

TEST REPORT FOR BLUETOOTH TESTING

Report No.: SRTC2016-9004(F)-0020

Product Name: IVT Corporation i145 module

Product Model: i145

Applicant: IVT Corporation

Manufacturer: IVT Corporation

Specification: FCC Part 15, Subpart C (10-1-2015 edition)

FCC ID: S78-IVTI145

The State Radio_monitoring_center Testing Center (SRTC)

No.80 Beilishi Road Xicheng District Beijing, China

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1. GENERAL INFORMATION

1.1 Notes of the test report

The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written permission of The State Radio_monitoring_center Testing Center (SRTC).

The test results relate only to individual items of the samples which have been tested.

1.2 Information about the testing laboratory

Company:	The State Radio_monitoring_center Testing Center (SRTC)
Address:	No.80 Beilishi Road, Xicheng District
City:	Beijing
Country or Region:	P.R.China
Contacted person:	liujia
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1.3 Applicant's details

Company:	IVT Corporation
Address:	5/F, Zhongguancun Fazhan Building No. 12, Shangdi Xinx Road, Haidian District, Beijing, CHINA
City:	Beijing
Country or Region:	P.R.China
Grantee Code:	S78
Contacted person:	Jason Zhu
Tel:	010-82898219
Fax:	010-82898219
Email:	yong.zhu@ivtwireless.com

1.4 Manufacturer's details

Company:	IVT Corporation
Address:	5/F, Zhongguancun Fazhan Building No. 12, Shangdi Xinx Road, Haidian District, Beijing, CHINA
City:	Beijing
Country or Region:	P.R.China
Contacted person:	Jason Zhu
Tel:	010-82898219
Fax:	010-82898219
Email:	yong.zhu@ivtwireless.com

1.5 Test Environment

Date of Receipt of test sample at SRTC:	2016.06.15
Testing Start Date:	2016.06.16
Testing End Date:	2016.06.20

Environmental Data:	Temperature (°C)	Humidity (%)
Ambient	25	38
Maximum Extreme	55	80
Minimum Extreme	-10	---

Normal Supply Voltage (V d.c.):	5.00
Maximum Extreme Supply Voltage (V d.c.):	5.80
Minimum Extreme Supply Voltage (V d.c.):	4.00

2 DESCRIPTION OF THE DEVICE UNDER TEST

2.1 Final Equipment Build Status

Frequency Range	2.4GHz~2.4835GHz
Number of Channel	40
Modulation Type	GFSK
Duplex Mode	TDD
Channel Spacing	1MHz
Data Rate	1Mbps
Antenna Type	Fixed Internal
Antenna Gain	0dBi
Power Supply	Battery or Charger
Rated Power Supply Voltage	5.0V
HW Version	i145_20151030
SW Version	BSE_AUD_2.1.0.7
Serial Number	20151030

3 REFERENCE SPECIFICATION

Specification	Version	Title
15.35	Mar. 6, 2014	Measurement detector functions and bandwidths.
15.209	Oct. 30, 1997	Radiated emission limits; general requirements.
15.247	May 1, 2014	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

4 KEY TO NOTES AND RESULT CODES

Code	Meaning
PASS	Test result shows that the requirements of the relevant specification have been met.
FAIL	Test result shows that the requirements of the relevant specification have not been met.
N/T	Test case is not tested.
NTC	Nominal voltage, Normal Temperature
HV	High voltage, Normal Temperature
LV	Low voltage, Normal Temperature
HTHV	high voltage, High Temperature
LTHV	High voltage, Low Temperature
HTLV	Low voltage, High Temperature
LTLV	Low voltage, Low Temperature

5 RESULT SUMMARY

No.	Test case	FCC reference	Verdict
1	Occupied Bandwidth	15.247(a)(2)	Pass
2	Peak Power Output	15.247(b)(3)	Pass
3	Transmitter Power Spectral Density	15.247(e)	Pass
4	Conducted Out of band emission measurement	15.247(d)	Pass
5	Spurious Radiated Emissions	15.247(d)/15.35(b)/15.209	Pass
6	AC Power line Conducted Emission	15.207	Pass

This Test Report Is Issued by: Mr. Tao Hongbo 	Checked by: Ms. Liu Jia 
Tested by: Mr. Jiang Shuo 	Issued date: 2016/7/6

6 TEST RESULT

6.1 Occupied Bandwidth

6.1.1 Ambient condition

Temperature	Relative humidity	Pressure
22°C	40%	101.5kPa

6.1.2 Test Description

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer and Bluetooth test set via a power splitter with a known loss. Which connected to the transmitter antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies. All modes of operation were investigated and the worst case configuration results are reported in this section.

6.1.3 Test limit

Part15.247(a)(2)

The minimum permissible 6dB bandwidth is 500 kHz

6.1.4 Test Procedure Used

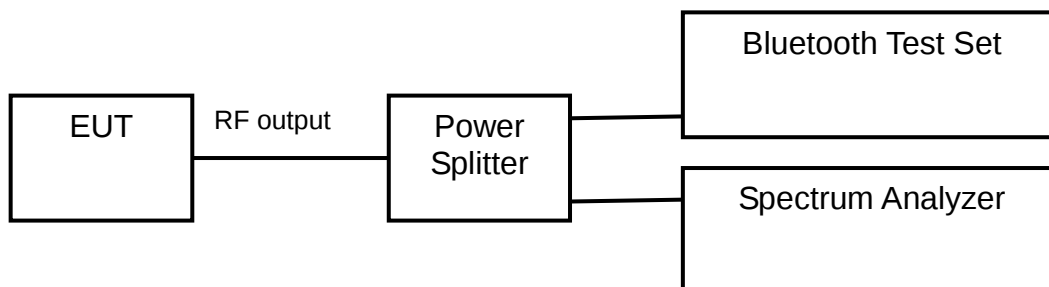
KDB 558074 D01 v03r05 - Section 8.1 Option 1

6.1.5 Test Settings

- Set RBW = 100 kHz.
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

6.1.6 Test Setup

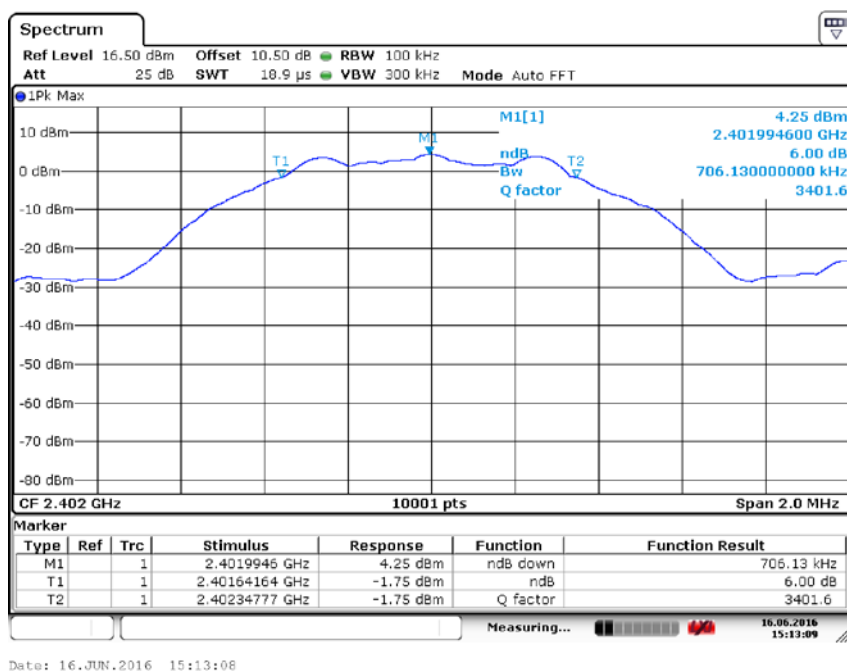
The EUT and measurement equipment were set up as shown in the diagram below.



6.1.7 Test result

Modulation type: GFSK (LE)

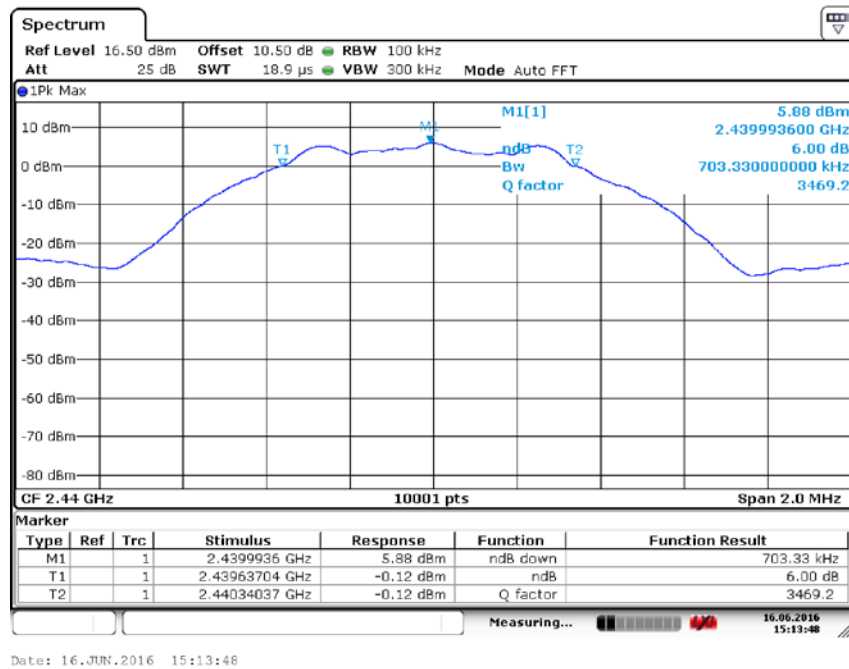
Carrier frequency (MHz)	Channel No.	6 dB bandwidth(kHz)
2402	0	706.1
2440	19	703.3
2480	39	698.5



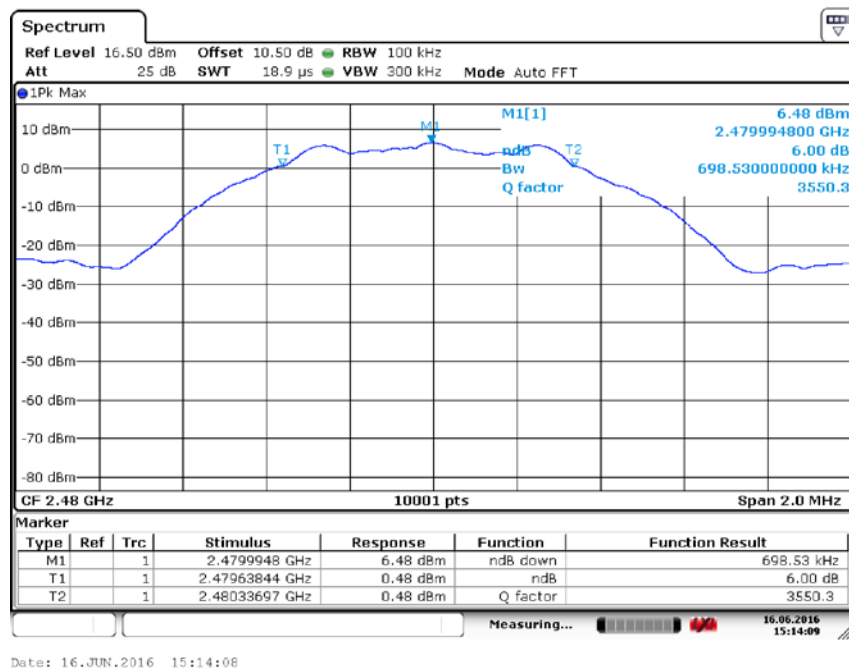
Carrier frequency (MHz): 2402

Channel No.:0

Modulation type: GFSK (LE)



Carrier frequency (MHz): 2440
Channel No.:19
Modulation type: GFSK (LE)



Carrier frequency (MHz): 2480
Channel No.:39
Modulation type: GFSK (LE)

6.2 Peak Power Output

6.2.1 Ambient condition

Temperature	Relative humidity	Pressure
22°C	40%	101.5kPa

6.2.2 Test Description

The transmitter antenna terminal of the EUT is connected to the spectrum analyzer and Bluetooth test set via a power splitter with a known loss. Measurements are made while the EUT is operating at maximum power and at the appropriate frequencies.

6.2.3 Test limit

Part15.247(b)(3)

The maximum permissible conducted output power is 1 Watt.

Used conversion factor: Limit (dBm) = 10 log (Limit (W)/1mW)

==> Maximum Output Power: 30.0 dBm

6.2.4 Test Procedure Used

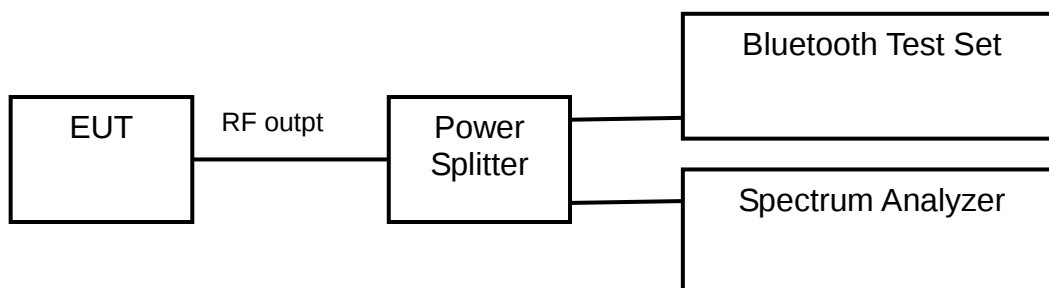
KDB 558074 D01 v03r05 - Section 9.1.1

6.2.5 Test Settings

- a) RBW =2 MHz
- b) VBW =10 MHz
- c) span ≥ 3 x RBW
- d) Sweep time = auto couple.
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use peak marker function to determine the peak amplitude level.

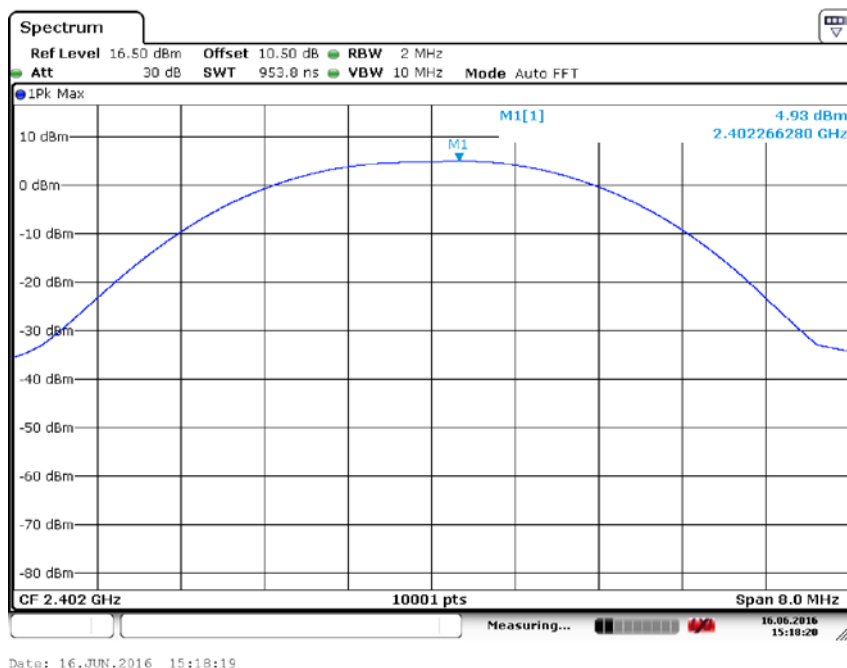
6.2.6 Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

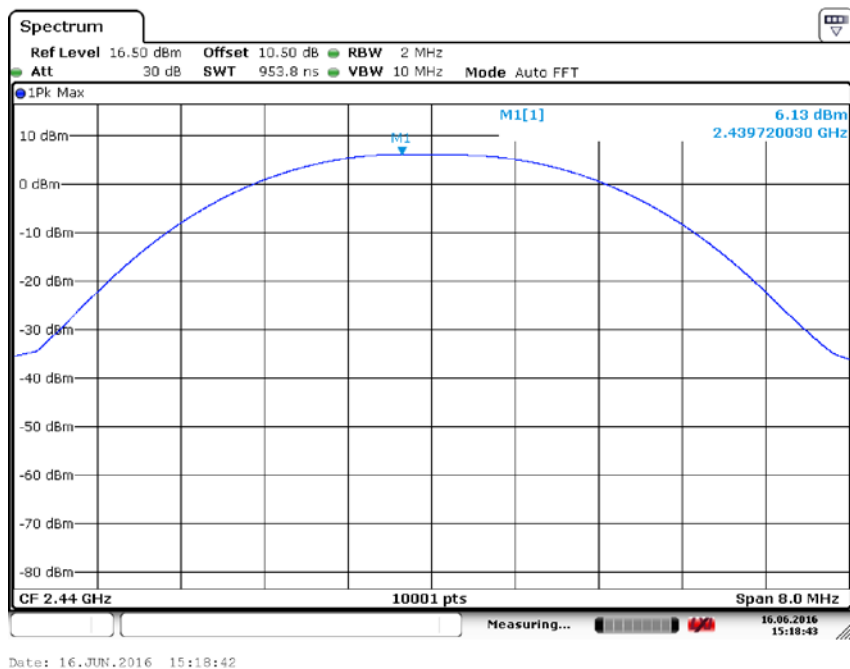


6.2.7 Test result

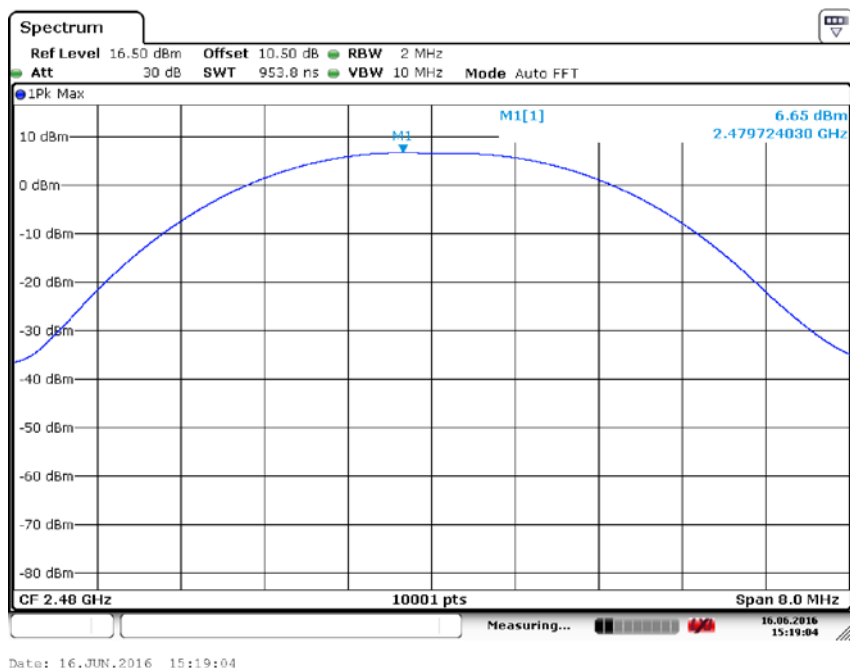
Modulation type	Peak Power Output (dBm)		
	2402MHz (Ch0)	2440MHz (Ch19)	2480MHz (Ch39)
GFSK (LE)	4.93	6.13	6.65



Carrier frequency (MHz): 2402
Channel No.:0
Modulation type: GFSK (LE)



Carrier frequency (MHz): 2440
Channel No.:19
Modulation type: GFSK (LE)



Carrier frequency (MHz): 2480
Channel No.:39
Modulation type: GFSK (LE)

6.3 Transmitter Power Spectral Density

6.3.1 Ambient condition

Temperature	Relative humidity	Pressure
22°C	40%	101.5kPa

6.3.2 Test Description

The peak power density is measured with a spectrum analyzer and Bluetooth test set via a power splitter with a known loss connected to the antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies.

6.3.3 Test limit

Part15.247(e)

The maximum permissible power spectral density is 8.0 dBm in any 3 kHz band.

6.3.4 Test Procedure Used

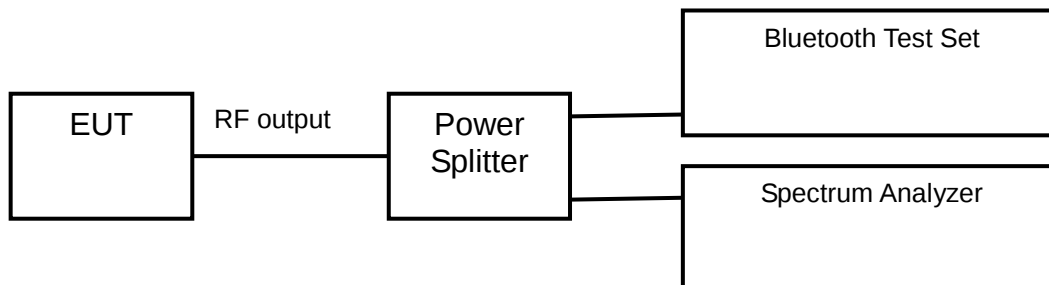
KDB 558074 D01 v03r05 Section 10.2.

6.3.5 Test Settings

- Set analyzer center frequency to DTS channel center frequency.
- Set the span to 1.5 times the DTS bandwidth.
- Set the RBW to: $3\text{ kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
- Set the VBW $\geq 3 \times \text{RBW}$.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.
- If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

6.3.6 Test Setup

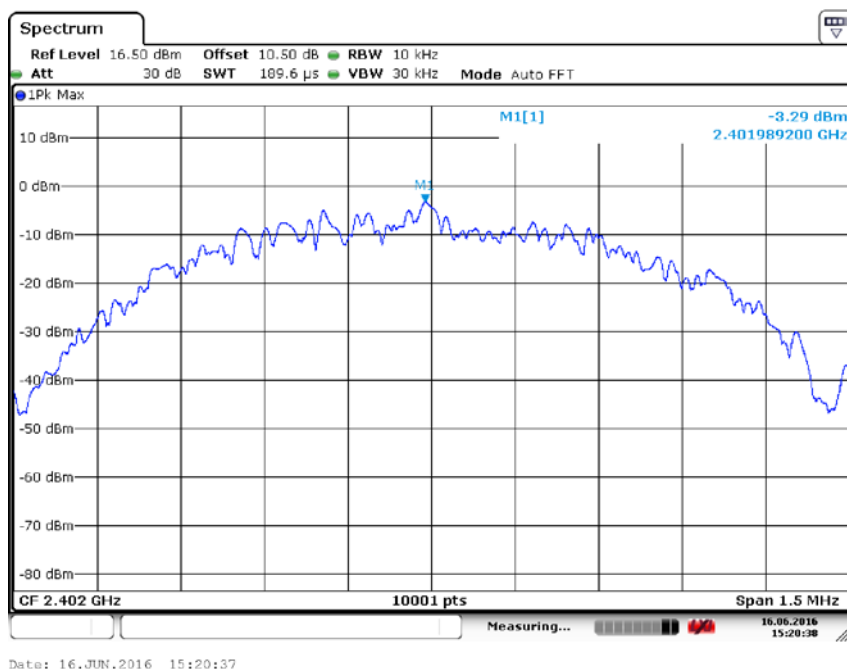
The EUT and measurement equipment were set up as shown in the diagram below.



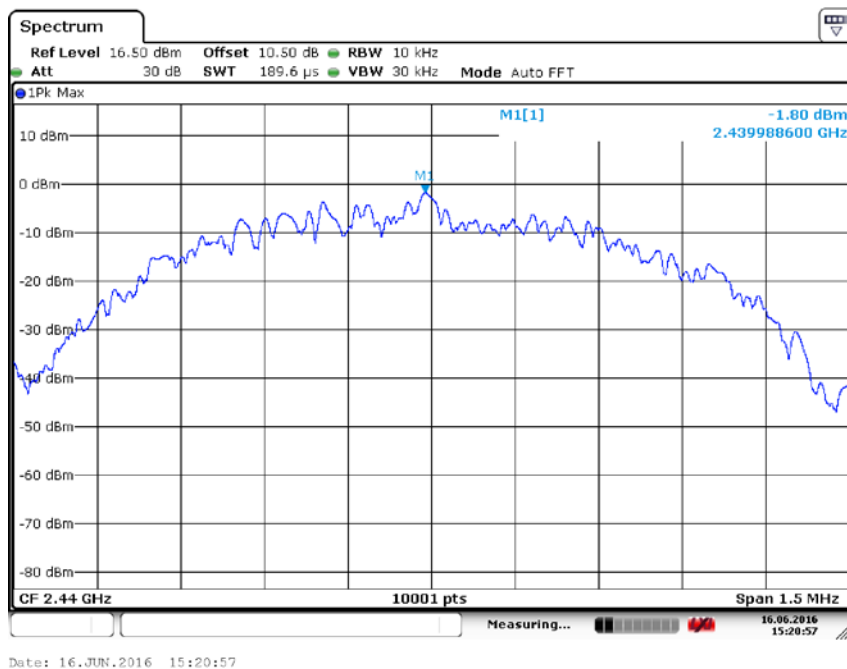
6.3.7 Test result:

Test limit : 8dBm/3kHz=13.2dBm/10kHz

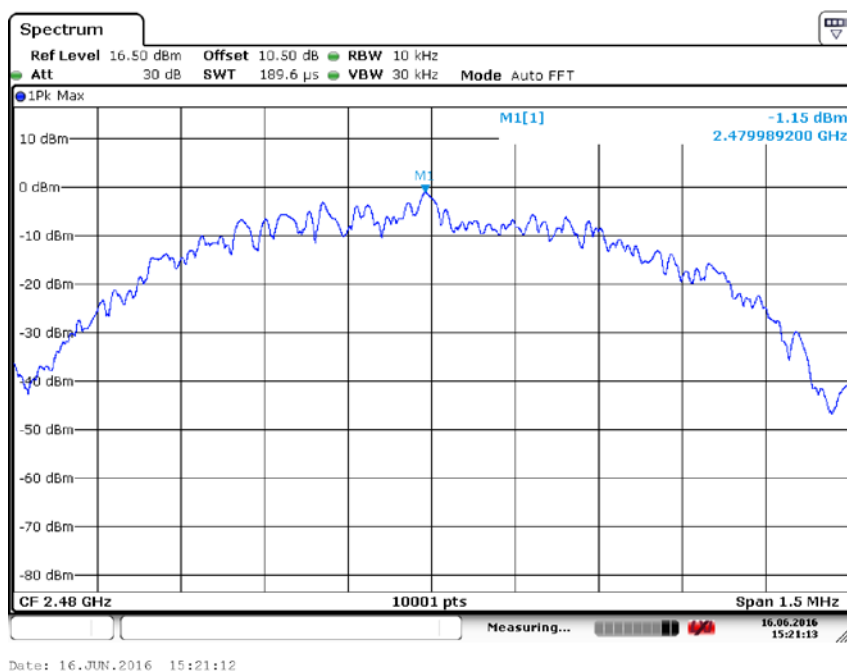
Carrier frequency (MHz)	Channel No	Power Density(dBm/10kHz)
2402	0	-3.29
2440	19	-1.80
2480	39	-1.15



Carrier frequency (MHz): 2402
Channel No.:0
Modulation type: GFSK (LE)



Carrier frequency (MHz): 2440
Channel No.:19
Modulation type: GFSK (LE)



Carrier frequency (MHz): 2480
Channel No.:39
Modulation type: GFSK (LE)

6.4 Conducted Out of band emission measurement

6.4.1 Ambient condition

Temperature	Relative humidity	Pressure
22°C	40%	101.5kPa

6.4.2 Test Description

For the following out of band conducted spurious emissions plots, the EUT was set to transmit at maximum power with the largest packet size available. The worst case spurious emissions were found in this configuration.

6.4.3 Test limit

Part 15.247(d)

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100 kHz bandwidth.

6.4.4 Test Procedure Used

KDB 558074 D01 v03r05 Section 11.3

6.4.5 Test Settings

- Set the center frequency and span to encompass frequency range to be measured.
- Set the RBW = 100kHz.
- Set the VBW $\geq$ 300kHz.
- Detector = peak.
- Set span to encompass the spectrum to be examined
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level.

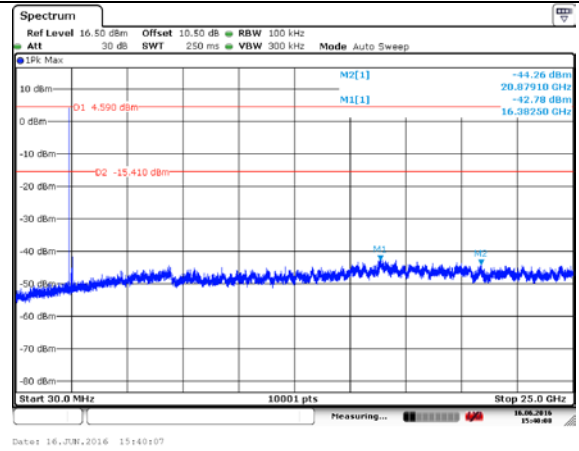
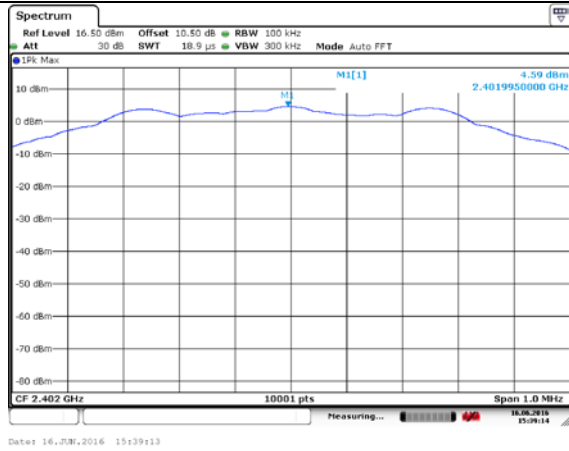
6.4.6 Test Setup

The EUT and measurement equipment were set up as shown in 2.2.3.6

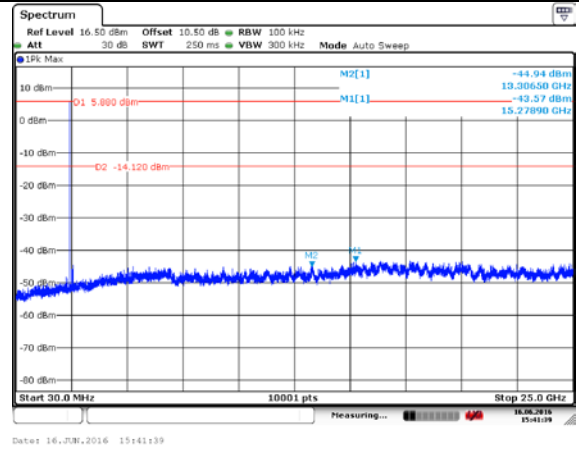
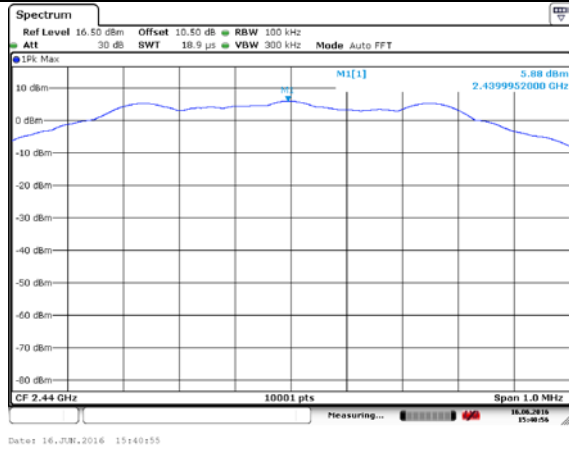
6.4.7 Test result

The spectrum plots are attached on the following pages. D1 line indicates the highest level, and D2 line indicates the 20dB offset below D1. It shows compliance with the requirement.

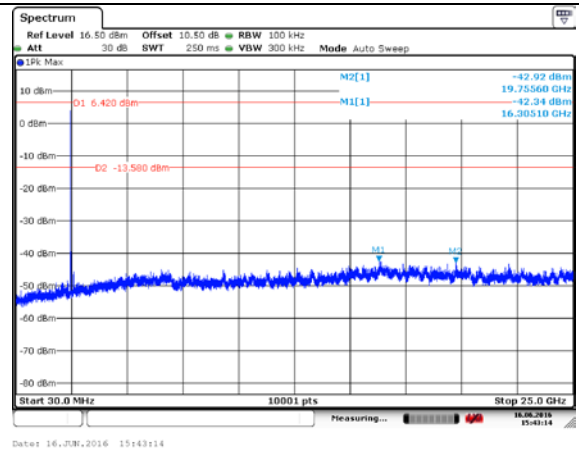
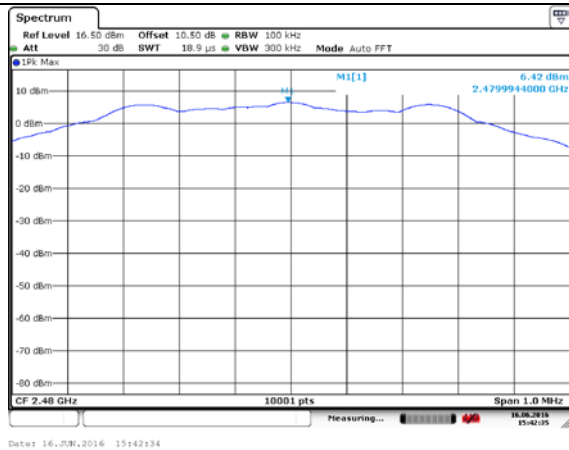
CH0



CH19



CH39



6.5 Spurious Radiated Emissions

6.5.1 Ambient condition

Temperature	Relative humidity	Pressure
20.8°C	36.5%	100.9kPa

6.5.2 Test Description

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at maximum power and at the appropriate frequencies. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

6.5.3 Test limit

Part15.205, 15.209, 15.247(d);

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in below Table per Section 15.209.

Frequency [MHz]	Field strength [$\mu\text{V/m}$]	Measured Distance [meters]
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

Radiated Limits

Part15.35(b):

there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit

Used conversion factor: $\text{Limit (dB}\mu\text{V/m)} = 20 \log (\text{Limit (}\mu\text{V/m)}/1\mu\text{V/m)}$

Frequency [MHz]	Detector	Unit (dB $\mu\text{V/m}$)
30~88	Quasi-peak	40.0
88~216	Quasi-peak	43.5
216~960	Quasi-peak	46.0
960~1000	Quasi-peak	54.0
1000~5th harmonic of the highest frequency or 40GHz, whichever is lower	Average	54.0
	Peak	74.0

Conversion Radiated limits

6.5.4 Test Procedure Used

- KDB 558074 D01 v03r05 - Section 12.2.5 (average power measurements)
KDB 558074 D01 v03r05 - Section 12.2.4 (peak power measurements)

6.5.5 Test Settings

Average Field Strength Measurements per Section 12.2.5.3 of KDB 558074 v03r05

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3kHz > 1/T
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace was allowed to run for at least 50 times (1/duty cycle) traces

Peak Field Strength Measurements per Section 12.2.4 of KDB 558074 v03r05

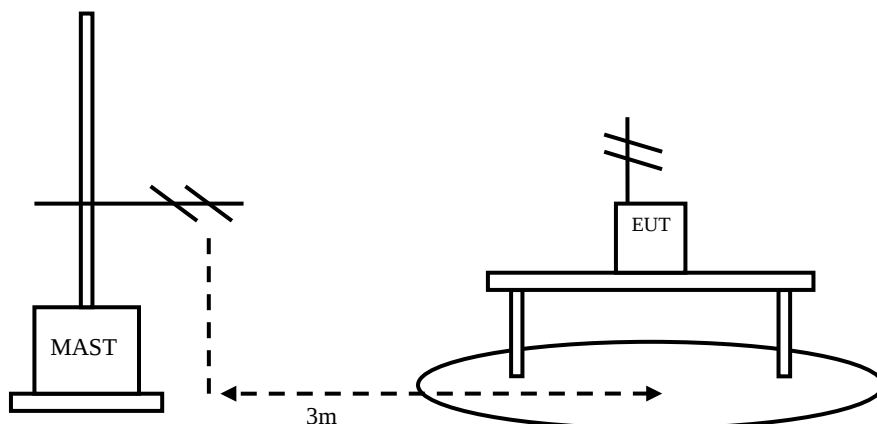
1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW is set depending on measurement frequency, as specified in following table

Frequency	RBW
9-150kHz	200-300Hz
0.15-30MHz	9-10kHz
30-1000MHz	100-120kHz
>1000MHz	1MHz

3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

6.5.6 Test Setup

The EUT and measurement equipment were set up as shown in the diagram below



The Equipment Under Test (EUT) was set up on a non-conductive table in the semi-anechoic chamber. The test was performed at the distance of 3 m between the EUT and the receiving antenna. The radiated emissions measurements were made in a typical installation configuration. Then start the test software ES-K1. Sweep the whole frequency band through the range from 30MHz to 1GHz or above, using receive log period antenna HL562 or Ridge horn antenna HF906.

During the test, the antenna height and EUT azimuth were varied in order to identify the maximum level of emission from the EUT. The height of receive antenna shall be moved from 1 to 4 meters, and the antenna shall be performed under horizontal and vertical polarization. The turn table shall be rotated from 0 to 360 degrees. The measurements shall be repeated with orthogonal polarization of the test antenna. The results shall be showed the worst case of the three orthogonal axes.

The data of cable loss and antenna factor has been calibrated in full testing frequency range before the testing.

6.5.7 Test result

The worst case attitude: The mobile lay down.

Carrier frequency (MHz): 2402

Channel No.:0

Test Mode: GFSK (LE)

Polarity: Vertical

Detector: Peak

No	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	cable loss (dB)	antenna factor (dB)
1	2402	84.54	50.54	N/A	N/A	8.90	25.10
2	2390	44.51	10.51	-29.49	74.00	8.90	25.10

Carrier frequency (MHz): 2402

Channel No.:0

Test Mode: GFSK (LE)

Polarity: Horizontal

Detector: Peak

No	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	cable loss (dB)	antenna factor (dB)
1	2402	87.47	53.47	N/A	N/A	8.90	25.10
2	2390	45.36	11.36	-28.64	74.00	8.90	25.10

Carrier frequency (MHz): 2402

Channel No.:0

Test Mode: GFSK (LE)

Polarity: Vertical

Detector: Average

No	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	cable loss (dB)	antenna factor (dB)
1	2402	83.69	49.69	N/A	N/A	8.90	25.10
2	2390	41.37	7.37	-12.63	54.00	8.90	25.10

Carrier frequency (MHz): 2402
Channel No.:0
Test Mode: GFSK (LE)
Polarity: Horizontal
Detector: Average

No	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	cable loss (dB)	antenna factor (dB)
1	2402	84.72	50.72	N/A	N/A	8.90	25.10
2	2390	43.27	9.27	-10.73	54.00	8.90	25.10

Carrier frequency (MHz): 2480
Channel No.:39
Test Mode: GFSK (LE)
Polarity: Vertical
Detector: Peak

No	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	cable loss (dB)	antenna factor (dB)
1	2480	83.92	49.92	N/A	N/A	8.90	25.10
2	2483.5	45.58	11.58	-28.42	74.00	8.90	25.10

Carrier frequency (MHz): 2480
Channel No.:39
Test Mode: GFSK (LE)
Polarity: Horizontal
Detector: Peak

No	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	cable loss (dB)	antenna factor (dB)
1	2480	86.78	52.78	N/A	N/A	8.90	25.10
2	2483.5	47.11	13.11	-26.89	74.00	8.90	25.10

Carrier frequency (MHz): 2480
Channel No.:39
Test Mode: GFSK (LE)
Polarity: Vertical
Detector: Average

No	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	cable loss (dB)	antenna factor (dB)
1	2480	83.21	49.21	N/A	N/A	8.90	25.10
2	2483.5	42.49	8.49	-11.51	54.00	8.90	25.10

Carrier frequency (MHz): 2480

Channel No.:39

Test Mode: GFSK (LE)

Polarity: Horizontal

Detector: Average

No	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	cable loss (dB)	antenna factor (dB)
1	2480	84.97	50.97	N/A	N/A	8.90	25.10
2	2483.5	39.71	5.71	-14.29	54.00	8.90	25.10

Sample Calculations

Determining Spurious Emissions Levels

A “reference path loss” is established and the A_{Rpl} is the attenuation of “reference path loss”, and including the gain of receive antenna, the gain of the preamplifier, the cable loss.

The measurement results are obtained as described below:

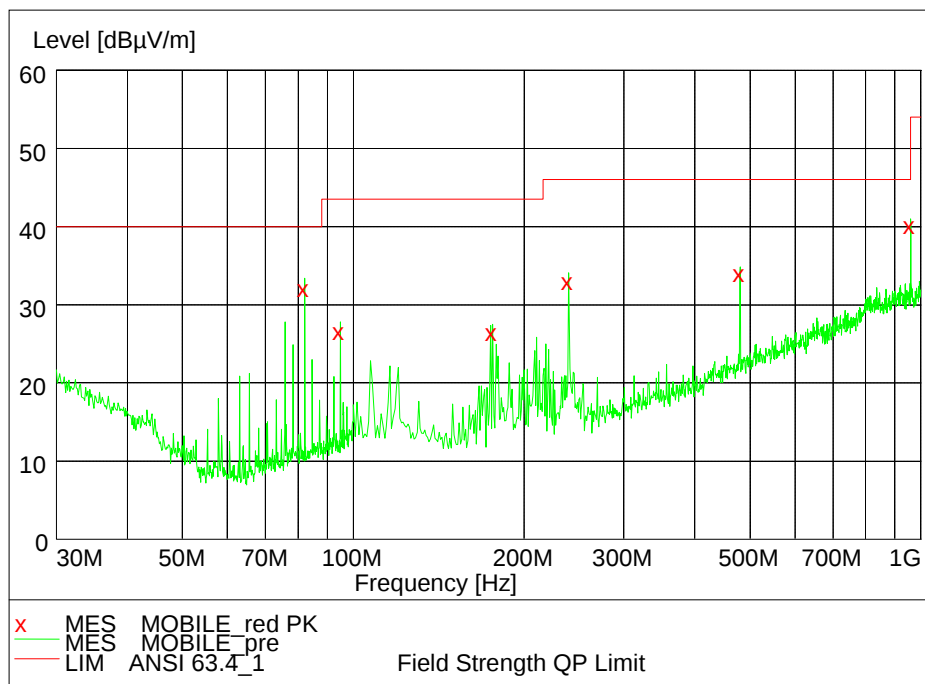
Result= $P_{mea} + A_{Rpl}$

The worst case attitude: The mobile lay down.

For GFSK (LE)

Channel No.:19

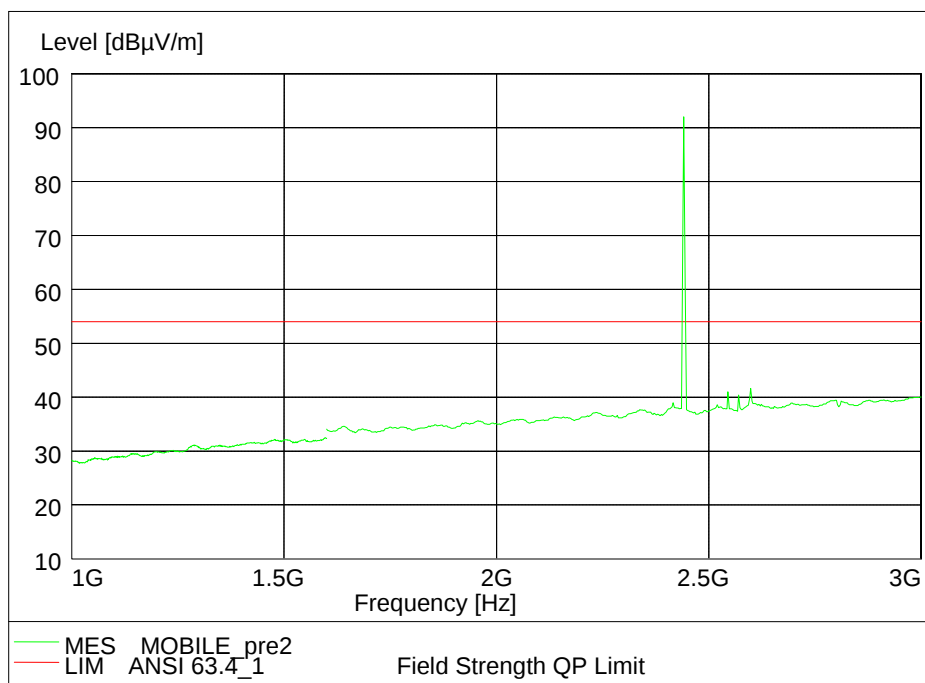
Frequency (MHz)	Result (dBuV/m)	A_{Rpl} (dB)	P_{mea} (dBuV/m)	Polarity	Limit (dBuV/m)
82.184369	31.39	8.42	22.97	Horizontal	40.0
94.949900	25.83	8.42	17.41	Vertical	43.5
176.152305	25.49	11.9	13.59	Horizontal	43.5
239.478958	31.12	14.2	16.92	Vertical	46.0
480.761523	32.84	20.1	12.74	Vertical	46.0
959.919840	37.99	28.5	9.45	Vertical	46.0



Frequency Range: 30MHz-1000 MHz

Detector: QP mode

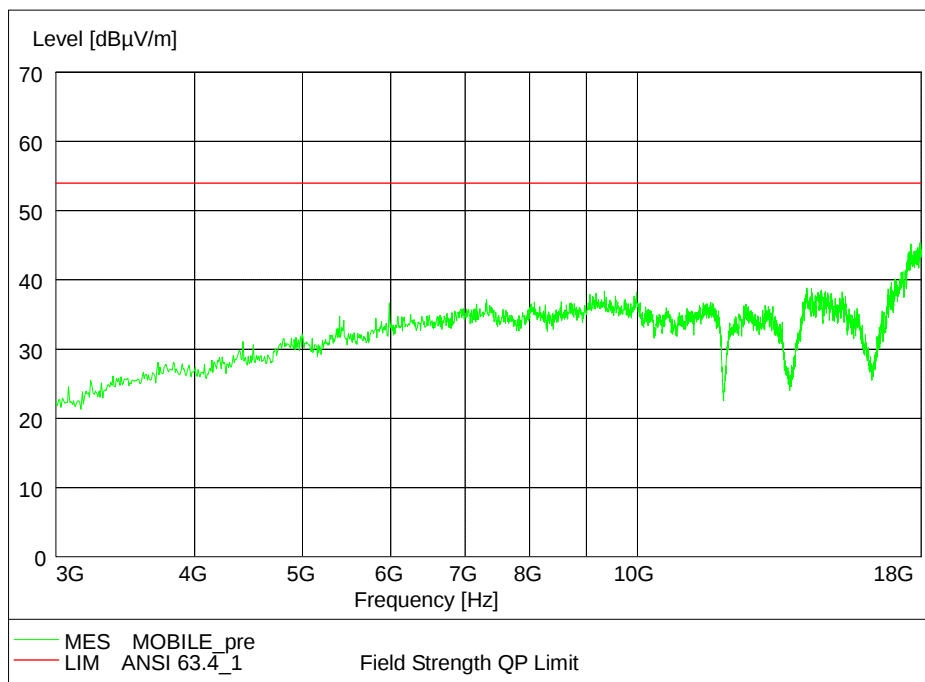
Modulation type: GFSK (LE)



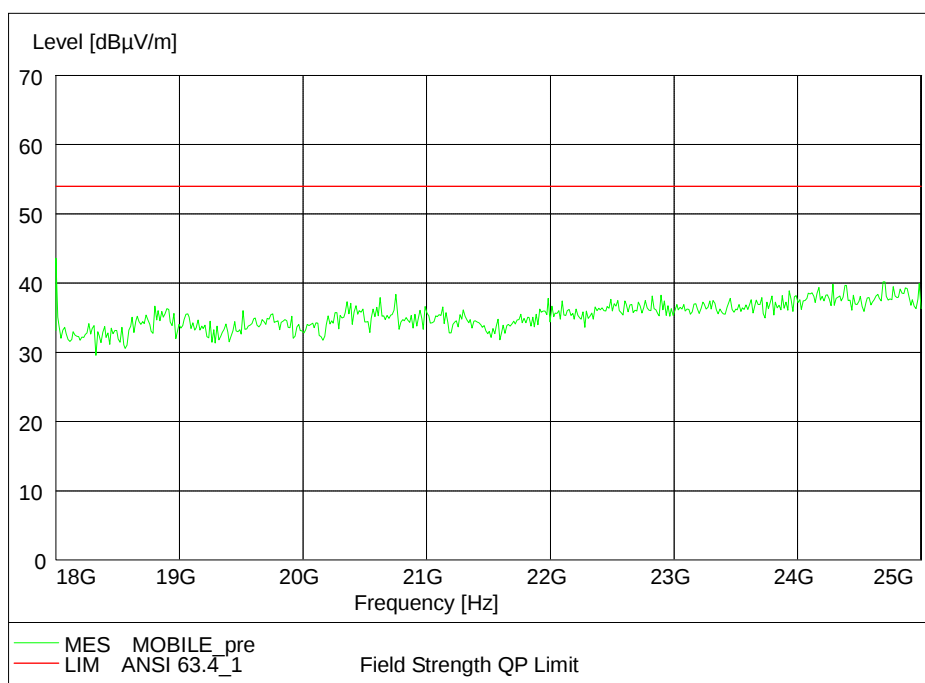
Frequency Range: 1GHz-3GHz

Detector: Av mode and PK mode

Modulation type: GFSK (LE)



Frequency Range: 3GHz-18GHz
Detector: Av mode and PK mode
Modulation type: GFSK (LE)



Frequency Range: 18GHz-25GHz
Detector: Av mode and PK mode
Modulation type: GFSK (LE)

6.6 AC Power line Conducted Emission

6.6.1 Ambient condition

Temperature	Relative humidity	Pressure
20.8°C	36.5%	100.9kPa

6.6.2 Test limit

FCC Part15.207

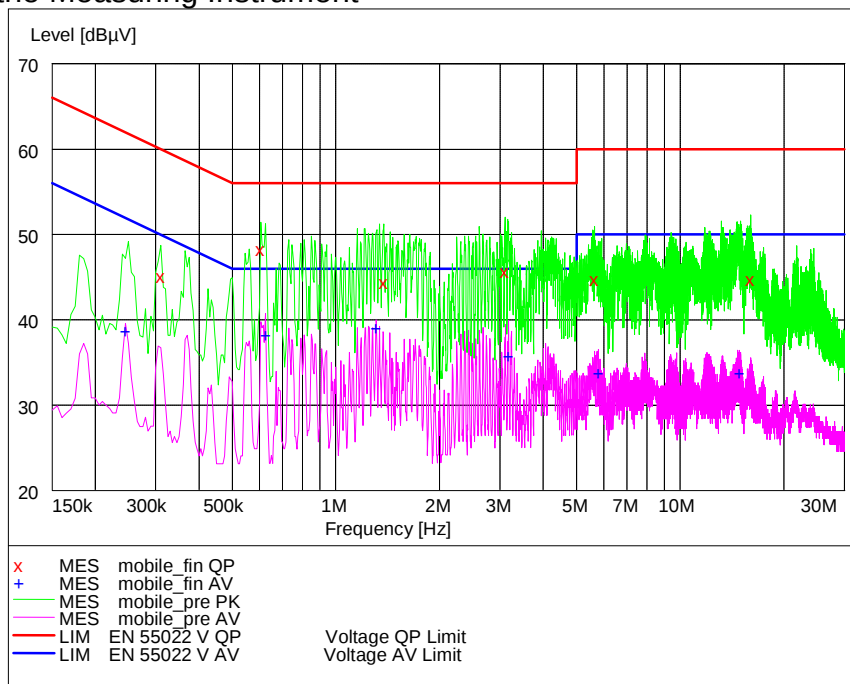
Frequency of Emission (MHz)	Conducted Limit (dBuV)	
0.15-0.5 0.5-5 5-30	Quasi-peak	Average
	66 to 56 *	56 to 46 *
	56	46
	60	50

* Decreases with the logarithm of the frequency.

The measurement is made according to ANSI C63.4-2014

6.6.3 Test result

Noise Level of the Measuring Instrument



L+N Line

MEASUREMENT RESULT: "MOBILE_fin QP"

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Line
0.310000	45.30	29.6	60	14.7	L
0.605000	48.40	29.7	56	7.6	N
1.380000	44.60	29.7	56	11.4	L
3.100000	45.90	29.7	56	10.1	L
5.640000	44.90	29.8	60	15.1	N
16.020000	45.00	30.0	60	15.0	L

MEASUREMENT RESULT: "MOBILE_fin AV"

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Line
0.245000	38.80	29.6	52	13.1	L
0.625000	38.30	29.7	46	7.7	N
1.310000	39.20	29.7	46	6.8	L
3.175000	35.90	29.7	46	10.1	L
5.790000	34.00	29.8	50	16.0	N
14.870000	33.90	29.9	50	16.1	L

7 MEASUREMENT UNCERTAINTIES

Items	Uncertainty	
Occupied Bandwidth	3kHz	
Peak power output	0.67dB	
Band edge compliance	1.20dB	
Spurious emissions	30MHz~1GHz	2.83dB
	1GHz~12.75GHz	2.50dB
	12.75GHz~25GHz	2.75dB

8 TEST EQUIPMENTS

No.	Name/ Model	Manufacturer	S/N	Cal Due date
1.	Spectrum Analyzer FSV	ROHDE&SCHWARZ	101065	2016.08.20
2.	Signal Generator MG3700A	Anritsu	6200677084	2016.08.20
3.	Bluetooth Test Set MT8852B	Anritsu	1142010	2017.03.01
4.	Cable 104EA	SUCOFLEX	9272/4EA	2016.08.20
5.	Cable 104EA	SUCOFLEX	9266/4EA	2016.08.20
6.	Power Splitter 11850C	Agilent	026057	2016.08.20
7.	12.65m×8.03m×7.50m Fully-Anechoic Chamber	FRANKONIA	----	----
8.	23.18m×16.88m×9.60m Semi-Anechoic Chamber	FRANKONIA	---	----
9.	Turn table Diameter:1m	HD	----	----
10.	Turn table Diameter:5m	HD	----	----
11.	Antenna master FAC(MA4.0)	MATURO	----	----
12.	Antenna master SAC(MA4.0)	MATURO	----	----
13.	9.080m×5.255m×3.525m Shielding room	FRANKONIA	----	----
14.	HF 906 Double-Ridged Waveguide Horn Antenna	R&S	100030	2016.08.20
15.	HF 906 Double-Ridged Waveguide Horn Antenna	R&S	100029	2016.08.20
16.	HL562 Ultra log antenna	R&S	100016	2016.08.20
17.	3160-09 Receive antenna	SCHWARZ-BECK	002058-002	2016.08.20
18.	ESI 40 EMI test receiver	R&S	100015	2016.08.20
19.	Radio tester	CMU 200	114667	2016.08.20
20.	ESCS30 EMI test receiver	R&S	100029	2016.08.20
21.	HL562 Receive antenna	R&S	100167	2016.08.20
22.	ESH3-Z5 LISN	R&S	100020	2016.08.20

APPENDIX

Appendix Test Setup

---End of Test Report---