Testing Laboratory
3023

Test Report No:
2550191R-RFNAV02S-A

TEST REPORT
FCC Rules & Regulations

Product Name	Advanced 5G Industrial Router
Brand Name	BEC by BILLION
Model No.	MX-220-UT-5G-B
FCC ID	QI3BEC-MX220UT5GC
Applicant´s Name / Address	Billion Electric Co., Ltd. 8F., No. 192, Sec. 2, Zhongxing Rd., Xindian Dist.,New Taipei City 231 Taiwan
Manufacturer's Name	Billion Electric Co., Ltd.
Test Method Requested, Standard	FCC CFR Title 47 Part 96 ANSI/TIA-603-E-2016 ANSI C63.26-2015
Verdict Summary	IN COMPLIANCE
Documented By Genie Chang	Genie Chang
Tested by Daniel Wu	Daniel Wu
Approved By Will Chen	Will Chen
Date of Receipt	2024/02/29
Date of Issue	2025/05/13
Report Version	V1.0

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Competences and Guarantees

DEKRA is a testing laboratory competent to carry out the tests described in this report.
In order to assure the traceability to other national and international laboratories, DEKRA has a calibration and maintenance program for its measurement equipment.

DEKRA guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated in the report and it is based on the knowledge and technical facilities available at DEKRA at the time of performance of the test.

DEKRA is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

General Conditions

1. The test results relate only to the samples tested.
2. The test results shown in the test report are traceable to the national/international standard through the calibration report of the equipment and evaluated measurement uncertainty herein.
3. This report must not be used to claim product endorsement by TAF or any agency of the government.
4. The test report shall not be reproduced without the written approval of DEKRA Testing and Certification Co., Ltd.
5. Measurement uncertainties evaluated for each testing system and associated connections are given here to provide the system information for reference. Compliance determinations do not take into account measurement uncertainties for each testing system, but are based on the results of the compliance measurement.

Revision History

Version	Description	Issued Date
V1.0	Initial issue of report	2025/05/13

Permissive Change

Report No.	Version	Description	Issued Date
2420505R-RFUSV26S-A	V1.0	Original application.	2024/06/20
2550191R-RFNAV02S-A	V1.0	This report is to request the Class II Permissive Change for FCC ID: QI3BEC-MX220UT5GC. The major change filed under this application is to: Change #1: Remove Category A CBSD information and test data. Change #2: Remove antenna (Model No.: ANT-SX-5048), which is declared to Category A CBSD. Except for the above differences, the hardware design and software are identical to the original grant.	2025/05/13

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3	Part 2.1046, 96.41(b)	RF Output Power	PASS	Note
4	Part 2.1046, 96.41(b)	Maximum Power Spectral Density	PASS	Note
5	Part 2.1049, 96.41	Occupied Bandwidth	PASS	Note
6	Part 2.1051, 96.41	Spurious Emission at Antenna Terminals	PASS	Note
7	Part 2.1051, 96.41	Spurious Emission	PASS	Note
8	Part 2.1055	Frequency Stability	PASS	Note
9	Part 96.41	Peak to Average Ratio	PASS	Note
Note: The test data are referred to original report (FCC ID: QI3BECMX220UT5GAB), and remove Category A CBSD data.				

Comments and Explanations
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1. General Information

1.1. EUT Description

Frequency Range	3550 ~ 3700 MHz (Uplink) 3550 ~ 3700 MHz (Downlink)	
Bandwidth	SCS: 30 kHz	10 / 20 / 40 MHz
Type of Modulation	DFT-s-OFDM (pi/2 BPSK / QPSK / 16QAM / 64QAM / 256QAM) CP-OFDM (QPSK / 16QAM / 64QAM / 256QAM)	
Maximum Output Power	20.98 dBm	
IMEI No.	359918921148290	

Accessories Information					
No.	Equipment Name	Brand Name	Model No.	Rating	Remark
1	AC to DC Power adapter	BILLION	BA024-15016AXU	Input: AC 100-240V~0.7A 50/60Hz Output: 15V⎓1.6A	With power cable: Non-Shielded, 1.6m
No.	Equipment Name	Description			
2	Terminal Block 3P to DC Jack cable	Brand Name: E-CALL, Model No.: 0116-368-J, Non-Shielded, 0.08m			
3	DB9 Female to Male Cable	Brand Name: Pan-International, Model No.: P96301A-23, Non-Shielded, 1m			

Antenna Information						
Item.	Ant.	Brand Name	Model No.	Type	Gain (dBi)	Remark
1	1	BECbyBILLION	DA-N48-20-01-BL	Patch (directional)	20.5	TX/RX
	3				20.0	TX/RX

1.2. EUT Information

EUT Power Type	From Adapter

1.3. Testing Location Information

USA	FCC Designation Number: TW0033
Canada	CAB Identifier Number: TW3023 / Company Number: 26930

Site Description	Accredited by TAF
	Accredited Number: 3023

Test Laboratory	DEKRA Testing and Certification Co., Ltd.
	Linkou Laboratory
Address	No. 85, Wenlin St., Linkou Dist., New Taipei City 244017, Taiwan, R.O.C.
Performed Location	No. 26, Huaya 1st Rd., Guishan Dist.,Taoyuan City 333411, Taiwan, R.O.C.
Phone Number	+886-3-275-7255
Fax Number	+886-3-327-8031

Ambient conditions in the laboratory:

Performed Item	Items	Required	Actual	Test Date
Conducted Emission	Temperature (°C)	15~35 ℃	22.8 ℃	2024/03/22 ~ 2024/06/19
	Humidity (%RH)	20~75 %	51.0 %	
Radiated Emission	Temperature (°C)	15~35 ℃	23.7 ℃	2024/06/18 ~ 2024/06/19
	Humidity (%RH)	20~75 %	54.0 %	

1.4. Measurement Uncertainty

Uncertainties have been calculated according to the DEKRA internal document with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2).

Test Item	Uncertainty
RF Output Power	± 1.58 dB
Maximum Spectral Density	± 1.58 dB
Occupied Bandwidth	± 1580.61 Hz
Peak to Average Power Ratio	± 2.14 dB
Spurious Emissions	± 5.88dB for 30MHz~1GHz ± 3.11dB for 1GHz~18GHz ± 3.09dB for 18GHz~40GHz
Spurious Emission at Antenna Terminals	± 2.14 dB
Frequency Stability	± 0.42 ppm

1.5. List of Test Equipment

Instrument	Manufacturer	Model No.	Serial No.	Cal. Date	Next Cal. Date
Bi-Log Antenna	SCHWARZBECK	VULB9168	9168-0675	2023/08/09	2025/08/08
Horn Antenna	Com-Power	AH-840	101100	2023/10/02	2025/10/01
Horn Antenna	RF SPIN	DRH18-E	210507A18ES	2024/05/15	2025/05/14
Pre-Amplifier	SGH	SGH0301-9	20211007-11	2024/01/10	2025/01/09
Pre-Amplifier	SGH	PRAMP118	20200701	2024/01/10	2025/01/09
Pre-Amplifier	EMCI	EMC05820SE	980310	2024/01/10	2025/01/09
Pre-Amplifier	EMCI	EMC184045SE	980369	2024/01/10	2025/01/09
Coaxial Cable	EMCI	EMC102-KM-KM-600	1160314	2024/01/10	2025/01/09
Coaxial Cable	EMCI	EMC102-KM-KM-7000	170242	2024/01/10	2025/01/09
Spectrum Analyzer	R&S	FSV3044	101114	2024/02/21	2025/02/20
Coaxial Cable	SGH	SGH18	2021005-1	2024/01/10	2025/01/09
Coaxial Cable	SGH	SGH18	202108-4	2024/01/10	2025/01/09
Coaxial Cable	SGH	HA800	GD20110223-1	2024/01/10	2025/01/09
Coaxial Cable	SGH	HA800	GD20110222-3	2024/01/10	2025/01/09
UXM 5G Wireless Test Platform	KEYSIGHT	E7515B	MY59321672	2023/05/30 2024/06/07	2024/05/29 2025/06/06
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510357	2023/05/18 2024/05/08	2024/05/17 2025/05/07
Temperature & Humidity Test Chamber	KSON	THS-D4T-100	A0606	2024/03/06	2025/03/05
Power Supply	KEYSIGHT	E36234A	MY59001234	2023/11/09	2024/11/08

Note: Test Software Version: e3 230303 dekra V9.

2. Test Configuration of EUT

2.1. Test Condition

EUT Operational Condition	
Testing Voltage	AC 120V/60Hz

2.2. The Worst Case Measurement Configuration

Test Mode	Mode 1: 5G NR n48

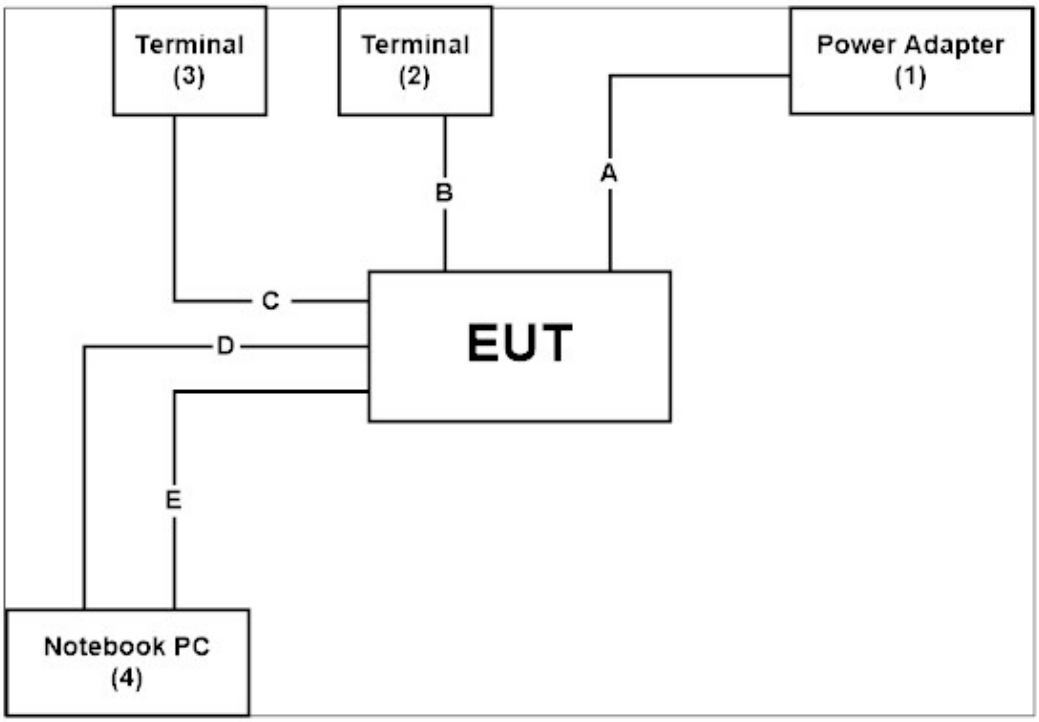
Note:
1. Determining compliance shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.
2. Regarding frequency band operation, the lowest, middle and highest frequency of channel were selected to perform the test, and the details were shown on this report.
3. The device was tested under all configurations, combinations, bandwidths, RB configurations and modulations, and the worst case was found in PI/2 BPSK modulation, therefore the “Maximum Power Spectral Density” & “Spurious Emission at Antenna Terminals” & “Spurious Emission” test items perform PI/2 BPSK modulation in this report.
4. For “Peak to Average Ratio” test item shown worst case modulation PI/2 BPSK, QPSK and 256QAM on this report.
5. The EUT was performed at X axis, Y axis and Z axis position for radiated spurious emission test. The worst case was found at Z axis, so the measurement will follow this same test configuration.
6. The product of 5G NR n48 supports the standalone mode and UL 2X2 MIMO.

2.3. Tested System Details

Product		Manufacturer	Model No.	Serial No.
1	AC to DC Power adapter	BILLION	BA024-15016AXU	N/A
2	Terminal	N/A	N/A	N/A
3	Terminal	N/A	N/A	N/A
4	Notebook PC	DELL	Latitude 5580	2HRD7H2

2.4. Configuration of Tested System

Connection Diagram



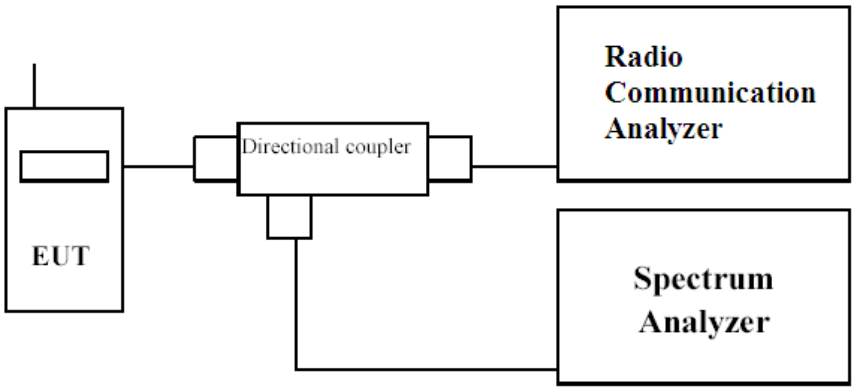
Signal Cable Type		Signal cable Description
A	Terminal Block 3P to DC Jack cable	Non-Shielded, 0.08m
B	DB9 Female to Male Cable	Non-Shielded, 1m
C	DB9 Female to Male Cable	Non-Shielded, 1m
D	LAN Cable	Non-Shielded, 8m
E	LAN Cable	Non-Shielded, 8m

2.5. EUT Operating Procedures

1.	Setup the EUT and simulators as shown on.
2.	Turn on the power of all equipment.
3.	The EUT will continue receive the signal from 5G NR function.
4.	Repeat the above procedure (3)

3. RF Output Power

3.1. Test Setup



3.2. Test Limit

Type	Device	Maximum EIRP (dBm/10 MHz)	Maximum PSD (dBm/MHz)
	End User Device	23	N/A
	Category A CBSD	30	20
X	Category B CBSD	47	37

3.3. Test Procedure

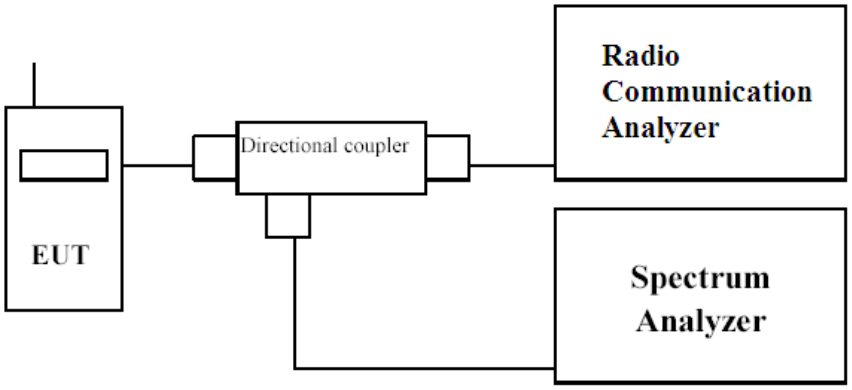
1. Channel power measurements are performed using the signal analyzer's "channel power" measurement capability for signals with continuous operation.
2. RBW = 1 – 5% of the expected OBW, not to exceed 1MHz.
3. VBW ≥ 3 x RBW.
4. Span = 1.5 times the OBW.
5. No. of sweep points > 2 x span / RBW.
6. Detector = RMS.
7. Trigger is set to "free run" for signals with continuous operation with the sweep times set to "auto".
8. The integration bandwidth was set to 10MHz.
9. Trace mode = trace averaging (RMS) over 100 sweeps.
10. The trace was allowed to stabilize.

3.4. Test Result of RF Output Power

Refer as Appendix A

4. Maximum Power Spectral Density

4.1. Test Setup



4.2. Test Limit

Type	Device	Maximum EIRP (dBm/10 MHz)	Maximum PSD (dBm/MHz)
	End User Device	23	N/A
	Category A CBSD	30	20
X	Category B CBSD	47	37

4.3. Test Procedure

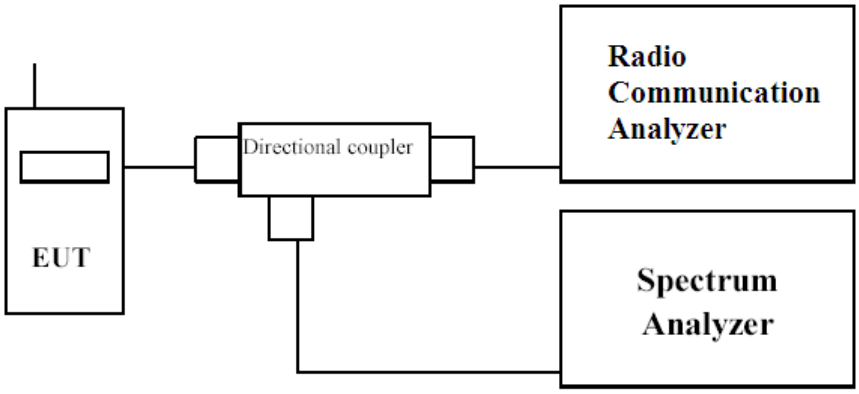
1. The EUT is tested with maximum rated TX power via the base station simulator, and connect the EUT to the spectrum analyzer.
2. Tune the spectrum analyzer to the nominal center frequency of the EBW.
3. RBW = 1MHz.
4. VBW ≥ 3 x RBW.
5. No. of sweep points > 2 x span / RBW.
6. Detector = RMS.
7. Trigger is set to “free run” for signals with continuous operation with the sweep times set to “auto”.
8. Trace mode = trace averaging (RMS) over 100 sweeps.
9. The trace was allowed to stabilize.

4.4. Test Result of Maximum Power Spectral Density

Refer as Appendix B

5. Occupied Bandwidth

5.1. Test Setup



5.2. Test Limit

N/A

5.3. Test Procedures

The EUT is tested with maximum rated TX power via the Base Station simulator, and the occupied bandwidth was measured at the antenna terminals of the EUT.

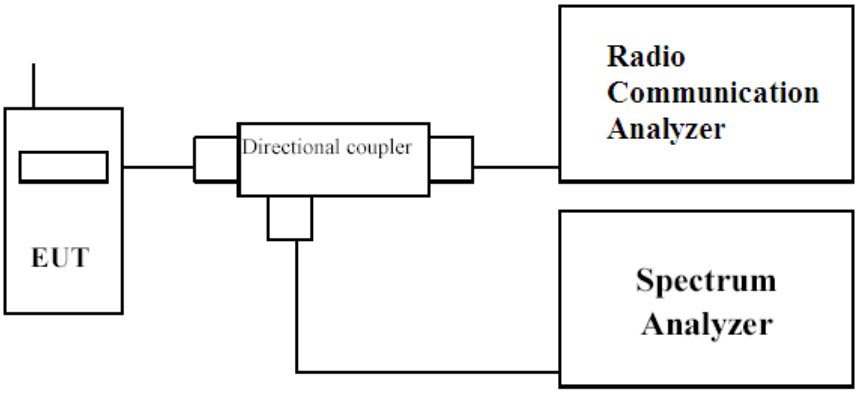
The Resolution BW of the analyzer is set to 1 %~5% of the emission bandwidth. The EUT's occupied bandwidth is measured as the width of the signal between two points, one below the carrier center frequency and one above the carrier frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power. The plots below show the resultant display from the Spectrum Analyser.

5.4. Test Result of Occupied Bandwidth

Refer as Appendix C

6. Spurious Emission at Antenna Terminals

6.1. Test Setup



6.2. Test Limit

(1) Within 0 MHz to 10 MHz above and below the assigned channel ≤ −13 dBm/MHz.

(2) Greater than 10 MHz above and below the assigned channel ≤ −25 dBm/MHz.

(3) Any emission below 3530 MHz and above 3720 MHz ≤ −40 dBm/MHz.

6.3. Test Procedure

In accordance with Part 96.41 at least 1% of the emission bandwidth was used for the resolution and video bandwidths up to 1MHz away from the Block Edge. At greater than 1MHz, the resolution and video bandwidth were increased to 1MHz/3MHz.

The reference power and path losses of all channels used for testing in each frequency block were measured.

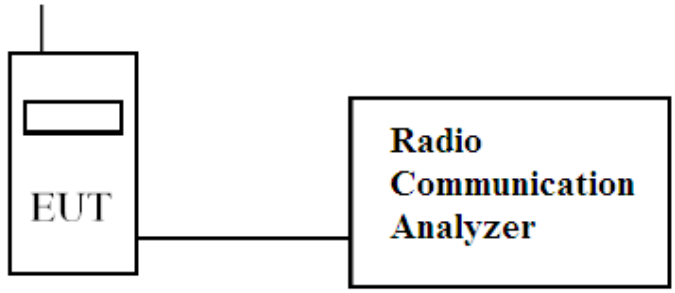
6.4. Test Result of Spurious Emission at Antenna Terminals

Refer as Appendix D

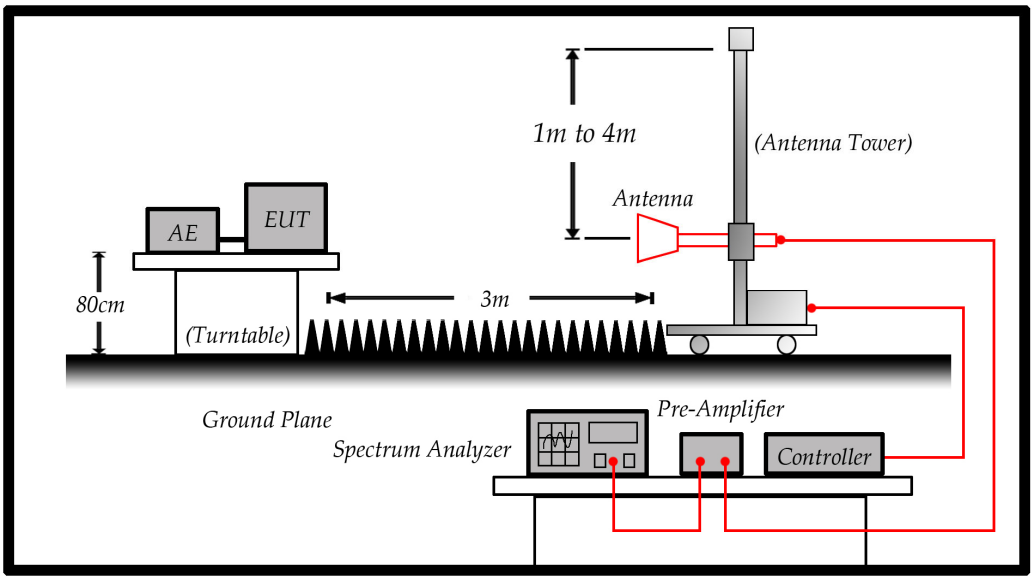
7. Spurious Emission

7.1. Test Setup

Conducted Spurious Emission.



Radiated Spurious.



Note: The Worst case Mode is QPSK Mode for Radiated spurious emissions.

7.2. Test Limit

Limit: <-40 dBm

43 + 10Log(P) down on the carrier where P is the power in Watts.

7.3. Test Procedure

In accordance with Part 2.1051, 96.41, the spurious emissions from the antenna terminal were measured. The transmitter output power was attenuated using a combination of filters and attenuators and the frequency spectrum investigated from 30MHz to 40GHz. The EUT was set to transmit on full power. The EUT was tested on Low, middle and High channels for both power levels. The resolution and video bandwidth was set to 1MHz/3MHz in accordance with Part 2.1051, 96.41. The spectrum analyzer detector was set to Max Hold. In addition, measurements were made up to the 10th harmonic of the fundamental. The device was then replaced with a substitution antenna, which input signal was adjusted until the received level matched that of the previously detected emission.
(1) The EUT is tested with maximum rated TX power via the Base Station simulator.
(2) The EUT is tested in three orthogonal planes, The worst case was showing in this report.

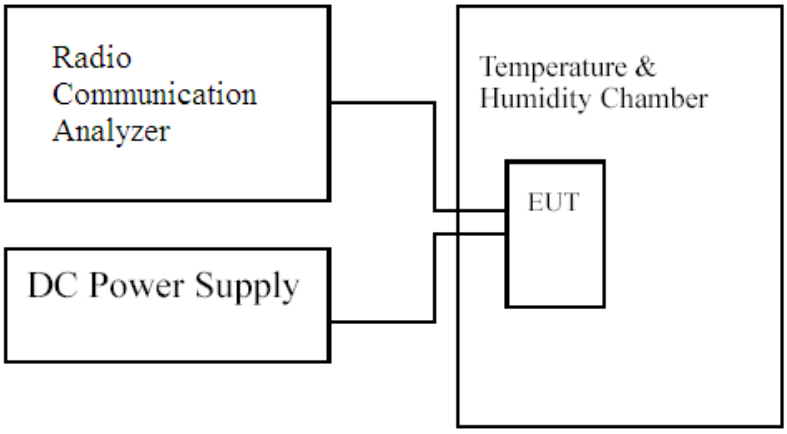
The EUT is placed on a turn table which is 0.8 meter above ground. The turn table can rotate 360 degrees to determine the position of the maximum emission level. The EUT was positioned such that the distance from antenna to the EUT was 3 meters.
The antenna can move up and down between 1 meter and 4 meters to find out the maximum emission level. Both horizontal and vertical polarization of the antenna are set on measurement. In order to find the maximum emission, all of the interface cables must be manipulated according to TIA/EIA 603-E on radiated measurement.

7.4. Test Result of Spurious Emission

Refer as Appendix E

8. Frequency Stability

8.1. Test Setup



8.2. Test Limit

Limit: <±2.5 ppm

8.3. Test Procedures

The frequency stability of transmitter is measured by:

(a) Temperature: The temperature is varied from -30˚C to 50˚C in 10˚C increment using a standard temperature & Humidity chamber.

(b) Primary Supply Voltage: The primary supply voltage is varied 85% to 115% of the nominal value for non hand-carried equipment. For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating endpoint which shall be specified by the manufacturer.

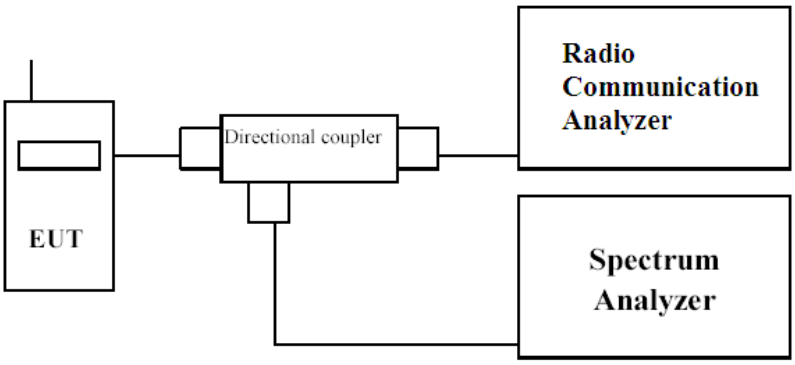
The EUT was connected via the base station simulator. Universal Radio Communication Tester, was used to measure The Frequency Error. The maximum result of measurements was recorded.

8.4. Test Result of Frequency Stability

Refer as Appendix F

9. Peak to Average Power Ratio

9.1. Test Setup



9.2. Test Limit

The peak-to-average power ratio (PAPR) of the transmitter output power must not exceed 13 dB. The PAPR measurements should be made using either an instrument with complementary cumulative distribution function (CCDF) capabilities to determine that PAPR will not exceed 13 dB for more than 0.1 percent of the time or other Commission approved procedure.

9.3. Test Procedure

a) Refer to instrument's analyzer instruction manual for details on how to use the power statistics/CCDF function;
b) Set resolution/measurement bandwidth ≥ signal's occupied bandwidth;
c) Set the number of counts to a value that stabilizes the measured CCDF curve;
d) Set the measurement interval as follows:
   1) for continuous transmissions, set to 1 ms,
   2) for burst transmissions, employ an external trigger that is synchronized with the EUT burst timing sequence, or use the internal burst trigger with a trigger level that allows the burst to stabilize and set the measurement interval to a time that is less than or equal to the burst duration.
e) Record the maximum PAPR level associated with a probability of 0.1%.

9.4. Test Result of Peak to Average Power Ratio

Refer as Appendix G