QAI Laboratories
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# RF EXPOSURE TEST REPORT

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|---|---|
| **Report Reference Number:** | E10992-2401_CastGroup_BTRM-001_Rev1.0 |
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|---|---|
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## Laboratory Accreditations (per ISO/IEC 17025:2017)

ACCREDITED
CERT #3657.02

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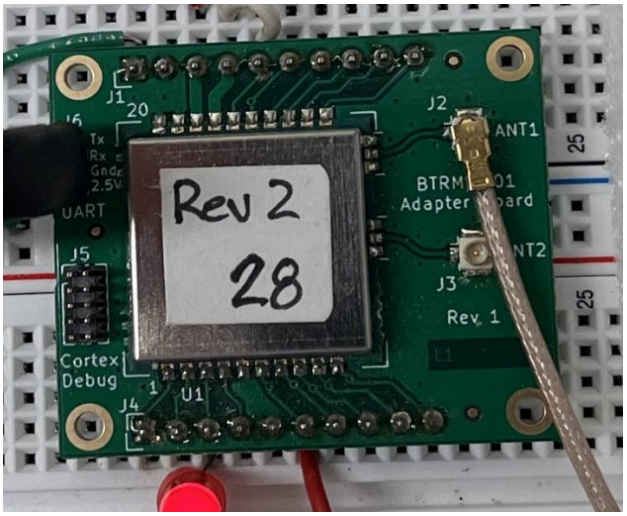
| | |
|---|---|
| **Manufacturer:** | Cast Group of Companies Inc. |
| **Address:** | 35 Ripley Avenue a Unit 1<br>Toronto, Ontario, M6S 3P2 |

| | |
|---|---|
| **Equipment Tested:** | **BTRM-001** |
| Model Number(s): | BTRM-001 |
| FCC ID: | RKT-BTRM001 |
| ISED ID: | 10858A-BTRM001 |




## REVISION HISTORY

| Date | Report Number | Details | Author's Initials |
|---|---|---|---|
| March 5, 2025 | E10992-2401_CastGroup_BTRM-001_RF Exposure_FCC_ISED_CE_Rev0.0 | Initial draft | DJ |
| March 6, 2025 | E10992-2401_CastGroup_BTRM-001_RF Exposure_FCC_ISED_CE_Rev1.0 | Final Release | DJ |
| All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly. | | | |

## REPORT AUTHORIZATION

The data documented in this report is for the test equipment provided by the manufacturer. The tests were conducted on the sample equipment as requested by the manufacturer for the purpose of demonstrating compliance with the standards outlined in Section I of this report as agreed upon by the Manufacturer under the quote 23RH02073R2.

The Manufacturer is responsible for the tested product configurations, continued product compliance, and for the appropriate auditing of subsequent products as required.

This report may comprise a partial list of tests that are required for FCC, ISED, CE, RCM and UKCA conformity. A Declaration of Conformity can only be produced by the manufacturer. This is to certify that the following report is true and correct to the best of our knowledge.

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## QAI EMC ACCREDITATION

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| EMC Laboratory Location | FCC Designation (3m SAC) | IC Registration (3m SAC) | A2LA Certificate |
|---|---|---|---|
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### EMC Facility Burnaby BC, Canada

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# 1 EXECUTIVE SUMMARY

## 1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of the Cast Group of Companies Wireless Transmitter Module as per Sections 1.2 and 1.3.

## 1.2 Scope

The information documented in this report is based on the test methods and levels as per Quote 23RH02073R2:

- **FCC KDB 447498 D04: v01 – General RF Exposure Guidance**
- **47 CFR FCC Part 2 Subpart J, section 2.1091**
- **47 CFR Part 1.1307**
- **47 CFR Part 1.1310**
- **RSS-102 Issue 6** – Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
- **EN 62479:2010** – Assessment of the compliance of low power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields

## 1.3 Summary of Results

| No. | Test | Applicable Standard | Description | Result |
|---|---|---|---|---|
| 1 | RF Exposure Evaluation | FCC 47 CFR 2.1093<br>FCC 47 CFR 1.1310<br>RSS-102 Issue 6 (6.6)<br>EN 62479 | RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm | Complies |

Table 1: Applicable Test Standards and Descriptions

Note: The gain of the antenna(s) is provided by the client to measure or calculate test results and is not independently measured by QAI.

## 1.4 Sample Calculations of Emissions Data

Radiated and conducted emissions were performed using EMC32 software developed by Rohde & Schwarz. Transducer factors like Antenna factors, Cable Losses and Amplifier gains were stored in the test templates which are used to perform the emissions measurements. After test is finished, data is generated from the EMC32 consisting of product details, emission plots and final data tables as shown below.

| Frequency (MHz) | Quasi Peak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Band width (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 31.0064 | 25.67 | 40.00 | **14.33** | 1000 | 120 | 315.0 | H | 161 | 4.0 |

Quasi-Peak reading shown in the table above is already corrected by the software using correction factor shown in column "Corr." The correction factor listed under "Corr." table calculated as:

**Corr.(dB) = Antenna factor + Cable loss**

Or

**Corr.(dB) = Antenna factor + Cable Loss - Amp gain (if pre-amplifier was used)**

The final Quasi peak reading shown in the data is calculated by the software using following equation:

**Corrected Quasi-Peak (dBµV/m) = Raw Quasi-Peak Reading + Antenna factor + Cable loss**

To obtain the final Quasi-Peak or Average reading during power line conducted emissions, transducer factors are included in the final measurement as shown below.

| Frequency (MHz) | Quasi Peak (dBµV) | Average (dBµV) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 0.2410 | --- | 23.71 | **52.06** | 28.35 | 1000.0 | 9.0 | L1 | GND | 10.0 |
| 0.2411 | 38.98 | --- | **62.06** | 23.08 | 1000.0 | 9.0 | L1 | GND | 10.0 |

Quasi Peak or Average reading shown in above table is already corrected by the software using the correction factor shown in column "Corr." The correction factor listed under "Corr." table calculated as:

**Corr.(dB) = Antenna factor + Cable loss**

The final Quasi-peak or Average reading shown in the data is calculated by the software using following equation:

**Corr. Quasi-Peak/Average Reading (dBµV) = Raw Quasi-Peak/Average Reading + Antenna factor + Cable loss**

The allowable margin from the limits, as per the standards, were calculated for both radiated and conducted emissions:

**Margin(dB) = Limit – Quasi-Peak or Average reading**

## 1.5 Test Equipment List

The tables below contain all the equipment used by 'QAI Laboratories' in conducting all tests on the Equipment Under Test (EUT) as per Section I.

**Emissions Test Equipment**

| | Manufacturer | Model | Description | Serial No. | S/W Version | Calibration Due Date |
|---|---|---|---|---|---|---|
| 1 | Com-Power Corporation | LI-220C | Line Impedance Stabilization Network (9kHz-30MHz) | 20070025 | N/A | 2026-Jan-23 |
| 2 | ETS Lindgren | 2165 | Turntable | 00043677 | N/A | N/A |
| 3 | Maturo GmbH | BAM 4.0-P | Boresight Antenna Mast | 365 | 3382.01 | N/A |
| 4 | ETS Lindgren | S201 | 5-meter Semi-Anechoic Chamber | 1030 | N/A | N/A |
| 5 | Hewlett Packard | 8449B | Preamplifier (1-26 GHz) | 3008A00982 | N/A | 2025-Feb-15 |
| 6 | Keysight Technologies | N9038B | MXE EMI Receiver, Multi-touch | MY60180014 | N/A | 2024-Aug-22 |
| 7 | ETS-Lindgren | 3117 | Horn, Double-Ridge Guide Ant, 1.0 - 18 GHz | 75944 | N/A | 2026-Jan-25 |
| 8 | Sunol Sciences | JB1 | Biconilog Antenna 30MHz – 2GHz | A070209 | N/A | 2026-Jan-04 |
| 9 | TESEQ | ISN T800 | Impedance Stabilization Network (150kHz – 30MHz) | 27133 | N/A | 2026-Feb-08 |
| 10 | Hewlett Packard | 8447F | Preamplifier (0.1-1300MHz) | 1726A00566 | N/A | N/A |

**Note:** Equipment listed above have 3 years calibration interval.

**Measurement Software List**

| | Manufacturer | Model | Version | Description |
|---|---|---|---|---|
| 1 | Rohde & Schwarz | EMC 32 | 10.35.10 | Emissions Test Software |

# 2 GENERAL INFORMATION

## 2.1 Product Description

The information provided in this section is for the Equipment Under Test (EUT) and the corresponding Auxiliary Equipment needed to perform the tests as a complete system.

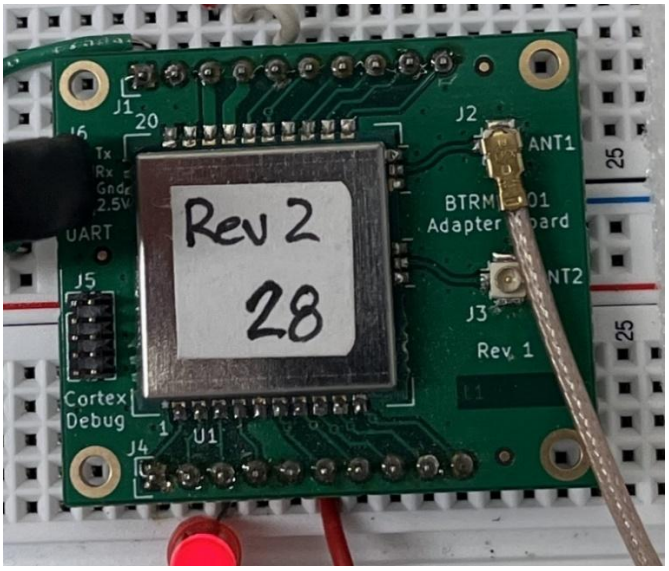



Figure 1: BTRM-001

**Equipment Under Test (EUT) – General Information**

| | |
|---|---|
| **Equipment** | 2400 MHz Radio |
| **Description** | Short range radio transceiver module, 802.15.4 |
| **Manufacturer** | Cast Group of Companies Inc. |
| **Model No.** | BTRM-001 |
| **Serial No.** | 28 |
| Clock frequencies tuned upon within the EUT:<br>Highest frequency generated within the EUT: | 16MHz, 48 MHz<br>2483.5 MHz |

**Equipment Under Test (EUT) – RF Information**

| | |
|---|---|
| **RF device type** | DTS |
| **Model No. (HVIN)** | BTRM-001 |
| **Operating frequency** | 2405 - 2480 MHz |
| **Number of available** | 16 |
| **Channel separation** | 5 MHz |
| **Channel bandwidth** | 2 MHz |
| **Output Power/Transmitter** | 10 dBm |
| **Modulation type** | O-QPSK DSSS |
| **Test Channels (L, M, H)** | 2405 MHz, 2445 MHz, 2480 MHz |
| **Data Rate** | 250 kbps |
| **Adaptive** | No |
| **Geo-location-capable** | No |
| **Number of antennas** | 2 |
| **Antenna type** | Flexible printed circuit stick-on dipole with UF.L Connector |
| **Antenna gain** | 4.0 dBi |

Notes: None.

**Equipment Under Test (EUT) – General Information**

| | |
|---|---|
| **Tested as** | Table top |
| **Dimensions** | 20 x 20 x 3.4 mm |
| **Declared operating temperature range:** | -30 to +70 °C |
| **Input power** | 3V, 40mA, 120 mW |
| **Grounded** | No |
| **Device use** | Mobile or portable |

Notes: None.

## 2.2 Environmental Conditions

The equipment under test was operated and tested under the following environmental conditions:

| Parameter | Conditions |
|---|---|
| Location | Indoors |
| Temperature | 20.1 °C |
| Relative Humidity | 43.5% |
| Atmospheric Pressure | 101.2 kPa |

## 2.3 Measurement Uncertainty

| Parameter | Uncertainty |
|---|---|
| Radiated Emissions, 30MHz-1GHz | ± 2.40 dB |
| Radiated Emissions, 1GHz-40GHz | ± 2.48 dB |
| Radio Frequency | ±1.5 x 10-5 MHz |
| Total RF Power Conducted | ±1.36 dB |
| Spurious Emissions, Conducted | ±1.36 dB |
| RF Power Density, Conducted | ±1.36 dB |
| Temperature | ±1ºC |
| Humidity | ±5 % |
| DC and low frequency voltages | ±3 % |

**Test Modes**

| Test Mode | Transmitter State | Power |
|---|---|---|
| 1 | ON – O-QPSK DSSS | Bench power supply |
| 5 | OFF – Rx only | Bench power supply |

**Auxiliary Manufacturer Supplied Equipment**

| Equipment | Manufacturer | Product Description | Model No. |
|---|---|---|---|
| Aux 1 | Lenovo | Laptop with Python script for controlling EUT | Model No |
| Aux 2 | FTDI | USB serial port adapter cable | TTL-232RG |

# 3 DATA & TEST RESULTS

## 3.1 RF Exposure Evaluation – Federal Communications Commission (FCC)

**Date Performed:** 04-Mar-25

**Test Standard:** FCC 47 CFR 1.1307
FCC 47 CFR 1.1310
FCC 47 CFR 2.1091

**Test Method:** FCC OET Bulletin 65 Ed 97-01
FCC KDB 477498 D01: v06

**Modifications:** None

**Final Result:** Complies

### 3.1.1 Applicable Regulations

#### 3.1.1.1 FCC – KDB 447498: General RF Exposure Guidance

7. RF EXPOSURE EVALUATION GUIDANCE FOR MOBILE CONDITIONS

7.1 Transmitters used in mobile device exposure conditions for standalone operations.
A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The minimum test separation distance required for a device to comply with mobile device exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements.

When a device qualifies for the categorical exclusion provision of 2.1091 (c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance.

When a device does not qualify for the categorical exclusion provision of 2.1091 (c), routine evaluation using MPE measurement or computational modeling is required to determine compliance. For mobile devices operating in mostly stationary configurations MPE estimated instead of measurements or numerical simulation may be acceptable.

7.2 Transmitters used in mobile device exposure conditions for simultaneous transmission operations.
For mobile exposure host platform devices to qualify for simultaneous transmission MPE test exclusion, all transmitters and antennas in the host must either be evaluated for MPE compliance, by measurement or computational modeling, or qualify for the standalone MPE test exclusion in 7.1. When modular transmitters are used, the minimum test separation distance required for each simultaneously transmitting antenna installed in the host device must satisfy MPE compliance for both standalone and simultaneous transmission operations. When simultaneous transmission MPE test exclusion applies, transmitter modules may be incorporated in host devices according to Class I permissive change requirements to document the test exclusion conditions.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0, according to calculated/estimated, numerically modeled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging should not be applied when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating

requirements for the host device must meet the minimum test separation distances required for all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

#### 3.1.1.2 FCC 47 CFR 1.1307: Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.

(b)(3)(i)(B) A single RF source is exempt if the available maximum time-averaged power or effective radiated power (ERP), whichever is greater is less than or equal to the threshold $P_{th}$ (mW) described in the following formula:

$$P_{th}(mW) = \begin{cases} ERP_{20cm}(d/20cm)^x & d \le 20cm \\ ERP_{20cm} & 20cm \le d \le 40cm \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

And

$$ERP_{20cm} = \begin{cases} 2040f & 0.3\ \text{GHz} \le f \le 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$

(b)(3)(i)(C) Table 1 – Single RF Sources Subject to Routine Environmental Evaluation:

| RF Source Frequency (MHz) | Threshold ERP (W) |
|---|---|
| 0.3 – 1.34 | 1,920 $R^2$ |
| 1.34 – 30 | 3,450 $R^2/f^2$ |
| 30 – 300 | 3.83 $R^2$ |
| 300 – 1,500 | 0.0128 $R^2f$ |
| 1,500 – 100,000 | 19.2 $R^2$ |

R is the separation distance in meters

Table 2: Single RF Sources Subject to Routine Evaluation

(b)(3)(ii)(B) in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation:

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \le 1$$

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using (b)(3)(i)(B) for $P_{th}$
b = number of fixed, mobile, or portable RF sources claiming exemption using (b)(3)(i)(C) for $ERP_{th}$
c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance.
$P_i$ = the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source *i* at a distance between 0.5 cm and 40 cm
$P_{th,i}$ = the exemption threshold power ($P_{th}$) according to (b)(3)(i)B) for fixed, mobile, or portable RF source *i*
$ERP_j$ = the ERP of fixed, mobile, or portable RF source *j*.
$ERP_{th,j}$ = exemption threshold ERP for fixed, mobile, or portable RF source *j*, at a distance of at least $\lambda/2\pi$ according to the applicable formula of (b)(3)(i)(C)
$Evaluated_k$ = the maximum reported SAR or MPE of fixed, mobile, or portable RF source *k* either in the device or at the transmitter site from an existing evaluation at the location of exposure.
Exposure $Limit_k$ = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source *k*, as applicable from 1.1310

### 3.1.1.3 FCC 47 CFR 1.1310: Radiofrequency radiation exposure limits

(e)(1) Table 1 – Limits for Maximum Permissible Exposure (MPE)

| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density ($mW/cm^2$) | Averaging Time (minutes) |
|---|---|---|---|---|
| (i) Limits for Occupational/Controlled Exposure | | | | |
| 0.3 – 3.0 | 614 | 1.63 | *(100) | ≤ 6 |
| 3.0 – 30 | 1842/f | 4.89/f | *($900/f^2$) | < 6 |
| 30 – 300 | 61.4 | 0.163 | 1.0 | < 6 |
| 300 – 1,500 | | | f/300 | < 6 |
| 1,500 – 100,000 | | | 5 | < 6 |
| (ii) Limits for General Population/Uncontrolled Exposure | | | | |
| 0.3 – 3.0 | 614 | 1.63 | *(100) | < 30 |
| 3.0 – 30 | 824/f | 2.19/f | *($180/f^2$) | < 30 |
| 30 – 300 | 27.5 | 0.073 | 0.2 | < 30 |
| 300 – 1,500 | | | f/1500 | < 30 |
| 1,500 – 100,000 | | | 1.0 | < 30 |

f = frequency in MHz
* = Plane-wave equivalent power density

Table 3: Limits for Maximum Permissible Exposure (MPE)

(e)(2) Occupational/controlled exposure limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure.

### 3.1.1.4 FCC 47 CFR 2.1091: Radiofrequency radiation exposure evaluation: mobile devices

(c) (1): Evaluation of compliance with the exposure limits in 1.1310 of this chapter, and preparation of an EA if the limits are exceeded, is necessary for mobile devices with single RF sources having either more than an available maximum time averaged power of 1 mW or more than the ERP listed in table 1 of 1.1307(b)(3)(i)(C), whichever is greater.

### 3.1.2 FCC Measurement Data and Results:

| | |
|---|---|
| Date Performed: | 10-Jan-2025 |
| Measurements: | refer to measurements from Test Report: E10992-2401_CastGroup_BTRM-001_ FCC-ISED_Rev1.0 |
| Peak Output Power: | 10.33 dBm, 10.79 mW – Conducted (refer to measurements from Test Report: E10992-2401_CastGroup_BTRM-001_ FCC-ISED_Rev1.0) |
| Duty Cycle Corr.: | 3.41ms ON; 64.84ms OFF (10log On/Off) = - 12.79dB |
| Peak Output Corr'd: | -2.46dBm = 0.57mw |
| Antenna Gain: | 4.0 dBi |
| Antenna Type: | Flexible printed circuit stick-on dipole with UF.L Connector |
| Frequency Range: | 2405 – 2480 MHz |
| Exposure Distance: | 0.5 cm |

Using the Maximum Permissible Exposure (MPE) threshold table above in section 3.1.1.3, taken from FCC 47 CFR 1.1310(e)(1), the limit for occupational/uncontrolled exposure at 2400 MHz is:

$$MPE_{2400MHz} = 1\ mW/cm^2$$

The plane-wave power density calculation for the transmitter is:

$$S = \frac{P_{mW} * G_{ant}}{4\pi * {R_{cm}}^2}\ mW/cm^2$$

Where,

S = power density
$P_{mW}$= conducted output power in mW
$G_{ant}$= linear antenna gain
$R_{cm}$= the separation distance in cm

$$S_{Tx1\_BLE} = \frac{0.57\ mW * \left(10^{4.0\ dBi/10}\right)}{4\pi * 0.5^2} = 0.46 mW/cm^2$$

| Transmitter | Detail | Power Density ($mW/cm^2$) | Power Density Limit ($mW/cm^2$) | Result |
|---|---|---|---|---|
| $Tx_1$ | 2.4 GHz BLE | 0.46 | 1 | Complies |

Table 4: FCC RF Exposure Evaluation Results

## 3.2 RF Exposure Evaluation – Innovation, Science and Economic Development Canada (ISED)

**Date Performed:** 25-Mar-4

**Test Standard:** RSS-102 Issue 6

**Test Method:** KDB 447498 D01

**Modifications:** None

**Final Result:** Complies

### 3.2.1 Applicable Regulations

#### 3.2.1.1 ISED – RSS-102

Section 6.6 Exemption Limits for Routine Evaluation – RF Exposure Evaluation:

# 4 6.1 General

All transmitters are exempt from routine NS, SAR, APD, IPD and/or FRL exposure evaluations provided that they comply with the appropriate requirements specified in the following sections. If the equipment under test (EUT) meets the appropriate requirements outlined in the following sections, applicants are required to submit a properly signed declaration of compliance (refer to annex B).

In addition, the following information, where applicable, shall also be part of the RF exposure technical brief:

- the root mean square (RMS) current
- the number of turns of the coil
- the maximum output power
- the information that demonstrates how the maximum output power of the transmitter was derived
- the rationale for the separation distances applied (see table 10, table 11 and table 12), which must be based on the most conservative exposure condition for the applicable radio apparatus module or host platform test procedure requirements

For an EUT that overlaps a frequency range with 2 types of evaluation (e.g. below 6 GHz and above 6 GHz), both exemption limits (e.g. SAR exemption limit and the APD exemption limit) shall be met to be exempt from the routine evaluation(s).

If the EUT does not meet the appropriate exemption limit, a complete NS, SAR, APD, IPD and/or FRL evaluation shall be performed. However, the exemption limits in table 10, table 11 and table 12, may be applied to reduce the number of test configurations (e.g. possibly eliminating the need for testing of a tablet edge). The RF exposure technical brief (refer to section 4.3) shall include a rationale for the separation distances applied, based on the applicable radio apparatus module or host platform test procedure requirements.

- It is emphasized that exemption from routine evaluation is **not** an exemption from compliance with the applicable exposure limit(s) and the other relevant requirements.

Section 3.2 RF Exposure Evaluation of Devices:

A device requiring an RF exposure evaluation shall be made in accordance with the latest version of IEEE C95.3.

If the device is designed such that more than one antenna can functionally transmit at the same time, the RF exposure evaluation shall be conducted while all antennas are transmitting. The individual exposure level ratios shall be totalled and used for compliance purposes.

If the device has more than one antenna but is not designed to have more than one antenna functionally transmit at the same time, the RF exposure evaluation of the device shall be performed for each of the individually transmitting antennas. The maximum RF field strength value shall be recorded and used for compliance purposes.

If the device combines groups of simultaneous and non-simultaneous transmitting antennas, the worst-case of the above scenarios applies.

Section 4 Exposure Limits:

| RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment) | | | | |
|---|---|---|---|---|
| **Frequency Range (MHz)** | **Electric Field (V/m rms)** | **Magnetic Field (A/m rms)** | **Power Density ($W/m^2$)** | **Reference Period (Minutes)** |
| 0.003 – 10 | 83 | 90 | - | Instantaneous* |
| 0.1 – 10 | - | 0.73 / f | - | 6** |
| 1.1 – 10 | $87 / f^{0.5}$ | - | - | 6** |
| 10 – 20 | 27.46 | 0.0728 | 2 | 6 |
| 20 – 48 | $58.07 / f^{0.25}$ | $0.1540 / f^{0.25}$ | $8.944 / f^{0.5}$ | 6 |
| 48 – 300 | 22.06 | 0.05852 | 1.291 | 6 |
| **300 – 6000** | **$3.142 f^{0.25}$** | **$0.008335 f^{0.25}$** | **$0.02619 f^{0.5}$** | **6** |
| 6000 – 15000 | 61.4 | 0.163 | 10 | 6 |
| 15000 – 150000 | 61.4 | 0.163 | 10 | $616000 / f^{1.2}$ |
| 150000 – 300000 | $0.158 f^{0.5}$ | $4.21 \times 10^{-4} f^{0.5}$ | $6.67 \times 10^{-5} f$ | $616000 / f^{1.2}$ |

**Note:** f is frequency in MHz.
* Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Table 5: ISED Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

| RF Field Strength Limits for Controlled Use Devices (Controlled Environment) | | | | |
|---|---|---|---|---|
| **Frequency Range (MHz)** | **Electric Field (V/m rms)** | **Magnetic Field (A/m rms)** | **Power Density ($W/m^2$)** | **Reference Period (Minutes)** |
| 0.003 – 10 | 170 | 180 | - | Instantaneous* |
| 0.1 – 10 | - | 1.6 / f | - | 6** |
| 1.1 – 10 | $193 / f^{0.5}$ | - | - | 6** |
| 10 – 20 | 61.4 | 0.163 | 10 | 6 |
| 20 – 48 | $129.8 / f^{0.25}$ | $0.3444 / f^{0.25}$ | $44.72 / f^{0.5}$ | 6 |
| 48 – 300 | 49.33 | 0.1309 | 6.455 | 6 |
| 300 – 6000 | $15.60 f^{0.25}$ | $0.04138 f^{0.25}$ | $0.6455 f^{0.5}$ | 6 |
| 6000 – 15000 | 137 | 0.364 | 50 | 6 |
| 15000 – 150000 | 137 | 0.364 | 50 | $616000 / f^{1.2}$ |
| 150000 – 300000 | $0.354 f^{0.5}$ | $9.4 \times 10^{-4} f^{0.5}$ | $3.33 \times 10^{-4} f$ | $616000 / f^{1.2}$ |

**Note:** f is frequency in MHz.
* Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Table 6: ISED Field Strength Limits for Controlled Use Devices (Controlled Environments)

### 4.1.1 ISED Measurement Data and Results:

From the RSS-102 limits for RF field strength limits in uncontrolled environments, the maximum power density at 2400 MHz is **$0.02619 f^{0.5}$** (1.284 $W/m^2$) and which is 12.84 $mW/cm^2$.

| Transmitter | Detail | Power Density ($mW/cm^2$) Note 1 | Power Density Limit ($mW/cm^2$) Note 2 | Result |
|---|---|---|---|---|
| $Tx_1$ | 2.4 GHz BLE | 0.54 | 12.84 | Complies |

Note 1: See section 3.1.1 for calculation of transmitter power density
Note 2: Power density limit converted from $W/m^2$ to $mW/cm^2$

Table 7: RSS-102 Exposure Evaluation

## 4.2 RF Exposure Evaluation – European Standard EN 62479:2010

**Date Performed:** 25-Jan-20

**Test Standard:** EN 62479:2010
IEEE C95.1

**Test Method:** IEEE C95.1
KDB 447498 D01

**Modifications:** None

**Final Result:** Complies

### 4.2.1 Applicable Regulations

#### 4.2.1.1 EN 62479:2010

4.1 General Considerations:

Compliance of electromagnetic emissions from electronic and electrical equipment with the basic restrictions usually is determined by measurements and, in some cases, calculation of the exposure level. If the electrical power used by or radiated by the equipment is sufficiently low, the electromagnetic fields emitted will be incapable of producing exposures that exceed the basic restrictions. This standard provides simple EMF assessment procedures for this low power equipment.

Any relevant compliance assessment procedure which is consistent with the state of the art, reproducible and gives valid results can be used.

For transmitters intended for use with more than one antenna configuration option, the combination of transmitter and antenna(s) which generates the highest available antenna power and/or average total radiated power shall be assessed.

4.2 Low Power Exclusion Level ($P_{max}$)

Low-power electronic and electrical equipment is deemed to comply with the provisions of this standard if it can be demonstrated that the average total radiated power is less than or equal to the applicable low-power exclusion level $P_{max}$.

4.3 Exposure to Multiple Transmitting Sources

If an equipment under test (EUT) is equipped with multiple intentional radiators, the overall conformity assessment might require more than just the assessment of conformity of each one of the radiators separately. The effect of multiple intentional radiators should be considered in the conformity assessment process.

#### 4.2.1.2 IEEE C95.1-2019

4.3.2 Whole-body exposure ERLs (100 kHz to 300 GHz)

The ERLs are provided in the subclause for convenience in exposure assessments. For human exposure to electromagnetic energy at radio frequencies from 100 kHz to 300 GHz, the ERLs, in terms of rms electric (E) and magnetic (H) field strengths, the power density (S) and plane0wave-equivalent power densities ($S_E$, $S_H$) are presented as a function of frequency in the following table. For uncorrelated (in time) fields, such as multiple field

exposure situations (e.g., different frequency field sources), compliance is determined by summing the percentages of the applicable ERLs in terms of $E^2$, $H^2$, or power density that each frequency field represents and ensuring that this sum does not exceed 100 %

| **ERLs for whole-body exposure of persons permitted in unrestricted environments** | | | | |
|---|---|---|---|---|
| **Frequency Range (MHz)** | **Electric Field (V/m rms)** | **Magnetic Field (A/m rms)** | **Power Density ($W/m^2$)** | |
| | | | **$S_E$** | **$S_H$** |
| 0.1 – 1 | 614 | 16.3 / f | 1000 | 100 000 / $f^2$ |
| 1 – 30 | 823.8 / f | 16.3 / $f^{1.668}$ | 1800 / $f^2$ | 100 000 / $f^2$ |
| 30 – 100 | 27.5 | 158.3 / f | 2 | 9 400 000 / $f^{3.336}$ |
| 100 – 400 | 27.5 | 0.0729 | 2 | |
| 400 - 2000 | - | - | f / 200 | |
| **2000 – 300 000** | **-** | **-** | **10** | |

**Note:** f is frequency in MHz.

Table 8: IEEE ERLs for whole-body eposure of persons permitted in unrestricted environments

| **ERLs for whole-body exposure of persons permitted in restricted environments (Controlled Environment)** | | | | |
|---|---|---|---|---|
| **Frequency Range (MHz)** | **Electric Field (V/m rms)** | **Magnetic Field (A/m rms)** | **Power Density ($W/m^2$)** | |
| | | | **$S_E$** | **$S_H$** |
| 0.1 – 1 | 1842 | 16.3 / f | 9000 | 100 000 / $f^2$ |
| 1 – 30 | 1842 / f | 16.3 / f | 9000 / $f^2$ | 100 000 / $f^2$ |
| 30 – 100 | 61.4 | 16.3 / f | 10 | 100 000 / $f^2$ |
| 100 – 400 | 61.4 | 0.163 | 10 | |
| 400 - 2000 | - | - | f / 40 | |
| 2000 – 300 000 | - | - | 50 | |

**Note:** f is frequency in MHz.

Table 9: IEEE ERLs for whole-body eposure of persons permitted in restricted environments

### 4.2.1 EN 62479 RF Exposure Evaluation

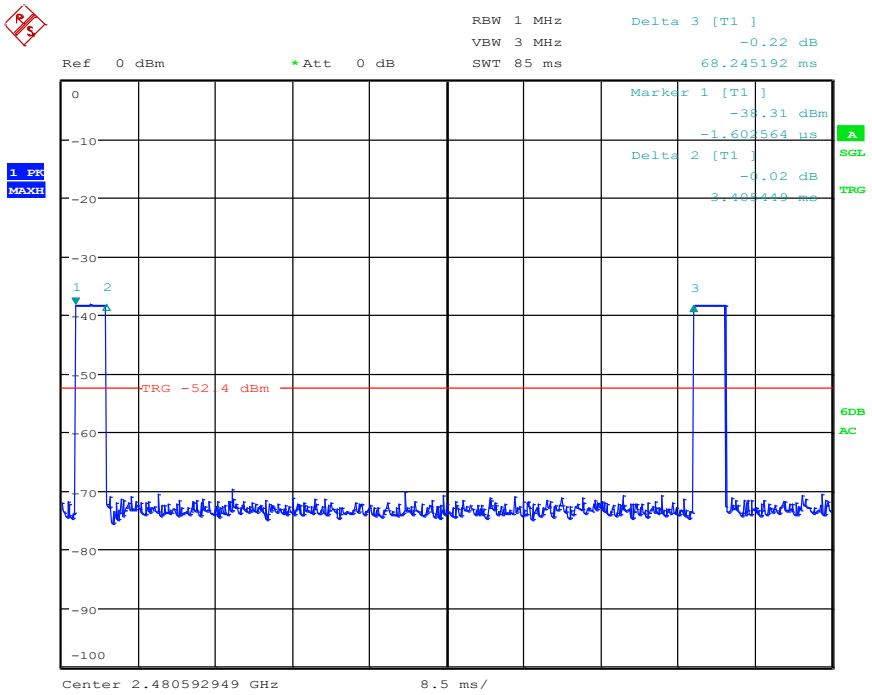
From the IEEE C95.1 table of ERLs for whole-body exposure in uncontrolled environments, the maximum power density in the 2000 – 300 000 MHz range is 10 $W/m^2$.(100 $mW/cm^2$)

| **Transmitter** | **Detail** | **Power Density ($mW/cm^2$) Note 1** | **Power Density Limit ($mW/cm^2$) Note 2** | **Result** |
|---|---|---|---|---|
| $Tx_1$ | 2.4 GHz BLE | 0.54 | 100 | Complies |

Note 1: See section 3.1.1 for calculation of transmitter power density
Note 2: Power density limit converted from $W/m^2$ to $mW/cm^2$ are multiplied by 10

Table 10: EN 62479 RF Exposure Evaluation

## 4.3 Dwell Time




Marker 1 to 2 - Pulse "ON" Duration: 3.41ms
Marker 2 to 3 – Pulse "OFF" Duration: 64.84ms

Duty Factor reduction: 10Log (On/Off) = -12.79dB

Peak Output Power: 10.33 dBm, 10.79 mW – Conducted

Peak Output Corrected: -2.46dBm = 0.57mw

***Note - Due to low transmitting power dwell time exception was not used in the RF and MPE calculations.***

# Appendix A: ABBREVIATIONS

| Abbreviation | Definition |
|---|---|
| AC | Alternating Current |
| AM | Amplitude Modulation |
| CE | European Conformity |
| CISPR | Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference) |
| DC | Direct Current |
| EFT | Electrical Fast Transient |
| EMC | Electro Magnetic Compatibility |
| EMI | Electro Magnetic Interference |
| ESD | Electrostatic Discharge |
| EUT | Equipment Under Test |
| FCC | Federal Communications Commission |
| FVIN | Firmware Version Identification Number FVIN |
| ICES | Interference Causing Equipment Standard |
| IEC | International Electrotechnical Commission |
| ISED | Innovation, Science and Economic Development (Canada) |
| LISN | Line Impedance Stabilizing Network |
| OATS | Open Area Test Site |
| RCM | Regulatory Compliance Mark |
| RF | Radio Frequency |
| RMS | Root-Mean-Square |
| SAC | Semi-Anechoic Chamber |
| UKCA | UK Conformity Assessed |

# END OF REPORT