Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

1807 Operational Description

Model 1807 is a Surface tablet running the Windows operating system.
The device contains an integrated 802.11 a/b/g/n/ac / BT 4.0 radio as well as a WCDMA/LTE cellular radio.

WLAN

The Wi-fi/BT subsystem is based on the Marvell 88W8897 WLAN/Bluetooth/NFC System-on-Chip (SoC). The SoC utilizes 3.3V and 1.8V voltage supply rails and is designed for both simultaneous and independent operation of the following:

- IEEE 802.11ac compliant, 2x2 MIMO spatial stream multiplexing with data rates up to VHT80 MCS9 2SS (866.7 Mbps)
- Bluetooth 4.0 + EDR/BDR/High speed/Low Energy Dual Mode Controller
- NFC functionality is not implemented in this product

The WLAN subsystem connects to the application processor via a PCIe Gen 2 interface and the Bluetooth subsystem connects to the application processor via a USB 2.0 interface. The wireless sub-system contains a 32.768 kHz sleep clock along with an internal 40 MHz crystal oscillator.

WLAN Antennas

The Chain B, MAIN 2.4 GHz WLAN path and the Bluetooth signal path share the same antenna through an RF switch. The 2.4GHz and 5GHz outputs from the module are routed to a diplexer to share the dual band (2.4GHz/5GHz) MAIN antenna. The product includes two dual band (2.4GHz and 5GHz) antennas. One antenna (MAIN) is used for both WLAN and Bluetooth functionality while the other (MIMO) is used solely for WLAN. Peak Gains are shown below;

Table 1: WLAN Antenna Gains

Frequency Band	Antenna Gain (dBi) Path B Wi-Fi / Bluetooth	Antenna Gain (dBi) Path A Wi-Fi MIMO
2400 to 2483.5 MHz	0.2	2.4
5150 to 5250 MHz	2.9	2.2
5250 to 5350 MHz	2.8	2.5
5470 to 5725 MHz	2.8	1.9
5725 to 5850 MHz	1.6	1.3

WWAN

The WWAN modem subsystem is based on the Qualcomm MDM9250 chipset. This is the multi-chip modem solution consisting of the 9250 baseband and the WTR5975 transceiver.

LTE Release 11 and W-CDMA Release 8 are supported.
Carrier aggregation is supported in downlink only.

	Modem FW Band Configure 1	Modem FW Band Configure 2
LTE Frequency Bands and Carrier Aggregation Combinations.(includes Roaming bands for each SKU)	4G(LTE): 1,2,3,4,5,7,8,12,20,29,30,38,39,40,41 LTE 2 CA Combinations(14): 12+30,2+12,2+2,2+29,2+30,2+4, 2+5,29+30,4+12,4+29,4+30,4+4, 4+5,5+30 LTE 3 CA Combinations(14): 2+12+30,2+2+12,,2+2+30, 2+29+30,2+4+12,2+4+5,2+5+30, 4+12+30,4+29+30,4+4+12, 4+5+30	4G(LTE): 2,3,4,5,7,13,20,28 LTE 2 CA Combinations(7): 2+13,2+2,2+4,2+5,4+13,4+ 4, 4+5 LTE 3 CA Combinations(6): 2+2+13, 2+4+13,2+4+5,4+4+13

The primary RF consists of the Tx and primary Rx paths. For Tx, the WTR5975 TX_CH0_LB2 port is used for all low-band Tx and TX_CH1_MB used for all mid-band Tx. TX_CH0_HB1 and TX_CH0_HB2 ports are used for all high-band Tx.

All low-band Tx is routed through the QM78012, with the exception of B13 which is routed through the QM78012 AUX path and an external duplexer. Tx output from the QM78012 is connected to the low-band antenna through a low-pass filter and a coupler. An inline RF switch connector is placed near the antenna feed point for calibration and test access. The coupler provides input to the WTR5975 FBRx for low-band closed-loop power control.

All mid-band Tx is routed through the QM78013, with the exception of B2/B4 (B25/B66) which are routed through an external quadlexer and the QM78013 TRX3 path. Tx output from the QM78013 is connected to the mid/high-band antenna through the triplexer. An inline RF switch connector is placed near the antenna feed point for calibration and test access for both mid- and high-bands. The CPL_OUT and TERM ports of the QM78013 provide input to the WTR5975 FBRx for mid-band closed-loop power control.

All high-band Tx is routed through the QM78035, with the exception of B30 which is routed through an external duplexer and the QM78035 TRX1 path. Tx output from the QM78035 is connected to the mid/high-band antenna through the triplexer. The CPL_OUT port of the QM78035 provides input to the WTR5975 FBRx for high-band closed-loop power control.

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For primary Rx, all low-band Rx is routed from the low-band antenna through the QM78012 to the QLN1020 LNA module. As with Tx, B13 is routed through the QM78012 AUX path and an external duplexer. QLN1010 Rx output is connected to the WTR5975 PRX_LB port, and also to QLN1030 for multi-band CA input to the WTR5975.

All mid-band and high-band Rx is routed from the mid/high-band antenna through the QM78013 and QM78035 to the QLN1030 LNA module. As with Tx, B2/B4 (B25/B66) are routed through the QM78013 TRX3 path and the external quadlexer. B30 is routed through the QM78035 TRX1 path and the external duplexer. QLN1030 mid-band Rx outputs are connected to the WTR5975 PRX_MB_A and PRX_MB_B ports. QLN1030 high-band Rx output is connected to the WTR5975 PRX_HB input.

For diversity Rx, all low-band Rx is routed from the low-band diversity antenna through the M552 LNA module. B28 and B29 are routed through the M552 AUX 1 & 2 paths and through external filters. The M552 Rx output is connected to the WTR5975 DRX_LB port, and also to M556 for multi-band CA input to the WTR5975. All mid-band and high-band Rx is routed from the mid/high-band diversity antenna through the M556 LNA module. B39 and B40 are routed through external filters via the M556 ASM_AUX1 and _AUX2 paths. The M556 mid-band Rx output is connected to the WTR5975 DRX_MB_A and DRX_MB_B ports. High-band Rx output is connected to the WTR5975 DRX_HB port.

WWAN Antennas

Table 2: WWAN Antenna Gains

Frequency Band	Antenna Gain (dBi) WWAN Primary TX/RX Low Band Antenna	Antenna Gain (dBi) WWAN Primary TX/RX Mid/High Band Antenna
Band 2: 1850 to 1910 MHz	-	0.5
Band 4: 1710 to 1755 MHz	-	0.4
Band 5: 824 to 849 MHz	0.3	-
Band 7: 2500 to 2570 MHz	-	0.8
Band 12: 699 to 716 MHz	-0.9	-
Band 13: 777 to 787 MHz	-0.7	-
Band 26: 814 to 849 MHz	0.3	-
Band 30: 2305 to 2315 MHz	-	0.02
Band 38: 2570 to 2620 MHz	-	0.8
Band 41: 2496 to 2690 MHz	-	0.8

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SAR test configurations

Note: SAR was conducted in accordance with KDB Inquiry 999667. See the Appendix of this document for the original KDB inquiry, follow up inquiry, and FCC responses.

To summarize, this device has two independent power reduction sensors used to comply with SAR requirements.

WLAN Keyboard Position Sensor: This sensor controls WLAN power only. When a keyboard is connected, and the device is in a Laptop configuration the WLAN is at normal power. When the keyboard is removed or folded back such that the device is in a Tablet configuration the output power is reduced.

WWAN Capacitive Proximity Sensor: This sensor is located next to the WWAN antennas. When a body is detected within the trigger distance of the sensor, the WWAN output power is reduced.

When considering simultaneous transmission modes for WLAN and WWAN radios, the following output states were proposed in KDB inquiry tracking Number 999667 and agreed to in the FCC response.

Table 3: WLAN and WWAN Power States versus Sensor States

Transmission Mode	State of Sensors		TX Output Power		
	Keyboard Position	**Proximity Sensor**	**WWAN**	**WLAN Main**	**WLAN MIMO**
Wi-Fi Only	Laptop Mode	-	-	Full Power	Full Power
Wi-Fi Only	Tablet Mode	-	-	Reduced power	Reduced power
Cellular Only	Laptop Mode	-	Full Power	-	-
Cellular Only	Laptop Mode	***Triggered***	Reduced Power	-	-
Cellular Only	Tablet Mode	-	Full Power	-	-
Cellular Only	Tablet Mode	***Triggered***	Reduced Power	-	-
Simultaneous: Wi-Fi & Cellular	Laptop Mode	-	Full Power	Full Power	Full Power
Simultaneous: Wi-Fi & Cellular	Laptop Mode	***Triggered***	Reduced Power	Full Power	Full Power
Simultaneous: Wi-Fi & Cellular	Tablet Mode	-	Full Power	OFF	Reduced Power
Simultaneous: Wi-Fi & Cellular	Tablet Mode	***Triggered***	Reduced Power	OFF	Reduced Power

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Fax 425 706 7329
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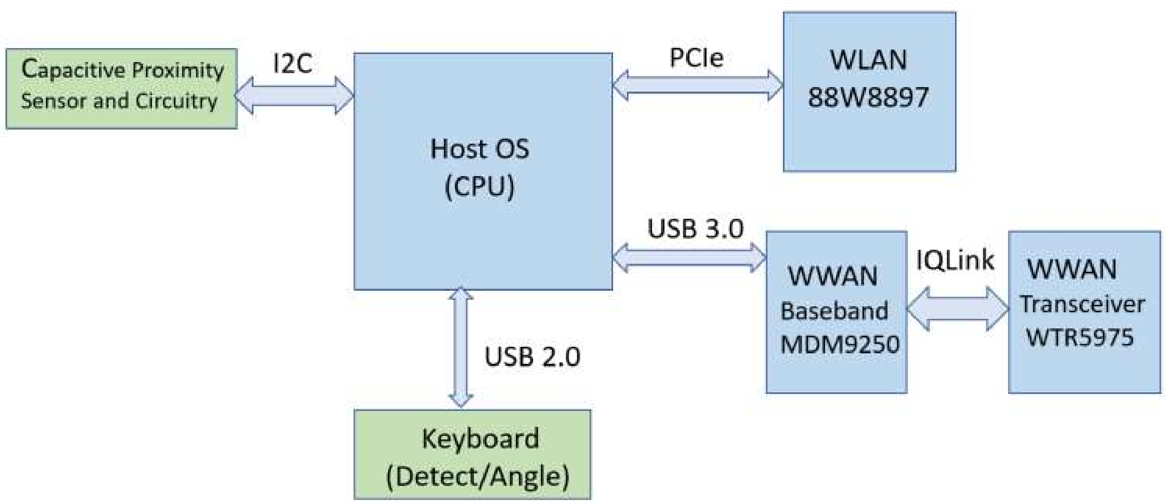
Sensors Operation

The Surface Keyboard is a USB device. The sensory logic inside the keyboard works in conjunction with other logic in the OS Host to conclude the keyboard angle. The SAR monitoring logic uses the keyboard angles in conjunction with the proximity sensor to determine the appropriate actions as detailed in Table 3.

In addition to proximity and angles, there is a SW function that determines also whether the LTE and Wi-Fi are enabled simultaneously. All three such inputs, proximity, keyboard angles and Simultaneous LTE + Wi-Fi coalesce in the SAR monitoring logic running on the OS Host (processor) to determine final back off action for each the LTE and Wi-Fi radios. If a communications error or other fault occurs such that the state of the sensors cannot be determined, low power mode is triggered until such time that the sensor state can be determined.



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WLAN and Bluetooth/Bluetooth LE powers for North American Region

Bluetooth and Bluetooth LE power is 2.5 dBm +/- 1.5 dB.

Tx power values in the table below for WLAN are in dBm with a tolerance of +/- 1.5 dB in Laptop mode, and +1 / -1.5 dB in Tablet mode.

Table 4: WLAN output power for North America

High Power – Laptop Mode

(SISO and MIMO power settings are the same)

Frequency Band	Wi-Fi Channels	NA(Code: 0x10) US, Canada, Mexico		
		20 MHz	MOD_CCK	
2400 to 2483.5 MHz	1	12	12	
	2	14	13	
	3	14	13	
	4	14	13	
	5	14	13	
	6	14	13	
	7	14	13	
	8	14	13	
	9	14	13	
	10	14	13	
	11	12	12	
	12	10	10	
	13	8	8	
		20 MHz	40 MHz	80 MHz
5.15 to 5.25 GHz	36	10	10	7
	40	10		
	44	10	10	
	48	10		
5.25 to 5.35 GHz (This is a RADAR band. Passive scanning only for this device. Disable in peer to peer)	52	14	11	7
	56	14		
	60	14	10	
	64	14		
5.47 to 5.725 GHz (This is a RADAR band. Passive scanning only for this device. Disable in peer to peer)	100	14	11	7
	104	14		
	108	14	13	
	112	14		
	116	14	13	10
	120	14		
	124	14	13	
	128	14		
	132	14	13	7
	136	14		
	140	13	11	
	144	12		
5.725 to 5.85 GHz	149	14	11	7
	153	14		
	157	14	11	
	161	14		
	165	14		

Low Power – Tablet Mode

(SISO and MIMO power settings are the same)

Frequency Band	Wi-Fi Channels	NA(Code: 0x10) US, Canada, Mexico		
		20 MHz	MOD_CCK	
2400 to 2483.5 MHz	1	9.5	9.5	
	2	9.5	9.5	
	3	9.5	9.5	
	4	9.5	9.5	
	5	9.5	9.5	
	6	9.5	9.5	
	7	9.5	9.5	
	8	9.5	9.5	
	9	9.5	9.5	
	10	9.5	9.5	
	11	9.5	9.5	
	12	9.5	9.5	
	13	8	8	
		20 MHz	40 MHz	80 MHz
5.15 to 5.25 GHz	36	8	8	7
	40	8		
	44	8	8	
	48	8		
5.25 to 5.35 GHz (This is a RADAR band. Passive scanning only for this device. Disable in peer to peer)	52	8	8	7
	56	8		
	60	8	8	
	64	8		
5.47 to 5.725 GHz (This is a RADAR band. Passive scanning only for this device. Disable in peer to peer)	100	8	8	7
	104	8		
	108	8	8	
	112	8		
	116	8	8	8
	120	8		
	124	8	8	
	128	8		
	132	8	8	7
	136	8		
	140	8	8	
	144	8		
5.725 to 5.85 GHz	149	10	10	7
	153	10		
	157	10	10	
	161	10		
	165	10		

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

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Table 5: WWAN output power for North America Region

WWAN Band	Mode	Target Power (dBm) Tolerence + 1 dB / - 1.5 dB	FCC Reduced Target Power (dBm) Tolerence + 1 dB / - 1.5 dB
LTE 2	QPSK	24.0	14.5
	16QAM	22.0	
LTE 4	QPSK	24.0	14.1
	16QAM	22.0	
LTE 5	QPSK	24.0	20.0
	16QAM	23.0	
LTE 7	QPSK	24.0	14.4
	16QAM	22.0	
LTE 12	QPSK	24.0	21.0
	16QAM	23.0	
LTE 13	QPSK	24.0	21.0
	16QAM	23.0	
LTE 26	QPSK	24.0	20.4
	16QAM	23.0	
LTE 30	QPSK	23.0	13.0
	16QAM	22.0	
LTE 38	QPSK	24.0	16.2
	16QAM	23.0	
LTE 41	QPSK	24.0	15.5
	16QAM	23.0	
WCDMA 2		24.0	15.0
WCDMA 5		24.0	20.6

Simultaneous Transmission Modes

Laptop & Tablet (WLAN/BT only. WWAN OFF)

These Transmission modes of Wi-Fi & BT are supported;

Path A Wi-Fi 2.4 GHz and Path B Wi-Fi 2.4 GHz

Path A Wi-Fi 5 GHz and Path B Wi-Fi 5 GHz

Path A Wi-Fi 2.4 GHz and Path B Bluetooth

Path A Wi-Fi 5 GHz and Path B Bluetooth

Laptop Mode(WLAN/BT/WWAN)

Path A Wi-Fi 2.4 GHz and Path B Wi-Fi 2.4 GHz and WWAN Low Band

Path A Wi-Fi 2.4 GHz and Path B Wi-Fi 2.4 GHz and WWAN Mid/High Band

Path A Wi-Fi 5 GHz and Path B Wi-Fi 5 GHz and WWAN Low Band

Path A Wi-Fi 5 GHz and Path B Wi-Fi 5 GHz and WWAN Mid/High Band

Path A Wi-Fi 2.4 GHz and Path B Bluetooth and WWAN Low Band

Path A Wi-Fi 2.4 GHz and Path B Bluetooth and WWAN Mid/High Band

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One Microsoft Way
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Path A Wi-Fi 5 GHz and Path B Bluetooth and WWAN Low Band
Path A Wi-Fi 5 GHz and Path B Bluetooth and WWAN Mid/High Band

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Fax 425 706 7329
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Tablet Mode (WLAN/BT/WWAN) WLAN Path A is at Reduced Power. WLAN Path B is OFF. Path B Bluetooth is ON
Path A Wi-Fi 2.4 GHz and WWAN Low Band
Path A Wi-Fi 2.4 GHz and WWAN Mid/High Band
Path A Wi-Fi 5 GHz and WWAN Low Band
Path A Wi-Fi 5 GHz and WWAN Mid/High Band
Path A Wi-Fi 2.4 GHz and Path B Bluetooth and WWAN Low Band
Path A Wi-Fi 2.4 GHz and Path B Bluetooth and WWAN Mid/High Band
Path A Wi-Fi 5 GHz and Path B Bluetooth and WWAN Low Band
Path A Wi-Fi 5 GHz and Path B Bluetooth and WWAN Mid/High Band

Active and Passive Channel Scanning

The following tables show the channels used for Active and Passive Scanning. The device does not have software configuration control which will affect the channel usage.

Channel BW	2400 to 2483.5 MHz	5.15 to 5.25 GHz	5.25 to 5.35 GHz	5.47 to 5.725 GHz	5.725 to 5.85 GHz
20 MHz	Ch. 1-13	Ch. 36, 40, 44, 48			Ch. 149, 153, 157, 161, 165
40 MHz		36/40 (5190 MHz) 44/48 (5230 MHz)			149/153(5755 MHz) 157/161(5795 MHz)
80 MHz		36/40/44/48(5210 MHz)			149/153/157/161(5775 MHz)

Channels used for Passive scanning

Channel BW	2400 to 2483.5 MHz	5.15 to 5.25 GHz	5.25 to 5.35 GHz	5.47 to 5.725 GHz	5.725 to 5.85 GHz
20 MHz			Ch. 52, 56, 60, 64	Ch. 100, 104, 108, 112, 116, 132, 136, 140, 144	
40 MHz			52/56 (5190 MHz), 60/64(5310 MHz)	100/104(5510 MHz) 108/112(5550 MHz) 116/120(5590 MHz) 124/128(5630 MHz) 132/136(5670 MHz) 140/144(5710 MHz)	
80 MHz			52/56/60/64 (5290 MHz)	100/104/108/112(5530 MHz) 116/120/124/128(5610 MHz) 132/136/140/144(5690 MHz)	

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One Microsoft Way
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Tel 425 882 8080
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Frequency Stability

The frequency stability of this device is adequate to ensure that the signal will remain in-band under all normal operating conditions.

Dynamic Frequency Selection (DFS)

The device meets all DFS requirements for a client device in the DFS bands. DFS bands are only used in infrastructure mode under control of an authorized Master Device. Per FCC KDB 848637, the client software and associated drivers will not initiate any transmission on DFS frequencies without initiation by a master. This includes restriction on transmissions for beacons and support for ad-hoc peer-to-peer modes.

Disable Transmitter in Case of Failure

In the case of either absence of information to transmit or operational failure, the radio will automatically discontinue transmission. This is accomplished through the Carrier Sense / Clear Channel Assessment (CS/CCA) feature which is part of the 802.11 protocol.

The information within this section of the Operational Description is to show compliance against the Software Security Requirements laid out within KDB 594280 D02 U-NII Security.

The information below describes how we maintain the overall security measures and systems so that only:

1. Authenticated software is loaded and operating on the device
2. The device is not easily modified to operate with RF parameters outside of the authorization

General Description	
1. Describe how any software /firmware update will be obtained, downloaded, and installed. Software that is accessed through manufacturer's website or device's management system, must describe the different levels of security.	Updates to the software and firmware are obtained, downloaded, and installed as part of the Microsoft Windows Update procedure. All updates are digitally signed and securely delivered over the internet.
2. Describe all the radio frequency parameters that are modified by any software/firmware without any hardware changes. Are these parameters in some way limited, such that, it will not exceed the authorized parameters?	The radio frequency parameters that are software/firmware modifiable without hardware changes are the following: calibration related values to adjust for transmit and receive path variations from device to device; thermal compensation calibration values; maximum transmit power limits per regulatory region; region identifier for the exact product SKU; and MAC addresses for the protocol layer.
3. Describe in detail the authentication protocols that are in place to ensure that the source of the software/ firmware is legitimate? Describe in detail show the software is protected against modification	Software and firmware update packages are digitally signed to be securely distributed over the internet via the Microsoft Windows Update procedure. If the software or firmware package components are modified, Microsoft Windows will fail to load the device driver and firmware and a driver authentication error will be reported in the Device Manager.

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One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
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General Description	
4. Describe in detail the verification protocols in place to ensure that the software/firmware is legitimate?	Authenticity of the driver software and firmware package is managed by the Windows Driver Signing process. Details can be found online here: https://msdn.microsoft.com/en-us/library/windows/hardware/ff544865%28v=vs.85%29.aspx
5. Describe in detail any encryption methods used to support the use of legitimate software/firmware	Industry leading encryption methods are used as part of the Windows Update secure delivery method.
6. For a device that can be configured as a master and client (with active or passive scanning), explain how the device ensures compliance for each mode? In particular if the device acts as master in some band of operation and client in another; how is compliance ensured in each band of operation?	There are regulatory compliance protections in place for the device operating in both bands in both master and client modes. Also, while operating in master mode in WFD, DFS channels are excluded as options in the mode.

3rd Party Access Control	
1. Explain if any third parties have the capability to operate a US sold device on any other regulatory domain, frequencies, or in any manner that is in violation of the certification.	Once the device is programmed at the factory to operate on the US, it cannot be changed.
2. What prevents third parties from loading non-US versions of the software/firmware on the device? Describe in detail how the device is protected from "flashing" and the installation of third-party firmware such as DD-WRT.	The multiple levels of driver and firmware authenticity gates.
3. For Certified Transmitter modular devices, describe how the module grantee ensures that hosts manufactures fully comply with these software security requirements for U-NII devices. If the module is controlled through driver software loaded in the host, describe how the drivers are controlled and managed such that the modular transmitter parameters are not modified outside the grant of authorization.	The device is not modular. The radio solution is physically integrated into the PCBA.

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
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SOFTWARE CONFIGURATION DESCRIPTION GUIDE – USER CONFIGURATION GUIDE[1]	
1. To whom is the UI accessible? (Professional installer, end user, other.)	The UI is generically enabled as part of the standard Windows 10 UI. The Windows environment allows for different levels of users (administrators, etc.)
a) What parameters are viewable to the professional installer/end-user?	Regulatory parameters are not viewable within the User Interface. Current operating channel information can be accessed via advanced features such as the command line application "netsh wlan show all"
b) What parameters are accessible or modifiable to the professional installer?	Only user level configuration and monitoring parameters are accessible and modifiable to the professional installer. Regulatory features are neither accessible nor modifiable by even the professional installer.
(1) Are the parameters in some way limited, so that the installers will not enter parameters that exceed those authorized?	Regulatory parameters cannot be modified.
(2) What controls exist that the user cannot operate the device outside its authorization in the U.S.?	See above.
c) What configuration options are available to the end-user?	The UI is generically enabled as part of the standard Windows 10 UI. The Windows environment allows for different levels of users (administrators, etc.)
(1) Are the parameters in some way limited, so that the installers will not enter parameters that exceed those authorized?	Regulatory parameters cannot be modified.
(2) What controls exist that the user cannot operate the device outside its authorization in the U.S.?	See above.
d) Is the country code factory set? Can it be changed in the UI?	The country code is (and can only be set) in the factory. It cannot be changed in the UI.
(1) If so, what controls exist to ensure that the device can only operate within its authorization in the U.S.?	N/A
e) What are the default parameters when the device is restarted?	This depends on the region/country code that is programmed at the factory.
2. Can the radio be configured in bridge or mesh mode? If yes, an attestation may be required. Further information is available in KDB Publication 905462 D02.	The device supports Wi-Fi Direct and the feature is gated by the same regulatory compliance protections in normal client mode.
3. For a device that can be configured as a master and client (with active or passive scanning),if this is user configurable, describe what controls exist, within the UI, to ensure compliance for each mode. If the device acts as a master in some bands and client in others, how is this configured to ensure compliance?	This is enabled as part of the Wi-Fi Direct and its control functions. See General Description Item 6 for more detail.

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

SOFTWARE CONFIGURATION DESCRIPTION GUIDE – USER CONFIGURATION GUIDE[1]	
4. For a device that can be configured as different types of access points, such as point-to-point or point-to-multipoint, and use different types of antennas, describe what controls exist to ensure compliance with applicable limits and the proper antenna is used for each mode of operation. (See Section 15.407(a))	N/A – The antennas are integrated in the device and there are RF connections accessible on the device.

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

Appendix

KDB inquiry tracking Number 999667

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

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CONFIDENTIAL

July 25, 2017

Confidential Treatment Requested

Hello OET Reviewer,

Thank you for the previous response. We would like to make an update on the details of this device. The proximity sensor does not cover the WLAN Main antenna as was previously shown and described. This requires a change in the WLAN Main transmitter state in the second to last row of Table 1 as shown on the next page.

- Tablet configuration + simultaneous TX + proximity not triggered -> WLAN Main OFF (instead of WLAN Main ON at reduced power as was indicated in the previous submission).

Since this is a more conservative change, we do not think there will be an issue with it. We just wanted to update the record here so that the inquiry information matches the certification submission details when it is time for the PAG review. Let us know if there are any issues with this change.

Thank you and best regards,

Mike Boucher - Sr. Compliance Engineer, Microsoft
Zack Gray - SAR Test Engineer, Microsoft

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

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Transmission Mode	State of Sensors		TX Output Power		
	Keyboard Position	**Proximity Sensor**	**WWAN**	**WLAN Main**	**WLAN MIMO**
Wi-Fi Only	Laptop Mode	-	-	Full Power	Full Power
Wi-Fi Only	Tablet Mode	-	-	Reduced power	Reduced power
Cellular Only	Laptop Mode	***Not Triggered***	Full Power	-	-
Cellular Only	Laptop Mode	***Triggered***	Reduced Power	-	-
Cellular Only	Tablet Mode	***Not Triggered***	Full Power	-	-
Cellular Only	Tablet Mode	***Triggered***	Reduced Power	-	-
Simultaneous: Wi-Fi & Cellular	Laptop Mode	***Not Triggered***	Full Power	Full Power	Full Power
Simultaneous: Wi-Fi & Cellular	Laptop Mode	***Triggered***	Reduced Power	Full Power	Full Power
Simultaneous: Wi-Fi & Cellular	Tablet Mode	***Not Triggered***	Full Power	~~Reduced Power~~ OFF	Reduced Power
Simultaneous: Wi-Fi & Cellular	Tablet Mode	***Triggered***	Reduced Power	OFF	Reduced Power

Table 1 rev1: WLAN and WWAN Power States vs. Sensor States

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

Microsoft

Your inquiry has been received by the FCC and it's been assigned tracking number is **999667**.

Inquiry Details on 06/08/2017:

Inquiry:

Microsoft Corporation (?Microsoft?) hereby respectfully seeks confidential treatment of this inquiry as well as for any OET response to this inquiry. Please see the inquiry in the separately attached document.

FCC response on 06/26/2017

Proposed test procedure and its confidentiality has been accepted,however, a PAG may be needed to ensure compliant

---Reply from Customer on 07/25/2017---

Please see the attached document with updated details on this inquiry, thank you.

Microsoft respectfully seeks continuous confidential treatment on this matter, thank you.

FCC response on 08/04/2017

Proposed test procedure has been accepted

Attachment Details:

With following attachments
- 1109209 bytes, Microsoft Inquiry 7June2017, on 06/08/2017
- 1109209 bytes, Microsoft Inquiry 7June2017, on 06/08/2017
- 538909 bytes, Microsoft Update 25July2017, on 07/25/2017

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

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June 7, 2017

Confidential Treatment Requested

Hello OET Reviewer,

In previous KDB Inquiry #328639 we received approval for a radio output power back off scheme for a tablet PC with a detachable keyboard. That device would only have high WLAN output power when the detachable keyboard was attached at an angle that would facilitate a laptop use case, and would back off WLAN power in tablet use case configurations. That WLAN only device has received approval without further update to that inquiry as the final RF power back offs did not exceed the estimates of that inquiry.

We are developing another model of this device with a 3G / 4G WWAN radio added, see Fig. 1 and Fig. 2 for device dimensions and antenna layout. The WWAN radio utilizes a low band TX antenna which transmits from 698 – 960 MHz and a high band TX antenna which transmits from 1710 – 2670 MHz, only one of which can transmit at a given time. The antennas of the 3G/4G radio will be covered by a capacitive proximity sensor to be compliant with SAR requirements in tablet use scenarios. The keyboard sensing mechanism described in the previous KDB inquiry will not affect the WWAN radio power; WWAN TX radio power will only depend on the state of the proximity detection.

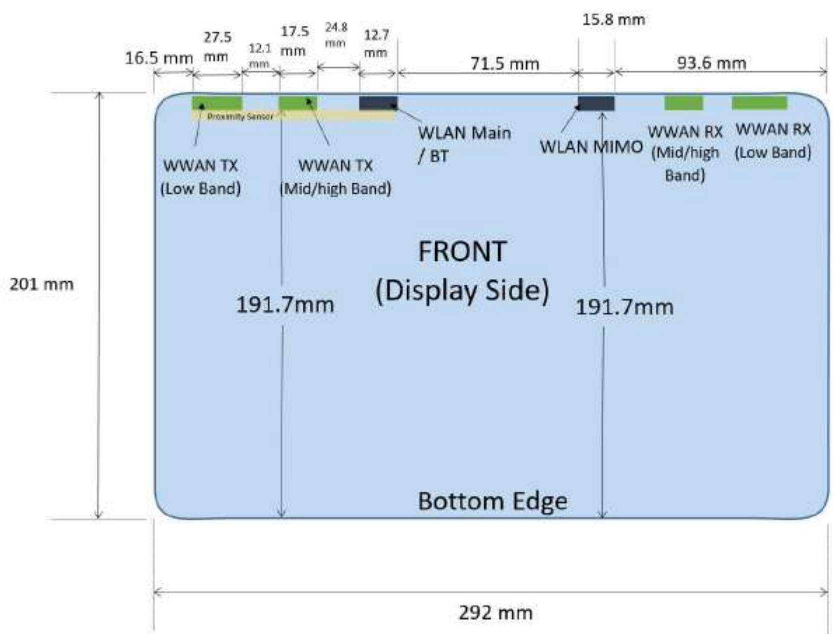

Fig. 1 - Tablet Dimensions and Antenna Locations

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

Device Top

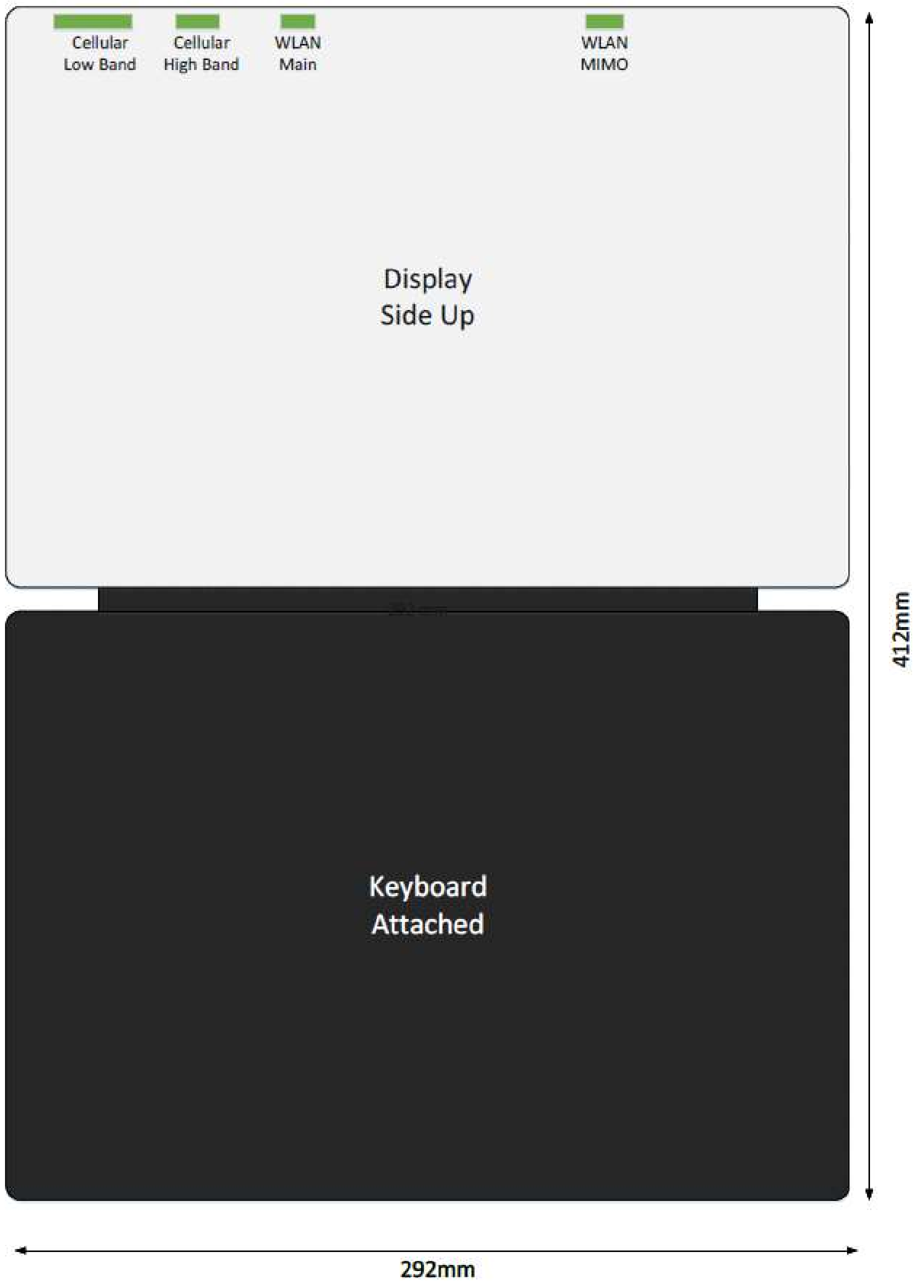

Fig. 2 - Device Dimensions with Keyboard Attached

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

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WLAN output power would again depend primarily on whether the keyboard is attached at an angle that would facilitate laptop use conditions. Details of the keyboard sensing mechanism are again shown at the end of this inquiry. Due to the relatively short distance between the WLAN Main antenna and the WWAN antennas, the WLAN main antenna will either be shut off or have its power reduced when the device is in a tablet configuration and WWAN + WLAN radios are simultaneously transmitting. It can be seen in Fig. 1 that the proximity sensor also covers the WLAN main antenna. We plan to use the proximity sensor to distinguish when a user is near the WLAN main antenna in order to keep the WLAN main antenna on when in simultaneous TX configurations and when the proximity sensor hasn't been triggered:

- Tablet configuration + simultaneous TX + proximity triggered -> WLAN Main OFF, no simultaneous TX for WLAN Main and WWAN. Only WLAN MIMO will be on.
- Tablet configuration + simultaneous TX + proximity not triggered -> WLAN Main ON at reduced power.
  - Simultaneous TX between either WWAN antenna and the WLAN Main antenna would be evaluated as the sum of reported SAR values for each as measured with the test separation distance determined by the proximity sensor trigger distance procedure (ie, 15-20mm.)
  - Since the WLAN MIMO antenna is not covered by the proximity sensor, its SAR would be measured with a test separation distance of 0mm. Simultaneous evaluation would use the WLAN MIMO 0mm measurement and either WLAN Main or WWAN antennas with SAR measured at the proximity trigger distance.

Table 1 shows all transmitter power states vs. both keyboard detection and proximity detection states on the next page.

Is it acceptable to use the proximity sensor to detect a user near only one WLAN antenna so that the WLAN Main antenna would have SAR measured at the trigger distance separation (15-20mm) while the WLAN MIMO antenna would have SAR measured at 0mm separation? This would only be for tablet use conditions when in in WWAN + WLAN simultaneous TX.

If this is not acceptable, we would shut the WLAN Main antenna off in all WWAN + WLAN simultaneous TX tablet use scenarios. In either case, the WLAN Main antenna would change its power state based upon two triggers: the keyboard state and WWAN + WLAN simultaneous TX state. Since this radio power will depend on two different triggering mechanisms, will a PAG be required?

Thank you and best regards,

Mike Boucher - Sr. Compliance Engineer, Microsoft

Zack Gray - SAR Test Engineer, Microsoft

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

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These are the intended output power states based upon the proximity sensor and keyboard sensing inputs:

Transmission Mode	State of Sensors		TX Output Power		
	Keyboard Position	**Proximity Sensor**	**WWAN**	**WLAN Main**	**WLAN MIMO**
Wi-Fi Only	Laptop Mode	-	-	Full Power	Full Power
Wi-Fi Only	Tablet Mode	-	-	Reduced power	Reduced power
Cellular Only	Laptop Mode	***Not Triggered***	Full Power	-	-
Cellular Only	Laptop Mode	***Triggered***	Reduced Power	-	-
Cellular Only	Tablet Mode	***Not Triggered***	Full Power	-	-
Cellular Only	Tablet Mode	***Triggered***	Reduced Power	-	-
Simultaneous: Wi-Fi & Cellular	Laptop Mode	***Not Triggered***	Full Power	Full Power	Full Power
Simultaneous: Wi-Fi & Cellular	Laptop Mode	***Triggered***	Reduced Power	Full Power	Full Power
Simultaneous: Wi-Fi & Cellular	Tablet Mode	***Not Triggered***	Full Power	Reduced Power	Reduced Power
Simultaneous: Wi-Fi & Cellular	Tablet Mode	***Triggered***	Reduced Power	OFF	Reduced Power

Table 1: WLAN and WWAN Power States vs. Sensor States

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

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Power Back Off Functionality Relative to Keyboard

When the keyboard is not attached, WLAN output power is always low. When the keyboard is attached, there is a function in the keyboard code which uses XYZ coordinates from both the device and keyboard accelerometers to give the angle between the device and the keyboard. The power will only be transmitted at the higher levels when this function can be called and returns an acceptable angle as shown in Fig.3 and Table 2 below. The cutoff is approximately 225°.

WWAN output power always depends on the capacitive proximity sensor state (proximity triggered = low power, proximity not triggered = high power.) The WWAN radio power does depend on this keyboard function.

These are estimated levels of WLAN power back off which will be required:

2.4 GHz WLAN: ~6 dBm power reduction

5 GHz WLAN: ~7 dB power reduction

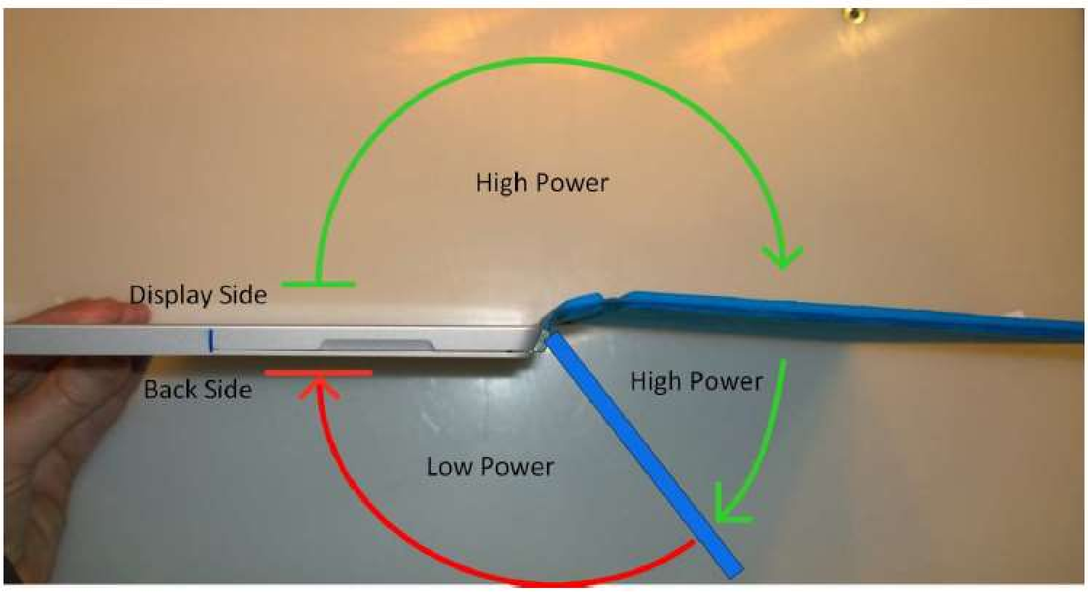

Fig. 3 – WLAN Output Power Relative to Keyboard Angle

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

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WLAN Power Reduction State vs. Angle between Device and Keyboard

Angle Between Tablet and Keyboard	Output Power State	Angle Between Tablet and Keyboard	Output Power State
0°(Device Closed)	Power Reduction OFF **(Laptop Mode)**	190°	Power Reduction OFF
10°	Power Reduction OFF	200°	Power Reduction OFF
20°	Power Reduction OFF	210°	Power Reduction OFF
30°	Power Reduction OFF	220°	Power Reduction OFF
40°	Power Reduction OFF	230°	Power Reduction ON **(Tablet Mode)**
50°	Power Reduction OFF	240°	Power Reduction ON
60°	Power Reduction OFF	250°	Power Reduction ON
70°	Power Reduction OFF	260°	Power Reduction ON
80°	Power Reduction OFF	270°	Power Reduction ON
90°	Power Reduction OFF	280°	Power Reduction ON
100°	Power Reduction OFF	290°	Power Reduction ON
110°	Power Reduction OFF	300°	Power Reduction ON
120°	Power Reduction OFF	310°	Power Reduction ON
130°	Power Reduction OFF	320°	Power Reduction ON
140°	Power Reduction OFF	330°	Power Reduction ON
150°	Power Reduction OFF	340°	Power Reduction ON
160°	Power Reduction OFF	350°	Power Reduction ON
170°	Power Reduction OFF	360° (Keyboard folded back for tablet use case)	Power Reduction ON

Table 2: WLAN Power State vs. Attached Keyboard Angle

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 706 7329
www.microsoft.com

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Keyboard / Display configuration.	SAR Test Requirements.
 Fig 4: Keyboard Disconnected – Tablet Mode	Tablet Test requirements apply. Device edges and back Body SAR required. **WLAN Radio** will operate in low power mode. **Cellular radio power** dependent on capacitive proximity sensor state: Prox. untriggered = high power mode Prox. triggered = low power mode **WWAN + WLAN Simultaneous TX:** WLAN Main transmitter shuts off only when prox. is triggered. When prox. is not triggered, WLAN Main antenna SAR is evaluated at trigger distance, WLAN MIMO antenna SAR is evaluated at 0mm.
 Fig 5: Keyboard connected and at an angle for typical laptop use – Laptop Mode	Laptop test requirements apply. **WLAN Radio** will operate in high power mode. **Cellular radio power** dependent on capacitive proximity sensor state: Prox. untriggered = high power mode Prox. triggered = low power mode
 Fig 6: Keyboard folded around back of display – Tablet Mode	Tablet test requirements apply. **WLAN Radio** will operate in low power mode. **Cellular Radio** would operate in low power mode.