



FCC LISTED,
 REGISTRATION NUMBER:
 720267

Informe de ensayo nº:
 Test report No:

NIE: 51746RRF.003

Test report USA FCC Part 25

Identificación del objeto ensayado.....: Identification of item tested	Satellite Smartphone
Marca Trade	Bittium
Modelo y/o referencia tipo Model and /or type reference	Mx Smart
Other identification of the product	FCC ID: V27SSD-51
HW version	0201
SW version	1.8.31
Características Features	SATELLITE <ul style="list-style-type: none"> • L-band 1525 – 1660.5 MHz • GMR-1 3G 45.005; Radio Transmission and Reception DL 186kbps, UL 30kbps • GMR-1 3G with internal antenna DL 21kbps, UL 2.6kbps • GMR-1 3G AMBE2+ voice call LTE <ul style="list-style-type: none"> • 3GPP rel10 (LTE Advanced) • FDD Cat4, DL 150 Mbit/s, UL 50 Mbit/s • Band configuration: B4 (1700), B28 (700) UMTS/HSPA <ul style="list-style-type: none"> • 3GPP R99 384/384kbps • 3GPP rel8, HSPA+, 42 Mbps / 5.76 Mbps • Band configuration: B2 (1900), B4 (1700), B5 (850) GSM/GPRS/EDGE <ul style="list-style-type: none"> • 850/900/1800/1900 MHz Other Radios <ul style="list-style-type: none"> • Wi-Fi 802.11 b/g/n Bluetooth 4.0
Fabricante Manufacturer	BITTIUM WIRELESS LTD. Tutkijantie 8 90590 Oulu, Finland
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 25 10-1-15 Edition: Satellite Communications Measurement Guidance 971168 D01 v02r02 for certification of Licensed Digital Transmitters. ANSI/TIA-603-D (2010).

Resultado:	IN COMPLIANCE
Summary	
Aprobado por (nombre / cargo y firma)	A. Llamas
Approved by (name / position & signature)	RF Lab. Manager
Fecha de realización	2017-03-13
Date of issue	
Formato de informe No.	FDT08_18
Report template No	

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Competences and guarantees

AT4 wireless is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

AT4 wireless is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

In order to assure the traceability to other national and international laboratories, AT4 wireless has a calibration and maintenance program for its measurement equipment.

AT4 wireless guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at AT4 wireless at the time of performance of the test.

AT4 wireless is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

IMPORTANT: No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of AT4 wireless.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

Uncertainty

Uncertainty (factor $k=2$) was calculated according to the AT4 wireless internal document PODT000.

Usage of samples

Samples undergoing test have been selected by: **the client**.

Sample S/01 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
51746/021	Satellite Smartphone	Mx Smart	---	2017-01-16
51746/016	Battery	9304576A01	---	2017-01-12

1. Sample S/01 has undergone the test(s).
All radiated tests with “internal antenna” indicated in appendix A.

Sample S/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
51746/021	Satellite Smartphone	Mx Smart	---	2017-01-16
51746/016	Battery	9304576A01	---	2017-01-12
51748/038	Antenna	---	---	2017-01-16

1. Sample S/02 has undergone the test(s).

The FCC 25.216 Subclause (c), (h), (i) / Limits on emissions from mobile earth stations for protection of aeronautical radionavigation satellite service with “external antenna” test indicated in appendix A.

Sample S/03 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
51746/021	Satellite Smartphone	Mx Smart	---	2017-01-16
51746/020	Dummy battery	DB-6BM proto 0.1	162510006	2017-01-16

1. Sample S/02 has undergone the test(s).

All conducted tests and the FCC 25.202 Subclause (f) / Emission limitations. Radiated emissions with “external antenna” indicated in appendix A.

Test sample description

The Mx Smart is a satellite and terrestrial phone targeted for professional Public Safety use.

Identification of the client

Bittium Wireless Ltd.

Tutkijantie 8 90590 Oulu, Finland

Testing period

The performed test started on 2017-01-20 and finished on 2017-02-21.

The tests have been performed at AT4 wireless.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

Remarks and comments

1: Used instrumentation:

Conducted Measurements

	Last Cal. date	Cal. due date
1. Spectrum analyser Agilent E4440A	2015/10	2017/10
2. Spectrum analyser Rohde & Schwarz FSQ8	2016/06	2018/06
3. DC power supply R&S NGPE 40/40	2014/11	2017/11

Radiated Measurements

	Last Cal. date	Cal. due date
1. Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2. BiconicalLog antenna ETS LINDGREN 3142E	2014/03	2017/03
3. Multi Device Controller EMCO 2090	N.A.	N.A.
4. Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2016/11	2019/11
5. Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2014/03	2017/03
6. EMI Test Receiver R&S ESU 40	2016/03	2018/03
7. Spectrum analyser Rohde & Schwarz FSW50	2015/12	2017/12
8. RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2016/04	2017/04
9. RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2016/02	2018/02

Testing verdicts

Not applicable	N/A
Pass	P
Fail	F
Not measured	N/M

1.- Satellite

FCC PART 25 PARAGRAPH		VERDICT			
		NA	P	F	NM
FCC 25.202 Subclause (d)	Frequency tolerance, Earth stations		P		
FCC 25.202 Subclause (f) (1, 2 & 3)	Emission limitations		P		
FCC 25.204 Subclause (a)	Power Limits for earth stations (radiated e.i.r.p.)		P		
FCC 25.216 subclause (c), (h), (i)	Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service		P		

Appendix A – Test result “Satellite”

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TEST CONDITIONS

Power supply (V):

$$V_{\text{nom}} = 4.2 \text{ Vdc}$$

$$V_{\text{max}} = 4.2 \text{ Vdc}$$

$$V_{\text{min}} = 3.8 \text{ Vdc}$$

The subscripts nom, min and max indicate voltage test conditions (nominal, minimum and maximum respectively, as declared by the applicant).

Type of power supply = DC Voltage from rechargeable battery

Internal antenna: Type of antenna = PIFA 1525 – 1660.5MHz (-0.7 dBi).

External antenna: Type of antenna = Quadrifilar helix 1525 – 1660.5MHz (+2.4 dBi).

TEST FREQUENCIES:

pi/2 BPSK voice 31.25kHz bandwidth:

Lowest channel: 1626.53125 MHz

Middle channel: 1643.5 MHz

Highest channel: 1660.46875 MHz

pi/4 QPSK packet data 31.25kHz bandwidth:

Lowest channel: 1626.53125 MHz

Middle channel: 1643.5 MHz

Highest channel: 1660.46875 MHz

pi/4 QPSK packet data 62.5kHz bandwidth:

Lowest channel: 1626.546875 MHz

Middle channel: 1643.515625 MHz

Highest channel: 1660.484375 MHz

pi/4 QPSK packet data 156.25kHz bandwidth:

Lowest channel: 1626.59375 MHz

Middle channel: 1643.5 MHz

Highest channel: 1660.40625 MHz

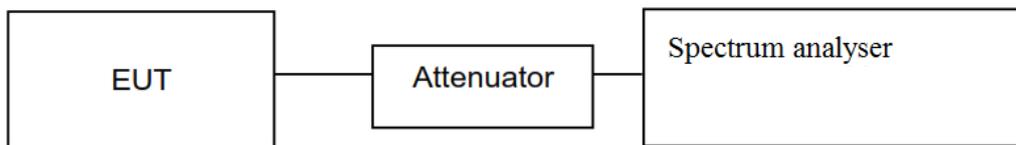
Occupied Bandwidth.

METHOD

The occupied bandwidth measurement was performed at the output terminals of the EUT using an attenuator power and a spectrum analyser. The EUT was set in continuous transmission with modulations and associated bandwidths.

The 99% occupied bandwidth and the -26 dBc bandwidth were measured directly using the built-in bandwidth measuring option of spectrum analyser.

TEST SETUP



RESULTS

pi/2 BPSK voice 31.25kHz bandwidth:

	Lowest frequency 1626.53125 MHz	Middle frequency 1643.5 MHz	Highest frequency 1660.46875 MHz
99% bandwidth (kHz)	27.487	27.474	27.591
-26 dBc bandwidth (kHz)	31.842	31.757	31.854
Measurement uncertainty (kHz)	<± 0.17		

pi/4 QPSK packet data 31.25kHz bandwidth:

	Lowest frequency 1626.53125 MHz	Middle frequency 1643.5 MHz	Highest frequency 1660.46875 MHz
99% bandwidth (kHz)	27.339	27.036	27.046
-26 dBc bandwidth (kHz)	30.962	30.705	30.686
Measurement uncertainty (kHz)	<± 0.17		

pi/4 QPSK packet data 62.5kHz bandwidth:

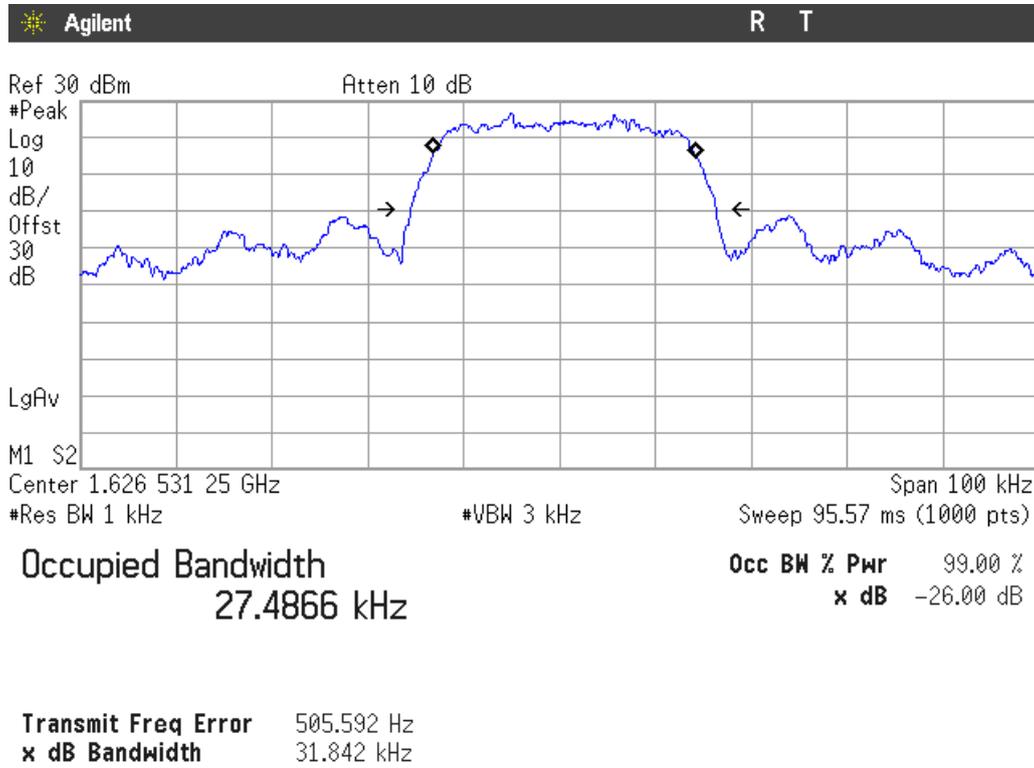
	Lowest frequency	Middle frequency	Highest frequency
	1626.546875 MHz	1643.515625 MHz	1660.484375 MHz
99% bandwidth (kHz)	56.956	56.202	56.5372
-26 dBc bandwidth (kHz)	70.614	65.308	65.519
Measurement uncertainty (kHz)	<± 0.33		

pi/4 QPSK packet data 156.25kHz bandwidth:

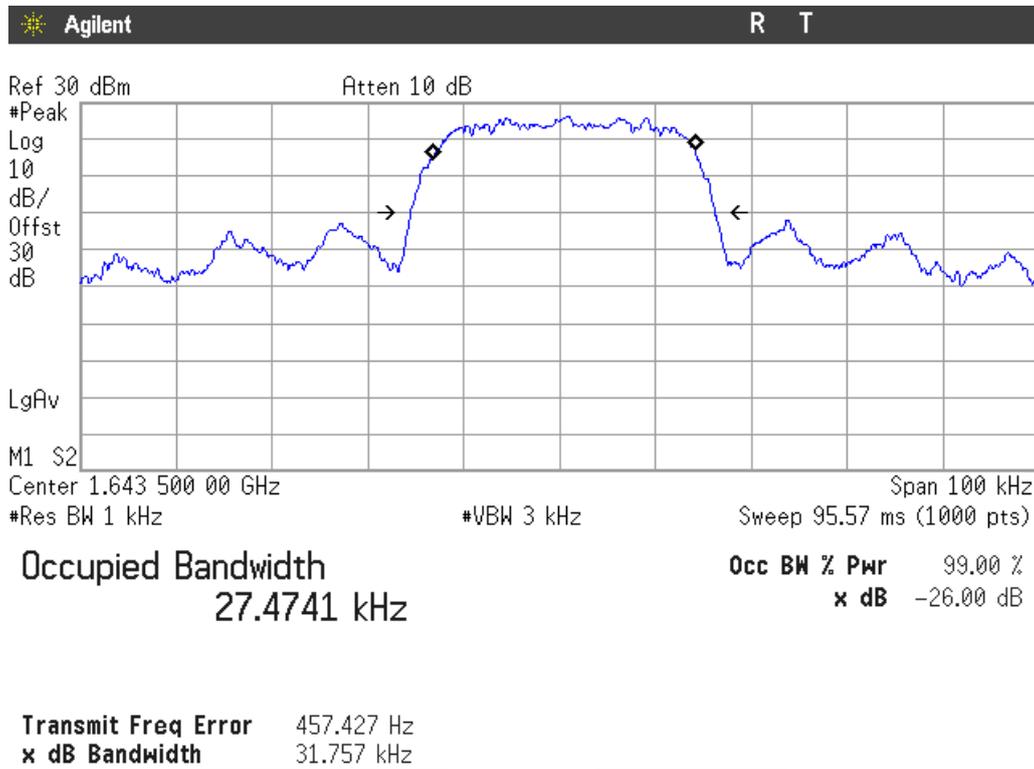
	Lowest frequency	Middle frequency	Highest frequency
	1626.59375 MHz	1643.5 MHz	1660.40625 MHz
99% bandwidth (kHz)	141.016	140.527	140.441
-26 dBc bandwidth (kHz)	162.769	162.010	164.781
Measurement uncertainty (kHz)	<± 0.67		

pi/2 BPSK voice 31.25kHz bandwidth:

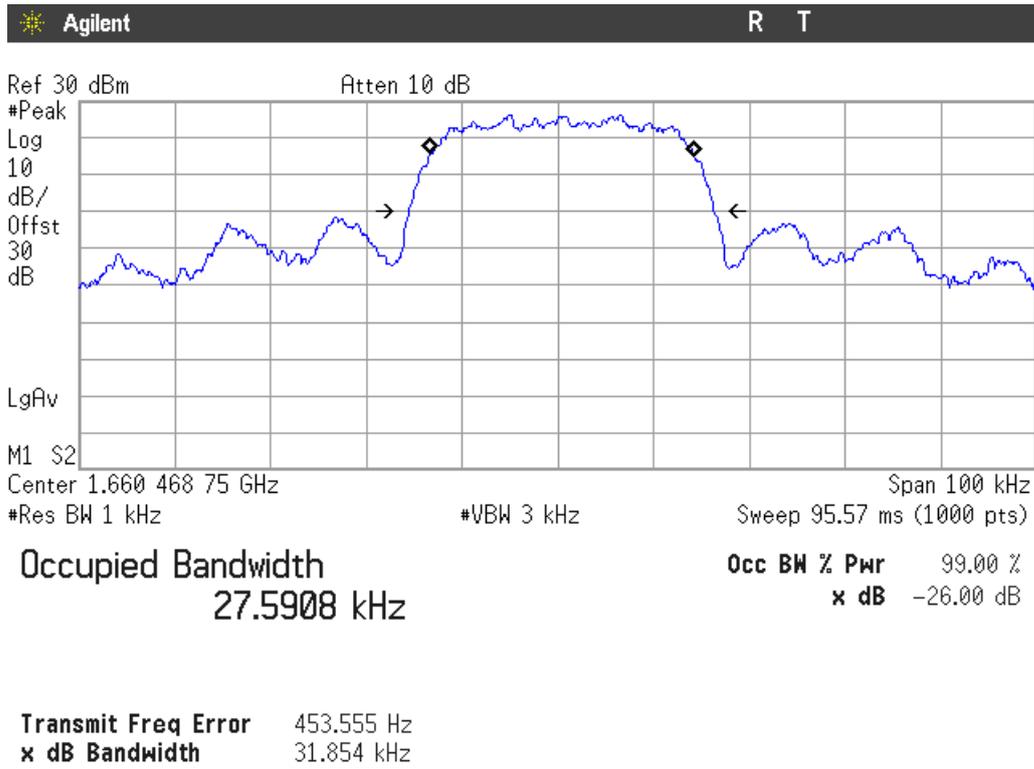
Lowest Channel



Middle Channel

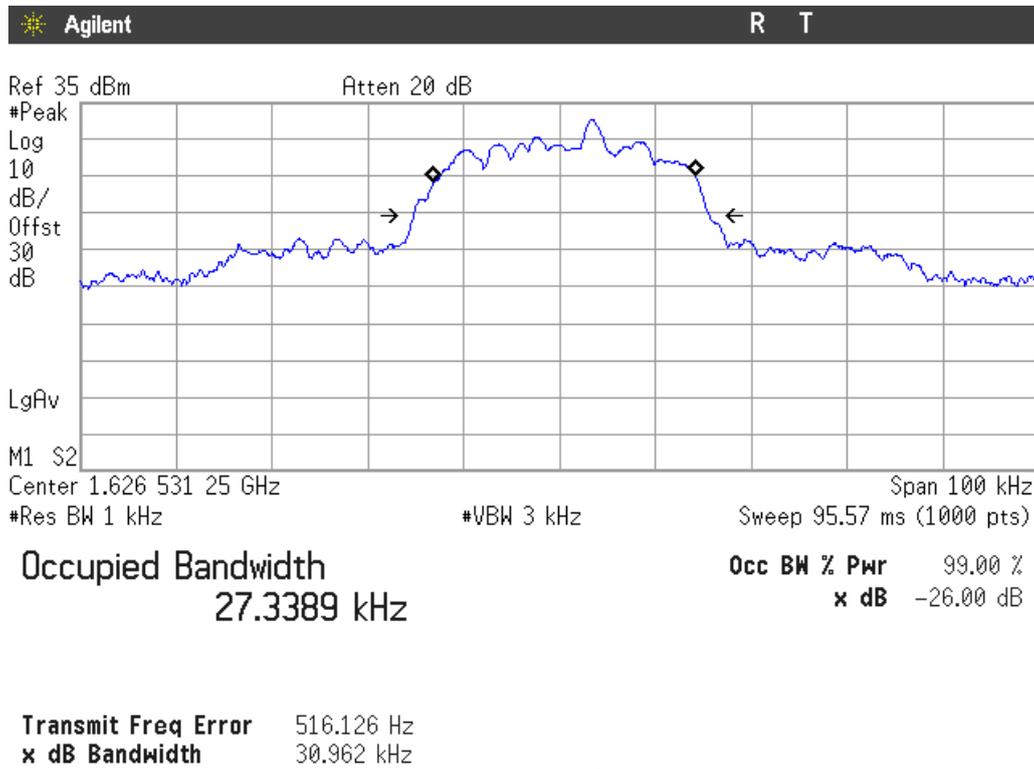


Highest channel

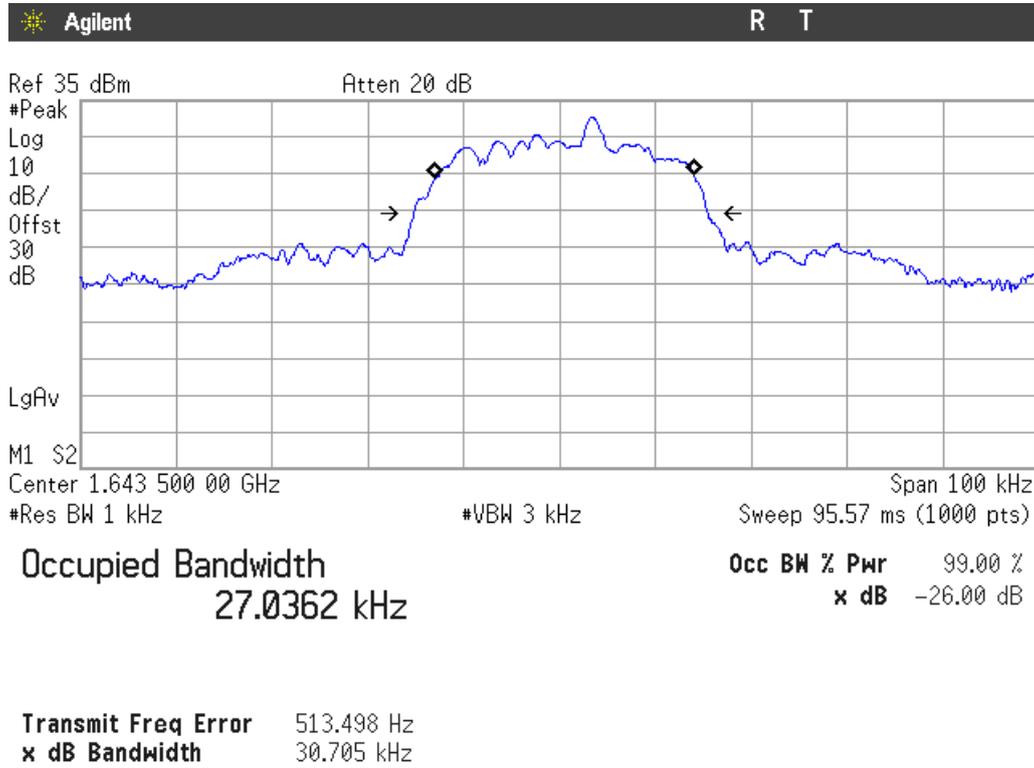


pi/4 QPSK packet data 31.25kHz bandwidth:

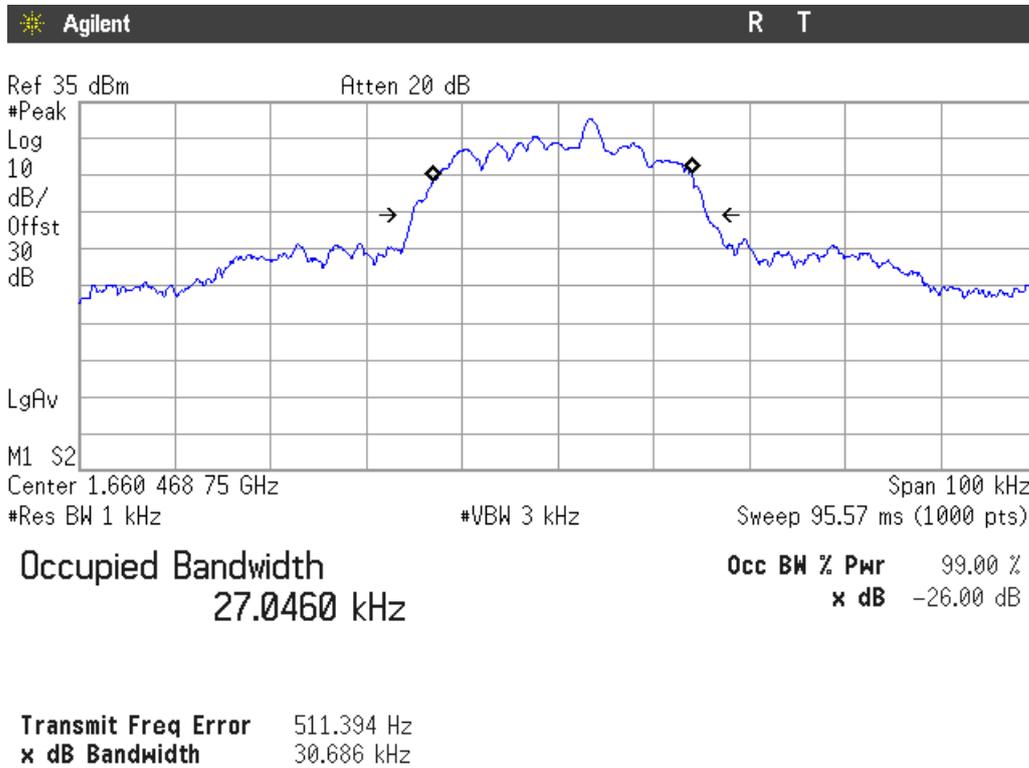
Lowest Channel



Middle Channel

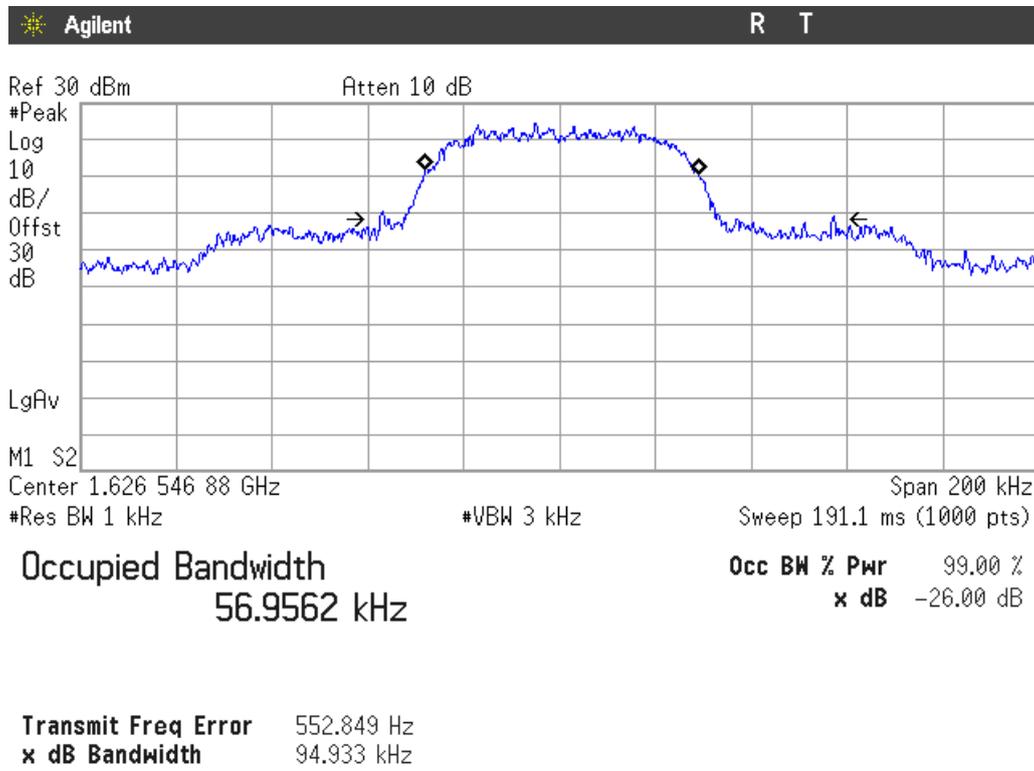


Highest channel

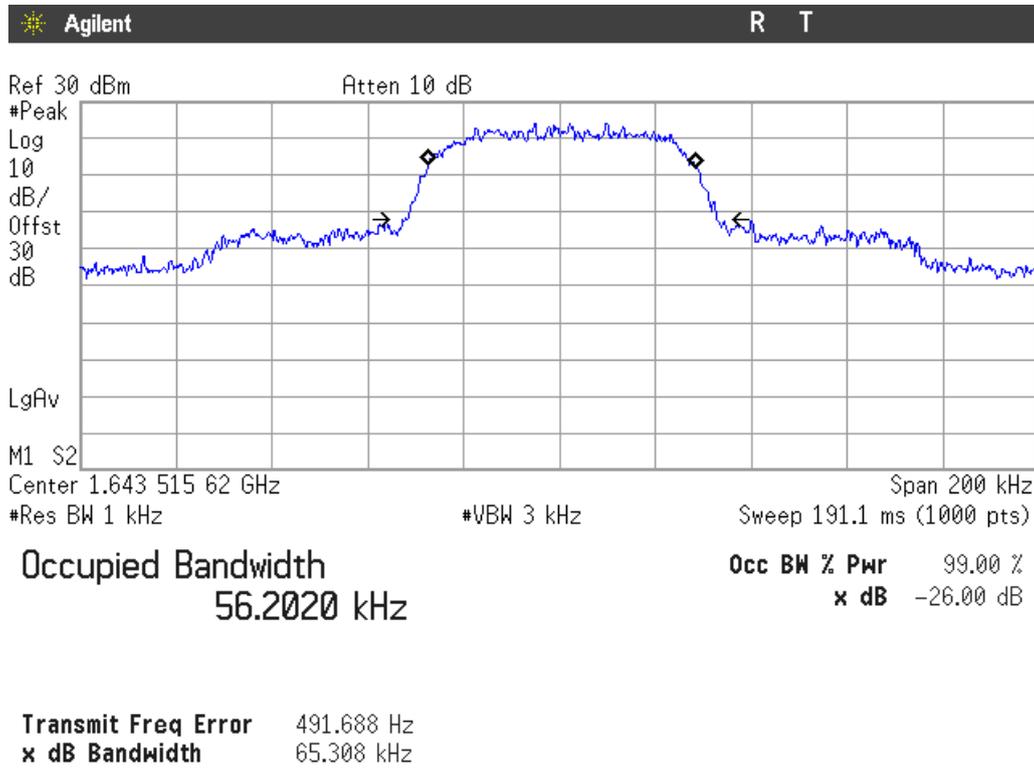


pi/4 QPSK packet data 62.5kHz bandwidth:

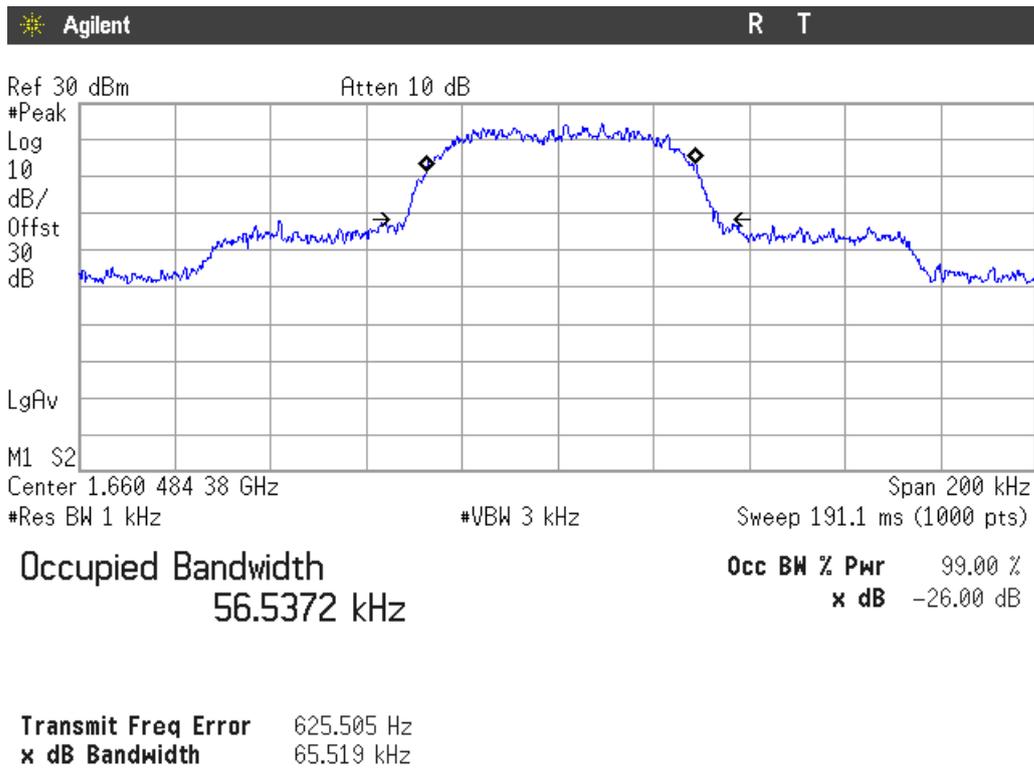
Lowest Channel



Middle Channel

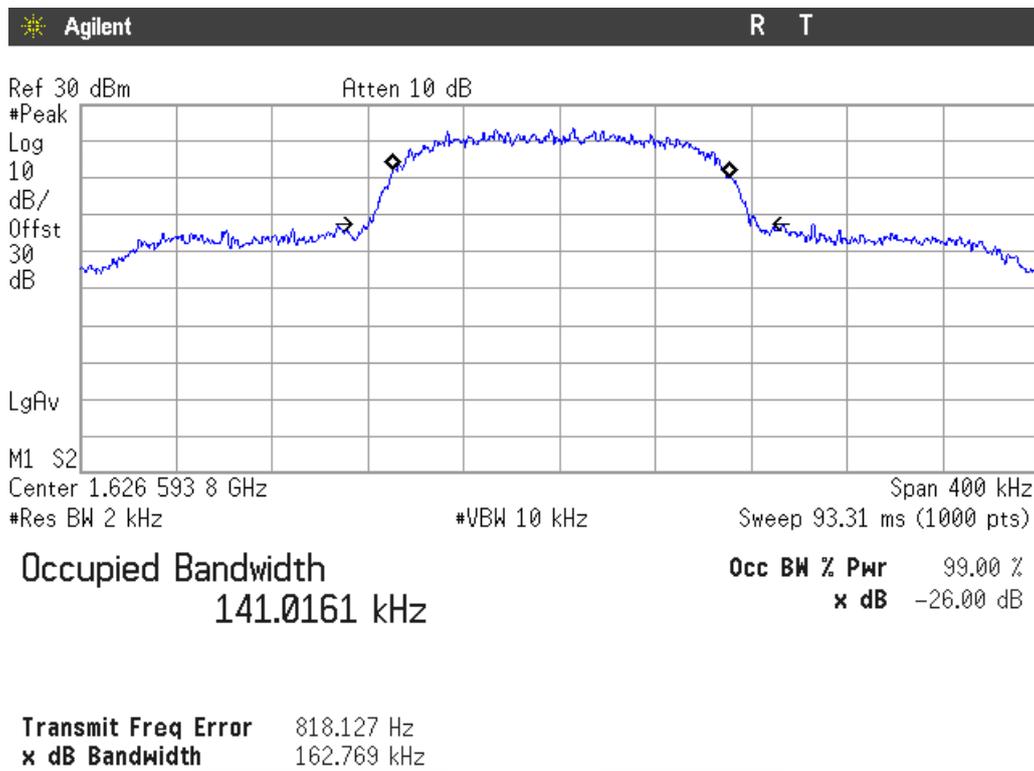


Highest channel

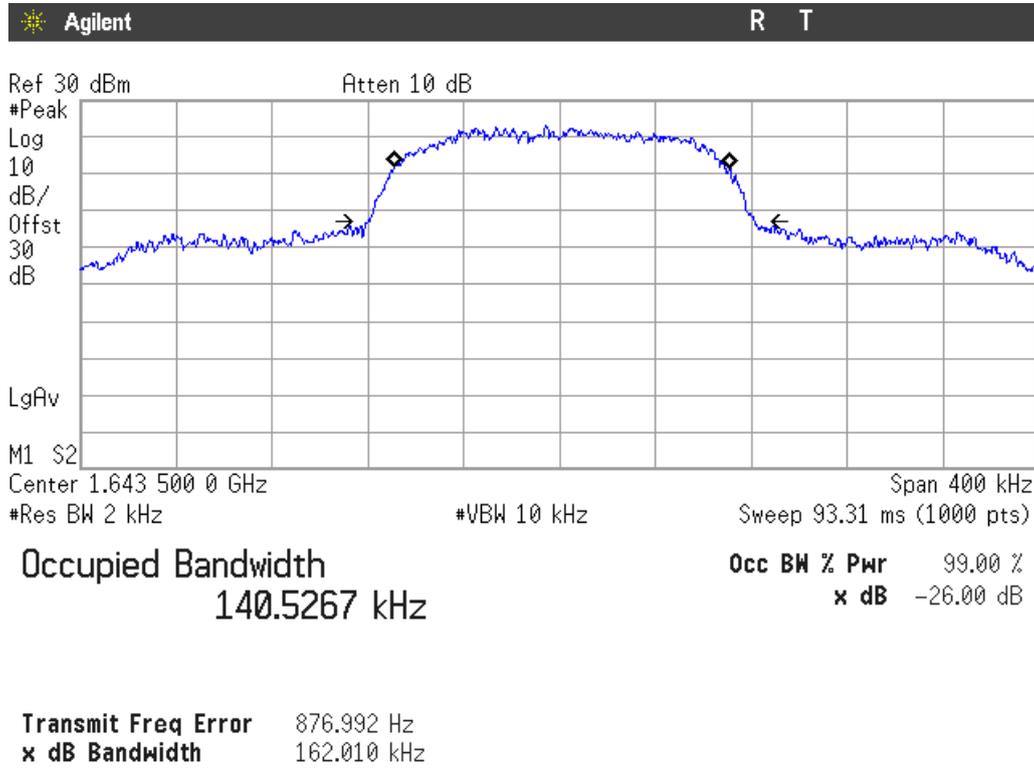


pi/4 QPSK packet data 156.25kHz bandwidth:

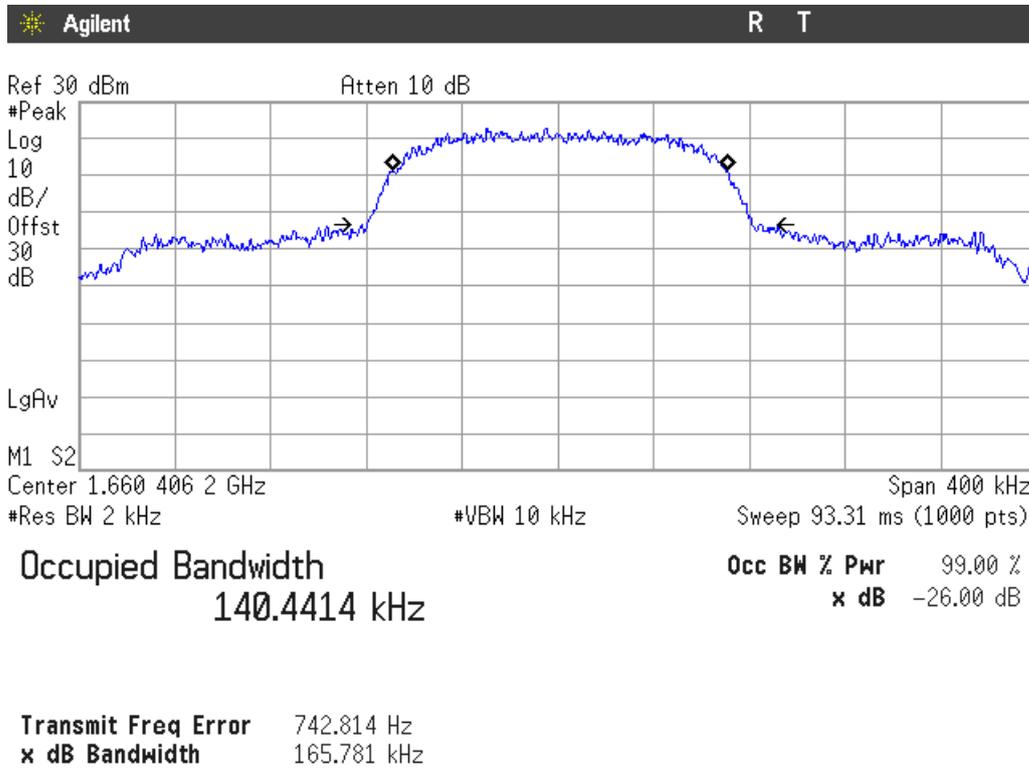
Lowest Channel



Middle Channel



Highest channel



FCC 25.202 Subclause (d) / Frequency tolerance, Earth stations.

SPECIFICATION

§25.202 (d).

The carrier frequency of each earth station transmitter authorized in these services shall be maintained within 0.001 percent of the reference frequency.

METHOD

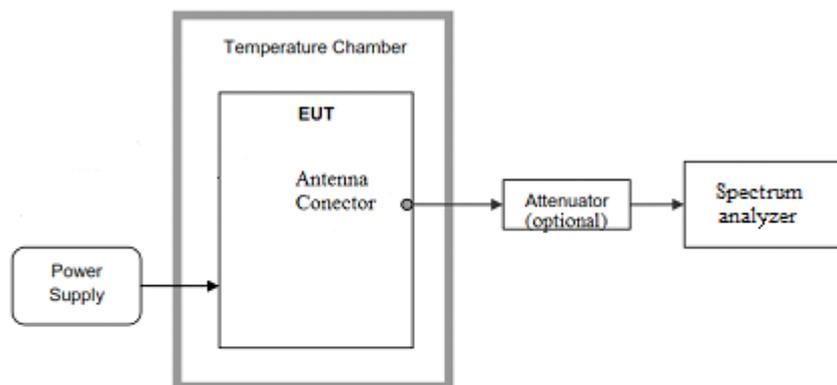
The frequency tolerance measurements over temperature variations were made over the temperature range of -30°C to $+50^{\circ}\text{C}$. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10°C steps from -30°C up to $+50^{\circ}\text{C}$.

The supply voltage was varied between the extreme voltages declared by the applicant.

The EUT was set in continuous transmission with modulation (BPSK and QPSK), in the middle channel and the maximum frequency error was measured using a spectrum analyser.

The DC supply voltage is applied using an external calibrated power supply.

TEST SETUP



RESULTS

pi/2 BPSK voice 31.25kHz bandwidth:

Nominal frequency: 1643.5 MHz

Frequency stability over temperature variations.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)	Frequency Error (%)
+50	893.169	0.54346	0.00005435
+40	722.073	0.43935	0.00004393
+30	610.139	0.37124	0.00003712
+20	567.646	0.34539	0.00003454
+10	579.879	0.35283	0.00003528
0	330.574	0.20114	0.00002011
-10	166.627	0.10139	0.00001014
-20	373.725	0.22740	0.00002274
-30	406.642	0.24742	0.00002474

Frequency stability over voltage variations.

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)	Frequency Error (%)
Vmax	4.2	653.178	0.39743	0.00003974
Vmin	3.8	567.646	0.34539	0.00003454

pi/4 QPSK packet data 62.5kHz bandwidth:

Nominal frequency: 1643.515625 MHz

Frequency stability over temperature variations.

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)	Frequency Error (%)
+50	1292	0.78612	0.00007861
+40	719.307	0.43766	0.00004377
+30	720.358	0.43830	0.00004383
+20	541.063	0.32921	0.00003292
+10	462.536	0.28143	0.00002814
0	518.261	0.31534	0.00003153
-10	117.389	0.07143	0.00000714
-20	169.125	0.10290	0.00001029
-30	399.085	0.24282	0.00002428

Frequency stability over voltage variations.

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)	Frequency Error (%)
Vmax	4.2	581.117	0.35358	0.00003536
Vmin	3.8	541.063	0.32921	0.00003292

Measurement uncertainty	$< \pm 1 \times 10^{-6}$
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Verdict: PASS

FCC 25.204 Subclause (a) / Power Limits for earth stations (radiated e.i.r.p.).

SPECIFICATION

§25.204 (a)

In bands shared coequally with terrestrial radio communication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station, other than an ESV, operating in frequency bands between 1 and 15 GHz, shall not exceed the following limits except as provided for in paragraph (c) of this section:

+40 dBW (70 dBm) in any 4 kHz band for $\theta \leq 0^\circ$
+40 + 3 θ dBW in any 4 kHz band for $0^\circ < \theta \leq 5^\circ$

where θ is the angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

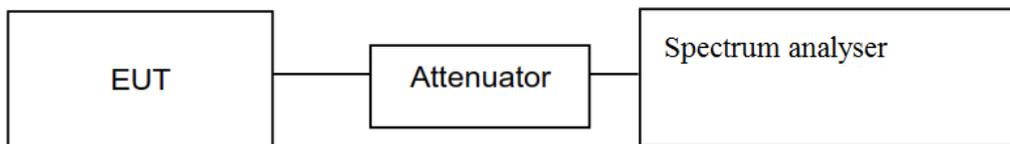
(c) For angles of elevation of the horizon greater than 5° there shall be no restriction as to the equivalent isotropically radiated power transmitted by an earth station towards the horizon.

METHOD

The EUT RF output connector was connected to a spectrum analyser using a 50 ohm attenuator and it is set in continuous transmission with different modes of modulation and nominal bandwidths.

The maximum equivalent isotropically radiated power e.i.r.p. is calculated by adding the declared maximum antenna gain (dBi respectively).

TEST SETUP



RESULTS

MAXIMUM OUTPUT POWER IN 4 kHz. See next plots.

Declared maximum antenna gain: -0.7 dBi.

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

pi/2 BPSK voice 31.25kHz bandwidth:

	Lowest frequency 1626.53125 MHz	Middle frequency 1643.5 MHz	Highest frequency 1660.46875 MHz
Maximum peak power (dBm)	25.89	26.32	25.99
Maximum EIRP power (dBm)	25.19	25.62	25.29
Measurement uncertainty (dB)	<± 0.66		

pi/4 QPSK packet data 31.25kHz bandwidth:

	Lowest frequency 1626.53125 MHz	Middle frequency 1643.5 MHz	Highest frequency 1660.46875 MHz
Maximum peak power (dBm)	27.31	27.31	27.86
Maximum EIRP power (dBm)	26.61	26.61	27.16
Measurement uncertainty (dB)	<± 0.66		

pi/4 QPSK packet data 62.5kHz bandwidth:

	Lowest frequency 1626.546875 MHz	Middle frequency 1643.515625 MHz	Highest frequency 1660.484375 MHz
Maximum peak power (dBm)	21.55	22.84	22.03
Maximum EIRP power (dBm)	20.85	22.14	21.33
Measurement uncertainty (dB)	<± 0.66		

pi/4 QPSK packet data 156.25kHz bandwidth:

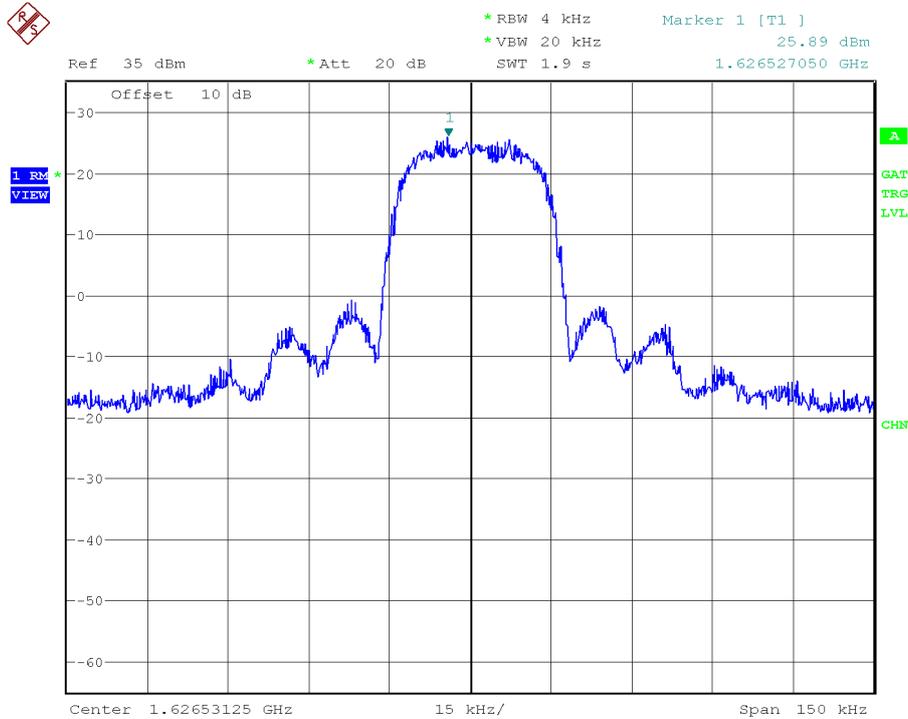
	Lowest frequency 1626.59375 MHz	Middle frequency 1643.5 MHz	Highest frequency 1660.40625 MHz
Maximum peak power (dBm)	17.02	17.23	17.55
Maximum EIRP power (dBm)	16.32	16.53	16.85
Measurement uncertainty (dB)	<± 0.66		

Verdict: PASS

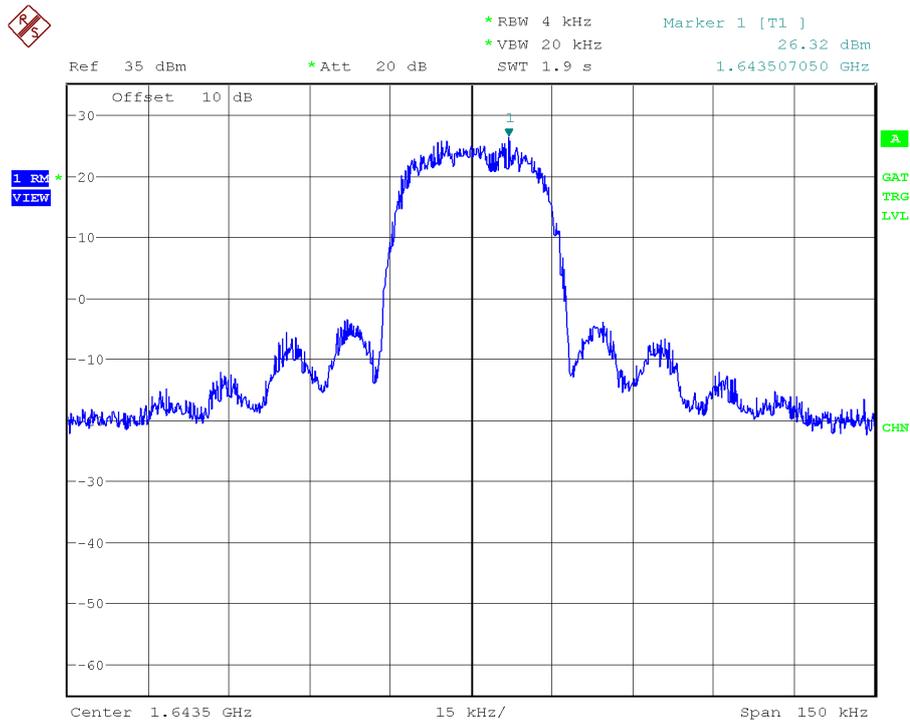
OUTPUT POWER (CONDUCTED).

pi/2 BPSK voice 31.25kHz bandwidth:

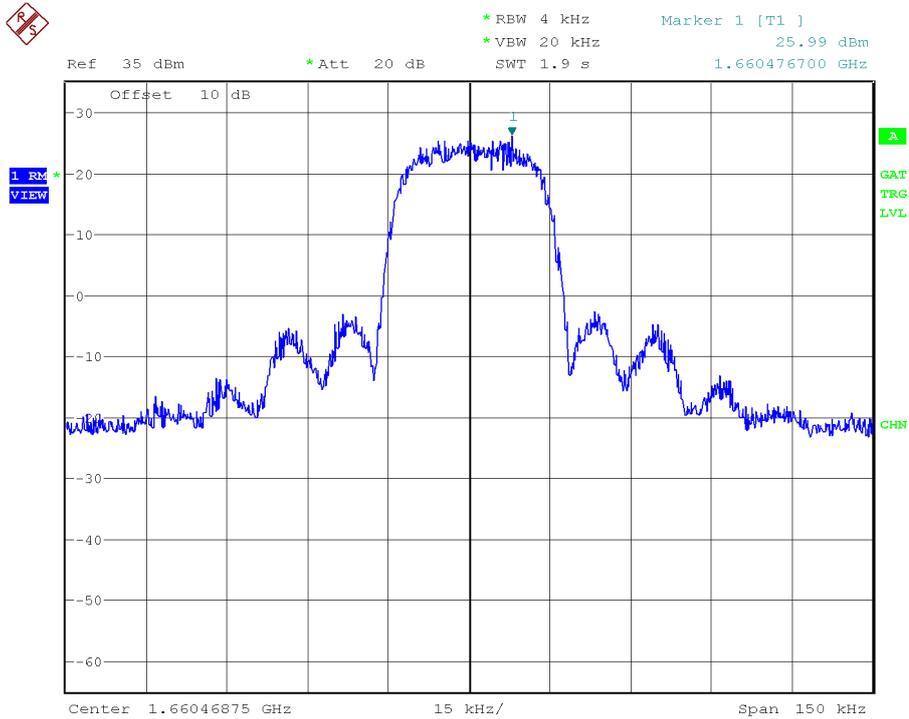
Lowest Channel



Middle Channel

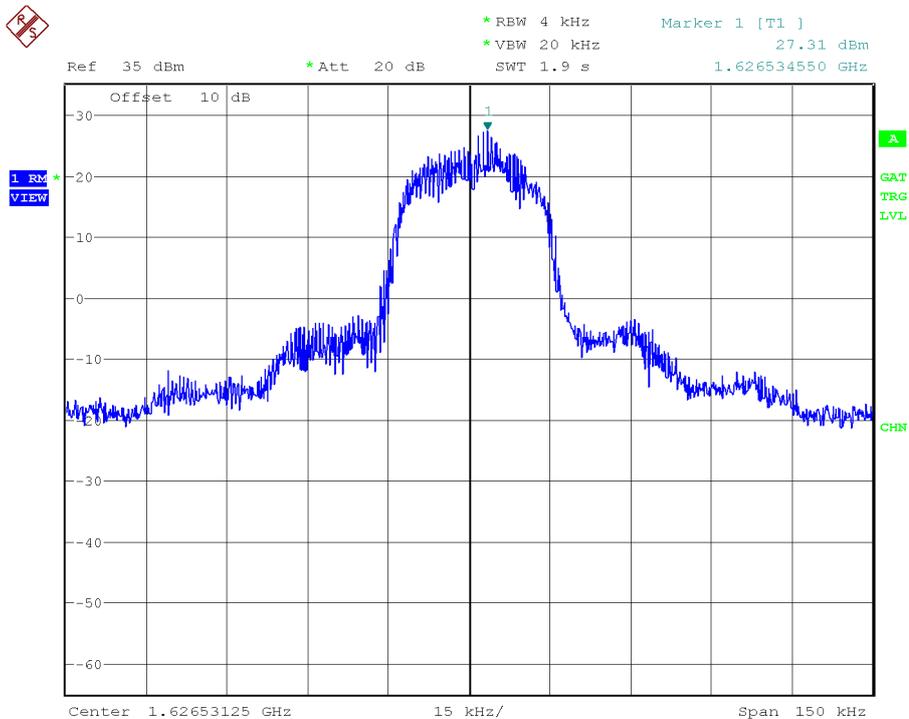


Highest Channel

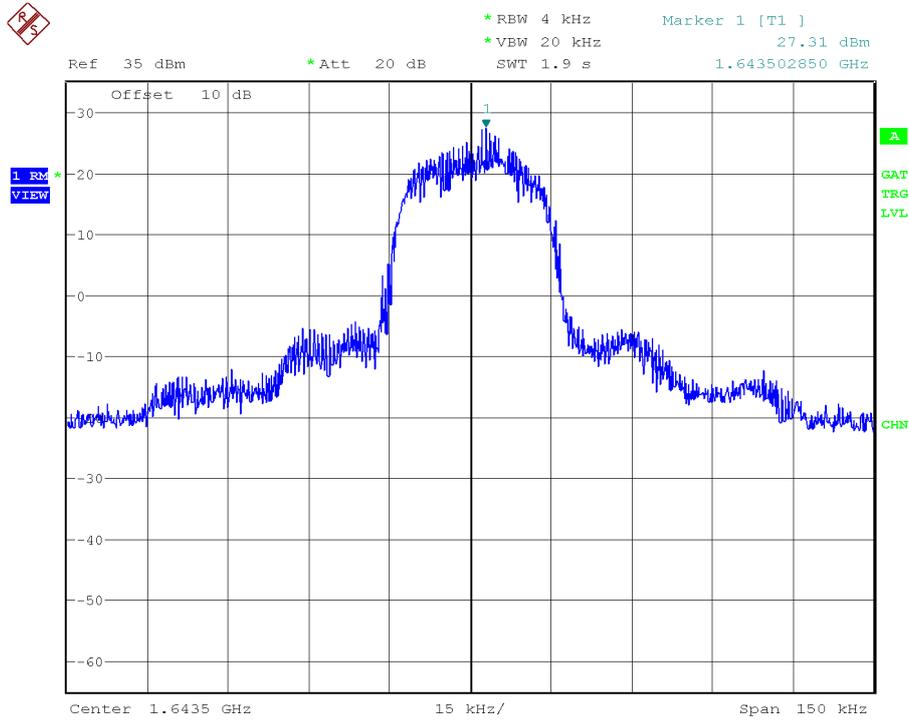


pi/4 QPSK packet data 31.25kHz bandwidth:

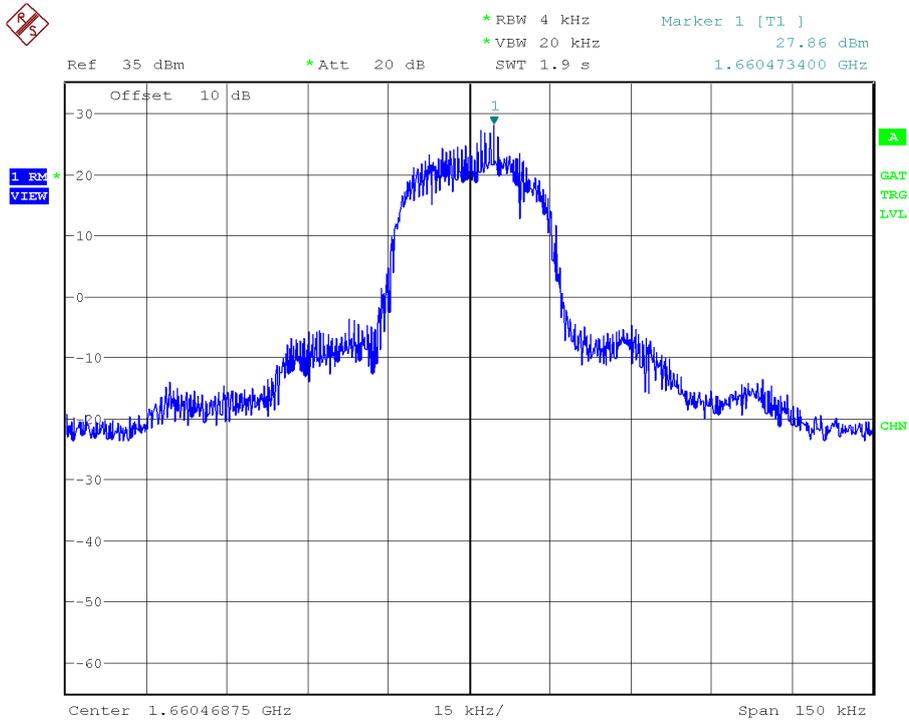
Lowest Channel



Middle Channel

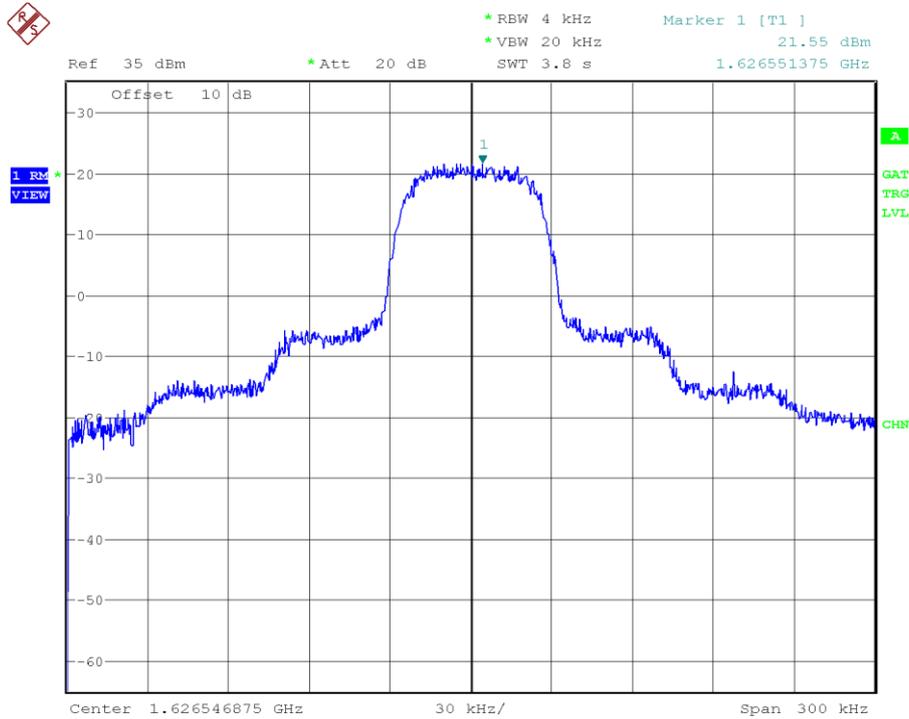


Highest Channel

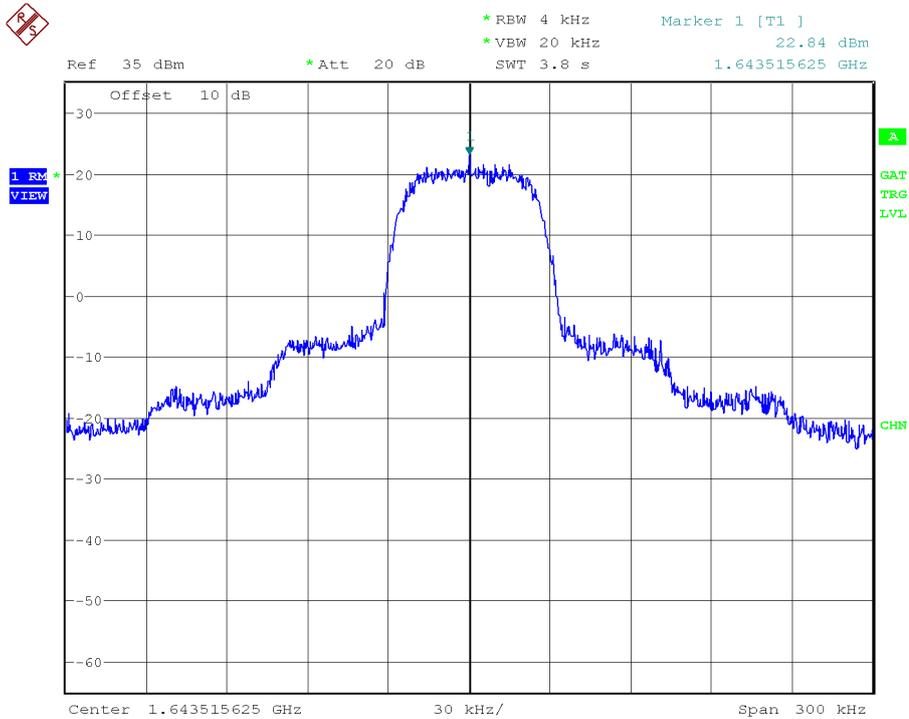


pi/4 QPSK packet data 62.5kHz bandwidth:

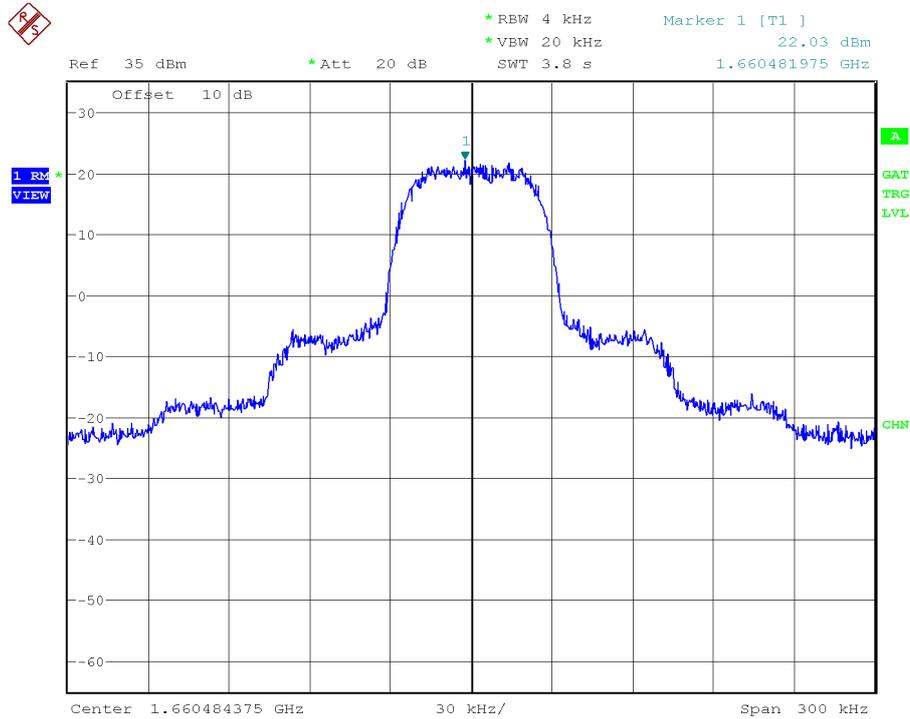
Lowest Channel



Middle Channel

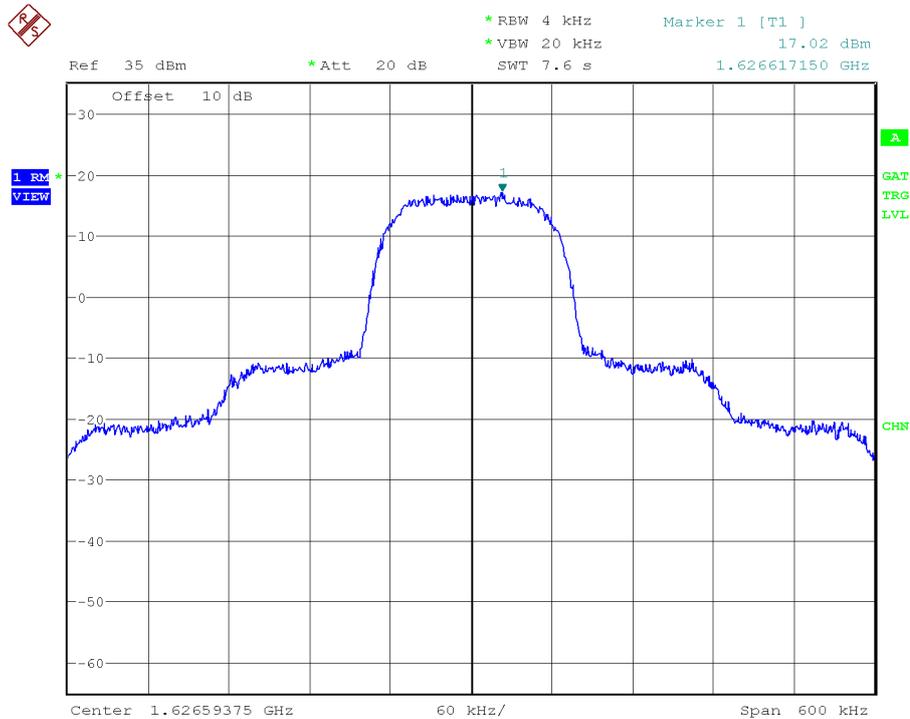


Highest Channel

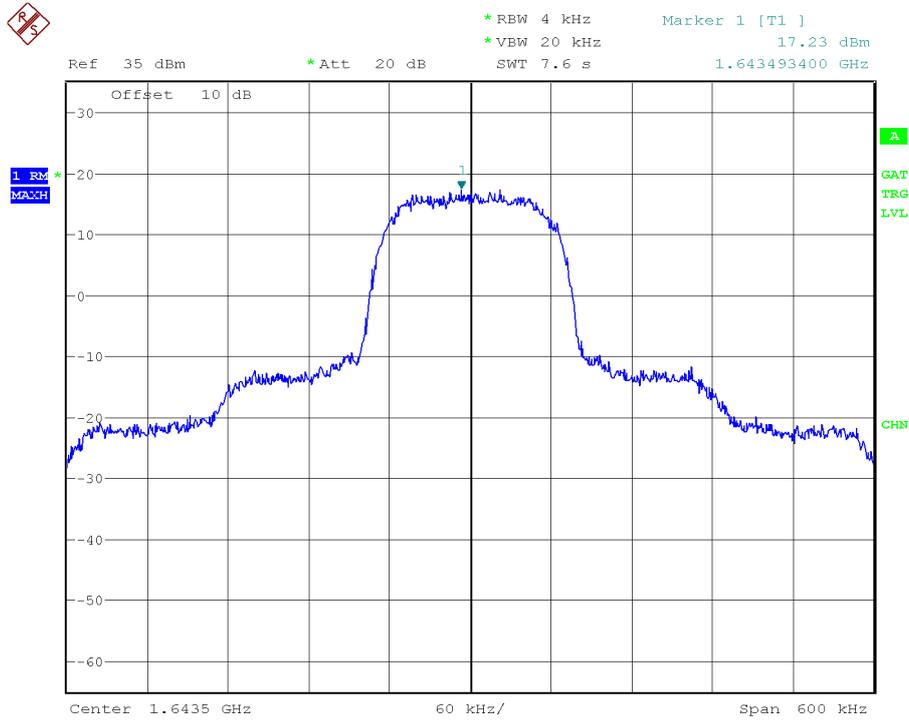


pi/4 QPSK packet data 156.25kHz bandwidth:

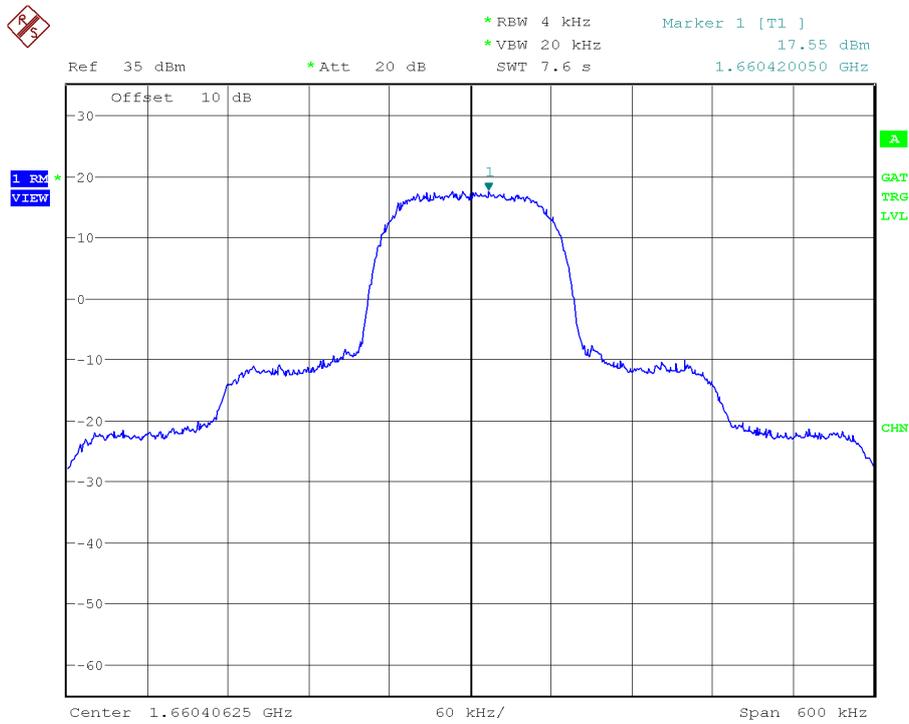
Lowest Channel



Middle Channel



Highest Channel



FCC 25.202 Subclause (f) / Emission limitations. Emission mask.

SPECIFICATION

§2.1051 and §25.202 (f).

METHOD

The EUT RF output connector was connected to a spectrum analyser using a 50 ohm attenuator and it is set in continuous transmission with different modes of modulation and nominal bandwidths.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

The emission masks were measured using the built-in spectrum mask measurement function of the spectrum analyser.

Measurement Limit:

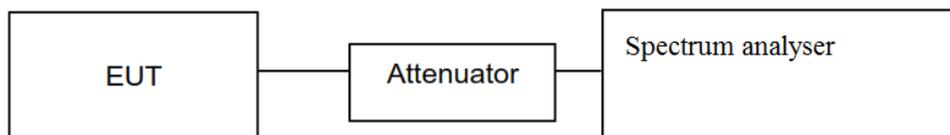
The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

- (1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;
- (2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;
- (3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts;

At P_o transmitting power, the specified minimum attenuation becomes $43+10\log(P_o)$, and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log (P_o \text{ in mwatts}) - 30] = - 13 \text{ dBm}$$

TEST SETUP



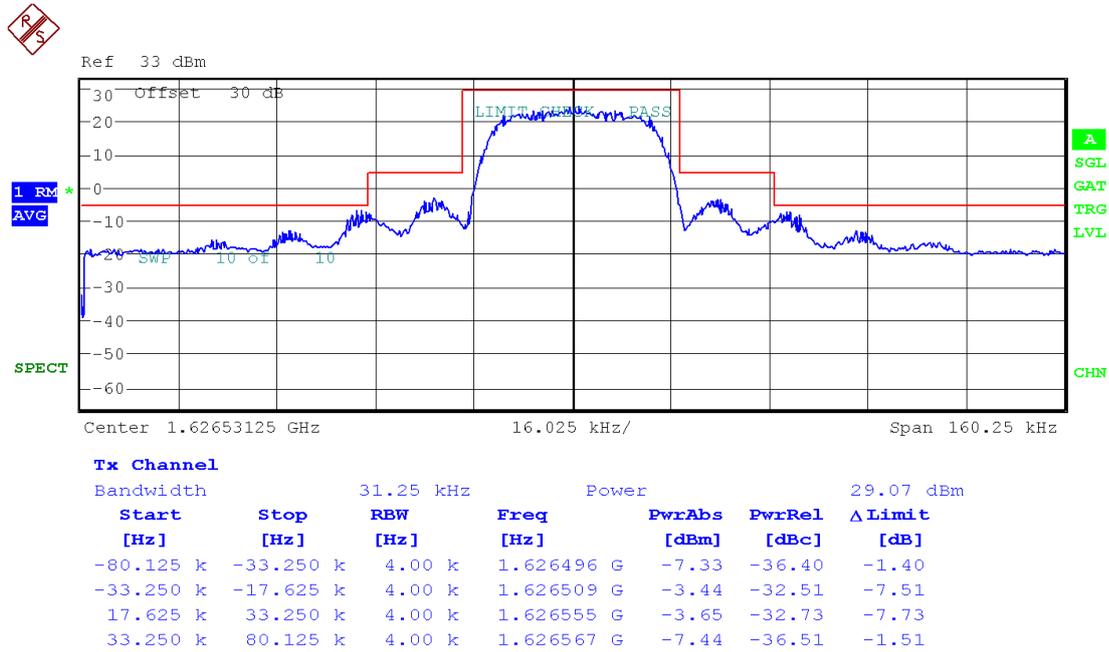
RESULTS (see plots in next pages)

Measurement uncertainty (dB)	<±0.66
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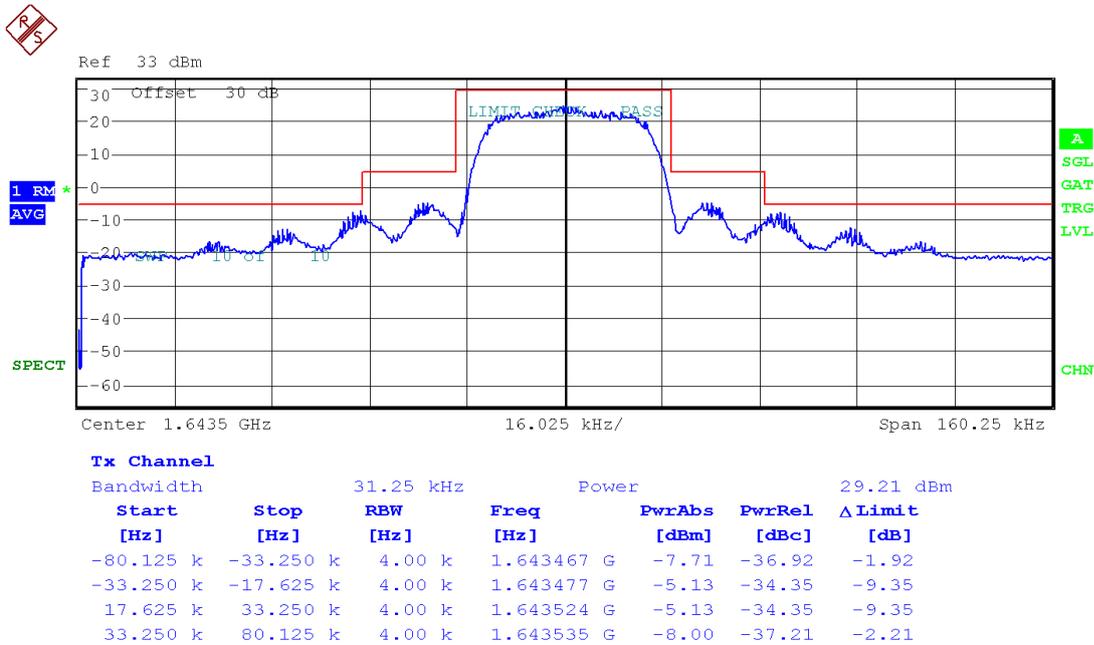
Verdict: PASS

pi/2 BPSK voice 31.25kHz bandwidth:

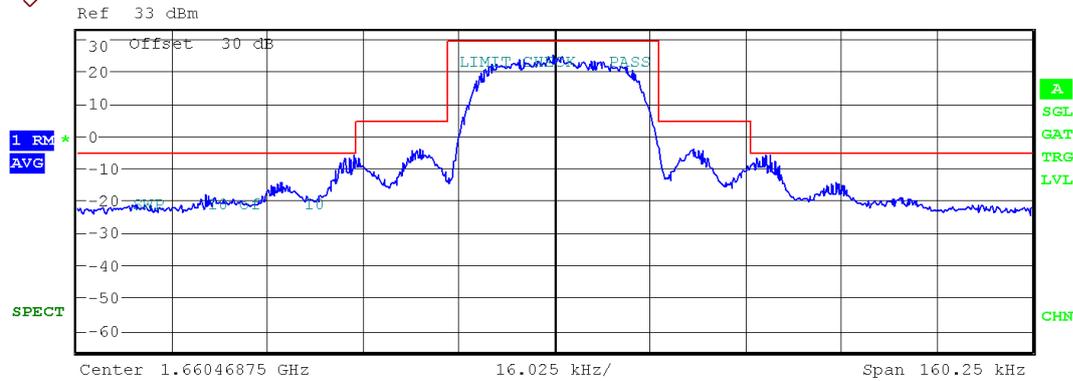
Lowest Channel



Middle Channel



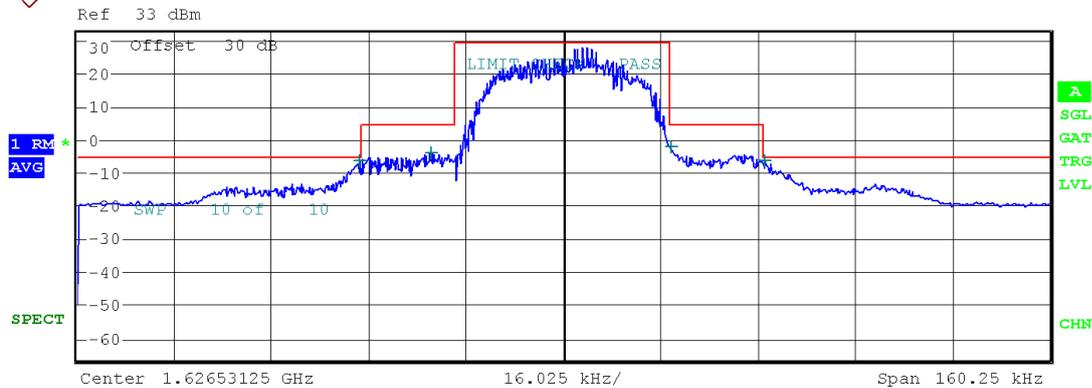
Highest channel



Tx Channel							
Bandwidth			Power		29.20 dBm		
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	PwrRel [dBc]	ΔLimit [dB]	
-80.125 k	-33.250 k	4.00 k	1.660435 G	-6.35	-35.56	-0.56	
-33.250 k	-17.625 k	4.00 k	1.660446 G	-4.38	-33.59	-8.59	
17.625 k	33.250 k	4.00 k	1.660487 G	-4.19	-33.40	-8.40	
33.250 k	80.125 k	4.00 k	1.660504 G	-5.99	-35.19	-0.19	

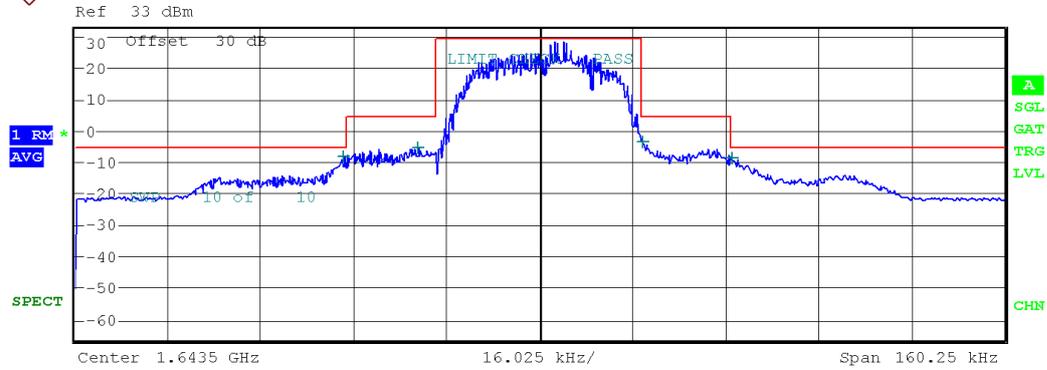
pi/4 QPSK packet data 31.25kHz bandwidth:

Lowest Channel



Tx Channel							
Bandwidth			Power		29.07 dBm		
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	PwrRel [dBc]	ΔLimit [dB]	
-80.125 k	-33.250 k	4.00 k	1.626498 G	-6.78	-35.85	-0.85	
-33.250 k	-17.625 k	4.00 k	1.626510 G	-4.16	-33.23	-8.23	
17.625 k	33.250 k	4.00 k	1.626549 G	-2.62	-31.69	-6.69	
33.250 k	80.125 k	4.00 k	1.626565 G	-6.66	-35.73	-0.73	

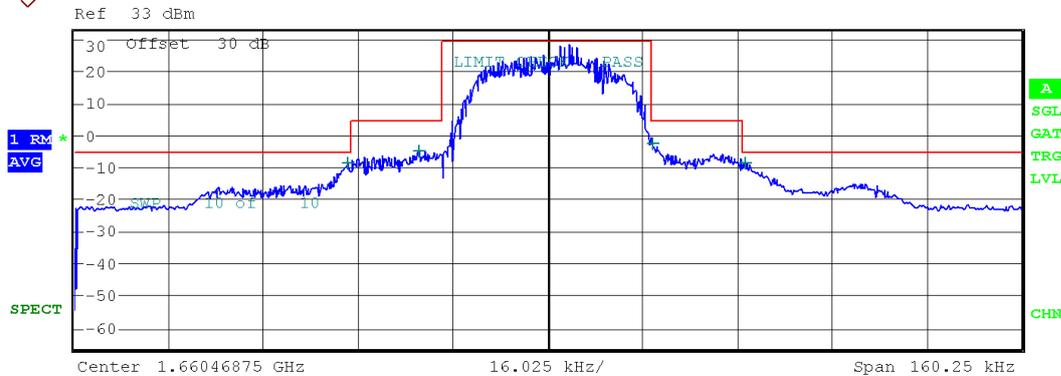
Middle Channel



Tx Channel

Bandwidth		31.25 kHz	Power		29.17 dBm	
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	PwrRel [dBc]	Δ Limit [dB]
-80.125 k	-33.250 k	4.00 k	1.643466 G	-8.50	-37.67	-2.67
-33.250 k	-17.625 k	4.00 k	1.643479 G	-5.89	-35.06	-10.06
17.625 k	33.250 k	4.00 k	1.643518 G	-3.68	-32.86	-7.86
33.250 k	80.125 k	4.00 k	1.643533 G	-9.06	-38.24	-3.24

Highest channel

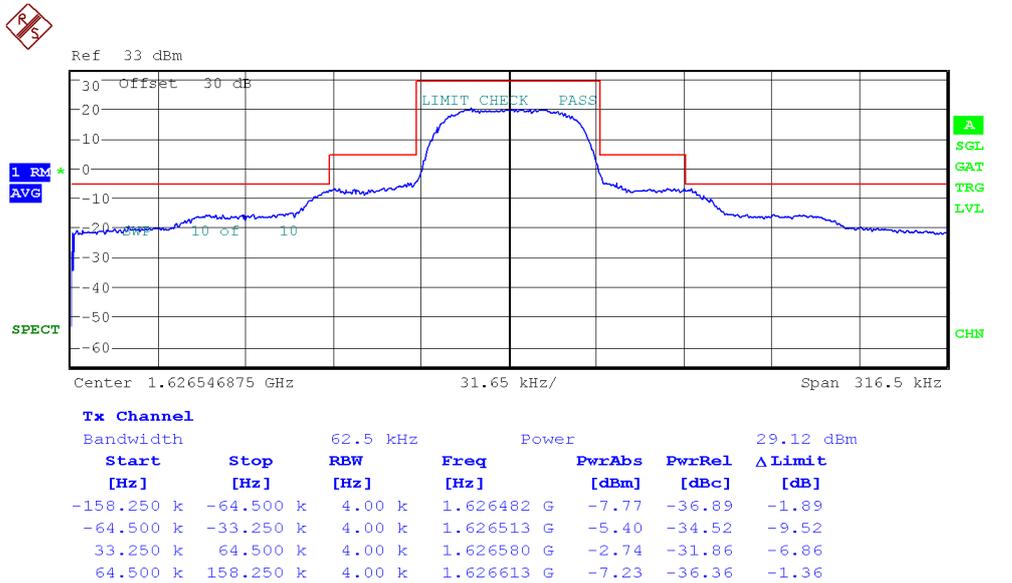


Tx Channel

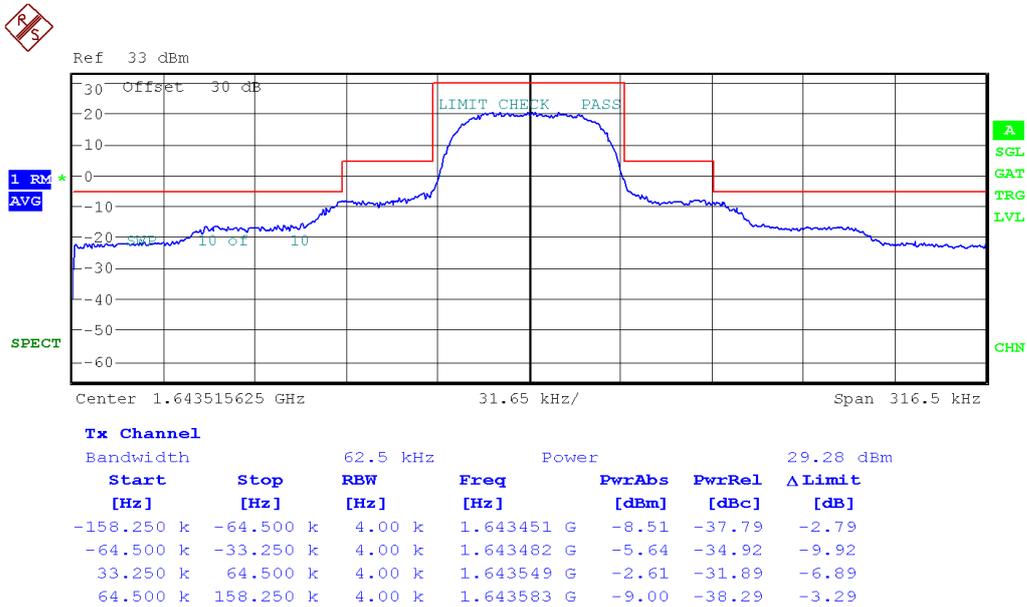
Bandwidth		31.25 kHz	Power		29.09 dBm	
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	PwrRel [dBc]	Δ Limit [dB]
-80.125 k	-33.250 k	4.00 k	1.660435 G	-9.11	-38.20	-3.20
-33.250 k	-17.625 k	4.00 k	1.660447 G	-5.13	-34.22	-9.22
17.625 k	33.250 k	4.00 k	1.660487 G	-2.93	-32.02	-7.02
33.250 k	80.125 k	4.00 k	1.660502 G	-9.13	-38.22	-3.22

pi/4 QPSK packet data 62.5kHz bandwidth:

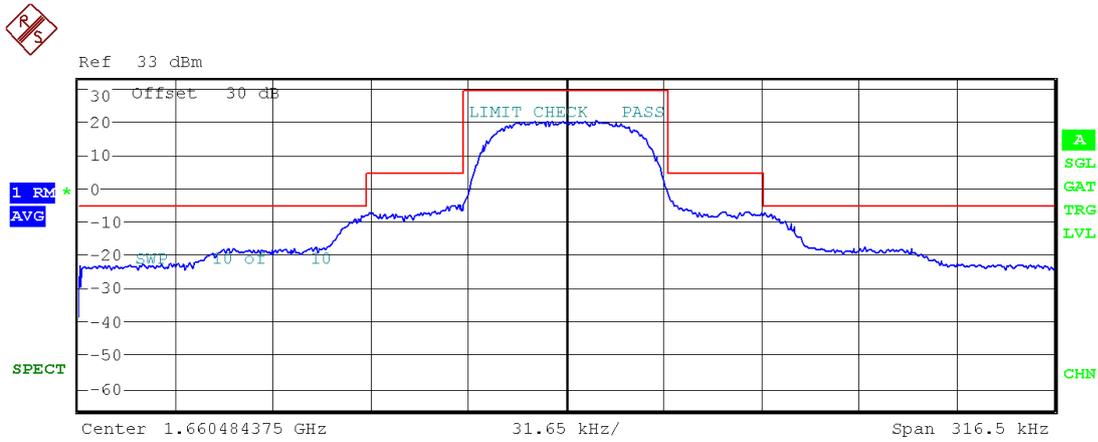
Lowest Channel



Middle Channel



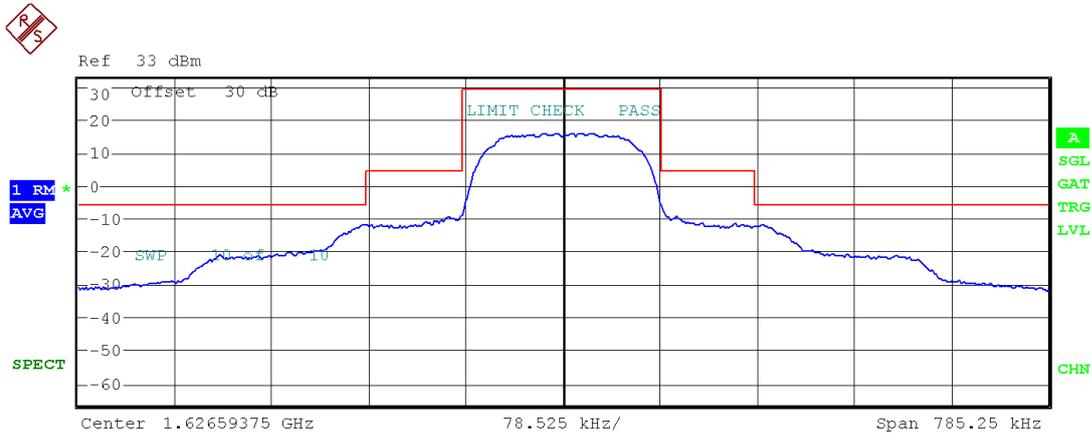
Highest channel



Tx Channel			Bandwidth	62.5 kHz	Power	29.21 dBm
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	PwrRel [dBc]	Δ Limit [dB]
-158.250 k	-64.500 k	4.00 k	1.660419 G	-8.41	-37.62	-2.62
-64.500 k	-33.250 k	4.00 k	1.660451 G	-5.04	-34.25	-9.25
33.250 k	64.500 k	4.00 k	1.660518 G	-2.57	-31.78	-6.78
64.500 k	158.250 k	4.00 k	1.660551 G	-7.91	-37.12	-2.12

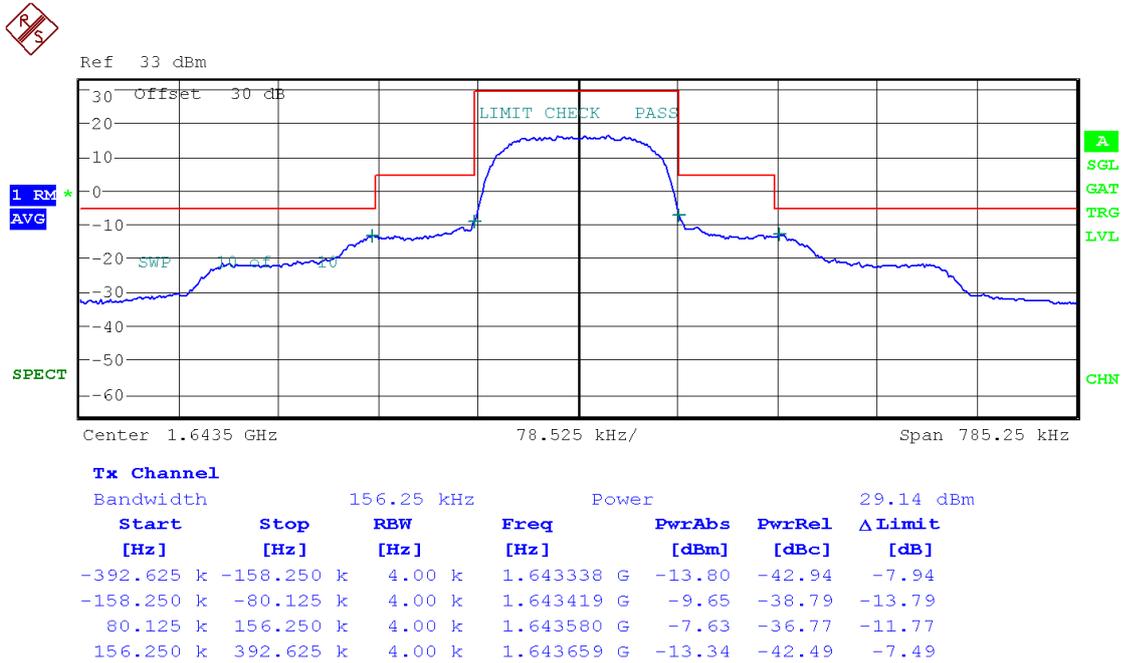
pi/4 QPSK packet data 156.25kHz bandwidth:

Lowest Channel

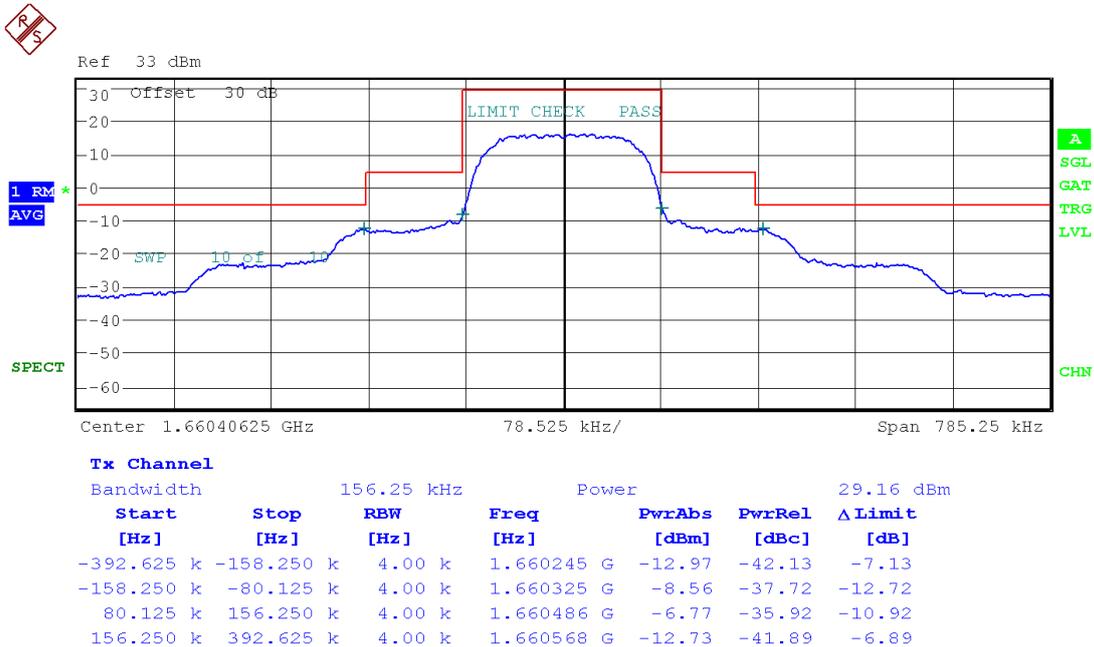


Tx Channel			Bandwidth	156.25 kHz	Power	29.02 dBm
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	PwrRel [dBc]	Δ Limit [dB]
-392.625 k	-158.250 k	4.00 k	1.626432 G	-12.19	-41.21	-6.21
-158.250 k	-80.125 k	4.00 k	1.626513 G	-8.61	-37.64	-12.64
80.125 k	156.250 k	4.00 k	1.626674 G	-6.82	-35.85	-10.85
156.250 k	392.625 k	4.00 k	1.626756 G	-11.91	-40.94	-5.94

Middle Channel



Highest channel



FCC 25.202 Subclause (f) / Emission limitations. Spurious emissions at antenna terminals.

SPECIFICATION

§2.1051 and §25.202 (f).

METHOD

The EUT RF output connector was connected to a spectrum analyser using a 50 ohm attenuator and it is set in continuous transmission with different modes of modulation and nominal bandwidths. The spectrum was investigated from 9 kHz to 18 GHz using a resolution bandwidth (RBW) of 100 kHz.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

Each emission detected is re-measured using a resolution bandwidth of 4 kHz to compare with the limit.

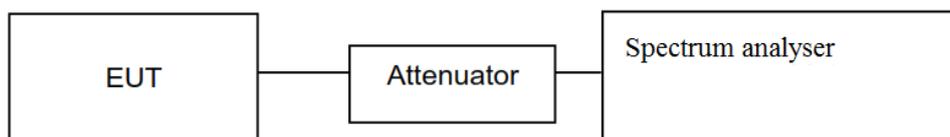
Measurement Limit:

According to specification, in any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts.

At P_o transmitting power, the specified minimum attenuation becomes $43+10\log(P_o)$, and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log(P_o \text{ in mwatts}) - 30] = -13 \text{ dBm}$$

TEST SETUP



RESULTS (see plots in next pages)

pi/2 BPSK voice 31.25kHz bandwidth:

Lowest Channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.2524	-19.43	< ± 2.33

Middle Channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.2875	-22.86	< ± 2.33

Highest channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.3205	-24.44	< ± 2.33

pi/4 QPSK packet data 31.25kHz bandwidth:

Lowest Channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.2524	-19.25	< ± 2.33

Middle Channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.2875	-21.46	< ± 2.33

Highest channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.3205	-24.28	< ± 2.33

pi/4 QPSK packet data 62.5kHz bandwidth:

Lowest Channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.2524	-21.52	< ± 2.33

Middle Channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.2875	-23.16	< ± 2.33

Highest channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.3205	-25.79	< ± 2.33

pi/4 QPSK packet data 156.25kHz bandwidth:

Lowest Channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.2524	-20.88	< ± 2.33

Middle Channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.2875	-23.61	< ± 2.33

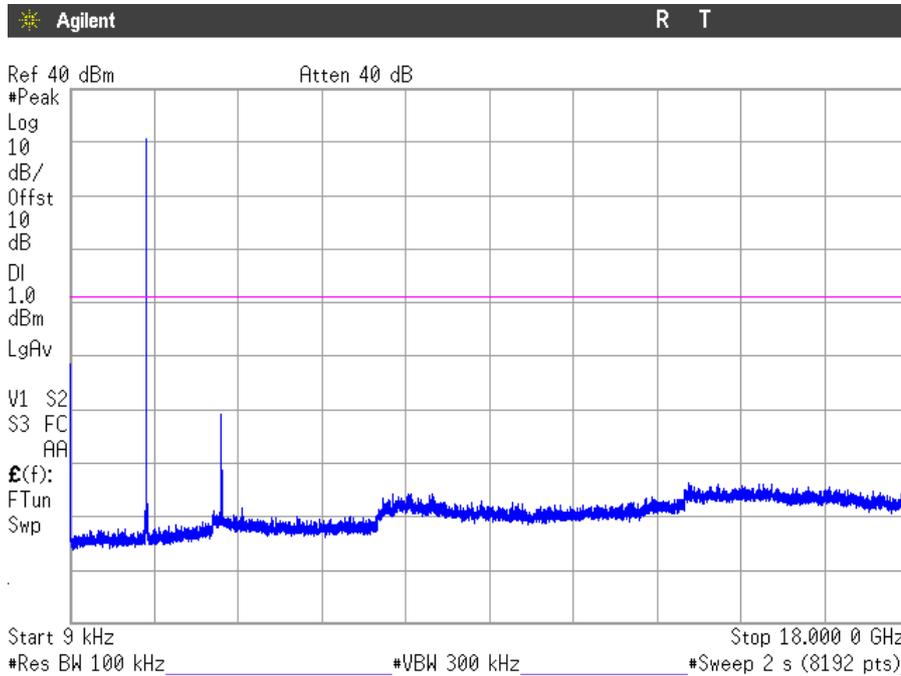
Highest channel

Spurious frequency (GHz)	Level (dBm)	Measurement uncertainty (dB)
3.3205	-24.57	< ± 2.33

Verdict: PASS

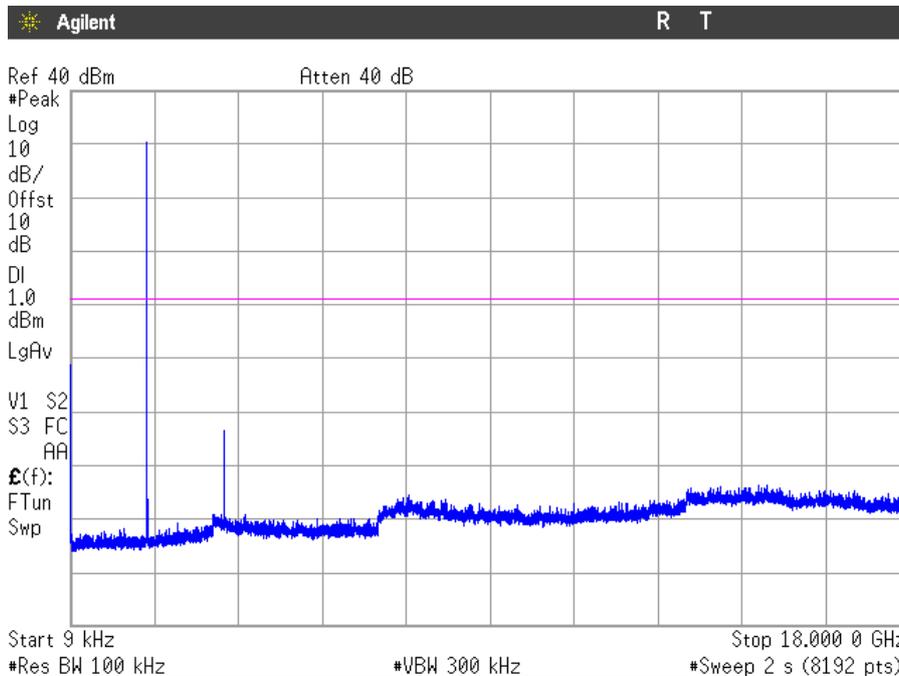
pi/2 BPSK voice 31.25kHz bandwidth:

Lowest Channel



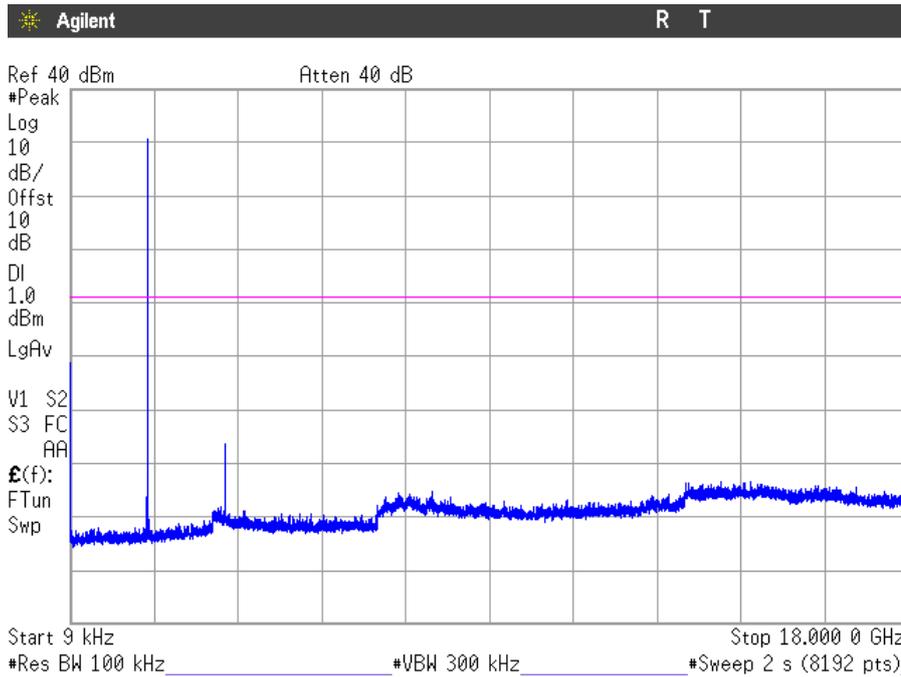
Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

Middle Channel



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

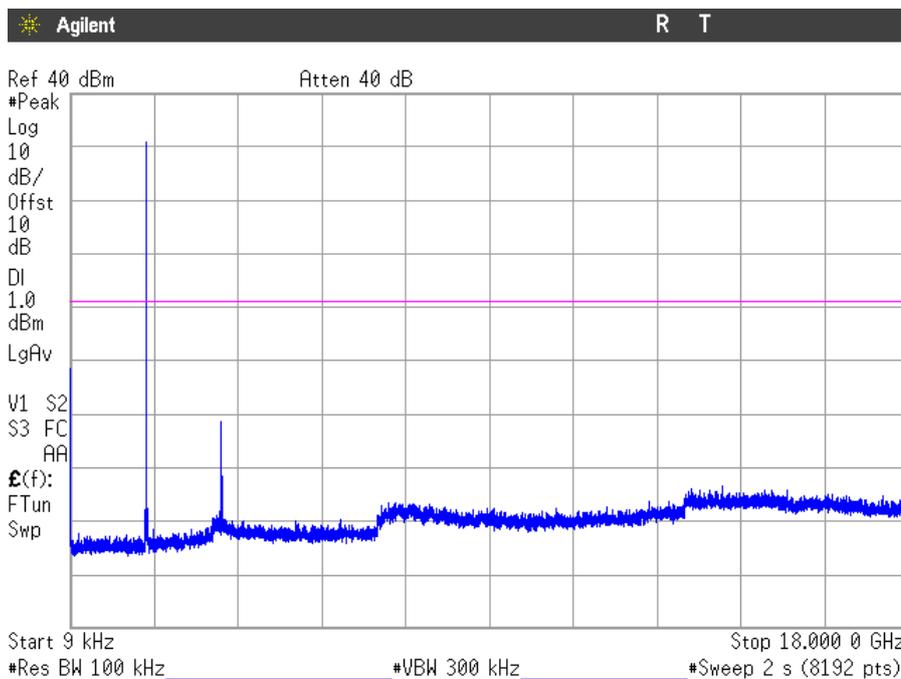
Highest channel



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

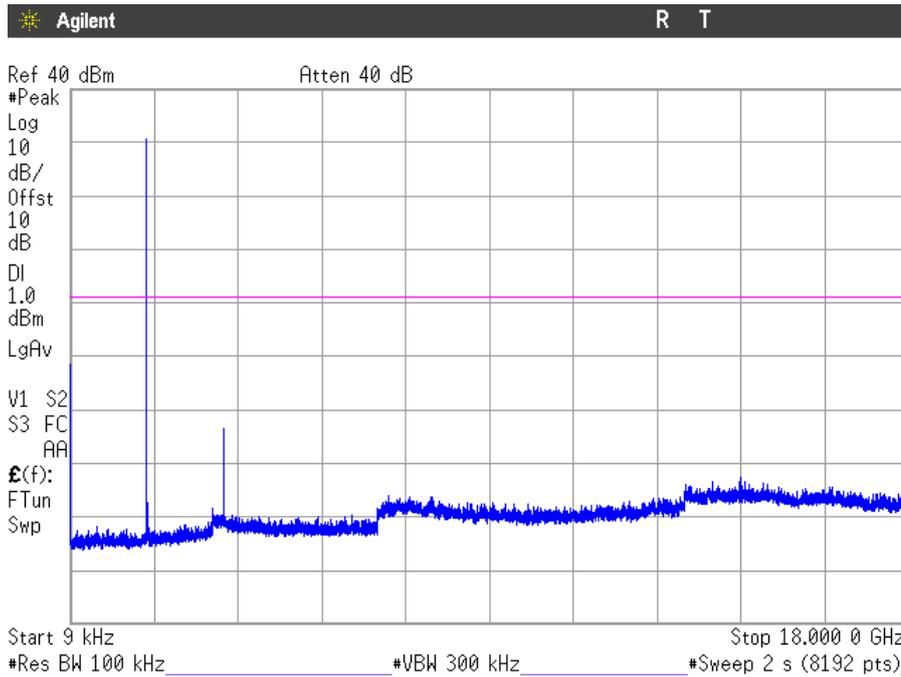
pi/4 QPSK packet data 31.25kHz bandwidth:

Lowest Channel



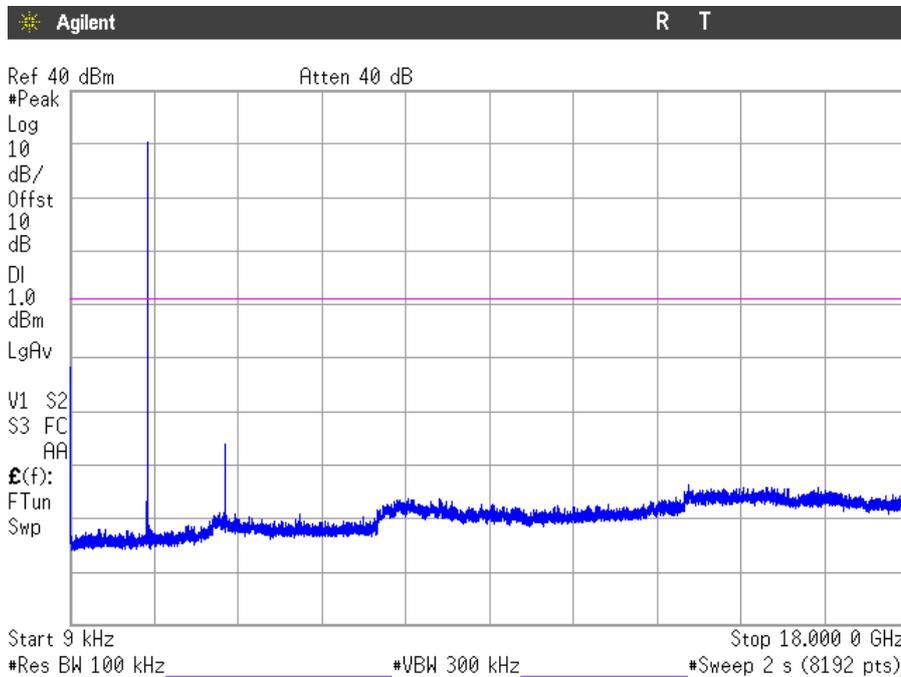
Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

Middle Channel



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

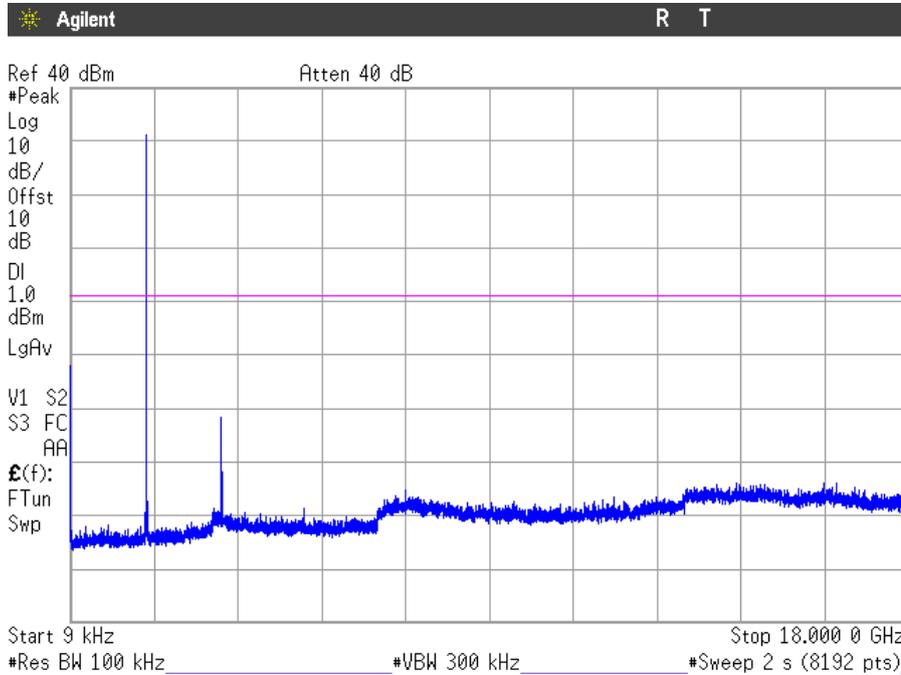
Highest channel



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

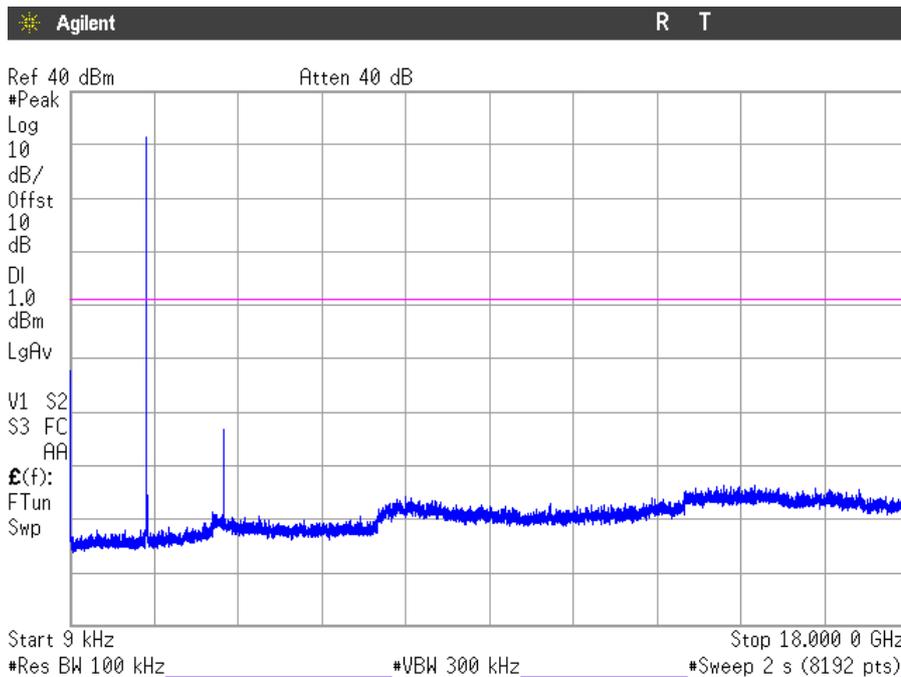
pi/4 QPSK packet data 62.5kHz bandwidth:

Lowest Channel



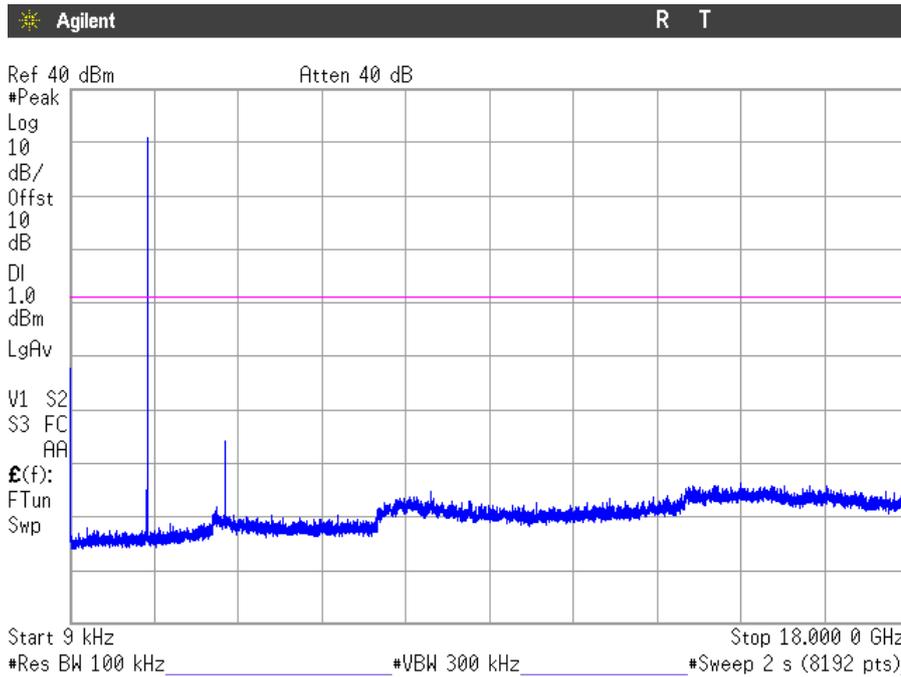
Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

Middle Channel



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

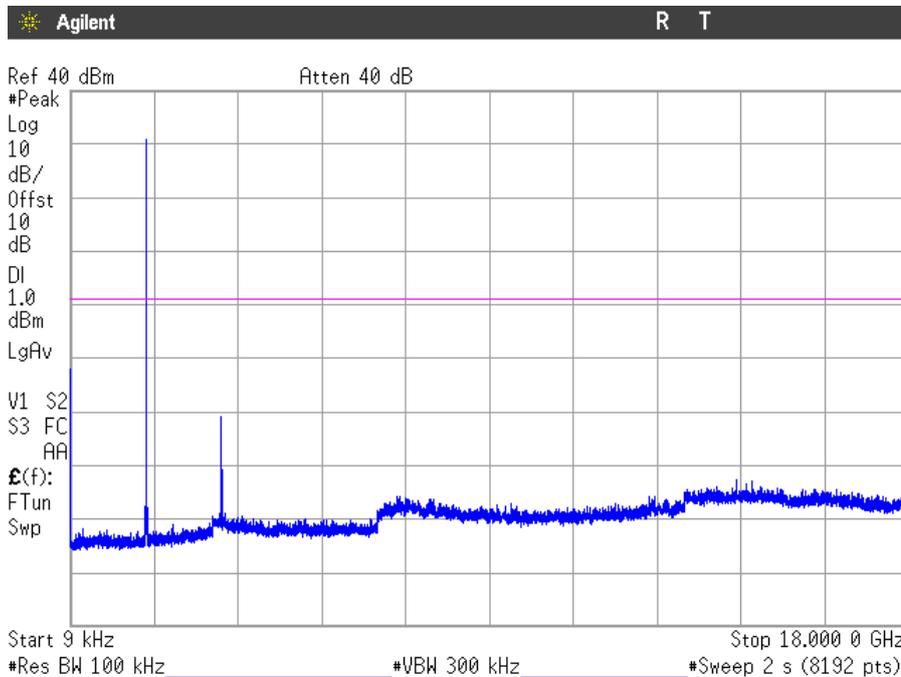
Highest channel



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

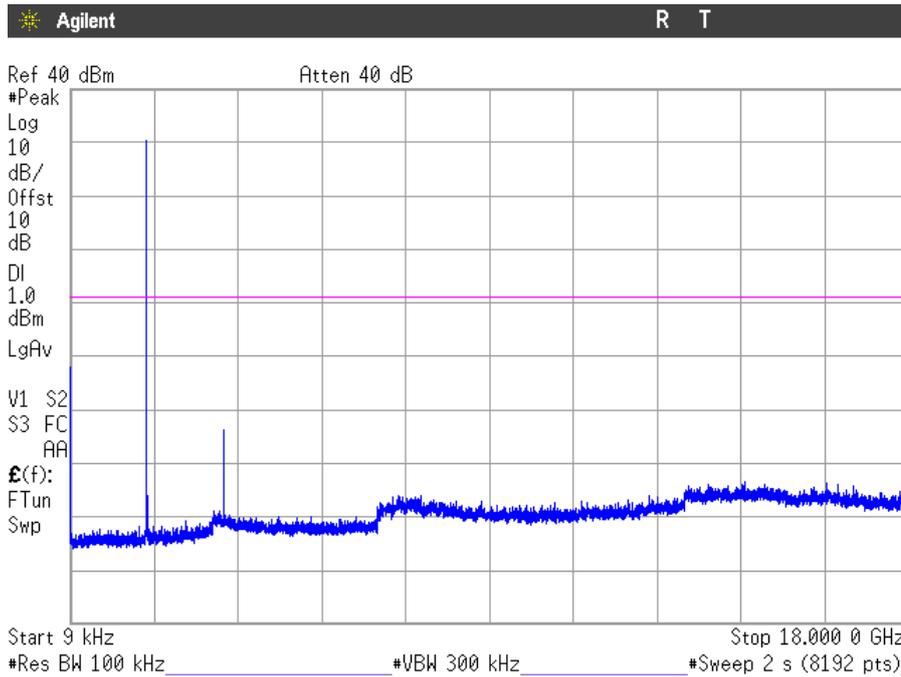
pi/4 QPSK packet data 156.25kHz bandwidth:

Lowest Channel



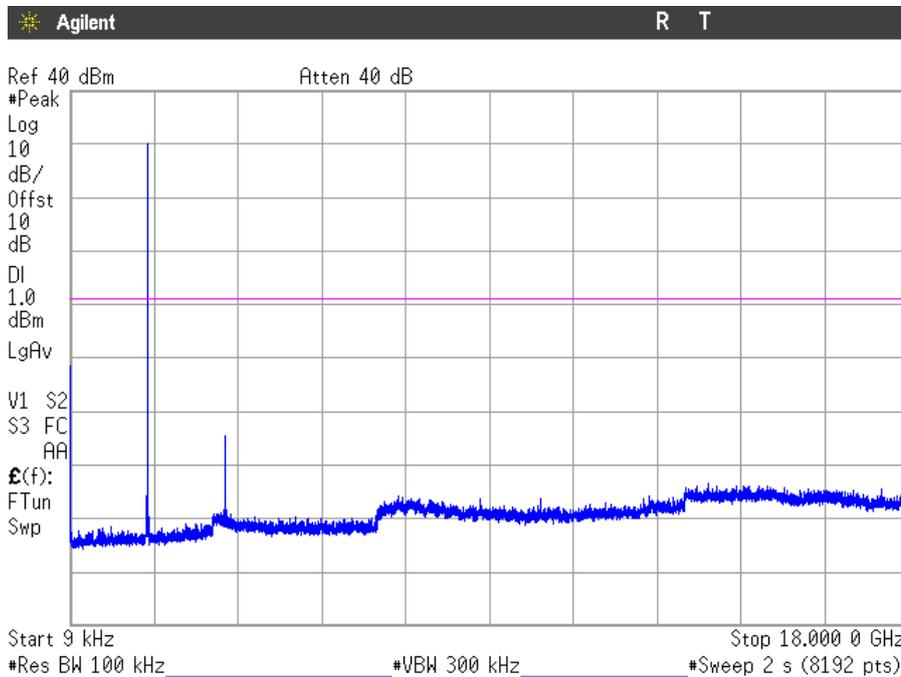
Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

Middle Channel



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

Highest channel



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

FCC 25.202 Subclause (f) / Emission limitations. Radiated emissions.

SPECIFICATION

§ 25.202 (f).

METHOD

For the internal antenna configuration the measurement was performed with the EUT inside an anechoic chamber and using its integral antenna.

For the external antenna configuration, the measurement was performed with the EUT inside an anechoic chamber. The RF output connector of the EUT is terminated with an attenuator and a 50 ohm load.

The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency generated within the equipment, using a resolution bandwidth (RBW) of 10 kHz in the range 30 MHz to 1 GHz and 100 kHz in the range 1 GHz to 18 GHz.

Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

Each detected emissions is re-measured with 4 kHz and the emissions at less than 20 dB respect to the limits are substituted by the Substitution method, in accordance with the ANSI/TIA/EIA-603-D: 2010.

The test was performed with the equipment transmitting first in only Satellite mode, repeated with the BT EDR/BT LE (modulation GFSK, which is the worst case) and repeated with WIFI (802.11b mode which is the worst case) radios transmitting simultaneously to check the impact of the co-location of both radio interfaces. The results and plots below show the worst results obtained in all modes.

Measurement Limit:

According to specification, in any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts.

At P_o transmitting power, the specified minimum attenuation becomes $43+10\log(P_o)$, and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log(P_o \text{ in mwatts}) - 30] = -13 \text{ dBm.}$$

TEST SETUP

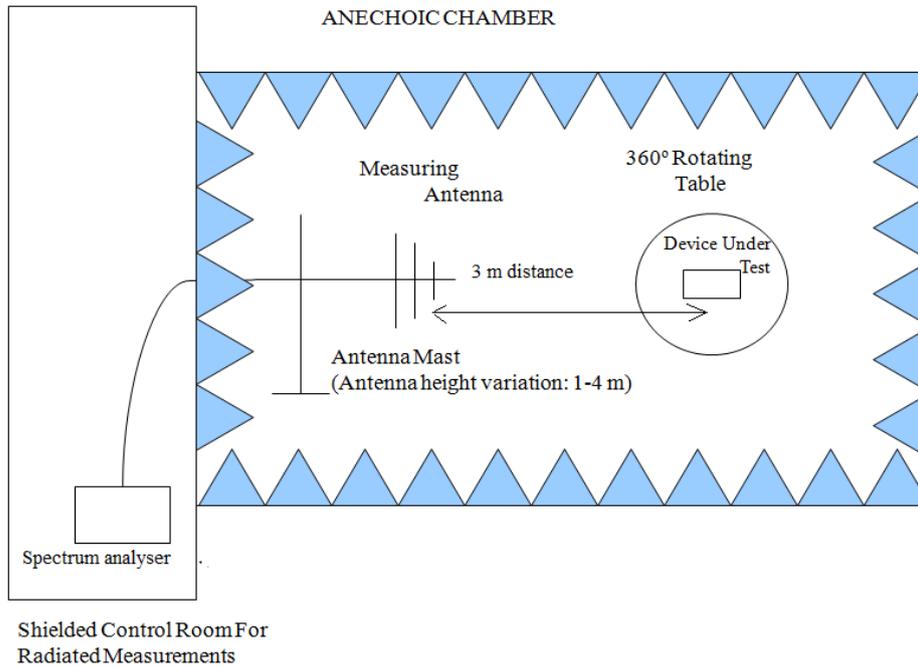
All radiated tests were performed in an anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-18 GHz (1 GHz-18 GHz Double ridge horn antenna).

For radiated emissions in the range 1 GHz-18 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

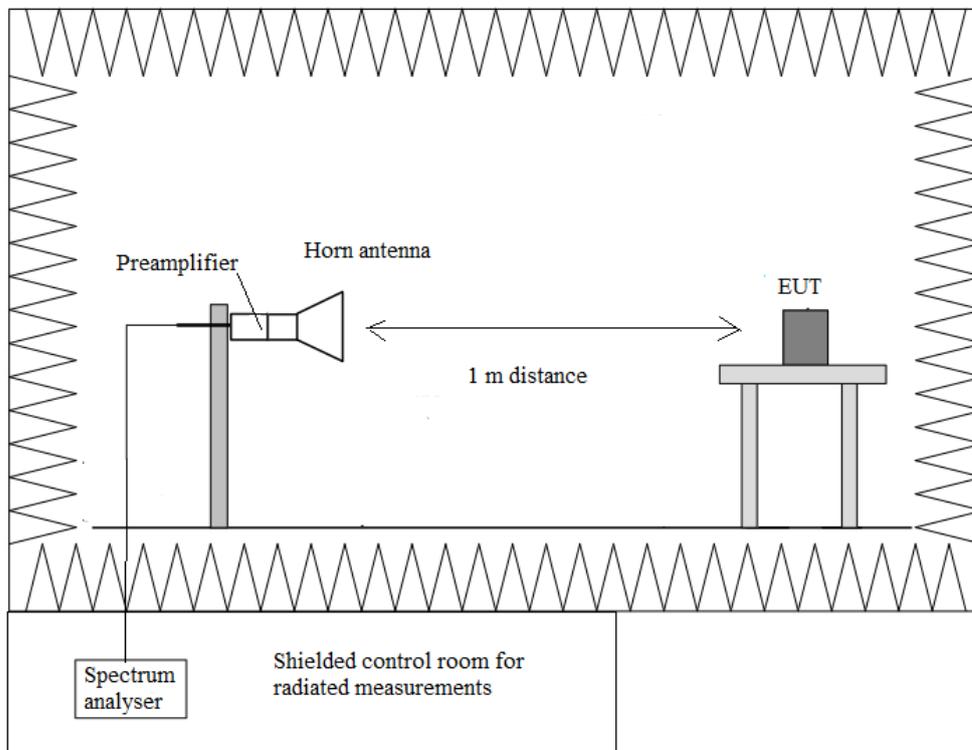
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

Radiated measurements setup $f < 1$ GHz



Radiated measurements setup $f > 1$ GHz



RESULTS

Internal antenna:

Preliminary tests were done with the equipment operating with the different possible modulations and bandwidths and the worst case was pi/2 BPSK modulation and nominal bandwidth of 31.25 kHz. Results shown below correspond to pi/2 BPSK modulation and nominal bandwidth of 31.25 kHz.

1. CHANNEL: LOWEST

Frequency range 30 MHz-1000 MHz.

No spurious signals were found in all the range.

Frequency range 1 GHz-18 GHz.

Substitution method data

Frequency (GHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
3253.25	-16.37	1000	RMS	Vertical	-32.51	2.45	11.41	-23.55
4879.75	-25.76	1000	RMS	Vertical	-37.88	3.10	11.62	-29.36

2. CHANNEL: MIDDLE

Frequency range 30 MHz-1000 MHz.

No spurious signals were found in all the range.

Frequency range 1 GHz-18 GHz.

Substitution method data

Frequency (GHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
3286.75	-15.32	1000	RMS	Vertical	-31.44	2.49	11.46	-22.47
4930.75	-10.94	1000	RMS	Vertical	-22.91	3.13	11.61	-14.43

3. CHANNEL: HIGHEST

Frequency range 30 MHz-1000 MHz.

No spurious signals were found in all the range.

Frequency range 1 GHz-18 GHz.

Substitution method data

Frequency (GHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
4981.39	-9.83	1000	RMS	Vertical	-21.64	3.18	11.60	-13.22

Measurement uncertainty (dB)	<±3.88 for f < 1GHz <±4.87 for f ≥ 1 GHz up to 18 GHz
------------------------------	--

Verdict: PASS

External antenna:

Preliminary tests were done with the equipment operating with the different possible modulations and bandwidths and the worst case was pi/2 BPSK modulation and nominal bandwidth of 31.25 kHz. Results shown below correspond to pi/2 BPSK modulation and nominal bandwidth of 31.25 kHz.

1. CHANNEL: LOWEST

Frequency range 30 MHz-1000 MHz.

No spurious signals were found in all the range.

Frequency range 1 GHz-18 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE

Frequency range 30 MHz-1000 MHz.

No spurious signals were found in all the range.

Frequency range 1 GHz-18 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST

Frequency range 30 MHz-1000 MHz.

No spurious signals were found in all the range.

Frequency range 1 GHz-18 GHz.

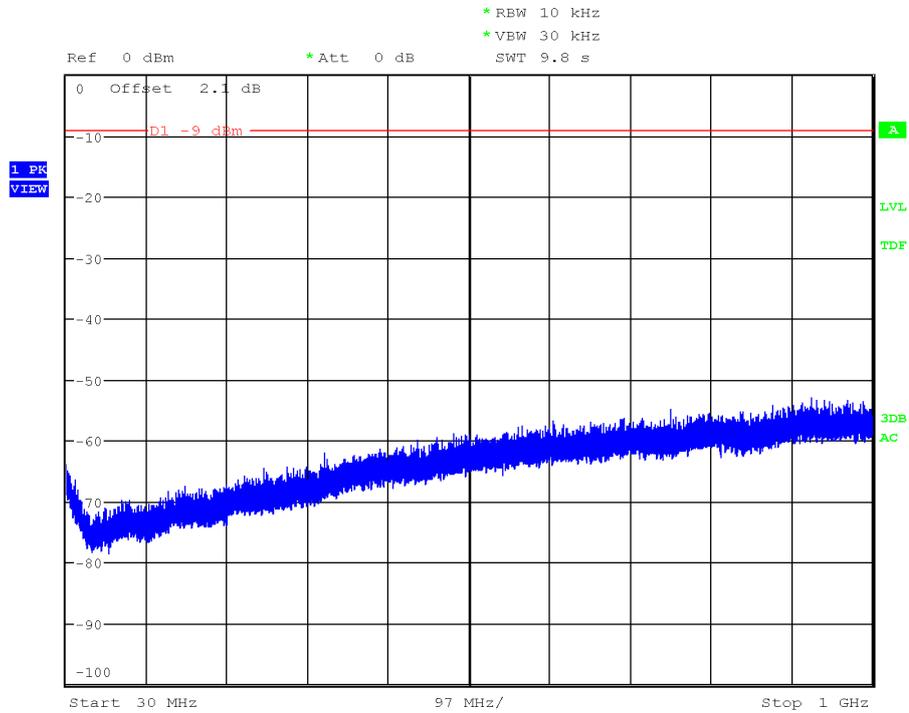
No radiated spurious signals were detected at less than 20 dB respect to the limit.

Measurement uncertainty (dB)	<±3.88 for $f < 1\text{GHz}$ <±4.87 for $f \geq 1\text{GHz}$ up to 18 GHz
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Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

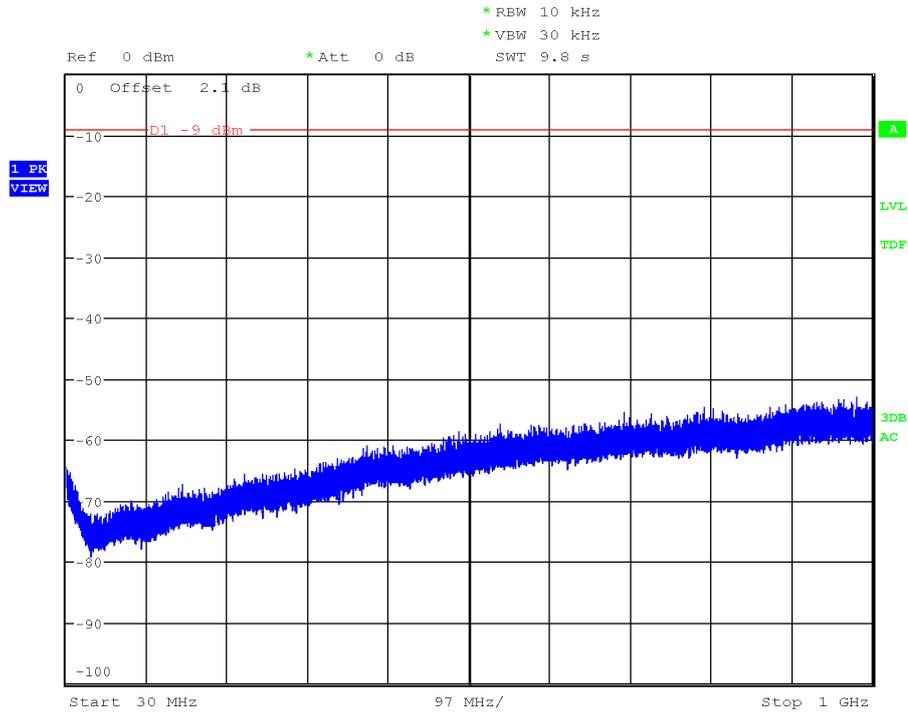
Internal antenna:



Note: The limit shown in the plot is extrapolated for 10 kHz measurement bandwidth.

(This plot is valid for all three channels)

External antenna:

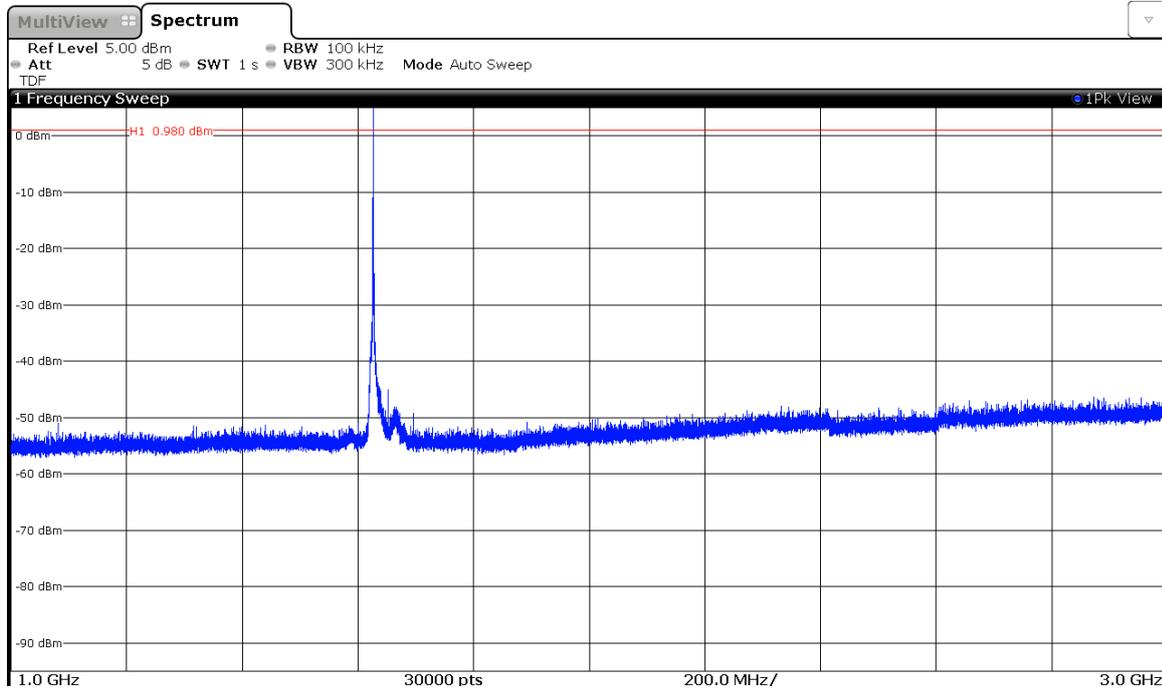


Note: The limit shown in the plot is extrapolated for 10 kHz measurement bandwidth.
(This plot is valid for all three channels)

FREQUENCY RANGE 1 GHz to 3 GHz.

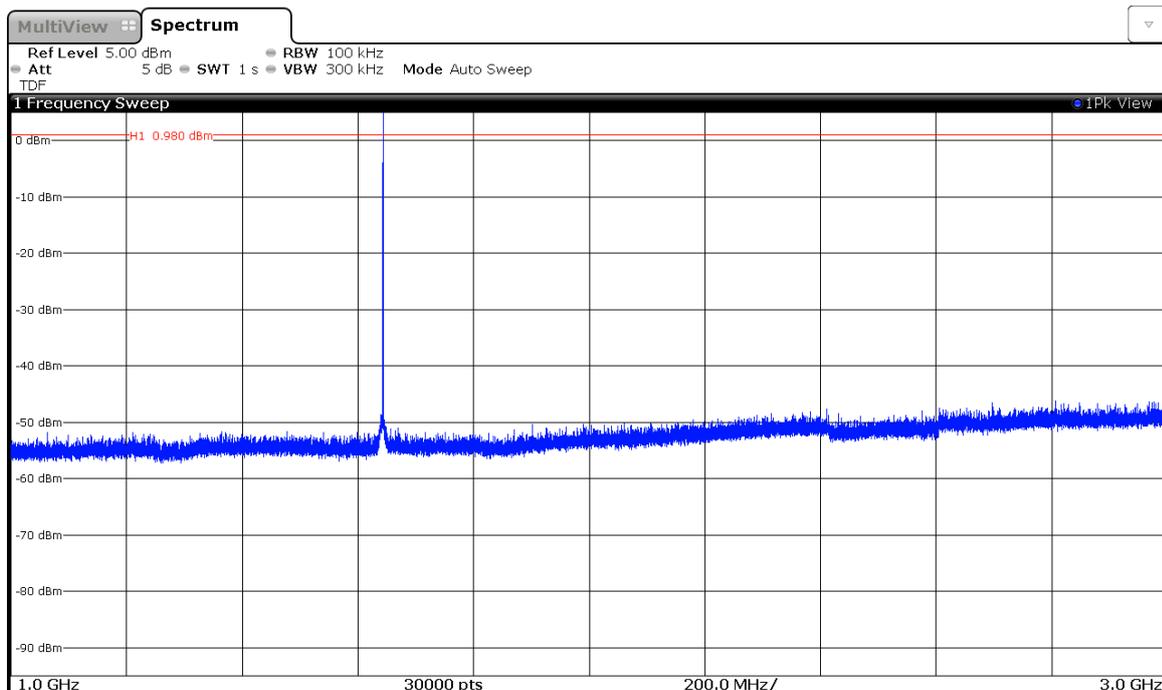
Internal antenna:

CHANNEL: LOWEST



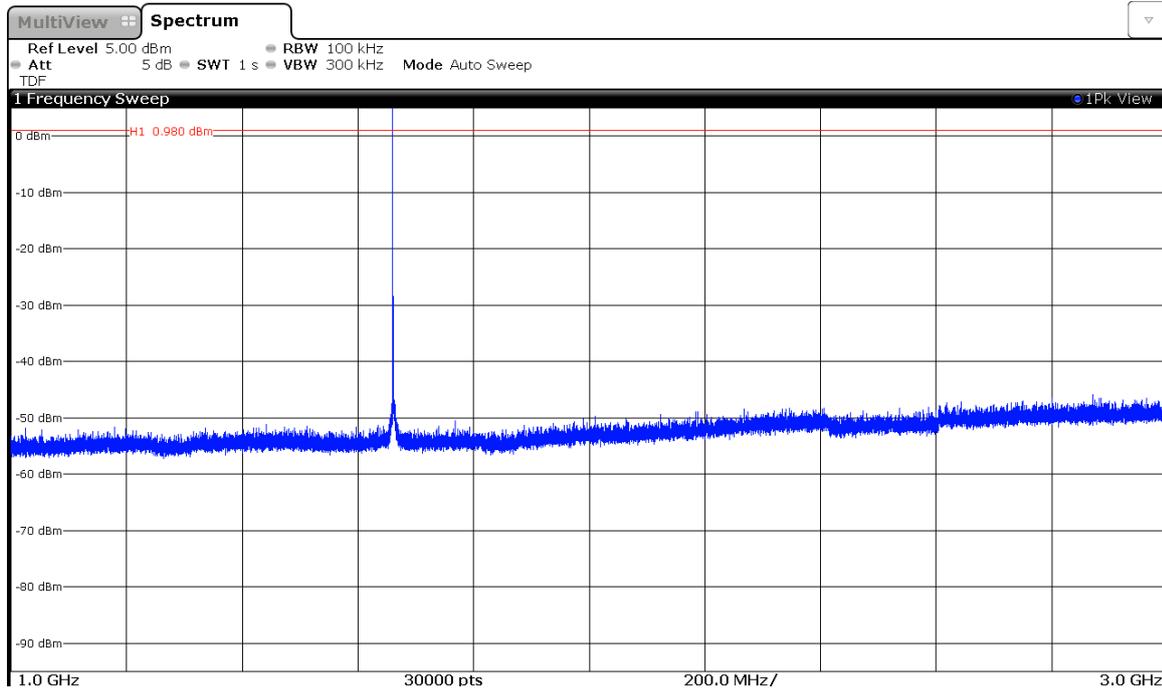
Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

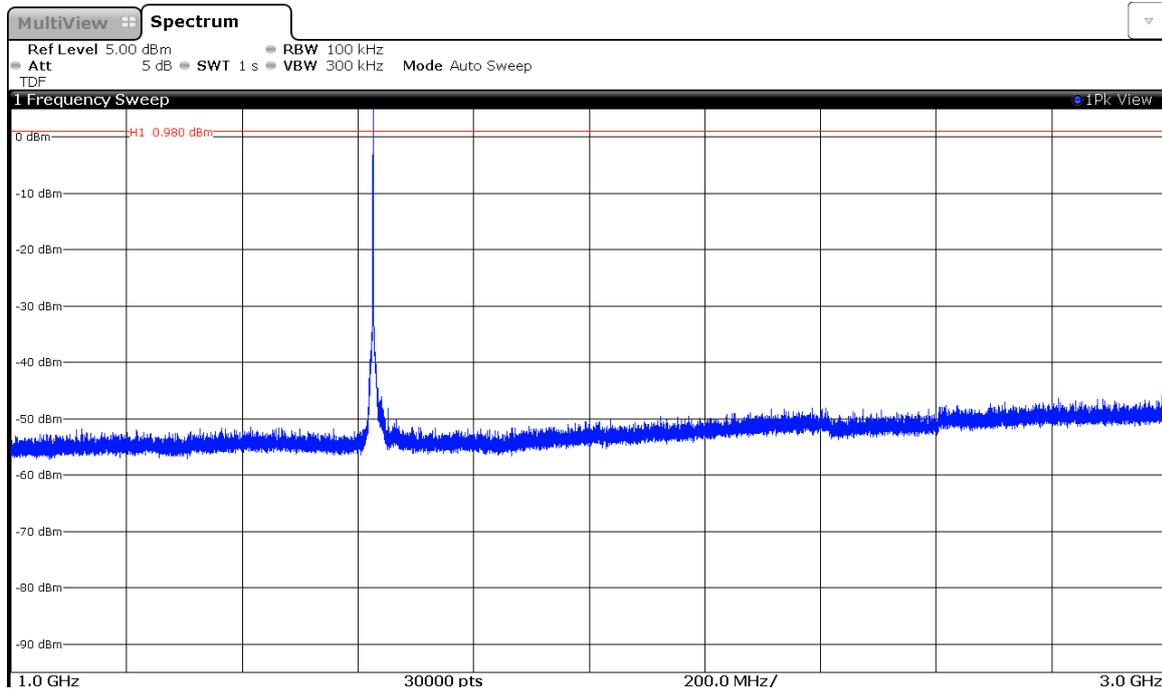
CHANNEL: HIGHEST



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

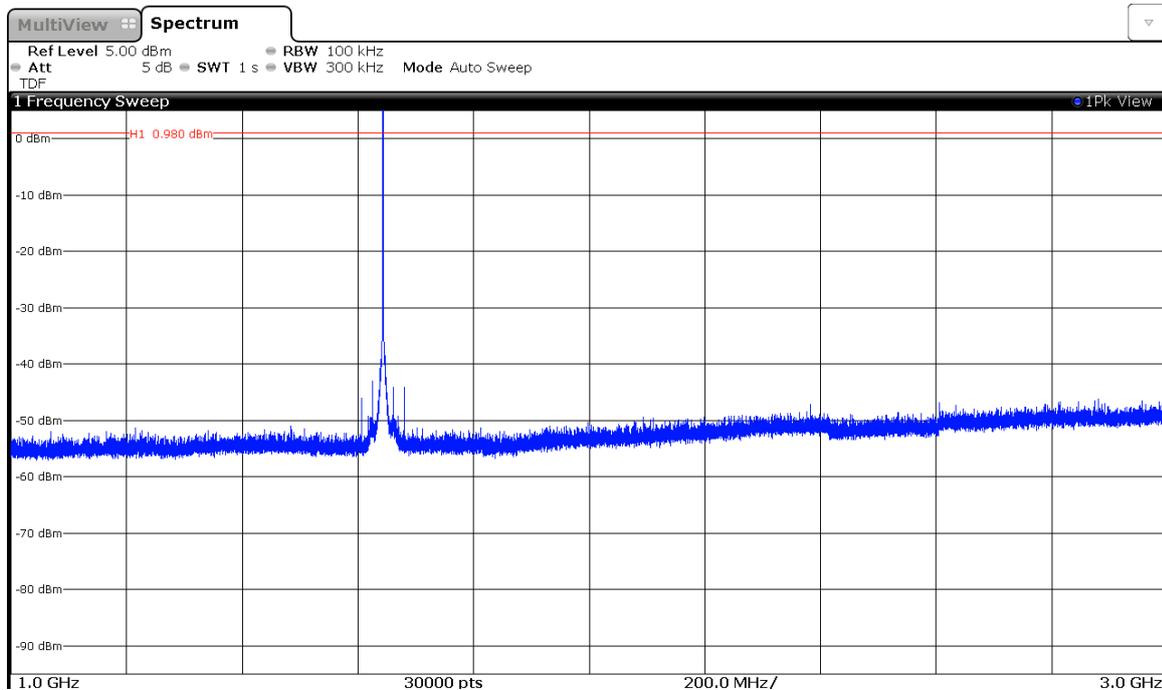
External antenna:

CHANNEL: LOWEST



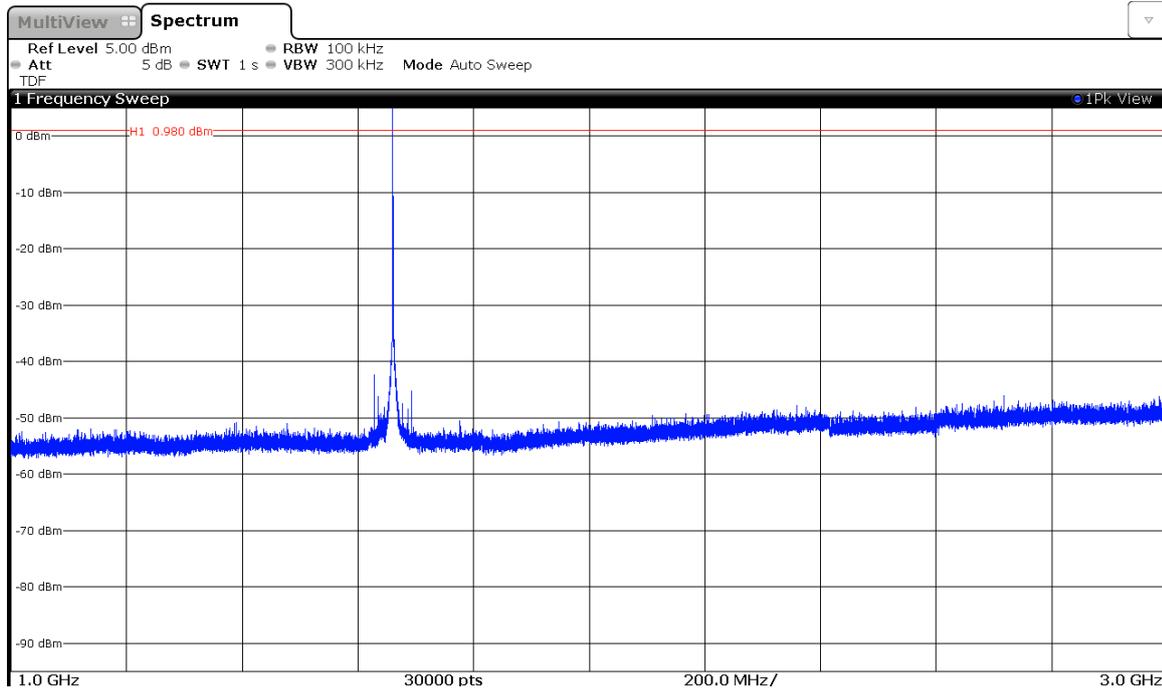
Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

CHANNEL: HIGHEST

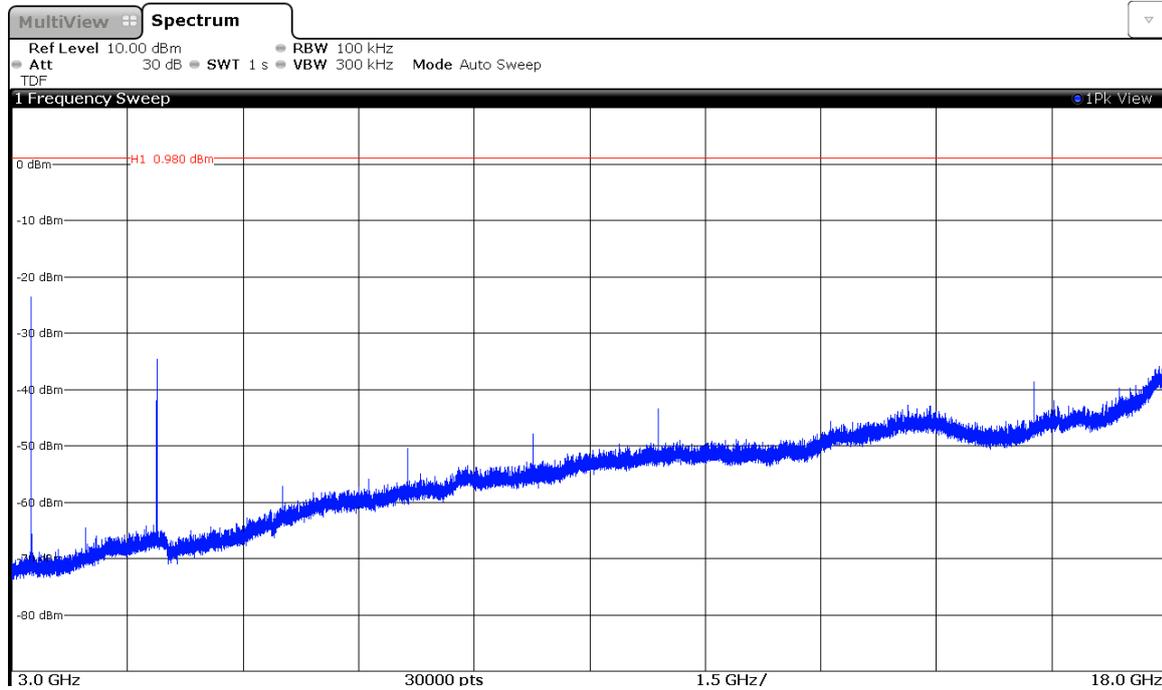


Note: The peak above the limit is the carrier frequency. The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

FREQUENCY RANGE 3 GHz to 18 GHz.

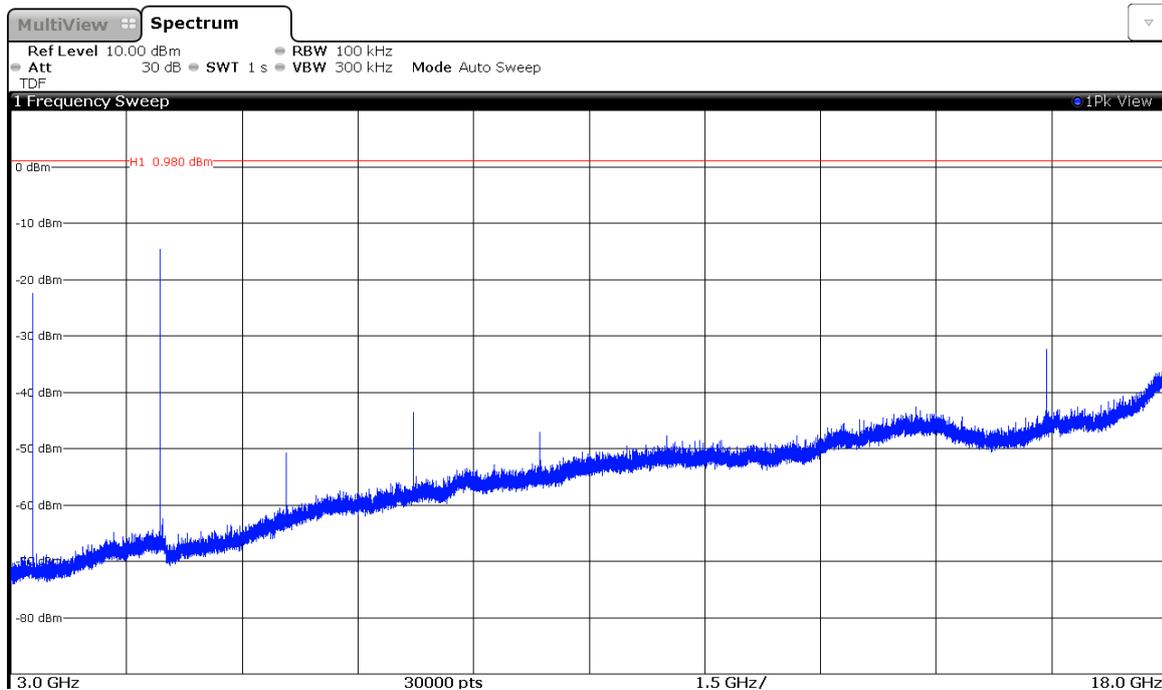
Internal antenna:

CHANNEL: LOWEST



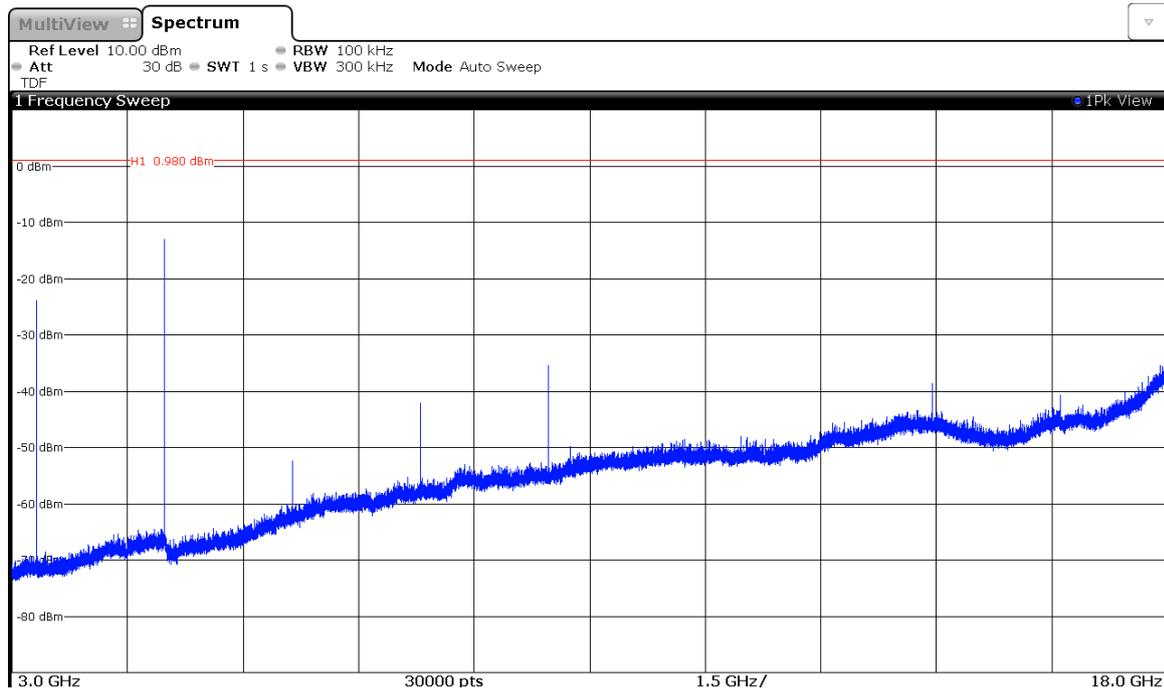
Note: The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

CHANNEL: MIDDLE



Note: The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

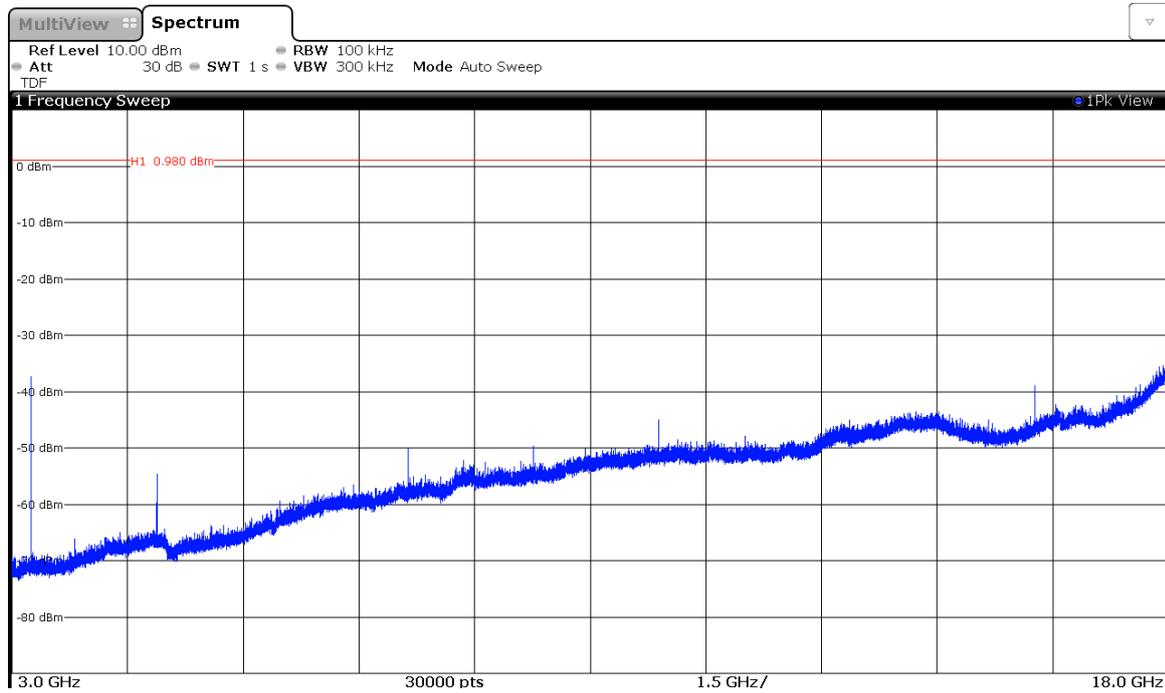
CHANNEL: HIGHEST



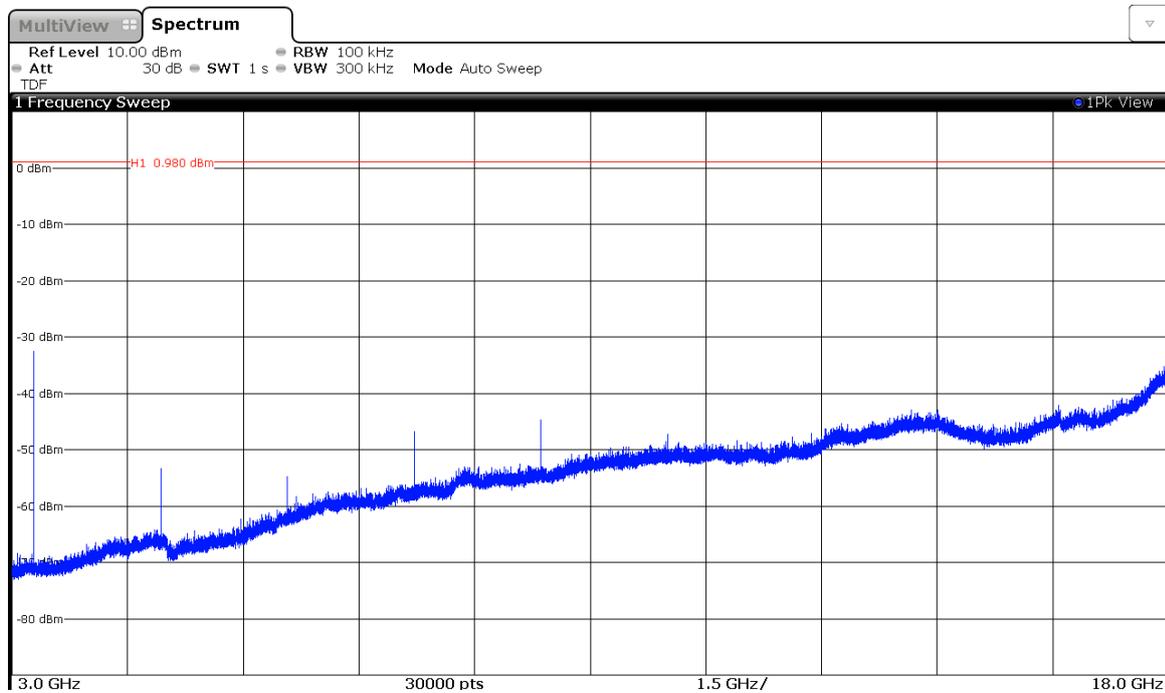
Note: The limit shown in the plot is extrapolated for 100 kHz measurement bandwidth.

External antenna:

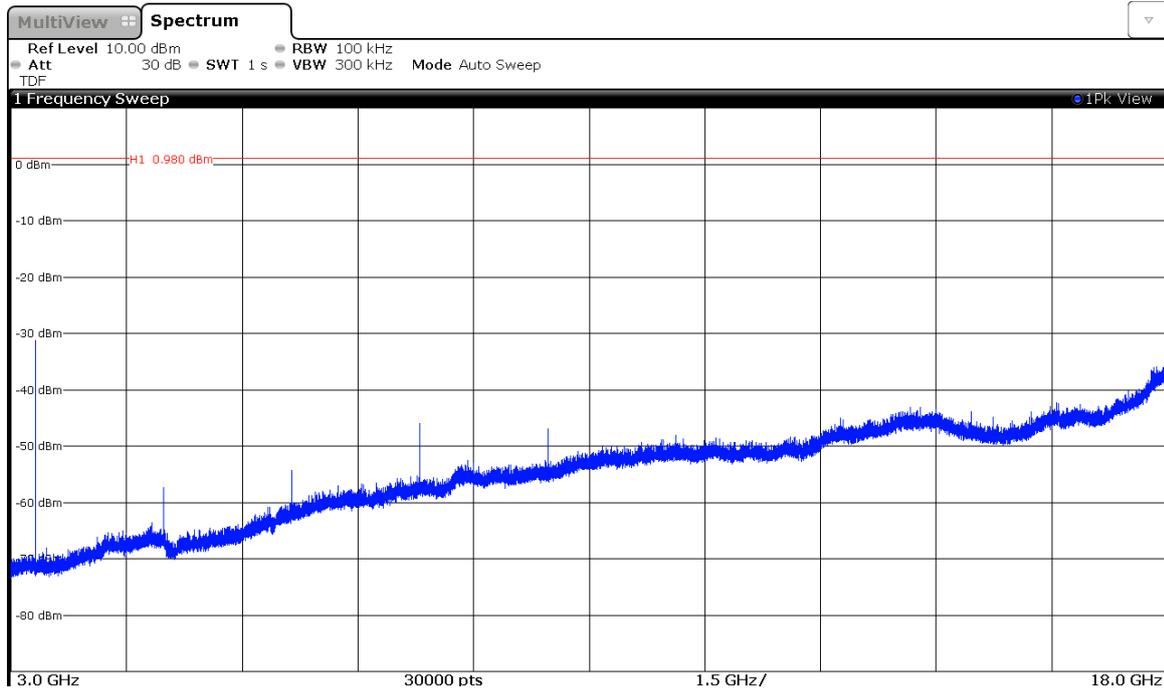
CHANNEL: LOWEST



CHANNEL: MIDDLE



CHANNEL: HIGHEST



FCC 25.216 Subclause (f) / Limits on emissions from mobile earth stations for protection of aeronautical radionavigation satellite service

SPECIFICATION

§ 25.216 (c), (h) & (i).

METHOD

For the internal antenna configuration the measurement was performed with the EUT inside an anechoic chamber and using its integral antenna.

For the external antenna configuration, the measurement was performed with the EUT inside an anechoic chamber. The external attachable antenna is connected to the RF output connector of the EUT.

For measurements in transmission mode, the EUT is set in continuous transmission with different modes of modulation and nominal bandwidths.

For the internal configuration antenna, the preliminary tests were done with the equipment operating with the different possible modulations and bandwidths and the worst case was for pi/4 QPSK packet data modulation and nominal bandwidth of 31.25 kHz. Results shown below correspond to pi/4 QPSK packet data modulation and nominal bandwidth of 31.25 kHz.

For the external configuration antenna, the preliminary tests were done with the equipment operating with the different possible modulations and bandwidths and the worst case was for pi/2 BPSK voice modulation and nominal bandwidth of 31.25 kHz. Results shown below correspond to pi/2 BPSK voice modulation and nominal bandwidth of 31.25 kHz.

The test was performed with the equipment transmitting first in only Satellite mode, repeated with the BT EDR/BT LE (modulation GFSK, which is the worst case) and repeated with WIFI (802.11b mode which is the worst case) radios transmitting simultaneously to check the impact of the co-location of both radio interfaces. The results and plots below show the worst results obtained in all modes.

The spectrum was investigated in the range of frequencies between 1559 MHz and 1610 MHz.

Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

Each detected emission at less than 20 dB below the limit were substituted by the Substitution method, in accordance with the ANSI/TIA/EIA-603-D: 2010.

TEST SETUP

All radiated tests were performed in an anechoic chamber. The measurement antenna is situated at a distance of 1m for the frequency range 1559 MHz and 1610 MHz (1 GHz-18 GHz Double ridge horn antenna).

For radiated emissions in the range 1559 MHz and 1610 MHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.
 See block diagrams above.

RESULTS

Frequency range 1559 MHz-1610 GHz.

Internal antenna:

1. Transmission state.

pi/4 QPSK packet data 31.25kHz bandwidth:

Lowest Channel

Substitution method data

Frequency (GHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain G_i (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) - (2) + (3)
1587.38	-36.98	1000	RMS	Horizontal	-55.28	1.76	8.47	-48.57

No discrete emissions were found.

Middle Channel

Substitution method data

Frequency (GHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain G_i (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) - (2) + (3)
1606.81	-28.13	1000	RMS	Horizontal	-46.41	1.81	8.55	-39.67

No discrete emissions were found.

Highest channel

No radiated spurious signals were detected.

2. Carrier-off state.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Measurement uncertainty (dB)	$\leq \pm 4.87$ for $f \geq 1$ GHz up to 18 GHz
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Verdict: PASS

External antenna:

1. Transmission state.

pi/2 BPSK voice 31.25kHz bandwidth:

Lowest Channel

Substitution method data

Frequency (GHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) - (2) + (3)
1600.05	-46.23	1000	RMS	Vertical	-64.52	1.80	8.52	-57.80

No discrete emissions were found.

Middle Channel

Substitution method data

Frequency (GHz)	Instrument reading (dBm)	RBW (kHz)	Detector	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) - (2) + (3)
1607.05	-35.45	1000	RMS	Vertical	-53.74	1.81	8.55	-47.00

No discrete emissions were found.

Highest channel

No radiated spurious signals were detected.

2. Carrier-off state.

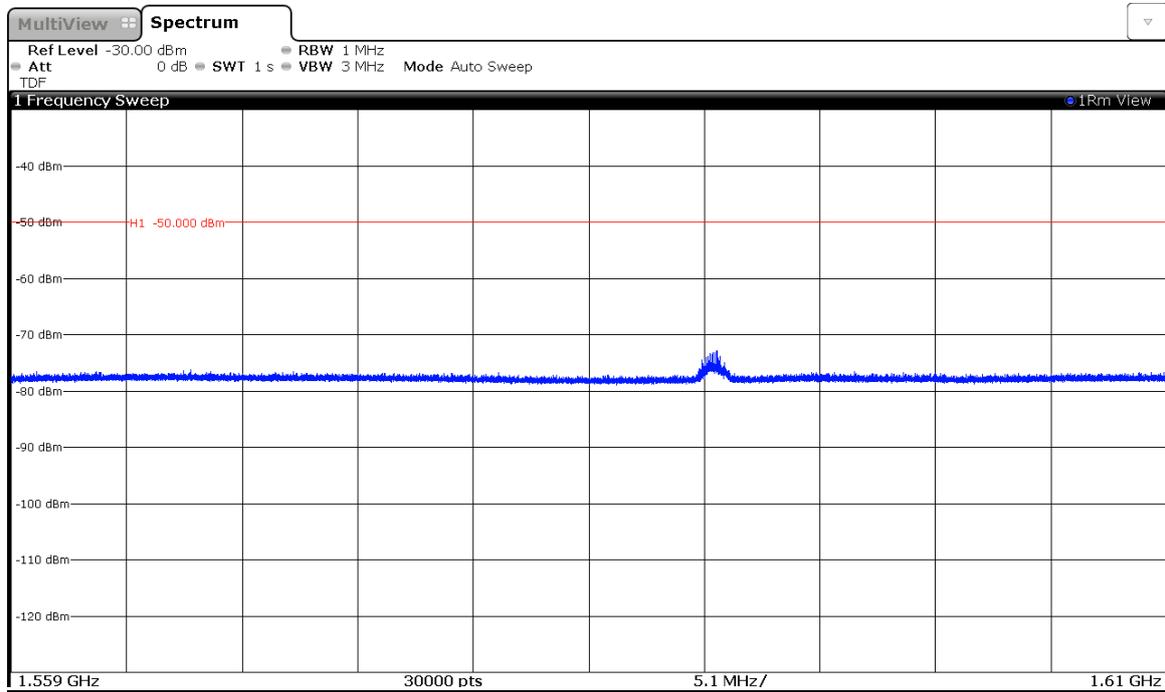
No radiated spurious signals were detected at less than 20 dB respect to the limit.

Measurement uncertainty (dB)	<±4.87 for f ≥ 1 GHz up to 18 GHz
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Verdict: PASS

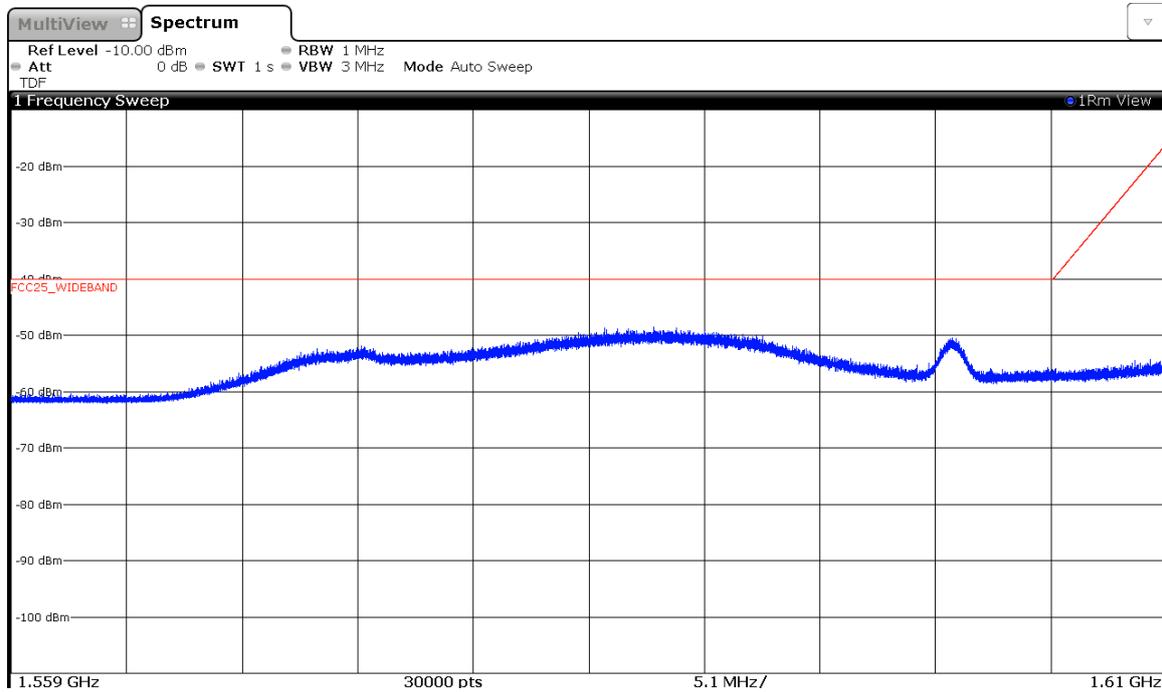
Internal antenna:

Carrier off state:

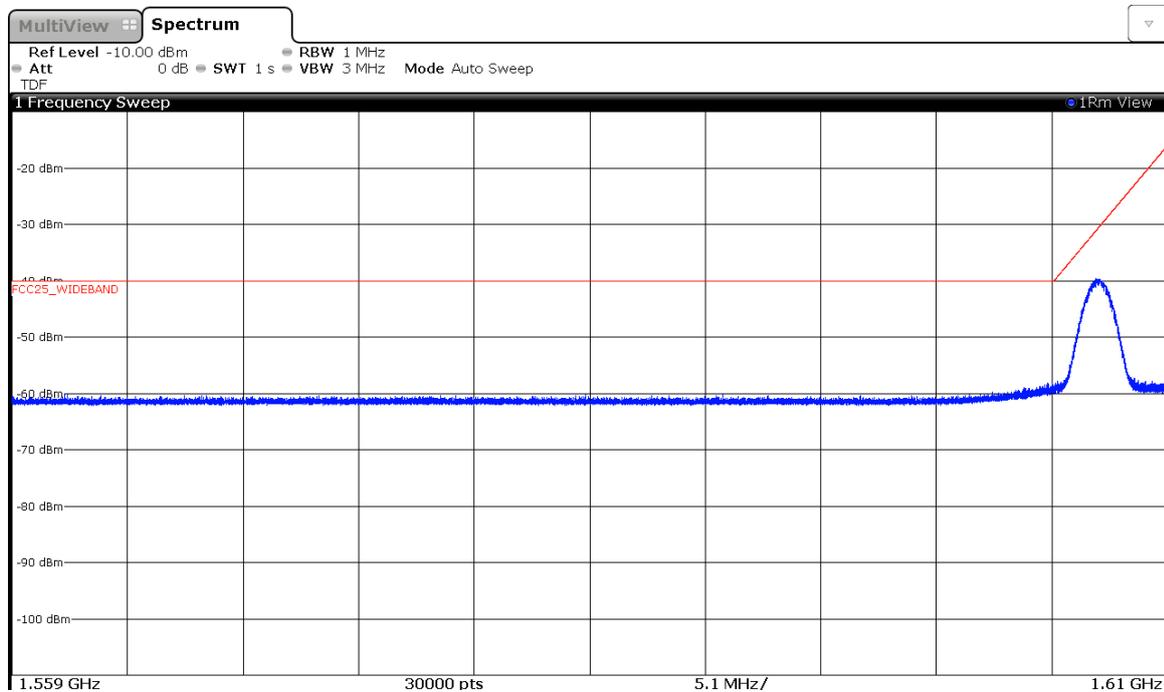


pi/4 QPSK packet data 31.25kHz bandwidth:

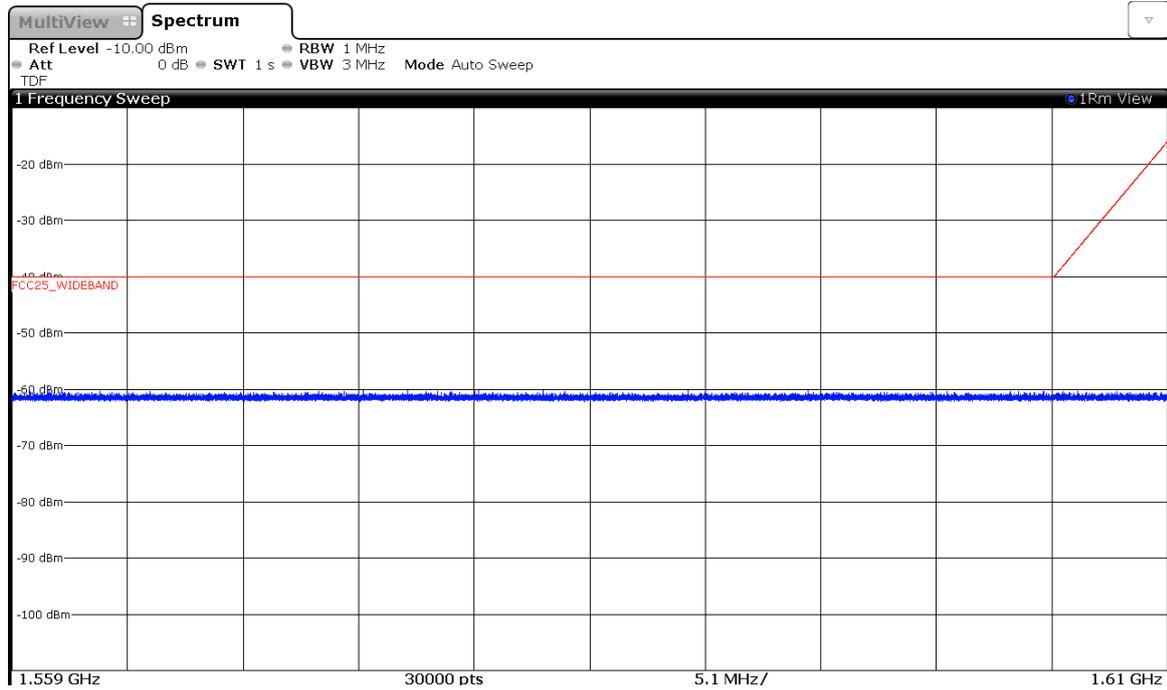
Lowest Channel



Middle Channel

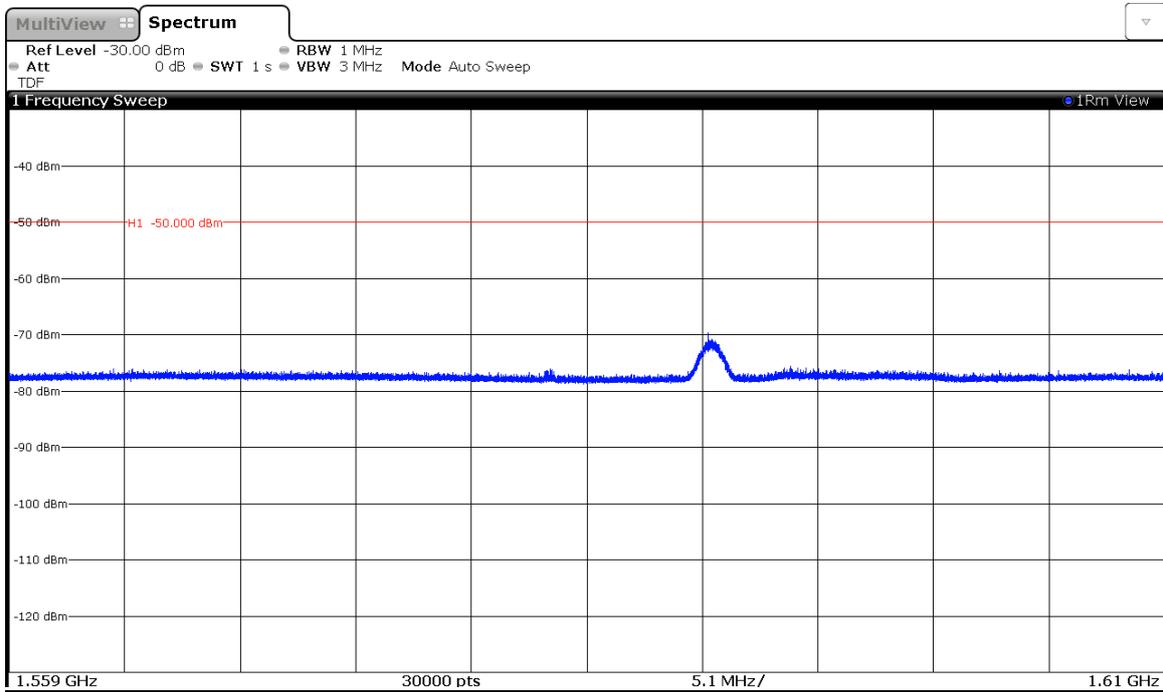


Highest channel



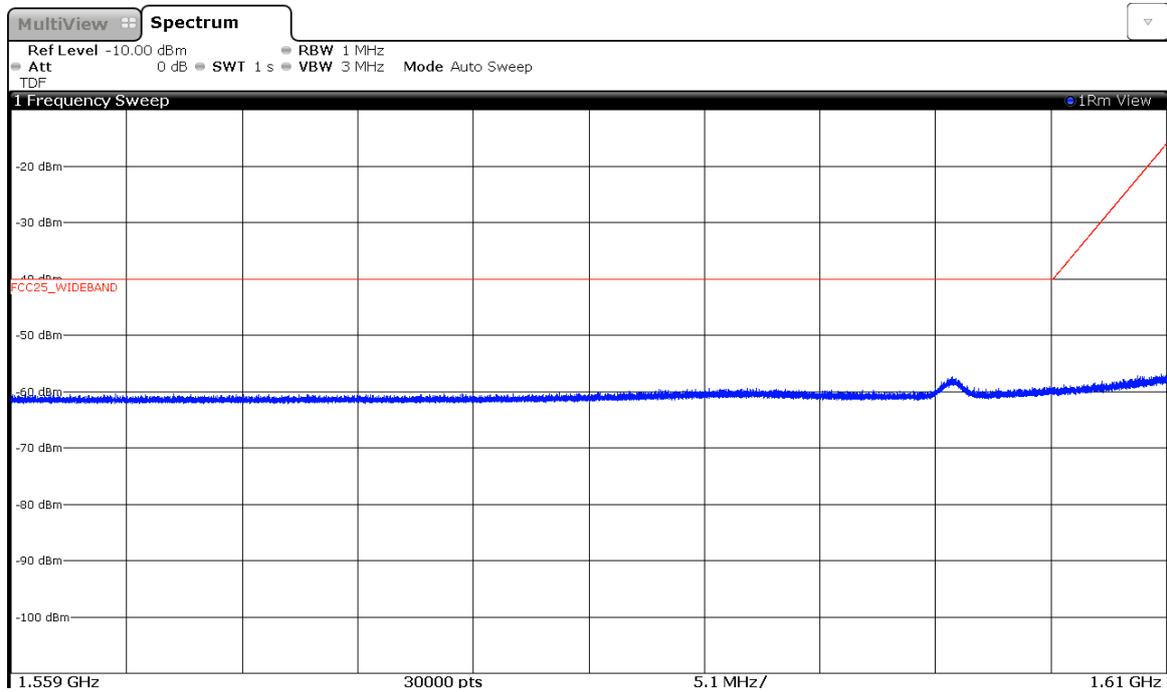
External antenna:

Carrier off state:

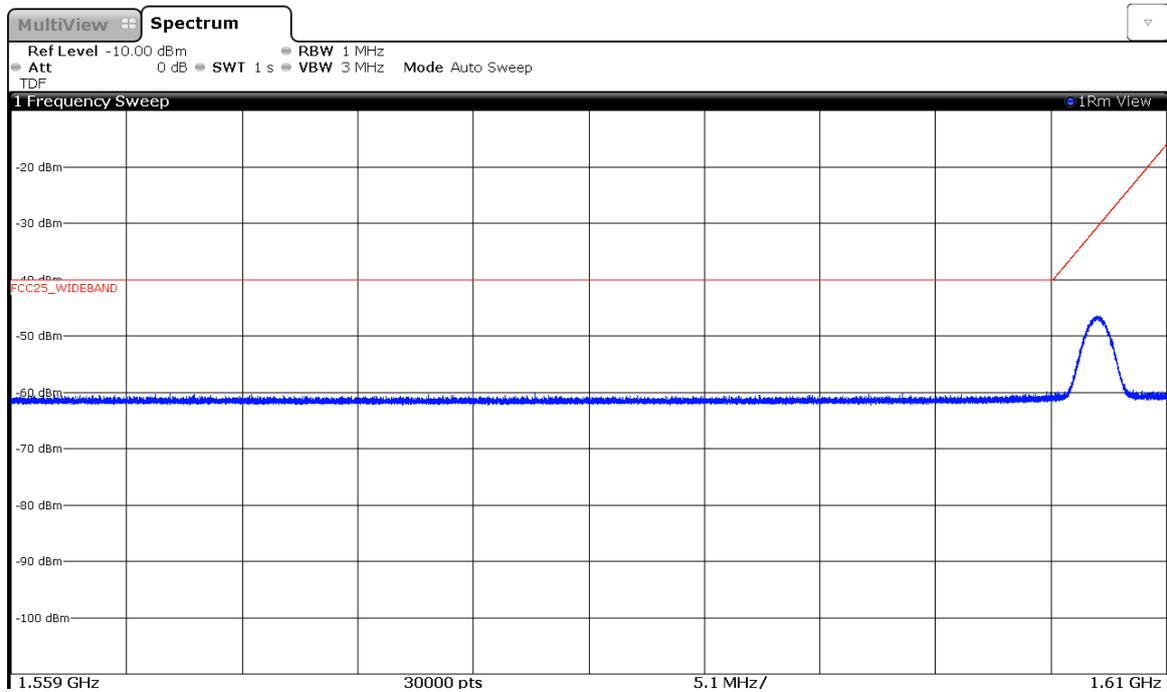


pi/2 BPSK voice 31.25kHz bandwidth:

Lowest Channel



Middle Channel



Highest channel

