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FCC IC RF Test Report

Test Report Number	WAP-22021511-LC-FCC-IC-WCDMA
FCC ID	KMH-14H317-NA1
IC	1422A-14H317NA1
Applicant	Ford Motor Company
Applicant Address	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124
Product Name	Vehicle Telematics Control Unit
Model (s)	FNV3-B6-NA
Family Product/Model	N/A
Date of Receipt	04/05/2022
Date of Test	05/17/2022 – 06/01/2022
Report Issue Date	06/03/2022
Test Standards	47CFR Part 22 47CFR Part 24 47CFR Part 27 RSS-132 Issue 3: Jan 2013 RSS-133 Issue 6: Jan 2018 RSS-139 Issue 3: Jul 2015
Test Result	**PASS**

Issued by:

Vista Compliance Laboratories
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REVISION HISTORY

Report Number	Version	Description	Issued Date
WAP-22021511-LC-FCC-IC-WCDMA	01	Initial report	06/03/2022

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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, § 27.50 (d) RSS-132 (4.4), RSS-133 (6.4), RSS-139	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Peak to Average Ratio	§ 2.1046, § 22.913 § 24.232, § 27.50 (d) RSS-133 (6.4), RSS-139	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Occupied bandwidth	§2.1049 RSS-Gen (6.7)	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Band Edge	§ 2.1051; § 22.917(a) § 24.238, § 27.53 (h) RSS-132 (4.5.1), RSS-133 (6.5.1), RSS-139	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Conducted Spurious Emission	§ 2.1051; § 22.917(a) § 24.238, § 27.53 (h) RSS-132 (4.5.1), RSS-133 (6.5.1), RSS-139	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, § 27.53 (h) RSS-132 (4.5.1), RSS-133 (6.5.1), RSS-139	ANSI C63.26: 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01	Pass
Frequency Stability	§ 2.1055, § 22.355 § 24.235, § 27.54 RSS-132 (4.3), RSS-133 (6.3), RSS-139, RSS-Gen	ANSI C63.26: 2015 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 Telematics Control Unit
Mode Name	FNV3-B6-NA
Model Number	U5T-14H317-D
Family Model Number	N/A
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 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 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
Type of modulation	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
Equipment Class/ Category	DSS, DTS, UNII, PCB
Maximum output power	See test result
Antenna Information	**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,
Clock Frequencies	N/A
Port/Connectors	CAN bus
Input Power	Vehicle Battery powered: 12VDC

Antenna	LB	MB	HB	N77/78/79	N41
Antenna1	DRX	TX+PRX	TX+PRX	TX+PRX	TX+PRX
Antenna2	TX+PRX	DRX	DRX	DRX	DRX
Antenna3	-	MIMO	MIMO	MIMO	MIMO
Antenna4	-	MIMO	MIMO	MIMO	MIMO

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 ERP/EIRP, radiated power will be measured in case when the calculated ERP/EIRP with declared antenna gain and measured conducted power is high.

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	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):

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
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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
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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 47CFR Part 27 RSS-132 Issue 3: Jan 2013 RSS-133 Issue 6: Jan 2018 RSS-139 Issue 3: Jul 2015 RSS-Gen Issue 5: Mar 2019
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	23.5°C	61.3%	1002 mbar
Radiated Emission Testing	23.5°C	61.3%	1002 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

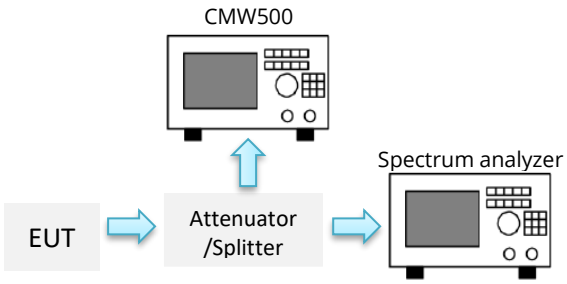
§ 22.913(a)(5) – ERP limit: 38.45 dBm

RSS-132(5.4) – EIRP limit: 40.61 dBm

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

§ 27.50(d) / RSS-139(6.5) – EIRP limit: 30 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)

WCDMA Band 2				
Mode	3GPP Release Subtest	Channel 9262	Channel 9400	Channel 9538
		1852.4 (MHz)	1880 (MHz)	1907.6 (MHz)
RMC	12.2k	23.61	23.38	23.48
HSDPA	1	23.01	23.18	22.84
	2	22.73	23.72	22.44
	3	23.22	22.38	22.97
	4	22.44	22.45	22.96
HSUPA	1	23	22.65	23.08
	2	22.68	23.01	22.64
	3	23.01	22.64	22.34
	4	22.47	22.17	21.84
	5	21.85	22.48	22.6

WCDMA Band 4				
Mode	3GPP Release Subtest	Channel 1312	Channel 1413	Channel 1513
		1712.4 (MHz)	1732.6 (MHz)	1752.6 (MHz)
RMC	12.2k	22.47	23.42	23.11
HSDPA	1	23.06	22.53	23.33
	2	23.41	22.43	22.62
	3	22.41	22.73	22.47
	4	22.68	22.24	22.53
HSUPA	1	23.66	23.02	23.12
	2	23.28	23.32	23.52
	3	23.19	23.01	22.58
	4	22.6	23.14	23.04
	5	22.68	23.42	22.26

WCDMA Band 5				
Mode	3GPP Release Subtest	Channel 4132	Channel 4183	Channel 4233
		826.4 (MHz)	836.6 (MHz)	846.6 (MHz)
RMC	12.2k	22.97	23.83	23.55
HSDPA	1	23.56	22.94	23.77
	2	22.91	22.84	23.06
	3	22.91	23.14	22.91
	4	22.18	21.65	22.97
HSUPA	1	23.16	23.43	22.66
	2	22.78	22.73	22.96
	3	22.69	23.42	23.02
	4	22.1	22.55	22.48
	5	22.18	21.83	21.7

Radiated Power

Mode	Channel	Frequency (MHz)	EIRP (dBm)	ERP (dBm)	EIRP/ERP Limit (dBm)	Conclusion
WCDMA B2	9262	1852.4	31.61	-	33	Pass
	9400	1880	31.72	-	33	Pass
	9538	1907.6	31.48	-	33	Pass
WCDMA B4	1312	1712.4	28.14	-	30	Pass
	1413	1732.6	28.53	-	30	Pass
	1513	1752.6	28.63	-	30	Pass
WCDMA B5	4132	826.4	29.56	27.41	40.61 / 38.45	Pass
	4183	836.6	29.83	27.68	40.61 / 38.45	Pass
	4233	846.6	29.77	27.62	40.61 / 38.45	Pass

7.2 Peak to Average Ratio

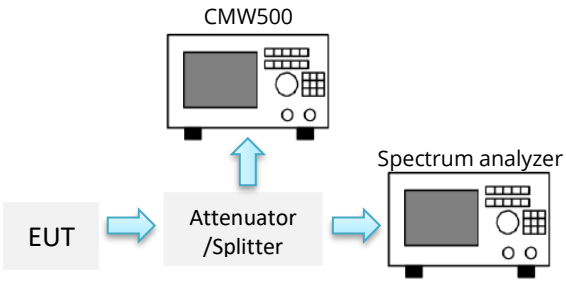
7.2.1 Requirement

§ 2.1046, § 22.913, § 24.232, § 27.50 (d)

RSS-132(5.4), RSS-133(6.4), RSS-139(6.5)

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

7.2.2 Test Setup



7.2.3 Test Procedure

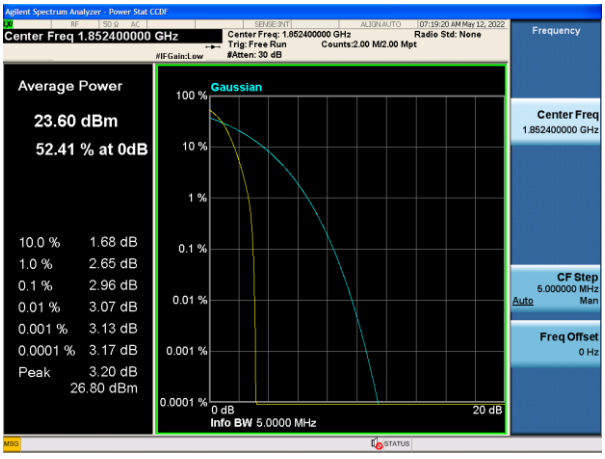
Measurement Procedure: FCC KDB 971168 D01 V03r01 Section 5.7.1

- 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%.

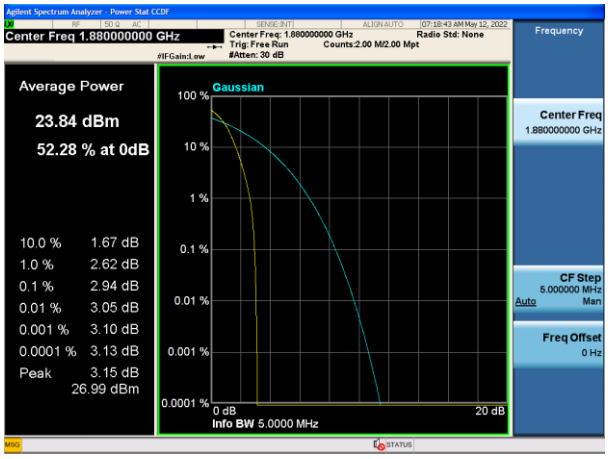
7.2.4 Test Result

Mode	Channel	Frequency (MHz)	PAR (dB)	Limit (dB)	Result
WCDMA B2	9262	1852.4	2.96	13	Pass
	9400	1880.0	2.94	13	Pass
	9538	1907.6	2.93	13	Pass
WCDMA B4	1312	1712.4	2.95	13	Pass
	1413	1732.5	2.96	13	Pass
	1513	1752.6	2.94	13	Pass
WCDMA B5	4132	826.4	2.99	13	Pass
	4183	836.6	2.96	13	Pass
	4233	846.6	2.95	13	Pass

7.2.5 Test Plots

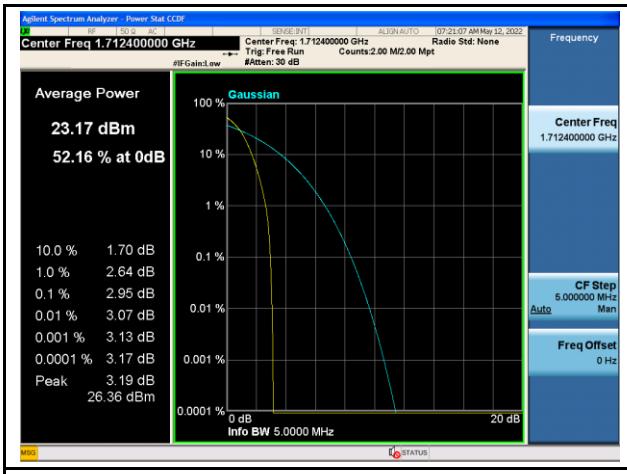


WCDMA B2-Low

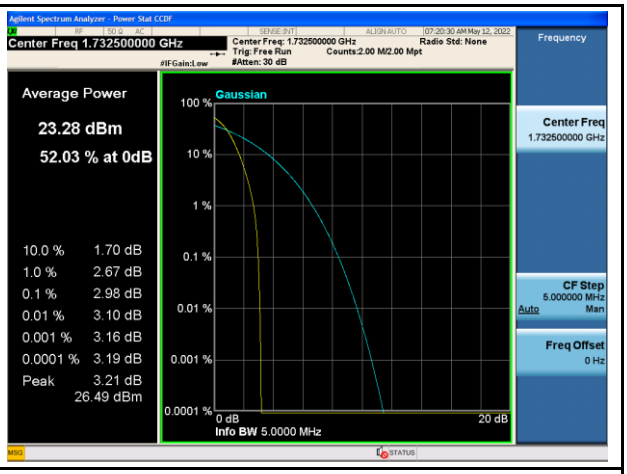


WCDMA B2-Mid

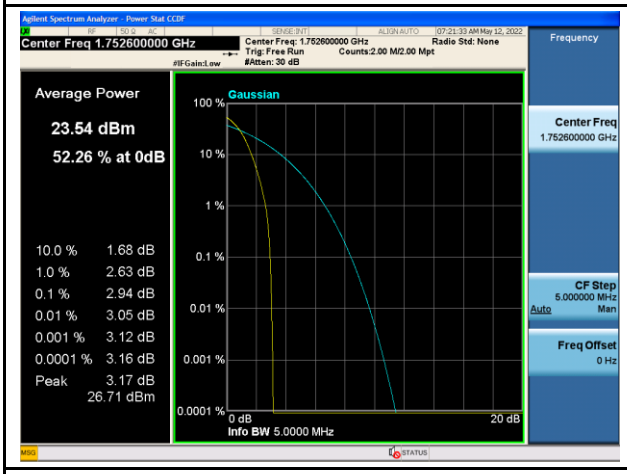
WCDMA B2-High



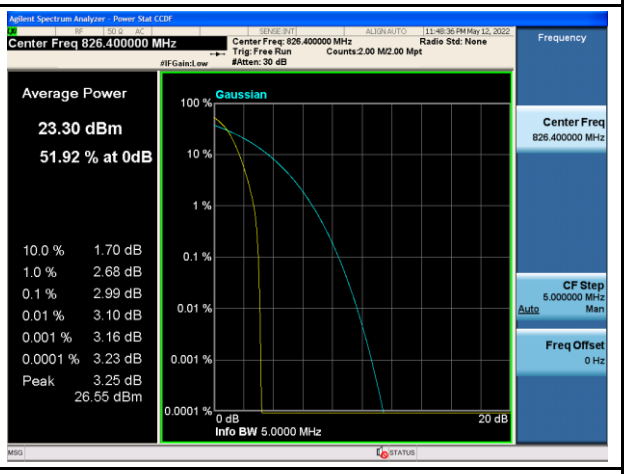
WCDMA B4-Low



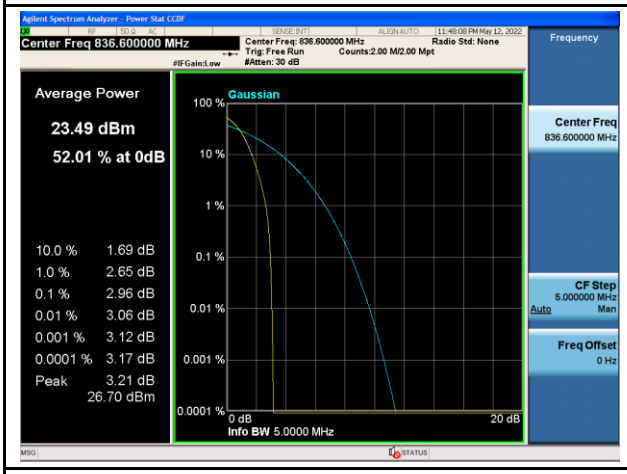
WCDMA B4-Mid



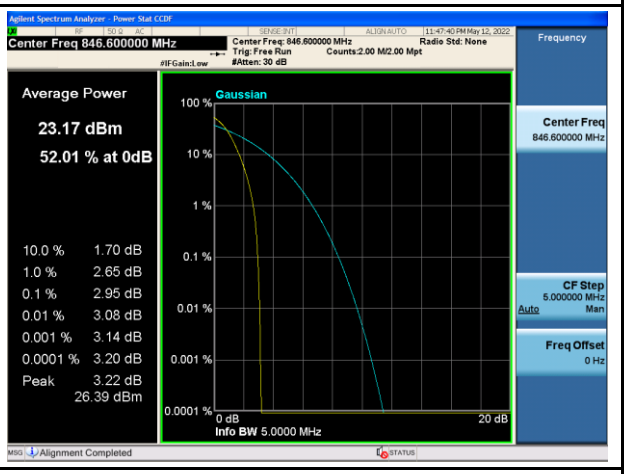
WCDMA B4-HIgh



WCDMA B5-Low



WCDMA B5-Mid



WCDMA B5-High

7.3 Occupied Bandwidth

7.3.1 Requirement

§2.1049, RSS-Gen (6.7)

- 99% Occupied Bandwidth(kHz)

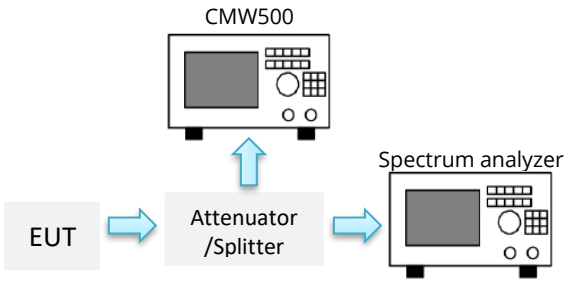
The occupied bandwidth that is the frequency bandwidth such that below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be Measured.

- 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



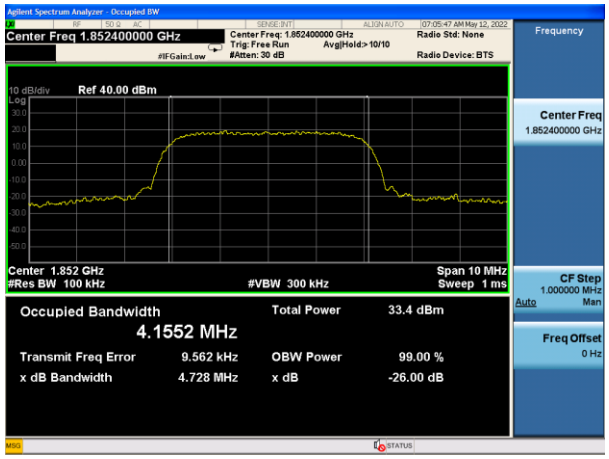
7.3.3 Test Procedure

- 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.

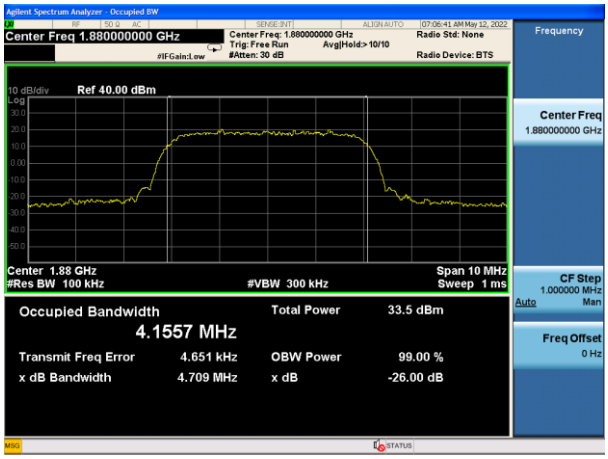
7.3.4 Test Result

Mode	Channel	Frequency (MHz)	99% Power Bandwidth (MHz)	-26dBc Bandwidth (MHz)
WCDMA B2	9262	1852.4	4.155	4.728
	9400	1880.0	4.156	4.709
	9538	1907.6	4.161	4.727
WCDMA B4	1312	1712.4	4.150	4.731
	1413	1732.5	4.158	4.738
	1513	1752.6	4.143	4.726
WCDMA B5	4132	826.4	4.157	4.728
	4183	836.6	4.138	4.731
	4233	846.6	4.142	4.710

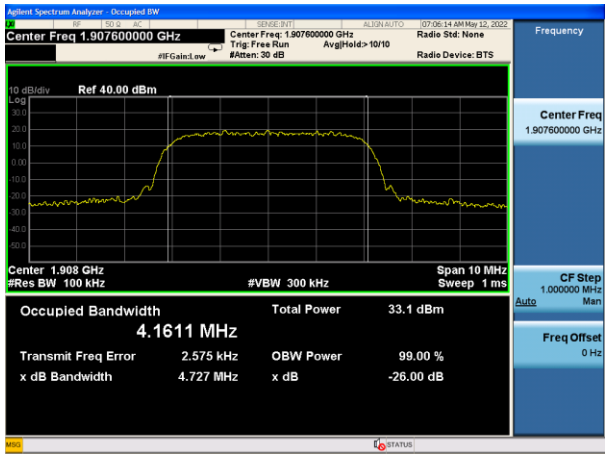
7.3.5 Test Plots



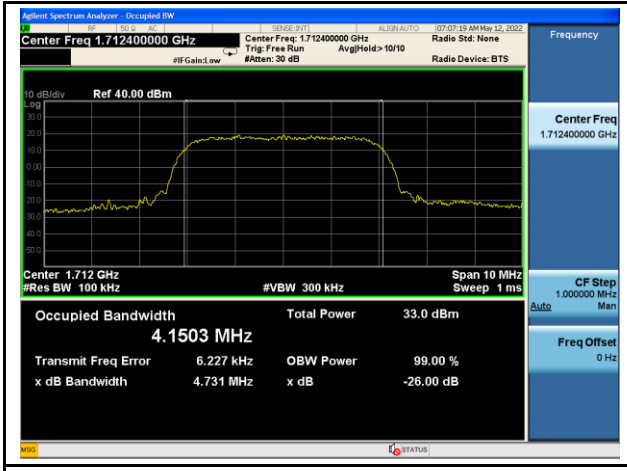
WCDMA B2-Low



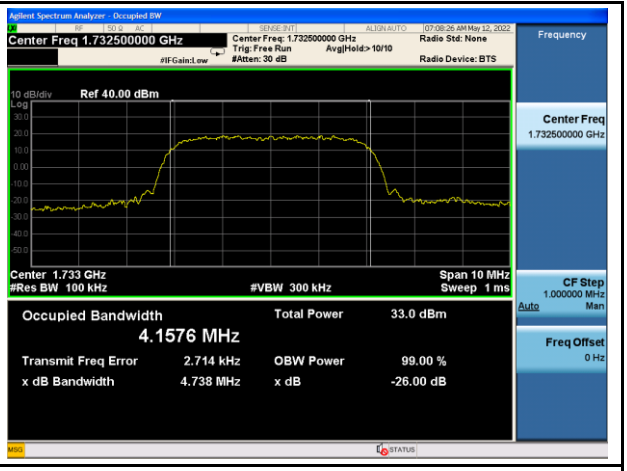
WCDMA B2-Mid



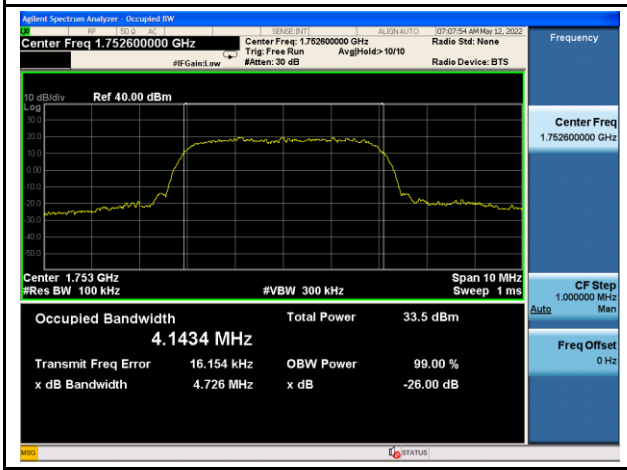
WCDMA B2-High



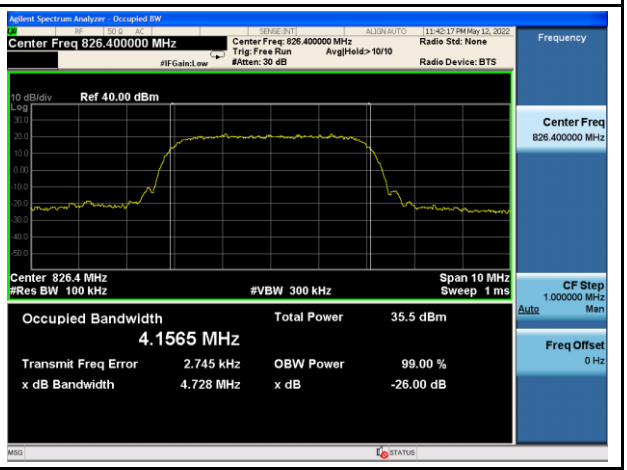
WCDMA B4-Low



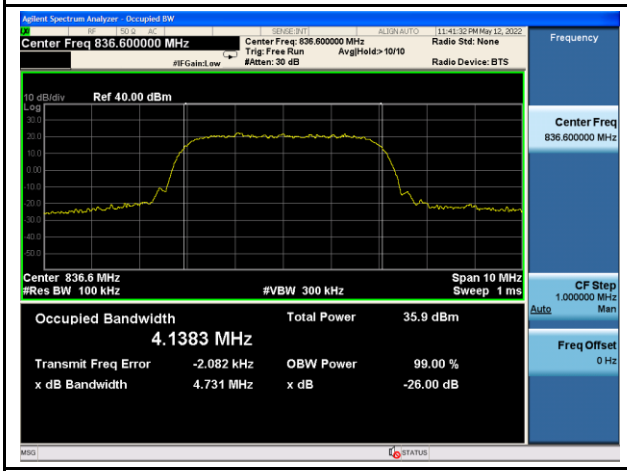
WCDMA B4-Mid



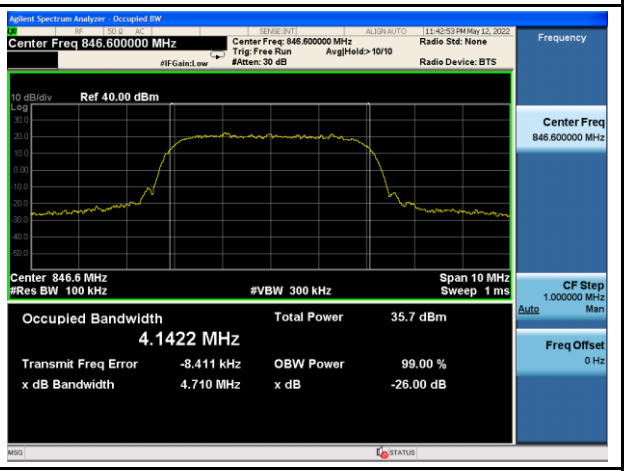
WCDMA B4-High



WCDMA B5-Low



WCDMA B5-Mid



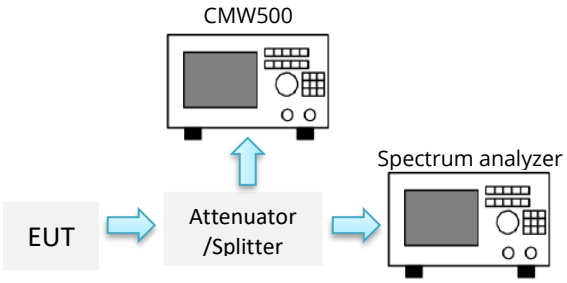
WCDMA B5-High

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



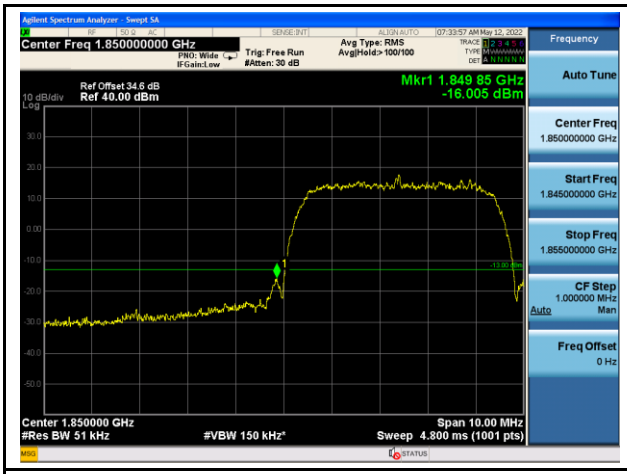
7.4.3 Test Procedure

- 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

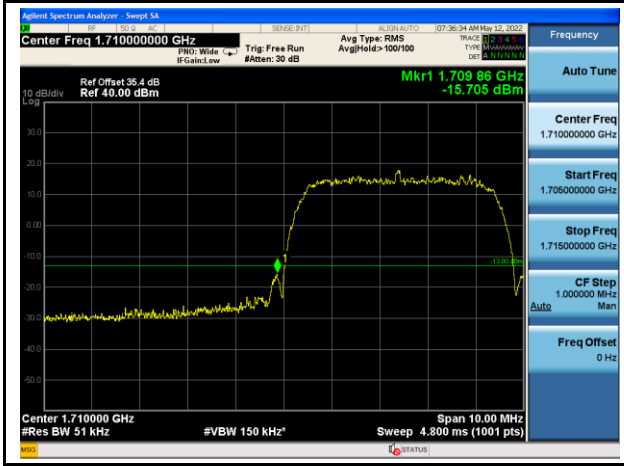
Mode	Channel	Frequency (MHz)	Band Edge measured (dBm)	Limit (dBm)	Result
WCDMA B2	9262	1852.4	-16.005	-13	Pass
	9538	1907.6	-17.254	-13	Pass
WCDMA B4	1312	1712.4	-15.705	-13	Pass
	1513	1752.6	-15.886	-13	Pass
WCDMA B5	4132	826.4	-13.289	-13	Pass
	4233	846.6	-15.730	-13	Pass

7.4.5 Test Plots



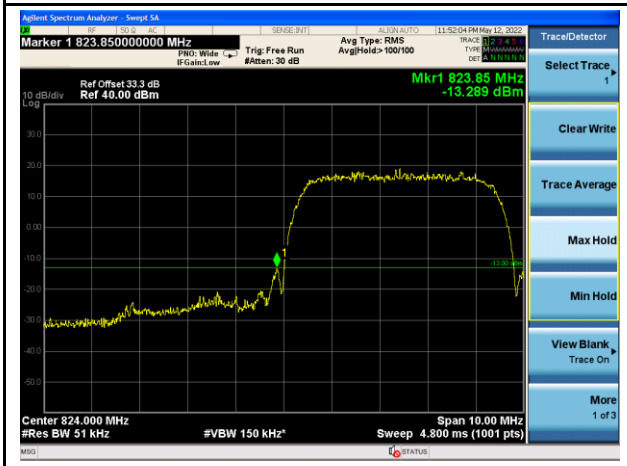
WCDMA B2-Low

WCDMA B2-Low



WCDMA B4-Low

WCDMA B4-HIgh



WCDMA B5-Low

WCDMA B5-HIgh

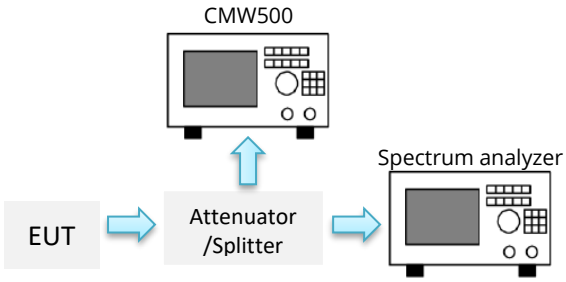
7.5 Conducted spurious emission

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.

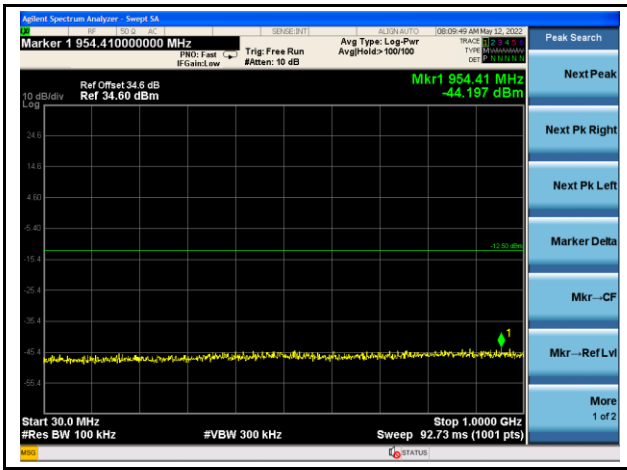
7.5.2 Test Setup



7.5.3 Test Procedure

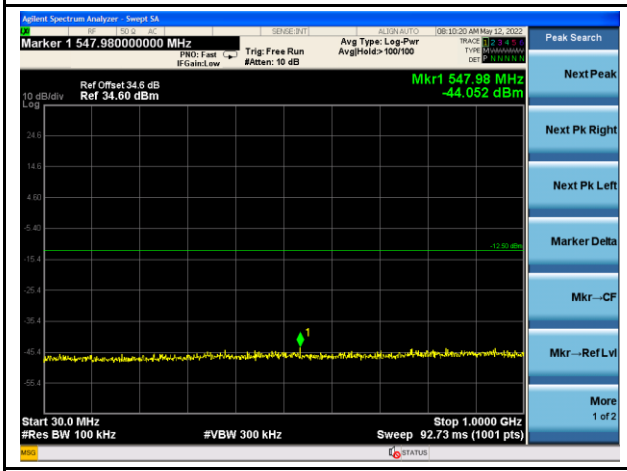
- The EUT was connected to Spectrum Analyzer and Base Station via power divider.
- Set RBW = 100KHz and VBW=300KHz for below 1GHz; set RBW=1MHz and VBW=3MHz for above 1GHz.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Use marker peak to search for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

7.5.4 Test Result



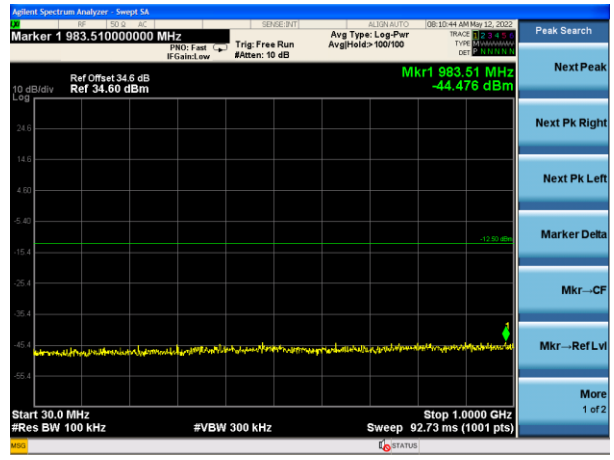
WCDMA B2 - Low- 30MHz~1GHz

WCDMA B2 - Low - 1GHz~20GHz



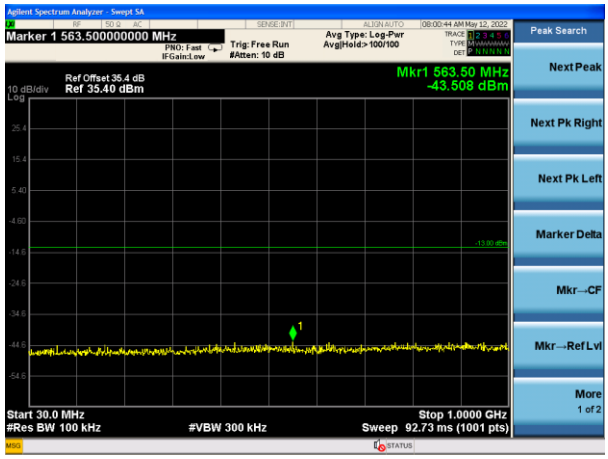
WCDMA B2 - Mid- 30MHz~1GHz

WCDMA B2 – Mid - 1GHz~20GHz



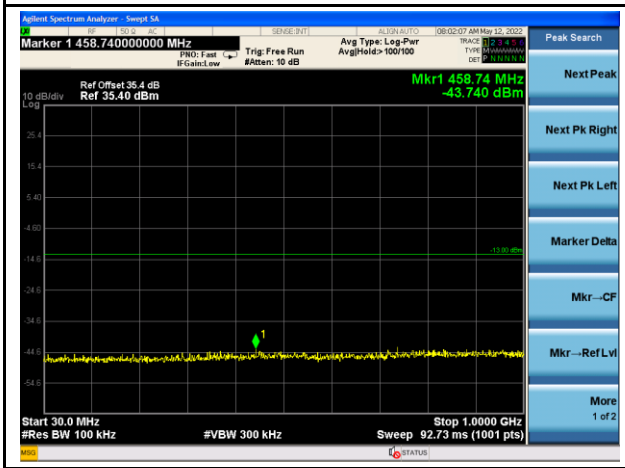
WCDMA B2 - High - 30MHz~1GHz

WCDMA B2 - High - 1GHz~20GHz



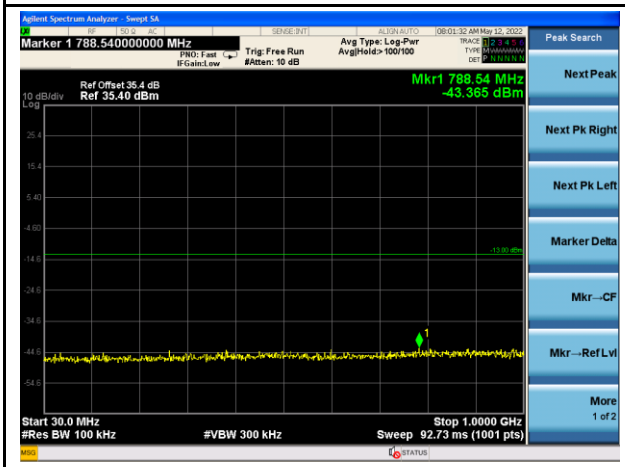
WCDMA B4 - Low- 30MHz~1GHz

WCDMA B4 - Low - 1GHz~20GHz



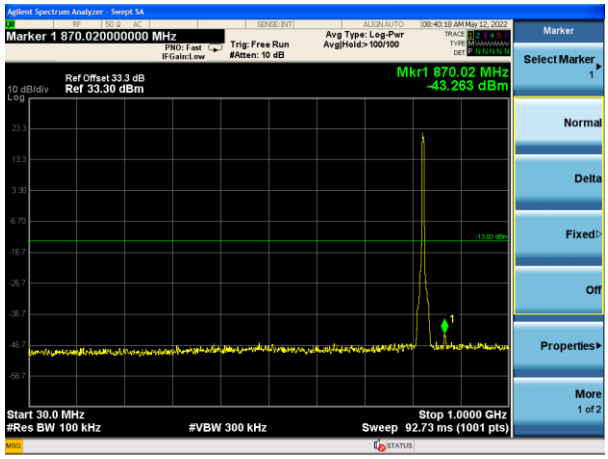
WCDMA B4 - Mid- 30MHz~1GHz

WCDMA B4 – Mid - 1GHz~20GHz



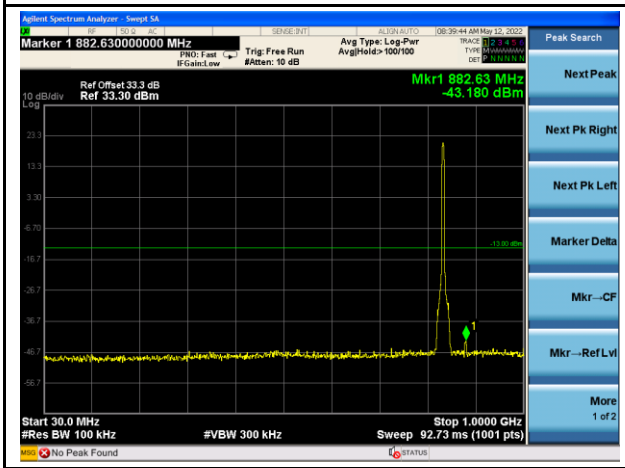
WCDMA B4 - High - 30MHz~1GHz

WCDMA B4 - High - 1GHz~20GHz



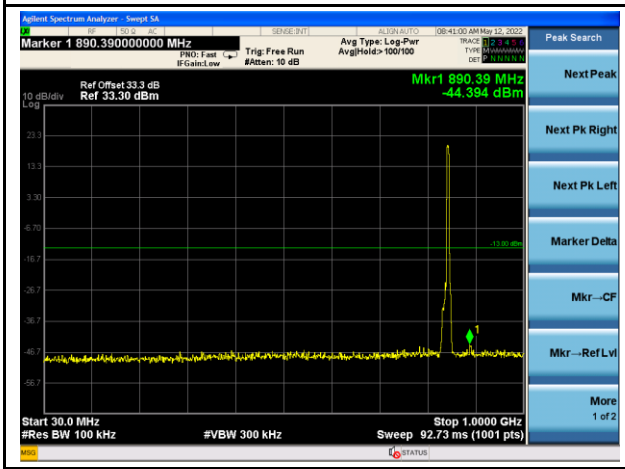
WCDMA B5 - Low- 30MHz~1GHz

WCDMA B5 - Low - 1GHz~20GHz



WCDMA B5 - Mid- 30MHz~1GHz

WCDMA B5 – Mid - 1GHz~20GHz



WCDMA B5- High - 30MHz~1GHz

WCDMA B5 - High - 1GHz~20GHz

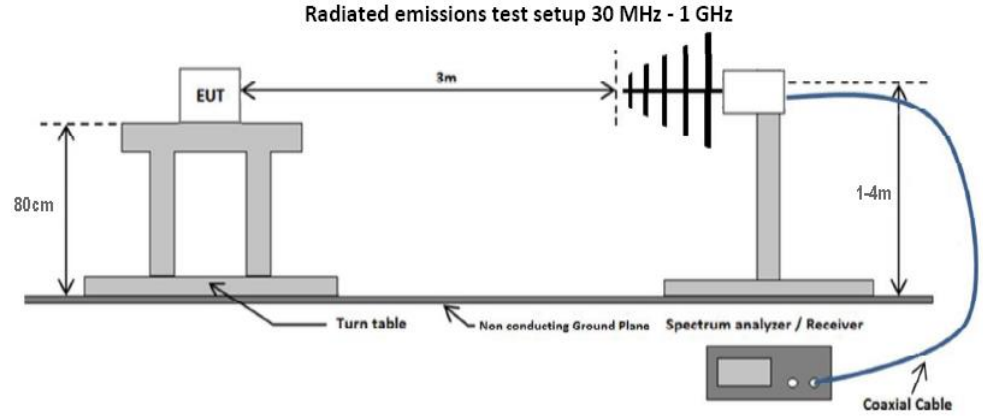
7.6 Field Strength of Radiated Spurious Emissions

7.6.1 Requirement

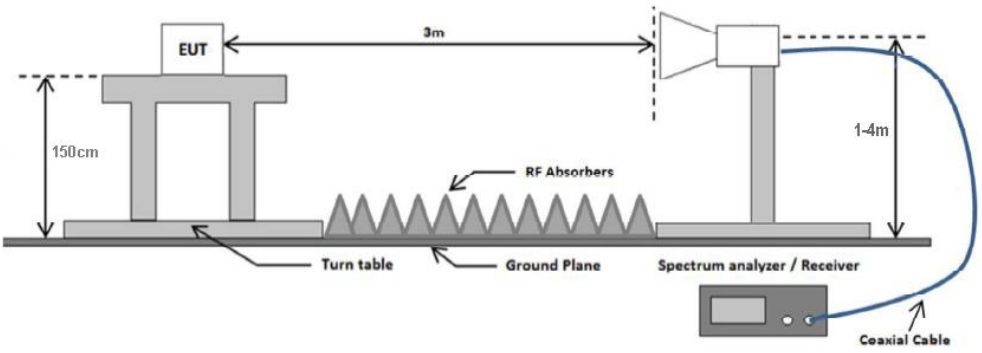
The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power(P)by a factor of at least 43+10 log(P)dB. The emission limit is equal to-13dBm.

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

WCDMA Band 2												
Low Channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	7409.513	-80.5	23.7	-5.5	-62.3	RMS Max	V	250	323	-13	-49.3	Pass
2	3704.258	-88.3	19.7	3.9	-64.7	RMS Max	H	385	109	-13	-51.7	Pass
3	5556.412	-77.8	21.7	-10.2	-66.3	RMS Max	V	155	284	-13	-53.3	Pass
Mid channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	3761.884	-88.6	19.8	5.1	-63.6	RMS Max	H	216	97	-13	-50.6	Pass
2	7520.877	-81.3	23.7	-5.7	-63.3	RMS Max	V	400	0	-13	-50.3	Pass
3	5638.215	-76.8	21.8	-10.4	-65.4	RMS Max	V	291	236	-13	-52.4	Pass
High channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	3815.1	-88.8	19.9	5.5	-63.4	RMS Max	H	197	182	-13	-50.4	Pass
2	7628.621	-82	24.1	-5.8	-63.6	RMS Max	V	151	0	-13	-50.6	Pass
3	5721.694	-76.8	21.8	-10.5	-65.5	RMS Max	V	341	68	-13	-52.5	Pass

WCDMA Band 4												
Low Channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	6848.947	-80.1	23.2	-6.8	-63.7	RMS Max	V	280	357	-13	-50.7	Pass
2	3424.728	-81	19.2	-3.1	-64.9	RMS Max	V	342	284	-13	-51.9	Pass
3	5136.019	-78.3	21.2	-8.1	-65.1	RMS Max	H	307	164	-13	-52.1	Pass
Mid channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	6929.125	-80.1	23.4	-6.5	-63.2	RMS Max	H	332	98	-13	-50.2	Pass
2	5196.741	-77.6	21.2	-8.4	-64.9	RMS Max	V	317	348	-13	-51.9	Pass
3	3466.202	-82.2	19.4	-1.8	-64.6	RMS Max	V	167	323	-13	-51.6	Pass
High channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	7011.797	-80.3	23.3	-6.2	-63.2	RMS Max	H	369	130	-13	-50.2	Pass
2	5255.361	-77.2	21.2	-8.8	-64.7	RMS Max	V	351	324	-13	-51.7	Pass
3	3503.742	-83.2	19.6	-0.7	-64.4	RMS Max	V	356	85	-13	-51.4	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 (dB/m) - Limit value(dB/m)

WCDMA Band 5												
Low Channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	4957.133	-79.6	20.9	-6.6	-65.3	RMS Max	V	116	54	-13	-52.3	Pass
2	3305.561	-76.9	19.2	-6.8	-64.5	RMS Max	V	252	318	-13	-51.5	Pass
3	4131.099	-88.5	19.9	3.9	-64.8	RMS Max	H	304	259	-13	-51.8	Pass
Mid channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	5080.695	-78.7	21.2	-7.6	-65.1	RMS Max	H	264	238	-13	-52.1	Pass
2	3346.695	-78	19.2	-5.5	-64.3	RMS Max	V	177	50	-13	-51.3	Pass
3	4182.805	-88	19.9	3.3	-64.8	RMS Max	V	299	126	-13	-51.8	Pass
High channel												
No.	Frequency MHz	Raw dBm	Cable Loss	AF dB	Level dBm	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBm	Margin dB	Result
1	3387.889	-79.7	19.1	-4.2	-64.8	RMS Max	V	296	140	-13	-51.8	Pass
2	4233.264	-87.8	20	2.7	-65.1	RMS Max	H	146	182	-13	-52.1	Pass
3	5078.501	-79	21.2	-7.6	-65.3	RMS Max	V	161	0	-13	-52.3	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 (dB/m) - Limit value(dB/m)

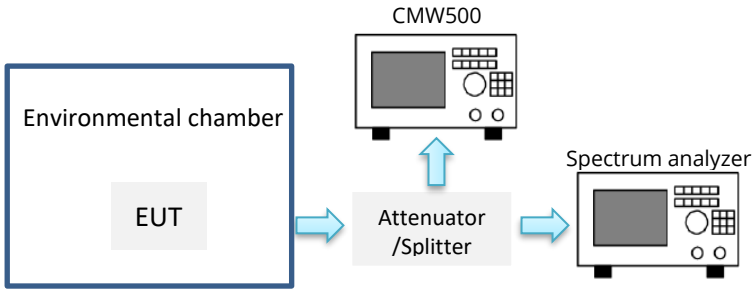
7.7 Frequency Stability

7.7.1 Requirement

§2.1055, §22.355 & §24.235, § 27.5(h); § 27.54
RSS-132(5.3), RSS-133(6.3), RSS-139(6.4)

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

WCDMA B2 – 1880 MHz					
Voltage (Vdc)	**Temperature (°C)**	**Frequency error (Hz)**	**Frequency error (ppm)**	**Limit (ppm)**	**Result**
12.0	-30	10	0.0053	2.50	PASS
	-20	9	0.0048		
	-10	10	0.0053		
	0	8	0.0043		
	10	6	0.0032		
	20	10	0.0053		
	30	11	0.0059		
	40	9	0.0048		
	50	7	0.0037		
10.2	20	10	0.0053		
13.8	20	12	0.0064		

WCDMA B4 – 1732.5 MHz					
Voltage (Vdc)	**Temperature (°C)**	**Frequency error (Hz)**	**Frequency error (ppm)**	**Limit (ppm)**	**Result**
12.0	-30	19	0.0110	2.50	PASS
	-20	15	0.0087		
	-10	20	0.0115		
	0	13	0.0075		
	10	9	0.0052		
	20	8	0.0046		
	30	11	0.0063		
	40	9	0.0052		
	50	7	0.0040		
10.2	20	13	0.0075		
13.8	20	10	0.0058		

WCDMA B5 – 836.5 MHz					
Voltage (Vdc)	**Temperature (°C)**	**Frequency error (Hz)**	**Frequency error (ppm)**	**Limit (ppm)**	**Result**
12.0	-30	20	0.0239	2.50	PASS
	-20	16	0.0191		
	-10	21	0.0251		
	0	14	0.0167		
	10	10	0.0120		
	20	9	0.0108		
	30	12	0.0143		
	40	10	0.0120		
	50	8	0.0096		
10.2	20	14	0.0167		
13.8	20	11	0.0132		

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	10/18/2021	10/18/2022
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	05/14/2022	05/14/2023
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	05/05/2022	05/05/2023
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	05/05/2022	05/05/2023
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	05/16/2022	05/16/2023
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	05/15/2022	05/15/2023
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	05/10/2022	05/10/2023
Radio Communication Tester	Anritsu	MT8000a	6262261939	02/23/2022	02/23/2023
Temperature/Humidity Chamber	Thermotron	SM-8-8200	40991	09/08/2021	09/08/2022

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