Prüfbericht-Nr.: *Test Report No.*:	**50176073 001**	**Auftrags-Nr.:** *Order No.*:	114080238	Seite 1 von 41 *Page 1 of 41*
Kunden-Referenz-Nr.: *Client Reference No.*:	N/A	**Auftragsdatum:** *Order date*:	27-Jul-2018	
Auftraggeber: *Client*:	GlobalSat WorldCom Corporation 16F., No. 186, Jian 1st Rd, Zhonghe Dist., New Taipei City 23553, Taiwan			
Prüfgegenstand: *Test item*:	Sigfox Tracker			
Bezeichnung / Typ-Nr.: *Identification / Type No.*:	ST-100UX,GP-10XX (X can be any alphanumeric character for marketing purpose)			
Auftrags-Inhalt: *Order content*:	FCC Part 15C Test report (Sigfox)			
Prüfgrundlage: *Test specification*:	FCC 47CFR Part 15: Subpart C Section 15.247(FHSS)			

Wareneingangsdatum: *Date of receipt*:	27-Jul-2018
Prüfmuster-Nr.: *Test sample No.*:	A000782489-001 Rad A000782489-002 Cond
Prüfzeitraum: *Testing period*:	17-Aug-2018 – 06-Sep-2018
Ort der Prüfung: *Place of testing*:	EMC/RF Laboratory Taipei
Prüflaboratorium: *Testing laboratory*:	TUV Rheinland Taiwan Ltd.
Prüfergebnis*: *Test result**:	Pass

Report date / *tested by*:

Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*
20-Sep-2018	Mars Y.J. Lin / Project Engineer	

kontrolliert von / *reviewed by*:

Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*
20-Sep-2018	Ryan W. T. Chen/Project Manager	

Sonstiges / *Other*:

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery*:	Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.
This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.

TEST SUMMARY

5.1.1 ANTENNA REQUIREMENT
RESULT: Passed

5.1.2 MAXIMUM CONDUCTED PEAK OUTPUT POWER
RESULT: Passed

5.1.3 FREQUENCY SEPARATION
RESULT: Passed

5.1.4 20DB BANDWIDTH
RESULT: Passed

5.1.5 NUMBER OF HOPPING CHANNELS
RESULT: Passed

5.1.6 CONDUCTED SPURIOUS EMISSIONS AND FREQUENCY BAND EDGE MEASURED IN 100KHZ BANDWIDTH
RESULT: Passed

5.1.7 TIME OF OCCUPANCY
RESULT: Passed

5.1.8 SPURIOUS EMISSION
RESULT: Passed

5.2.1 MAINS CONDUCTED EMISSIONS
RESULT: Passed

6.1.1 ELECTROMAGNETIC FIELDS
RESULT: Passed

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1. General Remarks

1.1 Complementary Materials

The following attachments are integral parts of this test report:

Appendix P: Photo Documentation internal view
(File Name: 50176073 APPENDIX P)

Appendix D: Test Result of Radiated Emissions
(File Name: 50176073 APPENDIX D)

Test Specifications

The following standards were applied.

Table 1: Applied Standard and Test Levels

Radio
FCC 47CFR Part 15: Subpart C Section 15.247 FCC 47CFR Part 2: Subpart J Section 2.1091 ANSI C63.10:2013 KDB558074 D01 DTS Meas Guidance v04 KDB447498 D01 General RF Exposure Guidance v06

2. Test Sites

2.1 Test Laboratory

TUV Rheinland Taiwan Ltd.
Taichung Branch Office

No.9, Lane 36, Minsheng Rd., Sec. 3, Daya District,
Taichung City 428
Taiwan (R.O.C.)

2.2 Test Facility

TUV Rheinland Taiwan Ltd.
Taipei Office

11F. No.758, Sec. 4, Bade Rd., Songshan Dist.
Taipei City 105
Taiwan (R.O.C.)

FCC RegistrationNo.: 340738
IC Canada Registration No.: 9465A-1
TAF Accredited NCC Test Lab. No.:0759
TAF ISO17025 Certification effective period: 2016-Jul-1st to 2019-Jun-30th

Testing Laboratory
0759

2.3 List of Test and Measurement Instruments

Table 2: List of Test and Measurement Equipment

Kind of Equipment	Manu-facturer	Type	S/N	Last Calibration	Next Calibration
Test Software	Farad	EZ_EMC	Ver. TUV3A1	N/A	N/A
EMI Test Receiver	R&S	ESR 7	101549	2017/11/10	2018/11/10
Spectrum Analyzer	R&S	FSV 40	100921	2018/05/02	2019/05/02
EXA Signal Analyzer	KEYSIGHT	N9010A	MY52221334	2018/02/05	2019/02/04
Preamplifier (30MHz -1GHz)	HP	8447F	2805A03335	2018/08/14	2019/08/14
Preamplifier (18 GHz -40 GHz)	COM-POWER	PAM-840	461257	2018/01/18	2019/01/18
Pre-Amplifier (1GHz~18GHz)	EM Electronics	EM01G18G	60558	2017/11/21	2018/11/21
Bilog Antenna	TESEQ	CBL6111D	29804	2018/08/18	2019/08/18
Horn Antenna	ETS-Lindgren	3117	201918	2018/08/18	2019/08/18
Horn Antenna (18GHz~40GHz)	COM-POWER	AH-840	101029	2017/11/28	2018/11/28
Loop Antenna	Schwarzbeck	FMZB 1513	1513-076	2018/06/14	2019/06/14
EMI Test Receiver	R&S	ESR 7	101549	2017/11/10	2018/11/10
Spectrum Analyzer	R&S	FSL3	101943	2018/09/07	2019/09/07
Temp. & Humid. Chamber	Giant Force	GCT-099-40-S	MAF0103-007	2017/03/09	2019/03/09

2.4 Traceability

All measurement equipment calibrations are traceable to NML(Taiwan)/NIST(USA) or where calibration is performed outside Taiwan, to equivalent nationally recognized standards organizations.

2.5 Calibration

Equipment requiring calibration is calibrated periodically in a suitably accredited Calibration Lab. Additionally all equipment is verified for proper performance on a regular schedule using in house standards or comparisons.

2.6 Measurement Uncertainty

The estimated combined standard uncertainty for radiated emissions and conducted emissions measurements .

Table 3: Emission Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	± 0.1 ppm
RF power, conducted	± 1.5 dB
RF power density, conducted	± 3 dB
spurious emissions, conducted	± 3 dB
all emissions, radiated	± 6 dB
Temperature	± 1 ºC
Humidity	± 5 %
DC and low frequency voltages	±3 %

3. General Product Information

3.1 Product Function and Intended Use

The EUT is a Sigfox Tracker. It contains a RCZ2 Sigfox compatible module enabling the user to communicate data through a Wireless interface.
For details refer to the User Guide, Data Sheet and Circuit Diagram.

3.2 System Details and Ratings

Table 4: Basic Information of EUT

Item	EUT information
Kind of Equipment/Test Item	Sigfox Tracker
Type Identification	ST-100UX,GP-100XX (X can be any alphanumeric character for marketing purpose)
FCC ID	RID-ST100

Table 5: Technical Specification of EUT

Technical Specification	Value
Operating Frequencies	902.1375MHz – 904.6625MHz
Channel Spacing	25kHz
Channel number	54 Channels (9 Macro channels × 6 Micro channels)
Operation Voltage	DC 3.3V
Modulation	DBPSK
Antenna gain	-1.81 dBi

3.3 Independent Operation Modes

Basic operation modes are:

A. Transmitting
    1. Low channel
    2. Middle channel
    3. High channel
B. Receiving
C. Hopping
D. Transmitting Hopping
    1. Low channel
    2. Middle channel
    3. High channel

3.4 Noise Generating and Noise Suppressing Parts

Refer to the Circuit Diagram.

3.5 Submitted Documents

- Circuit Diagram
- Instruction Manual
- Technical Description

4. Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

The equipment under test (EUT) was configured to measure its maximum power level. The test modes were adapted accordingly in reference to the instructions for use.

4.2 Test Operation and Test Software

Setup for testing: Test samples are provided with a USB interface which makes it possible to control them through a test software SFM10R installed on a notebook computer.

This software was running on the laptop computer connected to the EUT. It was used to enable the operation modes listed in section 3.3 as appropriate.

The samples were used as follows:
Conducted: A000782489-002
Radiation: A000782489-001

Full test was applied on all test modes, but only worst case was shown

4.3 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

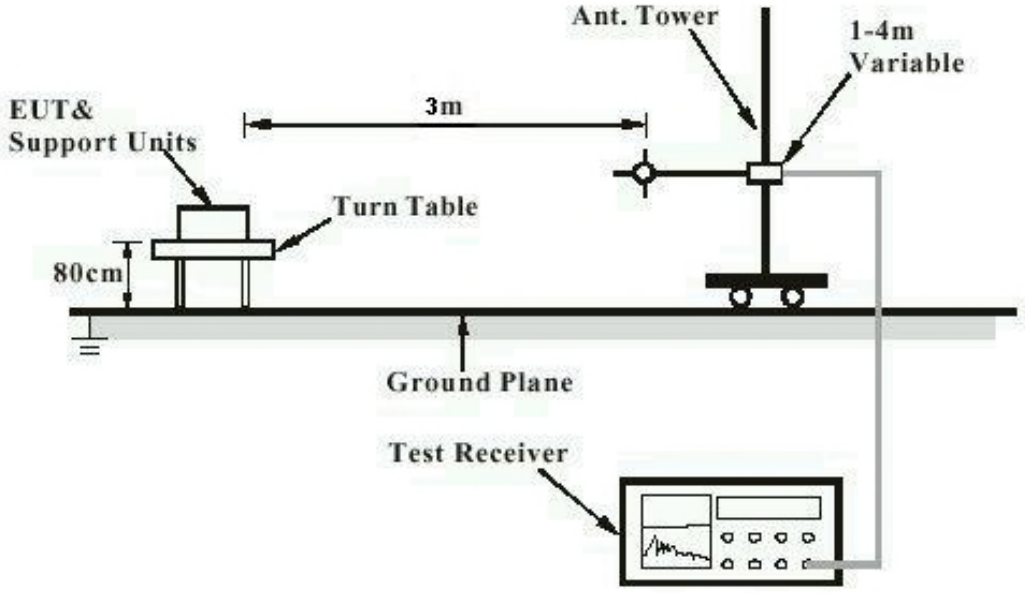
Description	Manufacturer	Model No.	Serial No.
Notebook(EMC-06)	Lenovo	TP00048A	PB-0F8B2

4.4 Countermeasures to achieve EMC Compliance

The test sample which has been tested contained the noise suppression parts as described in the Constructional Data Form or the Technical Construction File. No additional measures were employed to achieve compliance.

4.5 Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test



Note: Measurements above 1 GHz are done with a table height of 1.5m

Diagram of Measurement Equipment Configuration for Mains Conduction Measurement (if applicable)

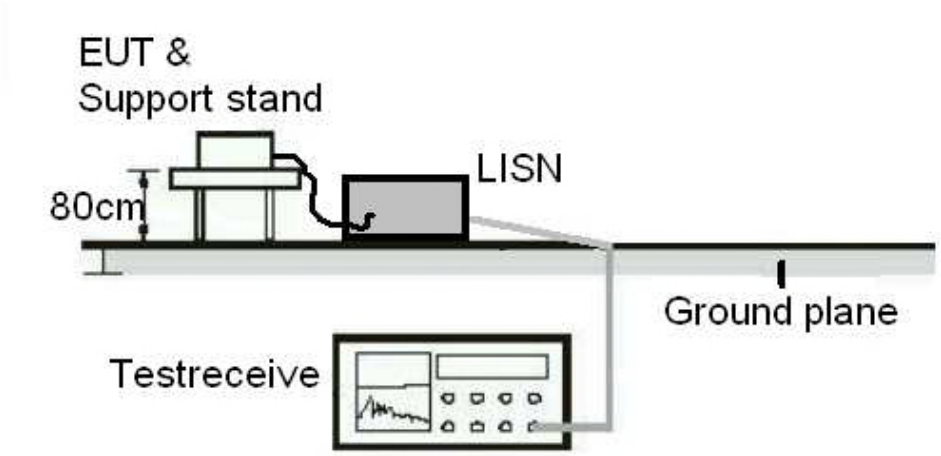
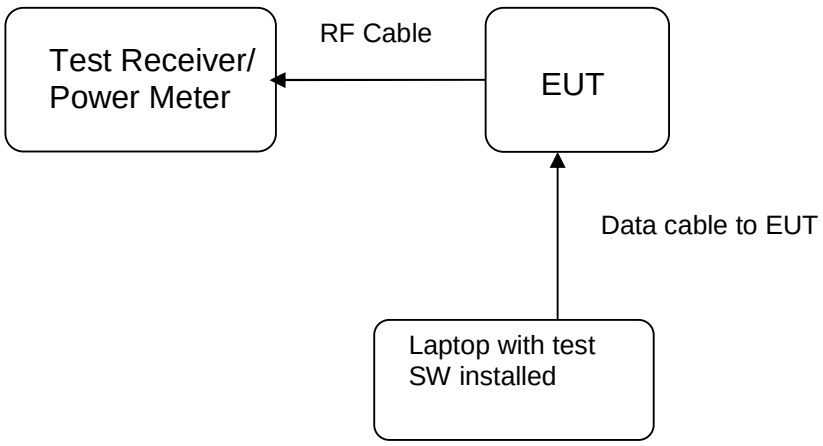


Diagram of Measurement Equipment Configuration for Conducted Transmitter Measurement



5. Test Results

5.1 Transmitter Requirement & Test Suites

5.1.1 Antenna Requirement

RESULT: **Passed**

Test standard	:	FCC Part 15.247(b)(4), Part 15.203
Requirement	:	use of approved antennas only with directional gains that do not exceed 6 dBi

According to the manufacturer declaration, the EUT has an antenna with a directional gain of -1.81 dBi. The antenna a printed PCB trace with no possibility of replacement with a non-approved antenna by the end-user. Therefore, the EUT is considered to comply with this provision.

Refer to EUT photo for details.

5.1.2 Maximum Conducted Peak Output Power

RESULT: **Passed**

Test standard	:	FCC Part 15.247(b)(2)
Basic standard	:	ANSI C63.10:2013, KDB558074
Limit	:	1 Watt
Kind of test site	:	Shielded room

Test setup

Test Channel	:	Low/ Middle/ High
Operation Mode	:	A
Ambient temperature	:	20-24 °C
Relative humidity	:	50-65 %
Atmospheric pressure	:	100-103 kPa

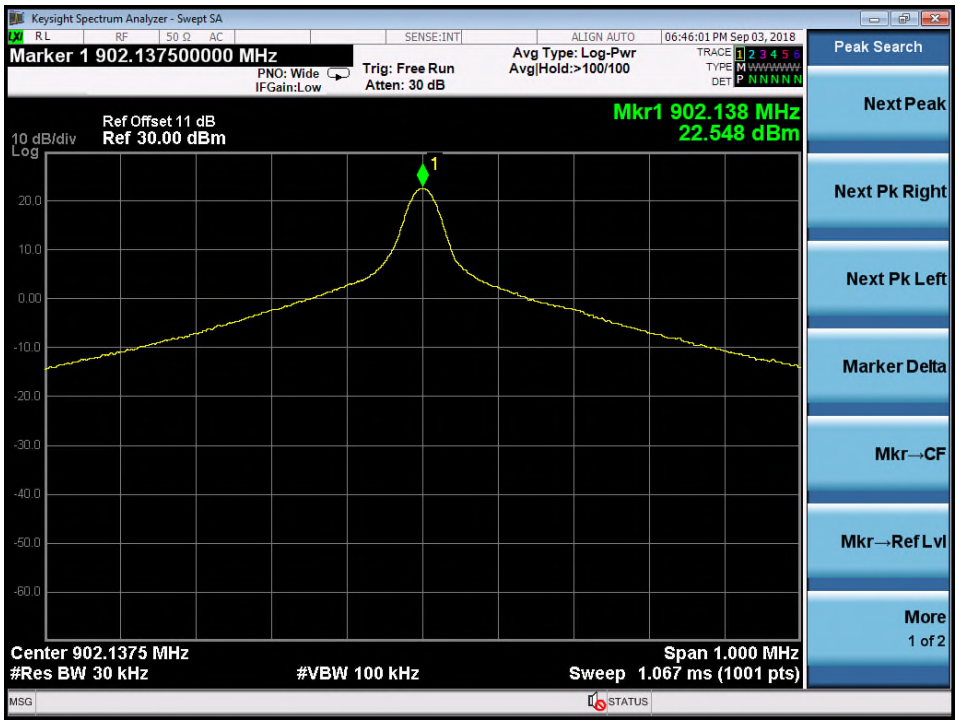
Table 6: Test result of Maximum conducted (average) output power

Channel	Channel Frequency (MHz)	Output Power		Limit
		(dBm)	(W)	(W)
Low Channel	902.1375	22.54	0.17947	1
Middle Channel	903.4125	22.25	0.16788	1
High Channel	904.6625	22.06	0.16069	1

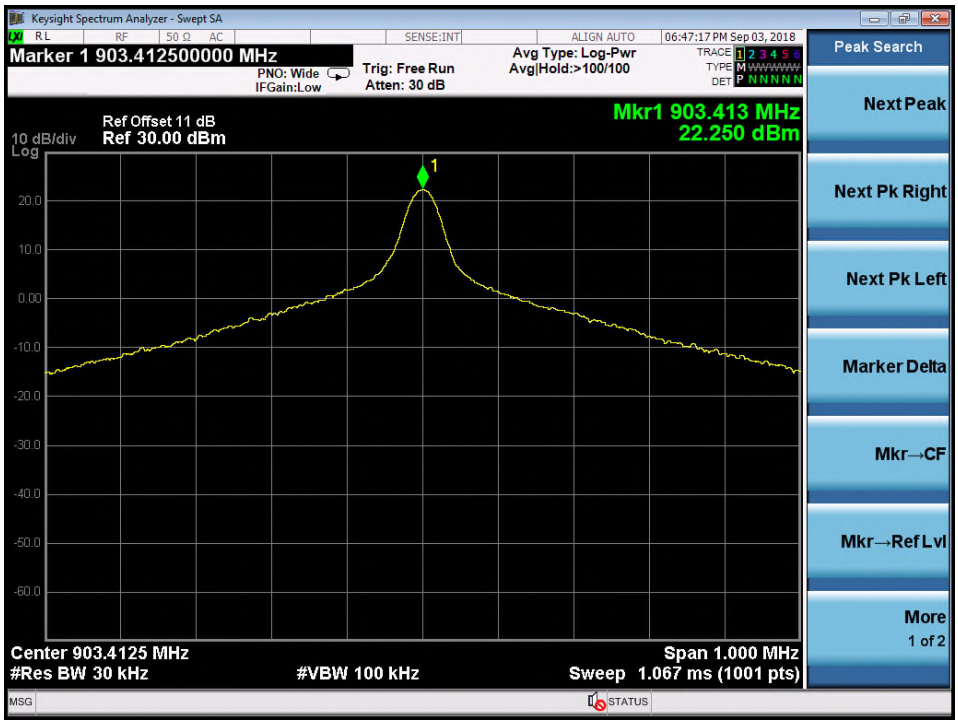
Pmax: 179.47 mW

Test Plot of Conducted Peak Power

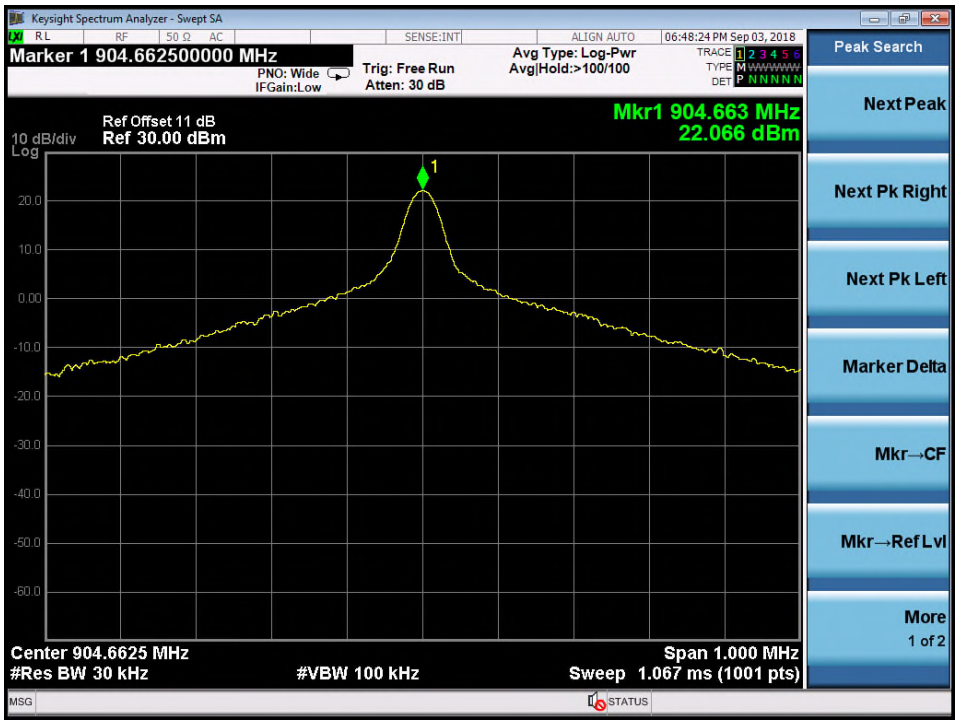
Low Channel



Middle Channel



High Channel



5.1.3 Frequency Separation

RESULT: **Passed**

Test standard	:	FCC part 15.247(a)(1)
Basic standard	:	ANSI C63.10:2013 LP0002(2016) Appendix II
Limit	:	≥ 25kHz or 20dB bandwidth, whichever is greater

Test setup

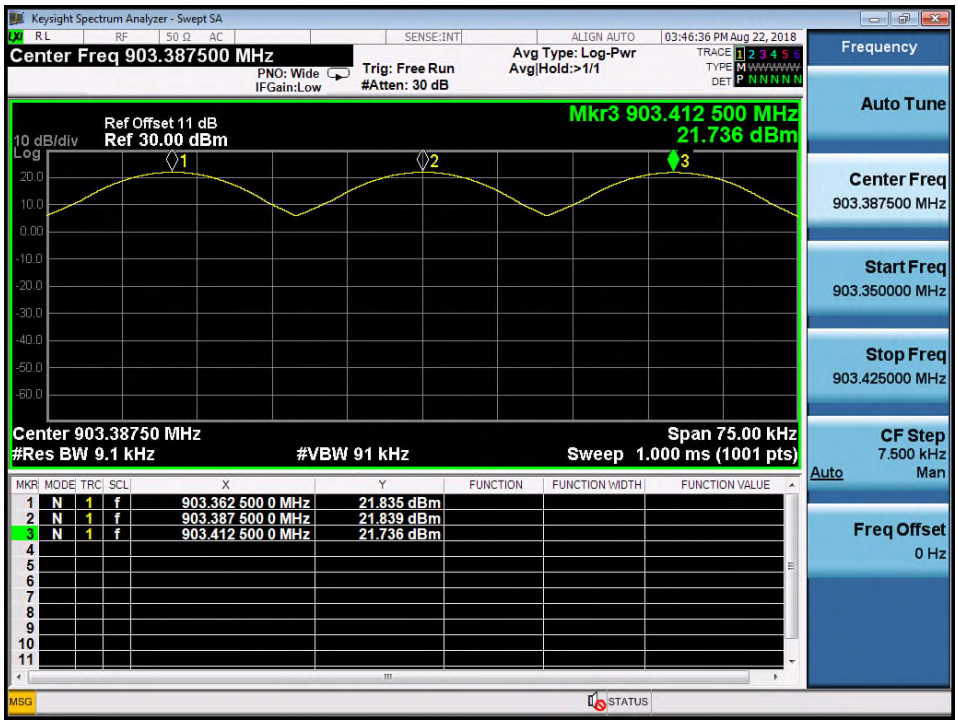
Test Channel	:	Hopping on
Operation Mode	:	C
Ambient temperature	:	24℃
Relative humidity	:	53%

Table 7: Test result of Frequency Separation

Channel	Channel Frequency (MHz)	Measured Channel Separation (kHz)	Limit (kHz)	Result
Record Channel	903.3875	25	≥ 25kHz or 20dB bandwidth	Pass
Record Channel adj 1	903.3625			
Record Channel adj 2	903.4125			

Test Plot of Frequency Separation

Channel Separation



5.1.4 20dB Bandwidth

RESULT: **Passed**

Test standard	:	FCC Part 15.247(a)(1)(i)
Basic standard	:	ANSI C63.10:2013, KDB558074
Kind of test site	:	Shielded room

Test setup

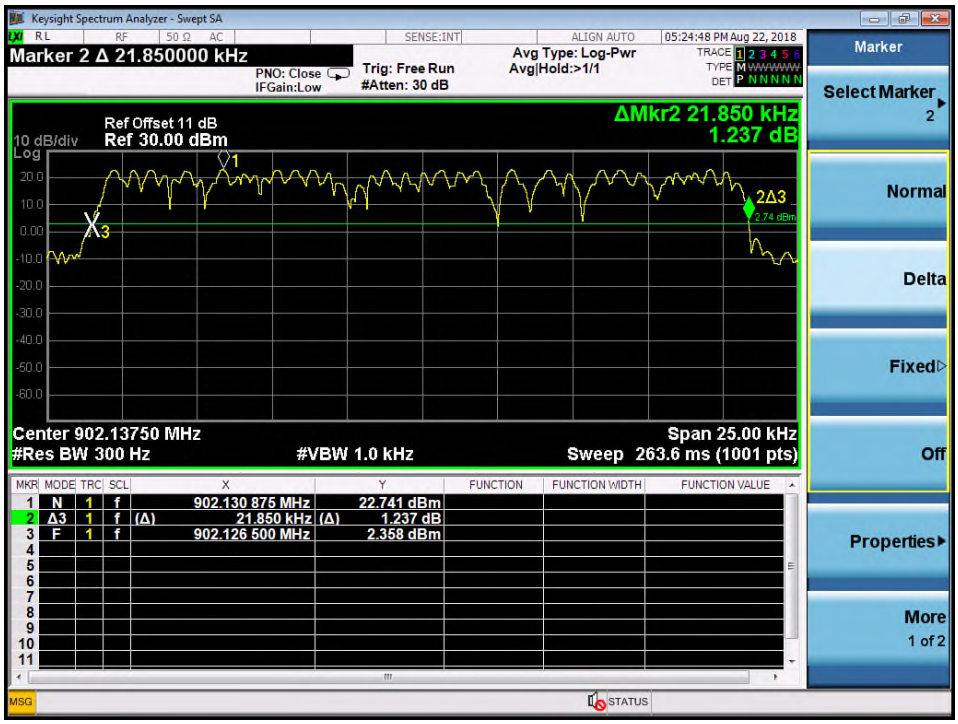
Test Channel	:	Low/ Middle/ High
Operation Mode	:	D
Ambient temperature	:	20-24°C
Relative humidity	:	50-65%
Atmospheric pressure	:	100-103 kPa

Table 8: Test result of 20dB Bandwidth

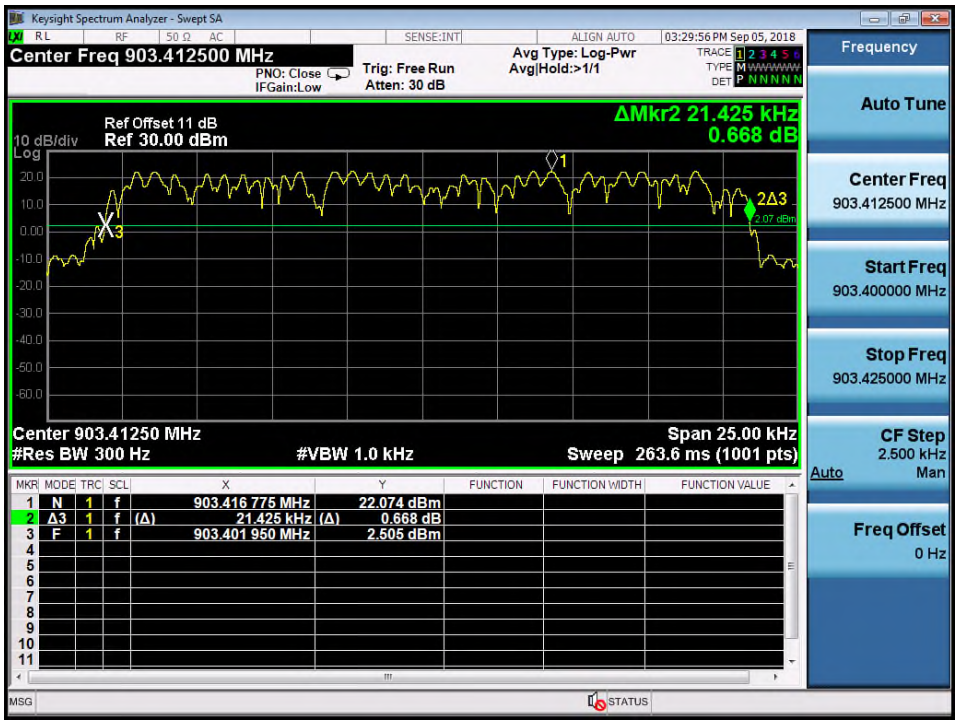
Channel	Channel Frequency (MHz)	20dB Bandwidth (kHz)	Limit (kHz)	Result
Low Channel	902.1375	21.850	<25	Pass
Mid Channel	903.4125	21.425	<25	Pass
High Channel	904.6625	21.575	<25	Pass

Test Plot of 20dB Bandwidth

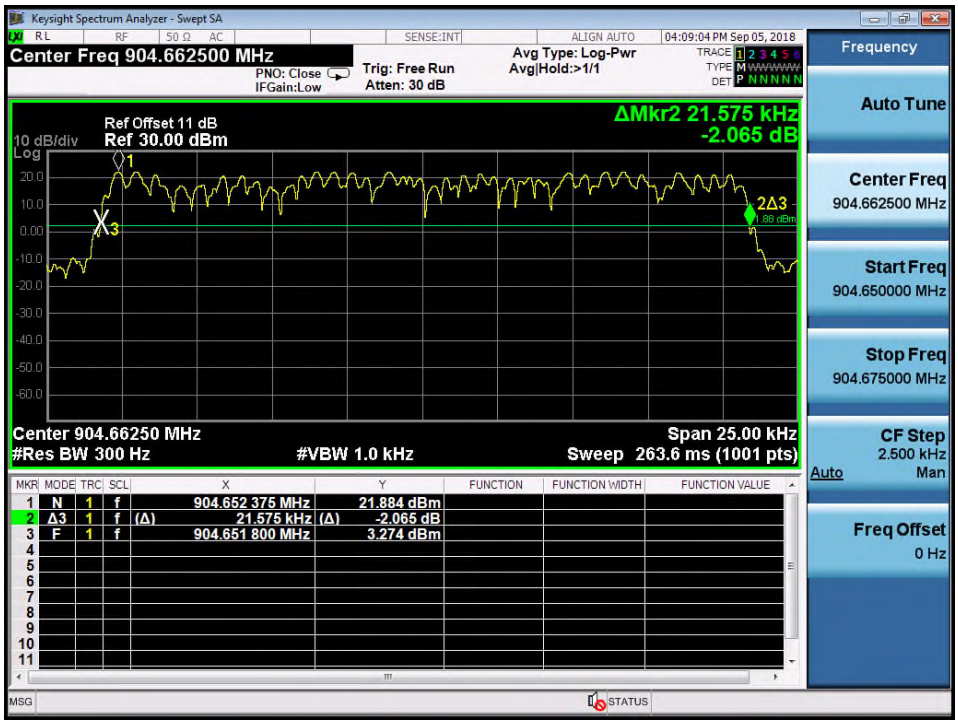
Low Channel



Middle Channel



High Channel



5.1.5 Number of Hopping Channels

RESULT: **Passed**

Test standard : FCC part 15.247(a)(1)(i)

Basic standard : ANSI C63.10:2013

Test setup

Test Channel : Hopping On
Operation Mode : C

Ambient temperature : 20-24°C
Relative humidity : 50-65%
Atmospheric pressure : 100-103 kPa

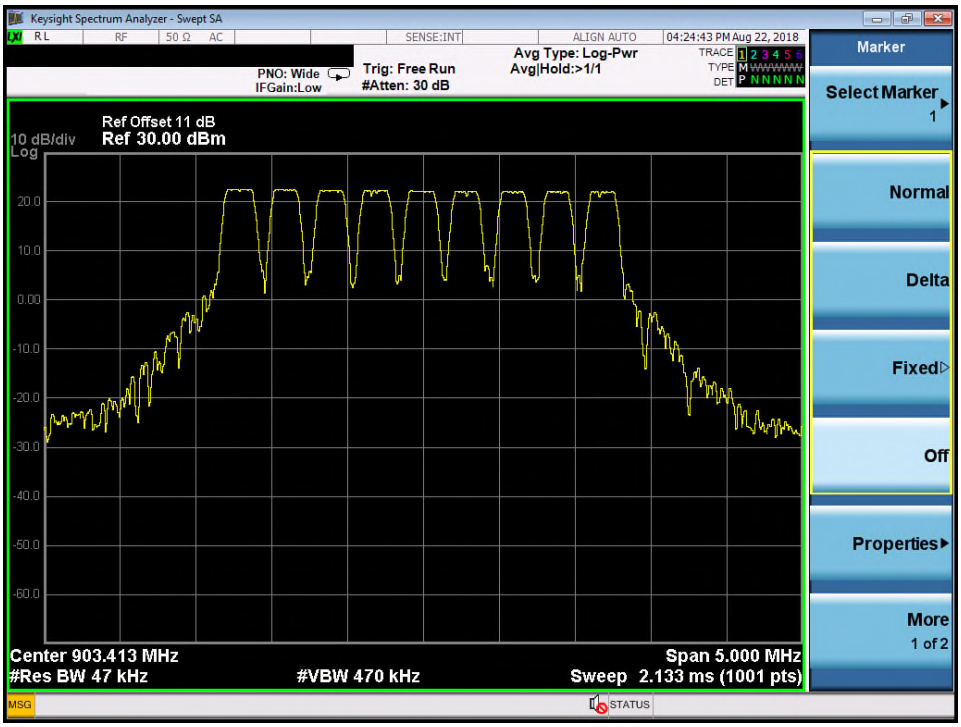
Table 9: Test result of Number of hopping frequency

Frequency Range	Measured Number of Hopping Channel	Limit	Result
902 to 928 MHz	54	≥50	Pass

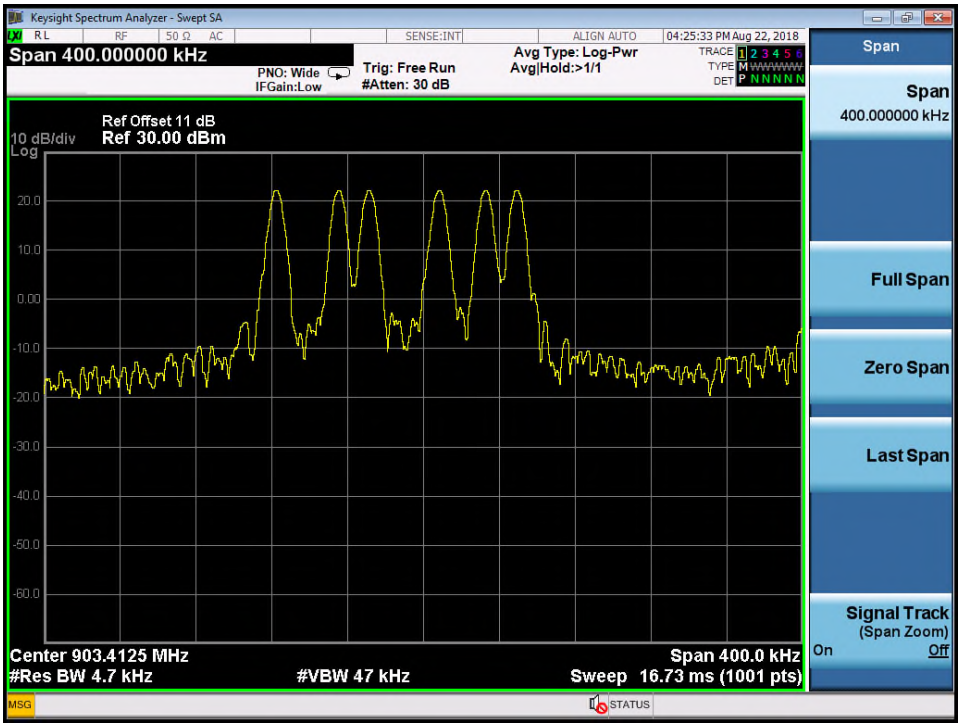
Note. 9 Macro channels × 6 Micro channels = 54 Channels

Test Plot of Number of hopping frequencies

Number of macro channels



Number of micro channels



5.1.6 Conducted spurious emissions and Frequency Band Edge measured in 100kHz Bandwidth

RESULT: **Passed**

Test standard	:	FCC part 15.247(d)
Basic standard	:	ANSI C63.10:2013, KDB558074
Limit	:	20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power)
Kind of test site	:	Shielded room

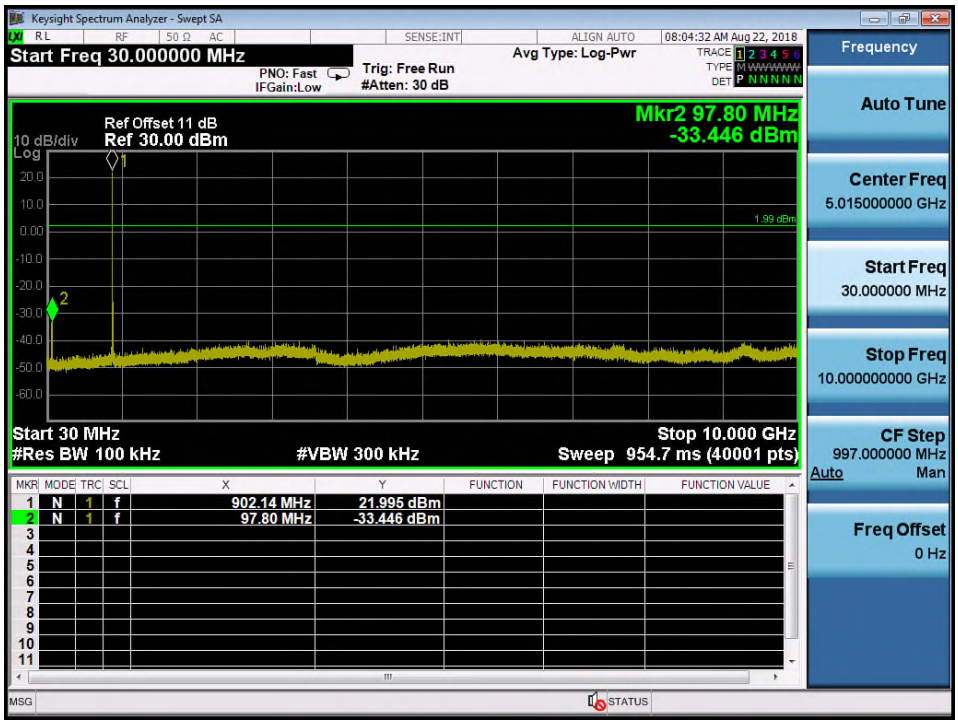
Test setup

Test Channel	:	Low/ Middle/ High for Conducted Spurious Emissions Low/ High/ Hopping for Frequency Band Edge
Operation Mode	:	A, D
Ambient temperature	:	20-24°C
Relative humidity	:	50-65%
Atmospheric pressure	:	100-103 kPa

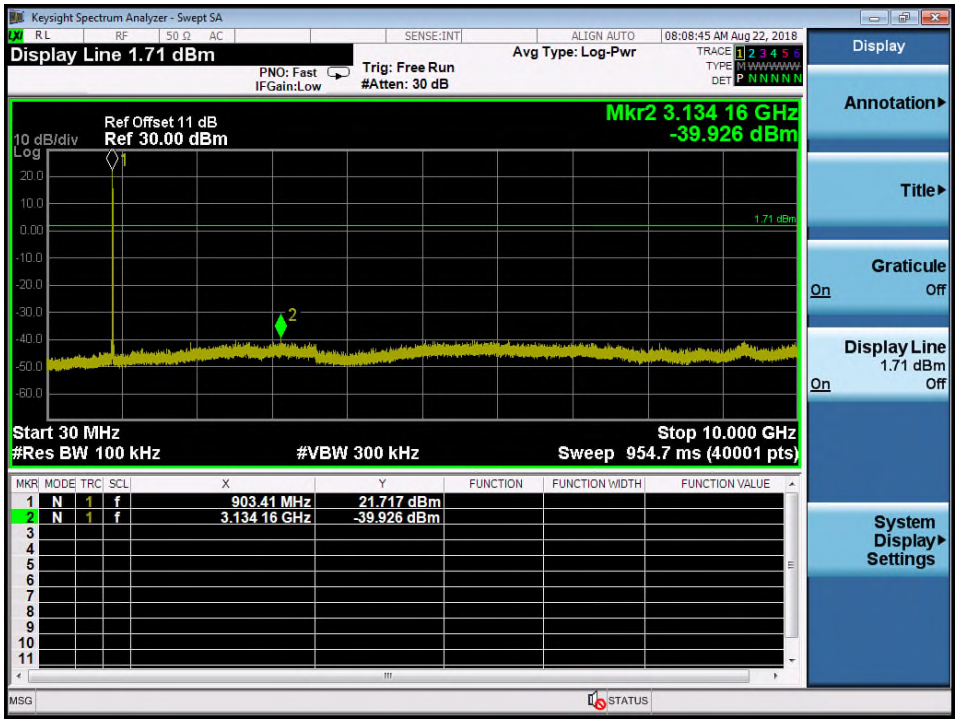
All emissions are more than 20dB below fundamental, details refer to following test plot, and compliance is achieved as well.
Due to the small size of the product and that there are no inductive components of significant size, 9kHz to 30MHz frequency range is not tested based on technical judgment.

Test Plot 100kHz Conducted Emissions

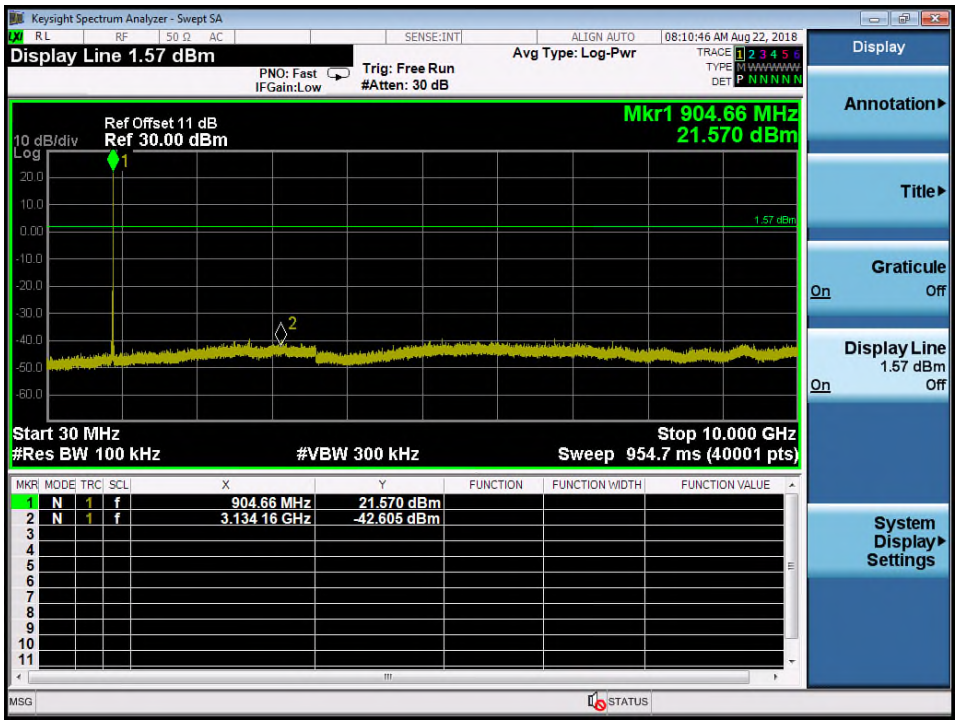
Low Channel



Middle Channel

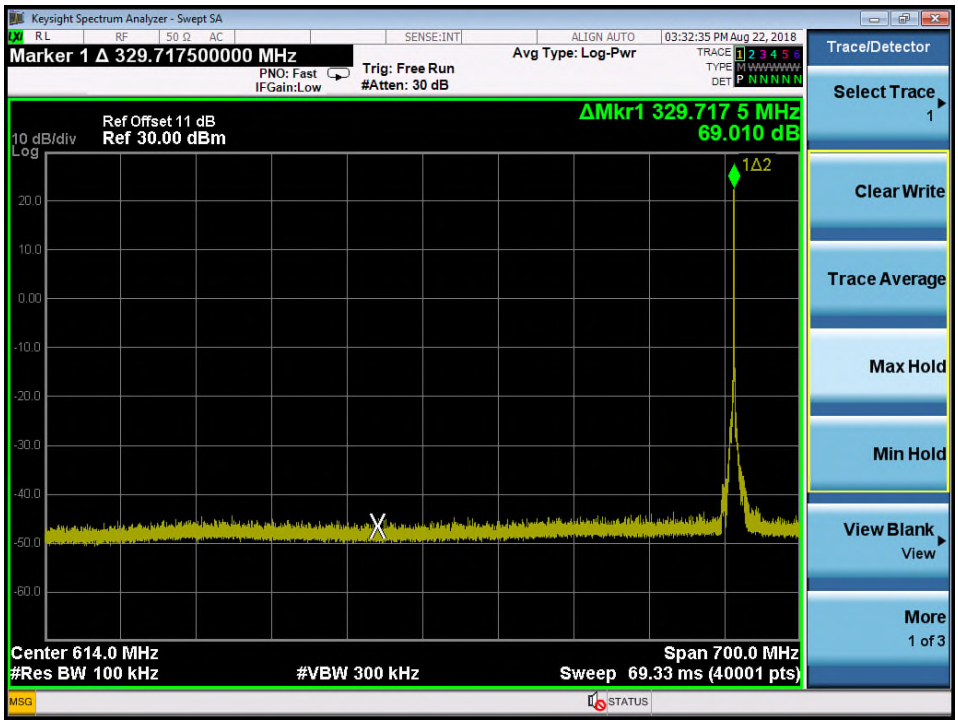


High Channel

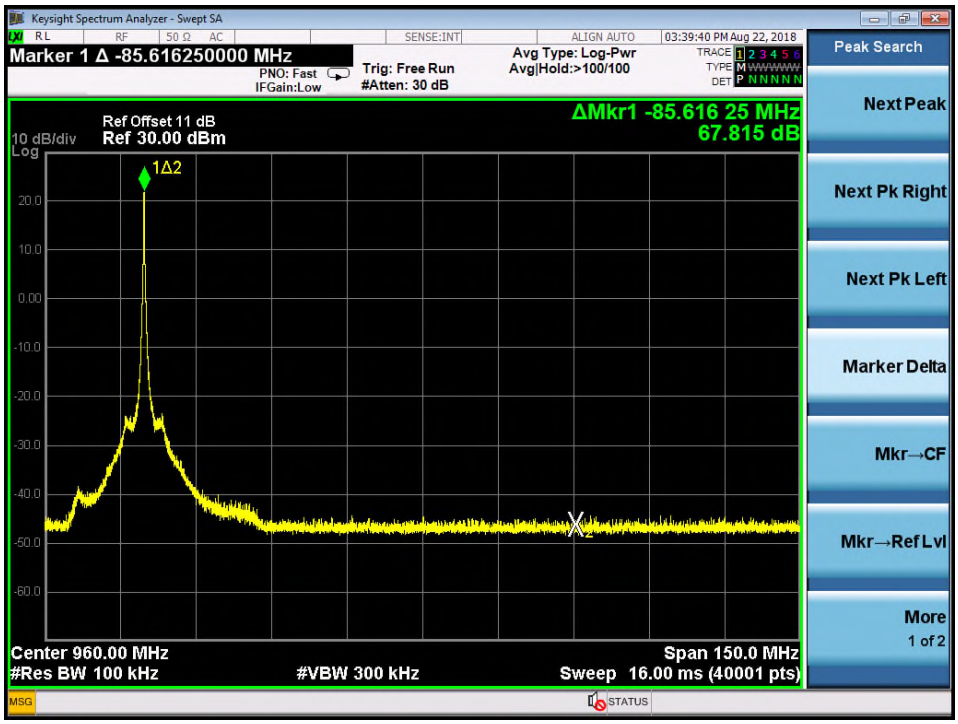


Test Plot 100kHz Band Edge

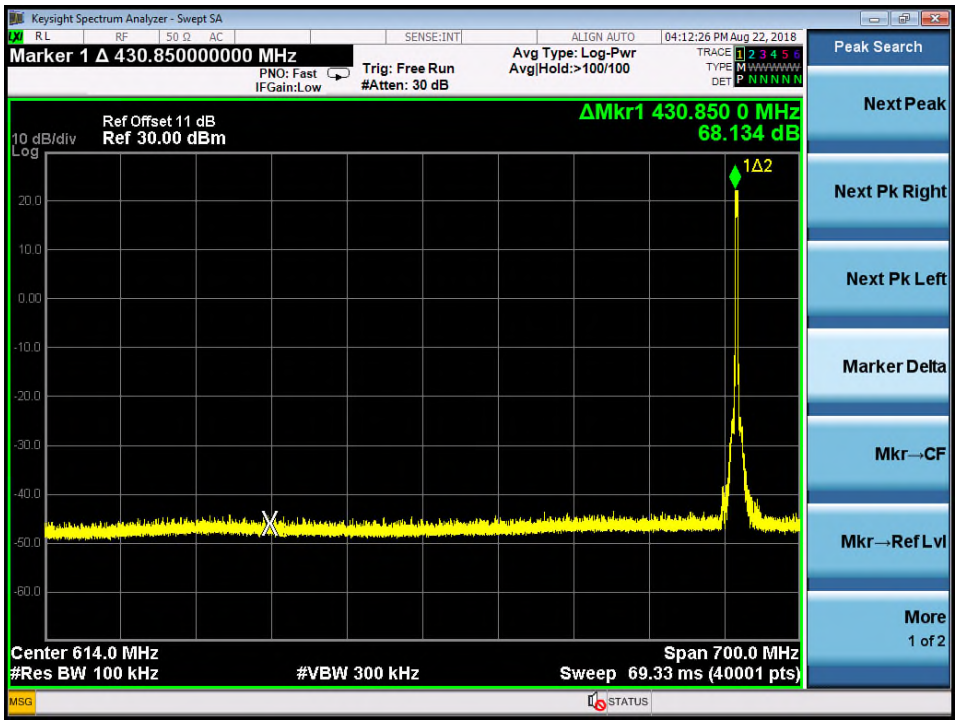
Without hopping low Channel



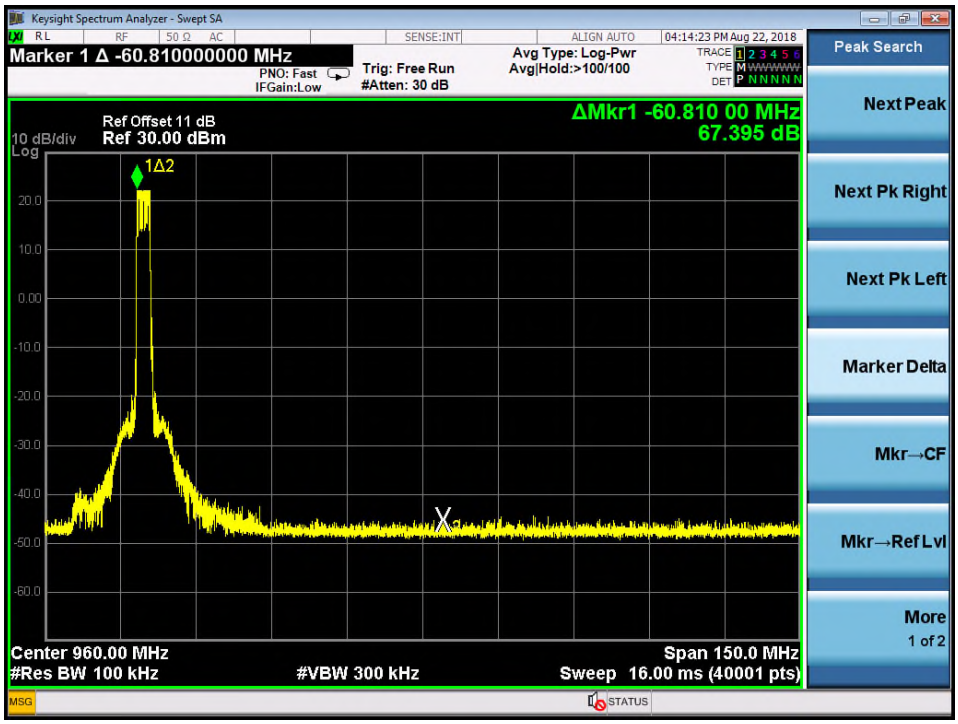
Without hopping high Channel



With hopping low hannel



With hopping high channel



5.1.7 Time of Occupancy

RESULT: **Passed**

Test standard : FCC part 15.247(a)(1)(i)

Basic standard : ANSI C63.10:2013

Prescribed Observation : 10 sec for frequency separation 25kHz < f < 250kHz
Period : 20 sec for frequency separation f < 250kHz
Limits : 0.4s
Kind of test site : Shield room

Test setup

Test Channel : Hopping on
Operation Mode : C

Ambient temperature : 20-24°C
Relative humidity : 50-65%
Atmospheric pressure : 100-103 kPa

Description of Hopping Scheme:

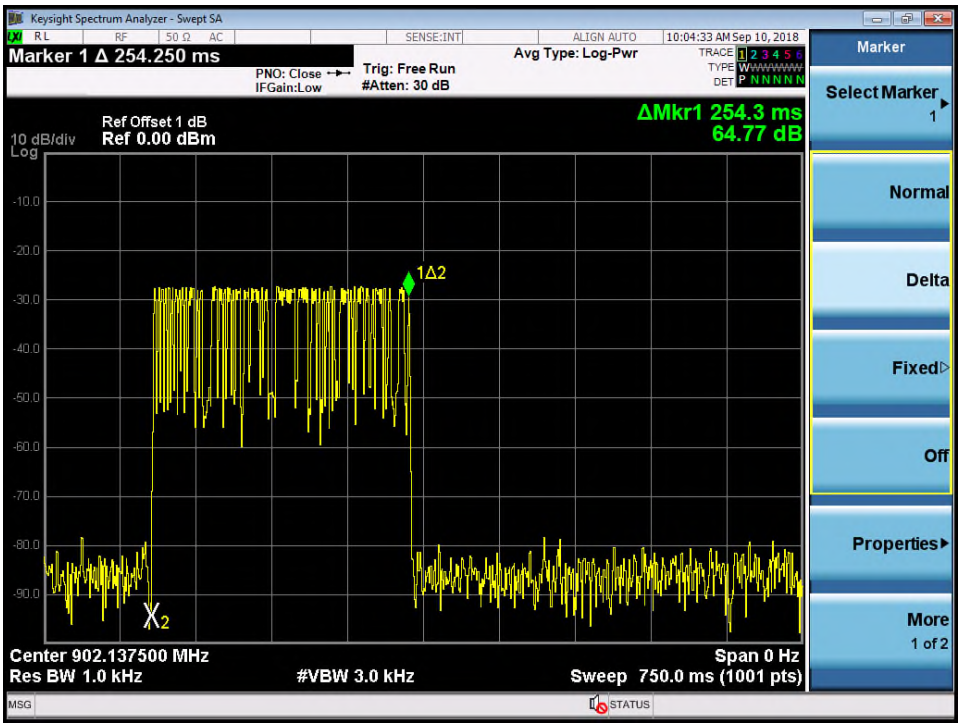
Number of Hopping Frequencies: 54

Table 10: Test result of Time of Occupancy

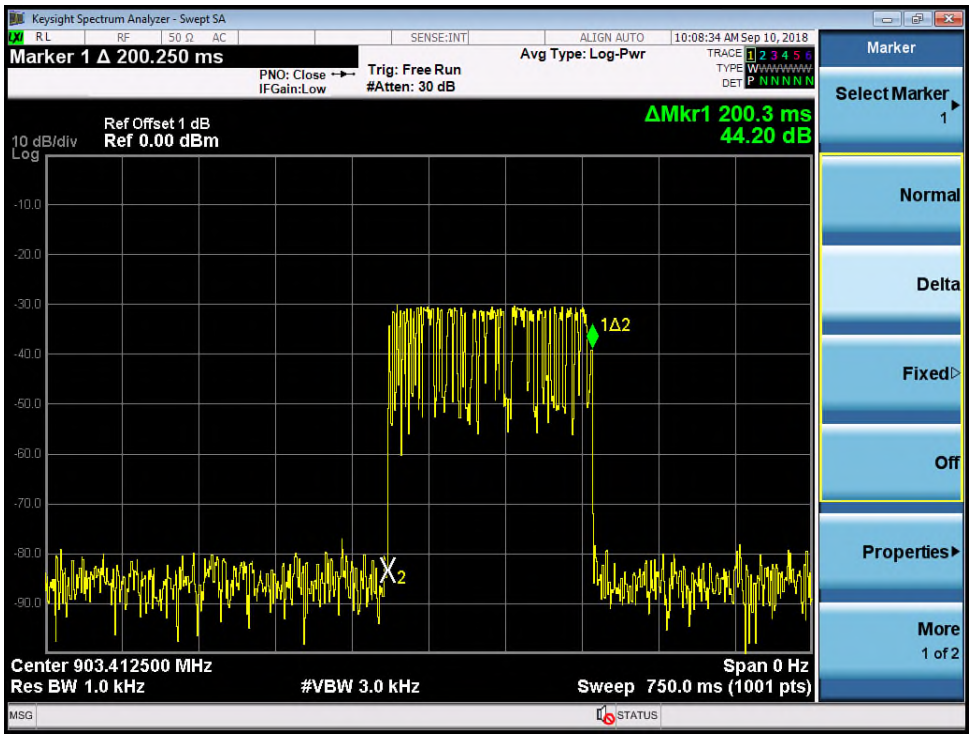
	Channel Frequency (MHz)	Dwell time (ms)	Limit (s)	Result
Pulse time (ms)	902.1375	254.3	0.4	Pass
	903.4125	200.3	0.4	Pass
	904.6625	308.3	0.4	Pass

Test Plot of Time of Occupancy

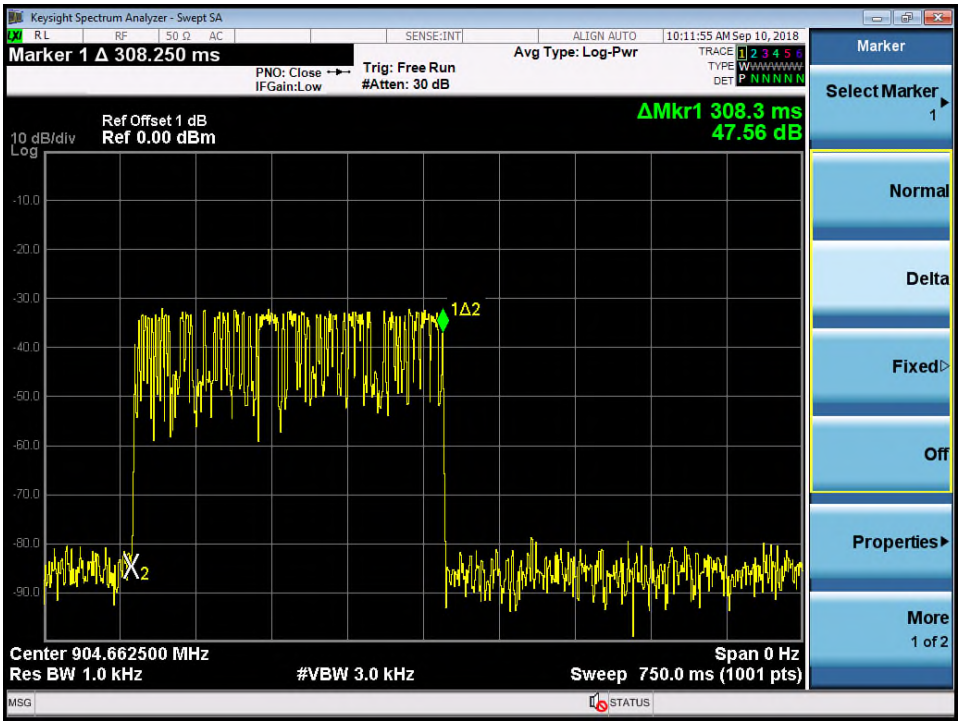
Hopping on for low channels



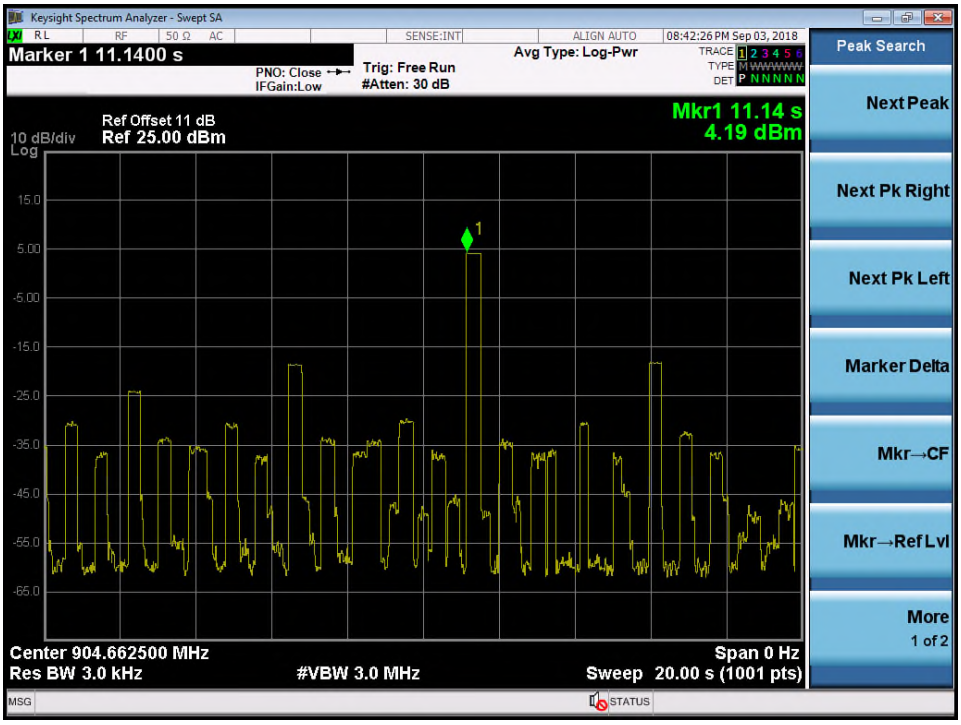
Hopping on for Middle channels



Hopping on for high channels



Hops / channel @ 20s = 1 (The highest emission is only relevant)



5.1.8 Spurious Emission

RESULT: **Passed**

Test standard	:	FCC part 15.247(d), FCC 15.205, FCC 15.209
Basic standard	:	ANSI C63.10: 2013
Limits	:	Radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a) and RSS-Gen i5, 8.10 (Table 7), must comply with the radiated emission limits specified in FCC 15.209(a) and RSS-Gen 5, 8.9 (Table 5 and 6). Emission radiated outside the restricted and authorized frequency bands must either comply with the radiated emission limits specified for the restricted bands or in FCC15.247(d) and RSS-247 i2, 5.5
Kind of test site	:	3m Semi-Anechoic Chamber

Test setup

Test Channel	:	Low/ Middle/ High
Operation mode	:	A
Ambient temperature	:	20-24 °C
Relative humidity	:	50-65 %
Atmospheric pressure	:	100-103 kPa

For details refer to Appendix D.

The Radiated Emissions testing was performed in the X, Y and Z axis orientation. The worst-case Axis orientation is recorded in this test report.

5.2 Mains Emissions

5.2.1 Mains Conducted Emissions

RESULT: **Passed**

Test standard	:	FCC Part 15.207 FCC Part 15.107
Limits	:	Mains Conducted emissions as defined in above test standards must comply with the mains conducted emission limits specified
Kind of test site	:	Shielded Room

Test setup

Test Channel	:	Middle
Operation mode	:	A
Ambient temperature	:	20-24 °C
Relative humidity	:	50-65 %
Atmospheric pressure	:	100-103 kPa

Remark: For details refer to Appendix D.

6. Safety Human exposure

6.1 Radio Frequency Exposure Compliance

6.1.1 Electromagnetic Fields

RESULT: **Passed**

Test standard : FCC KDB Publication 447498 D01, FCC Part 2.1093

Limit:

Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Test Separation Distances are illustrated in the following Table.

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	*SAR Test Exclusion Threshold* (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	

Justification for SAR test exclusion:

The Conducted Power of the device is **22.54** dBm, which corresponds to **179.47** mW.
Antenna gain is -**1.81**dBi.
The worst case duty cycle as declared by the manufacturer is as follows:

-1 frame = 208bits
-Transmission speed = 600dps
-1 Message = 3 Frames = (208/600) *3=1.04s
- Maximal send one message every 30 seconds
-Worst case of Duty cycle = (1.04/30)*100 = **3.47**%

The maximum conducted timebased-averaged output power is: **6.23** mW
The maximum radiated timebased-averaged output power is: **4.12** mW

The table below gives the calculated maximal power that could be used for source based time averaged conducted or radiated power. If this is below the calculated value the DUT is exempted from SAR evaluation.

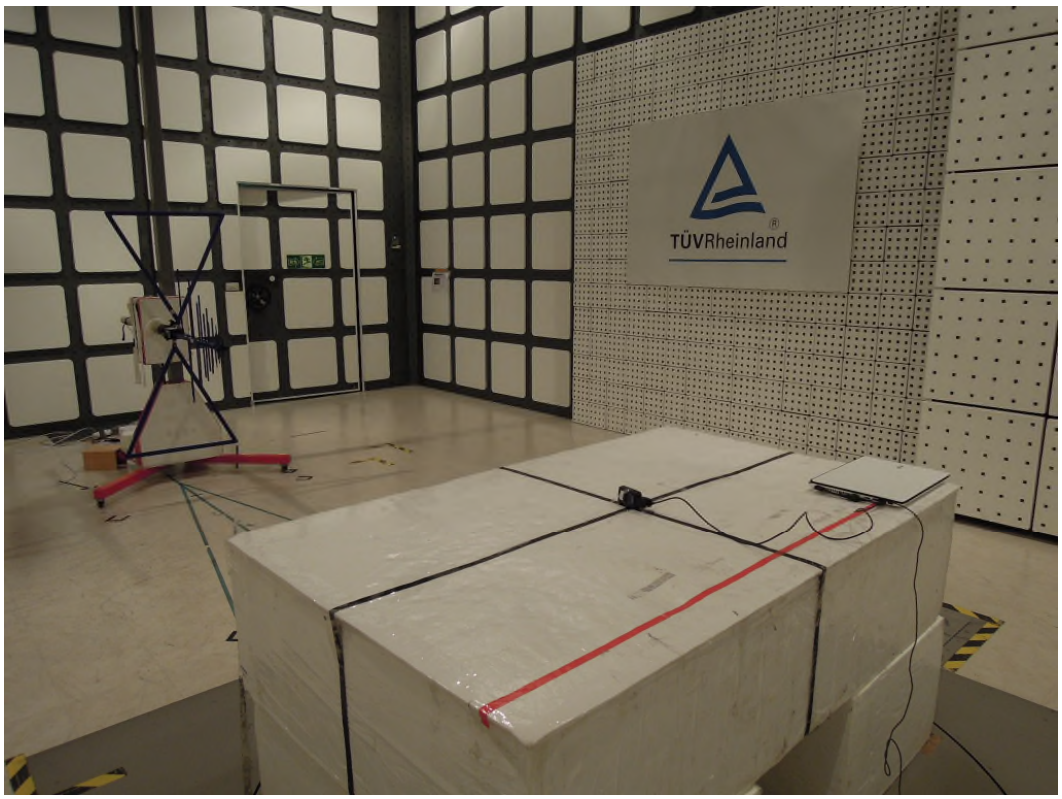
Frequency (MHz)	separation distances (mm)	Calculation Result (mW)	Limit (mW)	Result
900	5	4.12	16	Pass

The DUT is exempted from SAR evaluation with a declared minimum distance of 5 mm to the antenna for body worn operation or any hand-held or standalone use.

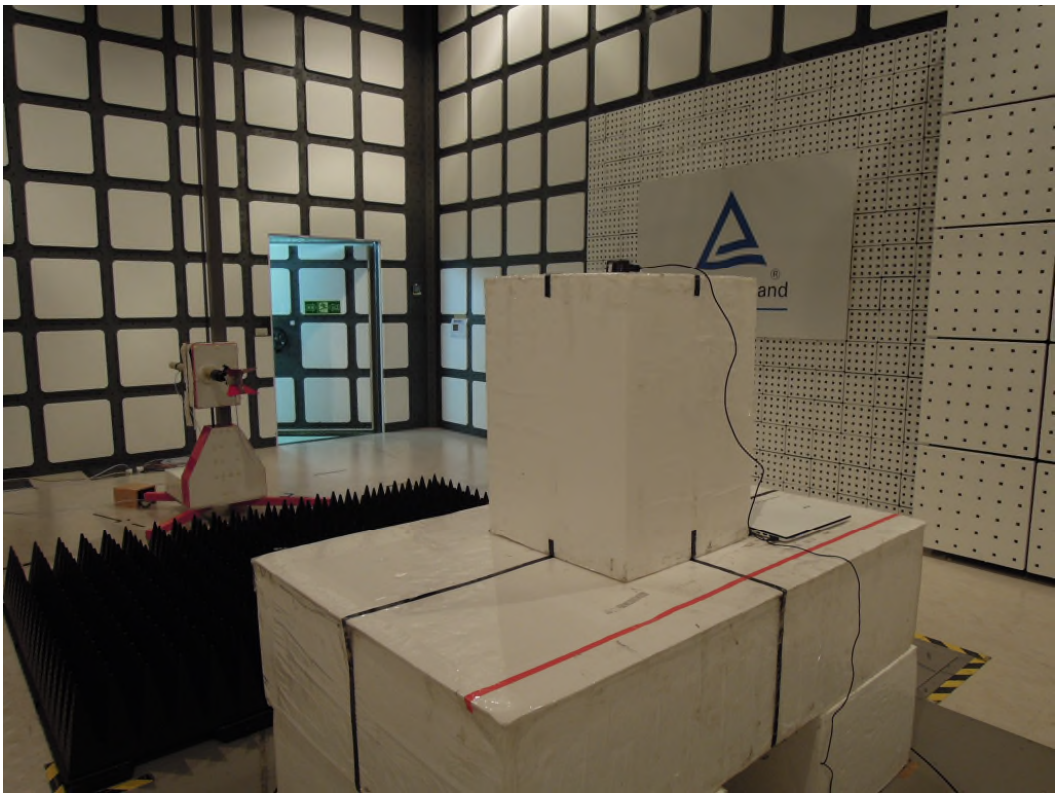
7. Photographs of the Test Set-Up

Photograph 1: Set-up for Spurious Emissions (Front View 1)

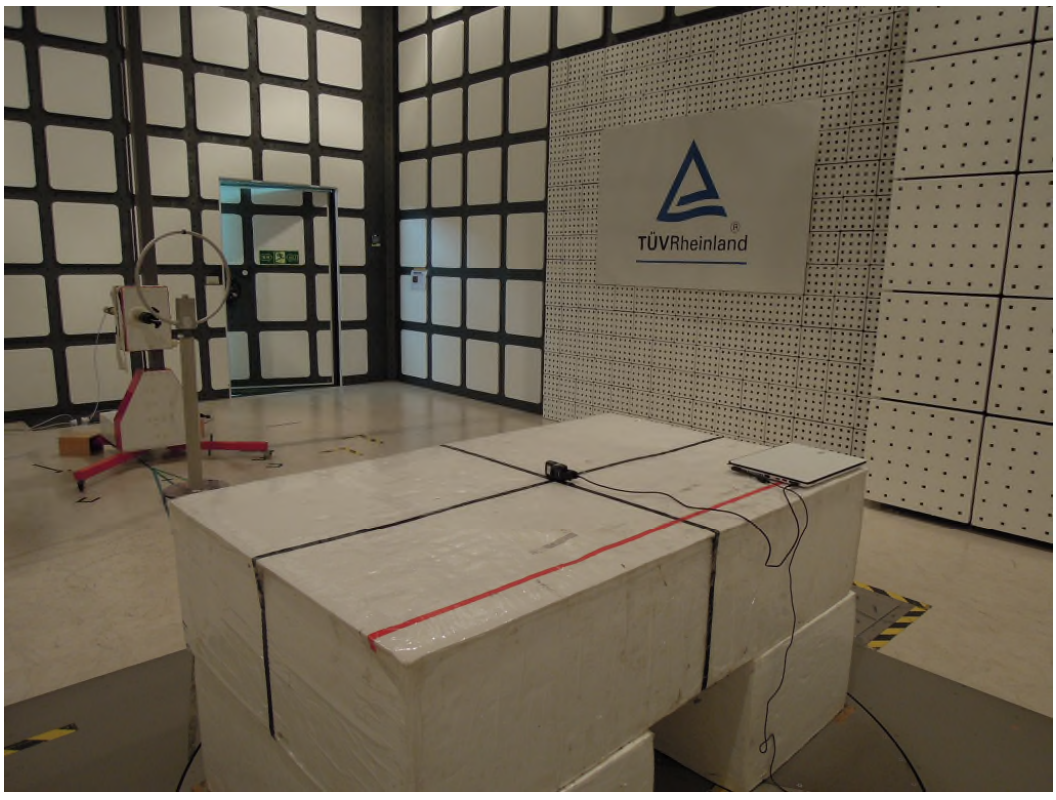
Photograph 2: Set-up for Spurious Emissions (Back View 1)



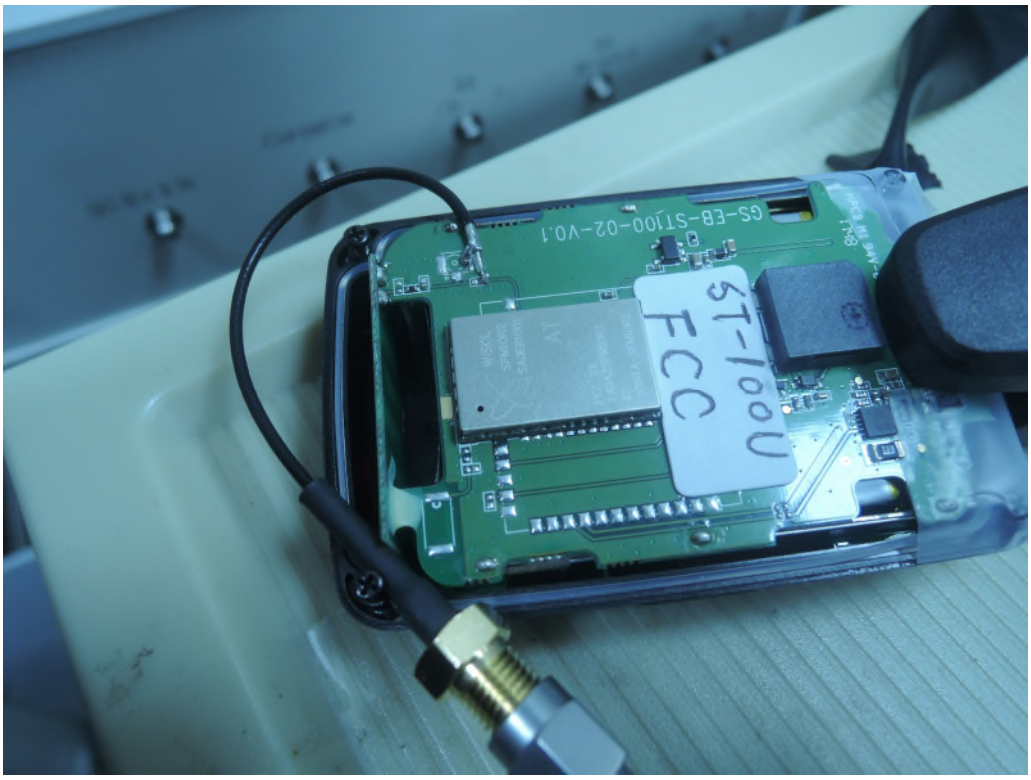
Photograph 3: Set-up for Spurious Emissions (Back View 2)



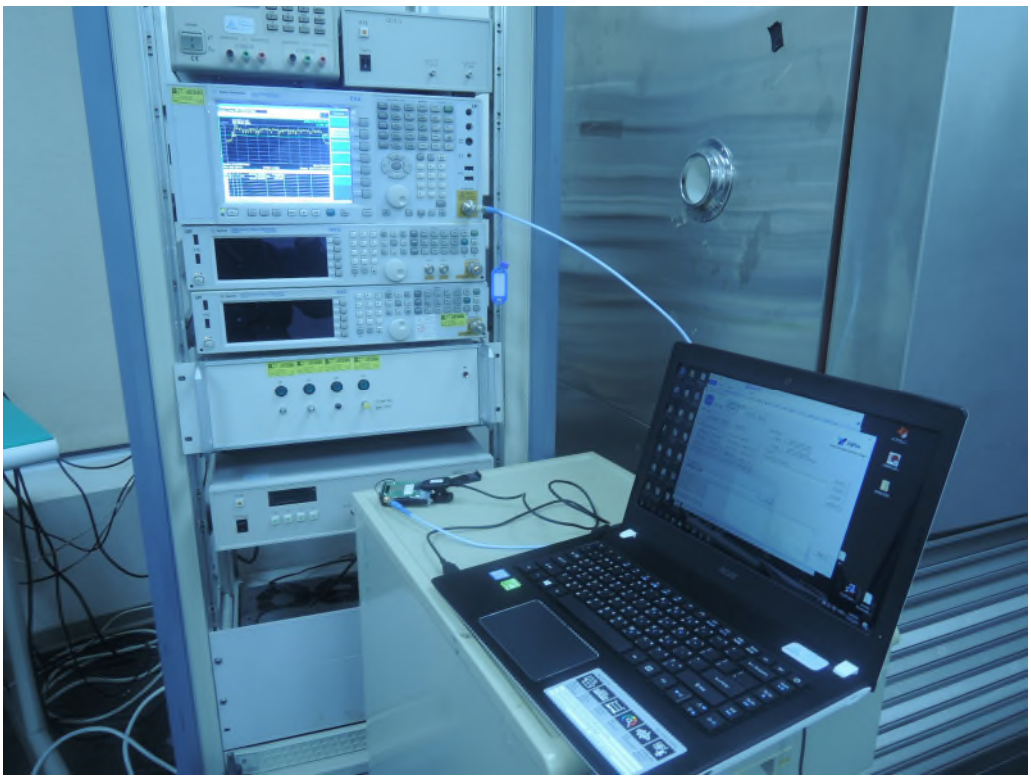
Photograph 4: Set-up for Spurious Emissions (Back View 3)



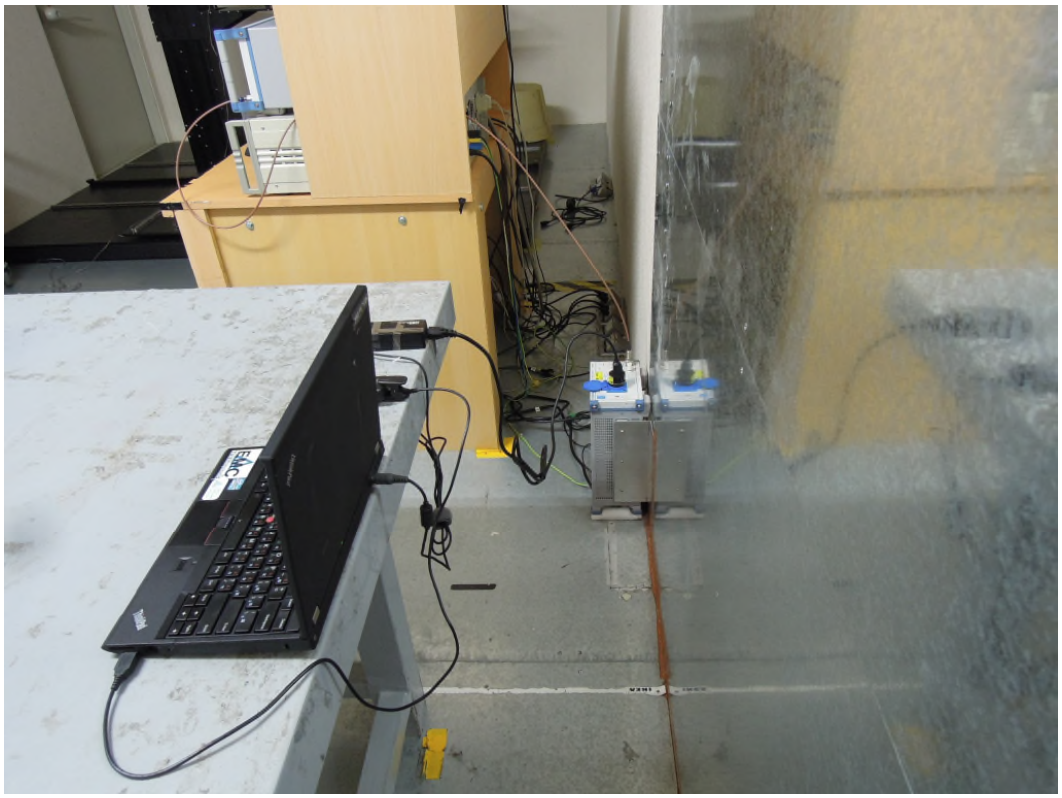
Photograph 5: Set-up for Conducted testing



Photograph 6: Set-up for Conducted testing



Photograph 7: Set-up for for Mains Conducted testing Back



Photograph 8: Set-up for for Mains Conducted testing Front

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