 and radio2 to transmit at maximum duty cycle to test radio1 and radio2 SAR exposure scenario for at least 120s. Then drop (or request low duty cycle) for radio2 configuration to test predominantly radio1 SAR exposure scenario for another at least 120s. Record the conducted Tx powers for both radio1 and radio2 configurations for the entire duration of this test.

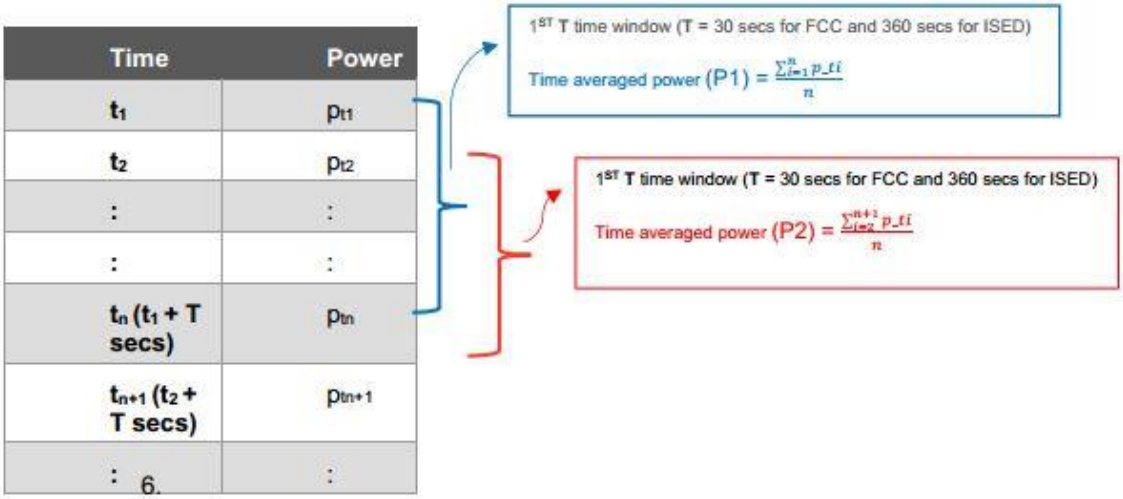
Note:
radio1 and radio2 should operate at different band.

5. Measure and record Tx power versus time.

a. Once the measurement is done, extract instantaneous Tx power versus time, and convert the conducted Tx power into 1g_or_10g SAR value, see Eq. (1 a), using Step 1 result.

b. Then perform 30s moving average to determine time-averaged 1g_or_10gSAR versus time as illustrated in Figure 4-6.

Figure 4-6 Time running/moving average illustration



6.

The following normalization is used to convert 1g_or_10gSAR exposure using Equation (1a) and (1c) in section 3.3 to validate the continuity of RF exposure limits during the transition. The procedures from step1 and step 2 in this section should be completed for each configuration under test and use below equations to validate the RF exposure during the transition.

if tested with both radio configurations below 6GHz:

$$1g\_or\_10gSAR_1(t) = \frac{Conducted\_Tx\_power\_1\ (t)}{Conducted\_Tx\_power\_Plim\_1} * 1g\_or\_10gSAR\_Plim\_1 \qquad (4a)$$

$$1g\_or\_10gSAR_2(t) = \frac{Conducted\_Tx\_power\_2\ (t)}{Conducted\_Tx\_power\_Plim\_2} * 1g\_or\_10gSAR\_Plim\_2 \qquad (4b)$$

$$\frac{\frac{1}{\mathrm{TSAR}}\left[\int_{t-\mathrm{TSAR}}^{t1} \mathrm{1g\_or\_10gSAR1(t)}\,dt + \int_{t-\mathrm{TSAR}}^{t} \mathrm{1g\_or\_10gSAR2(t)}\,dt\right]}{FCC\ or\ ICNIRP\ SAR\ limit} \leq 1 \qquad (4c)$$

where, conducted_Tx_power_1(t), conducted_Tx_power_Plim_1, and 1g or 10gSAR_*P*lim_1 correspond to the instantaneous Tx power, conducted Tx power at Plim_1 of DUT, and compliance 1g_or_10gSAR values of Antenna 1 (or Band 1 or DSI1) at Plim_1; conducted_Tx_power_2(t), conducted_Tx_power_*P*_2, and 1g_or_10gSAR_*P*lim_2 correspond to the instantaneous Tx power, conducted Tx power at Plim_2 of DUT, and compliance 1g_or_10gSAR values of Antenna 2 (or Band 2 or DSI2) at Plim_2.

Transition from the Antenna 1 (or Band 1 or DSI1) to the Antenna 2 (or Band 2 or DSI2) happens at time-instant 't1'.

if tested with radio configuration: 2.4/5GHz WLAN assessed using SAR + 6GHz WLAN band assessed using APD (e.g., applicable for ISED):

$$1g\_or\_10gSAR_1(t) = \frac{Conducted\_Tx\_power\_1\,(t)}{Conducted\_Tx\_power\_Plim\_1} * 1g\_or\_10gSAR\_Plim\_1 \qquad (5a)$$

$$4cm^2\ PD_2(t) = \frac{Conducted\_Tx\_power\_2\,(t)}{Conducted\_Tx\_power\_Plim\_2} * 4cm^2\ PD\_Plim\_2 \qquad (5b)$$

$$\frac{\frac{1}{TSAR}[\int_{t-TSAR}^{t1} 1g\_or\_10gSAR(t)\,dt}{ICNIRP\ SAR\ limit} + \frac{\frac{1}{TSAR}\int_{t-TSAR}^{t} 4cm2\ PD(t)\,dt}{APD\ 4cm^2 PD\ limit} \leq 1 \qquad (5c)$$

where, conducted_Tx_power(t), conducted_Tx_power_Plim_1 and 1g or 10g SAR_Plim_1 correspond to the measured instantaneous conducted Tx power and conducted Tx power at Plim_1 of DUT, and 1g or 10g SAR values at Plim_1 for the worst-case radio configuration within the tested 2.4/5GHz WLAN band;

conducted_Tx_power_2(t), conducted_Tx_power_*P*lim_2, and 4cm^2 PD_*P*lim_2 correspond to the instantaneous Tx power, conducted Tx power at Plim_2of DUT, and 4cm^2 PD values (APD) of at Plim_2 for the worst-case radio configuration within the tested 6GHz WLAN band.

Transition from the Band1 to the Band2 happens at time-instant 't1'.

if tested with both radio configurations greater than 6GHz bands that are assessed using APD (e.g., applicable for ISED):

$$4cm^2\ PD_1(t) = \frac{Conducted\_Tx\_power\_1\,(t)}{Conducted\_Tx\_power\_Plim\_1} * 4cm^2\ PD\_Plim\_1 \qquad (6a)$$

$$4cm^2\ PD_2(t) = \frac{Conducted\_Tx\_power\_2\,(t)}{Conducted\_Tx\_power\_Plim\_2} * 4cm^2\ PD\_Plim\_2 \qquad (6b)$$

$$\frac{\frac{1}{TSAR}[\int_{t-TSAR}^{t1} 4cm2\ PD1(t)\,dt + \int_{t-TSAR}^{t} 4cm2\ PD2(t)\,dt]}{APD\ 4cm^2 PD\ limit} \leq 1 \qquad (6c)$$

where, conducted_Tx_power_1(t), conducted_Tx_power_*P*lim_1, and 4cm^2 PD_ *P*lim_1 correspond to the instantaneous Tx power, conducted Tx power at Plim_1of DUT, and compliance 4cm^2 PD values (APD) of Band 1 (or Antenna 1) at Plim_1;

conducted_Tx_power_2(t), conducted_Tx_power_Plim_2, and 4cm^2 PD_ Plim_2correspond to the instantaneous Tx power, conducted Tx power at Plim_2 of DUT, and compliance 4cm^2 PD values (APD) of Antenna Band 2 (or Antenna 2) at Plim_2.

Transition from the Band 1 (or Antenna 1) to the Band 2 (or Antenna 2) happens at time instant 't1'.

6. Make one plot containing:

a. Computed time-averaged 1g_or_10gSAR (and/or 4cm2 PD) versus time from above procedure.

b. Corresponding regulatory 1g_or_10gSAR (and/or 4cm2 PD) limit.

The validation criteria is, at all times, the combined time-averaged 1g_or_10gSAR (and/or 4cm2 PD) versus time shall not exceed the regulatory 1g_or_10gSAR (and/or 4cm2 PD) limit.

4.5 point SAR measurement test sequence

4.5.1 Test selection criteria

The pointSAR test is performed only with Time-Varying Test Sequence to provide high confidence in the algorithm validation. The radio configuration for this test is selected by following the selection criteria described in Section 4.4.1.1 .

4.5.2 Test selection criteria

1. For a given radio configuration:

a. Enable WLAN connection with callbox in FastConnect TAS Peak Exposure Mode and enable high duty cycle Tx while performing the following steps.

b. Perform the area scan.

c. Conduct pointSAR measurement at peak location of the area scan for 120s.

This pointSAR value, pointSAR_Plim corresponds to pointSAR at the measured Plim.

NOTE: The measurement of Peak Exposure Mode should be performed with 70% or higher WLAN duty cycle (for example, using iPerf to generate UL traffic).

2. Set EUT to intended FastConnect Time-Averaged Exposure Mode with callbox to establish the same chosen radio configuration (mode/channel) for test.

a. Perform Time-averaged point SAR measurements at the same peak location as Peak Exposure Point SAR measurement for 120s. Note this includes initial 30s with WLAN with very low duty cycle (or WLAN is disconnected) and 90s of high duty cycle (WLAN has to be connected with high uplink traffic).

b. Once the measurement is done, extract instantaneous pointSAR versus time data, pointSAR(t).

c. Convert it into instantaneous 1gSAR versus time by using Equation (2a) and (2c) in Section 3.4:

$$1g\_or\_10gSAR(t) = \frac{pointSAR\ (t)}{pointSAR\_Plim} * 1g\_or\_10gSAR\_Plim \quad (2a)$$

$$4cm^2\ PD(t) = \frac{pointSAR\ (t)}{pointSAR\_Plim} * 4cm^2\ PD\_Plim \quad (2c)$$

where, pointSAR_Plim corresponds to the value determined in Step 1 , and pointSAR(t) corresponds to instantaneous pointSAR determined in Step 2 in this section.

d. Then perform 30s moving average to determine time-averaged 1gSAR versus time.

4.6 DUT worst case 1gSAR and test mode selection

The Plim is configurated in FastConnect TAS BDF per according to the Static SAR test and used for validation in this test report.

Base on the Qualcomm FastConnect TAS Static SAR Compliance Test Report (80-39282-11). The worst case 1gSAR of each radio configuration at each DSI are extracted from Static SAR report and listed in Table 4-2.

Table 4-2 Plim

				Main Ant		Aux Ant		Main+Aux Ant	
	Mode	Channel	Frequency (MHz)	Plimit	Pmax	Plimit	Pmax	Plimit	Pmax
2.4GHz WLAN	802.11b 1Mbps	1	2412	14.50	18.00	14.50	18.00	17.50	21.00
		6	2437	14.50	18.00	14.50	18.00	17.50	21.00
		11	2462	14.50	18.00	14.50	18.00	17.50	21.00
		12	2467	14.50	14.25	14.50	14.25	17.50	17.25
		13	2472	14.50	14.25	14.50	14.25	17.50	17.25
	802.11g 6Mbps	1	2412	14.50	18.00	14.50	18.00	17.50	21.00
		6	2437	14.50	18.00	14.50	18.00	17.50	21.00
		11	2462	14.50	18.00	14.50	18.00	17.50	21.00
		12	2467	14.50	16.00	14.50	16.00	17.50	17.25
		13	2472	14.50	12.25	14.50	12.25	17.50	17.25
	802.11n-HT20 MCS0	1	2412	14.50	17.75	14.50	17.75	17.50	20.75
		6	2437	14.50	18.00	14.50	18.00	17.50	21.00
		11	2462	14.50	15.00	14.50	15.00	17.50	18.00
		12	2467	14.50	13.00	14.50	13.00	17.50	16.00
		13	2472	14.50	9.00	14.50	9.00	17.50	12.00
	802.11n-HT40 MCS0	3	2422	14.50	14.75	14.50	14.75	17.50	17.75
		6	2437	14.50	16.00	14.50	16.00	17.50	19.00
		9	2452	14.50	14.25	14.50	14.25	17.50	17.25
		10	2457	14.50	11.75	14.50	11.75	17.50	14.75
		11	2462	14.50	6.50	14.50	6.50	17.50	9.50
	802.11ac-VHT20 MCS0	1	2412	14.50	17.75	14.50	17.75	17.50	20.75
		6	2437	14.50	18.00	14.50	18.00	17.50	21.00
		11	2462	14.50	15.00	14.50	15.00	17.50	18.00
		12	2467	14.50	13.00	14.50	13.00	17.50	16.00
		13	2472	14.50	9.00	14.50	9.00	17.50	12.00
	802.11ac-VHT40 MCS0	3	2422	14.50	14.75	14.50	14.75	17.50	17.75
		6	2437	14.50	16.00	14.50	16.00	17.50	19.00
		9	2452	14.50	14.25	14.50	14.25	17.50	17.25
		10	2457	14.50	11.75	14.50	11.75	17.50	14.75
		11	2462	14.50	6.50	14.50	6.50	17.50	9.50
	802.11ax-HE20 MCS0	1	2412	14.50	17.75	14.50	17.75	17.50	20.75
		6	2437	14.50	18.00	14.50	18.00	17.50	21.00
		11	2462	14.50	15.00	14.50	15.00	17.50	18.00
		12	2467	14.50	13.00	14.50	13.00	17.50	16.00
		13	2472	14.50	9.00	14.50	9.00	17.50	12.00

	802.11ax-HE40 MCS0	3	2422	14.50	14.75	14.50	14.75	17.50	17.75
		6	2437	14.50	16.00	14.50	16.00	17.50	19.00
		9	2452	14.50	14.25	14.50	14.25	17.50	17.25
		10	2457	14.50	11.75	14.50	11.75	17.50	14.75
		11	2462	14.50	6.50	14.50	6.50	17.50	9.50
	802.11be-EHT20 MCS0	1	2412	14.50	17.75	14.50	17.75	17.50	20.75
		6	2437	14.50	18.00	14.50	18.00	17.50	21.00
		11	2462	14.50	15.00	14.50	15.00	17.50	18.00
		12	2467	14.50	13.00	14.50	13.00	17.50	16.00
		13	2472	14.50	9.00	14.50	9.00	17.50	12.00
	802.11be-EHT40 MCS0	3	2422	14.50	14.75	14.50	14.75	17.50	17.75
		6	2437	14.50	16.00	14.50	16.00	17.50	19.00
		9	2452	14.50	14.25	14.50	14.25	17.50	17.25
		10	2457	14.50	11.75	14.50	11.75	17.50	14.75
		11	2462	14.50	6.50	14.50	6.50	17.50	9.50

				Main Ant		Aux Ant		Main+Aux Ant	
	Mode	Channel	Frequency (MHz)	Plimit	Pmax	Plimit	Pmax	Plimit	Pmax
5.2GHz WLAN	802.11a 6Mbps	36	5180	14.50	17.25	15.00	17.25	17.50	20.25
		40	5200	14.50	17.50	15.00	17.50	17.50	20.50
		44	5220	14.50	17.50	15.00	17.50	17.50	20.50
		48	5240	14.50	17.50	15.00	17.50	17.50	20.50
	802.11n-HT20 MCS0	36	5180	14.50	17.00	15.00	17.00	17.50	20.00
		40	5200	14.50	17.50	15.00	17.50	17.50	20.50
		44	5220	14.50	17.50	15.00	17.50	17.50	20.50
		48	5240	14.50	17.50	15.00	17.50	17.50	20.50
	802.11n-HT40 MCS0	38	5190	14.50	16.00	15.00	16.00	17.50	19.00
		46	5230	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ac-VHT20 MCS0	36	5180	14.50	17.00	15.00	17.00	17.50	20.00
		40	5200	14.50	17.50	15.00	17.50	17.50	20.50
		44	5220	14.50	17.50	15.00	17.50	17.50	20.50
		48	5240	14.50	17.50	15.00	17.50	17.50	20.50
	802.11ac-VHT40 MCS0	38	5190	14.50	16.00	15.00	16.00	17.50	19.00
		46	5230	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ac-VHT80 MCS0	42	5210	14.50	15.00	15.00	15.00	17.50	18.00
	802.11ax-HE20 MCS0	36	5180	14.50	17.00	15.00	17.00	17.50	20.00
		40	5200	14.50	17.50	15.00	17.50	17.50	20.50
		44	5220	14.50	17.50	15.00	17.50	17.50	20.50
		48	5240	14.50	17.50	15.00	17.50	17.50	20.50
	802.11ax-HE40 MCS0	38	5190	14.50	16.00	15.00	16.00	17.50	19.00
		46	5230	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ax-HE80 MCS0	42	5210	14.50	15.00	15.00	15.00	17.50	18.00
	802.11be-EHT20 MCS0	36	5180	14.50	17.00	15.00	17.00	17.50	20.00
		40	5200	14.50	17.50	15.00	17.50	17.50	20.50
		44	5220	14.50	17.50	15.00	17.50	17.50	20.50
		48	5240	14.50	17.50	15.00	17.50	17.50	20.50
	802.11be-EHT40 MCS0	38	5190	14.50	16.00	15.00	16.00	17.50	19.00
		46	5230	14.50	17.00	15.00	17.00	17.50	20.00
	802.11be-EHT80 MCS0	42	5210	14.50	15.00	15.00	15.00	17.50	18.00

				Main Ant		Aux Ant		Main+Aux Ant	
	Mode	Channel	Frequency (MHz)	Plimit	Pmax	Plimit	Pmax	Plimit	Pmax
5.3GHz WLAN	802.11a 6Mbps	52	5260	14.50	17.50	15.00	17.50	17.50	20.50
		56	5280	14.50	17.50	15.00	17.50	17.50	20.50
		60	5300	14.50	17.50	15.00	17.50	17.50	20.50
		64	5320	14.50	17.00	15.00	17.00	17.50	20.00
	802.11n-HT20 MCS0	52	5260	14.50	17.50	15.00	17.50	17.50	20.50
		56	5280	14.50	17.50	15.00	17.50	17.50	20.50
		60	5300	14.50	17.50	15.00	17.50	17.50	20.50
		64	5320	14.50	17.25	15.00	17.25	17.50	20.25
	802.11n-HT40 MCS0	54	5270	14.50	17.00	15.00	17.00	17.50	20.00
		62	5310	14.50	15.75	15.00	15.75	17.50	18.75
	802.11ac-VHT20 MCS0	52	5260	14.50	17.50	15.00	17.50	17.50	20.50
		56	5280	14.50	17.50	15.00	17.50	17.50	20.50
		60	5300	14.50	17.50	15.00	17.50	17.50	20.50
		64	5320	14.50	17.25	15.00	17.25	17.50	20.25
	802.11ac-VHT40 MCS0	54	5270	14.50	17.00	15.00	17.00	17.50	20.00
		62	5310	14.50	15.75	15.00	15.75	17.50	18.75
	802.11ac-VHT80 MCS0	58	5290	14.50	14.25	15.00	14.25	17.50	17.25
	802.11ac-VHT160 MCS0	50	5250	14.50	12.25	15.00	12.25	17.50	15.25
	802.11ax-HE20 MCS0	52	5260	14.50	17.50	15.00	17.50	17.50	20.50
		56	5280	14.50	17.50	15.00	17.50	17.50	20.50
		60	5300	14.50	17.50	15.00	17.50	17.50	20.50
		64	5320	14.50	17.25	15.00	17.25	17.50	20.25
	802.11ax-HE40 MCS0	54	5270	14.50	17.00	15.00	17.00	17.50	20.00
		62	5310	14.50	15.75	15.00	15.75	17.50	18.75
	802.11ax-HE80 MCS0	58	5290	14.50	14.25	15.00	14.25	17.50	17.25
	802.11ax-HE160 MCS0	50	5250	14.50	12.25	15.00	12.25	17.50	15.25
	802.11be-EHT20 MCS0	52	5260	14.50	17.50	15.00	17.50	17.50	20.50
		56	5280	14.50	17.50	15.00	17.50	17.50	20.50
		60	5300	14.50	17.50	15.00	17.50	17.50	20.50
		64	5320	14.50	17.25	15.00	17.25	17.50	20.25
	802.11be-EHT40 MCS0	54	5270	14.50	17.00	15.00	17.00	17.50	20.00
		62	5310	14.50	15.75	15.00	15.75	17.50	18.75
	802.11be-EHT80 MCS0	58	5290	14.50	14.25	15.00	14.25	17.50	17.25
	802.11be-EHT160 MCS0	50	5250	14.50	12.25	15.00	12.25	17.50	15.25

				Main Ant		Aux Ant		Main+Aux Ant	
	Mode	Channel	Frequency (MHz)	Plimit	Pmax	Plimit	Pmax	Plimit	Pmax
5.5GHz WLAN	802.11a 6Mbps	100	5500	14.50	17.50	15.00	17.50	17.50	20.50
		116	5580	14.50	17.50	15.00	17.50	17.50	20.50
		124	5620	14.50	17.50	15.00	17.50	17.50	20.50
		132	5660	14.50	17.50	15.00	17.50	17.50	20.50
		140	5700	14.50	17.50	15.00	17.50	17.50	20.50
		144	5720	14.50	17.50	15.00	17.50	17.50	20.50
	802.11n-HT20 MCS0	100	5500	14.50	17.50	15.00	17.50	17.50	20.50
		116	5580	14.50	17.50	15.00	17.50	17.50	20.50
		124	5620	14.50	17.50	15.00	17.50	17.50	20.50
		132	5660	14.50	17.50	15.00	17.50	17.50	20.50
		140	5700	14.50	16.25	15.00	16.25	17.50	19.25
		144	5720	14.50	17.50	15.00	17.50	17.50	20.50
	802.11n-HT40 MCS0	102	5510	14.50	15.25	15.00	15.25	17.50	18.25
		110	5550	14.50	17.00	15.00	17.00	17.50	20.00
		126	5630	14.50	17.00	15.00	17.00	17.50	20.00
		134	5670	14.50	17.00	15.00	17.00	17.50	20.00
		142	5710	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ac-VHT20 MCS0	100	5500	14.50	17.50	15.00	17.50	17.50	20.50
		116	5580	14.50	17.50	15.00	17.50	17.50	20.50
		124	5620	14.50	17.50	15.00	17.50	17.50	20.50
		132	5660	14.50	17.50	15.00	17.50	17.50	20.50
		140	5700	14.50	16.25	15.00	16.25	17.50	19.25
		144	5720	14.50	17.50	15.00	17.50	17.50	20.50
	802.11ac-VHT40 MCS0	102	5510	14.50	15.25	15.00	15.25	17.50	18.25
		110	5550	14.50	17.00	15.00	17.00	17.50	20.00
		126	5630	14.50	17.00	15.00	17.00	17.50	20.00
		134	5670	14.50	17.00	15.00	17.00	17.50	20.00
		142	5710	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ac-VHT80 MCS0	106	5530	14.50	14.50	15.00	14.50	17.50	17.00
		122	5610	14.50	16.50	15.00	16.50	17.50	19.50
		138	5690	14.50	16.50	15.00	16.50	17.50	19.50
	802.11ac-VHT160 MCS0	114	5570	14.50	12.75	15.00	12.75	17.50	15.75
	802.11ax-HE20 MCS0	100	5500	14.50	17.50	15.00	17.50	17.50	20.50
		116	5580	14.50	17.50	15.00	17.50	17.50	20.50
		124	5620	14.50	17.50	15.00	17.50	17.50	20.50
		132	5660	14.50	17.50	15.00	17.50	17.50	20.50
		140	5700	14.50	16.25	15.00	16.25	17.50	19.25
		144	5720	14.50	17.50	15.00	17.50	17.50	20.50
	802.11ax-HE40 MCS0	102	5510	14.50	15.25	15.00	15.25	17.50	18.25
		110	5550	14.50	17.00	15.00	17.00	17.50	20.00
		126	5630	14.50	17.00	15.00	17.00	17.50	20.00
		134	5670	14.50	17.00	15.00	17.00	17.50	20.00
		142	5710	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ax-HE80 MCS0	106	5530	14.00	14.50	15.00	14.50	17.00	17.00
		122	5610	14.50	16.50	15.00	16.50	17.50	19.50
		138	5690	14.50	16.50	15.00	16.50	17.50	19.50
	802.11ax-HE160 MCS0	114	5570	14.50	12.75	15.00	12.75	17.50	15.75
	802.11be-EHT20 MCS0	100	5500	14.50	17.50	15.00	17.50	17.50	20.50
		116	5580	14.50	17.50	15.00	17.50	17.50	20.50
		124	5620	14.50	17.50	15.00	17.50	17.50	20.50
		132	5660	14.50	17.50	15.00	17.50	17.50	20.50
		140	5700	14.50	16.25	15.00	16.25	17.50	19.25
		144	5720	14.50	17.50	15.00	17.50	17.50	20.50
	802.11be-EHT40 MCS0	102	5510	14.50	15.25	15.00	15.25	17.50	18.25
		110	5550	14.50	17.00	15.00	17.00	17.50	20.00
		126	5630	14.50	17.00	15.00	17.00	17.50	20.00
		134	5670	14.50	17.00	15.00	17.00	17.50	20.00
		142	5710	14.50	17.00	15.00	17.00	17.50	20.00
	802.11be-EHT80 MCS0	106	5530	14.00	14.50	15.00	14.50	17.00	17.00
		122	5610	14.50	16.50	15.00	16.50	17.50	19.50
		138	5690	14.50	16.50	15.00	16.50	17.50	19.50
	802.11be-EHT160 MCS0	114	5570	14.50	12.75	15.00	12.75	17.50	15.75

				Main Ant		Aux Ant		Main+Aux Ant	
	Mode	Channel	Frequency (MHz)	Plimit	Pmax	Plimit	Pmax	Plimit	Pmax
5.8GHz WLAN	802.11a 6Mbps	149	5745	14.50	17.50	15.00	17.50	17.50	20.50
		157	5785	14.50	17.50	15.00	17.50	17.50	20.50
		165	5825	14.50	17.50	15.00	17.50	17.50	20.50
	802.11n-HT20 MCS0	149	5745	14.50	17.50	15.00	17.50	17.50	20.50
		157	5785	14.50	17.50	15.00	17.50	17.50	20.50
		165	5825	14.50	17.50	15.00	17.50	17.50	20.50
	802.11n-HT40 MCS0	151	5755	14.50	17.00	15.00	17.00	17.50	20.00
		159	5795	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ac-VHT20 MCS0	149	5745	14.50	17.50	15.00	17.50	17.50	20.50
		157	5785	14.50	17.50	15.00	17.50	17.50	20.50
		165	5825	14.50	17.50	15.00	17.50	17.50	20.50
	802.11ac-VHT40 MCS0	151	5755	14.50	17.00	15.00	17.00	17.50	20.00
		159	5795	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ac-VHT80 MCS0	155	5775	14.50	16.50	15.00	16.50	17.50	19.50
	802.11ax-HE20 MCS0	149	5745	14.50	17.50	15.00	17.50	17.50	20.50
		157	5785	14.50	17.50	15.00	17.50	17.50	20.50
		165	5825	14.50	17.50	15.00	17.50	17.50	20.50
	802.11ax-HE40 MCS0	151	5755	14.50	17.00	15.00	17.00	17.50	20.00
		159	5795	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ax-HE80 MCS0	155	5775	14.50	16.50	15.00	16.50	17.50	19.50
	802.11be-EHT20 MCS0	149	5745	14.50	17.50	15.00	17.50	17.50	20.50
		157	5785	14.50	17.50	15.00	17.50	17.50	20.50
		165	5825	14.50	17.50	15.00	17.50	17.50	20.50
	802.11be-EHT40 MCS0	151	5755	14.50	17.00	15.00	17.00	17.50	20.00
		159	5795	14.50	17.00	15.00	17.00	17.50	20.00
	802.11be-EHT80 MCS0	155	5775	14.50	16.50	15.00	16.50	17.50	19.50

				Main Ant		Aux Ant		Main+Aux Ant	
	Mode	Channel	Frequency (MHz)	Plimit	Pmax	Plimit	Pmax	Plimit	Pmax
5.9GHz WLAN	802.11a 6Mbps	169	5845	14.50	13.75	15.00	13.75	17.50	16.75
		173	5865	14.50	13.75	15.00	13.75	17.50	16.75
		177	5885	14.50	13.75	15.00	13.75	17.50	16.75
	802.11n-HT20 MCS0	169	5845	14.50	17.25	15.00	17.25	17.50	20.25
		173	5865	14.50	17.25	15.00	17.25	17.50	20.25
		177	5885	14.50	16.00	15.00	16.00	17.50	19.00
	802.11n-HT40 MCS0	167	5835	14.50	17.00	15.00	17.00	17.50	20.00
		175	5875	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ac-VHT20 MCS0	169	5845	14.50	17.25	15.00	17.25	17.50	20.25
		173	5865	14.50	17.25	15.00	17.25	17.50	20.25
		177	5885	14.50	16.00	15.00	16.00	17.50	19.00
	802.11ac-VHT40 MCS0	167	5835	14.50	17.00	15.00	17.00	17.50	20.00
		175	5875	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ac-VHT80 MCS0	171	5855	14.50	16.50	15.00	16.50	17.50	19.50
	802.11ac-VHT160 MCS0	163	5815	14.50	12.00	15.00	12.00	17.50	15.00
	802.11ax-HE20 MCS0	169	5845	14.50	17.25	15.00	17.25	17.50	20.25
		173	5865	14.50	17.25	15.00	17.25	17.50	20.25
		177	5885	14.50	16.00	15.00	16.00	17.50	19.00
	802.11ax-HE40 MCS0	167	5835	14.50	17.00	15.00	17.00	17.50	20.00
		175	5875	14.50	17.00	15.00	17.00	17.50	20.00
	802.11ax-HE80 MCS0	171	5855	14.50	16.50	15.00	16.50	17.50	19.50
	802.11ax-HE160 MCS0	163	5815	14.50	12.00	15.00	12.00	17.50	15.00
	802.11be-EHT20 MCS0	169	5845	14.50	17.25	15.00	17.25	17.50	20.25
		173	5865	14.50	17.25	15.00	17.25	17.50	20.25
		177	5885	14.50	16.00	15.00	16.00	17.50	19.00
	802.11be-EHT40 MCS0	167	5835	14.50	17.00	15.00	17.00	17.50	20.00
		175	5875	14.50	17.00	15.00	17.00	17.50	20.00
	802.11be-EHT80 MCS0	171	5855	14.50	16.50	15.00	16.50	17.50	19.50
	802.11be-EHT160 MCS0	163	5815	14.50	12.00	15.00	12.00	17.50	15.00

				Main Ant		Aux Ant		Main+Aux Ant	
	Mode	Channel	Frequency (MHz)	Plimit	Pmax	Plimit	Pmax	Plimit	Pmax
WiFi 6GHz	802.11a 6Mbps	1	5955	14.50	15.75	15.00	15.75	17.50	18.75
		57	6235	14.50	15.75	15.00	15.75	17.50	18.75
		93	6415	14.50	15.75	15.00	15.75	17.50	18.75
		117	6535	14.50	16.50	15.00	16.50	17.50	19.50
		181	6855	14.50	16.50	15.00	16.50	17.50	19.50
	802.11ax-HE20 MCS0	1	5955	14.50	16.50	15.00	16.50	17.50	19.50
		57	6235	14.50	16.50	15.00	16.50	17.50	19.50
		93	6415	14.50	16.50	15.00	16.50	17.50	19.50
		117	6535	14.50	16.50	15.00	16.50	17.50	19.50
		181	6855	14.50	16.50	15.00	16.50	17.50	19.50
	802.11ax-HE40 MCS0	3	5965	14.50	16.00	15.00	16.00	17.50	19.00
		59	6245	14.50	16.00	15.00	16.00	17.50	19.00
		91	6405	14.50	16.00	15.00	16.00	17.50	19.00
		123	6565	14.50	16.00	15.00	16.00	17.50	19.00
		179	6845	14.50	16.00	15.00	16.00	17.50	19.00
	802.11ax-HE80 MCS0	7	5985	14.50	15.50	15.00	15.50	17.50	18.50
		55	6225	14.50	15.50	15.00	15.50	17.50	18.50
		87	6385	14.50	15.50	15.00	15.50	17.50	18.50
		135	6625	14.50	15.50	15.00	15.50	17.50	18.50
		167	6785	14.50	15.50	15.00	15.50	17.50	18.50
	802.11ax-HE160 MCS0	15	6025	14.50	15.50	15.00	15.50	17.50	18.50
		47	6185	14.50	15.50	15.00	15.50	17.50	18.50
		79	6345	14.50	15.50	15.00	15.50	17.50	18.50
		143	6665	14.50	15.50	15.00	15.50	17.50	18.50
	802.11be-EHT20 MCS0	1	5955	14.50	16.50	15.00	16.50	17.50	19.50
		57	6235	14.50	16.50	15.00	16.50	17.50	19.50
		93	6415	14.50	16.50	15.00	16.50	17.50	19.50
		117	6535	14.50	16.50	15.00	16.50	17.50	19.50
		181	6855	14.50	16.50	15.00	16.50	17.50	19.50
	802.11be-EHT40 MCS0	3	5965	14.50	16.00	15.00	16.00	17.50	19.00
		59	6245	14.50	16.00	15.00	16.00	17.50	19.00
		91	6405	14.50	16.00	15.00	16.00	17.50	19.00
		123	6565	14.50	16.00	15.00	16.00	17.50	19.00
		179	6845	14.50	16.00	15.00	16.00	17.50	19.00
	802.11be-EHT80 MCS0	7	5985	14.50	15.50	15.00	15.50	17.50	18.50
		55	6225	14.50	15.50	15.00	15.50	17.50	18.50
		87	6385	14.50	15.50	15.00	15.50	17.50	18.50
		135	6625	14.50	15.50	15.00	15.50	17.50	18.50
		167	6785	14.50	15.50	15.00	15.50	17.50	18.50
	802.11be-EHT160 MCS0	15	6025	14.50	15.50	15.00	15.50	17.50	18.50
		47	6185	14.50	15.50	15.00	15.50	17.50	18.50
		79	6345	14.50	15.50	15.00	15.50	17.50	18.50
		143	6665	14.50	15.50	15.00	15.50	17.50	18.50
	802.11be-EHT320 MCS0	31	6105	14.50	14.50	15.00	14.50	17.50	17.50
		63	6265	14.50	14.50	15.00	14.50	17.50	17.50

Antenna Group	
Tx chain	Antenna Group
2.4GHz Chain0	0
2.4GHz Chain1	1
5GHz Chain0	0
5GHz Chain1	1
6GHz Chain0	0
6GHz Chain1	1

Plim and Reserve Margin for DUT				
	Tx chain	Antenna	Plimit setting	Reserve margin (dB)
DSI0	2.4GHz SISO (Chain0)	Main	14.5	1
	2.4GHz SISO (Chain1)	Aux	14.5	
	2.4GHz MIMO (Chain0+1)	Main+Aux	17.5	
	5GHz SISO (Chain0)	Main	14.5	
	5GHz SISO (Chain1)	Aux	15	
	5GHz MIMO (Chain0+1)	Main+Aux	17.5	
	6GHz SISO (Chain0)	Main	15.5	
	6GHz SISO (Chain1)	Aux	16.5	
	6GHz MIMO (Chain0+1)	Main+Aux	17.5	

In this test report. The radio configurations selection for FastConnect Time-Varying Validation measurements as provided in Table 4-3. The conducted power is measured at DUT for this validation test under FastConnect TAS Peak Exposure Mode enabled as per procedure required in step 1 in Section 4.4.2.

Table 4-3 Radio configurations selected for FastConnect Time-Varying Validation measurements in this test report.

<Conducted Measurement>

Test case #	Test scenario	Band	mode	Test Position	Gap (mm)	Antenna	DSI	Channel	Freq (MHz)	Plimit (dBm)	pmax (dBm)	Conducte_Tx Power Plim (dBm)	Part 1, SAR@Plimit 1-g SAR (W/kg)
1	Time-Varying Test Sequence	WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0mm	Main	0	1	2412	14.5	18	14.46	0.790
2	Time-Varying Test Sequence	WLAN5GHz	802.11n-HT20 MCS0	Bottom of Laptop	0mm	Main	0	60	5300	14.5	17.5	14.7	0.747
3	Change in Antenna	WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0mm	Main	0	1	2412	14.5	18	14.46	0.790
		WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0mm	Aux	0	1	2412	14.5	18	14.08	0.805
4	Change in DSI	WLAN5GHz	802.11n-HT20 MCS0	Bottom of Laptop	0mm	Aux	0	36	5180	9	17.5	8.7	0.85
		WLAN5GHz	802.11n-HT20 MCS0	Bottom of Laptop	0mm	Aux	1	36	5180	15	17.5	14.8	0.85
5	Change in WLAN Band	WLAN5GHz	802.11n-HT20 MCS0	Bottom of Laptop	0mm	Main	0	60	5300	14.5	17.5	14.7	0.747
		WLAN2.4GHz	802.11n-HT20 MCS0	Bottom of Laptop	0mm	Main	0	6	2437	14.5	18	14.07	0.802
6	Simultaneous Transmissions	WLAN2.4GHz	802.11n-HT20 MCS0	Bottom of Laptop	0mm	Main	0	6	2437	14.5	18	14.07	0.802
		WLAN5GHz	802.11n-HT20 MCS0	Bottom of Laptop	0mm	Main	0	40	5200	14.5	17.5	15.74	0.889

<Point SAR Measurement>

Test case#	Test scenario	Band	mode	Test Position	Gap (mm)	Antenna	DSI	Channel	Freq (MHz)	Plimit (dBm)	pmax (dBm)	Conducte_Tx Power Plim (dBm)	Part 1, SAR@Plimit 1-g SAR (W/kg)
1	Time-Varying Test Sequence	WLAN2.4GHz	802.11b 1Mbps	Bottom of Laptop	0mm	Main	0	1	2412	14.5	18	14.46	0.790
2	Time-Varying Test Sequence	WLAN5GHz	802.11n-HT20 MCS0	Bottom of Laptop	0mm	Main	0	60	5300	14.5	17.5	14.7	0.747

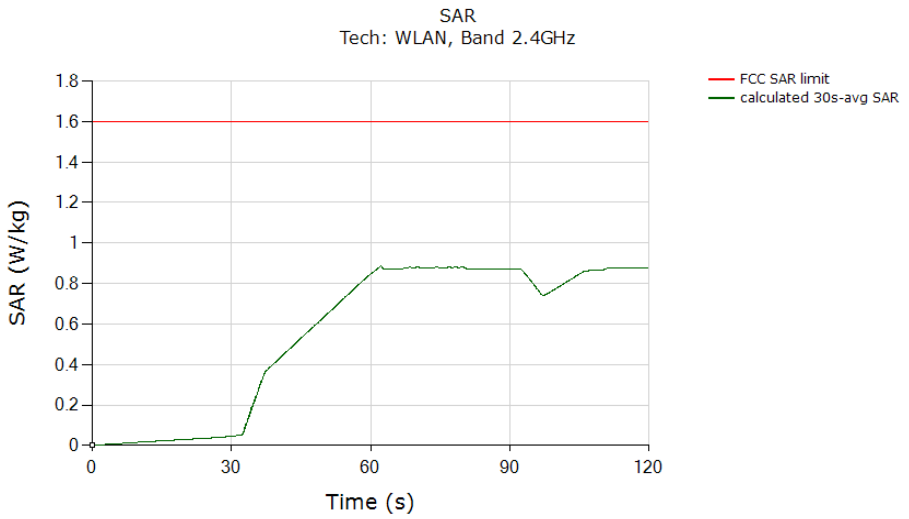
5. FCC Validation Test Result

5.1 Time-Varying Test Sequence

<Test parameters – 1st band>

Tech/Band/Ant/DSI	Parameters	Values
11b/ 1Mbps; 2.4GHz Main antenna;	Pmax	18.0
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	14.46
	Meas. SAR @ Plim (W/kg)	0.790

<Test plots and result – 1st Band>

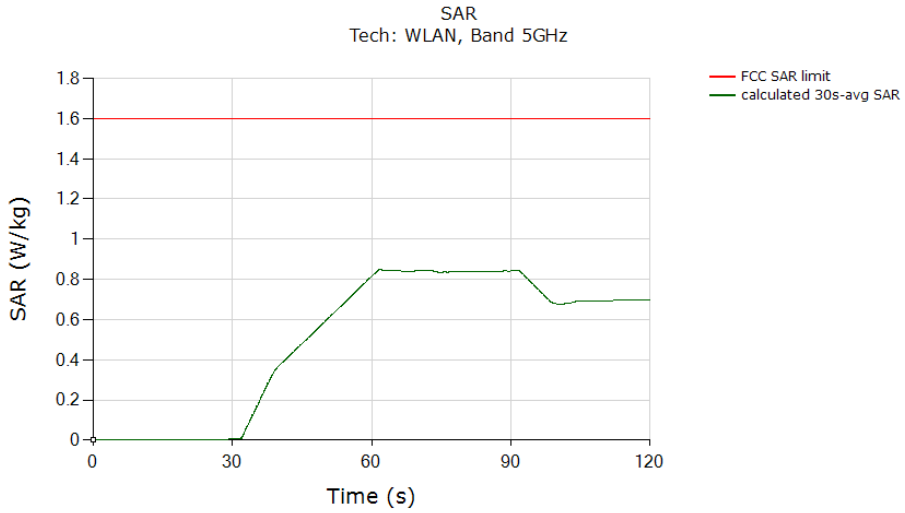


	(W/kg)
FCC Exposure limit	1.6
Max time averaged 1gSAR (green curve)	0.887
Validated	

<Test parameters – 2nd band>

Tech/Band/Ant/DSI	Parameters	Values
11an HT20/ MCS0; 5.3GHz Main antenna;	Pmax	17.50
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	14.7
	Meas. SAR @ Plim (W/kg)	0.747

<Test plots and result – 2nd Band>



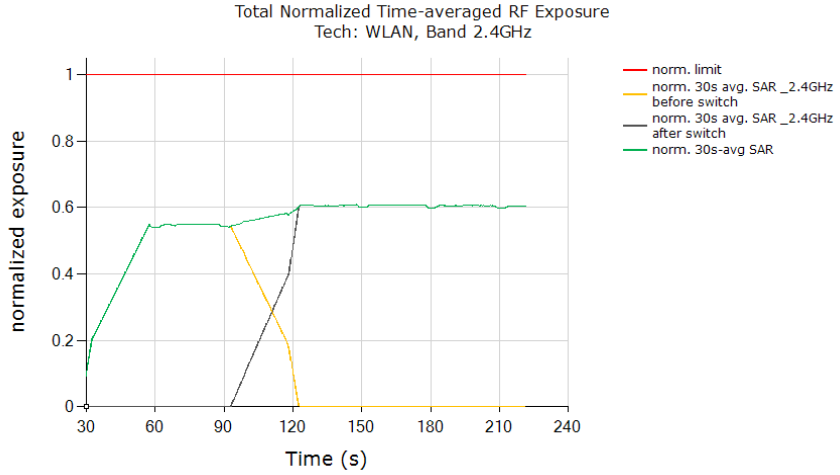
	(W/kg)
FCC Exposure limit	1.6
Max time averaged 1gSAR (green curve)	0.852
Validated	

5.2 Change in antenna

<Test parameters>

Tech/Band/Ant/DSI	Parameters	Values
11b/ 1Mbps; 2.4GHz Main antenna	Pmax	18
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	14.46
	Meas. SAR @ Plim (W/kg)	0.790
Switch time (sec)		93.2
11b/ 1Mbps; 2.4GHz Aux antenna	Pmax	18
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	14.08
	Meas. SAR @ Plim (W/kg)	0.805

<Test plots and result>



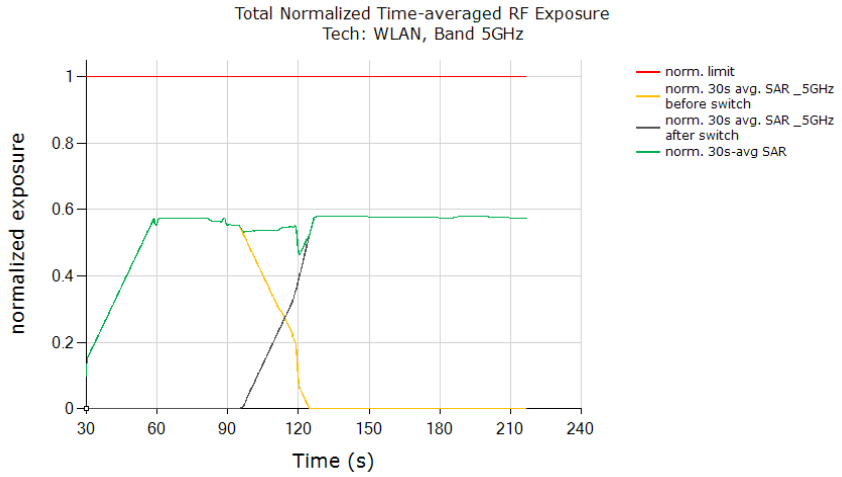
	Norm. exposure value
FCC normalized total exposure limit	1
Max total normalized time-averaged SAR (green curve)	0.610
Validated	

5.3 Change in DSI

<Test parameters>

Tech/Band/Ant/DSI	Parameters	Values
11an HT20/ MCS0; 5.2GHz SISO Aux Antenna	Pmax	17.5
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	8.7
	Meas. SAR @ Plim (W/kg)	0.85
Switch time (sec)		93.2
11an HT20/ MCS0; 5.2GHz SISO Aux Antenna	Pmax	17.5
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	14.8
	Meas. SAR @ Plim (W/kg)	0.85

<Test plots and result>



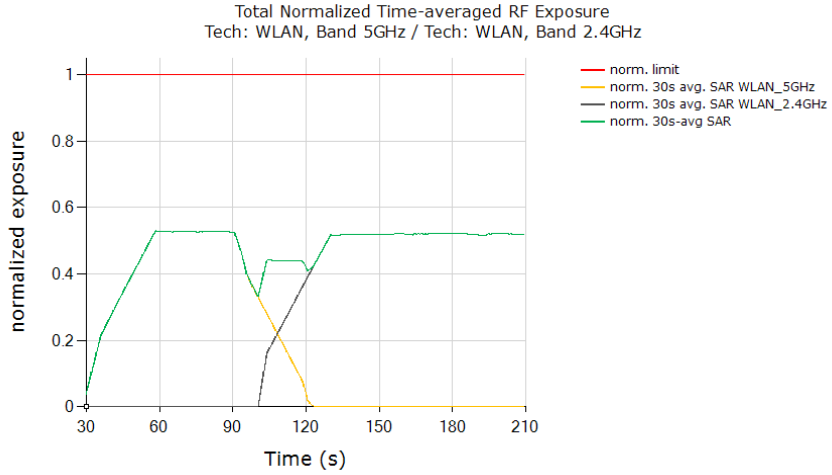
	Norm. exposure value
FCC normalized total exposure limit	1
Max total normalized time-averaged SAR (green curve)	0.582
Validated	

5.4 Change in WLAN band

<Test parameters>

Tech/Band/Ant/DSI	Parameters	Values
11b/ 1Mbps; 2.4GHz SISO Main antenna	Pmax	18
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	14.07
	Meas. SAR @ Plim (W/kg)	0.802
Switch time (sec)		94.2
11an HT20/ MCS0; 5.3GHz SISO Main Antenna	Pmax	17.5
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	14.7
	Meas. SAR @ Plim (W/kg)	0.747

<Test plots and result>



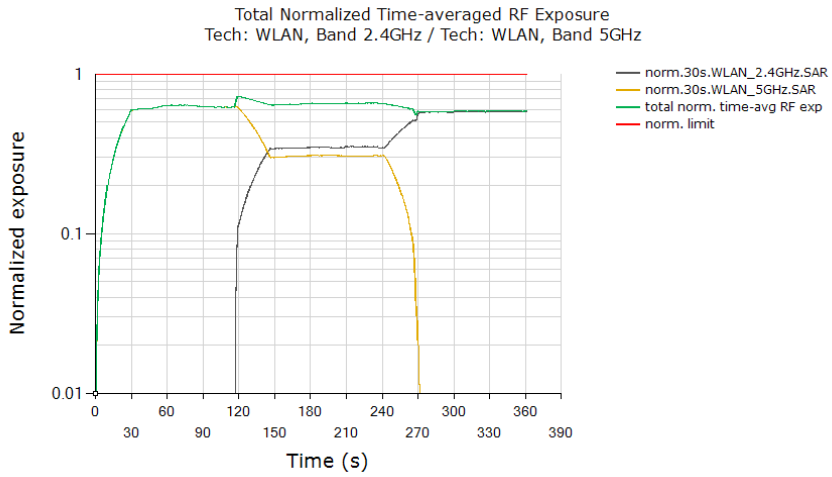
	Norm. exposure value
FCC normalized total exposure limit	1
Max total normalized time-averaged SAR (green curve)	0.531
Validated	

5.5 Simultaneous Transmissions

<Test parameters>

Tech/Band/Ant/DSI	Parameters	Values
11b/ 1Mbps; 2.4GHz SISO Main antenna	Pmax	18
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	14.07
	Meas. SAR @ Plim (W/kg)	0.802
11an HT20/ MCS0; 5.2GHz SISO Main Antenna	Pmax	17.5
	Reserve margin (dB)	1
	Meas. Cond. Plim (dBm)	15.74
	Meas. SAR @ Plim (W/kg)	0.889

<Test plots and result>



	Norm. exposure value
FCC normalized total exposure limit	1
Max total normalized time-averaged SAR (green curve)	0.733
Validated	

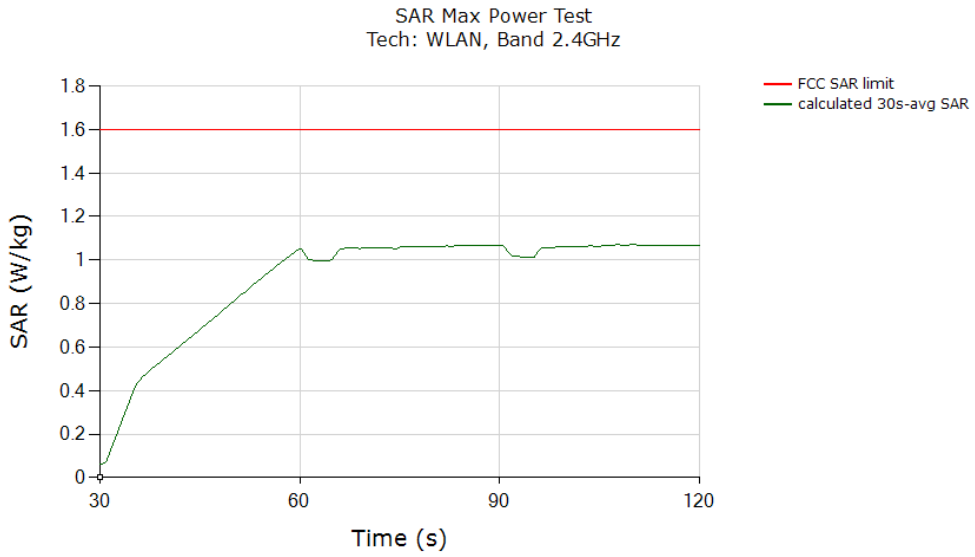
6. PointSAR Test

6.1 Time-Varying Test Sequence

<Test parameters – 1st band>

Tech/Band/Ant/DSI	Parameters	Values
11b/ 1Mbps; 2.4GHz SISO Main antenna	Test Position	Bottom of laptop
	Meas. SAR @ Plim (W/kg)	0.790

<Test plots and result – 1st Band>

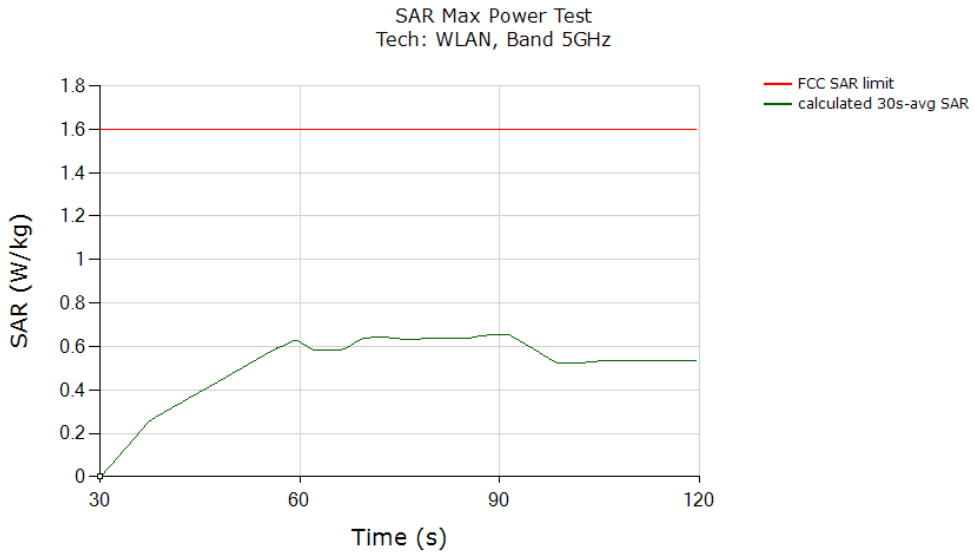


	(W/kg)
FCC Exposure limit	1.6
Max time averaged 1gSAR (green curve)	1.07
Validated	

<Test parameters – 2nd band>

Tech/Band/Ant/DSI	Parameters	Values
11an HT20/ MCS0; 5.3GHz SISO Main antenna	Test Position	Bottom of laptop
	Meas. SAR @ Plim (W/kg)	0.747

<Test plots and result – 2nd Band>



	(W/kg)
FCC Exposure limit	1.6
Max time averaged 1gSAR (green curve)	0.655
Validated	

7. Conclusion

Qualcomm® FastConnect™ time averaged SAR (TAS) feature employed in this device has been validated through the conducted power measurement, as well as SAR measurement. As demonstrated in this report, the power limiting enforcement is effective and the total normalized timeaveraged RF exposure does not exceed 1.0 for all the transmission scenarios described in Section 3. Therefore, the device complies with FCC RF exposure requirement.

8. Uncertainty Assessment

Declaration of Conformity:
The test results with all measurement uncertainty excluded is presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type An evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience, and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in table below.

Uncertainty Distributions	Normal	Rectangular	Triangular	U-Shape
Multi-plying Factor[a]	1/k[b]	$1/\sqrt{3}$	$1/\sqrt{6}$	$1/\sqrt{2}$

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity

(b) κ is the coverage factor

Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is shown in the following tables.

The judgment of conformity in the report is based on the measurement results excluding the measurement uncertainty.

Applicable for SAR Measurements:

Uncertainty Budget (4 MHz - 10 GHz range)							
Error Description	**Uncertainty Value (±%)**	**Probability**	**Divisor**	**(Ci) 1g**	**(Ci) 10g**	**Standard Uncertainty (1g) (±%)**	**Standard Uncertainty (10g) (±%)**
Measurement System							
Probe Calibration	18.60	N	2	1	1	9.3	9.3
Axial Isotropy	4.70	R	1.732	0.7	0.7	1.9	1.9
Hemispherical Isotropy	9.60	R	1.732	0.7	0.7	3.9	3.9
Linearity	4.70	R	1.732	1	1	2.7	2.7
Modulation Response	4.68	R	1.732	1	1	2.7	2.7
System Detection Limits	1.00	R	1.732	1	1	0.6	0.6
Boundary Effects	2.00	R	1.732	1	1	1.2	1.2
Readout Electronics	0.30	N	1	1	1	0.3	0.3
Response Time	0.00	R	1.732	1	1	0.0	0.0
Integration Time	2.60	R	1.732	1	1	1.5	1.5
RF Ambient Noise	3.00	R	1.732	1	1	1.7	1.7
RF Ambient Reflections	3.00	R	1.732	1	1	1.7	1.7
Probe Positioner	0.40	R	1.732	1	1	0.2	0.2
Probe Positioning	6.70	R	1.732	1	1	3.9	3.9
Post-processing	4.00	R	1.732	1	1	2.3	2.3
Test Sample Related							
Device Holder	3.60	N	1	1	1	3.6	3.6
Test sample Positioning	3.03	N	1	1	1	3.0	3.0
Power Scaling	0.00	R	1.732	1	1	0.0	0.0
Power Drift	5.00	R	1.732	1	1	2.9	2.9
Phantom and Setup							
Phantom Uncertainty	7.60	R	1.732	1	1	4.4	4.4
SAR correction	0.00	R	1.732	1	0.84	0.0	0.0
Liquid Conductivity Repeatability	0.03	N	1	0.78	0.77	0.0	0.0
Liquid Conductivity (target)	5.00	R	1.732	0.78	0.77	2.3	2.2
Liquid Conductivity (mea.)	2.50	R	1.732	0.78	0.77	1.1	1.1
Temp. unc. - Conductivity	3.68	R	1.732	0.78	0.77	1.7	1.6
Liquid Permittivity Repeatability	0.02	N	1	0.23	0.26	0.0	0.0
Liquid Permittivity (target)	5.00	R	1.732	0.23	0.26	0.7	0.8
Liquid Permittivity (mea.)	2.50	R	1.732	0.23	0.26	0.3	0.4
Temp. unc. - Permittivity	0.84	R	1.732	0.23	0.26	0.1	0.1
Combined Std. Uncertainty						14.5%	14.2%
Coverage Factor for 95 %						K=2	K=2
Expanded STD Uncertainty						29.0%	28.4%