



**EUROFINS ELECTRICAL TESTING SERVICE (SHENZHEN) CO., LTD.**

# **RADIO TEST - REPORT**

**FCC Compliance Test Report for**

**Product name: NEO S Controller**

**Model name: CK24NS**

**FCC ID: 2BAXLCK24NS**

**Test Report Number: EFGX24010146-IE-05-E05**



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## 1 General Information

### 1.1 Notes

The results of this test report relate exclusively to the item tested as specified in chapter "Description of test item" and are not transferable to any other test items.

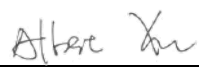
Eurofins Electrical Testing Service (Shenzhen) Co., Ltd. is not responsible for any generalisations and conclusions drawn from this report. Any modification of the test item can lead to invalidity of test results and this test report may therefore be not applicable to the modified test item.

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#### Operator:

|            |               |                                |                                                                                       |
|------------|---------------|--------------------------------|---------------------------------------------------------------------------------------|
| 2024-02-26 |               | Bruce Zheng / Project Engineer |  |
| Date       | Eurofins-Lab. | Name / Title                   | Signature                                                                             |

#### Technical responsibility for area of testing:

|            |               |                         |                                                                                       |
|------------|---------------|-------------------------|---------------------------------------------------------------------------------------|
| 2024-02-26 |               | Albert Xu / Lab Manager |  |
| Date       | Eurofins-Lab. | Name / Title            | Signature                                                                             |

## 1.2 Testing laboratory

Eurofins Electrical Testing Service (Shenzhen) Co., Ltd.

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The Laboratory has passed the Accreditation by the American Association for Laboratory Accreditation (A2LA). The Accreditation number is 5376.01

The Laboratory has been listed by industry Canada to perform electromagnetic emission measurements, The CAB identifier is CN0088

## 1.3 Details of applicant

Name : Freemode Go LLC dba CRKD  
Address : 3142 Constitution drive, Livermore, California, United States  
Telephone : +1 925 344 4045  
Fax : ./.

## 1.4 Details of manufacturer

Name : Freemode Go LLC dba CRKD  
Address : 3142 Constitution drive, Livermore, California, United States  
Telephone : +1 925 344 4045  
Fax : ./.

## 1.5 Application details

Date of receipt of application : 2024-01-11  
Date of receipt of test item : 2024-01-11  
Date of test : 2024-01-11 to 2024-01-25  
Date of issue : 2024-02-26

## 1.6 Test item

Product type : NEO S Controller  
Test Model : CK24NS  
Sample ID : 231208-10-001  
Model name : CK24NS  
Brand name : CRKD  
Serial number : ./.  
Hardware Version : V2.3  
Software / Firmware Version : VE8  
Ratings : DC 3.7V battery  
Test voltage : DC 3.7V

### RadioTechnical data

Frequency range : 2402MHz – 2480MHz  
Radio Tech. : Bluetooth Low Energy  
Frequency channel : 40 Channels  
Modulation : GFSK  
Antenna type : PCB antenna  
Maximum antenna gain : 2.499 dBi  
Additional information : ./.

The above sample(s) and sample information was/were submitted and identified on behalf of the applicant.  
Eurofins assures objectivity and impartiality of the test, and fulfills the obligation of confidentiality for applicant's commercial information and technical documents.

## 1.7 Test standards

| Test Standards        |                                                                        |
|-----------------------|------------------------------------------------------------------------|
| FCC Part 15 Subpart C | PART 15 - RADIO FREQUENCY DEVICES<br>Subpart C - Intentional Radiators |

### Test Method

- 1: ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- 2: ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless Devices.
- 3: KDB558074 D01 15.247 Meas Guidance v05r02

## 2 Technical test

### 2.1 Summary of test results

No deviations from the technical specification(s) were ascertained in the course of the tests performed.



or

The deviations as specified were ascertained in the course of the tests performed.



### 2.2 Test environment

Ac line conducted

| Environment Parameter | Temperature | Relative Humidity |
|-----------------------|-------------|-------------------|
| 101.2kPa              | 23.7 °C     | 61.3%             |

RF conducted

| Environment Parameter | Temperature | Relative Humidity |
|-----------------------|-------------|-------------------|
| 101.2kPa              | 24.7 °C     | 43.1%             |

Radiated

| Environment Parameter | Temperature | Relative Humidity |
|-----------------------|-------------|-------------------|
| 101.2kPa              | 24.3 °C     | 51.6%             |

### 2.3 Measurement uncertainty

The uncertainty is calculated using the methods suggested in the "Guide to the Expression of Uncertainty in Measurement" (GUM) published by ISO.

| System Measurement Uncertainty                               |                                                                                       |
|--------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Test Items                                                   | Extended Uncertainty                                                                  |
| Uncertainty in conducted measurements                        | 1.96dB                                                                                |
| Uncertainty for Conducted RF test                            | RF Power Conducted: 1.16dB<br>Frequency test involved:<br>1.05×10 <sup>-7</sup> or 1% |
| Uncertainty for Radiated Spurious Emission 25MHz-3000MHz     | Horizontal: 4.46dB;<br>Vertical: 4.54dB;                                              |
| Uncertainty for Radiated Spurious Emission 3000MHz-18000MHz  | Horizontal: 4.42dB;<br>Vertical: 4.41dB;                                              |
| Uncertainty for Radiated Spurious Emission 18000MHz-40000MHz | Horizontal: 4.63dB;<br>Vertical: 4.62dB;                                              |

## 2.4 Test mode

40 channels are provided for BT-LE-1M/2M:

| CHANNEL | FREQ.<br>(MHZ) | CHAN-<br>NEL | FREQ.<br>(MHZ) | CHAN-<br>NEL | FREQ.<br>(MHZ) | CHAN-<br>NEL | FREQ.<br>(MHZ) |
|---------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|
| 0       | 2402           | 10           | 2422           | 20           | 2442           | 30           | 2462           |
| 1       | 2404           | 11           | 2424           | 21           | 2444           | 31           | 2464           |
| 2       | 2406           | 12           | 2426           | 22           | 2446           | 32           | 2466           |
| 3       | 2408           | 13           | 2428           | 23           | 2448           | 33           | 2468           |
| 4       | 2410           | 14           | 2430           | 24           | 2450           | 34           | 2470           |
| 5       | 2412           | 15           | 2432           | 25           | 2452           | 35           | 2472           |
| 6       | 2414           | 16           | 2434           | 26           | 2454           | 36           | 2474           |
| 7       | 2416           | 17           | 2436           | 27           | 2456           | 37           | 2476           |
| 8       | 2418           | 18           | 2438           | 28           | 2458           | 38           | 2478           |
| 9       | 2420           | 19           | 2440           | 29           | 2460           | 39           | 2480           |

The EUT was set at continuously transmitting mode during the test.

The Lowest Channel 0, Middle 19 and Highest 39 were selected for test in the report.

## 2.5 Test equipment utilized

| EQUIPMENT ID | EQUIPMENT NAME               | MODEL NO.         | CAL. DUE DATE |
|--------------|------------------------------|-------------------|---------------|
| 23-2-13-05   | EMI Test Receiver            | ESR3              | 2024-03-21    |
| 23-2-13-06   | LISN                         | NNLK 8127 RC      | 2024-03-21    |
| 23-2-10-16   | Attenuator                   | VTSD 9561-F       | 2024-03-21    |
| 23-2-10-63   | Temperature & Humidity Meter | COS-03            | 2024-03-21    |
| 23-2-10-65   | Barometer                    | Baro              | 2024-03-21    |
| 23-2-13-12   | Signal Analyzer              | N9010B-544        | 2024-03-21    |
| 23-2-13-13   | BT/WLAN Tester               | CMW270            | 2024-03-21    |
| 23-2-13-14   | Signal Generator             | N5183B-520        | 2024-03-21    |
| 23-2-13-15   | Vector Signal Generator      | N5182B-506        | 2024-03-21    |
| 23-2-10-43   | Switch and Control Unit      | ERIT-E-JS0806-2   | 2024-03-21    |
| 23-2-10-44   | DC power supply              | E3642A            | 2024-03-21    |
| 23-2-10-45   | Temperature test chamber     | SG-80-CC-2        | 2024-03-21    |
| 23-2-10-50   | Temperature & Humidity Meter | COS-03            | 2024-03-21    |
| 23-2-10-66   | Barometer                    | Baro              | 2024-03-21    |
| 23-2-13-01   | EMI Test Receiver            | ESR7              | 2024-03-21    |
| 23-2-13-02   | Signal Analyzer              | N9020B-544        | 2024-03-21    |
| 23-2-12-01   | Active Loop Antenna          | FMZB 1519B        | 2024-05-29    |
| 23-2-12-02   | TRILOG Broadband Antenna     | VULB9168          | 2024-05-29    |
| 23-2-12-03   | Horn Antenna                 | 3117              | 2024-05-29    |
| 23-2-12-04   | Horn Antenna                 | BBHA 9170         | 2024-05-29    |
| 23-2-10-01   | Preamplifier                 | BBV9745           | 2024-03-21    |
| 23-2-10-02   | Preamplifier                 | TAP01018048       | 2024-03-21    |
| 23-2-10-03   | Preamplifier                 | TAP18040048       | 2024-03-21    |
| 23-2-10-62   | Temperature & Humidity Meter | COS-03            | 2024-03-21    |
| 23-2-10-64   | Barometer                    | Baro              | 2024-03-21    |
| 23-2-10-14   | Switch and Control Unit      | ERIT-E-JS0806-SF1 | N/A           |
| 23-2-13-03   | EMI Test Receiver            | ESR7              | 2024-03-21    |
| 23-2-13-04   | Signal Analyzer              | N9020B-526        | 2024-03-21    |
| 23-2-12-06   | Active Loop Antenna          | FMZB 1519B        | 2024-05-05    |
| 23-2-12-07   | TRILOG Broadband Antenna     | VULB9168          | 2024-05-05    |
| 23-2-12-08   | Horn Antenna                 | 3117              | 2024-05-05    |
| 23-2-10-46   | Preamplifier                 | BBV9745           | 2024-03-21    |
| 23-2-10-47   | Preamplifier                 | TAP01018048       | 2024-03-21    |
| 23-2-10-61   | Temperature & Humidity Meter | COS-03            | 2024-03-21    |
| 23-2-10-52   | Barometer                    | Baro              | 2024-03-21    |
| 23-2-10-15   | Switch and Control Unit      | ERIT-E-JS0806-SF1 | N/A           |

## 2.6 Auxiliary equipment used during test

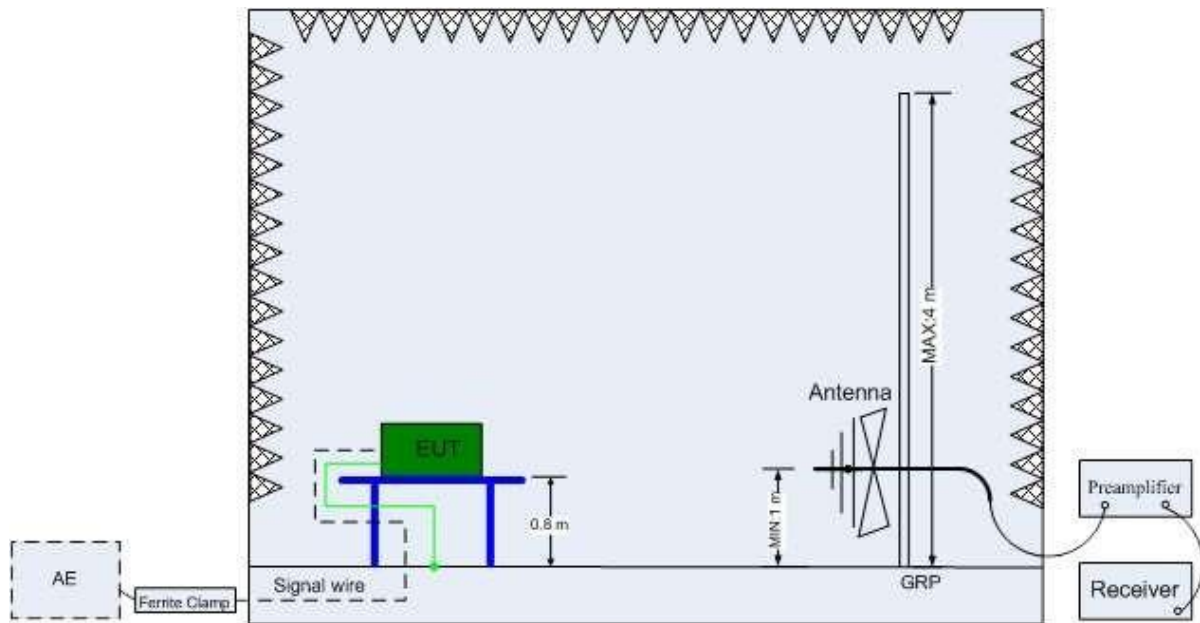
| DESCRIPTION | MANUFACTURER | MODEL NO. | S/N       |
|-------------|--------------|-----------|-----------|
| Laptop      | LENOVO       | TP00096A  | PF-1QH0LV |

## 2.7 Test software information

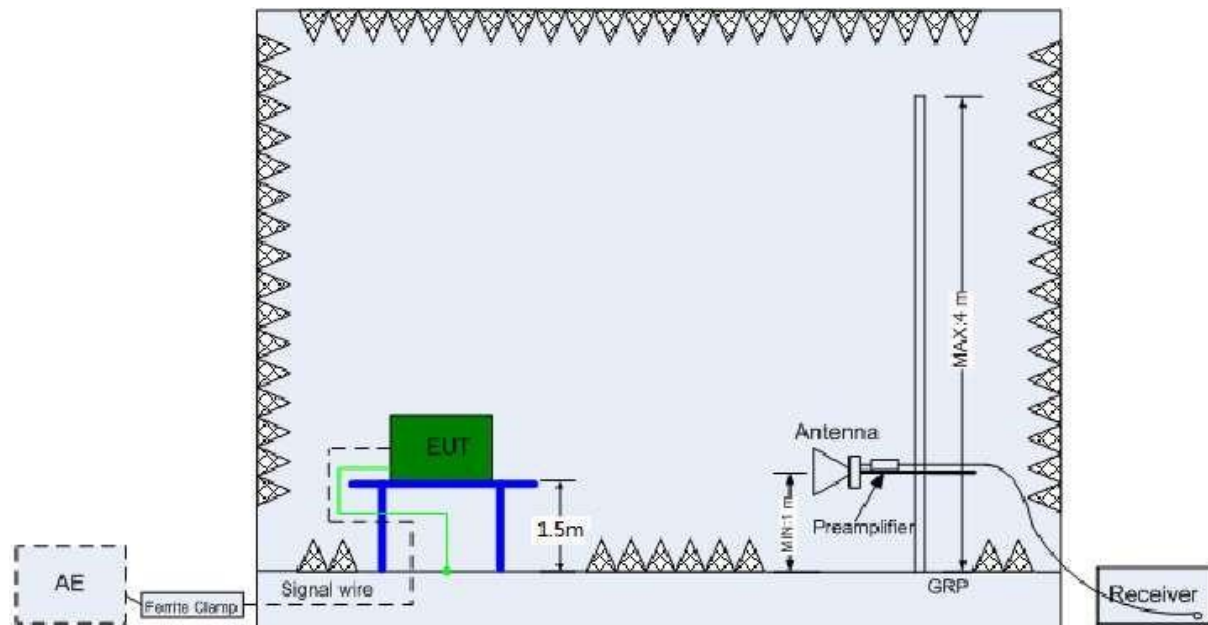
| Test Software&Version | FCC assist    |      |      |                 |
|-----------------------|---------------|------|------|-----------------|
| Mode                  | Power setting |      |      | Modulation Type |
| BLE_1M                | CH0           | CH19 | CH39 | GFSK            |
|                       | DEF           | DEF  | DEF  |                 |
| BLE_2M                | CH1           | CH19 | CH38 | GFSK            |
|                       | DEF           | DEF  | DEF  |                 |



## Radiated tests below 1GHz



## Radiated tests above 1GHz



## 2.9 Test results

☒ 1<sup>st</sup> test

☐ test after modification

☐ production test

| Technical Requirements                                |                             |                                                    |                          |         |           |
|-------------------------------------------------------|-----------------------------|----------------------------------------------------|--------------------------|---------|-----------|
| FCC Part 15 Subpart C/RSS-247 Issue 3/RSS-Gen Issue 5 |                             |                                                    |                          |         |           |
| Test Condition                                        |                             |                                                    | Test Result              | Verdict | Test Site |
| §15.207                                               | RSS-GEN 8.8                 | Conducted emission AC power port                   | Appendix J               | Pass    | Site 1    |
| §15.247(b)(1)                                         | RSS-247 Clause 5.4(b)       | Conducted output power for FHSS                    | --                       | N/A     | --        |
| §15.247(b)(3)                                         | RSS-247 Clause 5.4(d)       | Conducted output power for DTS                     | Appendix C               | Pass    | Site 1    |
| §15.247(e)                                            | RSS-247 Clause 5.2(b)       | Power spectral density                             | Appendix D               | Pass    | Site 1    |
| §15.247(a)(2)                                         | RSS-247 Clause 5.2(a)       | 6dB bandwidth                                      | Appendix A               | Pass    | Site 1    |
| §15.247(a)(1)                                         | RSS-247 Clause 5.1(a)       | 20dB Occupied bandwidth                            | --                       | N/A     | --        |
| --                                                    | RSS-GEN 6.7                 | 99% Occupied Bandwidth                             | Appendix B               | Pass    | Site 1    |
| §15.247(a)(1)                                         | RSS-247 Clause 5.1(b)       | Carrier frequency separation                       | --                       | N/A     | --        |
| §15.247(a)(1)(iii)                                    | RSS-247 Clause 5.1(d)       | Number of hopping frequencies                      | --                       | N/A     | --        |
| §15.247(a)(1)(iii)                                    | RSS-247 Clause 5.1(d)       | Dwell Time                                         | --                       | N/A     | --        |
| §15.247(d)                                            | RSS-247 Clause 5.5          | Conducted Band Edge & Conducted Spurious Emissions | Appendix E<br>Appendix F | Pass    | Site 1    |
| §15.209 & §15.205                                     | RSS-GEN 8.9<br>RSS-GEN 8.10 | Spurious emissions , Band edge & Restricted Band   | Appendix H<br>Appendix I | Pass    | Site 1    |
| --                                                    | --                          | Duty cycle                                         | Appendix G               | Pass    | Pass      |
| §15.203                                               | RSS-GEN 6.8                 | Antenna requirement                                | See note 1               | Pass    | --        |

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses PCB antenna. According to §15.203/ RSS-GEN 6.8, it is considered sufficiently to comply with the provisions of this section.

### 3 Technical Requirement

#### 3.1 Conducted emission AC power port

**Test Method:**

The test method was referred to the subclause 6.2 of ANSI C63.10-2013.

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both Neutral and Live lines.

**Limit:**

FCC §15.207 (a)

RSS-Gen 8.8

| Frequency   | QP Limit   | AV Limit   |
|-------------|------------|------------|
| MHz         | dB $\mu$ V | dB $\mu$ V |
| 0.150-0.500 | 66-56*     | 56-46*     |
| 0.500-5     | 56         | 46         |
| 5-30        | 60         | 50         |

Decreasing linear.

## 3.2 Duty cycle

### Test Method:

The test method was referred to the subclause 11.6 of ANSI C63.10-2013.

Measurements of duty cycle and transmission duration shall be performed using one of the following techniques:

- a) A diode detector and an oscilloscope that together have a sufficiently short response time to permit accurate measurements of the ON and OFF times of the transmitted signal.
- b) The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the ON and OFF times of the transmitted signal:
  - 1) Set the center frequency of the instrument to the center frequency of the transmission.
  - 2) Set  $RBW \geq OBW$  if possible; otherwise, set RBW to the largest available value.
  - 3) Set  $VBW \geq RBW$ . Set detector = peak or average.
  - 4) The zero-span measurement method shall not be used unless both RBW and VBW are  $> 50/T$  and the number of sweep points across duration  $T$  exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring the duty cycle shall not be used if  $T \leq 16.7 \mu s$ .)

Limit:

None; for reporting purposes only.

### 3.3 6dB bandwidth

**Test Method:**

The test method was referred to the subclause 11.8 of ANSI C63.10-2013.

**Option 1**

The steps for the first option are as follows:

- a) Set RBW = 100 kHz.
- b) Set the VBW  $\geq [3 \times \text{RBW}]$ .
- c) Detector = peak.
- d) Trace mode = max hold.
- e) Sweep = auto couple.
- f) Allow the trace to stabilize.
- g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

**Option 2**

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described in Option 1 (i.e., RBW = 100 kHz, VBW  $\geq 3 \times \text{RBW}$ , and peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be  $\geq 6$  dB.

**Limit:**

FCC §15.247 (a)

RSS-247 5.2 (a)

The minimum 6 dB bandwidth shall be at least 500 kHz.

### 3.4 99% Occupied Bandwidth

**Test Method:**

The test method was referred to the subclause 6.9.3 of ANSI C63.10-2013.

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

- a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than  $[10 \log (OBW/RBW)]$  below the reference level. Specific guidance is given in 4.1.5.2.
- d) Step a) through step c) might require iteration to adjust within the specified range.
- e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
- f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.
- g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.
- h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

**Limit:**

None; for reporting purposes only.

### 3.6 Conducted Peak output power

#### Test Method

The test method was referred to the subclause 11.9.1.1 of ANSI C63.10-2013.

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

- a) Set the RBW  $\geq$  DTS bandwidth.
- b) Set VBW  $\geq$   $[3 \times \text{RBW}]$ .
- c) Set span  $\geq$   $[3 \times \text{RBW}]$ .
- d) Sweep time = auto couple.
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use peak marker function to determine the peak amplitude level.

#### Limits:

##### FCC §15.247 (b) (3)

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

##### RSS-247 Clause 5.4 (d)

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

### 3.7 Power spectral density

**Test Method:**

The test method was referred to the subclause 11.10.2 of ANSI C63.10-2013.

The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

- a) Set analyzer center frequency to DTS channel center frequency.
- b) Set the span to 1.5 times the DTS bandwidth.
- c) Set the RBW to  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- d) Set the VBW  $\geq [3 \times \text{RBW}]$ .
- e) Detector = peak.
- f) Sweep time = auto couple.
- g) Trace mode = max hold.
- h) Allow trace to fully stabilize.
- i) Use the peak marker function to determine the maximum amplitude level within the RBW.
- j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

**Limit:**

FCC §15.247 (e)

RSS-247 (5.2) (b)

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### 3.8 Conducted Spurious Emissions

**Test Method:**

The test method was referred to the subclause 11.11/11.12 of ANSI C63.10-2013.

Establish a reference level by using the following procedure:

- a) Set instrument center frequency to DTS channel center frequency.
- b) Set the span to  $\geq 1.5$  times the DTS bandwidth.
- c) Set the RBW = 100 kHz.
- d) Set the VBW  $\geq [3 \times \text{RBW}]$ .
- e) Detector = peak.
- f) Sweep time = auto couple.
- g) Trace mode = max hold.
- h) Allow trace to fully stabilize.
- i) Use the peak marker function to determine the maximum PSD level.

Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

Establish an emission level by using the following procedure:

- a) Set the center frequency and span to encompass frequency range to be measured.
- b) Set the RBW = 100 kHz.
- c) Set the VBW  $\geq [3 \times \text{RBW}]$ .
- d) Detector = peak.
- e) Sweep time = auto couple.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified in 11.11. Report the three highest emissions relative to the limit.

**Limit:**

FCC §15.247 (d)

RSS-247 5.5

Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

### 3.9 Band edge

#### Test Method:

The test method was referred to the subclause 11.13.3 of ANSI C63.10-2013.

#### Peak detection

When using a peak detector to measure unwanted emissions at or near the band edge (within 2 MHz of the authorized band), the following integration procedure can be used:

- a) Set instrument center frequency to the frequency of the emission to be measured (must be within 2 MHz of the authorized band edge).
- b) Set span to 2 MHz.
- c) RBW = 100 kHz.
- d)  $VBW \geq [3 \times RBW]$ .
- e) Detector = peak.
- f) Sweep time = auto.
- g) Trace mode = max hold.
- h) Allow sweep to continue until the trace stabilizes (required measurement time may increase for low-duty-cycle applications).
- i) Compute the power by integrating the spectrum over 1 MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency ( $f_{\text{emission}} \pm 0.5$  MHz). If the instrument does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by  $f_{\text{emission}} \pm 0.5$  MHz.

#### Trace averaging with continuous EUT transmission at full power

If the EUT can be configured or modified to transmit continuously ( $D \geq 98\%$ ), then the average emission levels within 2 MHz of the authorized band edge may be measured using the following method (with EUT transmitting continuously):

- a) Set instrument center frequency to the frequency of the emission to be measured (must be within 2 MHz of the authorized band edge).
- b) Set span to 2 MHz.
- c) RBW = 100 kHz.
- d)  $VBW \geq [3 \times RBW]$ .
- e) Detector = RMS (power averaging), if  $[\text{span} / (\# \text{ of points in sweep})] \leq (RBW / 2)$ .
- f) Averaging type = power (i.e., rms):
  - 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
  - 2) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
- g) Sweep time = auto.
- h) Perform a trace average of at least 100 traces.
- i) Compute the power by integrating the spectrum over 1 MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency ( $f_{\text{emission}} \pm 0.5$  MHz). If the instrument does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by  $f_{\text{emission}} \pm 0.5$  MHz.

### Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction

If continuous transmission of the EUT ( $D \geq 98\%$ ) cannot be achieved and the duty cycle is constant (duty cycle variations are less  $\pm 2\%$ ), then the following procedure may be used to measure the average power of unwanted emissions within 2 MHz of the authorized band edge:

- a) The EUT shall be configured to operate at the maximum achievable duty cycle.
- b) Measure the duty cycle  $D$  of the transmitter output signal as described in 11.6.
- c) Set instrument center frequency to the frequency of the emission to be measured.
- d) Set span to 2 MHz.
- e) RBW = 100 kHz.
- f)  $VBW \geq 3 \times RBW$ .
- g) Detector = RMS (power averaging), if  $[\text{span} / (\# \text{ of points in sweep})] \leq (RBW / 2)$ . Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
- h) Averaging type = power (i.e., rms):
  - 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
  - 2) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
- i) Sweep time = auto.
- j) Perform a trace average of at least 100 traces.
- k) Compute the power by integrating the spectrum over 1 MHz using the instrument's band power measurement function with band limits set equal to the emission frequency ( $f_{\text{emission}} \pm 0.5 \text{ MHz}$ ). If the spectrum analyzer does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by  $f_{\text{emission}} \pm 0.5 \text{ MHz}$ .
- l) A correction factor shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
  - 1) If power averaging (rms) mode was used in step f), then the applicable correction factor is  $[10 \log (1 / D)]$ , where  $D$  is the duty cycle.
  - 2) If linear voltage averaging mode was used in step f), then the applicable correction factor is  $[20 \log (1 / D)]$ , where  $D$  is the duty cycle.
  - 3) If a specific emission is demonstrated to be continuous ( $D \geq 98\%$ ) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

Reduction of the measured emission amplitude levels to account for operational duty cycle is not permitted. Determining compliance is based on emission levels occurring during transmission—it is not based on an average across ON and OFF times of the transmitter.

**Reduced VBW averaging across ON and OFF times of the EUT transmissions with max hold**

If continuous transmission of the EUT ( $D \geq 98\%$ ) cannot be achieved and the duty cycle is not constant (duty cycle variations equal or exceed  $\pm 2\%$ ), then the following procedure may be used to measure unwanted emissions within 2 MHz of the authorized band edge:

- a) Set analyzer center frequency to the frequency of the emission to be measured.
- b) Set span to 2 MHz.
- c) RBW = 100 kHz.
- d)  $VBW \geq 1 / T$ .
- e) Video bandwidth mode or display mode:
  - 1) The analyzer shall be set to ensure that video filtering is applied in the power domain. Typically, this requires setting the detector mode to RMS (power averaging) and setting the average-VBW type to power (rms).
  - 2) As an alternative, the analyzer may be set to linear detector mode. Ensure that video filtering is applied in linear voltage domain (rather than in a log or dB domain). Some analyzers require linear display mode to accomplish this. Others have a setting for average-VBW type, which can be set to "voltage" regardless of the display mode.
- f) Detector = peak.
- g) Sweep time = auto.
- h) Trace mode = max hold.
- i) Allow max hold to run for at least  $[50 \times (1 / D)]$  traces.
- j) Compute the power by integrating the spectrum over 1 MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency ( $f_{\text{emission}} \pm 0.5$  MHz). If the spectrum analyzer does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by  $f_{\text{emission}} \pm 0.5$  MHz.

**Limit:**

FCC §15.247 (d)

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Output power was measured based on the use of a peak measurement, therefore the required at-tena-tion is 20 dB.

### 3.10 Spurious radiated emissions for transmitter

#### Test Method:

The test method was referred to the subclause 11.11/11.12 of ANSI C63.10-2013.

- 1: The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- 2: The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
- 3: The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- 4: For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- 5: Use the following spectrum analyzer settings According to C63.10:  
For Above 1GHz  
Span = wide enough to capture the peak level of the in-band emission and all spurious  
RBW = 1MHz, VBW ≥ RBW for peak measurement and VBW = 10Hz for average measurement, Sweep = auto, Detector function = peak, Trace = max hold.  
For Below 1GHz  
Use the following spectrum analyzer settings:  
Span = wide enough to capture the peak level of the in-band emission and all spurious  
RBW = 100 KHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.  
For Below 30MHz  
Use the following spectrum analyzer settings:  
Span = wide enough to capture the peak level of the in-band emission and all spurious  
RBW = 200 Hz, VBW ≥ RBW from 9KHz to 0.15MHz, RBW 9KHz VBW ≥ RBW from 0.15MHz to 30MHz for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

#### Note:

- 1: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 KHz for Quasi-peak detection (QP) at frequency below 1GHz.
- 2: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for peak detection (PK) at frequency above 1GHz.
- 3: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for RMS Average ((duty cycle < 98%) for Average detection (AV) at frequency above 1GHz, then the measurement results was added to a correction factor ( $20\log(1/\text{duty cycle})$ ).
- 4: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 10Hz (duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.
- 5: When duty cycle < 98%, The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is  $\text{VBW} \geq 1 / T$ , the T is transmission duration (T).

**Limit:**

FCC §15.205 and §15.209

RSS-GEN, Section 8.9 and 8.10.

| Frequency Range | Field Strength Limit | Field Strength Limit |
|-----------------|----------------------|----------------------|
| (MHz)           | (uV/m) at 3 m        | (dBuV/m) at 3 m      |
| 0.009-0.490     | 2400/F(kHz) @ 300 m  | -                    |
| 0.490-1.705     | 24000/F(kHz) @ 30 m  | -                    |
| 1.705 - 30      | 30 @ 30m             | -                    |
| 30 - 88         | 100                  | 40                   |
| 88 - 216        | 150                  | 43.5                 |
| 216 - 960       | 200                  | 46                   |
| Above 960       | 500                  | 54                   |

§15.205 Restricted bands of operation

| MHz               | MHz                 | MHz           | GHz         |
|-------------------|---------------------|---------------|-------------|
| 0.090-0.110       | 16.42-16.423        | 399.9-410     | 4.5-5.15    |
| 0.495-0.505       | 16.69475-16.69525   | 608-614       | 5.35-5.46   |
| 2.1735-2.1905     | 16.80425-16.80475   | 960-1240      | 7.25-7.75   |
| 4.125-4.128       | 25.5-25.67          | 1300-1427     | 8.025-8.5   |
| 4.17725-4.17775   | 37.5-38.25          | 1435-1626.5   | 9.0-9.2     |
| 4.20725-4.20775   | 73-74.6             | 1645.5-1646.5 | 9.3-9.5     |
| 6.215-6.218       | 74.8-75.2           | 1660-1710     | 10.6-12.7   |
| 6.26775-6.26825   | 108-121.94          | 1718.8-1722.2 | 13.25-13.4  |
| 6.31175-6.31225   | 123-138             | 2200-2300     | 14.47-14.5  |
| 8.291-8.294       | 149.9-150.05        | 2310-2390     | 15.35-16.2  |
| 8.362-8.366       | 156.52475-156.52525 | 2483.5-2500   | 17.7-21.4   |
| 8.37625-8.38675   | 156.7-156.9         | 2690-2900     | 22.01-23.12 |
| 8.41425-8.41475   | 162.0125-167.17     | 3260-3267     | 23.6-24.0   |
| 12.29-12.293      | 167.72-173.2        | 3332-3339     | 31.2-31.8   |
| 12.51975-12.52025 | 240-285             | 3345.8-3358   | 36.43-36.5  |
| 12.57675-12.57725 | 322-335.4           | 3600-4400     |             |
| 13.36-13.41       |                     |               |             |

## RSS-GEN 8.10

| MHz                 | MHz                   | MHz             | GHz           |
|---------------------|-----------------------|-----------------|---------------|
| 0.090 - 0.110       | 16.42 - 16.423        | 1660 - 1710     | 9.0 - 9.2     |
| 0.495 - 0.505       | 16.69475 - 16.69525   | 1718.8 - 1722.2 | 9.3 - 9.5     |
| 2.1735 - 2.1905     | 25.5 - 25.67          | 2200 - 2300     | 10.6 - 12.7   |
| 3.020 - 3.026       | 37.5 - 38.25          | 2310 - 2390     | 13.25 - 13.4  |
| 4.125 - 4.128       | 73 - 74.6             | 2483.5 - 2500   | 14.47 - 14.5  |
| 4.17725 - 4.17775   | 74.8 - 75.2           | 2655 - 2900     | 15.35 - 16.2  |
| 4.20725 - 4.20775   | 108 - 138             | 3260 - 3267     | 17.7 - 21.4   |
| 5.677 - 5.683       | 149.9 - 150.05        | 3332 - 3339     | 22.01 - 23.12 |
| 6.215 - 6.218       | 156.52475 - 156.52525 | 3345.8 - 3358   | 23.6 - 24.0   |
| 6.26775 - 6.26825   | 156.7 - 156.9         | 3500 - 4400     | 31.2 - 31.8   |
| 6.31175 - 6.31225   | 162.0125 - 167.17     | 4500 - 5150     | 36.43 - 36.5  |
| 8.291 - 8.294       | 167.72 - 173.2        | 5350 - 5460     | Above 38.6    |
| 8.362 - 8.366       | 240 - 285             | 7250 - 7750     |               |
| 8.37625 - 8.38675   | 322 - 335.4           | 8025 - 8500     |               |
| 8.41425 - 8.41475   | 399.9 - 410           |                 |               |
| 12.29 - 12.293      | 608 - 614             |                 |               |
| 12.51975 - 12.52025 | 960 - 1427            |                 |               |
| 12.57675 - 12.57725 | 1435 - 1626.5         |                 |               |
| 13.36 - 13.41       | 1645.5 - 1646.5       |                 |               |

## **4 Test Setup Photos**

Ref "EFGX24010146-IE-05-E04\_Setup\_Photos.pdf"

## **5 External Photo**

Ref "EFGX24010146-IE-05-E04\_External\_Photos.pdf"

## **6 Internal Photos**

Ref "EFGX24010146-IE-05-E04\_Internal\_Photos.pdf"

## **7 Appendix**

Ref "EFGX24010146-IE-05-E05\_appendix.pdf"

**-End of report-**