RF TEST REPORT

TEST STANDARD(S)	:	ETSI EN 301 908-1 V15.1.1 (2021-09) ETSI EN 301 908-13 V13.2.1 (2022-02)
CLIENT / APPLICANT	:	Robert Bosch (Pty) Ltd.
CLIENT ADDRESS	:	33 Piet Rautenbach, Industrial Site, Brits, 0250
TEST SAMPLE (EUT)	:	Tracking Device
MODEL NUMBER	:	MK2
UNTESTED VARIANT(s)	:	None
REPORT TYPE	:	Delta NBioT Test Report
REPORT NUMBER	:	TRR02193-4-23
ASSESSMENT RESULT	:	Pass
DATE ISSUED	:	28/11/2023
REVISION	:	1.0

iSERT (Pty) Ltd. Test reports apply only to the specific sample(s) tested under stated conditions. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to ensure that additional production units of this model are manufactured with identical electrical and mechanical components. iSERT (Pty) Ltd. shall have no liability for any deductions, inference or generalizations drawn by the client or others from the test reports issued by iSERT (Pty) Ltd. This report shall not be used to claim, constitute, or imply a product endorsement from iSERT (Pty) Ltd.

This test report was prepared by: ***Name:*** *HE Olivier*
Title: *RF Test Engineer*

This test report was approved by: ***Name:*** *RM van den Berg*
Title: *Technical Signatory (RF)*

T0812

This test report is issued in accordance with SANAS accreditation requirements. SANAS is a signatory to the ILAC Mutual Recognition arrangement for the mutual recognition of the equivalence of testing and calibration reports.

DOCUMENT CONTROL

Revision	Date	Author	Pages affected	Change proposal
1.0	28/11/2023	HE Olivier	All	N/A

TEST LABORATORY INFORMATION

Established in 2017, iSERT (Pty) Ltd. Provides EMC, RF, Safety & Performance testing services by our skilled Engineers. Our services employ a wide variety of advanced cutting-edge test equipment with one of the widest ranges of accredited standards in the country.

The site and apparatus are constructed in conformance with the requirements of CISPR 16-1-4, EN 50147-1 and other equivalent standards. The laboratory is compliant with the requirements of ISO/IEC 17025.

It is our definite objective to institute long-term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise, and devotion to a certified value structure. Our passion is to grant our clients with the best EMC, RF, Safety & Performance services by knowledgeable and accommodating staff.

Our test site is located at 129 Khai-Appel Street, Montana, Pretoria, South Africa 0186.

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ACRONYMS AND ABBREVIATIONS

AVE	Average
ARFCN	Absolute Radio Frequency Channel Number
C	Circular
CSE	Conducted Spurious Emissions
CSIR	Council for Scientific and Industrial Research
DCS	Digital Cellular System
E-Fields	Electric Fields
EIRP	Effective isotropic radiated power
ERP	Effective radiated power
EFT	Electrical Fast Transients
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
EUT	Equipment Under Test
FW	Firmware
GPRS	General packet radio service
GSM	Global System for Mobile Communications
HW	Hardware
MS	Mobile Station
NIST	National Institute of Science and Technology
N/A	Not Applicable
OATS	Open Area Test Site
PC	Personal Computer
PK	Peak
Pol	Polarized
QP	Quasi-Peak
RSE	Radiated Spurious Emissions
RED	Radio Equipment Directive
RCSE	Receiver Conducted Spurious Emissions (idle mode)
RMS	Root Mean Square
RRSE	Receiver Radiated Spurious Emissions (idle mode)
RSE	Radiated Spurious Emissions
RF	Radio Frequency
R&TTE	Radio and telecommunications terminal equipment
SANAS	South African National Accreditation System
SRD	Short Range Equipment
TCSE	Transmitted conducted Spurious Emissions (allocated mode)
TRSE	Transmitted Radiated Spurious Emissions (allocated mode)
UE	User Equipment
VH	Voltage High (Maximum
VL	Voltage Low (minimum)
VN	Voltage Normal
TH	Temperature High (maximum)
TN	Temperature Normal
TL	Temperature Low (Minimum)

TABLE OF CONTENTS

1. INTRODUCTION

This report details the results of the tests performed on the MPI Holdings Tracking Device with model number: MK2. The testing was carried out by HE Olivier on 17/10/2023.

The EUT was tested according to the following standards and methods:

- ETSI EN 301 908-1 V15.1.1: “IMT Cellular Networks; Harmonized Standard for Access to Radio Spectrum; Part 1: Introduction and Common Requirements - Release 15”
- ETSI EN 301 908-13 V13.2.1: “IMT cellular networks; Harmonized Standard for Access to Radio Spectrum; Part 13: Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE)”

2. SUMMARY OF TEST RESULTS

The module was fully tested according to the essential requirements of article 3.2 of Directive 2014/53/EU, see Appendix A.

For the EUT to fulfil the essential requirements of article 3.2 of Directive 2014/53/EU, delta tests were performed to ensure the EUT complies after integration.

Table 1: Summary of Test Results

ETSI EN 301 908-1 V15.1.1			
Parameter to be Tested	**Requirement**	**Method**	**Result**
Radiated Emissions (UE)	4.2.2	5.3.1.1	✓
Control and Monitoring (UE)	4.2.4	5.3.3.1	✓
ETSI EN 301 908-13 V13.2.1			
Parameter to be Tested	**Requirement**	**Method**	**Result**
Transmitter Maximum Output Power (1)	4.2.2	5.3.1	✓
Transmitter Spectrum Emission Mask	4.2.3	5.3.2	✓
Transmitter Spurious Emissions	4.2.4	5.3.3	✓
Transmitter Minimum Output Power	4.2.5	5.3.4	✓
Receiver Adjacent Channel Selectivity	4.2.6	5.3.5	✓
Receiver Blocking Characteristics	4.2.7	5.3.6	✓
Receiver Spurious Response	4.2.8	5.3.7	✓
Receiver Intermodulation Characteristics	4.2.9	5.3.8	✓
Receiver Spurious Emissions	4.2.10	5.3.9	✓
Transmitter Adjacent Channel Leakage Power Ratio	4.2.11	5.3.10	✓
Receiver Reference Sensitivity Level	4.2.12	5.3.11	✓
Receiver Total Radiated Sensitivity (2)	4.2.13	5.3.12	N/A
Total Radiated Power (2)	4.2.14	5.3.13	N/A

Notes:

1. *Effective Radiated Power for RF exposure calculations.*
2. *Only applies to handheld phones/DUTs that are wider than or equal to 56 mm and narrower than or equal to 72 mm.*

Test Case Verdicts:

N/A	Test case does not apply to EUT.
N/T	Test case was not performed on EUT.
✓	Test case passed the minimum conformance requirements.
✓	Test case passed the minimum conformance requirements as a certified module, assessed by an ISO 17025 accredited laboratory, refer to the test report Appendix A.
✓	Test case passed the minimum conformance requirements with a margin less than the uncertainty budget.
✗	Test case failed the minimum conformance requirements.

3. CONCLUSION

Based on the results of our investigation, it is concluded that the EUT (in the configuration tested) **complies** with the requirements of the standard(s) indicated in this test report. The results obtained in this test report are only valid for the item(s) tested. iSERT (Pty) Ltd. does not make any claims of compliance for samples or variants which were not tested.

In cases where levels measured are within the laboratory's stated uncertainty budget, there is a possibility that this unit, or a similar unit selected from production may not meet the required limit specification should it be tested by another agency.

4. EQUIPMENT DESCRIPTION

Table 2: Equipment Under Test Description

Description	Customer Declaration	
Type Of Equipment	Stand-alone radio equipment	
Intended Use	Portable Outdoor	
Operational Frequency Band (s)	B3 / B8	
Radio Modular Detail	Quectel BG600L-M3	
Maximum Transmitter Power	20 dBm (class 5)	
Channel Bandwidth	180 kHz	
Sub-carrier spacing	3.75 kHz, 15 kHz	
Modulation	BPSK, QPSK	
Data Rate:	Uplink	150 kbps
	Downlink	136 kbps
Category	NB1	
Other Radio Technologies	868 MHz Sigfox, 868 MHz LoRaWAN, 2G	
Antenna Details	Location	Internal
	Type	Cellular Flex Antenna
	Make/Model	Antenova FlexiiANT – Armata SRFC011
	Gain	2.46 dBi
Power Source	Internal	Lithium-Ion Polymer Battery
	External	--
Build Status	Production	
Build Revision	Hardware	V1.04
	Software	Not Provided

5. MEASURING EQUIPMENT SETUP AND CONFIGURATION

5.1. MEASUREMENT EQUIPMENT

Table 3: Calibration Information of Measurement Equipment

Instrument	Manufacturer	Model	Serial number	Next Cal date
Signal Analyzer	Keysight	N9020A	MY52330018	June 2024
Base Station	Amarisoft	XH110G	XH110G021I05F 00376	Verify before use
Horn antenna	AH systems	SAS-571	1129	February 2028
Combilog antenna	ETS Lingren	3142B	2613	June 2027
Pre-Amplifier	Adv Microwave	WLA652B	ISQ002	January 2024
High Pass Filter	Wainwright	WHKX12-1000	IS0002	November 2024
Coaxial Cable	Semflex	60637	X116BFSX10060	October 2024
Coaxial Cable	Mini-Circuits	CBL-0.5M-NMNM+	122547	November 2024
Multimeter	Fluke	179	40850243	November 2024
Laboratory Power Supply	Manson	HCS-3202	G071710100	Verify before use
Temperature Hygrometer	Flus	ET-951W	2015106449	November 2024
Environmental chamber	Jeiotech	PBV-012	1B097018	January 2024

5.2. MEASUREMENT UNCERTAINTY

ISO / IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions results be included in the test report. The uncertainties were calculated according to TF 100 028 [2] and are based on a 95.45% confidence level (coverage factor k = 2).

Table 4: Measurement Uncertainty

Parameter	Range	Test Uncertainty
Radio frequency	9kHz to 26.5GHz	±22.8Hz
Total RF power conducted	400MHz to 6GHz	±0.47dB
Effective radiated power	400MHz to 1GHz	±2.18dB
Equivalent Isotopically Radiated Power	1GHz to 3GHz	±3.42dB
RF emissions radiated	30MHz to 200MHz	±5.16dB
	200MHz to 1GHz	±4.44dB
	1GHz to 18GHz	±4.15dB
	18GHz to 26.5GHz	±4.34dB
RF emissions conducted	9kHz to 10MHz	±1.78dB
	10MHz to 1GHz	±1.56dB
	1GHz to 18GHz	±2.76dB
	18GHz to 26.5GHz	±2.83dB
Transmitter maximum output power	700MHz to 3GHz	±0.47dB
DC voltages	10mV to 600V	±0.7%
Temperature	-20°C to +85°C	±0.9°C
Humidity	10% to 75%	±5.0%

5.3. MEASUREMENT SETUP

5.3.1. RADIATED SETUP

All radiated measurements were performed inside a CISPR-16 compliant, fully anechoic shielded chamber, with an antenna-to-EUT distance of 3m, represented by Figures 1 and 2.

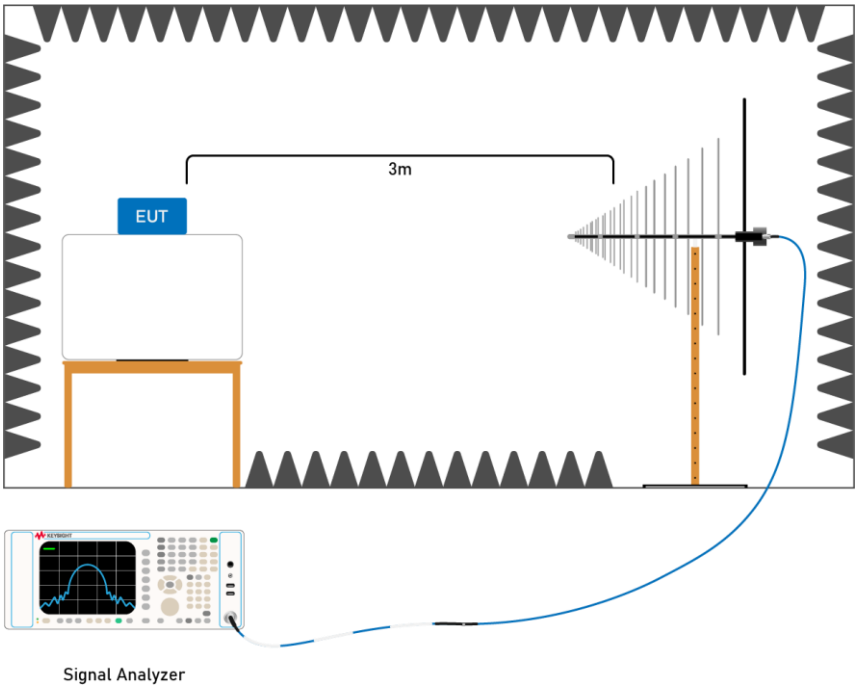


Figure 1: Radiated Emissions Setup Below 1 GHz

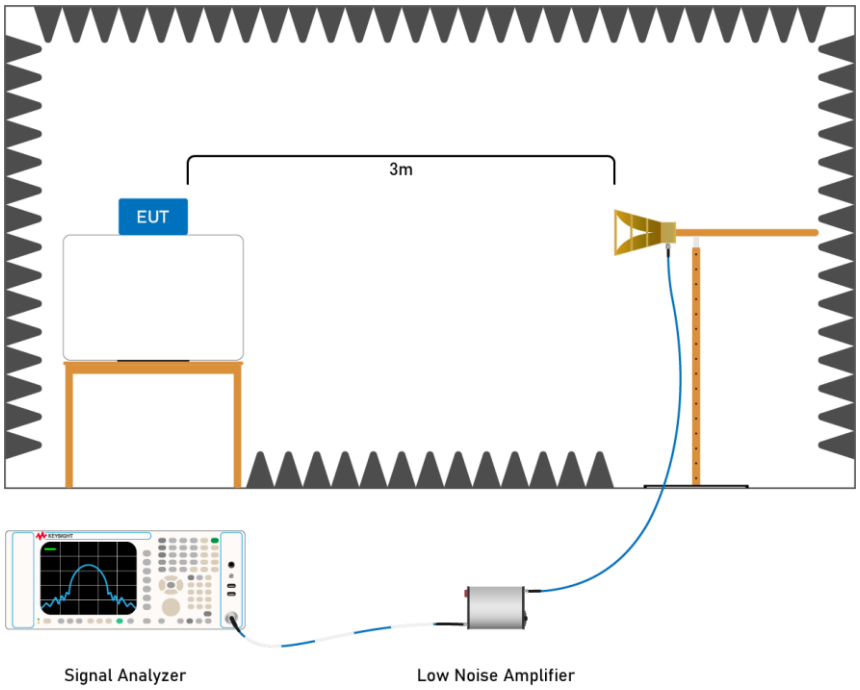


Figure 2: Radiated Emissions Setup Above 1 GHz

5.3.2. CONDUCTED SETUP

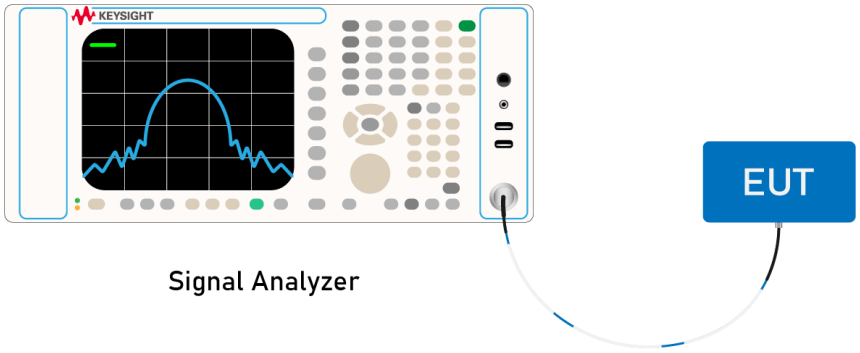


Figure 3: Conducted Setup

5.3.3. EXTREME CONDITIONS SETUP

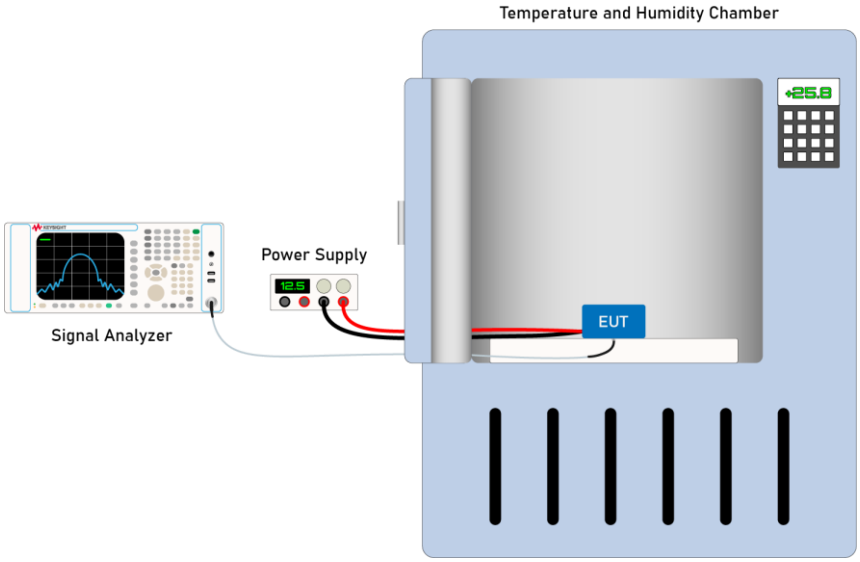


Figure 4: Extreme Conditions Setup

6. TEST SETUP AND CONFIGURATION

6.1. TEMPERATURE CONDITIONS

6.1.1. NORMAL

All measurements were taken under conditions of temperature and humidity that were within the limits specified in ETSI EN 301 908-13 V13.2.1 Table B.1.2-1.

Table 5: Environmental Conditions during Testing

Condition	Value	Limit
Temperature	+20°C to +22°C	+15°C to +35°C
Relative Humidity	38% to 42%	Up to 75%

6.1.2. EXTREME

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in ETSI EN 301 908-13 V13.2.1 Table B1.2-1, at the upper and lower temperature ranges given in the table below.

Table 6: Extreme Temperature Ranges

Description	Temperature Range
Small MS Units	-10°C to +55°C
Other Units	-20°C to +55°C

The RF module was already certified at extreme temperatures through an accredited test lab, therefore all tests in this report were conducted in normal temperature conditions.

6.2. POWER SUPPLY DETAILS

The equipment shall be tested using the appropriate test power source as specified ETSI EN 301 908-13 V13.2.1 Table B1.3-1.

The EUT was assessed at test voltages described in the table below as declared by the manufacturer.

Table 7: Equipment Under Test Extreme Voltages

Source Location	Source Type	Source Description	Power source range (V)		
			VL	VN	VH
Internal	DC	Lithium-Ion Polymer Battery	(1)	3.7	(1)
External	--	--	--	--	--

Notes:

1. *The RF module was already certified at extreme voltages through an accredited test lab, therefore all tests in this report were conducted in normal voltage conditions.*

6.3. SUPPORT EQUIPMENT AND SOFTWARE

6.3.1. SUPPORT EQUIPMENT

The support equipment below was used during this assessment:

Table 8: List of Support Equipment

Instrument	Manufacturer	Model	Serial number
Callbox	Amarisoft	Amari LTE callbox mini	XH110G0201ID05F00376

6.3.2. AUXILIARY EQUIPMENT

The EUT has been tested as an independent unit with Ancillary/auxiliary equipment. The following equipment/accessories were used to form a representative test configuration during this assessment:

Table 9: List of Auxiliary Equipment

Product Description	Manufacturer	Model Number	Serial number
--	--	--	--

6.3.3. INPUT/OUTPUT CABLES

Table 10: List of External Input and/or Output Cables

Cable Description	Length (m)	From Port	To
--	--	--	--

6.3.4. EXERCISE SOFTWARE

The EUT was programmed with production software for the test configuration.

6.4. MODIFICATION RECORD

No modification was made to the EUT during this assessment.

6.5. DEVIATIONS FROM THE TEST STANDARD

No deviations from the applicable test standards or test plan were made during this assessment.

6.6. OPERATING CHANNELS

Table 11: NBioT channel Information

Band	Name	Release	DL Frequency (MHz)			UL Frequency (MHz)			Tx Class	Power (dBm)
			L	M	H	L	M	H		
3	1800	Rel-14	1805	1842.5	1880	1710	1747.5	1785	5	20
8	900	Rel-14	925	942.5	960	880	897.5	915	5	20

6.7. TEST CONFIGURATION

Table 12: Equipment Under Test Configuration for NB-IoT Tests

Parameter to be tested	Test Channel	Power Source	Power Output	RF Port	Condition
Radiated Emissions (UE)	Middle	Internal	Max	Radiated	Normal
Control and Monitoring (UE)	Bottom / Middle / Top		--		
Transmitter Maximum Output Power	Middle		Max		

7. DETAILS OF TEST RESULTS

7.1. TRANSMITTER OUTPUT POWER

7.1.1. DESCRIPTION

According to ETSI EN 301 908-13 V13.2.1, the UE Power Classes define the maximum output power for any transmission bandwidth within the channel bandwidth.

For 3,75 kHz sub-carrier spacing, the maximum output power is defined as mean power of measurement which period is at least one slot (2 ms) excluding the 2 304Ts gap when UE is not transmitting. For 15 kHz sub-carrier spacing, the maximum output power is defined as mean power of measurement which period is at least one sub-frame (1 ms).

This test is normally done at the RF port but in this case the Effective Radiated Power is measured to determine antenna performance as well as to assist with Human exposure calculations when the product is operated at more than 20 cm from a human body.

7.1.2. LIMITS

Table 13: Transmitter Output Power Limits

EUTRA Band(s)	Mode of Operation	Power class	Maximum power (dBm)
All NB1 Bands	NB1	5	20

7.1.3. RESULTS

Table 14: Transmitted Radiated Output Power Results

Test Condition		EUTRA Band	ARFCN	Frequency (MHz)	Level Measured (dBm)	Limit (dBm)	Result
Temp (°C)	Voltage (V)						
TN	VN	B3	19575	1747.5	13.4	20	Pass
		B8	21625	897.5	7.6	20	Pass

7.2. RADIATED EMISSIONS (UE)

7.2.1. DESCRIPTION

According to ETSI EN 301 908-1 V15.1.1, this test assesses the ability of radio communications equipment and ancillary equipment to limit unwanted emissions from the enclosure port.

7.2.2. LIMITS

According to ETSI EN 301 908-13 V13.2.1, the radiated emissions from the UE's enclosure port shall not exceed the limits given in Table 15.

Table 15: Limits for Radiated Spurious Emissions – UE Allocated

Frequency Range	Power Level Limits	
	Traffic Mode (dBm)	Idle Mode (dBm)
30 MHz to 1 GHz	-36	-57
1 GHz to 12.75 GHz	-30	-47

7.2.3. RESULTS

Table 16: Results for Radiated Spurious Emissions – UE Allocated to Band 3

Frequency (MHz)	Level (dBm)	Receive Antenna Polarization	Receiver RBW (kHz)	Detector Used	Limit (dBm)	Margin (dB)	Test Result
2400	-55.2	H	1000	PK	-30	-25.2	Pass
2400	-54.3	V	1000	PK	-30	-24.3	Pass
2430	-53.9	V	1000	PK	-30	-23.9	Pass
2550	-57.0	H	1000	PK	-30	-27.0	Pass
2560	-54.9	V	1000	PK	-30	-24.9	Pass

Table 17: Results for Radiated Spurious Emissions – UE Allocated to Band 8

Frequency (MHz)	Level (dBm)	Receive Antenna Polarization	Receiver RBW (kHz)	Detector Used	Limit (dBm)	Margin (dB)	Test Result
1130	-62.0	V	1000	PK	-30	-32.0	Pass
1790	-50.2	H	1000	PK	-30	-20.2	Pass
1790	-47.6	V	1000	PK	-30	-17.6	Pass
2690	-55.6	H	1000	PK	-30	-25.6	Pass
2830	-54.2	V	1000	PK	-30	-24.2	Pass

Table 18: Results for Radiated Spurious Emissions – UE Idle

Frequency (MHz)	Level (dBm)	Receive Antenna Polarization	Receiver RBW (kHz)	Detector Used	Limit (dBm)	Margin (dB)	Test Result
30 – 1000	Noise Floor	H / V	100	PK	Table 15	--	Pass
1000 – 12750	Noise Floor	H / V	1000	PK		--	Pass

Notes:

*During this assessment, preliminary tests were performed in **Idle mode** in all the frequency bands covered in this test report. LTE Band 8 was selected as the worst-case condition and only the worst-case condition results were recorded in this test report.*

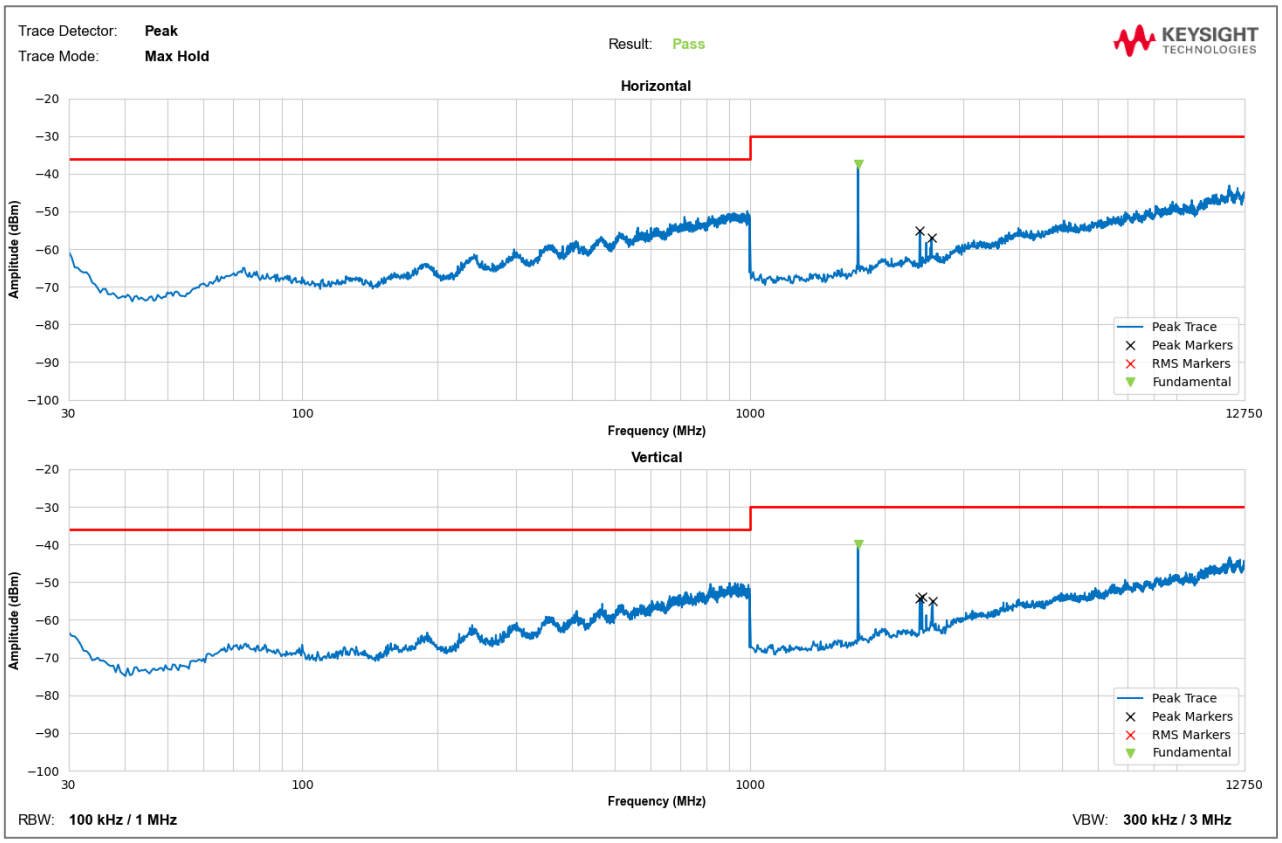


Figure 5: Results for Radiated Spurious Emissions – UE Allocated to Band 3

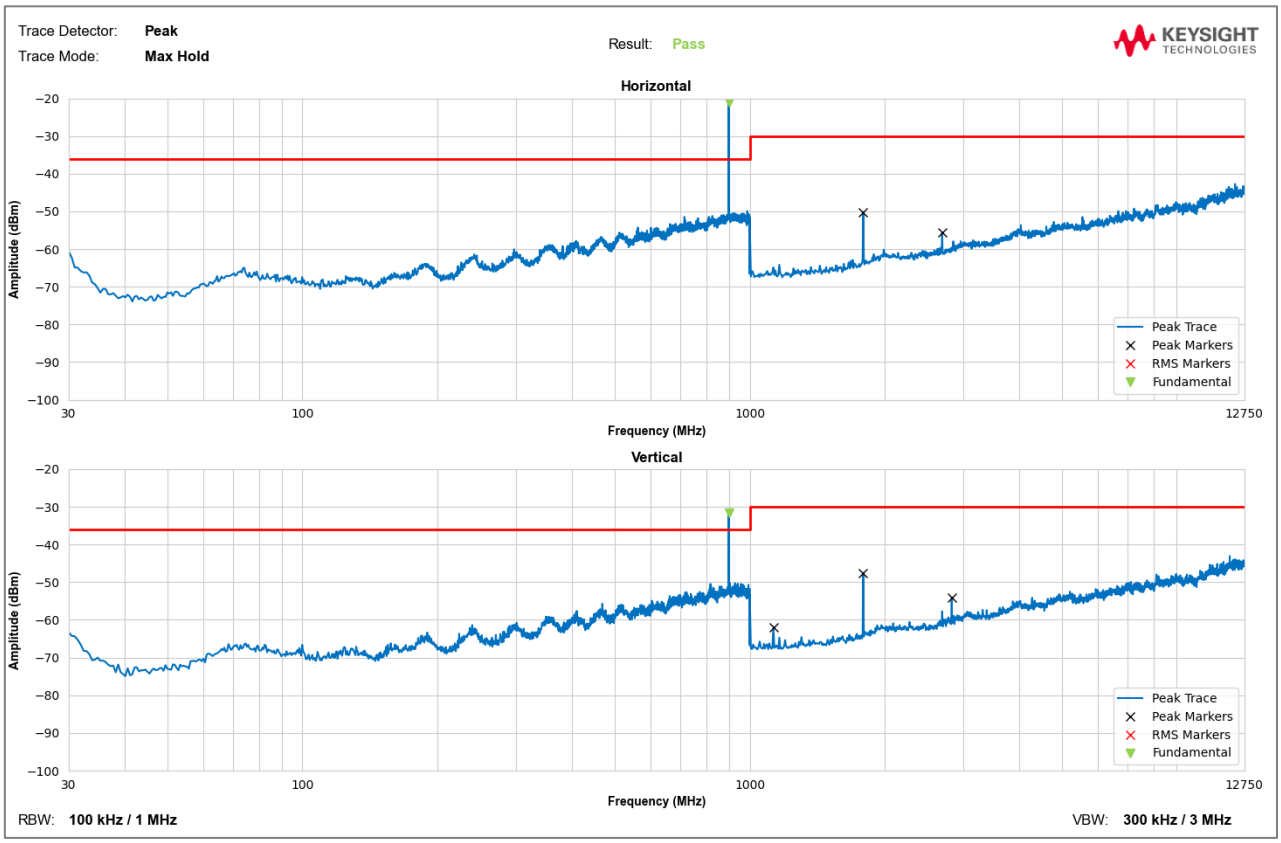


Figure 6: Results for Radiated Spurious Emissions – UE Allocated to Band 8

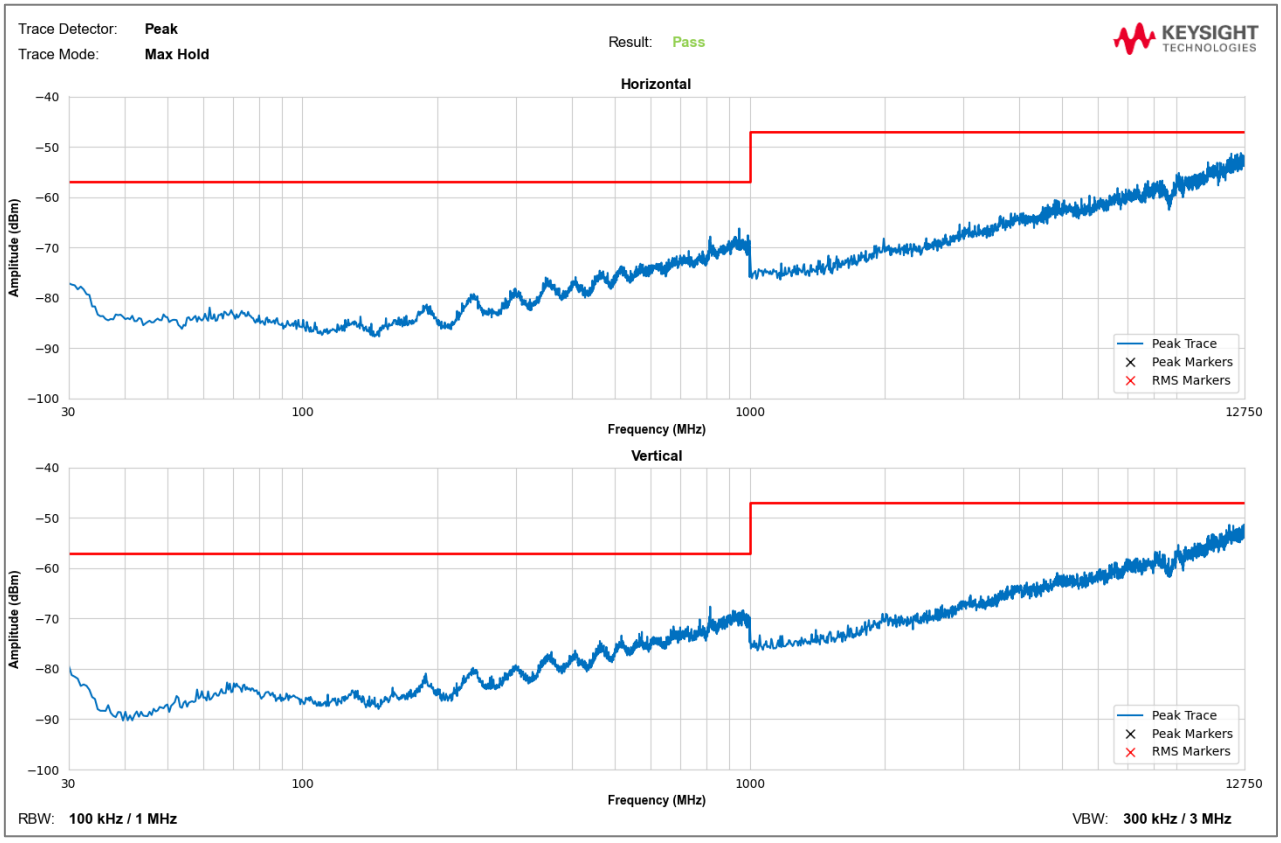


Figure 7: Results for Radiated Spurious Emissions – UE Idle

7.3. CONTROL AND MONITORING (UE)

7.3.1. DESCRIPTION

According to ETSI EN 301 908-1 V15.1.1, this requirement, together with other control and monitoring technical requirements identified in the table of cross references in the applicable part, verifies that the control and monitoring functions of the UE prevent it from transmitting in the absence of a valid network.

This test is applicable to radio communications equipment and ancillary equipment in the operating band defined in the applicable part of this multi-part harmonized standard.

This test shall be performed on the radio communications equipment and/or a representative configuration of the ancillary equipment.

7.3.2. LIMITS

The maximum measured power during the duration of the test shall not exceed -30 dBm.

7.3.3. RESULTS

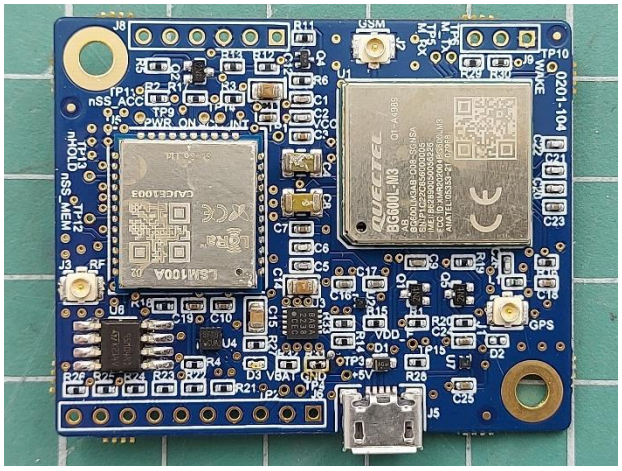
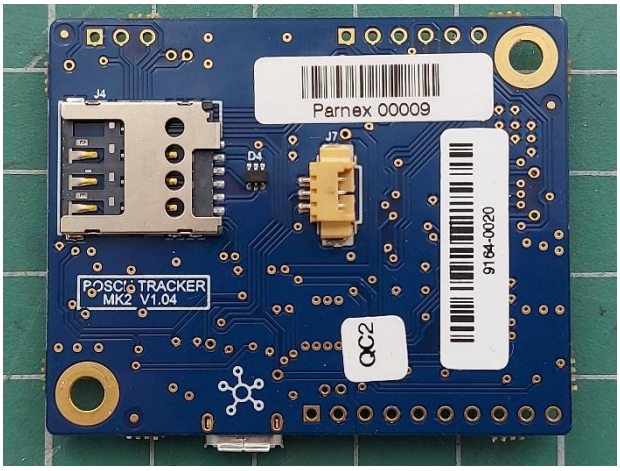
Table 19: Control and Monitoring Results

Band	Observed Frequency Range (MHz)	Maximum Measured Power (dBm)	Detector Used	Limit (dBm)	Test Result
3	1710 to 1785	System Noise Floor	PK	-30	Pass
8	880 to 915	System Noise Floor	PK	-30	Pass

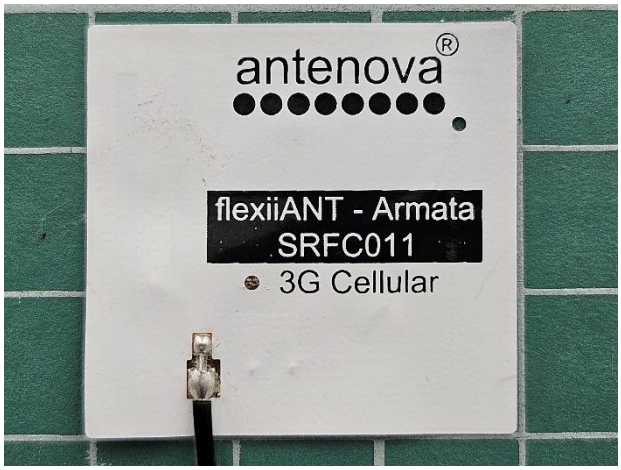
8. TEST IMAGES


Figures 8 & 9: Measurement Setup for Radiated Emissions between 30 MHz and 4 GHz

Figures 10 & 11: External Front and Rear View of EUT

Figures 12 & 13: Internal Top and Bottom View of EUT



Figures 14 & 15: Detailed View of RF Circuit and Antenna

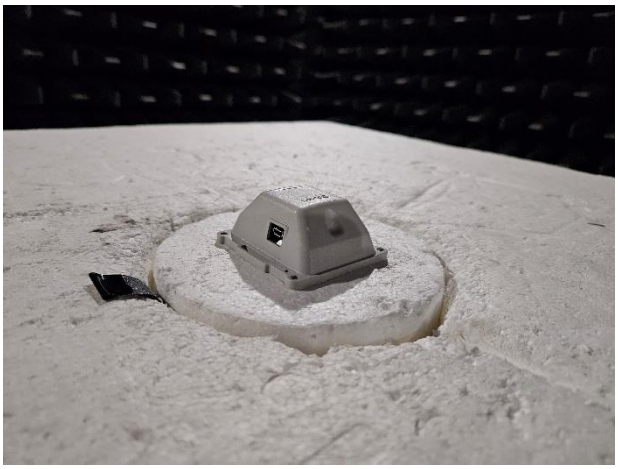


Figure 16: Setup of EUT in the Fully Anechoic Chamber

*** END OF THIS REPORT ***

APPENDIX A – MODULAR TEST REPORT

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RF TEST REPORT

Applicant	Quectel Wireless Solutions Co., Ltd
Product	LTE Cat M1 & Cat NB2 & EGPRS Module
Brand	Quectel
Model	BG600L-M3
Report No.	R2003A0167-R3
Issue Date	June 8, 2020

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **ETSI EN 301 908-1 V13.1.1/ ETSI EN 301 908-13 V13.1.1**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Performed by: Peng Tao	*Approved by: Kai Xu*

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TABLE OF CONTENT

Summary of measurement results

Test case		Results
ETSI EN 301908-13 V13.1.1 (ETSI TS 136 521-1 V15.2.0)	4.2.2.4(6.2.2F)UE Maximum Output Power for category NB1 and NB2	Pass
	4.2.3 (6.6.2.1F) Spectrum Emission Mask for UE category NB1	Pass
	4.2.4 (6.6.3F.1)Transmitter Spurious emissions for UE category NB2	Pass
ETSI TS 136 521-1 V15.2.0	4.2.4 (6.6.3F.2) Spurious emission band UE co-existence for category NB1	Pass
ETSI EN 301908-13 V13.1.1 (ETSI TS 136 521-1 V15.2.0)	4.2.5 (6.3.2F) Minimum Output Power for UE category NB1	Pass
	4.2.6 (7.5F) Adjacent Channel Selectivity (ACS) for UE category NB1	Pass
	4.2.7 (7.6.1F) In-band blocking for category NB1	Pass
	4.2.7(7.6.2F)Out-of-band blocking for category NB1	Pass
	4.2.8(7.7F)Receiver Spurious Response for UE category NB1	Pass
	4.2.9 (7.8.1F) Wide band Intermodulation for UE category NB1	Pass
	4.2.10(7.9F)Spurious emissions for UE category NB1	Pass
	4.2.11 (6.6.2.3F) Adjacent Channel Leakage power Ratio for UE category NB1	Pass
	4.2.12 (7.3F.1) Reference sensitivity level without repetitions for category NB1	Pass
ETSI EN 301 908-1 V13.1.1	4.2.2 Radiated emissions (UE)	Pass
	4.2.4 Control and monitoring functions (UE)	Pass
Date of Testing: April 23, 2020 ~ June 3, 2020		
Note: All indications of Pass/Fail in this report are opinions expressed by TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.		

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.

1.2. Test facility

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 Shanghai, China
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

2.1. Applicant and Manufacturer Information

Applicant	Quectel Wireless Solutions Co., Ltd
Applicant address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China 200233
Manufacturer	Quectel Wireless Solutions Co., Ltd
Manufacturer address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China 200233

2.2. General information

EUT Description			
Model	BG600L-M3		
IMEI	860873040012816		
Hardware Version	R1.2		
Software Version	BG600LM3LAR02A03		
Power Supply	External Power Supply		
Antenna Type	The EUT don't have standard Antenna, The Antenna used for testing in this report is the after-market accessory (Dipole Antenna)		
Antenna Gain	NB-IOT Band 1 :1.6dBi NB-IOT Band 3 :1.9dBi NB-IOT Band 8 :3dBi NB-IOT Band 20 :3dBi NB-IOT Band 28 :4dBi		
Test Mode(s)	NB-IOT Band 1/3/8/20/28		
Test Modulation	BPSK, QPSK		
Category	NB2		
Deployment	stand-alone		
Sub-carrier spacing	3.75KHz, 15KHz		
Ntones	single-tone, multi-tone		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	NB-IOT Band 1	1920 ~ 1980	2110 ~ 2170
	NB-IOT Band 3	1710 ~ 1785	1805 ~ 1880
	NB-IOT Band 8	880 ~ 915	925 ~ 960
	NB-IOT Band 20	832 ~ 862	791 ~ 821
	NB-IOT Band 28	703 ~ 748	758 ~ 803
Note: 1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant.			

3. Applied Standards

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

Test standards
ETSI EN 301 908-1 V13.1.1 (2019-11)
ETSI EN 301 908-13 V13.1.1 (2019-11)
ETSI TS 136 521-1 V15.2.0 (2018-10)
ETSI TS 136 101 V14.8.0 (2018-10)
ETSI TS 136 508 V14.5.0 (2018-04)

4. The Case Results

Test Information

Normal Condition:	
Ambient Temperature	19~25°C
Voltage	3.8 V
Relative Humidity	25~70%
Extreme Conditions:	
Temperature	High:+85°C
	Low: -40°C
Voltage	High: 4.3 V
	Low: 3.3 V
NV	Normal Voltage
HV	High Voltage
LV	Low Voltage
NT/ NV	Normal Temperature, Normal Voltage
LT/LV	Low Temperature, Low Voltage
LT/HV	Low Temperature, High Voltage
HT/LV	High Temperature, Low Voltage
HT/HV	High Temperature, High Voltage
NTC	Normal test condition
Test cases	Identification number and description in 3GPP test specification and ETSI test specification
Pass	Amount of test cases which are conformant to the applied standards in the given LTE frequency band
Fail	Amount of test cases which are not conformant to the applied standards in the given LTE frequency band
Category	Describes the current test categories as specified in the Conformance Assessment Table of GCF-CC and NAPRD TC list

ETSI EN 301908-13 V13.1.1 (ETSI TS 136 521-1 V15.2.0)						
Test case	Condition	NB-IOT Band 1	NB-IOT Band 3	NB-IOT Band 8	NB-IOT Band 20	NB-IOT Band 28
		Results				
4.2.2.4(6.2.2F)UE Maximum Output Power for category NB1 and NB2	NTC	Pass	Pass	Pass	Pass	Pass
	HTHV	Pass	Pass	Pass	Pass	Pass
	HTLV	Pass	Pass	Pass	Pass	Pass
	LTHV	Pass	Pass	Pass	Pass	Pass
	LTLV	Pass	Pass	Pass	Pass	Pass
4.2.3 (6.6.2.1F) Spectrum Emission Mask for UE category NB1	NTC	Pass	Pass	Pass	Pass	Pass
4.2.4 (6.6.3F.1) Transmitter Spurious emissions for UE category NB2	NTC	Pass	Pass	Pass	Pass	Pass
4.2.4 (6.6.3F.2) Spurious emission band UE co-existence for category NB1	NTC	Pass	Pass	Pass	Pass	Pass
4.2.5 (6.3.2F) Minimum Output Power for UE category NB1	NTC	Pass	Pass	Pass	Pass	Pass
	HTHV	Pass	Pass	Pass	Pass	Pass
	HTLV	Pass	Pass	Pass	Pass	Pass
	LTHV	Pass	Pass	Pass	Pass	Pass
	LTLV	Pass	Pass	Pass	Pass	Pass
4.2.6 (7.5F) Adjacent Channel Selectivity (ACS) for UE category NB1	NTC	Pass	Pass	Pass	Pass	Pass
4.2.7 (7.6.1F) In-band blocking for category NB1	NTC	Pass	Pass	Pass	Pass	Pass
4.2.7 (7.6.2F) Out-of-band blocking for category NB1	NTC	Pass	Pass	Pass	Pass	Pass
4.2.8 (7.7F) Receiver Spurious Response for UE category NB1	NTC	Pass	Pass	Pass	Pass	Pass
4.2.9 (7.8.1F) Wide band Intermodulation for UE category NB1	NTC	Pass	Pass	Pass	Pass	Pass
4.2.10(7.9F)	NTC	Pass	Pass	Pass	Pass	Pass

Spurious emissions for UE category NB1						
4.2.11 (6.6.2.3F) Adjacent Channel Leakage power Ratio for UE category NB1	NTC	Pass	Pass	Pass	Pass	Pass
	HTHV	Pass	Pass	Pass	Pass	Pass
	HTLV	Pass	Pass	Pass	Pass	Pass
	LTHV	Pass	Pass	Pass	Pass	Pass
	LTLV	Pass	Pass	Pass	Pass	Pass
4.2.12 (7.3F.1) Reference sensitivity level without repetitions for category NB1	NTC	Pass	Pass	Pass	Pass	Pass
	HTHV	Pass	Pass	Pass	Pass	Pass
	HTLV	Pass	Pass	Pass	Pass	Pass
	LTHV	Pass	Pass	Pass	Pass	Pass
	LTLV	Pass	Pass	Pass	Pass	Pass
ETSI EN 301908-1 V13.1.1						
Test case	**Condition**	**NB-IOT Band 1**	**NB-IOT Band 3**	**NB-IOT Band 8**	**NB-IOT Band 20**	**NB-IOT Band 28**
4.2.2 Radiated emissions (UE)	NTC	Pass	Pass	Pass	Pass	Pass
4.2.4 Control and monitoring functions (UE)	NTC	Pass	Pass	Pass	Pass	Pass

4.1. Maximum output power Results

During the test, the preliminary test was performed in Transmitter output power with five conditions (NTC, HTHV, HTLV, LTHV and LTLV), and the worst-case condition was recorded in this report.

Mode	Modulation	Sub-carrier spacing (KHz)	Ntones	Maximum output Power (dBm) for low/mid/high channel		
				18001/1920.1	18300/1950	18599/1979.9
Band 1 Standalone	BPSK	3.75	1@0	21.75	21.65	21.78
			1@47	21.67	21.55	21.65
	QPSK	15	1@0	21.95	21.86	21.76
			1@11	21.87	21.83	21.98

Mode	Modulation	Sub-carrier spacing (KHz)	Ntones	Maximum output Power (dBm) for low/mid/high channel		
				19201/1710.1	19575/1747.5	19949/1784.9
Band 3 Standalone	BPSK	3.75	1@0	21.64	21.72	21.45
			1@47	21.55	21.62	21.75
	QPSK	15	1@0	21.73	21.86	21.43
			1@11	21.55	21.80	21.82

Mode	Modulation	Sub-carrier spacing (KHz)	Ntones	Maximum output Power (dBm) for low/mid/high channel		
				21451/880.1	21625/897.5	21799/914.9
Band 8 Standalone	BPSK	3.75	1@0	21.92	21.67	21.32
			1@47	21.77	21.60	21.73
	QPSK	15	1@0	21.97	21.77	21.42
			1@11	21.77	21.58	21.81
		15	12@0	21.67	21.57	21.79

Mode	Modulation	Sub-carrier spacing (KHz)	Ntones	Maximum output Power (dBm) for low/mid/high channel		
				24151/832.1	24300/847	24449/861.9
Band 20 Standalone	BPSK	3.75	1@0	21.69	21.58	21.78
			1@47	21.67	21.46	21.35
	QPSK	15	1@0	21.61	21.48	21.31
			1@11	21.47	21.59	21.55

Mode	Modulation	Sub-carrier spacing (KHz)	Ntones	Maximum output Power (dBm) for low/mid/high channel		
				27211/703.1	27435/725.5	27659/747.9
Band 28 Standalone	BPSK	3.75	1@0	21.58	21.27	21.15
			1@47	21.32	21.45	21.11
	QPSK	15	1@0	21.51	21.43	21.38
			1@11	21.17	21.21	21.02

4.2. Radiated Spurious Emissions

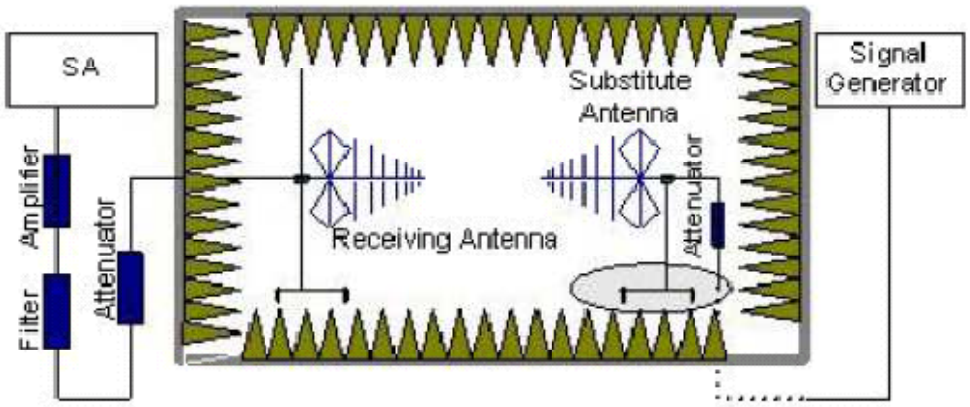
Ambient condition

Temperature	Relative humidity	Pressure
23°C ~26°C	45%~50%	101.5kPa

Methods of Measurement

Initially the test antenna is closely coupled to the MS and any spurious emission radiated by the MS are detected by the test antenna and receiver in the range 30 MHz to 12.75 GHz. Radiated spurious emissions s tested under normal voltage conditions and extreme voltage conditions.
The procedure of Radiates Spurious Emission is as follows:

1. Pre-calibration
   In a fully anechoic chamber, A log-periodic antenna or double-ridged waveguide horn antenna shall be substituted at a 3 meter test distance from the receive antenna. An RF signal source is connected to the dipole with a Tx cable that has been constructed to not interfere with radiation pattern of the antenna. A known (measured) power (Pin) is applied to input of dipole, and the power received (Pr) is recorded from the spectrum analyzer.
   "Reference Path loss" is established as Pin –Pr-Tx cable loss+ Substitution antenna gain.



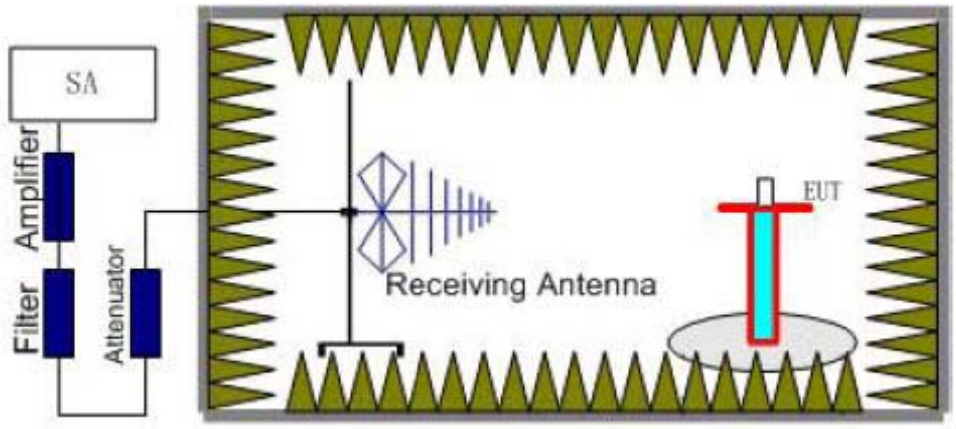
2. EUT Test
   EUT was placed on a 1.5 meter high non – conductive table at a 3 meter test distance from the receive antenna. The height of receiving antenna is 1.5 m. The test setup refers to figure below. Detected emissions were maximized at each frequency by rotating the table and adjusting the receiving antenna polarization. The measurement is carried out using a spectrum analyzer .The radiated emission measurements were measured with average detector. RBW is set to 100kHz and VBW is set to 300kHz for 30MHz to 1GHz. RBW is set to 1MHz and VBW is set to 3MHz for other frequency above 1GHz.A notch filter is necessary in the band near to the carrier frequency. A high pass filter is needed to avoid the distortion of the testing equipment in the band above the carrier frequency. If the harmonic could not be detected above the noise floor, the ambient level was recorded.

The level of the spurious emissions can be calculated through the level of the signal generator, cable loss, the gain of the substitution antenna and the reading of the spectrum analyzer or receiver.

Calculation procedure:

RSE = Rx (dBm) + Reference Path loss

Rx: reading of the receiver

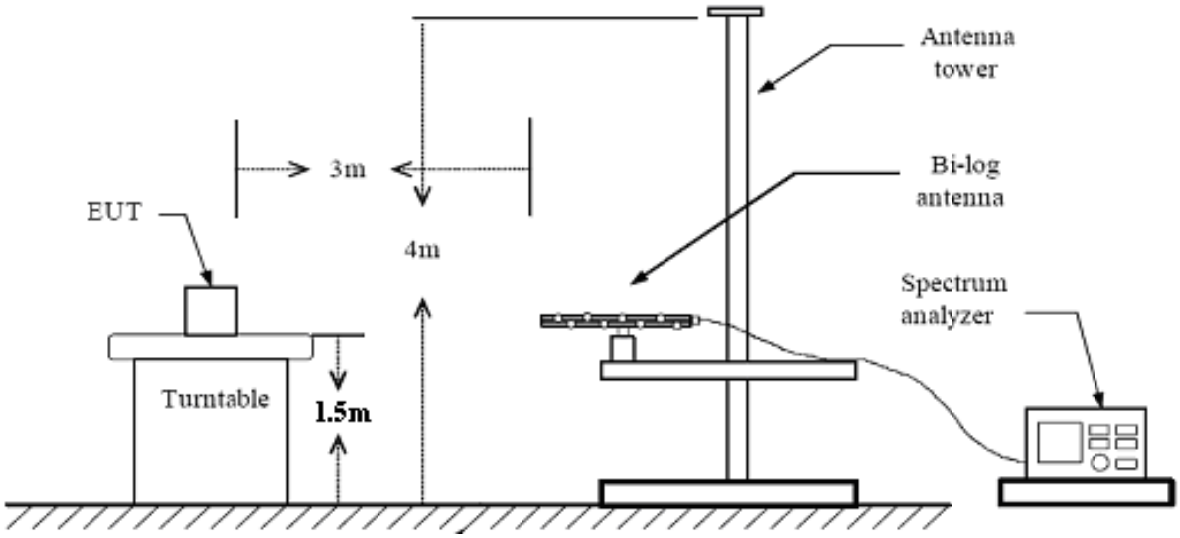


The field strength of spurious emission was measured in the following position: EUT stand-up position (Z axis), lie-down position (X, Y axis). Receiver antenna polarization (horizontal and vertical). The worst emission was found in position (z axis, vertical polarization) and the worst case was recorded.

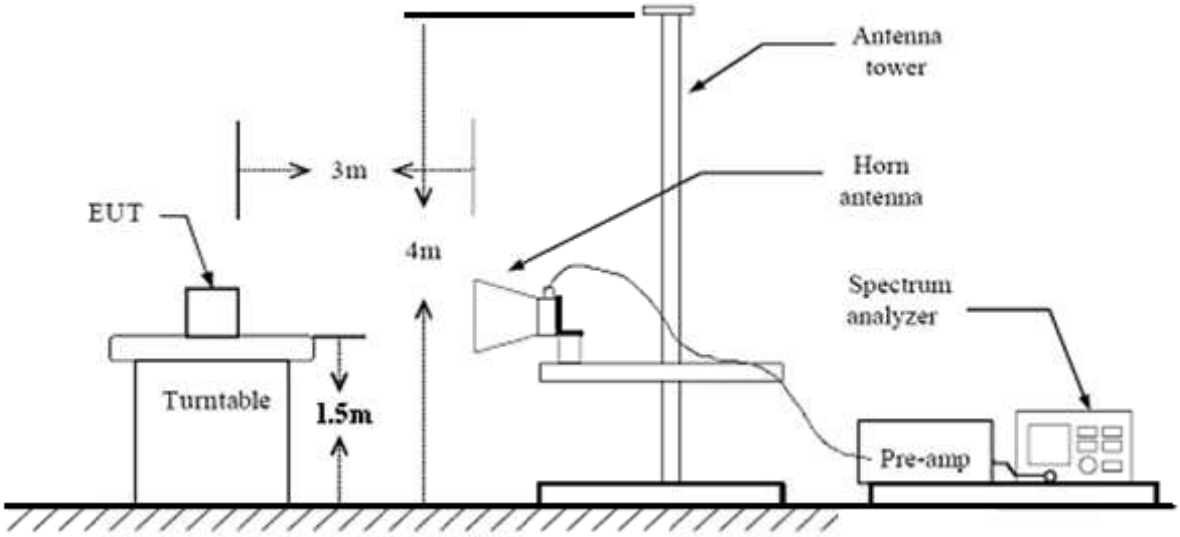
Radiated Spurious Emission was tested under normal temperature and normal voltage conditions. During the test, the EUT is worked at maximum output power, the power control set to“All Up Bits”. The tests were performed as link mode and idle mode.

Test Setup

Below 3 GHz



Above 3 GHz



Limits

The requirements shown in the flowing table are only applicable for frequencies in the spurious domain.

Frequency	Minimum requirement (e.r.p)/ reference bandwidth idle mode	Minimum requirement (e.r.p)/ reference bandwidth	Applicability
30 MHz ≤ f < 1000 MHz	-57 dBm/100 kHz	-36 dBm/100 kHz	All
1 GHz ≤ f < 12,75 GHz	-47 dBm/1 MHz	-30 dBm/1 MHz	All
fc - 12,5 MHz < f < fc + 12,5 MHz		-30	UTRA FDD UTRA TDD, 3,84 Mcps option cdma2000, spreading rate 3
fc - 4 MHz < f < fc + 4 MHz		Not applicable	UTRA TDD, 1,28 Mcps option cdma2000, spreading rate 1
fc - 500 kHz < f < fc + 500 kHz		Not applicable	UWC 136, 200 kHz option
fc - 250 kHz < f < fc + 250 kHz		Not applicable	UWC 136,30 kHz option

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.

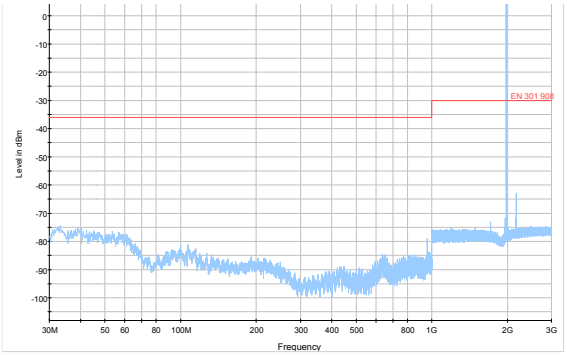
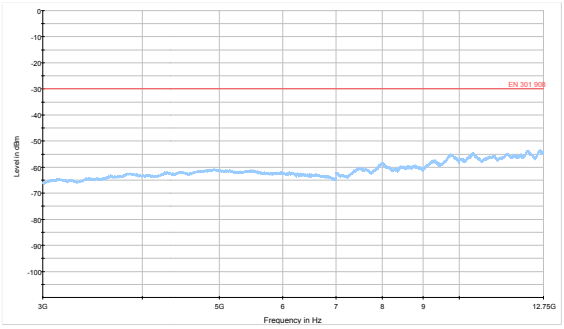
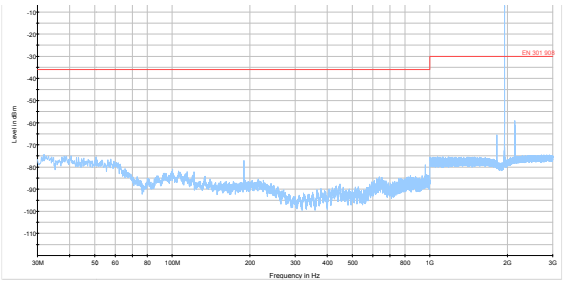
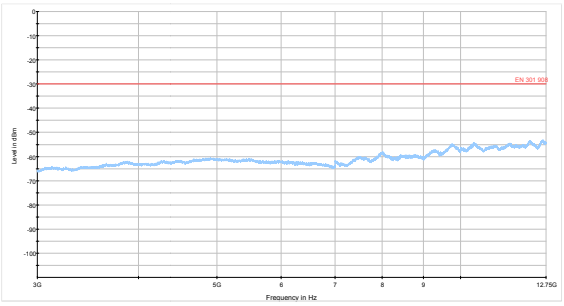
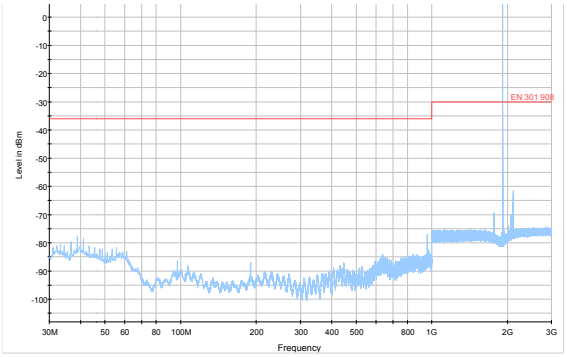
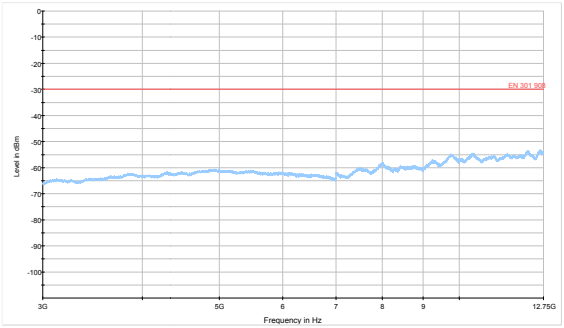
Test Results

Transmitter

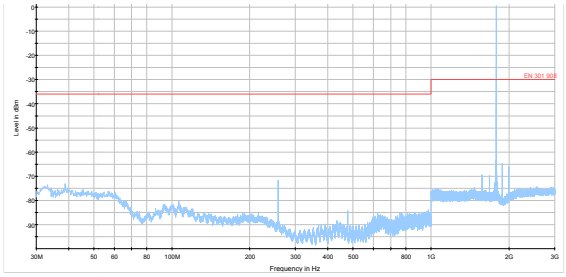
For radiated spurious emissions test, the worst mode (3.75kHz+BPSK) should be reflected in the report.

Sweep from 30MHz to 12.75GHz, emissions more than 20 dB below the limit are not reported.

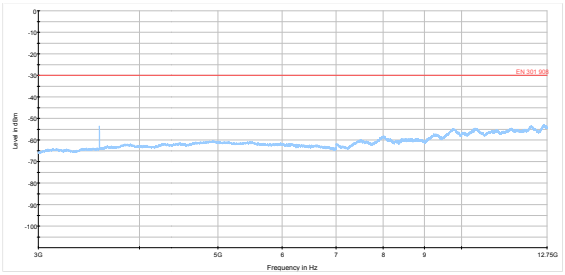
The signal beyond the limit is carrier.

NB-IOT Band 1 High Channel Link Mode 30MHz -3GHz	NB-IOT Band 1 High Channel Link Mode 3GHz -12.75GHz
	
NB-IOT Band 1 Middle Channel Link Mode 30MHz -3GHz	NB-IOT Band 1 Middle Channel Link Mode 3GHz -12.75GHz
	
NB-IOT Band 1 Low Channel Link Mode 30MHz -3GHz	NB-IOT Band 1 Low Channel Link Mode 3GHz -12.75GHz
	

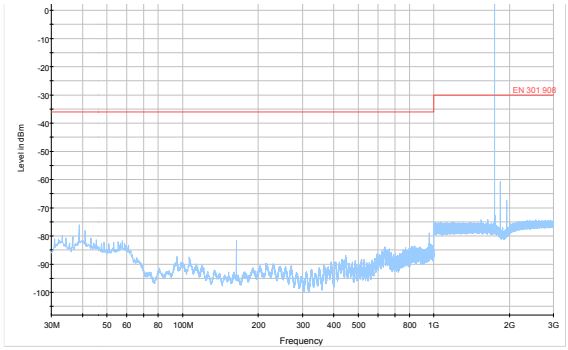
NB-IOT Band 3 High Channel Link Mode
30MHz -3GHz



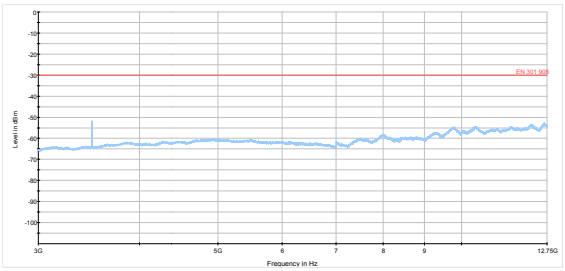
NB-IOT Band 3 High Channel Link Mode
3GHz -12.75GHz



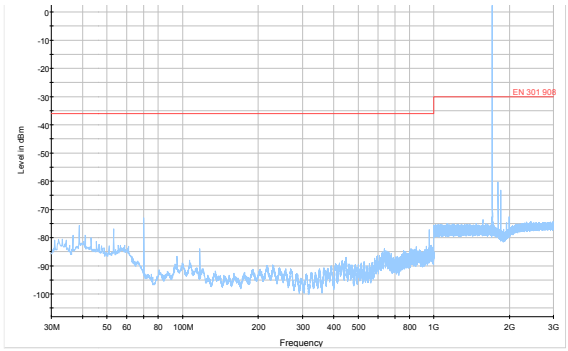
NB-IOT Band 3 Middle Channel Link Mode
30MHz -3GHz



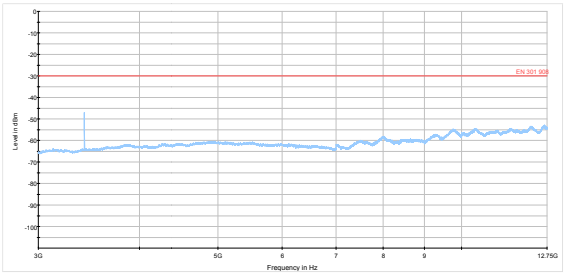
NB-IOT Band 3 Middle Channel Link Mode 3GHz
-12.75GHz



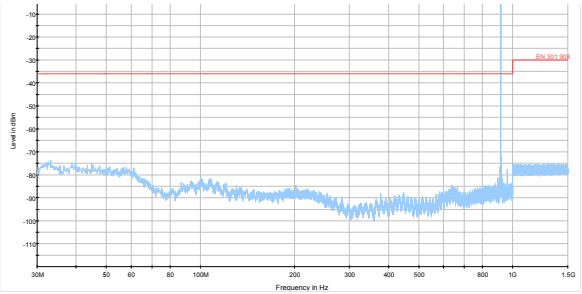
NB-IOT Band 3 Low Channel Link Mode
30MHz -3GHz



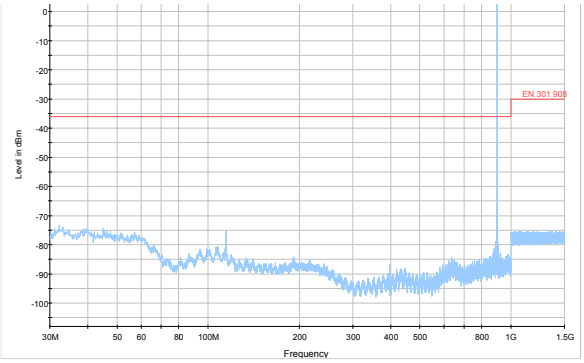
NB-IOT Band 3 Low Channel Link Mode
3GHz -12.75GHz



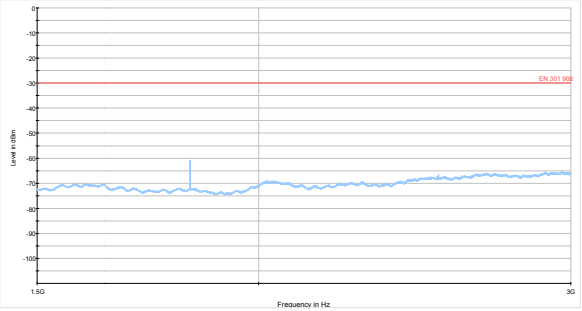
NB-IOT Band 8 High Channel Link Mode
30MHz -1.5GHz



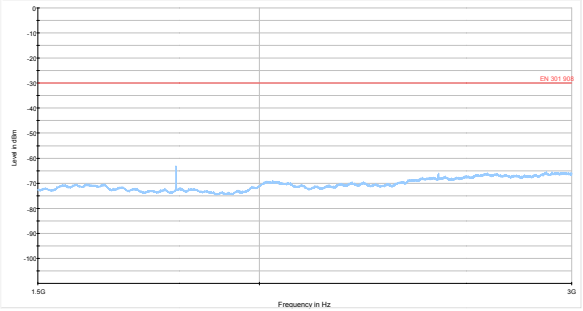
NB-IOT Band 8 Middle Channel Link Mode
30MHz -1.5GHz



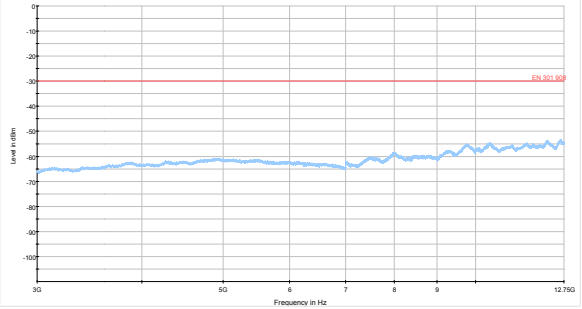
NB-IOT Band 8 High Channel Link Mode
1.5GHz -3GHz



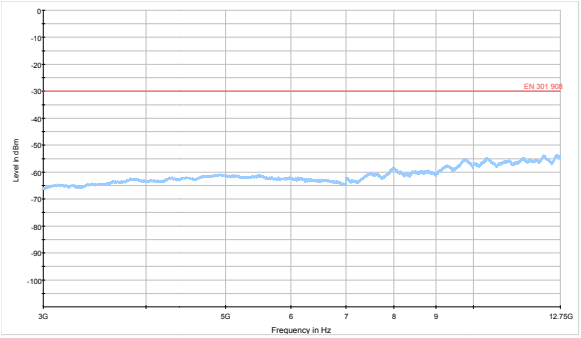
NB-IOT Band 8 Middle Channel Link Mode
1.5GHz -3GHz



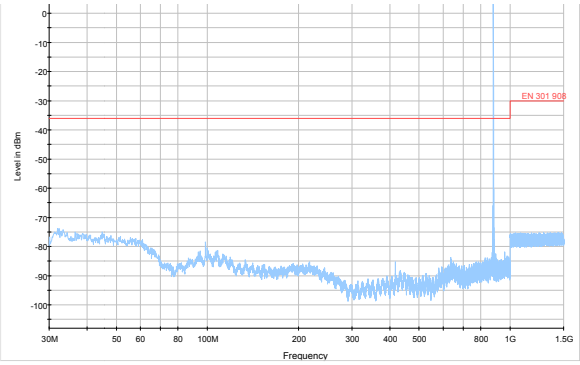
NB-IOT Band 8 High Channel Link Mode
3GHz -12.75GHz



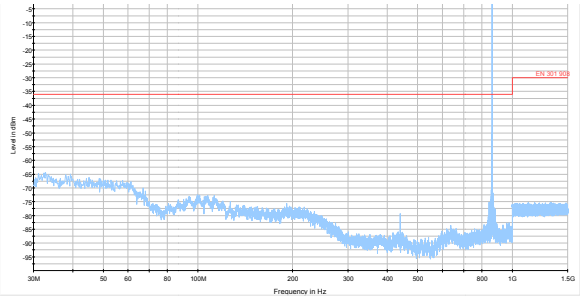
NB-IOT Band 8 Middle Channel Link Mode
3GHz -12.75GHz



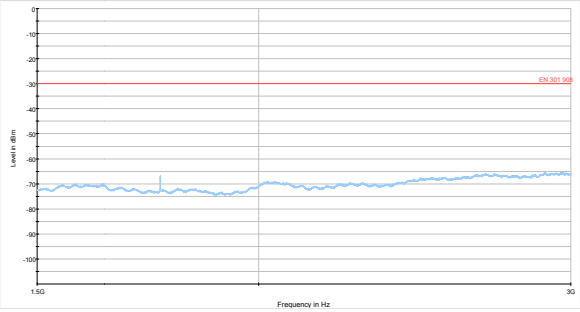
NB-IOT Band 8 Low Channel Link Mode
30MHz -1.5GHz



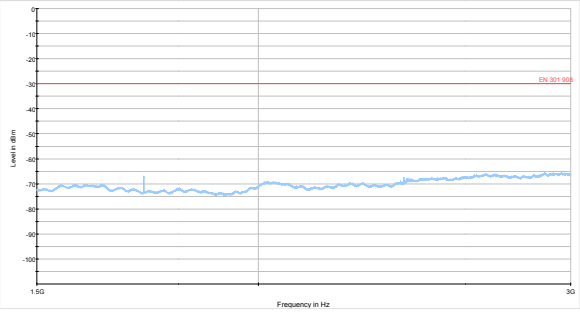
NB-IOT Band 20 High Channel Link Mode
30MHz -1.5GHz



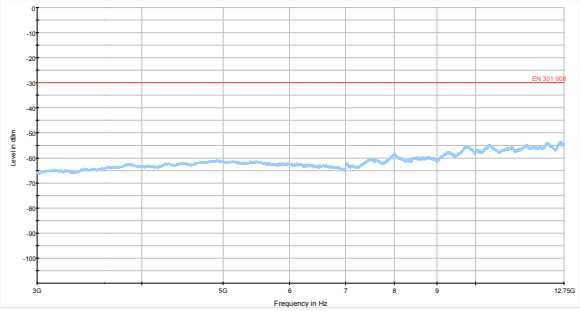
NB-IOT Band 8 Low Channel Link Mode
1.5GHz -3GHz



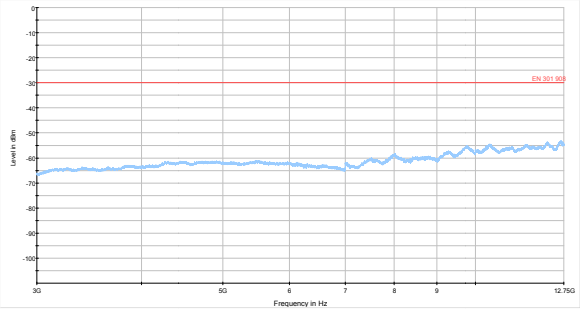
NB-IOT Band 20 High Channel Link Mode
1.5GHz -3GHz



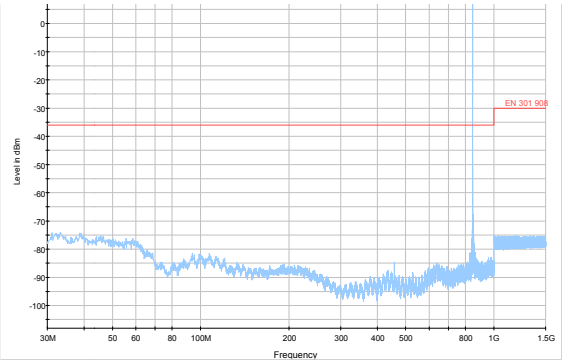
NB-IOT Band 8 Low Channel Link Mode
3GHz -12.75GHz



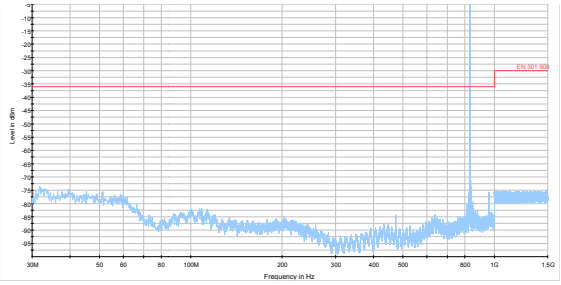
NB-IOT Band 20 High Channel Link Mode
3GHz -12.75GHz



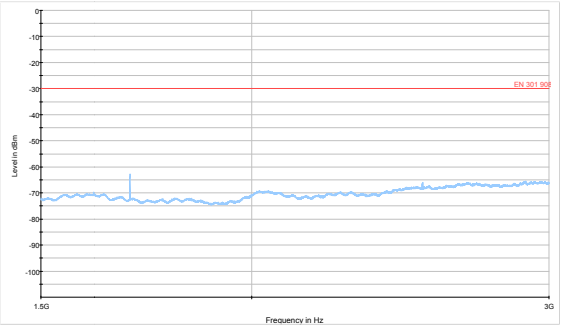
NB-IOT Band 20 Middle Channel Link Mode 30MHz -1.5GHz



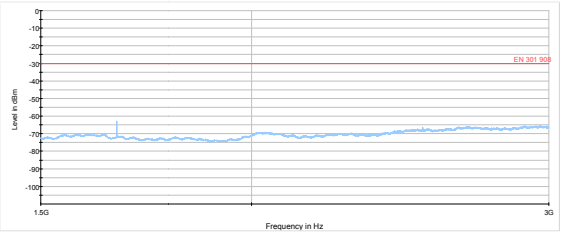
NB-IOT Band 20 Low Channel Link Mode 30MHz -1.5GHz



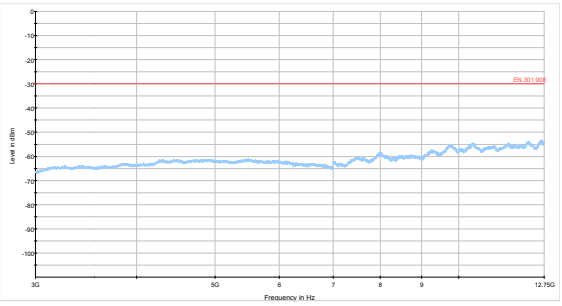
NB-IOT Band 20 Middle Channel Link Mode 1.5GHz -3GHz



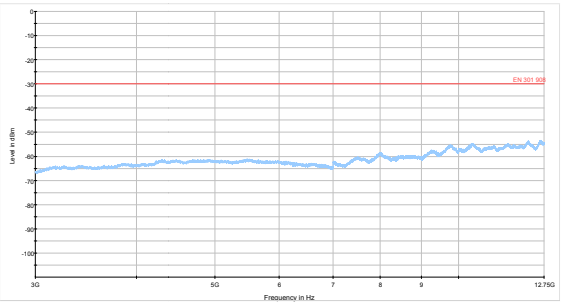
NB-IOT Band 20 Low Channel Link Mode 1.5GHz -3GHz



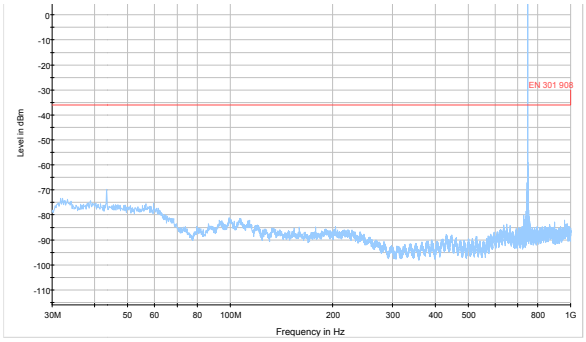
NB-IOT Band 20 Middle Channel Link Mode 3GHz -12.75GHz



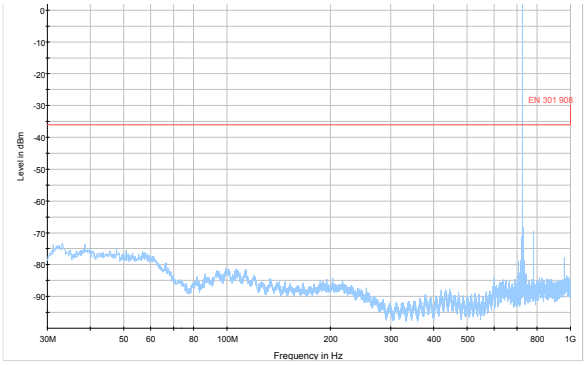
NB-IOT Band 20 Low Channel Link Mode 3GHz -12.75GHz



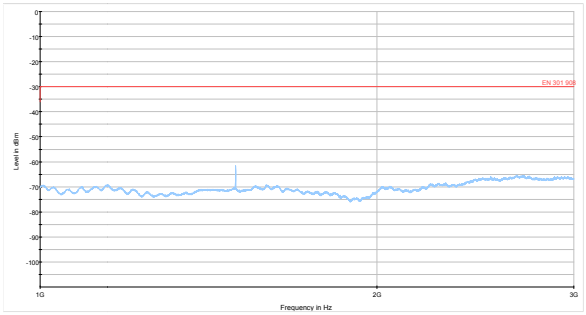
NB-IOT Band 28 High Channel Link Mode
30MHz -1GHz



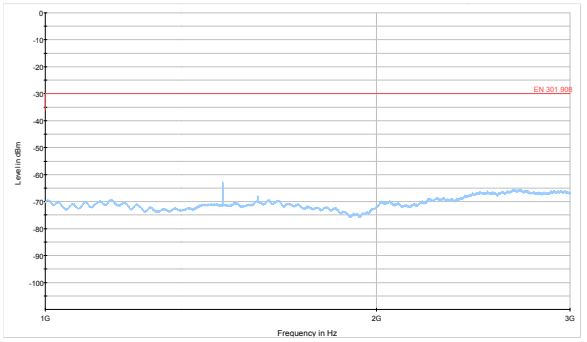
NB-IOT Band 28 Middle Channel Link Mode
30MHz -1GHz



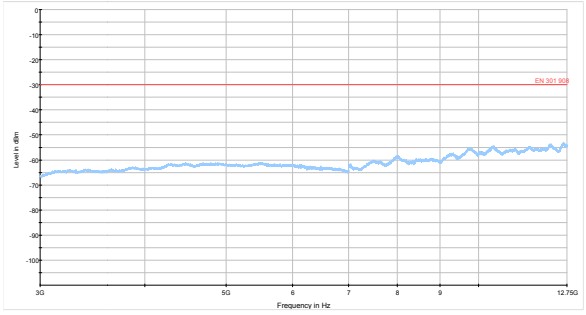
NB-IOT Band 28 High Channel Link Mode
1GHz -3GHz



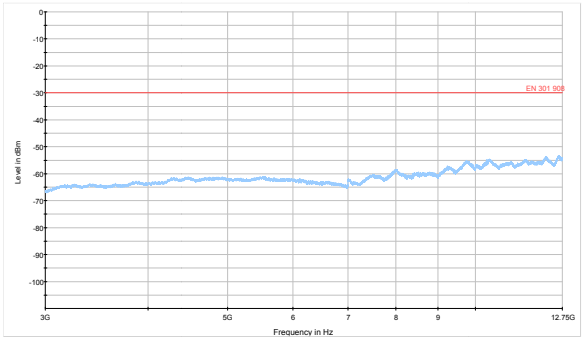
NB-IOT Band 28 Middle Channel Link Mode
1GHz -3GHz



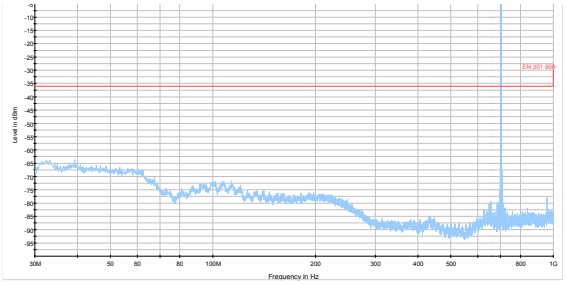
NB-IOT Band 28 High Channel Link Mode
3GHz -12.75GHz



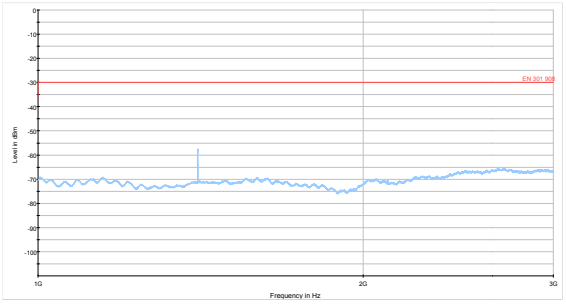
NB-IOT Band 28 Middle Channel Link Mode
3GHz -12.75GHz



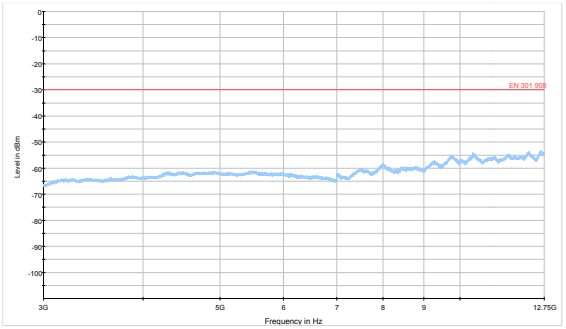
NB-IOT Band 28 Low Channel Link Mode
30MHz -1GHz



NB-IOT Band 28 Low Channel Link Mode
1GHz -3GHz



NB-IOT Band 28 Low Channel Link Mode
3GHz -12.75GHz

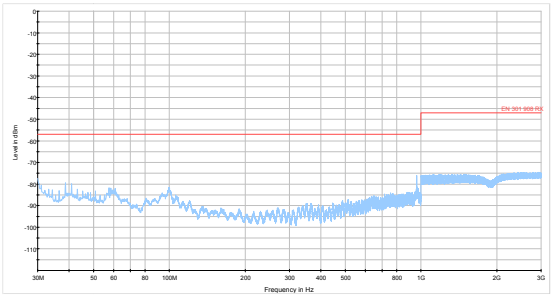
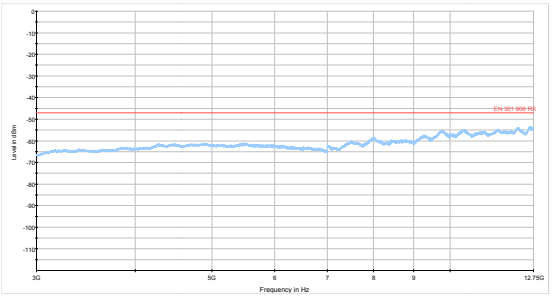


If disturbances were found more than 20dB below limit line, the mark is not required for the EUT.
The signal beyond the limit is carrier

Mode	Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Degree
RSE_3.75KHz+BPSK _NB B3_CHLOW_VV_3-12.75GHz	3420.00	-47.05	-30.00	17.05	90

Receiver

During the test, the preliminary test was performed in Idle Mode with all frequency bands, NB-IOT Band 3 are selected as the worst condition. The test data of the worst-case condition was recorded in this report.

NB-IOT Band 3 Idle Mode 30MHz -3GHz	NB-IOT Band 3 Idle Mode 3GHz -12.75GHz
	

4.3. Control and monitoring functions (UE)

Ambient condition

Temperature	Relative humidity	Pressure
23°C~25°C	45%~50%	101.5kPa

Methods of Measurement

a) At the start of the test, the UE shall be switched off. The UE antenna connector shall be connected to a power measuring equipment, with the following characteristics:

- the RF bandwidth shall exceed the total operating transmit frequency range of the UE for operation with an applicable part;

- the response time of the power measuring equipment shall be such that the measured power has reached within 1 dB of its steady state value within 100 μs of a CW signal.

it shall record the maximum power measured.

NOTE: The equipment may include a video low pass filter to minimize its response to transients or Gaussian noise peaks.

b) The UE shall be switched on for a period of approximately fifteen minutes, and then switched off.

c) The EUT shall remain switched off for a period of at least thirty seconds, and shall then be switched on for a period of approximately one minute.

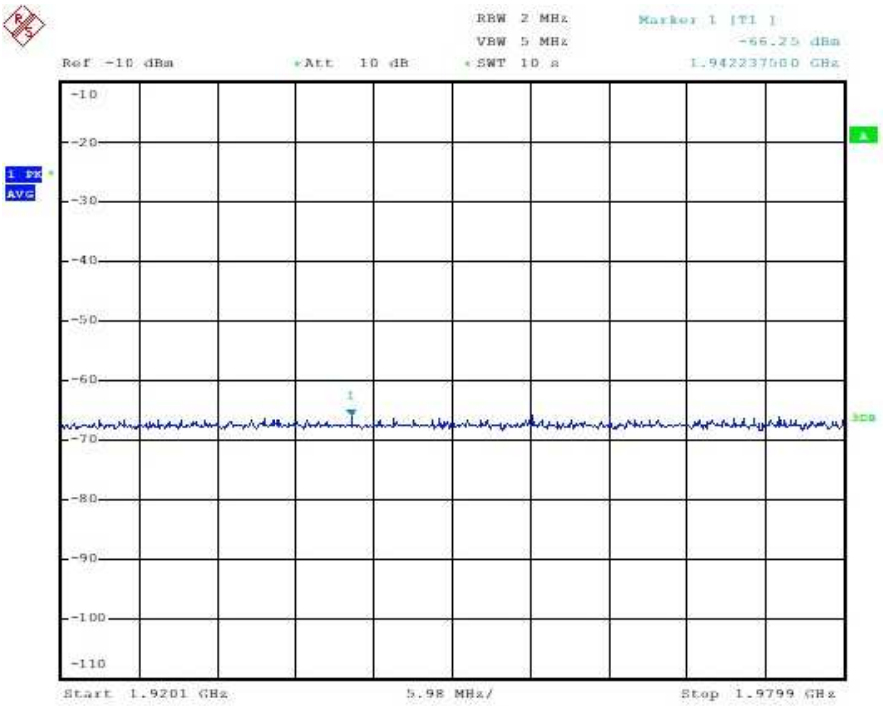
d) The maximum power emitted from the UE throughout the duration of the test shall be recorded.

Limits

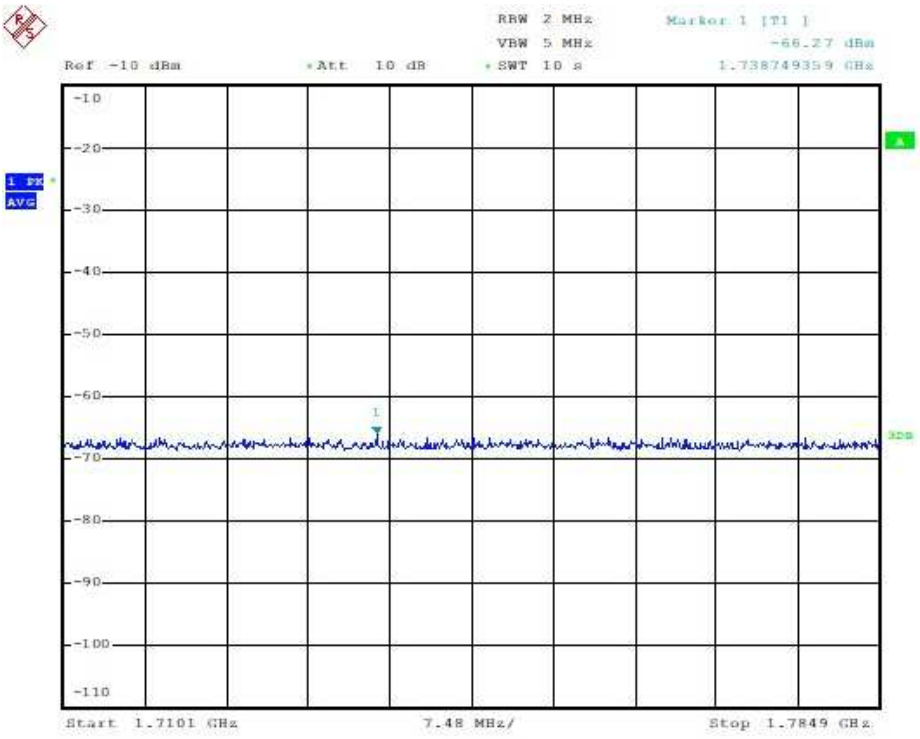
The maximum measured power during the duration of the test shall not exceed -30 dBm.

Test Results:

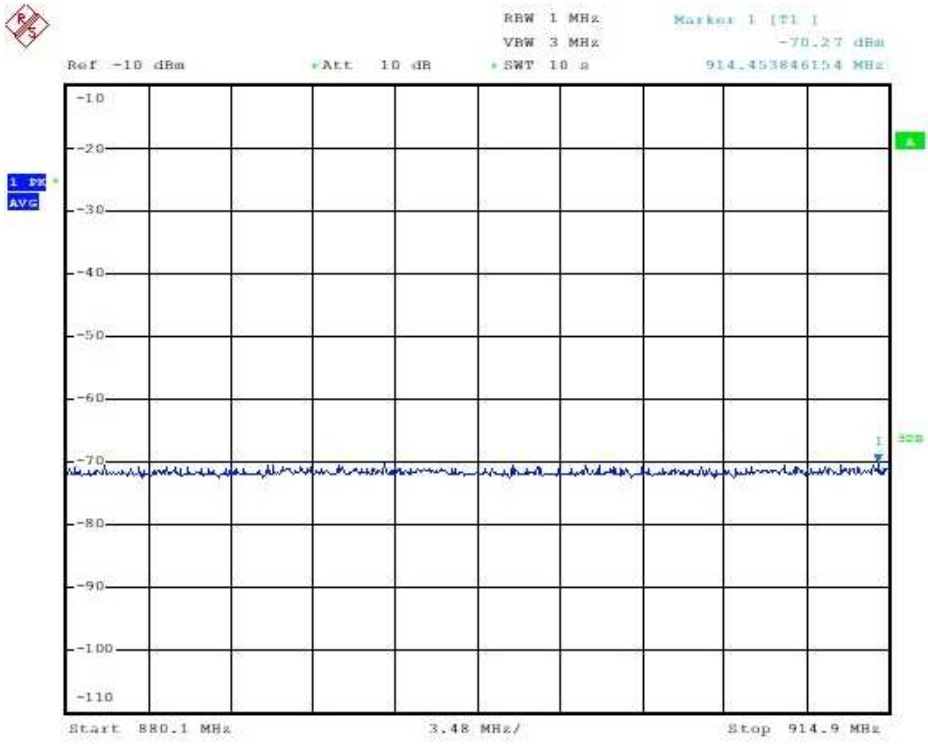
NB-IOT Band 1



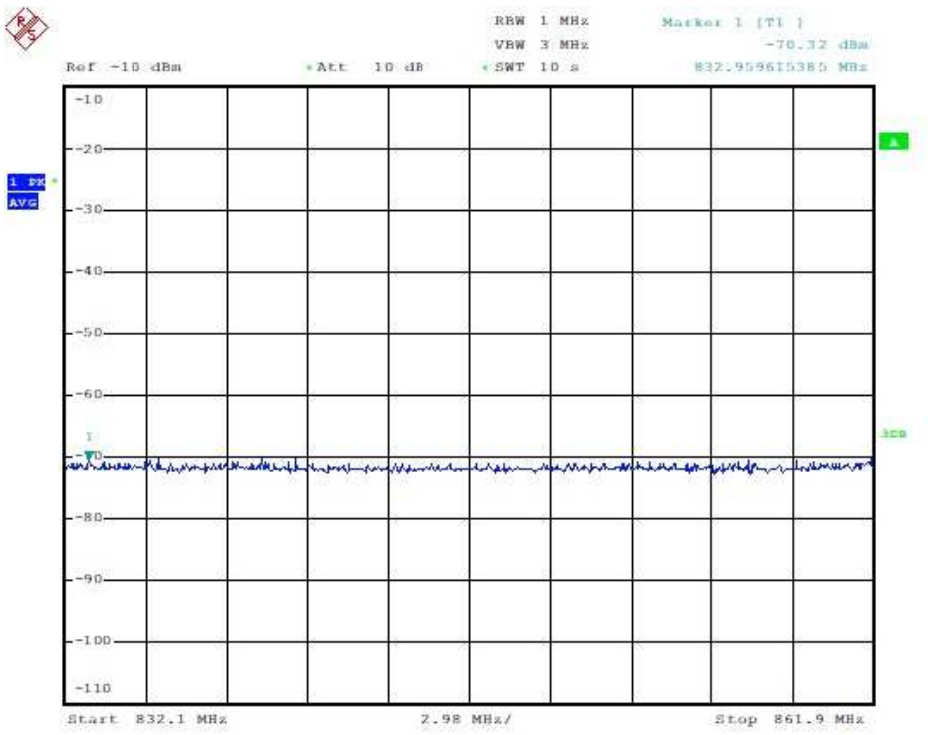
NB-IOT Band 3



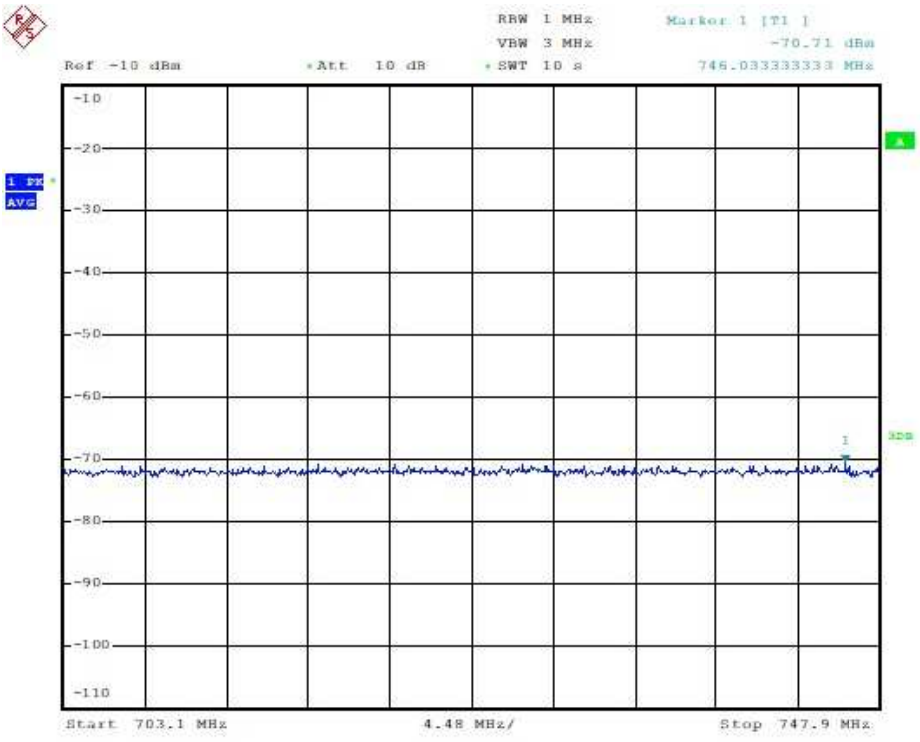
NB-IOT Band 8



NB-IOT Band 20



NB-IOT Band 28



5. Uncertainty Measurement

Test Case ID	Test System Uncertainty Limit	Maximum uncertainty of SP8630 Test system
6.2.2F UE Maximum Output Power For UE Category NBI	±0.7dB	±0.64dB
6.2.3F Maximum Power Reduction (MPR) for category NBI	±0.7dB	±0.64dB
6.2.5F Configured UE transmitted Output Power for UE category NBI	±0.7dB	±0.64dB
6.3. 2F Minimum Output Power for UE category NBI	±1.0dB	±0.64dB
6.3.4E.1 General ON/OFF time mask for category NBI	Transmission ON/OFF Power: ±1.5dB	Transmission ON/OFF Power: ±0.91dB
6.3.4F.2 NPRACH time mask forcategory NB1	Transmission ON/OFF Power: ±1.5dB	Transmission ON/OFF Power: ±0.91dB
6.3.5F.1 Power Control Absolutepower tolerance for category NB1	±1.0dB	±0.91dB
6.3.5F.2 Power Control Relativepower tolerance for category NB1	±0.7dB	±0.64dB
6.5.1F Frequency Error for category NB1	±15Hz DL Signal level: ±0.7dB	±15Hz ±0.64dB
6.5.2.1F.1 Error Vector Magnitude(EVM) for UE category NB1	NPUSCH:±2.5% NPRACH:±2.5%	NPUSCH:±2.5% NPRACH:±2.5%
6.5.2.2F Carrier leakage for UE category NB1	±0.8dB	±0.64dB
6.5.2.3F In-band emissions for non allocated RB for UE category NB1	±0.8dB	±0.64dB
6.6.1F Occupied bandwidth for UEI category NB1	200kHz: FFS	–
6.6.2.1F Spectrum Emission	±1.5dB	±0.64dB

Mask for UE category NB1		
6.6.2.3F Adjacent Channel Leakage power Ratio for UE category NB1	±0.8dB	±0.64dB
6.6.3.1F Transmitter Spurious emissions	9kHz<f≤4GHz; ±2.0dB 4GHz <f≤19GHz; ±4.0dB	9kHz<f≤4GHz; ±0.7dB 4GHz <f≤12.75GHz; ±0.74dB
6.6.3F.2 Spurious emission band UE co-existence for category NB1 UE	±2.0dB for results > -60dBm, f≤3.0GHz ±3.0dB for results ≤ -60dBm, f≤3.0GHz	±0.7dB for results > -60dBm, f≤3.0GHz ±0.7dB for results ≤ -60dBm, f≤3.0GHz
6.7F Transmit intermodulation	±2.6dB	±2.56dB
7.3F.1 Reference sensitivity level without repetitions for UE category NB1	Downlink power ±0.7dB	Downlink power ±0.64dB
7.3F.2 Reference sensitivity level with repetitions for category NB1	Downlink power ±0.7dB	Downlink power ±0.64dB
7.4F Maximum input level for UE category NB1	Downlink power ±0.7dB	Downlink power ±0.64dB
7.5F Adjacent Channel Selectivity(ACS) for UE category NB1	Downlink power ±0.7dB	Downlink power ±0.64dB
7.6.1F In-band blocking	ACS value ±1.1dB	ACS value ±1.01dB
7.6.2F Out of-band blocking	Blocking,1MHz<finterferer≤3.0GHz; ±1.3dB Blocking,3GHz< finterferer≤12.75GHz; ±3.2dB	Blocking,1MHz<finterferer≤3.0GHz; ±1.29dB Blocking,3GHz< finterferer≤12.75GHz; ±2.20dB

6. Main Test Instruments

Name	Manufacturer	Type	Serial Number	Calibration Date	Expiration Time
Signal Analyzer	R&S	FSV30	100815	2019-12-15	2020-12-14
EMI Test Receiver	R&S	ESCI	100948	2019-05-19	2020-05-18
EMI Test Receiver	R&S	ESCI	100948	2021-05-17	2021-05-16
Trilog Antenna	Schwarzbeck	VULB 9163	9163-201	2017-11-18	2020-11-17
Horn Antenna	R&S	HF907	100126	2018-07-07	2020-07-06
Climate Chamber	ESPEC	SU-242	93000506	2017-12-17	2020-12-16
Spectrum Analyzer	Keysight	E4445A	MY46181146	2019-05-19	2020-05-18
Spectrum Analyzer	Keysight	E4445A	MY46181146	2020-05-18	2021-05-17
Wireless Test Set	StarPoint	SP8315	SP8315-1202	2019-05-19	2020-05-18
Wireless Test Set	StarPoint	SP8315	SP8315-1202	2020-05-18	2021-05-17
Wireless Test Set	StarPoint	SP8315	SP8315-1203	2019-05-19	2020-05-18
Wireless Test Set	StarPoint	SP8315	SP8315-1203	2020-05-18	2021-05-17
MOB COMMS DC SUPPLY	Keysight	66319D	MY43004105	2019-05-19	2020-05-18
MOB COMMS DC SUPPLY	Keysight	66319D	MY43004105	2020-05-18	2021-05-17
Synthesized Signal Generator	Agilent	AV1464B	ZEL00307	2019-05-19	2020-05-18
Synthesized Signal Generator	Agilent	AV1464B	ZEL00307	2020-05-18	2021-05-17
Signal Analyzer	Conlighten	VSP6010	00VSPAAA0880006	2019-05-19	2020-05-18
Signal Analyzer	Conlighten	VSP6010	00VSPAAA0880006	2020-05-18	2021-05-17
Software	R&S	EMC32	9.26.0	/	/

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