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The Boeing Co.
MPE REPORT

SCOPE OF WORK
MPE CALCULATION
ON THE WI-FI MODULE

REPORT NUMBER
104056598LEX-018

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11/18/2020

PAGES
14

DOCUMENT CONTROL NUMBER
Non-Specific EMC Report Shell Rev. December 2017

MPE TEST REPORT

Report Number: **104056598LEX-018**
Project Number: **G104056598**

Report Issue Date: **11/18/2020**

Product Name: **Wi-Fi Module**

Standards: **FCC Part 1.1310 Limits for Maximum Permissible Exposure (MPE)**

RSS-102 Issue 5 RF Field Strength Limits for Devices Used by the General Public

Tested by:
Intertek Testing Services NA, Inc.
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Lexington, KY 40510
USA

Client:
The Boeing Co.
Spectrum Management, MC 1K-105
P.O. Box 3707
Seattle, WA 98124-2207
USA

Report prepared by

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Report reviewed by

Brian Lackey, Staff Engineer

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
10	FCC Part 1.1310 Limits for Maximum Permissible Exposure (MPE) (Limits for General Population / Uncontrolled Exposure)	Pass
	RSS-102 Issue 5 RF Field Strength Limits (For Devices Used by the General Public)	Pass

3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	The Boeing Co.
Address:	Spectrum Management, MC 1K-105 P.O. Box 3707 Seattle, WA 98124-2207 USA
Contact:	Joel Thorsheim
Email:	joel.d.thorsheim@boeing.com
Manufacturer Information	
Manufacturer Name:	The Boeing Co.
Manufacturer Address:	Spectrum Management, MC 1K-105 P.O. Box 3707 Seattle, WA 98124-2207 USA

4 Description of Equipment under Test and Variant Models

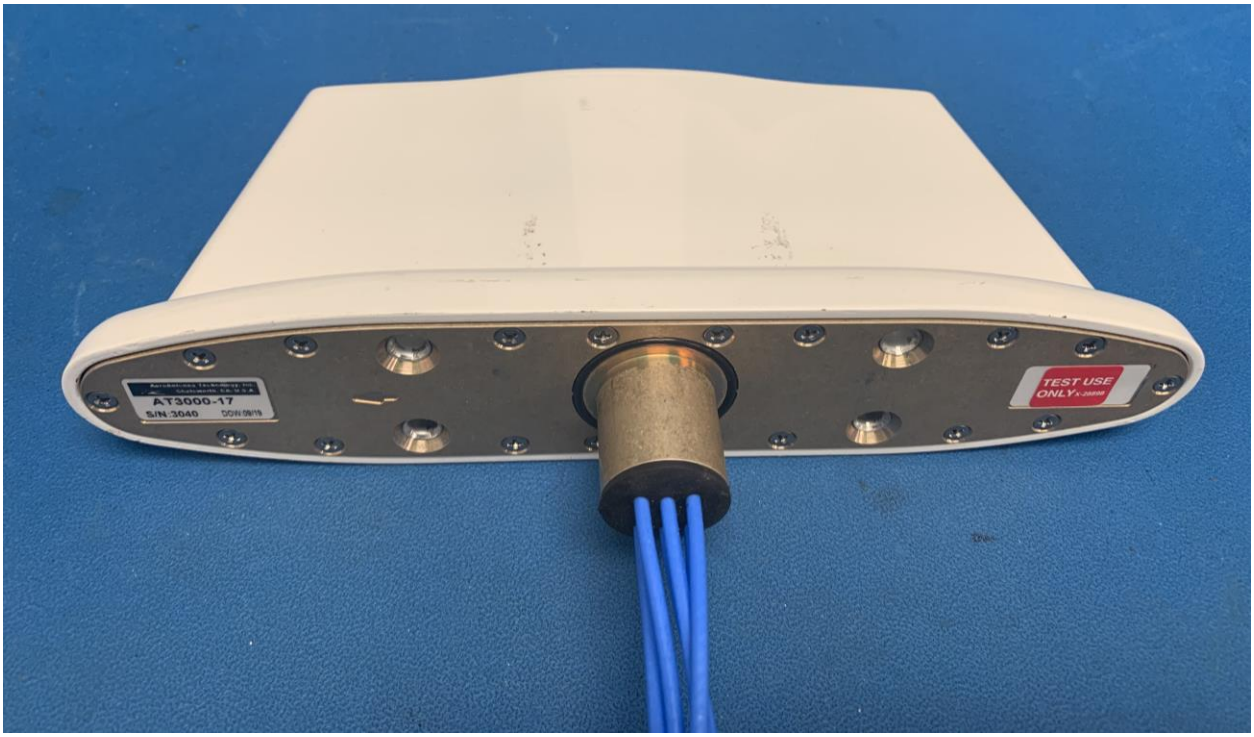
Equipment Under Test	
Product Name	Wi-Fi Module
Supported Transmit Bands	802.11 a/b/g/n/ac/Bluetooth 4.2 2.4 GHz (2.4GHz - 2.5 GHz) 5 GHz (5.180 GHz - 5. 825 GHz)
Embedded Module	Laird ST60-2230C-P
Embedded Module hardware Version	2.1
Embedded Module Software Version	Version 7.0.0.231
Embedded Module Firmware Version	88W8997_ST_pcie_uart_v5.4.23.1.bin
FCCID	H8V-60SIPT
Receive Date	1/20/2020
Test Start Date	1/23/2019
Test End Date	2/19/2020
Device Received Condition	Good
Test Sample Type	Production
Rated Voltage	3.3 VDC (2.97 - 3.63VDC)
Description of Equipment Under Test (provided by client)	
Wi-Fi Module	

4.1 Variant Models:

There were no variant models covered by this evaluation.

5 Antenna Gains:

The Antenna used was model AT3000-17. It was used for the MPE calculations since it had the highest overall gain of the antennas proposed for use by The Boeing Co. The AT3000-18 or AT2400-35B antenna may also be used since they have equal or lesser gain.



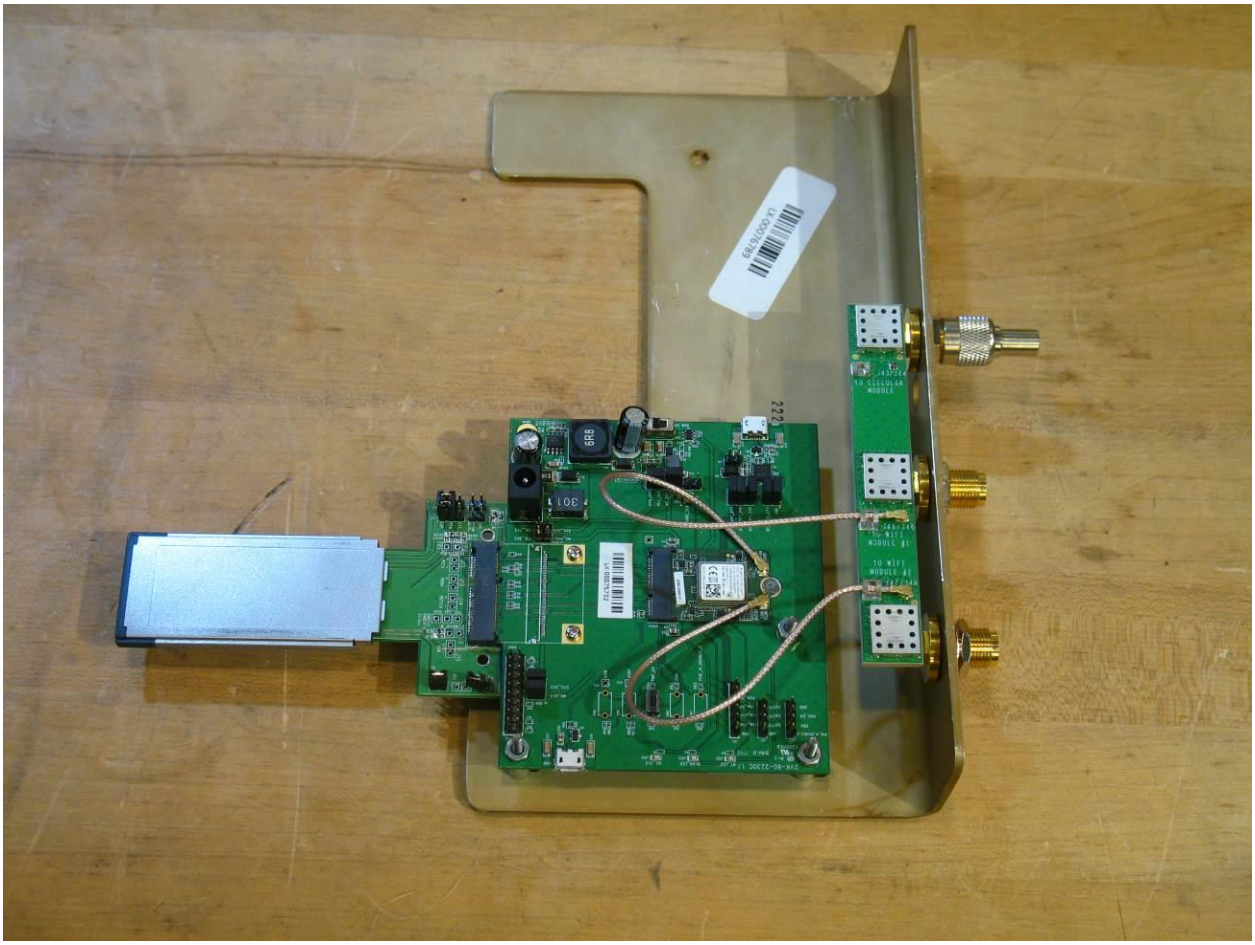
Antenna p/n	Function	Frequency (MHz)	Max Gain (dBi)	Min Cable Loss (dB)
AT3000-17	WiFi	2400-2500	4	0.5
		5100-5900	5	0.5
	Cellular	700-1500	6	0.5
		1700-2700	4	0.5
AT3000-18	WiFi	2400-2500	4	0.5
		5100-5900	5	0.5
	Cellular	700-1500	4	0.5
		1700-2700	4	0.5
AT2400-35B	WiFi	2400-2500	1	0.5
		5100-5900	3	0.5

Note: these antennas gains were provided by the client and used in the MPE calculations. Their values could impact results.

6 Output Power:

The maximum output power used for the MPE calculations was taken from the MPE on file with the FCC for the Laird ST60-2230C-P module. These output power values could impact results.

6.1 EUT Photo



7 FCC Limits

§ 1.1310: The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

Part 1.1310 Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f^2)	30
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

8 RSS-102 Issue 5 Exposure Limits:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	-2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
* Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

9 Test Procedure

An MPE evaluation for was performed in order to show that the device was compliant with the general population exposure limits from FCC §2.1091 and RSS-102 Issue 5. The maximum power density was calculated for each transmitter band at a separation distance of 20cm using the maximum declared output power including tune up tolerance.

For each transmitter the maximum RF exposure at a 20 cm distance using the formula:

$$Conducted\,Power_{mW} = 10^{Conducted Power(dBm)/10}$$

$$PowerDensity = \frac{Conducted\,Power_{mW} \times Ant.Gain}{4\pi \times (20_{cm})^2}$$

For transmitters that could operate simultaneously, the MPE to limit ratio for each was calculated and then summed. If the sum of the MPE to limit ratios was less than 1, that specific combination of transmitters was deemed to comply.

10 Results:

The calculated maximum power density at 20cm distance was equal to or less than the required limits for general population exposure for FCC Part 1.1310 and RSS-102 Issue 5.

FCC MPE Data

Duty Cycle	100 (%)							
Separation Dist.	20 (cm)							
Operating Mode	Frequecy (MHz)	Declared Max Cond. Power (Inc. Tolerance) (dBm)	Duty Cycle Adjusted Cond. Output Power (dBm)	Antenna Gain (dB)	MPE Value (mW/cm^2)	MPE Limit (mW/cm^2)	Margin to Limit (mW/cm^2)	MPE / Limit Ratio (for Co-Location)
WLAN	2412	21.41	21.41	3.5	0.0616	1.00	0.9384	0.0616
WLAN	5180	21.6	21.6	4.5	0.0810	1.00	0.9190	0.0810
WLAN	5260	18.92	18.92	4.5	0.0437	1.00	0.9563	0.0437
WLAN	5500	21.01	21.01	4.5	0.0708	1.00	0.9292	0.0708
WLAN	5745	21.28	21.28	4.5	0.0753	1.00	0.9247	0.0753
Bluetooth	2402	10.79	10.79	3.5	0.0053	1.00	0.9947	0.0053
BLE	2402	10.75	10.75	3.5	0.0053	1.00	0.9947	0.0053

RSS-102 Issue 5 MPE Data

Duty Cycle	100 (%)							
Separation Dist.	20 (cm)							
Operating Mode	Frequecy (MHz)	Declared Max Cond. Power (Inc. Tolerance) (dBm)	Duty Cycle Adjusted Cond. Output Power (dBm)	Antenna Gain (dB)	MPE Value (W/m^2)	MPE Limit (W/m^2)	Margin to Limit (W/m^2)	MPE / Limit Ratio (for Co-Location)
WLAN	2412	21.41	21.41	3.5	0.6162	5.37	4.7498	0.114836
WLAN	5180	21.6	21.6	4.5	0.8105	9.05	8.2366	0.089582
WLAN	5260	18.92	18.92	4.5	0.4373	9.14	8.7051	0.047827
WLAN	5500	21.01	21.01	4.5	0.7075	9.43	8.7179	0.075064
WLAN	5745	21.28	21.28	4.5	0.7529	9.71	8.9574	0.077535
Bluetooth	2402	10.79	10.79	3.5	0.0534	5.35	5.2974	0.252245
BLE	2402	10.75	10.75	3.5	0.0529	5.35	5.2979	0.009893

11 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	11/18/2020	104056598LEX-018	BCT	BL	Original Issue