InterLab

FCC Measurement/Technical Report on

TOBY-L201 UMTS/HSPA/LTE Data Module

FCC ID XPYTOBYL201
IC: 8595A-TOBYL201

Report Reference: MDE_UBLOX_1502_FCCc_rev1

according to FCC Part 24, Subpart E

Test Laboratory:
7Layers AG
Borsigstrasse 11
40880 Ratingen
Germany

DAkkS Deutsche Akkreditierungsstelle D-PL-12140-01-01

Note:
The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

Table of Contents

0 Summary

0.1 Technical Report Summary

Type of Authorization
Certification for a GSM/WCDMA/LTE cellular radiotelephone device. This report covers only the LTE portion of this device.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 0 to 69. The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

§ 2.1046 Measurement required: RF power output
§ 2.1049 Measurement required: Occupied bandwidth
§ 2.1051 Measurement required: Spurious emissions at antenna terminals
§ 2.1053 Measurement required: Field strength of spurious radiation
§ 2.1055 Measurement required: Frequency stability
§ 2.1057 Frequency spectrum to be investigated

Part 24, Subpart E - Broadband PCS

§ 24.232 Power and antenna height limits
§ 24.235 Frequency stability
§ 24.236 Field strength limits
§ 24.238 Emission limitations for Broadband PCS equipment

Additional documents

ANSI TIA-603-C-2004

Correlation of measurement requirements for Cellular Equipment from FCC and IC

FCC Rule / IC Standard	Part 22 / RSS-132		Part 24 / RSS-133 (NA)		Part 27 / RSS-139 / RSS-199		
Effective (isotropic) Radiated Power	§2.1046 §22.913	RSS-GEN, §4.8 RSS-132, §5.4	§2.1046 §24.232	RSS-GEN, §4.8 RSS-133, §6.4	§2.1046 §27.50 (d)	RSS-GEN, §4.8 RSS-139; §6.4	RSS-GEN, §4.8 RSS-199; §4.4
Occupied Bandwidth	§2.1049	RSS-GEN §4.6	§2.1049	RSS-GEN §4.6	§2.1049	RSS-GEN §4.6	RSS-GEN §4.6
"Spuri" at Antenna Terminal	§2.1051 §22.917	RSS-GEN, §4.9 RSS-132, §5.5	§2.1051 §24.238	RSS-GEN, §4.9 RSS-132, §6.5	§2.1051 §27.5 (h)	RSS-GEN, §4.9 RSS-139, §6.5	RSS-GEN, §4.9 RSS-199, §4.6
Band Edge compliance	§2.1051 §22.917	RSS-GEN, §4.6	§2.1051 §24.238	RSS-GEN, §4.6	§2.1051 §27.5 (h)	RSS-GEN, §4.6	RSS-GEN, §4.6
Frequency Stability	§2.1055 §22.355	RSS-GEN, §4.7	§2.1055 §24.235	RSS-GEN, §4.7 RSS-132, §6.3	§2.1055 §27.51	RSS-GEN, §4.7 RSS-139, §6.3	RSS-GEN, §4.7 RSS-199, §4.3
Peak to Average Ration	N/A	RSS-132, §5.3	§2.1046 §24.232	RSS-133, §6.4	§2.1046 §27.50 (d)	RSS-139, §6.4	NA
Modulation Characteristics	§2.1047	RSS-132, §5.4	§2.1047	RSS-133, §6.2	§2.1047	RSS-139, §6.2	RSS-199, §4.1
Field Strength of Spurious Radiation	§2.1053 §22.917	RSS-132, §5.2	§2.1053 §24.235	RSS-GEN, §4.9 RSS-133, §6.5	§2.1053 §27.51	RSS-GEN, §4.9 RSS-139, §6.5	RSS-GEN, §4.9 RSS-199, §4.6

*) Receivers which are part of Transceivers are exempted with respect to Notice 2012-DRS0126.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.

0.2 Measurement Summary

FCC Part 24, Subpart E		**§2.1046, §24.232**	
RF Power Output			
	Setup	**Port**	**Final Result**
	Setup_01	Temp.ant.connector	passed 2015-03-12
FCC Part 24, Subpart E		**§2.1055, §24.235**	
Frequency stability			
	Setup	**Port**	**Final Result**
	Setup_02	Temp.ant.connector	passed 2015-03-27
FCC Part 24, Subpart E		**§2.1051, §24.238**	
Spurious emissions at antenna terminals			
	Setup	**Port**	**Final Result**
	Setup_02	Temp.ant.connector	passed 2015-04-02
FCC Part 24, Subpart E		**§2.1049, §24.238**	
Emission and Occupied Bandwidth			
	Setup	**Port**	**Final Result**
	Setup_01	Temp.ant.connector	passed 2015-03-11
FCC Part 24, Subpart E		**§2.1049, §24.238**	
Band edge compliance			
	Setup	**Port**	**Final Result**
	Setup_02	Temp.ant.connector	passed 2015-03-24
FCC Part 24, Subpart E		**§2.1046, §24.232 RSS-133 §64**	
Peak-Average Ratio			
	Setup	**Port**	**Final Result**
	Setup_01	Temp.ant.connector	passed 2015-03-13
FCC Part 24, Subpart E		**§2.1046, §24.238**	
Field strength of spurious radiation			
	Setup	**Port**	**Final Result**
	Setup_02/03/04 1)	Enclosure	Passed 2015-05-14

1) Run of the complete frequency range, Setup_02 high and low channel, Setup_03 mid channel, spot checks Setup_04.

The current HW and SW versions of the module are: HW 218A03 SW 09.87. The tests were performed with an older SW and HW version, see DUT description. According to the information provided by the applicant, changes have only been made to Hard- and Software related to bands not covered by this report, so no additional testing was performed

Responsible for Accreditation Scope: MARCO KULLIK 2015.06.10 18:32:42 +02'00'

Responsible for Test Report: DANIEL GALL 2015.06.10 18:30:07 +02'00'

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2015-05-29	--	invalid
rev1	2015-06-10	Extended Test Description testcase Field strength of spurious radiation	valid

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7Layers AG
Address	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716 .

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Thomas Hoell Dipl.-Ing. Marco Kullik Dipl.-Ing. Andreas Petz
Report Template Version	2014-09-18

1.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Daniel Gall
Date of Test(s):	2015-03-11 to 2015-05-14
Date of Report:	2015-06-10

1.3 Applicant Data

Company Name:	u-blox AG
Address:	Zürcherstrasse 68, CH-8800 Thalwil Switzerland
Contact Person:	Mr. Giulio Comar
Phone:	+41 44 722 7462
Email Address:	giulio.comar@u-blox.com

1.4 Manufacturer Data

Company Name:	please see applicant data
Address:	
Contact Person:	

2 Test object Data

2.1 General EUT Description

Equipment under Test:	UMTS/HSPA/LTE Data Module
Type Designation:	TOBY-L201
Kind of Device:	Module
(optional)	
Voltage Type:	DC
Voltage Level:	3.8 V
Tested Modulation Type:	QPSK;16QAM

General product description:

The Module is able to operating in the following bands:
UMTS/HSDPA/HSUPA FDD II, V
LTE eFDD 2, 4, 5, 13 and 17

The EUT provides the following ports:

Ports
Temporary antenna connector
Enclosure

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status
EUT A (Code: DE1015014aa01)	UMTS/LTE Module	TOBY-L201	358502060012807	218A02	09.81
EUT B (Code: DE1015014aa02)	UMTS/LTE Module	TOBY-L201	358502060012807	218A02	09.82
EUT C (Code: DE1015014ae01)	UMTS/LTE Module	TOBY-L201	358502060012930	218A02	09.81
EUT D (Code: DE1015014ae02)	UMTS/LTE Module	TOBY-L201	358502060012930	218A02	09.82
Remark: EUT A is equipped with a temporary antenna connector. The Module is not sold with a predefined antenna.					

NOTE: The code mentioned in short description is used to simplify the identification of the EUT in this test report.

2.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	HW Status	SW Status	Serial no.	FCC ID
AE 1	AC/DC converter	UUX324-1215	-	-	E09-0291981	–
AE 2	AC/DC converter	UUX324-1215	-	-	E09-0291993	–
AE 3	Evaluation test board	EVB-WL3	NO_EVK_CS_191A00	-	-	-
AE 4	Evaluation test board	EVB-WL3	NO_EVK_CS_191A00	-	-	-

2.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Auxiliary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial no.	HW Status	SW Status	FCC ID
*						

* No auxiliary equipment was required to operate the module

2.5 EUT Setups

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup No.	Combination of EUTs	Description and Rationale
Setup_01	EUT A + AE 1 + AE 3	setup for conducted measurements
Setup_02	EUT B + AE 1 + AE 3	setup for conducted and radiated measurements
Setup_03	EUT C + AE 2 + AE 4	setup for conducted and radiated measurements
Setup_04	EUT D + AE 2 + AE 4	setup for conducted and radiated measurements

2.6 Operating Modes

The below tables show the test frequencies and channels bandwidths used for testing.

TEST MODE	TX / RX	RF Channel		
		Low	Mid	High
LTE eFDD 2	TX (1.4M)	18607	18900	19193
		1850.7 MHz	1880 MHz	1909.3 MHz
	TX (3M)	CH 18615	CH 18900	CH 19185
		1851.5 MHz	1880 MHz	1908 MHz
	TX (5M)	CH 18625	CH 18900	CH 19175
		1852.5 MHz	1880 MHz	1907.5 MHz
	TX (10)	CH 18650	CH 18900	CH 19150
		1855 MHz	1880 MHz	1905 MHz
	TX (15M)	CH 18675	CH 18900	CH 19125
		1857.5 MHz	1880 MHz	1902.5 MHz
	TX (20M)	CH 18700	CH 18900	CH 19100
		1860 MHz	1880 MHz	1900 MHz
	RX (1.4M)	CH 607	CH 900	CH 1193
		1930.7 MHz	1960 MHz	1989.3 MHz
	RX (3M)	CH 615	CH 900	CH 1185
		1931.5 MHz	1960 MHz	1988.5 MHz
	RX (5M)	CH 625	CH 900	CH 1175
		1932.50 MHz	1880.00 MHz	1987.5 MHz
	RX (10M)	CH 650	CH 900	CH 1150
		1935.00 MHz	1960.00 MHz	1985.00 MHz
	RX (15M)	CH 675	CH 900	CH 1125
		1937.50 MHz	1960.00 MHz	1982.50 MHz
	RX (20M)	CH 700	CH 900	CH 1100
		1940.00 MHz	1960.00 MHz	1980.00 MHz

eFDD 2 Test configuration					
Setup Number	**Test ITEM**	**Channel Band width**	**Channels tested**	**Modulation**	**RB Allocation**
01	RF OUTPUT POWER	1.4 MHz	18607, 18900, 19193	QPSK, 16QAM	1RB, 3RB, 6RB
		3 MHz	18618, 18900, 19185	QPSK, 16QAM	1RB, 15RB
		5 MHz	18625, 18900, 19175	QPSK, 16QAM	1RB , 12RB , 25RB
		10 MHz	18650, 18900, 19150	QPSK, 16QAM	1RB, 50RB
		15 MHz	18675, 18900, 19125	QPSK, 16QAM	1RB, 36RB, 75RB
		20 MHz	18700, 18900, 19100	QPSK, 16QAM	1RB, 100RB
02	FREQUENCY STABILITY	1.4	18900	QPSK	1RB
01	OCCUPIED BANDWIDTH	1.4 MHz	18607, 18900, 19193	QPSK, 16QAM	6RB
		3 MHz	18618, 18900, 19185	QPSK, 16QAM	15RB
		5 MHz	18625, 18900, 19175	QPSK, 16QAM	25RB
		10 MHz	18650, 18900, 19150	QPSK, 16QAM	50RB
		15 MHz	18675, 18900, 19125	QPSK, 16QAM	75RB
		20 MHz	18700, 18900, 19100	QPSK, 16QAM	100RB
01	PEAK TO AVERAGE RATIO	5 MHz	18625, 18900, 19175	QPSK, 16QAM	25RB
02	BAND EDGE Compliance	1.4 MHz	18607, 18900, 19193	QPSK, 16QAM	6RB / Max offset
		3 MHz	18618, 18900, 19185	QPSK, 16QAM	15RB/ Max offset
		5 MHz	18625, 18900, 19175	QPSK, 16QAM	25RB/ Max offset
		10 MHz	18650, 18900, 19150	QPSK, 16QAM	50RB/ Max offset
		15 MHz	18675, 18900, 19125	QPSK, 16QAM	75RB/ Max offset
		20 MHz	18700, 18900, 19100	QPSK, 16QAM	100RB/ Max offset
02	CONDUCTED EMISSION	5 MHz	18625, 18900, 19175	QPSK, 16QAM	1RB
02/03/04	RADIATED EMISSION	10 MHz 1)	See external report	QPSK	1 RB mid channel / 50 RB

1) Run of the complete frequency range, spot checks also at 1.4 MHz, 3 MHz, 5 MHz, 15 MHz, 20 MHz.

2.7 Special software used for testing

- NA

2.7.1 Software to control the EUT directly

- NA

2.7.2 Software to enable control the EUT by a signaling unit

- NA

2.8 Product labeling

-

2.8.1 FCC ID label

Please refer to the documentation of the applicant.

2.8.2 Location of the label on the EUT

Please refer to the documentation of the applicant.

3 Test Results

3.1 RF Power Output

Standard FCC Part 24, Subpart E

The test was performed according to: FCC §2.1046

3.1.1 Test Description (conducted procedure)

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
4) Important Settings:
5) Channel (Frequency): please refer to the detailed results
6) The transmitted power of the EUT was recorded by using a spectrum analyser.

Test Description (radiated measurement procedure)

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
1) Important Settings:
2) Output Power: Maximum
3) Channel: please refer to the detailed results
4) A substitution procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
5) The output power was measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid channel and on the highest channel. To find the worst case power all orientations (X, Y, Z) of the EUT have been measured.
6) The test procedure according to TIA-603-C-2004 has been considered.

3.1.2 Test Requirements / Limits

§2.1046 Measurements Required: RF Power Output
(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the output terminals when this test is made shall be stated.
§24.232 Power and antenna height limits
(c) Mobile/portable stations are limited to 2 watts EIRP peak power and the equipment must employ means to limit the power to the minimum necessary for successful

communications.
(e) Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

3.1.3 Test Protocol

Test Band	Bandwidth (MHz)	Channel	Modulation	RB	RMS Conducted Power (dBm)	FCC EIRP Limit (W)	IC EIRP Limit (W)	Maximum Antenna Gain (dBi)	Verdict
eFDD2	1.4	18607	QPSK	RB 1	21.86	2	2	11.14	Passed
				RB 3	21.79	2	2	11.21	Passed
				RB 6	20.86	2	2	12.14	Passed
			16QAM	RB 1	21.71	2	2	11.29	Passed
				RB 6	19.85	2	2	13.15	Passed
		18900	QPSK	RB 1	22.16	2	2	10.84	Passed
				RB 3	22.15	2	2	10.85	Passed
				RB 6	21.26	2	2	11.74	Passed
			16QAM	RB 1	21.23	2	2	11.77	Passed
				RB 6	20.20	2	2	12.8	Passed
		19193	QPSK	RB 1	22.19	2	2	10.81	Passed
				RB 3	22.21	2	2	10.79	Passed
				RB 6	21.23	2	2	11.77	Passed
			16QAM	RB 1	21.26	2	2	11.74	Passed
				RB 6	20.23	2	2	12.77	Passed
	3	18615	QPSK	RB 1	21.85	2	2	11.15	Passed
				RB 15	20.89	2	2	12.11	Passed
			16QAM	RB 1	20.96	2	2	12.04	Passed
				RB 15	19.86	2	2	13.14	Passed
		18900	QPSK	RB 1	22.16	2	2	10.84	Passed
				RB 15	21.23	2	2	11.77	Passed
			16QAM	RB 1	21.37	2	2	11.63	Passed
				RB 15	20.10	2	2	12.9	Passed
		19185	QPSK	RB 1	22.31	2	2	10.69	Passed
				RB 15	21.30	2	2	11.7	Passed
			16QAM	RB 1	21.23	2	2	11.77	Passed
				RB 15	20.33	2	2	12.67	Passed

Test Band	Bandwidth (MHz)	Channel	Modulation	RB	RMS Conducted Power (dBm)	FCC EIRP Limit (W)	IC EIRP Limit (W)	Maximum Antenna Gain (dBi)	Verdict
eFDD2	5	18625	QPSK	RB 1	22.01	2	2	10.99	Passed
				RB 12	20.95	2	2	12.05	Passed
				RB 25	21.03	2	2	11.97	Passed
			16QAM	RB 1	21.11	2	2	11.89	Passed
				RB 25	19.95	2	2	13.05	Passed
		18900	QPSK	RB 1	22.20	2	2	10.8	Passed
				RB 12	21.22	2	2	11.78	Passed
				RB 25	21.23	2	2	11.77	Passed
			16QAM	RB 1	21.33	2	2	11.67	Passed
				RB 25	20.28	2	2	12.72	Passed
		19175	QPSK	RB 1	22.44	2	2	10.56	Passed
				RB 12	21.45	2	2	11.55	Passed
				RB 25	21.38	2	2	11.62	Passed
			16QAM	RB 1	21.59	2	2	11.41	Passed
				RB 25	20.46	2	2	12.54	Passed
	10	18650	QPSK	RB 1	22.21	2	2	10.79	Passed
				RB 50	21.21	2	2	11.79	Passed
			16QAM	RB 1	21.43	2	2	11.57	Passed
				RB 50	20.17	2	2	12.83	Passed
		18900	QPSK	RB 1	22.26	2	2	10.74	Passed
				RB 50	21.22	2	2	11.78	Passed
			16QAM	RB 1	21.16	2	2	11.84	Passed
				RB 50	20.22	2	2	12.78	Passed
		19150	QPSK	RB 1	22.55	2	2	10.45	Passed
				RB 50	21.39	2	2	11.61	Passed
			16QAM	RB 1	21.49	2	2	11.51	Passed
				RB 50	20.32	2	2	12.68	Passed
	15	18675	QPSK	RB 1	22.36	2	2	10.64	Passed
				RB 36	21.06	2	2	11.94	Passed
				RB 75	21.21	2	2	11.79	Passed
			16QAM	RB 1	21.46	2	2	11.54	Passed
				RB 75	20.20	2	2	12.8	Passed
		18900	QPSK	RB 1	22.23	2	2	10.77	Passed
				RB 36	21.30	2	2	11.7	Passed
				RB 75	21.30	2	2	11.7	Passed
			16QAM	RB 1	21.20	2	2	11.8	Passed
				RB 75	20.27	2	2	12.73	Passed
		19125	QPSK	RB 1	22.58	2	2	10.42	Passed
				RB 36	21.23	2	2	11.77	Passed
				RB 75	21.38	2	2	11.62	Passed
			16QAM	RB 1	21.51	2	2	11.49	Passed
				RB 75	20.32	2	2	12.68	Passed

Test Band	Bandwidth (MHz)	Channel	Modulation	RB	RMS Conducted Power (dBm)	FCC EIRP Limit (W)	IC EIRP Limit (W)	Maximum Antenna Gain (dBi)	Verdict
eFDD2	20	18700	QPSK	RB 1	22.52	2	2	10.48	Passed
				RB 100	21.43	2	2	11.57	Passed
			16QAM	RB 1	21.53	2	2	11.47	Passed
				RB 100	20.38	2	2	12.62	Passed
		18900	QPSK	RB 1	22.30	2	2	10.7	Passed
				RB 100	21.42	2	2	11.58	Passed
			16QAM	RB 1	21.29	2	2	11.71	Passed
				RB 100	20.40	2	2	12.6	Passed
		19100	QPSK	RB 1	22.43	2	2	10.57	Passed
				RB 100	21.43	2	2	11.57	Passed
			16QAM	RB 100	20.40	2	2	12.6	Passed
				RB 1	21.50	2	2	11.5	Passed

3.2 Frequency stability

Standard FCC Part 24, Subpart E

The test was performed according to: FCC §2.1055

3.2.1 Test Description

1) The EUT was placed inside a temperature chamber.
2) The EUT was coupled to a Digital Communication Tester. Refer to chapter "Setup Drawings".
3) The climatic chamber was cycled down/up to a certain temperature, starting with the EUT minimum temperature.
4) After the temperature was stabilized the EUT was switched on and a call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Mid Channel
5) The frequency error of the EUT was recorded by using an internal measurement function of the Digital Communication Tester immediately after the call was established, five minutes after the call was established and ten minutes after the call was established.
6) This measurement procedure was performed for temperature variation from –30°C to +50°C in increments of 10°C, if not otherwise stated in the detailed results.
When the EUT did not operate at certain temperature levels, these measurements were left out.

3.2.2 Test Requirements / Limits

§2.1055 Measurements required: Frequency stability

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the

battery operating end point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.
The frequency stability shall be sufficient to ensure that he fundamental emission stays within the authorized frequency block.

3.2.3 Test Protocol

Channel: 18900/ 1.4MHz Bandwidth / 1 Resource Block / QPSK Modulation

Temp. °C	Duration min	Voltage	Limit Hz	Freq. error Average (Hz)	Freq. error Max. (Hz)	Verdict
-30	0	normal	4700	-3.68	-23.47	passed
-30	5			-3.28	-17.25	passed
-30	10			-4.31	-27.82	passed
-20	0	normal	4700	-1.9	-12.3	passed
-20	5			-0.96	-13.19	passed
-20	10			-1.34	11.99	passed
-10	0	normal	4700	-0.64	-11.84	passed
-10	5			-1.5	-15.34	passed
-10	10			-1.79	-12.35	passed
0	0	normal	4700	-1.79	-10.66	passed
0	5			-1.13	13.13	passed
0	10			-2.92	-15.11	passed
10	0	normal	4700	-4.79	-21.84	passed
10	5			-2.22	-21.92	passed
10	10			-1.97	-15.45	passed
20	0	low	4700	-1.16	-16.26	passed
20	5			-0.74	14.05	passed
20	10			-1.83	-9.43	passed
20	0	normal	4700	-1.34	16.36	passed
20	5			-1.34	-11.76	passed
20	10			-1.63	-13.79	passed
20	0	high	4700	-0.23	-15.09	passed
20	5			-0.51	11.03	passed
20	10			-1.49	-14.45	passed
30	0	normal	4700	-1.56	-19.88	passed
30	5			-0.82	-11.73	passed
30	10			-1.13	-11.3	passed
40	0	normal	4700	-1.16	13.86	passed
40	5			-1.92	-16.41	passed
40	10			-1.02	71.38	passed
50	0	normal	4700	-0.97	-16.32	passed
50	5			-1.03	-10.9	passed
50	10			-2.15	-16.38	passed

3.3 Spurious emissions at antenna terminals

Standard FCC Part 24, Subpart E

The test was performed according to FCC §2.1051

3.3.1 Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings
- [Resolution Bandwidth]:
a) [>=1% of wanted signal bandwidth] in the Span of 1 MHz directly below and above the PCS-Band,
b) otherwise [100 kHz] (or [1 MHz] for accelerated sweep times)
c) [reduced resolution bandwidth] in case the curve of the analyser IF-Filter or the wanted EUT signal leads to an exceeding of the limit, in this case a correction factor was used
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
5) The spurious emissions peaks were measured in the frequency range from 9 kHz to 10 GHz (up to the 10th harmonic) during the call was established

3.3.2 Test Requirements / Limits

§ 2.1051 Spurious emissions at antenna terminals

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in Sec. 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Sec. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the

permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 24.238 Emission limitations for Broadband PCS equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
Remark of the test laboratory: This is calculated to be -13 dBm.
(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

3.3.3 Test Protocol

Band / Bandwidth, Resource Blocks	Modulation (MHz)	Channel	Detector	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Margin to Limit /dB	Limit /dBm	Verdict
eFDD2 / 5MHz, 1RB	QPSK	18625	rms	100	1849.000	-24.4	11.4	-13.0	Passed
		18900	rms	-	-	-	-	-13.0	Passed
		19175	rms	100	1911.000	-21.8	8.8	-13.0	Passed
	16QAM	18625	rms	100	1849.000	-24.6	11.6	-13.0	Passed
		18900	rms	-	-	-	-	-13.0	Passed
		19175	rms	100	1911.000	-22.6	9.6	-13.0	Passed

no further values have been found with a margin of less than 20 dB

3.4 Emission and Occupied Bandwidth

Standard FCC Part 24, Subpart E

The test was performed according to: FCC §2.1049

3.4.1 Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth: >1% of the manufacturer's stated occupied bandwidth
5) The maximum spectral level of the modulated signal was recorded as the reference.
6) The emission bandwidth is measured as follows:
the two furthest frequencies above and below the frequency of the maximum reference level where the spectrum is –26 dB down have to be found.
7) The occupied bandwidth (99% Bandwidth) is measured as follows:
the occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5 percent of the total mean power.

The maximum number of resource blocks are used for each channel bandwidth.

3.4.2 Test Requirements / Limits

§ 2.1049 Measurements required: Occupied bandwidth

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions (as applicable):

(h) Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

3.4.3 Test Protocol

The maximum number of resource blocks are used for each channel bandwidth.

LTE Band 2							
Channel BW: 1.4 MHz				Channel BW: 3 MHz			
		99% BW (MHz)				99% BW (MHz)	
Channel	Frequency (MHz)	QPSK	16QAM	Channel	Frequency (MHz)	QPSK	16QAM
18607	1850.7	1.1	1.1	18615	1851.5	2.8	2.8
18900	1880.0	1.1	1.1	18900	1880.0	2.8	2.8
19193	1909.3	1.1	1.1	19185	1908.5	2.8	2.8

LTE Band 2							
Channel BW: 5MHz				Channel BW: 10 MHz			
		99% BW (MHz)				99% BW (MHz)	
Channel	Frequency (MHz)	QPSK	16QAM	Channel	Frequency (MHz)	QPSK	16QAM
18625	1852.5	4.5	4.6	18650	1855.0	9.1	9.1
18900	1880.0	4.5	4.6	18900	1880.0	9.1	9.1
19175	1907.5	4.6	4.5	19150	1905.0	9.1	9.1

LTE Band 2							
Channel BW: 15MHz				Channel BW: 20 MHz			
		99% BW (MHz)				99% BW (MHz)	
Channel	Frequency (MHz)	QPSK	16QAM	Channel	Frequency (MHz)	QPSK	16QAM
18675	1857.5	13.5	13.6	18700	1860.0	18.0	18.1
18900	1880.0	13.6	13.5	18900	1880.0	18.1	18.0
19125	1902.5	13.6	13.6	19100	1900.0	18.1	18.1

3.5 Band edge compliance

Standard FCC Part 24, Subpart E

The test was performed according to: FCC §24.238

3.5.1 Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth = Video Bandwidth: >1% of the manufacturer’s stated occupied bandwidth

3.5.2 Test Requirements / Limits

§ 24.238 Effective radiated power limits

Refer to chapter "Field strength of spurious radiation".

3.5.3 Test Protocol

Band	Bandwidth (MHz)	Modulation	Resource Blocks / Offset	Channel	Detector	Frequency (MHz)	Peak Value (dBm)	Limit (dBm)	Verdict
eFDD2	1.4	QPSK	6 / 0	18607	Average	1850	-24.3	-13	Passed
					RMS	1850	-22.62	-13	Passed
			6 / Max	19193	Average	1910	-24.78	-13	Passed
					RMS	1910	-22.62	-13	Passed
		16QAM	6/ 0	18607	Average	1850	-23.42	-13	Passed
					RMS	1850	-21.88	-13	Passed
			6 / Max	19193	Average	1910	-24.78	-13	Passed
					RMS	1910	-23.14	-13	Passed
	3	QPSK	15 / 0	18615	Average	1850	-26.8	-13	Passed
					RMS	1850	-24	-13	Passed
			15 / Max	19185	Average	1910	-26.6	-13	Passed
					RMS	1910	-24.15	-13	Passed
		16QAM	15 / 0	18615	Average	1850	-27.22	-13	Passed
					RMS	1850	-24.3	-13	Passed
			15 / Max	19185	Average	1910	-27.44	-13	Passed
					RMS	1910	-24.95	-13	Passed
	5	QPSK	25 / 0	18625	Average	1850	-29.16	-13	Passed
					RMS	1850	-25.64	-13	Passed
			25 / Max	19175	Average	1910	-27.9	-13	Passed
					RMS	1910	-25.29	-13	Passed
		16QAM	25 / 0	18625	Average	1850	-30.64	-13	Passed
					RMS	1850	-27.22	-13	Passed
			25 / Max	19175	Average	1910	-28.64	-13	Passed
					RMS	1910	-26.01	-13	Passed
	10	QPSK	50/ 0	18650	Average	1850	-32.42	-13	Passed
					RMS	1850	-30.32	-13	Passed
			50 / Max	19150	Average	1910	-30.64	-13	Passed
					RMS	1910	-28.9	-13	Passed
		16QAM	50 / 0	18650	Average	1850	-32.42	-13	Passed
					RMS	1850	-30.32	-13	Passed
			50 / Max	19150	Average	1910	-31.66	-13	Passed
					RMS	1910	-30.02	-13	Passed
	15	QPSK	75 / 0	18675	Average	1850	-32.42	-13	Passed
					RMS	1850	-30.97	-13	Passed
			75 / Max	19125	Average	1910	-29.16	-13	Passed
					RMS	1910	-27.9	-13	Passed
		16QAM	75 / 0	18675	Average	1850	-33.24	-13	Passed
					RMS	1850	-31.66	-13	Passed
			75 / Max	19125	Average	1910	-30.32	-13	Passed
					RMS	1910	-29.16	-13	Passed

Band	Bandwidth (MHz)	Modulation	Resource Blocks / Offset	Channel	Detector	Frequency (MHz)	Peak Value (dBm)	Limit (dBm)	Verdict
eFDD2	20	QPSK	100 / 0	18700	Average	1850	-34.16	-13	Passed
					RMS	1850	-33.24	-13	Passed
			100 / Max	19100	Average	1910	-30.02	-13	Passed
					RMS	1910	-29.16	-13	Passed
		16QAM	100 / 0	18700	Average	1850	-35.18	-13	Passed
					RMS	1850	-34.16	-13	Passed
			100 / Max	19100	Average	1910	-31.31	-13	Passed
					RMS	1910	-30.64	-13	Passed

3.6 Power to Average Ratio

Standard §2.1046, §24.232

The test was performed according to: §2.1046, §24.232

A peak to average ratio measurement is performed at the conducted port of the EUT. The spectrum analyzers Complementary Cumulative Distribution Function (CCDF) measurement profile is used to determine the largest deviation between the average and the peak power of the EUT in a given bandwidth.
The CCDF curve shows how much time the peak waveform spends at or above a given average power level. The percent of time the signal spends at or above the level defines the probability for that particular power level.

KDB 971168 v02r01 – Section 5.7.1 was applied.

Test Settings
1. The signal analyzer's CCDF measurement profile is enabled
2. Frequency = carrier center frequency
3. Measurement BW > Emission bandwidth of signal
4. The signal analyser was set to collect one million samples to generate the CCDF curve
5. The measurement interval was set depending on the type of signal analysed. For continuous
signals (>98% duty cycle), the measurement interval was set to 1ms.

3.6.1 Test Protocol

Band	Bandwidth / Resource Blocks	Channel	Modulation	Measured Value (dB)	Limit (dB)	Verdict
eFDD2	1.4 MHz / 6 RB	18607	QPSK	5.51	13	Passed
		18900		5.71	13	Passed
		19193		5.39	13	Passed
		18607	16-QAM	6.43	13	Passed
		18900		6.38	13	Passed
		19193		6.17	13	Passed

3.7 Field strength of spurious radiation

3.7.1 Test Description

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to the R&S CMW500 Digital Communication Tester which was located outside the chamber via coaxial cable.
2) A call was established on a Traffic Channel (TCH) between the EUT and the base station simulator (R&S CMW500 Digital Communication Tester).
Important Settings:
- Discontinuous Transmission: OFF
- Modulation Signal: PSR16-1 (Pseudo Random Sequence)
- Output Power: Maximum
- Channel : Varied during measurements
3) A pre-calibration procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
4) All spurious radiation measurements were made with spectrum analyser and the appropriate calibrated antennas for the frequency range of 30 MHz to 20 GHz (up to the 10th harmonic of the transmit frequency).
5) Important Analyser Settings
- [Resolution Bandwidth / Video Bandwidth]:
a) [>1% of Emission Bandwidth] in the Span of 1 MHz directly below and above the LTE-Band,
b) [100 kHz / 100 kHz] in case the curve of the analyser IF-Filter leads to an exceeding of the limit, in this case a worst case correction factor of 10 dB (1 MHz -> 10 kHz) was used
c) [1 MHz / 1 MHz] otherwise
- Sweep Time: Calculated by using a formula given in the Product Standard "11.10-1 edition 4" for spurious emissions measurements (depending on the transmitting signal, the span and the resolution bandwidth)
6) The spurious emissions (peak) were measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid channel and on the highest channel.
7) After this initial test, a final test according to TIA-603-C 2.2.12 Unwanted Emissions is performed on signals which are identified as being close to the limit. For any emissions found to be within 10 dB of the limit, a specific signal substitution measurement is performed at the frequency of the emission to determine the exact e.i.r.p. value.

3.7.2 Test Requirements / Limits

§ 2.1053 Measurements required: Field strength of spurious radiation.

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of Sec. 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements.

Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
(2) All equipment operating on frequencies higher than 25 MHz.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 24.238 Emission limitations for Broadband PCS equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
This is calculated to be -13 dBm (effective radiated power) which corresponds to 84.6 dBµV/m (field strength) in a distance of 3 m.
(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

3.7.3 Test Protocol

eFDD2 worst case of pre-measurement (3 MHz 15RB)

detector	resolution bandwidth /kHz	frequency /MHz	peak value /dBm	limit /dBm	margin to limit /dB	verdict
rms	100	1848.96	-24.79	-13	11.79	passed
rms	30	1849.992	-22.73	-13	9.73	passed
rms	30	1910.008	-24.37	-13.00	11.37	passed
rms	100	1911.00	-21.67	-13.00	8.67	passed

no further values have been found with a margin of less than 20 dB

4 Test Equipment

The calibration, hardware and software states are shown for the testing period.

Test Equipment Anechoic Chamber

Lab ID:	**Lab 1**
Manufacturer:	Frankonia
Description:	Anechoic Chamber for radiated testing
Type:	10.58x6.38x6.00 m³

Calibration Details	*Last Execution*	*Next Exec.*
NSA (FCC)	2014/01/09	2017/01/09

Single Devices for Anechoic Chamber

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Air compressor	none	-	Atlas Copco	
Anechoic Chamber	10.58 x 6.38 x 6.00 m³	none	Frankonia	
	Calibration Details		*Last Execution*	*Next Exec.*
	FCC listing 96716 3m Part15/18		2014/01/09	2017/01/08
Controller Maturo	MCU	961208	Maturo GmbH	
EMC camera	CE-CAM/1	-	CE-SYS	
EMC camera Nr.2	CCD-400E	0005033	Mitsubishi	
Filter ISDN	B84312-C110-E1		Siemens&Matsushita	
Filter Universal 1A	BB4312-C30-H3	-	Siemens&Matsushita	

Test Equipment Auxiliary Equipment for Radiated emissions

Lab ID:	**Lab 1**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Auxiliary Equipment for Radiated emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Antenna mast	AM 4.0	AM4.0/180/11920513	Maturo GmbH	
Biconical Broadband Antenna	SBA 9119	9119-005	Schwarzbeck	
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck	
Broadband Amplifier 18MHz-26GHz	JS4-18002600-32-5P	849785	Miteq	
Broadband Amplifier 1GHz-4GHz	AFS4-01000400-1Q-10P-4	-	Miteq	
Broadband Amplifier 30MHz-18GHz	JS4-00101800-35-5P	896037	Miteq	
Cable "ESI to EMI Antenna"	EcoFlex10	W18.01-2+W38.01-2	Kabel Kusch	
Cable "ESI to Horn Antenna"	UFB311A+UFB293C	W18.02-2+W38.02-2	Rosenberger Micro-Coax	
Double-ridged horn	HF 906	357357/001	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2012/05/18	2015/05/17

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2012/06/26	2015/06/25
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic	
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic	
High Pass Filter	5HC3500/12750-1.2-KK	200035008	Trilithic	
High Pass Filter	WHKX 7.0/18G-8SS	09	Wainwright	
Horn Antenna Schwarzbeck 15-26 GHz BBHA 9170	BBHA 9170	BBHA9170262		
Log.-per. Antenna	HL 562 Ultralog	100609	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2012/12/18	2015/12/17
Log.-per. Antenna	HL 562 Ultralog	830547/003	Rohde & Schwarz GmbH & Co. KG	
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	DKD Calibration		2014/11/27	2017/11/27
Standard Gain / Pyramidal Horn Antenna 26,5 GHz	3160-09	00083069	EMCO Elektronik GmbH	
Standard Gain / Pyramidal Horn Antenna 40 GHz	3160-10	00086675	EMCO Elektronik GmbH	
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.5-10kg/024/3790709	Maturo GmbH	

Test Equipment Auxiliary Test Equipment

Lab ID:	**Lab 1, Lab 2**
Manufacturer:	see single devices
Description:	Single Devices for various Test Equipment
Type:	various
Serial Number:	none

Single Devices for Auxiliary Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
AC Power Source	Chroma 6404	64040001304	Chroma ATE INC.
Broadband Power Divider N (Aux)	1506A / 93459	LM390	Weinschel Associates
Broadband Power Divider SMA	WA1515	A855	Weinschel Associates
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.
	Calibration Details		*Last Execution* *Next Exec.*
	Customized calibration		2013/12/04 2015/12/03
Fibre optic link Satellite (Aux)	FO RS232 Link	181-018	Pontis
Fibre optic link Transceiver (Aux)	FO RS232 Link	182-018	Pontis
Isolating Transformer	LTS 604	1888	Thalheimer Transformatorenwerke GmbH
Notch Filter Ultra Stable (Aux)	WRCA800/960-6EEK	24	Wainwright
Signal Analyzer	FSV30	103005	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard		2014/02/10 2016/02/09
Spectrum Analyser	FSP3	836722/011	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard		2012/06/13 2015/06/12
Spectrum Analyser	FSU26	200418	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2014/07/29 2015/07/28
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG

Test Equipment Digital Signalling Devices

Lab ID: **Lab 1, Lab 2**
Description: Signalling equipment for various wireless technologies.

Single Devices for Digital Signalling Devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Bluetooth Signalling Unit CBT	CBT	100589	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standart calibration		2015/01/21	2018/01/19
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/01/27	2016/01/26
Digital Radio Communication Tester	CMD 55	831050/020	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	DKD calibration		2014/12/02	2017/12/01
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG	
	HW/SW Status		*Date of Start*	*Date of End*
	Hardware: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04 Software: K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22 Firmware: µP1 8v50 02.05.06 ---		2007/07/16	
Universal Radio Communication Tester	CMU 200	837983/052	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	DKD calibration		2014/12/03	2017/12/02
	HW/SW Status		*Date of Start*	*Date of End*
	HW options: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02 SW options: K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10, Firmware: µP1 8v40 01.12.05 ---		2007/01/02	
	SW: K62, K69		2008/11/03	
Vector Signal Generator	SMU200A	100912	Rohde & Schwarz GmbH & Co. KG	

Test Equipment Emission measurement devices

Lab ID:	**Lab 1**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Emission measurement devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
EMI Receiver / Spectrum Analyser	ESR 7	101424	Rohde & Schwarz	
	Calibration Details		*Last Execution*	*Next Exec.*
	Initial Factory Calibration		2014/11/13	2016/11/12
Personal Computer	Dell	30304832059	Dell	
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/05/13	2015/05/12
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/05/13	2015/05/12
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2014/06/24	2017/06/23
Spectrum Analyser	FSW 43	103779	Rohde & Schwarz	
	Calibration Details		*Last Execution*	*Next Exec.*
	Initial Factory Calibration		2014/11/17	2016/11/16
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2014/01/07	2016/01/31
	HW/SW Status		*Date of Start*	*Date of End*
	Firmware-Update 4.34.4 from 3.45 during calibration		2009/12/03	

Test Equipment Radio Lab Test Equipment

Lab ID: **Lab 2**
Description: Radio Lab Test Equipment

Single Devices for Radio Lab Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Broadband Power Divider SMA	WA1515	A856	Weinschel Associates
Coax Attenuator 10dB SMA 2W	4T-10	F9401	Weinschel Associates
Coax Attenuator 10dB SMA 2W	56-10	W3702	Weinschel Associates
Coax Attenuator 10dB SMA 2W	56-10	W3711	Weinschel Associates
Coax Cable Huber&Suhner	Sucotest 2,0m		Huber&Suhner
Coax Cable Rosenberger Micro Coax FA210A0010003030 SMA/SMA 1,0m	FA210A0010003030	54491-2	Rosenberger Micro-Coax
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2014/05/13 2015/05/12
RF Step Attenuator RSP	RSP	833695/001	Rohde & Schwarz GmbH & Co.KG
Rubidium Frequency Standard	Datum, Model: MFS	5489/001	Datum-Beverly
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2014/07/03 2015/07/02
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2014/05/13 2015/05/12
Signal Generator SME	SME03	827460/016	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2014/12/02 2017/12/01
Signal Generator SMP	SMP02	836402/008	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2013/05/06 2016/05/05
Spectrum Analyser	FSIQ26	840061/005	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Calibration after reparation		2015/04/02 2017/04/01

Test Equipment T/A Logger 13

Lab ID:	**Lab 1, Lab 2**
Description:	Lufft Opus10 TPR
Type:	Opus10 TPR
Serial Number:	13936

Single Devices for T/A Logger 13

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoAirpressure Datalogger 13 (Environ)	Opus10 TPR (8253.00)	13936	Lufft Mess- und Regeltechnik GmbH

Calibration Details	*Last Execution*	*Next Exec.*
Customized calibration	2015/02/27	2017/02/26

Test Equipment T/H Logger 03

Lab ID:	**Lab 2**
Description:	Lufft Opus10
Serial Number:	7482

Single Devices for T/H Logger 03

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoHygro Datalogger 03 (Environ)	Opus10 THI (8152.00)	7482	Lufft Mess- und Regeltechnik GmbH

Calibration Details	*Last Execution*	*Next Exec.*
Customized calibration	2015/02/27	2017/02/26

Test Equipment T/H Logger 12

Lab ID:	**Lab 1**
Description:	Lufft Opus10
Serial Number:	12482

Single Devices for T/H Logger 12

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoHygro Datalogger 12 (Environ)	Opus10 THI (8152.00)	12482	Lufft Mess- und Regeltechnik GmbH

Calibration Details	*Last Execution*	*Next Exec.*
Customized calibration	2015/03/10	2017/03/09

Test Equipment Temperature Chamber 05

Lab ID:	**Lab 2**
Manufacturer:	see single devices
Description:	Temperature Chamber VT4002
Type:	Vötsch
Serial Number:	see single devices

Single Devices for Temperature Chamber 05

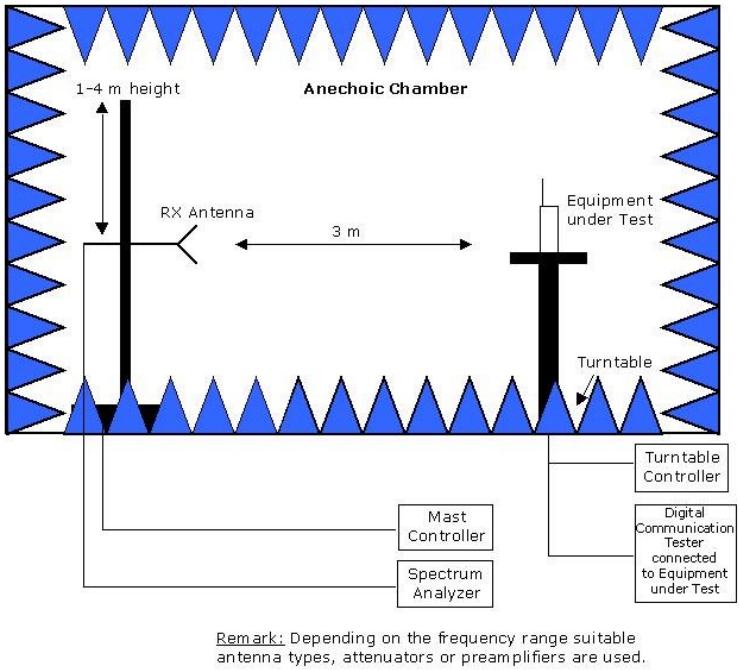
Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Temperature Chamber Vötsch 05	VT 4002	58566080550010	Vötsch

Calibration Details	*Last Execution*	*Next Exec.*
Customized calibration	2014/03/11	2016/03/10

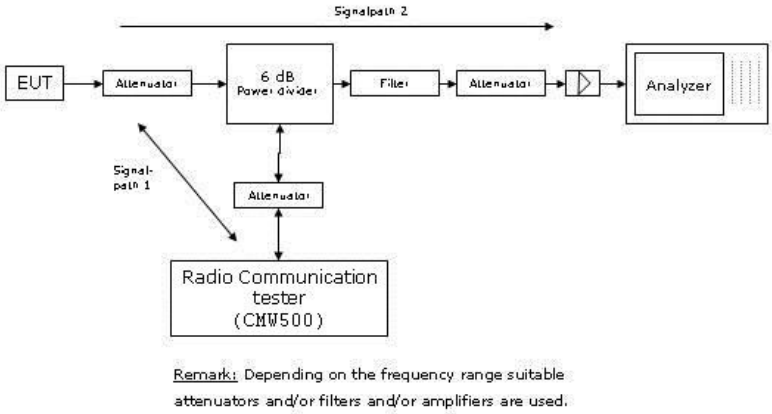
5 Photo Report

Photos are included in an external report.

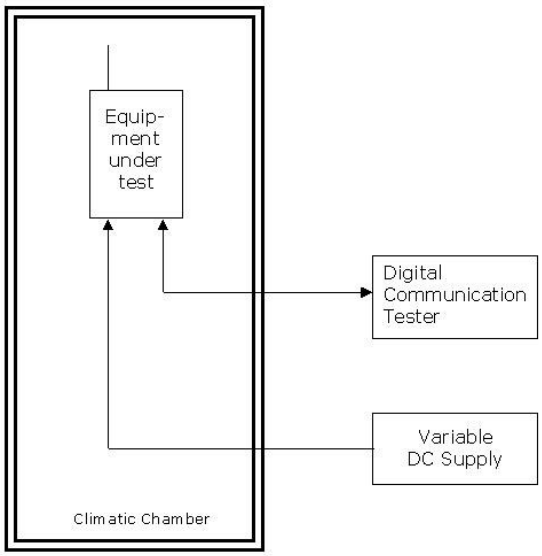
6 Setup Drawings



Drawing 1: Setup in the anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting ground plane.



Principle set-up for conducted measurements under nominal conditions

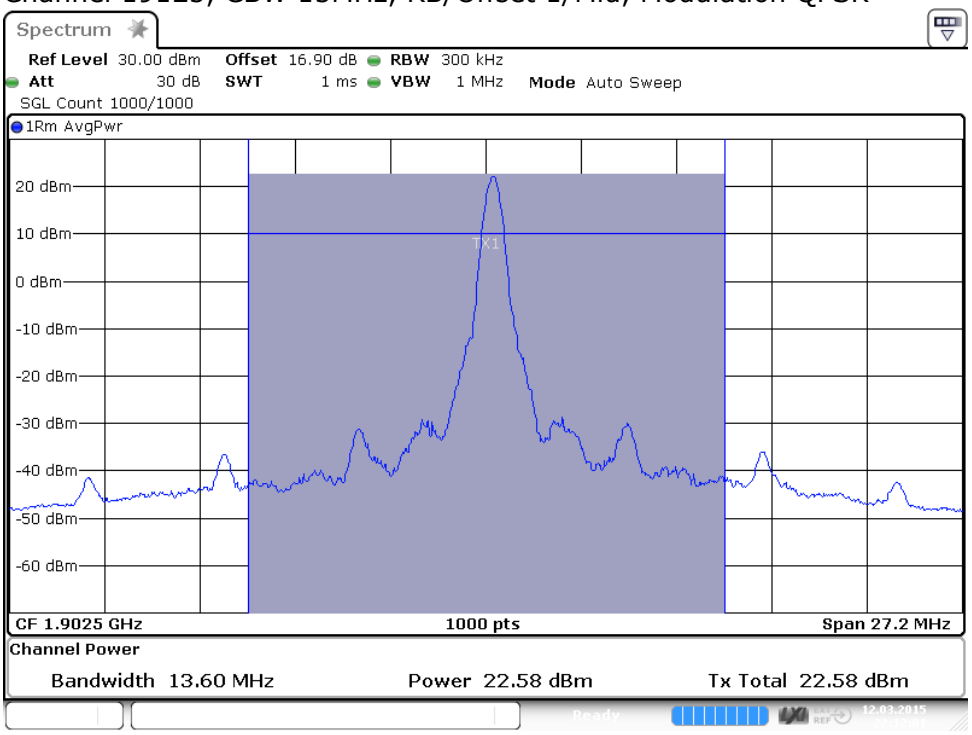


Principle set-up for tests under extreme test conditions

7 Annex measurement plots

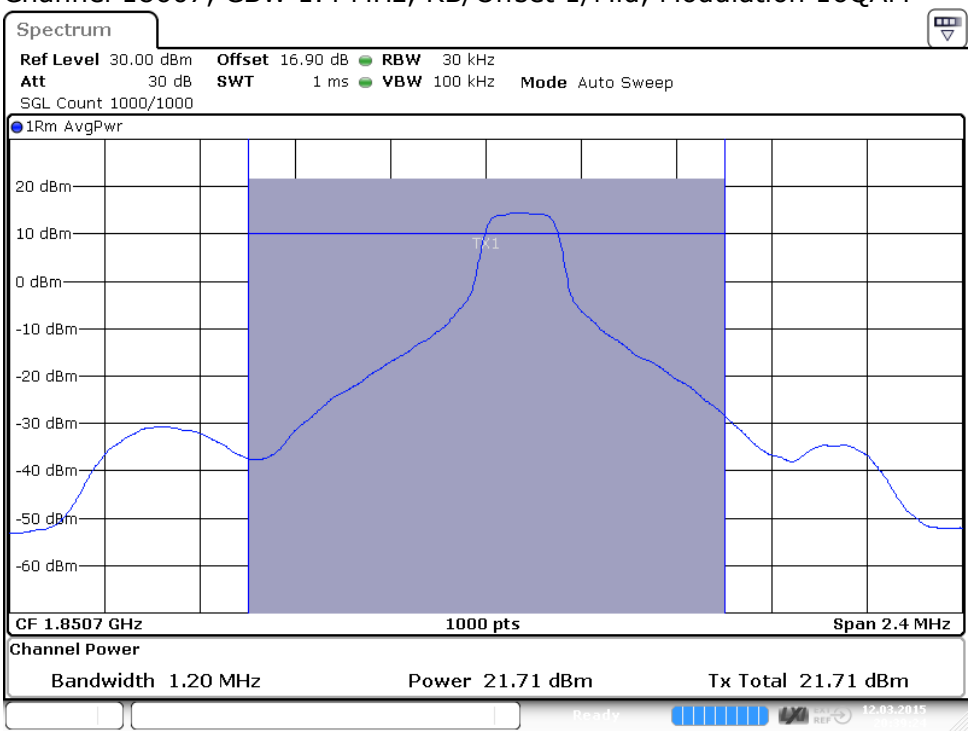
7.1 RF Power Output §2.1046, §24.232

Channel 19125, CBW 15MHz, RB/Offset 1/Mid, Modulation QPSK



Date: 12.MAR.2015 22:12:01

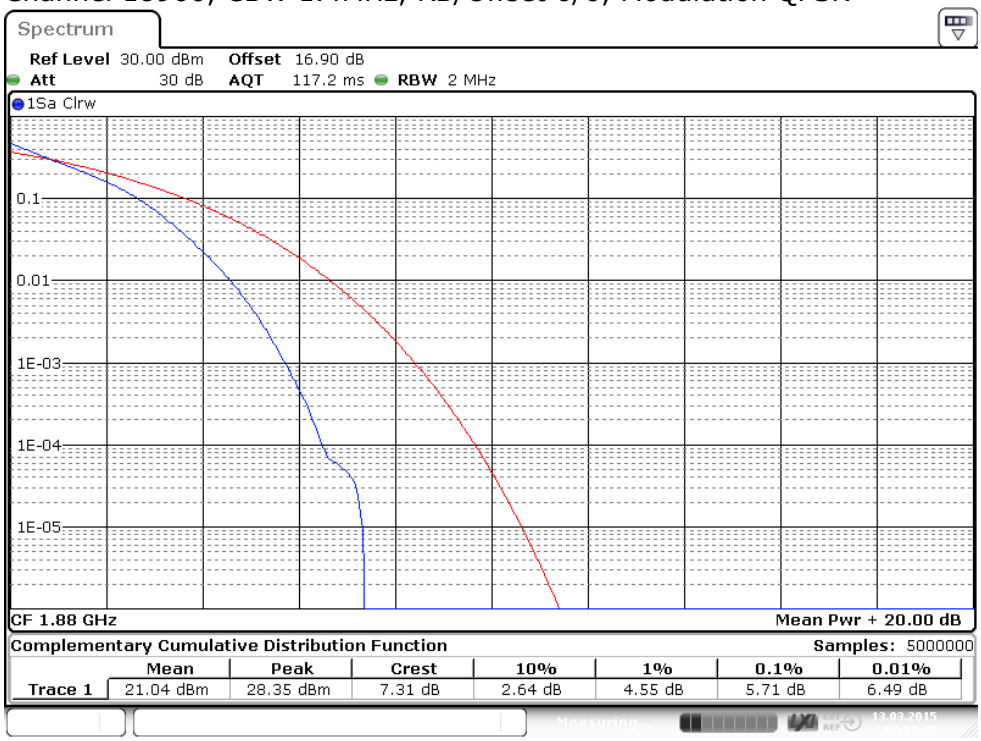
Channel 18607, CBW 1.4 MHz, RB/Offset 1/Mid, Modulation 16QAM



Date: 12.MAR.2015 20:39:24

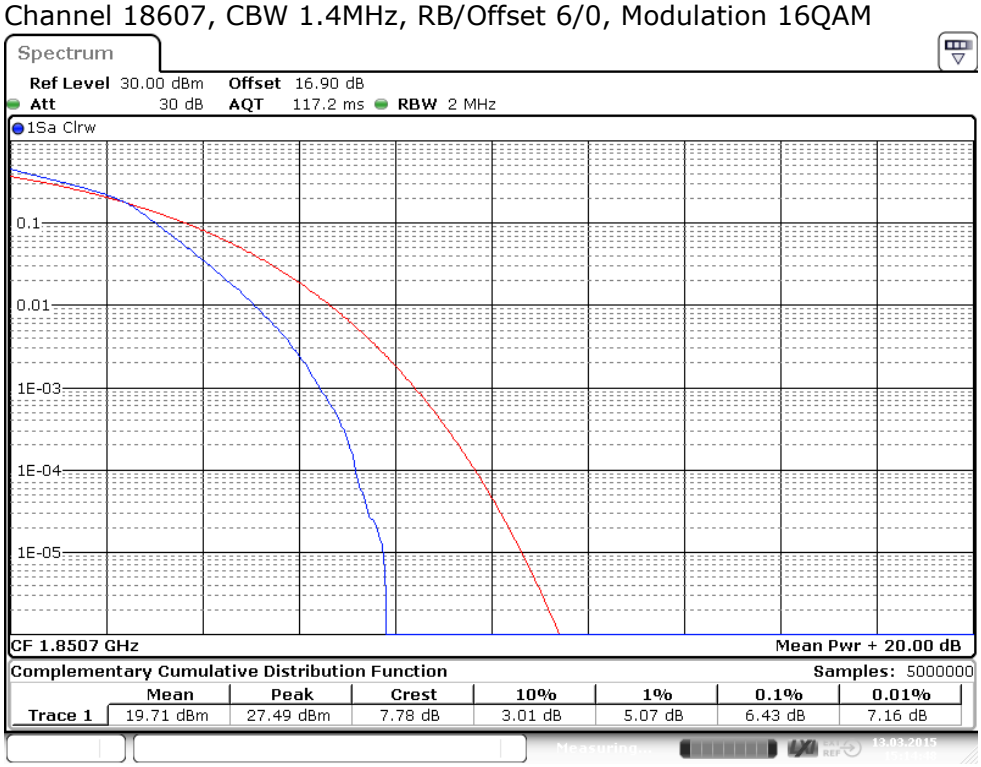
7.2 Peak to Average Ratio §2.1046, §24.232

Channel 18900, CBW 1.4MHz, RB/Offset 6/0, Modulation QPSK



Date: 13.MAR.2015 15:13:25

Channel 18607, CBW 1.4MHz, RB/Offset 6/0, Modulation 16QAM

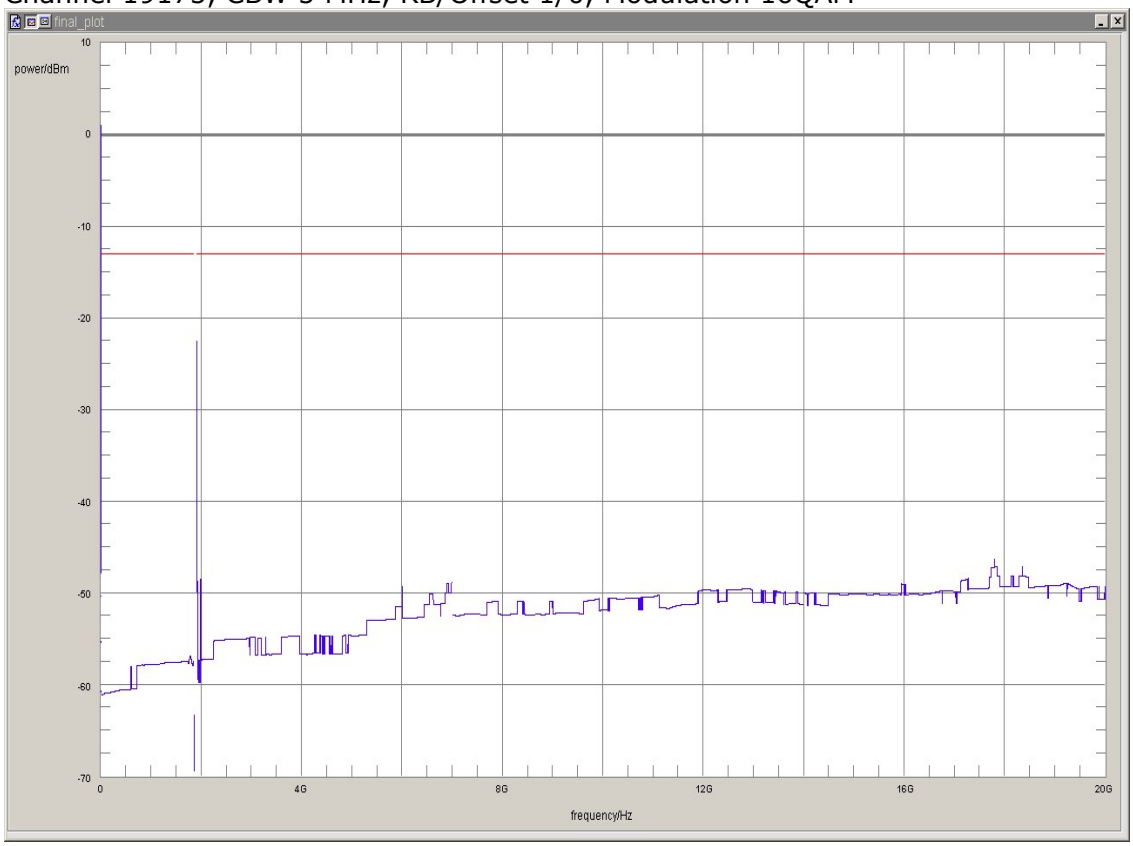


Date: 13.MAR.2015 15:14:47

7.3 Spurious emissions at antenna terminals §2.1051, §24.238

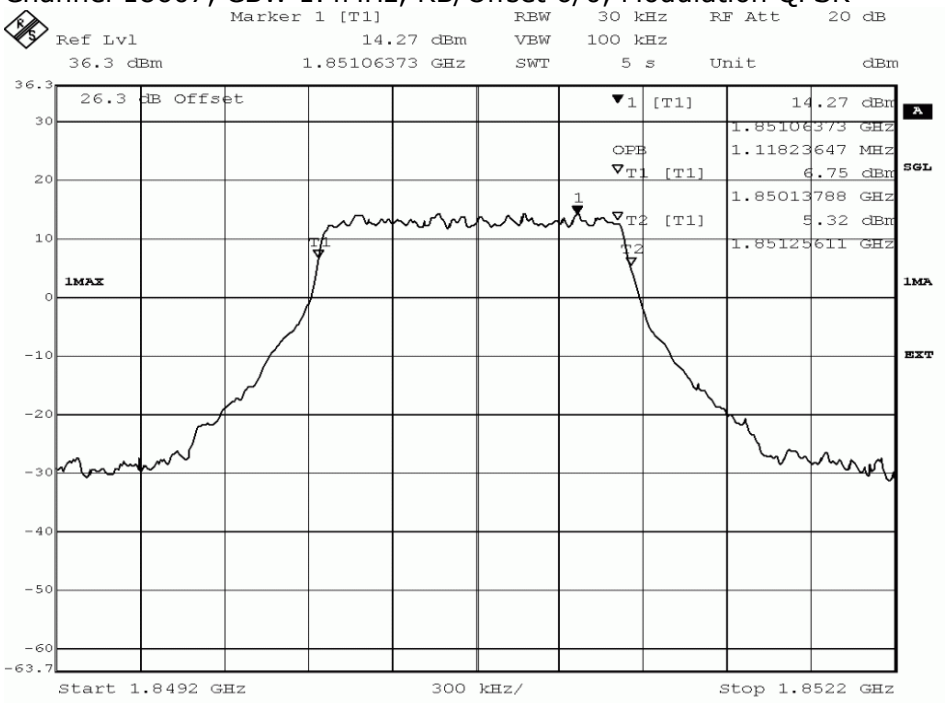
Channel 19175, CBW 5 MHz, RB/Offset 1/0, Modulation QPSK

Channel 19175, CBW 5 MHz, RB/Offset 1/0, Modulation 16QAM

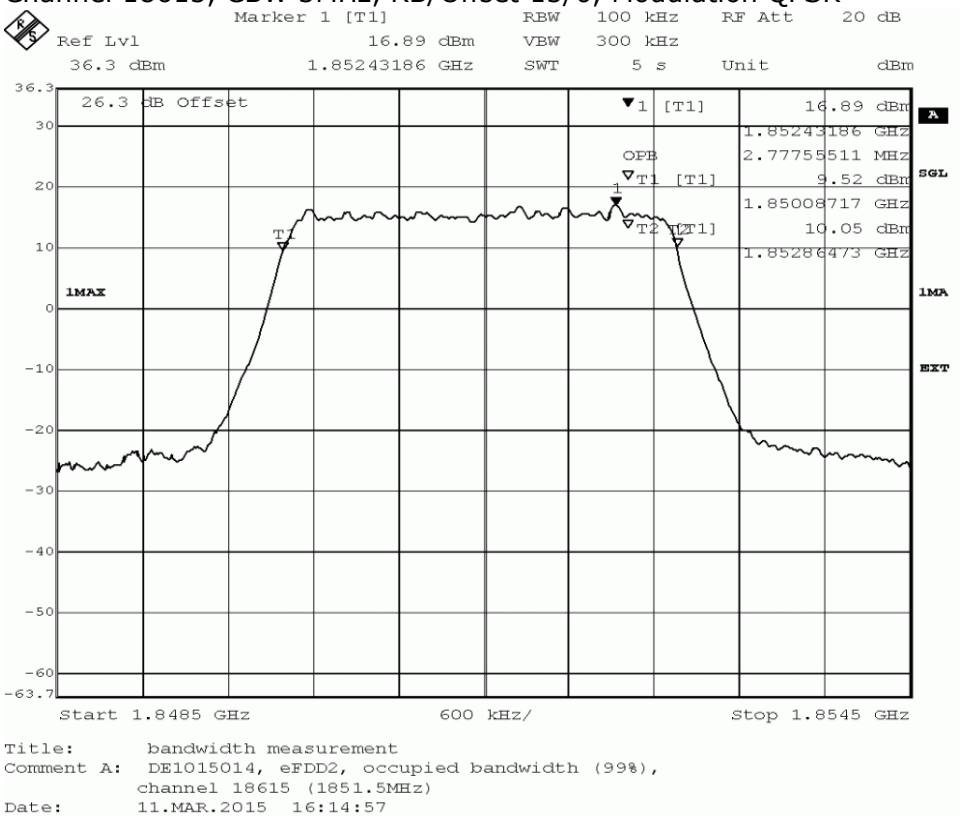


7.4 Emission and Occupied Bandwidth §2.1049, §24.238

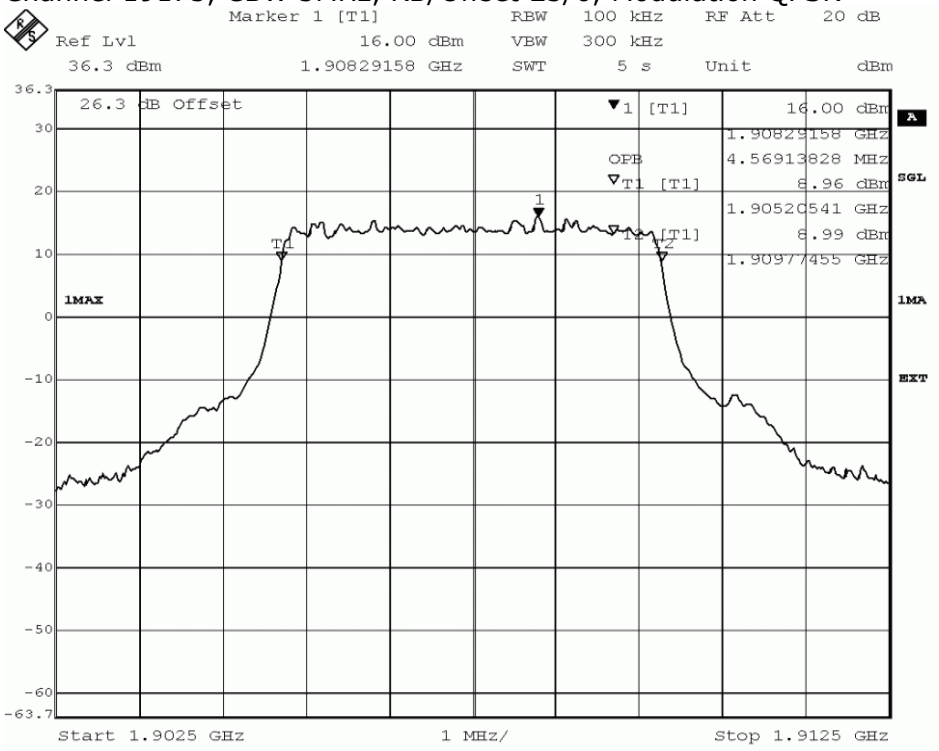
Channel 18607, CBW 1.4MHz, RB/Offset 6/0, Modulation QPSK



Channel 18615, CBW 3MHz, RB/Offset 15/0, Modulation QPSK

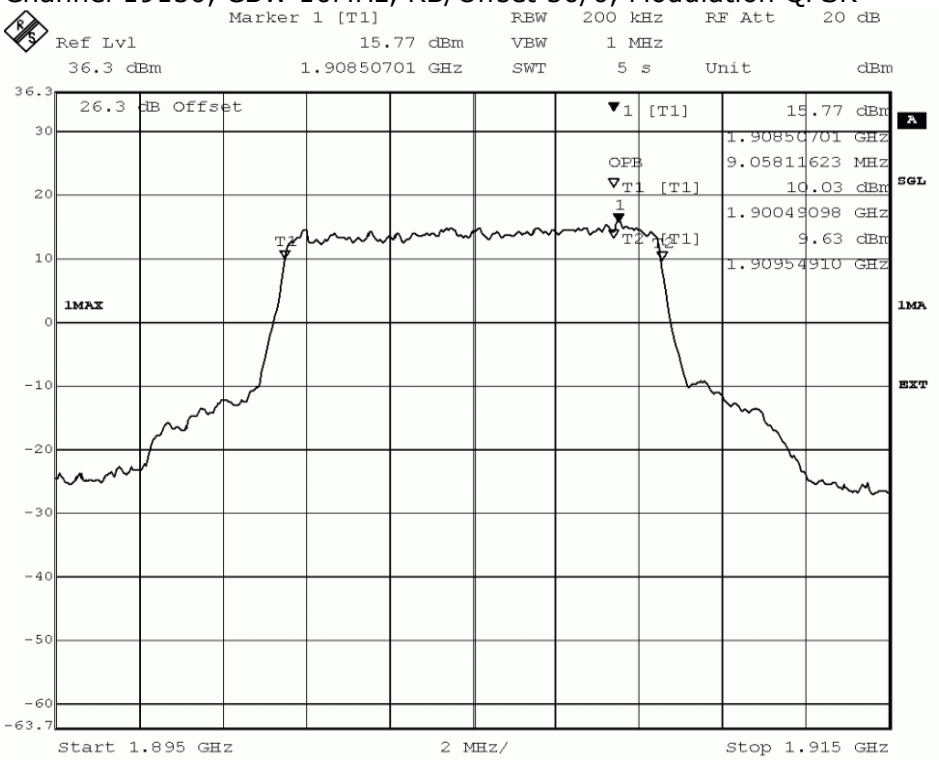


Channel 19175, CBW 5MHz, RB/Offset 25/0, Modulation QPSK



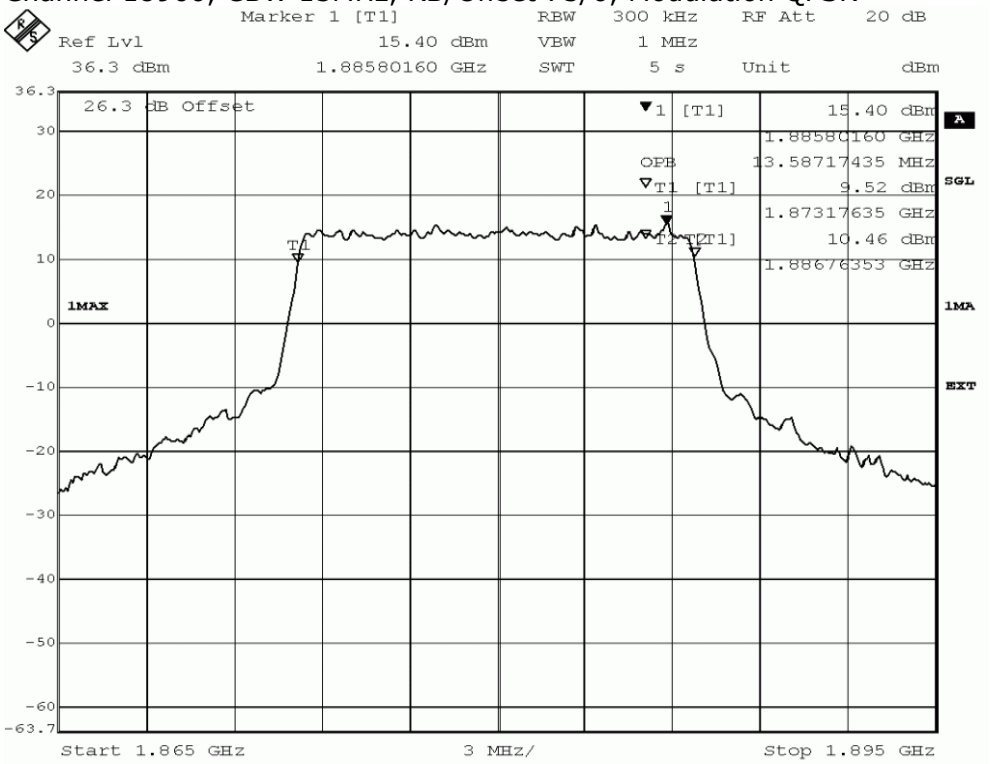
Title: bandwidth measurement
Comment A: De1015014, eFDD2, occupied bandwidth (99%),
channel 19193 (1909.3MHz)
Date: 11.MAR.2015 16:30:04

Channel 19150, CBW 10MHz, RB/Offset 50/0, Modulation QPSK



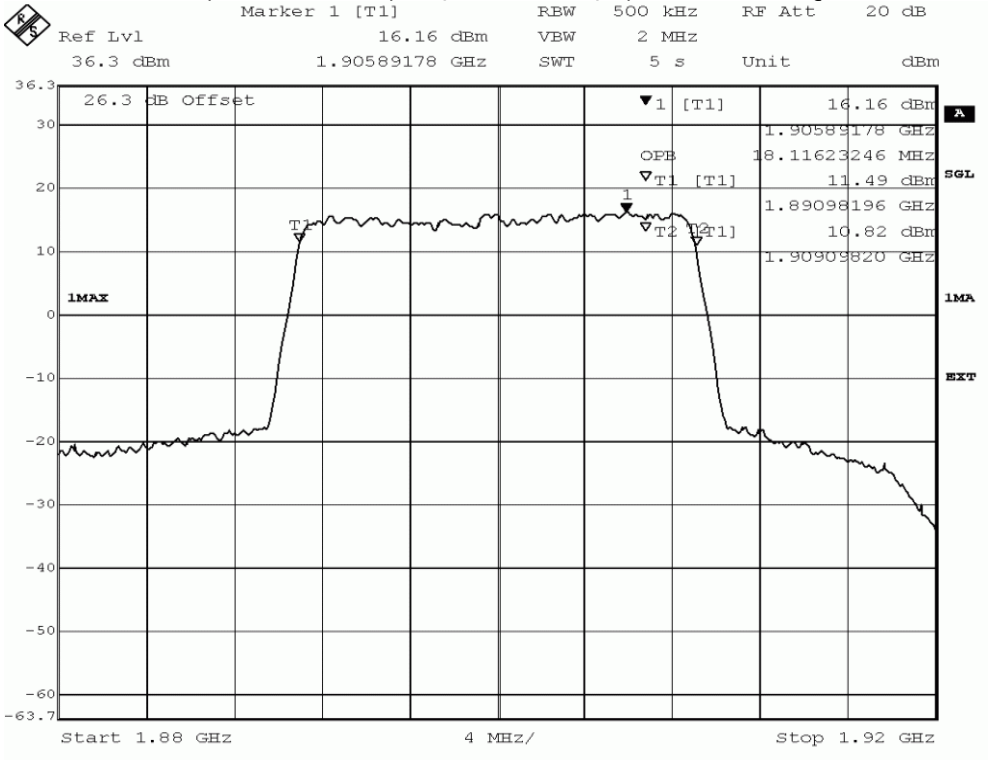
Title: bandwidth measurement
Comment A: DE1015014, eFDD2, occupied bandwidth (99%),
channel 19150 (1905.0MHz)
Date: 11.MAR.2015 16:40:08

Channel 18900, CBW 15MHz, RB/Offset 75/0, Modulation QPSK



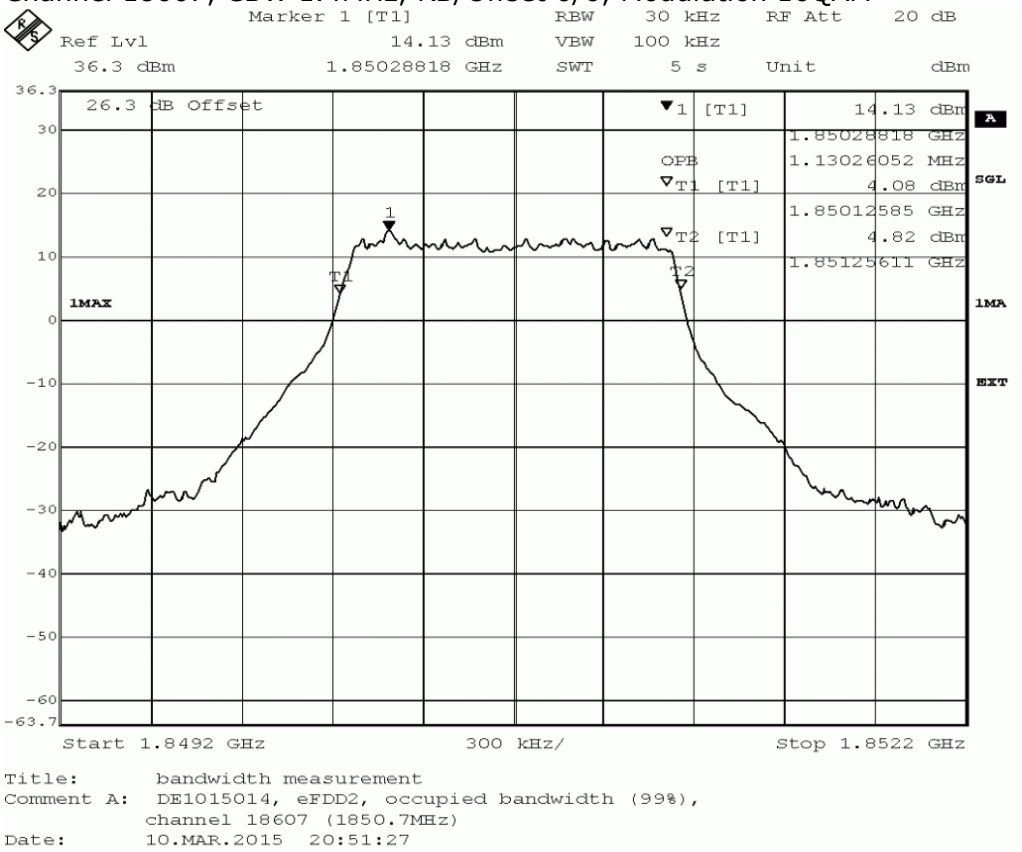
Title: bandwidth measurement
Comment A: DE1015014, eFDD2, occupied bandwidth (99%),
channel 18900 (1880.0MHz)
Date: 11.MAR.2015 16:51:23

Channel 19100, CBW 20MHz, RB/Offset 100/0, Modulation QPSK



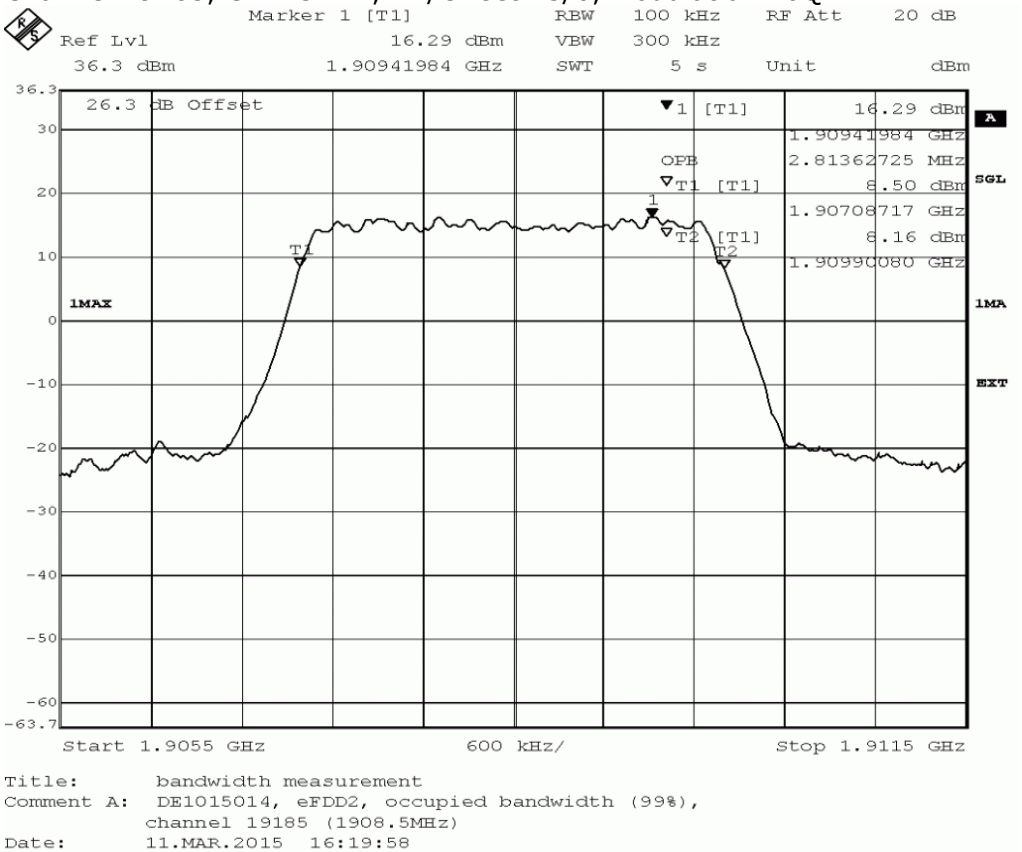
Title: bandwidth measurement
Comment A: DE1015014, eFDD2, occupied bandwidth (99%),
channel 19100 (1900.0MHz)
Date: 11.MAR.2015 17:08:15

Channel 18607, CBW 1.4MHz, RB/Offset 6/0, Modulation 16QAM



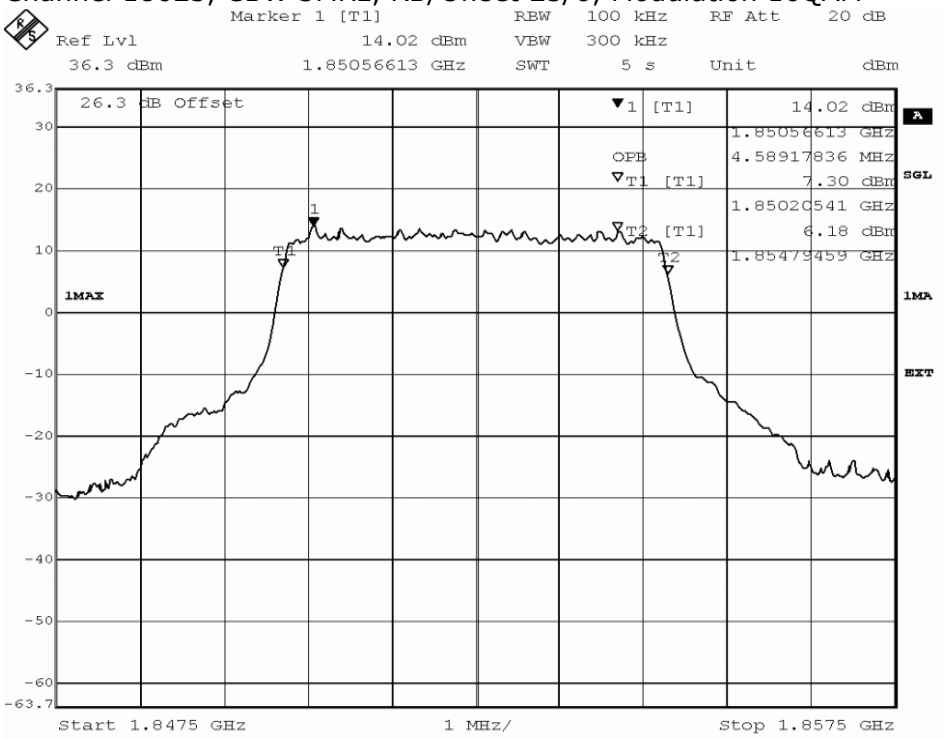
Title: bandwidth measurement
Comment A: DE1015014, eFDD2, occupied bandwidth (99%), channel 18607 (1850.7MHz)
Date: 10.MAR.2015 20:51:27

Channel 19185, CBW 3MHz, RB/Offset 15/0, Modulation 16QAM



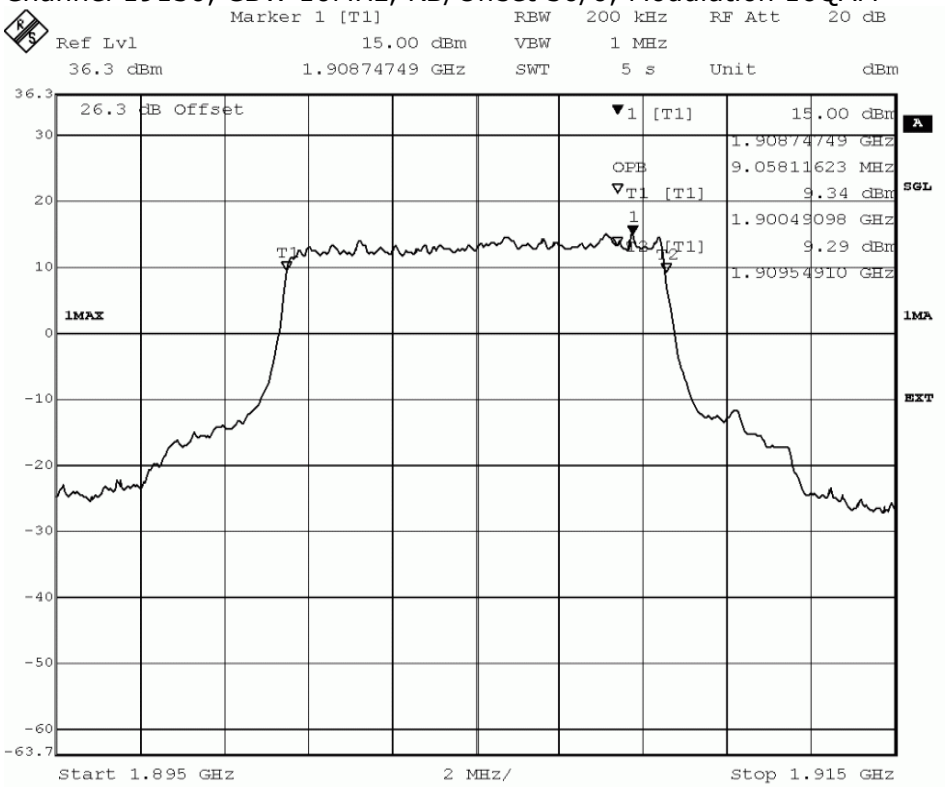
Title: bandwidth measurement
Comment A: DE1015014, eFDD2, occupied bandwidth (99%), channel 19185 (1908.5MHz)
Date: 11.MAR.2015 16:19:58

Channel 18625, CBW 5MHz, RB/Offset 25/0, Modulation 16QAM



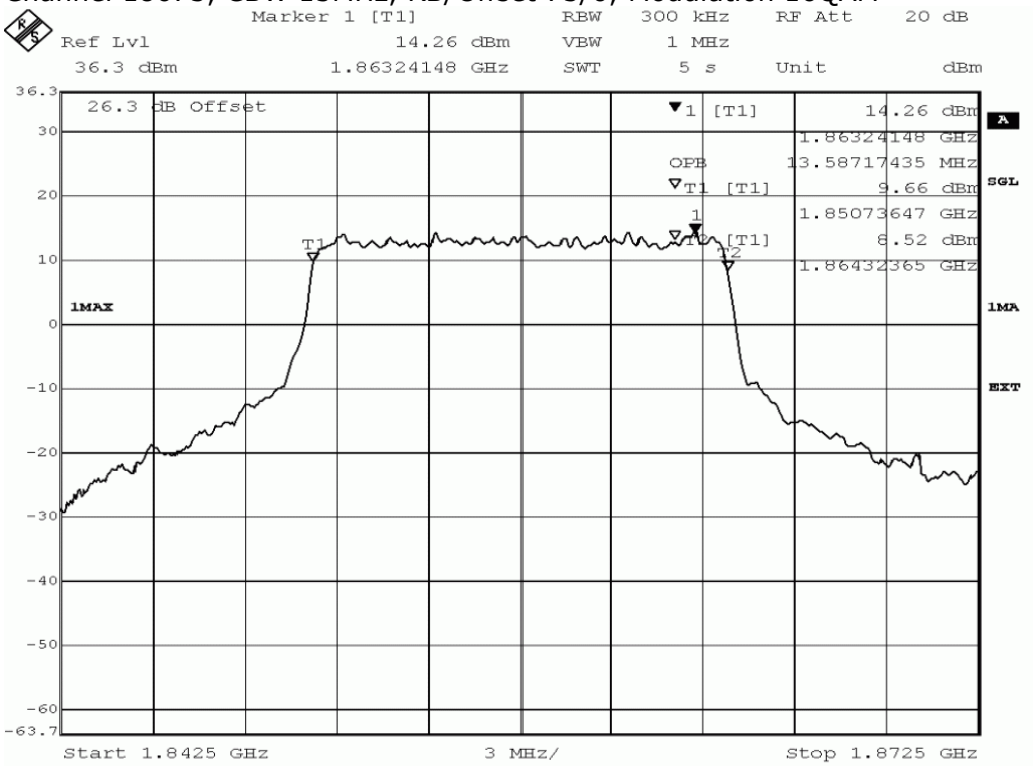
Title: bandwidth measurement
Comment A: DE1015014, eFDD2, occupied bandwidth (99%),
channel 18607 (1850.7MHz)
Date: 11.MAR.2015 16:25:45

Channel 19150, CBW 10MHz, RB/Offset 50/0, Modulation 16QAM



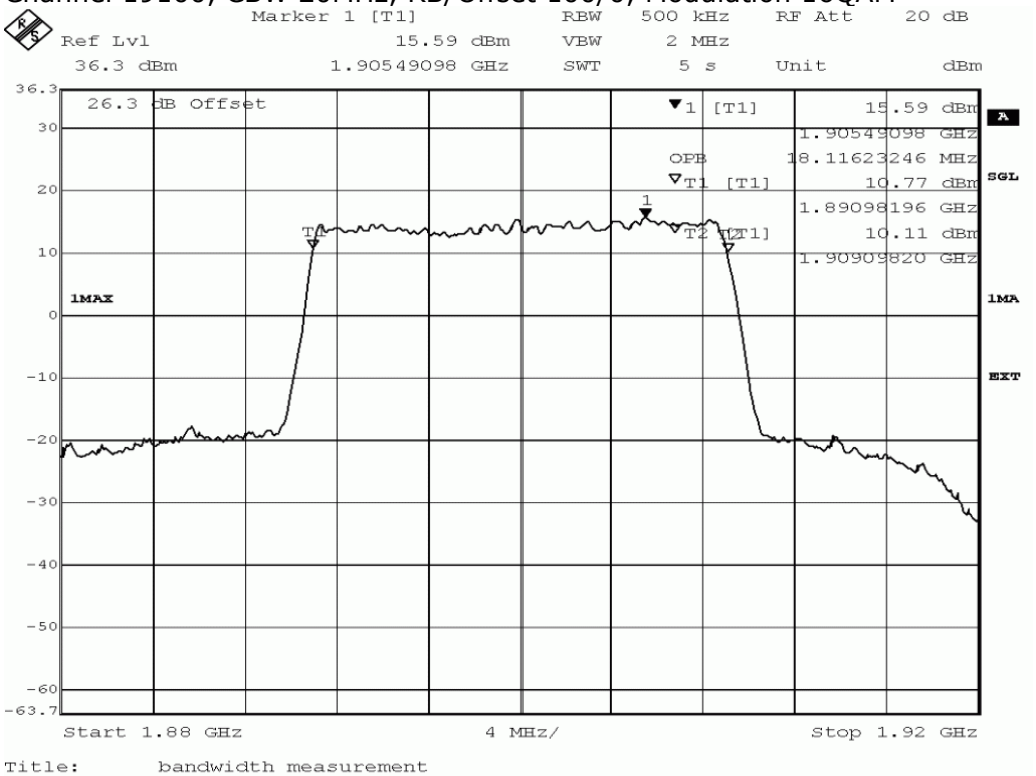
Title: bandwidth measurement
Comment A: DE1015014, eFDD2, occupied bandwidth (99%),
channel 19150 (1905.0MHz)
Date: 11.MAR.2015 16:41:10

Channel 18675, CBW 15MHz, RB/Offset 75/0, Modulation 16QAM



Title: bandwidth measurement
Comment A: DE1015014, eFDD2, occupied bandwidth (99%), channel 18675 (1857.5MHz)
Date: 11.MAR.2015 16:44:57

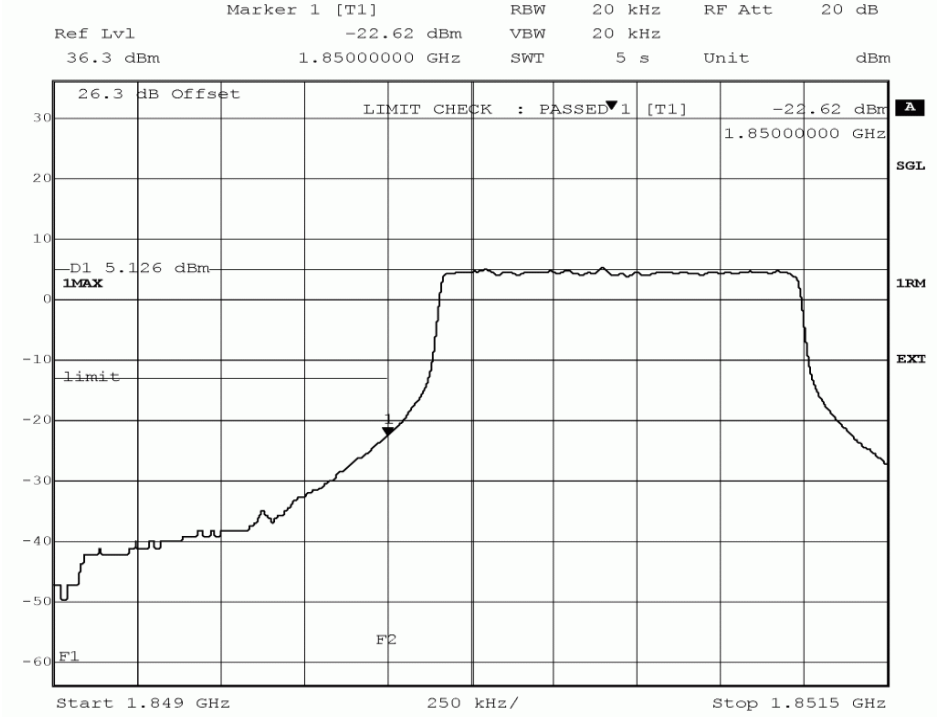
Channel 19100, CBW 20MHz, RB/Offset 100/0, Modulation 16QAM



Title: bandwidth measurement
Comment A: DE1015014, eFDD2, occupied bandwidth (99%), channel 19100 (1900.0MHz)
Date: 11.MAR.2015 17:09:41

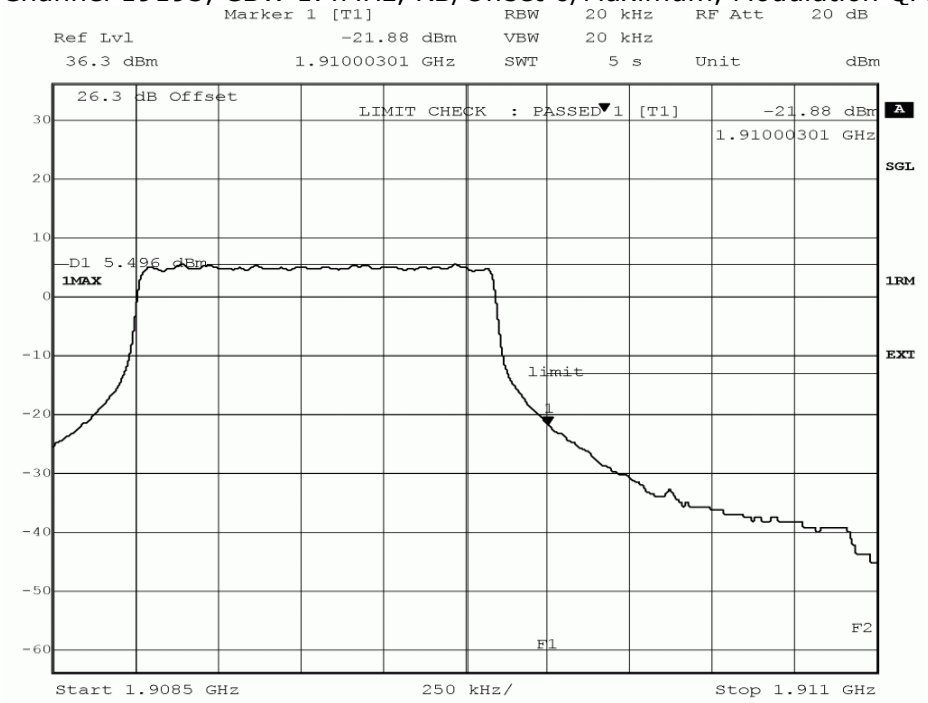
7.5 Band edge compliance §2.1053, §24.238

Channel 18607, CBW 1.4MHz, RB/Offset 6/Maximum, Modulation QPSK



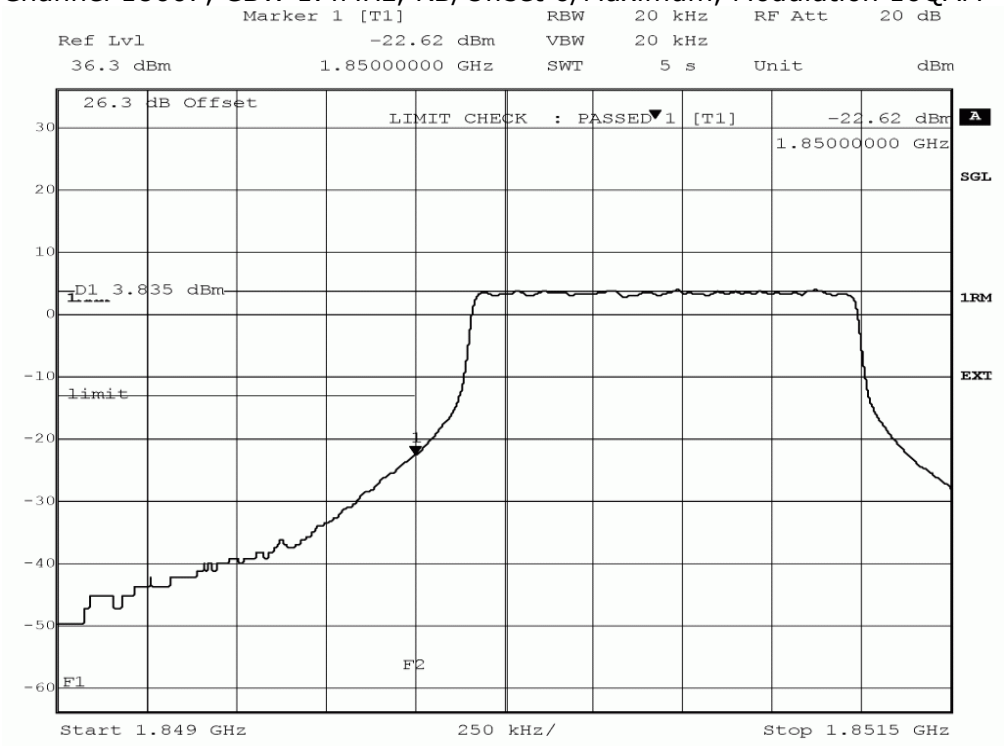
Title: band edge compliance measurement
Comment A: DE1015014, eFDD2 1.4MHz BW, band edge compliance, channel 18607 (1850.7MHz)
Date: 24.MAR.2015 19:26:24

Channel 19193, CBW 1.4MHz, RB/Offset 6/Maximum, Modulation QPSK



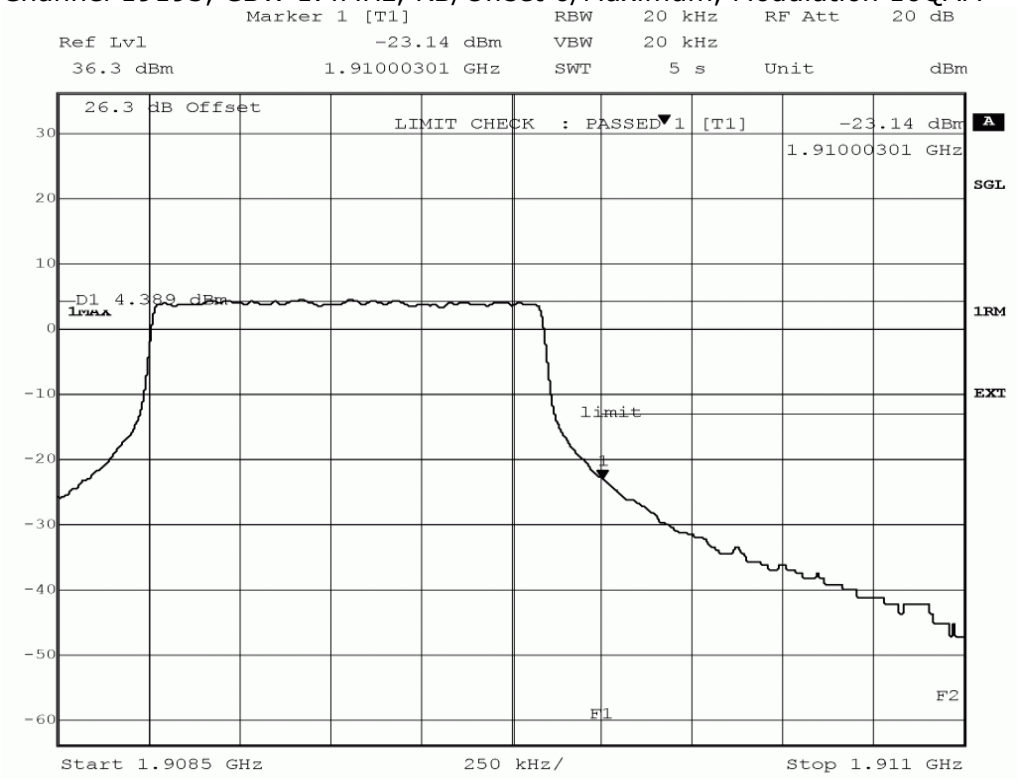
Title: band edge compliance measurement
Comment A: DE1015014, eFDD2 1.4MHz BW, band edge compliance, channel 19193 (1909.3MHz)
Date: 24.MAR.2015 19:33:41

Channel 18607, CBW 1.4MHz, RB/Offset 6/Maximum, Modulation 16QAM



Title: band edge compliance measurement
Comment A: DE1015014, eFDD2 1.4MHz BW, band edge compliance, channel 18607 (1850.7MHz)
Date: 24.MAR.2015 19:31:31

Channel 19193, CBW 1.4MHz, RB/Offset 6/Maximum, Modulation 16QAM



Title: band edge compliance measurement
Comment A: DE1015014, eFDD2 1.4MHz BW, band edge compliance, channel 19193 (1909.3MHz)
Date: 24.MAR.2015 19:35:56

7.6 Field strength of spurious radiation §2.1046, §24.238

Channel 18900, CBW 10MHz, RB/Offset 1/Mid, Modulation QPSK