



| | | | | |
|---|--|--|---|---|
| Prüfbericht-Nr.: <i>Test report no.:</i> | 50348468 001 | Auftrags-Nr.: <i>Order no.:</i> | 238112162 | Seite 1 von 36 Page 1 of 36 |
| Kunden-Referenz-Nr.: <i>Client reference no.:</i> | N/A | Auftragsdatum: <i>Order date:</i> | 6-Feb-2020 | |
| Auftraggeber: <i>Client:</i> | STMicroelectronics SAS 190 Avenue Celestin Coq, Rousset, France | | | |
| Prüfgegenstand: <i>Test item:</i> | STM32WB5MMG | | | |
| Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i> | 32WB5M | | | |
| Auftrags-Inhalt: <i>Order content:</i> | FCC Part 15C/ISED RSS-247/ Test report (Zigbee) | | | |
| Prüfgrundlage: <i>Test specification:</i> | FCC 47CFR Part 15: Subpart C Section 15.247(DTS) ISED RSS-247 ISSUE 2 FEB 2017 | | | |
| Wareneingangsdatum: <i>Date of sample receipt:</i> | 19-Feb-2020 | | | |
| Prüfmuster-Nr.: <i>Test sample no.:</i> | A001065433-003, A001065433-004 | | | |
| Prüfzeitraum: <i>Testing period:</i> | 22-Feb-2020 - 3-Mar-2020 | | | |
| Ort der Prüfung: <i>Place of testing:</i> | EMC/RF Laboratory Taipei | | | |
| Prüflaboratorium: <i>Testing laboratory:</i> | Taipei Testing laboratories | | | |
| Prüfergebnis*: <i>Test result*:</i> | Pass | | | |
| überprüft von: <i>reviewed by:</i> |  Mars Y.J. Lin | genehmigt von: <i>authorized by:</i> |  Ryan W.T. Chen | |
| Datum: 02-Jul-2020 <i>Date:</i> | | Datum: 02-Jul-2020 <i>Date:</i> | | |
| Stellung / Position: | Project Engineer | Stellung / Position: | Project Manager | |
| Sonstiges / Other: | | | | |
| Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i> | | Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i> | | |
| * Legende: | 1 = sehr gut P(ass) = entspricht o.g. Prüfgrundlage(n) | 2 = gut F(ail) = entspricht nicht o.g. Prüfgrundlage(n) | 3 = befriedigend N/A = nicht anwendbar | 4 = ausreichend N/T = nicht getestet |
| * Legend: | 1 = very good P(ass) = passed a.m. test specification(s) | 2 = good F(ail) = failed a.m. test specification(s) | 3 = satisfactory N/A = not applicable | 4 = sufficient N/T = not tested |
| <p>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. <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></p> | | | | |

TEST SUMMARY

5.1.1 ANTENNA REQUIREMENT

RESULT: *Passed*

5.1.2 PEAK OUTPUT POWER

RESULT: *Passed*

5.1.3 6dB BANDWIDTH AND 99% 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*

5.2.1 MAINS CONDUCTED EMISSIONS

RESULT: *Passed*

6.1.1 ELECTROMAGNETIC FIELDS

RESULT: *Passed*

Contents

| | | |
|--------------|---|-----------|
| 1. | GENERAL REMARKS | 5 |
| 1.1 | COMPLEMENTARY MATERIALS..... | 5 |
| 1.2 | DECISION RULE OF CONFORMITY | 5 |
| 2. | TEST SITES | 6 |
| 2.1 | TEST LABORATORY | 6 |
| 2.2 | TEST FACILITY..... | 6 |
| 2.3 | LIST OF TEST AND MEASUREMENT INSTRUMENTS..... | 7 |
| 2.4 | TRACEABILITY | 8 |
| 2.5 | CALIBRATION | 8 |
| 2.6 | MEASUREMENT UNCERTAINTY | 8 |
| 3. | GENERAL PRODUCT INFORMATION..... | 9 |
| 3.1 | PRODUCT FUNCTION AND INTENDED USE | 9 |
| 3.2 | SYSTEM DETAILS AND RATINGS..... | 9 |
| 3.3 | INDEPENDENT OPERATION MODES..... | 10 |
| 3.4 | NOISE GENERATING AND NOISE SUPPRESSING PARTS | 10 |
| 3.5 | SUBMITTED DOCUMENTS..... | 10 |
| 4. | TEST SET-UP AND OPERATION MODES..... | 11 |
| 4.1 | PRINCIPLE OF CONFIGURATION SELECTION | 11 |
| 4.2 | TEST OPERATION AND TEST SOFTWARE..... | 11 |
| 4.3 | SPECIAL ACCESSORIES AND AUXILIARY EQUIPMENT | 12 |
| 4.4 | COUNTERMEASURES TO ACHIEVE EMC COMPLIANCE..... | 12 |
| 4.5 | TEST SETUP DIAGRAM | 12 |
| 5. | TEST RESULTS | 14 |
| 5.1 | TRANSMITTER REQUIREMENT & TEST SUITES..... | 14 |
| 5.1.1 | <i>Antenna Requirement.....</i> | <i>14</i> |
| 5.1.2 | <i>Peak Output Power.....</i> | <i>15</i> |
| 5.1.3 | <i>6dB Bandwidth and 99% Bandwidth.....</i> | <i>17</i> |
| 5.1.4 | <i>Power Density.....</i> | <i>21</i> |
| 5.1.5 | <i>Conducted spurious emissions and Frequency Band Edge measured in 100kHz Bandwidth.....</i> | <i>24</i> |
| 5.1.6 | <i>Spurious Emission</i> | <i>28</i> |
| 5.2 | MAINS EMISSIONS..... | 29 |
| 5.2.1 | <i>Mains Conducted Emissions.....</i> | <i>29</i> |
| 6. | SAFETY HUMAN EXPOSURE | 30 |

| | | |
|------------|--|-----------|
| 6.1 | RADIO FREQUENCY EXPOSURE COMPLIANCE | 30 |
| 6.1.1 | <i>Electromagnetic Fields.....</i> | <i>30</i> |
| 7. | PHOTOGRAPHS OF THE TEST SET-UP..... | 32 |
| 8. | LIST OF TABLES | 36 |
| 9. | LIST OF PHOTOGRAPHS..... | 36 |

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: 50348468 001 Appendix P)

Appendix D: Test Result of Radiated Emissions
(File Name: 50348468 001 Appendix D)

Test Specifications

The following standards were applied.

Table 1: Applied Standard and Test Levels

| Radio |
|--|
| FCC CFR47 Part 15: Subpart C Section 15.247 ISED RSS-247 Issue 2 Feb 2017 ISED RSS-Gen, Issue 5, April 2018 ANSI C63.10:2013 KDB558074 D01 DTS Meas Guidance v05 |

1.2 Decision Rule of conformity

The decision rule of conformity of this test report is following the requirements of the requested standard in the quotation, and agreed among testing laboratory and manufacturer (applicant) to exclude the consideration of Measurement Uncertainty, unless it is required by the specific standard

2. Test Sites

2.1 Test Laboratory

Taipei Testing Laboratories

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

2.2 Test Facility

AC Mains Conduction:
11F. No.758, Sec. 4, Bade Rd., Songshan Dist.
Taipei City 105
Taiwan (R.O.C.)
FCC Registration No.: 180491
IC Canada Registration No.: 9465A

Conducted Test / Radiated Test:
No. 458-18, Sec 2, Fenliao., Linkou Dist.
New Taipei City 244
Taiwan (R.O.C.)
FCC Registration No.: 226631
IC Canada Registration No.: 25563

TAF Accredited NCC Test Lab. No.:3567
TAF ISO17025 Certification effective period: 6th-May-2019 to 05th-May-2022



Testing Laboratory
3567

2.3 List of Test and Measurement Instruments

Table 2: List of Test and Measurement Equipment

| Equipment | Manufacturer | Model No. | Serial No. | Cal. Date | Cal. Due Date |
|------------------------------------|----------------------------------|--------------------------|----------------------------|------------------|----------------------|
| EMI Test Receiver | R&S | ESR7 | 102108 | 2019/4/17 | 2020/4/16 |
| Spectrum Analyzer | R&S | FSV40 | 101508 | 2019/10/15 | 2020/10/15 |
| Pre-Amplifier | Agilent | 8447D | 2944A10772 | 2020/2/14 | 2021/2/13 |
| Pre-Amplifier | EMCI | EMC051845SE | 980633 | 2020/2/07 | 2021/2/06 |
| Pre-Amplifier | EMCI | EMC184045SE | 980657 | 2020/2/07 | 2021/2/06 |
| Bilog Antenna | SCHWARZBECK | VULB-9168 | 00951 | 2020/1/14 | 2021/1/13 |
| Horn Antenna | ETS-Lindgren | 3117 | 00218930 | 2020/12/27 | 2021/12/26 |
| Horn Antenna | SCHWARZBECK | BBHA 9170 | 00887 | 2019/4/12 | 2020/4/11 |
| Loop Antenna | EMCI | LPA600 | 287 | 2019/12/20 | 2020/12/19 |
| Test Software | Audix | e3 | Ver. 9 | N/A | N/A |
| Test Cable | HUBER+SUHNER | SUCOFLEX 104EA_9k~18G | 800056/4EA | 2019/4/18 | 2020/4/17 |
| Test Cable | HUBER+SUHNER | SUCOFLEX 104_9k~18G | 804680/4 | 2019/4/18 | 2020/4/17 |
| Test Cable | HUBER+SUHNER | SUCOFLEX 104_9k~18G | MY37202/4 | 2019/4/18 | 2020/4/17 |
| Test Cable | HUBER+SUHNER | SUCOFLEX 102EA_1G~40G | 800898/2EA | 2019/4/18 | 2020/4/17 |
| Test Cable | HUBER+SUHNER | SUCOFLEX 102EA_1G~40G | 800901/2EA | 2019/4/18 | 2020/4/17 |
| Test Cable | HUBER+SUHNER | SUCOFLEX 102EA_1G~40G | 801027/2EA | 2019/4/18 | 2020/4/17 |
| Power Meter | Anritsu | ML2495A | 1901008 | 2019/4/29 | 2020/4/28 |
| Power Sensor | Anritsu | MA2411B | 1725269 | 2019/4/29 | 2020/4/28 |
| EMI Test Receiver | Rohde & Schwarz | ESR 7 | 101062 | 2019/10/15 | 2020/10/15 |
| Two-Line V-Network (for EUT) | Rohde & Schwarz | ENV216 | 101243 | 2019/06/23 | 2020/06/23 |
| Two-Line V-Network | Rohde & Schwarz | ENV216 | 101262 | 2019/07/16 | 2020/07/16 |
| Telecom ISN 4 Line | Fischer Custom Communications | FFCC-TLISN- T4-02-09 | 101168 | 2020/02/03 | 2021/02/03 |
| Impedance Stabilization Network | TESEQ | ISN T800 | 51949 | 2020/02/25 | 2021/02/25 |
| Pulse Limiter | Rohde & Schwarz | ESH3-Z2 | 0357.8810.54- 102102-HN | 2019/07/25 | 2020/07/25 |
| Test Software | Audix | e3 | Ver. 9 | N/A | N/A |

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/RF Exposure(MPE), conducted | ± 1.5 dB |
| RF power density, conducted | ± 3 dB |
| spurious emissions, conducted | ± 3 dB |
| all emissions, radiated | ± 6 dB |
| Temperature | ± 1 °C |
| Humidity | ± 5 % |
| DC and low frequency voltages | ±3 % |

3. General Product Information

3.1 Product Function and Intended Use

The EUT is a STM32WB5MMG. It contains a Zigbee compatible chip 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 | STM32WB5MMG |
| Type Identification | 32WB5M |
| Brand Name | STMicroelectronics SAS |
| FCC ID | YCP-STM32WB5M001 |
| Canada ID | 8976A-STM32WB5M01 |
| HVIN | STM32WB5M01 |

Table 5: Technical Specification of EUT

| Technical Specification | Value |
|-------------------------|----------------|
| Operating Frequencies | 2405- 2480 MHz |
| Channel Spacing | 5 MHz |
| Channel number | 16 |
| Operation Voltage | 3.3Vdc |
| Modulation | QPSK |
| Antenna gain | 2.0dBi |

3.3 Independent Operation Modes

Basic operation modes are:

- A. Transmitting
 - 1. Low channel
 - 2. Middle channel
 - 3. High channel
- B. Receiving
- C. Standby
- D. Off

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.

Table 6: Table for Parameters of Test Software Setting

| Mode | Channel Frequency | | |
|-------|-------------------|----------|----------|
| | 2405 MHz | 2440 MHz | 2480 MHz |
| OQPSK | 6 | 6 | 6 |

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 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:

A001065433-003

A001065433-004

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

| | |
|----------------------|---------------------|
| Test Software | STM32CubeMonitor-RF |
|----------------------|---------------------|

4.3 Special Accessories and Auxiliary Equipment

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

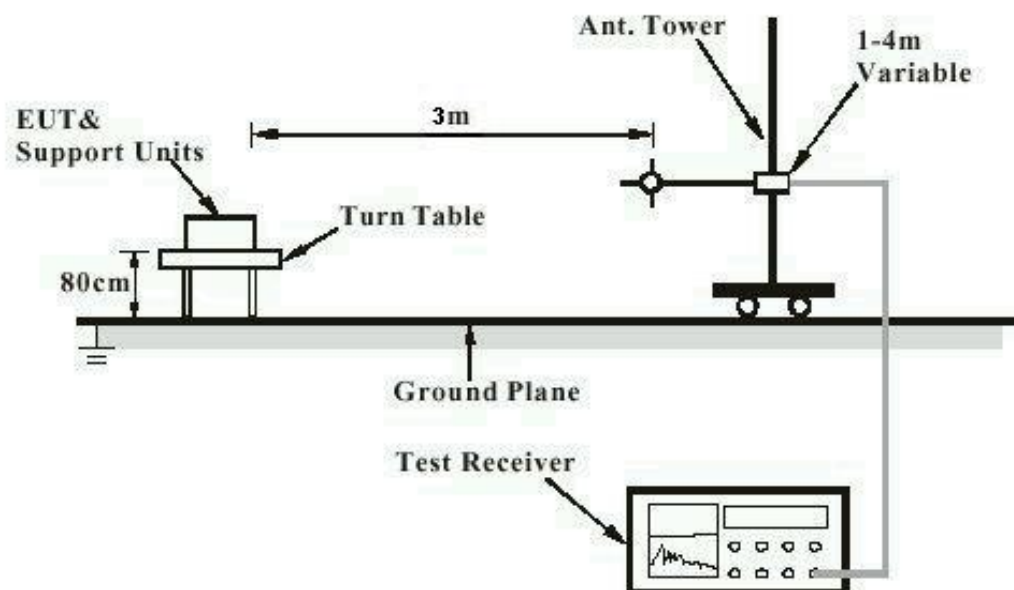
| Description | Manufacturer | Model No. | Serial No. |
|------------------|--------------|-----------|------------|
| Notebook(EMC-06) | Lenovo | TP00048A | PB-0F8B2 |

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)

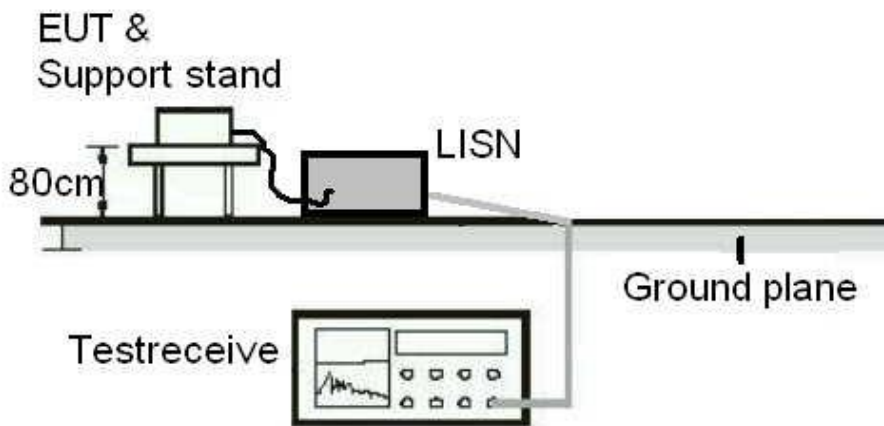
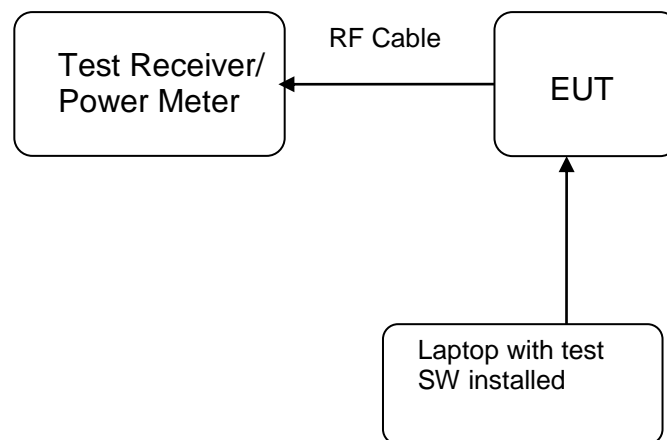


Diagram of Measurement Equipment Configuration for Conducted Transmitter Measurement



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 and ISED
RSS-Gen 6.8

According to the manufacturer declaration, the EUT has an antenna with a directional gain of 2.0dBi. The antenna is a chip 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)(3), ISED RSS-247 5.4(d)
 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 7: Test result of Peak Output Power

| Channel | Channel Frequency (MHz) | Output Power | | Limit |
|----------------|-------------------------|--------------|---------|-------|
| | | (dBm) | (W) | (W) |
| Low Channel | 2405 | 4.95 | 0.00313 | 1 |
| Middle Channel | 2435 | 4.87 | 0.00307 | 1 |
| High Channel | 2480 | 4.86 | 0.00306 | 1 |

Pmax: 3.1261 mW
 Maximum EIRP: 6.95 dBm

Prüfbericht - Nr.: 50348468 001
Test Report No.

Seite 16 von 36
Page 16 of 36

5.1.3 6dB Bandwidth and 99% Bandwidth

RESULT:
Passed

Test standard : FCC Part 15.247(a)(2), ISED RSS-247 5.2(a)
 ISED RSS-Gen (Issue 5)
 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 : 20-24°C
 Relative humidity : 50-65%
 Atmospheric pressure : 100-103 kPa

Table 8: Test result of 6dB Bandwidth

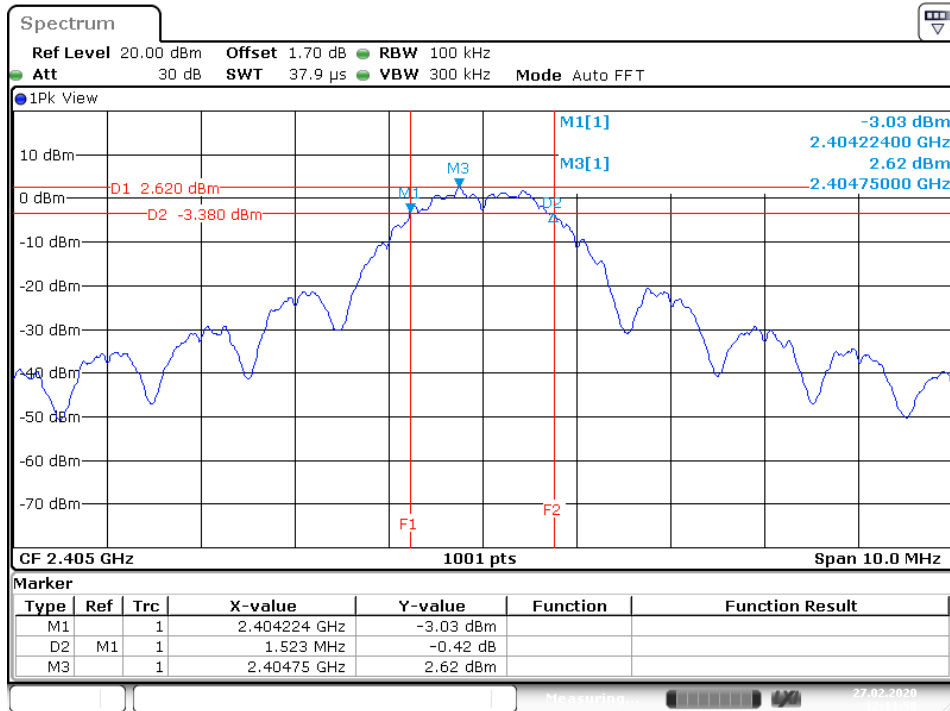
| Channel | Channel Frequency (MHz) | 6dB Bandwidth (MHz) | Limit (kHz) | Result |
|--------------|-------------------------|---------------------|-------------|--------|
| Low Channel | 2405 | 1.523 | >500 | Pass |
| Mid Channel | 2435 | 1.548 | >500 | Pass |
| High Channel | 2480 | 1.558 | >500 | Pass |

Table 9: Test result of 99% Bandwidth,

| Channel | Channel Frequency (MHz) | 99% Bandwidth (MHz) |
|--------------|-------------------------|---------------------|
| Low Channel | 2405 | 2.4076 |
| Mid Channel | 2435 | 2.4276 |
| High Channel | 2480 | 2.4575 |

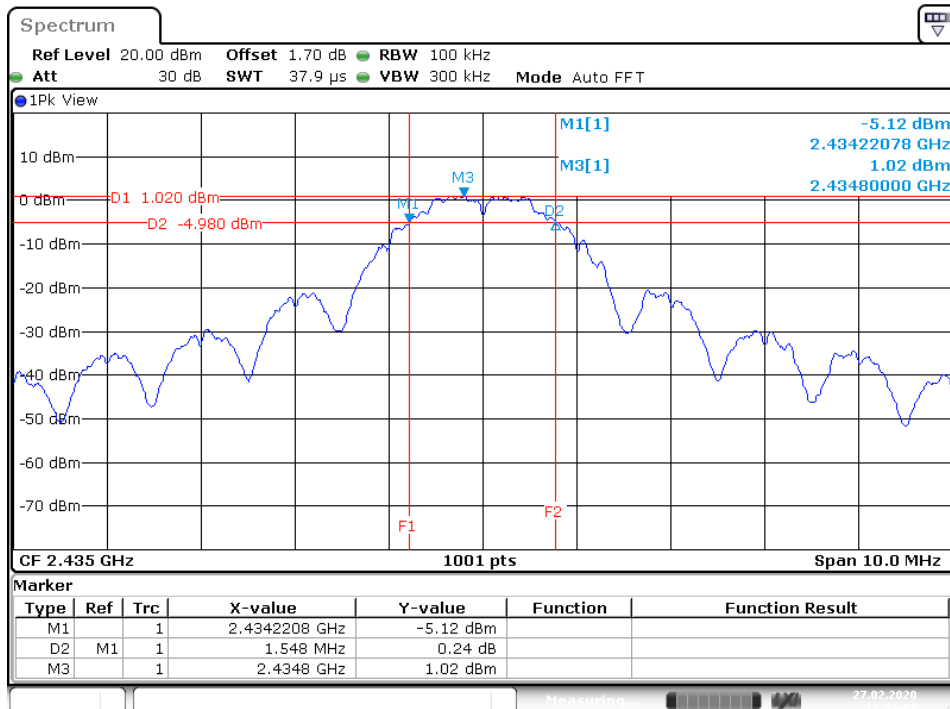
Test Plot of 6dB Bandwidth

Low Channel

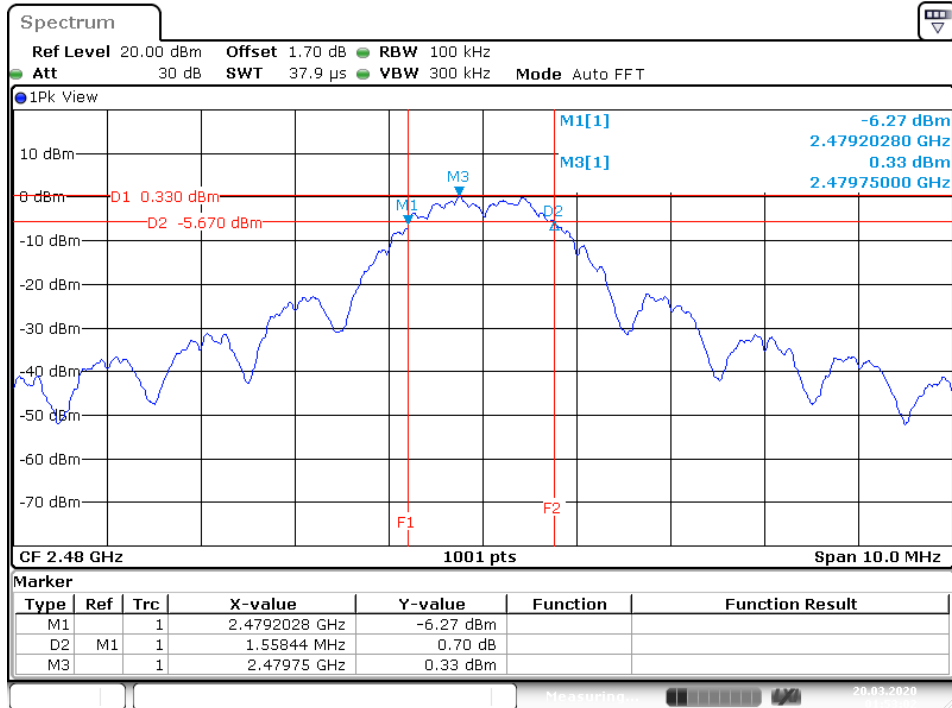


Date: 27.FEB.2020 12:13:58

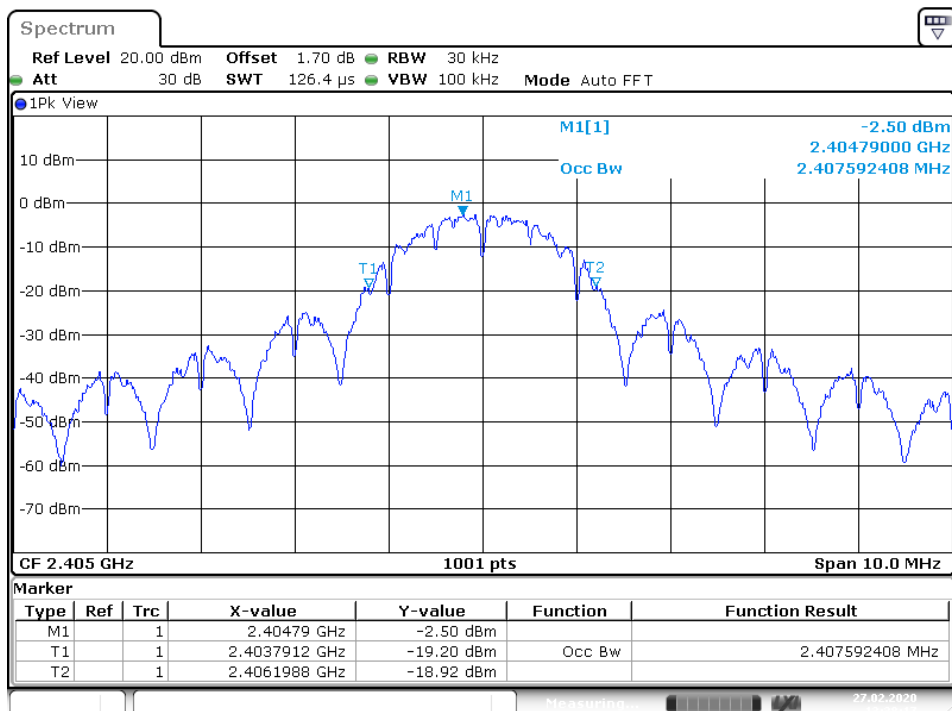
Middle Channel



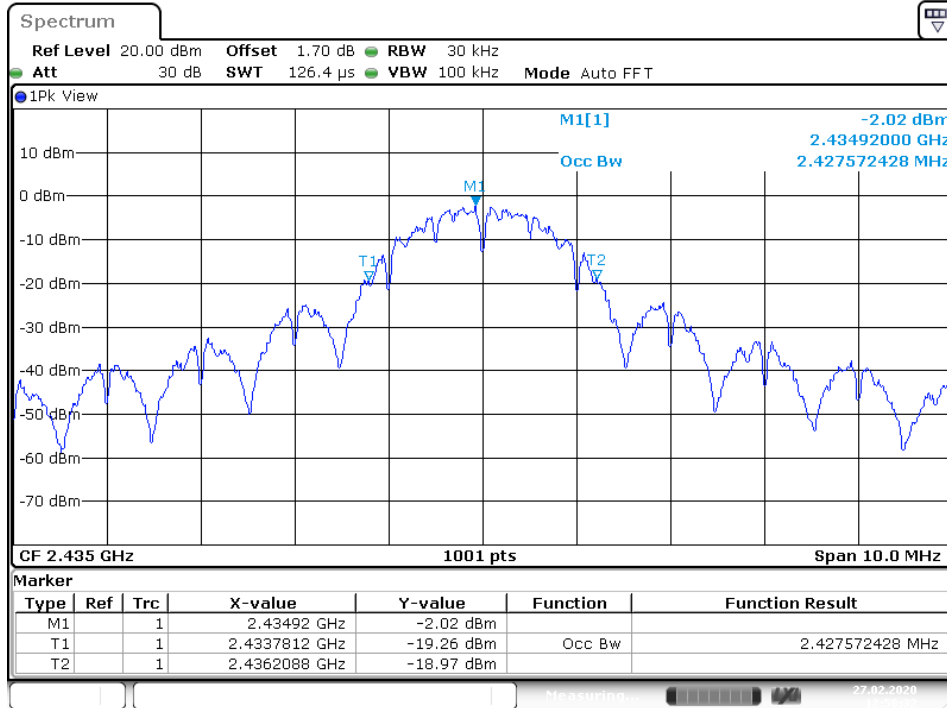
Date: 27.FEB.2020 12:58:08

High Channel


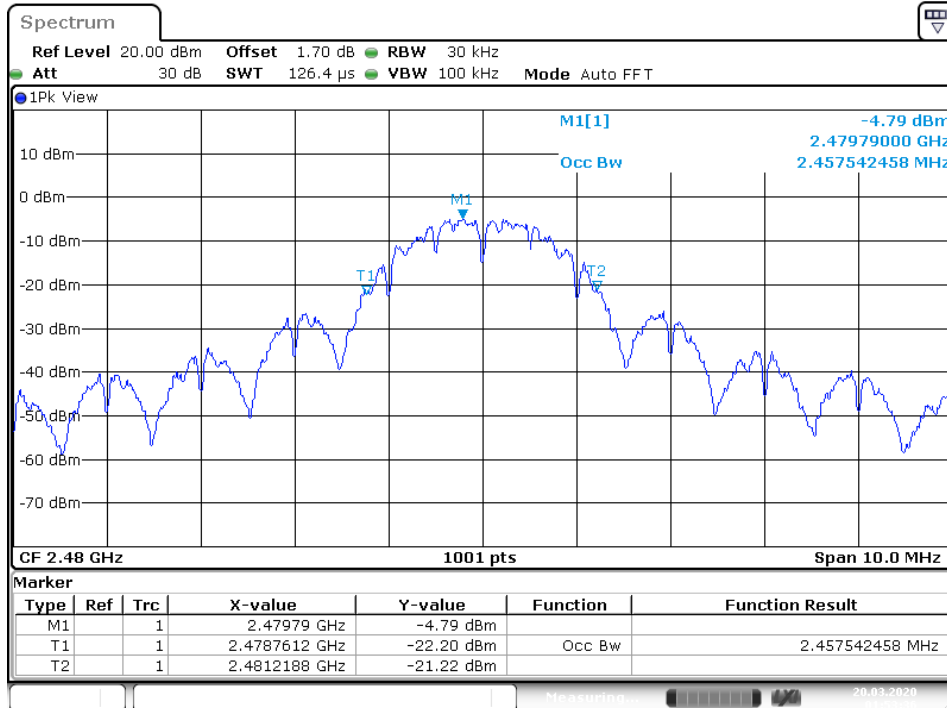
Date: 20.MAR.2020 01:53:02

Test Plot of 99% Bandwidth
Low Channel


Date: 27.FEB.2020 13:38:16

Middle Channel


Date: 27.FEB.2020 12:58:32

High Channel


Date: 20.MAR.2020 01:53:36

5.1.4 Power Density

RESULT:
Passed

Test standard : FCC Part 15.247(e) , ISED RSS-247 5.2(b)
 Basic standard : ANSI C63.10:2013, KDB558074
 Kind of test site : Shielded room

Test setup

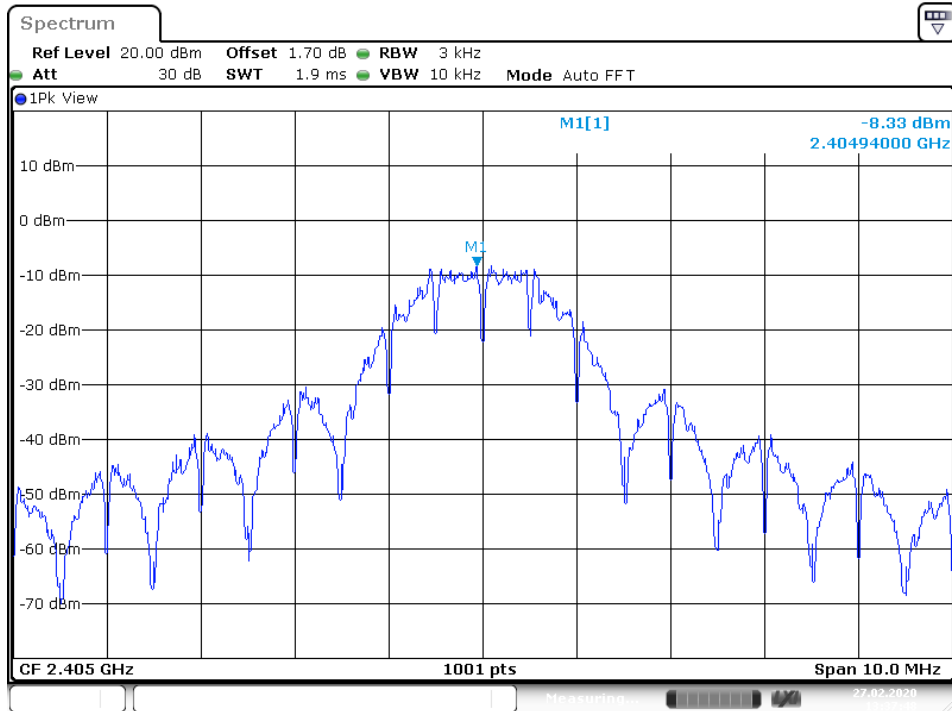
Test Channel : Low/ Middle/ High
 Operation Mode : A
 Ambient temperature : 20-24°C
 Relative humidity : 50-65%
 Atmospheric pressure : 100-103 kPa

Table 10: Test result of Power Density

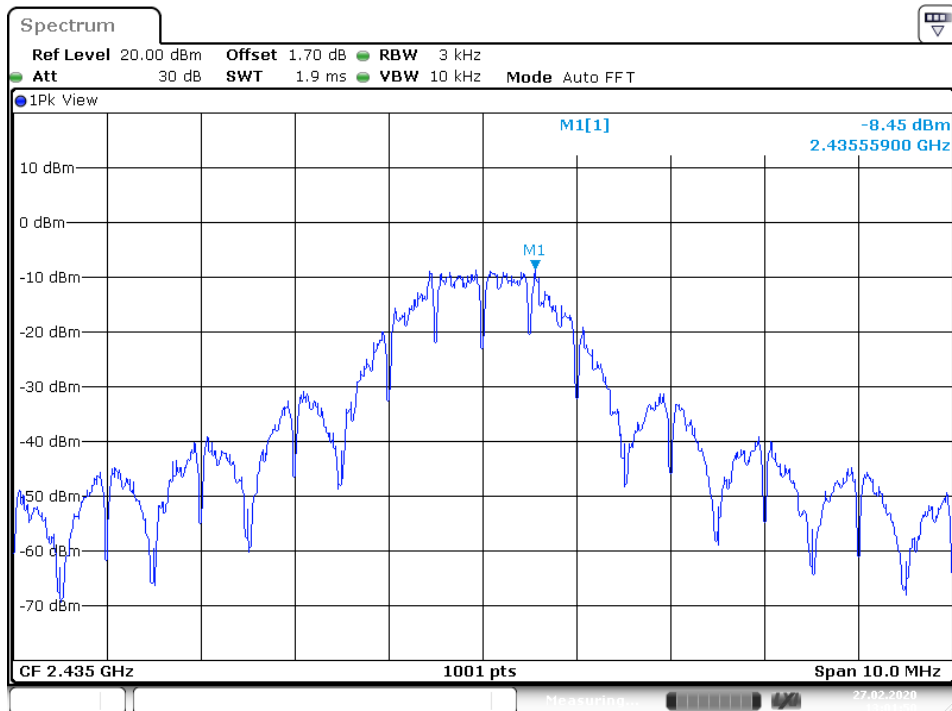
| Channel | Channel Frequency (MHz) | Power Density | Limit |
|----------------|-------------------------|---------------|-------|
| | | (dBm) | (dBm) |
| Low Channel | 2405 | -8.33 | 8 |
| Middle Channel | 2435 | -8.45 | 8 |
| High Channel | 2480 | -11.24 | 8 |

Test Plot of Power Density

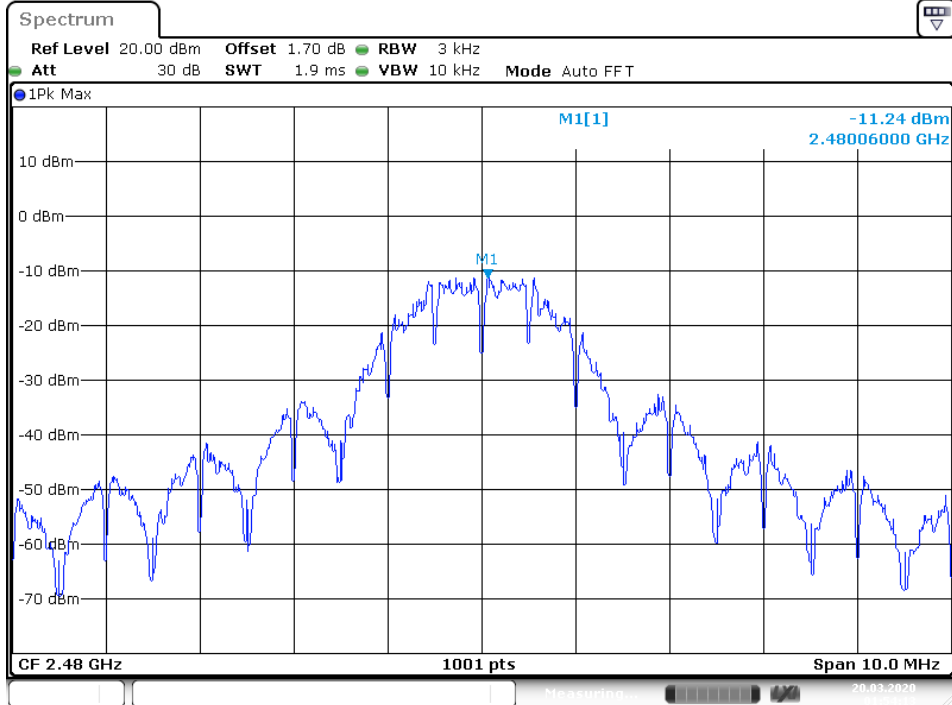
Low Channel



Middle Channel



High Channel



Date: 20.MAR.2020 01:54:13

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

RESULT:**Passed**

| | | |
|-------------------|---|--|
| Test standard | : | FCC part 15.247(d), ISED RSS-247 5.5 |
| 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

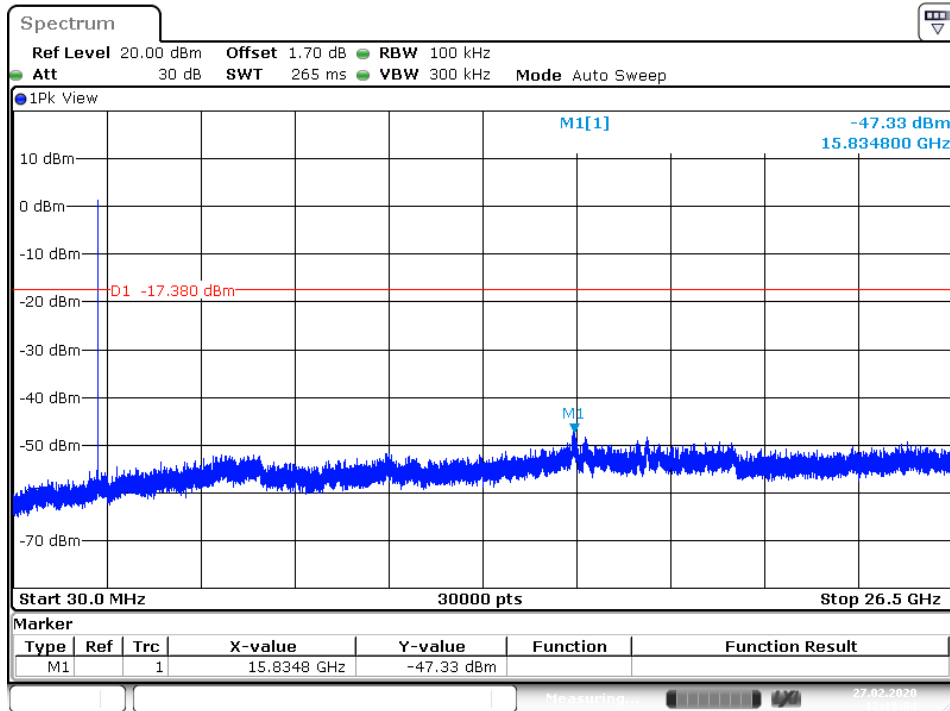
| | | |
|----------------------|---|---|
| Test Channel | : | Low/ Middle/ High for Conducted Spurious Emissions Low/ High for Frequency Band Edge |
| Operation Mode | : | A |
| Ambient temperature | : | 20-24°C |
| Relative humidity | : | 50-65% |
| Atmospheric pressure | : | 100-103 kPa |

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 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.

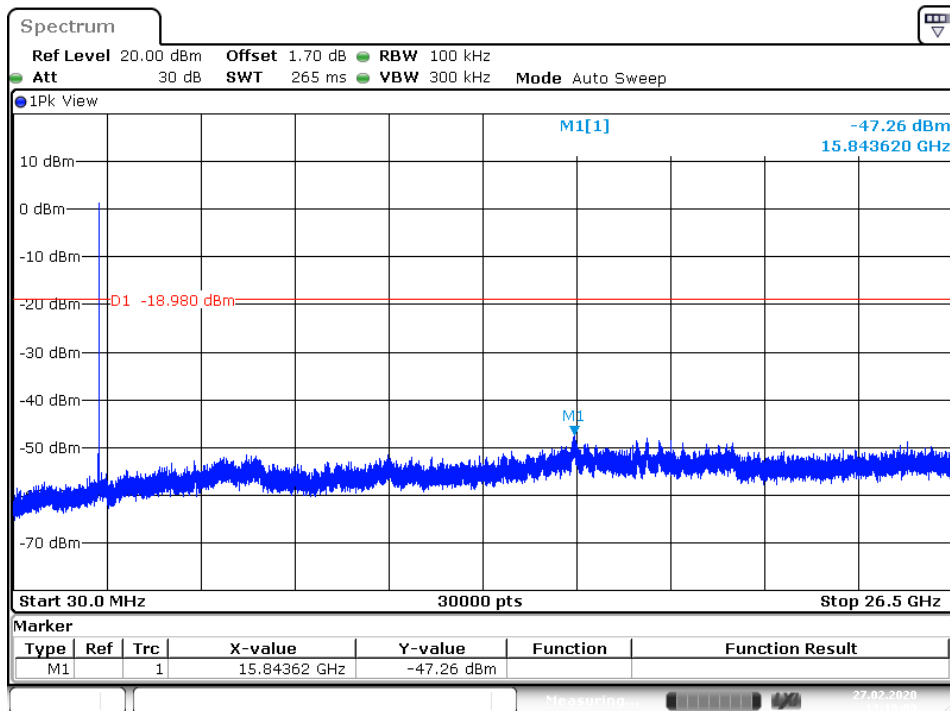
Test Plot 100kHz Conducted Emissions

Low Channel

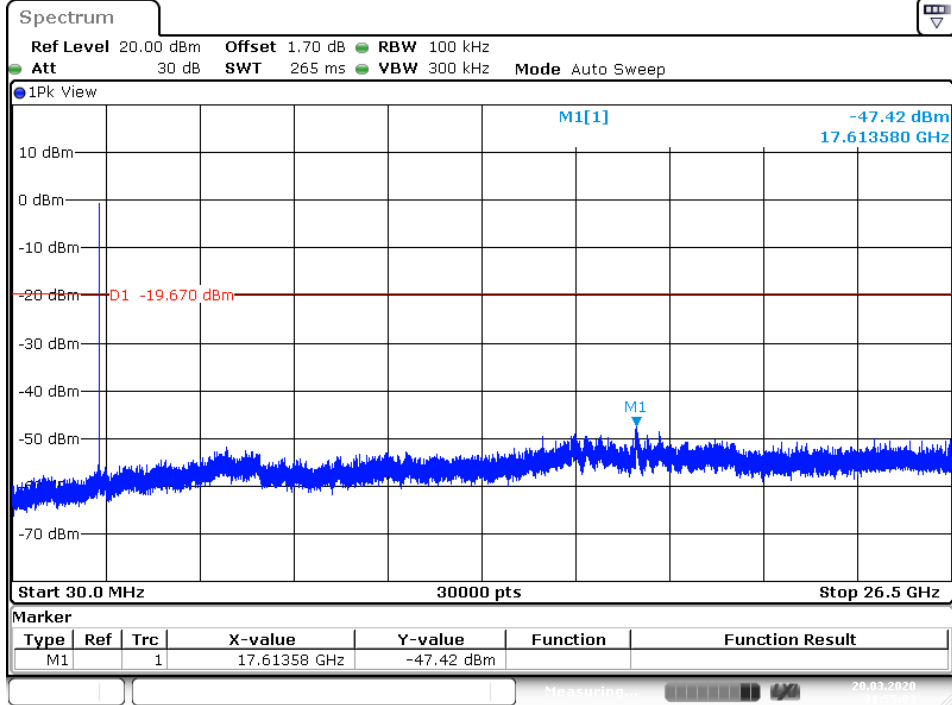


Date: 27.FEB.2020 12:19:04

Middle Channel



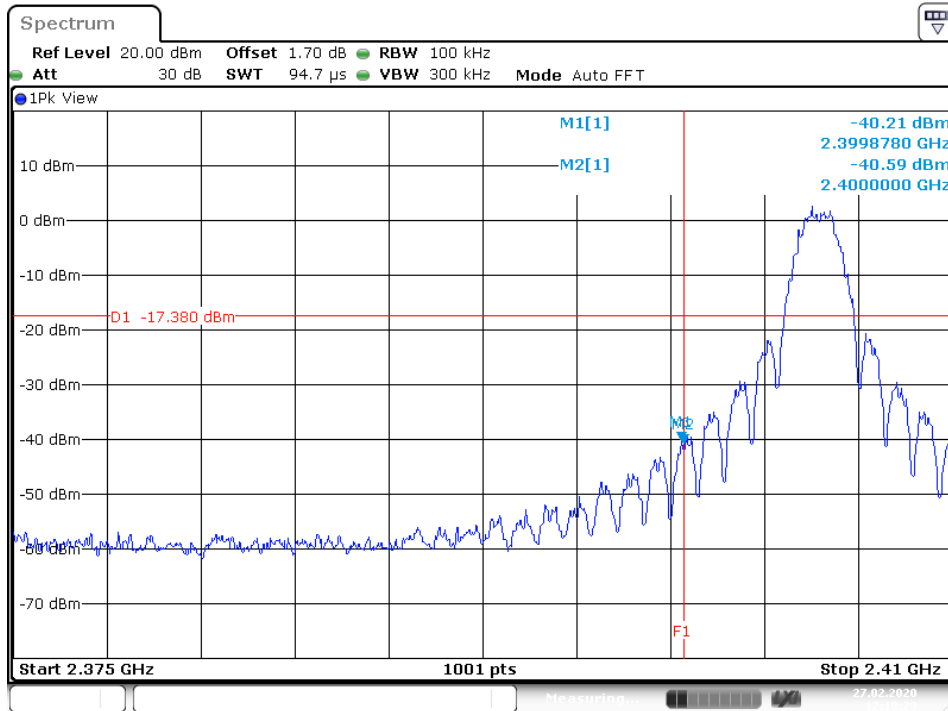
Date: 27.FEB.2020 13:18:00

High Channel


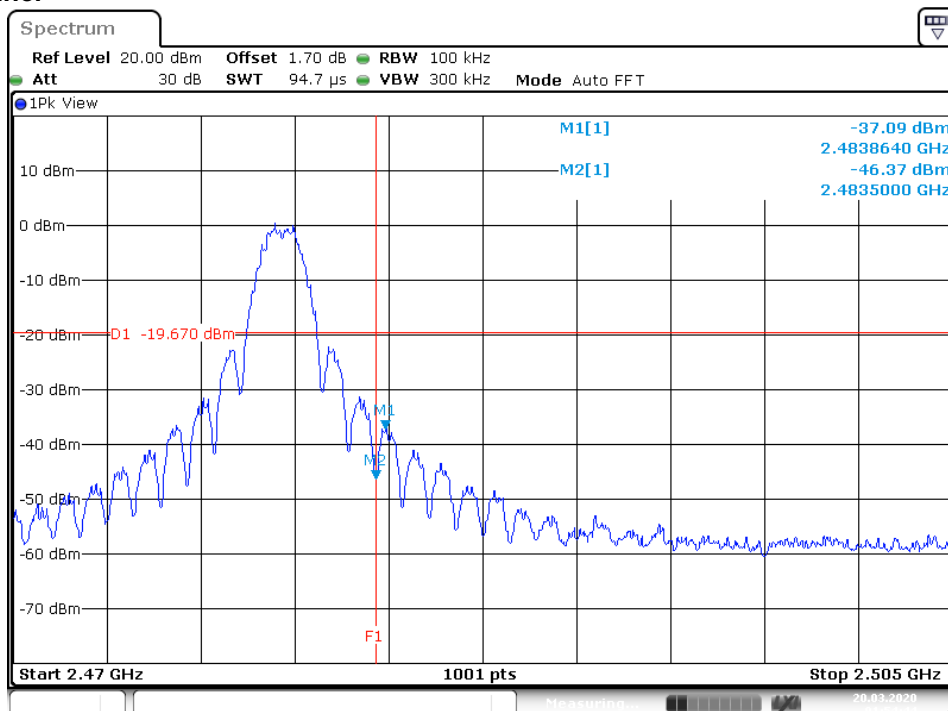
Date: 20.MAR.2020 01:55:03

Test Plot 100kHz RBW of Band Edge

Low Channel



High Channel



5.1.6 Spurious Emission

RESULT:**Passed**

Test standard : FCC part 15.247(d), FCC 15.205, FCC 15.209 and ISED
RSS-Gen 8.9 and ISED RSS-Gen 8.10

Basic standard : ANSI C63.10: 2013
Limits : Radiated emissions which fall in the restricted bands, as
defined in FCC 15.205(a) and ISED RSS-Gen i5, 8.10
(Table 7), must comply with the radiated emission limits
specified in FCC 15.209(a) and ISED 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 ISED RSS-247 i2, 5.5

Kind of test site : 3m Semi-Anechoic Chamber

Test setup

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

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

Factor (dB/m)=Antenna Factor(dB/m)+Cable loss (dB)

Level(dBuV/m)=Reading(dBuV)+ Factor(dB/m)

For details refer to Appendix D.

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.

5.2 Mains Emissions

5.2.1 Mains Conducted Emissions

RESULT:**Passed**

| | | |
|----------------------|---|---|
| Test standard | : | FCC Part 15.207 FCC Part 15.107 ISED RSS-Gen 8.8 |
| 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 | : | 2405MHz |
| 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 Specification**

Test standard

: CFR47 FCC Part 2: Section 2.1091
CFR47 FCC Part 1: Section 1.1310
FCC KDB Publication 447498 v06, section 7
ISED RSS-102 Issue 5 March 2015, section 2.5.1

➤ FCC requirements

FCC requirement: Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess limit for maximum permissible exposure. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device whereby a distance of 20cm normally can be maintained between the user and the device.

MPE Calculation Method according to KDB 447498 v06Power Density: $S_{(mW/cm^2)} = PG/4\pi R^2$ or $EIRP/4\pi R^2$

Where:

S = power density (mW/cm²)

P = power input to the antenna (mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (cm)

From the peak RF output power, the minimum mobile separation distance, d=20 cm, as well as the antenna gain (Max. 2.0 dBi), the RF power density can be calculated as below:

$$S_{(mW/cm^2)} = PG/4\pi R^2$$

a) EUT RF Exposure Evaluation standalone operations

| Test Mode | Measured Conducted Power | | Antenna Gain (dBi) | Measured e.i.r.p (mW) | | $S_{(mW/cm^2)} = \frac{PG}{4\pi R^2}$ | Limit (mW/cm ²) |
|-----------|--------------------------|------|--------------------|-----------------------|------|---------------------------------------|-----------------------------|
| | (dBm) | (mW) | | (dBm) | (mW) | | |
| Zigbee | 4.95 | 3.13 | 2 | 6.95 | 4.95 | 0.001 | 1.0 |

b) EUT RF Exposure Evaluation simultaneous transmission operations

| Simultaneous transmission mode | The sum of the ratios | Result |
|--------------------------------|-----------------------|--------|
| Not supported | N/A | N/A |

➤ **IC requirements:** The EUT shall comply with the requirement of RSS-102 section 2.5.2.

Exemption from Routine Evaluation Limits – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;

- RF exposure evaluation exempted power for BLE: 2.670 W
- RF exposure evaluation exempted power for ZigBee: 2.671 W

a) EUT RF Exposure Evaluation standalone operations:

| Test Mode | Measured Peak Power | | Antenna Gain (dBi) | Measured e.i.r.p (mW) | |
|-----------|---------------------|------|--------------------|-----------------------|------|
| | (dBm) | (W) | | (dBm) | (W) |
| Zigbee | 4.95 | 3.13 | 2 | 6.95 | 4.95 |

b) EUT RF Exposure Evaluation simultaneous transmission operations

| Simultaneous transmission mode | The sum of the ratios | Result |
|--------------------------------|-----------------------|--------|
| Not supported | N/A | N/A |

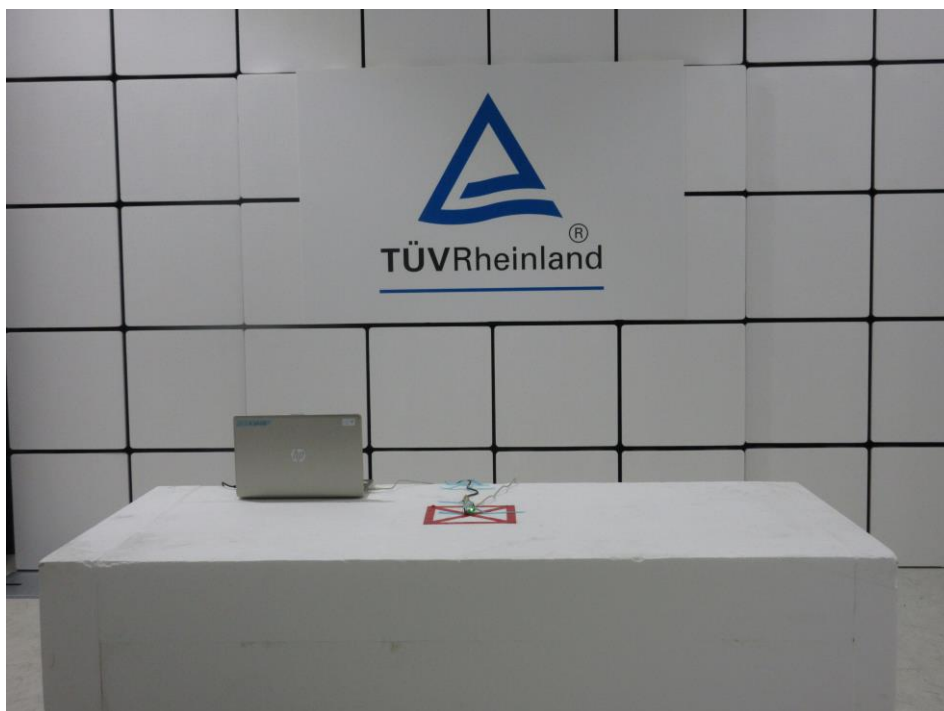
“RF Radiation Exposure Statement Caution: This Transmitter must be installed to provide a separation distance of at least 20 cm from all persons.”

7. Photographs of the Test Set-Up

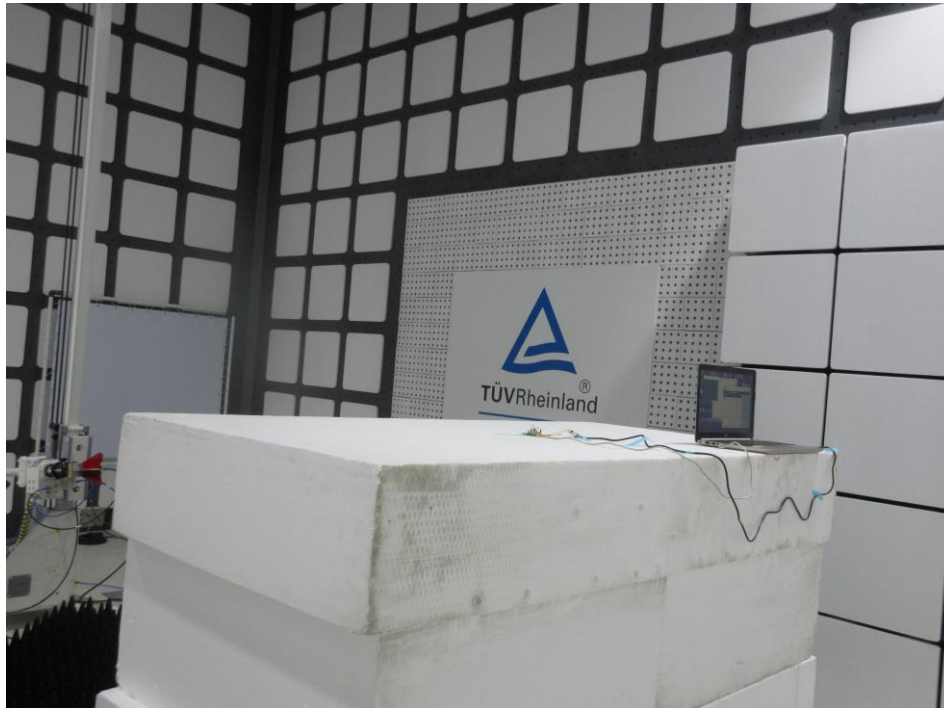
Photograph 1: Set-up for Spurious Emissions (Front View 1)



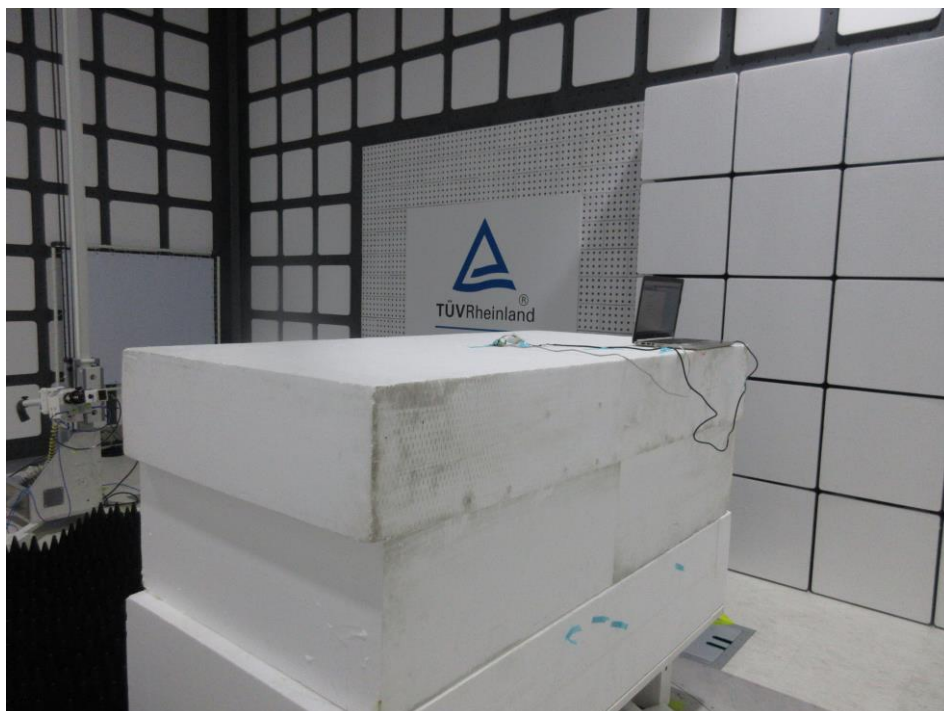
Photograph 2: Set-up for Spurious Emissions (Front View 2)



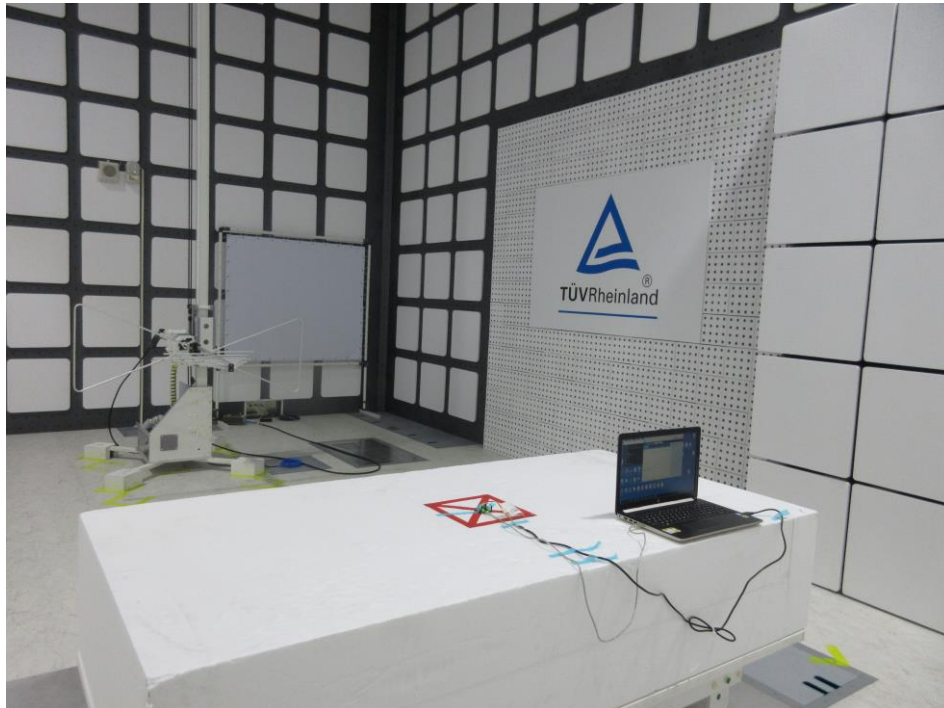
Photograph 3: Set-up for Spurious Emissions (Back View 1)



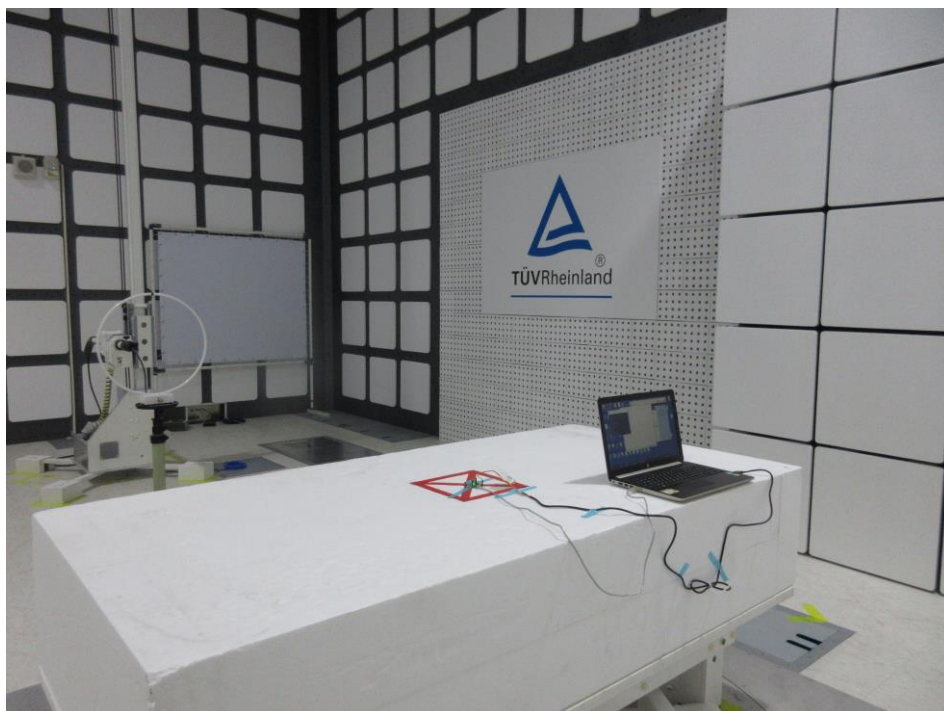
Photograph 4: Set-up for Spurious Emissions (Back View 2)



Photograph 5: Set-up for Spurious Emissions (Back View 3)



Photograph 6: Set-up for Spurious Emissions (Back View 4)



Photograph 7: Set-up for AC Mains Conducted testing (Front View)



Photograph 8: Set-up for AC Mains Conducted testing (Back View)



8. List of Tables

| | |
|--|----|
| Table 1: Applied Standard and Test Levels | 5 |
| Table 2: List of Test and Measurement Equipment | 7 |
| Table 3: Emission Measurement Uncertainty..... | 8 |
| Table 4: Basic Information of EUT | 9 |
| Table 5: Technical Specification of EUT | 9 |
| Table 6: Table for Parameters of Test Software Setting | 11 |
| Table 7: Test result of Peak Output Power | 15 |
| Table 8: Test result of 6dB Bandwidth | 17 |
| Table 9: Test result of 99% Bandwidth,..... | 17 |
| Table 10: Test result of Power Density | 21 |

9. List of Photographs

| | |
|--|----|
| Photograph 1: Set-up for Spurious Emissions (Front View 1)..... | 32 |
| Photograph 2: Set-up for Spurious Emissions (Front View 2)..... | 32 |
| Photograph 3: Set-up for Spurious Emissions (Back View 1) | 33 |
| Photograph 4: Set-up for Spurious Emissions (Back View 2) | 33 |
| Photograph 5: Set-up for Spurious Emissions (Back View 3) | 34 |
| Photograph 6: Set-up for Spurious Emissions (Back View 4) | 34 |
| Photograph 7: Set-up for AC Mains Conducted testing (Front View) | 35 |
| Photograph 8: Set-up for AC Mains Conducted testing (Back View) | 35 |