



IMQ S.p.A. - Società con Socio Unico
Via Quintiliano, 43 I-20138 MILANO
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TEST REPORT

No. ARSO00149/1

performed in accordance with

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

PRODUCT	RF Module
MODEL(s) TESTED	SPSGRF-915
FCC ID	S9NSPSGRF
TRADE MARK(s)	STMicroelectronics

APPLICANT	STMicroelectronics S.r.l. ~ Centro Direzionale Colleoni - Palazzo Andromeda 3 I-20864 Agrate Brianza (MB)
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Tested by	Robertino Torri	 
Approved by	Roberto Colombo [Laboratory manager]	 

Revision Sheet

Release No.	Date	Revision Description
Rev. 0	2014-10-17	First edition Digital signed - ARSO00149-1_TR_FCC 15.247_STMICELECTRONICS_Modulo SPSG915
Rev. 1	2014-12-12	Page 30 Conducted power changed unit from W to mW and corrected value Digital signed - ARSO00149-1 rev.1_TR_FCC 15.247_STMICELECTRONICS_Modulo SPSG915
Rev. 2	2015-01-13	Erased § 10 Photographic documentation Digital signed - ARSO00149-1 rev.2_TR_FCC 15.247_STMICELECTRONICS_Modulo SPSGRF-915

The results of tests and checks reported in this Test Report refer exclusively to the samples tested and described in the Report itself.
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1. GENERAL DATA

SAMPLE		
Samples received on	2014-09-25	(item sent and sampling by applicant)
IMQ reference samples	BEM	74535
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	2014-09-25 ÷ 2014-10-10	
Testing laboratory.	IMQ S.p.A. - Via Quintiliano, 43 – I-20138 Milano	
Testing site	Viale Lombardia, 20 – I-20021 Bollate (MI) Via Quintiliano, 43 – I-20138 Milano	
ENVIRONMENTAL CONDITIONING		
Parameter	Measured	
Ambient Temperature	25 ÷ 35 °C	
Relative Humidity	50 ÷ 60 %	
Atmospheric Pressure	900 ÷ 1000 mbar	



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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



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3. UNIT UNDER TEST (EUT) DETAILS

GENERAL DATA

MODEL (basic)	Description
SPSGRF-915	RF Module
VARIANTS (derived)	Description
/	/

FCC ID	S9NSPSGRF
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Manufacturer	STMicroelectronics S.r.l. ~ Centro Direzionale Colleoni - Palazzo Andromeda 3 I-20864 Agrate Brianza (MB)
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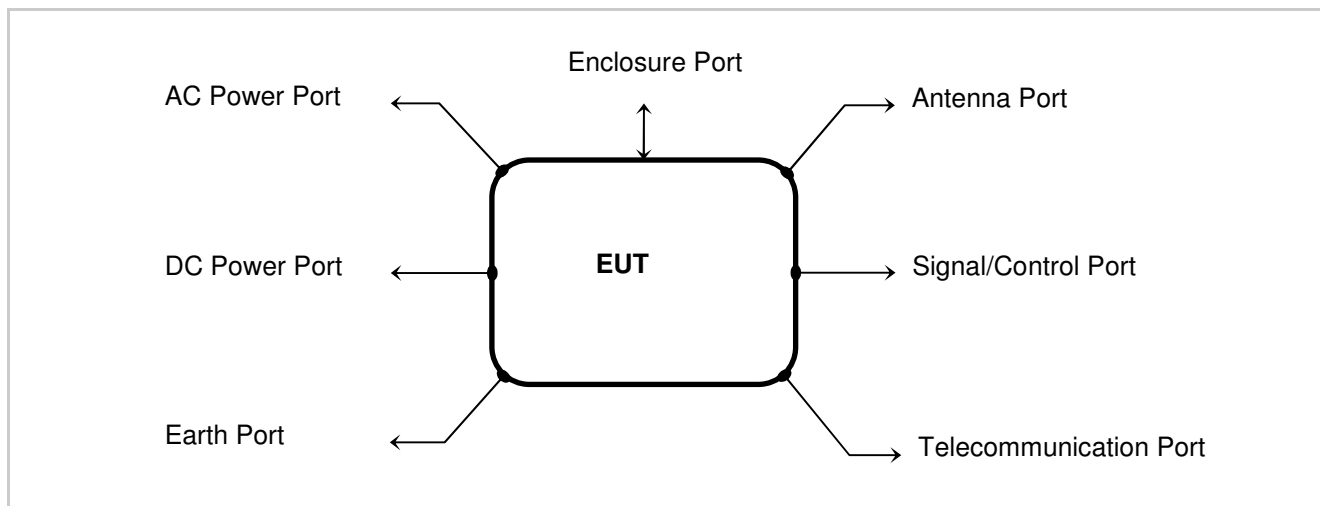
Type of equipment	Radio module
Operating frequency:	903.5 ÷ 926.5 MHz
Maximum RF radiated power:	2.68 dBm
Modulation:	2FSK, GFSK and MSK
Channel Spacing:	/
Antenna:	Dedicated antenna (MITSUBISHI mod. AM11DG-ST01 -0.2 dBi max gain)
RX sensitivity:	/
Main SW identification	/
Main HW Board identification	/
Peripherals included (for system application)	/
Interfaces :	/
Integrated interfaces :	/
AC adapter:	/

RF parameters will be those used on transceiver module during test for limits compliance in FCC certification.

Operation band MHz	Modulation	Data rate Min/Max [kbps]	Frequency deviation Min/Max [kHz]	Output power maximum [dBm]
903.5 ÷ 926.5	2FSK / GFSK	1/500	160/732	+11.6
	MSK	310/500	20/732	

4. TEST CONFIGURATION OF UNIT UNDER TEST

EUT PORTS



Port	Description	Max length
Enclosure	Not present (open frame)	/
AC power	Not present	/
DC power	DC power supply 3.3 V DC	/
Earth	/	/
Telecommunication	/	/
Signal	I/O pin (see also schematics data sheet)	/
Control	I/O pin (see also schematics data sheet)	/
Antenna	Dedicated	/



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STATE OF THE EUT DURING TESTS

Ref.	Mode	Description
#1	Operating	Continuous transmission (single channel transmission) 5V DC battery supply by dedicated dongle. The EUT is installed on module device board (dongle). The dongle is powered from the USB cable port. The USB cable is connected to 12 V DC battery through DC/DC adapter (12/5 V DC). The EUT is in continuously transmitting at the highest power with 100% approximately duty cycle.

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	PC92A V01

ELECTROMAGNETICALLY RELEVANT COMPONENTS

Component	No.	Manufacturer	Model
Radio module	1	STMicroelectronics	PC74A V01

RFI SUPPRESSION DEVICES

Component	No.	Manufacturer	Model
/	/	/	/

EMI PROTECTION DEVICES

Component	No.	Manufacturer	Model
/	/	/	/

EUT TECHNICAL DOCUMENTATION

Document	Reference
/	/



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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

Radiated emission tests: from 9 kHz to tenth harmonic of fundamental.



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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	Antenna Requirements	PASS
§ 15.247 (b)(4)(i)		
§ 15.207 (a)	Conducted Emission	PASS ¹
§ 15.209 (a) (f)	Radiated Emission	PASS
§ 15.247 (a)	Frequency Hopping Spread Spectrum Specifications	
§ 15.247(a)	20 dB Bandwidth	N.A. ²
§ 15.247(a)(1)	Carrier frequency (Hopping Channel) Separation	N.A. ²
§ 15.247(a)(1)(iii)	Number of Hopping Channels Used	N.A. ²
§ 15.247(a)(1)(iii)	Time occupancy (Dwell Time) of Each Ch. within a 0,4 x Nch (sec) Period	N.A. ²
§ 15.247(a)(2)	6dB Minimum Bandwidth	PASS
§ 15.247(b)	Maximum Peak Output Power	
§ 15.247(b) (1)	Peak Output Power	N.A.
§ 15.247(b) (3)	RF power output, radiated (EIRP)	PASS
§ 15.247(b) (4)	Antenna gain	N.A.
§ 15.247(c)	Operation with directional antenna gains greater than 6 dBi	N.A.
§ 15.247 (d)	100 kHz Bandwidth of Frequency Band Edges	PASS
§ 15.247 (d)	Radiated Emission	PASS
§ 15.247 (e)	Power Spectral Density	PASS
§ 15.247 (f)	Hybrid systems	N.A. ²
§ 15.247 (g)	FHSS Transmission characteristics	N.A. ²
§ 15.247 (h)	Recognition of occupied channel and multiple transmission system	N.A. ²
§ 15.247(i) (§ 47CFR 1.1307(b)(1))	RF humane exposure	PASS
Note 1	The test has been carried out on DC power port of dongle.	
Note 2	Not applicable for DTS equipment	



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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	Not Applicable
Antenna type	Integral antenna
Maximum total gain	----
External power amplifiers	Not present

TEST RESULT

The EUT meets the requirements of section 15.203 and 15.204



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7.2 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

LIMITS

Band of operations	Quasi-Peak (dB μ V)	Average Limit (dB μ V)
0.15 $\div$ 0.5	66 $\div$ 56	56 $\div$ 46
0.5 $\div$ 5	56	46
5 $\div$ 30	60	50

TEST RESULT

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

TEST PROCEDURE

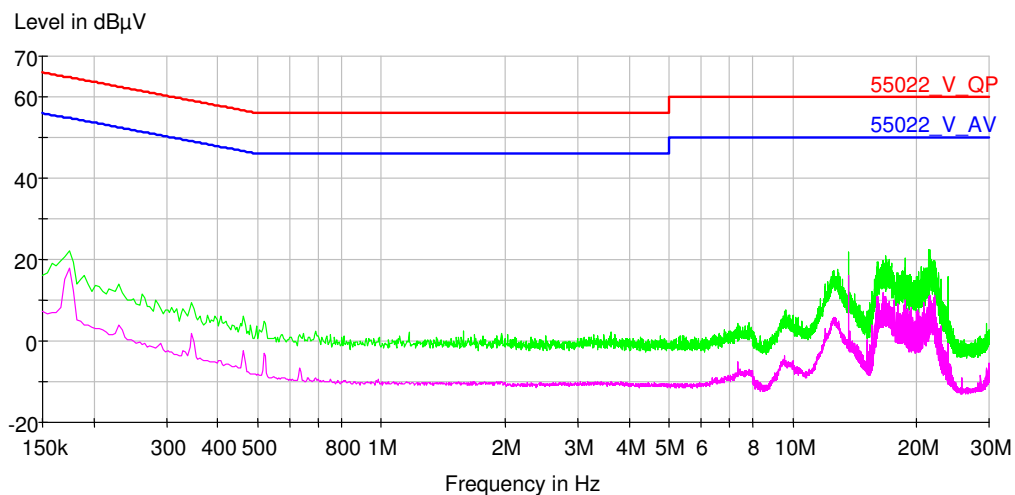
- 1) The EUT was placed on a wooden table of size, 80 cm by 80 cm, raised 80 cm in which is located 40 cm away from the vertical wall the shielded room.
- 2) Each EUT power cord input cord was individually connected through a 50 Ω /50 μ H LISN to the input power source.
- 3) Exploratory measurements 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 $\geq$ (Q.P. limit - 6 dB).

MEASUREMENTS RESULTS

Conducted disturbance on DC dongle power port (battery supplied)

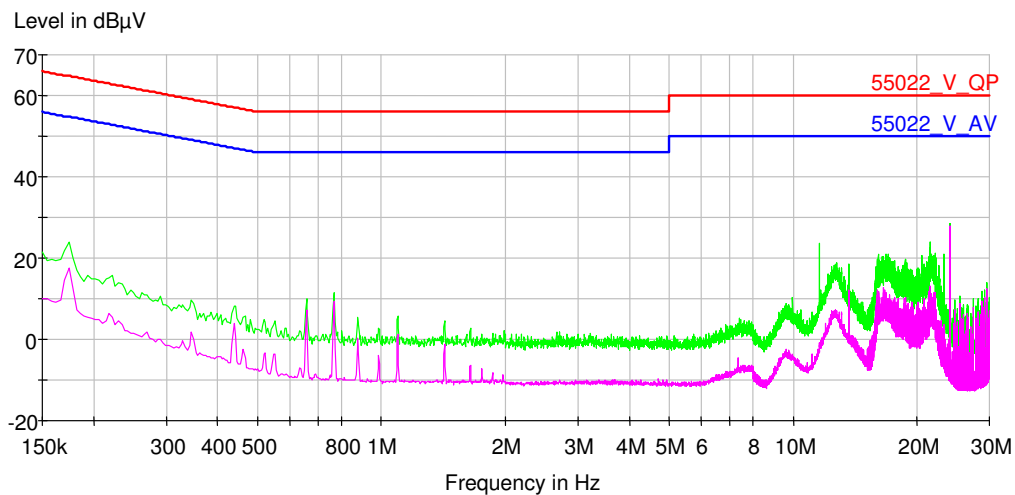
150 kHz÷30 MHz – PHASE LINE

Modulation: 2FSK



150 kHz÷30 MHz – NEUTRAL LINE

Modulation: 2FSK

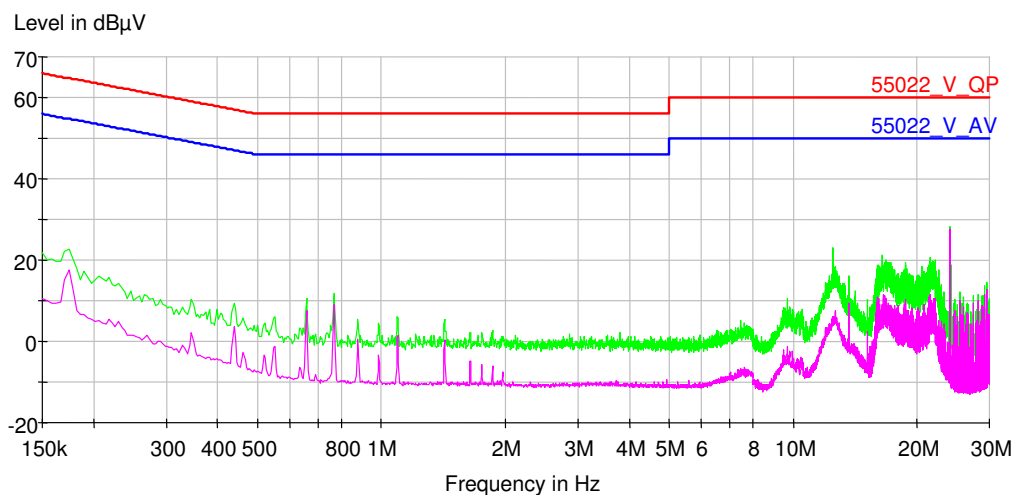


MEASUREMENTS RESULTS

Conducted disturbance on DC dongle power port (battery supplied)

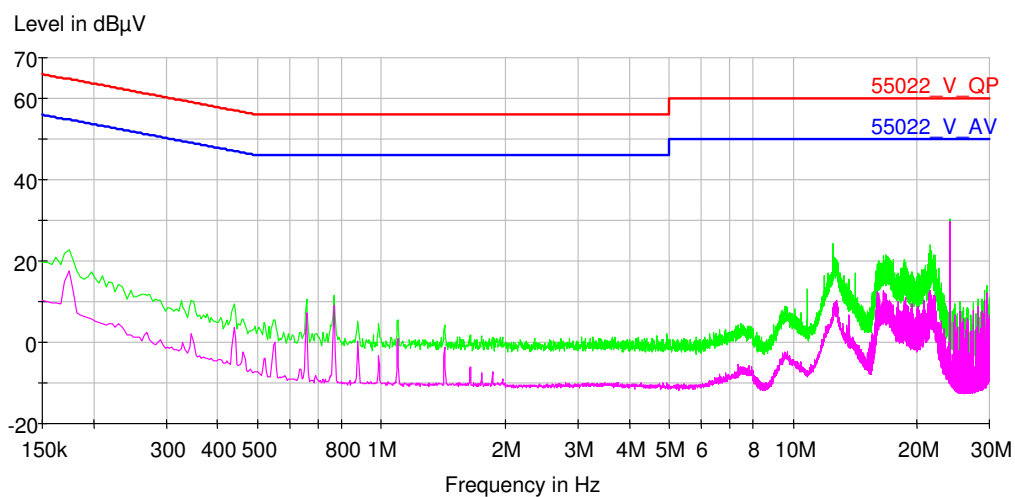
150 kHz÷30 MHz – PHASE LINE

Modulation: GFSK



150 kHz÷30 MHz – NEUTRAL LINE

Modulation: GFSK

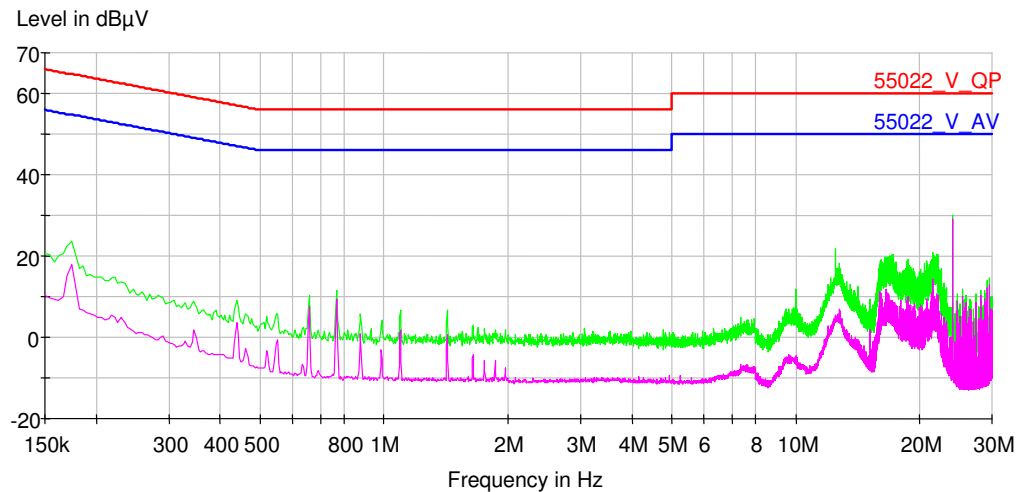


MEASUREMENTS RESULTS

Conducted disturbance on DC dongle power port (battery supplied)

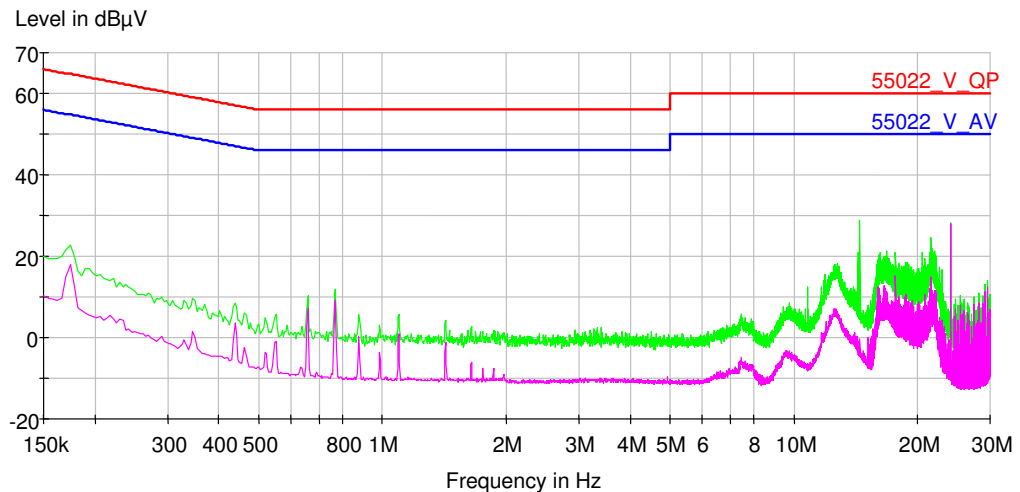
150 kHz÷30 MHz – PHASE LINE

Modulation: MSK



150 kHz÷30 MHz – NEUTRAL LINE

Modulation: MSK





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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
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) = $40\log(300\text{meter} / 3\text{meter}) = +80\text{db}$ Extrapolation (dB) = $40\log(30\text{meter} / 3\text{meter}) = +40\text{db}$

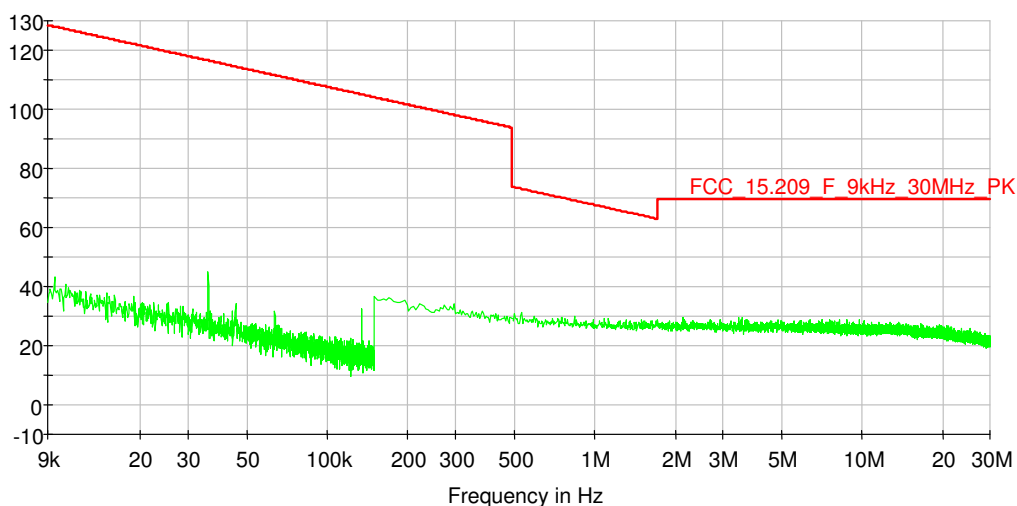
LIMITS		
Band of operations	Peak (dB μ V/m)	Average Limit (dB μ V/m)
Restricted bands (par. 15.205)	74	54
Other bands	According to 15.209 or fundamental -20dB (which is greater)	According to 15.209 or fundamental -20dB (which is greater)

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 $\geq$ (Q.P. limit - 6 dB).

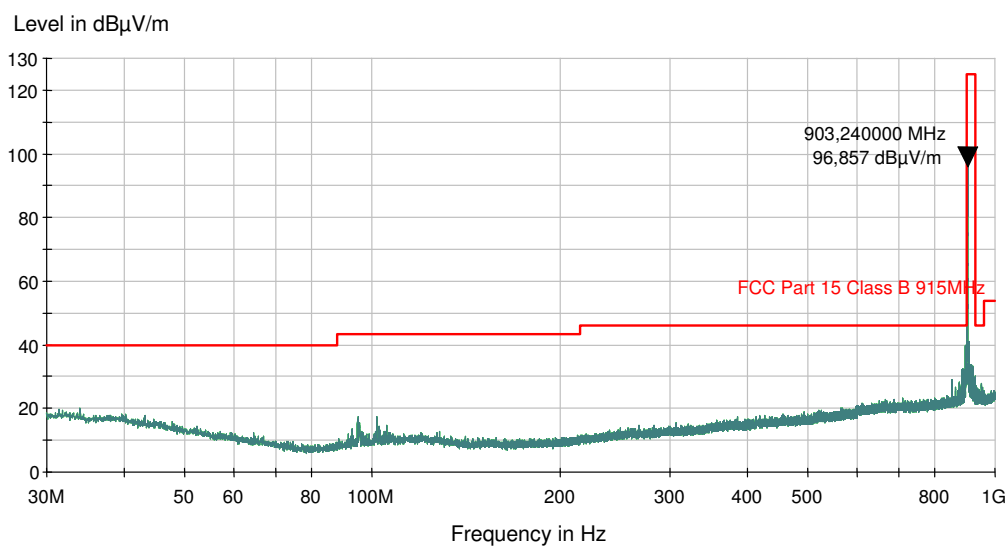
MEASUREMENTS RESULTS

Modulation: 2FSK

9 kHz÷30 MHz



30÷1,000 MHz

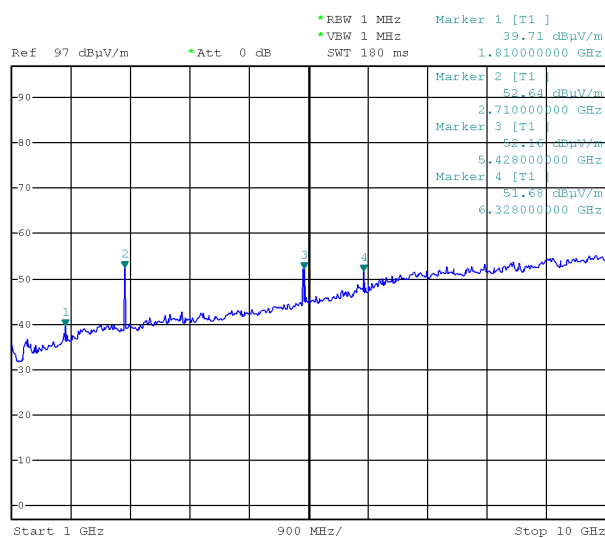




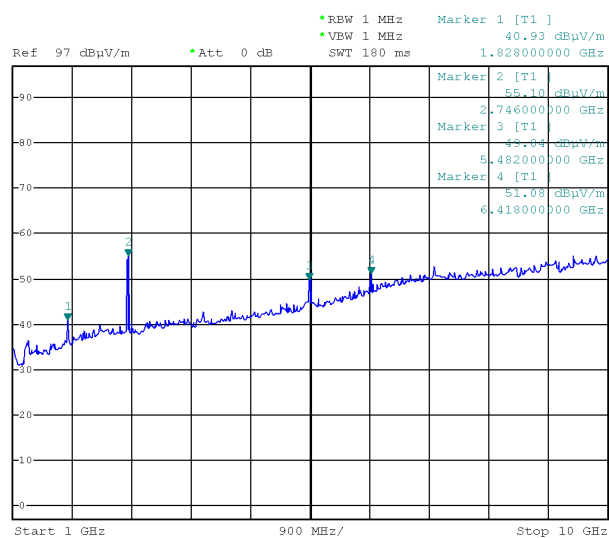
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1000 MHz ÷ 10000 MHz

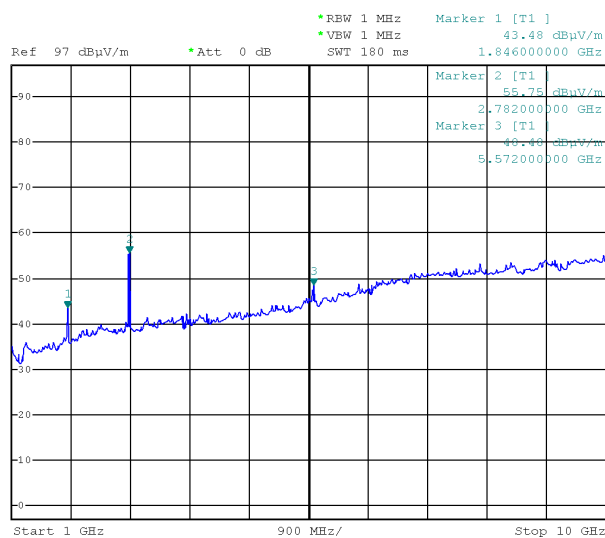
Lowest frequency



Middle frequency

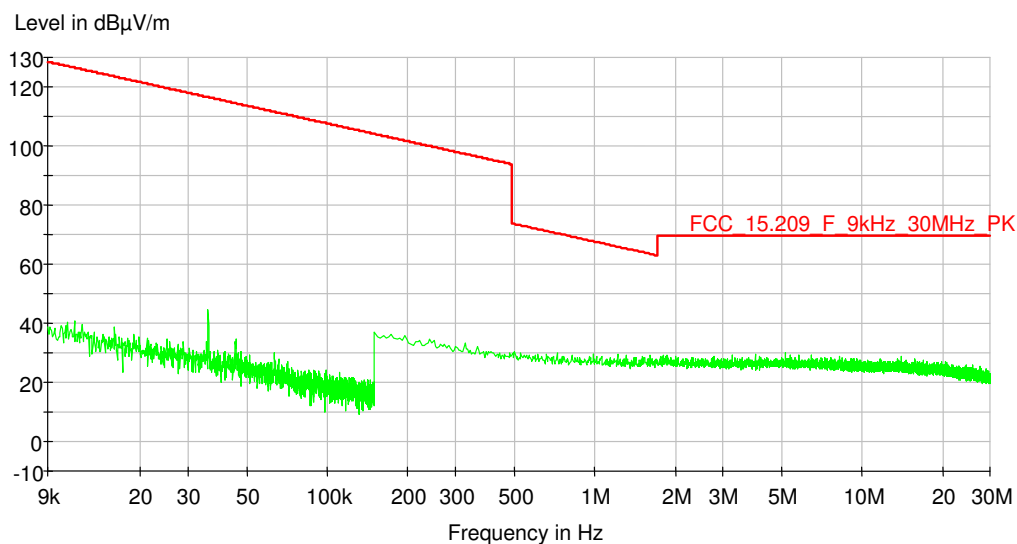


Highest frequency

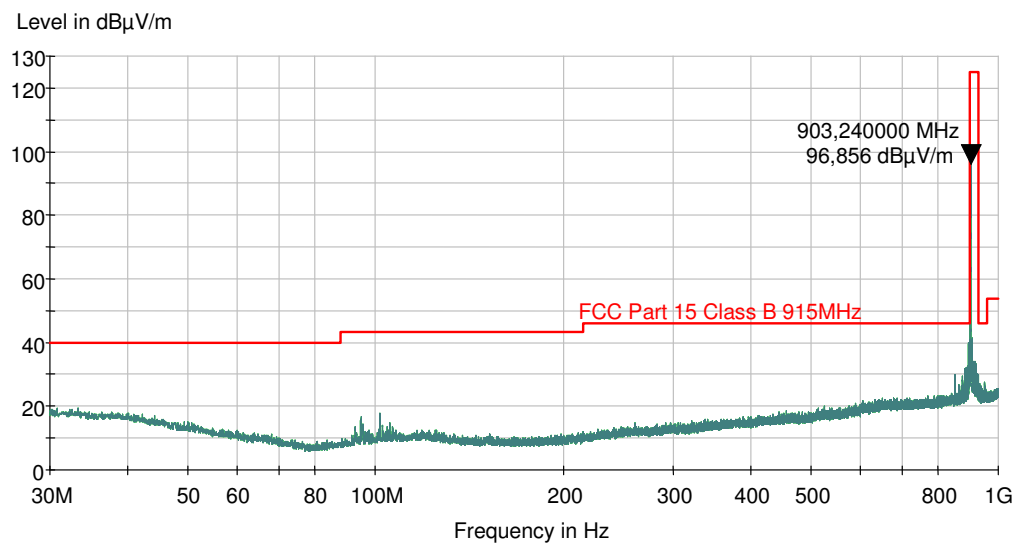


Modulation: GFSK

9 kHz÷30 MHz



30÷1,000 MHz

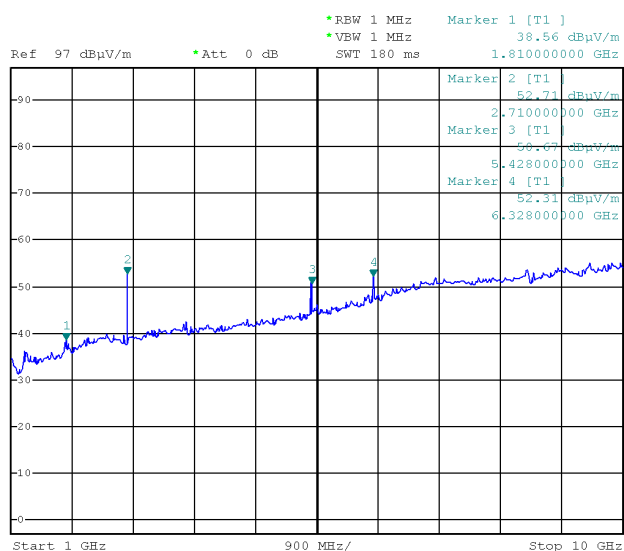




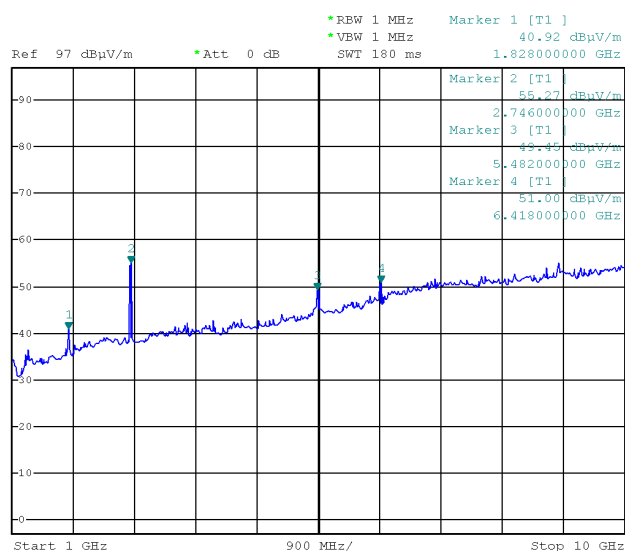
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1000 MHz ÷ 10000 MHz

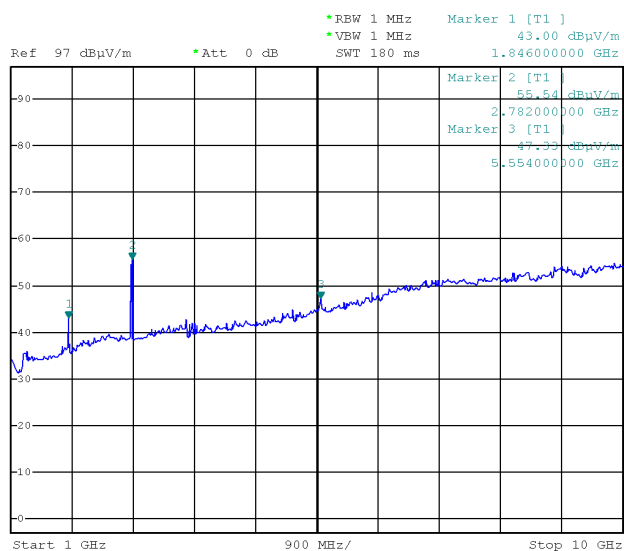
Lowest frequency



Middle frequency



Highest frequency

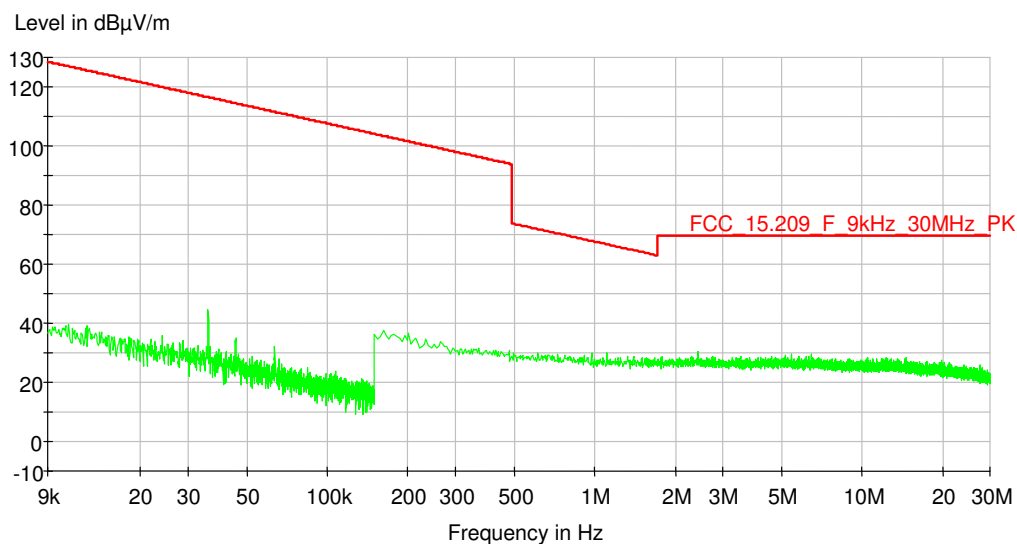




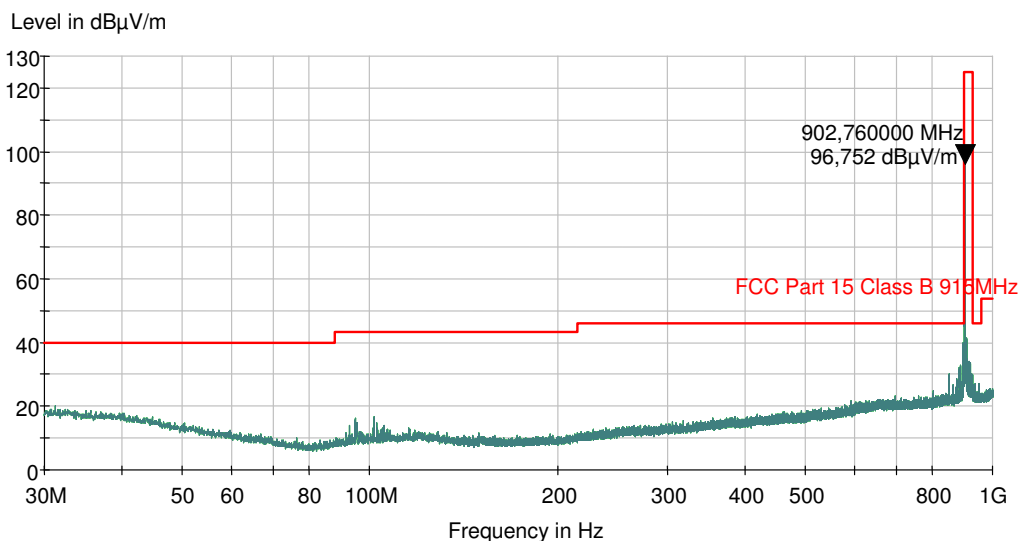
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Modulation: MSK

9 kHz÷30 MHz



30÷1,000 MHz

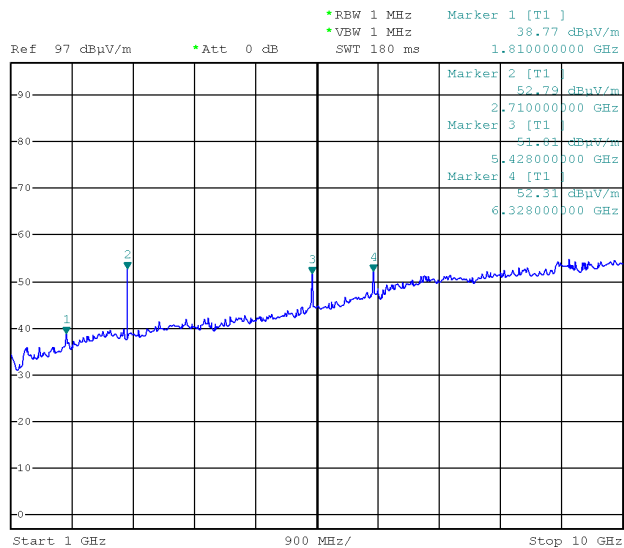




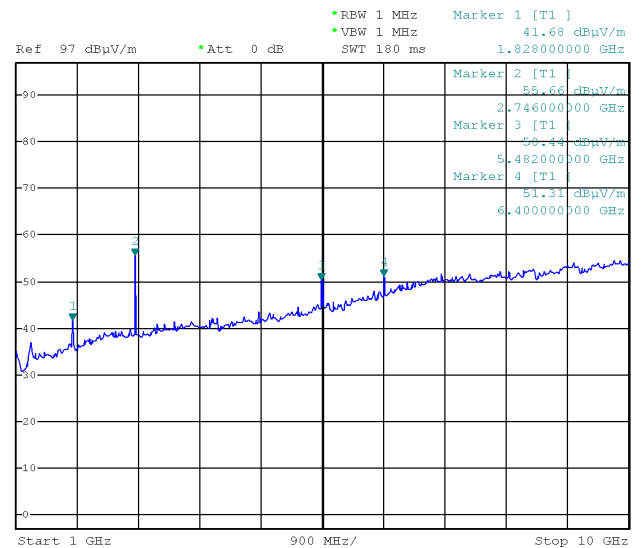
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1000 MHz ÷ 10000 MHz

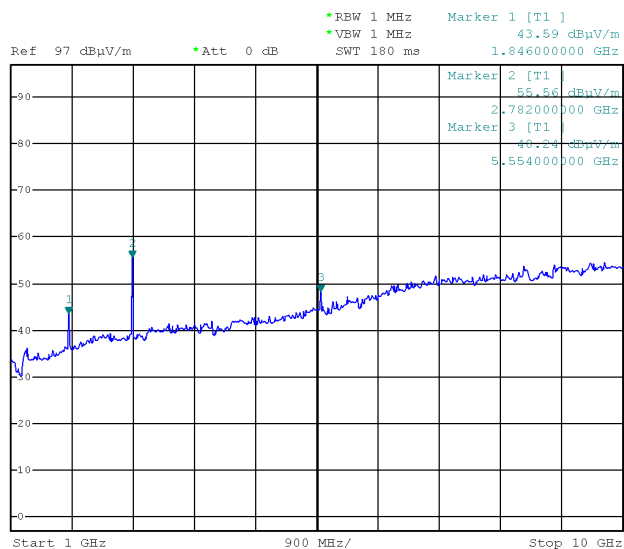
Lowest frequency



Middle frequency



Highest frequency





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HARMONICS – Worst case reported

Modulation 2FSK

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

Frequency (MHz)	Measured Level (dBμV/m)	Limit (μV/meter)	Limit (dBμV/m)	Margin (dB)
1,852	45.24	5000	74.00	-28.76
2,782	56.53	5000	74.00	-17.47
3,709	42.98	5000	74.00	-31.02
5,411	53.36	5000	74.00	-20.64
f>5,42	No spurious detected	5000	74.00	---

AVERAGE FACTOR

T. Pulse (ms)	TX on + TX off (ms)	Duty cycle	Average Factor (dB)
/	/	100 %	/

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Frequency (MHz)	Measured Level (dBμV/m)	Limit (μVolt/meter)	Limit (dBμV/m)	Margin (dB)
1,851	36.11	500	54	-17.89
2,777	48.10	500	54	-5.90
3,703	30.67	500	54	-23.33
5,420	42.38	500	54	-11.62
f>5,43	No spurious detected	500	54	---



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Modulation GFSK

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

Frequency (MHz)	Measured Level (dBμV/m)	Limit (μV/meter)	Limit (dBμV/m)	Margin (dB)
1.855	45.91	5000	74.00	-28.09
2,782	56.35	5000	74.00	-17.65
3,703	31.04	5000	74.00	-42.6
5,494	52.63	5000	74.00	-21.37
6,312	53.85	5000	74.00	-20.15
f> 6,42	No spurious detected	5000	74.00	---

AVERAGE FACTOR

T. Pulse (ms)	TX on + TX off (ms)	Duty cycle	Average Factor (dB)
/	/	100 %	/

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Frequency (MHz)	Measured Level (dBμV/m)	Limit (μVolt/meter)	Limit (dBμV/m)	Margin (dB)
1,851	36.14	500	54	-17.86
2,777	47.74	500	54	-6.26
3,703	43.02	500	54	-10.98
5,420	53.42	500	54	-0.58
6,410	53.60	500	54	-0.40
f> 6,42	No spurious detected	500	54	---



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Modulation MSK

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

Frequency (MHz)	Measured Level (dBμV/m)	Limit (μV/meter)	Limit (dBμV/m)	Margin (dB)
1,853	45.59	5000	74.00	-28.41
2,780	56.29	5000	74.00	-17.71
3,705	44.01	5000	74.00	-29.99
5,416	53.51	5000	74.00	-20.49
6,316	54.47	5000	74.00	-19.53
f> 6,32	No spurious detected	5000	74.00	---

AVERAGE FACTOR

T. Pulse (ms)	TX on + TX off (ms)	Duty cycle	Average Factor (dB)
/	/	100 %	/

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Frequency (MHz)	Measured Level (dBμV/m)	Limit (μVolt/meter)	Limit (dBμV/m)	Margin (dB)
1,853	38.46	500	54	-15.54
2,780	50.16	500	54	-3.84
3,705	32.19	500	54	-21.81
5,417	43.73	500	54	-10.27
6,316	43.65	500	54	-10.35
f> 6.32	No spurious detected	500	54	---

TEST RESULT

The EUT has been tested in 3 orthogonal axes at the frequencies lowest, middle and highest for each modulation.

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.



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7.4 6 dB BANDWIDTH

TEST REQUIREMENT

Spectrum analyzer settings

Span	2 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
Remark	None

TEST RESULT

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

TEST PROCEDURE

The EUT is set to transmit has its maximum data rate.

The Channel bandwidth is defined as the total spectrum the power of which is higher than peak power minus 6 dB.



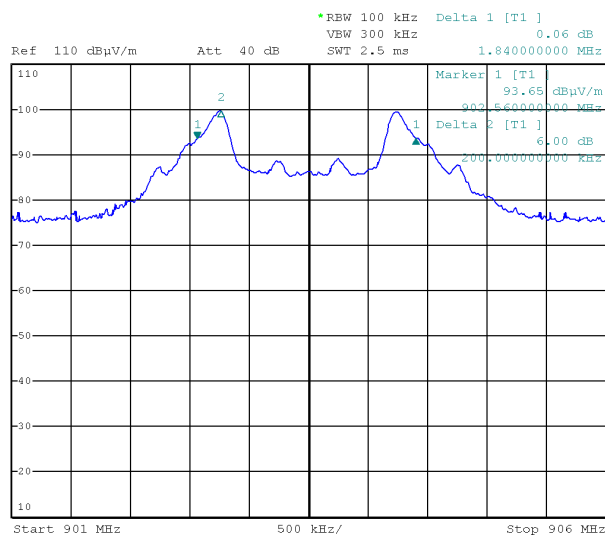
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MEASUREMENTS RESULTS

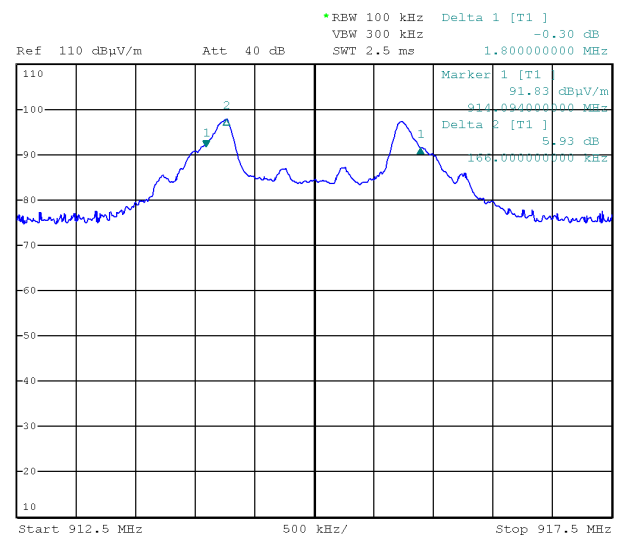
Modulation 2FSK

Channel (No.)	Frequency (MHz)	Channel Bandwidth (MHz)	Plot (No.)
Low	903.5	1.840	1
Middle	915	1.800	2
High	926.5	1.840	3

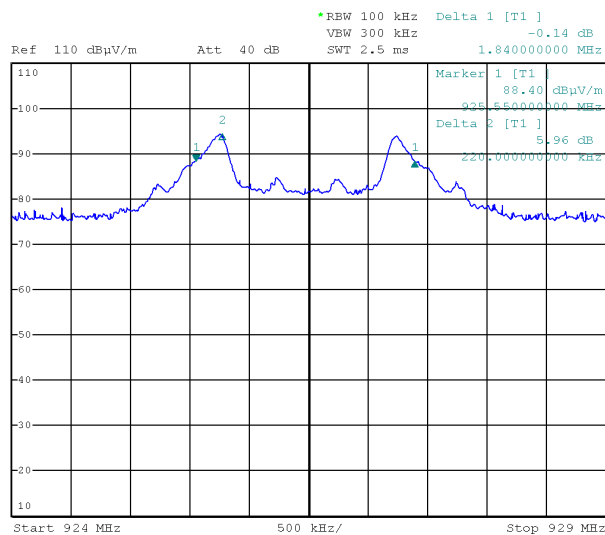
Plot 1



Plot 2



Plot 3





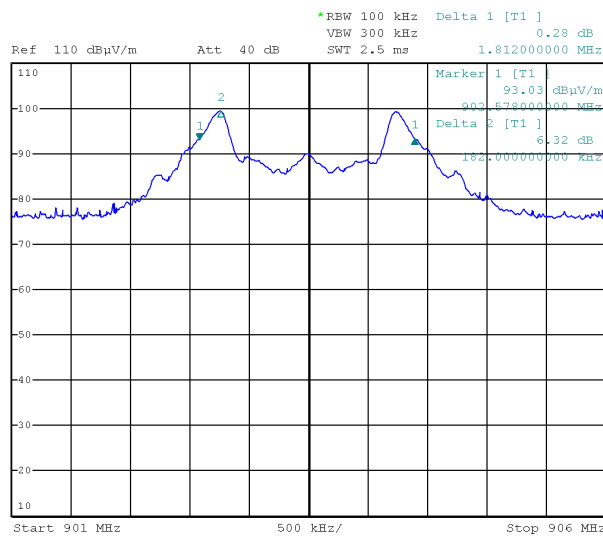
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MEASUREMENTS RESULTS

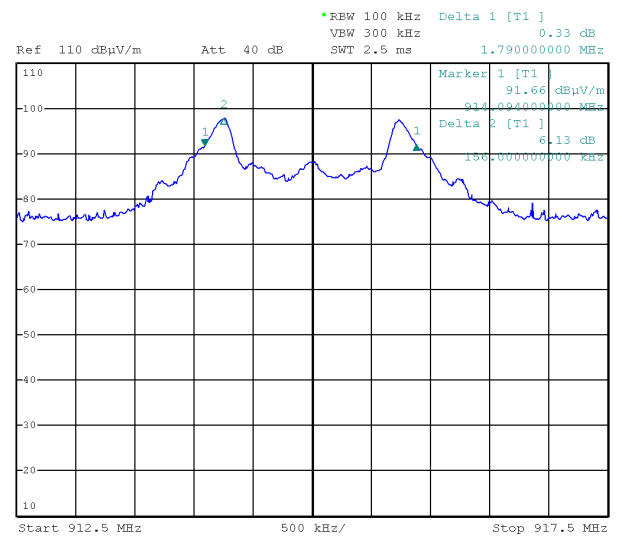
Modulation GFSK

Channel (No.)	Frequency (MHz)	Channel Bandwidth (MHz)	Plot (No.)
Low	903.5	1.812	1
Middle	915	1.790	2
High	926.5	1.850	3

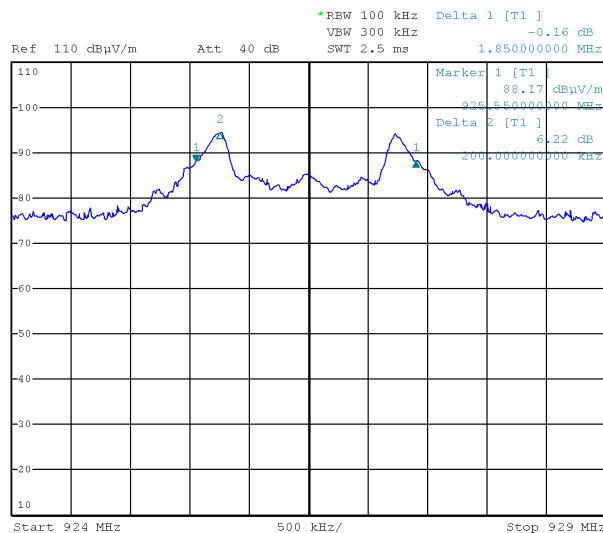
Plot 1



Plot 2



Plot 3





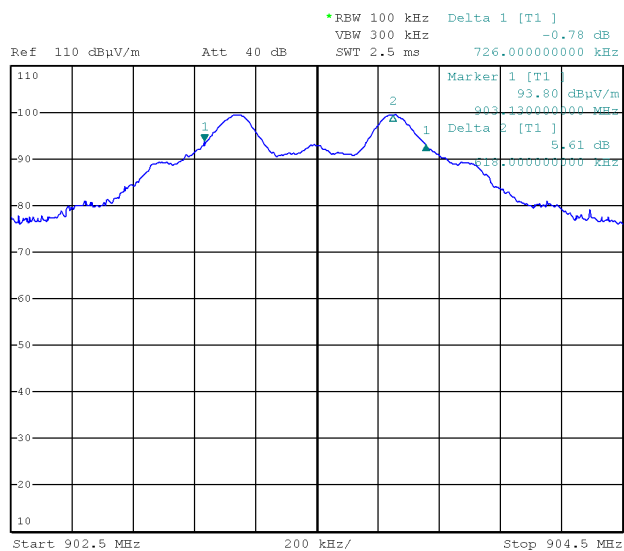
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MEASUREMENTS RESULTS

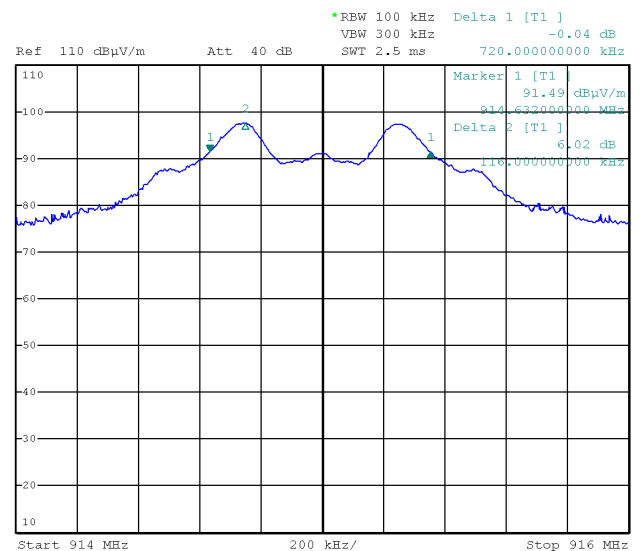
Modulation MSK

Channel (No.)	Frequency (MHz)	Channel Bandwidth (MHz)	Plot (No.)
Low	903.5	0.726	1
Middle	915	0.720	2
High	926.5	0.726	3

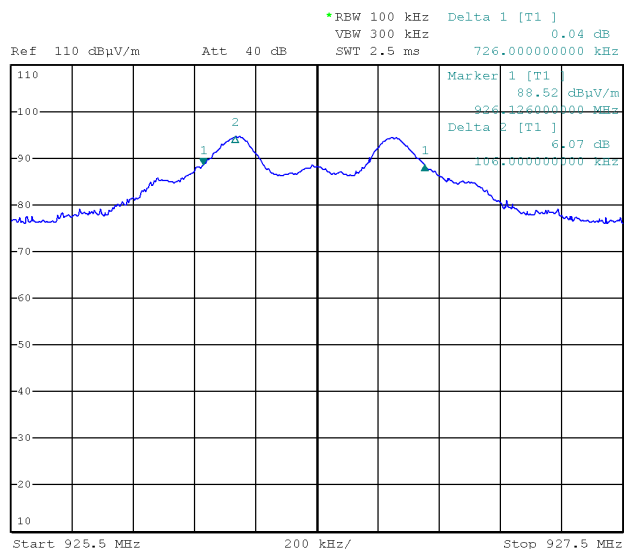
Plot 1



Plot 2



Plot 3



/



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7.5 MAXIMUM PEAK OUTPUT POWER WITH EXTERNAL ANTENNA (DE FACTO EIRP)

TEST REQUIREMENT

Spectrum analyzer settings

Resolution bandwidth (RBW)	10 MHz
Video bandwidth (VBW)	10 MHz
Sweep time (SWT)	2,5 ms
Detector function	Peak
Trace	max hold
Test distance	3 meters
EUT operating condition	#1
Remark	$\text{eirp} = p_t \times g_t = (E \times d)^2 / 30$ where: pt = transmitter output power in watts, gt = numeric gain of the transmitting antenna (unitless) -0.2 dBi, E = electric field strength in V/m, d = measurement distance in meters (m).

TEST RESULT

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

LIMITS

1 Watt (30dBm)

TEST PROCEDURE

Conducted measurements:

As the conducted measurement cannot be performed because the transmitter antenna is integrated, it has been carried out as a radiated measurement, according to KDB 558074 measurements guidance for DTS equipment. The field strength levels shall be converted to equivalent conducted power levels for comparison to the applicable output power limit. Refer to KDB 412172.

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.



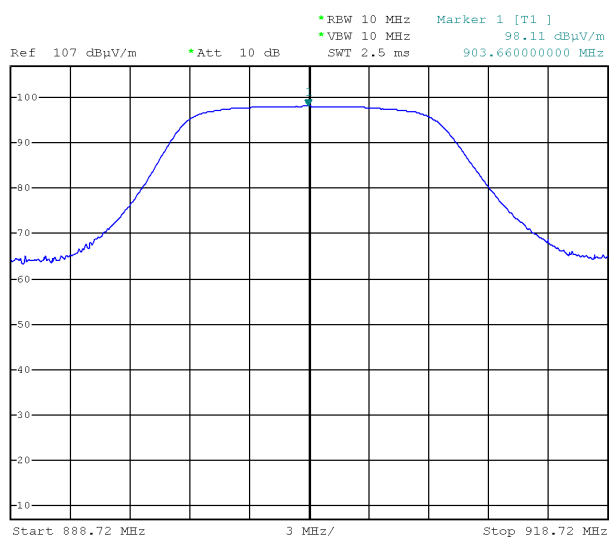
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MEASUREMENTS RESULTS (RADIATED)

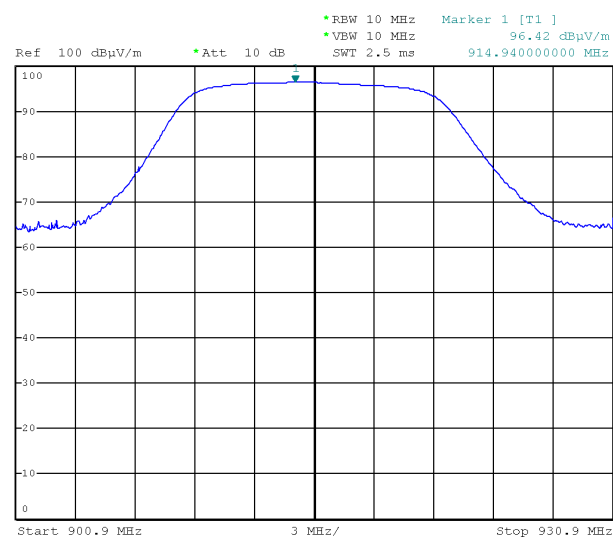
Modulation 2FSK

Channel (No.)	Frequency (MHz)	Measured Output Power (dBμV/m)	Measured Radiated Output Power (dBm)	Measured Output Power (V/m)	Conducted power (dBm)	Conducted power (mW)
Low	903.5	98.11	2.88	0.08045	3.08	2.03
Middle	915	96.42	1.69	0.06622	1.89	1.54
High	926.5	92.79	-2.44	0.04360	-2.24	0.60

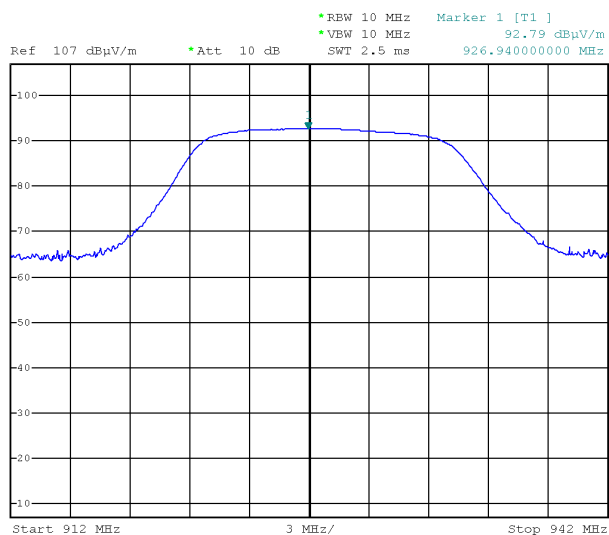
Plot 1



Plot 2



Plot 3



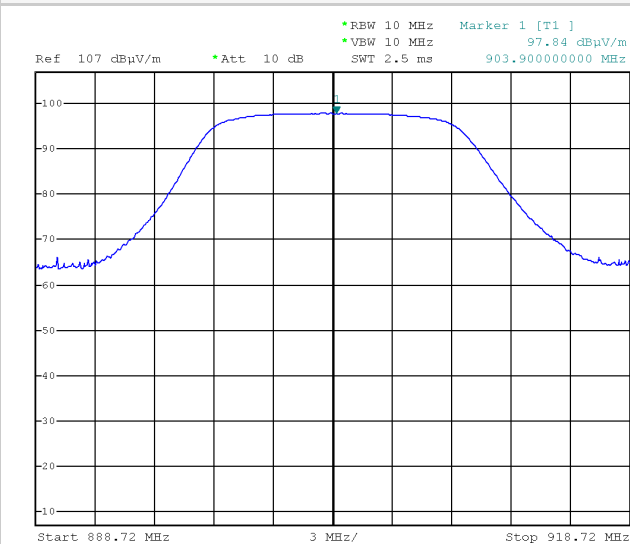


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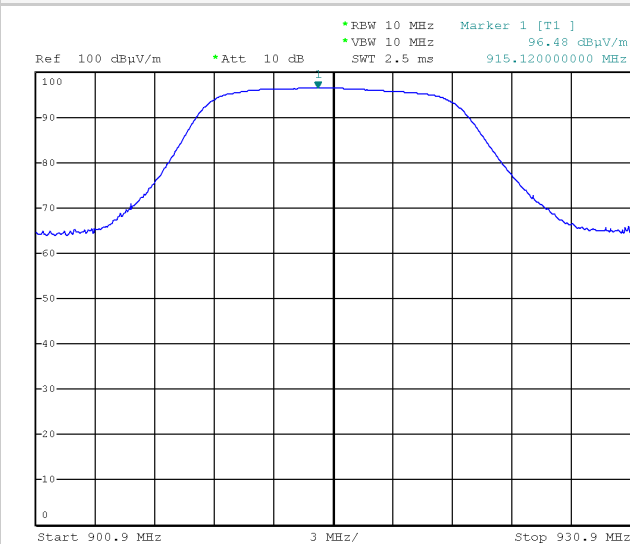
Modulation GFSK

Channel (No.)	Frequency (MHz)	Measured Output Power (dBμV/m)	Measured Radiated Output Power (dBm)	Measured Output Power (V/m)	Conducted power (dBm)	Conducted power (mW)
Low	903.5	97.84	2.61	0.07798	2.81	1.91
Middle	915	96.48	1.25	0.06668	1.45	1.40
High	926.5	92.70	-2.53	0.04315	-2.33	0.58

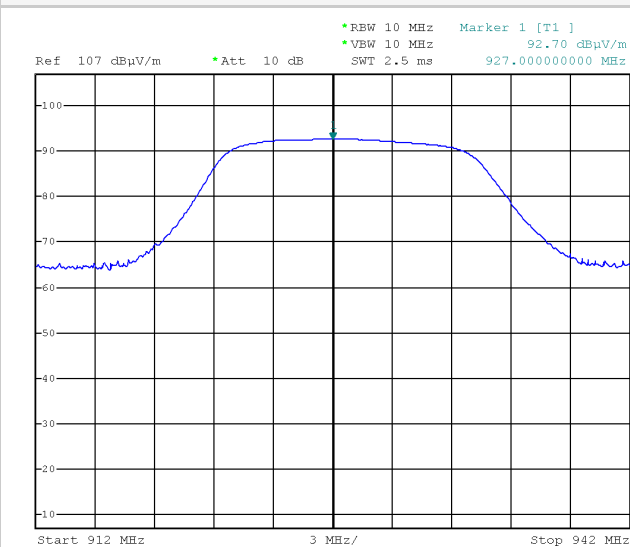
Plot 1



Plot 2



Plot 3



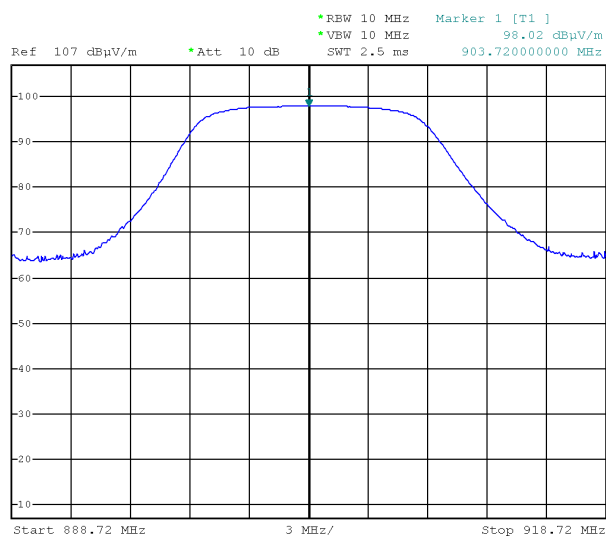


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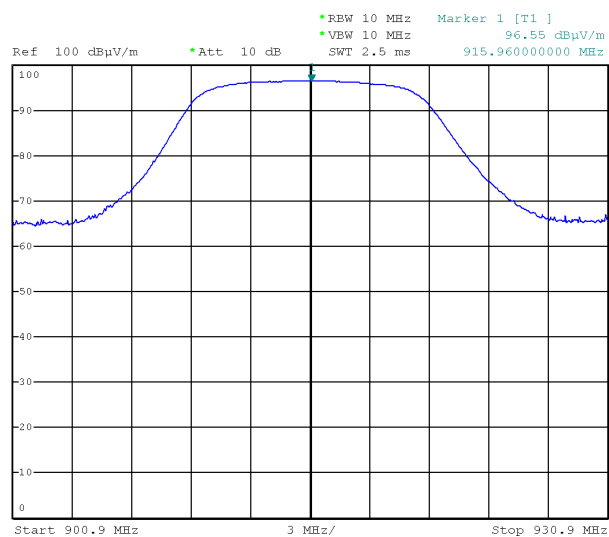
Modulation MSK

Channel (No.)	Frequency (MHz)	Measured Output Power (dBμV/m)	Measured Radiated Output Power (dBm)	Measured Output Power (V/m)	Conducted power (dBm)	Conducted power (mW)
Low	903.5	98.02	2.79	0.07962	2.59	1.82
Middle	915	96.55	1.32	0.06722	1.12	1.29
High	926.5	92.25	-2.98	0.04097	-3.18	0.48

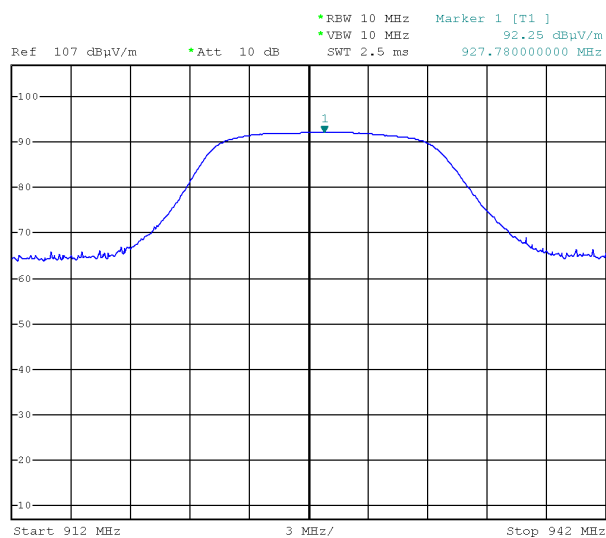
Plot 1



Plot 2



Plot 3





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7.6 BAND-EDGE COMPLIANCE OF RF RADIATED EMISSIONS

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)	1 MHz (100 kHz band-edge)
Video bandwidth (VBW)	1 MHz (100 kHz band-edge)
Sweep time (SWT)	Auto
Detector function	Peak
Trace	Max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#1
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)

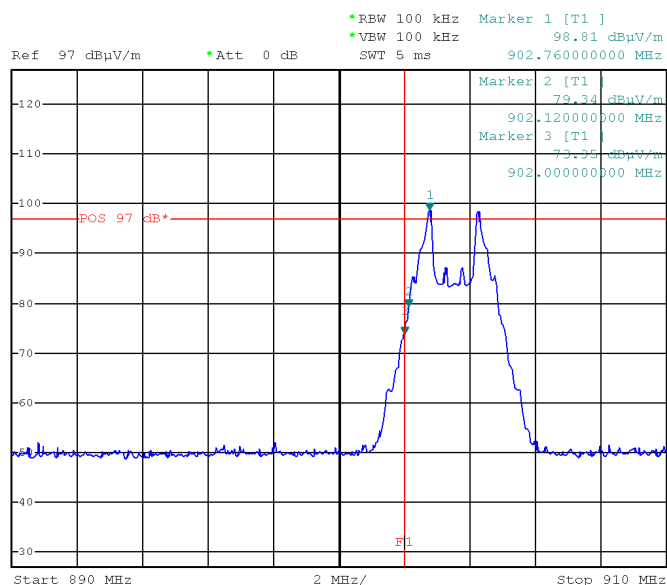
Once the trace is stabilized, by the marker the emission at the band edge (or on the highest modulation product outside of the band, if this level is greater than that at the band edge) was set.

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

Modulation 2FSK

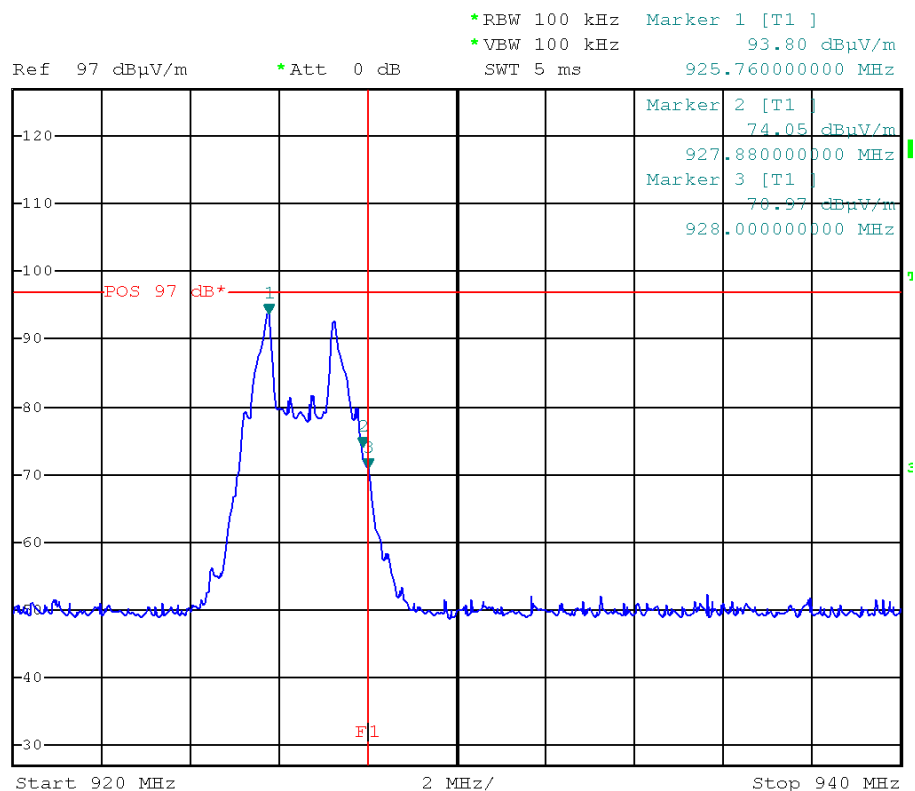
Band-edge compliance, lower band edge, (Peak)



Measured power (dBm)	Measured power at the band edge (dBm)	Difference Peak / band edge (dBm)	Peak Limit at PK power -20 dB (dBm)	Margin (dB)
3.58	-21.88	-25.46	-16.42	-9.08

Measured Level (dBμV/m)	Limit (μVolt/meter)	Limit (dBμV/m)	Margin (dB)
73.35	5000	74.00	-0.65

Band-edge compliance, upper band edge, (Peak)

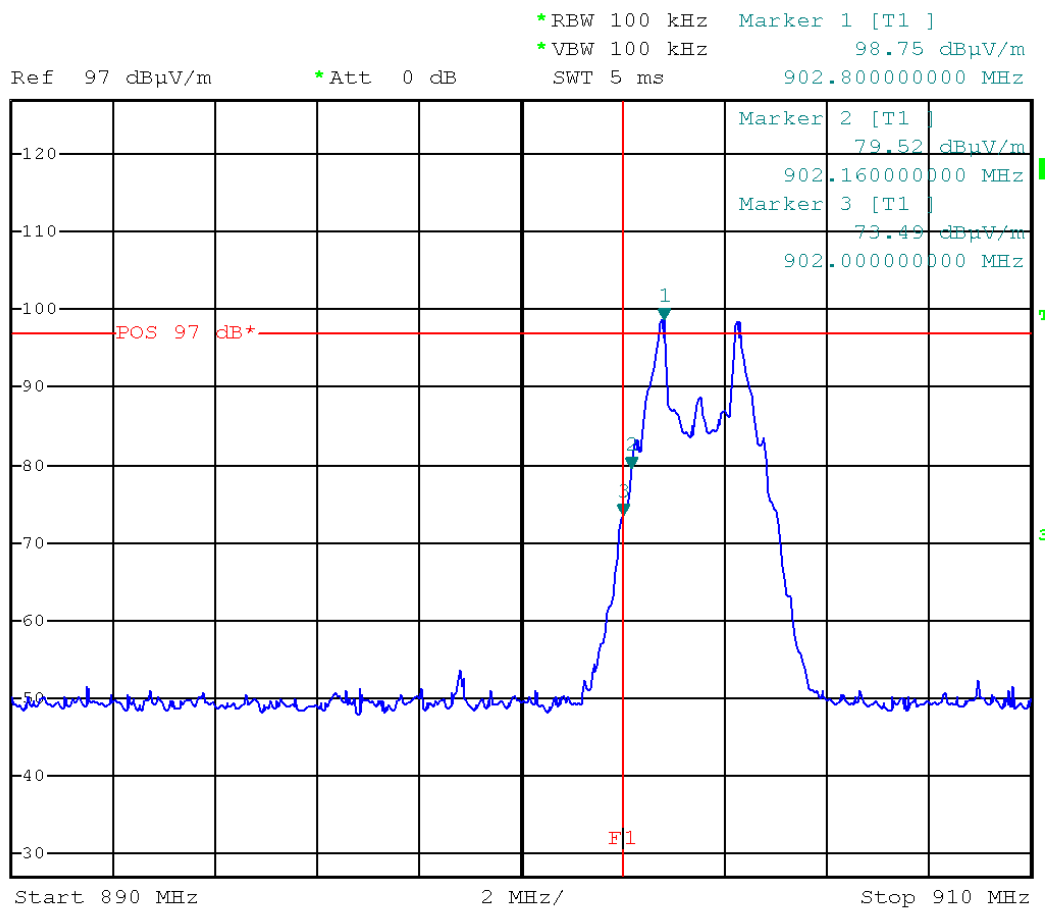


Measured power (dBm)	Measured power at the band edge (dBm)	Difference Peak – band edge (dBm)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
-1.43	-24.26	-22.83	-21.43	-1.40

Measured Level (dBμV/m)	Limit (μVolt/meter)	Limit (dBμV/m)	Margin (dB)
70.97	5000	74.00	-3.03

Modulation GFSK

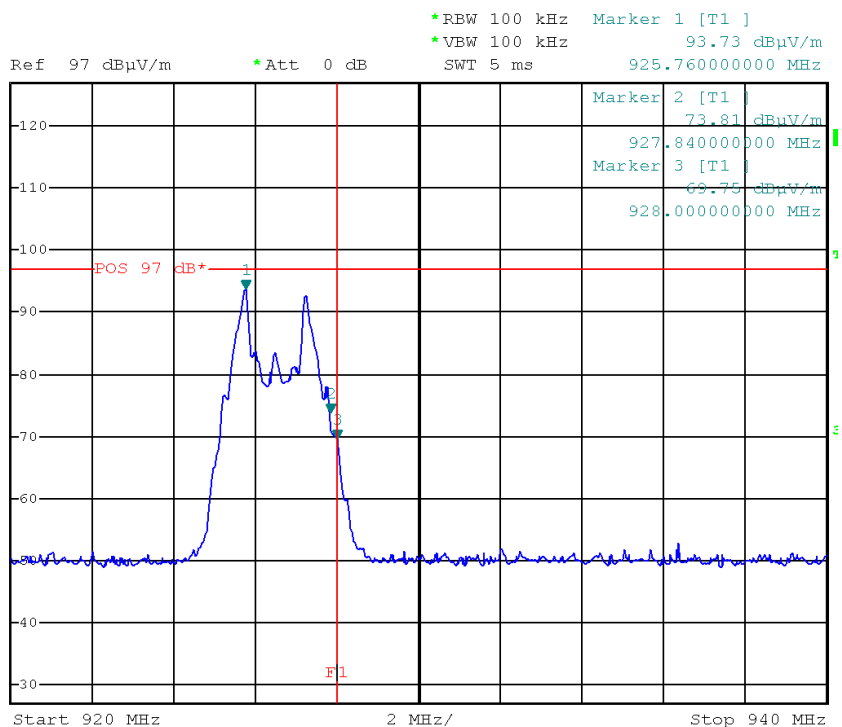
Band-edge compliance, lower band edge, (Peak)



Measured power (dBm)	Measured power at the band edge (dBm)	Difference Peak – band edge (dBm)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
3.52	-21.47	-24.99	-16.48	-8.51

Measured Level (dBμV/m)	Limit (μVolt/meter)	Limit (dBμV/m)	Margin (dB)
73.49	5000	74.00	-0.51

Band-edge compliance, upper band edge, (Peak)

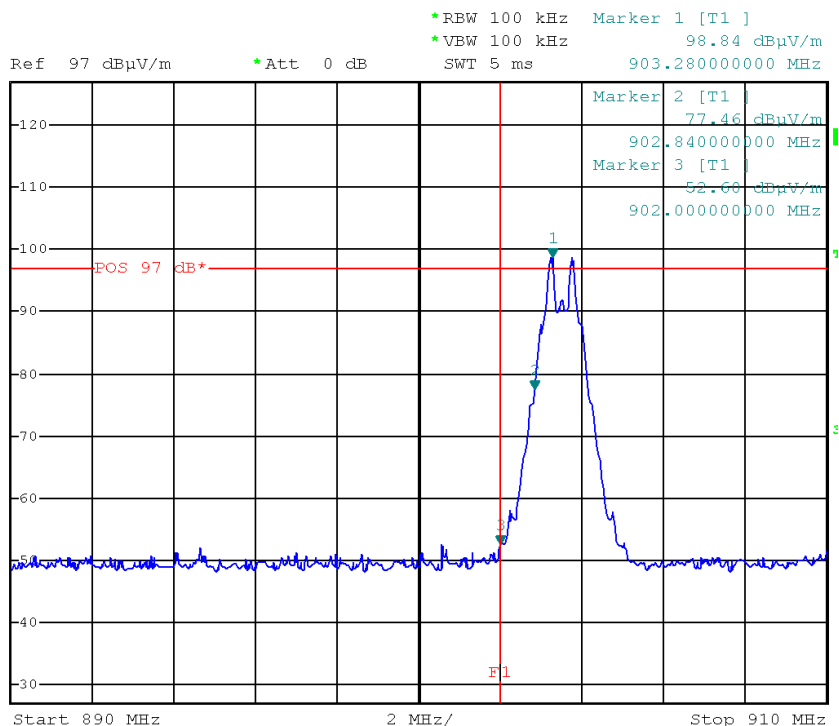


Measured power (dBm)	Measured power at the band edge (dBm)	Difference Peak – band edge (dBm)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
-1.50	-25.48	-23.98	-21.50	-2.48

Measured Level (dBμV/m)	Limit (μVolt/meter)	Limit (dBμV/m)	Margin (dB)
69.75	5000	74.00	-4.25

Modulation MSK

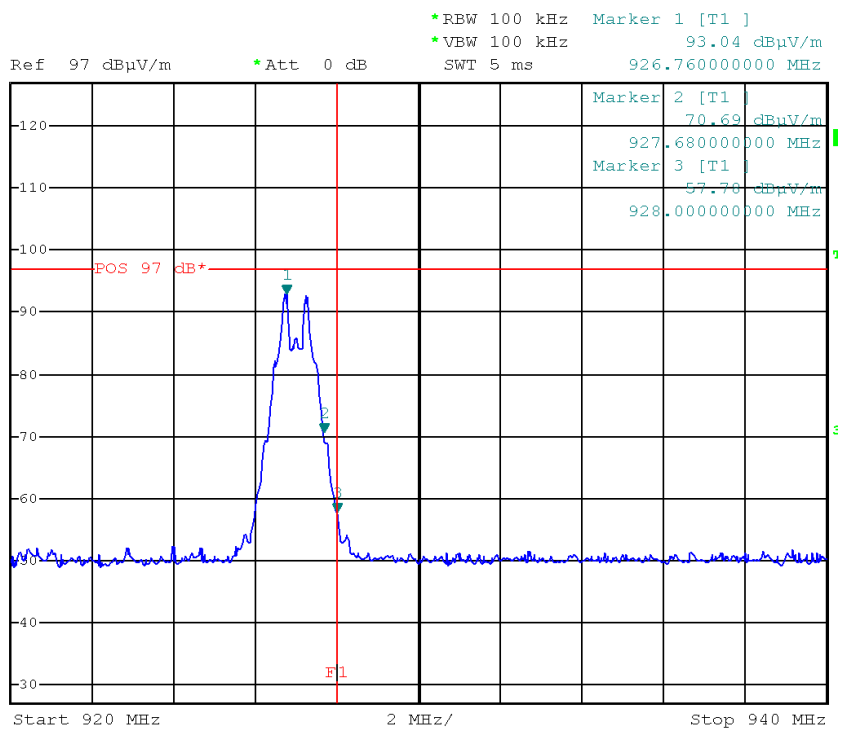
Band-edge compliance, lower band edge, (Peak)



Measured power (dBm)	Measured power at the band edge (dBm)	Difference Peak – band edge (dBm)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
3.61	-42.63	-46.24	-16.39	-29.85

Measured Level (dBμV/m)	Limit (μVolt/meter)	Limit (dBμV/m)	Margin (dB)
52.60	5000	74.00	-21.40

Band-edge compliance, upper band edge, (Peak)



Measured power (dBm)	Measured power at the band edge (dBm)	Difference Peak – band edge (dBm)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
-2.19	-37.53	-35.34	-22.19	-13.15

Measured Level (dBμV/m)	Limit (μVolt/meter)	Limit (dBμV/m)	Margin (dB)
57.70	5000	74.00	-16.30



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7.7 RADIATED EMISSIONS OUTSIDE THE BAND

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
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

As the conducted measurement cannot be performed because the transmitter antenna is integrated, it has been carried out radiated measurement, according to KDB 558074 measurements guidance for DTS equipment. The field strength levels shall be converted to equivalent conducted power levels for comparison to the applicable output power limit refer to KDB 412172.
The measure has been executed with the lowest transmit channel, the highest transmit channel and one located somewhere in the middle of the band.



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MEASUREMENTS RESULTS

PEAK RESULT - Worst case reported

Modulation 2FSK -				
Frequency (MHz)	Measured Level (dBm)	Limit (dBm) Fundamental value – 20dB	Limit (dBm) Restricted band - 33dBm	Margin (dB)
926.5 (fundamental)	-3.15	---	---	
1,852	-49.99	-23.15	---	-26.84
2,782	-38.70	---	-33	-5.70
3,709	-52.25	---	-33	-19.25
5,411	-41.87	---	-33	-8.87

Modulation GFSK -				
Frequency (MHz)	Measured Level (dBm)	Limit (dBm) Fundamental value – 20dB	Limit (dBm) Restricted band - 33dBm	Margin (dB)
926.5 (fundamental)	-3.26	---	---	---
1,855	-49.32	-23.26	---	-26.06
2,782	-38.88	---	-33	-5.88
3,703	-63.83	---	-33	-30.83
5,494	-42.60	-23.26	---	-19.34
6,312	-41.38	-23.26	---	-18.12



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Modulation MSK -				
Frequency (MHz)	Measured Level (dBm)	Limit (dBm) Fundamental value – 20dB	Limit (dBm) Restricted band - 33dBm	Margin (dB)
926.5 (fundamental)	-3.16	---	---	---
1,853	-49.64	-23.16	---	-26.48
2,780	-38.94	---	-33	-5.94
3,705	-51.22	---	-33	-18.22
5,416	-41.72	---	-33	-8.72
6,316	-40.76	-23.16	---	-17.60



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7.8 TRANSMITTER POWER SPECTRAL DENSITY

TEST REQUIREMENT

Spectrum analyzer settings

Span	1.5 MHz
Resolution bandwidth (RBW)	3 kHz
Video bandwidth (VBW)	10 kHz
Sweep time (SWT)	500 s
Detector function	Peak
Trace	Max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#1
Remark	None

TEST RESULT

The EUT meets the requirements of sections 15.247 (e)

LIMITS

8 dBm in 3 kHz bandwidth.

TEST PROCEDURE

After trace stabilisation the marker shall be set on the signal peak. The indicated level is the power spectral density.



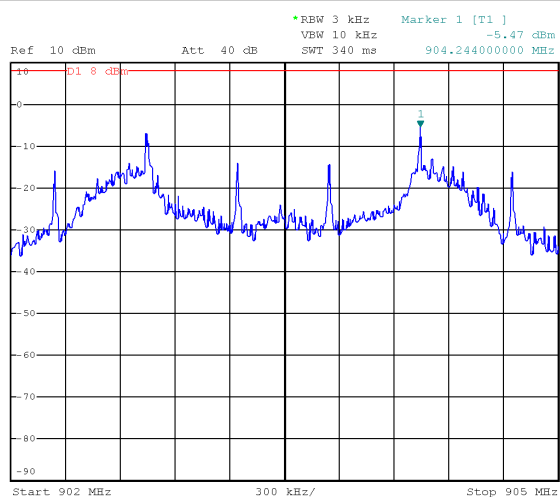
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MEASUREMENTS RESULTS

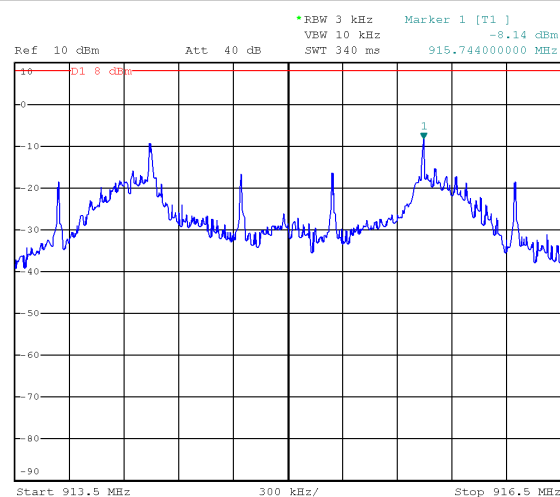
Modulation 2FSK

Channel (No.)	Frequency (MHz)	Transmitter power on 3 kHz band (dBm)	Plot (No.)
Low	903.5	-5.47	1
Middle	915	-8.14	2
High	926.5	-13.35	3

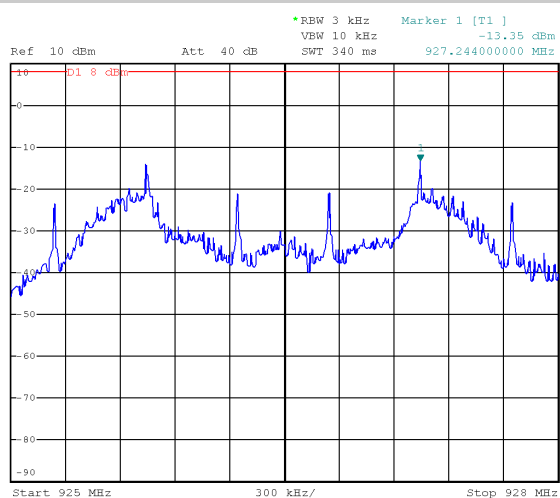
Plot 1



Plot 2



Plot 3



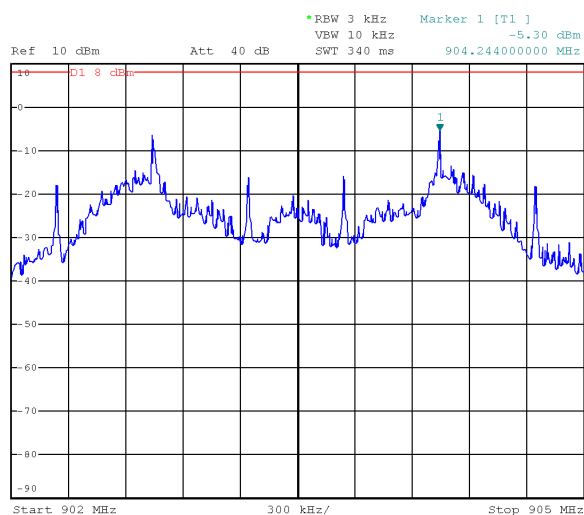


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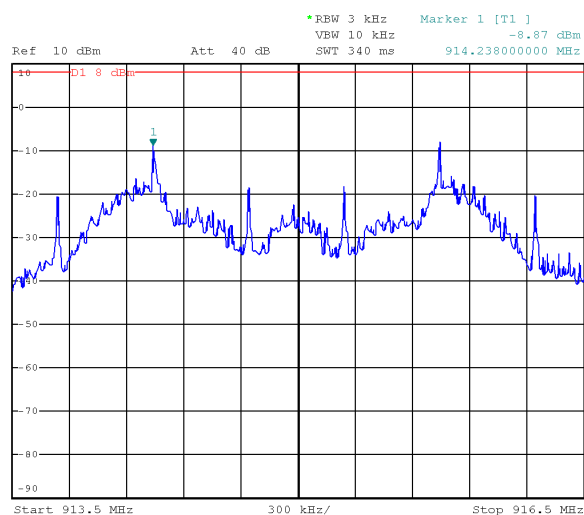
Modulation GFSK

Channel (No.)	Frequency (MHz)	Transmitter power on 3 kHz band (dBm)	Plot (No.)
Low	903.5	-5.30	1
Middle	915	-8.87	2
High	926.5	-13.14	3

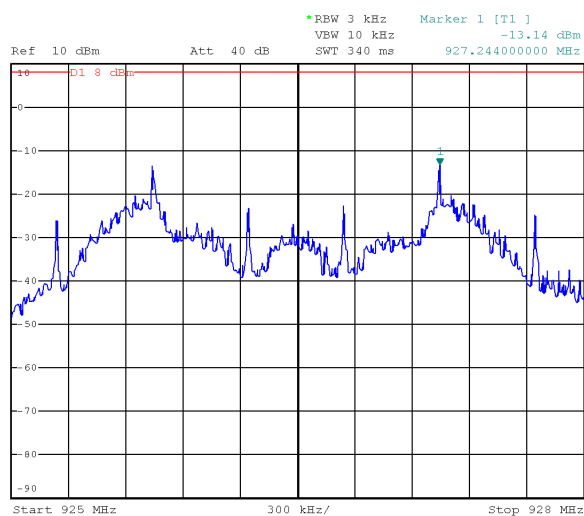
Plot 1



Plot 2



Plot 3



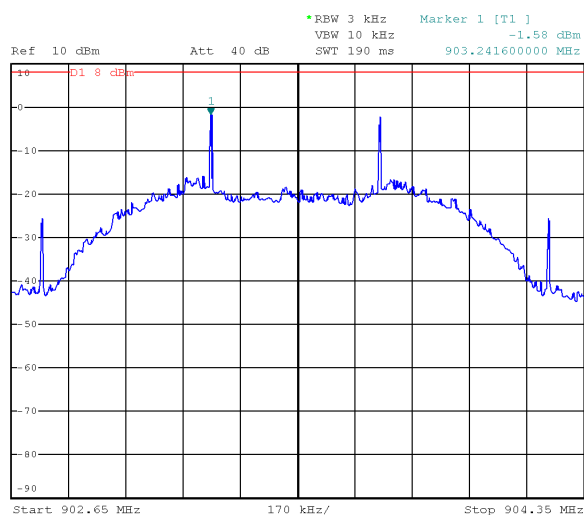


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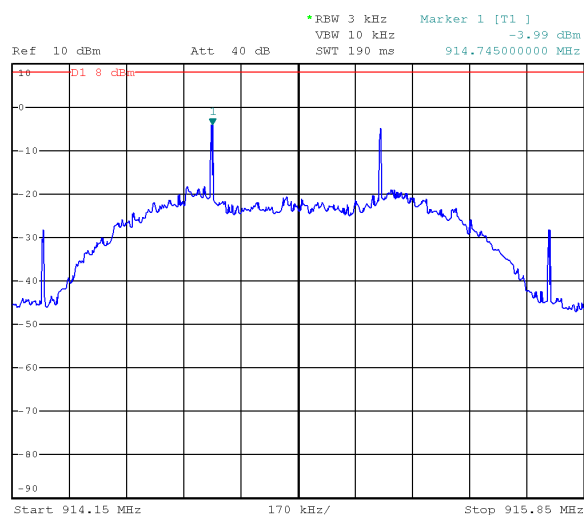
Modulation MSK

Channel (No.)	Frequency (MHz)	Transmitter power on 3 kHz band (dBm)	Plot (No.)
Low	903.5	-1.58	1
Middle	915	-3.99	2
High	926.5	-8.50	3

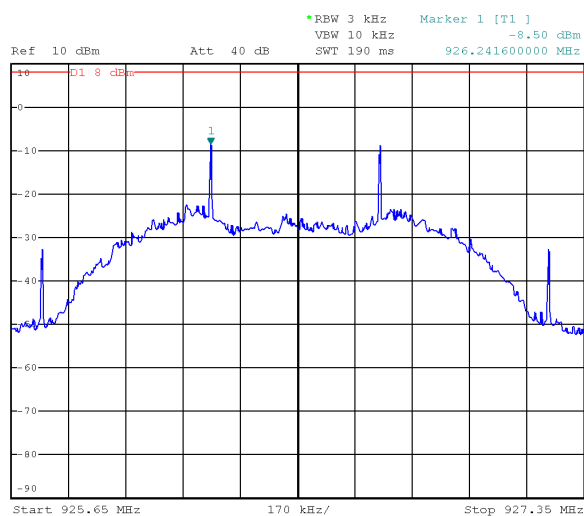
Plot 1



Plot 2



Plot 3





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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.



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

447498 D01 General RF Exposure Guidance v05r02 § 4.3

Modulation 2FSK

Channel No.	Frequency (MHz)	Conducted power (dBm)	Conducted power (mW)	Distance (mm)	$\frac{\text{max. power (mW)}}{\text{min. distance (mm)}} \times \sqrt{f(\text{GHz})}$	Limits
Lowest	903.5	2.68	1.854	5	0.352	≤ 3.0 for 1-g head SAR or ≤ 7.5 for 10-g extremity SAR
Middle	915	0.99	1.256	5	0.240	
Highest	926.5	-2.64	0.545	5	0.105	

Modulation GFSK

Channel No.	Frequency (MHz)	Conducted power (dBm)	Conducted power (mW)	Distance (mm)	$\frac{\text{max. power (mW)}}{\text{min. distance (mm)}} \times \sqrt{f(\text{GHz})}$	Limits
Lowest	903.5	1.74	1.493	5	0.283	≤ 3.0 for 1-g head SAR or ≤ 7.5 for 10-g extremity SAR
Middle	915	1.27	1.340	5	0.256	
Highest	926.5	0.53	1.130	5	0.217	

Modulation MSK

Channel No.	Frequency (MHz)	Conducted power (dBm)	Conducted power (mW)	Distance (mm)	$\frac{\text{max. power (mW)}}{\text{min. distance (mm)}} \times \sqrt{f(\text{GHz})}$	Limits
Lowest	903.5	1.82	1.521	5	0.289	≤ 3.0 for 1-g head SAR or ≤ 7.5 for 10-g extremity SAR
Middle	915	1.29	1.346	5	0.257	
Highest	926.5	0.48	1.117	5	0.215	

TEST RESULT

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



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8. MEASUREMENTS AND TESTS UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the IMQ procedure No. IO-DT-U01 and requirement of NIST Technical Note 1297 and NIS 81: 1994 “The Treatment of Uncertainty in EMC Measurements”

Methods	Expanded Uncertainty	Unit	confidence level	Coverage factor	Degree of freedom
Radiated emission (30 ÷ 1000 MHz)	4.77	dB	95 %	2	9
Radiated emission (above 1000 MHz)	3.53	dB	95 %	2	9



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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	/	03-13	24	IMQ
P02486	Turntable controller unit	FRANKONIA	FCTAM01	/	/	/
P02488	Mast antenna	FRANKONIA	FAM4	/	/	/
S05562	EMI Receiver	ROHDE & SCHWARZ	ESU 8	05-14	12	ROHDE & SCHWARZ
S02350	EMI Receiver	ROHDE & SCHWARZ	ESMI-RF	06-14	12	INRIM
S03511	Log antenna	ARA	LPB-2520/1	04-12	36	NPL
S04271	Log antenna	ARA	LPB-2513/A	11-11	36	NPL
S03463	Horn Antenna	SCHWARZBECK	BBHA 9120D	09-11	36	NPL
S04272	Horn antenna	SCHWARZBECK	BBHA 9120D	07-14	36	NPL
S02508	Loop Antenna	ROHDE & SCHWARZ	HFH2-Z2	01-12	36	SEIBERSDORF
S03629	Spectrum Analyzer	Rohde & Schwarz	FSP40	12-13	12	ROHDE & SCHWARZ
S03542	Preamplifier	Hewlett Packard	HP 8449B	06-13	24	IMQ
S04193	Preamplifier	Bonn Elektronik	BLNA 0110-15C35	06-13	24	IMQ
S-05039	EMI cable	/	EMI1	10-13	12	IMQ
S-05041	Micro-coax cable	Rosenberger micro	UFB311A	10-13	12	IMQ
S04159	Multimeter	Fluke	45	05-14	12	IMQ
W-00199/E	Software	ROHDE & SCHWARZ	EMC32 Ver. 6.30	/	/	/
H-00165	PC	/	/	/	/	/

END OF TEST REPORT