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LAB N° 0121

RTTE AND AUTOMOTIVE COMPONENTS LABORATORY

TEST REPORT
No. ARSP00101-01b

performed in accordance with

FCC Rules: Code of Federal Regulations (CFR) no. 47
Part 15 Subpart C Section 15.247

PRODUCT	Bluetooth® smart ready module
MODEL(s) TESTED	SPBT4.0DP
FCC ID	S9NSPBT40DP
TRADE MARK(s)	STMicroelectronics

APPLICANT	STMicroelectronics S.r.l. ~ Centro Direzionale Colleoni - Palazzo Andromeda 3 I-20864 Agrate Brianza (MB)

Tested by	Roberto Radice	Radice Roberto
Approved by	Roberto Colombo *[Laboratory manager]*	Roberto Colombo

Revision Sheet

Release No.	Date	Revision Description
Rev. 0	2015-09-07	First edition Digital signed - ARSP00101-01b_TR_FCC 15.247_STMICROELECTRONICS_Modulo SPBT4.0DP

1. GENERAL DATA

SAMPLE		
Samples received on	**2015-06-16**	**(item sent and sampling by applicant)**
IMQ reference samples	**BEM**	**77868**
Samples tested No.	1	
Object under analysis recognition	**Not carried out** Except where stated, characteristics of products were taken from client description and were not verified by the laboratory	
TEST LOCATION		
Testing dates	2015-06-16 ÷ 2015-07-02	
Testing laboratory	IMQ S.p.A. - Via Quintiliano, 43 – I-20138 Milano	
ENVIRONMENTAL CONDITIONING		
Parameter	***Measured***	
Ambient Temperature	20 ÷ 25 °C	
Relative Humidity	50 ÷ 60 %	
Atmospheric Pressure	900 ÷ 1000 mbar	

2. REFERENCE DOCUMENT

DOCUMENT		DATE	TITLE
☒	47 CFR Part 15	2008	Radio Frequency Device
☒	ANSI C63.4	2009	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
☒	ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices

3. EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL DATA

MODEL (basic)	Description
SPBT4.0DP	Bluetooth® smart ready module

FCC ID	S9NSPBT40DP

Manufacturer	STMicroelectronics S.r.l. ~ Centro Direzionale Colleoni - Palazzo Andromeda 3 I-20864 Agrate Brianza (MB)

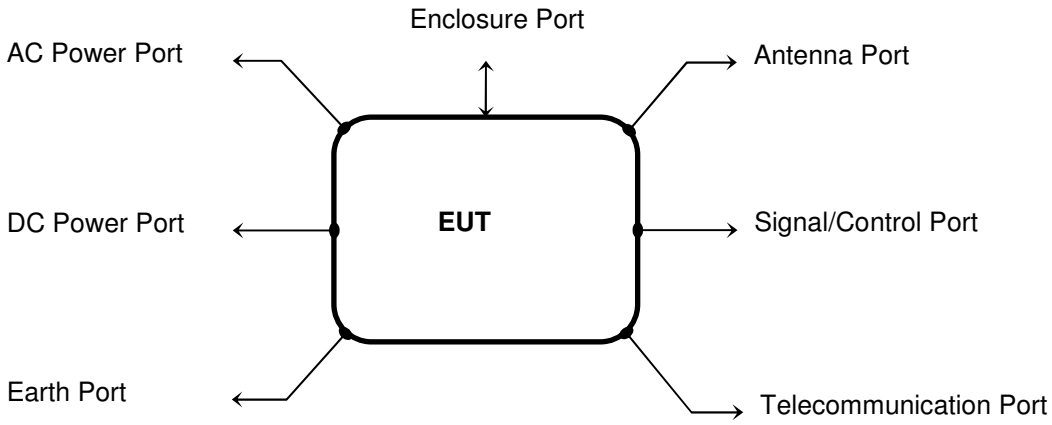
Equipment classification	According to the definition 15.3 (o) EUT is a **Intentional Radiator operating within the bands 2400 ÷ 2483.5 MHz** so it shall fulfill provisions of 47CFR Part 15 Subpart C – Intentional radiators – and Section 15.247

Type of equipment	Radio module
Operating frequency	2402 ÷ 2480 MHz
Equipment Class	DTS
Max radiated power	93,11 dBµV/m (at 3m. distance)
Modulation	GFSK
Channel Spacing	2MHz (low energy bluetooth GFSK)
Channel bandwidth	2MHz
Antenna	Dedicated antenna (JOHANSON P/N 2450AT18A100 - +0.5 dBi max gain)
Number of channels	40 (low energy bluetooth GFSK)

Low Energy bluetooth GFSK							
Channel No.	**Frequency (MHz)**	**Channel No.**	**Frequency (MHz)**	**Channel No.**	**Frequency (MHz)**	**Channel No.**	**Frequency (MHz)**
1	2402	2	2404	3	2406	4	2408
5	2410	6	2412	7	2414	8	2416
9	2418	10	2416	11	2422	12	2424
13	2426	14	2420	15	2430	16	2432
17	2434	18	2424	19	2438	20	2440
21	2442	22	2428	23	2446	24	2448
25	2450	26	2432	27	2454	28	2456
29	2458	30	2436	31	2462	32	2464
33	2466	34	2440	35	2470	36	2472
37	2474	38	2444	39	2478	40	2480

4. TEST CONFGURATION OF EQUIPMENT UNDER TEST

EUT PORTS



Port	Description	Max length
Enclosure	Open frame board	/
AC power	Not present	/
DC power	DC power supply 3.3 V DC	/
Signal/ Control	I/O pin (see also schematics data sheet)	/
Antenna	Integrated on PCB	/

STATE OF THE EUT DURING TESTS

#1	Operating	Bluetooth 4.0 BLE: Continuous transmission (single channel transmission 2402MHz, 2440MHz, 2480MHz) with GFSK 1Mbit/s modulation Signal pattern PRBS9 The EUT is installed on module device board (dongle). The dongle is powered from the USB cable port. The EUT is in continuously transmitting with max. RF power setting

SUPPORT EQUIPMENT

Defined as equipment needed for correct operation or loading of the EUT, but not considered as tested:

Equipment	Manufacturer	Model
Dongle furnished by manufacturer for supply and management of radio module	ST Microelectronics	PC95A V01
Software used for testing: Bluetooth HCI TOOLBOX R3.0B5 (ST-Ericsson) This software was running on PC connected via USB to the Dongle. It was used to enable the test operation mode #1		

ELECTROMAGNETICALLY RELEVANT COMPONENTS

Component	No.	Manufacturer	Model
Microprocessor	1	ST	Cortex-M4

RFI SUPPRESSION DEVICES

Component	No.	Manufacturer	Model
/	/	/	/

EMI PROTECTION DEVICES

Component	No.	Manufacturer	Model
/	/	/	/

EUT TECHNICAL DOCUMENTATION

Document	Reference
Datasheet – Preliminary data	SPBT4.0DP – July 2015
Schematic diagram	STEVAL-BT4DM – Drawing n° PC95AV01.V01
Layout	PC95AV01-Layout - top and bottom
Bill of Materials	STEVAL-BT4DM - Doc. Ref. PC95AV01.V01

5. METHODS OF MEASUREMENT

All compliance measurements have been carried out using the procedures described in the standard ANSI C63.4-2009, ANSI C63.10-2009 and Section 15.31 of CFR47 Part 15 – Subpart A (General). Additional test requirements have been adopted according to the reference Section indicated in the § 6 of this test report.
FREQUENCY RANGE INVESTIGATED
Conducted emission tests: from 150 kHz to 30MHz
Radiated emission tests: from 9 kHz to tenth harmonic of fundamental.

6. SUMMARY OF TEST RESULTS

POSSIBLE TEST CASE VERDICTS	
Test object does meet the requirement	PASS
Test object does not meet the requirement	FAIL
Test case does not apply to the test object	N.A.
Test not performed	N.P.

CFR47 Part 15	TITLE	RESULT
§ 15.203 § 15.247 (b)(4)(i)	Antenna Requirements	PASS
§ 15.207 (a)	Power Line Conducted Emission	PASS
§ 15.209 (a) (f)	Radiated Emission	PASS
§ 15.247 (d)	Out-of-band emissions	PASS
§ 15.247 (d)	100 kHz Bandwidth of Frequency Band Edges	PASS
§ 15.247 (a)	Frequency Hopping Spread Spectrum Specifications	
§ 15.247(a)	20 dB Bandwidth	N.A.
§ 15.247(a)(1)	Carrier frequency (Hopping Channel) Separation	N.A.
§ 15.247(a)(1)(iii)	Number of Hopping Channels Used	N.A.
§ 15.247(a)(1)(iii)	Time occupancy (Dwell Time) of Each Ch. within a 0,4 x Nch (sec) Period	N.A.
§ 15.247(a)(2)	6dB Minimum Bandwidth	PASS
§ 15.247(b)	Maximum Peak Output Power	
§ 15.247(b) (1)	Peak Output Power, radiated (EIRP)	PASS
§ 15.247(b) (3)	RF power output, radiated (EIRP)	N.A.
§ 15.247(b) (4)	Antenna gain	N.A.
§ 15.247(c)	Operation with directional antenna gains greater than 6 dBi	N.A.
§ 15.247 (e)	Power Spectral Density	PASS
§ 15.247 (f)	Hybrid systems	PASS
§ 15.247 (g)	FHSS Transmission characteristics	N.A.
§ 15.247 (h)	Recognition of occupied channel and multiple transmission system	N.A
§ 15.247(i) (§ 47CFR 1.1307(b)(1))	RF humane exposure	PASS

7. TEST RESULTS

7.1 ANTENNA REQUIREMENTS

TEST REQUIREMENT
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

Antenna specifications	
N° of authorized antenna types	1
Antenna type	Integral antenna on PCB
Maximum total gain	----
External power amplifiers	Not present

TEST RESULT
The EUT meets the requirements of section 15.203 and 15.204

7.2 POWER LINE CONDUCTED EMISSION

TEST REQUIREMENT	
Test setup	ANSI C63.4
Test facility	Shielded chamber
Frequency range	150 kHz – 30 MHz
IF bandwidth	9 kHz
EMC class	B
EUT operating condition	#1 (4.0 BLE)

LIMITS

Band of operations	Quasi-Peak (dBµV)	Average Limit (dBµV)
0.15 ÷ 0.5	66 ÷ 56	56 ÷ 46
0.5 ÷ 5	56	46
5 ÷ 30	60	50

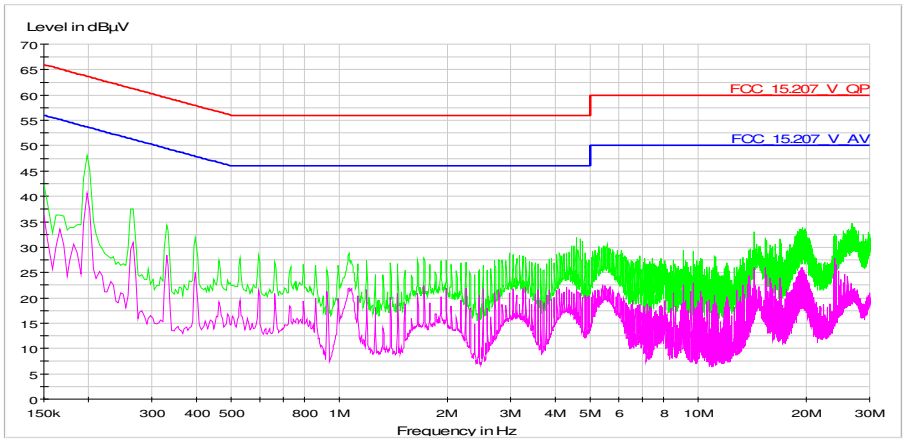
TEST RESULT

The EUT meets the requirements of sections 15.207 (a).

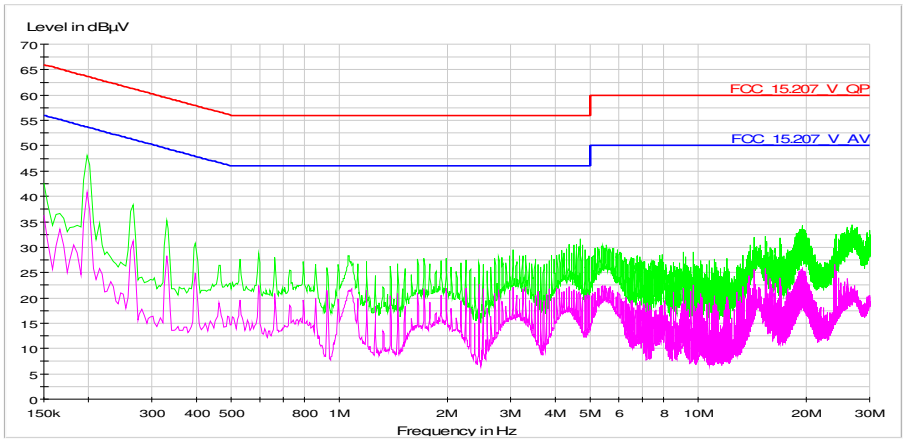
TEST PROCEDURE

1) The EUT was placed on a wooden table of size, 80 cm by 80 cm, raised 80 cm in which is located 40 cm away from the vertical wall the shielded room.
2) Each EUT power cord input cord was individually connected through a 50Ω/50µH LISN to the input power source.
3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
5) The measurements were made with the detector set to PEAK and AVERAGE amplitude within a bandwidth of 9 kHz during the measurements.
6) The measurements with Quasi-Peak detector are performed only for frequencies for which the Peak values are ≥ (Q.P. limit - 6 dB).

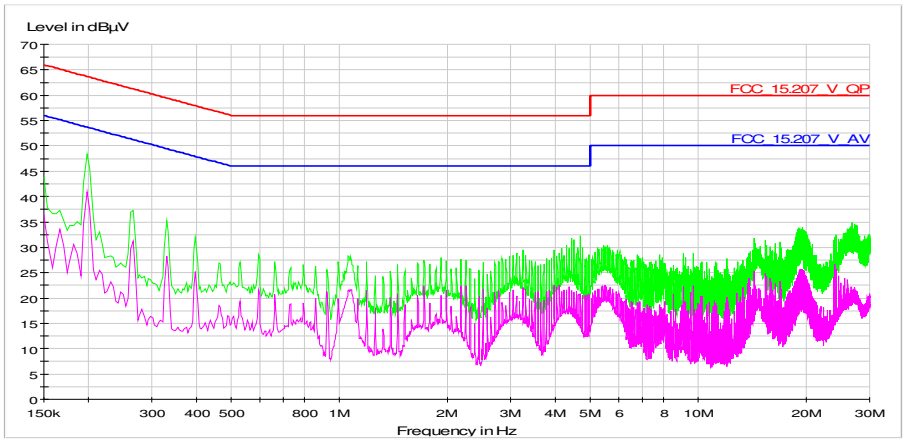
Test condition: Lower channel (2402MHz) – 4.0 BLE Modulation: GFSK 1Mbit/s



Test condition: Middle channel (2440MHz) – 4.0 BLE Modulation: GFSK 1Mbit/s



Test condition: Higher channel (2480MHz) – 4.0 BLE Modulation: GFSK 1Mbit/s



7.3 RADIATED DISTURBANCES

TEST REQUIREMENT	
Test setup	ANSI C63.4
Test facility	Semi-anechoic chamber
Test distance	3 meters
Frequency range	9 kHz to tenth harmonic of fundamental
IF bandwidth (below 30 MHz)	9 kHz
IF bandwidth (below 1,000 MHz)	120 kHz
IF bandwidth (above 1,000 MHz)	1 MHz
EMC class	B
EUT operating condition	#1 (4.0 BLE)
Remark: In accordance with part 15.31 (f) (2), where the measurement distance was specified to be 30 or 300 meters, a correction factor was applied in order to permit measurement to be performed at a separation distance. The applied formula for limits at 3 meter is:Extrapolation (dB) = 40log (300meter / 3meter) = +80db Extrapolation (dB) = 40log (30meter / 3meter) = +40db	

LIMITS		
Band of operations	**Peak (dBµV/m)**	**Average Limit (dBµV/m)**
Restricted bands (§ 15.205)	74	54
Other bands	According to 15.209 or fundamental –20dB (which is greater)	

TEST RESULT

The EUT has been tested in 3 orthogonal axes at the frequencies lowest, middle and highest.
The results reported are worst case.
The measurement of spurious emission of EUT in receiver mode is deemed to be fulfilled as no limits are exceeded in transmitter mode (condition considered more burdensome).
The EUT meets the requirements of sections 15.205 (b), 15.209 and 15.247.

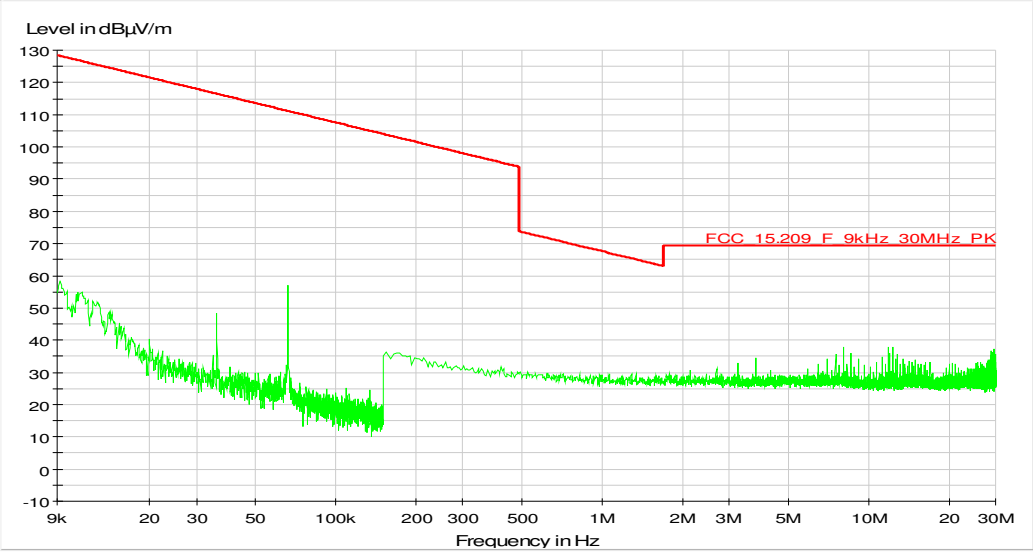
TEST PROCEDURE

1) The EUT was placed on turntable which is 0.8 m above the ground plane
2) The turntable shall rotate from 0° to 360° degrees to determine the position of maximum emission level.
3) The EUT is positioned 3 m away from the receiving antenna which varied from 1 to 4 m to find the highest emission.
4) The measurements were made with the detector set to PEAK and AVERAGE amplitude within a bandwidth of 100 kHz below 1000 MHz and 1 MHz above 1000 MHz.
5) The receiving antenna was positioned in both horizontal and vertical polarization.
6) The measurements with Quasi-Peak detector, below 1000 MHz are performed only for frequencies for which the Peak values are ≥ (Q.P. limit - 6 dB).

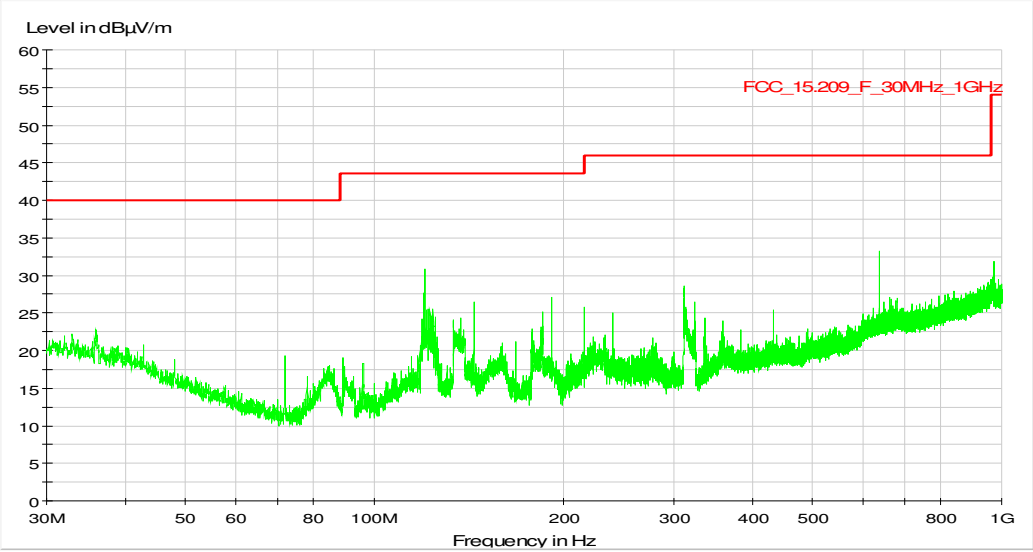
MEASUREMENTS RESULTS - RADIATED

BLUETOOTH 4.0 BLE – MODULATION GFSK 1Mbit/s (LOWER CHANNEL 2402MHZ)

9 kHz÷30 MHz

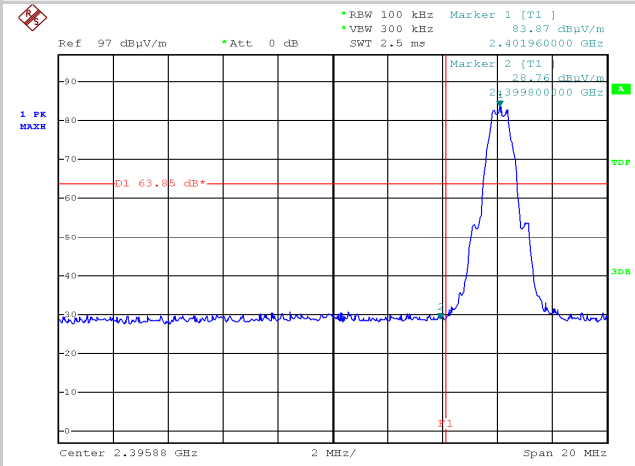
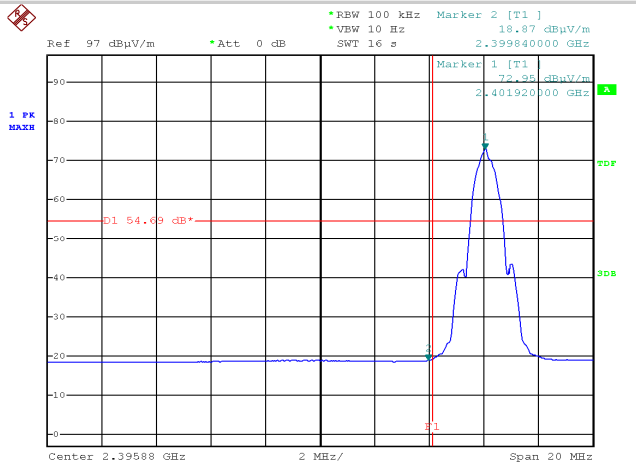


30÷1,000 MHz



1÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Pre-Amp. Gain**	**Correcting reading**	**PK Limit (AV + 20dB)**	**PK Limit (AV + 20dB)**	**Margin**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dB)**	**(dBµV/m)**	**(µV/m)**	**(dBµV/m)**	**(dB)**
2402 (fundamental)	95.19	27.50	4.70	-37.60	**89.79**	-----	------	------
4804	31.90	31.70	7.22	-36.80	**34.02**	5000	74.00	>39
7206	33.12	37.06	8.03	-37.06	**41.15**	5000	74.00	>32
9608	< 30	37.90	10.21	-37.12	**< 40**	5000	74.00	>34
12010	< 30	39.20	11.90	-36.71	**< 45**	5000	74.00	>29
f>12010	not significant	---	---	---	---	5000	74.00	---
NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.								

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)								
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Pre-Amp. Gain**	**Correcting reading**	**AV Limit**	**AV Limit**	**Margin**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dB)**	**(dBµV/m)**	**(µV/m)**	**(dBµV/m)**	**(dB)**
2402 (fundamental)	85.52	27.50	4.70	-37.60	**80.12**	-----	------	------
4804*	---	---	---	---	---	500	54.00	---
7206*	---	---	---	---	---	500	54.00	---
9608*	---	---	---	---	---	500	54.00	---
12010*	---	---	---	---	---	500	54.00	---
f>12010*	not significant	---	---	---	---	500	54.00	---
NOTE*: Peak value under Average Limit; no measure executed								

Bluetooth 4.0 BLE – Modulation GFSK 1Mbit/s	
Radiated Band-edge compliance - Lower band edge	
Peak	**Average**
	

Only for measuring emissions up to 2 MHz removed from the band-edge the "delta" technique for Radiated emissions was used.

PEAK

Measured peak (dBµV/m)	Measured band edge (dBµV/m)	Δ Peak/band edge (dB)	Limit at PK power –20 dB (dBµV/m)	Margin (dB)
83.87	28.76	55.11	63.87	35.11

AVERAGE

Measured (dBµV/m)	Measured band edge (dBµV/m)	Δ peak /band edge (dB)	Limit at peak –20 dB (dBµV/m)	Margin (dB)
72.95	18.87	54.08	52.95	34.08

Spurious Emission in restricted band near 2400-2483.5 MHz

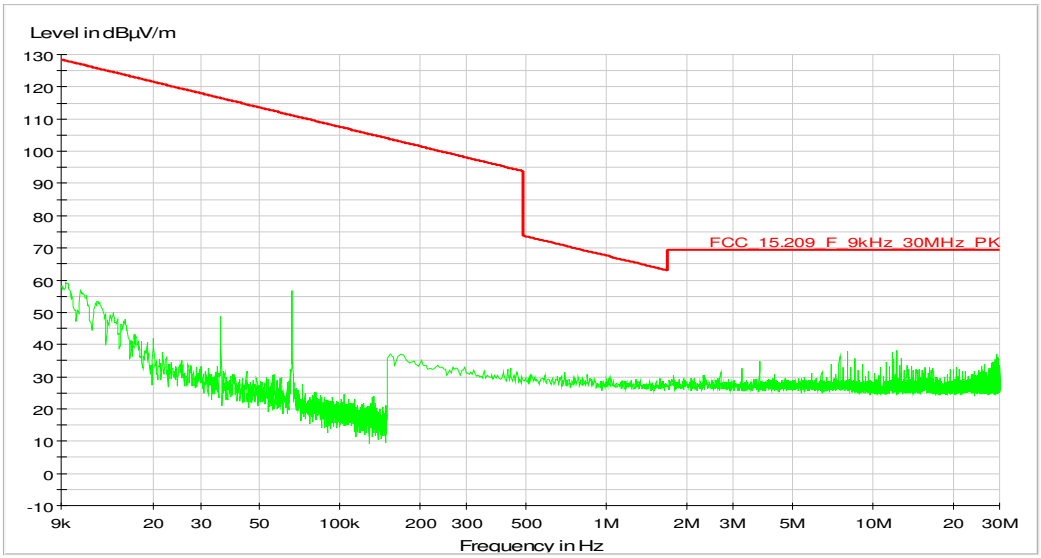
PEAK RESULT (RBW=1MHz; VBW=3MHz)

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	AV Limit	AV Limit	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2390.00	42.85	27.50	4.70	-37.60	**37.45**	500	54.00	16.55

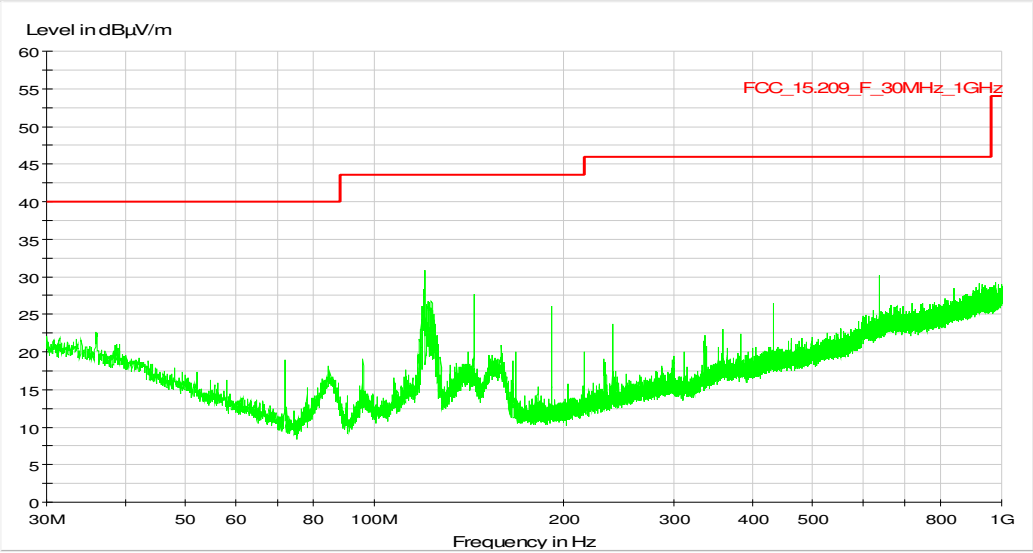
NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.
Peak value under Average Limit; no average measure executed.

BLUETOOTH 4.0 BLE – MODULATION GFSK 1Mbit/s (MIDDLE CHANNEL 2440MHZ)

9 kHz÷30 MHz



30÷1,000 MHz

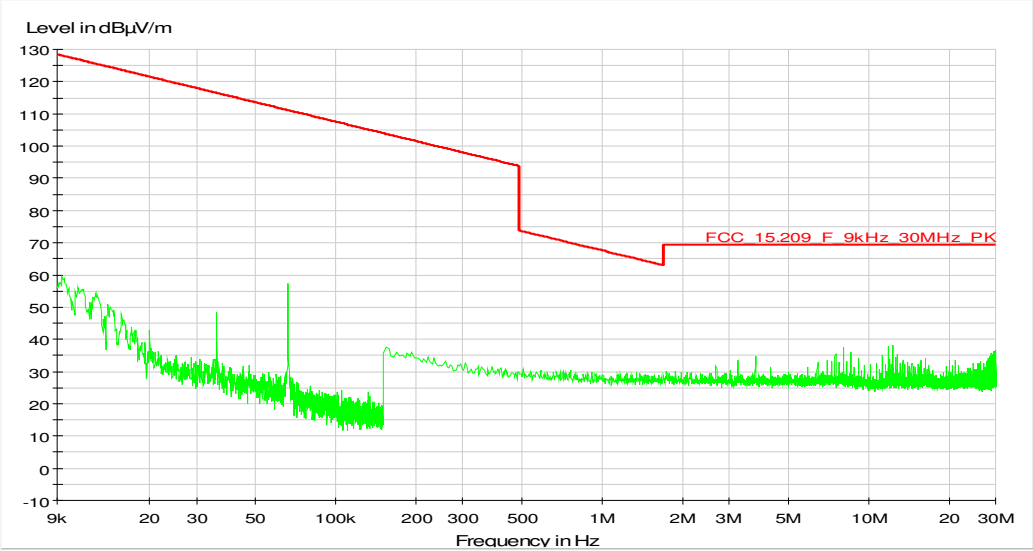


1÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Pre-Amp. Gain**	**Correcting reading**	**PK Limit (AV + 20dB)**	**PK Limit (AV + 20dB)**	**Margin**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dB)**	**(dBµV/m)**	**(µV/m)**	**(dBµV/m)**	**(dB)**
2440 (fundamental)	97.92	27.50	4.70	-37.60	**92.52**	-----	------	------
4880	31.32	31.70	7.22	-36.80	**33.44**	5000	74.00	>40
7320	32.85	37.06	8.03	-37.06	**40.88**	5000	74.00	>33
9760	< 30	37.90	10.21	-37.12	**< 40**	5000	74.00	>34
12200	< 30	39.20	11.90	-36.71	**< 45**	5000	74.00	>29
f>12200	not significant	---	---	---	---	5000	74.00	---
NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.								

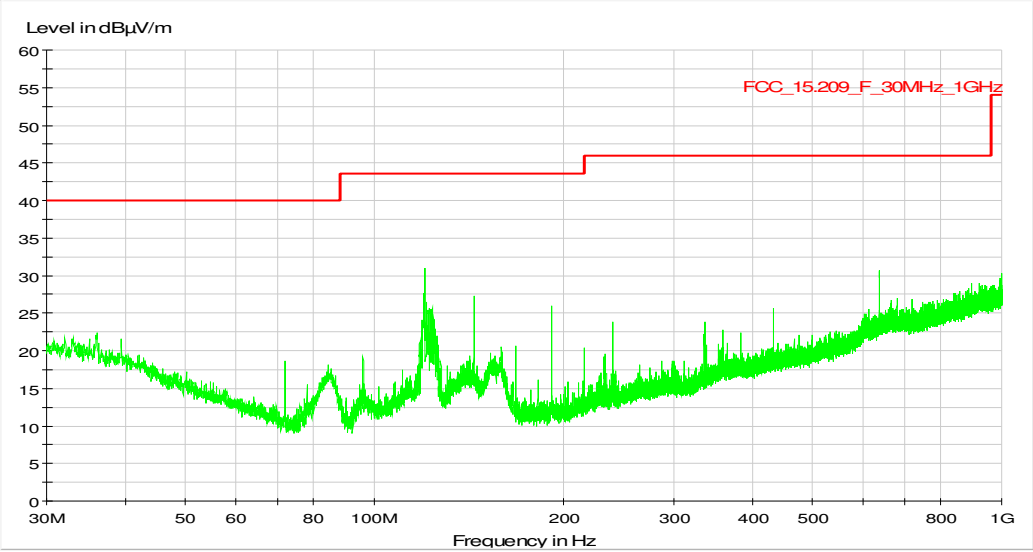
AVERAGE RESULT (RBW=1MHz; VBW=10Hz)								
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Pre-Amp. Gain**	**Correcting reading**	**AV Limit**	**AV Limit**	**Margin**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dB)**	**(dBµV/m)**	**(µV/m)**	**(dBµV/m)**	**(dB)**
2440 (fundamental)	89.15	27.50	4.70	-37.60	**83.75**	-----	------	------
4880*	---	---	---	---	---	500	54.00	---
7320*	---	---	---	---	---	500	54.00	---
9760*	---	---	---	---	---	500	54.00	---
12200*	---	---	---	---	---	500	54.00	---
f>12200*	not significant	---	---	---	---	500	54.00	---
NOTE*: Peak value under Average Limit; no measure executed								

BLUETOOTH 4.0 BLE – MODULATION GFSK 1Mbit/s (HIGHER CHANNEL 2480MHZ)

9 kHz÷30 MHz

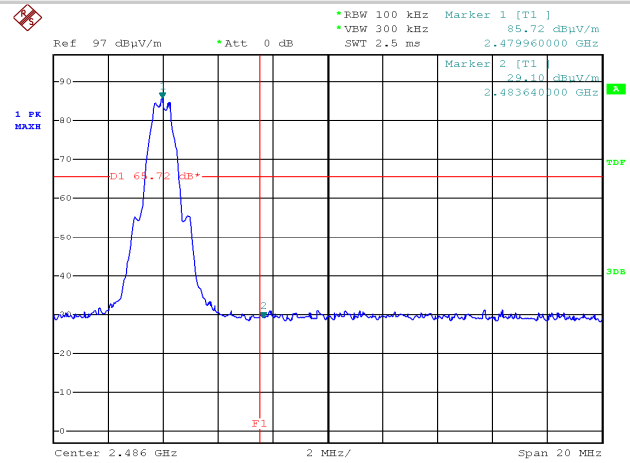
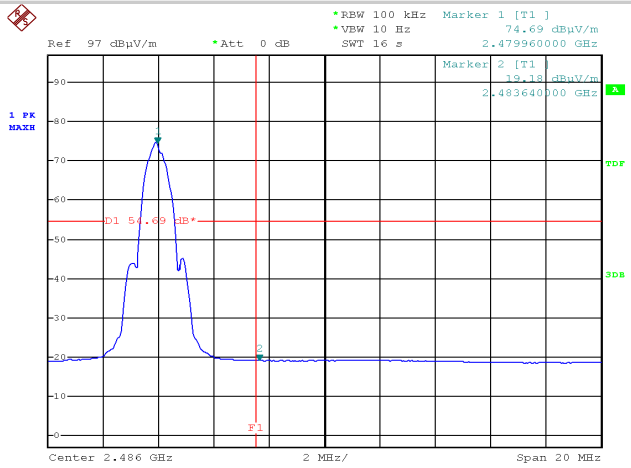


30÷1,000 MHz



1÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Pre-Amp. Gain**	**Correcting reading**	**PK Limit (AV + 20dB)**	**PK Limit (AV + 20dB)**	**Margin**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dB)**	**(dBµV/m)**	**(µV/m)**	**(dBµV/m)**	**(dB)**
2480 (fundamental)	98.51	27.50	4.70	-37.60	**93.11**	-----	------	------
4960	31.69	31.70	7.22	-36.80	**33.81**	5000	74.00	>40
7440	32.82	37.06	8.03	-37.06	**40.85**	5000	74.00	>33
9920	< 30	37.90	10.21	-37.12	**< 40**	5000	74.00	>34
12400	< 30	39.20	11.90	-36.71	**< 45**	5000	74.00	>29
f>12400	not significant	---	---	---	---	5000	74.00	---
NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.								

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)								
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Pre-Amp. Gain**	**Correcting reading**	**AV Limit**	**AV Limit**	**Margin**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dB)**	**(dBµV/m)**	**(µV/m)**	**(dBµV/m)**	**(dB)**
2480 (fundamental)	88.72	27.50	4.70	-37.60	**83.32**	-----	------	------
4960*	---	---	---	---	---	500	54.00	---
7440*	---	---	---	---	---	500	54.00	---
9920*	---	---	---	---	---	500	54.00	---
12400*	---	---	---	---	---	500	54.00	---
f>12400*	not significant	---	---	---	---	500	54.00	---
NOTE*: Peak value under Average Limit; no measure executed								

Bluetooth 4.0 BLE – Modulation GFSK 1Mbit/s	
Radiated Band-edge compliance - Higher band edge	
Peak	**Average**
	

Only for measuring emissions up to 2 MHz removed from the band-edge the "delta" technique for Radiated emissions was used.

PEAK

Measured peak (dBµV/m)	Measured band edge (dBµV/m)	Δ Peak/band edge (dB)	Limit at PK power –20 dB (dBµV/m)	Margin (dB)
85.72	29.10	56.62	65.72	36.62

AVERAGE

Measured (dBµV/m)	Measured band edge (dBµV/m)	Δ peak /band edge (dB)	Limit at peak –20 dB (dBµV/m)	Margin (dB)
74.69	19.18	55.51	54.69	35.51

Spurious Emission in restricted band near 2400-2483.5 MHz

PEAK RESULT (RBW=1MHz; VBW=3MHz)

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	AV Limit	AV Limit	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2483.50	51.42	27.50	4.70	-37.60	**46.02**	500	54.00	7.98

NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.
Peak value under Average Limit; no average measure executed.

7.4 OUT-OF-BAND EMISSIONS

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	/
Resolution bandwidth (RBW)	100 kHz
Video bandwidth (VBW)	300 kHz
Sweep time (SWT)	as necessary to capture the entire dwell time
Detector function	Peak
Trace	Max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#1 (4.0 BLE)
Remark	None

TEST PROCEDURE
A spectrum analyzer is connected to the antenna port of the transmitter. The measure has been executed with the lowest transmit channel, the highest transmit channel and one located somewhere in the middle of the band. The measurement takes into account the loss generated by the used cable.

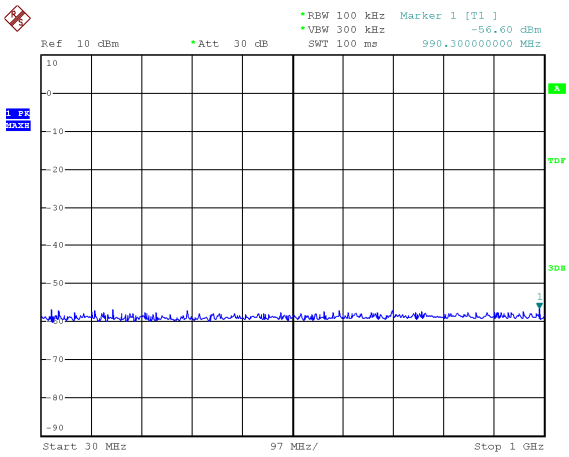
LIMITS
-20 dB below peak output power

TEST RESULT
The EUT meets the requirements of sections 15.247 (d) All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

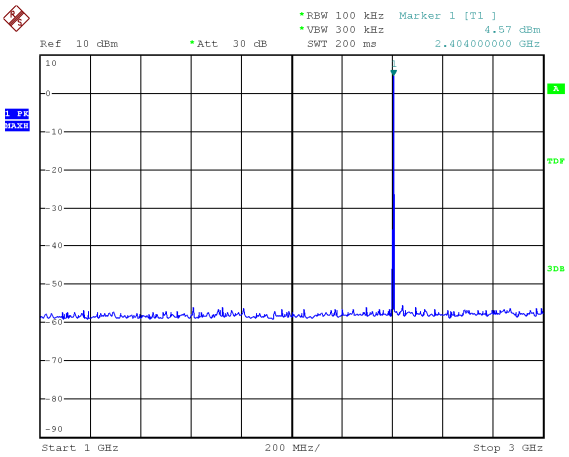
MEASUREMENTS RESULTS - CONDUCTED

BLUETOOTH 4.0 BLE – MODULATION GFSK 1Mbit/s (LOWER CHANNEL 2402MHZ)

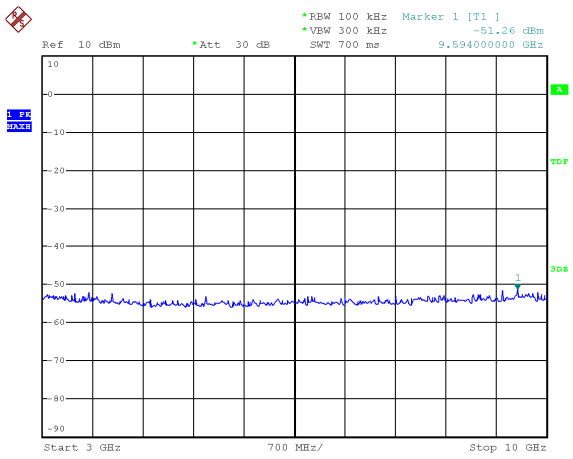
Plot 1 (30÷1000MHz)



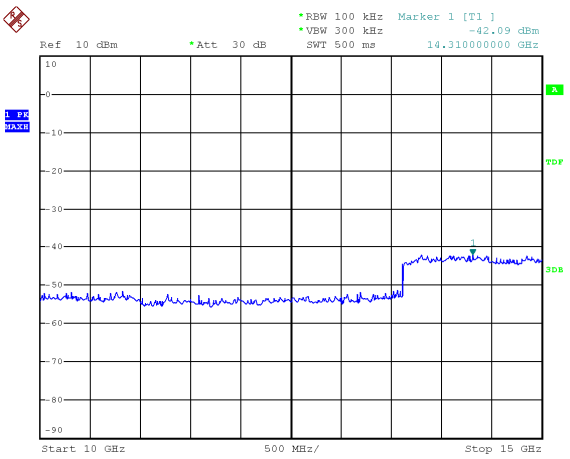
Plot 2 (1÷3GHz)



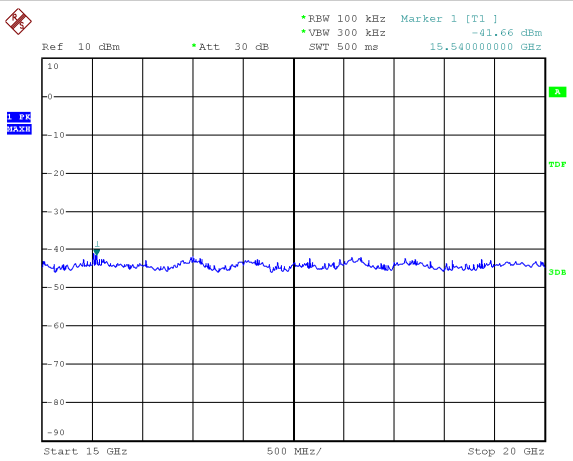
Plot 3 (3÷10GHz)



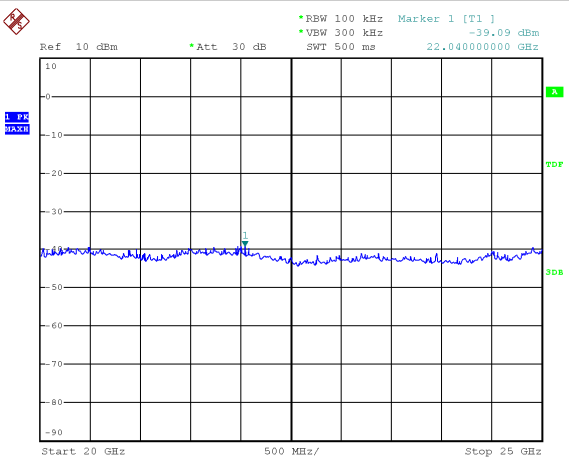
Plot 4 (10÷15GHz)



Plot 5 (15÷20GHz)

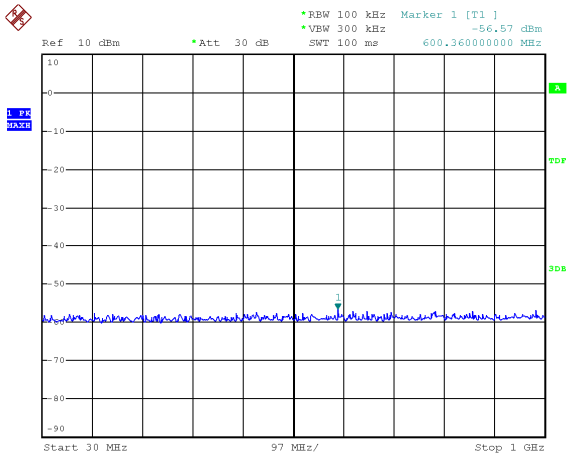


Plot 6 (20÷26GHz)

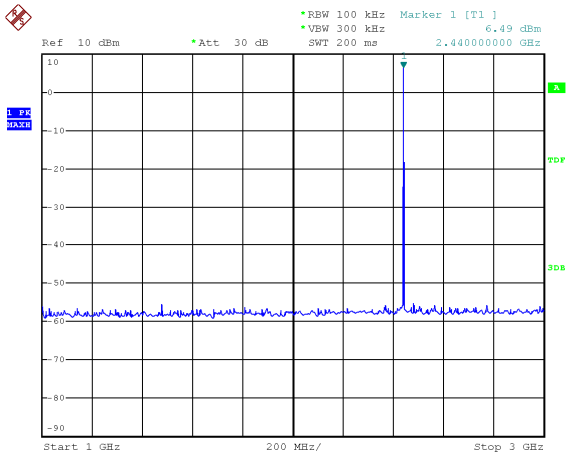


BLUETOOTH 4.0 BLE – MODULATION GFSK 1Mbit/s (MIDDLE CHANNEL 2440MHZ)

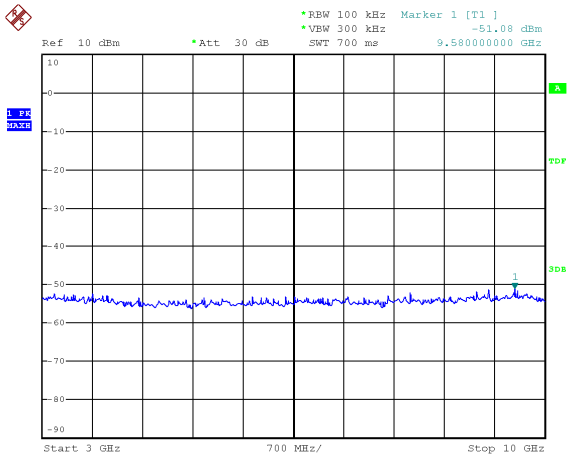
Plot 1 (30÷1000MHz)



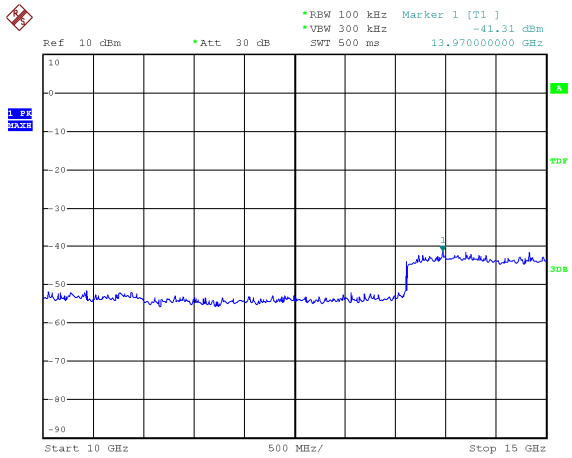
Plot 2 (1÷3GHz)



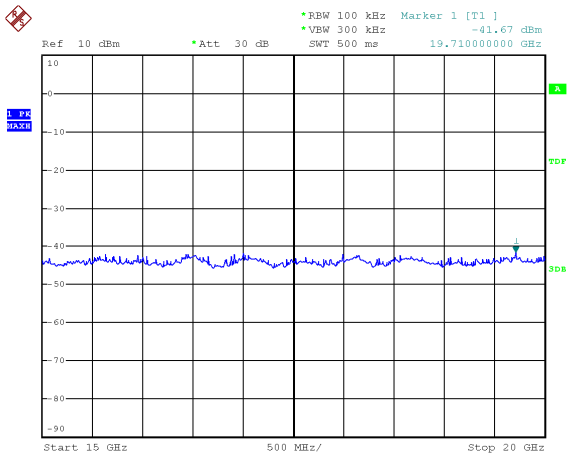
Plot 3 (3÷10GHz)



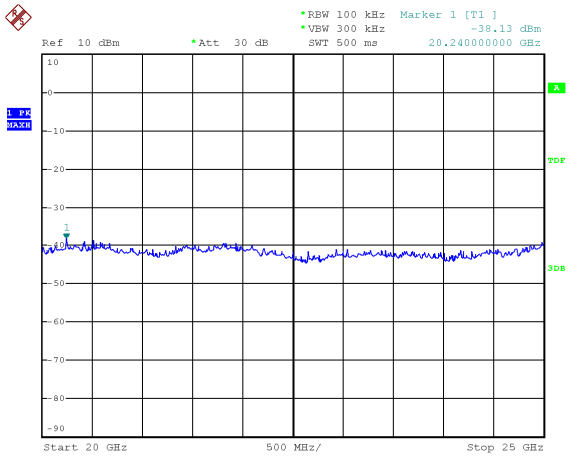
Plot 4 (10÷15GHz)



Plot 5 (15÷20GHz)

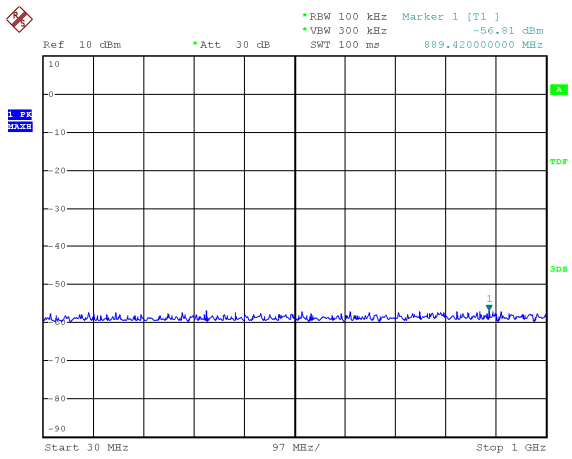


Plot 6 (20÷26GHz)

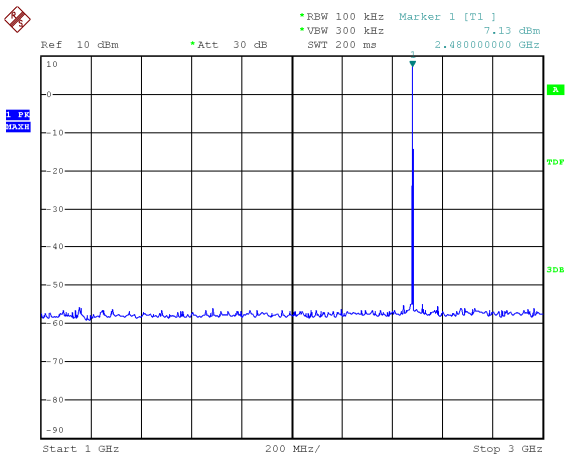


BLUETOOTH 4.0 BLE – MODULATION GFSK 1Mbit/s (HIGHER CHANNEL 2480MHZ)

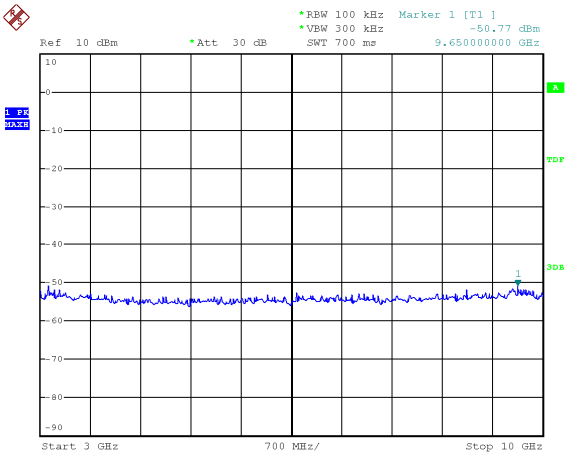
Plot 1 (30÷1000MHz)



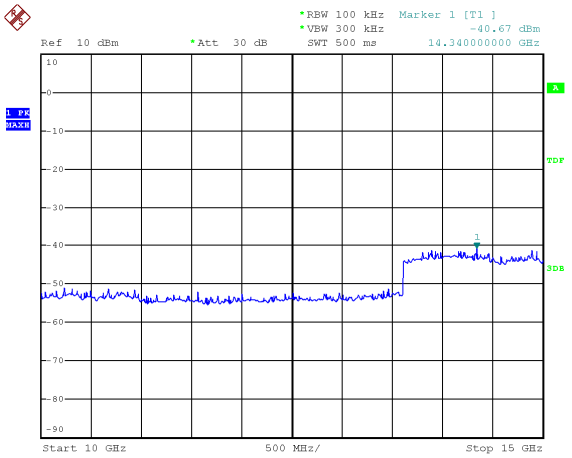
Plot 2 (1÷3GHz)



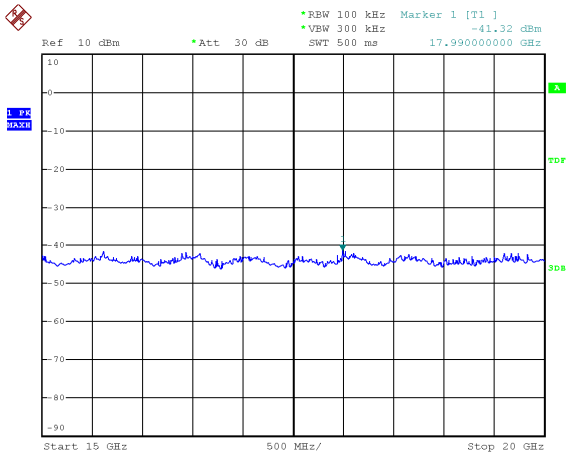
Plot 3 (3÷10GHz)



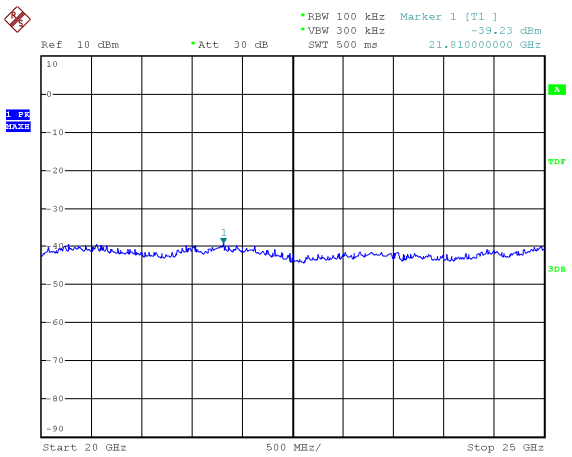
Plot 4 (10÷15GHz)



Plot 5 (15÷20GHz)



Plot 6 (20÷26GHz)



7.5 100 KHZ BANDWIDTH OF FREQUENCY BAND EDGES

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
Resolution bandwidth (RBW)	100 kHz band-edge
Video bandwidth (VBW)	300 kHz band-edge
Sweep time (SWT)	Auto
Detector function	Peak
Trace	Max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#1 (4.0 BLE)
Remark	None

TEST RESULT
The EUT meets the requirements of sections 15.247 (d) All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

LIMITS
-20 dB below peak output power

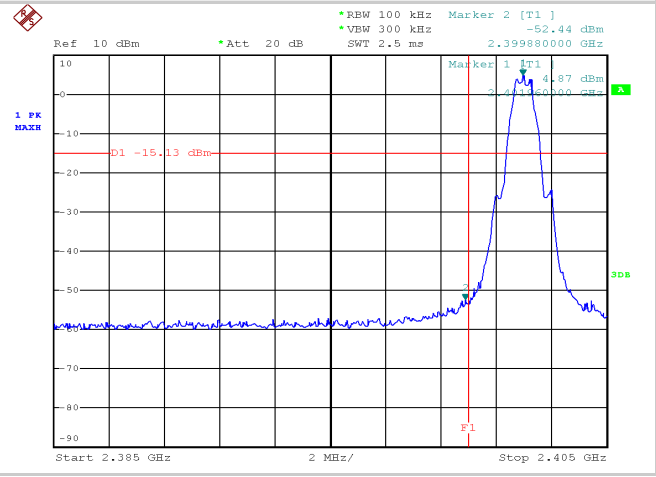
TEST PROCEDURE
Only for measuring emissions up to 2 MHz removed from the band-edge the "delta" technique for Radiated emissions was used. Delta technique: The transmitter output was connected to the spectrum analyzer through a test fixture (radio frequency coupling device associated with the dedicated antenna of the equipment under test) Once the trace is stabilized, by the marker the emission at the band edge (or on the highest modulation product outside of the band, if this level is greater than that at the band edge) was set. The “n” by the marker-delta function and the marker-to-peak function the peak of the in-band emission was selected. The marker-delta value displayed was compared with the limit specified in this Section

MEASUREMENTS RESULTS (CONDUCTED)

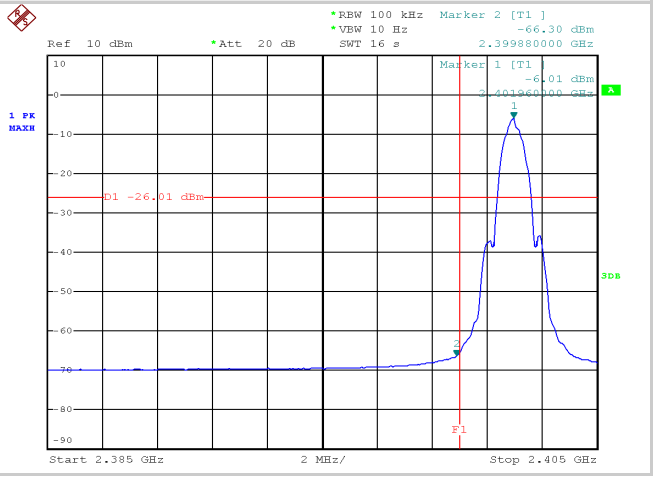
Bluetooth 4.0 BLE – Modulation GFSK 1Mbit/s

Band-edge compliance - Lower band edge

Peak



Average



PEAK

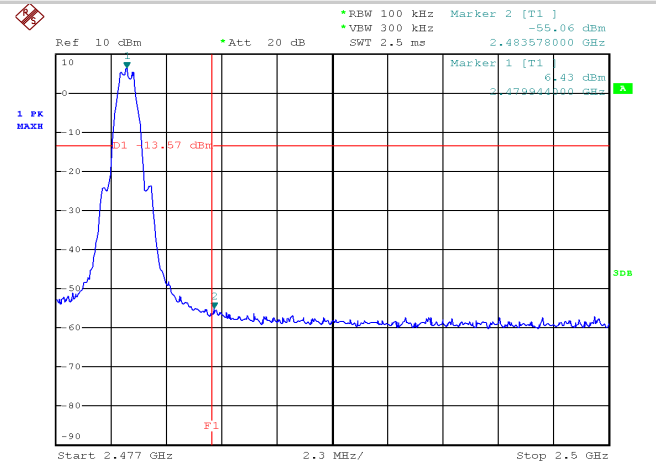
Measured peak (dBm)	Measured band edge (dBm)	Δ Peak/band edge (dB)	Limit at PK power –20 dB (dBm)	Margin (dB)
+4.87	-52.44	57.31	-15.13	37.31

AVERAGE

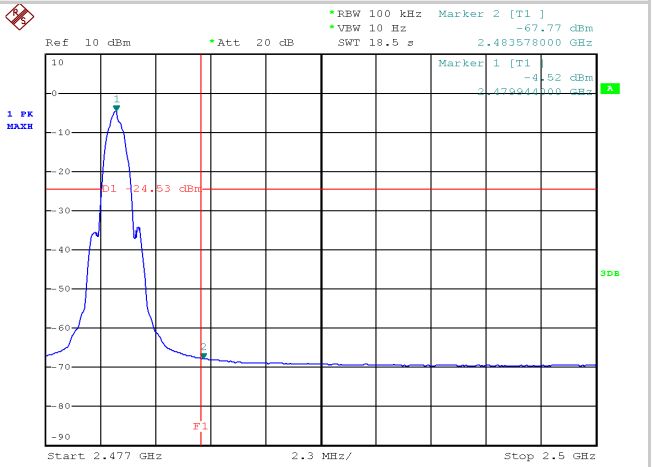
Measured (dBm)	Measured band edge (dBm)	Δ peak /band edge (dB)	Limit at peak –20 dB (dBm)	Margin (dB)
-6.01	-66.30	60.29	-26.01	40.29

Band-edge compliance - Higher band edge

Peak



Average



PEAK

Measured peak (dBm)	Measured band edge (dBm)	Δ Peak/band edge (dB)	Limit at PK power –20 dB (dBm)	Margin (dB)
+6.43	-55.06	61.49	-13.57	41.49

AVERAGE

Measured (dBm)	Measured band edge (dBm)	Δ peak /band edge (dB)	Limit at peak –20 dB (dBm)	Margin (dB)
-4.52	-67.77	63.25	-24.52	43.25

7.6 6dB BANDWIDTH

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	3 MHz
Resolution bandwidth (RBW)	100 kHz
Video bandwidth (VBW)	300 kHz
Sweep time (SWT)	2,5 ms
Detector function	Peak
Trace	max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#1 (4.0 BLE)
Remark	None

TEST PROCEDURE
The transmitter output was connected to the spectrum analyzer through a temporary RF 50Ω connector. The Channel bandwidth is defined as the total spectrum the power of which is higher than peak power minus 6 dB.

LIMITS
At least 500kHz

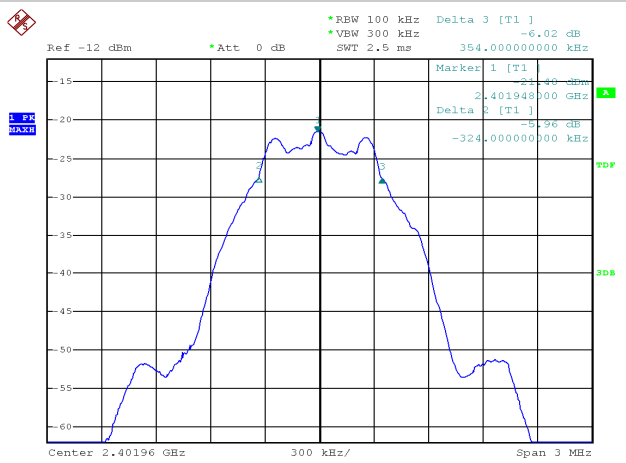
TEST RESULT
The EUT meets the requirements of sections 15.247 (a) (2)

MEASUREMENTS RESULTS

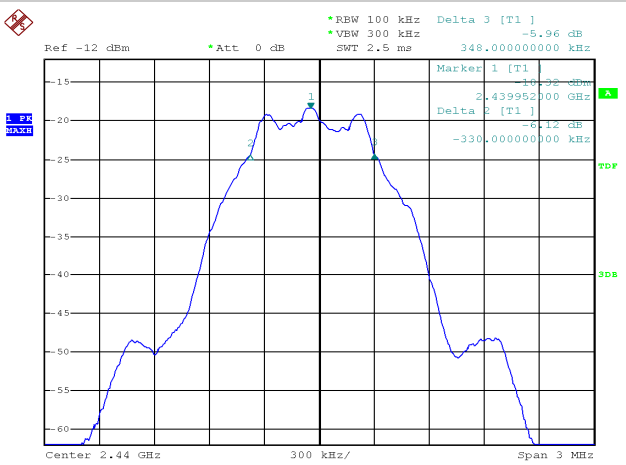
BLUETOOTH 4.0 BLE – MODULATION GFSK 1MBIT/S

Channel (No.)	Frequency (MHz)	Channel Bandwidth at -6dB (kHz)	Plot (No.)
Low	2402	678	1
Middle	2440	678	2
High	2480	684	3

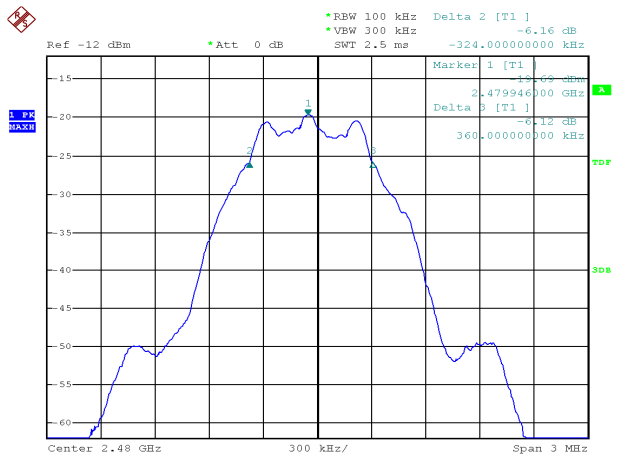
Plot 1



Plot 2



Plot 3



7.7 MAXIMUM PEAK OUTPUT POWER (DE FACTO EIRP)

TEST REQUIREMENT	
Spectrum analyzer settings	
Resolution bandwidth (RBW)	3 MHz
Video bandwidth (VBW)	10 MHz
Sweep time (SWT)	2,5 ms
Detector function	Peak
Trace	max hold
Test distance	/
EUT operating condition	#1 (4.0 BLE)
Remark	none

TEST PROCEDURE
Conducted measurements:
The transmitter output was connected to the spectrum analyzer through a temporary RF 50Ω connector type SMA.
Radiated measurements:
As the EUT is supplied with a dedicated antenna, the effective radiated power is measured in a 3 m anechoic chamber with the substitution antenna method. The field strength levels shall be converted to equivalent conducted power levels for comparison to the applicable output power limit refer to KDB 412172.

LIMITS
1 Watt (30dBm) ⇒ (4.0 BLE)

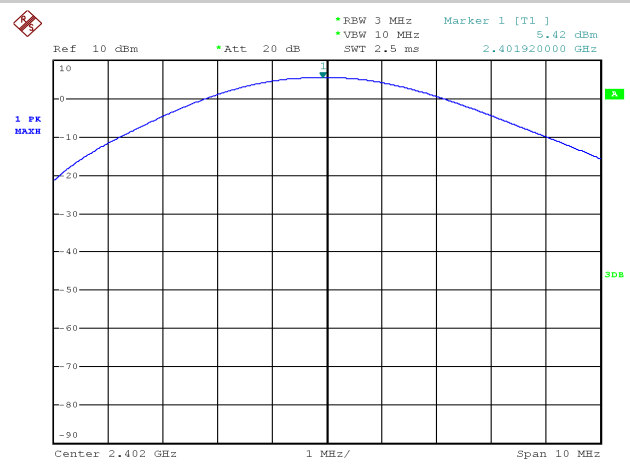
TEST RESULT
The EUT meets the requirements of sections 15.247 (b) (3)

MEASUREMENTS RESULTS (CONDUCTED)

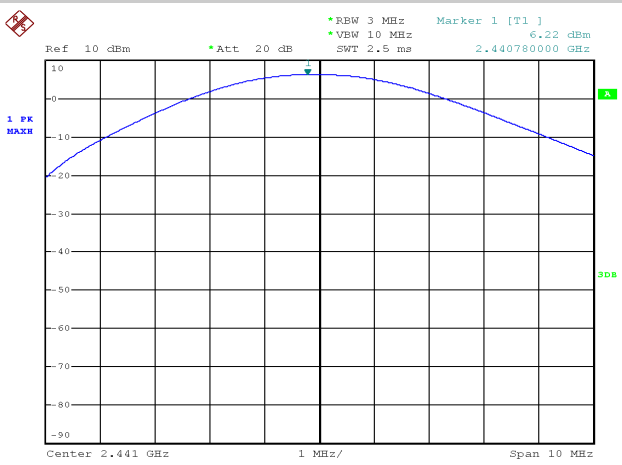
BLUETOOTH 4.0 BLE – MODULATION GFSK 1Mbit/s

Channel (No.)	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Plot (No.)
Low	2402	+5.42	+30	1
Middle	2441	+6.22	+30	2
High	2480	+6.83	+30	3

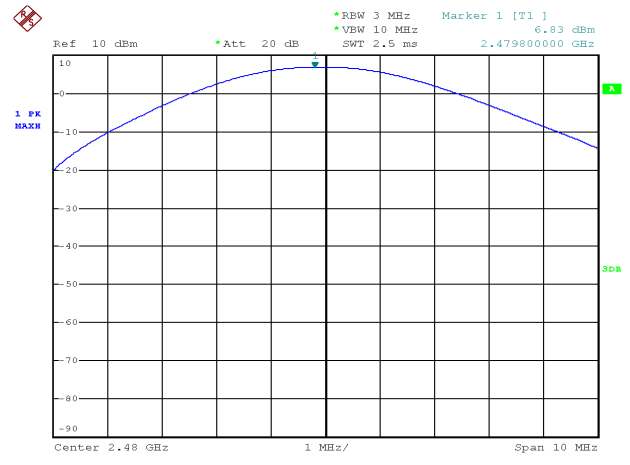
Plot 1



Plot 2



Plot 3



MEASUREMENTS RESULTS (RADIATED)

BLUETOOTH 4.0 BLE – MODULATION GFSK 1Mbit/s

Channel (No.)	Frequency (MHz)	Radiated Output Power (at 3m. distance) (dBµV/m)	Calculated E.I.R.P (dBm)	Limit (dBm)
Low	2402	89.79	-5.44	30
Middle	2440	92.52	-2.71	30
High	2480	93.11	-2.12	30

7.8 TRANSMITTER POWER SPECTRAL DENSITY

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	3 MHz
Resolution bandwidth (RBW)	3 kHz
Video bandwidth (VBW)	10 kHz
Sweep time (SWT)	Auto
Detector function	Peak
Trace	Max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#1 (4.0 BLE)
Remark	None

TEST PROCEDURE
The transmitter output was connected to the spectrum analyzer through a temporary RF 50Ω connector. After trace stabilisation the marker shall be set on the signal peak. The indicated level is the power spectral density.

LIMITS
8 dBm in 3 kHz bandwith.

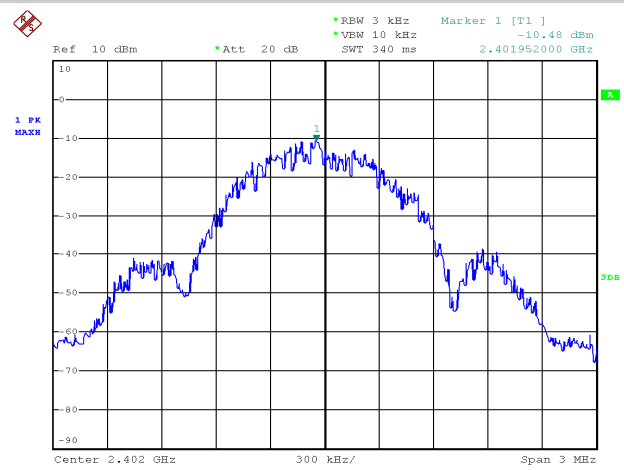
TEST RESULT
The EUT meets the requirements of sections 15.247 (e)

MEASUREMENTS RESULTS

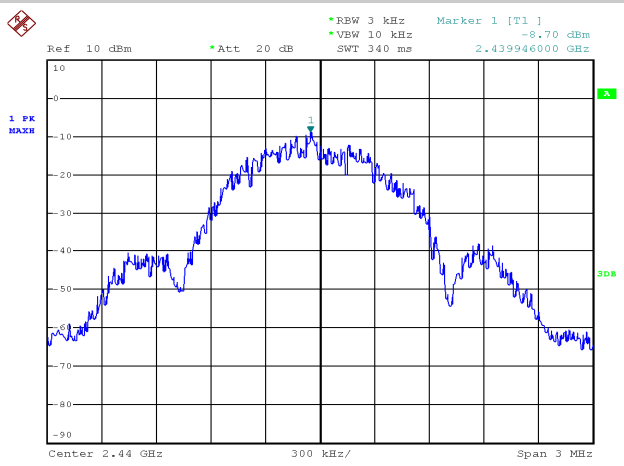
BLUETOOTH 4.0 BLE – MODULATION GFSK 1MBIT/S

Channel (No.)	Frequency (MHz)	Transmitter power on 3 kHz band (dBm)	Limit (dBm)	Plot (No.)
Low	2402	-10.48	+8	1
Middle	2441	-8.70	+8	2
High	2480	-8.05	+8	3

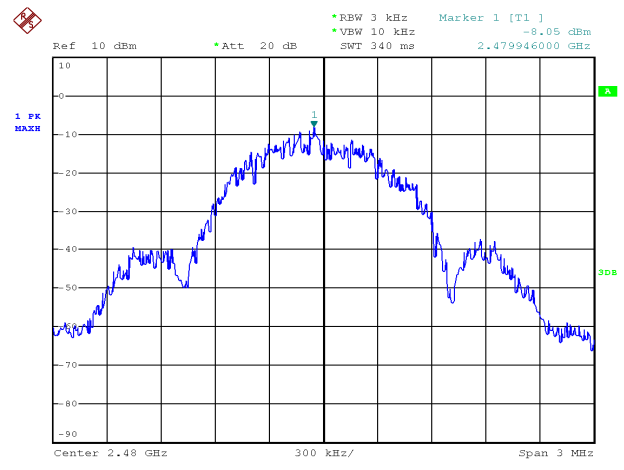
Plot 1



Plot 2



Plot 3



7.9 RF EXPOSURE EVALUATION

TEST 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 levels in excess of the Commission's guidelines § 1.1307(b)(1).	
EUT classification (fixed, mobile or portable devices)	Portable according to § 2.1093(b) of this Chapter
LIMITS	According to § 2.1093 of this Chapter, by means of the following guidelines: OET Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies (447498 D01 General RF Exposure Guidance v05r02)

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm

447498 D01 General RF Exposure Guidance v05r02 – Appendix A

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	

The *test separation distances* ≥ 5 *mm* is applied to determine SAR test exclusion.

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm

447498 D01 General RF Exposure Guidance v05r02 § 4.3

Channel No.	Frequency (MHz)	Measured Radiated power (at 3 m distance)	E.I.R.P.	Distance	$\frac{max.\ power\ (mW)}{min.distance\ (mm)} \times \sqrt{f_{(GHz)}}$	Limits
		(dBuV/m)	(mW)	(mm)		
Lowest	2402	89.79	0.28	5	0.086	≤ 3.0 for 1-g head SAR or ≤ 7.5 for 10-g extremity SAR

Channel No.	Frequency (MHz)	Measured Radiated power (at 3 m distance)	E.I.R.P.	Distance	$\frac{max.\ power\ (mW)}{min.distance\ (mm)} \times \sqrt{f_{(GHz)}}$	Limits
		(dBuV/m)	(mW)	(mm)		
Middle	2440	92.52	0.53	5	0.165	≤ 3.0 for 1-g head SAR or ≤ 7.5 for 10-g extremity SAR

Channel No.	Frequency (MHz)	Measured Radiated power (at 3 m distance)	E.I.R.P.	Distance	$\frac{max.\ power\ (mW)}{min.distance\ (mm)} \times \sqrt{f_{(GHz)}}$	Limits
		(dBuV/m)	(mW)	(mm)		
Highest	2480	93.11	0.61	5	0.192	≤ 3.0 for 1-g head SAR or ≤ 7.5 for 10-g extremity SAR

TEST RESULT

This value is less than the low threshold limit. No SAR test is required.

8. MEASUREMENTS AND TESTS UNCERTAINTY

Unless otherwise stated the uncertainties for the tests and measurements are evaluated in according to IMQ Operational Instruction IO-LAB-001 and IO-LAB-004. and requirement of NIST Technical Note 1297 and NIS 81: 1994 "The Treatment of Uncertainty in EMC Measurements"
The expanded uncertainty was calculated for all measurements and tests listed in this test report according to CISPR 16-4-2 "Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainty in EMC Measurements", with UKAS document LAB 34 and is documented in the quality system accordance to ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device
Internal Procedure PI-037 ensures that the requirements for traceability of calibrations, of all test equipment requiring calibration, and calibration intervals are met.

Methods/Standard	Parameter	Expanded Uncertainty	Unit	Confidence level	Coverage Factor	Degree of freedom
Continuous disturbance	QP detector 9 – 150 kHz	2,47	dB	95%	2,00	25
	QP detector 150 k – 30 MHz	2,61	dB	95%	2,00	26
	QP detector using Voltage Probe	2,45	dB	95%	2,00	26
	QP detector using ISN	3,15	dB	95%	2,00	> 60
	QP detector using Current Probe	2,15	dB	95%	2,00	35
Radiated disturbance	QP detector (30 MHz - 100 MHz) H polarization	4,33	dB	95%	2,00	> 60
	QP detector (30 MHz - 100 MHz) V polarization	4,22	dB	95%	2,00	> 60
	QP detector (100 MHz - 200 MHz) H polarization	3,40	dB	95%	2,00	> 60
	QP detector (100 MHz - 200 MHz) V polarization	4,76	dB	95%	2,00	> 60
	QP detector (200 MHz - 1000 MHz) H polarization	3,91	dB	95%	2,00	> 60
	QP detector (200 MHz - 1000 MHz) V polarization	3,82	dB	95%	2,00	> 60
	P detector 1-6 GHz	4,77	dB	95%	2,00	> 60
	P detector 6 – 18 GHz	5,14	dB	95%	2,00	> 60

9. LIST OF MEASURING EQUIPMENT AND CALIBRATION INFORMATION

IMQ Serial Number	Instrument	Manufacturer	Type	Last Cal.	Cal. Period.	Calibration Company
P01709	Shielded semi-anechoic chamber	SIDT	/	03-15	24	IMQ
P02486	Turntable controller unit	FRANKONIA	FCTAM01	/	/	/
P02488	Mast antenna	FRANKONIA	FAM4	/	/	/
S05562	EMI Receiver	ROHDE & SCHWARZ	ESU 8	05-15	12	Rohde & Schwarz
S03511	Log antenna	ARA	LPB-2520/1	05-15	36	NPL
S03463	Horn Antenna	SCHWARZBECK	BBHA 9120D	12-14	36	NPL
S04272	Horn antenna	SCHWARZBECK	BBHA 9120D	07-14	36	NPL
S03668	Horn antenna	SCHWARZBECK	BBHA 9170	08-13	36	Liberty Labs
S03724	Horn antenna	SCHWARZBECK	BBHA 9170	08-13	36	Liberty Labs
S03629	Spectrum Analyzer	Rohde & Schwarz	FSP40	02-15	12	Rohde & Schwarz
S03542	Preamplifier	Hewlett Packard	HP 8449B	06-13	24	IMQ
S06762	Preamplifier	SCHWARZBECK	BBV 9745	11-14	12	IMQ
W-00199/E	Software	ROHDE & SCHWARZ	EMC32 Ver. 6.30	/	/	/
H-00165	PC	/	/	/	/	/

END OF TEST REPORT