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SAR EVALUATION REPORT

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Date of Testing:
11/29/2021 – 2/7/2022
Test Site/Location:
Element, Morgan Hill, CA, USA
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FCC ID: **2AXMS-SHOUTSPR1**

APPLICANT: **NAL RESEARCH CORPORATION**

DUT Type: Shout sp Handheld Iridium Smartphone
Application Type: Certification
FCC Rule Part(s): CFR §2.1093

Equipment Class	Band & Mode	Tx Frequency	SAR		
			1g Head (W/kg)	1g Body Worn (W/kg)	10g Extremity (W/kg)
TNE	Iridium	1616-1626.5 MHz	0.441	0.597	1.911
DTS	2.4 GHz WLAN	2412 - 2462 MHz	0.026	0.000	0.022
DSS/DTS	Bluetooth	2402 - 2480 MHz	0.000	0.000	0.000
Simultaneous SAR per KDB 690783 D01v01r03:			0.441	0.597	2.911

Note: This revised Test Report supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in Section 1.7 of this report; for North American frequency bands only.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them. Test results reported herein relate only to the item(s) tested.

RJ Ortanez
Executive Vice President

CERT #2041.02

The SAR Tick is an initiative of the Mobile & Wireless Forum (MWF). While a product may be considered eligible, use of the SAR Tick logo requires an agreement with the MWF. Further details can be obtained by emailing: sartick@mwfai.info.

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1 DEVICE UNDER TEST

1.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
Iridium	Voice/Data	1616-1626.5 MHz
2.4 GHz WLAN	Voice/Data	2412 - 2462 MHz
Bluetooth	Data	2402 - 2480 MHz

1.2 Power Reduction for SAR

There is no power reduction used for any band/mode implemented in this device for SAR purposes.

1.3 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v06.

1.3.1 Maximum Output Power

Table 1-1
Iridium Maximum Output Power – Antenna A

Mode / Band		Modulated Average declared by Manufacturer (dBm)
Iridium	Maximum	**37.70**

Table 1-2
2.4 GHz WLAN Maximum Output Power – Antenna B

Mode / Band		Modulated Average declared by Manufacturer (dBm)		
		Ch.1	Ch. 6	Ch. 11
IEEE 802.11b (2.4 GHz)	Maximum	**17.30**	**17.30**	**17.30**
IEEE 802.11g (2.4 GHz)	Maximum	**12.00**	**17.10**	**12.00**
IEEE 802.11n (2.4 GHz)	Maximum	**12.00**	**16.10**	**12.00**

Table 1-3
Bluetooth Maximum Output Power – Antenna B

Mode / Band		Modulated Average declared by Manufacturer (dBm)
Bluetooth BR	Maximum	**11.70**
Bluetooth EDR	Maximum	**7.20**
Bluetooth LE	Maximum	**7.00**

1.4 DUT Antenna Locations

A diagram showing the location of the device antennas can be found in Appendix F.

Table 1-4
Device Edges/Sides for SAR Testing

Device Sides/Edges for SAR Testing						
Mode	Back	Front	Top	Bottom	Right	Left
Iridium Antenna A	Yes	Yes	Yes	No	Yes	Yes
2.4 GHz WLAN Antenna B	Yes	Yes	No	No	Yes	Yes
Bluetooth Antenna B	Yes	Yes	No	No	Yes	Yes

Note: Particular DUT edges were not required to be evaluated for Body Extremity SAR based on the SAR exclusion threshold in KDB 447498 D01v06.

a) [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] * [$\sqrt{f}$(GHz)] $\leq$ 7.5

b) {[Power allowed at *numeric threshold* for 50 mm in step a)] + [(test separation distance-50 mm)*10]} mW

2.4 GHz WLAN Antenna B Top Edge Exclusion

Power allowed at *numeric threshold* for 50 mm in step a = $\frac{(7.5*50)}{\sqrt{2.462}}$ = 239.0 + (154.89-50)*10 = 1287.9 mW or 31.1 dBm

2.4 GHz WLAN Antenna B Bottom Edge Exclusion

Power allowed at *numeric threshold* for 50 mm in step a = $\frac{(7.5*50)}{\sqrt{2.462}}$ = 239.0 + (125.88-50)*10 = 997.8 mW or 30.0 dBm

2.4 GHz Bluetooth Antenna B Top Edge Exclusion

Power allowed at *numeric threshold* for 50 mm in step a = $\frac{(7.5*50)}{\sqrt{2.48}}$ = 238.1 + (154.89-50)*10 = 1287 mW or 31.1 dBm

2.4 GHz Bluetooth Antenna B Bottom Edge Exclusion

Power allowed at *numeric threshold* for 50 mm in step a = $\frac{(7.5*50)}{\sqrt{2.48}}$ = 238.1 + (125.88-50)*10 = 996.9 mW or 30.0 dBm

Per KDB 865664 D01v01r04, for Iridium Antenna A, bottom edge was not evaluated since the measurement region corresponding to the antenna and radiating structures of the device needs to be at least 3 cm to 5 cm from the flat phantom boundaries. However, the cable connected to the device used for transmission while testing prevents it to be positioned under the phantom. Based on antenna location, top edge was used for analysis as it is most conservative.

1.5 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D01v06, transmitters are considered to be operating simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds.

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v06 4.3.2 procedures.

Table 1-5
Simultaneous Transmission Scenarios

No.	Capable Transmit Configuration	Head	Body-Worn Accessory	Extremity
1	Iridium + 2.4 GHz Wi-Fi	Yes	Yes	Yes
2	Iridium + Bluetooth	Yes	Yes	Yes

1. 2.4 GHz WLAN and 2.4 GHz Bluetooth share the same antenna path and cannot transmit simultaneously.

1.6 Miscellaneous SAR Test Considerations

Based on expected use conditions, head SAR, body-worn SAR and extremity SAR exposure condition was tested for this device. Additionally, face SAR PTT was evaluated for this device.

1.7 Guidance Applied

- IEEE 1528-2013
- FCC KDB Publication 248227 D01v02r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01v06 (General SAR Guidance)
- FCC KDB Publication 865664 D01v01r04, D02v01r02 (SAR Measurements up to 6 GHz)
- FCC KDB Publication 643646 D01v01r03 (SAR Test for PTT Radios)

1.8 Device Serial Numbers

Several samples with identical hardware were used to support SAR testing. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units. The serial numbers used for each test are indicated alongside the results in Section 10.

2 INTRODUCTION

The FCC and Innovation, Science, and Economic Development Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [22]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

2.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 2-1).

Equation 2-1
SAR Mathematical Equation

$$SAR = \frac{d}{dt}\left(\frac{dU}{dm}\right) = \frac{d}{dt}\left(\frac{dU}{\rho dv}\right)$$

SAR is expressed in units of Watts per Kilogram (W/kg).

$$SAR = \frac{\sigma \cdot E^2}{\rho}$$

where:

σ = conductivity of the tissue-simulating material (S/m)
ρ = mass density of the tissue-simulating material (kg/m^3)
E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

3 DOSIMETRIC ASSESSMENT

3.1 Measurement Procedure

The evaluation was performed using the following procedure compliant to FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013:

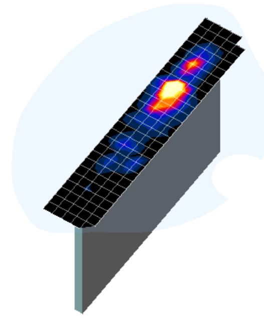

Figure 3-1
Sample SAR Area Scan

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01r04 (See Table 3-1) and IEEE 1528-2013.
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.
3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r04 (See Table 3-1) and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):
    a. SAR values at the inner surface of the phantom are extrapolated from the measured values along the line away from the surface with spacing no greater than that in Table 3-1. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
    b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.
    c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

Table 3-1
Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04*

Frequency	Maximum Area Scan Resolution (mm) (Δx_{area}, Δy_{area})	Maximum Zoom Scan Resolution (mm) (Δx_{zoom}, Δy_{zoom})	Maximum Zoom Scan Spatial Resolution (mm)			Minimum Zoom Scan Volume (mm) (x,y,z)
			Uniform Grid	Graded Grid		
			$\Delta z_{zoom}(n)$	$\Delta z_{zoom}(1)$*	$\Delta z_{zoom}(n>1)$*	
≤ 2 GHz	≤ 15	≤ 8	≤ 5	≤ 4	$\leq 1.5 * \Delta z_{zoom}(n-1)$	≥ 30
2-3 GHz	≤ 12	≤ 5	≤ 5	≤ 4	$\leq 1.5 * \Delta z_{zoom}(n-1)$	≥ 30
3-4 GHz	≤ 12	≤ 5	≤ 4	≤ 3	$\leq 1.5 * \Delta z_{zoom}(n-1)$	≥ 28
4-5 GHz	≤ 10	≤ 4	≤ 3	≤ 2.5	$\leq 1.5 * \Delta z_{zoom}(n-1)$	≥ 25
5-6 GHz	≤ 10	≤ 4	≤ 2	≤ 2	$\leq 1.5 * \Delta z_{zoom}(n-1)$	≥ 22

*Also compliant to IEEE 1528-2013 Table 6

4 DEFINITION OF REFERENCE POINTS

4.1 EAR REFERENCE POINT

Figure 4-2 shows the front, back and side views of the SAM Twin Phantom. The point "M" is the reference point for the center of the mouth, "LE" is the left ear reference point (ERP), and "RE" is the right ERP. The ERP is 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 4-1. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front), also called the Reference Pivoting Line, is not perpendicular to the reference plane (see Figure 4-1). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning [5].

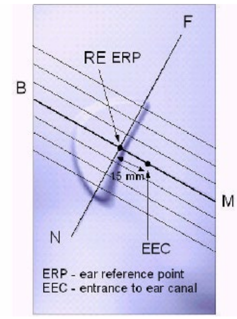

Figure 4-1
Close-Up Side view of ERP

4.2 HANDSET REFERENCE POINTS

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the acoustic output located along the "vertical centerline" on the front of the device aligned to the "ear reference point" (See Figure 4-3). The acoustic output was than located at the same level as the center of the ear reference point. The test device was positioned so that the "vertical centerline" was bisecting the front surface of the handset at its top and bottom edges, positioning the "ear reference point" on the outer surface of the both the left and right head phantoms on the ear reference point.

Figure 4-2
Front, back and side view of SAM Twin Phantom

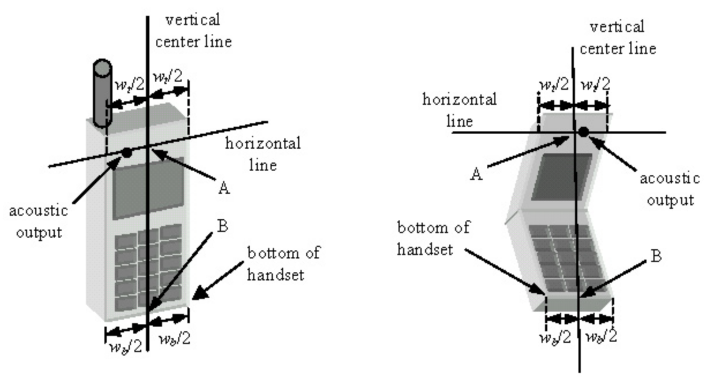

Figure 4-3
Handset Vertical Center & Horizontal Line Reference Points

5 TEST CONFIGURATION POSITIONS

5.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02.

5.2 Positioning for Cheek

1. The test device was positioned with the device close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 5-1), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.

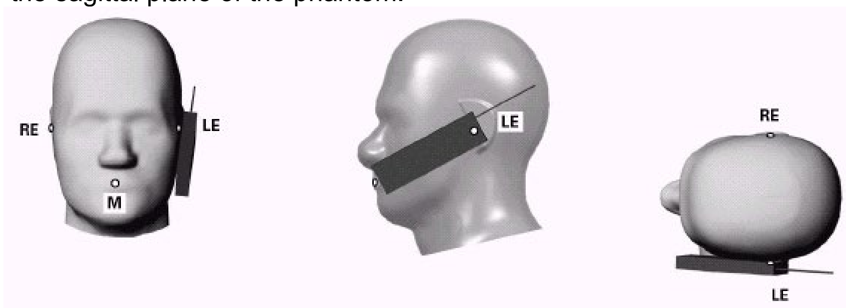

Figure 5-1 Front, Side and Top View of Cheek Position

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the pinna.
3. While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the reference plane.
4. The phone was then rotated around the vertical centerline until the phone (horizontal line) was symmetrical was respect to the line NF.
5. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the device contact with the ear, the device was rotated about the NF line until any point on the handset made contact with a phantom point below the ear (cheek) (See Figure 5-2).

5.3 Positioning for Ear / 15º Tilt

With the test device aligned in the "Cheek Position":

1. While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15degrees.
2. The phone was then rotated around the horizontal line by 15 degrees.
3. While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the handset touched the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. In this situation, the tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head (see Figure 5-2).

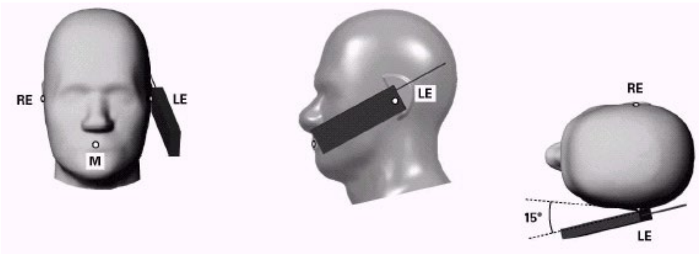

Figure 5-2 Front, Side and Top View of Ear/15º Tilt Position

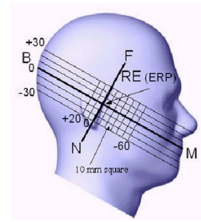

Figure 5-3
Side view w/ relevant markings

5.4 SAR Evaluations near the Mouth/Jaw Regions of the SAM Phantom

Antennas located near the bottom of a phone may require SAR measurements around the mouth and jaw regions of the SAM head phantom. This typically applies to clam-shell style phones that are generally longer in the unfolded normal use positions or to certain older style long rectangular phones. Per IEEE 1528-2013, a rotated SAM phantom is necessary to allow probe access to such regions. Both SAM heads of the TwinSAM-Chin20 are rotated 20 degrees around the NF line. Each head can be removed from the table for emptying and cleaning.

Under these circumstances, the following procedures apply, adopted from the FCC guidance on SAR handsets document FCC KDB Publication 648474 D04v01r03. The SAR required in these regions of SAM should be measured using a flat phantom. The phone should be positioned with a separation distance of 4 mm between the ear reference point (ERP) and the outer surface of the flat phantom shell. While maintaining this distance at the ERP location, the low (bottom) edge of the phone should be lowered from the phantom to establish the same separation distance between the peak SAR location identified by the truncated partial SAR distribution measured with the SAM phantom. The distance from the peak SAR location to the phone is determined by the straight line passing perpendicularly through the phantom surface. When it is not feasible to maintain 4 mm separation at the ERP while also establishing the required separation at the peak SAR location, the top edge of the phone will be allowed to touch the phantom with a separation < 4 mm at the ERP. The phone should not be tilted to the left or right while placed in this inclined position to the flat phantom.

5.5 Body-Worn Accessory Configurations

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 5-4). Per FCC KDB Publication 648474 D04v01r03, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 D01v06 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

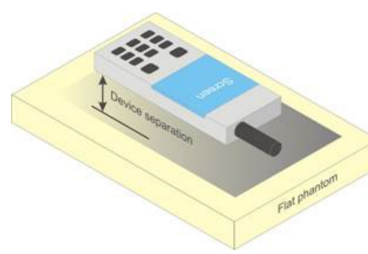

Figure 5-4
Sample Body-Worn Diagram

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented.
Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom in head fluid. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

5.6 Extremity Exposure Configurations

Devices that are designed or intended for use on extremities or mainly operated in extremity only exposure conditions; i.e., hands, wrists, feet and ankles, may require extremity SAR evaluation. When the device also operates in close proximity to the user's body, SAR compliance for the body is also required. The 1g body and 10g extremity SAR Exclusion Thresholds found in KDB Publication 447498 D01v06 should be applied to determine SAR test requirements.

5.7 SAR Testing for PTT Radios

PTT Face SAR was considered for push-to-talk (PTT) radios. See KDB Publication 643646 D01v01r03 for more details.

5.7.1 Head SAR Test Considerations

Head SAR is measured with the front surface of the radio positioned at 2.5 cm parallel to a flat phantom (See Figure 5-1). A phantom shell thickness of 2mm is required. When the head SAR of an antenna tested is:

a) ≤ 3.5 W/kg, testing of all other required channels is not necessary for that antenna
b) > 3.5 W/kg and ≤ 4.0W/kg, testing of the required immediately adjacent channel(s) is not necessary
c) > 4.0 W/kg and ≤ 6.0 W/kg, head SAR should be measured for that antenna on the required immediately adjacent channels; testing of the other required channels still needs consideration
d) > 6.0 W/kg, test all required channels for that antenna
e) for the remaining channels that cannot be excluded in b) and c), which still require consideration, the 3.5 W/kg exclusion in a) and 4.0 W/kg exclusion in b) may be applied recursively with respect to the highest output power channel among the remaining channels; measure the SAR for the remaining channels that cannot be excluded
f) if an immediately adjacent channel measured in c) or a remaining channel measured in e) is > 6.0 W/kg, test all required channels for that antenna

6 RF EXPOSURE LIMITS

6.1 Uncontrolled Environment

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

6.2 Controlled Environment

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

Table 6-1
SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6

HUMAN EXPOSURE LIMITS		
	UNCONTROLLED ENVIRONMENT *General Population* (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT *Occupational* (W/kg) or (mW/g)
Peak Spatial Average SAR Head	1.6	8.0
Whole Body SAR	0.08	0.4
Peak Spatial Average SAR Hands, Feet, Ankle, Wrists, etc.	4.0	20

1. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The Spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

7 FCC MEASUREMENT PROCEDURES

7.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v06, when SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as *reported* SAR. The highest *reported* SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

7.2 SAR Testing with 802.11 Transmitters

The normal network operating configurations of 802.11 transmitters are not suitable for SAR measurements. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable. See KDB Publication 248227 D01v02r02 for more details.

7.2.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters.

A periodic duty factor is required for current generation SAR systems to measure SAR. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

7.2.2 Initial Test Position Procedure

For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured. When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

7.2.3 2.4 GHz SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either the fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

1) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.

2) When the reported SAR is > 0.8 W/kg, SAR is required for that position using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

2.4 GHz 802.11 g/n OFDM are additionally evaluated for SAR if the highest reported SAR for 802.11b, adjusted by the ratio of the OFDM to DSSS specified maximum output power, is > 1.2 W/kg. When SAR is required for OFDM modes in 2.4 GHz band, the Initial Test Configuration Procedures should be followed. When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

7.3 Procedures used to Establish RF Signal for SAR

The DUT was connected to a laptop while testing for SAR. The test software forced the DUT to transmit. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters.

8 RF CONDUCTED POWERS

8.1 Iridium Conducted Powers

Table 8-1
Iridium Maximum Average RF Power – Ant A

1.6GHz Conducted Power [dBm]		
Freq [MHz]	Iridium	
	Channel	Average
1616	1	36.21
1621	121	36.87

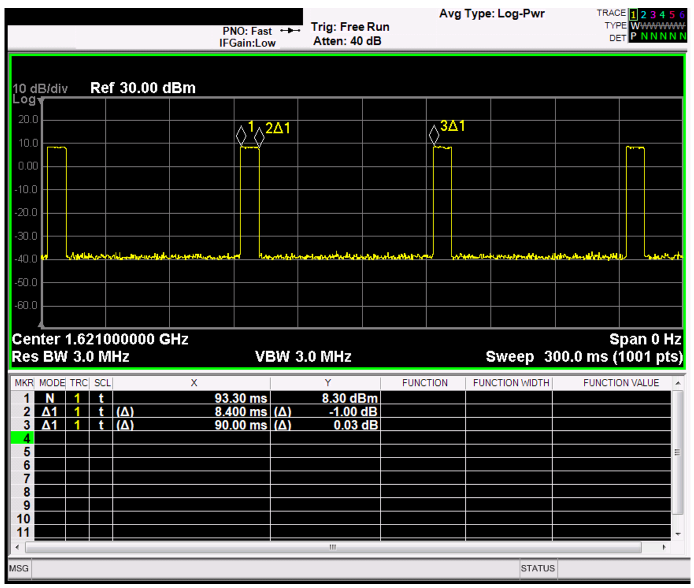

Figure 8-1
Iridium Transmission Plot

Equation 8-1
Iridium Duty Cycle Calculation

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{8.400ms}{90.00ms} * 100\% = 9.33\%$$

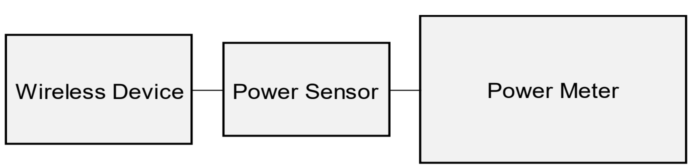

Figure 8-2
Power Measurement Setup

8.2 WLAN Conducted Powers

Table 8-2
2.4 GHz WLAN Maximum Average RF Power – Ant B

2.4GHz Conducted Power [dBm]				
Freq [MHz]	**Channel**	**IEEE Transmission Mode**		
		802.11b	**802.11g**	**802.11n**
		Average	**Average**	**Average**
2412	1	15.40	11.71	11.68
2437	6	15.81	15.41	14.65
2462	11	15.95	11.94	11.98

Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02:

- Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
- For transmission modes with the same maximum output power specification, powers were measured for the largest channel bandwidth, lowest order modulation and lowest data rate.
- For transmission modes with identical maximum specified output power, channel bandwidth, modulation and data rates, power measurements were required for all identical configurations.
- For each transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel(s) when there were at least 3 channels supported. For configurations with multiple mid-band channels, due to an even number of channels, both channels were measured.
- The bolded data rate and channel above were tested for SAR.

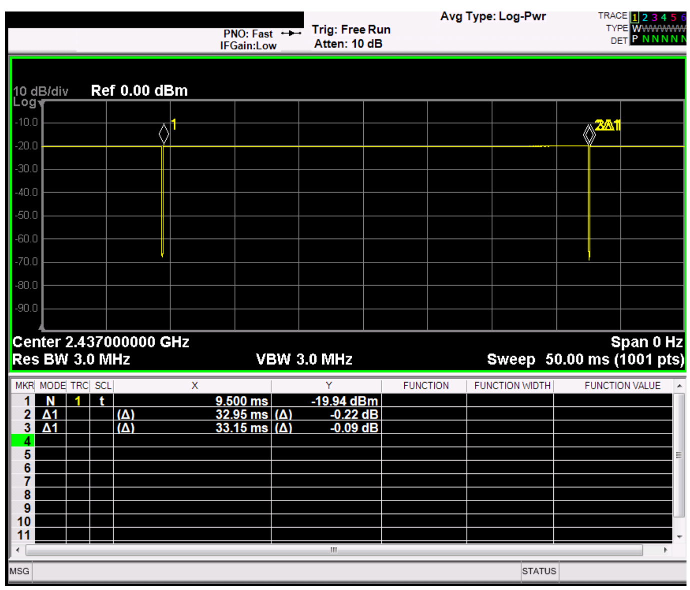

Figure 8-3
2.4 GHz WLAN Transmission Plot

Equation 8-2
2.4 GHz WLAN Duty Cycle Calculation

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{32.95ms}{33.15ms} * 100\% = 99.4\%$$

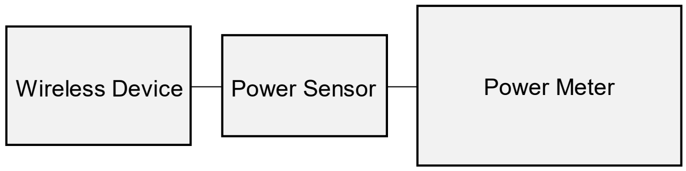

Figure 8-4
Power Measurement Setup

8.3 Bluetooth Conducted Powers

Table 8-3
Bluetooth Average RF Power – Ant B

Frequency [MHz]	Modulation	Data Rate [Mbps]	Channel No.	Avg Conducted Power	
				[dBm]	[mW]
2402	GFSK	1.0	0	11.70	14.791
2441	GFSK	1.0	39	11.63	14.555
2480	GFSK	1.0	78	11.60	14.454

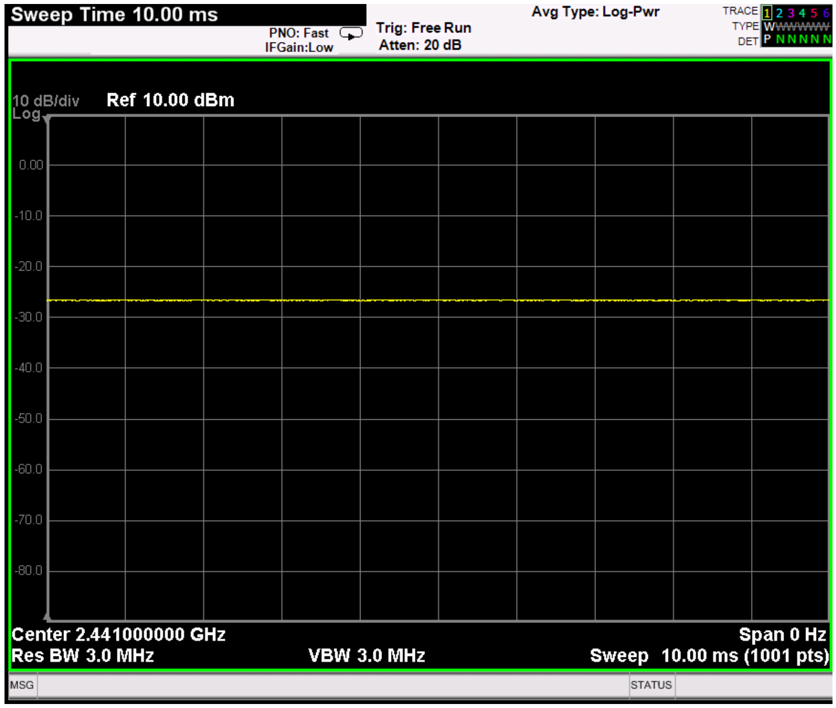

Figure 8-5
Bluetooth Transmission Plot

Equation 8-3
Bluetooth Duty Cycle Calculation

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{10ms}{10ms} * 100\% = 100\%$$

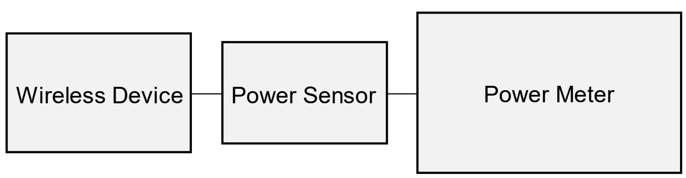

Figure 8-6
Power Measurement Setup

9 SYSTEM VERIFICATION

9.1 Tissue Verification

Table 9-1
Measured Tissue Properties

Calibrated for Tests Performed on:	Tissue Type	Tissue Temp During Calibration (˚C)	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ε	TARGET Conductivity, σ (S/m)	TARGET Dielectric Constant, ε	% dev σ	% dev ε
12/06/2021	1640H	22.1	1610	1.229	39.891	1.290	40.300	-4.73%	-1.01%
			1620	1.238	39.847	1.296	40.284	-4.48%	-1.08%
			1640	1.256	39.761	1.307	40.253	-3.90%	-1.22%
			1650	1.265	39.721	1.313	40.237	-3.66%	-1.28%
01/31/2022	1640H	20.6	1610	1.264	39.766	1.290	40.300	-2.02%	-1.33%
			1620	1.270	39.743	1.296	40.284	-2.01%	-1.34%
			1640	1.282	39.692	1.307	40.253	-1.91%	-1.39%
			1650	1.287	39.671	1.313	40.237	-1.98%	-1.41%
12/06/2021	2450H	24.5	2400	1.766	39.274	1.756	39.289	0.57%	-0.04%
			2450	1.827	39.096	1.800	39.200	1.50%	-0.27%
			2480	1.860	38.968	1.833	39.162	1.47%	-0.50%
01/25/2022	2450H	19.4	2400	1.797	39.425	1.756	39.289	2.33%	0.35%
			2450	1.836	39.339	1.800	39.200	2.00%	0.35%
			2480	1.863	39.278	1.833	39.162	1.64%	0.30%
01/31/2022	2450H	20.6	2400	1.772	38.642	1.756	39.289	0.91%	-1.65%
			2450	1.807	38.568	1.800	39.200	0.39%	-1.61%
			2480	1.833	38.511	1.833	39.162	0.00%	-1.66%

Table 9-2
Measured Body Tissue Properties

Calibrated for Tests Performed on:	Tissue Type	Tissue Temp During Calibration (˚C)	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ε	TARGET Conductivity, σ (S/m)	TARGET Dielectric Constant, ε	% dev σ	% dev ε
12/06/2021	1640B	21.5	1610	1.401	52.808	1.400	53.800	0.07%	-1.84%
			1620	1.406	52.768	1.406	53.774	0.00%	-1.87%
			1640	1.416	52.689	1.419	53.721	-0.21%	-1.92%
			1650	1.420	52.654	1.425	53.695	-0.35%	-1.94%
02/07/2022	1640B	19.9	1610	1.365	52.287	1.400	53.800	-2.50%	-2.81%
			1620	1.376	52.254	1.406	53.774	-2.13%	-2.83%
			1640	1.399	52.186	1.419	53.721	-1.41%	-2.86%
			1650	1.411	52.150	1.425	53.695	-0.98%	-2.88%
11/29/2021	2450B	19.9	2400	1.985	52.278	1.902	52.767	4.36%	-0.93%
			2450	2.032	52.247	1.950	52.700	4.21%	-0.86%
			2480	2.058	52.188	1.993	52.662	3.26%	-0.90%
01/24/2022	2450B	18.6	2400	1.894	51.790	1.902	52.767	-0.42%	-1.85%
			2450	1.935	51.707	1.950	52.700	-0.77%	-1.88%
			2480	1.966	51.654	1.993	52.662	-1.35%	-1.91%

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB Publication 865664 D01v01r04 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

Test System Verification

Prior to SAR assessment, the system is verified to ±10% of the SAR measurement on the reference dipole at the time of calibration by the calibration facility. Full system validation status and result summary can be found in Appendix E.

Table 9-3
System Verification Results – 1g

System Verification TARGET & MEASURED												
SAR System #	**Tissue Frequency (MHz)**	**Tissue Type**	**Date**	**Amb. Temp (°C)**	**Liquid Temp (°C)**	**Input Power (W)**	**Source SN**	**Probe SN**	**Measured SAR_{1g} (W/kg)**	**1 W Target SAR_{1g} (W/kg)**	**1 W Normalized SAR_{1g} (W/kg)**	**$Deviation_{1g}$ (%)**
AM6	1640	HEAD	12/06/2021	21.1	20.9	0.100	321	7416	3.670	34.900	36.700	5.16%
AM6	1640	HEAD	01/31/2022	23.1	20.6	0.100	321	7416	3.600	34.900	36.000	3.15%
AM6	2450	HEAD	12/06/2021	22.1	23.1	0.100	750	7416	5.560	53.100	55.600	4.71%
AM6	2450	HEAD	01/25/2022	21.4	19.0	0.100	750	7416	5.550	53.100	55.500	4.52%
AM6	2450	HEAD	01/31/2022	23.1	20.6	0.100	921	7416	5.400	53.100	54.000	-0.37%
AM6	1640	BODY	12/06/2022	21.9	21.5	0.100	321	7416	3.730	34.600	37.300	7.80%
AM6	2450	BODY	11/29/2021	21.4	20.7	0.100	750	7416	5.400	51.000	54.000	5.88%
AM6	2450	BODY	01/24/2022	21.1	19.5	0.100	750	7416	5.330	51.000	53.300	4.51%

Table 9-4
System Verification Results – 10g

System Verification TARGET & MEASURED												
SAR System #	**Tissue Frequency (MHz)**	**Tissue Type**	**Date**	**Amb. Temp (°C)**	**Liquid Temp (°C)**	**Input Power (W)**	**Source SN**	**Probe SN**	**Measured SAR_{10g} (W/kg)**	**1 W Target SAR_{10g} (W/kg)**	**1 W Normalized SAR_{10g} (W/kg)**	**$Deviation_{10g}$ (%)**
AM6	1640	BODY	02/07/2022	20.3	19.9	0.100	321	7416	1.920	18.800	19.200	2.13%
AM6	2450	BODY	11/29/2021	21.4	20.7	0.100	750	7416	2.510	24.100	25.100	4.15%
AM6	2450	BODY	01/24/2022	21.1	19.5	0.100	750	7416	2.500	24.100	25.000	3.73%

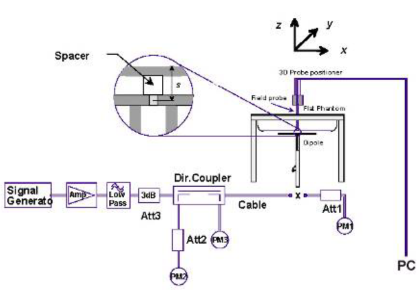

Figure 9-1
System Verification Setup Diagram

Figure 9-2
System Verification Setup Photo

10 SAR DATA SUMMARY

10.1 Standalone Head SAR Data

Table 10-1
Iridium Head SAR Data

MEASUREMENT RESULTS															
FREQUENCY		Mode	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Antenna Config.	Device Serial Number	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.										(W/kg)			(W/kg)	
1616	1	Iridium	37.70	36.21	-0.02	Right	Cheek	A	IRID0425G03	9.33	0.023	1.409	1.018	0.033	
1621	121	Iridium	37.70	36.87	-0.05	Right	Cheek	A	IRID0425G03	9.33	0.030	1.211	1.018	**0.037**	A1
1621	121	Iridium	37.70	36.87	-0.14	Right	Tilt	A	IRID0425G03	9.33	0.020	1.211	1.018	0.025	
1621	121	Iridium	37.70	36.87	0.06	Left	Cheek	A	IRID0425G03	9.33	0.017	1.211	1.018	0.021	
1621	121	Iridium	37.70	36.87	0.07	Left	Tilt	A	IRID0425G03	9.33	0.008	1.211	1.018	0.010	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						Head 1.6 W/kg (mW/g) averaged over 1 gram									

Note: The reported SAR was scaled to the 9.5% transmission duty factor to determine compliance since duty factor of the device is permanently limited to 9.5% per the manufacturer.

Table 10-2
2.4 WLAN Head SAR Data

MEASUREMENT RESULTS																		
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.													(W/kg)			(W/kg)	
2462	11	802.11b	DSSS	22	17.30	15.95	0.09	Right	Cheek	B	IRID0425G03	1	99.4	0.019	1.365	1.006	**0.026**	A2
2462	11	802.11b	DSSS	22	17.30	15.95	0.15	Right	Tilt	B	IRID0425G03	1	99.4	0.008	1.365	1.006	0.011	
2462	11	802.11b	DSSS	22	17.30	15.95	0.01	Left	Cheek	B	IRID0425G03	1	99.4	0.018	1.365	1.006	0.025	
2462	11	802.11b	DSSS	22	17.30	15.95	-0.03	Left	Tilt	B	IRID0425G03	1	99.4	0.007	1.365	1.006	0.010	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Head 1.6 W/kg (mW/g) averaged over 1 gram										

Table 10-3
Bluetooth Head SAR Data

MEASUREMENT RESULTS																	
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Side	Test Position	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Duty Cycle (%)	SAR (1g)	Scaling Factor (Cond Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.												(W/kg)			(W/kg)	
2402.00	0	Bluetooth	FHSS	11.70	11.70	0.02	Right	Cheek	B	IRID0425G03	1	100.00	0.000	1.000	1.000	0.000	
2402.00	0	Bluetooth	FHSS	11.70	11.70	-0.05	Right	Tilt	B	IRID0425G03	1	100.00	0.000	1.000	1.000	**0.000**	A3
2402.00	0	Bluetooth	FHSS	11.70	11.70	0.06	Left	Cheek	B	IRID0425G03	1	100.00	0.000	1.000	1.000	0.000	
2402.00	0	Bluetooth	FHSS	11.70	11.70	-0.08	Left	Tilt	B	IRID0425G03	1	100.00	0.000	1.000	1.000	0.000	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram										

Table 10-4
Iridium PTT Head Face SAR Data

MEASUREMENT RESULTS															
FREQUENCY		Mode	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.										(W/kg)			(W/kg)	
1621	121	Iridium	37.70	36.87	-0.03	25 mm	A	IRID0425G03	front	9.33	0.358	1.211	1.018	0.441	A4
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						Head 1.6 W/kg (mW/g) averaged over 1 gram									

Note: The reported SAR was scaled to the 9.5% transmission duty factor to determine compliance since duty factor of the device is permanently limited to 9.5% per the manufacturer.

Table 10-5
2.4 WLAN PTT Head Face SAR Data

MEASUREMENT RESULTS																		
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.													(W/kg)			(W/kg)	
2462	11	802.11b	DSSS	22	17.30	15.95	0.20	25 mm	B	IRID0425G03	1	front	99.4	0.000	1.365	1.006	0.000	A5
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Head 1.6 W/kg (mW/g) averaged over 1 gram										

Table 10-6
Bluetooth PTT Head Face SAR Data

MEASUREMENT RESULTS																	
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Cond Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.												(W/kg)			(W/kg)	
2402	0	Bluetooth	FHSS	11.70	11.70	0.20	25 mm	B	IRID0425G03	1	front	100.00	0.000	1.000	1.000	0.000	A6
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Head 1.6 W/kg (mW/g) averaged over 1 gram										

10.2 Standalone Body-Worn SAR Data

Table 10-7
Iridium Body-Worn SAR Data

MEASUREMENT RESULTS															
FREQUENCY		Mode	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.										(W/kg)			(W/kg)	
1621	121	Iridium	37.70	36.87	-0.01	0 mm	A	IRID0425G03	back	9.33	0.484	1.211	1.018	0.597	A7
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						Body 1.6 W/kg (mW/g) averaged over 1 gram									

Note: The reported SAR was scaled to the 9.5% transmission duty factor to determine compliance since duty factor of the device is permanently limited to 9.5% per the manufacturer.

Table 10-8
2.4 WLAN Body-Worn SAR Data

MEASUREMENT RESULTS																	
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.													(W/kg)			(W/kg)	
2462	11	802.11b	DSSS	22	17.30	15.95	-0.10	0 mm	B	IRID0425G03	1	back	99.4	0.000	1.365	1.006	0.000	A8
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Body 1.6 W/kg (mW/g) averaged over 1 gram										

Table 10-9
Bluetooth Body-Worn SAR Data

MEASUREMENT RESULTS																
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Cond Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.												(W/kg)			(W/kg)	
2402	0	Bluetooth	FHSS	11.7	11.70	0.02	0 mm	B	IRID0425G03	1	back	100	0.000	1.000	1.000	0.000	A9
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population							Body 1.6 W/kg (mW/g) averaged over 1 gram									

10.3 Standalone Extremity SAR Data

Table 10-10
Iridium Extremity SAR Data

MEASUREMENT RESULTS															
FREQUENCY		Mode	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Side	Duty Cycle (%)	SAR (10g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (10g)	Plot #
MHz	Ch.										(W/kg)			(W/kg)	
1621	121	Iridium	37.70	36.87	0.10	0 mm	A	IRID0425G03	back	9.33	0.260	1.211	1.018	0.321	
1621	121	Iridium	37.70	36.87	0.09	0 mm	A	IRID0425G03	front	9.33	0.267	1.211	1.018	0.329	
1616	1	Iridium	37.70	36.21	0.05	0 mm	A	IRID0425G03	top	9.33	1.230	1.409	1.018	1.764	
1621	121	Iridium	37.70	36.87	-0.05	0 mm	A	IRID0425G03	top	9.33	1.550	1.211	1.018	1.911	A10
1621	121	Iridium	37.70	36.87	0.03	0 mm	A	IRID0425G03	right	9.33	1.080	1.211	1.018	1.331	
1621	121	Iridium	37.70	36.87	0.06	0 mm	A	IRID0425G03	left	9.33	0.023	1.211	1.018	0.028	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						Body 4.0 W/kg (mW/g) averaged over 10 gram									

Note: The reported SAR was scaled to the 9.5% transmission duty factor to determine compliance since duty factor of the device is permanently limited to 9.5% per the manufacturer.

Table 10-11
2.4 WLAN Extremity SAR Data

MEASUREMENT RESULTS																		
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (10g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (10g)	Plot #
MHz	Ch.													(W/kg)			(W/kg)	
2462	11	802.11b	DSSS	22	17.30	15.95	-0.10	0 mm	B	IRID0425G03	1	back	99.4	0.000	1.365	1.006	0.000	
2462	11	802.11b	DSSS	22	17.30	15.95	0.02	0 mm	B	IRID0425G03	1	front	99.4	0.016	1.365	1.006	0.022	A11
2462	11	802.11b	DSSS	22	17.30	15.95	0.01	0 mm	B	IRID0425G03	1	right	99.4	0.000	1.365	1.006	0.000	
2462	11	802.11b	DSSS	22	17.30	15.95	-0.06	0 mm	B	IRID0425G03	1	left	99.4	0.000	1.365	1.006	0.000	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Body 4.0 W/kg (mW/g) averaged over 10 gram										

Table 10-12
Bluetooth Extremity SAR Data

MEASUREMENT RESULTS																	
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (10g)	Scaling Factor (Cond Power)	Scaling Factor (Duty Cycle)	Reported SAR (10g)	Plot #
MHz	Ch.												(W/kg)			(W/kg)	
2402	0	Bluetooth	FHSS	11.70	11.70	0.02	0 mm	B	IRID0425G03	1	back	100.00	0.000	1.000	1.000	0.000	
2402	0	Bluetooth	FHSS	11.70	11.70	0.07	0 mm	B	IRID0425G03	1	front	100.00	0.000	1.000	1.000	0.000	A12
2402	0	Bluetooth	FHSS	11.70	11.70	0.08	0 mm	B	IRID0425G03	1	right	100.00	0.000	1.000	1.000	0.000	
2402	0	Bluetooth	FHSS	11.70	11.70	0.07	0 mm	B	IRID0425G03	1	left	100.00	0.000	1.000	1.000	0.000	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population								Body 4.0 W/kg (mW/g) averaged over 10 gram									

10.4 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2013, and FCC KDB Publication 447498 D01v06.
2. Liquid tissue depth was at least 15.0 cm for all frequencies.
3. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
4. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v06.
5. Device was tested using a fixed spacing for body-worn accessory testing. A separation distance of 0 mm was used for SAR testing and considered to be the most conservative to determine compliance.
6. Per FCC KDB Publication 648474 D04v01r03, body-worn SAR was evaluated without a headset connected to the device. Since the standalone reported body-worn SAR was ≤ 1.2 W/kg, no additional body-worn SAR evaluations using a headset cable were required.
7. Per FCC KDB 865664 D01v01r04, variability SAR tests were not required since measured SAR Results for all frequency bands were less than 0.8 W/kg and 2.0 W/kg for 10g.
8. Unless otherwise noted, when 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds below.
9. Based on expected use conditions, head SAR, body-worn SAR and extremity SAR exposure condition was tested for this device.
10. Additionally, per FCC KDB Publication 643646 D01v01r03, Head Face SAR PTT was evaluated for the DUT with a separation distance of 25 mm between the flat phantom and the DUT. The phantom was filled with head tissue equivalent medium.
11. The orange highlights throughout the report represents the highest scaled SAR per Equipment class.

WLAN Notes:

1. For held-to-ear, and Body-Worn, Extremity, and PTT operations, the initial test position procedures were applied. Otherwise, SAR is evaluated at the subsequent highest measured power until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
2. Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02 for 2.4 GHz WIFI single transmission chain operations, the highest measured maximum output power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4 GHz 802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR. See Section 7.2.3 for more information.
3. When the maximum reported 1g averaged SAR is ≤0.8 W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was ≤ 1.20 W/kg for 1g evaluations or all test channels were measured.
4. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools. The reported SAR was scaled to the 100% transmission duty factor to determine compliance.

Bluetooth Notes

1. The DUT was connected to a test laptop and test script was used to enable transmission BT Tx test transmission. Per October 2016 TCB workshop Notes, the reported SAR was scaled to the 100% transmission duty factor to determine compliance. See section 8.1 for the time domain plot and calculation for the duty factor of device.

11 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

11.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v06 are applicable to devices with built-in unlicensed transmitters such as 802.11 and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

11.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore, simultaneous transmission analysis is required. Per FCC KDB Publication 447498 D01v06 4.3.2 and IEEE 1528-2013 Section 6.3.4.1.2, simultaneous transmission SAR test exclusion may be applied when the sum of the 1g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤1.6 W/kg. The different test positions in an exposure condition may be considered collectively to determine SAR test exclusion according to the sum of 1g or 10g SAR.

11.3 Head SAR Simultaneous Transmission Analysis

Table 11-1
Simultaneous Transmission Scenario with 2.4 GHz WLAN

Simult Tx	Configuration	Iridium Antenna A (W/kg)	2.4 WLAN Antenna B (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Head SAR	Right Cheek	0.037	0.026	0.063
	Right Tilt	0.025	0.011	0.036
	Left Cheek	0.021	0.025	0.046
	Left Tilt	0.010	0.010	0.020
	Face PTT	0.441	0.000	0.441

Table 11-2
Simultaneous Transmission Scenario with Bluetooth

Simult Tx	Configuration	Iridium Antenna A (W/kg)	Bluetooth Antenna B (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Head SAR	Right Cheek	0.037	0.000	0.037
	Right Tilt	0.025	0.000	0.025
	Left Cheek	0.021	0.000	0.021
	Left Tilt	0.010	0.000	0.010
	Face PTT	0.441	0.000	0.441

11.4 Body-Worn Simultaneous Transmission Analysis

Table 11-3
Simultaneous Transmission Scenario with 2.4 GHz WLAN (Body-Worn at 0mm)

Simult Tx	Configuration	Iridium Antenna A (W/kg)	2.4 WLAN Antenna B (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Body SAR	Back	0.597	0.000	0.597

Table 11-4
Simultaneous Transmission Scenario with Bluetooth (Body-Worn at 0mm)

Simult Tx	Configuration	Iridium Antenna A (W/kg)	Bluetooth Antenna B (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Body SAR	Back	0.597	0.000	0.597

11.5 Extremity SAR Simultaneous Transmission Analysis

(*) - When the antenna separation distance was > 50 mm, an estimated SAR of 1.0 W/kg for 10-g SAR was used to determine the simultaneous transmission SAR exclusion for test positions excluded per FCC KDB Publication 447498 D01v06.

Table 11-5
Simultaneous Transmission Scenario with 2.4 GHz WLAN

Simult Tx	Configuration	Iridium Antenna A (W/kg)	2.4 WLAN Antenna B (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Extremity SAR	Back	0.321	0.000	0.321
	Front	0.329	0.022	0.351
	Top	1.911	1.000*	2.911
	Right	1.331	0.000	1.331
	Left	0.028	0.000	0.028

Table 11-6
Simultaneous Transmission Scenario with Bluetooth

Simult Tx	Configuration	Iridium Antenna A (W/kg)	Bluetooth Antenna B (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Extremity SAR	Back	0.321	0.000	0.321
	Front	0.329	0.000	0.329
	Top	1.911	1.000*	2.911
	Right	1.331	0.000	1.331
	Left	0.028	0.000	0.028

11.6 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v06 and IEEE 1528-2013 Section 6.3.4.1.2.

12 SAR MEASUREMENT VARIABILITY

12.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r04, SAR measurement variability was not assessed for each frequency band since all measured SAR values are <0.8 W/Kg for 1g and <2.0 W/Kg for 10g SAR.

12.2 Measurement Uncertainty

The measured SAR was <1.5 W/kg for 1g and <3.75 W/kg for 10g for all frequency bands. Therefore, per KDB Publication 865664 D01v01r04, the extended measurement uncertainty analysis per IEEE 1528-2013 was not required.

13 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	E4438C	Signal Generator	1/16/2020	Triennial	1/16/2023	MY49070496
Agilent	E4404B	Spectrum Analyzer	N/A	N/A	N/A	MY45113238
Agilent	E5515C	8960 Series 10 Wireless Communications Test Set	1/15/2020	Triennial	1/15/2023	MY45090479
Agilent	E4438C	ESG Vector Signal Generator	1/15/2020	Triennial	1/15/2023	MY45090479
Amplifier Research	15S1G6	Amplifier	N/A	N/A	N/A	0433972
Amplifier Research	15S1G6	Amplifier	N/A	N/A	N/A	0433973
Anritsu	ML2495A	Power Meter	12/6/2021	Annual	12/6/2022	1039008
Anritsu	MA24106A	USB Power Sensor	8/10/2021	Annual	8/10/2022	1231538
Anritsu	MA24106A	USB Power Sensor	8/10/2021	Annual	8/10/2022	1231535
Anritsu	MA2411B	Pulse Power Meter	9/21/2021	Annual	9/21/2022	1315051
Control Company	4352	Ultra Long Stem Thermometer	1/21/2022	Annual	1/21/2023	160508097
Control Company	4352	Ultra Long Stem Thermometer	10/25/2021	Annual	10/25/2022	200645916
Control Company	4040	Therm./Clock/Humidity Monitor	03/06/202	Biennial	3/6/2022	200170313
Insize	1108-150	Digital Capliper	CBT	N/A	CBT	N/A
MCL	BW-N6W5+	6dB Attenuator	N/A	N/A	N/A	1139
MiniCircuits	SLP-2400+	Low Pass Filter	N/A	N/A	N/A	R8979500903
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter	N/A	N/A	N/A	
Mini-Circuits	NLP-1200+	Low Pass Filter DC to 1000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	PWR-4GHS	Power Sensor	4/27/2021	Annual	4/27/2022	12010120004
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Pasternack	PE2208-6	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	PE2209-10	Bidirectional Coupler	CBT	N/A	CBT	N/A
Pasternack	NC-100	Torque Wrench	8/5/2020	Biennial	8/5/2022	N/A
Seekonk	NC-100	Torque Wrench (8" lb)	8/4/2020	Biennial	8/4/2022	021053
SPEAG	MAIA	Modulation and Audio Interface Analyzer	N/A	N/A	N/A	1324
SPEAG	DAK-12	Dielectric Assessment Kit (10MHz - 3GHz)	3/10/2021	Annual	3/10/2022	1102
SPEAG	DAE4	Dasy Data Acquistion Electronics	5/11/2021	Annual	5/11/2022	701
SPEAG	EX3DV4	SAR Probe	5/18/2021	Annual	5/18/2022	7416
SPEAG	D1640V2	1640 MHz SAR Dipole	12/11/2019	Triennial	12/11/2022	321
SPEAG	D2450V2	2450 MHz SAR Dipole	6/14/2019	Triennial	6/14/2022	750
SPEAG	D2450V2	2450 MHz SAR Dipole	11/9/2021	Triennial	11/9/2022	921

Note: CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.

14 MEASUREMENT UNCERTAINTIES

a	b	c	d	e= f(d,k)	f	g	h = c x f/e	i = c x g/e	k
Uncertainty Component	IEEE 1528 Sec.	Tol. (± %)	Prob. Dist.	Div.	c_i 1gm	c_i 10 gms	1gm u_i (± %)	10gms u_i (± %)	v_i
Measurement System									
Probe Calibration	E.2.1	7	N	1	1	1	7.0	7.0	∞
Axial Isotropy	E.2.2	0.25	N	1	0.7	0.7	0.2	0.2	∞
Hemishperical Isotropy	E.2.2	1.3	N	1	0.7	0.7	0.9	0.9	∞
Boundary Effect	E.2.3	2	R	1.732	1	1	1.2	1.2	∞
Linearity	E.2.4	0.3	N	1	1	1	0.3	0.3	∞
System Detection Limits	E.2.4	0.25	R	1.732	1	1	0.1	0.1	∞
Modulation Response	E.2.5	4.8	R	1.732	1	1	2.8	2.8	∞
Readout Electronics	E.2.6	0.3	N	1	1	1	0.3	0.3	∞
Response Time	E.2.7	0.8	R	1.732	1	1	0.5	0.5	∞
Integration Time	E.2.8	2.6	R	1.732	1	1	1.5	1.5	∞
RF Ambient Conditions - Noise	E.6.1	3	R	1.732	1	1	1.7	1.7	∞
RF Ambient Conditions - Reflections	E.6.1	3	R	1.732	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.8	R	1.732	1	1	0.5	0.5	∞
Probe Positioning w/ respect to Phantom	E.6.3	6.7	R	1.732	1	1	3.9	3.9	∞
Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation	E.5	4	R	1.732	1	1	2.3	2.3	∞
Test Sample Related									
Test Sample Positioning	E.4.2	3.12	N	1	1	1	3.1	3.1	35
Device Holder Uncertainty	E.4.1	1.67	N	1	1	1	1.7	1.7	5
Output Power Variation - SAR drift measurement	E.2.9	5	R	1.732	1	1	2.9	2.9	∞
SAR Scaling	E.6.5	0	R	1.732	1	1	0.0	0.0	∞
Phantom & Tissue Parameters									
Phantom Uncertainty (Shape & Thickness tolerances)	E.3.1	7.6	R	1.73	1.0	1.0	4.4	4.4	∞
Liquid Conductivity - measurement uncertainty	E.3.3	4.3	N	1	0.78	0.71	3.3	3.0	76
Liquid Permittivity - measurement uncertainty	E.3.3	4.2	N	1	0.23	0.26	1.0	1.1	75
Liquid Conductivity - Temperature Uncertainty	E.3.4	3.4	R	1.732	0.78	0.71	1.5	1.4	∞
Liquid Permittivity - Temperature Unceritainty	E.3.4	0.6	R	1.732	0.23	0.26	0.1	0.1	∞
Liquid Conductivity - deviation from target values	E.3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Permittivity - deviation from target values	E.3.2	5.0	R	1.73	0.60	0.49	1.7	1.4	∞
Combined Standard Uncertainty (k=1)			RSS				12.2	12.0	191
Expanded Uncertainty (95% CONFIDENCE LEVEL)			k=2				24.4	24.0	

The above measurement uncertainties are according to IEEE Std. 1528-2013

15 CONCLUSION

15.1 Measurement Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Innovation, Science, and Economic Development Canada, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]

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