Power Density Measurement Report

Report No.	:	**SP181015C09 R3**
Applicant	:	**NETGEAR INC.**
Address	:	**350 East Plumeria Drive, San Jose, CA 95134, USA**
Product	:	**5G MHS Travel Router**
FCC ID	:	**PY318300428**
Brand	:	**NETGEAR**
Model No.	:	**MR5000**
Standards	:	**FCC 47 CFR Part 2 (2.1093), IEC TR 63170:2018** **KDB 865664 D02 v01r02, KDB 447498 D01 v06**
Sample Received Date	:	**Dec. 12, 2018**
Date of Testing	:	**Dec. 13, 2018 ~ Dec. 15, 2018**
Lab Address	:	**No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan, R.O.C.**
Test Location	:	**No. 19, Hwa Ya 2nd Rd, Wen Hwa Vil, Kwei Shan Dist., Taoyuan City 33383, Taiwan (R.O.C)**

CERTIFICATION: The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch – Lin Kou Laboratories**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

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Approved By :

Roy Wu / Senior Manager

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Release Control Record

Report No.	Reason for Change	Date Issued
SP181015C09	Initial release.	Nov. 19, 2018
SP181015C09 R1	Retest power density at 10 mm due to proximity sensor disabling.	Nov. 27, 2018
SP181015C09 R2	Remove power density scaling down calculation due to 5G duty cycle resuming to 100%, and update TER analysis due to LTE SAR retesting.	Dec. 07, 2018
SP181015C09 R3	Retest all power density due to disabling the array antenna module 1 and module 3; firmware update; and calculate power density result based on final production duty cycle of 25%.	Dec. 15, 2018

1. Summary of Maximum Value

Mode	Highest Averaged Power Density Tested at 10 mm [W/m^2]
5G NR n260	0.38

Simultaneous Transmission	Total Exposure Ratio
LTE + 5G NR + WLAN	0.844

Note:

1. According to 47 CFR part 2.1093, the MPE limits specified in part 1.1310 apply to portable devices that transmit at frequencies above 6 GHz. The localized power density limit for general population exposure is **1.0 mW/cm^2 (equal to 10 W/m^2)** for frequency up to 100 GHz.
2. Per FCC guidance in Oct 2018 TCBC workshop, the total exposure ratio calculated by taking ratio of maximum reported SAR divided by SAR limit and adding it to maximum measured power density divided by power density limit. Numerical sum of the ratios should be less than 1.
3. Per FCC interim guidance for near-field power density measurement, the power density was spatially averaged over a circular area of 4 cm^2.

2. Description of Equipment Under Test

EUT Type	5G MHS TRAVEL ROUTER
FCC ID	PY318300428
Brand Name	NETGEAR
Model Name	MR5000
Hardware Version	1.0
Firmware Version	NTGX50_15.04.08.00
Tx Frequency Bands [Unit: GHz]	5G NR n260 : 37.6 ~ 40.0
Uplink Modulations	5G NR : QPSK, 16QAM, 64QAM
Supported Channel Bandwidth	100 MHz
Supported Carrier Component	1 CC only
Uplink Transmission Duty Cycle	Limited to 25 %
Antenna Information	There are three QTM's 5G array antenna modules, and each 5G array antenna module consists of two sub-arrays. 1. One 1x4 Dipole Antenna Sub-Array Single-polarized dipole antennas, Omni-directional individually but directional when all 4 active depending on phase. 2. One 1x4 Patch Antenna Sub-Array Cross-polarized patch antennas, patch antenna +/- 45 degrees vertical or horizontal at full gain (falls off 90 degrees). The dipole sub-array and patch sub-array cannot transmit simultaneously, only 1 sub-array active at one time. These three 5G arrays antenna modules do not operate simultaneously of each other. The purpose of the three spatially separated 5G arrays is for spatial diversity. As for beam-steering/beam-forming mechanism, the product's beam formation selects between dipole or patch array, the wide beam-width on the best array, sweeps begin to improve link, and beam-width then reduces on best beam location. For this version, the array antenna module 1 and module 3 are disabled by software. Only array antenna module 2 on right side of the device is active. Only patch array antenna of module 2 on the right side of the device is active, the dipole array antenna of module 2 is disabled. The location of the antenna module 2 is shown in Appendix D.
EUT Stage	Engineering Sample

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

List of Accessory:

Battery	**Brand Name**	NETGEAR
	Model Name	W-10a
	Power Rating	3.85Vdc, 5040mAh
	Type	Li-ion

3. Power Density Measurement System

3.1 Definition of Power Density

The power density for an electromagnetic field represents the rate of energy transfer per unit area. The local power density (i.e. Poynting vector) at a given spatial point is deduced from electromagnetic fields by the following formula:

$$S = \frac{1}{2}\text{Re}\{E \times H^{*}\} \cdot \vec{n}$$

Where: E is the complex electric field peak phasor and H is the complex conjugate magnetic field peak phasor.

The spatial-average power density distribution on the evaluation surface is determined per the IEC TR 63170. The spatial area, A is specified by the applicable exposure limit or regulatory requirements. The circular shape was used.

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

3.2 SPEAG DASY6 System

The SPEAG DASY6 system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY6 software defined. The DASY6 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

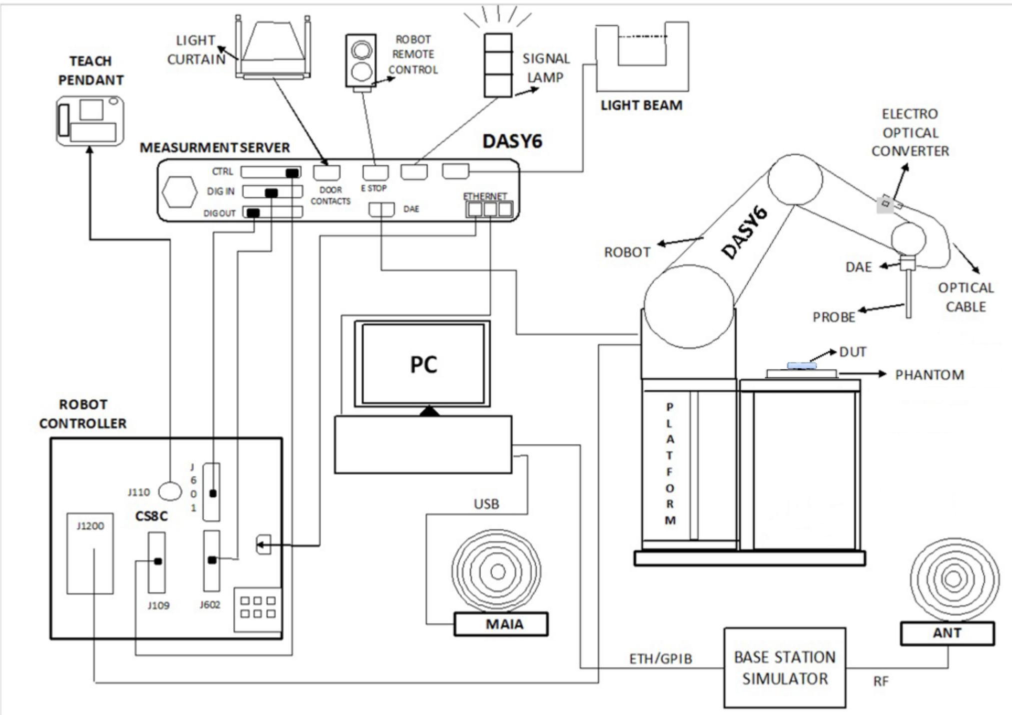


Fig-3.1 SPEAG DASY6 System Configuration

3.2.1 Robot

The DASY6 system use the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version of CS8c from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

Fig-3.2 SPEAG DASY6 System

3.2.2 EUmmWV2 mm-Wave Probe

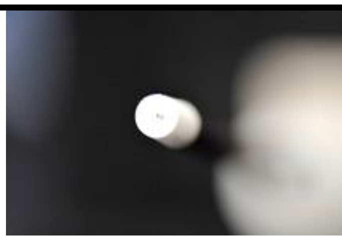
The EUmmWV2 probe is an electric (E) universal (U) field probe with two dipole sensors for field measurements at frequencies up to 110 GHz and as close as 2 mm from any field source or transmitter. The sensors consist of two diode-loaded small dipoles that provide the rectified voltage from the coupled E-field. From the voltages at three different orientations in the field at known angles, both the magnitude of the field component and the field polarization can be calculated. Due to the small size of the sensors, the probe can be used for measurements over an extremely wide frequency range from <1 GHz to 110 GHz. The probe sensors are protected by non-removable 8 mm high-density foam.

The EUmmWV2 probe is based on the pseudo-vector probe design, which not only measures the field magnitude but also derives its polarization ellipse. This probe concept also has the advantage that the sensor angle errors or distortions of the field by the substrate can be largely nullified by calibration. This is particularly important as, at these very high frequencies, field distortions by the substrate are dependent on the wavelength. The design entails two small 0.8 mm dipole sensors mechanically protected by high-density foam, printed on both sides of a 0.9 mm wide and 0.12 mm thick glass substrate. The body of the probe is specifically constructed to minimize distortion by the scattered fields.

The probe consists of two sensors with different angles arranged in the same plane in the probe axis. Three or more measurements of the two sensors are taken for different probe rotational angles to derive the amplitude and polarization information. These probes are the most flexible and accurate probes currently available for measuring field amplitude.

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. The exact distance is calibrated.

Model	EUmmWV2
Frequency	750 MHz to 110 GHz
Dynamic Range	< 20 V/m - 10000 V/m with PRE-10 < 50 V/m - 3000 V/m minimum
Linearity	< ±0.2 dB
Hemispherical Isotropy	< 0.5 dB
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



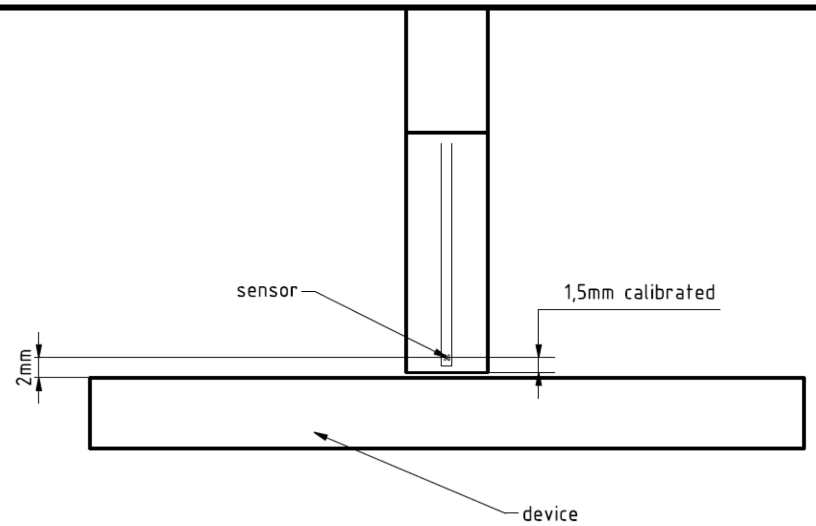


Illustration of Distance - Sensor to DUT Surface

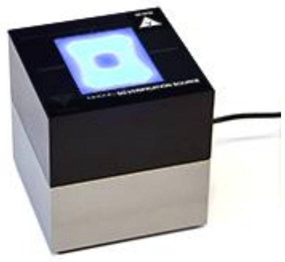
3.2.3 Data Acquisition Electronics (DAE)

Model	DAE3, DAE4
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset Voltage	< 5µV (with auto zero)
Input Bias Current	< 50 fA
Dimensions	60 x 60 x 68 mm

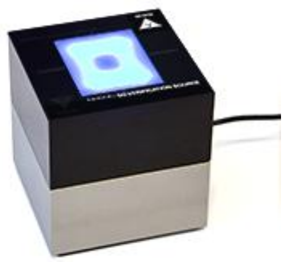
3.2.4 System Verification Sources

System verification device consists of a horn antenna with corresponding gun oscillator packaged within a cube-shaped housing and power supply provided.

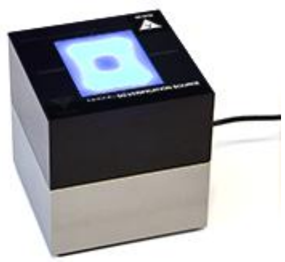
Model	System Verification for Ka-band
Calibrated Frequency	30 GHz at 10mm from the case surface
Frequency Accuracy	± 100 MHz
E-field Polarization	Linear
Harmonics	-20 dBc
Total Radiated Power	14 dBm
Power Stability	0.05 dB
Power Consumption	5 W
Size	100 x 100 x 100 mm
Weight	1 kg



Model	System Verification for V-band
Calibrated Frequency	60 GHz at 10mm from the case surface
Frequency Accuracy	± 100 MHz
E-field Polarization	Linear
Harmonics	-20 dBc
Total Radiated Power	20 dBm
Power Stability	0.1 dB
Power Consumption	5 W
Size	100 x 100 x 100 mm
Weight	1 kg



Model	System Verification for W-band
Calibrated Frequency	90 GHz at 10mm from the case surface
Frequency Accuracy	± 150 MHz
E-field Polarization	Linear
Harmonics	-20 dBc
Total Radiated Power	16 dBm
Power Stability	0.15 dB
Power Consumption	5 W
Size	100 x 100 x 100 mm
Weight	1 kg



3.3 Power Density System Verification

System check provides a fast and reliable method to routinely verify that the measurement system is operational with no system component failures, including probe defects, drifts or deviation from target performance requirements. A system check also verifies the repeatability of the measurement system before compliance testing.

The measurement of a verification source is started from 5G probe installed and the phantom taught. The verification source is placed on the 5G phantom. Due to the internal distance from the horn to the outer surface of the verification source, the measurement distance set in the software should be offset by -4.45 mm; e.g., for measurement of the verification source at 10 mm, the measurement distance set in the software should be 5.55 mm (10mm - 4.45 mm).

The system check is a complete measurement using simple well-defined reference sources. The system check is successful if the measured results are within ±10 % tolerances to the target value shown in the calibration certificate of the verification source. The instrumentation and procedures used for system check should ensure the system is ready for performing compliance tests.

Frequency [GHz]	Grid Step	Grid Extent X/Y [mm]	Measurement Points
10	0.25 (λ /4)	120 / 120	16 x 16
30	0.25 (λ /4)	60 / 60	24 x 24
60	0.25 (λ /4)	32.5 / 32.5	26 x 26
90	0.25 (λ /4)	30 / 30	36 x 36

Table-3.1 Settings for Measurement of Verification Sources

Fig-3.3 System Verification Setup

3.4 Power Density Measurement Procedure

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. When the measurement surface does not correspond to the evaluation surface, reconstruction algorithms are necessary to project or transform the fields from the measurement surface to the evaluation surface. The general measurement approach is summarized in following:

(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. The requirements of measurement surface dimensions and spatial resolution are dependent on the measurement system and assessment methodology applied. 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. When measurements are acquired in regions where evanescent modes are not negligible, smaller spatial resolution may be required. Similar criteria also apply to cylindrical scanning systems where the spatial resolution in the vertical direction should be less than λ / 2.

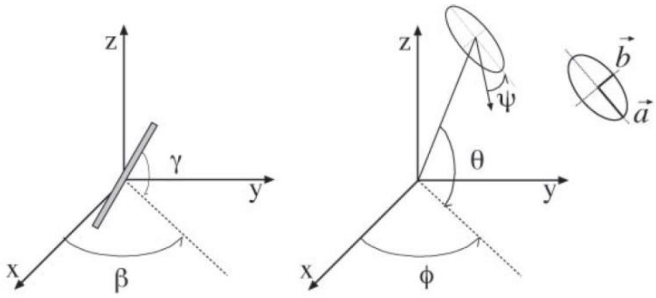
(d) Since only E-field is measured on the measurement system, the H-field is calculated from the measured field using a reconstruction algorithm. As power density requires knowledge of both amplitude and phase, reconstruction algorithms can also be used to obtain field information from the measured data (e.g. the phase from the amplitude if only the amplitude is measured). The measurement involves two planes with three different probe rotations on two measurement planes separated by λ / 4. The grid steps are optimized by the software based on the test frequency. The location of the lowest measurement plane is defined by the distance of first measurement layer from device under test entered by the user. In addition, when the measurement surface does not correspond to the evaluation surface, reconstruction algorithms are employed to project or transform the fields from the measurement surface to the evaluation surface. 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 E- and H-field (amplitude and phase) on the evaluation surface.

(e) 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.

(f) 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 (f). 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.

3.4.1 Computation of the Electric Field Polarization Ellipse

For the numerical description of an arbitrarily oriented ellipse in three-dimensional space, five parameters are needed: the semi-major axis (a), the semi-minor axis (b), two angles describing the orientation of the normal vector of the ellipse (Φ, θ), and one angle describing the tilt of the semi-major axis (ψ). For the two extreme cases, i.e., circular and linear polarizations, three parameters only (a, Φ, and θ) are sufficient for the description of the incident field.



For the reconstruction of the ellipse parameters from measured data, the problem can be reformulated as a nonlinear search problem. The semi-major and semi-minor axes of an elliptical field can be expressed as functions of the three angles (Φ, θ, and ψ). The parameters can be uniquely determined towards minimizing the error based on least-squares for the given set of angles and the measured data. In this way, the number of free parameters is reduced from five to three, which means that at least three sensor readings are necessary to gain sufficient information for the reconstruction of the ellipse parameters. However, to suppress the noise and increase the reconstruction accuracy, it is desirable that the system of equations be over-determined. The solution use a probe consisting of two sensors angled by γ_1 and γ_2 toward the probe axis and to perform measurements at three angular positions of the probe, i.e., at β_1, β_2, and β_3, results in over-determinations by a factor of two. If there is a need for more information or increased accuracy, more rotation angles can be added.

The reconstruction of the ellipse parameters can be separated into linear and non-linear parts that are best solved by the givens algorithm combined with a downhill simplex algorithm. To minimize the mutual coupling, sensor angles are set with a shift of 90° ($\gamma_2 = \gamma_1 + 90°$), and, to simplify, the first rotation angle of the probe (β_1) can be set to 0°.

3.4.2 Total Field and Power Flux Density Reconstruction

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 EUmmWV2 probe. This reconstruction algorithm, together with the ability of the probe to measure extremely close to the source without perturbing the field, permits reconstruction of the E- and H-fields, as well as of the power density, on measurement planes located as near as λ / 5 away.

3.4.3 Power Flux Density Averaging

The average of the reconstructed power density is evaluated over a circular area in each measurement plane. The area of the circle is defined by the user; the default is 1 cm^2. The computed peak average value is displayed in the box at the top right. Note that the average is evaluated only for grid points where the averaging circle is completely filled with values; for points at the edge where the averaging circle is only partly filled with values, the average power density is set to zero. Two average power density values are computed:

1) $|\mathrm{Re}(S)|$ is the average total power density.
2) $\vec{n} \cdot \mathrm{Re}(S)$ is the average incident power density.

4. Power Density Measurement Evaluation

4.1 EUT Configuration and Setting

The 5G NR signal in this device under test was configured by engineering testing software of QRCT (Qualcomm Radio Control Tool) provided by manufacturer that can be used to set the relevant 5G radio parameters such as Tx carrier, RFM device, polarization, Tx band, channel, bandwidth, Tx mode, modulation, output power, RB allocation etc. which can provide continuous transmitting RF signal. During power density testing, this device was operated to transmit continuously at the 100 % transmission duty with specified transmission mode, operating frequency, and maximum output power.

4.2 EUT Testing Position

According to the guidance in KDB 941225 D06, the test separation distance was considered as 10 mm for wireless router device and its dimension is larger than 9 x 5 cm.

The array antenna module 2 is located on the right side of the device. The power density measurement was performed on the right side for all 3 modulations with lowest, mid and highest channels on both polarization of horizontal and vertical. The adjacent surfaces to module 2 antenna location as front face, rear face and bottom side was verified using worst-configuration with highest power density on right side to confirm all exposure conditions have been considered for compliance.

4.3 System Verification

The measuring result for system verification is tabulated as below.

Test Date	Frequency [GHz]	mmWave Probe S/N	Verification Source S/N	Averaging Area [cm^2]	Distance [mm]	Target Power Density [W/m^2]	Measured Power Density [W/m^2]	Deviation [%]
Dec. 13, 2018	30	9361	1016	4	10.0	35.8	36.4	1.68%
Dec. 14, 2018	30	9361	1016	4	10.0	35.8	35.6	-0.56%
Dec. 15, 2018	30	9361	1016	4	10.0	35.8	35.4	-1.12%

Note:

Comparing to the reference value provided by SPEAG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

4.4 Power Density Testing Results

4.4.1 Test Considerations

1. The radio configurations of maximum output power found in part 30 RF report as 1CC, BW 100 MHz, SCS 120 kHz, and maximum power setting was used to set the EUT during the power density testing, and the RB allocation marked as bold in below table for each modulation with highest EIRP measured in RF chamber was chosen for power density testing accordingly.

5G NR module	2	Polarization	Horizontal	5G NR module	2	Polarization	Vertical
Modulation	Channel	RB# / Offset	EIRP [dBm]	Modulation	Channel	RB# / Offset	EIRP [dBm]
QPSK	2239991	1RB / 0	14.96	QPSK	2239991	1RB / 0	14.97
	2260003	1RB / 0	14.87		2260003	1RB / 0	14.89
	2278337	1RB / 0	14.67		2278337	1RB / 0	14.73
QPSK	2239991	**1RB / 32**	**14.97**	QPSK	2239991	**1RB / 32**	**14.98**
	2260003	1RB / 32	14.83		2260003	1RB / 32	14.93
	2278337	1RB / 32	14.76		2278337	1RB / 32	14.92
QPSK	2239991	1RB / 65	14.92	QPSK	2239991	1RB / 65	14.98
	2260003	1RB / 65	14.84		2260003	1RB / 65	14.93
	2278337	1RB / 65	13.99		2278337	1RB / 65	14.77
16QAM	2239991	1RB / 0	14.82	16QAM	2239991	1RB / 0	14.83
	2260003	1RB / 0	14.52		2260003	1RB / 0	14.62
	2278337	1RB / 0	14.63		2278337	1RB / 0	14.84
16QAM	2239991	**1RB / 32**	**14.83**	16QAM	2239991	1RB / 32	14.83
	2260003	1RB / 32	14.63		2260003	**1RB / 32**	**14.85**
	2278337	1RB / 32	14.64		2278337	1RB / 32	14.67
16QAM	2239991	1RB / 65	14.73	16QAM	2239991	1RB / 65	14.79
	2260003	1RB / 65	14.82		2260003	1RB / 65	14.85
	2278337	1RB / 65	13.93		2278337	1RB / 65	14.13
64QAM	2239991	1RB / 0	14.78	64QAM	2239991	1RB / 0	14.79
	2260003	1RB / 0	14.83		2260003	1RB / 0	14.86
	2278337	1RB / 0	13.63		2278337	1RB / 0	14.33
64QAM	2239991	1RB / 32	14.73	64QAM	2239991	1RB / 32	14.85
	2260003	1RB / 32	14.83		2260003	1RB / 32	14.83
	2278337	1RB / 32	14.50		2278337	1RB / 32	14.60
64QAM	2239991	**1RB / 65**	**14.85**	64QAM	2239991	**1RB / 65**	**14.89**
	2260003	1RB / 65	14.75		2260003	1RB / 65	14.75
	2278337	1RB / 65	13.38		2278337	1RB / 65	14.34

2. The power density measurement was performed at the 10 mm separation distance due to its form factor per KDB 941225 D06.
3. The dipole array antenna of module 2 has been disabled. Only patch array antenna of module 2 has been tested. Module 1 and module 3 have been disabled. None of the modules are user-accessible. Please refer to Appendix D for antenna module location and test setup position.
4. Both horizontal and vertical polarization have been tested and are generated using patch array antenna configurations of module 2.
5. The antenna location on right side has been fully tested for all 3 modulations, 3 required channels and 2 polarizations due to it is major radiation direction of module 2. These are all the configurations the device will operate in. The adjacent surfaces as front face, rear face and bottom side have been verified using worst configuration of right side for compliance consideration.

6. The test duty cycle was 100 % to facilitate test measurements only. It was confirmed by the manufacturer that the device was not over driven at this test duty cycle, to facilitate linear scaling in the test report. The power density results were scaled down from the test software duty cycle of 100 % to the final production duty cycle of 25 % to demonstrate compliance. Letter of attestation from the network operator indicating it will not schedule more than 25 % UL for the life of the device is listed on Appendix E.

4.4.2 Power Density Test Results

Plot No.	Band	Modulation	Test Position	Channel	Frequency [MHz]	RB# / Offset	Antenna Module	Polarization	Averaging Area [cm²]	Avg- Incident Power Density [W/m²]	Avg-Total Power Density [W/m²]	Power Drift [dB]	Test Duty Cycle [%]	Production Duty Cycle [%]	Duty Cycle Factor	Scaled Avg-Total P.D. [W/m²]
	5G NR n260	QPSK	Right Side	2239991	37649.52	1 / 32	2	H	4	0.686	0.709	0.10	100.0	25.0	0.25	0.18
	5G NR n260	QPSK	Right Side	2260003	38850.24	1 / 32	2	H	4	1.35	1.42	-0.02	100.0	25.0	0.25	0.36
	5G NR n260	QPSK	Right Side	2278337	39950.28	1 / 32	2	H	4	1.36	1.48	0.13	100.0	25.0	0.25	0.37
	5G NR n260	16QAM	Right Side	2239991	37649.52	1 / 32	2	H	4	1.02	1.08	0.18	100.0	25.0	0.25	0.27
	5G NR n260	16QAM	Right Side	2260003	38850.24	1 / 32	2	H	4	1.04	1.11	0.17	100.0	25.0	0.25	0.28
01	5G NR n260	16QAM	Right Side	2278337	39950.28	1 / 32	2	H	4	1.41	1.52	0.01	100.0	25.0	0.25	0.38
	5G NR n260	64QAM	Right Side	2239991	37649.52	1 / 65	2	H	4	0.928	0.981	0.05	100.0	25.0	0.25	0.25
	5G NR n260	64QAM	Right Side	2260003	38850.24	1 / 65	2	H	4	1.04	1.07	0.10	100.0	25.0	0.25	0.27
	5G NR n260	64QAM	Right Side	2278337	39950.28	1 / 65	2	H	4	1.20	1.29	0.13	100.0	25.0	0.25	0.32
	5G NR n260	QPSK	Right Side	2239991	37649.52	1 / 32	2	V	4	0.794	0.852	-0.13	100.0	25.0	0.25	0.21
	5G NR n260	QPSK	Right Side	2260003	38850.24	1 / 32	2	V	4	0.870	0.940	0.14	100.0	25.0	0.25	0.24
	5G NR n260	QPSK	Right Side	2278337	39950.28	1 / 32	2	V	4	1.22	1.30	0.05	100.0	25.0	0.25	0.33
	5G NR n260	16QAM	Right Side	2239991	37649.52	1 / 32	2	V	4	0.765	0.826	0.18	100.0	25.0	0.25	0.21
	5G NR n260	16QAM	Right Side	2260003	38850.24	1 / 32	2	V	4	0.877	0.934	0.13	100.0	25.0	0.25	0.23
	5G NR n260	16QAM	Right Side	2278337	39950.28	1 / 32	2	V	4	1.23	1.32	0.11	100.0	25.0	0.25	0.33
	5G NR n260	64QAM	Right Side	2239991	37649.52	1 / 65	2	V	4	0.715	0.774	0.10	100.0	25.0	0.25	0.19
	5G NR n260	64QAM	Right Side	2260003	38850.24	1 / 65	2	V	4	0.800	0.857	0.11	100.0	25.0	0.25	0.21
	5G NR n260	64QAM	Right Side	2278337	39950.28	1 / 65	2	V	4	1.27	1.36	0.03	100.0	25.0	0.25	0.34
	5G NR n260	16QAM	Front Face	2278337	39950.28	1 / 32	2	H	4	0.390	0.443	-0.17	100.0	25.0	0.25	0.11
	5G NR n260	16QAM	Rear Face	2278337	39950.28	1 / 32	2	H	4	0.105	0.113	-0.07	100.0	25.0	0.25	0.03
	5G NR n260	16QAM	Bottom Side	2278337	39950.28	1 / 32	2	H	4	0.020	0.029	-0.12	100.0	25.0	0.25	0.01

4.4.3 Simultaneous Transmission Evaluation

<Possibilities of Simultaneous Transmission>

The simultaneous transmission possibilities for this device are listed as below.

Simultaneous TX Combination	Capable Transmit Configurations	Hotspot Exposure Condition
1	LTE + WLAN 2.4G	Yes
2	LTE + WLAN 5G	Yes
3	LTE + 5G NR + WLAN 2.4G	Yes
4	LTE + 5G NR + WLAN 5G	Yes

<Total Exposure Ratio Analysis>

The fields generated by the antennas can be correlated or uncorrelated. At different frequencies, fields are always uncorrelated, and the aggregate power density contributions can be summed according to spatially averaged values of corresponding sources at any point in space, r, to determine the total exposure ratio (TER). Assuming I sources, the TER at each point in space is equal to

$$\mathrm{TER}^{\mathrm{uncorr}}(\mathrm{r}) = \sum_{\mathrm{i}=1}^{\mathrm{I}} \mathrm{ER}_{\mathrm{i}} = \sum_{\mathrm{i}=1}^{\mathrm{I}} \frac{\mathrm{S}_{\mathrm{av,i}}(\mathrm{r}, \mathrm{f}_{\mathrm{i}})}{\mathrm{S}_{\mathrm{lim}}(\mathrm{f}_{\mathrm{i}})}$$

where $S_{av,i}$ is the power density for the source i operating at a frequency f_i, and S_{lim} is the power density limit as specified by the relevant standard.

Exposure from transmitters operating above and below 6 GHz, where 6 GHz denotes the transition frequency where the basic restrictions change from being defined in terms of SAR to being defined in terms of power density, are therefore uncorrelated and the TER is determined as

$$\mathrm{TER}^{\mathrm{uncorr}}(\mathrm{r}) = \mathrm{TER}(\mathrm{r})_{\mathrm{f} \leq 6\mathrm{GHz}} + \mathrm{TER}(\mathrm{r})_{\mathrm{f} > 6GHz}$$

According to the FCC guidance in Oct 2018 TCBC workshop and IEC TR 63170, the total exposure ratio calculated by taking ratio of maximum reported SAR divided by SAR limit and adding it to maximum measured power density divided by power density limit. Numerical sum of the ratios should be less than 1. The TER analysis for this device is listed as below.

Items	Maximum SAR / PD	Relevant Limit	Exposure Ratio
Exposure Ratio 1 LTE	1.16 W/kg	1.6 W/kg	0.725
Exposure Ratio 2 5G NR	0.38 W/m^2	10 W/m^2	0.038
Exposure Ratio 3 WLAN	0.13 W/kg	1.6 W/kg	0.081
Total Exposure Ratio (< 1)			**0.844**

Note: The SAR evaluation for LTE and WLAN was assessed in separate SAR report (by BVADT, report number SA181015C09), and the maximum SAR value here referred from that SAR report.

Test Engineer： Raymond Wu and Eric Wu

5. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
E-Field Probe	SPEAG	EUmmWV3	9361	Oct. 12, 2018	1 Year
System Verification Source	SPEAG	5G Verification Source 30 GHz	1016	Oct. 02, 2018	1 Year
Data Acquisition Electronics	SPEAG	DAE4	861	May 30, 2018	1 Year
cDASY6 Module mmWave Software	SPEAG	V1.4.0.14682	N/A	N/A	N/A

6. Measurement Uncertainty

Source of Uncertainty	Uncertainty (± dB)	Probability Distribution	Divisor	Ci	Standard Uncertainty (± dB)	Vi
Measurement System						
Probe Calibration	0.49	Normal	1	1	0.49	∞
Hemispherical Isotropy	0.50	Rectangular	√3	1	0.29	∞
Linearity	0.20	Rectangular	√3	1	0.12	∞
System Detection Limits	0.04	Rectangular	√3	1	0.02	∞
Modulation Response	0.40	Rectangular	√3	1	0.23	∞
Readout Electronics	0.03	Normal	1	1	0.03	∞
Response Time	0.00	Rectangular	√3	1	0.00	∞
Integration Time	0.00	Rectangular	√3	1	0.00	∞
RF Ambient Conditions – Noise	0.20	Rectangular	√3	1	0.12	∞
RF Ambient Conditions – Reflections	0.20	Rectangular	√3	1	0.12	∞
Probe Positioner Mechanical Tolerance	0.04	Rectangular	√3	1	0.02	∞
Probe Positioning with Respect to Phantom	0.30	Rectangular	√3	1	0.17	∞
S_{avg} Reconstruction	0.60	Rectangular	√3	1	0.35	∞
Test Sample Related						
Power Drift of Measurement	0.20	Rectangular	√3	1	0.12	∞
Input Power	0.00	Normal	1	1	0.00	∞
Combined Standard Uncertainty					± 0.76	
Expanded Uncertainty (K=2)					**± 1.52**	

Uncertainty Budget for mmWave Power Density Measurement

7. Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Taiwan HwaYa EMC/RF/Safety/Telecom Lab:
Add: No. 19, Hwa Ya 2nd Rd, Wen Hwa Vil., Kwei Shan Hsiang, Taoyuan Hsien 333, Taiwan, R.O.C.
Tel: 886-3-318-3232
Fax: 886-3-327-0892

Taiwan LinKo EMC/RF Lab:
Add: No. 47-2, 14th Ling, Chia Pau Vil., Linkou Dist., New Taipei City 244, Taiwan, R.O.C.
Tel: 886-2-2605-2180
Fax: 886-2-2605-1924

Taiwan HsinChu EMC/RF Lab:
Add: E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 30078, Taiwan, R.O.C.
Tel: 886-3-593-5343
Fax: 886-3-593-5342

Email: service.adt@tw.bureauveritas.com
Web Site: www.bureauveritas-adt.com

The road map of all our labs can be found in our web site also.

---END---

Appendix A. Plots of System Verification

The plots for system verification with largest deviation for each system combination are shown as follows.

Test Lab: Bureau Veritas ADT SAR/HAC/PD Testing Lab

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
SPEAG, 5G Verification Source 30 GHz	100.0x 100.0x100.0	SN: 1016	Verification Source

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5GAir	FRONT, 5.55	Validation band	CW	30000.0	1.0

Hardware Setup

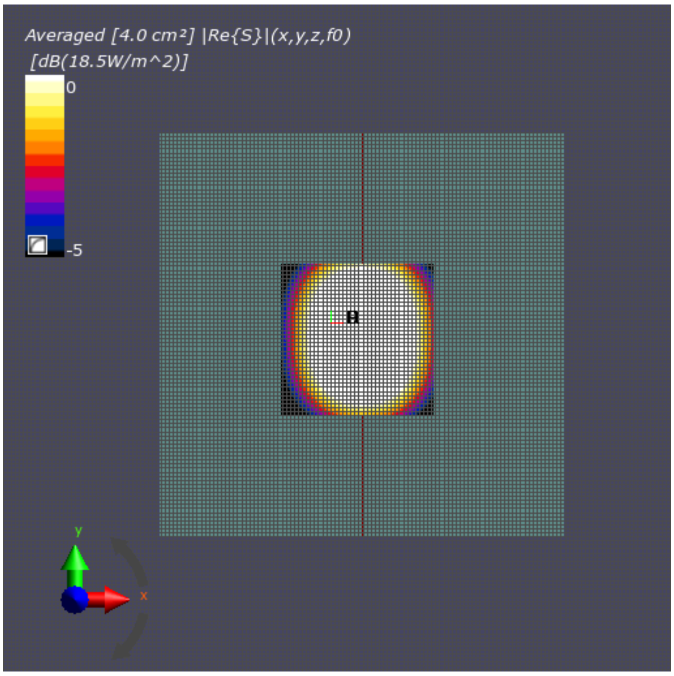
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
5G Cover- 015025	--Air-	EUmmWV3 - SN9361, 2018-10-12	DAE4 Sn861, 2018-05-30

Scan Setup

	5G Scan
Grid Extents [mm]	60.0x 60.0
Grid Steps [lambda]	0.25x 0.25
Sensor Surface [mm]	5.55

Measurement Results

	5G Scan
Date	2018-12-13
Avg. Area [cm^2]	4.00
$pS_{tot}avg[W/m^2]$	36.4
pS_navg [W/m^2]	35.9
E_{peak} [V/m]	138
Power Drift [dB]	0.02



Appendix B. Plots of Power Density Measurement

The plots for highest maximum averaged power density in each exposure configuration, wireless mode and frequency band combination are shown as follows.

Test Lab: Bureau Veritas ADT SAR/HAC/PD Testing Lab

Power Density Plot No.: 01

5G NR n260, 1CC, BW 100 MHz, SCS 120 kHz, 16QAM, 1RB, 32 Offset, ANT2, Horizontal, CH2278337

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
181015C09	130.0x 10.0x125.0		Hotspot

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5GAir	Right Side, 10.00	n260	-	39950.28	1.0

Hardware Setup

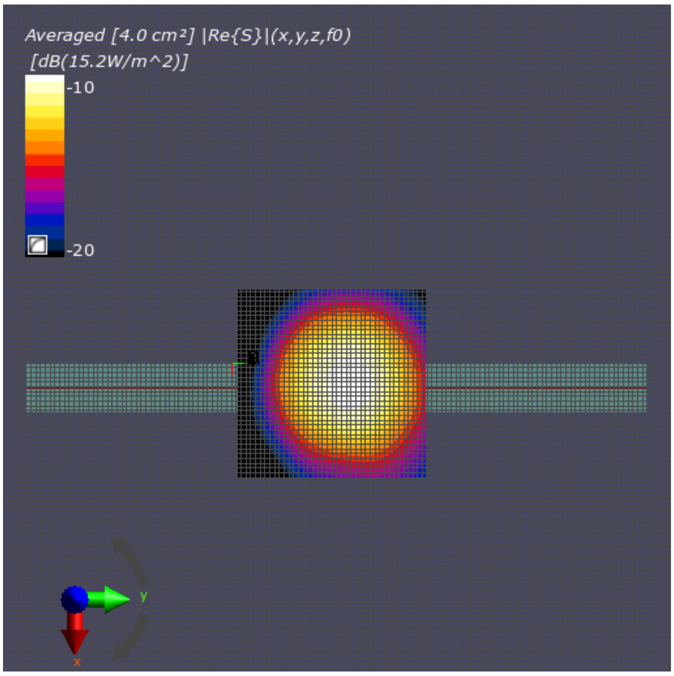
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
5G Cover- 015025	--Air-	EUmmWV3 - SN9361, 2018-10-12	DAE4 Sn861, 2018-05-30

Scan Setup

	5G Scan
Grid Extents [mm]	60.0x 60.0
Grid Steps [lambda]	0.25x 0.25
Sensor Surface [mm]	10.0

Measurement Results

	5G Scan
Date	2018-12-14
Avg. Area [cm^2]	4.00
$pS_{tot}avg$[W/m^2]	1.52
$pS_{n}avg$ [W/m^2]	1.41
E_{peak} [V/m]	32.5
Power Drift [dB]	0.01



Appendix C. Calibration Certificate for Probe and System Verification Source

The SPEAG calibration certificates are shown as follows.

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client **BV ADT (Auden)**

Certificate No: EUmmWV3-9361_Oct18

CALIBRATION CERTIFICATE

Object	EUmmWV3 - SN:9361
Calibration procedure(s)	QA CAL-02.v8, QA CAL-25.v6, QA CAL-42.v2 Calibration procedure for E-field probes optimized for close near field evaluations in air
Calibration date:	October 12, 2018

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-18 (No. 217-02682)	Apr-19
Reference Probe ER3DV6	SN: 2328	09-Oct-18 (No. ER3-2328_Oct18)	Oct-19
DAE4	SN: 789	07-Aug-18 (No. DAE4-789_Aug18)	Aug-19
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-18)	In house check: Oct-19

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: October 16, 2018

Glossary:

NORMx,y,z	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system
Sensor Angles	sensor deviation from the probe axis, used to calculate the field orientation and polarization
k	is the wave propagation direction

Calibration is Performed According to the Following Standards:

a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 for XY sensors and ϑ = 90 for Z sensor (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). For frequencies > 6 GHz, the far field in front of waveguide horn antennas is measured for a set of frequencies in various waveguide bands up to 110 GHz.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- The frequency sensor model parameters are determined prior to calibration based on a frequency sweep (sensor model involving resistors R, R_p, inductance L and capacitors C, C_p).
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z*: *A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *Sensor Offset*: The sensor offset corresponds to the mechanical from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).
- *Equivalent Sensor Angle*: The two probe sensors are mounted in the same plane at different angles. The angles are assessed using the information gained by determining the *NORMx* (no uncertainty required).
- *Spherical isotropy (3D deviation from isotropy)*: in a locally homogeneous field realized using an open waveguide / horn setup.

DASY - Parameters of Probe: EUmmWV3 - SN:9361

Basic Calibration Parameters

	Sensor X	Sensor Y	Unc (k=2)
Norm (µV/(V/m)^2)	0.02131	0.02392	± 10.1 %
DCP (mV)[B]	113.0	98.0	
Equivalent Sensor Angle	-58.1	31.3	

Calibration results for Frequency Response (25 – 110 GHz)

Frequency GHz	Target E-Field V/m	Deviation Sensor X dB	Deviation Sensor Y dB	Unc (k=2) dB
26.6	96.89	0.27	0.28	± 0.98 dB
30	92.55	0.32	0.24	± 0.98 dB
35	93.71	-0.11	0.03	± 0.98 dB
40	91.46	0.00	-0.27	± 0.98 dB
50	19.62	0.42	0.41	± 0.98 dB
55	22.38	0.56	0.37	± 0.98 dB
60	23.03	-0.02	-0.03	± 0.98 dB
65	27.40	-0.10	-0.13	± 0.98 dB
70	23.95	-0.09	-0.21	± 0.98 dB
75	19.61	-0.53	-0.44	± 0.98 dB
75	14.11	-0.31	-0.15	± 0.98 dB
80	21.51	-0.19	-0.08	± 0.98 dB
85	22.75	0.14	0.15	± 0.98 dB
90	23.84	0.07	0.22	± 0.98 dB
92	23.93	0.07	0.02	± 0.98 dB
95	20.55	0.14	0.04	± 0.98 dB
97	24.41	0.13	0.04	± 0.98 dB
100	22.61	0.12	0.08	± 0.98 dB
105	22.75	-0.05	-0.02	± 0.98 dB
110	18.85	-0.37	-0.26	± 0.98 dB

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√µV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	123.8	+ 3.5 %	± 4.7 %
		Y	0.0	0.0	1.0		59.4		

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[B] Numerical linearization parameter: uncertainty not required.

[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY - Parameters of Probe: EUmmWV3 - SN:9361

Sensor Frequency Model Parameters

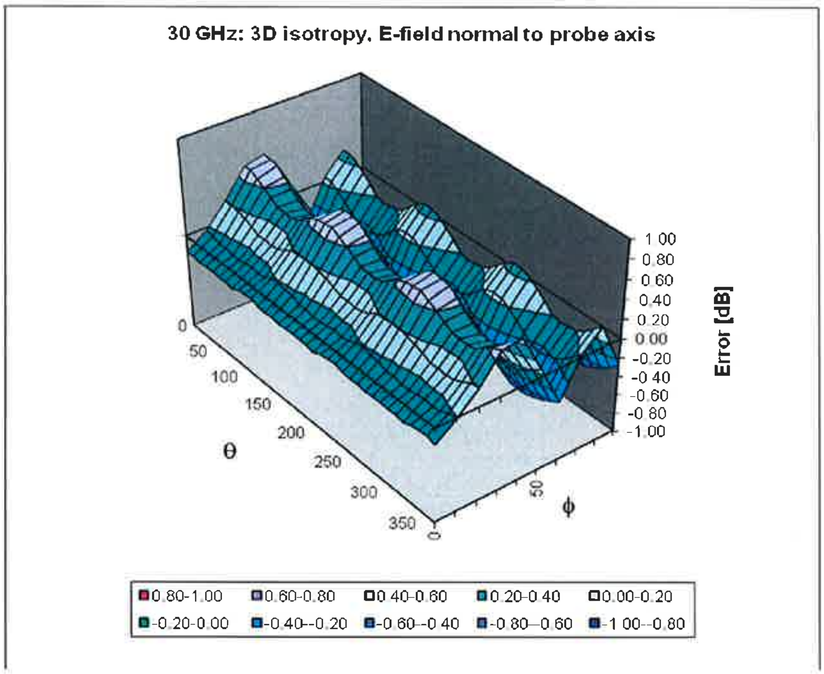
	Sensor X	Sensor Y
R (Ω)	40.89	43.40
R_p (Ω)	95.03	91.33
L (nH)	0.03127	0.03162
C (pF)	0.2392	0.2687
C_p (pF)	0.1263	0.1182

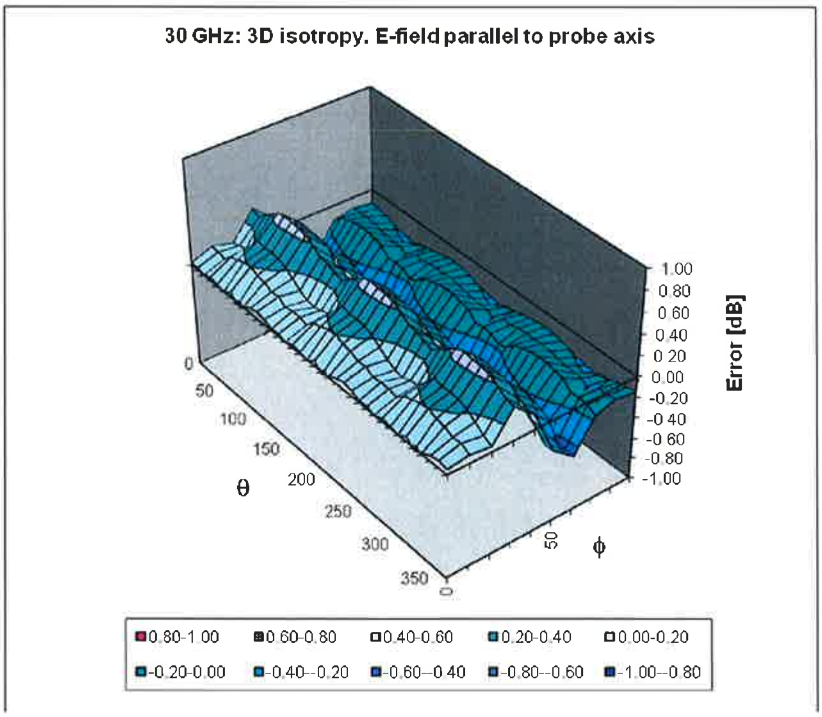
Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	-5.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	320 mm
Probe Body Diameter	8 mm
Tip Length	23 mm
Tip Diameter	8.0 mm
Probe Tip to Sensor X Calibration Point	1.5 mm
Probe Tip to Sensor Y Calibration Point	1.5 mm

Deviation from Isotropy in Air

f = 30 GHz





Probe isotropy for E_{tot}: probe rotated φ = 0° to 360°, tilted from field propagation direction $\vec{k}$
Parallel to the field propagation (ψ =0° - 90°): deviation within ± 0.47 dB
Normal to field orientation (ϑ =0° - 90°): deviation within ± 0.53 dB

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client **BV ADT (Auden)**

Certificate No: 5G-Veri30-1016_Oct18

CALIBRATION CERTIFICATE

Object	5G Verification Source 30 GHz – SN: 1016
Calibration procedure(s)	QA CAL-45.v2 Calibration procedure for sources in air above 6 GHz
Calibration date:	October 02, 2018

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Reference Probe EUmmWV3	SN: 9374	23-Mar-18 (No. EUmmWV3-9374_Mar18)	Mar-19
DAE4	SN: 1215	26-Feb-18 (No. DAE4-1215_Feb18)	Feb-19

Secondary Standards	ID #	Check Date (in house)	Scheduled Check

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: October 13, 2018

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Glossary

CW Continuous wave

Calibration is Performed According to the Following Standards

- Internal procedure QA CAL-45-5Gsources
- IEC TR 63170 ED1, "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", January 2018
- S. Pfeifer et al. Total Field Reconstruction in the Near Field Using Pseudo-Vector E-Field Measurements, *IEEE Transactions on Electromagnetic Compatibility*, TEMC.2018.2837897

Methods Applied and Interpretation of Parameters

- *Coordinate System:* z-axis in the waveguide horn boresight, x-axis is in the direction of the E-field, y-axis normal to the others in the field scanning plane parallel to the horn flare and horn flange.
- *Measurement Conditions: (1) 10 GHz:* The forward power to the horn antenna is measured prior and after the measurement with a power sensor. During the measurements, the horn is directly connected to the cable considering the 0.4dB horn loss. (2) 30, 60 and 90 GHz: The verification sources are switched on for at least 30 minutes. Absorbers are used around the probe cub and at the ceiling to minimize reflections.
- *Horn Positioning:* The waveguide horn is mounted vertically on the flange of the waveguide source to allow vertical positioning of the EUmmW probe during the scan. The plane is parallel to the phantom surface. Probe distance is verified using mechanical gauges positioned on the flare of the horn.
- *E- field distribution:* E field is measured in two x-y-plane (10mm, 10mm + λ/4) with a vectorial E-field probe. The E-field value stated as calibration value represents the E-field-maxima.
- *Power Density:* The power density values averaged over 1cm^2 and 4cm^2 at 10mm in front of the horn are reconstructed from the E-field according to TEMC.2018.2837897.
- *Field polarization:* Above the open horn, linear polarization of the field is expected. This is verified graphically in the field representation.

Calibrated Quantity

- Local peak E-field (V/m) and peak values of the total and normal component of the poynting vector |Re{S}| and n.Re{S} averaged over the surface area of 1 cm^2 ($pS_{tot}avg1cm^2$ and $pS_{n}avg1cm^2$) and 4cm^2 ($pS_{tot}avg4cm^2$ and $pS_{n}avg4cm^2$) at the nominal operational frequency of the verification source.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	cDASY6 Module mmWave	V1.4
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
XY Scan Resolution	dx, dy = 2.5 mm	
Number of measured planes	2 (10mm, 10mm + λ/4)	
Frequency	30 GHz ± 10 MHz	

Calibration Parameters, 30 GHz

Distance Horn Aperture to Measured Plane	***Prad***[1] ***(mW)***	**Max E-field (V/m)**	Uncertainty (k = 2)	Avg Power Density n.Re{S}, |Re{S}| (W/m2)		Uncertainty (k = 2)
				1 cm^2	**4** cm^2	
10 mm	34.7	**127**	1.27 dB	**39.9, 40.3**	**35.3, 35.8**	1.28 dB

[1] derived from far-field data

DASY Report

Measurement Report for 5G Verification Source 30 GHz, UID 0 -, Channel 30000 (30000.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 30 GHz	100.0 x 100.0 x 100.0	SN: 1016	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group,	Frequency [MHz], Channel Number	Conversion Factor
5G -	5.55 mm	Validation band	CW	30000.0, 30000	1.0

Hardware Setup

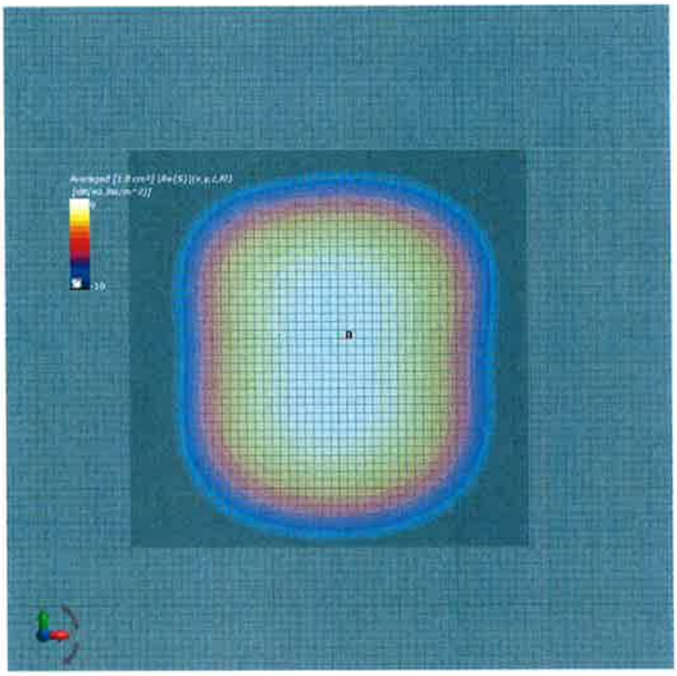
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
5G Phantom	Air	EUmmWV3 - SN9374, 2018-03-23	DAE4 Sn1215, 2018-02-26

Scan Setup

	5G Scan
Grid Extents [mm]	60.0 x 60.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	5.55
MAIA	MAIA not used

Measurement Results

	5G Scan
Date	2018-10-02, 10:39
Avg. Area [cm²]	1.00
pS_{tot} avg [W/m²]	40.3
pS_n avg [W/m²]	39.9
E_{peak} [V/m]	133
Power Drift [dB]	-0.08



Appendix E. Attestation Letter for Uplink Duty Cycle

Gordon Mansfield
Vice President
Converged Access & Device Design

AT&T Services, Inc.
1057 Lenox Park Blvd
Atlanta GA 30319

470.773.5953 office
Wm7666@att.com

October 3rd, 2018

To whom it may concern:

AT&T confirms that the Netgear M5f UE (User Equipment) will operate on its 5G network with a configuration of 3:1 DL: UL ratio, i.e., the highest Uplink duty cycle is 25% for the lifetime of this device.

Sincerely,

Gordon Mansfield
Vice President – Converged Access & Device Design
AT&T