POWER DENSITY EVALUATION REPORT

FCC 47 CFR § 2.1093

For
Radio Module
(Tested inside of Panasonic Tablet PC FZ-G2mk2)

FCC ID: ACJ9TGWL22A
Model Name: WL22A

Report Number: R14206457-S5V3
Issue Date: 2022-09-01

Prepared for
Panasonic Corporation of North America
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ACCREDITED
CERT #0751.06

REVISION HISTORY

Rev.	Date	Revisions	Revised By
V1	2022-08-23	Initial Issue	--
V2	2022-08-25	Updated FCC ID to ACJ9TGWL22A, and model to WL22A	Richard Jankovics
V3	2022-09-01	Updated Battery Cover description in § 6.1	Richard Jankovics

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1. Attestation of Test Results

Applicant Name	Panasonic Corporation of North America 2 Riverfront Plaza, 9th Floor Newark, NJ, 07102-5940, USA	
FCC ID	ACJ9TGWL22A	
Model Name	WL22A	
Applicable Standards	FCC 47 CFR § 2.1093	
Exposure Category	Radiofrequency (RF) Radiation Exposure (above 6GHz)	
	Uncontrolled (mW/cm^2 over 4 cm^2) 30 min average	Occupational/controlled (mW/cm^2 over 4 cm^2) 6 min average
	1.0	5
Applicable limit	☒ Uncontrolled / ☐ Occupational/controlled	
PD Result (mW/cm^2 over 4cm^2)	0.240	
Simultaneous Result (mW/cm^2)	0.399	
Date Tested	2022-07-07 to 2022-07-08	
Test Results	Pass	

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

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Approved & Released By:	Prepared By:
Dave Weaver Operations Leader UL Verification Services Inc.	Richard Jankovics Operations Leader UL LLC

2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, the following FCC Published RF exposure KDB procedures:

- 447498 D01 General RF Exposure Guidance v06
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02
- SPEAG DASY8 System Handbook; DASY8 Module mmWave
- IEC TR 63170: 2018

In addition to the above, TCB workshop information was used.

- TCB workshop November, 2017; RF Exposure Procedures (Power Density Evaluation)
- TCB workshop October, 2018; RF Exposure Procedures (Millimeter Wave Assessment)
- TCB workshop April, 2019; RF Exposure Procedures (Millimeter Wave RF Exposure Evaluation)
- TCB workshop November, 2019; RF Exposure Procedures (Millimeter Wave Scan Requirements)
- TCB workshop October 2020; RF Exposure Procedures (U NII 6-7 GHz RF Exposure)

3. Facilities and Accreditation

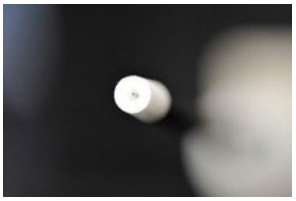
UL LLC is accredited by A2LA, cert. # 0751.06 for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
☐	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
☒	Building: 2800 Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A	US0067	27265	825374

4. Measurement System & Test Equipment

4.1. EUmmWVx / E-Field 5G Probe

E-Field mm-Wave Probe for General Near-Field Measurements

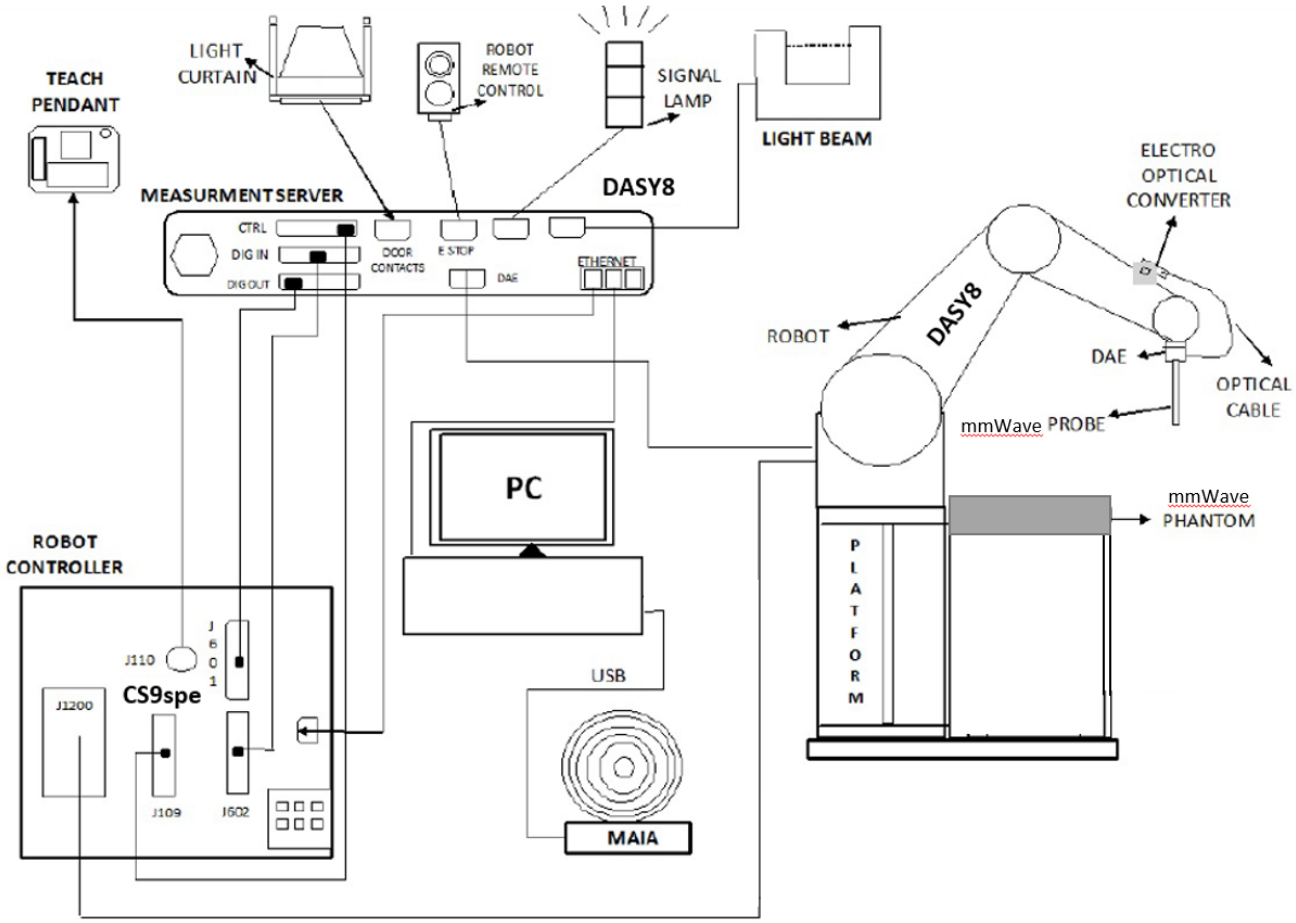
	Two dipoles optimally arranged to obtain pseudo-vector information Minimum 3 measurements/point, 120º rotated around probe axis Sensors (0.8mm length) printed on glass substrate protected by high density foam Low perturbation of the measured field Requires positioner which can do accurate probe rotation
Frequency Range	750 MHz – 110 GHz (EUmmWV4)
Dynamic Range	< 20 V/m – 10 000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm (DASY8)
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 6GHz in < 2 mm distance from device (free-space) Power density, H-field and far-field analysis using total field reconstruction (DASY8 Module mmWave)
Compatibility	DASY8 Module mmWave V3.0.0.841

4.2. Data Acquisition Electronics(DAE)

	Serial optical link for communication with DASY8 embedded system (fully remote controlled) Two-step probe touch detector for mechanical surface detection and emergency robsot stop
Measurement Range	−100 – +300 mV (16 bit resolution and two range settings: 4 mV, 400 mV)
Input Offset Voltage	<5 µV (with auto zero)
Input Resistance	200 Mohm
Input Bias Current	<50 fA
Battery Power	>10 hours of operation (with two 9.6 V NiMH batteries)
Dimensions (L × W × H)	60 × 60 × 68 mm

4.3. Measurement System

The DASY8 system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- The EUmmWVx probe is based on the pseudo-vector probe design, which not only measures the field magnitude but also derives its polarization ellipse.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running Win10 and the DASY8[1] software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom which is specialized for 5G other accessories according to the targeted measurement.

[1] DASY8 software used: DASY mmWave 3.0.0.841 and older generations.

4.4. Measurement Procedures

4.4.1 System Verification Scan Procedures

cDASY6_Module mmWave supports “5G Scan”, a fine resolution scan performed on two different planes which is used to reconstruct the E- and H-fields as well as the power density; the average power density is derived from this measurement.

Step 1: Power Reference Measurement
The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to devise under test.

Step 2: 5G Scan
The steps in the X, Y, and Z directions are specified in terms of fractions of the signal wavelength ,lambda. Area Scan Parameters extracted from SPEAG DASY 6System Handbook; part 4 cDASY6 Module mmWave.

Recommended settings for measurement of verification sources

Frequency [GHz]	Grid step	Grid extent X/Y [mm]	Measurement points
10	0.25 ($\frac{\lambda}{4}$)	120/120	16 × 16
30	0.25 ($\frac{\lambda}{4}$)	60/60	24 × 24
60	0.25 ($\frac{\lambda}{4}$)	31/31	26 × 26
90	0.25 ($\frac{\lambda}{4}$)	29/29	35 × 35

The minimum distance of probe sensors to the verification source surface, horn antenna, is 10 mm for 10 GHz and 5.55mm for 30 GHz and above.

Step 3: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.
When the drift is larger than ± 5 %, test is repeated from step1.

4.4.2 Scan Procedures

Step 1: Power Reference Measurement
Same as System Verification Scan Procedures step 1.

Step 2: 5G Scan
Same as System Verification Scan Procedures step 2. But measurement area is defined based on TCB work shop April 2019, “A sufficiently large measurement region and proper measurement spatial resolution are required to maintain field reconstruction accuracy”.
–Fields at the measurement region boundary should be ~20-30 dB below the peaks

Step 3: Power drift measurement
Same as System Verification Scan Procedures step 3.
When the drift is smaller than ± 5 %, it is considered in the uncertainty budget if drifts larger than 5%, uncertainty is re-calculate.

4.5 Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Signal Generator	Rohde & Schwarz	SMA100B	105115	2023-04-18
Signal Generator	Keysight	N5182B	MY51350128	2023-05-19
Power Meter	Keysight	N1912A	MY55136012	2022-07-16
Power Sensor	Keysight	N1921A	MY55090030	2023-06-15
Power Sensor	Keysight	N1921A	MY55090025	2022-09-07
Directional coupler	Mini-Circuits	ZUDC10-183+	1438	NA

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
E-Field Probe (SAR Lab 6)	SPEAG	EUmmWV4	9619	3/10/2023
Data Acquisition Electronics	SPEAG	DAE4	1715	2/2/2023
10 GHz Verification Source	SPEAG	SM 003 120 AA	1040	3/14/2023

Note(s):

*Equipment not used past calibration due date.

5 Measurement Uncertainty

a	b	c	d f(d,k)	e	f = b×e/d	g
Error Description	Unc.Value (±dB)	Probab. Distri.	Div.	*ci*	Std. Unc. (±dB)	vi
Uncertainty terms dependent on the measurement system						
Calibration	0.49	Normal	1	1	0.49	∞
Probe correction	0	Rectangular	1.732	1	0	∞
Frequency response (BW □ 1 GHz)	0.20	Rectangular	1.732	1	0.12	∞
Sensor cross coupling	0	Rectangular	1.732	1	0	∞
Isotropy	0.50	Rectangular	1.732	1	0.29	∞
Linearity	0.20	Rectangular	1.732	1	0.12	∞
Probe scattering	0	Rectangular	1.732	1	0	∞
Probe positioning o□set	0.30	Rectangular	1.732	1	0.17	∞
Probe positioning repeatability	0.04	Rectangular	1.732	1	0.02	∞
Sensor mechanical o□set	0	Rectangular	1.732	1	0	∞
Probe spatial resolution	0	Rectangular	1.732	1	0	∞
Field impedance dependance	0	Rectangular	1.732	1	0	∞
Amplitude and phase drift	0	Rectangular	1.732	1	0	∞
Amplitude and phase noise	0.04	Rectangular	1.732	1	0.02	∞
Measurement area truncation	0	Rectangular	1.732	1	0	∞
Data acquisition	0.03	Normal	1	1	0.03	∞
Sampling	0	Rectangular	1.732	1	0	∞
Field reconstruction	0.60	Rectangular	1.732	1	0.35	∞
Forward transformation	0	Rectangular	1.732	1	0	∞
Power density scaling	-	Rectangular	1.732	1	-	∞
Spatial averaging	0.10	Rectangular	1.732	1	0.06	∞
System detection limit	0.04	Rectangular	1.732	1	0.02	∞
Uncertainty terms dependent on the DUT and environmental factors						
Probe coupling with DUT	0	Rectangular	1.732	1	0	∞
Modulation response	0.40	Rectangular	1.732	1	0.23	∞
Integration time	0	Rectangular	1.732	1	0	∞
Response time	0	Rectangular	1.732	1	0	∞
Device holder influence	0.10	Rectangular	1.732	1	0.06	∞
DUT alignment	0	Rectangular	1.732	1	0	∞
RF ambient conditions	0.04	Rectangular	1.732	1	0.02	∞
Ambient reflections	0.04	Rectangular	1.732	1	0.02	∞
Immunity / secondary reception	0	Rectangular	1.732	1	0	∞
Drift of the DUT	0.21	Rectangular	1.732	1	0.12	∞
Combined Standard Uncertainty Uc(f) =		RSS			0.76	∞
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =					1.52	

6 Device Under Test (DUT) Information

6.1 DUT Description

Device Dimension	Overall (Length x Width): 280.4 mm x 198.8 mm Overall Diagonal: 318 mm Display Diagonal: 281 mm This is a Tablet / laptop device (overall diagonal dimension of the keyboard and/or display section of a laptop or tablet is > 20 cm)
Back Cover	Normal Battery Cover (cover integrated with battery)
Battery Options	Standard – Lithium-ion battery, Rating 11.4 Vdc, 50 Wh
Test sample information	**S/N** **IMEI** **Notes** 1JTSA76425 N/A
Hardware Version	N/A
Software Version	DRTU.00514.22.110.0

6.2 Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
Wi-Fi 6E	6 GHz	802.11ax (HE20) 802.11ax (HE40) 802.11ax (HE80) 802.11ax (HE160)	98.5% (802.11ax 160MHz BW)

7 RF Exposure Conditions (Test Configurations)

Refer to Appendix A for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

Power density evaluated at worst-surfaces/channel according to test results of R 14206457-S1 SAR report. Per TCB workshop October 2020 presentation, PD testing with the mmWave probe is performed on the highest SAR test configurations. Testing for WLAN #1 antenna performed on Edge1 channel 207, while WLAN #2 was performed on Rear Tilt (Edge4 side) channel 143.

8 System Performance Check

Per Nov 2017,TCB Workshop

System validation is required before a system is deployed for measurement.

System check is also required before each series of continuous measurement and, as applicable, repeated at least weekly.

Peak and spatially averaged power density at the peak location(s) must be compared to calibrated results according to the defined test conditions

- the same spatial resolution and measurement region used in the waveguide calibration should be applied to system validation and system check.
- 1 cm^2 and 4 cm^2 spatial averaging have been recommended in the AHG10 draft TR with reference targets available for specific waveguide.
- power density distribution should also be verified, both spatially (shape) and numerically (level) through visual inspection for noticeable differences.
- the measured results should be within 10% of the calibrated targets.

The system components, software settings and other system parameters shall be the same as those used for the compliance tests. The system check shall be performed at closest probe calibration frequency point as in the compliance tests, e.g., if the EUT operates at 35 GHz, it is recommended to perform the validation at 30 GHz.

SAR Lab	Date	5G Verification Source_SN	Cal. Due Date	Drive Power (mW)	Cal Power (mW)	W/m² over 1cm²							W/m² over 4cm²							Plot No.
						Measured W/m²				Scaled Avg PD	Target W/m²	Deviation (%)	Measured W/m²				Scaled Avg PD	Target W/m²	Deviation (%)	
						psPDn+	psPDtot+	psPDmod+	Avg PD				psPDn+	psPDtot+	psPDmod+	Avg PD				
1A	2022-07-10	10GHz SN:1040	2023-03-14	20.00	86.10	12.5	12.6	12.7	12.6	54.243	58.8	-7.75	11.6	11.7	11.8	11.7	50.4	55.2	-8.75	1

Note(s):

None.

9 Measured and Reported (Scaled) Results

Per TCB workshop October 2018, 4 cm^2 averaging area is considered.

1. psPD value (mW/cm^2) used the pS_{tot} avg value (W/m^2) of test result plot.

9.1 Wi-Fi 6 GHz (U-NII Bands)

Band	Mode	Antenna	Dist. (mm)	Test Position	Freq. (MHz)	Ch #.	Duty Cycle	Power (dBm)		Power Density mW/cm^2 over $4cm^2$				Plot No.
										pS_navg (mW/cm^2)		pS_{tot}avg (mW/cm^2)		
								Tune-up Limit	Meas.	Meas.	Scaled	Meas.	Scaled	
Wi-Fi 6E	802.11ax	WLAN #1	2	Edge1	6985	207	98.5%	11.75	10.32	0.133	0.188	0.170	0.240	1
		WLANM #2	2	Rear Tilt (Edge1 side)	6665	143	98.5%	7.25	6.71	0.129	0.148	0.138	0.159	2

Note(s):

None.

10 Simultaneous Transmission Conditions

Total exposure ratio calculated by taking ratio of reported SAR divided by SAR limit and adding it to measured power density divided by power density limit. Numerical sum of the two ratios should be less than 1

$$TER = \sum_{a=1}^{A} \frac{SAR_a}{SAR_a, limit} + \sum_{b=1}^{B} \frac{psPD_b}{psPD_b, limit} < 1$$

10.1 Simultaneous Transmission Combinations

Tx Mode	WLAN #1			WLAN #2			
	2.4 GHz	5 GHz	6 GHz	2.4 GHz	5 GHz	6 GHz	BT
1	x			x			
2		x			x		
3			x			x	
4	x						x
5		x					x
6			x				x

10.2 Simultaneous Transmission Results

Range	Max SAR or PD	Unit	Limit	Result	Ratio
Below 6GHz	Wosrt case simultaneous transmission reported from R14206457-S1V1 (Tx Mode 6)	W/kg	1.6	0.138	0.086
Above 6GHz	Worst case PD refer to section 9	mW/cm^2	1.0	0.240	0.240
TOTAL RATIO LIMIT < 1			SUM of ratio		0.326

Total exposure ratio:$SAR/SARLimit+PD/PDLimit$ < 1

For Tx Mode 3 (6 GHz WLAN on WLAN #1 and WLAN #2), sum of PD = 0.240 + 0.159 = 0.399 mW/cm^2.

Conclusion:

Simultaneous transmission PD is compliant because the sum of the 4 cm^2 PD is < 1 mW/cm^2 and the total exposure ratio is < 1

Appendixes

Refer to separated files for the following appendixes.

Appendix A: Setup Photos

Appendix B: System Check Plots

Appendix C: Highest PD Test Plots

Appendix D: Probe Certificates

Appendix E: Verification source Certificates

END OF REPORT