mmWave POWER DENSITY EVALUATION REPORT

FCC ID:	2ARPAJW-WGA6001
Applicant:	Shenzhen Jaguar Wave Technology LTD.
Application Type:	Certification
Product:	Wireless Gigabit Adapter
Model No.:	JW-WGA6001
Brand Name:	JAGUAR WAVE, SUGAR Lady
FCC Classification:	Part 15 Low Power Transceiver, Rx Verified (DXT)
FCC Rule Part(s):	FCC 47 CFR Part 2.1093
Test Procedure(s):	IEC TR 63170: 2018; TCB Workshop Notes
Test Date:	August 14 ~ 15, 2019

Reviewed By: Sunny Sun

(Sunny Sun)

Approved By: Robin Wu

(Robin Wu)

Revision History

Report No.	Version	Description	Issue Date	Note
1810RSU034-U2	Rev. 01	Initial Report	09-04-2019	Valid

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§2.1033 General Information

Applicant:	Shenzhen Jaguar Wave Technology LTD.
Applicant Address:	Unit 1002/1003, Block 2A, Tongtai Times Center No.6259 Baoan Road, Fuhai Street, Baoan District, Shenzhen City, P.R.China.
Manufacturer:	Shenzhen Jaguar Wave Technology LTD.
Manufacturer Address:	Unit 1002/1003, Block 2A, Tongtai Times Center No.6259 Baoan Road, Fuhai Street, Baoan District, Shenzhen City, P.R.China.

MRT Test Facility / Accreditations

Measurements were performed at MRT Laboratory located in Tian'edang Rd., Suzhou, China.

- **MRT facility is a FCC registered (MRT Reg. No. 893164) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules.**
- **MRT facility is an IC registered (MRT Reg. No. 11384A-1) test laboratory with the site description on file at Industry Canada.**
- **MRT facility is a VCCI registered (R-20025, G-20034, C-20020, T-20020) test laboratory with the site description on file at VCCI Council.**
- **MRT Lab is accredited to ISO 17025 by the American Association for Laboratory Accreditation (A2LA) under the American Association for Laboratory Accreditation Program (A2LA Cert. No. 3628.01) in EMC, Telecommunications, Radio and SAR testing.**


Accredited Laboratory

A2LA has accredited

MRT TECHNOLOGY (SUZHOU) CO., LTD.

Suzhou, Jiangsu, People's Republic of China

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

Presented this 24th day of July 2018.

President and CEO
For the Accreditation Council
Certificate Number 3628.01
Valid to August 31, 2020

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

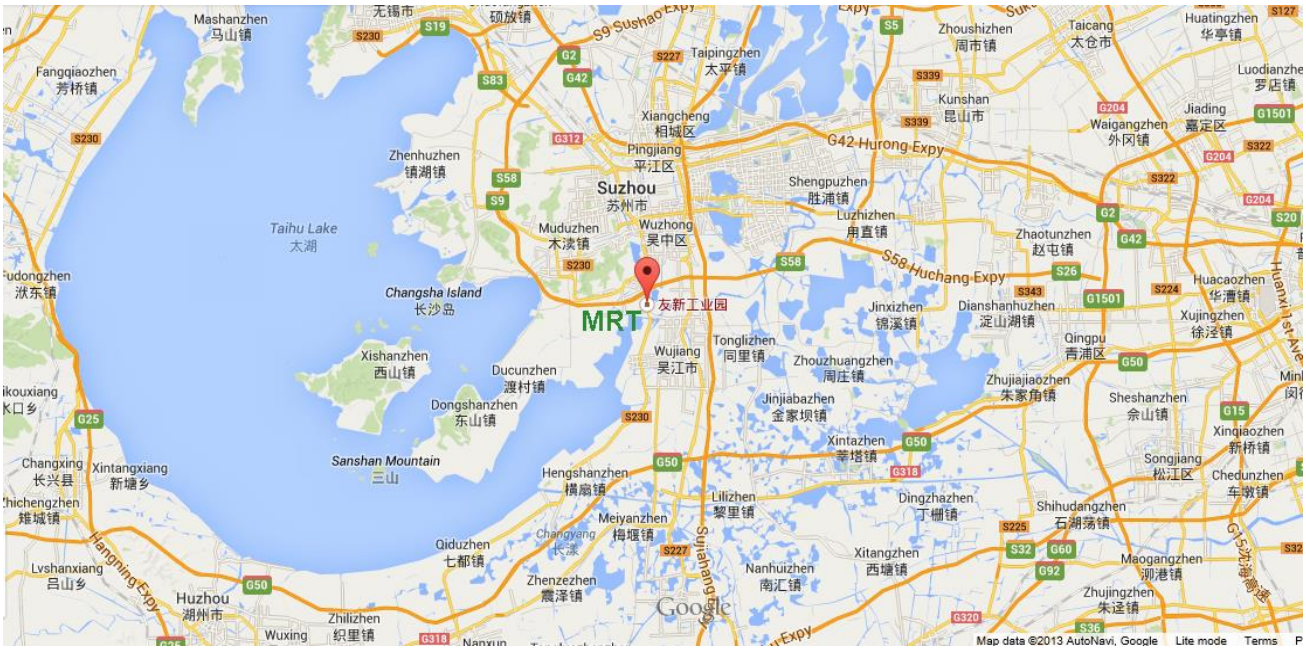
1. Introduction

1.1. Scope

Measurement and determination of specific absorption rate (SAR) of radio frequency devices including intentional and/or unintentional radiators is compliance with the technical rules and regulations of the Federal Communications Commission.

1.2. MRT Test Location

The map below shows the location of the MRT LABORATORY, its proximity to the Taihu Lake. These measurement tests were conducted at the MRT Technology (Suzhou) Co., Ltd. Facility located at D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China. The measurement facility compliant with the test site requirements specified in ANSI C63.4-2014.



2. Product Information

2.1. General Description for EUT

Product Name	Wireless Gigabit Adapter
Model No.	JW-WGA6001
EUT Type	Portable Device
Exposure Category	General Population/Uncontrolled Exposure

2.2. Product Specification Subjective to this Report

EUT Specification	
Transmitting Frequency	58.32GHz ~ 64.80GHz
Channel Number	4
Modulation Type	16QAM
Antenna Type	Integrated antenna
Antenna Gain	1.0dBi

2.3. Operation Frequency and Channel List

Channel	Frequency	Channel	Frequency
1	58.32 GHz	2	60.48 GHz
3	62.64 GHz	4	64.80 GHz

3. Summary of Test Result

3.1. Test Standards

No.	Identity	Document Title
1	47 CFR Part 2.1093	Radiofrequency radiation exposure evaluation: portable devices
2	IEC TR 63170-2018	Measurement procedure for the evaluation of power density related to human exposure to radio frequency fields from wireless communication devices operating between 6 GHz and 100 GHz
3	TCB Workshop	RF Exposure Procedures (November 2017, October 2018, April 2019)
4	KDB 447498 D01 v06	General RF Exposure Guidance
5	KDB 865664 D02 v01r02	RF Exposure Reporting

3.2. Environment Condition

Ambient Temperature	22.0℃
Relative Humidity	46.7%

3.3. RF Exposure Limits

FCC 15.255(g)

Regardless of the power density levels permitted under this section, devices operating under the provisions of this section are subject to the radiofrequency radiation exposure requirements specified in §§1.1307(b), 2.1091 and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

§2.1093 Radiofrequency radiation exposure evaluation: portable devices

Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in §1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

§1.1310 Radiofrequency radiation exposure limits.

Below sets forth limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields

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/ Control 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
300-1,500	--	--	f/300	6
1,500-100,000	--	--	5	6
(B) Limits for General Population/ Uncontrolled Exposures				
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
300-1,500	--	--	f/1500	30
1,500-100,000	--	--	1.0	30

f= Frequency in MHz

* = Plane-wave equivalent power density

3.4. Test Result Summary

Worst SAR List

Test Mode	Total PSD averaging over $4cm^2$ (mW/cm^2)	Limit (FCC Part 1.310) (mW/cm^2)
802.11ad, 60.48GHz	0.1252	1

4. Measurement System

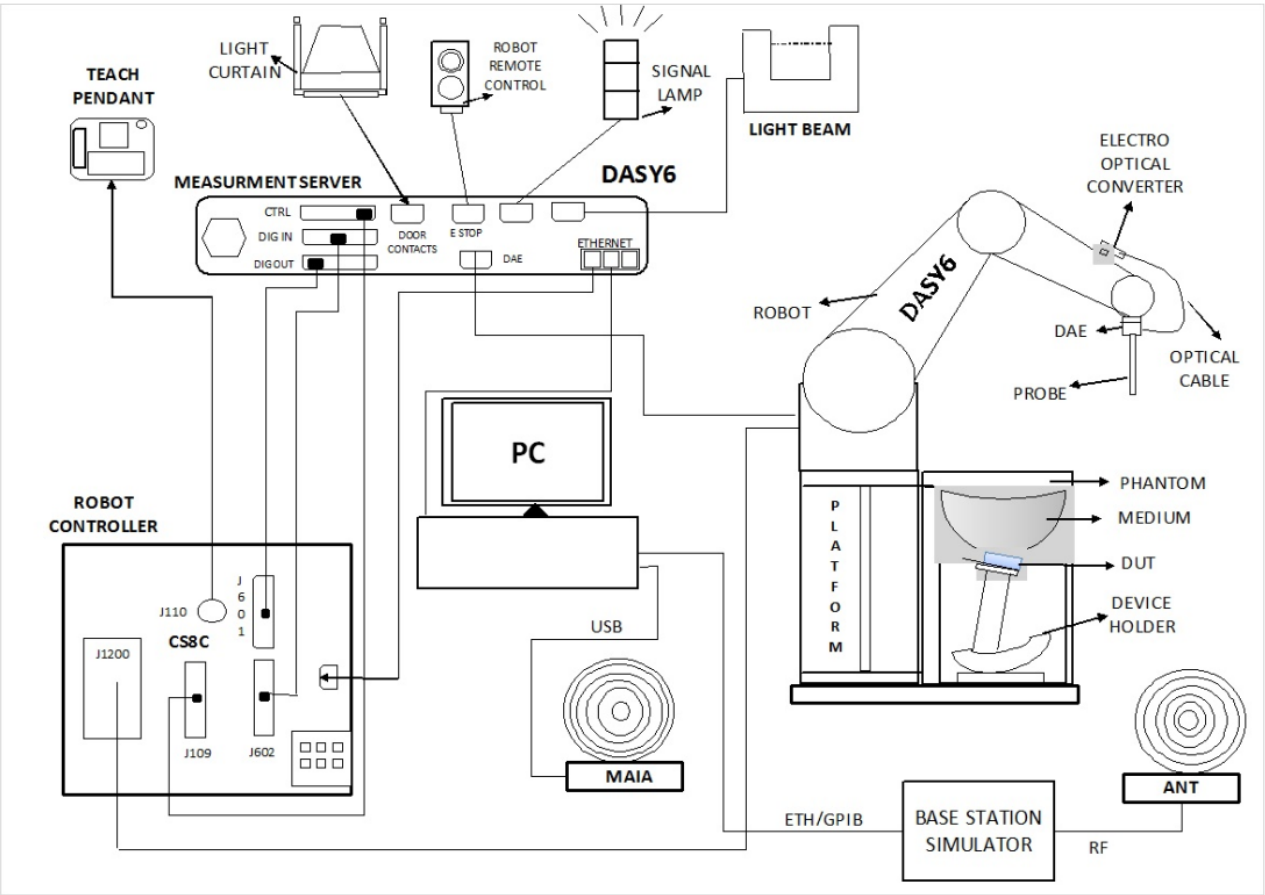
4.1. Introduction

The following system configuration is required to perform 5G measurements:

- DASY6 system
- EUmmWVx probe
- 5G phantom cover
- cDASY6 5G Module software with a valid license

4.2. DASY6 Measurement System Diagram

The DASY6 system is shown below:



The System consist of the following components:

DASY6 Measurement Server, Data Acquisition Electronics (DAE), Probes, Light-Beam Unit, Phantoms, Media, Device Holder for SAM-Twin Phantom, Laptop Extension Kit to Mounting Device, Robot System Platform & Pedestal, Verification of the Parameters with the Dielectric Assessment Kit (DAK), Modulation and Interference Analyzer (MAIA), Omni-Directional Ultra-Wideband Antenna (ANT), cDASY6 software, DASY5 NEO software and SEMCAD data evaluation software.

4.3. E-Field mm-Wave Probe

EUmmwv3 Probe

Two dipoles optimally arranged to obtain pseudo-vector information.

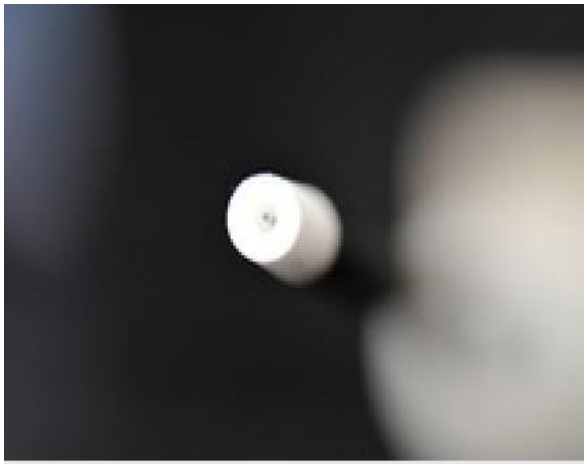
Minimum 3 measurements/point, 120º rotated around probe axis.

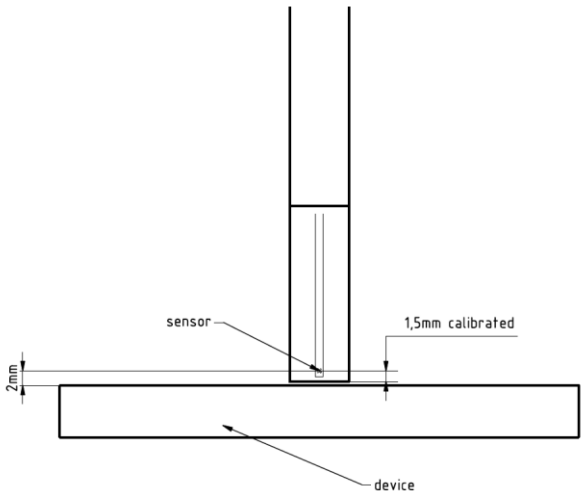
Sensors (0.8mm length) printed on glass substrate protected by high density foam.

Low perturbation of the measured field.

Requires positioner which can do accurate probe rotation.

Frequency Range	750 MHz – 110 GHz
Dynamic Range	< 20 V/m - 10'000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm
Dimensions	Overall length: 337 mm (tip: 20 mm)
	Tip diameter: encapsulation 8 mm (internal sensor < 1mm)
	Distance from probe tip to dipole centers: < 2 mm
	Sensor displacement to probe's calibration point: < 0.3 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. Measurement Procedure

5.1. Power Density Assessment Based on E-field

Within a short distance from the transmitting source, power density is determined based on both electric and magnetic fields. Generally, the magnitude and phase of two components of either the E-field or H-field are needed on a sufficiently large surface to fully characterize the total E-field and H-field distributions. Nevertheless, solutions based on direct measurement of E-field and H-field can be used to compute power density. The general measurement approach is summarized in a) to g).

a) Measure the E-field on the measurement surface at a reference location where the field is well above the noise level. This reference level will be used at the end of this procedure to assess output power drift of the DUT during the measurement.

b) Scan the electric field on the measurement surface. Measurements are therefore conducted according to the instructions provided by the measurement system manufacturer.

c) Measurement spatial resolution can depend on the measured field characteristic and measurement methodology used by the system. Planar scanners typically require a step size of less than λ /2.

d) For cDASY6, H-field was calculated from the measured E-field using a reconstruction algorithm. As the power density calculation requires knowledge of both amplitude and phase, reconstruction algorithms can also be used to obtain field information from the measured E-field data (e.g. the phase from the amplitude if only the amplitude is measured). In substance, reconstruction algorithms are the set of algorithms, mathematical techniques and procedures that are applied to the measured field on the measurement surface to determine H-field (amplitude and phase) on the evaluation surface.

e) Use Formula to determine the spatial-average power density distribution on the evaluation surface. The spatial averaging area, A, is specified by the applicable exposure limits or regulatory requirements. If the shape of the area is not provided by the relevant regulatory requirements, a circular shape is recommended.

$$S_{\mathrm{av}} = \frac{1}{2A}\Re\left(\int \mathbf{E}\times\mathbf{H}^{*}\cdot\hat{\mathbf{n}}\mathrm{d}A\right)$$

f) The maximum spatial-average and/or local power density on the evaluation surface is the final quantity to determine compliance against applicable limits.

g) Measure the E-field on the measurement surface position at the reference location chosen in step a). The power drift of the DUT is estimated as the difference between the squared amplitude of the field

values taken in steps a) and g). When the drift is smaller than ± 5 %, this term should be considered in the uncertainty budget. Drifts larger than 5 % due to the design and operating characteristics of the device should be accounted for or addressed according to regulatory requirements to determine compliance.

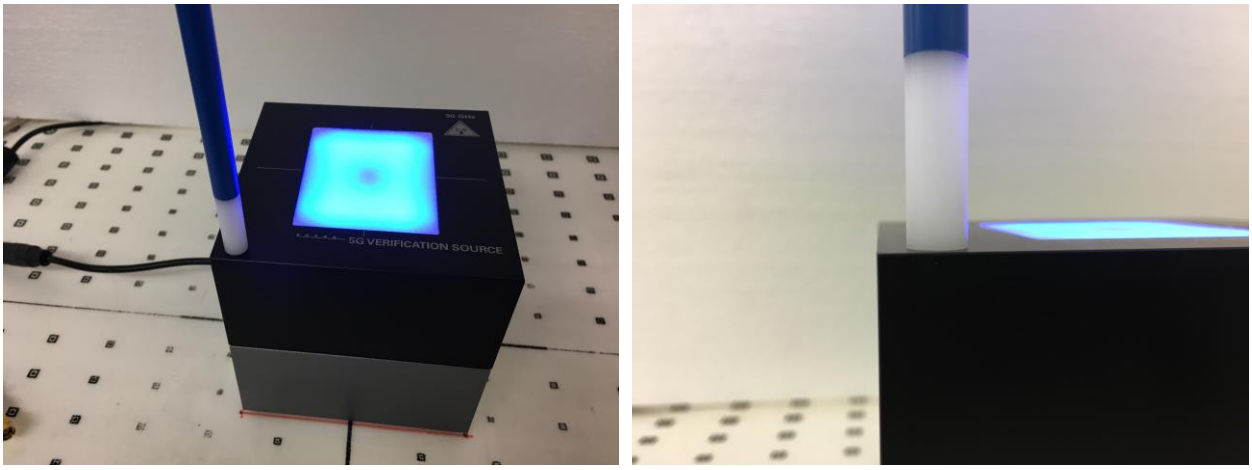
5.2. Reconstruction Algorithms

Computation of the power density in general requires knowledge of the electric (E-) and magnetic (H-) 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. The 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 EUmmWV3 probe.

6. System Verificaiton

The system was verified to be within ±10% of the power density targets on the calibration certificate according to the test system specification in the user's manual and calibration facility recommendation. The ±10% deviation threshold represents the expanded uncertainty for system performance checks using SPEAG's mmWave verification sources. The same spatial resolution and measurement region used in the source calibration was applied during the system check.

The measured power density distribution of verification source was also confirmed through visual inspection to have no noticeable differences, both spatially (shape) and numerically (level) from the distribution provided by the manufacturer, per November 2017 TCBC Workshop Notes.



System Verification Setup Photo

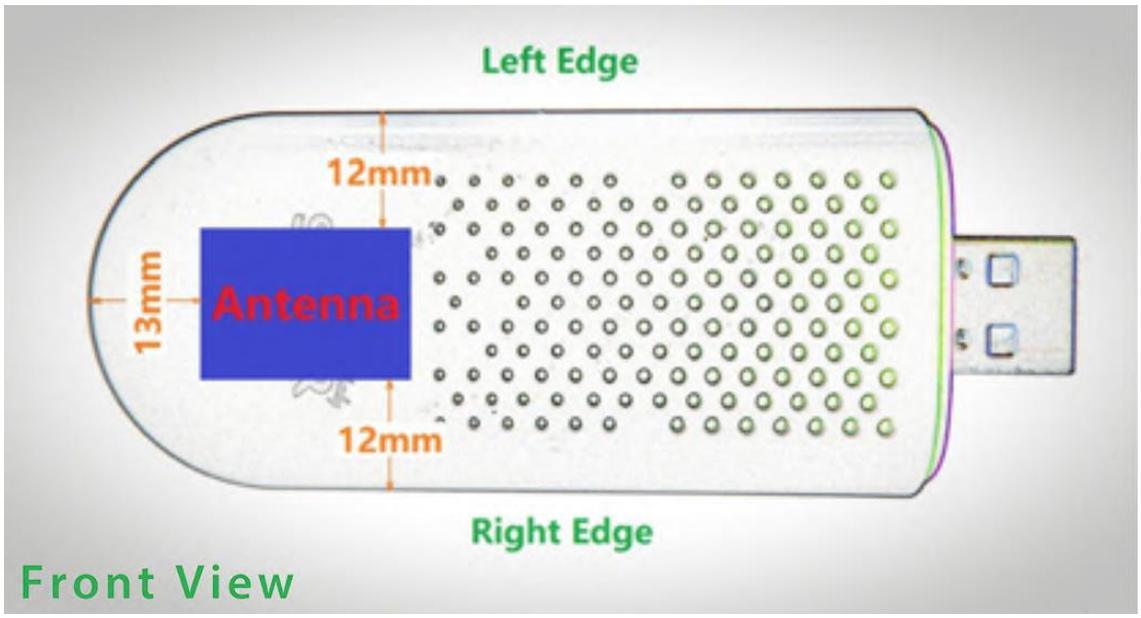
■ Result of System Performance Check

System check									
Freq. (GHz)	Source S/N	Probe S/N	Normal S (W/m^2 over $4cm^2$)		Deviation (%)	Total S (W/m^2 over $4cm^2$)		Deviation (%)	Test Date
			Meas.	Target		Meas.	Target		
60	1018	9399	325	313	3.8	327	315	3.8	08.14. 2019

Note: A 10 mm distance spacing was used from the reference horn antenna aperture to the probe element. This includes 4.45 mm from the reference antenna horn aperture to the surface of the verification source plus 5.55 mm from the surface to the probe. The SPEAG software requires a setting of "5.55 mm" for the correct setup.

7. Analysis and Results

7.1. Antenna Location



7.2. Power Density Test Results

Beam ID	Channel (GHz)	Probe Sensor to EUT Surface (mm)	Meas. Position	Avg. EIRP (dBm)	Max. Tune-up EIRP (dBm)	Scaling Factor	$S_{avg\ Nor}$ (W/m^2 over $4cm^2$)	$S_{avg\ tot}$ (W/m^2 over $4cm^2$)	Reported $S_{avg\ tot}$ (W/m^2 over $4cm^2$)	Plot #
5	60.48	5	Front	9.78	10.0	1.052	0.732	0.786	0.827	
35	60.48	5	Front	9.78	10.0	1.052	1.12	1.19	1.252	1
1	60.48	5	Front	9.78	10.0	1.052	0.656	0.718	0.755	
35	58.32	5	Front	8.20	8.5	1.072	0.603	0.670	0.718	
35	64.80	5	Front	6.33	6.5	1.040	0.477	0.520	0.541	
35	60.48	5	Back	9.78	10.0	1.052	0.333	0.368	0.387	
35	60.48	5	Left	9.78	10.0	1.052	0.023	0.030	0.032	
35	60.48	5	Right	9.78	10.0	1.052	0.710	0.751	0.790	
35	60.48	5	Bottom	9.78	10.0	1.052	0.107	0.125	0.131	

8. Test Equipment Used

Instrument	Manufacturer	Model No.	Serial No.	Cali. Interval	Cali. Due Date
5G Verification Source	Speag	60GHz	1018	1 year	11.15.2019
Data Acquisition Electronics	Speag	DAE4	1260	1 year	11.29.2019
EUmmWV3 Probe	Speag	EUmmWV3	9399	1 year	11.15.2019

Software	Version	Function
cDASY6 5G Module software	cDASY6_1.6.2.6	mmWave Power Density Test Software

9. Measurement Uncertainty

Error Description	Uncert. Value (±dB)	Prob. Dist.	Div.	ci	Std. Unc. (±dB)	(vi) veff
Measurement System						
Probe Calibration	0.49	N	1	1	0.49	∞
Hemispherical Isotropy	0.50	R	$\sqrt{3}$	1	0.29	∞
Linearity	0.20	R	$\sqrt{3}$	0	0.00	∞
System Detection Limits	0.04	R	$\sqrt{3}$	1	0.02	∞
Modulation Response	0.40	R	$\sqrt{3}$	1	0.23	∞
Readout Electronics	0.03	N	1	1	0.03	∞
Response Time	0.00	R	$\sqrt{3}$	1	0.00	∞
Integration Time	0.00	R	$\sqrt{3}$	1	0.00	∞
RF Ambient Noise	0.04	R	$\sqrt{3}$	1	0.02	∞
RF Ambient Reflections	0.21	R	$\sqrt{3}$	1	0.12	∞
Probe Positioner	0.04	R	$\sqrt{3}$	1	0.02	∞
Probe Positioning	0.30	R	$\sqrt{3}$	1	0.17	∞
S_{avg} Recontruction	0.60	R	$\sqrt{3}$	1	0.35	
Test Sample Related						
Power Drift	0.22	R	$\sqrt{3}$	1	0.13	∞
Input Power	0	N	1	0	0.00	∞
Combined Std. Uncertainty					0.75	∞
Expanded STD Uncertainty					**1.50**	

Annex A System Check Result

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	DUT Type
60GHz Validation Device	100.0 x 100.0 x 100.0	60GHz

Exposure Conditions

Phantom Section	Position,	Test Distance [mm]	Frequency [MHz]	Conversion Factor
5G Air	FRONT	5.55	60000.0	1.0

Hardware Setup

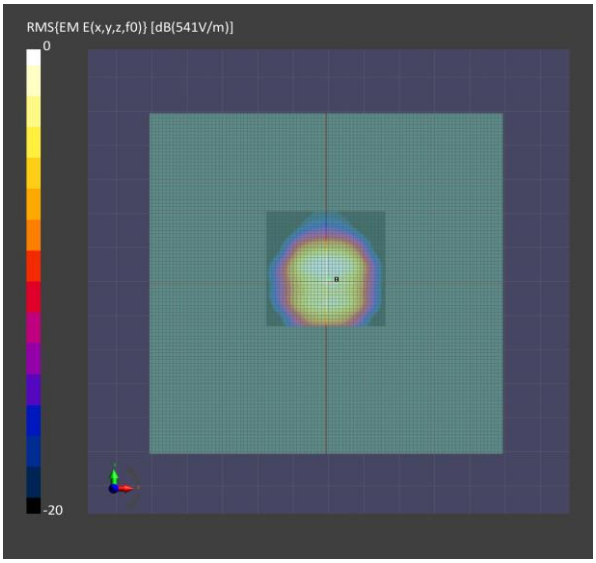
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
5G Cover	--Air-	EUmmWV3 - SN9399, 2018-11-16	DAE4 Sn1260, 2018-11-30

Scan Setup

Grid Extents [mm]	**32.5 x 32.5**
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	5.55

Measurement Results

Date	**2019-08-14, 09:32**
Avg. Area [cm^2]	4.00
pS_{tot} avg [W/m^2]	327
pS_n avg [W/m^2]	325
E_{peak} [V/m]	541
Power Drift [dB]	-0.02



Annex B Test Data Plots

Plot 1#

Test item: Beam ID 35_Front View_60480MHz

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	DUT Type
JW-WGA6001	60.0 x 60.0 x 10.0	WiGig USB Dongle

Exposure Conditions

Phantom Section	Position	Test Distance [mm]	Frequency [MHz]	Conversion Factor
5G Air	FRONT	5.00	60480.0	1.0

Hardware Setup

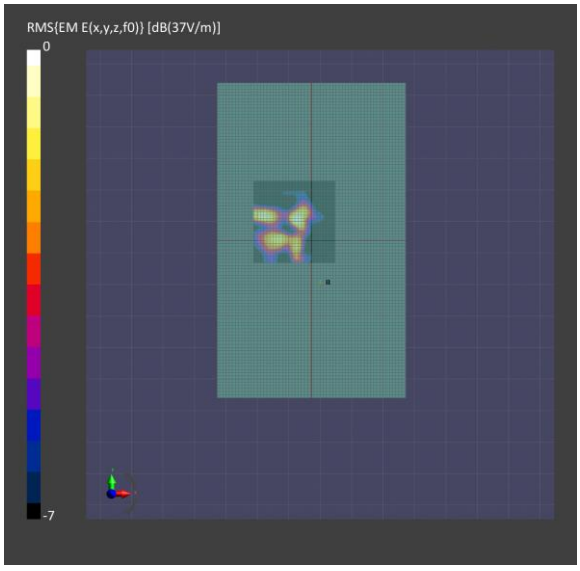
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
5G Cover	--Air-	EUmmWV3 - SN9399, 2018-11-16	DAE4 Sn1260, 2018-11-30

Scan Setup

Grid Extents [mm]	25.0 x 25.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	5.0

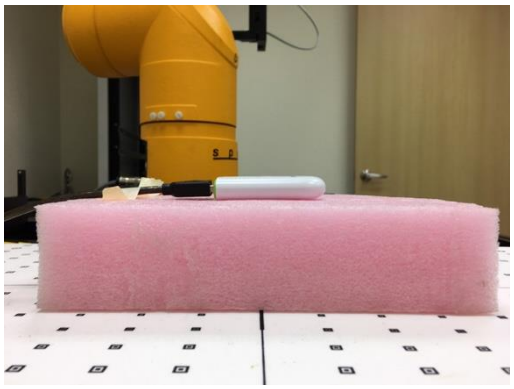
Measurement Results

Date	2019-08-14, 20:32
Avg. Area [cm^2]	4.00
pS$_{tot}$ avg [W/m^2]	1.19
pS$_n$ avg [W/m^2]	1.12
E$_{peak}$ [V/m]	37.0
Power Drift [dB]	-0.14

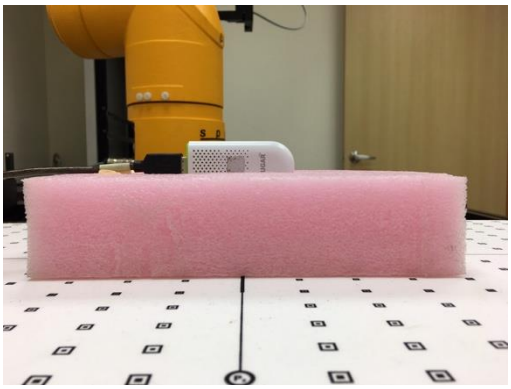


Annex C Test Setup Photos

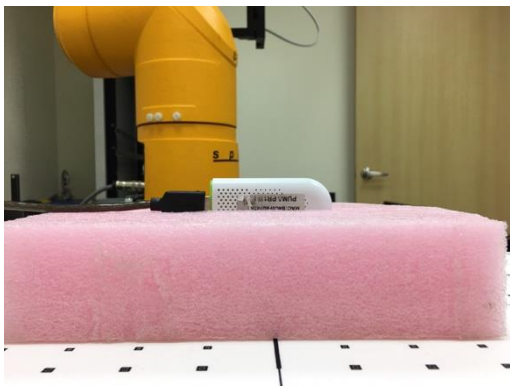
Front View



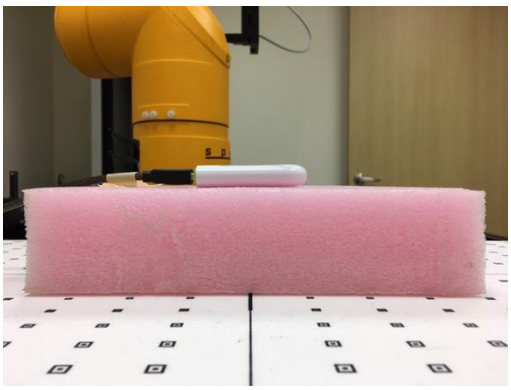
Right Side



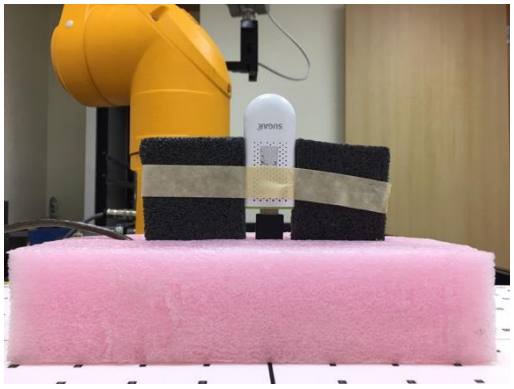
Left Side



Back View



Bottom Side



Annex D EUT External Photos

Refer to “1801RSU034-UE” file.

Annex E Equipment Calibration Report

Please refer to document “Annex E - Equipment Calibration Report.pdf”.

The End