

# TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C §15.247 (FHSS),  
RSS-247 Issue 3:2023, RSS-Gen Issue 5

FOR:

**ARAD TECHNOLOGIES**

**Allegro Cellular**

**Models: PIT Unit X**

**PIT\_Unit X**

**FCC ID: 2A7AA-CM2R1PIT4G**

**IC: 28664-CM2R1PIT4G**

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## 1 Applicant information

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**Contact name:** Mr. Vily Negreanu

## 2 Equipment under test attributes

**Product name:** Allegro Cellular  
**Product type:** Transceiver  
**Model(s):** PIT Unit X\*  
**Serial number:** 80E12696A18F  
**Hardware version:** PCB00266 (1)  
**Software release:** 74.1.12  
**Receipt date** 23-May-24

\*According to manufacturer's declaration provided in Appendix G the PIT Unix X is a Super Set product that is fully identical to PIT\_Unix X, some components were added/replaced because they are required for the functionality of their specific application. This component does not change the radio functions. Therefore, only the model PIT Unix X was tested.

## 3 Manufacturer information

**Manufacturer name:** ARAD TECHNOLOGIES  
**Address:** POB 537, HaMada 4, Yokneam Ind. Zone, Yokneam Ilit 20692, Israel  
**Telephone:** 04-9935222, Ext: 271  
**Fax:** 04-9935227  
**E-Mail:** [viorel.negreanu@aradtec.com](mailto:viorel.negreanu@aradtec.com)  
**Contact name:** Mr. Vily Negreanu

## 4 Test details

**Project ID:** 54470  
**Location:** Hermon Laboratories Ltd. 66 HaTachana str., P.O. Box 23, Binyamina 3055001, Israel  
**Test started:** 27-Jun-24  
**Test completed:** 11-Jul-24  
**Test specification(s):** FCC 47CFR part 15 subpart C §15.247 (FHSS),  
RSS-247 Issue 3:2023, RSS-Gen Issue 5

## 5 Tests summary

| Test                                                                       | Status                                                            |
|----------------------------------------------------------------------------|-------------------------------------------------------------------|
| <b>Transmitter characteristics</b>                                         |                                                                   |
| Section 15.247(a)1 / RSS-247 section 5.1(c), 20 dB bandwidth               | Pass                                                              |
| Section 15.247(b) / RSS-247 section 5.4(a), Peak output power              | Pass                                                              |
| Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions       | Pass                                                              |
| Section 15.247(a)1 / RSS-247 section 5.1(b), Frequency separation          | Pass                                                              |
| Section 15.247(a)1 / RSS-247 section 5.1(c), Number of hopping frequencies | Pass                                                              |
| Section 15.247(a)1 / RSS-247 section 5.1(c), Average time of occupancy     | Pass                                                              |
| Section 15.247(i)5 / RSS-102 section 2.5, RF exposure                      | Pass, the exhibit to the application of certification is provided |
| Section 15.247(d) / RSS-247 section 5.5, Emissions at band edges           | Pass                                                              |
| Section 15.207(a) / RSS-Gen section 8.8, Conducted emission                | Not required                                                      |
| Section 15.203 / RSS-Gen section 8.3, Antenna requirements                 | Pass                                                              |

This is to request a Class II Permissive Change for FCC ID: 2A7AA-CM2R1PIT4G, original granted on 23/08/2024. The change filed under this application is:

1. To add additional Hybrid Spread spectrum technique for LoRa wireless technology via embedded software.

Except outlined above, Certified product remain identical to original one.

This test report supersedes the previously issued test report identified by Doc ID: ARARAD\_FCC.54470\_LoRa\_Rev2

Testing was completed against all relevant requirements of the test standard. However, results obtained indicate that the product under test complies in full with the requirements tested.  
The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

|                     | Name and Title                                                     | Date                  | Signature                                                                             |
|---------------------|--------------------------------------------------------------------|-----------------------|---------------------------------------------------------------------------------------|
| <b>Tested by:</b>   | Mrs. E. Pitt, test engineer,<br>EMC & Radio                        | 27-Jun-24 – 11-Jul-24 |  |
| <b>Reviewed by:</b> | Mrs. S. Peysahov Sheynin, certification<br>specialist, EMC & Radio | 20-Jul-24             |  |
| <b>Approved by:</b> | Mr. M. Nikishin, group leader,<br>EMC & Radio                      | 09-Oct-24             |  |

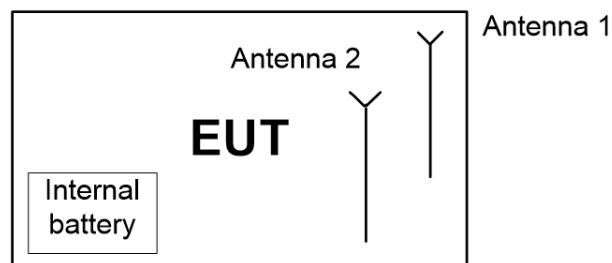
## 6 EUT description

Note: The following data in this clause is provided by the customer and represents his sole responsibility

### 6.1 General information

The Allegro cellular PIT booster Module is a battery-operated radio module designed for automated water meter reading. The Allegro cellular is capable of reading water consumption data from residential and commercial water meters equipped with an Encoder or Solid-State Register. It uses CAT-M cellular / LoRaWAN radio for relaying water consumption data to the utility. And Bluetooth short range wireless technology for unit parameters configuration and maintenance interface.

### 6.2 Test configuration



### 6.3 Transmitter characteristics

|                                                                               |                                                                                                          |                                                           |                                   |                                |                                |  |
|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------|--------------------------------|--------------------------------|--|
| <b>Type of equipment</b>                                                      |                                                                                                          |                                                           |                                   |                                |                                |  |
| X                                                                             | Stand-alone (Equipment with or without its own control provisions)                                       |                                                           |                                   |                                |                                |  |
|                                                                               | Combined equipment (Equipment where the radio part is fully integrated within another type of equipment) |                                                           |                                   |                                |                                |  |
|                                                                               | Plug-in card (Equipment intended for a variety of host systems)                                          |                                                           |                                   |                                |                                |  |
| <b>Intended use</b>                                                           |                                                                                                          | <b>Condition of use</b>                                   |                                   |                                |                                |  |
| X                                                                             | fixed                                                                                                    | Always at a distance more than 2 m from all people        |                                   |                                |                                |  |
|                                                                               | mobile                                                                                                   | Always at a distance more than 20 cm from all people      |                                   |                                |                                |  |
|                                                                               | portable                                                                                                 | May operate at a distance closer than 20 cm to human body |                                   |                                |                                |  |
| <b>Assigned frequency ranges</b>                                              |                                                                                                          | 902 – 928 MHz                                             |                                   |                                |                                |  |
| <b>Operating frequencies</b>                                                  |                                                                                                          | 902.3 – 914.9 MHz                                         |                                   |                                |                                |  |
| <b>Maximum rated output power</b>                                             |                                                                                                          | At transmitter 50 $\Omega$ RF output connector            |                                   |                                | dBm                            |  |
|                                                                               |                                                                                                          | Peak output power                                         |                                   |                                | 27.94 dBm                      |  |
| <b>Is transmitter output power variable?</b>                                  |                                                                                                          | X                                                         | No                                |                                |                                |  |
|                                                                               |                                                                                                          |                                                           | Yes                               |                                | continuous variable            |  |
|                                                                               |                                                                                                          |                                                           |                                   | stepped variable with stepsize | dB                             |  |
|                                                                               |                                                                                                          |                                                           |                                   | minimum RF power               | dBm                            |  |
|                                                                               |                                                                                                          |                                                           |                                   | maximum RF power               | dBm                            |  |
| <b>Antenna connection</b>                                                     |                                                                                                          |                                                           |                                   |                                |                                |  |
| unique coupling                                                               |                                                                                                          | standard connector                                        |                                   | X                              | integral                       |  |
|                                                                               |                                                                                                          |                                                           |                                   | X                              | without temporary RF connector |  |
| <b>Antenna/s technical characteristics</b>                                    |                                                                                                          |                                                           |                                   |                                |                                |  |
| <b>Type</b>                                                                   |                                                                                                          | <b>Manufacturer</b>                                       |                                   | <b>Model number</b>            |                                |  |
| Integrated                                                                    |                                                                                                          | Inhouse design                                            |                                   | N/A                            |                                |  |
| <b>Transmitter aggregate data rate/s</b>                                      |                                                                                                          | 980bps<br>5470bps                                         |                                   |                                |                                |  |
| <b>Type of modulation</b>                                                     |                                                                                                          | Chirp Spread Spectrum CSS                                 |                                   |                                |                                |  |
| <b>Modulating test signal (baseband)</b>                                      |                                                                                                          | LoRa                                                      |                                   |                                |                                |  |
| <b>Transmitter power source</b>                                               |                                                                                                          |                                                           |                                   |                                |                                |  |
| X                                                                             | Battery                                                                                                  | <b>Nominal rated voltage</b>                              | 3.6 VDC                           | <b>Battery type</b>            | Lithium Inorganic battery      |  |
|                                                                               | DC                                                                                                       | <b>Nominal rated voltage</b>                              |                                   |                                |                                |  |
|                                                                               | AC mains                                                                                                 | <b>Nominal rated voltage</b>                              |                                   | <b>Frequency</b>               |                                |  |
| <b>Common power source for transmitter and receiver</b>                       |                                                                                                          |                                                           |                                   | X                              | yes                            |  |
|                                                                               |                                                                                                          |                                                           |                                   |                                | no                             |  |
| <b>Spread spectrum technique used</b>                                         |                                                                                                          | X                                                         | Frequency hopping (FHSS)          |                                |                                |  |
|                                                                               |                                                                                                          |                                                           | Digital transmission system (DTS) |                                |                                |  |
|                                                                               |                                                                                                          |                                                           | Hybrid                            |                                |                                |  |
| <b>Spread spectrum parameters for transmitters tested per FCC 15.247 only</b> |                                                                                                          |                                                           |                                   |                                |                                |  |
| FHSS                                                                          | Total number of hops                                                                                     |                                                           | 64                                |                                |                                |  |
|                                                                               | Bandwidth per hop                                                                                        |                                                           | 144.36 kHz                        |                                |                                |  |
|                                                                               | Max. separation of hops                                                                                  |                                                           | 200 kHz                           |                                |                                |  |



|                                                                                        |                                |                               |                       |
|----------------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10, section 7.8.7                                      |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                           |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 27-Jun-24                                                              |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                              | <b>Relative Humidity:</b> 58 % | <b>Air Pressure:</b> 1012 hPa | <b>Power:</b> 3.6 VDC |
| <b>Remarks:</b>                                                                        |                                |                               |                       |

## 7 Transmitter tests according to 47CFR part 15 subpart C and RSS-247 requirements

### 7.1 20 dB bandwidth

#### 7.1.1 General

This test was performed to measure the 20 dB bandwidth of the transmitter hopping channel. Specification test limits are given in Table 7.1.1.

Table 7.1.1 The 20 dB bandwidth limits

| Assigned frequency, MHz | Maximum bandwidth, kHz | Modulation envelope reference points*, dBc |
|-------------------------|------------------------|--------------------------------------------|
| 902.0 – 928.0           | 250                    | 20                                         |
| 2400.0 – 2483.5         | NA                     |                                            |
| 5725.0 – 5850.0         | 1000                   |                                            |

\* - Modulation envelope reference points provided in terms of attenuation below the peak of modulated carrier.

#### 7.1.2 Test procedure

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.

7.1.2.2 The EUT was set to transmit modulated carrier at maximum data rate.

7.1.2.3 The transmitter bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.1.2 and associated plot.

7.1.2.4 The test was repeated for each data rate and each modulation format.

Figure 7.1.1 The 20 dB bandwidth test setup





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|                                                                                        |                                |                               |                       |
|----------------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10, section 7.8.7                                      |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                           |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 27-Jun-24                                                              |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                              | <b>Relative Humidity:</b> 58 % | <b>Air Pressure:</b> 1012 hPa | <b>Power:</b> 3.6 VDC |
| <b>Remarks:</b>                                                                        |                                |                               |                       |

Table 7.1.2 The 20 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 902-928 MHz  
DETECTOR USED: Peak  
SWEEP TIME: Auto  
VIDEO BANDWIDTH: ≥ RBW  
FREQUENCY HOPPING: Disabled

REQUENCY HOPPING: Disabled

| Carrier frequency, MHz | Type of modulation | Data rate, bps | 99% OBW kHz | 20 dB bandwidth, kHz | Limit, kHz | Margin, kHz | Verdict |
|------------------------|--------------------|----------------|-------------|----------------------|------------|-------------|---------|
| Low frequency          |                    |                |             |                      |            |             |         |
| 902.3                  | LoRa               | 980            | 126.05      | 143.86               | 250        | -106.14     | Pass    |
|                        |                    | 5470           | 127.24      | 137.86               | 250        | -112.14     | Pass    |
| Mid frequency          |                    |                |             |                      |            |             |         |
| 908.7                  | LoRa               | 980            | 126.28      | 144.36               | 250        | -105.64     | Pass    |
|                        |                    | 5470           | 127.20      | 138.86               | 250        | -111.14     | Pass    |
| High frequency         |                    |                |             |                      |            |             |         |
| 914.9                  | LoRa               | 980            | 126.02      | 143.86               | 250        | -106.14     | Pass    |
|                        |                    | 5470           | 127.08      | 137.86               | 250        | -112.14     | Pass    |

**Reference numbers of test equipment used**

|         |         |         |  |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|--|
| HL 5288 | HL 5902 | HL 3903 |  |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|--|

Full description is given in Appendix A.





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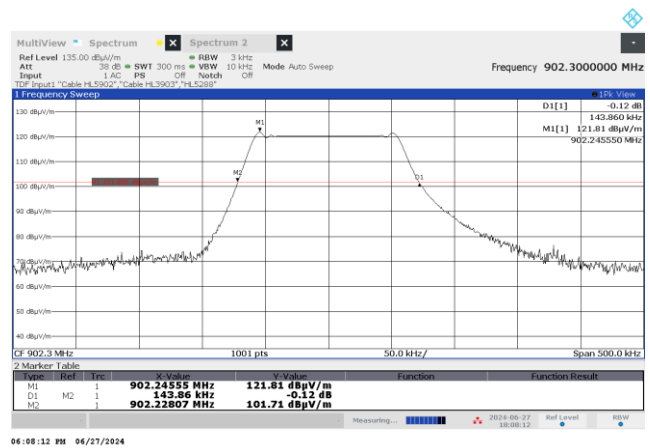
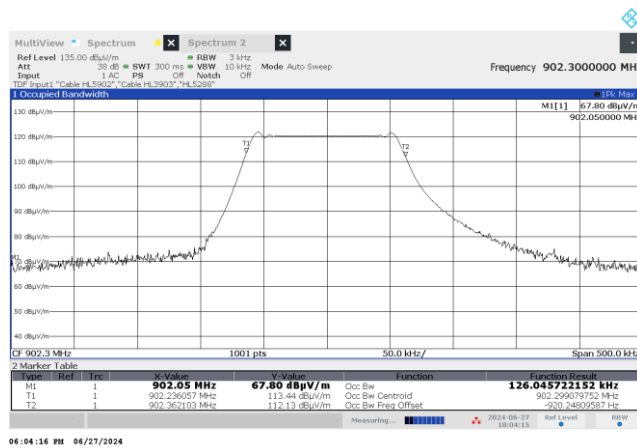
|                                                                                 |                         |                        |                |
|---------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth |                         |                        |                |
| Test procedure: ANSI C63.10, section 7.8.7                                      |                         |                        |                |
| Test mode: Compliance                                                           |                         | Verdict: PASS          |                |
| Date(s): 27-Jun-24                                                              |                         |                        |                |
| Temperature: 23 °C                                                              | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                        |                         |                        |                |

Plot 7.1.1 20 dB bandwidth test result at low frequency

BIT RATE 980 bps

99%OBW

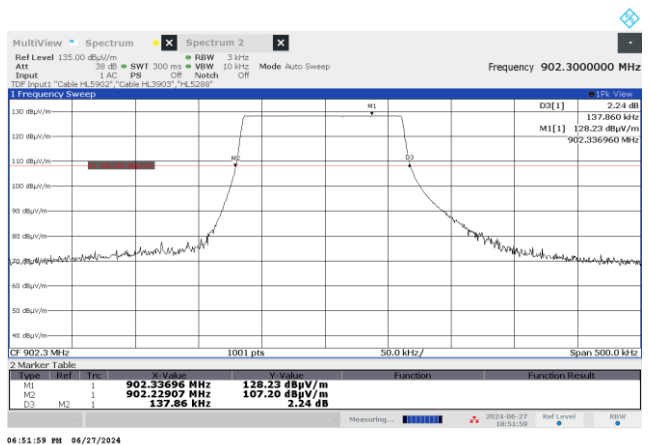
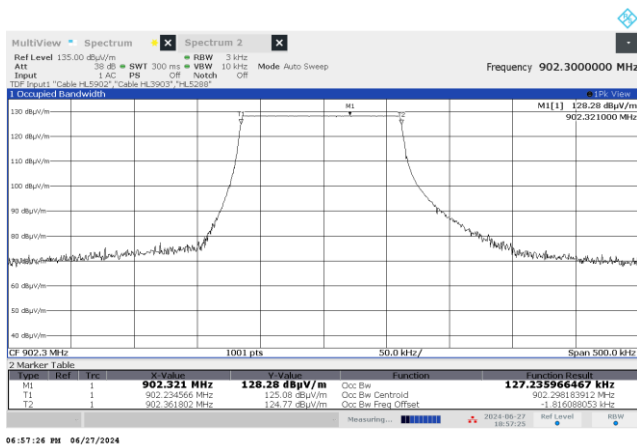
20 dB OBW



BIT RATE 5470 bps

99%OBW

20 dB OBW





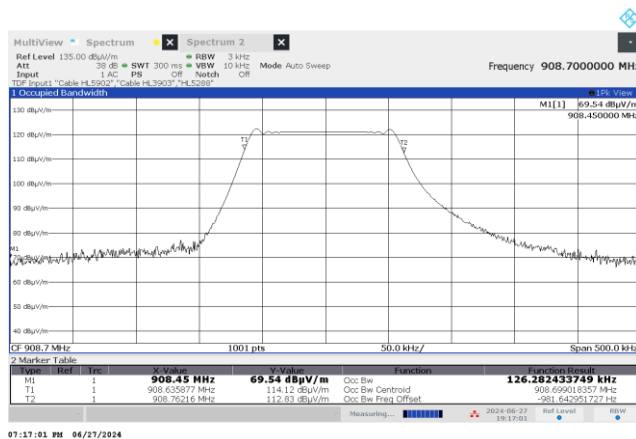
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|                                                                                 |                         |                        |                |
|---------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth |                         |                        |                |
| Test procedure: ANSI C63.10, section 7.8.7                                      |                         |                        |                |
| Test mode: Compliance                                                           |                         | Verdict: PASS          |                |
| Date(s): 27-Jun-24                                                              |                         |                        |                |
| Temperature: 23 °C                                                              | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                        |                         |                        |                |

Plot 7.1.2 The 20 dB bandwidth test result at mid frequency

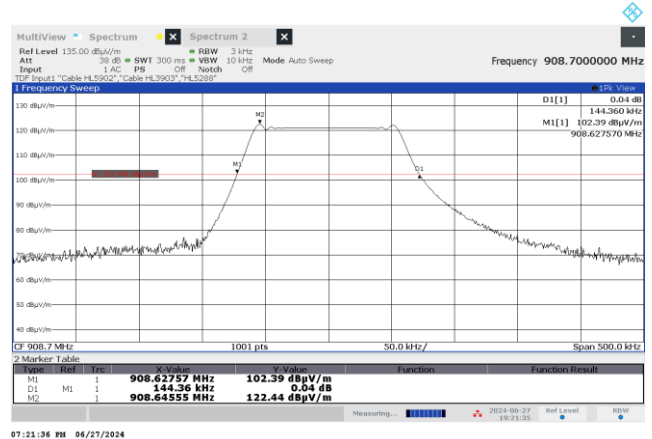
BIT RATE 980 bps

99%OBW



07:17:01 PM 06/27/2024

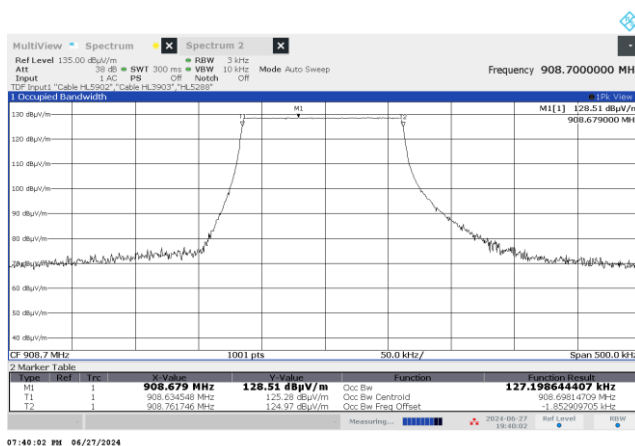
20 dB OBW



07:21:36 PM 06/27/2024

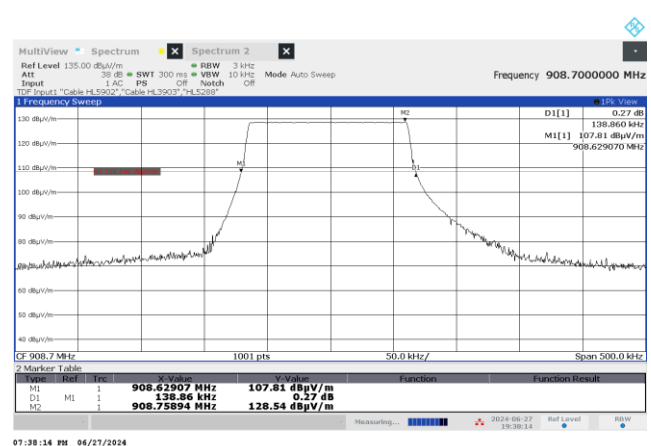
BIT RATE 5470 bps

99%OBW



07:40:02 PM 06/27/2024

20 dB OBW



07:38:14 PM 06/27/2024



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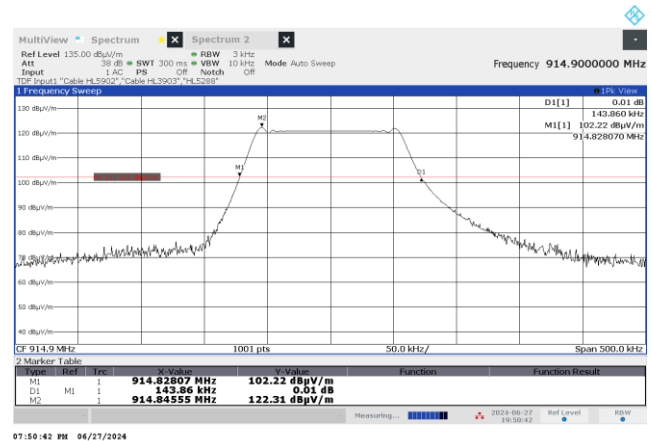
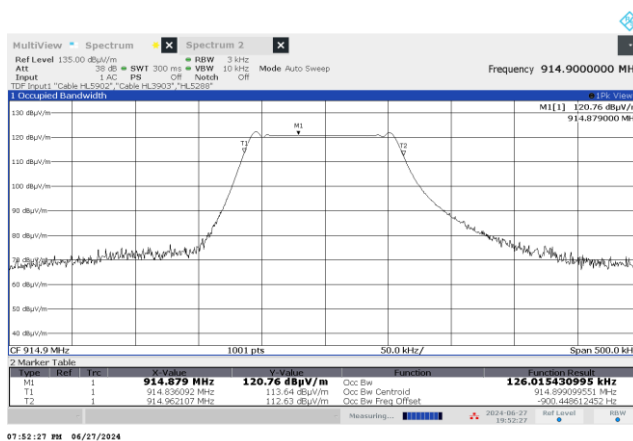
|                                                                                 |                         |                        |                |
|---------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), 20 dB bandwidth |                         |                        |                |
| Test procedure: ANSI C63.10, section 7.8.7                                      |                         |                        |                |
| Test mode: Compliance                                                           |                         | Verdict: PASS          |                |
| Date(s): 27-Jun-24                                                              |                         |                        |                |
| Temperature: 23 °C                                                              | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                        |                         |                        |                |

Plot 7.1.3 The 20 dB bandwidth test result at high frequency

BIT RATE 980 bps

99%OBW

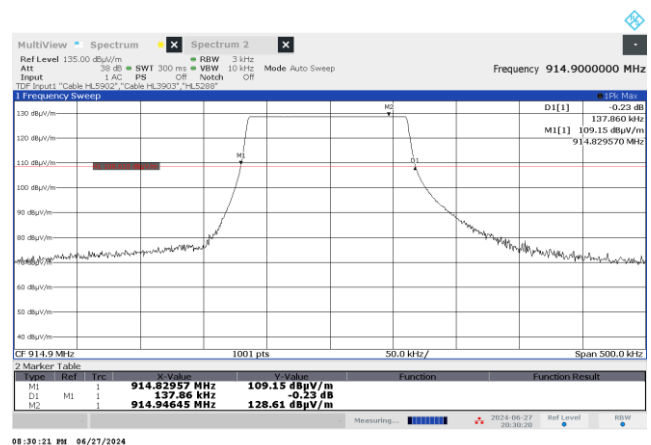
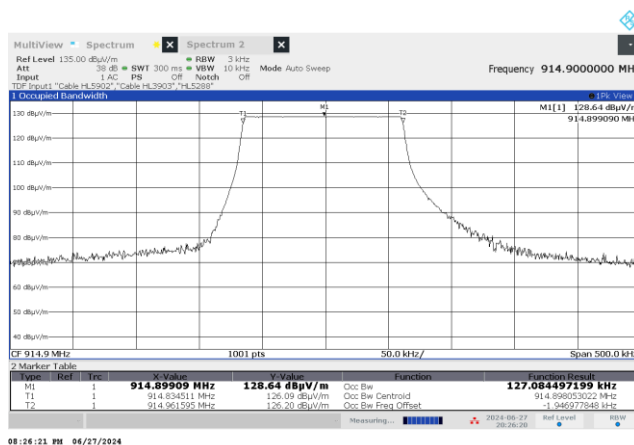
20 dB OBW



BIT RATE 5470 bps

99%OBW

20 dB OBW





|                                                                                             |                                |                               |                       |
|---------------------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(a)1, RSS-247 section 5.1(2), Frequency separation |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10, section 7.8.2                                           |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                                |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 01-Jul-24                                                                   |                                |                               |                       |
| <b>Temperature:</b> 25 °C                                                                   | <b>Relative Humidity:</b> 47 % | <b>Air Pressure:</b> 1003 hPa | <b>Power:</b> 3.6 VDC |
| <b>Remarks:</b>                                                                             |                                |                               |                       |

## 7.2 Carrier frequency separation

### 7.2.1 General

This test was performed to measure frequency separation between the peaks of adjacent channels. Specification test limits are given in Table 7.2.1.

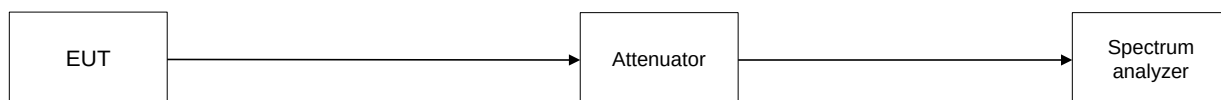
Table 7.2.1 Carrier frequency separation limits

| Assigned frequency range,<br>MHz | Carrier frequency separation                                                 |                                                                                                |
|----------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
|                                  | Output power 30 dBm                                                          | Output power 21 dBm                                                                            |
| 902.0 – 928.0                    | 25 kHz or 20 dB bandwidth of the<br>hopping channel,<br>whichever is greater | 25 kHz or two-thirds of the 20 dB<br>bandwidth of the hopping channel,<br>whichever is greater |
| 2400.0 – 2483.5                  |                                                                              |                                                                                                |
| 5725.0 – 5850.0                  |                                                                              |                                                                                                |

### 7.2.2 Test procedure

- 7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized with frequency hopping function enabled and its proper operation was checked.
- 7.2.2.2 The spectrum analyzer span was set to capture the carrier frequency and both of adjacent channels, the lower and the higher. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.2.2.3 The spectrum analyzer was set in max hold mode and allowed trace to stabilize.
- 7.2.2.4 The frequency separation between the peaks of adjacent channels was measured as provided in Table 7.2.2 and associated plots.

Figure 7.2.1 Carrier frequency separation test setup





|                                                                                             |                                |                               |                       |
|---------------------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(a)1, RSS-247 section 5.1(2), Frequency separation |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10, section 7.8.2                                           |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                                |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 01-Jul-24                                                                   |                                |                               |                       |
| <b>Temperature:</b> 25 °C                                                                   | <b>Relative Humidity:</b> 47 % | <b>Air Pressure:</b> 1003 hPa | <b>Power:</b> 3.6 VDC |
| <b>Remarks:</b>                                                                             |                                |                               |                       |

Table 7.2.2 Carrier frequency separation test results

ASSIGNED FREQUENCY: 902.0 – 928.0 MHz  
 MODULATION: LoRa  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH:  $\geq 1\%$  of the span  
 VIDEO BANDWIDTH:  $\geq$  RBW  
 FREQUENCY HOPPING: Enabled

BIT RATE: 980 bps  
 20 dB BANDWIDTH: 144.36 kHz

| Carrier frequency separation, kHz | Limit, kHz | Margin, kHz* | Verdict |
|-----------------------------------|------------|--------------|---------|
| 200                               | 144.36     | -55.64       | Pass    |

BIT RATE: 5470 bps  
 20 dB BANDWIDTH: 138.86 kHz

| Carrier frequency separation, kHz | Limit, kHz | Margin, kHz* | Verdict |
|-----------------------------------|------------|--------------|---------|
| 200                               | 138.86     | -60.14       | Pass    |

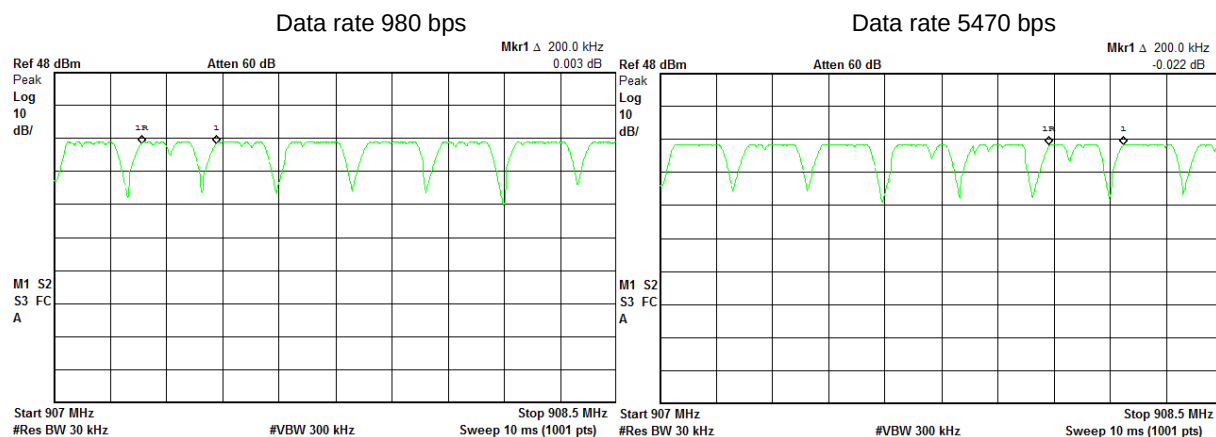
\* - Margin = Carrier frequency separation – specification limit.

## Reference numbers of test equipment used

|         |         |         |         |         |  |  |  |
|---------|---------|---------|---------|---------|--|--|--|
| HL 2780 | HL 3434 | HL 4136 | HL 7546 | HL 5622 |  |  |  |
|---------|---------|---------|---------|---------|--|--|--|

Full description is given in Appendix A.

Plot 7.2.1 Carrier frequency separation





|                     |                         |                                                                           |                |
|---------------------|-------------------------|---------------------------------------------------------------------------|----------------|
| Test specification: |                         | Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies |                |
| Test procedure:     |                         | ANSI C63.10, section 7.8.3                                                |                |
| Test mode:          |                         | Verdict: PASS                                                             |                |
| Date(s):            |                         |                                                                           |                |
| 01-Jul-24           |                         |                                                                           |                |
| Temperature: 25 °C  | Relative Humidity: 47 % | Air Pressure: 1003 hPa                                                    | Power: 3.6 VDC |
| Remarks:            |                         |                                                                           |                |

## 7.3 Number of hopping frequencies

### 7.3.1 General

This test was performed to calculate the number of hopping frequencies used by the EUT. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Minimum number of hopping frequencies

| Assigned frequency range, MHz | Number of hopping frequencies                                                                         |
|-------------------------------|-------------------------------------------------------------------------------------------------------|
| 902.0 – 928.0                 | 50 (if the 20 dB bandwidth is less than 250 kHz)<br>25 (if the 20 dB bandwidth is 250 kHz or greater) |
| 2400.0 – 2483.5               | 15                                                                                                    |
| 5725.0 – 5850.0               | 75                                                                                                    |

### 7.3.2 Test procedure

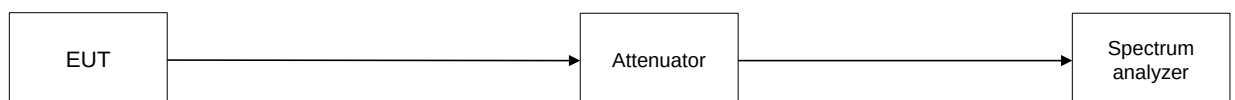
**7.3.2.1** The EUT was set up as shown in Figure 7.3.1, energized with frequency hopping function enabled and its proper operation was checked.

**7.3.2.2** Initially the spectrum analyzer span was set equal to frequency band of operation and the resolution bandwidth was set wider than 1 % of the frequency span. If the separate hopping channels were not clearly resolved the frequency band of operation was broken to sections and the resolution bandwidth was set wider than 1 % of the frequency span of each section.

**7.3.2.3** The spectrum analyzer was set in max hold mode and allowed trace to stabilize.

**7.3.2.4** The number of frequency hopping channels was calculated as provided in Table 7.3.2 and associated plots.

Figure 7.3.1 Hopping frequencies test setup





|                     |                         |                                                                           |                |
|---------------------|-------------------------|---------------------------------------------------------------------------|----------------|
| Test specification: |                         | Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies |                |
| Test procedure:     |                         | ANSI C63.10, section 7.8.3                                                |                |
| Test mode:          |                         | Verdict: PASS                                                             |                |
| Date(s):            |                         |                                                                           |                |
| 01-Jul-24           |                         |                                                                           |                |
| Temperature: 25 °C  | Relative Humidity: 47 % | Air Pressure: 1003 hPa                                                    | Power: 3.6 VDC |
| Remarks:            |                         |                                                                           |                |

Table 7.3.2 Hopping frequencies test results

ASSIGNED FREQUENCY: 902.0 – 928.0 MHz  
MODULATION: LoRa  
DETECTOR USED: Peak  
FREQUENCY HOPPING: Enabled

BIT RATE: 980 bps

| Number of hopping frequencies | Minimum number of hopping frequencies | Margin* | Verdict |
|-------------------------------|---------------------------------------|---------|---------|
| 64                            | 50                                    | 14      | Pass    |

BIT RATE: 5470 bps

| Number of hopping frequencies | Minimum number of hopping frequencies | Margin* | Verdict |
|-------------------------------|---------------------------------------|---------|---------|
| 64                            | 50                                    | 14      | Pass    |

\* - Margin = Number of hopping frequencies – Minimum number of hopping frequencies.

**Reference numbers of test equipment used**

|         |         |         |         |         |  |  |  |
|---------|---------|---------|---------|---------|--|--|--|
| HL 2780 | HL 4136 | HL 3434 | HL 7546 | HL 5622 |  |  |  |
|---------|---------|---------|---------|---------|--|--|--|

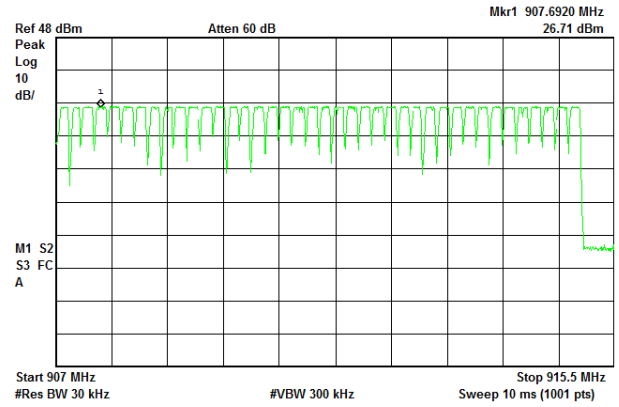
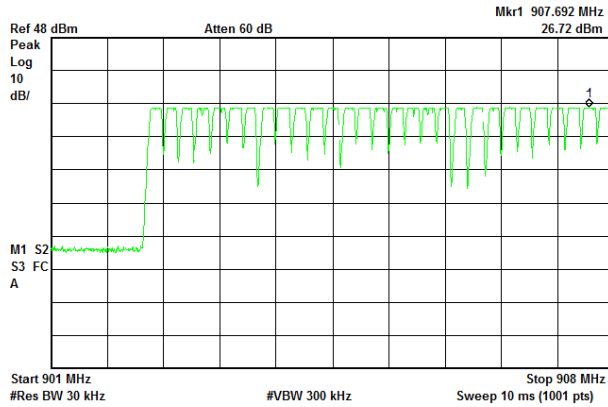
Full description is given in Appendix A.



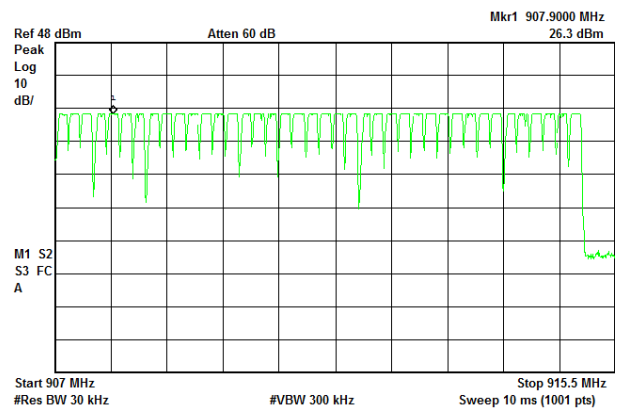
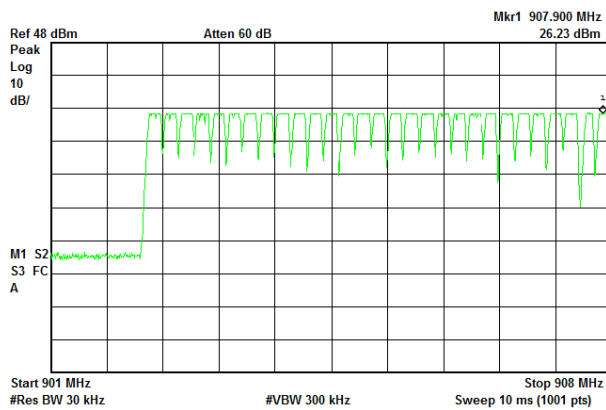
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|                     |                         |                                                                           |                |
|---------------------|-------------------------|---------------------------------------------------------------------------|----------------|
| Test specification: |                         | Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies |                |
| Test procedure:     |                         | ANSI C63.10, section 7.8.3                                                |                |
| Test mode:          |                         | Verdict: PASS                                                             |                |
| Date(s):            |                         |                                                                           |                |
| 01-Jul-24           |                         |                                                                           |                |
| Temperature: 25 °C  | Relative Humidity: 47 % | Air Pressure: 1003 hPa                                                    | Power: 3.6 VDC |
| Remarks:            |                         |                                                                           |                |

Plot 7.3.1 Number of hopping frequencies with bit rate 980 bps



Plot 7.3.2 Number of hopping frequencies with bit rate 5470 bps







|                                                                                                  |                                |                               |                       |
|--------------------------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10, section 7.8.4                                                |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                                     |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 01-Jul-24                                                                        |                                |                               |                       |
| <b>Temperature:</b> 25 °C                                                                        | <b>Relative Humidity:</b> 47 % | <b>Air Pressure:</b> 1003 hPa | <b>Power:</b> 3.6 VDC |
| <b>Remarks:</b>                                                                                  |                                |                               |                       |

## 7.4 Average time of occupancy

### 7.4.1 General

This test was performed to calculate the average time of occupancy (dwell time) on any frequency channel of the EUT. Specification test limits are given in Table 7.4.1.

**Table 7.4.1 Average time of occupancy limits**

| Assigned frequency range, MHz | Maximum average time of occupancy, s | Investigated period, s | Number of hopping frequencies |
|-------------------------------|--------------------------------------|------------------------|-------------------------------|
| 902.0 – 928.0                 | 0.4                                  | 20.0                   | ≥ 50                          |
| 902.0 – 928.0                 | 0.4                                  | 10.0                   | < 50                          |
| 2400.0 – 2483.5               | 0.4                                  | 0.4 × N                | N (≥ 15)                      |
| 5725.0 – 5850.0               | 0.4                                  | 30.0                   | ≥ 75                          |

### 7.4.2 Test procedure

- 7.4.2.1** The EUT was set up as shown in Figure 7.4.1, energized with frequency hopping function enabled and its proper operation was checked.
- 7.4.2.2** The spectrum analyzer span was set to zero centered on a hopping channel.
- 7.4.2.3** The single transmission duration and period were measured with oscilloscope.
- 7.4.2.4** The average time of occupancy was calculated as the single transmission time multiplied by the investigated period and divided by the single transmission period.
- 7.4.2.5** The test was repeated at each data rate and modulation type as provided in Table 7.4.2 and associated plots.

**Figure 7.4.1 Average time of occupancy test setup**





|                                                                                                  |                                |                               |                       |
|--------------------------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10, section 7.8.4                                                |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                                     |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 01-Jul-24                                                                        |                                |                               |                       |
| <b>Temperature:</b> 25 °C                                                                        | <b>Relative Humidity:</b> 47 % | <b>Air Pressure:</b> 1003 hPa | <b>Power:</b> 3.6 VDC |
| <b>Remarks:</b>                                                                                  |                                |                               |                       |

Table 7.4.2 Average time of occupancy test results

ASSIGNED FREQUENCY: 902.0 – 928.0 MHz  
 MODULATION: LoRa  
 DETECTOR USED: Peak  
 NUMBER OF HOPPING FREQUENCIES: 64  
 INVESTIGATED PERIOD: 21 s  
 FREQUENCY HOPPING: Enabled

| Carrier frequency, MHz | Single transmission duration, s | Number of transmissions within investigated period | Average time of occupancy*, s | Bit rate, bps | Limit, s | Margin, s** | Verdict |
|------------------------|---------------------------------|----------------------------------------------------|-------------------------------|---------------|----------|-------------|---------|
| 908.7                  | 0.3715                          | 1                                                  | 0.37                          | 980           | 0.4      | -0.03       | Pass    |
| 914.9                  | 0.3715                          | 1                                                  | 0.37                          | 5470          | 0.4      | -0.03       | Pass    |

\* - Average time of occupancy = (Single transmission duration × Investigated period) / (Single transmission period × number of hopping channels).

\*\* - Margin = Average time of occupancy – specification limit.

**Reference numbers of test equipment used**

|         |         |         |         |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|
| HL 2780 | HL 4136 | HL 7546 | HL 5622 |  |  |  |  |
|---------|---------|---------|---------|--|--|--|--|

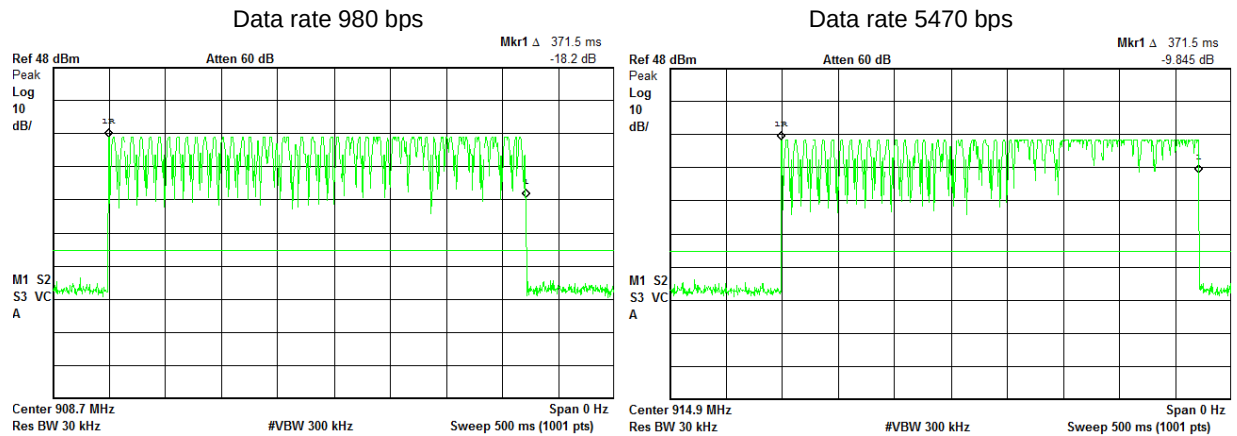
Full description is given in Appendix A.



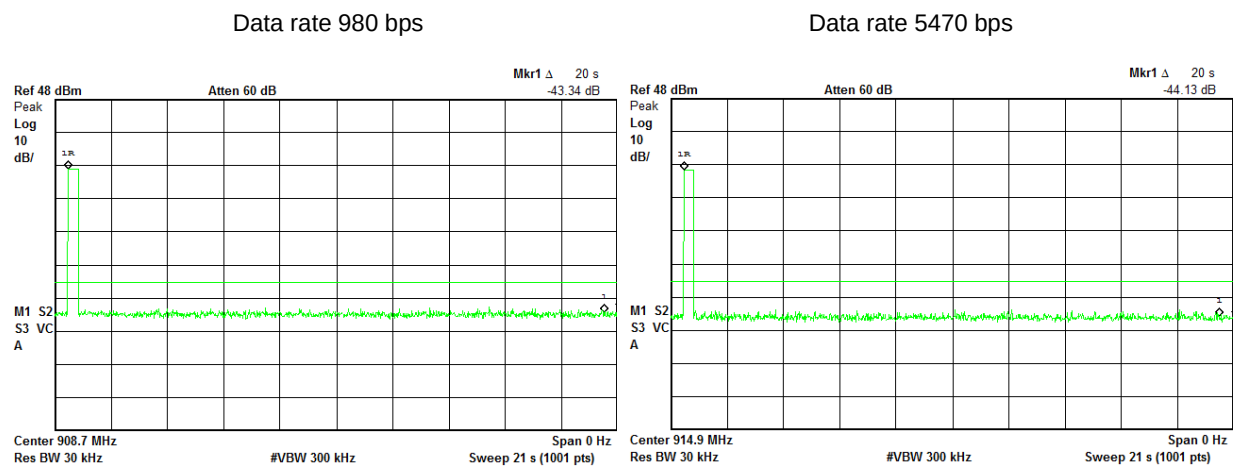
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|                                                                                           |                         |                        |                |
|-------------------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy |                         |                        |                |
| Test procedure: ANSI C63.10, section 7.8.4                                                |                         |                        |                |
| Test mode: Compliance                                                                     |                         | Verdict: PASS          |                |
| Date(s): 01-Jul-24                                                                        |                         |                        |                |
| Temperature: 25 °C                                                                        | Relative Humidity: 47 % | Air Pressure: 1003 hPa | Power: 3.6 VDC |
| Remarks:                                                                                  |                         |                        |                |

Plot 7.4.1 Single transmission duration



Plot 7.4.2 Number of transmissions within investigated period





|                                                                                  |                         |                        |                |
|----------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power |                         |                        |                |
| Test procedure: ANSI C63.10, section 7.8.5                                       |                         |                        |                |
| Test mode: Compliance                                                            |                         | Verdict: PASS          |                |
| Date(s): 04-Jul-24                                                               |                         |                        |                |
| Temperature: 24 °C                                                               | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                         |                         |                        |                |

## 7.5 Peak output power

### 7.5.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.5.1.

**Table 7.5.1 Peak output power limits**

| Assigned frequency range, MHz | Peak output power*           |                             | Equivalent field strength limit @ 3m, dB(μV/m)* | Maximum antenna gain, dBi |
|-------------------------------|------------------------------|-----------------------------|-------------------------------------------------|---------------------------|
|                               | W                            | dBm                         |                                                 |                           |
| 902.0 – 928.0                 | 0.25 (<50 hopping channels)  | 24.0(<50 hopping channels)  | 125.2 (<50 hopping channels)                    | 6.0*                      |
|                               | 1.0 (≥50 hopping channels)   | 30.0 (≥50 hopping channels) | 131.2 (≥50 hopping channels)                    |                           |
| 2400.0 – 2483.5               | 0.125 (<75 hopping channels) | 21.0(<75 hopping channels)  | 122.2 (<75 hopping channels)                    |                           |
|                               | 1.0 (≥75 hopping channels)   | 30.0 (≥75 hopping channels) | 131.2 (≥75 hopping channels)                    |                           |
| 5725.0 – 5850.0               | 1.0                          | 30.0                        | 131.2                                           |                           |

\*- Equivalent field strength limit was calculated from the peak output power as follows:  $E = \sqrt{(30 \times P \times G)/r}$ , where P is peak output power in Watts, r is antenna to EUT distance in meters and G is transmitter antenna gain in dBi.

\*\* - The limit is provided in terms of conducted RF power at the antenna connector. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:

- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band;
- without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;
- by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

### 7.5.2 Test procedure

**7.5.2.1** The EUT was set up as shown in Figure 7.5.1, energized and its proper operation was checked.

**7.5.2.2** The EUT was adjusted to produce maximum available to end user RF output power.

**7.5.2.3** The frequency span of spectrum analyzer was set approximately 5 times wider than 20 dB bandwidth of the EUT and the resolution bandwidth was set wider than 20 dB bandwidth of the EUT. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept in both vertical and horizontal polarizations.

**7.5.2.4** The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.5.2 and associated plots.

**7.5.2.5** The maximum peak output power was calculated from the field strength of carrier as follows:

$$P = (E \times d)^2 / (30 \times G),$$

where P is the peak output power in W, E is the field strength in V/m, d is the test distance and G is the transmitter numeric antenna gain over an isotropic radiator.

The above equation was converted in logarithmic units for 3 m test distance:

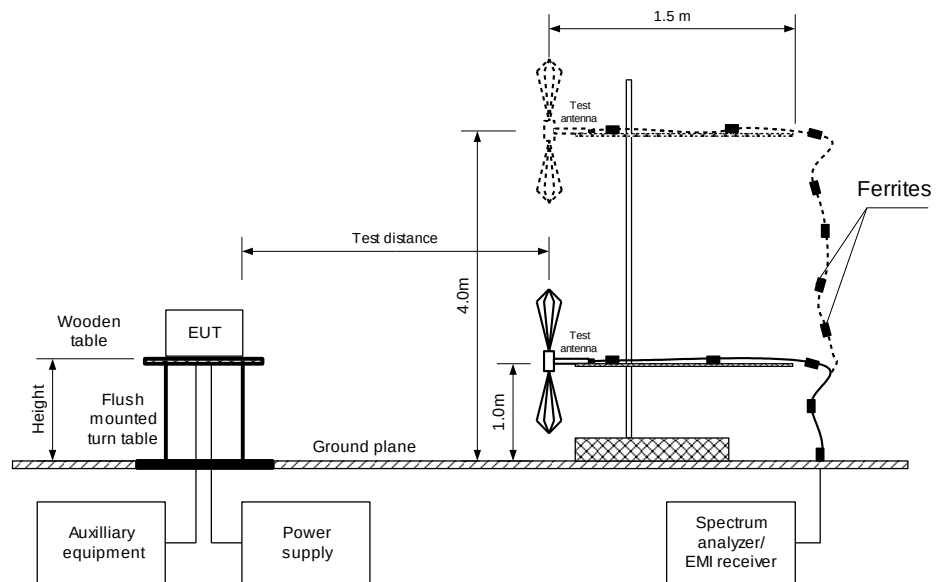
$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

**7.5.2.6** The worst test results (the lowest margins) were recorded in Table 7.5.2.



|                     |                         |                                                              |                |
|---------------------|-------------------------|--------------------------------------------------------------|----------------|
| Test specification: |                         | Section 15.247(b), RSS-247 section 5.4(1), Peak output power |                |
| Test procedure:     |                         | ANSI C63.10, section 7.8.5                                   |                |
| Test mode:          |                         | Verdict: PASS                                                |                |
| Date(s):            |                         |                                                              |                |
| 04-Jul-24           |                         |                                                              |                |
| Temperature: 24 °C  | Relative Humidity: 58 % | Air Pressure: 1012 hPa                                       | Power: 3.6 VDC |
| Remarks:            |                         |                                                              |                |

Figure 7.5.1 Setup for carrier field strength measurements





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|                                                                                         |                                |                               |                       |
|-----------------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(b), RSS-247 section 5.4(1), Peak output power |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10, section 7.8.5                                       |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                            |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 04-Jul-24                                                               |                                |                               |                       |
| <b>Temperature:</b> 24 °C                                                               | <b>Relative Humidity:</b> 58 % | <b>Air Pressure:</b> 1012 hPa | <b>Power:</b> 3.6 VDC |
| <b>Remarks:</b>                                                                         |                                |                               |                       |

Table 7.5.2 Peak output power test results

ASSIGNED FREQUENCY: 902-928 MHz  
 TEST DISTANCE: 3 m  
 TEST SITE: Semi anechoic chamber  
 EUT HEIGHT: 0.8 m  
 DETECTOR USED: Peak  
 TEST ANTENNA TYPE: Biconilog (30 MHz – 1000 MHz)  
 MODULATION: LoRa  
 DETECTOR USED: Peak  
 EUT 20 dB BANDWIDTH: 144.36 kHz  
 RESOLUTION BANDWIDTH: 300 kHz  
 VIDEO BANDWIDTH: 1 MHz  
 FREQUENCY HOPPING: Disabled  
 NUMBER OF FREQUENCY HOPPING CHANNELS: 64

BIT RATE 980 bps

| Frequency, MHz | Field strength, dB(μV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | EUT antenna gain, dBi | Peak output power, dBm** | Limit, dBm | Margin, dB*** | Verdict |
|----------------|--------------------------|----------------------|-------------------|-------------------|-----------------------|--------------------------|------------|---------------|---------|
| 902.3          | 122.16                   | Vertical             | 1.0               | -38               | 0                     | 26.96                    | 30         | -3.04         | Pass    |
| 908.7          | 123.10                   | Vertical             | 1.0               | -30               | 0                     | 27.90                    | 30         | -2.10         | Pass    |
| 914.9          | 123.12                   | Vertical             | 1.0               | -32               | 0                     | 27.92                    | 30         | -2.08         | Pass    |

BIT RATE 5470 bps

| Frequency, MHz | Field strength, dB(μV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | EUT antenna gain, dBi | Peak output power, dBm** | Limit, dBm | Margin, dB*** | Verdict |
|----------------|--------------------------|----------------------|-------------------|-------------------|-----------------------|--------------------------|------------|---------------|---------|
| 902.3          | 122.86                   | Vertical             | 1.0               | -39               | 0                     | 27.66                    | 30         | -2.34         | Pass    |
| 908.7          | 123.05                   | Vertical             | 1.0               | -30               | 0                     | 27.85                    | 30         | -2.15         | Pass    |
| 914.9          | 123.14                   | Vertical             | 1.0               | -37               | 0                     | 27.94                    | 30         | -2.06         | Pass    |

\*- EUT front panel refer to 0 degrees position of turntable.

\*\* - Peak output power was calculated from the field strength of carrier as follows:  $P = (E \times d)^2 / (30 \times G)$ , where P is the peak output power in W, E is the field strength in V/m, d is the test distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator. The above equation was converted in logarithmic units for 3 m test distance: *Peak output power in dBm = Field strength in dB(μV/m) - Transmitter antenna gain in dBi - 95.2 dB*

\*\*\* - Margin = Peak output power – specification limit.

#### Reference numbers of test equipment used

|         |         |         |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|
| HL 5288 | HL 5902 | HL 3903 |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|

Full description is given in Appendix A.



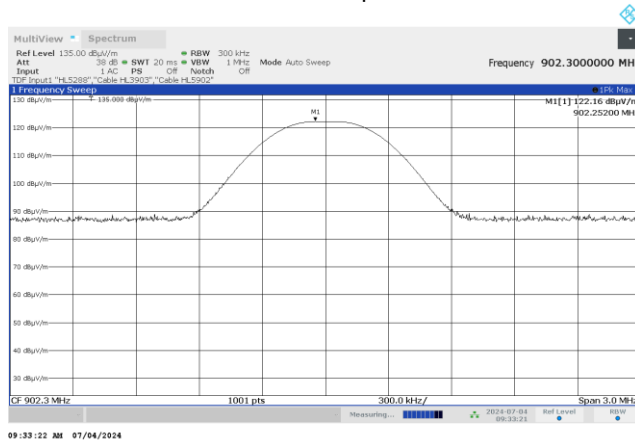
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|                                                                                  |                         |                        |                |
|----------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power |                         |                        |                |
| Test procedure: ANSI C63.10, section 7.8.5                                       |                         |                        |                |
| Test mode: Compliance                                                            |                         | Verdict: PASS          |                |
| Date(s): 04-Jul-24                                                               |                         |                        |                |
| Temperature: 24 °C                                                               | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                         |                         |                        |                |

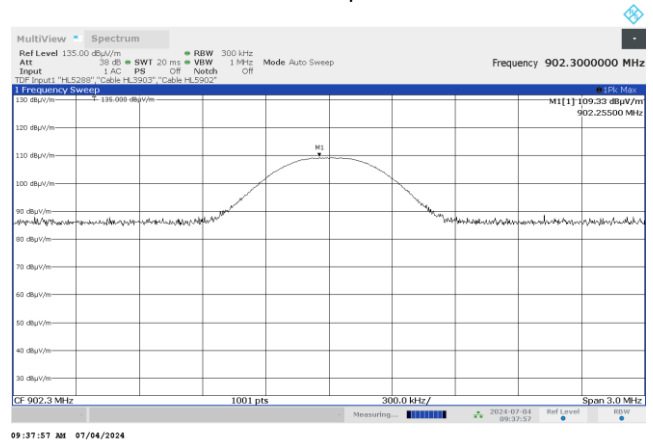
### Plot 7.5.1 Field strength of carrier at low frequency

Data rate 980 bps

Vertical antenna polarization

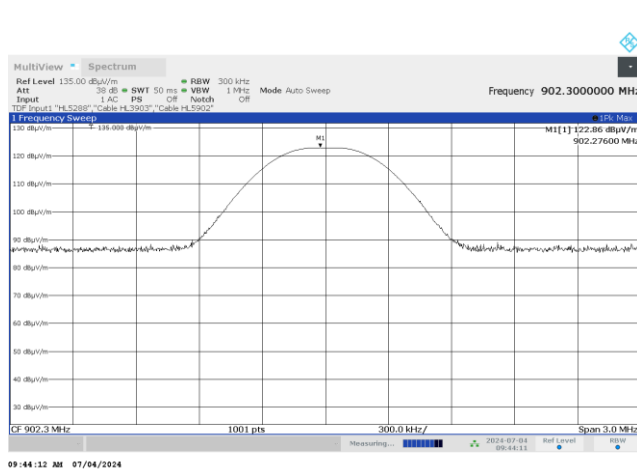


Horizontal antenna polarization

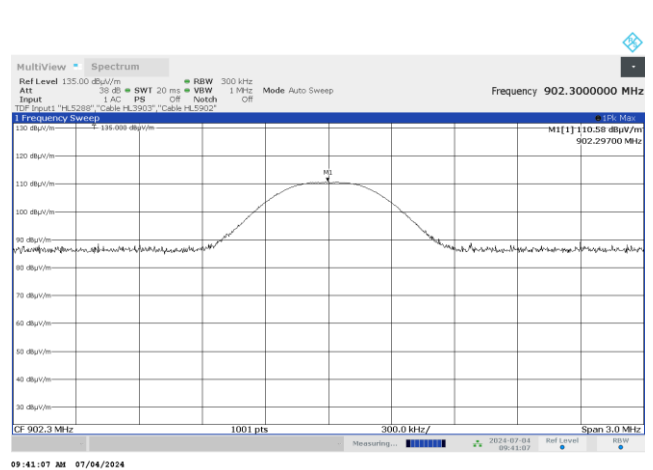


Data rate 5470 bps

Vertical antenna polarization



Horizontal antenna polarization





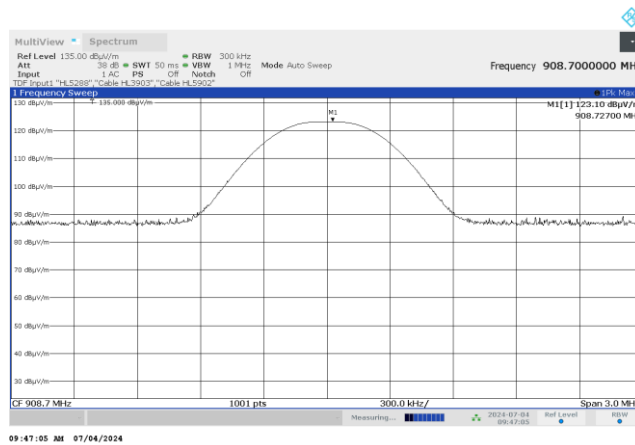
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|                                                                                  |                         |                        |                |
|----------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power |                         |                        |                |
| Test procedure: ANSI C63.10, section 7.8.5                                       |                         |                        |                |
| Test mode: Compliance                                                            |                         | Verdict: PASS          |                |
| Date(s): 04-Jul-24                                                               |                         |                        |                |
| Temperature: 24 °C                                                               | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                         |                         |                        |                |

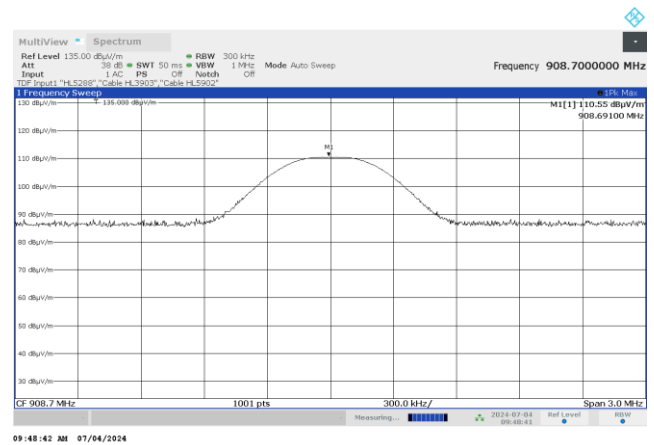
Plot 7.5.2 Field strength of carrier at mid frequency

Data rate 980 bps

Vertical antenna polarization

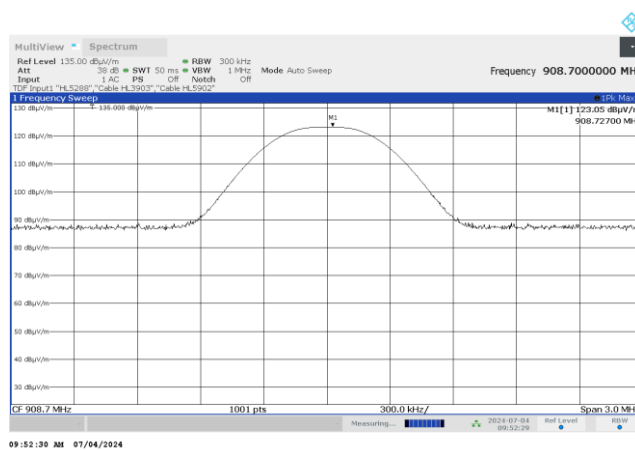


Horizontal antenna polarization

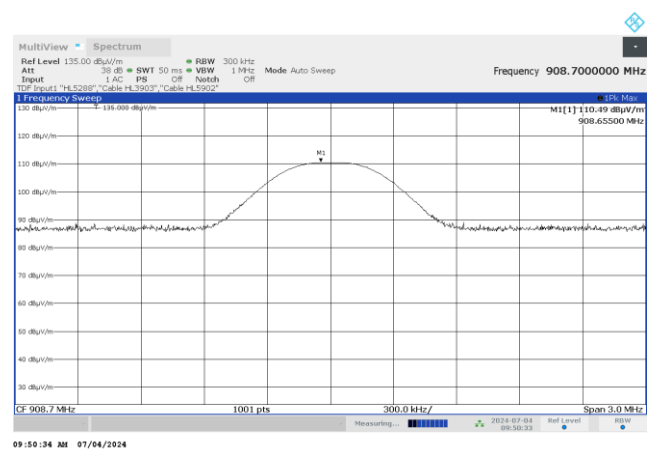


Data rate 5470 bps

Vertical antenna polarization



Horizontal antenna polarization







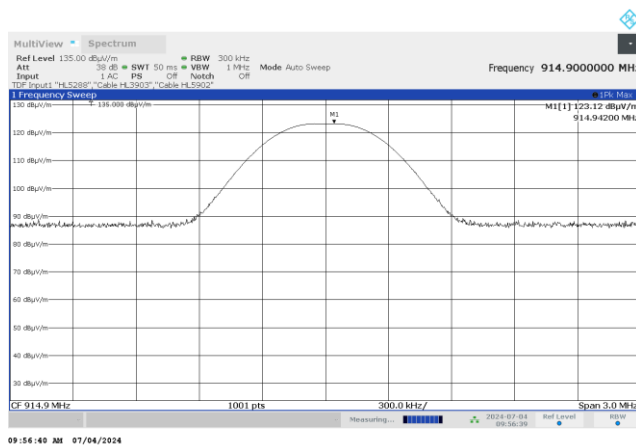
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|                     |                         |                                                              |                |
|---------------------|-------------------------|--------------------------------------------------------------|----------------|
| Test specification: |                         | Section 15.247(b), RSS-247 section 5.4(1), Peak output power |                |
| Test procedure:     |                         | ANSI C63.10, section 7.8.5                                   |                |
| Test mode:          |                         | Verdict: PASS                                                |                |
| Date(s):            |                         |                                                              |                |
| 04-Jul-24           |                         |                                                              |                |
| Temperature: 24 °C  | Relative Humidity: 58 % | Air Pressure: 1012 hPa                                       | Power: 3.6 VDC |
| Remarks:            |                         |                                                              |                |

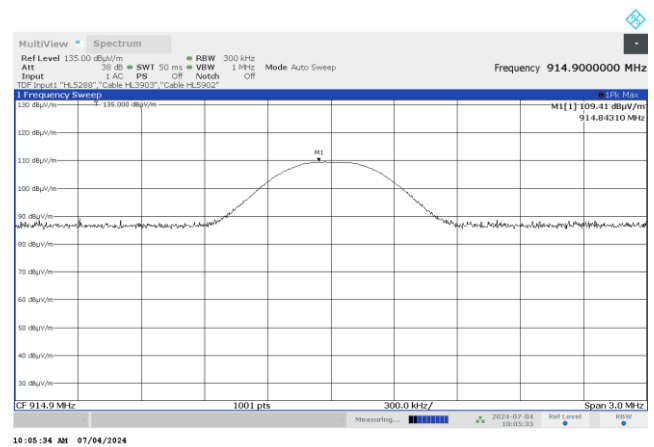
Plot 7.5.3 Field strength of carrier at high frequency

Data rate 980 bps

Vertical antenna polarization

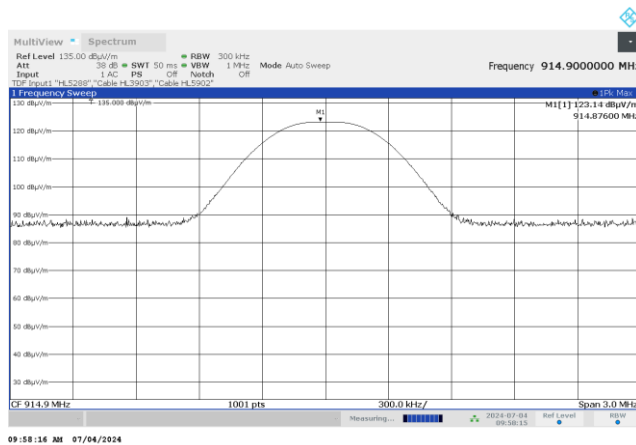


Horizontal antenna polarization

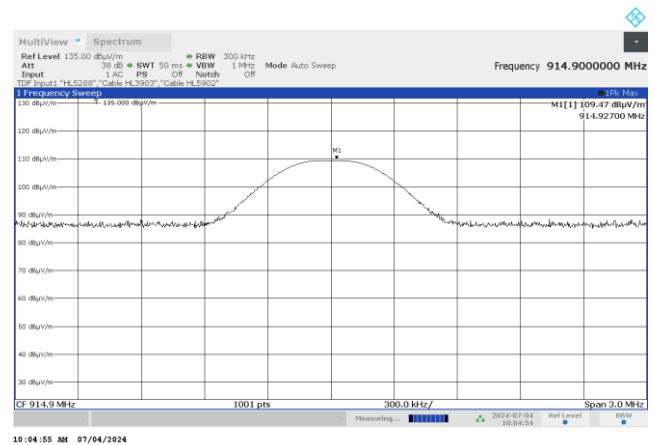


Data rate 5470 bps

Vertical antenna polarization



Horizontal antenna polarization





|                                                                                         |                         |                        |                |
|-----------------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10, sections 6.5, 6.6                                          |                         |                        |                |
| Test mode: Compliance                                                                   |                         | Verdict: PASS          |                |
| Date(s): 08-Jul-24 - 11-Jul-24                                                          |                         |                        |                |
| Temperature: 24 °C                                                                      | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                                |                         |                        |                |

## 7.6 Field strength of spurious emissions

### 7.6.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.6.1.

**Table 7.6.1 Radiated spurious emissions limits**

| Frequency, MHz                   | Field strength at 3 m within restricted bands, dB(μV/m)*** |                 |                 | Attenuation of field strength of spurious versus carrier outside restricted bands, dBc*** |
|----------------------------------|------------------------------------------------------------|-----------------|-----------------|-------------------------------------------------------------------------------------------|
|                                  | Peak                                                       | Quasi Peak      | Average         |                                                                                           |
| 0.009 – 0.090                    | 148.5 – 128.5                                              | NA              | 128.5 – 108.5** | 20.0                                                                                      |
| 0.090 – 0.110                    | NA                                                         | 108.5 – 106.8** | NA              |                                                                                           |
| 0.110 – 0.490                    | 126.8 – 113.8                                              | NA              | 106.8 – 93.8**  |                                                                                           |
| 0.490 – 1.705                    | NA                                                         | 73.8 – 63.0**   | NA              |                                                                                           |
| 1.705 – 30.0*                    |                                                            | 69.5            |                 |                                                                                           |
| 30 – 88                          |                                                            | 40.0            |                 |                                                                                           |
| 88 – 216                         |                                                            | 43.5            |                 |                                                                                           |
| 216 – 960                        |                                                            | 46.0            |                 |                                                                                           |
| 960 - 1000                       |                                                            | 54.0            |                 |                                                                                           |
| 1000 – 10 <sup>th</sup> harmonic | 74.0                                                       | NA              | 54.0            |                                                                                           |

\*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:  

$$\text{Lim}_{S2} = \text{Lim}_{S1} + 40 \log (S_1/S_2),$$

where  $S_1$  and  $S_2$  – standard defined and test distance respectively in meters.

\*\* - The limit decreases linearly with the logarithm of frequency.

\*\*\* - The field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

### 7.6.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

**7.6.2.1** The EUT was set up as shown in Figure 7.6.1, energized and the performance check was conducted.

**7.6.2.2** The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

**7.6.2.3** The worst test results (the lowest margins) were recorded and shown in the associated plots.

### 7.6.3 Test procedure for spurious emission field strength measurements above 30 MHz

**7.6.3.1** The EUT was set up as shown in Figure 7.6.2, Figure 1.1.3, energized and the performance check was conducted.

**7.6.3.2** The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

**7.6.3.3** The worst test results (the lowest margins) were recorded and shown in the associated plots.



|                       |                         |                                                                     |                |
|-----------------------|-------------------------|---------------------------------------------------------------------|----------------|
| Test specification:   |                         | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                |
| Test procedure:       |                         | ANSI C63.10, sections 6.5, 6.6                                      |                |
| Test mode:            |                         | Verdict: PASS                                                       |                |
| Date(s):              |                         |                                                                     |                |
| 08-Jul-24 - 11-Jul-24 |                         |                                                                     |                |
| Temperature: 24 °C    | Relative Humidity: 58 % | Air Pressure: 1012 hPa                                              | Power: 3.6 VDC |
| Remarks:              |                         |                                                                     |                |

Figure 7.6.1 Setup for spurious emission field strength measurements below 30 MHz

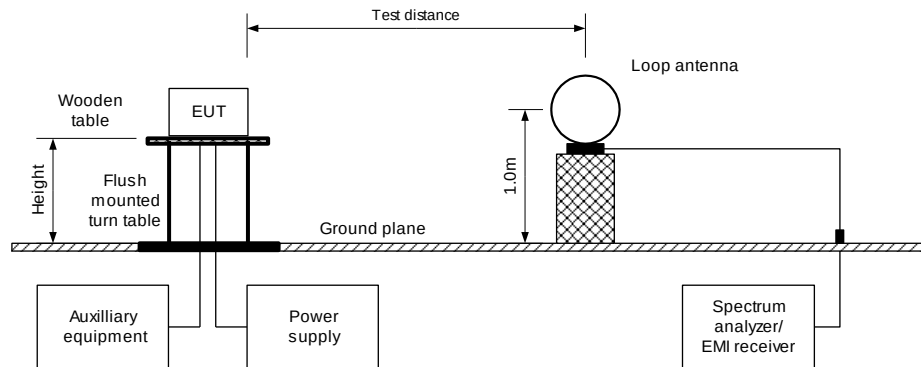
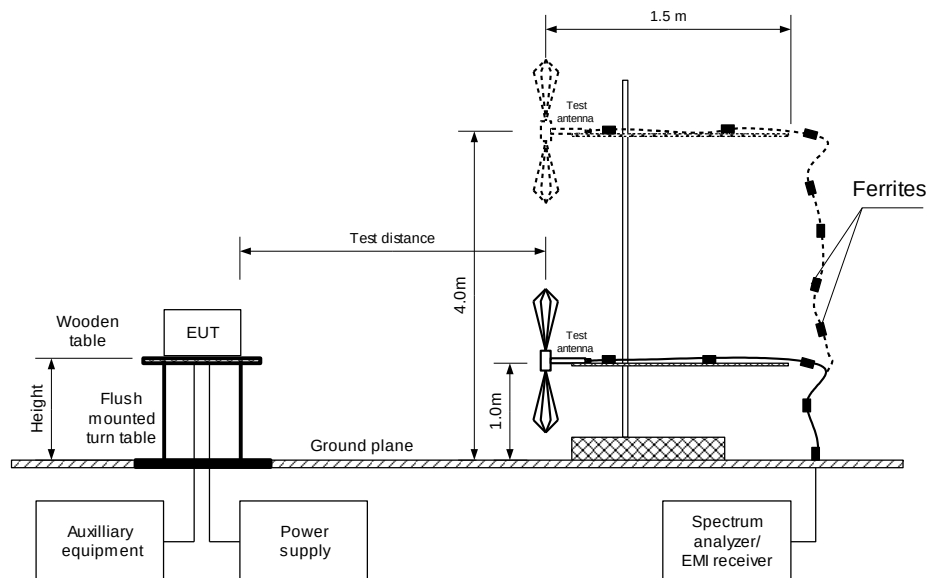


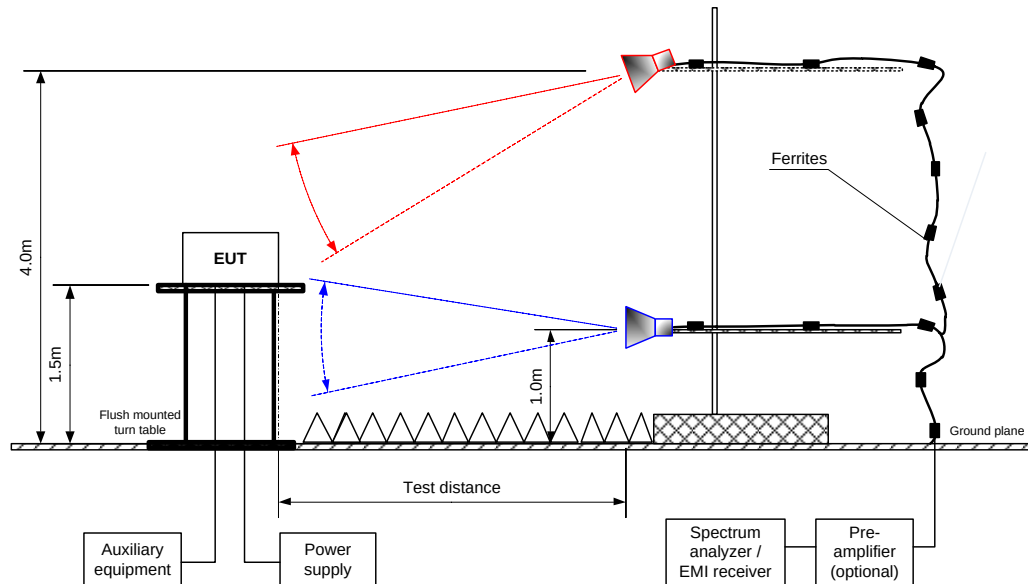
Figure 7.6.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz





|                       |                         |                                                                     |                |
|-----------------------|-------------------------|---------------------------------------------------------------------|----------------|
| Test specification:   |                         | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                |
| Test procedure:       |                         | ANSI C63.10, sections 6.5, 6.6                                      |                |
| Test mode:            |                         | Verdict: PASS                                                       |                |
| Date(s):              |                         |                                                                     |                |
| 08-Jul-24 - 11-Jul-24 |                         |                                                                     |                |
| Temperature: 24 °C    | Relative Humidity: 58 % | Air Pressure: 1012 hPa                                              | Power: 3.6 VDC |
| Remarks:              |                         |                                                                     |                |

Figure 7.6.3 Setup for spurious emission field strength measurements above 1000 MHz





|                                                                                         |                         |                        |                |
|-----------------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10, sections 6.5, 6.6                                          |                         |                        |                |
| Test mode: Compliance                                                                   |                         | Verdict: PASS          |                |
| Date(s): 08-Jul-24 - 11-Jul-24                                                          |                         |                        |                |
| Temperature: 24 °C                                                                      | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                                |                         |                        |                |

Table 7.6.2 Field strength of spurious emissions below 1 GHz within restricted bands

ASSIGNED FREQUENCY: 902-928 MHz  
 INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz  
 TEST DISTANCE: 3 m  
 MODULATION: LoRa  
 RESOLUTION BANDWIDTH: 0.2 kHz (9 kHz – 150 kHz)  
 9.0 kHz (150 kHz – 30 MHz)  
 120 kHz (30 MHz – 1000 MHz)  
 VIDEO BANDWIDTH: > Resolution bandwidth  
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)  
 Biconilog (30 MHz – 1000 MHz)  
 FREQUENCY HOPPING: Disabled

| Frequency, MHz                   | Peak emission, dB(μV/m) | Quasi-peak                  |                 |             | Antenna polarization | Antenna height, m | Turn-table position**, degrees | Verdict |
|----------------------------------|-------------------------|-----------------------------|-----------------|-------------|----------------------|-------------------|--------------------------------|---------|
|                                  |                         | Measured emission, dB(μV/m) | Limit, dB(μV/m) | Margin, dB* |                      |                   |                                |         |
| Low, mid, high carrier frequency |                         |                             |                 |             |                      |                   |                                |         |
| No spurious emissions were found |                         |                             |                 |             |                      |                   |                                | Pass    |

\*- Margin = Measured emission - specification limit.

\*\*- EUT front panel refer to 0 degrees position of turntable.

Table 7.6.3 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY: 902-928 MHz  
 INVESTIGATED FREQUENCY RANGE: 0.009 - 9500 MHz  
 TEST DISTANCE: 3 m  
 MODULATION: LoRa  
 DETECTOR USED: Peak  
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)  
 Biconilog (30 MHz – 1000 MHz)  
 Double ridged guide (above 1000 MHz)  
 FREQUENCY HOPPING: Disabled

| Frequency, MHz         | Field strength of spurious, dB(μV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | Field strength of carrier, dB(μV/m) | Attenuation below carrier, dBc | Limit, dBc | Margin, dB** | Verdict |
|------------------------|--------------------------------------|----------------------|-------------------|-------------------|-------------------------------------|--------------------------------|------------|--------------|---------|
| Low carrier frequency  |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 1804.6                 | 61.89                                | Horizontal           | 1.5               | -41               | 122.86                              | 60.97                          | 20.0       | 40.97        | Pass    |
| 7218.4                 | 51.71                                | Vertical             | 1.5               | -19               |                                     | 71.15                          | 20.0       | 51.15        | Pass    |
| Mid carrier frequency  |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 1817.4                 | 62.93                                | Horizontal           | 1.5               | -40               | 123.10                              | 60.17                          | 20.0       | 40.17        | Pass    |
| 6360.9                 | 47.96                                | Vertical             | 1.5               | 67                |                                     | 75.14                          | 20.0       | 55.14        | Pass    |
| High carrier frequency |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 1829.8                 | 62.23                                | Horizontal           | 1.5               | -36               | 123.14                              | 60.91                          | 20.0       | 40.91        | Pass    |

\*- EUT front panel refers to 0 degrees position of turntable.

\*\*- Margin = Attenuation below carrier – specification limit.



|                                                                                         |                         |                        |                |
|-----------------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10, sections 6.5, 6.6                                          |                         |                        |                |
| Test mode: Compliance                                                                   |                         | Verdict: PASS          |                |
| Date(s): 08-Jul-24 - 11-Jul-24                                                          |                         |                        |                |
| Temperature: 24 °C                                                                      | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                                |                         |                        |                |

Table 7.6.4 Field strength of spurious emissions above 1 GHz within restricted bands

ASSIGNED FREQUENCY: 902-928 MHz  
 INVESTIGATED FREQUENCY RANGE: 1000 - 9500 MHz  
 TEST DISTANCE: 3 m  
 MODULATION: LoRa  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 1000 kHz  
 TEST ANTENNA TYPE: Double ridged guide  
 FREQUENCY HOPPING: Disabled

| Antenna                |              |           | Peak field strength |                    |                 |               | Average field strength |                      |                 |               | Verdict |
|------------------------|--------------|-----------|---------------------|--------------------|-----------------|---------------|------------------------|----------------------|-----------------|---------------|---------|
| Frequency, MHz         | Polarization | Height, m | Azimuth, degrees**  | Measured, dB(μV/m) | Limit, dB(μV/m) | Margin, dB*** | Measured, dB(μV/m)     | Calculated, dB(μV/m) | Limit, dB(μV/m) | Margin, dB*** |         |
| Low carrier frequency  |              |           |                     |                    |                 |               |                        |                      |                 |               |         |
| 2706.9                 | Vertical     | 1.3       | -170                | 48.34              | 74              | -25.66        | 45.57                  | NA                   | 54              | -8.43         | Pass    |
| 8120.7                 | Vertical     | 1.5       | -24                 | 58.30              | 74              | -15.7         | 53.45                  | NA                   | 54              | -0.55         |         |
| Mid carrier frequency  |              |           |                     |                    |                 |               |                        |                      |                 |               |         |
| 2726.1                 | Vertical     | 1.5       | 180                 | 47.26              | 74              | -26.74        | 47.26                  | NA                   | 54              | -6.74         | Pass    |
| 4543.5                 | Vertical     | 1.5       | 100                 | 44.48              | 74              | -29.52        | 44.48                  | NA                   | 54              | -9.52         |         |
| 7269.6                 | Vertical     | 1.5       | -17                 | 50.70              | 74              | -23.30        | 44.13                  | NA                   | 54              | -9.87         |         |
| 8178.3                 | Horizontal   | 1.5       | 0                   | 54.82              | 74              | -19.18        | 47.54                  | NA                   | 54              | -6.46         |         |
| High carrier frequency |              |           |                     |                    |                 |               |                        |                      |                 |               |         |
| 2744.7                 | Vertical     | 1.5       | 180                 | 47.16              | 74              | -26.84        | 47.16                  | NA                   | 54              | -6.84         | Pass    |
| 7319.2                 | Vertical     | 1.5       | -48                 | 50.12              | 74              | -23.88        | 42.62                  | NA                   | 54              | -11.38        |         |
| 8234.1                 | Horizontal   | 1.5       | -20                 | 57.43              | 74              | -16.57        | 52.21                  | NA                   | 54              | -1.79         |         |

\*- EUT front panel refers to 0 degrees position of turntable.

\*\* - Margin = Measured field strength - specification limit.

\*\*\* - Margin = Calculated field strength - specification limit,  
where Calculated field strength = Measured field strength + average factor.

Table 7.6.5 Average factor calculation

| Transmission pulse |            | Transmission burst |            | Transmission train duration, ms | Average factor, dB |
|--------------------|------------|--------------------|------------|---------------------------------|--------------------|
| Duration, ms       | Period, ms | Duration, ms       | Period, ms |                                 |                    |
| NA                 | NA         | NA                 | NA         | NA                              | NA                 |

\*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left( \frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{\text{Train duration}} \times \text{Number of bursts within pulse train} \right)$$

for pulse train longer than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left( \frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{100 \text{ ms}} \times \text{Number of bursts within 100 ms} \right)$$



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|                                                                                         |                         |                        |                |
|-----------------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10, sections 6.5, 6.6                                          |                         |                        |                |
| Test mode: Compliance                                                                   |                         | Verdict: PASS          |                |
| Date(s): 08-Jul-24 - 11-Jul-24                                                          |                         |                        |                |
| Temperature: 24 °C                                                                      | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                                |                         |                        |                |

Table 7.6.6 Restricted bands according to FCC section 15.205

| MHz               | MHz                 | MHz                   | MHz             | MHz           | GHz           |
|-------------------|---------------------|-----------------------|-----------------|---------------|---------------|
| 0.09 - 0.11       | 8.37625 - 8.38675   | 73 - 74.6             | 399.9 - 410     | 2690 - 2900   | 10.6 - 12.7   |
| 0.495 - 0.505     | 8.41425 - 8.41475   | 74.8 - 75.2           | 608 - 614       | 3260 - 3267   | 13.25 - 13.4  |
| 2.1735 - 2.1905   | 12.29 - 12.293      | 108 - 121.94          | 960 - 1240      | 3332 - 3339   | 14.47 - 14.5  |
| 4.125 - 4.128     | 12.51975 - 12.52025 | 123 - 138             | 1300 - 1427     | 3345.8 - 3358 | 15.35 - 16.2  |
| 4.17725 - 4.17775 | 12.57675 - 12.57725 | 149.9 - 150.05        | 1435 - 1626.5   | 3600 - 4400   | 17.7 - 21.4   |
| 4.20725 - 4.20775 | 13.36 - 13.41       | 156.52475 - 156.52525 | 1645.5 - 1646.5 | 4500 - 5150   | 22.01 - 23.12 |
| 6.215 - 6.218     | 16.42 - 16.423      | 156.7 - 156.9         | 1660 - 1710     | 5350 - 5460   | 23.6 - 24     |
| 6.26775 - 6.26825 | 16.69475 - 16.69525 | 162.0125 - 167.17     | 1718.8 - 1722.2 | 7250 - 7750   | 31.2 - 31.8   |
| 6.31175 - 6.31225 | 16.80425 - 16.80475 | 167.72 - 173.2        | 2200 - 2300     | 8025 - 8500   | 36.43 - 36.5  |
| 8.291 - 8.294     | 25.5 - 25.67        | 240 - 285             | 2310 - 2390     | 9000 - 9200   | Above 38.6    |
| 8.362 - 8.366     | 37.5 - 38.25        | 322 - 335.4           | 2483.5 - 2500   | 9300 - 9500   |               |

Table 7.6.7 Restricted bands according to RSS-Gen

| MHz               | MHz                 | MHz                   | MHz             | MHz           | GHz           |
|-------------------|---------------------|-----------------------|-----------------|---------------|---------------|
| 0.09 - 0.11       | 8.291 - 8.294       | 16.80425 - 16.80475   | 399.9 - 410     | 3260 - 3267   | 10.6 - 12.7   |
| 2.1735 - 2.1905   | 8.362 - 8.366       | 25.5 - 25.67          | 608 - 614       | 3332 - 3339   | 13.25 - 13.4  |
| 3.020 - 3.026     | 8.37625 - 8.38675   | 37.5 - 38.25          | 960 - 1427      | 3345.8 - 3358 | 14.47 - 14.5  |
| 4.125 - 4.128     | 8.41425 - 8.41475   | 73 - 74.6             | 1435 - 1626.5   | 3500 - 4400   | 15.35 - 16.2  |
| 4.17725 - 4.17775 | 12.29 - 12.293      | 74.8 - 75.2           | 1645.5 - 1646.5 | 4500 - 5150   | 17.7 - 21.4   |
| 4.20725 - 4.20775 | 12.51975 - 12.52025 | 108 - 138             | 1660 - 1710     | 5350 - 5460   | 22.01 - 23.12 |
| 5.677 - 5.683     | 12.57675 - 12.57725 | 156.52475 - 156.52525 | 1718.8 - 1722.2 | 7250 - 7750   | 23.6 - 24     |
| 6.215 - 6.218     | 13.36 - 13.41       | 156.7 - 156.9         | 2200 - 2300     | 8025 - 8500   | 31.2 - 31.8   |
| 6.26775 - 6.26825 | 16.42 - 16.423      | 240 - 285             | 2310 - 2390     | 9000 - 9200   | 36.43 - 36.5  |
| 6.31175 - 6.31225 | 16.69475 - 16.69525 | 322 - 335.4           | 2655 - 2900     | 9300 - 9500   | Above 38.6    |

Reference numbers of test equipment used

|        |         |         |         |         |         |         |    |
|--------|---------|---------|---------|---------|---------|---------|----|
| HL 446 | HL 5288 | HL 4933 | HL 3903 | HL 5902 | HL 7585 | HL 4339 | HL |
|--------|---------|---------|---------|---------|---------|---------|----|

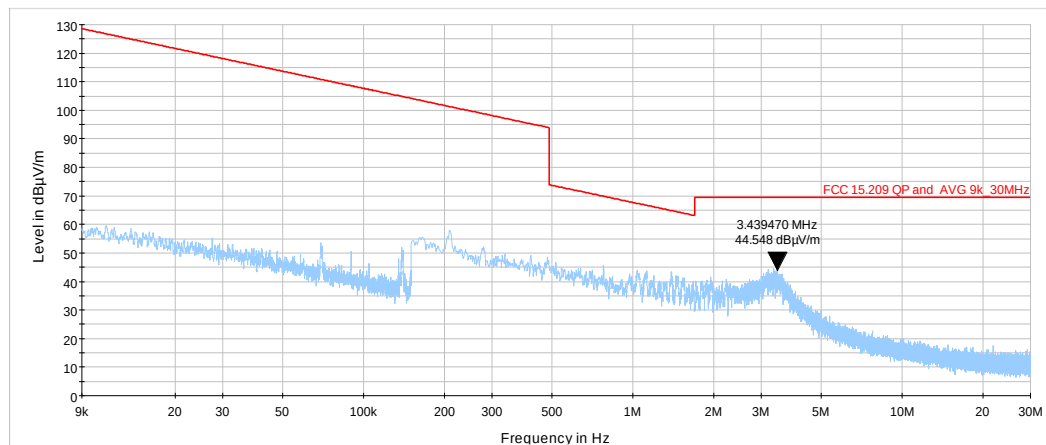
Full description is given in Appendix A.



|                                                                                                |                                |                               |                       |
|------------------------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10, sections 6.5, 6.6                                          |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                                   |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 08-Jul-24 - 11-Jul-24                                                          |                                |                               |                       |
| <b>Temperature:</b> 24 °C                                                                      | <b>Relative Humidity:</b> 58 % | <b>Air Pressure:</b> 1012 hPa | <b>Power:</b> 3.6 VDC |
| <b>Remarks:</b>                                                                                |                                |                               |                       |

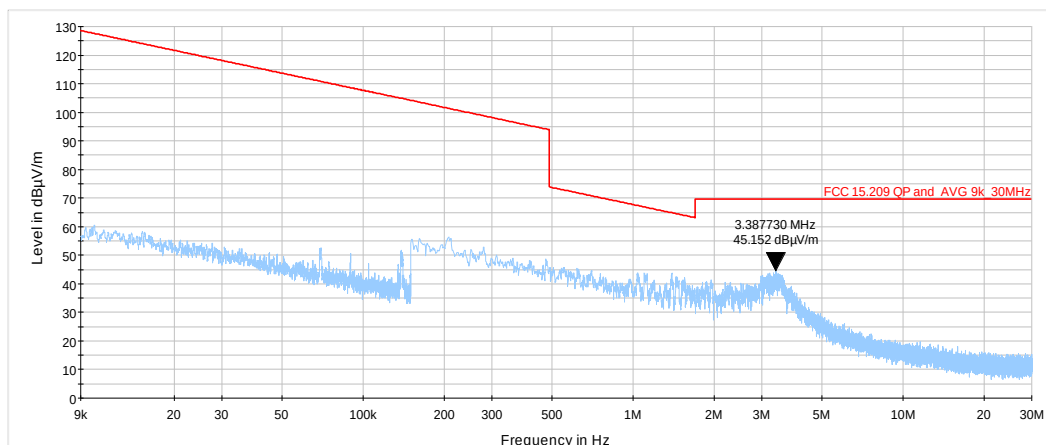
**Plot 7.6.1 Radiated emission measurements from 9 kHz to 30 MHz at the low carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical



**Plot 7.6.2 Radiated emission measurements from 9 kHz to 30 MHz at the mid carrier frequency**

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical



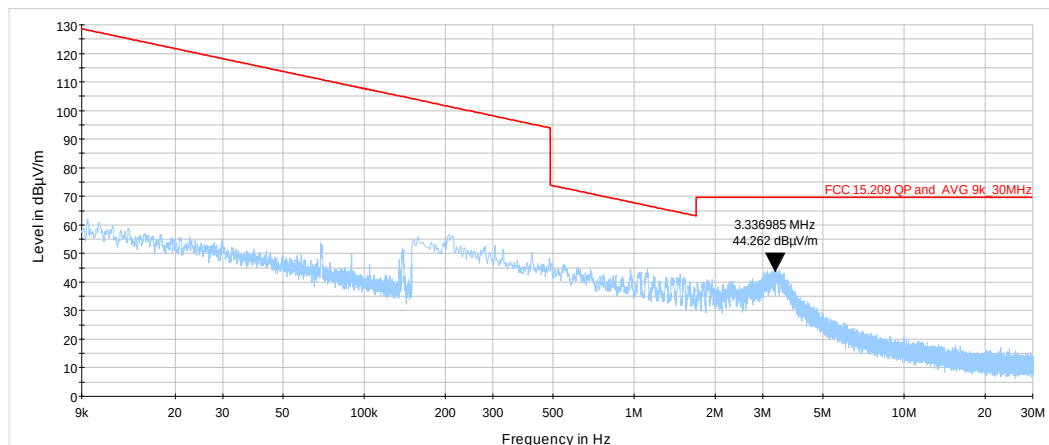




|                                                                                         |                         |                        |                |
|-----------------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10, sections 6.5, 6.6                                          |                         |                        |                |
| Test mode: Compliance                                                                   |                         | Verdict: PASS          |                |
| Date(s): 08-Jul-24 - 11-Jul-24                                                          |                         |                        |                |
| Temperature: 24 °C                                                                      | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                                |                         |                        |                |

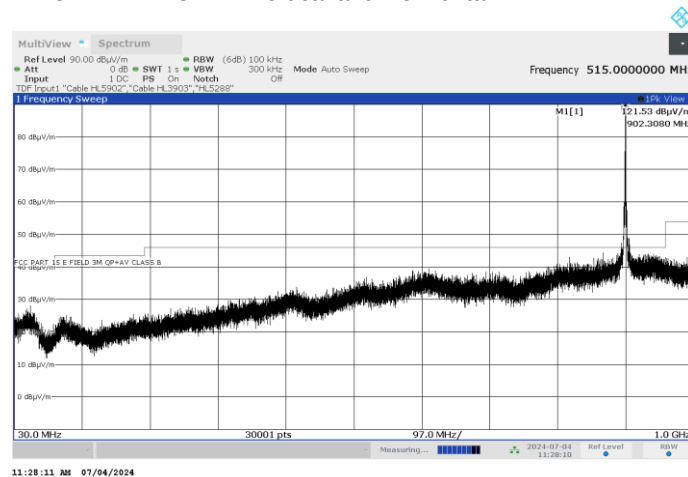
Plot 7.6.3 Radiated emission measurements from 9 kHz to 30 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical



Plot 7.6.4 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



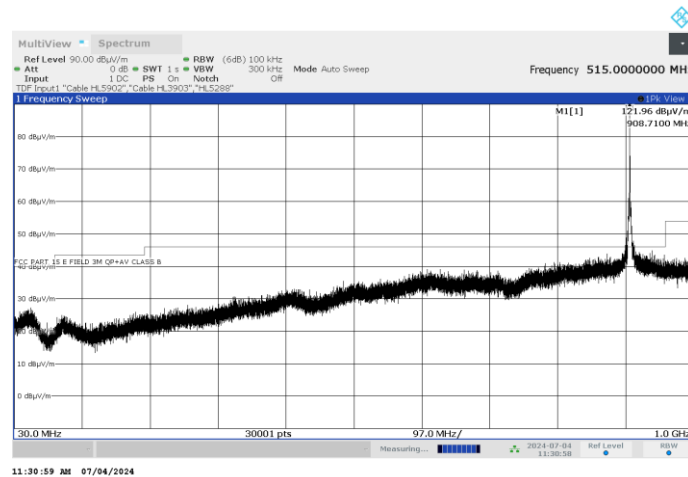


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|                                                                                         |                         |                        |                |
|-----------------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10, sections 6.5, 6.6                                          |                         |                        |                |
| Test mode: Compliance                                                                   |                         | Verdict: PASS          |                |
| Date(s): 08-Jul-24 - 11-Jul-24                                                          |                         |                        |                |
| Temperature: 24 °C                                                                      | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                                |                         |                        |                |

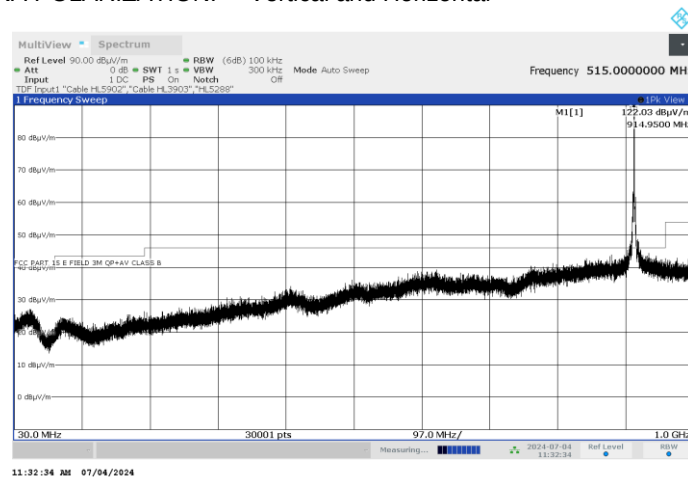
Plot 7.6.5 Radiated emission measurements from 30 to 1000 MHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.6.6 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



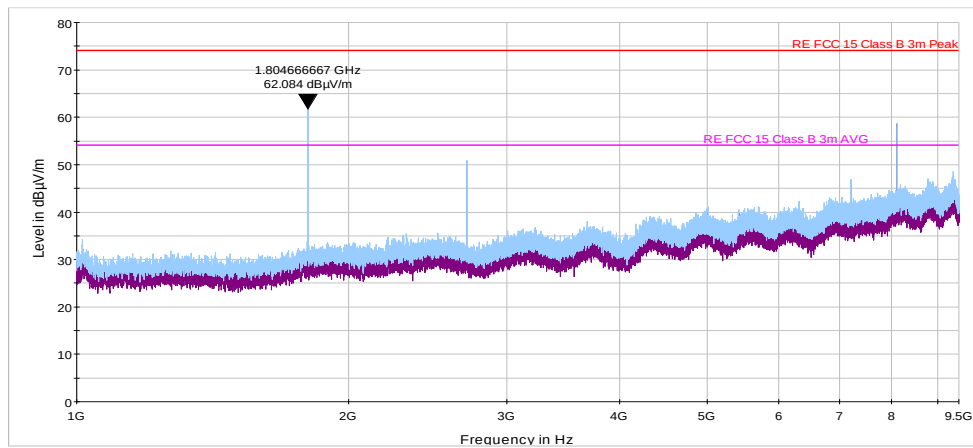


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|                       |                         |                                                                     |                |
|-----------------------|-------------------------|---------------------------------------------------------------------|----------------|
| Test specification:   |                         | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                |
| Test procedure:       |                         | ANSI C63.10, sections 6.5, 6.6                                      |                |
| Test mode:            |                         | Verdict: PASS                                                       |                |
| Date(s):              |                         |                                                                     |                |
| 08-Jul-24 - 11-Jul-24 |                         |                                                                     |                |
| Temperature: 24 °C    | Relative Humidity: 58 % | Air Pressure: 1012 hPa                                              | Power: 3.6 VDC |
| Remarks:              |                         |                                                                     |                |

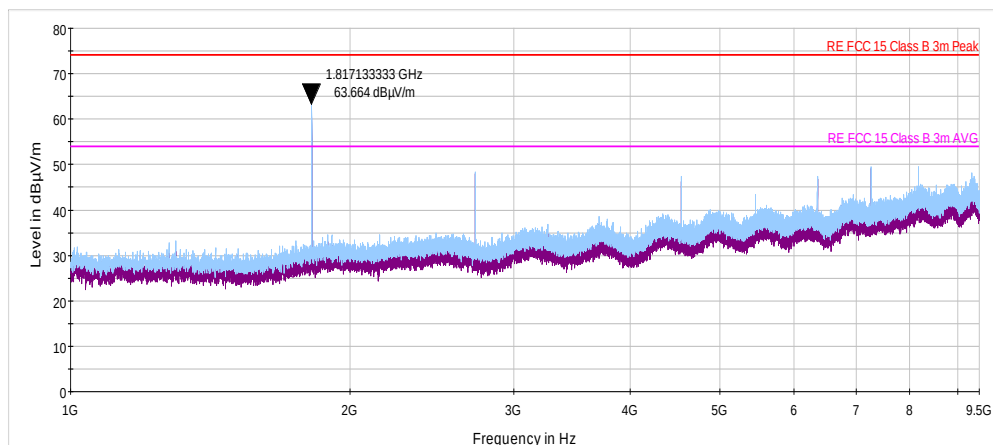
Plot 7.6.7 Radiated emission measurements from 1000 to 9500 MHz at the low carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.6.8 Radiated emission measurements from 1000 to 9500 MHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



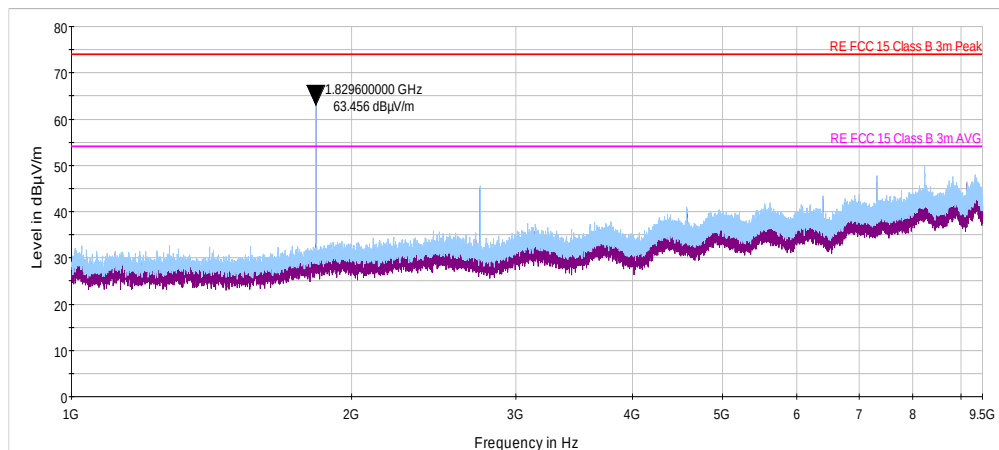


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|                       |                         |                                                                     |                |
|-----------------------|-------------------------|---------------------------------------------------------------------|----------------|
| Test specification:   |                         | Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                |
| Test procedure:       |                         | ANSI C63.10, sections 6.5, 6.6                                      |                |
| Test mode:            |                         | Verdict: PASS                                                       |                |
| Date(s):              |                         |                                                                     |                |
| 08-Jul-24 - 11-Jul-24 |                         |                                                                     |                |
| Temperature: 24 °C    | Relative Humidity: 58 % | Air Pressure: 1012 hPa                                              | Power: 3.6 VDC |
| Remarks:              |                         |                                                                     |                |

Plot 7.6.9 Radiated emission measurements from 1000 to 9500 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



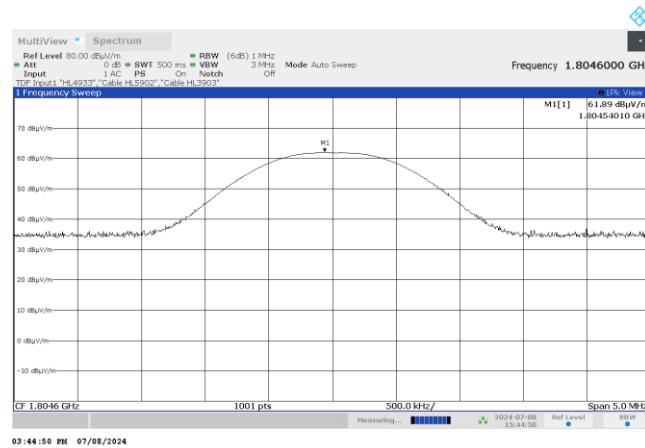


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|                                                                                         |                         |                        |                |
|-----------------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10, sections 6.5, 6.6                                          |                         |                        |                |
| Test mode: Compliance                                                                   |                         | Verdict: PASS          |                |
| Date(s): 08-Jul-24 - 11-Jul-24                                                          |                         |                        |                |
| Temperature: 24 °C                                                                      | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                                |                         |                        |                |

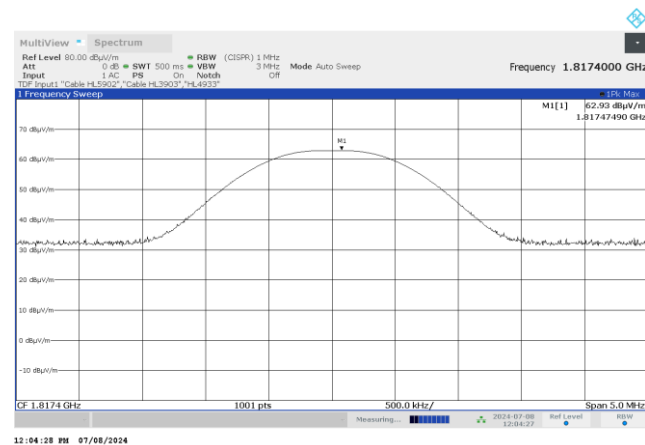
Plot 7.6.10 Radiated emission measurements at the second harmonic of low carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m



Plot 7.6.11 Radiated emission measurements at the second harmonic of mid carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m



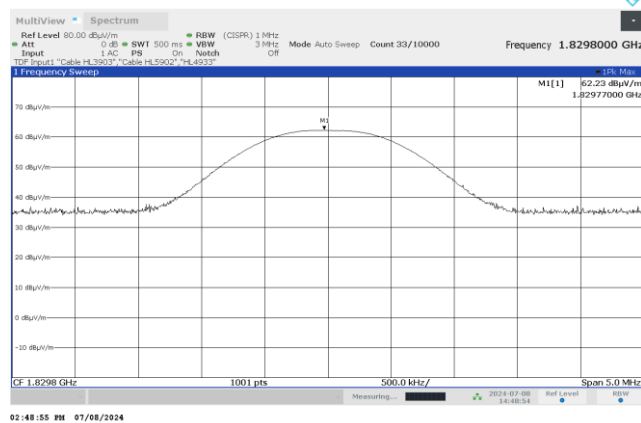


HERMON LABORATORIES

|                                                                                         |                         |                        |                |
|-----------------------------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10, sections 6.5, 6.6                                          |                         |                        |                |
| Test mode: Compliance                                                                   |                         | Verdict: PASS          |                |
| Date(s): 08-Jul-24 - 11-Jul-24                                                          |                         |                        |                |
| Temperature: 24 °C                                                                      | Relative Humidity: 58 % | Air Pressure: 1012 hPa | Power: 3.6 VDC |
| Remarks:                                                                                |                         |                        |                |

Plot 7.6.12 Radiated emission measurements at the second harmonic of high carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m



Plot 7.6.13 Radiated emission measurements at the 3 harmonic of low carrier frequency

TEST SITE: Semi anechoic chamber  
TEST DISTANCE: 3 m

