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检测
TESTING
CNAS L2264

RF TEST REPORT

Applicant	UAB TELTONIKA
FCC ID	2AJLOTM2500TLT
Brand	TELTONIKA
Product	GSM/GPRS/GNSS/BLUETOOTH module
Model	TM2500
Report No.	RXA1606-0123RF01R2
Issue Date	November 23, 2016

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 2 (2015)/ FCC CFR 47 Part 22H (2015)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Xianqing Li

Performed by: Xianqing Li

Kai Xu

Reviewed by: Kai Xu

TA Technology (Shanghai) Co., Ltd.

No.145, Jintang Rd, Tangzhen Industry Park, Pudong Shanghai, China

TEL: +86-021-50791141/2/3

FAX: +86-021-50791141/2/3-8000

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Summary of measurement results

No.	Test Type	Clause in FCC rules	Verdict
1	RF power output	2.1046	PASS
2	Effective Radiated Power	22.913(a)(2)	PASS
3	Occupied Bandwidth	2.1049	PASS
4	Band Edge Compliance	2.1051 / 22.917(a)	PASS
5	Frequency Stability	2.1055 / 22.355	PASS
6	Spurious Emissions at Antenna Terminals	2.1051 / 22.917(a)	PASS
7	Radiates Spurious Emission	2.1053 / 22.917 (a)	PASS
Date of Testing: July 28, 2016 ~ August 26, 2016			

1. Test Laboratory

1.1. Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd).**The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein .Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above. This report must not be used by the client to claim product certification, approval, or endorsement by CNAS or any government agencies.

1.2. Test facility

CNAS (accreditation number:L2264)

TA Technology (Shanghai) Co., Ltd. has obtained the accreditation of China National Accreditation Service for Conformity Assessment (CNAS).

FCC (recognition number is 428261)

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

IC (recognition number is 8510A)

TA Technology (Shanghai) Co., Ltd. has been listed by industry Canada to perform electromagnetic emission measurement.

VCCI (recognition number is C-4595, T-2154, R-4113, G-766)

TA Technology (Shanghai) Co., Ltd. has been listed by industry Japan to perform electromagnetic emission measurement.

A2LA (Certificate Number: 3857.01)

TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

1.3. Testing Location

Company:	TA Technology (Shanghai) Co., Ltd.
Address:	No.145, Jintang Rd, Tangzhen Industry Park, Pudong
City:	Shanghai
Post code:	201201
Country:	P. R. China
Contact:	Xu Kai
Telephone:	+86-021-50791141/2/3
Fax:	+86-021-50791141/2/3-8000
Website:	http://www.ta-shanghai.com
E-mail:	xukai@ta-shanghai.com

2. General Description of Equipment under Test

Client Information

Applicant	UAB TELTONIKA
Applicant address	Saltoniskiu st. 10c, Vilnius, Lithuania
Manufacturer	UAB TELTONIKA
Manufacturer address	Saltoniskiu st. 10c, Vilnius, Lithuania

General Information

Model:	TM2500		
Product IMEI:	357454070000011		
Hardware Version:	TM2500_01		
Software Version:	TM25_D_00.00.01.00		
Power Supply:	external power supply		
Antenna Type:	External Antenna		
Test Mode(s):	GSM 850		
Test Modulation:	GMSK		
GPRS Multislot Class:	12		
Maximum E.R.P.	GSM 850: 33.49dBm		
Rated Power Supply Voltage:	4V		
Extreme Voltage:	Minimum: 3.4V Maximum: 4.2V		
Extreme Temperature:	Lowest: -30°C Highest: +85°C		
Operating Frequency Range	Band	Tx (MHz)	Rx (MHz)
	GSM850	824 ~ 849	869 ~ 894
Note: The information of the EUT is declared by the manufacturer. Please refer to the specifications or user manual for details.			

3. Applied Standards

According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC CFR47 Part 2 (2015)

FCC CFR 47 Part 22H (2015)

ANSI/TIA-603-D (2010)

KDB 971168 D01 Power Meas License Digital Systems v02r02

4. Test Configuration

Radiated measurements are performed by rotating the EUT in three different orthogonal test planes. EUT stand-up position (Z axis), lie-down position (X, Y axis). Receiver antenna polarization (horizontal and vertical), the worst emission was found in position (Z axis, vertical polarization) and the worst case was recorded.

All mode and data rates and positions were investigated.
The following testing in GSM is set based on the maximum RF Output Power.
Test modes are chosen to be reported as the worst case configuration below:

	Test items	Modes/Modulation
		GSM 850
Conducted Test cases	RF power output	GSM/GPRS
	Occupied Bandwidth	GSM/GPRS
	Band Edge Compliance	GSM/GPRS
	Frequency Stability	GSM/GPRS
	Spurious Emissions at Antenna Terminals	GSM
Radiated Test cases	Effective Radiated Power	GSM/GPRS
	Radiates Spurious Emission	GSM

5. Test Case Results

5.1. RF Power Output

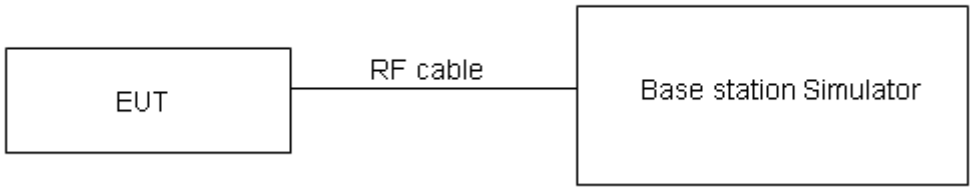
Ambient condition

Temperature	Relative humidity
21°C ~25°C	40%~60%

Methods of Measurement

During the process of the testing, The EUT is controlled by the Base Station Simulator to ensure max power transmission and proper modulation.

Test Setup



The loss between RF output port of the EUT and the input port of the tester has been taken into consideration.

Limits

No specific RF power output requirements in part 2.1046.

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 0.4 dB.

Test Results

GSM 850		Conducted Power(dBm)		
		Channel 128	Channel 190	Channel 251
		824.2 (MHz)	836.6 (MHz)	848.8 (MHz)
GSM	Results	**33.26**	**33.27**	**33.25**
GPRS (GMSK)	1TXslot	**33.19**	**33.19**	**33.20**
	2TXslots	32.36	32.33	32.35
	3TXslots	30.41	30.40	30.41
	4TXslots	29.39	29.34	29.31
Note: 1) The maximum RF Output Power numbers are marks in bold. 2) The following testing in GPRS is set to 1TXslot based on the maximum RF Output Power.				

5.2. Effective Radiated Power

Ambient condition

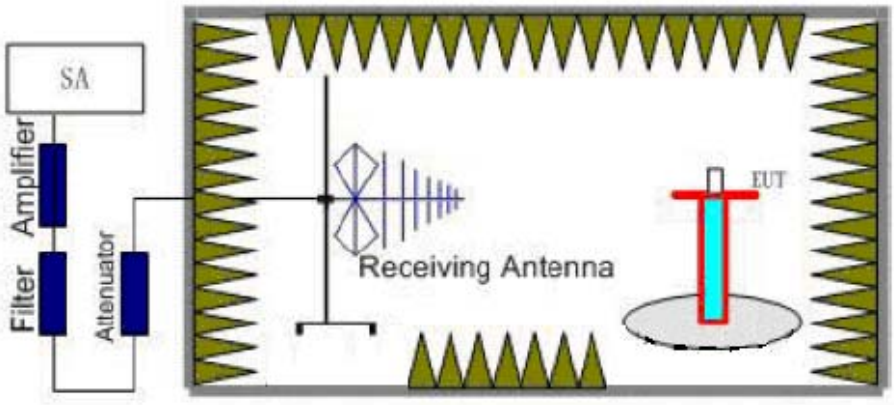
Temperature	Relative humidity
21°C ~25°C	40%~60%

Methods of Measurement

The measurement procedures in TIA- 603-D are used.
1. The EUT was placed on a turntable with 1.5 meter height in a fully anechoic chamber.
2. The EUT was set at 3 meters from the receiving antenna, which was mounted on the antenna tower.
3. GSM operating modes: Set RBW= 1MHz, VBW= 3MHz, RMS detector over burst;
UMTS operating modes: Set RBW= 100 KHz, VBW= 300 KHz, RMS detector over frame, and use channel power option with bandwidth=5MHz, per section 4.0 of KDB 971168 D01.
4. The table was rotated 360 degrees to determine the position of the highest radiated power.
5. The height of the receiving antenna is adjusted to look for the maximum ERP/EIRP.
6. Taking the record of maximum ERP/EIRP.
7. A dipole antenna was substituted in place of the EUT and was driven by a signal generator.
8. The conducted power at the terminal of the dipole antenna is measured.
9. Repeat step 3 to step 5 to get the maximum ERP/EIRP of the substitution antenna.
10. ERP/EIRP = Ps + Et – Es + Gs = Ps + Rt – Rs + Gs
Ps (dBm)：Input power to substitution antenna.
Gs (dBi or dBd)：Substitution antenna Gain.
Et = Rt + AF
Es = Rs + AF
AF (dB/m)：Receive antenna factor
Rt：The highest received signal in spectrum analyzer for EUT.
Rs：The highest received signal in spectrum analyzer for substitution antenna.

EIRP= E.R.P+2.15

Test Setup



Limits

Rule Part 22.913(a) specifies that "Mobile/portable stations are limited to 7 watts ERP".

Limit	≤ 7 W (38.45 dBm)

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 1.19 dB

Test Results:

Mode	Polarization	Frequency (MHz)	Rt (dBm)	Rs (dBm)	Ps (dBm)	Gs (dBd)	ERP (dBm)	Limit (dBm)	Conclusion
GSM 850	H	824.2	-14.55	-45.53	0.00	1.06	32.04	38.45	Pass
	H	836.6	-15.46	-45.38	0.00	1.24	31.16	38.45	Pass
	H	848.8	-17.52	-45.37	0.00	1.38	29.23	38.45	Pass
	V	824.2	-21.89	-45.65	0.00	1.06	24.82	38.45	Pass
	V	836.6	-22.88	-45.46	0.00	1.24	23.82	38.45	Pass
	V	848.8	-24.13	-45.49	0.00	1.38	22.74	38.45	Pass
GPRS 850	H	824.2	-13.10	-45.53	0.00	1.06	33.49	38.45	Pass
	H	836.6	-14.03	-45.38	0.00	1.24	32.59	38.45	Pass
	H	848.8	-15.96	-45.37	0.00	1.38	30.79	38.45	Pass
	V	824.2	-20.35	-45.65	0.00	1.06	26.36	38.45	Pass
	V	836.6	-20.92	-45.46	0.00	1.24	25.78	38.45	Pass
	V	848.8	-21.96	-45.49	0.00	1.38	24.91	38.45	Pass

5.3. Occupied Bandwidth

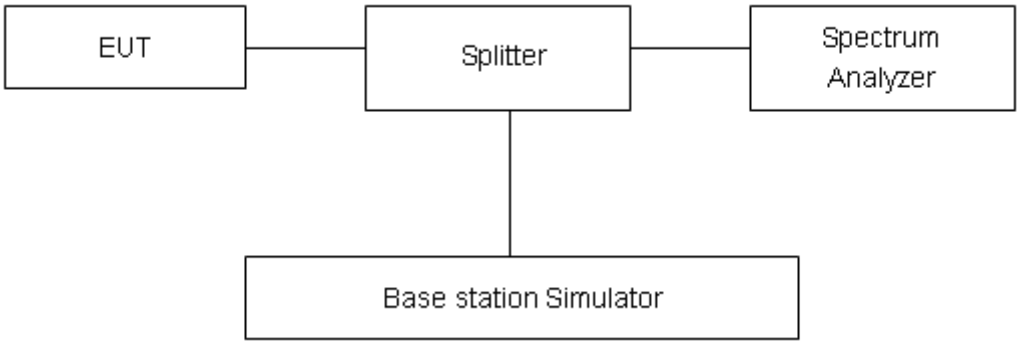
Ambient condition

Temperature	Relative humidity
21°C ~25°C	40%~60%

Method of Measurement

The EUT was connected to Spectrum Analyzer and Base Station Simulator via power Splitter. The occupied bandwidth is measured using spectrum analyzer.
RBW is set to 3kHz, VBW is set to 10kHz for GSM 850,
99% power and -26dBc occupied bandwidths are recorded. Spectrum analyzer plots are included on the following pages.

Test Setup



Limits

No specific occupied bandwidth requirements in part 2.1049.

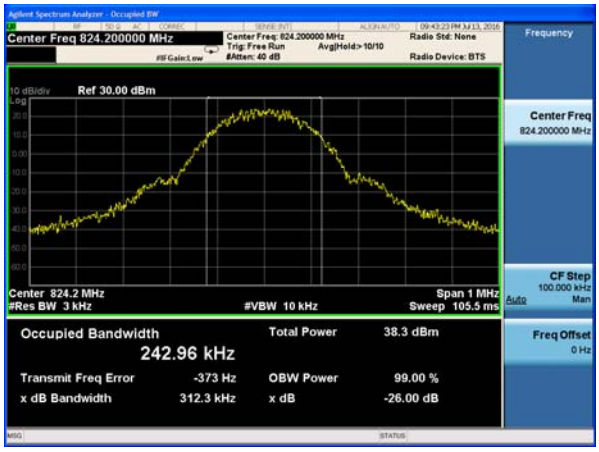
Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 624Hz.

Test Result

Mode	Channel	Frequency (MHz)	99% Power Bandwidth (kHz)	-26dBc Bandwidth(kHz)
GSM 850 (GSM)	128	824.2	242.96	312.3
	190	836.6	244.05	312.7
	251	848.8	246.54	306.5
GPRS 850 (GMSK)	128	824.2	245.65	306.4
	190	836.6	243.01	313.2
	251	848.8	245.47	312.9

GSM 850 CH-Low



GSM 850 GPRS CH-Low

GSM 850 CH-Middle

GSM 850 GPRS CH-Middle

GSM 850 CH-High

GSM 850 GPRS CH-High

5.4. Band Edge Compliance

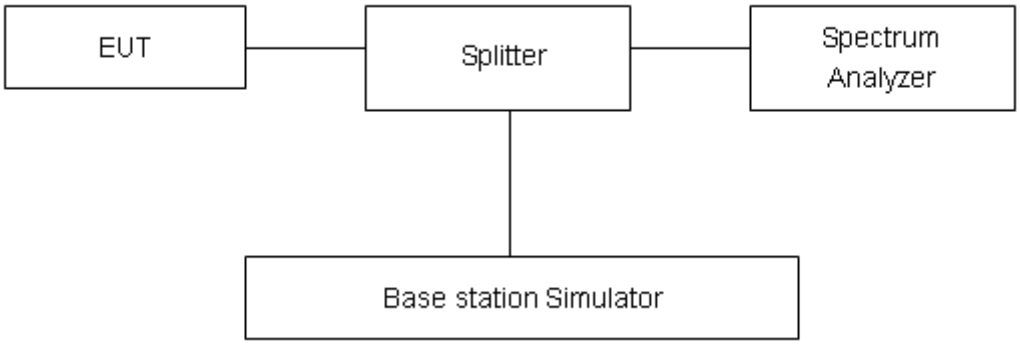
Ambient condition

Temperature	Relative humidity
21°C ~25°C	40%~60%

Method of Measurement

The EUT was connected to Spectrum Analyzer and Base Station Simulator via power Splitter. The band edge of the lowest and highest channels were measured. The average detector is used.
RBW is set to 3kHz,VBW is set to 10kHz for GSM 850,
Spectrum analyzer plots are included on the following pages.

Test Setup



Limits

Rule Part 22.917(a) specifies that “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.”

Limit	-13 dBm

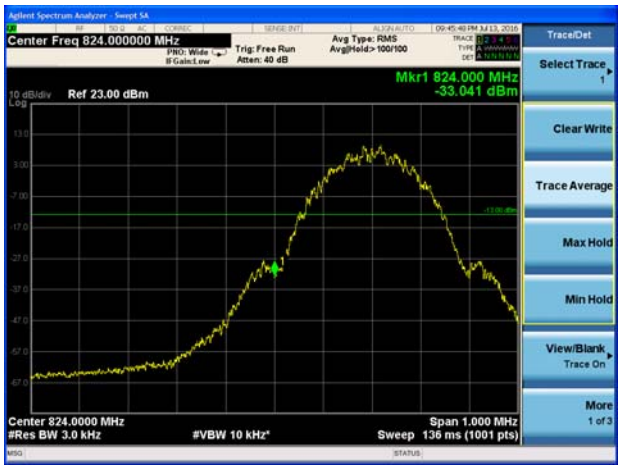
Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 1.96, U=0.684dB.

Test Result:

Mode	Carrier frequency (MHz)	Reference value (dBm)	Limit (dBm)	Conclusion
GSM 850 (GSM)	824.0	-33.041	-13	PASS
	849.0	-30.456	-13	PASS
GPRS 850 (GMSK)	824.0	-29.660	-13	PASS
	849.0	-26.834	-13	PASS

GSM 850 CH-Low



GSM 850 CH-High

GSM 850 GPRS CH-Low

GSM 850 GPRS CH-High

5.5. Frequency Stability

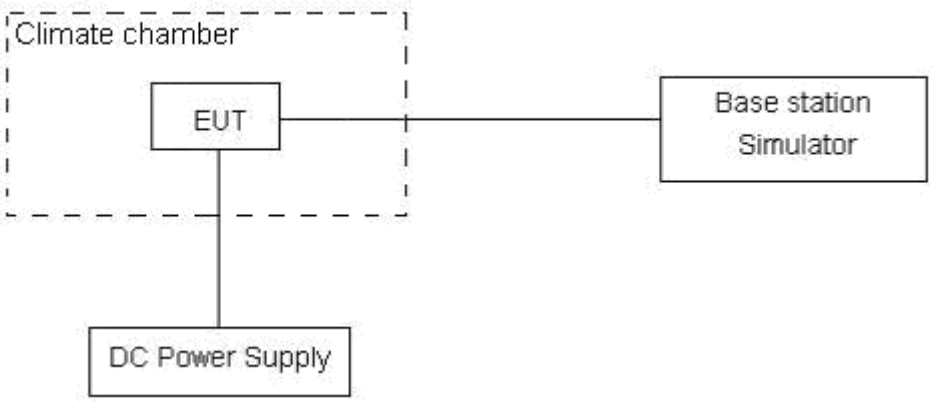
Ambient condition

Temperature	Relative humidity
21°C ~25°C	40%~60%

Method of Measurement

1. Frequency Stability (Temperature Variation)
   The temperature inside the climate chamber is varied from -30°C to +50°C in 10°C step size,
   (1) With all power removed, the temperature was decreased to 0°C and permitted to stabilize for three hours.
   (2) Measure the carrier frequency with the test equipment in a “call mode”. These measurements should be made within 1 minute of powering up the mobile station, to prevent significant self warming.
   (3) Repeat the above measurements at 10°C increments from -30°C to +50°C. Allow at least 1.5 hours at each temperature, un-powered, before making measurements.
2. Frequency Stability (Voltage Variation)
   The frequency stability shall be measured with variation of primary supply voltage as follows:
   (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
   (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery-operating end point which shall be specified by the manufacturer.
   This transceiver is specified to operate with an input voltage of between 3.4 V and 4V, with a nominal voltage of 4.2V.

Test setup



Limits

According to the Sec. 22.355, the frequency stability of the carrier shall be accurate to within 2.5 ppm of the received frequency for mobile stations.

Limits	≤ 2.5 ppm

Measurement Uncertainty

The assessed measurement uncertainty to ensure 99.75% confidence level for the normal distribution is with the coverage factor k = 3, U= 0.01ppm.

Test Result

Mode	Test status	Test Results (ppm)		Limit (ppm)	Conclusion
		GSM (GMSK)	GPRS (GMSK)		
GSM 850 Channel 190	-30°C/4 V	-0.0222	-0.0246	2.5	PASS
	-20°C/4 V	-0.0356	-0.0140	2.5	PASS
	-10°C/4 V	-0.0227	-0.0202	2.5	PASS
	0°C/4 V	-0.0356	-0.0265	2.5	PASS
	10°C/4 V	-0.0210	-0.0179	2.5	PASS
	20°C/4 V	-0.0400	-0.0426	2.5	PASS
	30°C/4 V	-0.0236	-0.0222	2.5	PASS
	40°C/4 V	-0.0311	-0.0165	2.5	PASS
	50°C/4 V	-0.0264	-0.0357	2.5	PASS
	20°C/3.4 V	-0.0222	-0.0246	2.5	PASS
	20°C/4.2 V	-0.0356	-0.0140	2.5	PASS

5.6. Spurious Emissions at Antenna Terminals

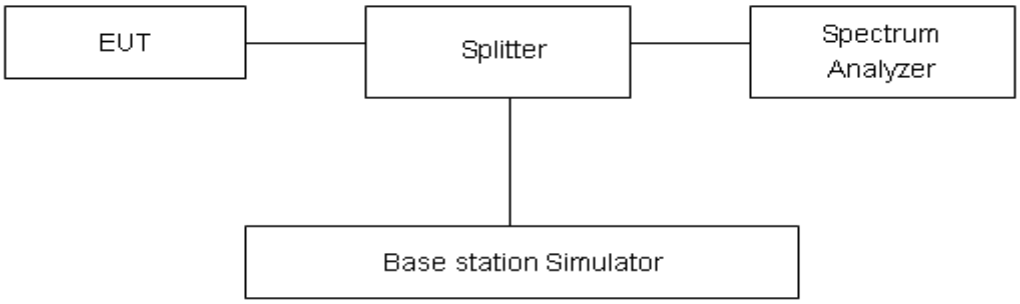
Ambient condition

Temperature	Relative humidity
21°C ~25°C	40%~60%

Method of Measurement

The EUT was connected to Spectrum Analyzer and Base Station Simulator via power Splitter. The measurement is carried out using a spectrum analyzer. The spectrum analyzer scans from 30MHz to the 10th harmonic of the carrier. The peak detector is used. RBW and VBW are set to 100 kHz, Sweep is set to ATUO.

Test setup



Limits

Rule Part 22.917(a) specifies that “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.”

Limit	-13 dBm

Measurement Uncertainty

The assessed measurement uncertainty to ensure 99.75% confidence level for the normal distribution is with the coverage factor k = 1.96.

Frequency	Uncertainty
100kHz-2GHz	0.684 dB
2GHz-12.75GHz	1.407 dB

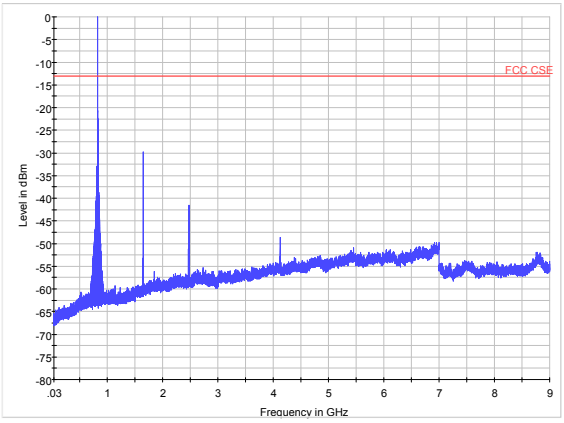
Test Result

Sweep from 9 kHz to 30MHz, and the emissions more than 20 dB below the permissible value are not reported.

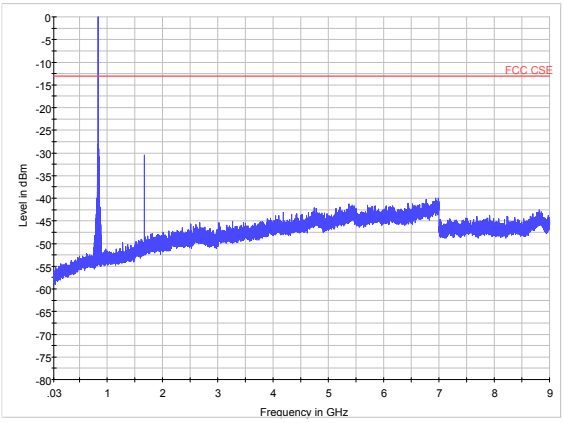
If disturbances were found more than 20dB below limit line, the mark is not required for the EUT. The signal beyond the limit is carrier.

Mode	Frequency (MHz)	Peak (dBm)	Limit (dBm)	Margin (dB)
GSM850_CH128_0.03-9GHz	1648.5	-29.8	-13.0	16.8
GSM850_CH190_0.03-9GHz	1673.1	-30.5	-13.0	17.5

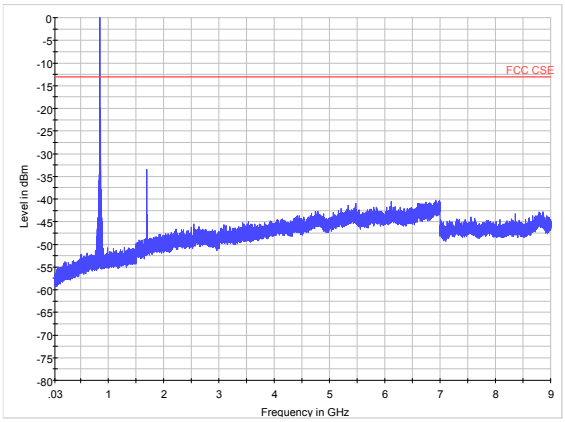
GSM 850 CH-Low 30MHz~9GHz



GSM 850 CH-Middle 30MHz~9GHz



GSM 850 CH-High 30MHz~9GHz



5.7. Radiated Spurious Emission

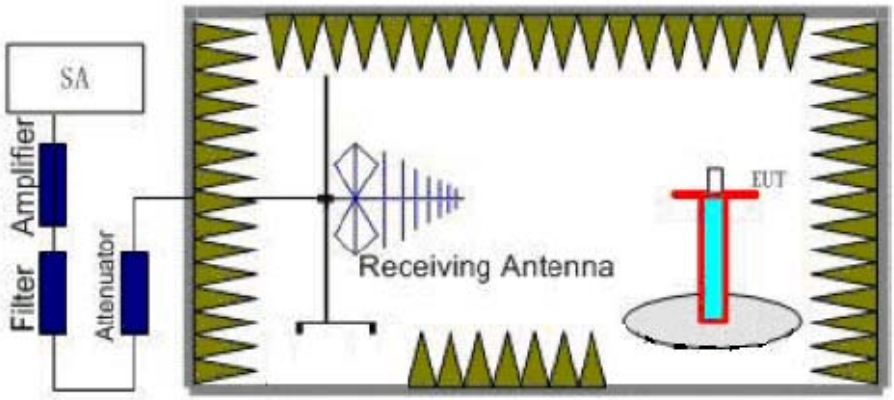
Ambient condition

Temperature	Relative humidity
21°C ~25°C	40%~60%

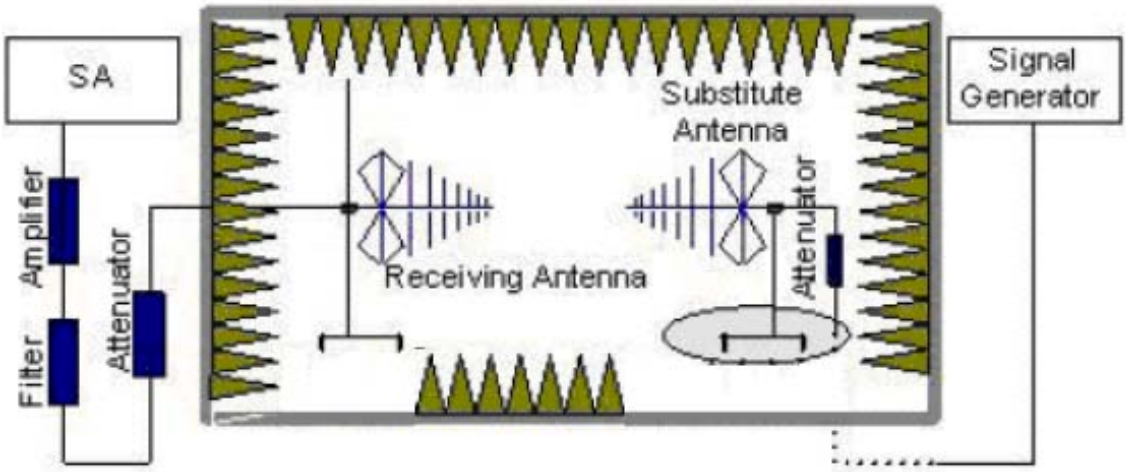
Method of Measurement

The measurements procedures in TIA -603-D are used.
The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment.
The emissions less than 20 dB below the permissible value are reported.

The procedure of Radiated Spurious Emission is as follows:
Step 1:
The measurement is carried out in the semi-anechoic chamber. EUT was placed on a 1.5 meters high non-conductive table at a 3 meters test distance from the test receive antenna. A receiving antenna was placed on the antenna mast 3 meters from the EUT. A radio link shall be established between EUT and Tester. The output power of the cell signal of the tester will be decreased until the output power of the EUT reach a maximum value. A peak detector is used while RBW and VBW are both set to 100kHz. During the measurement, the highest emission was recorded from analyzer power level (LVL) from the 360 degrees rotation of the turntable and the test antenna moved up and down over a range from 1 to 4 meters in both horizontally and vertically polarized orientations. The test setup refers to figure below.



Step 2:
A dipole antenna shall be substituted in place of the EUT. The antenna will be driven by a signal generator with a adjustable S.G. applied through a Tx cable. Adjust the level of the signal generator output until the value of the receiver reach the previously recorded analyzer power level (LVL).Then The E.R.P. /E.I.R.P. of the EUT can be calculated through the level of the signal generator, Tx cable loss and the gain of the substitution antenna. The test setup refers to figure below.



E.R.P (peak power) =S.G. - Tx Cable loss + Substitution antenna gain – 2.15.
EIRP= E.R.P+2.15

Limits

Rule Part 22.917(a) specifies that “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.”

Limit	-13 dBm

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95％ confidence level for the normal distribution is with the coverage factor *k* = 1.96, *U*= 3.55 dB.

Test Result

Receiver antenna polarization (horizontal and vertical), the worst emission was found in vertical polarization，and the worst case in vertical polarization was recorded.

GSM 850 CH-Low

Harmonic	Frequency (MHz)	SG (dBm)	Cable Loss (dB)	Gain (dBi)	Antenna Polarization	ERP Level (dBm)	Limit (dBm)	Margin (dB)	Azimuth (deg)
2	1648	-50.75	2	10.15	Vertical	-42.6	-13.00	29.6	225
3	2473	-35.14	2.51	11.35	Vertical	-26.3	-13.00	13.3	135
4	3297	-58.55	4.2	10.85	Vertical	-51.9	-13.00	38.9	270
5	4121	-51.55	5.2	11.35	Vertical	-45.4	-13.00	32.4	180
6	4945	-56.05	5.5	11.95	Vertical	-49.6	-13.00	36.6	90
7	5769	-62.85	5.7	13.55	Vertical	-55.0	-13.00	42.0	45
8	6594	-60.45	6.3	13.75	Vertical	-53.0	-13.00	40.0	180
9	7418	-60.35	6.8	13.85	Vertical	-53.3	-13.00	40.3	135
10	8242	-60.15	6.9	14.25	Vertical	-52.8	-13.00	39.8	225

Note: 1.The other Spurious RF Radiated emissions level is no more than noise floor.

GSM 850 CH-Middle

Harmonic	Frequency (MHz)	SG (dBm)	Cable Loss (dB)	Gain (dBi)	Antenna Polarization	ERP Level (dBm)	Limit (dBm)	Margin (dB)	Azimuth (deg)
2	1673	-48.85	2	10.75	Vertical	-40.1	-13.00	27.1	45
3	2498	-48.04	2.51	11.05	Vertical	-39.5	-13.00	26.5	135
4	3346	-57.35	4.2	11.15	Vertical	-50.4	-13.00	37.4	180
5	4183	-50.45	5.2	11.15	Vertical	-44.5	-13.00	31.5	90
6	5020	-55.15	5.5	11.95	Vertical	-48.7	-13.00	35.7	45
7	5856	-57.45	5.7	13.55	Vertical	-49.6	-13.00	36.6	180
8	6693	-60.65	6.3	13.75	Vertical	-53.2	-13.00	40.2	135
9	7529	-59.55	6.8	13.85	Vertical	-52.5	-13.00	39.5	225
10	8366	-59.75	6.9	14.25	Vertical	-52.4	-13.00	39.4	315

Note: 1.The other Spurious RF Radiated emissions level is no more than noise floor.

GSM 850 CH-High

Harmonic	Frequency (MHz)	SG (dBm)	Cable Loss (dB)	Gain (dBi)	Antenna Polarization	ERP Level (dBm)	Limit (dBm)	Margin (dB)	Azimuth (deg)
2	1698	-49.05	2	10.15	Vertical	-40.9	-13.00	27.9	180
3	2546	-47.94	2.51	11.05	Vertical	-39.4	-13.00	26.4	135
4	3395	-58.65	4.2	11.15	Vertical	-51.7	-13.00	38.7	225
5	4244	-48.75	5.2	11.15	Vertical	-42.8	-13.00	29.8	45
6	5093	-56.55	5.5	11.95	Vertical	-50.1	-13.00	37.1	135
7	5942	-61.55	5.7	13.55	Vertical	-53.7	-13.00	40.7	180
8	6790	-60.05	6.3	13.75	Vertical	-52.6	-13.00	39.6	90
9	7639	-59.55	6.8	13.85	Vertical	-52.5	-13.00	39.5	45
10	8488	-59.35	6.9	14.25	Vertical	-52.0	-13.00	39.0	180

Note: 1.The other Spurious RF Radiated emissions level is no more than noise floor.

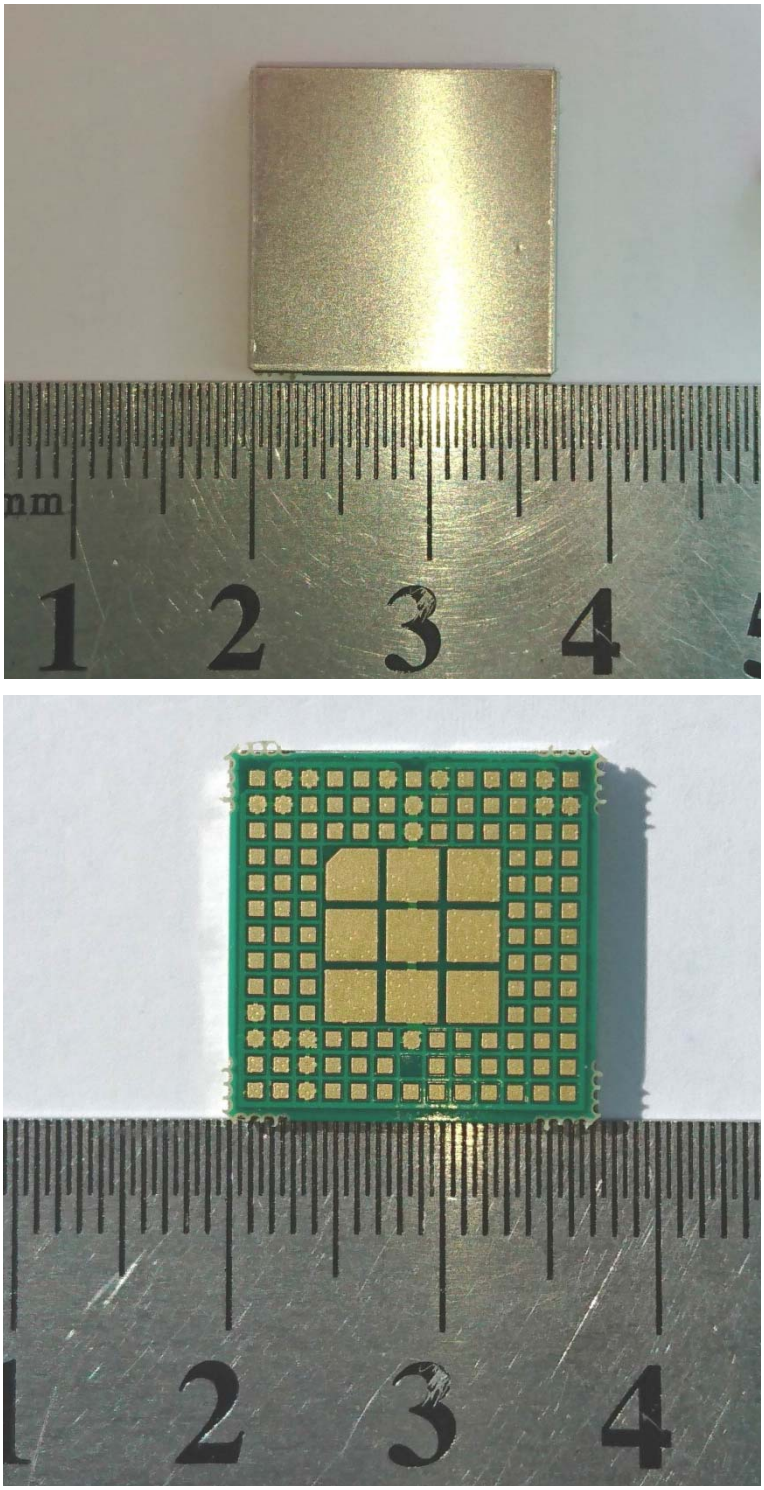
6. Main Test Instruments

Name	Type	Manufacturer	Serial Number	Calibration Date	Expiration Time
Base Station Simulator	CMW500	R&S	113645	2016-05-21	2017-05-20
Power Splitter	SHX-GF2-2-13	Hua Xiang	10120101	NA	NA
Spectrum Analyzer	N9010A	Agilent	MY47191109	2016-05-21	2017-05-20
Universal Radio Communication Tester	E5515C	Agilent	MY48367192	2016-05-21	2017-05-20
Signal Analyzer	FSV30	R&S	100815	2015-12-17	2016-12-16
Signal generator	SMB 100A	R&S	102594	2016-05-22	2017-05-21
Signal generator	SMR27	R&S	100365	2016-05-22	2017-05-21
EMI Test Receiver	ESCI	R&S	100948	2016-06-01	2017-05-31
Trilog Antenna	VUBL 9163	SCHWARZBECK	9163-201	2014-12-06	2017-12-05
Trilog Antenna	VUBL 9163	SCHWARZBECK	9163-391	2014-12-06	2017-12-05
Horn Antenna	HF907	R&S	100126	2014-12-06	2017-12-05
Horn Antenna	HF907	R&S	100125	2014-12-06	2017-12-05
Climatic Chamber	PT-30B	Re Ce	20101891	2015-07-18	2018-07-17
RF Cable	SMA 15cm	Agilent	0001	2016-06-06	2016-09-05

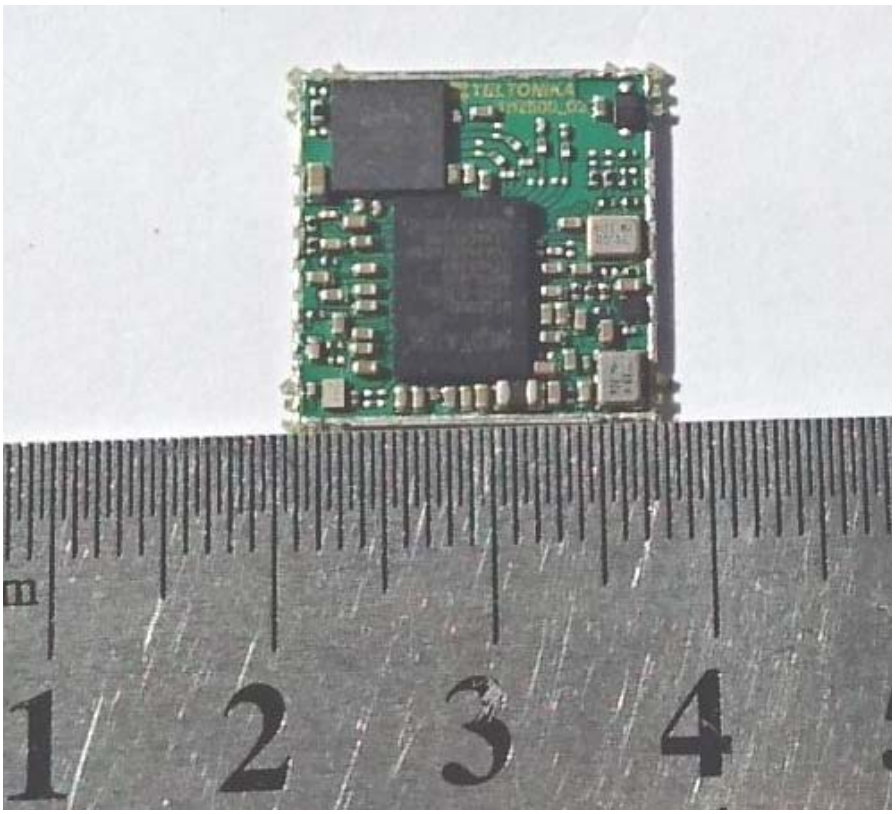
*******END OF REPORT *******

ANNEX A: EUT Appearance and Test Setup

A.1 EUT Appearance



Front Side

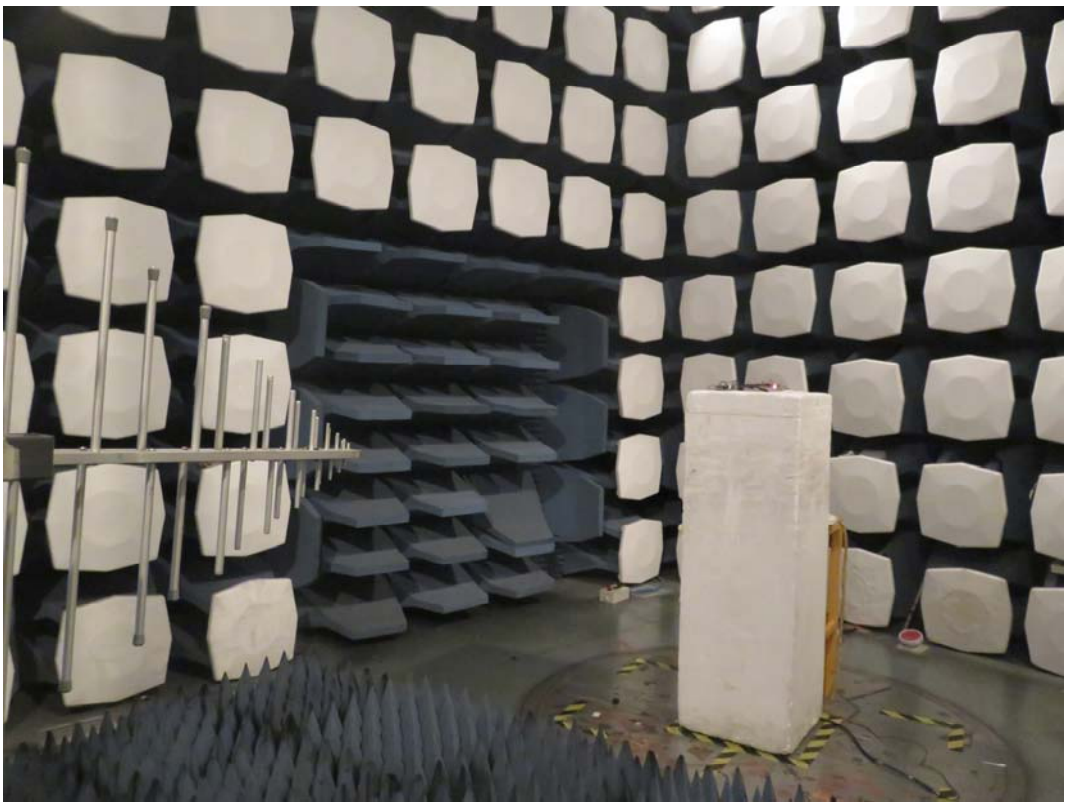


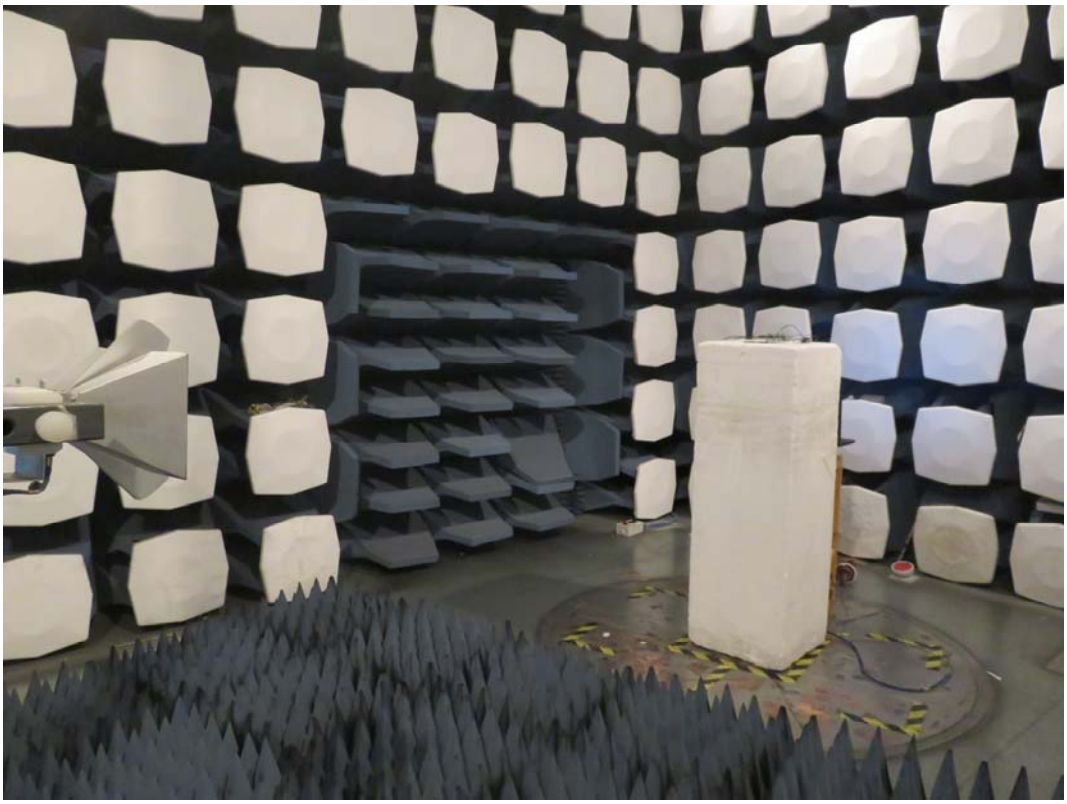
Back Side

a: EUT

Picture 1 EUT and Auxiliary

A.2 Test Setup





Picture 2: Radiated Spurious Emissions Test setup