SAR EVALUATION REPORT

IEEE Std 1528-2013

For
Transportable Tool Accessory

Contains FCC ID: XBee: 2A3WE-XBPSX, BLE: SQGBL653
Model Name: Pull CONNECT

Report Number: R14081273-S1V3
Issue Date: 11/17/2023

Prepared for
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CERT #0751.06

Revision History

Rev.	Date	Revisions	Revised By
V1	10/17/2023	Initial Issue	--
V2	11/15/2023	Updated Model and XBee FCC ID. Updated Cal. Dates in §4.3. Added ERP note to §7.	Richard Jankovics
V3	11/17/2023	Corrected §1 equipment classes.	Lindsay Ryan

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1. Attestation of Test Results

Applicant Name	Greenlee Tools Inc	
FCC ID	XBee: 2A3WE-XBPSX, BLE: SQGBL653	
Model Name	Pull CONNECT	
Applicable Standards	Published RF exposure KDB procedures IEEE Std 1528-2013	
Exposure Category	SAR Limits (W/Kg)	
	Extremities (hands, wrists, ankles, etc.) (10g of tissue)	
General population / Uncontrolled exposure	4	
RF Exposure Conditions	Equipment Class - Highest Reported SAR (W/kg)	
	DSS	DTS
Extremity	1.390	0.430
Simultaneous TX	1.820	1.820
Date Tested	8/30/2022 to 8/31/2022	
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.

This report contains data provided by the customer which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.

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.

This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the U.S. Government, or any agency of the U.S. government.

Approved & Released By:	Prepared By:
	
Devin Chang Senior Test Engineer UL Verification Services	Richard Jankovics Staff Engineer UL LLC

2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE STD 1528-2013, the following FCC Published RF exposure KDB procedures:

- 447498 D04 Interim General RF Exposure Guidance v01
- 447498 D03 Supplement C Cross-Reference v01
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02

In addition to the above, the following information was used:

- TCB Workshop October 2015; RF Exposure Procedures (KDB 941225 D05A)
- TCB Workshop October 2016; RF Exposure Procedures (DUT Holder Perturbations)
- TCB Workshop April 2019; RF Exposure Procedures (Tissue Simulating Liquids (TSL))
- TCB Workshop April 2019; RF Exposure Procedures (Dynamic Antenna Tuning)

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.

The test sites and measurement facilities used to collect data are located at 2800 Perimeter Park Dr, Morrisville, NC, USA.

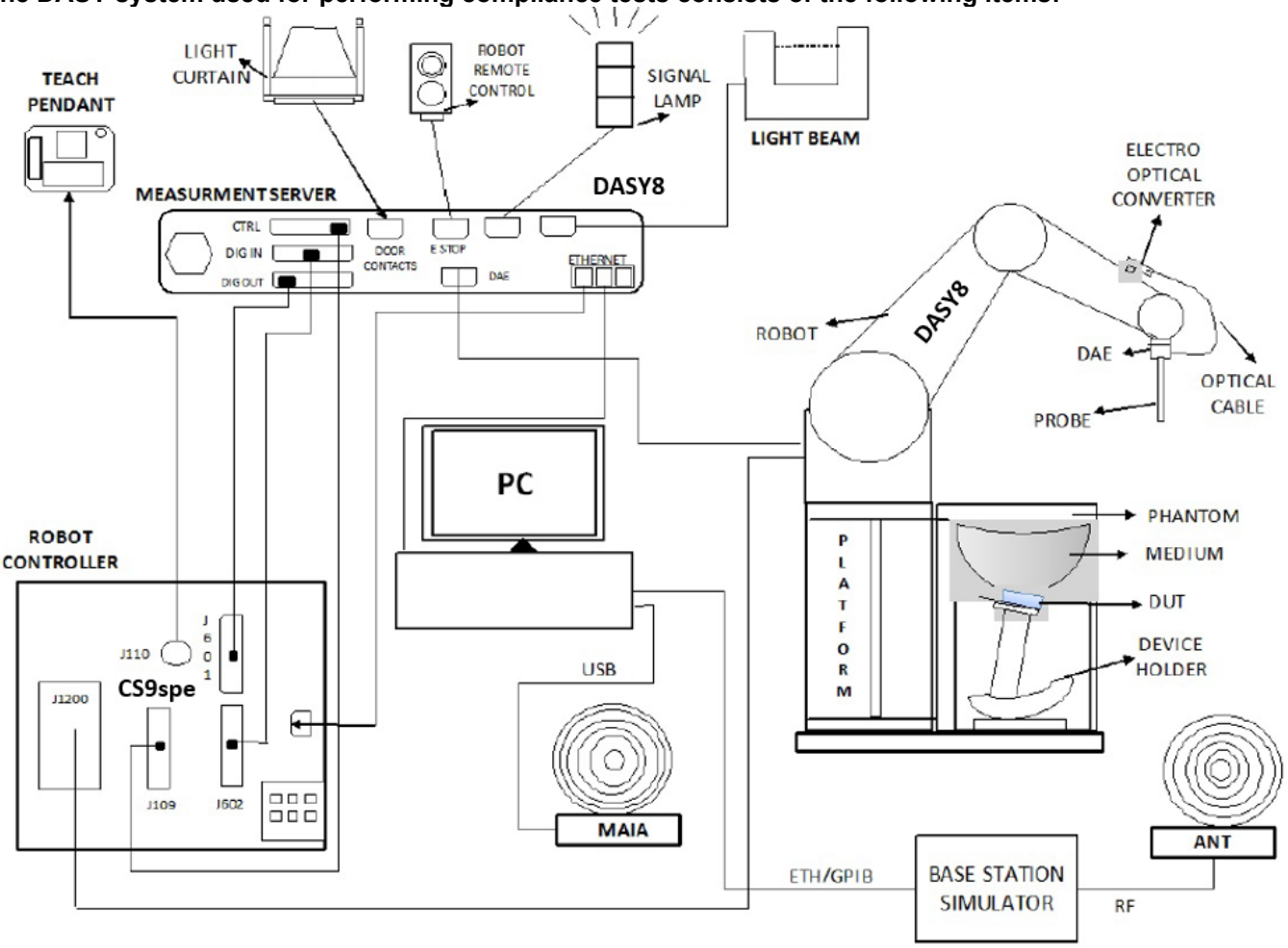
- SAR Lab 1A

	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. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY 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).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- 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, the device holder and other accessories according to the targeted measurement.

[1] DASY8 software used: DASY16.0.2.83 and older generations.

4.2. SAR Scan Procedures

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 phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEC/IEEE 62209-1528, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Zoom Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

Step 4: 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.

4.3. 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.

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
Network Analyzer	Keysight	E5063A	MY54100681	8/20/2021	8/31/2022
Dielectric Probe	SPEAG	DAKS-3.5	1147	3/13/2022	3/13/2023
Shorting Block	SPEAG	DAK-3.5 Short	SM DAK 200 DB	3/13/2022	3/13/2023
Thermometer	Fisher Scientific	15-078-181	210204689	3/13/2021	3/13/2023

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
RF Power Source	Speag	PowerSource1	4278	6/21/2022	6/21/2023

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
E-Field Probe	SPEAG	EX3DV4	7549	2/21/2022	2/21/2023
Data Acquisition Electronics	SPEAG	DAE4	1715	2/22/2022	2/22/2023
System Validation Dipole	SPEAG	D900V2	1d180	10/6/2021	10/6/2022
Environmental Indicator	Control Company	06-662-4	200037610	2/24/2022	2/24/2023

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
RF Power Meter	Keysight	N1911a	MY55116003	8/31/2021	8/31/2022
RF Power Sensor	Keysight	N1921a	MY55120011	7/7/2022	7/7/2023

5. Measurement Uncertainty

Measurement uncertainty for 300 MHz to 3 GHz

a	b	c	d	e f(d,k)	f	g	h = *c×f/e*	I = *c×g/e*
Uncertainty component	Reference	Tol. (±%)	Prob. Dist.	Div.	*ci* (1 g)	*ci* (10 g)	1 g *ui* (± %)	10 g *ui* (± %)
Measurement System								
Probe Calibration	E.2.1	6.00	Normal	1	1	1	6.00	6.00
Axial Isotropy	E.2.2	1.15	Rectangular	1.732	0.7	0.7	0.46	0.46
Hemispherical Isotropy	E.2.2	2.30	Rectangular	1.732	0.7	0.7	0.93	0.93
Boundary Effect	E.2.3	0.90	Rectangular	1.732	1	1	0.52	0.52
Linearity	E.2.4	3.45	Rectangular	1.732	1	1	1.99	1.99
System Detection Limits	E.2.4	1.00	Rectangular	1.732	1	1	0.58	0.58
Modulation Response	E.2.5	2.40	Rectangular	1.732	1	1	1.39	1.39
Readout Electronics	E.2.6	0.30	Normal	1	1	1	0.30	0.30
Response Time	E.2.7	0.80	Rectangular	1.732	1	1	0.46	0.46
Integration Time	E.2.8	2.60	Rectangular	1.732	1	1	1.50	1.50
RF Ambient Conditions—noise	E.6.1	3.00	Rectangular	1.732	1	1	1.73	1.73
RF Ambient Conditions—reflections	E.6.1	3.00	Rectangular	1.732	1	1	1.73	1.73
Probe Positioner Mechanical Tolerance	E.6.2	0.80	Rectangular	1.732	1	1	0.46	0.46
Probe Positioning with Respect to Phantom shell	E.6.3	6.70	Rectangular	1.732	1	1	3.87	3.87
Extrapolation, Interpolation, and Integration Algorithms for max. SAR Evaluation	E.5	4.00	Rectangular	1.732	1	1	2.31	2.31
Test Sample Related								
Test Sample Positioning	E.4.2	2.90	Normal	1	1	1	2.90	2.90
Device Holder Uncertainty	E.4.1	3.60	Normal	1	1	1	3.60	3.60
Output Power Variation—SAR drift measurement	E.2.9	5.00	Rectangular	1.732	1	1	2.89	2.89
SAR Scaling	E.6.5	0.00	Rectangular	1.732	1	1	0.00	0.00
Phantom and Tissue Parameters								
Phantom Uncertainty—shape, thickness and permittivity	E.3.1	7.90	Rectangular	1.732	1	1	4.56	4.56
Uncertainty in SAR Correction for Deviations in Permittivity and Conductivity	E.3.2	1.90	Normal	1	1	0.84	1.90	1.60
Liquid Conductivity - measurement	E.3.3	**2.25**	Normal	1	0.78	0.71	1.76	1.60
Liquid Permittivity - measurement	E.3.3	**-3.77**	Normal	1	0.23	0.26	0.87	0.98
Liquid Conductivity - temperature uncertainty	E.3.4	3.40	Rectangular	1.732	0.78	0.71	1.53	1.39
Liquid Permittivity - temperature uncertainty	E.3.4	0.40	Rectangular	1.732	0.23	0.26	0.05	0.06
Combined Standard Uncertainty Uc(y) =			RSS				11.37	11.34
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =							22.74	22.68

6. Device Under Test (DUT) Information

6.1. DUT Description

Device Dimension	Overall (Length x Width x Depth): 225.6 mm x 130.5 mm x 42.1 mm Overall Diagonal: 250 mm This is a Handheld device
Back Cover	The Back Cover is not removable
Battery Options	The rechargeable battery is not user accessible.
Accessory	Holster
Test sample information	**S/N** **IMEI** **Notes** Non-serialized Radiated/Conducted
Hardware Version	Pre-Production PCBA REV 2D
Software Version	Regulatory Test REV 1.1.0

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
XBee	915 MHz	GFSK	82.1% $_{(GFSK)}$ [1]
Bluetooth	2.4 GHz	LE	N/A[2]

Notes:

1. Refer to § 9.1 for XBee 915 MHz Duty Cycle measurement.
2. Measured Duty Cycle is not required due to SAR test exemption. See §7 for details.

7. RF Exposure Conditions (Test Configurations)

Refer to "SAR Photos and Ant locations" Appendix for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

Per KDB 447498 D04 Interim General RF Exposure Guidance v01 Appendix B.4:
SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum time-averaged power or maximum time-averaged ERP, whichever is greater.

The SAR-based exemption formula of §1.1307(b)(3)(i)(B), repeated here as Formula (B.2), applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold P_{th} (mW).
This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by Formula (B.2).

$$P_{\text{th}}\ (\text{mW}) = ERP_{20\ \text{cm}}\ (\text{mW}) = \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases} \quad \text{(B.1)}$$

$$P_{\text{th}}\ (\text{mW}) = \begin{cases} ERP_{20\ \text{cm}}(d/20\ \text{cm})^{x} & d \le 20\ \text{cm} \\ ERP_{20\ \text{cm}} & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases} \quad \text{(B.2)}$$

where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ \text{cm}}\sqrt{f}}\right)$$

and f is in GHz, d is the separation distance (cm), and $ERP_{20\text{cm}}$ is per Formula (B.1).

Table B.2—Example Power Thresholds (mW)

Frequency (MHz)	Distance (mm)										
	5	10	15	20	25	30	35	40	45	50
300	39	65	88	110	129	148	166	184	201	217
450	22	44	67	89	112	135	158	180	203	226
835	9	25	44	66	90	116	145	175	207	240
1900	3	12	26	44	66	92	122	157	195	236
2450	3	10	22	38	59	83	111	143	179	219
3600	2	8	18	32	49	71	96	125	158	195
5800	1	6	14	25	40	58	80	106	136	169

For 10g SAR P_{th} is generated by multiplying the calculated value by 2.5.

SAR Exemption Calculations

Antenna	Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						SAR Exemption Limit (mW) & Exclusion					
			dBm	mW	Back	Front	Edge Top	Edge Right	Edge Bottom	Edge Left	Back	Front	Edge Top	Edge Right	Edge Bottom	Edge Left
High Power																
Bluetooth	BLE	2480	8.00	6	15.1	25.9	70.2	191.5	50.6	24.4	Limit: 56 mW -EXEMPT-	Limit: 156 mW -EXEMPT-	Limit: 1041 mW -EXEMPT-	Limit: 7043 mW -EXEMPT-	Limit: 558 mW -EXEMPT-	Limit: 139 mW -EXEMPT-
XBee	XBee	927.5	30.00	1000	20.1	18.2	34.1	23.5	92.6	24.9	Limit: 157 mW -MEASURE-	Limit: 135 mW -MEASURE-	Limit: 344 mW -MEASURE-	Limit: 198 mW -MEASURE-	Limit: 1511 mW -EXEMPT-	Limit: 216 mW -MEASURE-

Notes:

1. The DUT has beveled edges that allow tilted conditions which may yield higher exposure conditions, so the applicable edges were evaluated perpendicular relative to the phantom surface and tilted.
2. The worst-case calculated Power threshold (P_{th}) for BLE is 56 mW. The conducted power (6 mW) is ≤ P_{th} therefore SAR testing is not required.
3. The EUT utilizes a -0.94 dBi gain antenna for BLE and a 2.1 dBi gain antenna for XBee. Both yield negative gain in terms of ERP, so output power is the higher of the two and used for exemption.

8. Dielectric Property Measurements & System Check

8.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.
The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.
Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.
The dielectric constant (εr) and conductivity (σ) of typical tissue-equivalent media recipes are expected to be within ± 5% of the required target values; but for SAR measurement systems that have implemented the SAR error compensation algorithms documented in IEC/IEEE 62209-1528, to automatically compensate the measured SAR results for deviations between the measured and required tissue dielectric parameters, the tolerance for εr and σ may be relaxed to ± 10%. This is limited to frequencies ≤ 3 GHz.

Tissue Dielectric Parameters

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

Dielectric Property Measurements Results:

SAR Lab	Date	Band (MHz)	Tissue Type	Frequency (MHz)	Relative Permittivity (εr)			Conductivity (σ)		
					Measured	Target	Delta (%)	Measured	Target	Delta (%)
1A	2022-08-30	900	Head	900	40.1	41.5	-3.47	0.98	0.97	0.52
				880	40.0	41.5	-3.59	0.97	0.95	2.25
				930	39.9	41.5	-3.77	0.99	0.99	0.23

8.2. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are re-measured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

System Performance Check Measurement Conditions:

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 3 mm.
- The dipole input power (forward power) was recorded and the results are normalized to 1 W input power.

System Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within ±10% of the manufacturer calibrated dipole SAR target. Refer to Appendix B for the SAR System Check Plots.

SAR Lab	Date	Tissue Type	Dipole Type_Serial #	Dipole Cal. Due Data	Dipole Power (dBm)	Measured Results for 1g SAR				Measured Results for 10g SAR				Plot No.
						Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10 %	Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10 %	
1A	8/30/2022	Head	D900V2 SN: 1d180	10/6/2022	17.0	0.557	11.11	10.63	4.55	0.358	7.14	6.97	2.48	1

9. Conducted Output Power Measurements

Tune-Up Power Limits provided by the manufacturer are used to scale measured SAR values.

9.1. XBee

RF Air interface	Mode	Tune-up Pow erLimit (dBm)
		XBee Antenna
		Maximum
XBee 915 MHz	GFSK 10 kbps	30
	GFSK 110 kbps	30
	GFSK 250 kbps	30

XBee 915 MHz Band Measured Results

Band	Mode	Ch #	Freq. (MHz)	XBee Average Power (dBm)		
				Meas Pwr	Tune-up	SAR Test (Yes/No)
900MHz	GFSK 10kbps	1	902.50	28.0	30.0	Yes
		51	915.00	28.3	30.0	
		100	927.50	28.6	30.0	
	GFSK 110kbps	1	902.50	28.0	30.0	No
		51	915.00	28.3	30.0	
		100	927.50	28.6	30.0	
	GFSK 250kbps	2	902.75	28.0	30.0	No
		52	915.25	28.3	30.0	
		99	927.25	28.6	30.0	

Duty Factor Measured Results

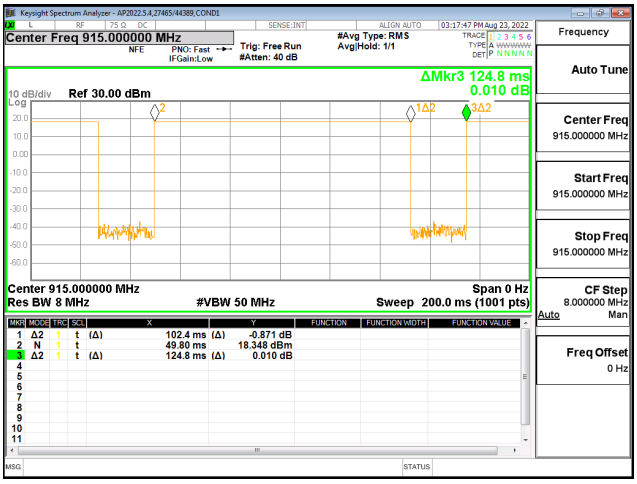
Mode	Type	T_{on} (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
GFSK	10 kbps	102.4	124.8	82.1%	1.22

Note(s):

Duty Cycle = (T_{on} / period) * 100%

Duty Cycle plots

10 kbps



10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

- Reported SAR(W/kg) for XBee = Measured SAR * Tune-up scaling factor * Duty Cycle scaling factor
- Duty Cycle scaling factor = 1 / Duty cycle (%)

KDB 447498 D04 Interim General RF Exposure Guidance v01:

Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
- ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

10.1. XBee

RF Exposure Conditions	Mode	Antenna	Power	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Duty Cycle	Power (dBm)		10-g SAR (W/kg)		Plot No.
									Tune-up Limit	Meas.	Meas.	Scaled	
Extremity	10 kbps	Xbee	High	0	Back	100	927.5	82.10%	30.0	28.6	0.827	**1.390**	1
					Front	100	927.5	82.10%	30.0	28.6	0.411	0.691	
					Edge Top	100	927.5	82.10%	30.0	28.6	0.458	0.770	
					Edge Top Back Tilt	100	927.5	82.10%	30.0	28.6	0.561	0.943	
					Edge Right	100	927.5	82.10%	30.0	28.6	0.138	0.232	
					Edge Right Back Tilt	100	927.5	82.10%	30.0	28.6	0.172	0.289	
					Edge Left	100	927.5	82.10%	30.0	28.6	0.120	0.202	
					Edge Left Back Tilt	100	927.5	82.10%	30.0	28.6	0.131	0.220	

11. SAR Measurement Variability

In accordance with published RF Exposure KDB 865664 D01 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.8 or 2 W/kg (1-g or 10-g respectively); steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.8 or 2 W/kg (1-g or 10-g respectively), repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 or 3.6 W/kg (~ 10% from the 1-g or 10-g respective SAR limit).
4) Perform a third repeated measurement only if the original, first, or second repeated measurement is ≥ 1.5 or 3.75 W/kg (1-g or 10-g respectively) and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Frequency Band (MHz)	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR (Yes/No)	Highest Measured SAR (W/kg)	First Repeated		Second Repeated		Third Repeated
						Measured SAR (W/kg)	Largest to Smallest SAR Ratio	Measured SAR (W/kg)	Largest to Smallest SAR Ratio	Measured SAR (W/kg)
915	XBee 915 MHz	Extremity	Back	No	0.827	N/A	N/A	N/A	N/A	N/A

Note(s):

Repeated measurement is not required since the original highest measured SAR is < 2 W/kg (10-g) .

12. Simultaneous Transmission Conditions

RF Exposure Condition	Item	Capable Transmit Configurations		
Extremity	1	DTS	+	DSS
Notes: None				

12.1. Simultaneous transmission SAR test exclusion considerations

KDB 447498 D04 General RF Exposure Guidance provides two procedures for determining simultaneous transmission SAR test exclusion: Sum of SAR and SAR to Peak Location Ratio (SPLSR)

Sum of SAR

To qualify for simultaneous transmission SAR test exclusion based upon Sum of SAR the sum of the reported standalone SARs for all simultaneously transmitting antennas shall be below the applicable standalone SAR limit. If the sum of the SARs is above the applicable limit then simultaneous transmission SAR test exclusion may still apply if the requirements of the SAR to Peak Location Ratio (SPLSR) evaluation are met.

12.2. Estimated SAR for Simultaneous Transmission SAR Analysis

Considerations for SAR estimation

Per KDB 447498 D04 Interim General RF Exposure Guidance v01 Appendix E.1
When an antenna qualifies for test exemption in single transmitter/antenna mode, its actual SAR value may not be available, because it was not required to be measured. In this case, the SAR contribution of that antenna to simultaneous transmission must be estimated relative to the SAR or MPE based exemption criteria for the applicable terms in the equation of § 1.1307(b)(3(ii)(B) (see also Appendix C), by multiplying the corresponding ratio by the SAR limit of 1.6 W/kg for 1-g SAR. This is referred to as estimated SAR.

Given that the following estimations apply to 10-g SAR extremity exposure, the corresponding ratio is multiplied by the SAR limit of 4 W/kg.

Estimated SAR for WLAN

Tx Interface	Frequency (MHz)	Output Power		Antenna Gain (dBi)	ERP		Exemption Limit (mW)						10g SAR Result (W/kg)					
		dBm	mW		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Bluetooth	2480.0	8.00	6.00	-0.94	4.91	3.10	56	1041	7043	558	139	156	0.430	0.023	0.003	0.043	0.173	0.154

Notes:
Threshold values calculated in § 7.

12.3. Sum of the SAR for XBee 915 MHz & BLE

RF Exposure conditions	Standalone SAR (W/kg)		∑ 10-g SAR (W/kg)
	1	2	1+2
	XBee	BLE Module	
Extremity	1.390	0.430	**1.820**

Conclusion:
Simultaneous transmission SAR measurement (Volume Scan) is not required because the sum of the 1-g SAR is < 4.0 W/kg.

Appendixes

Refer to separated files for the following appendixes.

Appendix A: SAR Setup Photos

Appendix B: SAR System Check Plots

Appendix C: SAR Highest Test Plots

Appendix D: SAR Tissue Ingredients

Appendix E: SAR Probe Certificates

Appendix F: SAR Dipole Certificates

END OF REPORT