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COMPLIANCE SUMMARY REPORT

Applicant Name:
Microsoft Corporation
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Redmond, WA 98052 USA

Test Site/Location:
Element, Columbia, MD, USA
Document Serial No.:
1M2504010035-05.C3K (Rev1)

FCC ID (Licensed):	**C3K2119**
FCC ID (Unlicensed):	**C3K00002102A**
APPLICANT:	**MICROSOFT CORPORATION**

Report Type:	Compliance Summary
DUT Type:	Modular Approval - Host Integration (Portable Computing Device)
Model:	2114, HWB-Q94

Note: This revised Test Report supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

ACCREDITED
CERT #2041.01

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1 STRATEGY FOR COMPLIANCE DEMONSTRATION

1.1 RF Exposure Evaluation Strategy

The FCC RF exposure limits defined based on time-averaged RF exposure. The device under test (DUT) uses the Qualcomm® Smart Transmit feature to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure is in compliance with the FCC requirement for WWAN operations and via FastConnect TAS for WLAN operations. Additionally, this device supports BT technologies, but the output power of these modems is not controlled by the TAS algorithm.

Demonstrating compliance of DUT enabled with Qualcomm Smart Transmit and Qualcomm FastConnect TAS features is completed in three parts:

0. **RF Exposure Compliance Test Report Part 0: SAR Characterization**

   The SAR Characterization, denoted as SAR Char, determines the power limit that meets FCC exposure requirement after accounting for device design related uncertainties for each supported radio configuration and RF exposure usage scenario. The determined power limits will be loaded and stored in the EUT via the Embedded File System (EFS) for Smart Transmit and the Board Data File (BDF) for Fast Connect, and then used as inputs for Smart Transmit and FastConnect to operate.

   For WWAN and WLAN SAR Char is derived from SAR test measurements and conducted power measurements to determine PLimit for each technology/band. The PLimit and input.power.limit represents the maximum time-averaged power level for the corresponding radio/antenna configuration.

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

   Part 1 demonstrates that DUT meets FCC SAR limits when transmitting at pre-determined maximum time-averaged power level: PLimit for WWAN, WLAN. The SAR measurement in Part 1 is under static transmission condition.

   The compliance for BT radio is demonstrated at a fixed power level (fixed = maximum RF tune-up level or power-back off level).

   The exposure from the simultaneous transmission of WWAN radios and WLAN radios are independently evaluated in their respective Part 2 test reports.

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

   Part 2 demonstrates compliance in Tx varying transmission conditions and validates Qualcomm Smart Transmit and FastConnect algorithms. The test results reported in Part 2 demonstrates that DUT complies with FCC RF exposure requirement under Tx varying transmission scenarios, thereby validity of Qualcomm Smart Transmit and FastConnect algorithms.

1.2 Nomenclature

Applicable Technologies	Term	Description
WWAN, WLAN	P_{Limit}	Power level that corresponds to the exposure design target (*SAR_design_target)* after accounting for all device design related uncertainties
	P_{Max}	Maximum tune up output power
	T_{SAR}	Defined time averaging window for $f < 6$ GHz
	SAR_design_target	Target SAR level resulting in maximum time-averaged exposure optimized from total uncertainty
	SAR Char	Table containing *Plimit* for all technologies
WWAN, WLAN	*regulatory body*	Regulatory body that the algorithm is designed to comply. Algorithm's time averaging window is dependent on either FCC or ICNIRP requirements.

1.3 Bibliography

Report Type	Report Serial Number
RF Exposure Part 2 WLAN Test Report	1M2504010035-12.C3K
RF Exposure Part 2 WWAN Test Report	1M2504010035-06.C3K
RF Exposure Part 1 Test Report	1M2504010035-03.C3K
RF Exposure Part 0 Test Report	1M2504010035-04.C3K

2 TIME AVERAGING ALGORITHM

2.1 Algorithm Description

The FCC RF exposure limit is defined based on time-averaged RF exposure. When running in a wireless device, Qualcomm Smart Transmit and FastConnect algorithm enables more elegant power control mechanisms for RF exposure management. It ensures at all times the wireless device is in compliance with the FCC limit of RF exposure time-averaged over a defined time window, denoted as TSAR for specific absorption rate (SAR for transmit frequency < 8 GHz).

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

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

The Qualcomm Smart Transmit and FastConnect algorithms embedded in Qualcomm modems reliably controls the transmit power of the wireless device in real time to maintain the time-averaged transmit power, in turn, timeaveraged RF exposure, below the predefined time-averaged power limit for each characterized technology and band.
• This predefined time-averaged power limit is denoted as PLimit corresponding SAR limit (frequency < 8 GHz) in this report.
• The wireless device continuously transmitting at PLimit level complies with the FCC RF exposure requirement.

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

2.2 Basic concept of the algorithm

The Qualcomm Smart Transmit and FastConnect algorithms control and manage the instantaneous transmit power (Tx) to maintain the time-averaged Tx power and therefore, time-averaged RF exposure in compliance with FCC limits.

- If time-averaged transmit power approaches P_{Limit}, then the modem needs to limit instantaneous transmit power to ensure the time-averaged transmit power does not exceed P_{Limit} in any T_{SAR} time windows since the time-averaged RF exposure is required to comply with the FCC RF exposure limit in any T_{SAR} time window.
- The wireless device can instantaneously transmit at high transmit powers and exceed the P_{Limit} level for a short duration before limiting the power to maintain the time-averaged transmit power under P_{Limit}.
- If the wireless device transmits at high power for a long time, then the radio link needs to be dropped to be compliant with time-averaged Tx power requirement (see Figure 2-1).
- To avoid dropping the radio link, TAS algorithm starts the power limiting enforcement earlier in time to back off the Tx power to a reserve level, so the wireless device can maintain the radio link at a minimum reserve power level for as long as needed, and at the same time ensure the time-averaged Tx power over any defined time window is less than P_{Limit} at all times (see Figure 2-2). At all times, TAS meets the below equation:

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

Equation 2-1

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

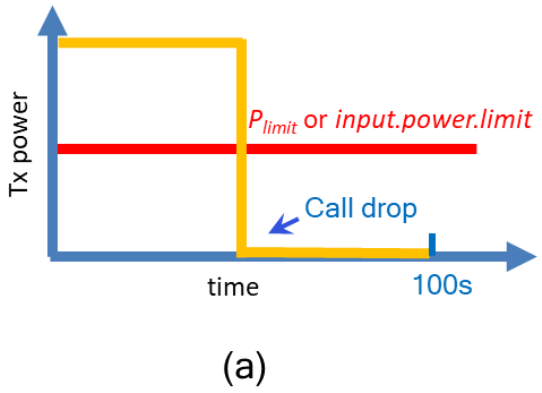
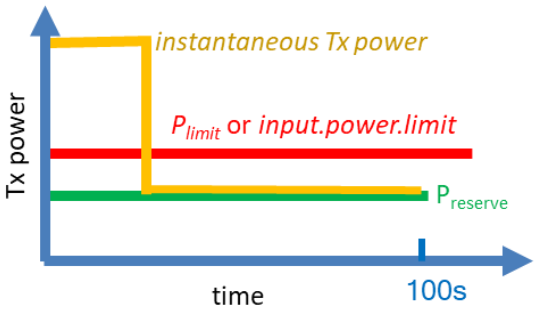


Figure 2-1
Transmit at high power when needed and permitted



(b)

Figure 2-2
Transmit with reserve power to support continuous transmission at a minimum power level

- In the case of simultaneous transmission, TAS manages all active transmitters and make sure the total exposure ratio is less than 1

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

Equation 2-2

2.3 Configurable Parameters

The following input parameters are required for functionality of Qualcomm Smart Transmit and FastConnect algorithms. These parameters cannot be accessed by the end user, because at the factory they are entered through the Embedded File System (EFS) for Smart Transmit and the Board Data File (BDF) for Fast Connect entries by the OEM.

Input Parameter	Description
regulatory body	• Inputs of "0" and "1" corresponding to FCC and ICNIRP requirements for the averaging time windows. • For FCC, algorithm uses an averaging window of 100 seconds for f < 3 GHz, 60 seconds for 3 GHz < f < 6 GHz, and 4 seconds for 24 GHz < f < 42 GHz.
Tx_power_at_SAR_design_target (P_{Limit} *in dBm)* f < 6 GHz	The maximum time-averaged transmit power, in dBm, corresponding to the *SAR_design_targe*t. *SAR_design_target* is pre-determined for this DUT and it is 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. P_{Limit} could vary with technology, band and Device State Index (DSI) and therefore, it has the unique value for each technology, band and DSI.

3 DUT DESCRIPTION

3.1 Device Overview

The equipment under test (EUT), Model 2119, is a portable computing device that incorporates two previously certified transmitter modules. The first is a WLAN/Bluetooth module authorized under FCC ID: C3K00002102A, and the second is a cellular module authorized under FCC ID: C3K2119. No hardware or software modifications have been made to either module for the purposes of this host integration. This report evaluates the host device for compliance with the applicable FCC rules, including assessment of co-location and simultaneous transmission conditions involving the integrated modules.

Band & Mode	Operating Modes	Tx Frequency
UMTS 850	Data	826.40 - 846.60 MHz
UMTS 1750	Data	1712.4 - 1752.6 MHz
UMTS 1900	Data	1852.4 - 1907.6 MHz
LTE Band 71	Data	665.5 - 695.5 MHz
LTE Band 12	Data	699.7 - 715.3 MHz
LTE Band 13	Data	779.5 - 784.5 MHz
LTE Band 14	Data	790.5 - 795.5 MHz
LTE Band 26	Data	814.7 - 848.3 MHz
LTE Band 5	Data	824.7 - 848.3 MHz
LTE Band 66	Data	1710.7 - 1779.3 MHz
LTE Band 4	Data	1710.7 - 1754.3 MHz
LTE Band 25	Data	1850.7 - 1914.3 MHz
LTE Band 2	Data	1850.7 - 1909.3 MHz
LTE Band 30	Data	2307.5 - 2312.5 MHz
LTE Band 41	Data	2498.5 - 2687.5 MHz
LTE Band 48	Data	3552.5 - 3697.5 MHz
NR Band n71	Data	665.5 - 695.5 MHz
NR Band n12	Data	701.5 - 713.5 MHz
NR Band n14	Data	790.5 - 795.5 MHz
NR Band n26	Data	816.5 - 846.5 MHz
NR Band n5	Data	826.5 - 846.5 MHz
NR Band n66	Data	1712.5 - 1777.5 MHz
NR Band n25	Data	1852.5 - 1912.5 MHz
NR Band n2	Data	1852.5 - 1907.5 MHz
NR Band n30	Data	2307.5 - 2312.5 MHz
NR Band n41	Data	2501.01 - 2685 MHz
NR Band n48	Data	3555 - 3694.98 MHz
NR Band n77	Data	3455.01 - 3544.98 MHz; 3705 - 3975 MHz
2.4 GHz WIFI	Data	2412 - 2472 MHz
5 GHz WIFI	Data	U-NII-1: 5180 - 5240 MHz U-NII-2A: 5260 - 5320 MHz U-NII-2C: 5500 - 5720 MHz U-NII-3: 5745 - 5825 MHz U-NII-4: 5845 - 5885 MHz
6 GHz WIFI	Data	U-NII-5: 5935 - 6415 MHz U-NII-6: 6435 - 6515 MHz U-NII-7: 6535 - 6875 MHz U-NII-8: 6895 - 7115 MHz
2.4 GHz Bluetooth	Data	2402 - 2480 MHz

This device uses the Qualcomm Smart Transmit and FastConnect feature to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure is in compliance with the FCC requirement for WWAN and WLAN operations. Additionally, this device supports BT technologies but the output power of these modems is not controlled by the either TAS algorithm.

4 COMPLIANCE SUMMARY

4.1 RF Exposure Compliance Summary

All transmission scenarios that the DUT supports comply with FCC time-averaged RF exposure requirements, as shown in Table 4-1.

Table 4-1
Reported RF Exposure Levels

	RFx Evaluation	Power Level	FCC Limit	***Reported*** RF Exposure Level	Test Report
SAR (W/kg)	Standalone 1g SAR	P_{limit}	1.6	1.20	RF Exposure Part 1 Test Report
	Simultaneous Tx 1g SAR	P_{limit}	1.6	1.37	