RF EXPOSURE EVALUATION REPORT

FCC ID	**: 2AJASU3WG360**
Equipment	**: WiGig USB Adapter**
Brand Name	**: Millitronic**
Model Name	**: MG360**
Applicant	**: Millitronic 7F.-6, No.237, Sec.1,Datong Rd. Xizhi Dist.,New Taipei City 22161 Taiwan**
Manufacturer	**: Millitronic 7F.-6, No.237, Sec.1,Datong Rd. Xizhi Dist.,New Taipei City 22161 Taiwan**
Standard	**: FCC 47 CFR Part 2 (2.1093)**

We, SPORTON INTERNATIONAL INC have been evaluated in accordance with 47 CFR Part 2.1091 for the device and pass the limit.

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

Cona Huang

Approved by: Cona Huang / Deputy Manager

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History of this test report

Report No.	Version	Description	Issued Date
FA872417	01	Initial issue of report	Nov. 23, 2018
FA872417	02	1. Add measured power level in section10 2. Add tip-to-EUT-enclosure spacing in appendix D	Dec. 12, 2018

1. Summary

The maximum measured average power density found during testing for Millitronic, WiGig USB Adapter, MG360, are as follows.

Standalone transmission		
Band	Highest Total Power Density, averaging over 4cm^2 (mW/cm^2)	Limit (FCC part 1.310) (mW/cm^2)
802.11ad, 60GHz	0.734	1

Reviewed by: Jason Wang
Report Producer: Wan Liu

2. Guidance Applied

The Power Density testing specification, method, and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2.1091
- FCC 47 CFR Part 2.1093
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- TCBC workshop notes
- IEC Draft TR 63170

3. Equipment Under Test (EUT) Information

3.1 General Information

Product Feature & Specification	
Equipment Name	WiGig USB Adapter
Brand Name	Millitronic
Model Name	MG360
FCC ID	2AJASU3WG360
Wireless Technology and Frequency Range	802.11ad 60GHz channel 2: 60.48GHz
EUT Stage	Production Unit

4. RF Exposure Limits

4.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

4.2 Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. The exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure above 6GHz to radio frequency (RF) radiation as specified in §1.1310.

General Population Basic restriction for power density for frequencies between 1.5GHz and 100 GHz is 1.0 mW/cm^2 = 10 W/m^2

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/f2)	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/f2)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

5. System Description and Setup

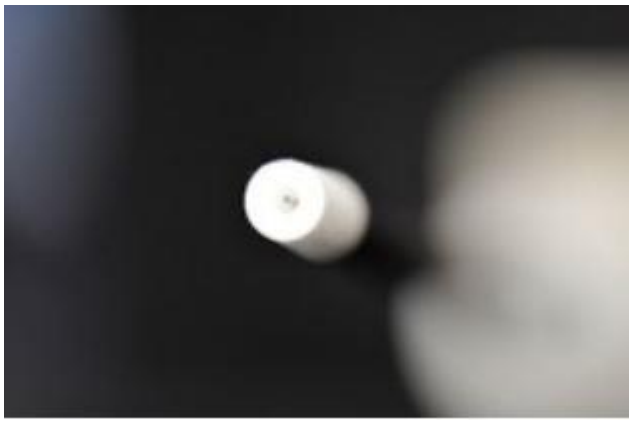
The system to be used for the near field power density measurement

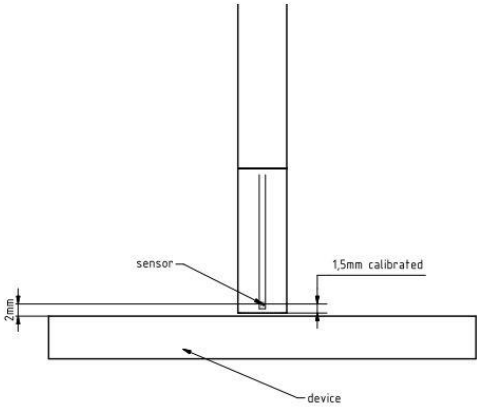
- SPEAG DASY6 system
- SPEAG cDASY6 5G module software
- EUmmWV2 probe
- 5G Phantom cover

5.1 EUmmWave Probe / E-Field 5G Probe

The probe design allows measurements at distances as small as 2 mm from the sensors to the surface of the device under test (DUT). The typical sensor to probe tip distance is 1.5 mm.

Frequency	750 MHz – 110 GHz
Probe Overall Length	320 mm
Probe Body Diameter	8.0 mm
Tip Length	23.0 mm
Tip Diameter	8.0 mm
Probe's two dipoles length	0.9 mm – Diode loaded
Dynamic Range	< 20 V/m - 10000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm
Distance between diode sensors and probe's tip	1.5 mm
Minimum Mechanical separation between probe tip and a Surface	0.5 mm
Applications	E-field measurements of 5G devices and other mm-wave transmitters operating above 10GHz in < 2 mm distance from device (free-space) Power density, H-field and far-field analysis using total field reconstruction.
Compatibility	cDASY6 + 5G-Module SW1.0 and higher





5.2 Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.
The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

5.3 Scan configuration

Fine-resolution scans on 2 different planes are performed to reconstruct the E- and H-fields as well as the power density; the z-distance between the 2 planes is set to $\lambda/4$.
The (x, y) grid step is also set $\lambda/4$, the grid extent is set to sufficiently large to identify the field pattern and the peak.

5.4 Total Field and Power Flux Density Reconstruction

Computation of the power density in general requires knowledge of the electric and magnetic field amplitudes and phases in the plane of incidence. Reconstruction of these quantities from pseudo-vector E-field measurements is feasible, as they are constrained by Maxwell's equations. SPEAG have developed a reconstruction approach based on the Gerchberg-Saxton algorithm, which benefits from the availability of the E-field polarization ellipse information obtained with the EUmmWV2 probe.
The average of the reconstructed power density is evaluated over a circular area in each measurement plane. Two average power density values can be computed, the average total power density and the average incident power density, and the average total power density is used to determine compliance.

6. Test Equipment List

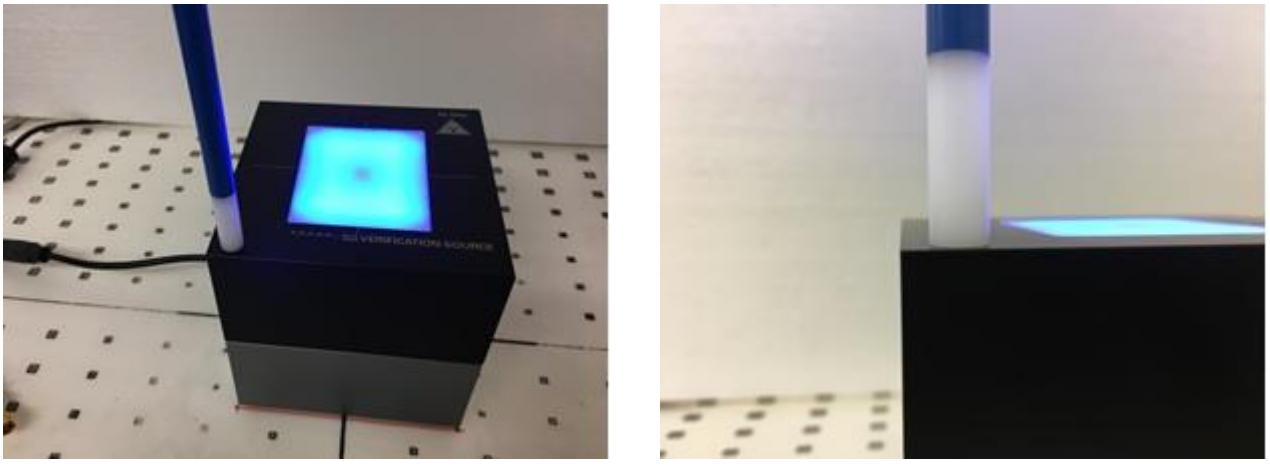
Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	5G Verification Source	60 GHz	1009	Apr. 05, 2018	Apr. 04, 2019
SPEAG	EUmmWV Probe	EUmmWV2	9388	Apr. 10, 2018	Apr. 09, 2019
SPEAG	Data Acquisition Electronics	DAE4	910	Jun. 21,2018	Jun. 20,2019
TESTO	Hygro meter	608-H1	34913631	Aug. 27, 2018	Aug. 26, 2019
Rohde & Schwarz	Spectrum Analyzer	FSV40	101408	Jul. 30, 2018	Jul. 29, 2019

7. System Verification

The system performance check verifies that the system operates within its specifications.

The EUT is replaced by a calibrated source, the same spatial resolution, measurement region and the test separation used in the calibration was applied to system check. Through visual inspection into the measured power density distribution, both spatially (shape) and numerically (level) have no noticeable difference. The measured results should be within 10% of the calibrated targets

Date	Frequency (GHz)	Source S/N	Probe S/N	DAE S/N	Distance (mm)	Measured 4cm^2 Avg Power Density (W/m^2)	Target 4cm^2 Avg Power Density (W/m^2)	Deviation (%)
2018/11/17	60Hz	1009	9388	910	10	221	239	-7.53



Verification Setup photo

8. Antenna Location

9. Test Setup

1. The 802.11ad PD test was performed of a 10mm separation between sensor and EUT surface (the probe tip is 0.5mm to the EUT surface) and the test procedure based on guidance from the FCC.
2. This device has 3 sub-arrays, only one array operates at a time, and there is only 1 beam configuration supported for each array.
3. The measurement frequency was set at the 60.48GHz frequency.
4. According to TCBC Workshop in October 2018, 4 cm2 averaging area may now be considered.
5. Above 6 GHz, Maximum Permissible Exposure (MPE) limits apply to portable exposure conditions according to 47 CFR §2.1093.

10. RF Exposure Evaluation Results

Plot No.	Wireless Technology	Exposure Plane	Probe Sensor to EUT surface (mm)	Ch.	Freq. (GHz)	Sub-array	Average EIRP (dBm)	Measured E peak (V/m)	Measured H peak (A/m)	Measured 4cm^2 Average Normal PD (W/m^2)	4cm^2 Average Total PD (W/m^2)
	802.11ad	Back	10mm	2	60.48	9	17.76	58.9	0.169	3.28	3.47
	802.11ad	Back	10mm	2	60.48	17	18.92	32.9	0.087	1.96	1.97
	802.11ad	Back	10mm	2	60.48	1	13.84	9.99	0.031	0.116	0.123
	802.11ad	Front	10mm	2	60.48	1	13.84	32.7	0.082	1.42	1.49
	802.11ad	Front	10mm	2	60.48	9	17.76	23	0.062	0.631	0.683
	802.11ad	Front	10mm	2	60.48	17	18.92	31.7	0.079	0.972	1.06
	802.11ad	Left Side	10mm	2	60.48	1	13.84	16.5	0.041	0.266	0.277
	802.11ad	Left Side	10mm	2	60.48	9	17.76	28.3	0.076	0.77	0.867
1	802.11ad	Left Side	10mm	2	60.48	17	18.92	74.8	0.193	7.08	7.34
	802.11ad	Right Side	10mm	2	60.48	1	13.84	10.2	0.034	0.114	0.124
	802.11ad	Right Side	10mm	2	60.48	9	17.76	21.9	0.061	0.613	0.646
	802.11ad	Right Side	10mm	2	60.48	17	18.92	22.3	0.062	0.526	0.587
	802.11ad	Bottom Side	10mm	2	60.48	1	13.84	6.49	0.024	0.05	0.055
	802.11ad	Bottom Side	10mm	2	60.48	9	17.76	6.94	0.025	0.052	0.058
	802.11ad	Bottom Side	10mm	2	60.48	17	18.92	6.07	0.024	0.042	0.048

Test Engineer： Steven Chang

11. Uncertainty Assessment

Preliminary uncertainty budget for Module mmWave based on the IEC 62209 standard family and in compliance with the WG10 draft report. The budget is valid for evaluation distances > λ/2π. For specific tests and configurations, the Uncertainty could be considerably smaller.

Preliminary Module mmWave Uncertainty Budget Evaluation Distances to the Antennas > λ / 2π Base on the 62209 Standard Family						
Error Description	**Uncertainty Value (±%)**	**Probability**	**Divisor**	**(Ci)**	**Standard Uncertainty (±%)**	**(Vi) Veff**
Measurement System						
Probe Calibration	0.49	N	1	1	0.49	∞
Hemispherical Isotrop	0.50	R	1.732	1	0.29	∞
Linearity	0.20	R	1.732	0	0.00	∞
System Detection Limits	0.04	R	1.732	1	0.02	∞
Modulation Response	0.40	R	1.732	1	0.23	∞
Readout Electronics	0.03	N	1	1	0.03	∞
Response Time	0.00	R	1.732	1	0.00	∞
Integration Time	0.00	R	1.732	1	0.00	∞
RF Ambient Noise	0.04	R	1.732	1	0.02	∞
RF Ambient Reflections	0.21	R	1.732	1	0.12	∞
Probe Positioner	0.04	R	1.732	1	0.02	∞
Probe Positioning	0.30	R	1.732	1	0.17	∞
S_{avg} Reconstruction	0.60	R	1.732	1	0.35	∞
Test Sample Related						
Power Drift	0.10	R	1.732	1	0.06	∞
Input Power	0.27	N	1	0	0.00	∞
Combined Std. Uncertainty					0.74%	∞
Coverage Factor for 95 %					K=2	
Expanded STD Uncertainty					1.48%	

12. References

[1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

[2] FCC KDB 447498 D01 v06, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, Oct 2015

[3] FCC KDB 865664 D02 v01r02, “RF Exposure Compliance Reporting and Documentation Considerations” Oct 2015.