



<b>Prüfbericht-Nr.:</b> <i>Test Report No.:</i>	<b>50280657 001</b>	<b>Auftrags-Nr.:</b> <i>Order No.:</i>	<b>114084638</b>	<b>Seite 1 von 40</b> <i>Page 1 of 40</i>
<b>Kunden-Referenz-Nr.:</b> <i>Client Reference No.:</i>	<b>N/A</b>	<b>Auftragsdatum:</b> <i>Order date:</i>	<b>December 6, 2018</b>	
<b>Auftraggeber:</b> <i>Client:</i>	<b>AKCess Pro Limited, 121/39 RS Tower.Ratchadapisek Rd., Dindaeng,TH-10400</b> <b>Dindaeng, Bangkok Thailand</b>			
<b>Prüfgegenstand:</b> <i>Test item:</i>	<b>LoRa RF Transceiver Module</b>			
<b>Bezeichnung / Typ-Nr.:</b> <i>Identification / Type No.:</i>	<b>LRM9B</b>			
<b>Auftrags-Inhalt:</b> <i>Order content:</i>	<b>FCC Part 15C Test report (LoRa) (Hybrid)</b>			
<b>Prüfgrundlage:</b> <i>Test specification:</i>	<b>FCC 47CFR Part 15: Subpart C Section 15.247</b>			
<b>Wareneingangsdatum:</b> <i>Date of receipt:</i>	<b>07/08/2019</b>			
<b>Prüfmuster-Nr.:</b> <i>Test sample No.:</i>	<b>A000953063-003</b> <b>A000953063-004</b>			
<b>Prüfzeitraum:</b> <i>Testing period:</i>	<b>26-Feb-2019 - 3-Jan-2020</b>			
<b>Ort der Prüfung:</b> <i>Place of testing:</i>	<b>EMC/RF Laboratory Taipei</b>			
<b>Prüflaboratorium:</b> <i>Testing laboratory:</i>	<b>TUV Rheinland Taiwan Ltd.</b>			
<b>Prüfergebnis*:</b> <i>Test result*:</i>	<b>Pass</b>			
<b>Report date / tested by:</b>		<b>kontrolliert von / reviewed by:</b>		
				
<b>30-Jan-2020</b>	<b>Mars Y.J. Lin/Project Engineer</b>	<b>30-Jan-2020</b>	<b>Ryan W. T. Chen / Project Manager</b>	
<b>Datum</b>	<b>Name / Stellung</b>	<b>Unterschrift</b>	<b>Datum</b>	<b>Name / Stellung</b>
<i>Date</i>	<i>Name / Position</i>	<i>Signature</i>	<i>Date</i>	<i>Name / Position</i>
<b>Sonstiges / Other:</b>				
<b>Zustand des Prüfgegenstandes bei Anlieferung:</b> <i>Condition of the test item at delivery:</i>		<b>Prüfmuster vollständig und unbeschädigt</b> <i>Test item complete and undamaged</i>		
* 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				
<b>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.</b> <i>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.</i>				

## TEST SUMMARY

### 5.1.1 ANTENNA REQUIREMENT

RESULT: *Passed*

### 5.1.2 PEAK OUTPUT POWER

RESULT: *Passed*

### 5.1.3 20dB BANDWIDTH

RESULT: *Passed*

### 5.1.4 POWER DENSITY

RESULT: *Passed*

### 5.1.5 CONDUCTED SPURIOUS EMISSIONS AND FREQUENCY BAND EDGE MEASURED IN 100KHZ BANDWIDTH

RESULT: *Passed*

### 5.1.6 SPURIOUS EMISSION

RESULT: *Passed*

### 5.1.7 FREQUENCY SEPARATION

RESULT: *Passed*

### 5.1.8 NUMBER OF HOPPING FREQUENCY

RESULT: *Passed*

### 5.1.9 TIME OF OCCUPANCY

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**  
(File Name: 50280657APPENDIX P)
- Appendix D: Test Result of Radiated Emissions**  
(File Name: 50280657APPENDIX D)

Test Specifications

The following standards were applied

**Table 1: Applied Standard and Test Levels**

<b>Radio</b>
FCC CFR47 Part 15: Subpart C Section 15.247 ANSI C63.10:2013 KDB558074 D01 DTS Meas Guidance v05 FCC Part 2.1091

## 2. Test Sites

### 2.1 Test Laboratory

TUV Rheinland Taiwan Ltd.  
Taipei Testing Laboratories

11F. No.758, Sec. 4, Bade Rd., Songshan Dist.  
Taipei City 105  
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.: 180491  
IC Canada Registration No.: 9465A  
TAF Accredited NCC Test Lab. No.:3567  
TAF ISO17025 Certification effective period: 6<sup>th</sup>-May-2019 to 05<sup>th</sup>-May-2022



Testing Laboratory  
3567

## 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	Audix	e3	Ver.9	N/A	N/A
EMI Test Receiver	R&S	ESR 7	101549	2018/11/12	2019/11/10
Spectrum Analyzer	R&S	FSV 40	101514	2019/02/07	2020/02/07
Preamplifier (30MHz -1GHz)	Hewlett Packard	8447D	2944A06641	2018/08/31	2019/08/31
Preamplifier (18 GHz -40 GHz)	EMC Instruments	EMC184045SE	980652	2019/02/25	2020/02/25
Pre-Amplifier (1GHz~18GHz)	EM Electronics	EM01G18G	60649	2018/08/24	2019/08/24
Bilog Antenna	TESEQ	CBL 6111D	40101	2018/10/03	2019/10/03
Horn Antenna	ETS-Lindgren	3117	218931	2018/12/27	2019/12/27
Horn Antenna (18GHz~40GHz)	COM-POWER	AH-840	101029	2018/12/22	2019/12/22
Loop Antenna	Schwarzbeck	FMZB 1513	1513-076	2019/07/11	2020/07/11
EMI Test Receiver	R&S	ESR 7	101549	2018/11/12	2019/11/10
LISN (1 phase)	R&S	ENV216	101243	2019/06/23	2020/06/23
EXA Signal Analyzer	KEYSIGHT	N9010A	MY53470241	2019/02/15	2020/02/15
power Meter	Anritsu	ML2495A	1901008	2019/04/29	2020/04/28
Power Sensor	Anritsu	MA2411B	1725269	2019/04/29	2020/04/28
Spectrum Analyzer	R&S	FSP30	837866	2019/09/16	2020/09/15

## 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

requiring calibration is calibrated periodically in a suitably accredited Calibration Lab. Additionally all equipment is verified for proper performance on a regular basis 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
Adjacent channel power	± 3 dB
Radiated emission of transmitter, valid up to 26 GHz	± 6 dB
Radiated emission of receiver, valid up to 26 GHz	± 6 dB
Temperature	± 2 °C
Humidity	± 10 %



### 3. General Product Information

#### 3.1 Product Function and Intended Use

The EUT is a LoRa Module. It contains a LoRa/FSK technology 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	LoRa RF Transceiver Module
Type Identification	LRM9B
FCC ID	2ARUS-LRM9B

**Table 5: Technical Specification of EUT**

Technical Specification	Value
Operating Frequency	902.3-914.9MHz
Channel number	17 channels
Operation Voltage	3.7Vdc
Modulation	GFSK and LoRa
Antenna gain	3.55 dBi

Channel list					
Frequency (MHz)	902.3	905.5	908.5	910.9	914.9
	902.9	906.5	908.9	911.5	
	903.5	906.9	909.5	912.5	
	904.9	907.9	909.9	912.9	

### 3.3 Independent Operation Modes

The basic operation modes are:

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

### **3.4 Noise Generating and Noise Suppressing Parts**

Refer to the Circuit Diagram.

### **3.5 Submitted Documents**

- Circuit Diagram
- Instruction Manual
- Rating Label
- 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

Test operation refers to test setup in chapter 4. All testing were performed according to the procedures in ANSI C63.10: 2013

The samples were used as follows:

Conducted: **A000953063-004**

Radiation: **A000953063-003**

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

Test Software	Hyperterminal
---------------	---------------

### 4.3 Special Accessories and Auxiliary Equipment

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

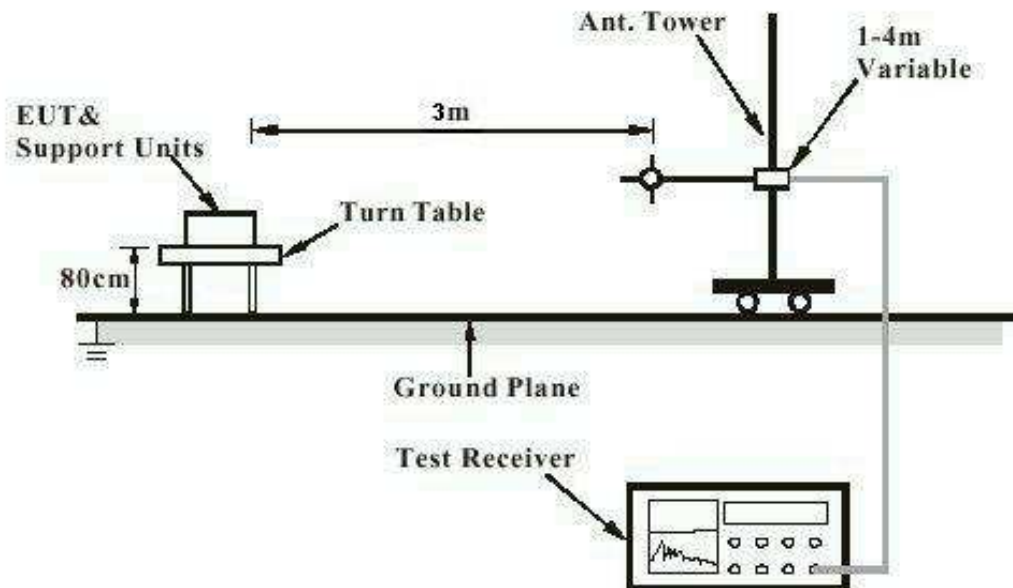
Description	Manufacturer	Model No.	Serial No.
Notebook(EMC-06)	Lenovo	TP00048A	PB-0F8B2

## 4.4 Countermeasures to achieve EMC Compliance

The test sample which has been tested containing the noise suppression parts as in the Photo Appendix and the Test Setup Photos. No additional measures were employed to achieve compliance.

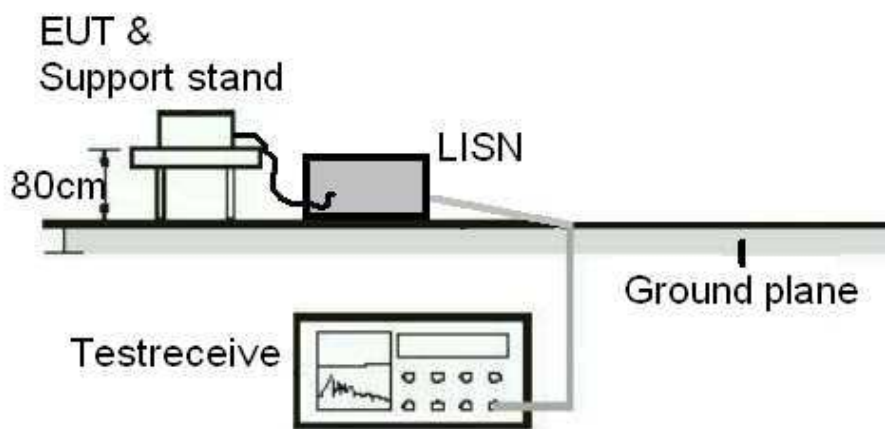
## 4.5 Test Setup Diagram

**Diagram of Measurement Configuration for Radiation Test**

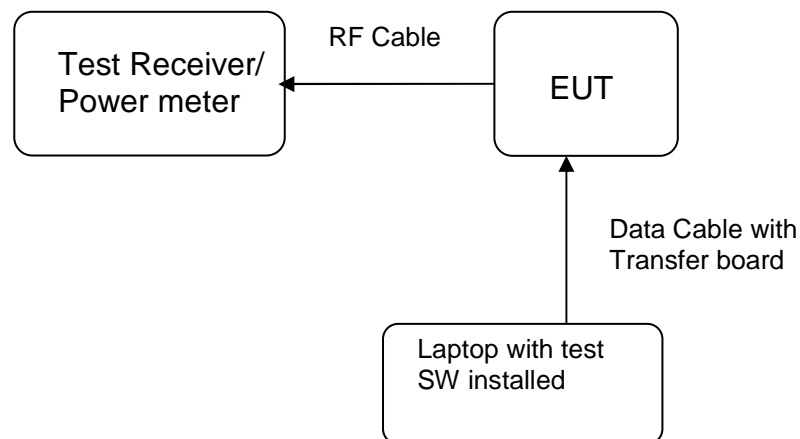


Note: Measurements above 1 GHz are done with a table height of 1.5m

**Diagram of Measurement Equipment Configuration for Mains Conduction Measurement**



**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 3.55 dBi . The antenna is a Dipole Antenna 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 Peak Output Power

**RESULT:**
**Passed**

Test standard : FCC Part 15.247(b)(1),

Basic standard : ANSI C63.10:2013

Kind of test site : Shielded room

**Test setup**

 Test Channel : Low/ Middle/ High  
 Operation Mode : A

 Ambient temperature : 22-26 °C  
 Relative humidity : 50-65 %  
 Atmospheric pressure : 100-103 kPa

**Table 6: Test result of Peak Output Power**

Channel	Channel Frequency	Peak Output Power		Limit
	(MHz)	(dBm)	(W)	(W)
Low Channel	902.3	16.63	0.04603	0.125
Middle Channel	908.5	16.60	0.04571	0.125
High Channel	914.9	16.56	0.04529	0.125

 Pmax: 46.0257 mW  
 Average Conducted power: 16.61dBm (45.81mW)



**Produkte**

Products

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**5.1.3 20dB Bandwidth****RESULT:****Passed**

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

**Test setup**

Test Channel : Low/ Middle/ High  
Operation Mode : A

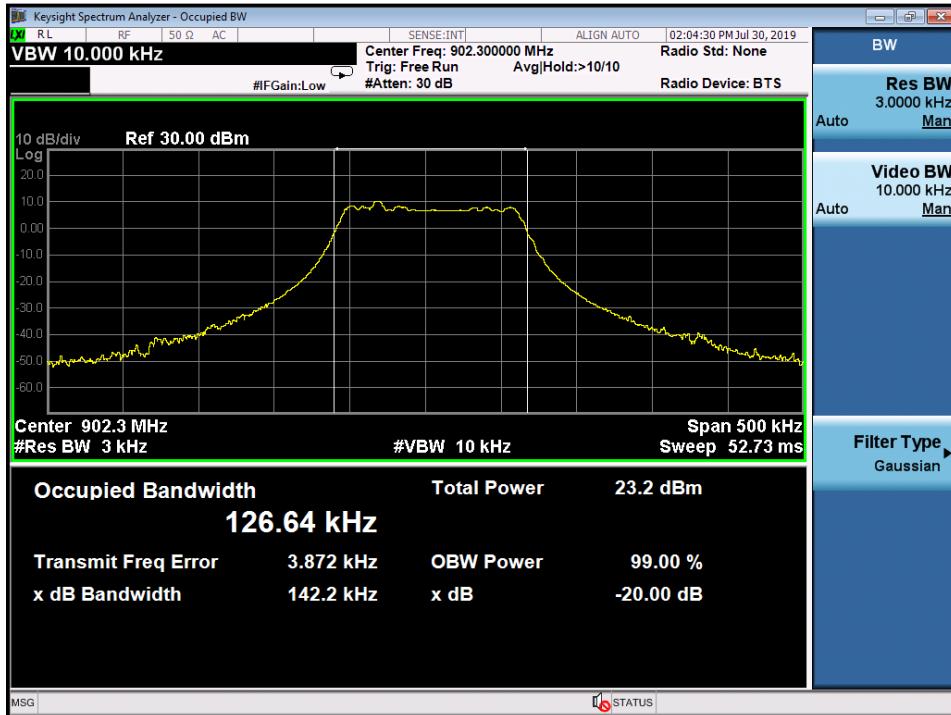
Ambient temperature : 22-26°C  
Relative humidity : 50-65%  
Atmospheric pressure : 100-103kPa

**Table 7: Test result of 20dB Bandwidth**

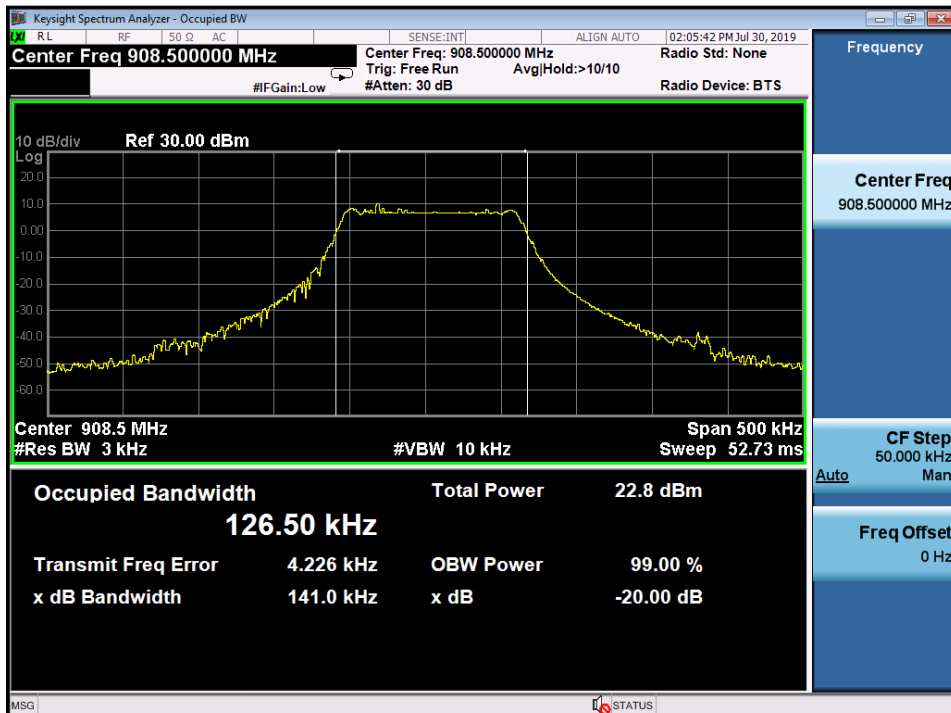
Channel	Channel Frequency (MHz)	20dB Bandwidth (kHz)	Limit (MHz)	Result
Low Channel	902.3	142.2	1.5	Pass
Mid Channel	908.5	141	1.5	Pass
High Channel	914.9	142	1.5	Pass

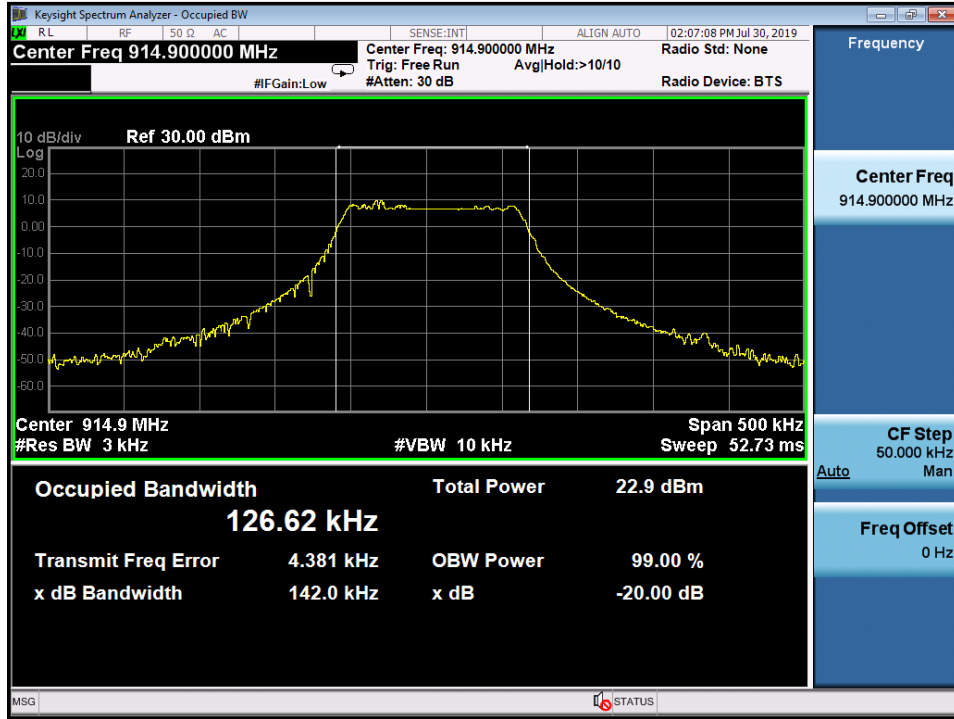
## Test Plot of 20dB Bandwidth

### Low Channel



### Middle Channel



**High Channel**


## 5.1.4 Power Density

**RESULT:****Passed**

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

**Test setup**

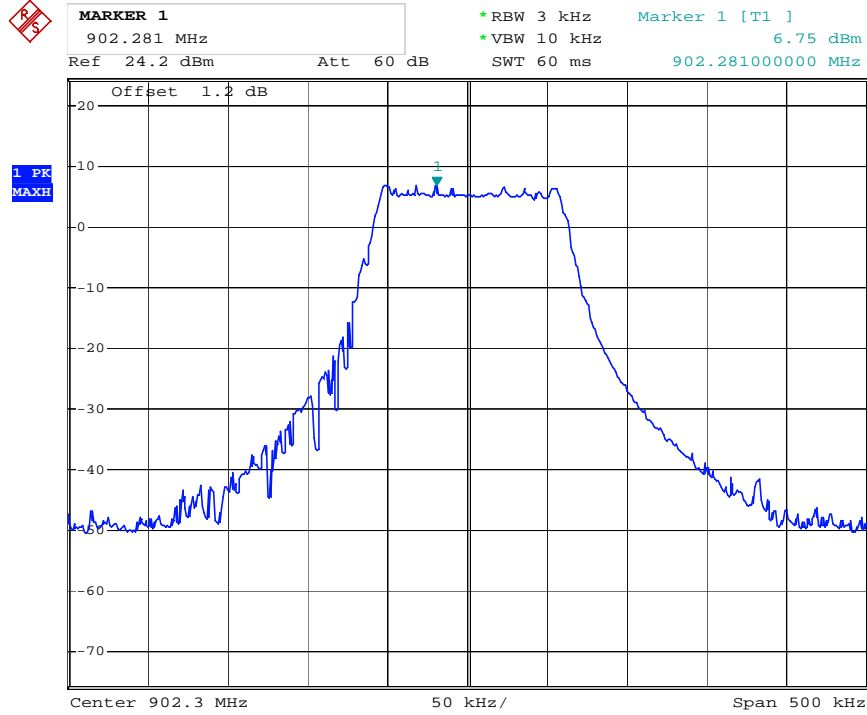
Test Channel : Low/ Middle/ High  
Operation Mode : A  
Ambient temperature : 22-26°C  
Relative humidity : 50-65%  
Atmospheric pressure : 100-103 kPa

**Table 8: Test result of Power Density**

Channel	Channel Frequency (MHz)	Power Density	Limit
		(dBm)	(dBm)
Low Channel	902.3	6.75	8
Middle Channel	908.5	6.72	8
High Channel	914.9	7.06	8

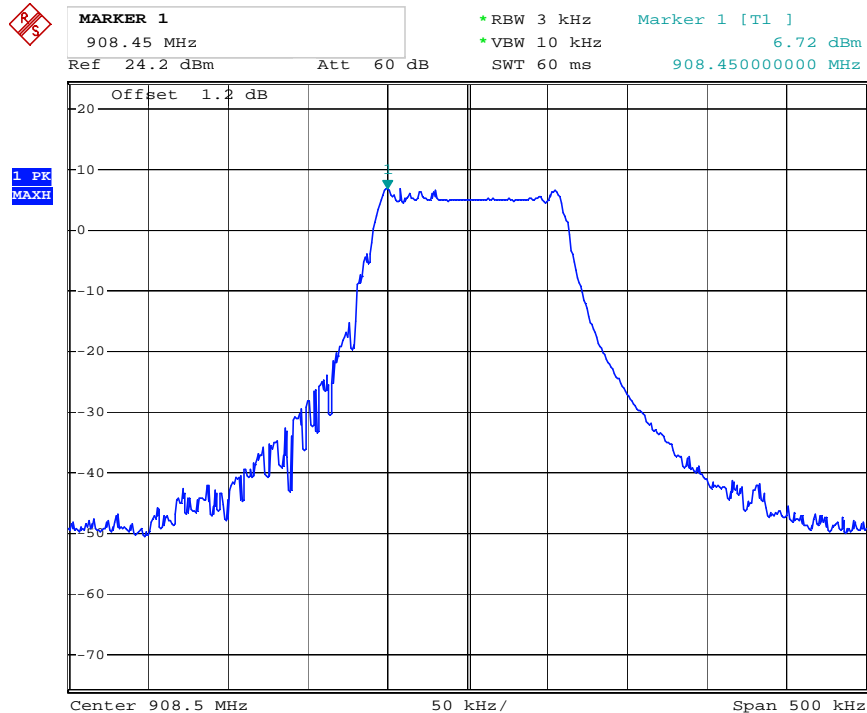
## Test Plot of Power Density

### Low Channel



Date: 3.JAN.2020 16:22:50

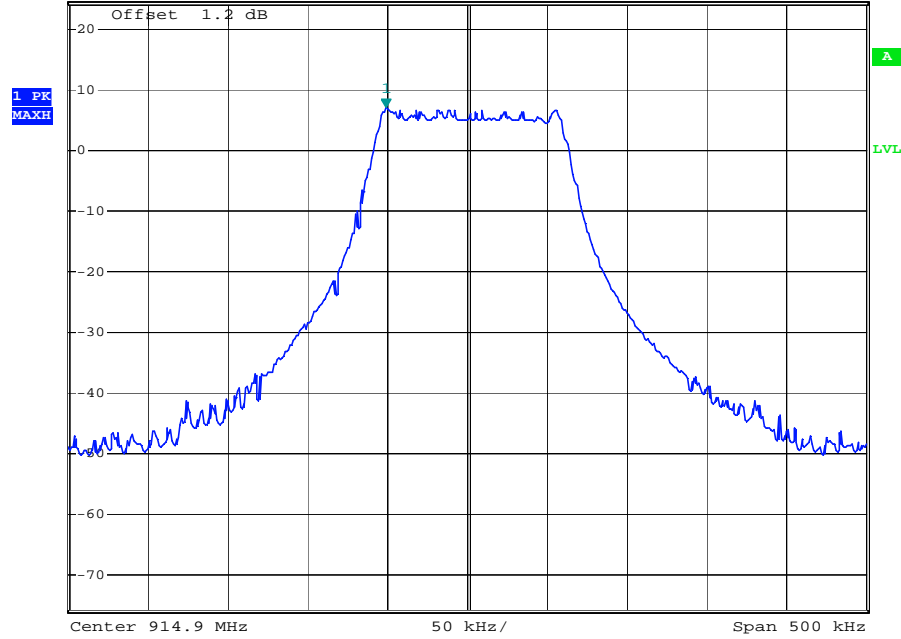
### Middle Channel



Date: 3.JAN.2020 16:21:46

**High Channel**


<b>MARKER 1</b>	*RBW 3 kHz	Marker 1 [T1 ]
914.849 MHz	*VBW 10 kHz	7.06 dBm
Ref 24.2 dBm	Att 60 dB	SWT 60 ms
		914.849000000 MHz



Date: 3.JAN.2020 16:20:21

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### 5.1.5 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 LP0002(2018) Appendix II
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**

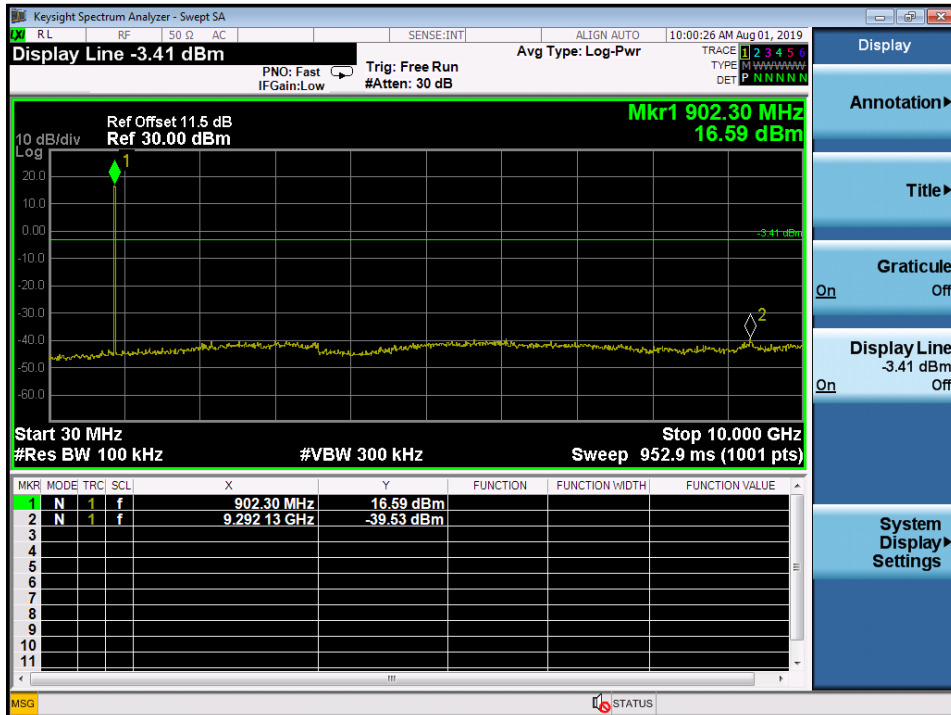
Test Channel	:	Low/ Middle/ High for Conducted Spurious Emissions Low/ High/ Hopping on for Frequency Band Edge
Operation Mode	:	A
Ambient temperature	:	22-26°C
Relative humidity	:	50-65%
Atmospheric pressure	:	100-103 kPa

All emissions are more than 20dB below fundamental, details refer to following test plot, and compliance is achieved as well.

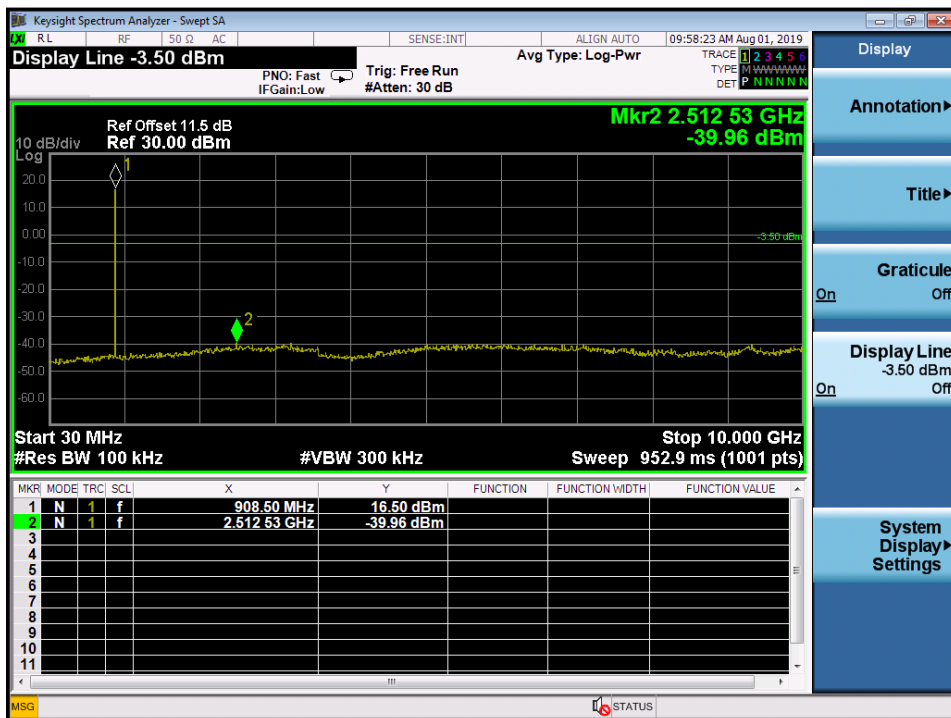
Due to the small size of the RF circuit and that there are no inductive components of significant size connected to the antenna port, 9kHz to 30MHz frequency range is not tested based on technical judgment.

## Test Plot of 100kHz Conducted Emissions

### Low Channel

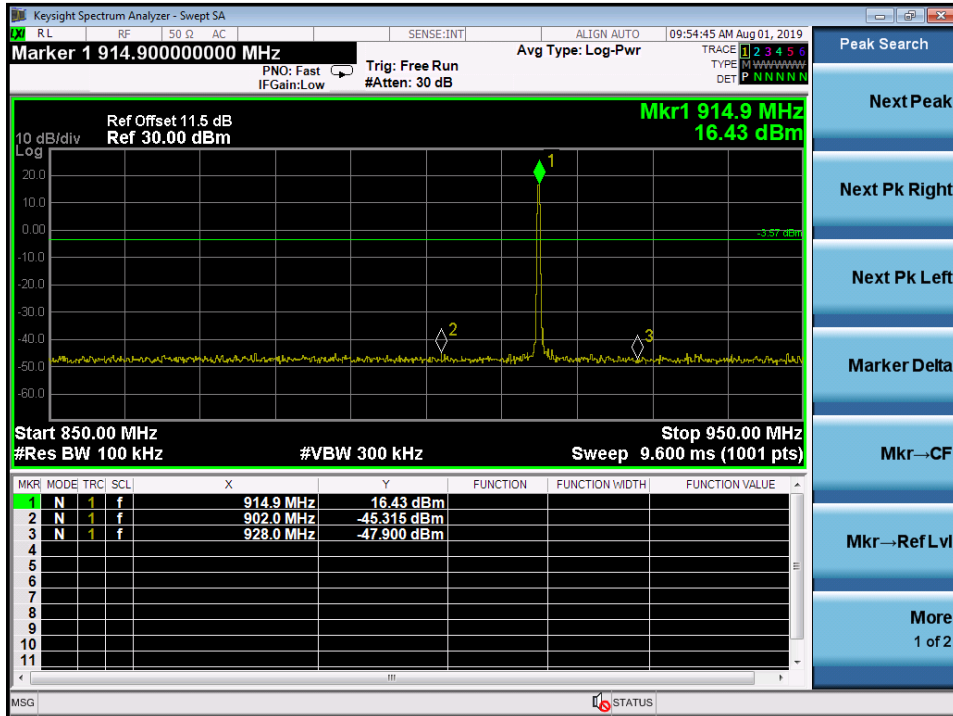
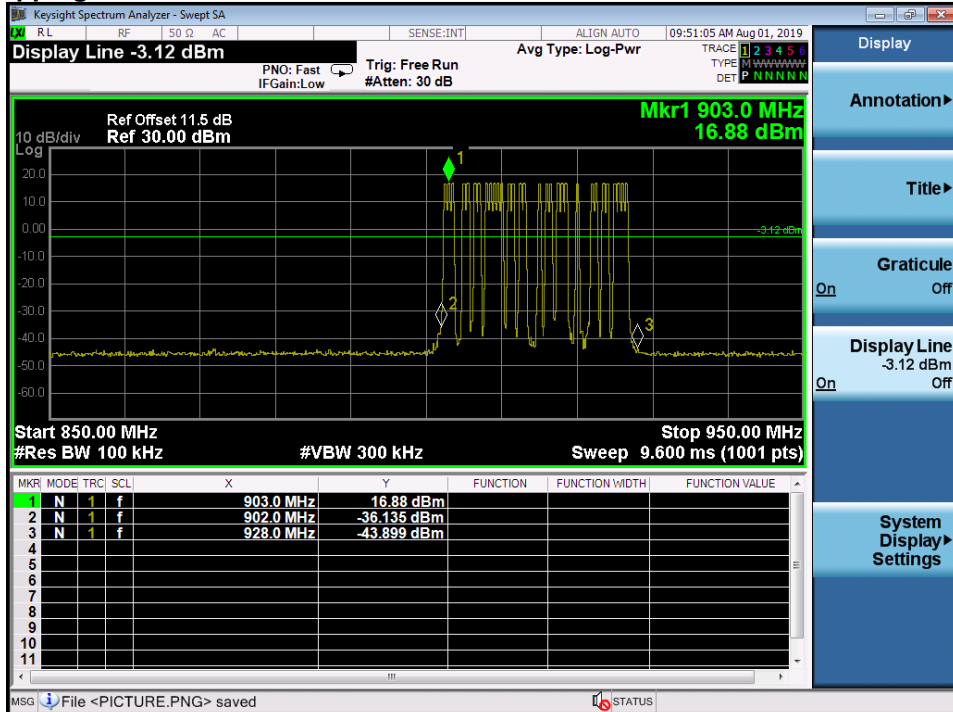


### Middle Channel







**High Channel**

**Hopping ON**


## 5.1.6 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), must comply with the  
radiated emission limits specified in FCC 15.209(a).

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).

Kind of test site : 3m Semi-Anechoic Chamber

**Test setup**

Test Channel : Low/ Middle/ High  
Operation Mode : A, B

Ambient temperature : 22-26°C  
Relative humidity : 50-65%  
Atmospheric pressure : 100-103 kPa

Remark: Testing was carried out within frequency range 9kHz to the tenth harmonic. 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.

### 5.1.7 Frequency Separation

**RESULT:**
**Passed**

Test standard	:	FCC part 15.247(a)(1)
Basic standard	:	ANSI C63.10:2013 LP0002(2018) Appendix II
Limit	:	≥ 25kHz or 2/3 of 20dB bandwidth, whichever is greater
Kind of test site	:	Shielded room

**Test setup**

Test Channel	:	Hopping On
Operation Mode	:	C
Ambient temperature	:	22-26°C
Relative humidity	:	50-65%
Atmospheric pressure	:	100-103 kPa

**Table 9: Test result of Frequency Separation**

Channel	Channel Frequency (MHz)	Measured Channel Separation (MHz)	Limit (kHz)	Result
Record Channel	908	0.5	≥ 25kHz or 2/3 of 20dB bandwidth	Pass
Record Channel adj 1	908.5			
Record Channel adj 2	909			



### 5.1.8 Number of hopping frequency

**RESULT:**
**Passed**

Test standard : FCC part 15.247(a)(1)(iii)  
 Basic standard : ANSI C63.10:2013  
 LP0002(2018) Appendix II  
 Kind of test site : Shielded room

**Test setup**

Test Channel : Hopping On  
 Operation Mode : C  
  
 Ambient temperature : 22-26°C  
 Relative humidity : 50-65%  
 Atmospheric pressure : 100-103 kPa

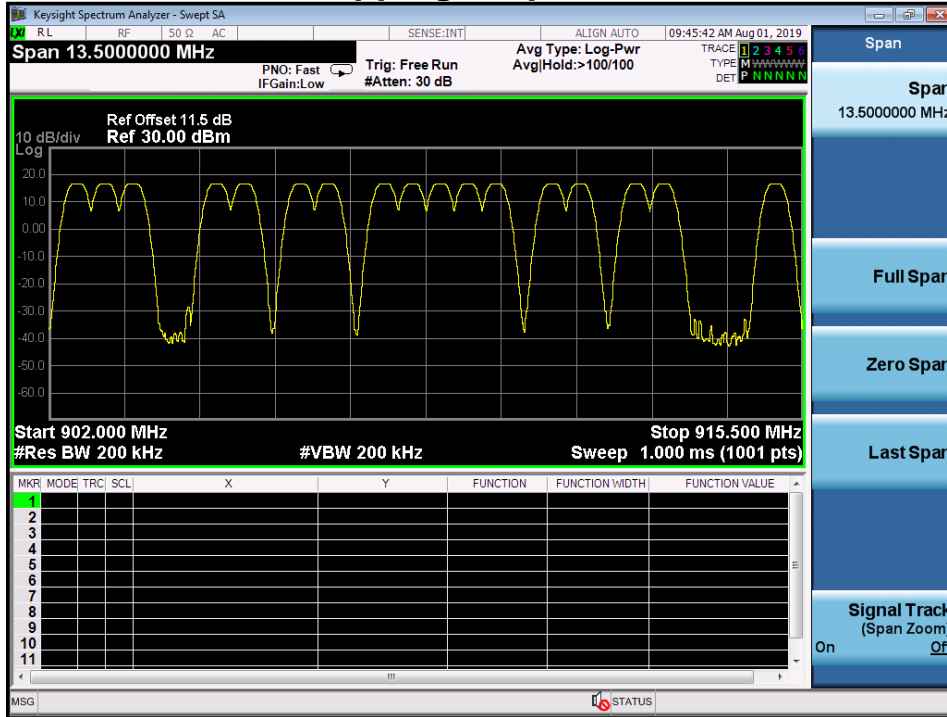
Remark: According to KDB558074 D01 10 (b) 4  
 There is no minimum number of hopping channels associated with this type of hybrid system.  
 While there is not a specific minimum limit, the hop sequence is required to appear as  
 pseudorandom per Section 15.247(a)(1) .

**Table 10: Test result of Number of hopping frequency**

Frequency Range	Measured Quantity of Hopping Channel	Limit	Result
<u>902</u> to <u>915</u> MHz	17	N/A	Pass

Remark: there is no specific minimum limit of hopping frequency.

### Test Plot of Number of hopping frequencies



### 5.1.9 Time of Occupancy

**RESULT:**
**Passed**

Test standard : FCC part 15.247(a)(1)(iii)  
 Basic standard : ANSI C63.10:2013  
                   : LP0002(2018) Appendix II  
 Limits : 0.4s  
 Kind of test site : Shield room

**Test setup**

Test Channel : Low  
 Operation Mode : A  
  
 Ambient temperature : 22-26°C  
 Relative humidity : 50-65%  
 Atmospheric pressure : 100-103 kPa

**Table 11: Test result of Time of Occupancy**

Captured Burst (ms)	Pulse Number	Dwell time (ms)	Limit (ms)	Result
9.434	10	94.34	400	Pass

Note:

Dwell time = Pulse Width x Pulse number in Period

Period = 0.4 (seconds/ channel) x 17 (channel) = 6.8 seconds.





## 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
<b>Test setup</b>		
Test Channel	:	Normal link
Operation mode	:	Normal link
Ambient temperature	:	22-26°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 : 47CFR 1.1310  
 47CFR 2.1091

The EUT will maintain a 20 cm distance to all persons.

**Maximum Exposure FCC:**

Power to Antenna (mW)	45.81 mW
Power to Antenna (dBm)	16.6 dBm
Antenna Gain	3.55 dBi
Power+Ant Gain	103.7 mW
Distance	20 cm
S=	0.021 mW/cm <sup>2</sup>

Limit FCC: 0.61 mW/cm<sup>2</sup>

**FCC:**

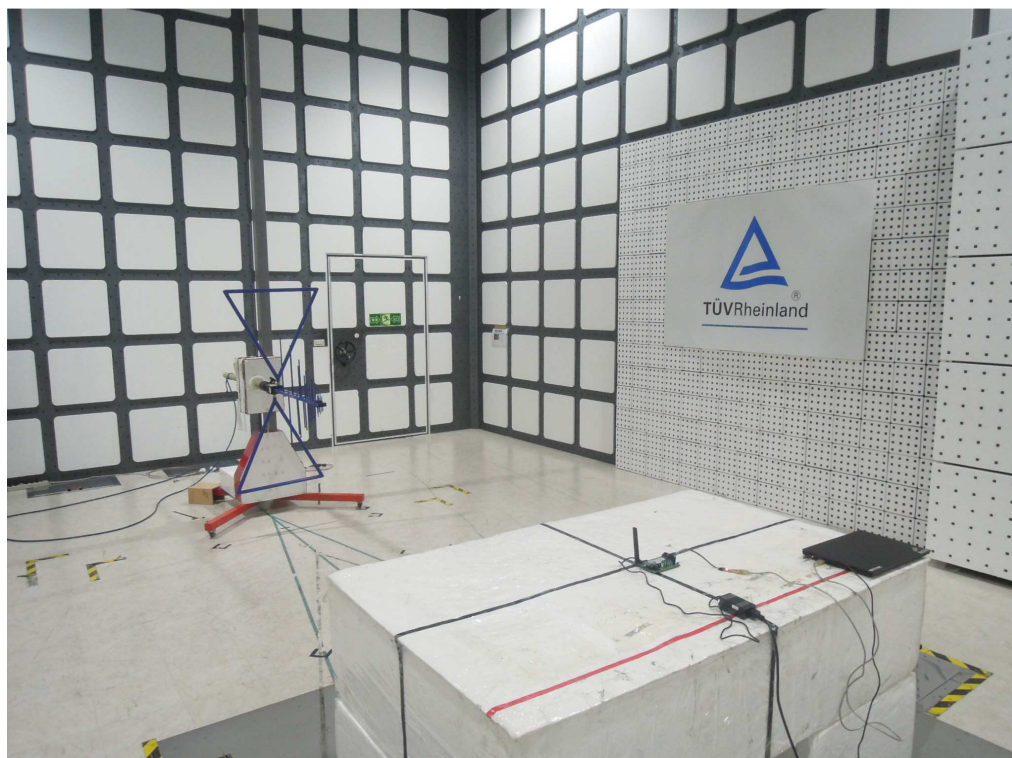
0.3-1.34 MHz (100) mW/cm<sup>2</sup>  
 1.34-30 MHz (180/f<sup>2</sup>) mW/cm<sup>2</sup>  
 30-300 MHz 0.2 mW/cm<sup>2</sup>  
 300-1500 MHz f/1500 mW/cm<sup>2</sup>  
 1500-100,000 MHz 1.0 mW/cm<sup>2</sup>

## 7. Photographs of the Test Set-Up

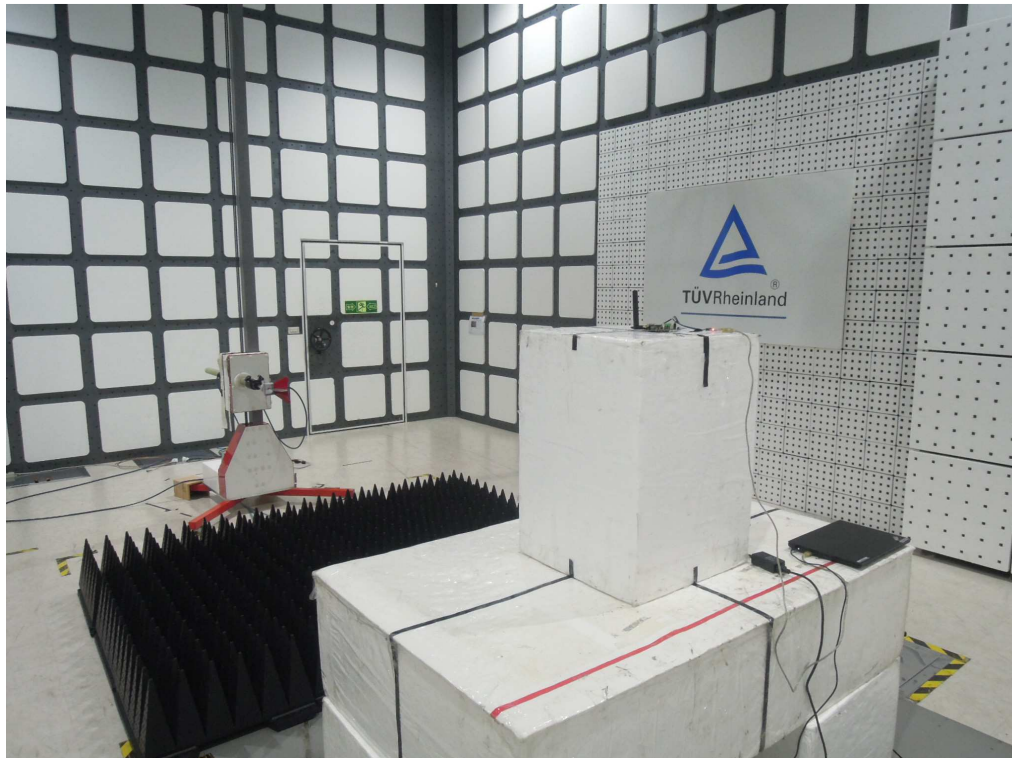
Photograph 1: Set-up for Spurious Emissions (Front View)



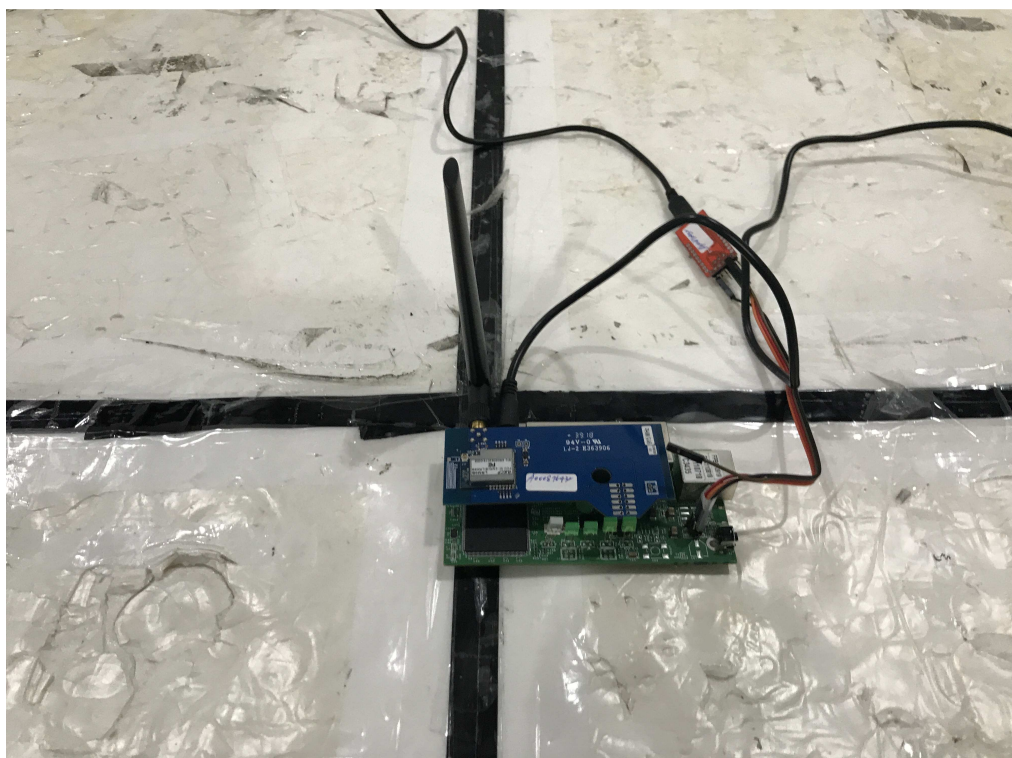
Photograph 2: Set-up for Spurious Emissions (Back View 1)



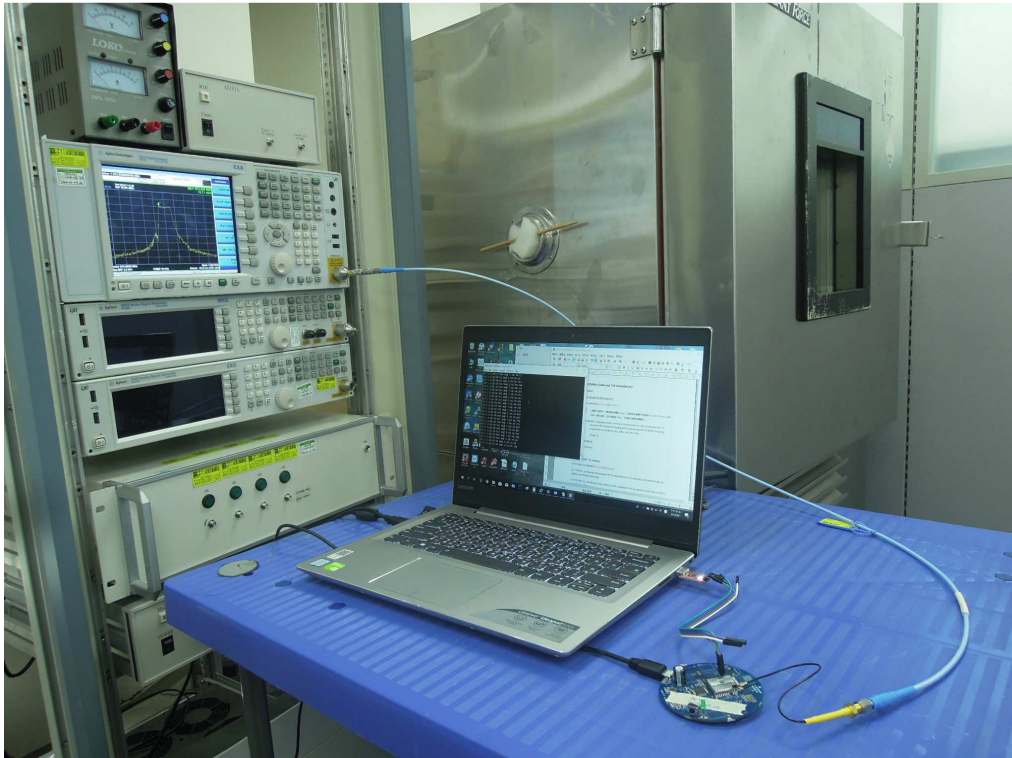
**Photograph 3: Set-up for Spurious Emissions (Back View 2)**



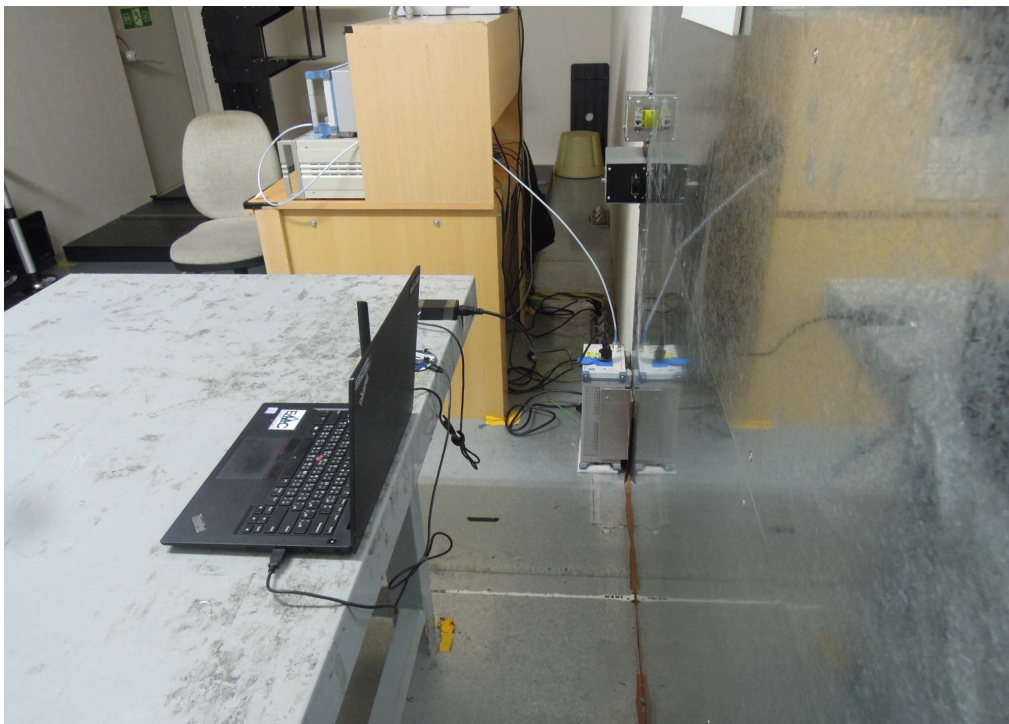
**Photograph 4: Set-up for Spurious Emissions (Zoom In)**



**Photograph 5: Set-up for Conducted testing**



**Photograph 6: Set-up for for Mains Conducted testing Back**



**Photograph 7: Set-up for for Mains Conducted testing Front**



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