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FCC RF Test Report

Test Report Number	WAP-22061561-LC-FCC-GSM-F
FCC ID	KMH-14H317-NA1
Applicant	Ford Motor Company
Applicant Address	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124
Product Name	Vehicle Telematics Control Unit
Model Name	FNV3-B6-NA
Model Number	U5T-14H317-D
Family Model Name	FNV3-B6-ROW
Family Model Number	U5T-14H317-J, U5T-14H317-H, U5T-14H317-L
Date of Receipt	04/05/2022
Date of Test	10/10/2022 – 10/18/2022
Report Issue Date	10/20/2022
Test Standards	47CFR Part 22 47CFR Part 24
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-22061561-LC-FCC-GSM	01	Initial report	10/20/2022

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1 Test Summary

Test Item	FCC IC Rules	Test Method	Result
Effective (Isotropic) Radiated Power	§ 2.1046, § 22.913 § 24.232	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Peak to Average Ratio	§ 2.1046, § 22.913 § 24.232	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Occupied bandwidth	§2.1049	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Band Edge	§ 2.1051; § 22.917(a) § 24.238	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Conducted Spurious Emission	§ 2.1051; § 22.917(a) § 24.238	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Field Strength of Radiated Spurious Emissions	§ 2.1051; § 22.917(a) § 24.238	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Frequency Stability	§ 2.1055, § 22.355 § 24.235	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass

2 General Information

2.1 Applicant

Applicant	Ford Motor Company (Brand: FoMoCo)
Applicant address	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124
Manufacturer	Ford Motor Company (Brand: FoMoCo)
Manufacturer Address	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124

2.2 Product information

Product Name	Vehicle Telematics Control Unit
Mode Name	FNV3-B6-NA
Mode Name	FNV3-B6-NA
Model Number	U5T-14H317-D
Family Model Name	FNV3-B6-ROW
Family Model Number	U5T-14H317-J, U5T-14H317-H, U5T-14H317-L
Serial Number	ANHGG22022104741, ANHGG22027104975 (Conducted), ANHGG22022104737, ANHGG21328102795 (Radiated)
Frequency Band	BT BDR/EDR: 2402-2480MHz BLE: 2402-2480MHz 802.11b/g/n-20MHz: 2412-2462MHz 802.11n-40MHz: 2422-2452MHz 802.11a/n-20MHz: 5500-5580MHz, 5660-5720, 5725-5825MHz 802.11n-40MHz: 5510-5550MHz, 5630-5710, 5755-5795MHz 802.11ac: 5530, 5690MHz, 5775MHz GPRS/EDGE 850: 824.2- 848.8 MHz GPRS/EDGE 1800: 1710.2- 1784.8 MHz WCDMA Band 2: UL: 1850- 1910MHz; DL: 1930-1990MHz WCDMA Band 4: UL: 1710- 1755MHz. DL: 2110-2155MHz WCDMA Band 5: UL: 824- 849MHz; DL: 869-894MHz LTE Band 2: UL: 1850-1910MHz; DL: 1930-1990MHz LTE Band 4: UL:1710-1755MHz; DL: 2110-2155MHz LTE Band 5: UL:824-849MHz; DL: 869-894MHz LTE Band 7: UL:2500-2570MHz; DL: 2620-2690MHz LTE Band 12: UL:699-716MHz; DL: 729-746MHz LTE Band 13: UL:777-787MHz; DL:746-756MHz LTE Band 17: UL: 704-716MHz; DL: 734-746MHz LTE Band 29: DL: 717-728MHz (UE Receive Only) LTE Band 38: UL: 2570-2620MHz; DL: 2570-2620MHz LTE Band 66: UL:1710-1780MHz; DL: 2110-2200MHz LTE Band 71: UL: 663-698MHz; DL: 617-652MHz 5G NR n2: UL: 1850-1910MHz; DL: 1930-1990MHz 5G NR n5: UL:824-849MHz; DL: 869-894MHz 5G NR n7: UL:2500-2570MHz; DL: 2620-2690MHz 5G NR n41: UL:2496-2690MHz; DL: 2496-2690MHz 5G NR n66: UL:1710-1780MHz; DL: 2110-2200MHz

<table>
<tr><td></td><td>5G NR n71: UL:663-698MHz; DL: 617-652MHz
5G NR n77-L: UL:3450-3550MHz; DL: 3450-3550MHz
5G NR n77-H: UL:3700-3980MHz; DL: 3700-3980MHz
5G NR n78-L: UL:3450-3550MHz; DL: 3450-3550MHz
5G NR n78-H: UL: 3700-3800MHz; DL: 3700-3800MHz</td></tr>
<tr><td>Type of modulation</td><td>BT BDR/EDR: GFSK, π/4DQPSK, 8DPSK
BLE: GFSK
802.11b: DSSS (CCK, DQPSK, DBPSK)
802.11g: OFDM-CCK (BPSK, QPSK, 16QAM, 64QAM)
802.11a/n/ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM)
WCDMA: QPSK
LTE: QPSK, 16QAM, 64QAM, 256QAM
5G NR: Pi/2-BPSK, QPSK, 16QAM, 64QAM, 256QAM</td></tr>
<tr><td>Equipment Class/ Category</td><td>DSS, DTS, UNII, PCB</td></tr>
<tr><td>Maximum output power</td><td>See test result</td></tr>
<tr><td>Antenna Information</td><td>2 x Internal BT/WLAN PCB trace antenna
Peak Gain:
- 3.7 dBi @2.4GHz WiFi/Bluetooth, 6.4 dBi @5GHz WiFi

Cellular External antennas:
Peak Gain: 6 dBi @ 617 - 960 MHz
8 dBi @ 1710-2200MHz
8.5 dBi @ 2300-2700MHz
9.5 dBi @ 3300-4200MHz
11.0 dBi @ 4400-5000MHz

Antenna connector type: quad mini-Fakra connector

Modem 6 TCU will support 4 vehicle cellular antenna ports. The antenna port mapping is at below table,

<table>
<tr><td>Antenna</td><td>LB</td><td>MB</td><td>HB</td><td>N77/78/79</td><td>N41</td></tr>
<tr><td>Antenna1</td><td>DRX</td><td>TX+PRX</td><td>TX+PRX</td><td>TX+PRX</td><td>TX+PRX</td></tr>
<tr><td>Antenna2</td><td>TX+PRX</td><td>DRX</td><td>DRX</td><td>DRX</td><td>DRX</td></tr>
<tr><td>Antenna3</td><td>-</td><td>MIMO</td><td>MIMO</td><td>MIMO</td><td>MIMO</td></tr>
<tr><td>Antenna4</td><td>-</td><td>MIMO</td><td>MIMO</td><td>MIMO</td><td>MIMO</td></tr>
</table>
Note:
1. Antenna 1 and 3 go to the left-side rooftop external antenna (cellular antennas) and antenna 2 and 4 go to the right-side rooftop external antenna (cellular antennas). The cable length between left left-side and right-side rooftop external antenna are more than 20 cm.
2. Antenna 3 and 4 are for 4G-5G MIMO diversity only, no TX.
3. The antenna gain is declared by the manufacturer. Not all antennas support TX. The declared peak gain may have overestimated the TX gain of the single cellular antenna. For</td></tr>
</table>

<table>
<tr><td></td><td>ERP/EIRP, radiated power will be measured in case when the calculated ERP/EIRP with declared antenna gain and measured conducted power is high.
4. 5G NR n77 overlaps the entire frequency range of 5G NR n78. Therefore, the test data provided I this report covers 5G NR n77 as well as 5G NR n78.</td></tr>
<tr><td>Clock Frequencies</td><td>N/A</td></tr>
<tr><td>Port/Connectors</td><td>CAN bus</td></tr>
<tr><td>Input Power</td><td>Vehicle Battery powered: 12VDC</td></tr>
<tr><td>Power Adapter Manu/Model</td><td>N/A</td></tr>
<tr><td>Power Adapter SN</td><td>N/A</td></tr>
<tr><td>Hardware version</td><td>N/A</td></tr>
<tr><td>Software version</td><td>N/A</td></tr>
<tr><td>Simultaneous Transmission</td><td>BT/BLE, WLAN and cellular radio can transmit simultaneously</td></tr>
<tr><td>Additional Info</td><td>Vehicle Telematics Control Unit has four variants. They have the same radio circuitry. The difference between these variants can be found in the table below, the worst-case model of U5T-14H317-D and U5T-14H317-J are tested. These variants may be configured to support different cellular bands depending on local spectrum regulation.
<table>
<tr><th>Model Name (Type Designator)</th><th>Model No.</th><th>C-V2X</th><th>Backup Antenna</th><th>eCALL</th><th>Back Up Battery</th><th>GNSS L1+L5</th><th>Ext WiFi Ant</th></tr>
<tr><td>FNV3-B6-NA</td><td>U5T-14H317-D</td><td>-</td><td>-</td><td>-</td><td>-</td><td>Yes</td><td>-</td></tr>
<tr><td>FNV3-B6-ROW</td><td>U5T-14H317-H</td><td>-</td><td>-</td><td>Yes</td><td>Yes</td><td>Yes</td><td>-</td></tr>
<tr><td>FNV3-B6-ROW</td><td>U5T-14H317-J</td><td>-</td><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td><td>-</td></tr>
<tr><td>FNV3-B6-ROW</td><td>U5T-14H317-L</td><td>-</td><td>-</td><td>-</td><td>-</td><td>Yes</td><td>-</td></tr>
</table>
BT BLE/BDR/EDR: 2402-2480MHz
2.4G WLAN: 2412-2472MHz
5G WLAN: 5180-5320MHz, 5500-5700MHz
5.8G WLAN: 5745-5825MHz

2G Band: 850MHz, 1900MHz
3G Band: B2, B4, B5
4G Band: B2, B4, B5, B7, B12, B13, B17, B29, B38, B66, B71
5G SA Band: n78, n77, n71, n66, n41, n7, n5, n2
5G NSA Band: n77, n71, n66, n41, n5, n2
5G SCS spacing: 15 KHz (FDD), 30 KHz (TDD)

MRDC Band Combination (NSA):</td></tr>
</table>

MRDC Band Combinations

NR CA Config		LTE CA Config	
DL	UL	DL	UL
n71a	n71a	66a-66a	66a
n71a	n71a	2a-66a	66a
n71a	n71a	2a-66a	2a
n66a	n66a	2a-12a-66a	12a
n66a	n66a	2a-5a-66a	5a
n66a	n66a	13a	13a
n66a	n66a	2a-2a-12a	12a
n66a	n66a	2a-2a-5a	5a
n5a	n5a	5a-66a-66a	66a
n5a	n5a	2a-66a-66a	66a
n5a	n5a	2a-66a-66a	2a
n5a	n5a	66a-66a	66a
n5a	n5a	2a-5a-66a	66a
n5a	n5a	2a-5a-66a	2a
n5a	n5a	2a-2a-66a	66a
n5a	n5a	2a-2a-66a	2a
n5a	n5a	2a-2a-5a	2a
n5a	n5a	2a-2a	2a
n2a	n2a	12a-66a-66a	12a
n2a	n2a	5a-66a-66a	5a
n2a	n2a	13a-66a	13a
n2a	n2a	2a-12a-66a	12a
n2a	n2a	2a-5a-66a	5a
n77a	n77a	66a-66a	66a
n77a	n77a	12a-66a	66a
n77a	n77a	12a-66a	12a
n77a	n77a	5a-66a	66a
n77a	n77a	5a-66a	5a
n77a	n77a	2a-66a	66a
n77a	n77a	2a-66a	2a
n77a	n77a	66a	66a
n77a	n77a	2a-29a	2a
n77a	n77a	13a	13a
n77a	n77a	2a-12a	12a
n77a	n77a	2a-12a	2a
n77a	n77a	2a-5a	5a
n77a	n77a	2a-5a	2a
n77a	n77a	2a-2a	2a
n77a	n77a	2a	2a

2.3 Test standard and method

Test standard	47CFR Part 22 47CFR Part 24
Test method	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01 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

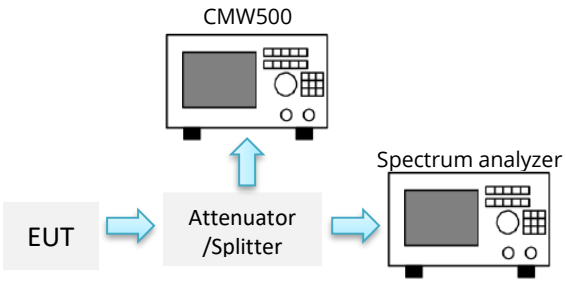
7.1 RF Output Power

7.1.1 Requirement

§ 22.913(a)(5) – ERP limit: 38.45 dBm

§ 24.232(c) – 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)	31.90	31.37	31.58	29.52	29.87	30.03
GPRS (Slot 2)	30.05	30.01	29.92	27.95	28.07	28.06
GPRS (Slot 3)	27.45	27.93	27.33	25.56	25.46	25.84
GPRS (Slot 4)	26.13	26.51	26.27	24.16	24.28	24.27
EDGE (Slot 1)	26.21	26.30	26.01	27.75	26.90	27.76
EDGE (Slot 2)	24.65	25.03	25.21	26.26	25.79	25.85
EDGE (Slot 3)	23.30	22.90	23.18	23.06	23.88	23.27
EDGE (Slot 4)	20.58	20.37	20.43	21.52	21.75	21.32

Radiated Power

Mode	Channel	Frequency (MHz)	EIRP (dBm)	ERP (dBm)	EIRP/ERP Limit (dBm)	Result
GPRS 850	128	824.2	-	31.40	38.45	Pass
	190	836.6	-	31.76	38.45	Pass
	251	848.8	-	31.58	38.45	Pass
GPRS 1900	512	1850.2	26.68	-	33	Pass
	661	1880	26.26	-	33	Pass
	810	1909.9	25.43	-	33	Pass

Mode	Channel	Frequency (MHz)	EIRP (dBm)	ERP (dBm)	EIRP/ERP Limit (dBm)	Result
EDGE 850	128	824.2	-	24.49	38.45	Pass
	190	836.6	-	24.48	38.45	Pass
	251	848.8	-	24.89	38.45	Pass
EDGE 1900	512	1850.2	23.68	-	33	Pass
	661	1880	22.70	-	33	Pass
	810	1909.9	22.74	-	33	Pass

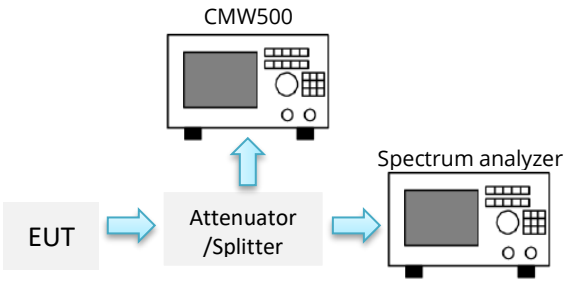
7.2 Peak to Average Ratio

7.2.1 Requirement

§ 2.1046, § 22.913, § 24.232

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

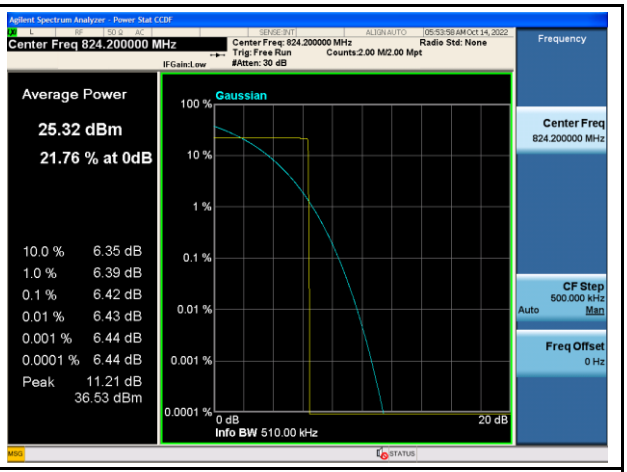
- The signal analysers CCDF measurement profile Is enabled
- Frequency carrier center frequency
- Measurement BW> Emission bandwidth of signal
- The signal analyzer was set to collect one million samples to generate the CCDF curve
- The measurement interval was set depending on the type of signal analyzed. 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

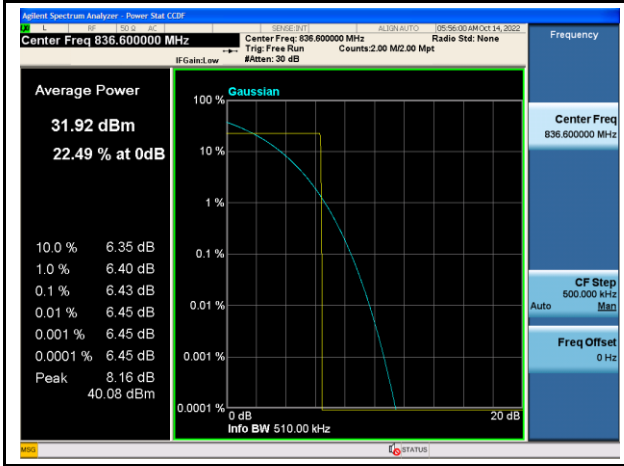
Mode	Channel	Frequency (MHz)	PAR (dB)	Limit (dB)	Result
GPRS 850	128	824.2	6.26	13	Pass
	190	836.6	6.43	13	Pass
	251	848.8	6.52	13	Pass
EDGE 850	128	824.2	6.42	13	Pass
	190	836.6	6.41	13	Pass
	251	848.8	6.69	13	Pass
GPRS 1800	512	1710.2	6.77	13	Pass
	699	1747.6	6.54	13	Pass
	885	1784.8	6.57	13	Pass
EDGE 1800	512	1710.2	6.50	13	Pass
	699	1747.6	6.49	13	Pass
	885	1784.8	6.61	13	Pass

7.2.5 Test Plots

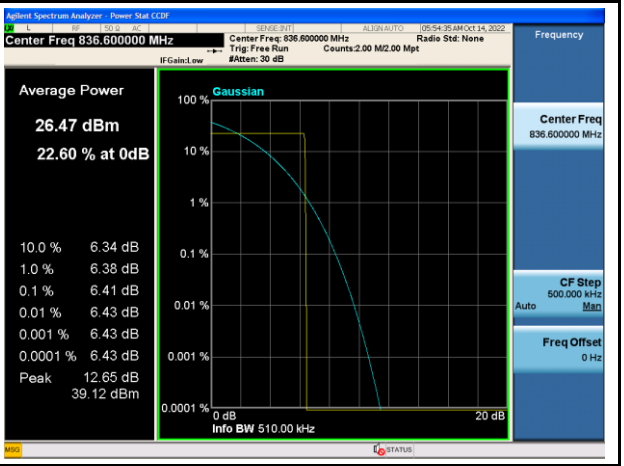
GPRS850-Low



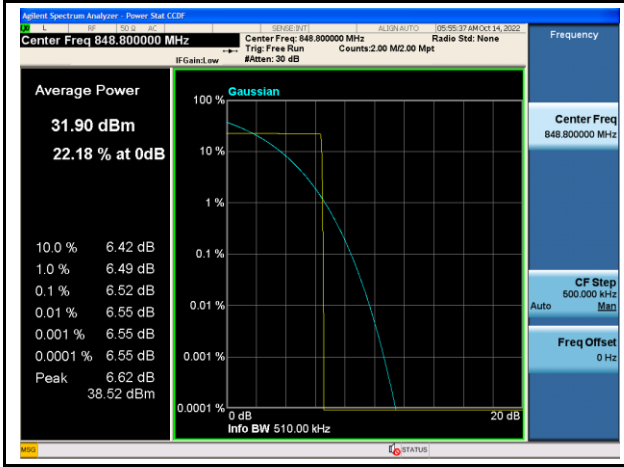
EDGE850-Low



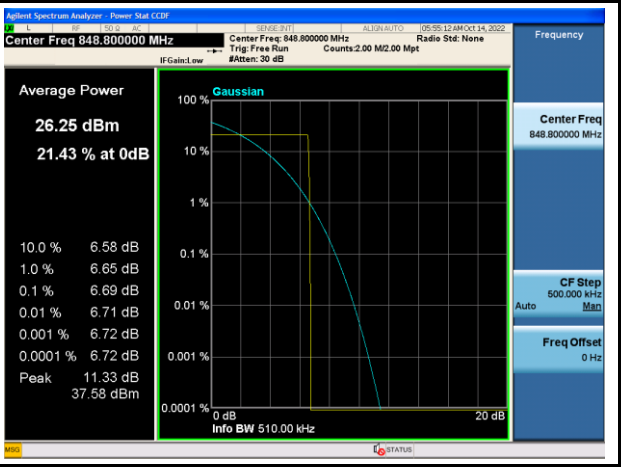
GPRS850-Mid



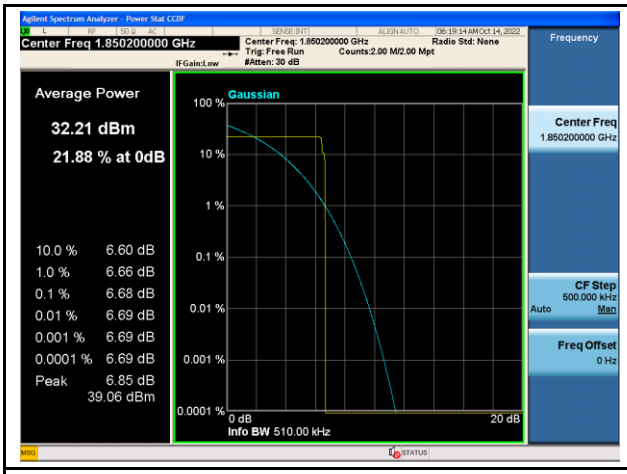
EDGE850-Mid



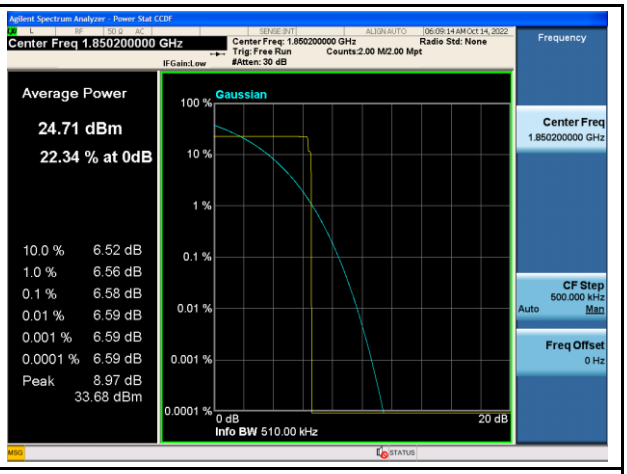
GPRS850-High



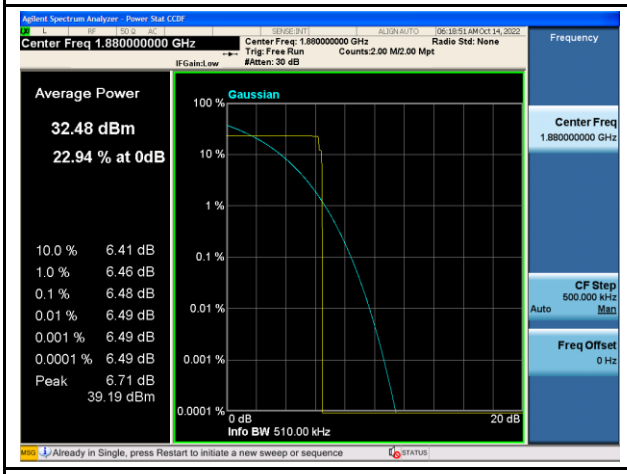
EDGE850-High



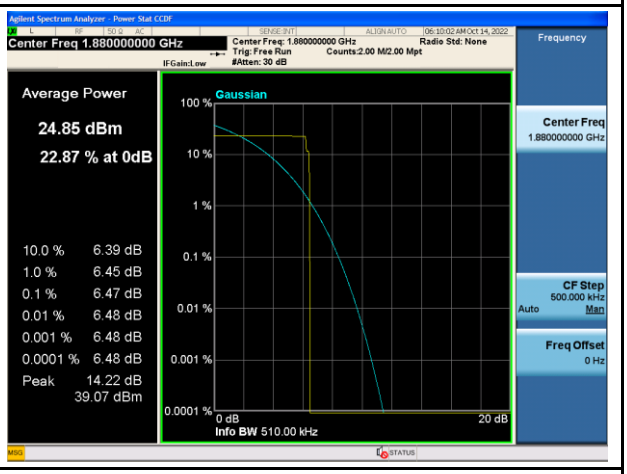
GPRS1900-Low



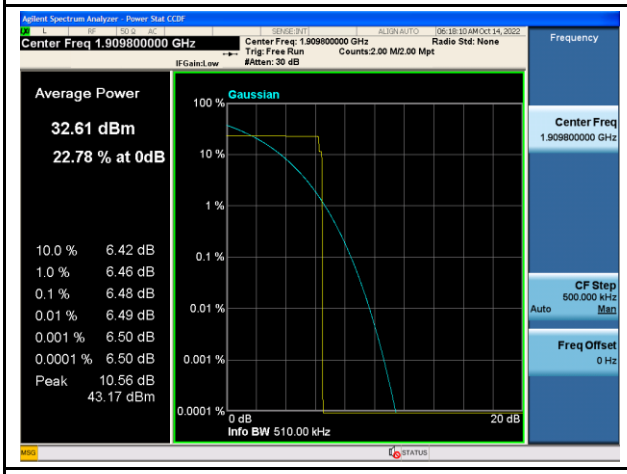
EDGE1900-Low



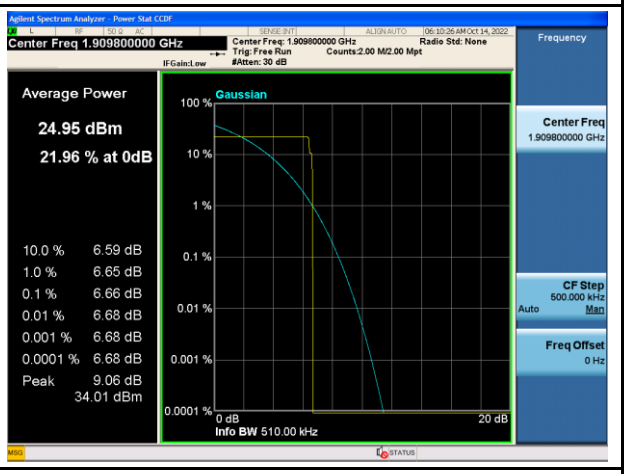
GPRS1900-Mid



EDGE1900-Mid



GPRS1900-High



EDGE1900-High

7.3 Occupied Bandwidth

7.3.1 Requirement

§2.1049

- 99% Occupied Bandwidth(kHz)

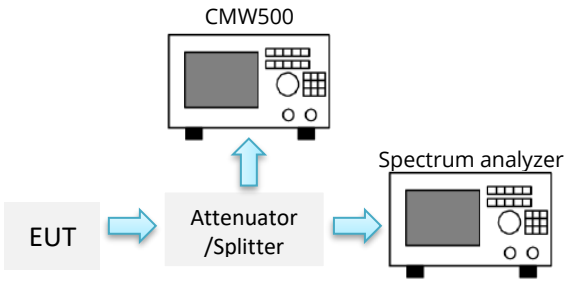
The occupied bandwidth that is the frequency bandwidth such that below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be Measured.

- 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



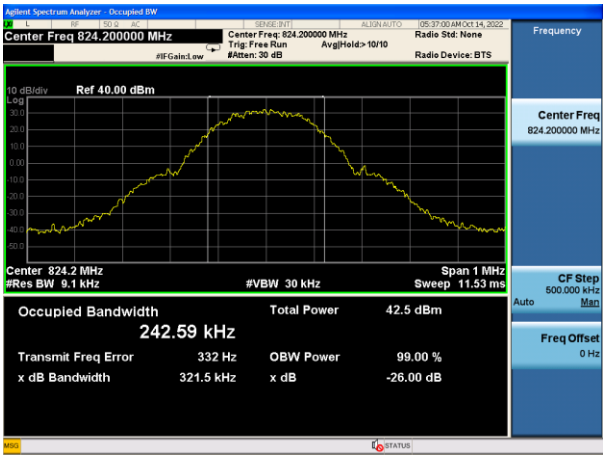
7.3.3 Test Procedure

- 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

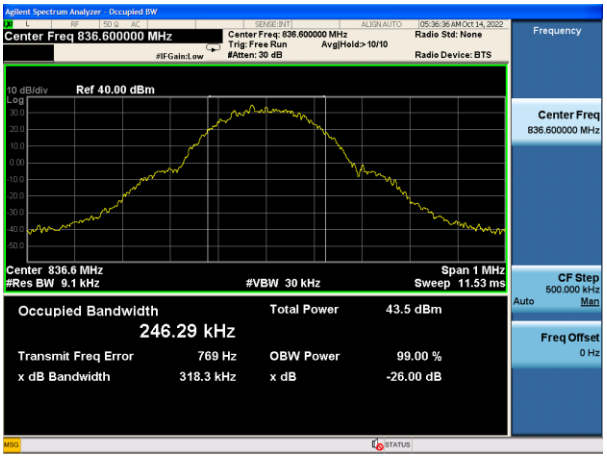
Mode	Channel	Frequency (MHz)	99% Power Bandwidth (kHz)	-26dBc Bandwidth (kHz)
GPRS850	128	824.2	242.59	321.5
	190	836.6	246.29	318.3
	251	848.8	241.90	321.5
EDGE850	128	824.2	244.68	312.0
	190	836.6	243.14	314.2
	251	848.8	245.36	315.7
GPRS 1900	512	1850.2	243.41	313.8
	661	1880	243.81	311.8
	810	1909.8	245.56	317.4
EDGE 1900	512	1850.2	243.03	317.9
	661	1880	246.52	315.1
	810	1909.8	245.17	306.8

7.3.5 Test Plots

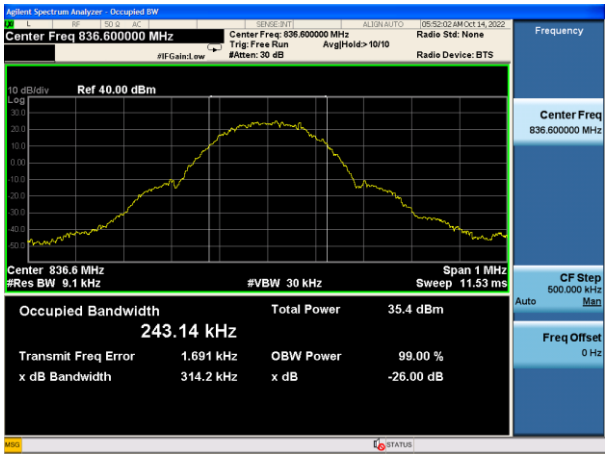


GPRS850-Low

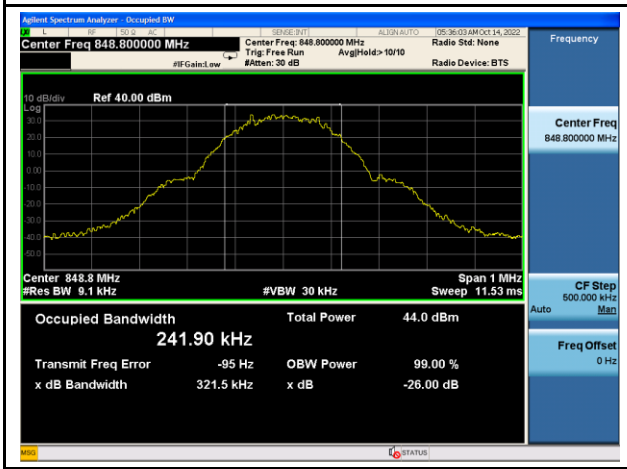
EDGE850-Low



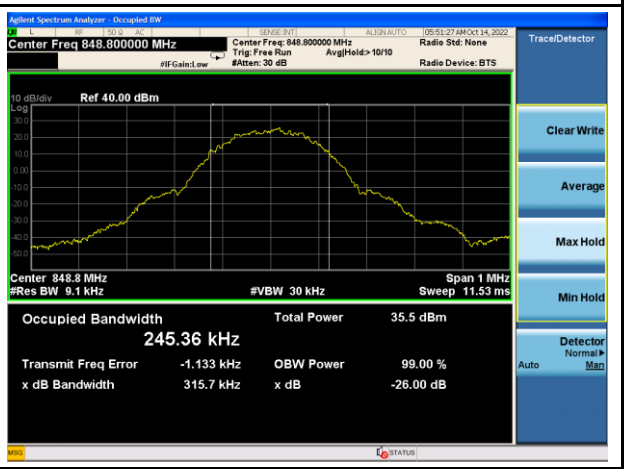
GPRS850-Mid



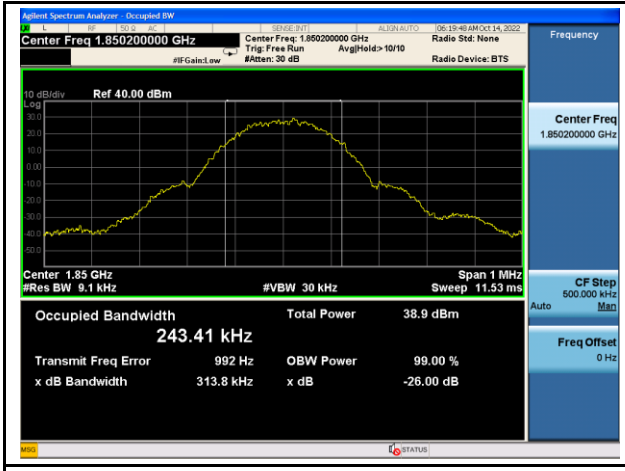
EDGE850-Mid



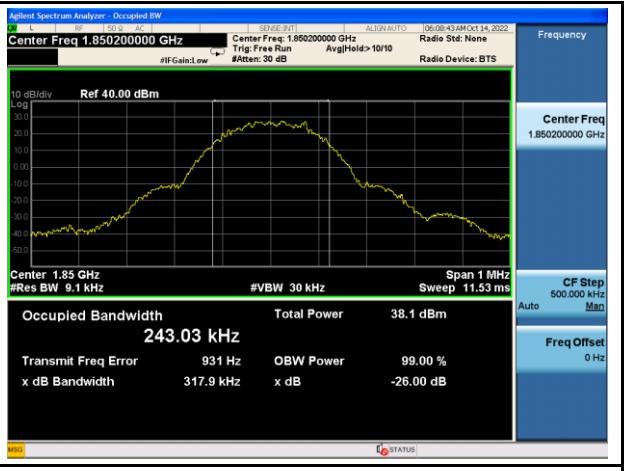
GPRS850-High



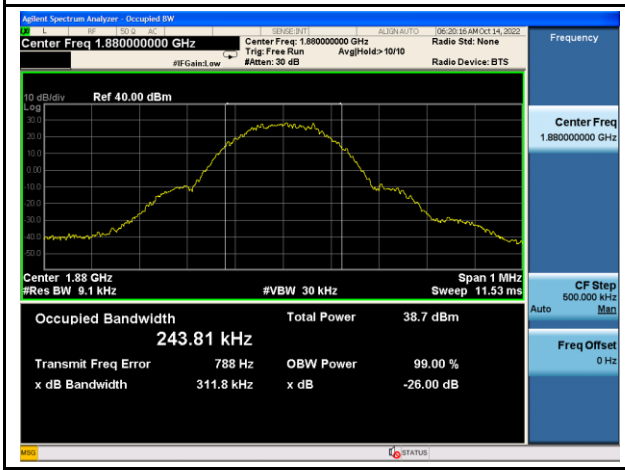
EDGE850-High



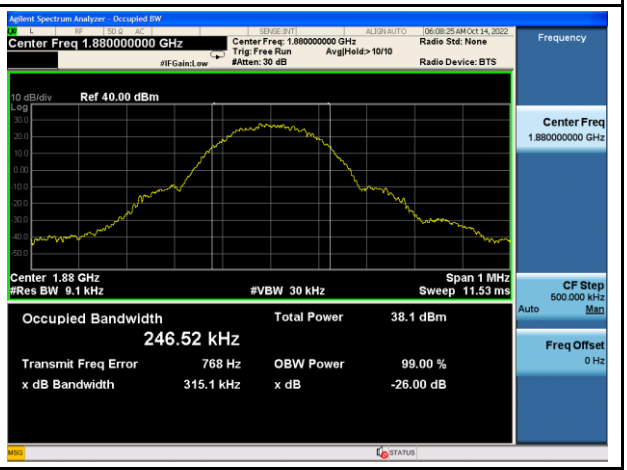
GPRS1900-Low



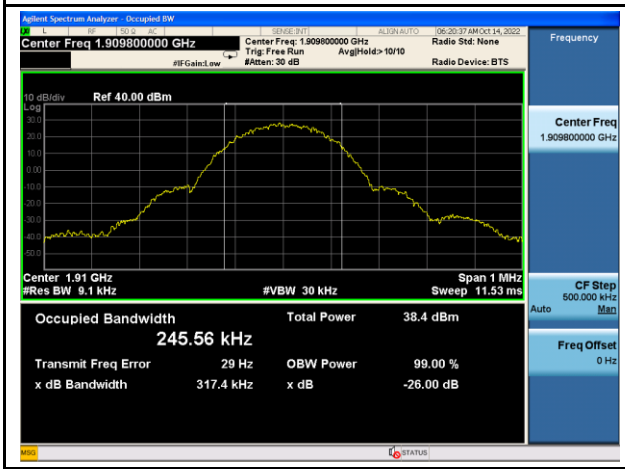
EDGE1900-Low



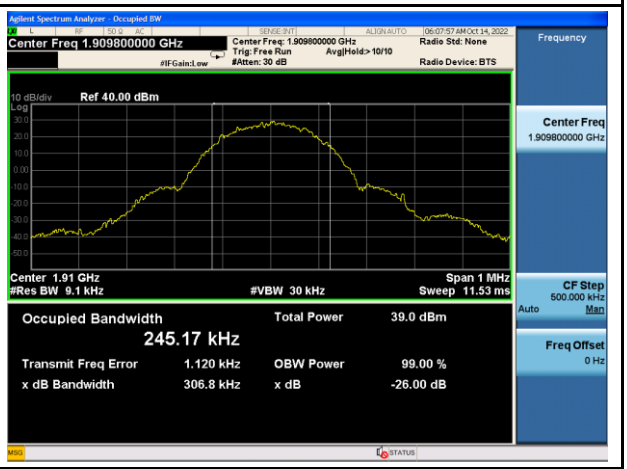
GPRS1900-Mid



EDGE1900-Mid



GPRS1900-High



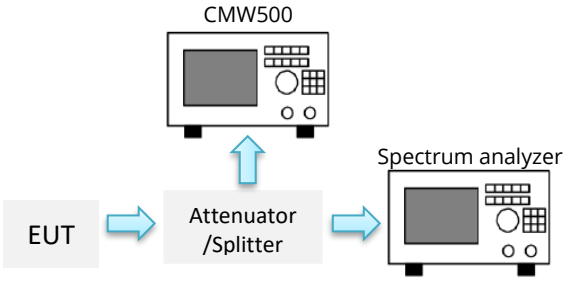
EDGE1900-High

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



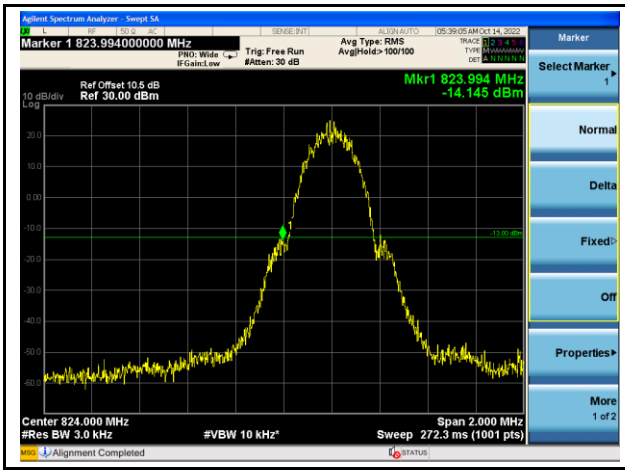
7.4.3 Test Procedure

- 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

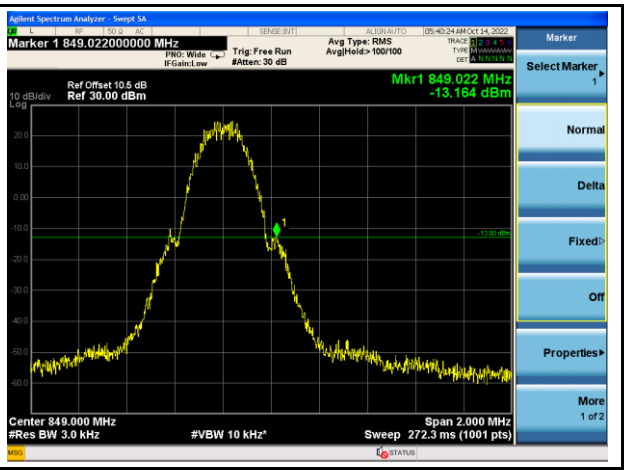
7.4.4 Test Result

Mode	Channel	Frequency (MHz)	Band Edge measured (dBm)	Limit (dBm)	Result
GPRS850	128	824.2	-14.145	-13	Pass
	251	848.8	-13.164	-13	Pass
EDGE850	128	824.2	-14.437	-13	Pass
	251	848.8	-13.411	-13	Pass
GPRS1900	512	1850.2	-16.735	-13	Pass
	810	1909.8	-14.885	-13	Pass
EDGE1900	512	1850.2	-17.071	-13	Pass
	810	1909.8	-15.693	-13	Pass

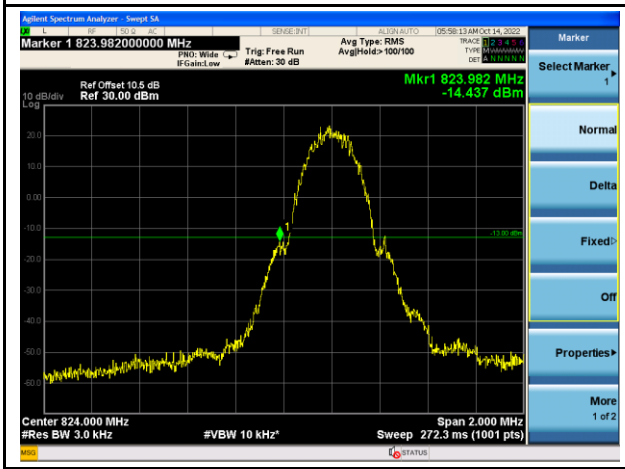
7.4.5 Test Plots



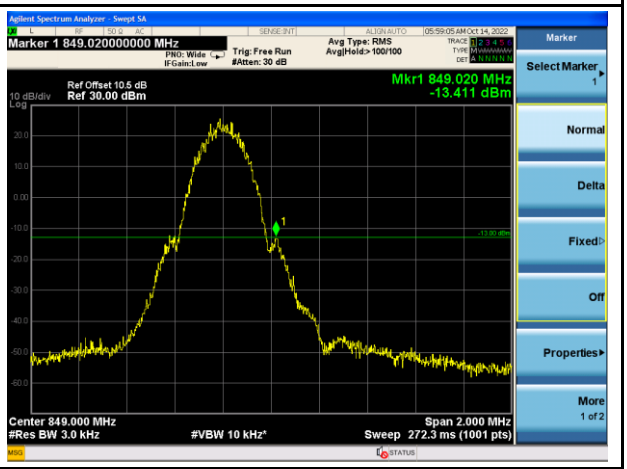
GPRS850-Low



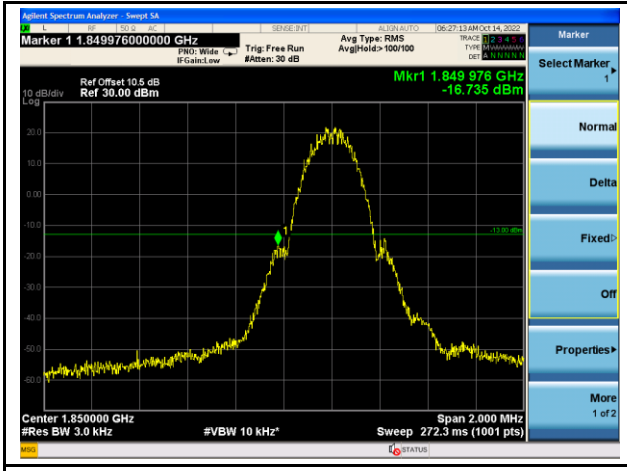
GPRS850-High



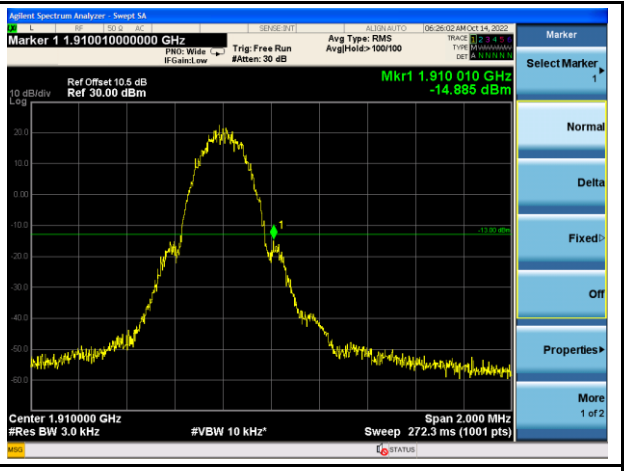
EDGE850-Low



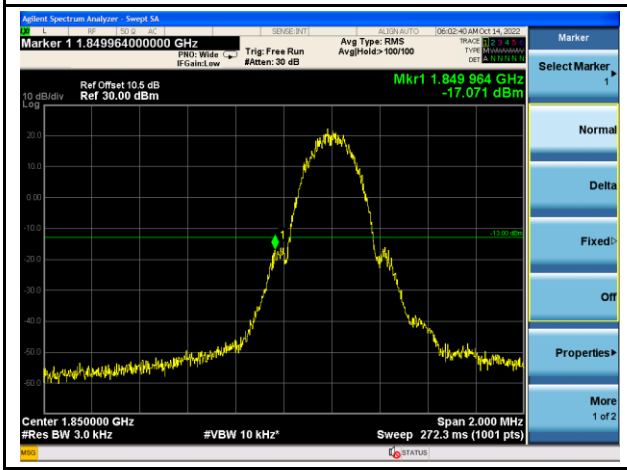
EDGE850-High



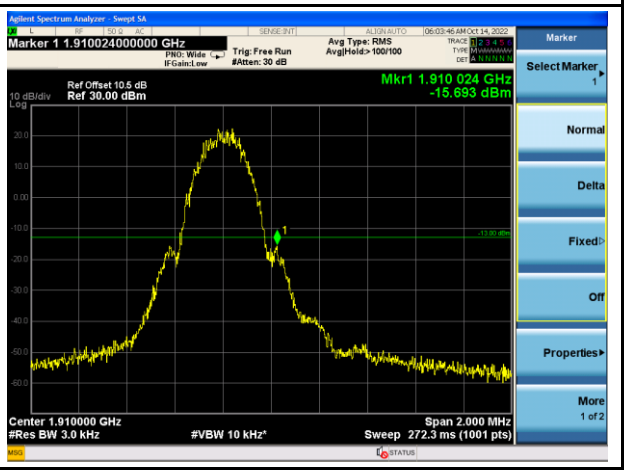
GPRS1900-Low



GPRS1900-High



EDGE1900-High



EDGE1900-High

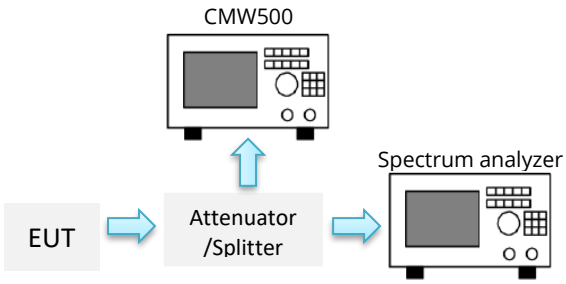
7.5 Conducted spurious emission

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.

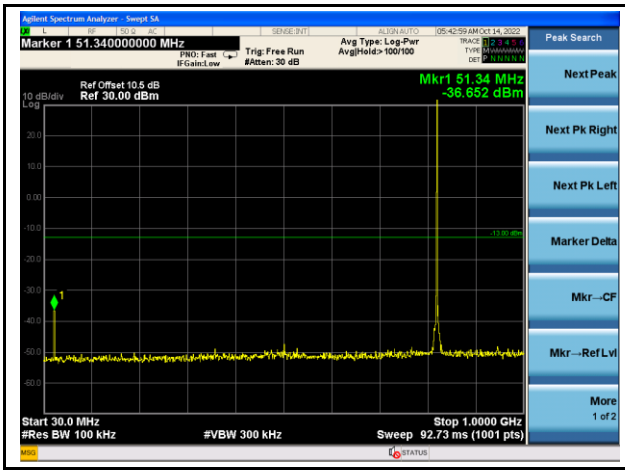
7.5.2 Test Setup



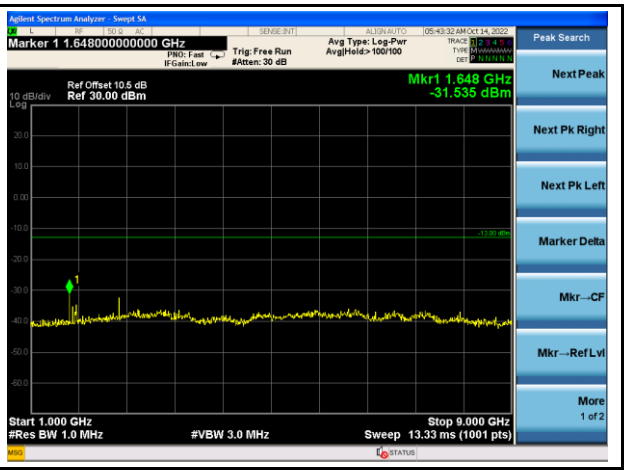
7.5.3 Test Procedure

- 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

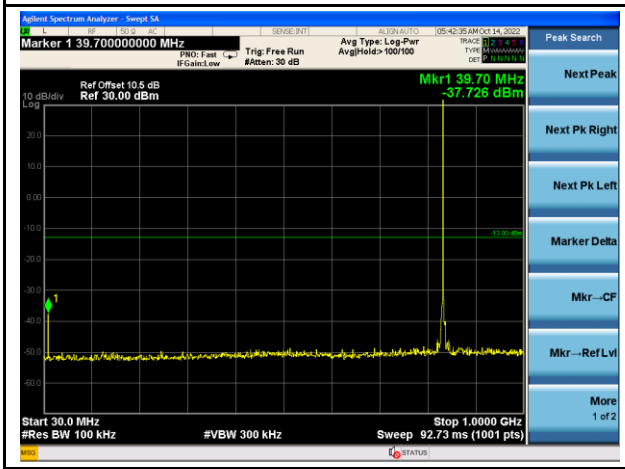
7.5.4 Test Result



GPRS850 - Low- 30MHz~1GHz

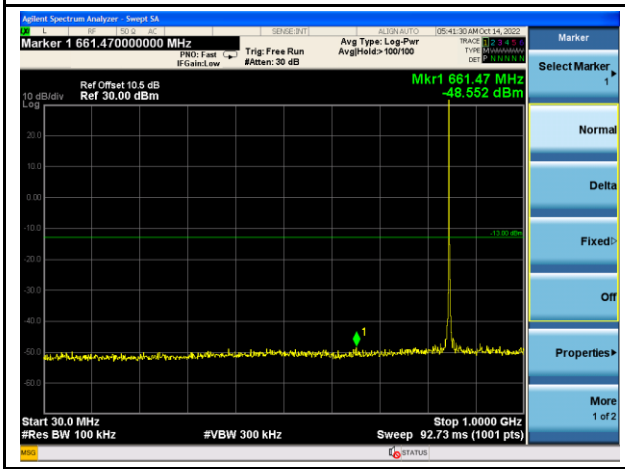


GPRS850 - Low - 1GHz~9GHz

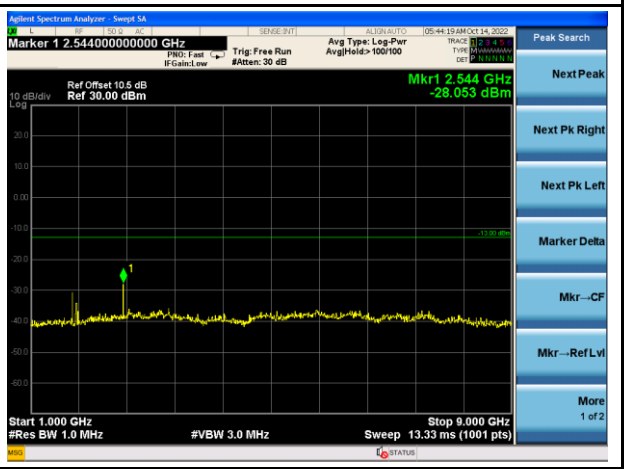


GPRS850 - Mid- 30MHz~1GHz

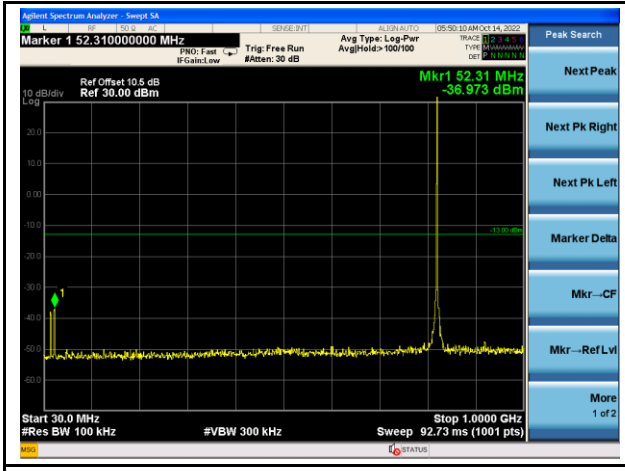
GPRS850 – Mid - 1GHz~9GHz



GPRS850 - High - 30MHz~1GHz

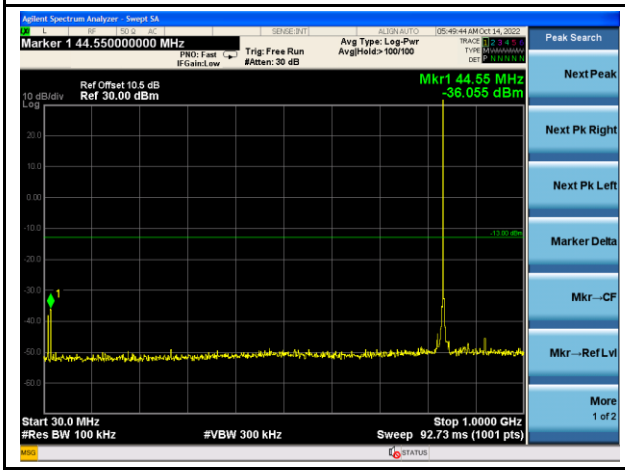


GPRS850 - High - 1GHz~9GHz



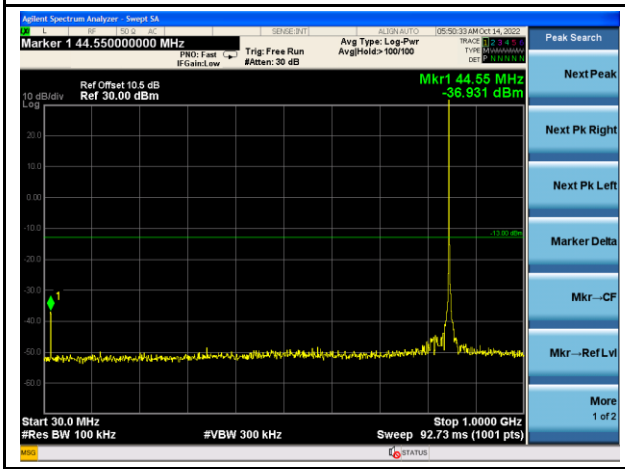
EDGE850 - Low- 30MHz~1GHz

EDGE850 - Low - 1GHz~9GHz



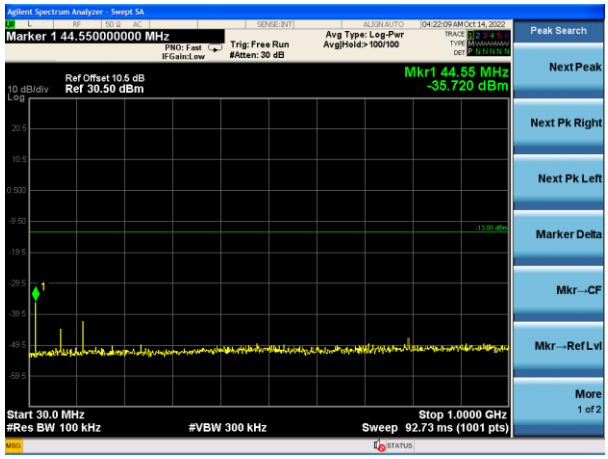
EDGE850 - Mid- 30MHz~1GHz

EDGE850 – Mid - 1GHz~9GHz



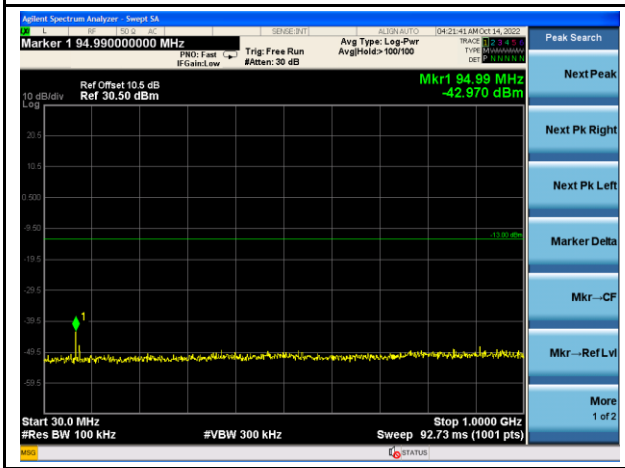
EDGE850 - High - 30MHz~1GHz

EDGE850 - High - 1GHz~9GHz



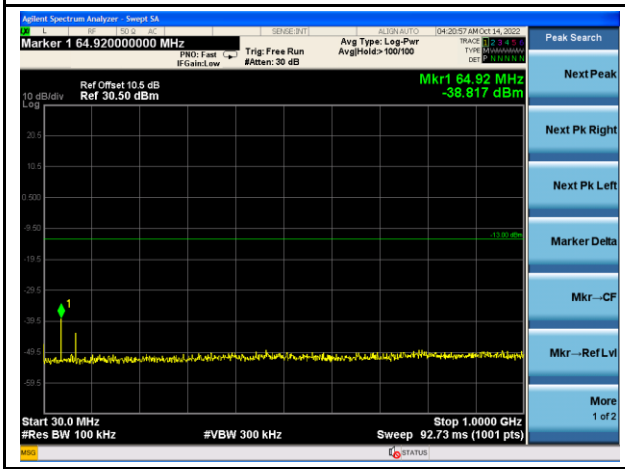
GPRS1900 - Low- 30MHz~1GHz

GPRS1900 - Low - 1GHz~20GHz



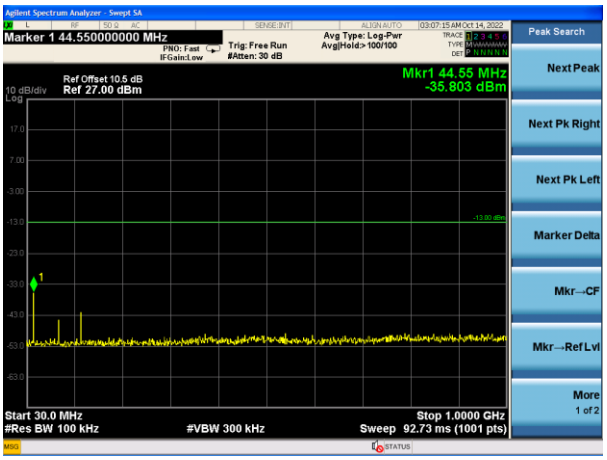
GPRS1900 - Mid- 30MHz~1GHz

GPRS1900 – Mid - 1GHz~20GHz



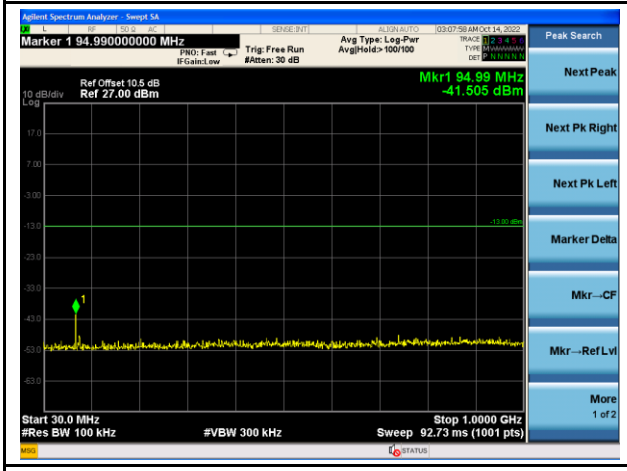
GPRS1900 - High - 30MHz~1GHz

GPRS1900 - High - 1GHz~20GHz



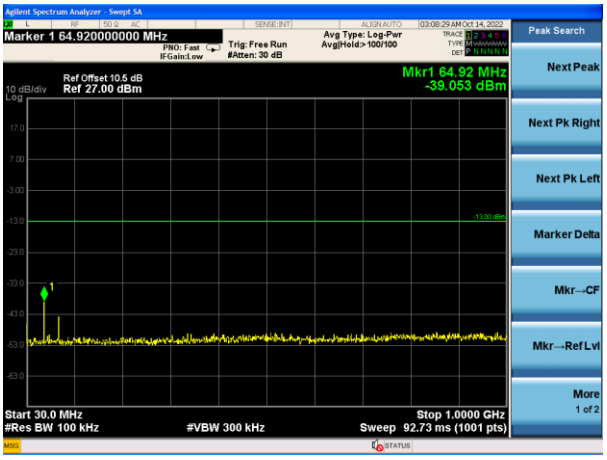
EDGE1900 - Low- 30MHz~1GHz

EDGE1900 - Low - 1GHz~20GHz



EDGE1900 - Mid- 30MHz~1GHz

EDGE1900 – Mid - 1GHz~20GHz



EDGE1900 - High - 30MHz~1GHz

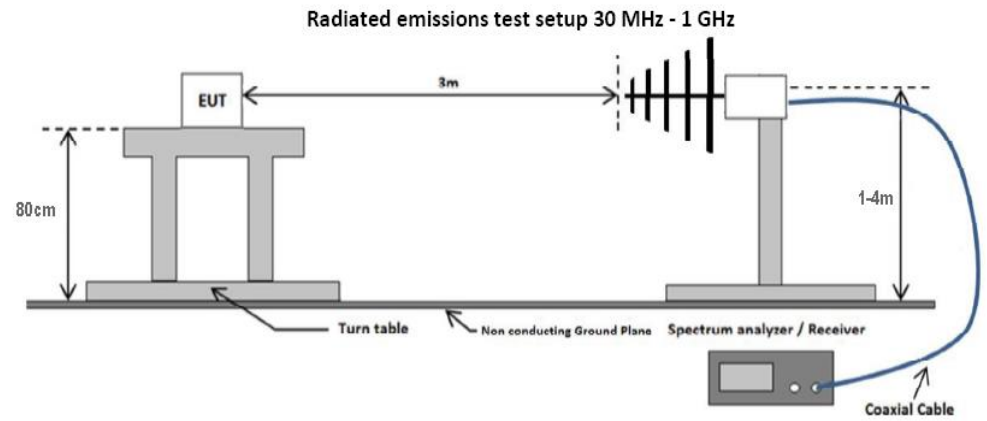
EDGE1900 - High - 1GHz~20GHz

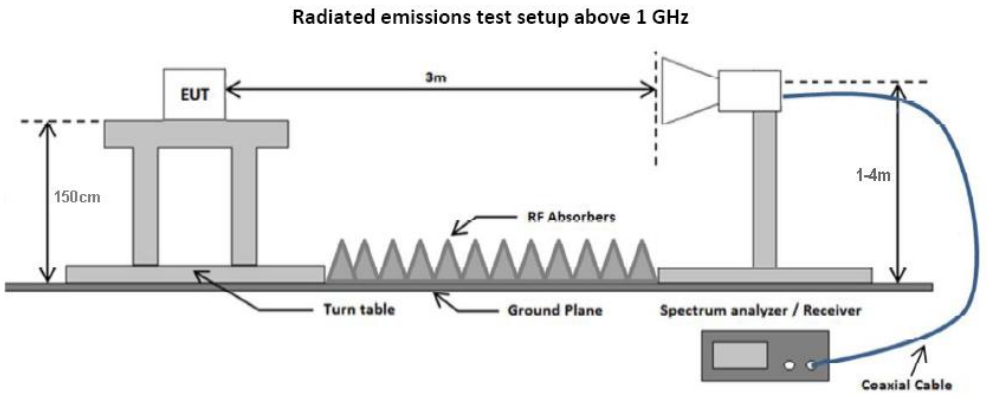
7.6 Field Strength of Radiated Spurious Emissions

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





7.6.3 Test Procedure

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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 dBm	Cable Loss	AF dB/m	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	1648.041	-95.5	32	0.12	-63.38	RMS Max	H	144	95	-13	-50.38	Pass
2	2472.367	-93.2	33.1	2.51	-57.59	RMS Max	V	105	178	-13	-44.59	Pass
3	3296.516	-66.1	19.8	-7.13	-53.43	RMS Max	H	348	305	-13	-40.43	Pass
Mid channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB/m	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	1678.822	-95.9	32.1	0.23	-63.57	RMS Max	V	270	173	-13	-50.57	Pass
2	2507.303	-93.9	33.1	2.71	-58.09	RMS Max	H	201	247	-13	-45.09	Pass
3	3346.256	-73.3	19.8	-5.52	-59.02	RMS Max	V	302	218	-13	-46.02	Pass
High channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB/m	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	1697.327	-94.1	32.1	0.24	-61.76	RMS Max	H	293	160	-13	-48.76	Pass
2	2546.712	-92	33.1	2.91	-55.99	RMS Max	V	214	129	-13	-42.99	Pass
3	3395.333	-71.3	19.9	-4.3	-55.7	RMS Max	V	355	308	-13	-42.7	Pass

Remarks:

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

GSM1900												
Low Channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB/m	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	3700.696	-80.9	20.5	3.28	-57.12	RMS Max	V	256	214	-13	-44.12	Pass
2	5550.857	-65.7	22.7	-10.11	-53.11	RMS Max	H	281	360	-13	-40.11	Pass
3	7401.47	-72.8	24.9	-5.51	-53.41	RMS Max	V	119	46	-13	-40.41	Pass
Mid channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB/m	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	3760.286	-80.6	20.6	5.21	-54.79	RMS Max	V	188	207	-13	-41.79	Pass
2	5641.626	-69.7	22.9	-10.4	-57.2	RMS Max	H	157	103	-13	-44.2	Pass
3	7521.538	-71.6	25.1	-5.72	-52.22	RMS Max	V	163	293	-13	-39.22	Pass
High channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB/m	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	3819.184	-83.7	20.9	5.15	-57.65	RMS Max	V	105	105	-13	-44.65	Pass
2	5729.627	-68.1	23.1	-10.51	-55.51	RMS Max	H	155	219	-13	-42.51	Pass
3	7640.274	-72.4	25.3	-5.82	-52.92	RMS Max	H	296	308	-13	-39.92	Pass

Remarks:

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

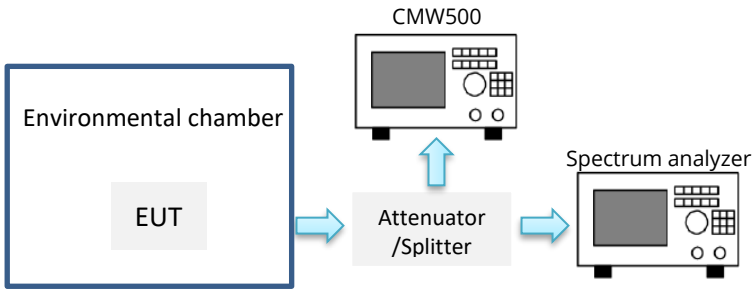
7.7 Frequency Stability

7.7.1 Requirement

§2.1055, §22.355 & §24.235

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	24	0.0287	2.50	PASS
	-20	20	0.0239		
	-10	19	0.0227		
	0	24	0.0287		
	10	21	0.0251		
	20	19	0.0227		
	30	23	0.0275		
	40	21	0.0251		
	50	22	0.0263		
10.2	20	24	0.0287		
13.8	20	18	0.0215		

GPRS1900 – 1880 MHz					
Voltage (Vdc)	**Temperature (℃)**	**Frequency error (Hz)**	**Frequency error (ppm)**	**Limit (ppm)**	**Result**
12.0	-30	13	0.0069	2.50	PASS
	-20	16	0.0085		
	-10	13	0.0069		
	0	19	0.0101		
	10	23	0.0122		
	20	14	0.0074		
	30	25	0.0133		
	40	14	0.0074		
	50	20	0.0106		
10.2	20	20	0.0106		
13.8	20	15	0.0080		

8 EUT and Test Setup Photos

See FCC exhibits

9 Test Instrument List

Equipment	Manufacturer	Model	Serial Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	10/18/2020	10/18/2022
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A	N/A
Spectrum Analyzer	Keysight	N9020A	MY50110074	06/09/2022	06/09/2023
EMC Test Receiver	R&S	ESL6	100230	06/07/2022	06/07/2023
Bi-Log Antenna	ETS-Lindgren	3142E	217921	08/15/2021	08/15/2022
Horn Antenna	AH Systems	SAS-571	433	07/21/2022	07/21/2023
Horn Antenna	Electro-Metrics	EM-6961	6292	07/21/2022	07/21/2023
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	07/21/2022	07/21/2023
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	07/16/2022	07/16/2023
True RMS Multi-meter	UNI-T	UT181A	C173014829	06/07/2022	06/07/2023
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	06/07/2022	06/07/2023
RF Attenuator	Pasternack	PE7005-3	VL061	07/16/2022	07/16/2023
USB RF Power Sensor	Radi Power	RPR3006W	00159859	06/07/2022	06/07/2023
USB RF Power Sensor	ETS-Lindgren	7002-006	00151268	06/07/2022	06/07/2023
2.4GHz Notch Filter	Micro-Tronics	BRM50702	G332	N/A	N/A
5GHz Notch Filter	Micro-Tronics	BRM50716	G239	N/A	N/A
Smart Fieldmeter	EMC Test Design	RFP-04CE	248/116	N/A	N/A
Synthesized Signal Generator (10MHz - 40GHz)	Anritsu	68367C A/NV	11625	06/09/2022	06/09/2023
Spectrum Analyser (9kHz-40GHz)	Rohde & Schwarz	FSP38	100630	06/09/2022	06/09/2023
Power Splitter/Combiner	Mini-Circuits	ZFSC-2-9G+	VL052	N/A	N/A
Power Splitter/Combiner	Mini-Circuits	ZFSC-2-9G+	VL053	N/A	N/A
Power Splitter/Combiner	Mini-Circuits	ZFSC-2-9G+	VL054	N/A	N/A
Power Splitter/Combiner	Mini-Circuits	ZFSC-2-9G+	VL055	N/A	N/A
Power Splitter/Combiner	Mini-Circuits	ZFSC-2-9G+	VL056	N/A	N/A
High Pass Filter / SMA 9000 - 13000 MHz	Mini-Circuits	VHF-8400+	31732	N/A	N/A
High Pass Filter / SMA 3400 - 9900 MHz	Mini-Circuits	VHF-3100+	31741	N/A	N/A
2 x Attenuator - 10dB	Pasternack	PE7005-10	VL059-1, VL059-2	N/A	N/A
Attenuator - 20dB	Pasternack	PE7005-20	VL060	N/A	N/A
Attenuator - 3dB	Pasternack	PE7005-3	VL060	N/A	N/A
Wideband Communication	R&S	CMW500	147508	05/10/2022	05/10/2023
Radio Communication Tester	Anritsu	MT8000a	6262261939	02/23/2022	02/23/2023
Attenuator - 30dB	JFW Industries, Inc	50HF-030 SMA	VL085	N/A	N/A
Temperature/Humidity Chamber	Bemco	FBW1.5-100/350	3621-9	06/07/2022	06/07/2023

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