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# FCC ISED RF Test Report

| | |
|---|---|
| **Test Report Number** | WAP-21122143-LC-FCC-IC-GSM |
| **FCC ID** | KMH-14H074-NA1 |
| **IC** | 1422A-14H074NA1 |
| **Applicant** | Ford Motor Company |
| **Applicant Address** | Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124 |
| **Product Name** | Vehicle Telematics Control Unit |
| **Model (s)** | FB5-TCU-NA |
| **Family Product/Model** | FB5-TCU-ROW |
| **Date of Receipt** | 01/04/2022 |
| **Date of Test** | 01/04/2022 – 01/12/2022 |
| **Report Issue Date** | 04/15/2022 |
| **Test Standards** | 47CFR Part 22<br>47CFR Part 24<br>RSS-132 Issue 3: Jan 2013<br>RSS-133 Issue 6: Jan 2018 |
| **Test Result** | **PASS** |

Issued by:

**Vista Compliance Laboratories**
1261 Puerta Del Sol, San Clemente, CA 92673 USA
www.vista-compliance.com

**Devin Tai (Test Engineer)**

**David Zhang (Technical Manager)**

## REVISION HISTORY

| Report Number | Version | Description | Issued Date |
|---|---|---|---|
| WAP-21122143-LC-FCC-IC-GSM | 01 | Initial report | 04/15/2022 |
| | | | |
| | | | |
| | | | |
| | | | |

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# 1 Test Summary

| Test Item | FCC IC Rules | Test Method | Result |
|---|---|---|---|
| Effective (Isotropic) Radiated Power | § 2.1046, § 22.913<br>§ 24.232<br>RSS-132 (4.4), RSS-133 (6.4) | ANSI C63.26: 2015<br>KDB 971168 D01 Power Meas License Digital Systems v03r01 | Pass |
| Peak to Average Ratio | § 2.1046, § 22.913<br>§ 24.232<br>RSS-133 (6.4) | ANSI C63.26: 2015<br>KDB 971168 D01 Power Meas License Digital Systems v03r01 | Pass |
| Occupied bandwidth | §2.1049<br>RSS-Gen (6.7) | ANSI C63.26: 2015<br>KDB 971168 D01 Power Meas License Digital Systems v03r01 | Pass |
| Band Edge | § 2.1051; § 22.917(a)<br>§ 24.238<br>RSS-132 (4.5.1), RSS-133 (6.5.1), | ANSI C63.26: 2015<br>KDB 971168 D01 Power Meas License Digital Systems v03r01 | Pass |
| Conducted Spurious Emission | § 2.1051; § 22.917(a)<br>§ 24.238<br>RSS-132 (4.5.1), RSS-133 (6.5.1) | ANSI C63.26: 2015<br>KDB 971168 D01 Power Meas License Digital Systems v03r01 | Pass |
| Field Strength of Radiated Spurious Emissions | § 2.1051; § 22.917(a)<br>§ 24.238<br>RSS-132 (4.5.1), RSS-133 (6.5.1), | ANSI C63.26: 2015<br>KDB 971168 D01 Power Meas License Digital Systems v03r01 | Pass |
| Frequency Stability | § 2.1055, § 22.355<br>§ 24.235,<br>RSS-132 (4.3), RSS-133 (6.3),<br>RSS-Gen | ANSI C63.26: 2015<br>KDB 971168 D01 Power Meas License Digital Systems v03r01 | Pass |

# 2 General Information

## 2.1 Applicant

| | |
|---|---|
| **Applicant** | Ford Motor Company |
| **Applicant address** | Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124 |
| **Manufacturer** | Ford Motor Company |
| **Manufacturer Address** | Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124 |

## 2.2 Product information

| | |
|---|---|
| **Product Name** | Vehicle Infotainment System |
| **Model Number** | FB5-TCU-NA |
| **Family Model Number** | FB5-TCU-ROW |
| **Serial Number** | ENMHF19050112411, ENMHF19050112546 (Conducted), ENMHF19050112536, ENMHF19050112440 (Radiated) |
| **Frequency Band** | BT BDR/EDR: 2402-2480MHz<br>BLE: 2402-2480MHz<br>802.11b/g/n-20MHz: 2412-2462MHz<br>802.11n-40MHz: 2422-2452MHz<br>802.11a/n-20MHz: 5500-5580MHz, 5660-5720, 5725-5825MHz<br>802.11n-40MHz: 5510-5550MHz, 5630-5710, 5755-5795MHz<br>802.11ac: 5530, 5690MHz, 5775MHz<br>GPRS/EDGE 850: 824.2- 848.8 MHz<br>GPRS/EDGE 1900: 1850.2- 1909.8 MHz<br>WCDMA Band 2: 1852.4- 1907.6MHz<br>WCDMA Band 4: 1712.4- 1752.6MHz<br>WCDMA Band 5: 826.4- 846.6MHz<br>LTE Band 2: 1850.7-1909.3MHz<br>LTE Band 4: 1710.7-1754.3MHz<br>LTE Band 5: 824.7-848.3MHz<br>LTE Band 7: 2502.5-2567.5MHz<br>LTE Band 12: 699.7-713.5MHz<br>LTE Band 17: 706.5-784.5MHz<br>LTE Band 38: 2572.5-2617.5MHz<br>LTE Band 66: 1710.7-1779.3MHz |
| **Type of modulation** | BT BDR/EDR: GFSK, π/4DQPSK, 8DPSK<br>BLE: GFSK<br>802.11b: DSSS (CCK, DQPSK, DBPSK)<br>802.11g: OFDM-CCK (BPSK, QPSK, 16QAM, 64QAM)<br>802.11a/n/ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM)<br>GPRS/EDGE: GMSK, 8PSK<br>WCDMA: QPSK<br>LTE: QPSK, 16QAM |
| **Equipment Class/ Category** | DSS, DTS, UNII, PCB |
| **Maximum output power** | See test result |

| | |
|---|---|
| **Antenna Information** | **Internal PCB trace antenna**<br>Peak Gain:<br>- Antenna1: 3.40 dBi @2.4GHz WiFi/Bluetooth, 8.00 dBi @5GHz WiFi<br>- Antenna2: 3.39 dBi @2.4GHz WiFi/Bluetooth, 6.17 dBi @5GHz WiFi<br><br>**External Antenna**<br>Peak Gain:<br>- Antenna3: 9.74 dBi @2.4GHz WiFi/Bluetooth<br><br>**Cellular main and diversity antennas:**<br>Peak Gain: 4.32 dBi @ 698-850MHz<br>5.53 dBi @ 1700-1910MHz<br>5.91dBi @ 2500-2600MHz<br><br>For 2.4GHz Wi-Fi, it has total 3 antennas that can transmit simultaneously (Internal antenna 1 &2, and external antenna). For 5GHz Wi-Fi, it has total 2 antennas that can transmit simultaneously (Internal antenna 1 &2). The directional gain is calculated per KDB 662911 D01 Multiple Transmitter Output v02r01,<br>Directional Gain:<br>- 12.59 dBi @2.4GHz<br>- 10.143 dBi @5GHz |
| **Clock Frequencies** | N/A |
| **Port/Connectors** | CAN bus |
| **Input Power** | Vehicle Battery powered: 12VDC |
| **Power Adapter Manu/Model** | N/A |
| **Power Adapter SN** | N/A |
| **Hardware version** | N/A |
| **Software version** | N/A |
| **Simultaneous Transmission** | BT/BLE, WLAN and cellular radio can transmit simultaneously |
| **Additional Info** | 1. FB5-TCU-NA and FB5-TCU-ROW have the same PCB layout. The hardware difference is the population of each RF filters for cellular bands, but the RF paths between FB5-TCU-NA and FB5-TCU-ROW are completely independent for all cellular bands and does not affect other bands. WCDMA and LTE Band 5 are populated in both FB5-TCU-NA and FB5-TCU-ROW.<br>Model FB5-TCU-ROW contains functions that are not operational in U.S. Territories. This report is only applicable for its bands that fall in U.S. operations.<br>2. FB5-TCU-NA and FB5-TCU-ROW can support following non-US bands but will not be operational in U.S. Territories,<br><br>- GPRS/EDGE 900<br>- GPRS/EDGE 1800<br>- WCDMA Band 1<br>- WCDMA Band 3<br>- WCDMA Band 8<br>- LTE Band 3<br>- LTE Band 8<br>- LTE Band 28 |

## 2.3 Test standard and method

| | |
|---|---|
| **Test standard** | 47CFR Part 22<br>47CFR Part 24<br>RSS-132 Issue 3: Jan 2013<br>RSS-133 Issue 6: Jan 2018<br>RSS-Gen Issue 5: Mar 2019 |
| **Test method** | ANSI C63.26: 2015<br>KDB 971168 D01 Power Meas License Digital Systems v03r01<br>KDB 412172 D01 Determining ERP and EIRP v01r01 |

# 3 Test Site Information

| | |
|---|---|
| **Lab performing tests** | Vista Laboratories, Inc. |
| **Lab Address** | 1261 Puerta Del Sol, San Clemente, CA 92673 USA |
| **Phone Number** | +1 (949) 393-1123 |
| **Website** | www.vista-compliance.com |

| Test Condition | Temperature | Humidity | Atmospheric Pressure |
|---|---|---|---|
| RF Testing | 23.2°C | 57.5% | 996 mbar |
| Radiated Emission Testing | 23.2°C | 57.5% | 996 mbar |

# 4 Modification of EUT / Deviations from Standards

N/A

# 5 Test Configuration and Operation

## 5.1 EUT Test Configuration

EUT is powered by external DC power supply for testing purpose. EUT's RF antenna port is connected to spectrum analyzer through RF test cable for measurement. The test software is used to set EUT to different transmission mode in terms of radio mode (WLAN, BLE), test channel, data rate, etc. For Cellular radio, it's controlled by communication tester to change to different mode.

## 5.2 Supporting Equipment

| Description | Manufacturer | Model # | Serial # |
|---|---|---|---|
| AC/DC Adapter | MEAN WELL | GST60A12-P1J | EB74Q81066 |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# 6 Uncertainty of Measurement

| Test item | Measurement Uncertainty (dB) |
|---|---|
| RF Output Power (Conducted) | ±1.2 dB |
| Power Spectral Density | ±0.9 dB |
| Unwanted Emission (conducted) | ±2.6 dB |
| Occupied Channel Bandwidth | ±5 % |
| Radiated Emission (9KHz-30MHz) | ±3.5 dB |
| Radiated Emission (30MHz-1GHz) | ±4.6 dB |
| Radiated Emission (1-18GHz) | ±4.9 dB |
| Radiated Emission (18-40GHz) | ±3.5 dB |

# 7 Test Results

## 7.1 RF Output Power

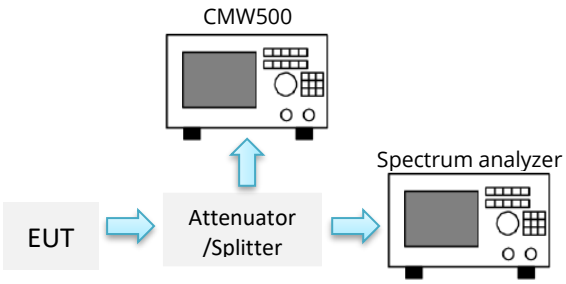
### *7.1.1 Requirement*

§ 22.913(a)(5) – ERP limit: 38.45 dBm

RSS-132(5.4) – EIRP limit: 40.61 dBm

§ 24.232(c) / RSS-133(6.4) – EIRP limit: 33 dBm

### *7.1.2 Test setup*




### *7.1.3 Test Procedure*

**For Conducted Power:**

- The transmitter output port was connected to base station.
- Set EUT at maximum power through base station.
- Select lowest, middle, and highest channels for each band and different test mode.

**For ERP/EIRP:**

- According with 971168 D01 Power Meas License Digital Systems v03r01
- The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load which was also placed on the turntable.
- The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3-orthogonal axis.
- The frequency ranges up to tenth harmonic of the fundamental frequency was investigated.
- Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.
- Spurious emissions in dB = 10 log (TX power in Watts/0.001) – the absolute level
- Spurious attenuation limit in dB = 43 + 10 Log10 (power out in Watts).

### *7.1.4 Test Result*

## Conducted Output Power (dBm)

| Band | GSM850 | | | PCS1900 | | |
|---|---|---|---|---|---|---|
| Channel | 128 | 190 | 251 | 512 | 661 | 810 |
| Frequency (MHz) | 824.2 | 836.6 | 848.8 | 1850.2 | 1880 | 1909.8 |
| GPRS (Slot 1) | 31.76 | 31.23 | 31.44 | 29.38 | 29.73 | 29.89 |
| GPRS (Slot 2) | 29.87 | 29.83 | 29.74 | 27.77 | 27.89 | 27.88 |
| GPRS (Slot 3) | 27.34 | 27.82 | 27.22 | 25.45 | 25.35 | 25.73 |
| GPRS (Slot 4) | 25.38 | 25.76 | 25.52 | 23.41 | 23.53 | 23.52 |
| EDGE (Slot 1) | 25.44 | 25.53 | 25.24 | 26.98 | 26.13 | 26.99 |
| EDGE (Slot 2) | 24.28 | 24.66 | 24.84 | 25.89 | 25.42 | 25.48 |
| EDGE (Slot 3) | 22.57 | 22.17 | 22.45 | 22.33 | 23.15 | 22.54 |
| EDGE (Slot 4) | 20.48 | 20.27 | 20.33 | 21.42 | 21.65 | 21.22 |

**Radiated Power**

| Mode | Channel | Frequency (MHz) | EIRP (dBm) | ERP (dBm) | EIRP/ERP Limit (dBm) | Result |
|---|---|---|---|---|---|---|
| GPRS 850 | 128 | 824.2 | - | 30.53 | 38.45 | Pass |
| | 190 | 836.6 | - | 31.04 | 38.45 | Pass |
| | 251 | 848.8 | - | 30.58 | 38.45 | Pass |
| GPRS 1900 | 512 | 1850.2 | 25.84 | - | 33 | Pass |
| | 661 | 1880 | 25.47 | - | 33 | Pass |
| | 810 | 1909.9 | 25.42 | - | 33 | Pass |

| Mode | Channel | Frequency (MHz) | EIRP (dBm) | ERP (dBm) | EIRP/ERP Limit (dBm) | Result |
|---|---|---|---|---|---|---|
| EDGE 850 | 128 | 824.2 | - | 24.42 | 38.45 | Pass |
| | 190 | 836.6 | - | 23.98 | 38.45 | Pass |
| | 251 | 848.8 | - | 24.36 | 38.45 | Pass |
| EDGE 1900 | 512 | 1850.2 | 22.82 | - | 33 | Pass |
| | 661 | 1880 | 22.21 | - | 33 | Pass |
| | 810 | 1909.9 | 22.47 | - | 33 | Pass |

## 7.2 Peak to Average Ratio

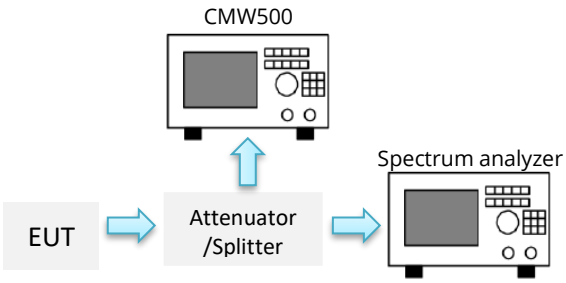
### *7.2.1 Requirement*

§ 2.1046, § 22.913, § 24.232

RSS-132(5.4), RSS-133(6.4)

The peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

### *7.2.2 Test Setup*




### *7.2.3 Test Procedure*

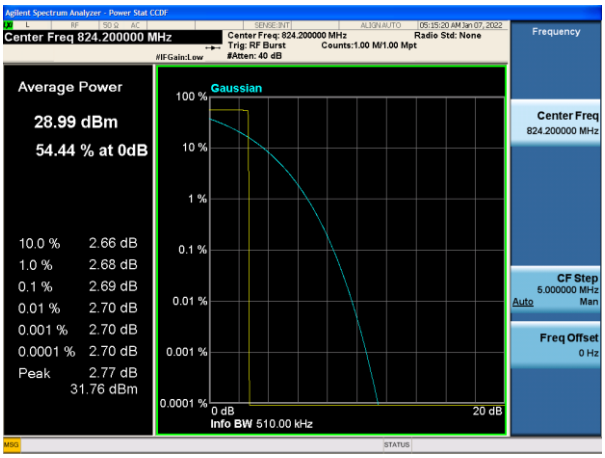
Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 5.7.1

- The signal analysers CCDF measurement profile Is enabled
- Frequency carrier center frequency
- Measurement BW> Emission bandwidth of signal
- The signal analyzer was set to collect one million samples to generate the CCDF curve
- The measurement interval was set depending on the type of signal analyzed. For continuous signals (>98% duty cycle) the measurement interval was set to 1ms. For burst transmissions, the spectrum analyzer is set to use an internal "RF Burst trigger that is synced with an incoming pulse and the measurement interval set to less than the duration of the "on time" of one burst to ensure that energy is only captured during a time in which the transmitter is operating at maximum power.
- Record the maximum PAPR level associated with a probability of 0. 1%.

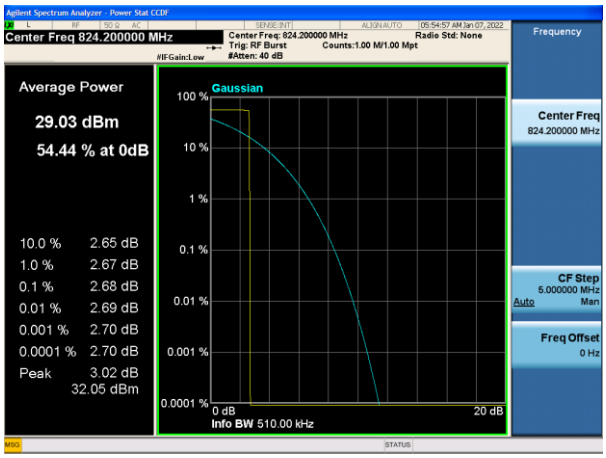
### *7.2.4 Test Result*

| Mode | Channel | Frequency (MHz) | PAR (dB) | Limit (dB) | Result |
|---|---|---|---|---|---|
| GPRS 850 | 128 | 824.2 | 2.69 | 13 | Pass |
| | 190 | 836.6 | 2.72 | 13 | Pass |
| | 251 | 848.8 | 2.68 | 13 | Pass |
| EDGE 850 | 128 | 824.2 | 2.68 | 13 | Pass |
| | 190 | 836.6 | 2.66 | 13 | Pass |
| | 251 | 848.8 | 2.66 | 13 | Pass |
| GPRS 1900 | 512 | 1850.2 | 2.78 | 13 | Pass |
| | 661 | 1880 | 2.76 | 13 | Pass |
| | 810 | 1909.8 | 2.79 | 13 | Pass |
| EDGE 1900 | 512 | 1850.2 | 2.75 | 13 | Pass |
| | 661 | 1880 | 2.75 | 13 | Pass |
| | 810 | 1909.8 | 2.90 | 13 | Pass |

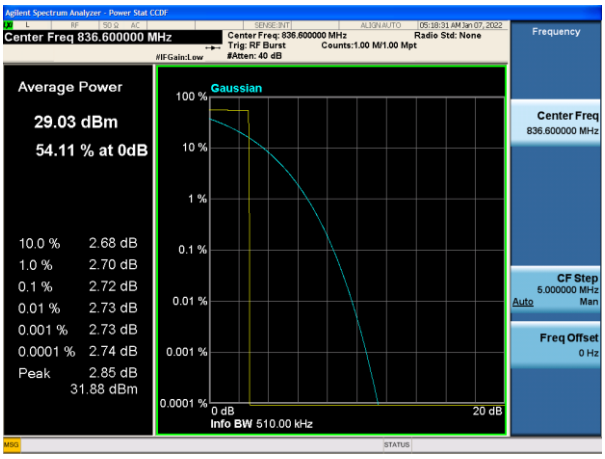
### *7.2.5 Test Plots*



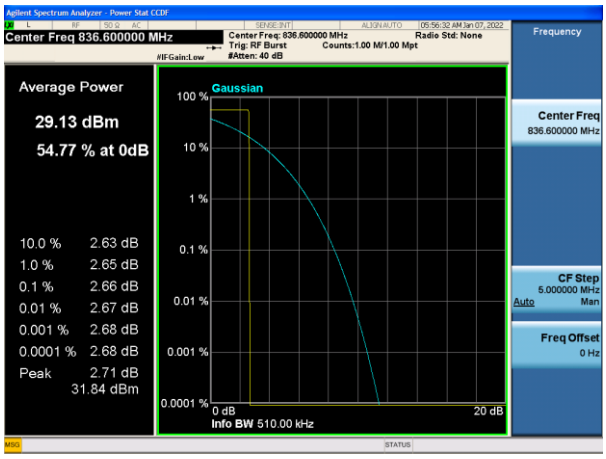

GPRS850-Low



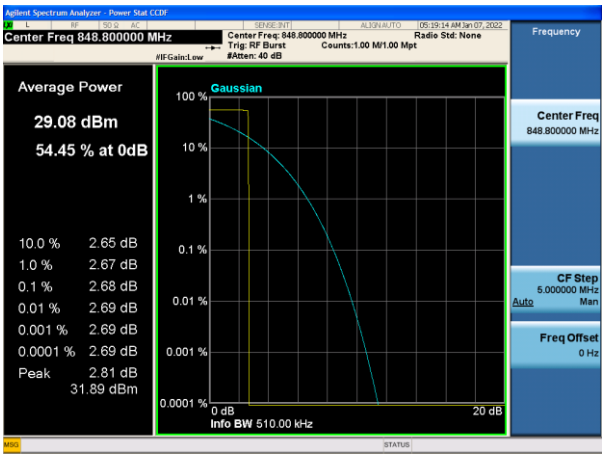

EDGE850-Low



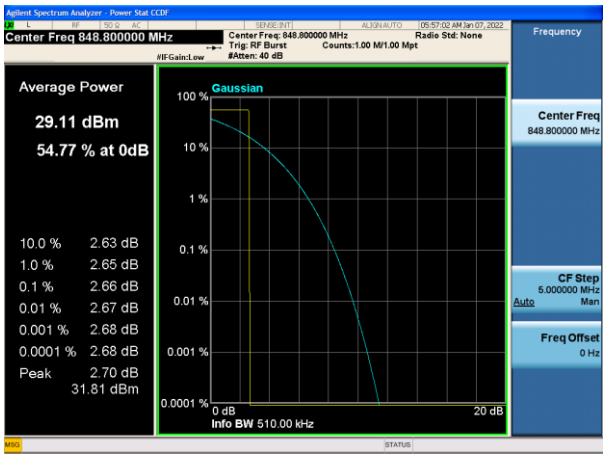

GPRS850-Mid



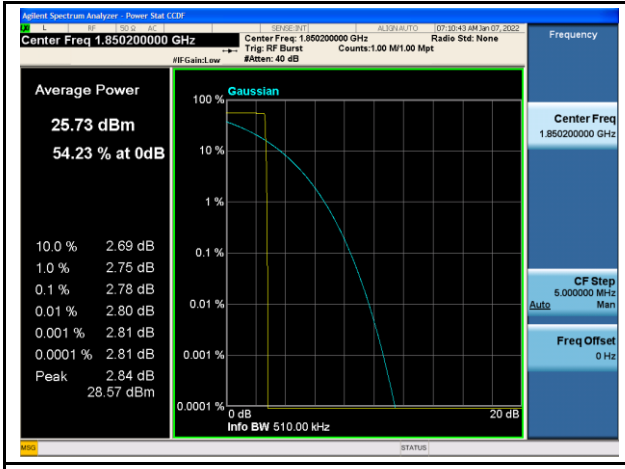

EDGE850-Mid



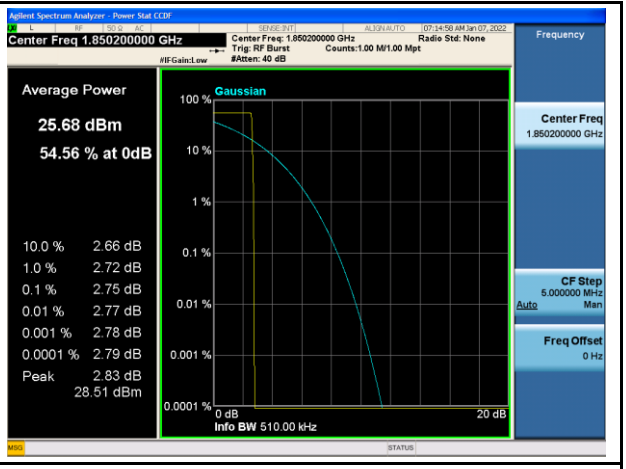

GPRS850-High



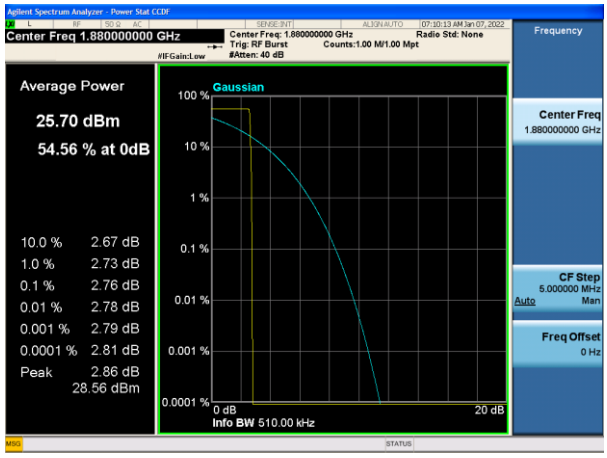

EDGE850-High



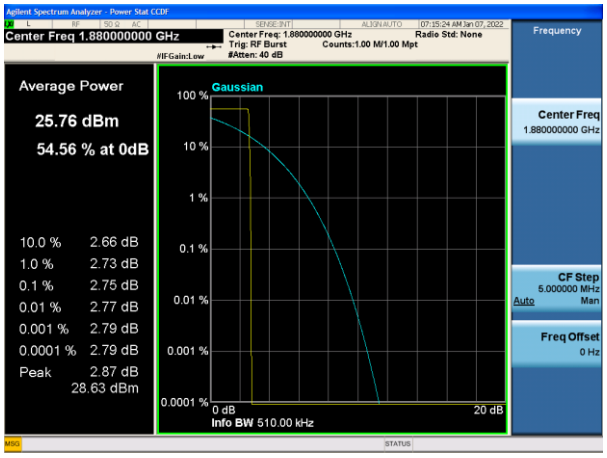

GPRS1900-Low



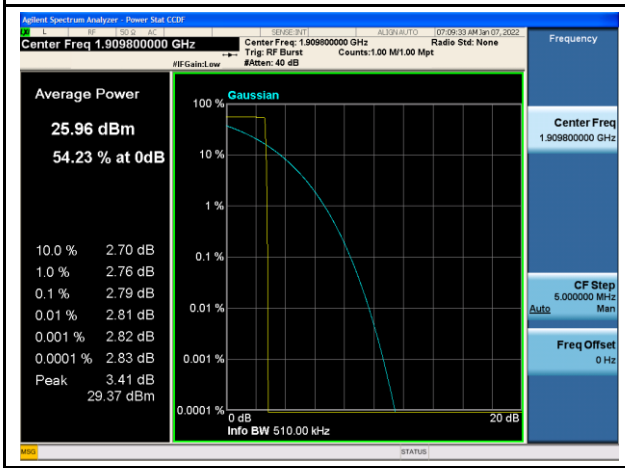

EDGE1900-Low



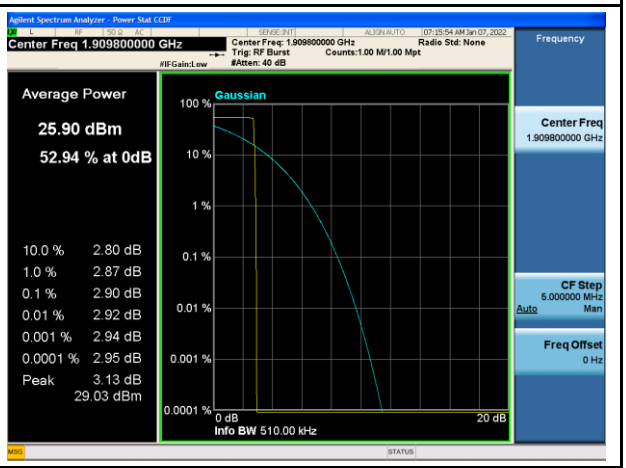

GPRS1900-Mid




EDGE1900-Mid




GPRS1900-High




EDGE1900-High

## 7.3 Occupied Bandwidth

### *7.3.1 Requirement*

§2.1049, RSS-Gen (6.7)

- 99% Occupied Bandwidth(kHz)

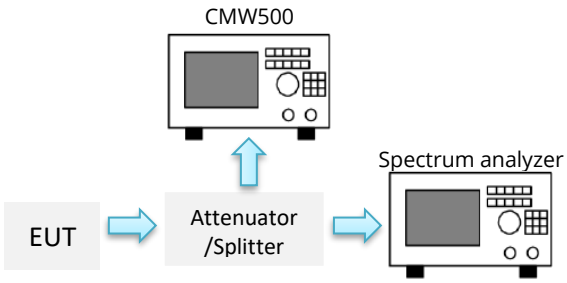
The occupied bandwidth that is the frequency bandwidth such that below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be Measured.

- 26 dB Bandwidth(kHz)

The 26 dB emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 26 dB below the maximum in-band spectral density of the modulated signal Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth equal to approximately 1.0% of the emission bandwidth.

All modes of operation were investigated and the worst-case configuration results are reported in this section

### *7.3.2 Test Setup*



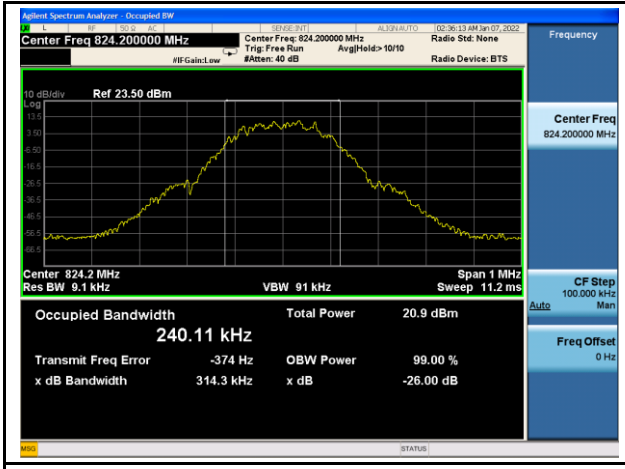

### *7.3.3 Test Procedure*

- The EUT was connected to Spectrum Analyzer and Base Station via power divider.
- Set RBW = 1% to 5% of the actual occupied BW.
- Set the video bandwidth (VBW) ≥ 3 x RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Span = large enough to capture all products of the modulation process
- Allow the trace to stabilize.
- Use automatic bandwidth measurement capability on instrument to obtain 99% and -26dB BW.

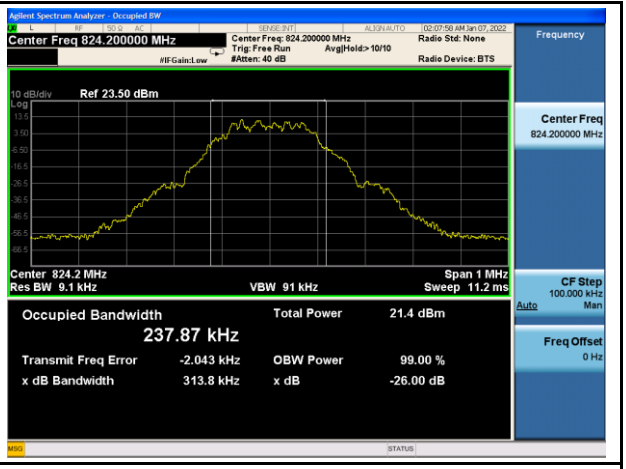
### *7.3.4 Test Result*

| Mode | Channel | Frequency (MHz) | 99% Power Bandwidth (kHz) | -26dBc Bandwidth (kHz) |
|---|---|---|---|---|
| GPRS850 | 128 | 824.2 | 240.11 | 314.3 |
| | 190 | 836.6 | 240.10 | 316.6 |
| | 251 | 848.8 | 240.51 | 318.2 |
| EGRS850 | 128 | 824.2 | 237.87 | 313.8 |
| | 190 | 836.6 | 237.84 | 307.4 |
| | 251 | 848.8 | 241.56 | 316.0 |
| GPRS 1900 | 512 | 1850.2 | 244.10 | 313.2 |
| | 661 | 1880 | 245.92 | 316.5 |
| | 810 | 1909.8 | 245.33 | 320.7 |
| EDGE 1900 | 512 | 1850.2 | 248.38 | 314.0 |
| | 661 | 1880 | 245.04 | 319.2 |
| | 810 | 1909.8 | 247.26 | 318.1 |

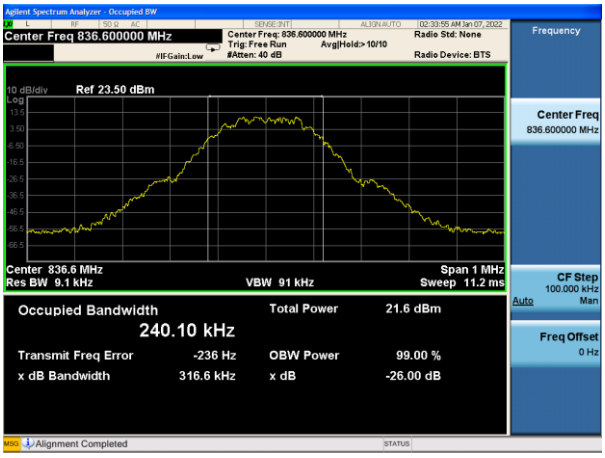
### *7.3.5 Test Plots*




GPRS850-Low

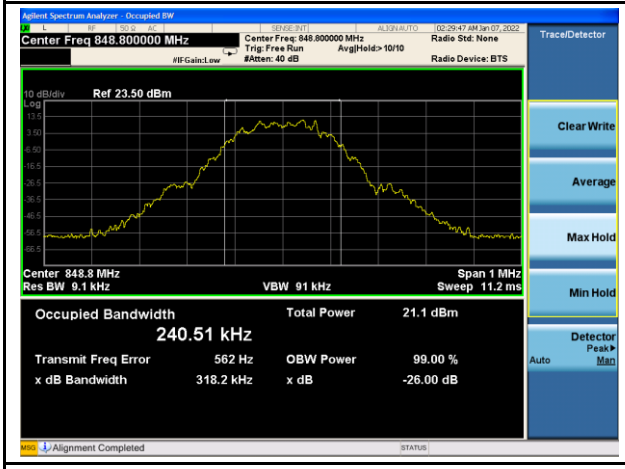



EDGE850-Low

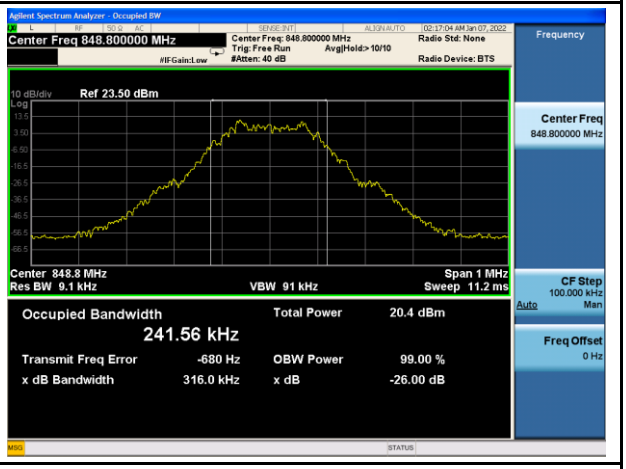



GPRS850-Mid

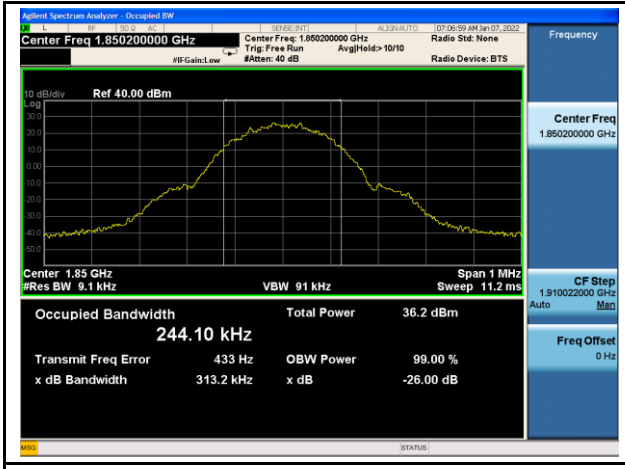

EDGE850-Mid



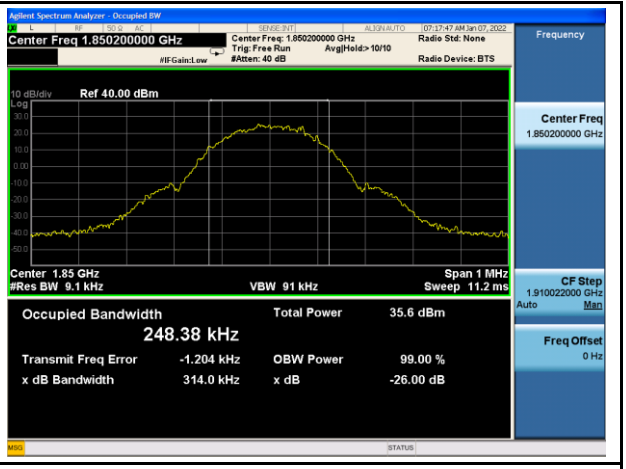

GPRS850-High



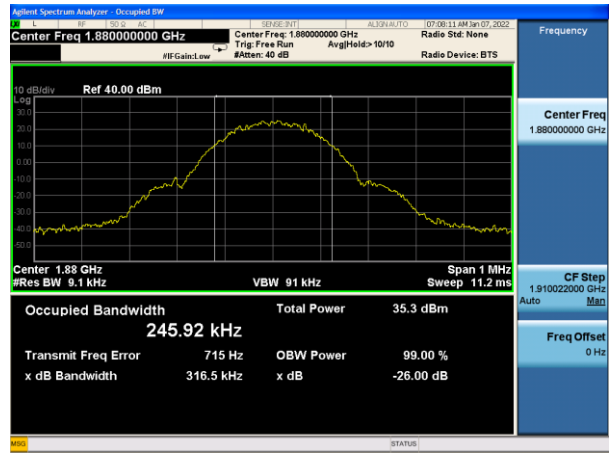

EDGE850-High



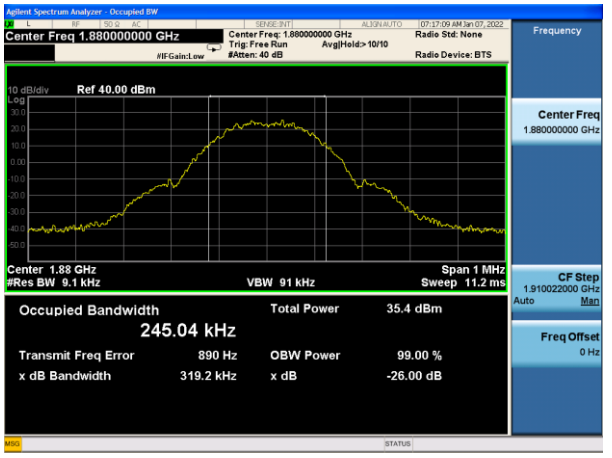

GPRS1900-Low



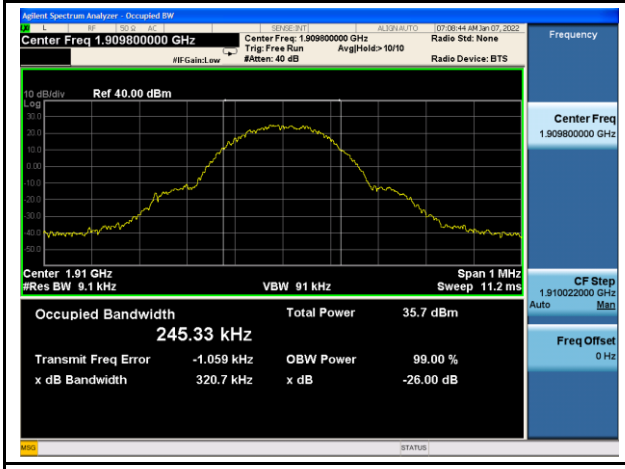

EDGE1900-Low



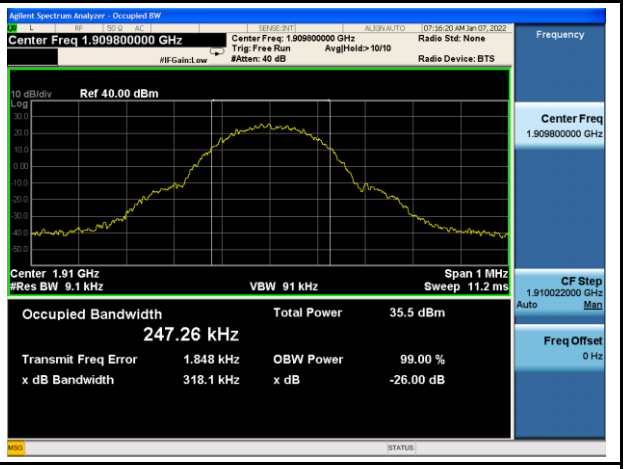

GPRS1900-Mid




EDGE1900-Mid




GPRS1900-High



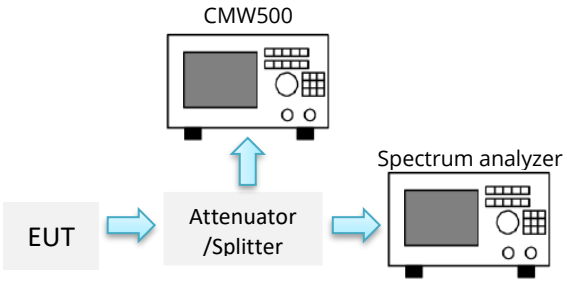

EDGE1900-High

## 7.4 Band Edge

### *7.4.1 Requirement*

The power of any emission outside of the authorized operating frequency ranges must be lower than the transmitter power(P)by a factor of at least 43+10 log(P)dB.

### *7.4.2 Test Setup*



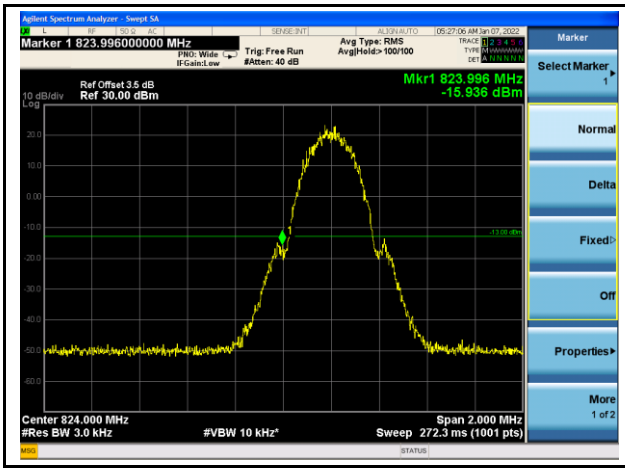

### *7.4.3 Test Procedure*

- The EUT was connected to Spectrum Analyzer and Base Station via power divider.
- Set RBW as roughly BW/100.
- Detector = average
- Sweep = auto couple.
- Allow the trace to stabilize.
- Set Marker to edge frequency
- The Band Edges of low and high channels for the highest RF powers were measured

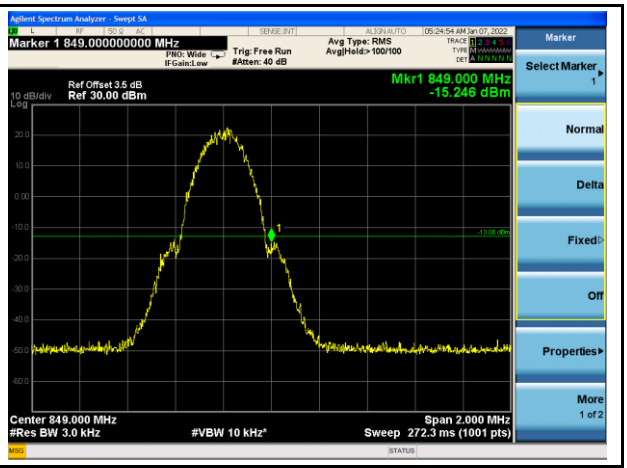
### *7.4.4 Test Result*

| Mode | Channel | Frequency (MHz) | Band Edge measured (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|---|
| GPRS850 | 128 | 824.2 | -15.936 | -13 | Pass |
| | 251 | 848.8 | -15.246 | -13 | Pass |
| EDGE850 | 128 | 824.2 | -13.758 | -13 | Pass |
| | 251 | 848.8 | -14.972 | -13 | Pass |
| GPRS1900 | 512 | 1850.2 | -18.958 | -13 | Pass |
| | 810 | 1909.8 | -16.777 | -13 | Pass |
| EDGE1900 | 512 | 1850.2 | -18.837 | -13 | Pass |
| | 810 | 1909.8 | -17.793 | -13 | Pass |

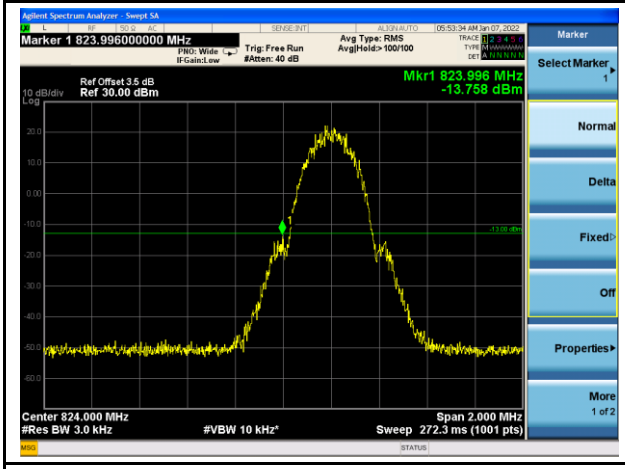
### *7.4.5 Test Plots*



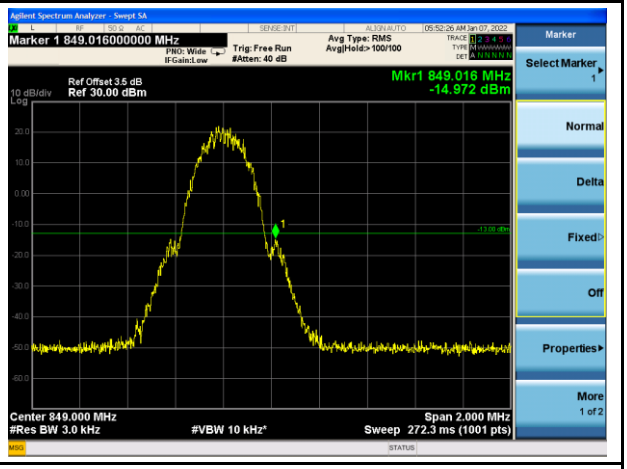

GPRS850-Low



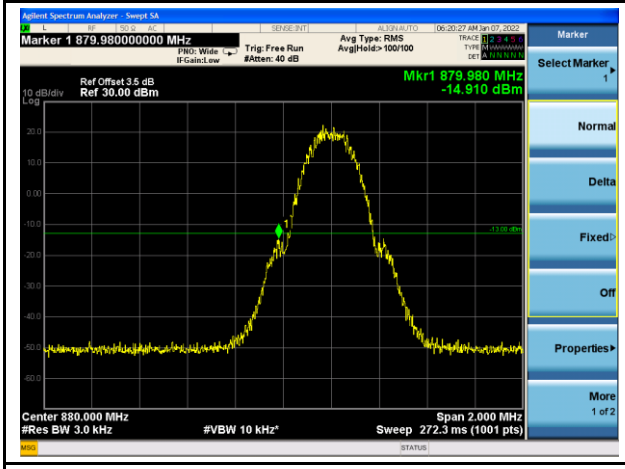

GPRS850-High



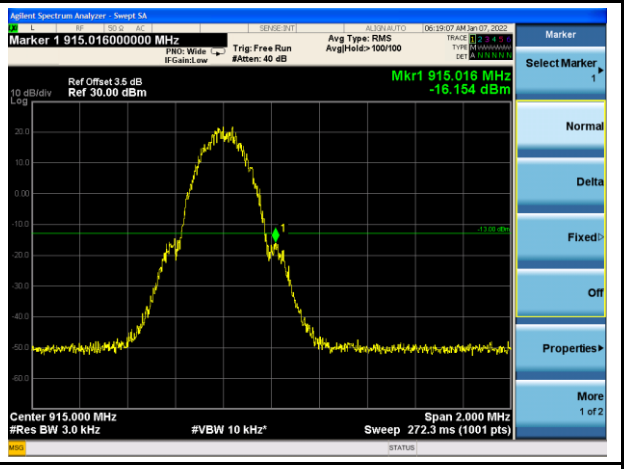

EDGE850-Low



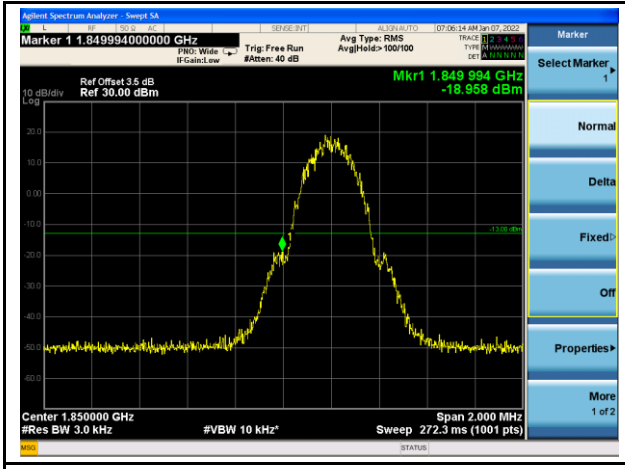

EDGE850-High



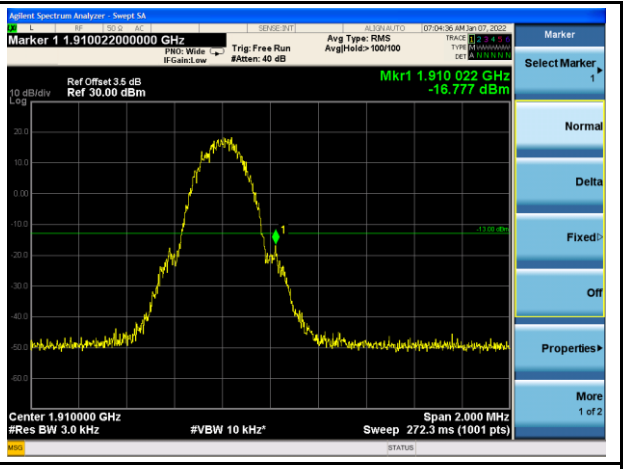

GPRS900-Low



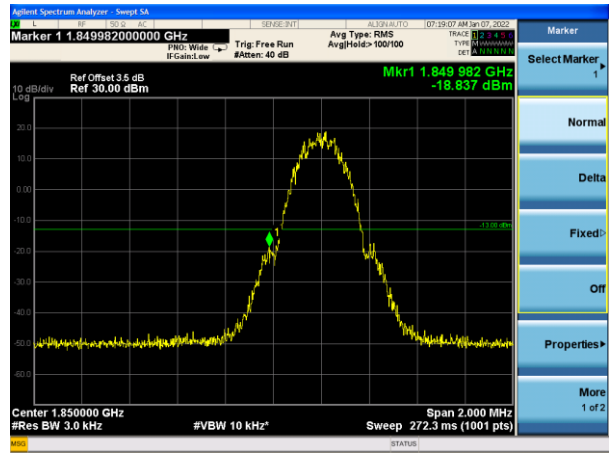

GPRS900-High



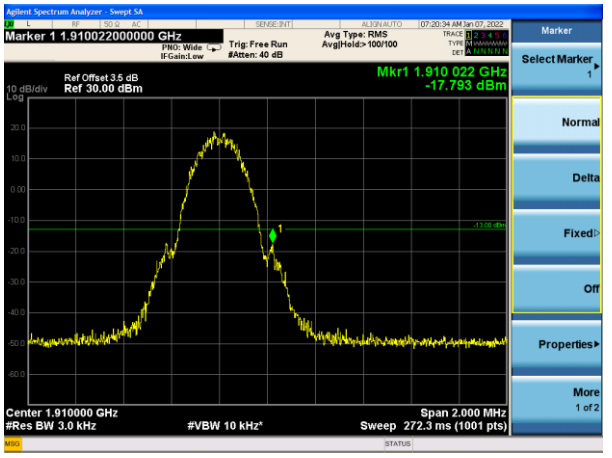

GPRS1900-Low




GPRS1900-High




EDGE1900-High




EDGE1900-High

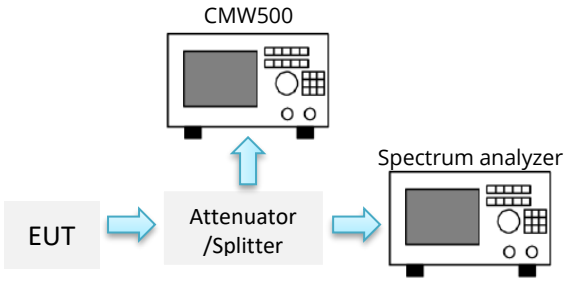
## 7.5 Conducted spurious emission

### *7.5.1 Requirement*

The power of any emission outside of the authorized operating frequency ranges must be lower than the transmitter power(P)by a factor of at least 43+10 log(P)dB.

It is measured by means of a calibrated spectrum analyzer and scanned from 30 MHZ up to a frequency including its 10 harmonics.

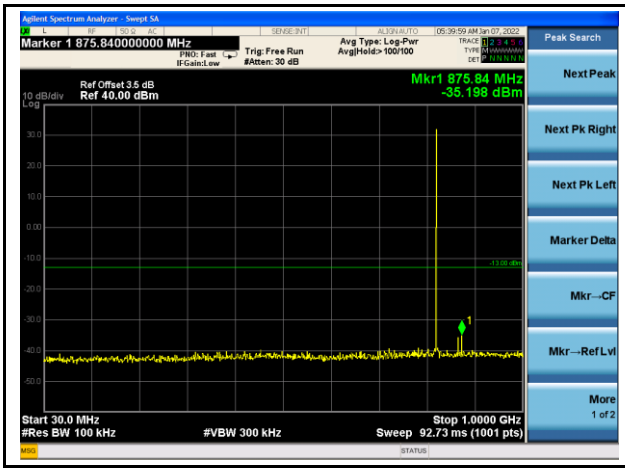
### *7.5.2 Test Setup*




### *7.5.3 Test Procedure*

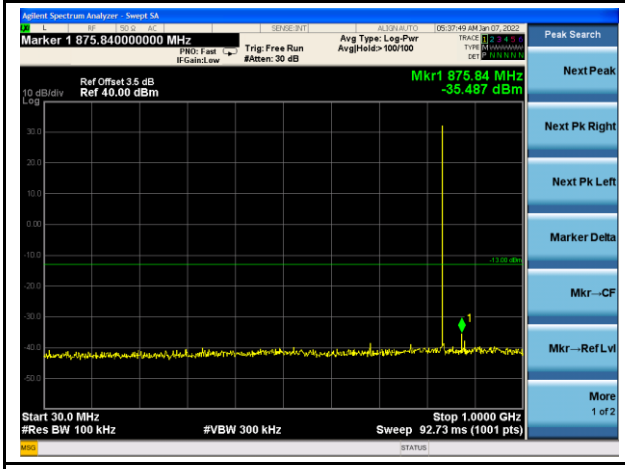
- The EUT was connected to Spectrum Analyzer and Base Station via power divider.
- Set RBW = 100KHz and VBW=300KHz for below 1GHz; set RBW=1MHz and VBW=3MHz for above 1GHz.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Use marker peak to search for spurious emission

### *7.5.4 Test Result*



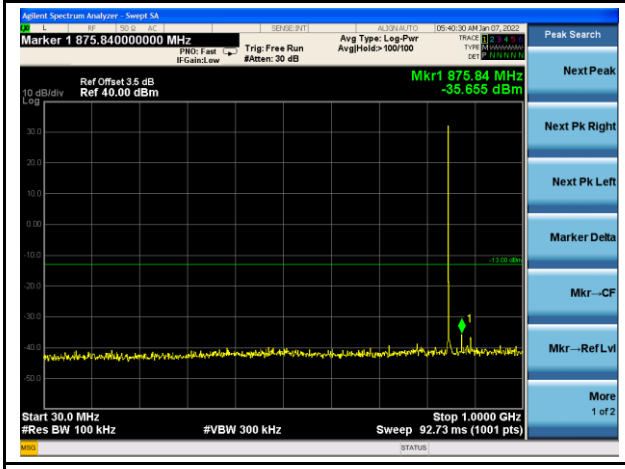

GPRS850 - Low- 30MHz~1GHz


GPRS850 - Low - 1GHz~10GHz



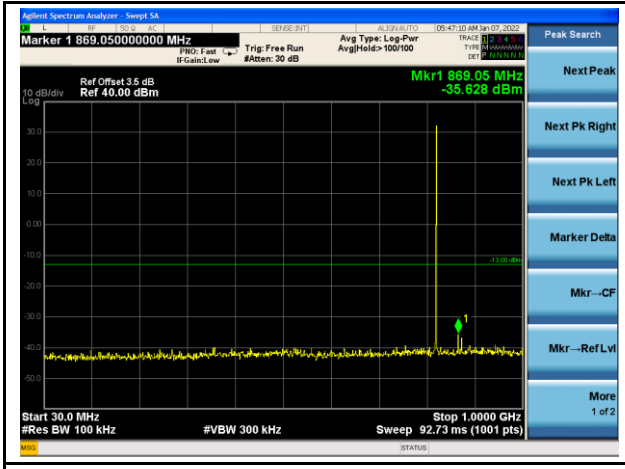

GPRS850 - Mid- 30MHz~1GHz


GPRS850 – Mid - 1GHz~10GHz



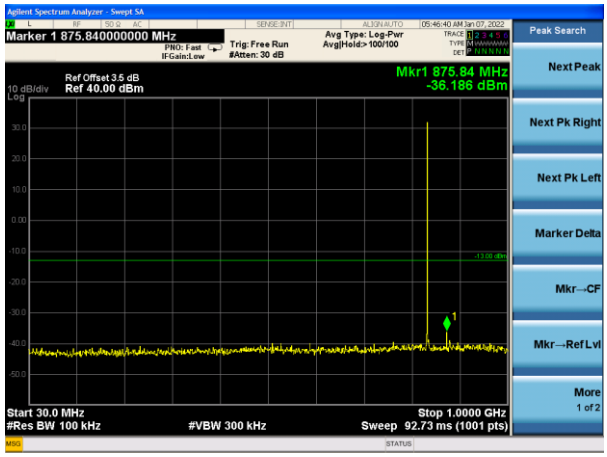

GPRS850 - High - 30MHz~1GHz


GPRS850 - High - 1GHz~10GHz

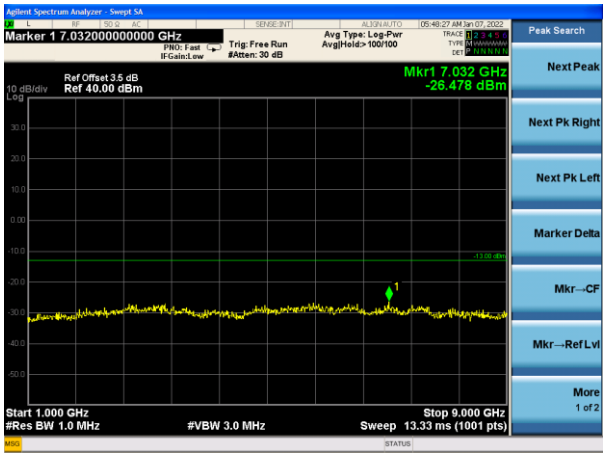



EDGE850 - Low- 30MHz~1GHz

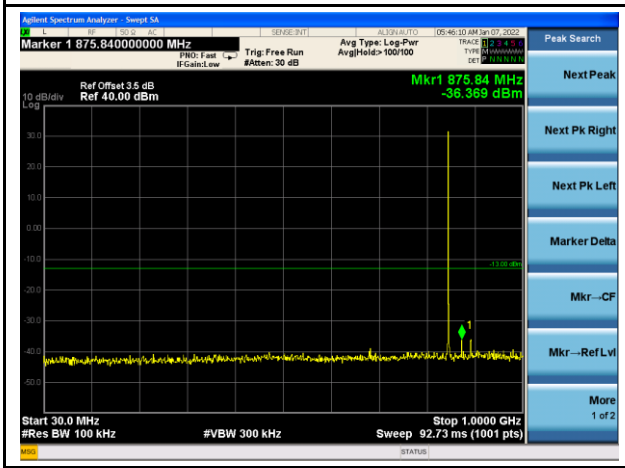

EDGE850 - Low - 1GHz~10GHz




EDGE850 - Mid- 30MHz~1GHz

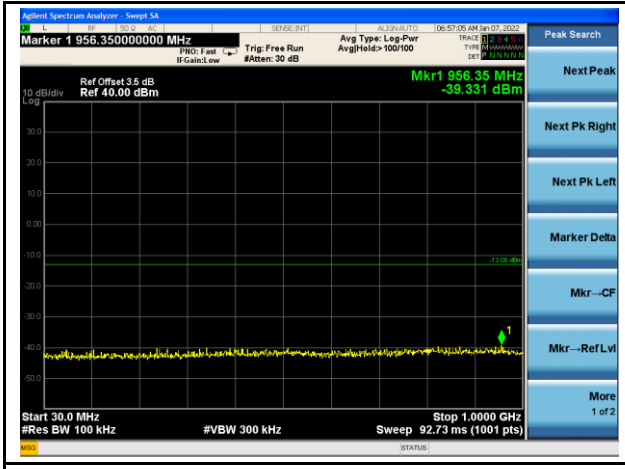



EDGE850 – Mid - 1GHz~10GHz



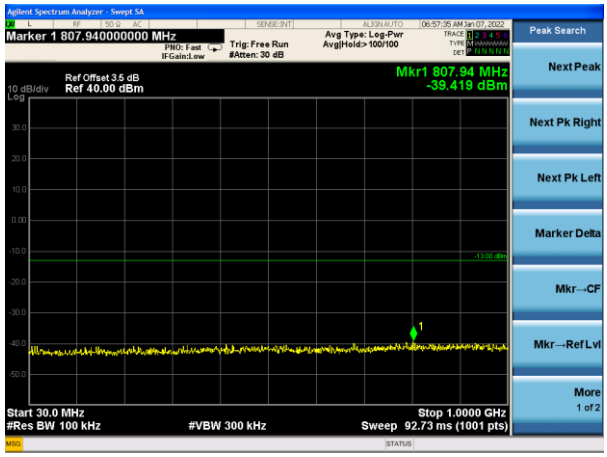

EDGE850 - High - 30MHz~1GHz


EDGE850 - High - 1GHz~10GHz

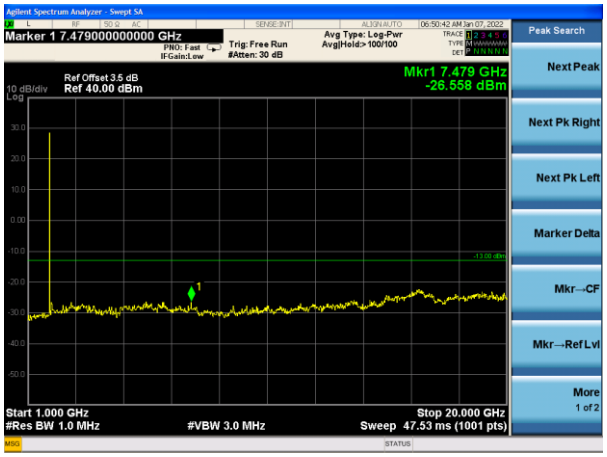



GPRS1900 - Low- 30MHz~1GHz

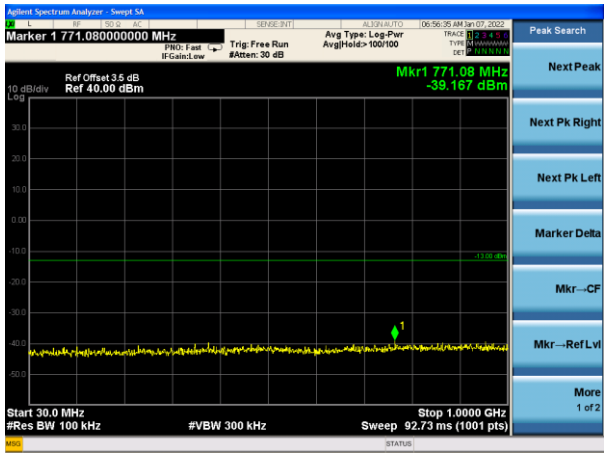

GPRS1900 - Low - 1GHz~20GHz




GPRS1900 - Mid- 30MHz~1GHz

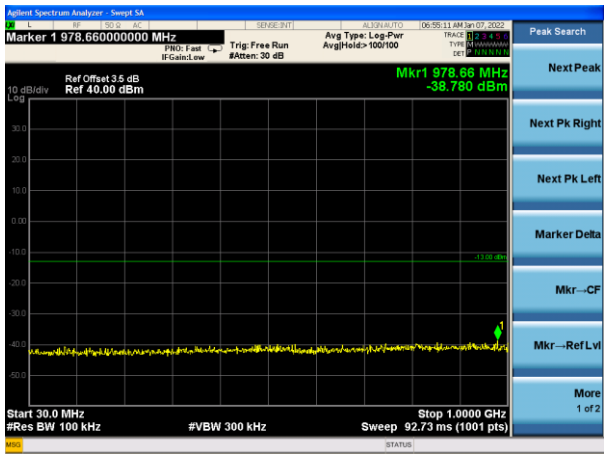



GPRS1900 – Mid - 1GHz~20GHz

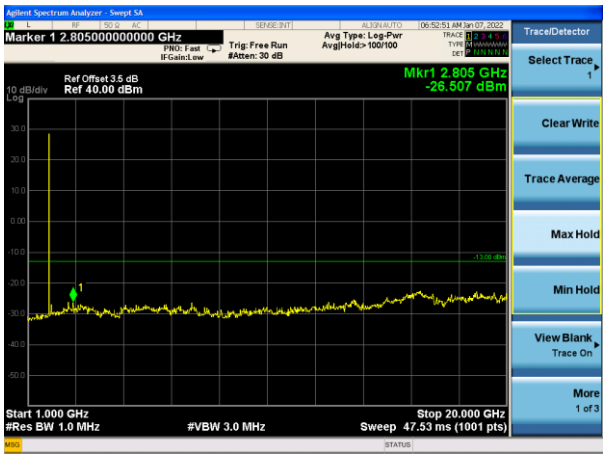



GPRS1900 - High - 30MHz~1GHz

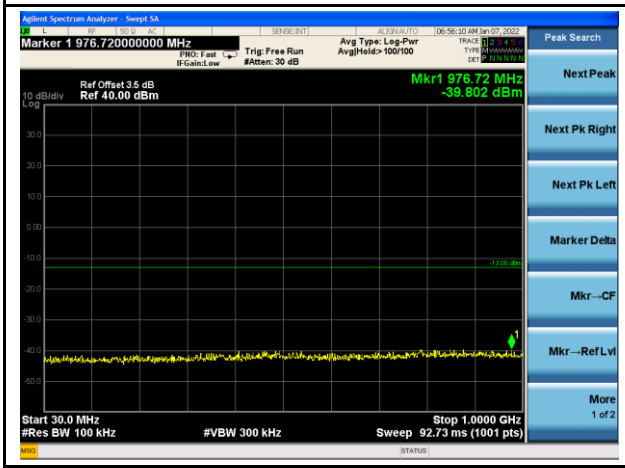

GPRS1900 - High - 1GHz~20GHz




EDGE1900 - Low- 30MHz~1GHz

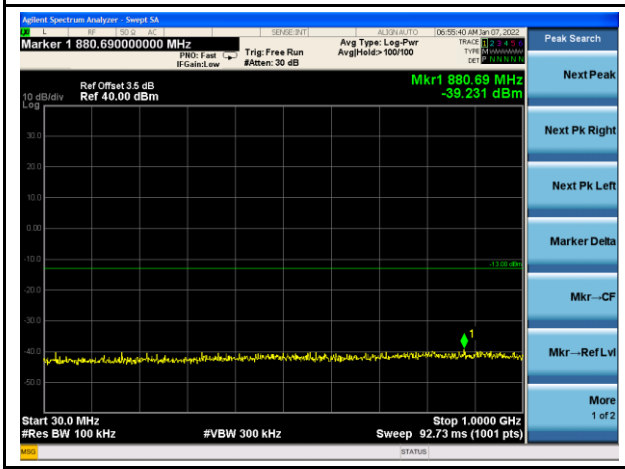



EDGE1900 - Low - 1GHz~20GHz




EDGE1900 - Mid- 30MHz~1GHz


EDGE1900 – Mid - 1GHz~20GHz




EDGE1900 - High - 30MHz~1GHz


EDGE1900 - High - 1GHz~20GHz

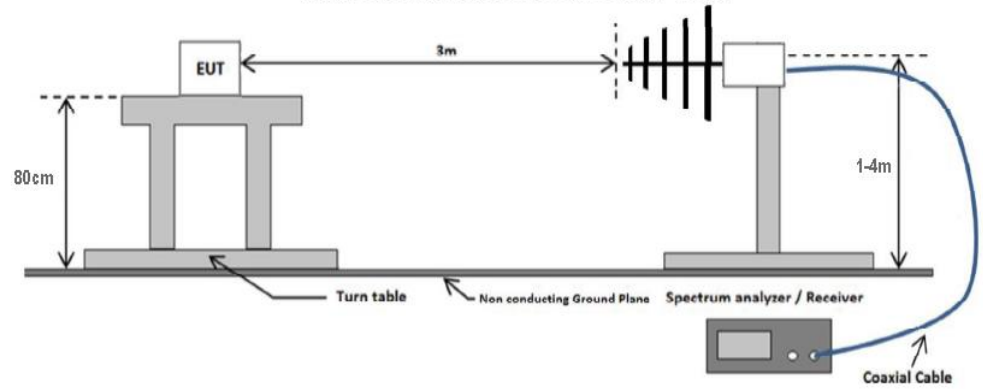
## 7.6 Field Strength of Radiated Spurious Emissions

### *7.6.1 Requirement*

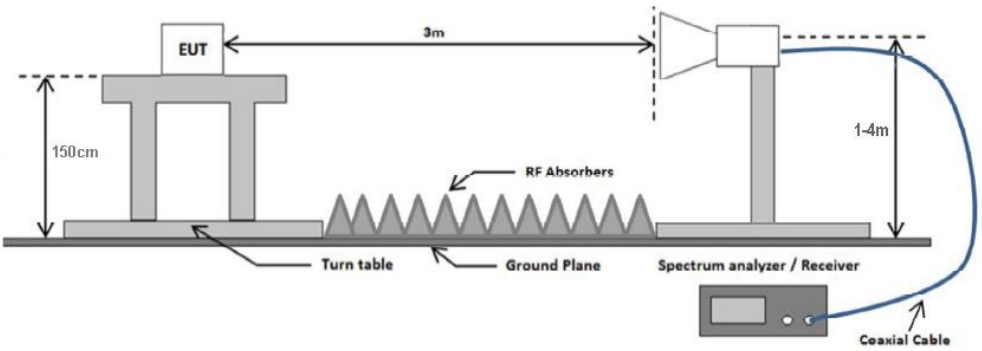
The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power(P)by a factor of at least 43+10 log(P)dB. The emission limit is equal to-13dBm.

### *7.6.2 Test Setup*

Radiated emissions test setup 30 MHz - 1 GHz




Radiated emissions test setup above 1 GHz



### *7.6.3 Test Procedure*

ANSI C63.26: 2015 section 5.5

KDB 971168 D01 Power Meas License Digital Systems v03r01 section 7

Boresight antenna mast was used during the scanning to point to EUT to maximize the emission. The process will be repeated in 3 EUT orientations.

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 300 Hz for frequency below 150KHz.
4. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 kHz for frequency between 150KHz – 30MHz.
5. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-Peak detection at frequency between 30MHz - 1GHz.
6. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz with Peak detection for Peak and average measurement at frequency above 1GHz.
7. Remove the transmitter and replace it with a substitution antenna (the antenna should be half-wavelength for each frequency involved). The center of the substitution antenna should be approximately at the same location as the center of the transmitter.
8. Feed the substitution antenna at the transmitter end with a signal generator connected to the antenna by means of a non-radiating cable. With the antennas at both ends horizontally polarized, and with the signal generator tuned to a particular spurious frequency, raise and lower the test antenna to obtain a maximum reading at the spectrum analyzer. Adjust the level of the signal generator output until the previously recorded maximum reading for this set of conditions is obtained.
9. Steps 2 - 8 were repeated for the next frequency point, until all selected frequency points were measured

### *7.6.4 Test Result*

| GSM850 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low Channel | | | | | | | | | | | | |
| No. | Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Result |
| 1 | 1648.619 | -69.18 | 17.07 | -9.43 | -61.54 | RMS Max | H | 120 | 124 | -13 | -48.54 | Pass |
| 2 | 2472.306 | -71.59 | 18.05 | -9.21 | -62.76 | RMS Max | H | 220 | 267 | -13 | -49.76 | Pass |
| 3 | 3295.734 | -73.31 | 19.2 | -6.21 | -60.32 | RMS Max | H | 111 | 338 | -13 | -47.32 | Pass |
| Mid channel | | | | | | | | | | | | |
| No. | Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Result |
| 1 | 1673.492 | -68.58 | 17.14 | -9.53 | -60.97 | RMS Max | V | 215 | 353 | -13 | -47.97 | Pass |
| 2 | 2507.129 | -72.64 | 18.07 | -9 | -63.57 | RMS Max | H | 291 | 60 | -13 | -50.57 | Pass |
| 3 | 3345.667 | -73.38 | 19.16 | -5.96 | -60.18 | RMS Max | H | 204 | 97 | -13 | -47.18 | Pass |
| High channel | | | | | | | | | | | | |
| No. | Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Result |
| 1 | 1697.483 | -68.65 | 17.21 | -9.62 | -61.06 | RMS Max | V | 162 | 202 | -13 | -48.06 | Pass |
| 2 | 2546.866 | -72.91 | 18.13 | -8.78 | -63.55 | RMS Max | H | 211 | 260 | -13 | -50.55 | Pass |
| 3 | 3395.773 | -73.79 | 19.09 | -5.78 | -60.47 | RMS Max | V | 255 | 3 | -13 | -47.47 | Pass |

| GSM1900 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low Channel | | | | | | | | | | | | |
| No. | Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Result |
| 1 | 3700.235 | -73.87 | 19.66 | -4.6 | -58.81 | RMS Max | V | 139 | 261 | -13 | -45.81 | Pass |
| 2 | 5550.011 | -78.82 | 21.65 | -0.39 | -57.57 | RMS Max | H | 224 | 32 | -13 | -44.57 | Pass |
| 3 | 7401.827 | -77.15 | 23.75 | 1.08 | -52.33 | RMS Max | V | 295 | 57 | -13 | -39.33 | Pass |
| Mid channel | | | | | | | | | | | | |
| No. | Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Result |
| 1 | 3759.893 | -73.56 | 19.83 | -4.28 | -58.01 | RMS Max | V | 131 | 357 | -13 | -45.01 | Pass |
| 2 | 5639.809 | -79.02 | 21.76 | -0.35 | -57.61 | RMS Max | V | 156 | 31 | -13 | -44.61 | Pass |
| 3 | 7520.457 | -76.82 | 23.73 | 0.76 | -52.33 | RMS Max | H | 235 | 351 | -13 | -39.33 | Pass |
| High channel | | | | | | | | | | | | |
| No. | Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Result |
| 1 | 3819.017 | -74.51 | 19.89 | -3.86 | -58.48 | RMS Max | H | 128 | 276 | -13 | -45.48 | Pass |
| 2 | 5731.08 | -78.38 | 21.83 | -0.2 | -56.75 | RMS Max | V | 257 | 326 | -13 | -43.75 | Pass |
| 3 | 7639.914 | -76.18 | 24.11 | 0.47 | -51.6 | RMS Max | V | 142 | 30 | -13 | -38.6 | Pass |

Remarks:

1. Level (dBuV) = Raw (dBuV) + Cable loss(dB) + AF (dB).
2. AF(dB) = Antenna Factor (dB) – Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

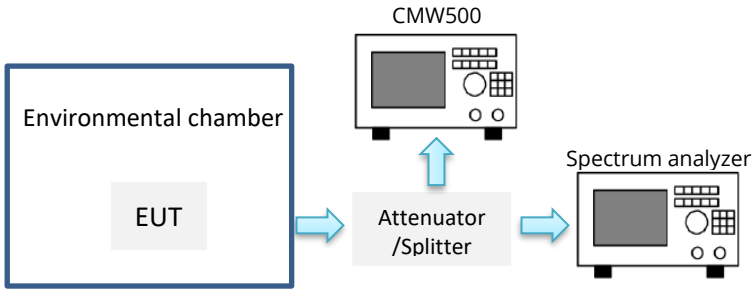
## 7.7 Frequency Stability

### *7.7.1 Requirement*

§2.1055, §22.355 & §24.235
RSS-132(5.3), RSS-133(6.3)

The frequency stability shall be measured by variation of ambient temperature and variation of primary supply voltage to ensure that the fundamental emission stays within the authorized frequency block. The carrier frequency shall not depart from the reference frequency in excess of ±2.5ppm (±0.00025%) for mobile stations.

### *7.7.2 Test Setup*




### *7.7.3 Test Procedure*

- The testing follows ANSI C63.26 section 5.6.4.
- A communication link was established between EUT and base station.
- The EUT was set up in the thermal chamber and connected with the communication tester.
- With power OFF, the temperature was decreased to -30°C and the EUT was stabilized before testing. Power was applied and the maximum change in frequency was recorded within one minute.
- With power OFF, the temperature was raised in 10°C steps up to 50°C. The EUT was stabilized at each step for at least half an hour. Power was applied and the maximum frequency change was recorded within one minute.
- The frequency error was monitored and measured by base station under variation of ambient temperature and variation of primary supply voltage.

### *7.7.4 Test Result*

| GPRS850 – 836.6MHz | | | | | |
|---|---|---|---|---|---|
| **Voltage (Vdc)** | **Temperature (℃)** | **Frequency error (Hz)** | **Frequency error (ppm)** | **Limit (ppm)** | **Result** |
| 12.0 | -30 | 21 | 0.02510 | 2.50 | PASS |
| | -20 | 19 | 0.02271 | | |
| | -10 | 18 | 0.02152 | | |
| | 0 | 20 | 0.02391 | | |
| | 10 | 19 | 0.02271 | | |
| | 20 | 17 | 0.02032 | | |
| | 30 | 19 | 0.02271 | | |
| | 40 | 18 | 0.02152 | | |
| | 50 | 21 | 0.02510 | | |
| 10.2 | 20 | 21 | 0.02510 | | |
| 13.8 | 20 | 15 | 0.01793 | | |

| GPRS1900 – 1880 MHz | | | | | |
|---|---|---|---|---|---|
| **Voltage (Vdc)** | **Temperature (℃)** | **Frequency error (Hz)** | **Frequency error (ppm)** | **Limit (ppm)** | **Result** |
| 12.0 | -30 | 9 | 0.00479 | 2.50 | PASS |
| | -20 | 13 | 0.00691 | | |
| | -10 | 12 | 0.00638 | | |
| | 0 | 15 | 0.00798 | | |
| | 10 | 19 | 0.01011 | | |
| | 20 | 13 | 0.00691 | | |
| | 30 | 21 | 0.01117 | | |
| | 40 | 13 | 0.00691 | | |
| | 50 | 18 | 0.00957 | | |
| 10.2 | 20 | 16 | 0.00851 | | |
| 13.8 | 20 | 13 | 0.00691 | | |

# 8 EUT and Test Setup Photos

See FCC exhibits

# 9 Test Instrument List

| Equipment | Manufacturer | Model | Instrument Number | Cal. Date | Cal. Due |
|---|---|---|---|---|---|
| Semi-Anechoic Chamber | ETS-Lindgren | 10M | VL001 | 10/18/20 | 10/18/22 |
| Shielding Control Room | ETS-Lindgren | Series 81 | VL006 | N/A | N/A |
| Spectrum Analyzer | Keysight | N9020A | MY50110074 | 06/17/2021 | 06/17/2022 |
| EMC Test Receiver | R&S | ESL6 | 100230 | 06/14/2021 | 06/14/2022 |
| Bi-Log Antenna | ETS-Lindgren | 3142E | 217921 | 11/15/2021 | 11/15/2022 |
| Horn Antenna (1-18GHz) | Electro-Metrics | EM-6961 | 6292 | 05/14/2021 | 05/14/2022 |
| Horn Antenna (18-40GHz) | Com-Power | AH-840 | 101109 | 06/24/2021 | 06/24/2022 |
| Preamplifier | RF Bay, Inc. | LPA-10-20 | 11180621 | 07/16/2021 | 07/16/2022 |
| True RMS Multi-meter | UNI-T | UT181A | C173014829 | 05/05/2021 | 05/05/2022 |
| Temp / Humidity / Pressure Meter | PCE Instruments | PCE-THB 40 | R062028 | 05/15/2021 | 05/15/2022 |
| RF Attenuator | Pasternack | PE7005-3 | VL061 | 07/16/2021 | 07/16/2022 |
| Preamplifier 100KHz - 40GHz | Aeroflex | 33711-392-77150-11 | 064 | 07/16/2021 | 07/16/2022 |
| EM Center Control | ETS-Lindgren | 7006-001 | 160136 | N/A | N/A |
| Turn Table | ETS-Lindgren | 2181-3.03 | VL002 | N/A | N/A |
| Boresight Antenna Tower | ETS-Lindgren | 2171B | VL003 | N/A | N/A |
| Loop Antenna (9k-30MHz) | Com-Power | AL-130 | 121012 | 05/16/21 | 05/16/22 |
| RE test cable (below 6GHz) | Vista | RE-6GHz-01 | RE-6GHz-01 | 07/16/2021 | 07/16/2022 |
| RE test cable (1-18GHz) | PhaseTrack | II-240 | RE-18GHz-01 | 07/16/2021 | 07/16/2022 |
| RE test cable (>18GHz) | Sucoflex | 104 | 344903/4 | 07/16/2021 | 07/16/2022 |
| Pulse limiter | Com-Power | LIT-930A | 531727 | 07/16/2021 | 07/16/2022 |
| CE test cable #1 | FIRST RF | FRF-C-1002-001 | CE-6GHz-01 | 07/16/2021 | 07/16/2022 |
| CE test cable#2 | FIRST RF | FRF-C-1002-001 | CE-6GHz-02 | 07/16/2021 | 07/16/2022 |
| Vector Signal Generator | Keysight | N5182A | US47080548 | 06/17/2021 | 06/17/2022 |
| USB RF Power Sensor | ETS-Lindgren | 7002-006 | SN 00151268 | 05/15/2019 | 05/15/2022 |
| RF Power Amplifier (80-1000MHz) | Ophir | 5226FE | 1013/1815 | N/A | N/A |
| RF Power Amplifier (700-6000MHz) | Ophir | 5293FE | 1063/1815 | N/A | N/A |
| Horn Antenna (1-18GHz) | FT-RF | HA-07M18G-NF | 180010HA | N/A | N/A |
| Wideband Communication | R&S | CMW500 | 147508 | 05/10/2021 | 05/10/2022 |
| Temperature/Humidity Chamber | Thermotron | SM-8-8200 | 40991 | 09/08/2021 | 09/08/2022 |

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