InterLab®

FCC Measurement/Technical Report on

TOBY-L280 GSM/UMTS/HSPA/LTE Data Module

FCC ID: XPYTOBYL280
IC:8595A-TOBYL280

Report Reference: MDE_UBLOX_1510_FCCc

according to FCC Part 27, Subpart C

Test Laboratory:
7Layers AG
Borsigstrasse 11
40880 Ratingen
Germany

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

Table of Contents

The results in chapter 3 show the results of the original variant of the module, Report Reference: MDE_UBLOX_1409_FCCd (conducted results) and RF140820C14 (radiated results).
Chapter 7 provides the measurement results of the new version of the module and a comparison to the original values.

0.1 Summary

0.2 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 27, Subpart C—Technical Standards

§ 27.50 Power and antenna height limits
§ 27.53 Emissions limits
§ 27.54 Frequency stability

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.

0.3 Measurement Summary

FCC Part 27, Subpart C		**§2.1046, §27.50(d)**	
RF Power Output			
	Setup	**Port**	**Final Result**
	Setup_01	AC Port (power line)	passed 09-18-2014
FCC Part 27, Subpart C		**§2.1055, §27.51**	
Frequency stability			
	Setup	**Port**	**Final Result**
	Setup_02	Temp.ant.connector	passed 09-18-2014
FCC Part 27, Subpart C		**§2.1051, §27.53(h)**	
Spurious emissions at antenna terminals			
	Setup	**Port**	**Final Result**
	Setup_01	Temp.ant.connector	passed 09-18-2014
FCC Part 27, Subpart C		**§2.1049**	
Emission and Occupied Bandwidth			
	Setup	**Port**	**Final Result**
	Setup_01	Temp.ant.connector	passed 09-18-2014
FCC Part 27, Subpart C		**§2.1051, §27.53 (h)**	
Band edge compliance			
	Setup	**Port**	**Final Result**
	Setup_01	Temp.ant.connector	passed 09-18-2014
FCC Part 27, Subpart C		**§2.1046, §27.50(d)**	
Peak-Average Ratio			
	Setup	**Port**	**Final Result**
	Setup_01	Temp.ant.connector	passed 09-18-2014
FCC Part 27, Subpart C		**§2.1046, §27.50(d)**	
Field strength of spurious radiation			
	Setup	**Port**	**Final Result**
	na	na	Not performed see external report

This test report incorporates results of variants of this Module that were previously already tested (original conducted results: TOBY-L210 test report reference: MDE_UBLOX_1409_FCCd, original radiated results: TOBY-L200 test report reference: RF140820C14).
For this variant the eFDD20 band was removed while the non FCC relevant band eFDD28 was added. According to the applicant the changes in Hard- and Software are only related to these two bands and will not affect the other bands. Due to this the old results were reused and only partial testing of the previous worst case results were performed. These results and a comparison to the old results are added to this report as an additional chapter (chapter 8).

Responsible for Accreditation Scope:	MARCO KULLIK 2015.06.02 15:38:10 +02'00'	Responsible for Test Report:	Daniel Gall 2015.05.29 13:42:41 +02'00'

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:	Patrick Lomax
Date of Test(s):	2014-07-14 to 2014-09-18
Date of comparison Tests:	2015-03-31 to 2015-04-25
Date of Report:	2015-05-29

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:	GSM/UMTS/HSPA/LTE Data Module
Type Designation:	TOBY-L210
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 operate in the following bands:
GSM 850/1900 900/1800
UMTS/HSDPA/HSUPA FDD1,2,5,8
LTE eFDD 1,3,5,7,8,28

*This report only covers the LTE portion.

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: DE1015004AX12)	GSM/UMTS/ LTE Module	TOBY-L210	352255060018185	192BA04	09.41
EUT B (Code: DE1015004BC13)	GSM/UMTS/ LTE Module	TOBY-L210	352255060017906	192BA00	09.39
EUT C (Code: DE1015016aa01)	GSM/UMTS/ LTE Module	TOBY-L280	358503060011765	217001	09.90
EUT D (Code: DE1015016ag01)	GSM/UMTS/ LTE Module	TOBY-L280	358503060012011	217001	09.90
Remark: EUT A,B 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	-	-	E04-0392137	–
AE 2	Evaluation test board	EVB-WL1	HP02_HW_CS_136000		BS 081110	
AE 3	AC/DC converter	UUX324-1215	-	-	F02-0117096	–
AE 4	Evaluation test board	EVB-WL3	EVB-WL3	-	-	-
AE 5	AC/DC converter	UUX324-1215	-	-	F02-0117108	–
AE 6	Evaluation test board	EVB-WL3	EVB-WL3	-	-	-

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 2	setup for conducted measurements
Setup_02	EUT B + AE 1 + AE 2	setup for conducted measurements
Setup_03	EUT C + AE 3 + AE 4	setup for conducted and radiated measurements
Setup_04	EUT D + AE 5 + AE 6	setup for conducted measurements

2.6 Operating Modes

The below table shows the test frequencies and channels bandwidths used for testing.

TEST MODE	TX / RX	RF Channel		
		Low	Mid	High
LTE eFDD 7	TX (5M)	CH 20775	CH 21100	CH 21425
		2502.50 MHz	2535.00 MHz	2567.50 MHz
	TX (10)	CH 20800	CH 21100	CH 21400
		2505.00 MHz	2535.00 MHz	2565.00 MHz
	TX (15M)	CH 20825	CH 21100	CH 21375
		2507.50 MHz	2535.00 MHz	2562.50 MHz
	TX (20M)	CH 20850	CH 21100	CH 21350
		2510.00 MHz	2535.00 MHz	2560.00 MHz
	RX (5M)	CH 2775	CH 3100	CH 3425
		2622.50 MHz	2655.00 MHz	2687.50 MHz
	RX (10M)	CH 2800	CH 3100	CH 3400
		2625.00 MHz	2655.00 MHz	2685.00 MHz
	RX (15M)	CH 2825	CH 3100	CH 3375
		2675.50 MHz	2655.00 MHz	2682.50 MHz
	RX (20M)	CH 2850	CH 3100	CH 3350
		2630.00 MHz	2655.00 MHz	2680.00 MHz

eFDD 7 Test configuration					
Setup Number	**Test ITEM**	**Channel Band width**	**Channels tested**	**Modulation**	**RB Allocation**
01	RF OUTPUT POWER	5 MHz	20775, 21110, 21425	QPSK, 16QAM	1RB , 12RB , 25RB
		10 MHz	20800, 2110, 21400	QPSK, 16QAM	1RB, 50RB
		15 MHz	20825, 21110, 21375	QPSK, 16QAM	1RB, 36RB, 75RB
		20 MHz	20850, 21100, 21350	QPSK, 16QAM	1RB, 100RB
02	FREQUENCY STABILITY	5	21100	QPSK	1RB
01	OCCUPIED BANDWIDTH	5 MHz	20775, 21110, 21425	QPSK, 16QAM	25RB
		10 MHz	20800, 2110, 21400	QPSK, 16QAM	50RB
		15 MHz	20825, 21110, 21375	QPSK, 16QAM	75RB
		20 MHz	20850, 21100, 21350	QPSK, 16QAM	100RB
01	PEAK TO AVERAGE RATIO	5 MHz	19975, 20175, 20375	QPSK, 16QAM	25RB
01	BAND EDGE Compliance	5 MHz	20775, 21110, 21425	QPSK, 16QAM	25RB/ Max offset
		10 MHz	20800, 2110, 21400	QPSK, 16QAM	50RB/ Max offset
		15 MHz	20825, 21110, 21375	QPSK, 16QAM	75RB/ Max offset
		20 MHz	20850, 21100, 21350	QPSK, 16QAM	100RB/ Max offset
01	CONDCUDETED EMISSION	5 MHz	20775, 21110, 21425	QPSK, 16QAM	1RB
NA	RADIATED EMISSION	NA	See external report	NA	NA

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

FCC Part 27, Subpart C

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".

a) The EUT was set up for the maximum power with LTE link data modulation and link up with simulator.
b) Set the EUT to transmit under low, middle and high channel and record the power level shown on simulator.

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:
- Channel (Frequency): please refer to the detailed results
4) The transmitted power of the EUT was recorded by using a spectrum analyser.
a. The EUT was set up for the maximum power with LTE link data modulation and link up with simulator.

b. Set the EUT to transmit under low, middle and high channel and record the power level shown on simulator.

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.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results

3) 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).

4) 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.

5) 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.
§27.50 Power and antenna height limits.

(d) The following power and antenna height requirements apply to stations transmitting in the 1710–1755 MHz and 2110–2155 MHz bands:

(2) Fixed, mobile, and portable (hand-held) stations operating in the 1710–1755 MHz band are limited to a peak EIRP of 1 watt.

Fixed stations operating in this band are limited to a maximum antenna height of 10 meters above ground, and mobile and portable stations must employ a means for limiting power to the minimum necessary for successful communications.

Portable stations (hand-held devices) operating in the 704-716 MHz band are limited to 3 watts ERP

3.1.3 Test Protocol

eFDD 7

Test Band	Band width	Channel	Modulation	RB	RMS Conducted power	FCC EIRP limit (W)	IC EIRP limit per SRSP-503 (W)	Maximum antenna gain (dBi)	Verdict
BAND 7	5	Low	QPSK	RB 1	21.94	1	1	8.06	Passed
	5	Low	QPSK	RB 12	20.85	1	1	9.15	Passed
	5	Low	QPSK	RB 25	21.05	1	1	8.95	Passed
	5	Low	16QAM	RB 1	21.11	1	1	8.89	Passed
	5	Low	16QAM	RB 25	20.15	1	1	9.85	Passed
	5	MID	QPSK	RB 1	22.45	1	1	7.55	Passed
	5	MID	QPSK	RB 12	21.51	1	1	8.49	Passed
	5	MID	QPSK	RB 25	21.52	1	1	8.48	Passed
	5	MID	16QAM	RB 1	21.45	1	1	8.55	Passed
	5	MID	16QAM	RB 25	22.39	1	1	7.61	Passed
	5	High	QPSK	RB 1	22.27	1	1	7.73	Passed

	5	High	QPSK	RB 12	21.75	1	1	8.25	Passed
	5	High	QPSK	RB 25	21.67	1	1	8.33	Passed
	5	High	16QAM	RB 1	21.67	1	1	8.33	Passed
	5	High	16QAM	RB 25	20.64	1	1	9.36	Passed
	10	Low	QPSK	RB 1	21.78	1	1	8.22	Passed
	10	Low	QPSK	RB 50	21.12	1	1	8.88	Passed
	10	Low	16QAM	RB 1	21	1	1	9	Passed
	10	Low	16QAM	RB 50	20.19	1	1	9.81	Passed
	10	MID	QPSK	RB 1	22.34	1	1	7.66	Passed
	10	MID	QPSK	RB 50	21.51	1	1	8.49	Passed
	10	MID	16QAM	RB 1	21.58	1	1	8.42	Passed
	10	MID	16QAM	RB 50	20.62	1	1	9.38	Passed
	10	High	QPSK	RB 1	22.42	1	1	7.58	Passed
	10	High	QPSK	RB 50	21.6	1	1	8.4	Passed
	10	High	16QAM	RB 1	21.61	1	1	8.39	Passed
	10	High	16QAM	RB 50	20.72	1	1	9.28	Passed
	15	Low	QPSK	RB 1	22.08	1	1	7.92	Passed
	15	Low	QPSK	RB 36	21.11	1	1	8.89	Passed
	15	Low	QPSK	RB 75	21.22	1	1	8.78	Passed
	15	Low	16QAM	RB 1	21.24	1	1	8.76	Passed
	15	Low	16QAM	RB 75	20.39	1	1	9.61	Passed
	15	MID	QPSK	RB 1	22.36	1	1	7.64	Passed
	15	MID	QPSK	RB 36	21.44	1	1	8.56	Passed
	15	MID	QPSK	RB 75	21.52	1	1	8.48	Passed
	15	MID	16QAM	RB 1	21.37	1	1	8.63	Passed
	15	MID	16QAM	RB 75	20.67	1	1	9.33	Passed
	15	High	QPSK	RB 1	22.46	1	1	7.54	Passed
	15	High	QPSK	RB 36	21.67	1	1	8.33	Passed
	15	High	QPSK	RB 75	21.63	1	1	8.37	Passed
	15	High	16QAM	RB 1	21.53	1	1	8.47	Passed
	15	High	16QAM	RB 75	20.79	1	1	9.21	Passed
	20	MID	QPSK	RB 1	22.39	1	1	7.61	Passed
	20	MID	QPSK	RB 100	21.64	1	1	8.36	Passed
	20	MID	16QAM	RB 1	21.6	1	1	8.4	Passed
	20	MID	16QAM	RB 100	20.8	1	1	9.2	Passed
	20	Low	QPSK	RB 1	22.18	1	1	7.82	Passed
	20	Low	QPSK	RB 100	21.3	1	1	8.7	Passed
	20	Low	16QAM	RB 1	21.41	1	1	8.59	Passed
	20	Low	16QAM	RB 100	20.46	1	1	9.54	Passed
	20	High	QPSK	RB 1	22.41	1	1	7.59	Passed
	20	High	QPSK	RB 100	21.75	1	1	8.25	Passed
	20	High	16QAM	RB 100	20.79	1	1	9.21	Passed
	20	High	16QAM	RB 1	21.61	1	1	8.39	Passed

3.2 Frequency stability

Standard FCC Part 27, Subpart C

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.

§27.54 Frequency stability
The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

7Layers interpretation of limit:

To ensure that the frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block following limit was used:

+/- 2.5 ppm = 4350 Hz for channel 1450, frequency 1740.0 MHz
+/- 2.5 ppm = 4331 Hz for channel 1412, frequency 1732.4 MHz

in accordance with FCC Part 22, Subpart H, §22.355, table C-1: Frequency tolerance for the carrier frequency of mobile transmitters in the Public Mobile Service in the frequency range 821 to 896 MHz.

3.2.3 Test Protocol

Temp. °C	Duration min	Voltage	Limit Hz	Freq. error Average (Hz)	Freq. error Max. (Hz)	Verdict
-30	0	normal	6337.5	4	16	passed
-30	5			1	9	passed
-30	10			-5	-14	passed
-20	0	normal	6337.5	-2	-13	passed
-20	5			2	17	passed
-20	10			-1	7	passed
-10	0	normal	6337.5	0	-15	passed
-10	5			7	21	passed
-10	10			4	12	passed
0	0	normal	6337.5	-1	7	passed
0	5			-1	15	passed
0	10			-2	-11	passed
10	0	normal	6337.5	5	11	passed
10	5			8	21	passed
10	10			-3	-7	passed
20	0	low	6337.5	8	21	passed
20	5			7	18	passed
20	10			-5	-21	passed
20	0	normal = high [1)]	6337.5	9	17	passed
20	5			7	19	passed
20	10			-6	-13	passed
20	0	high	6337.5	4	19	passed
20	5			11	21	passed
20	10			1	-10	passed
30	0	normal	6337.5	1	-13	passed
30	5			-7	-14	passed
30	10			-7	-14	passed
40	0	normal	6337.5	2	-4	passed
40	5			5	15	passed
40	10			-6	-11	passed
50	0	normal	6337.5	-3	-10	passed
50	5			4	12	passed
50	10			-1	-6	passed

3.3 Spurious emissions at antenna terminals

Standard FCC Part 27, Subpart C

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 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.

§ 27.53 Emission limits

(h) For operations in the 1710–1755 MHz and 2110–2155 MHz bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) by at least 43 + 10 log10(P) dB.
Remark of the test laboratory: This is calculated to be -13 dBm.
(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. 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.
(2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.
(3) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

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

3.3.3 Test Protocol

Band	Band width	Modu-lation	Channel	detector	trace	resolution bandwidth /kHz	frequency /MHz	peak value /dBm	margin to limit /dB	limit /dBm	verdict
eFDD7	5	16QAM	20775	rms	maxhold	100	2498.95	-16.7	3.7	-13.0	passed
				rms	maxhold	50	2499.99	-25.0	12.0	-13.0	passed
			21100	rms	maxhold	1000	2653.533	-42.62	29.62	-13	passed
			21425	rms	maxhold	50	2570.00	-24.9	11.9	-13.0	passed
				rms	maxhold	100	2571.00	-17.1	4.1	-13.0	passed
		QPSK	20775	rms	maxhold	100	2498.98	-15.5	2.5	-13.0	passed
				rms	maxhold	50	2499.99	-23.9	10.9	-13.0	passed
			21100	rms	maxhold	1000	2653.533	-42.62	29.62	-13	passed
			21425	rms	maxhold	50	2570.00	-23.9	10.9	-13.0	passed
				rms	maxhold	100	2571.00	-15.8	2.8	-13.0	passed

3.4 Emission and Occupied Bandwidth

Standard FCC Part 27, Subpart C

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 7							
Channel BW: 5MHz				Channel BW: 10 MHz			
Channel	Frequency (MHz)	99% BW (MHz)		Channel	Frequency (MHz)	99% BW (MHz)	
		QPSK	16QAM			QPSK	16QAM
low	2502.50 MHz	4.558611	4.544139	low	2505.00 MHz	8.972504	8.972504
mid	2535.00 MHz	4.529667	4.544139	mid	2535.00 MHz	8.972504	8.972504
High	2567.50 MHz	4.544139	4.529667	High	2565.00 MHz	9.001447	8.972504

LTE Band 7							
Channel BW: 15MHz				Channel BW: 20 MHz			
Channel	Frequency (MHz)	99% BW (MHz)		Channel	Frequency (MHz)	99% BW (MHz)	
		QPSK	16QAM			QPSK	16QAM
low	2507.50 MHz	13.50217	13.54559	low	2510.00 MHz	17.88712	17.94501
mid	2535.00 MHz	13.54559	13.54559	mid	2535.00 MHz	17.88712	17.94501
High	2562.50 MHz	13.50217	13.54559	High	2560.00 MHz	17.88712	17.88712

3.5 Band edge compliance

Standard FCC Part 24, Subpart C

The test was performed according to: FCC §27.53

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

§ 27.53 Emission limitations for cellular equipment

(h) For operations in the 1710–1755 MHz and 2110–2155 MHz bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) by at least 43 + 10 log10(P) dB.
Remark of the test laboratory: This is calculated to be -13 dBm.
(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. 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.
(2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.
(3) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

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

3.5.3 Test Protocol

Band	Band-width (MHz)	Modu-lation	Resource Blocks / Offset	Channel	Detector	Frequency (MHz)	Peak Value (dBm)	Limit (dBm)	Verdict
eFDD7	5	QPSK	25 / 0	20775	Average	2500	-28.18	-13	Passed
		QPSK	25 / 0	20775	RMS	2500	-25.62	-13	Passed
		QPSK	25 /Max	21425	Average	2570	-27.7	-13	Passed
		QPSK	25 /Max	21425	RMS	2570	-25.26	-13	Passed
		16QAM	25 / 0	20775	Average	2500	-28.44	-13	Passed
		16QAM	25 / 0	20775	RMS	2500	-26.2	-13	Passed
		16QAM	25 /Max	21425	Average	2570	-28.44	-13	Passed
		16QAM	25 /Max	21425	RMS	2570	-26	-13	Passed
	10	QPSK	50 / 0	20800	Average	2500	-31.11	-13	Passed
		QPSK	50 / 0	20800	RMS	2500	-29.52	-13	Passed
		QPSK	50 /Max	21400	Average	2570	-31.83	-13	Passed
		QPSK	50 /Max	21400	RMS	2570	-30.12	-13	Passed
		16QAM	50 / 0	20800	Average	2500	-31.11	-13	Passed
		16QAM	50 / 0	20800	RMS	2500	-29.82	-13	Passed
		16QAM	50 /Max	21400	Average	2570	-32.62	-13	Passed
		16QAM	50 /Max	21400	RMS	2570	-31.11	-13	Passed
	15	QPSK	75 / 0	20825	Average	2500	-30.77	-13	Passed
		QPSK	75 / 0	20825	RMS	2500	-29.52	-13	Passed
		QPSK	75 /Max	21375	Average	2570	-31.83	-13	Passed
		QPSK	75 /Max	21375	RMS	2570	-30.44	-13	Passed
		16QAM	75 / 0	20825	Average	2500	-30.77	-13	Passed
		16QAM	75 / 0	20825	RMS	2500	-29.52	-13	Passed
		16QAM	75 /Max	21375	Average	2570	-32.2	-13	Passed
		16QAM	75 /Max	21375	RMS	2570	-31.11	-13	Passed
	20	QPSK	100 / 0	20850	Average	2500	-32.22	-13	Passed
		QPSK	100 / 0	20850	RMS	2500	-31.11	-13	Passed
		QPSK	100 / Max	21350	Average	2570	-32.62	-13	Passed
		QPSK	100 / Max	21350	RMS	2570	-31.46	-13	Passed
		16QAM	100 / 0	20850	Average	2500	-31.83	-13	Passed
		16QAM	100 / 0	20850	RMS	2500	-31.11	-13	Passed
		16QAM	100 / Max	21350	Average	2570	-33.49	-13	Passed
		16QAM	100 / Max	21350	RMS	2570	-32.22	-13	Passed

3.6 Peak to Average Ratio

Standard FCC §2.1046, §27.50 (d)

The test was performed according to: §2.1046, §27.50 (d)

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	Channel	Modulation	Measured Vaule (dB)	Limit	Verdict
eFDD7	5	Low	QPSK	5.57	13 dB	Passed
		mid		5.71	13 dB	Passed
		High		5.59	13 dB	Passed
		Low	16QAM	6.32	13 dB	Passed
		mid		6.38	13 dB	Passed
		High		6.32	13 dB	Passed

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 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	
	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		2011/11/25	2014/11/24
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.*
	Standard Calibration		2013/02/12	2015/02/11

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

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*	
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		2013/07/29	2014/07/28
	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.

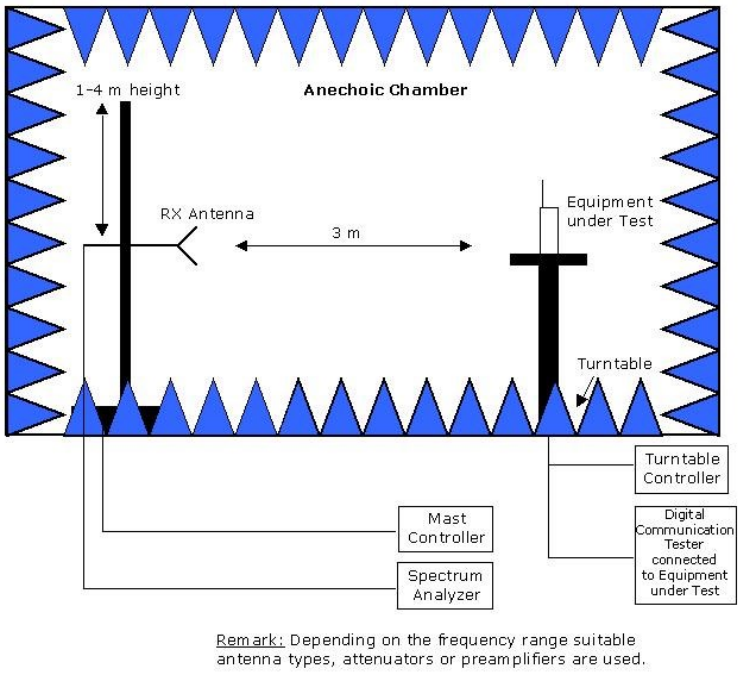
Single Devices for Digital Signalling Devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Bluetooth Signalling Unit CBT	CBT	100589	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2011/11/24	2014/11/23
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.*
	Standard calibration		2011/11/28	2014/11/27
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.*
	Standard calibration		2011/12/07	2014/12/06
	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 --- SW: K62, K69		2007/01/02 2008/11/03	
Vector Signal Generator	SMU200A	100912	Rohde & Schwarz GmbH & Co. KG	

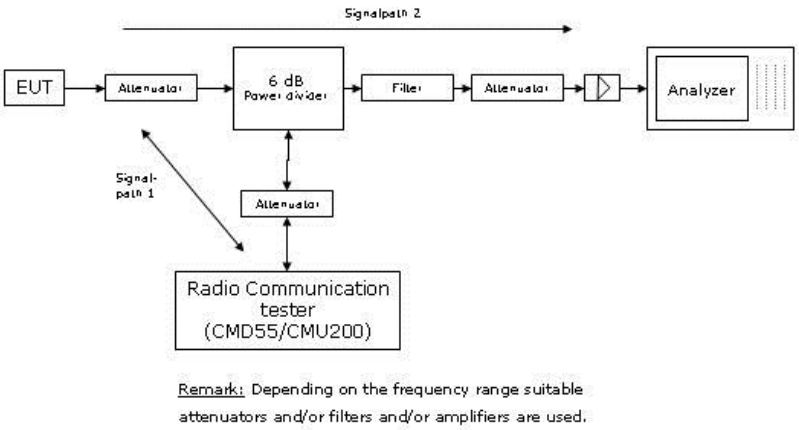
5 Photo Report

Photos are included in an external report.

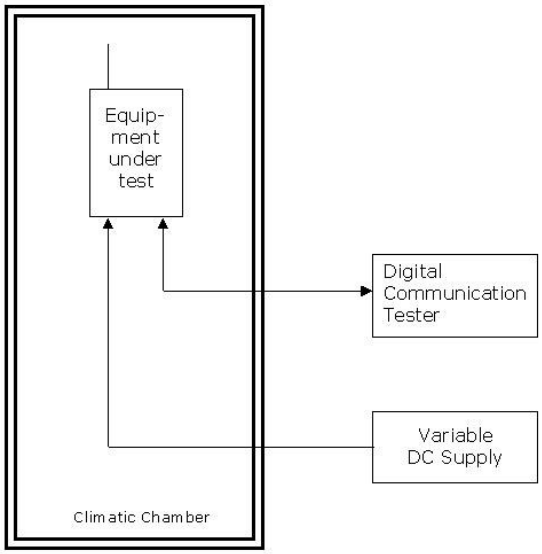
6 Setup Drawings



Drawing 1: Setup in the anechoic chamber.



Principle set-up for conducted measurements under nominal conditions



Principle set-up for tests under extreme test conditions

7 Comparison of new Hard and Software to the original results

See original results for Test Description / Requirements / Limits.
The same settings were used as in the original testrun.

7.1 RF Power Output

Test Band	Bandwidth	Channel	Modulation	RB	RMS Conducted power (dBm)	Deviation to original results	FCC / IC EIRP limit (W)	Maximum antenna gain (dBi)	Verdict
eFDD7	5	Low	QPSK	RB 1	21.92	-0.02	1	8.08	Passed
				RB 12	21.68	0.83	1	8.32	Passed
				RB 25	21.27	0.22	1	8.73	Passed
			16QAM	RB 1	21.07	-0.04	1	8.93	Passed
				RB 25	20.38	0.23	1	9.62	Passed
		MID	QPSK	RB 1	21.8	-0.65	1	8.2	Passed
				RB 12	21.77	0.26	1	8.23	Passed
				RB 25	21.46	-0.06	1	8.54	Passed
			16QAM	RB 1	21.29	-0.16	1	8.71	Passed
				RB 25	20.59	1)	1	9.41	Passed
		High	QPSK	RB 1	22.2	-0.07	1	7.8	Passed
				RB 12	21.91	0.16	1	8.09	Passed
				RB 25	21.71	0.04	1	8.29	Passed
			16QAM	RB 1	21.48	-0.19	1	8.52	Passed
				RB 25	20.67	0.03	1	9.33	Passed

Negative deviation => values of new hard- / software are lower than original result values

1) Wrong result in original report, not to compare.

7.2 Frequency stability

Not tested since no Frequency Stability relevant Hardware was changed.

7.3 Spurious emissions at antenna terminals

Band / Band width	Modulation	Channel	detector	frequency /MHz	peak value /dBm	Deviation to original results / dB	margin to limit /dB	limit /dBm	verdict
eFDD7 / 5MHz	QPSK	20775	rms	2498.96	-21.8	-5.1	8.8	-13	Passed
			rms	2500.00	-23.6	1.4	10.6	-13	Passed
		21425	rms	2570.00	-25.5	-0.6	12.5	-13	Passed
			rms	2571.00	-20.6	-3.5	7.6	-13	Passed
	16QAM	20775	rms	2499.00	-23.1	-7.6	10.1	-13	Passed
			rms	2499.99	-25.9	-2	12.9	-13	Passed
		21425	rms	2570.02	-26.8	-2.9	13.8	-13	Passed
			rms	2571.05	-22.9	-7.1	9.9	-13	Passed

Negative deviation => values of new hard- / software are lower than original result values

7.4 Emission and Occupied Bandwidth

LTE Band 7					
Channel BW: 5MHz					
		99% BW (MHz)		Deviation to original values	
Channel	Frequency (MHz)	QPSK	16QAM	QPSK	16QAM
low	2502.50 MHz	4.5	4.5	0.0	0.0
mid	2535.00 MHz	4.5	4.6	0.0	0.0
High	2567.50 MHz	4.5	4.6	0.0	0.1

Negative deviation => values of new hard- / software are lower than original result values

7.5 Band edge compliance

Band	Band width (MHz)	Modulation	Resource Blocks / Offset	Channel	Detector	Freq. (MHz)	Peak Value (dBm)	Deviation to original values (dB)	Limit (dBm)	Verdict
eFDD7	5	QPSK	25 / 0	20775	Average	2500	-27.94	0.24	-13	Passed
					RMS	2500	-25.44	0.18	-13	Passed
			25 /Max	21425	Average	2570	-28.18	-0.48	-13	Passed
					RMS	2570	-26.2	-0.94	-13	Passed
		16QAM	25 / 0	20775	Average	2500	-28.7	-0.26	-13	Passed
					RMS	2500	-25.81	0.39	-13	Passed
			25 /Max	21425	Average	2570	-29.24	-0.8	-13	Passed
					RMS	2570	-26.6	-0.6	-13	Passed

Negative deviation => values of new hard- / software are lower than original result values

7.6 Peak to Average Ratio

Band	Bandwidth / RB	Channel	Modulation	Measured Value (dB)	Deviation to original values (dB)	Limit	Verdict
eFDD7	5 MHz / 25	21100	QPSK	5.74	0.03	13 dB	Passed
		21100	16-QAM	6.32	-0.06	13 dB	Passed

Negative deviation => values of new hard- / software are lower than original result values

7.7 Field strength of spurious radiation

Detector: Peak, Trace: Max Hold, RBW: 1 MHz

Band	Bandwidth	Modulation	Channel	Frequency	Highest value / dBm	Deviation to original results / dB	Verdict
eFDD7	20 MHz, 1 RB	QPSK	mid	5070	-48.82	-5.61	Passed

Negative deviation => values of new hard- / software are lower than original result values

7.8 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	5HC3500/12750-1.2-KK	200035008	Trilithic	
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
Standard Gain / Pyramidal Horn Antenna 26,5 GHz	3160-09	00083069	EMCO Elektronik GmbH	
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.5-10kg/024/3790709	Maturo GmbH	

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*	
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/01/27	2016/01/26

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*
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 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*	
Personal Computer	Dell	30304832059	Dell	
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 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	
Rubidium Frequency Standard	Datum, Model: MFS	5489/001	Datum-Beverly	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/07/03	2015/07/02
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

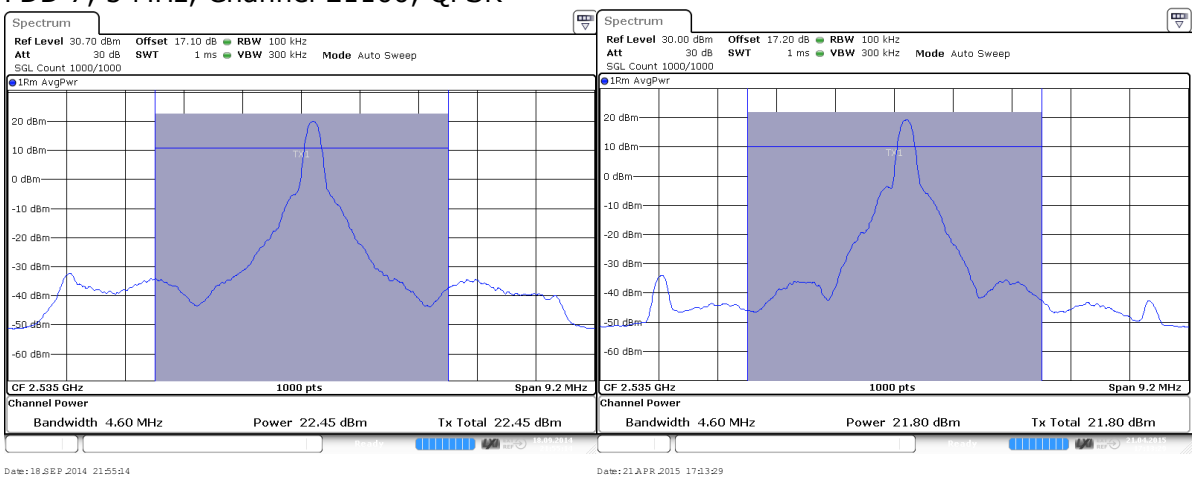
Calibration Details	*Last Execution*	*Next Exec.*
Customized calibration	2015/03/10	2017/03/09

8 Annex measurement plots (worst case)

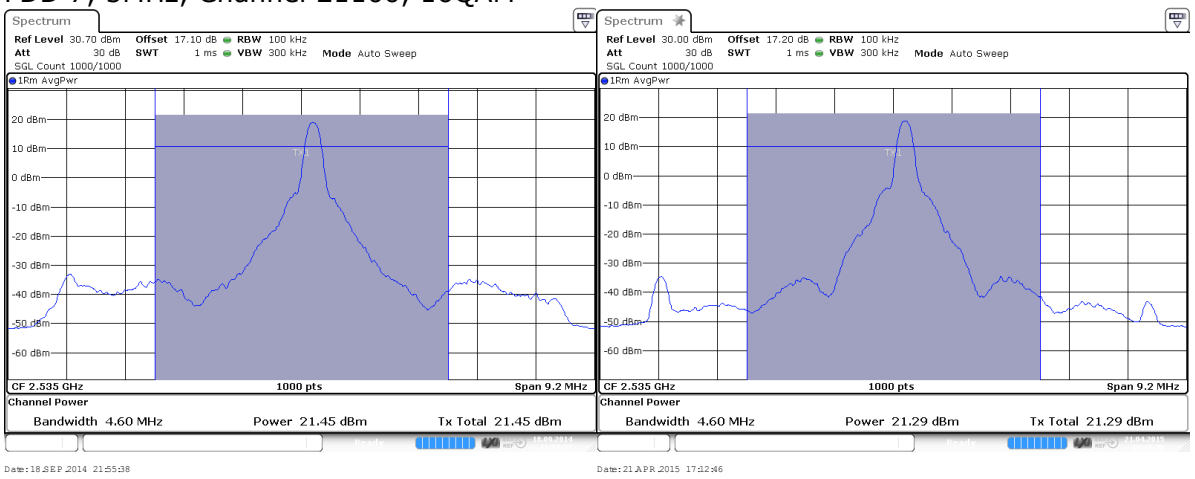
Where tested the result plots of the original measurement with the previous module and the new module variant are shown next to each other, previous module plot on the left, new module on the right.

8.1 RF Power Output

FDD 7, 5 MHz, Channel 21100, QPSK

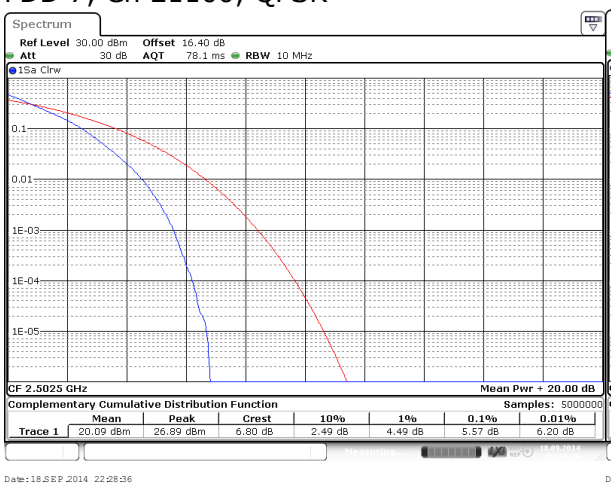


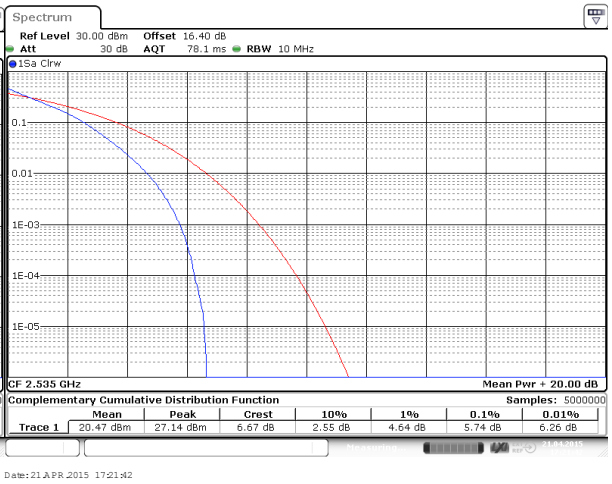
FDD 7, 5MHz, Channel 21100, 16QAM



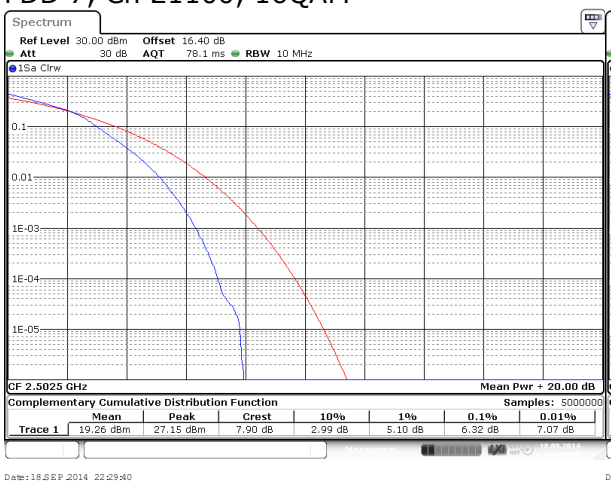
8.2 Peak to Average Ratio

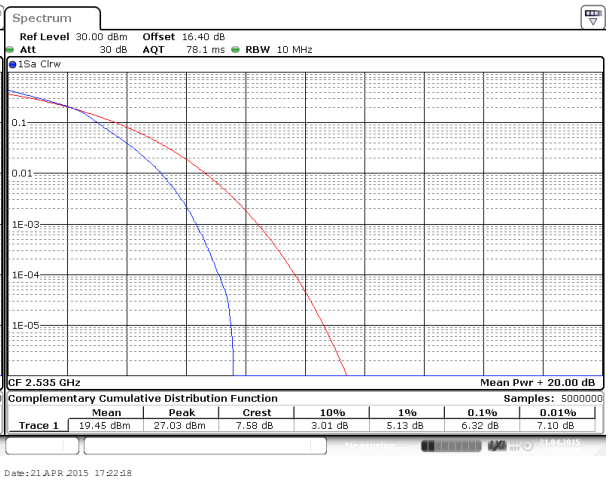
FDD 7, Ch 21100, QPSK





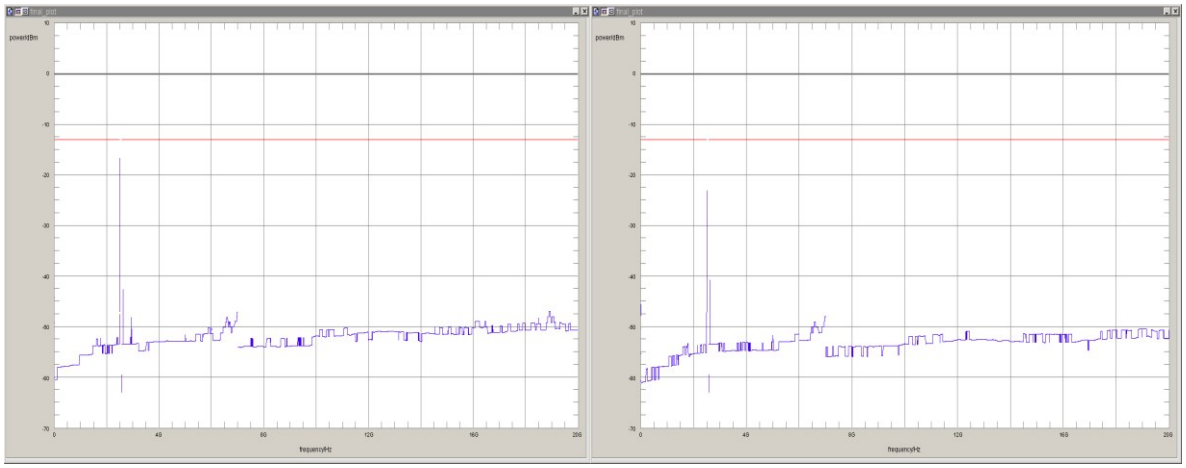
FDD 7, Ch 21100, 16QAM





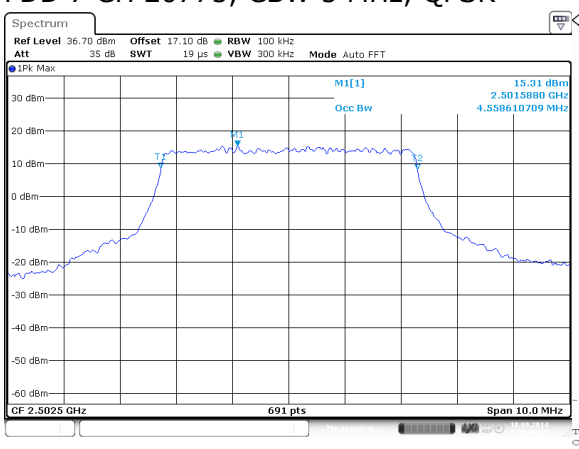
8.3 Spurious emissions at antenna terminals

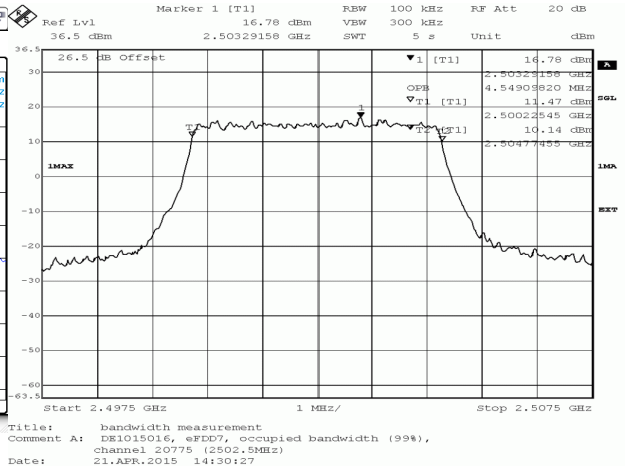
eFDD 7 Channel 20775, 16QAM



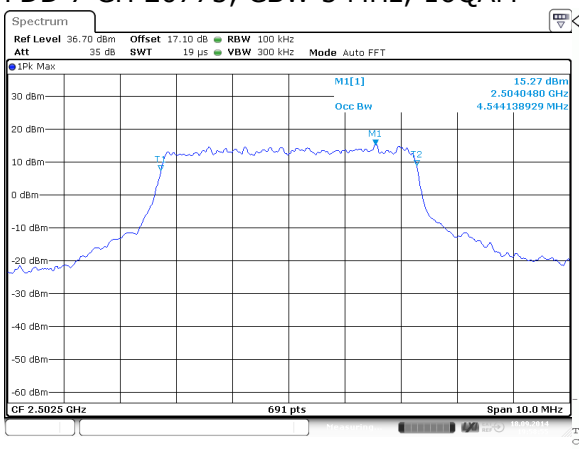
8.4 Emission and Occupied Bandwidth

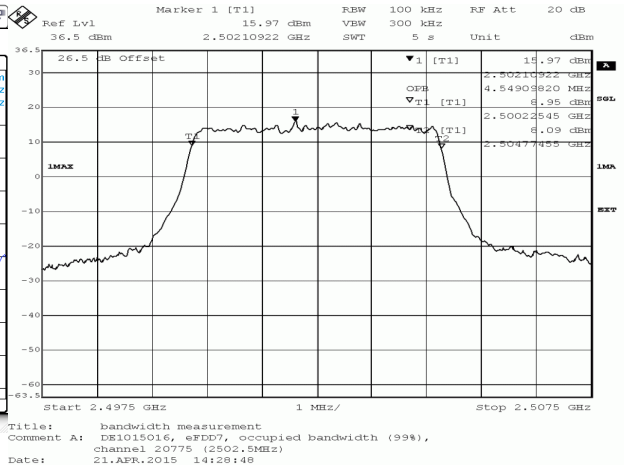
FDD 7 CH 20775, CBW 5 MHz, QPSK



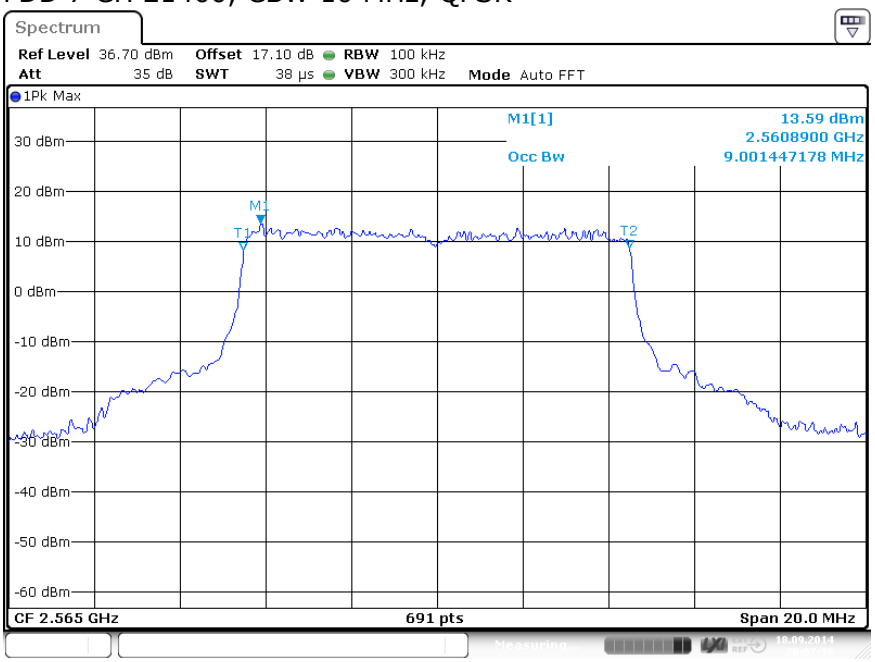


FDD 7 CH 20775, CBW 5 MHz, 16QAM



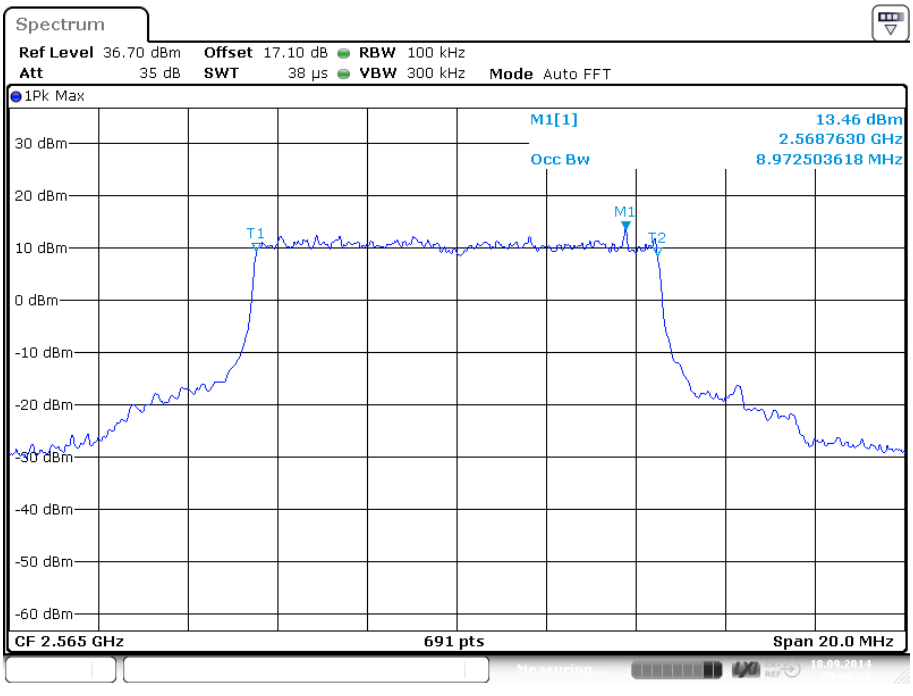


FDD 7 CH 21400, CBW 10 MHz, QPSK



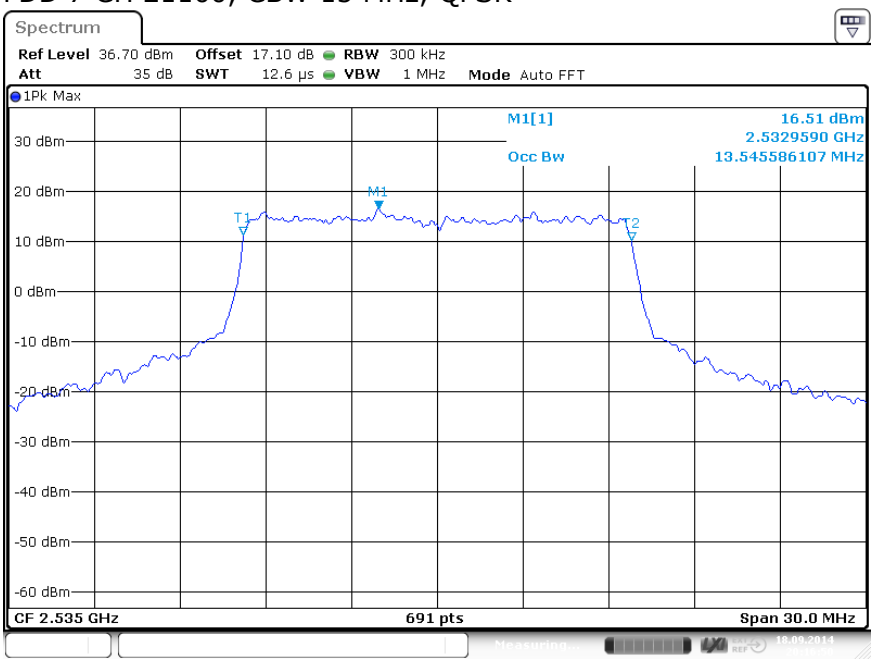
Original measurement

FDD 7 CH 21400, CBW 10 MHz, 16QAM



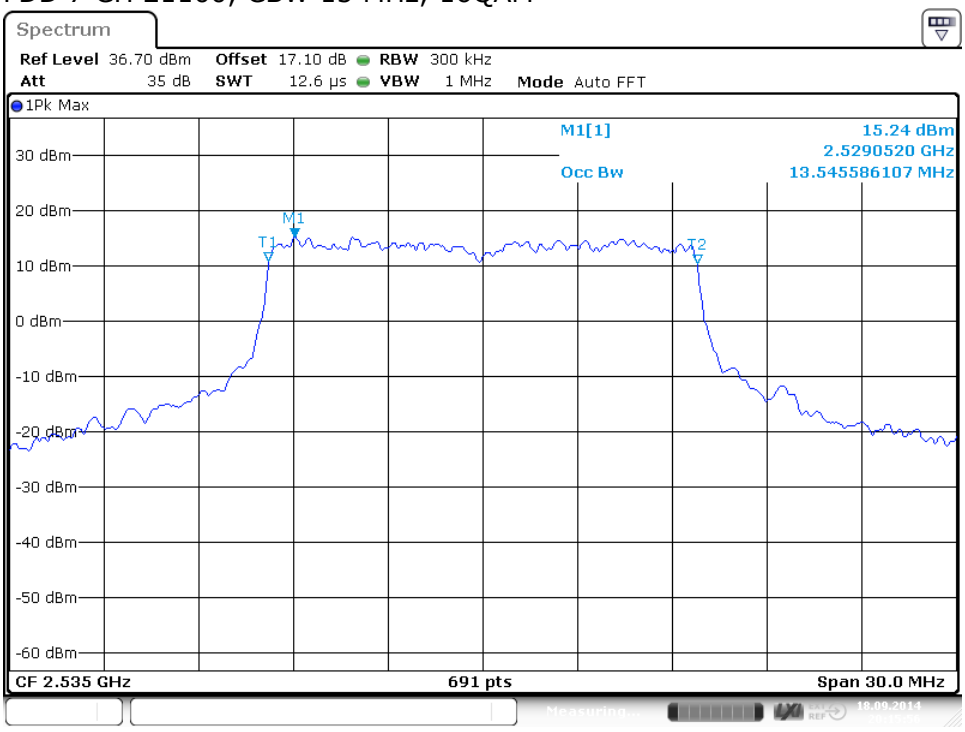
Original measurement

FDD 7 CH 21100, CBW 15 MHz, QPSK



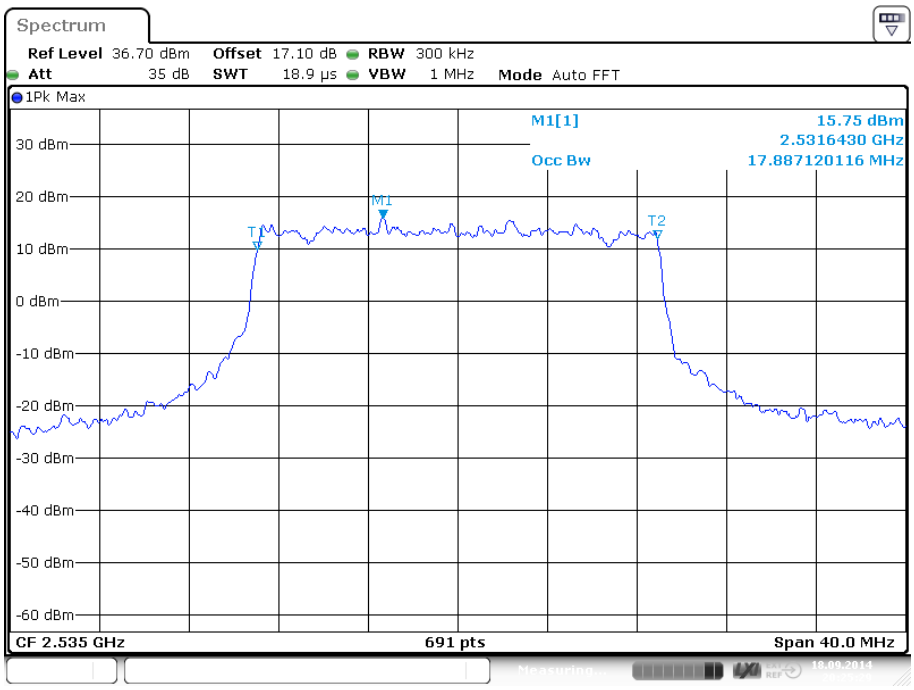
Original measurement

FDD 7 CH 21100, CBW 15 MHz, 16QAM



Original measurement

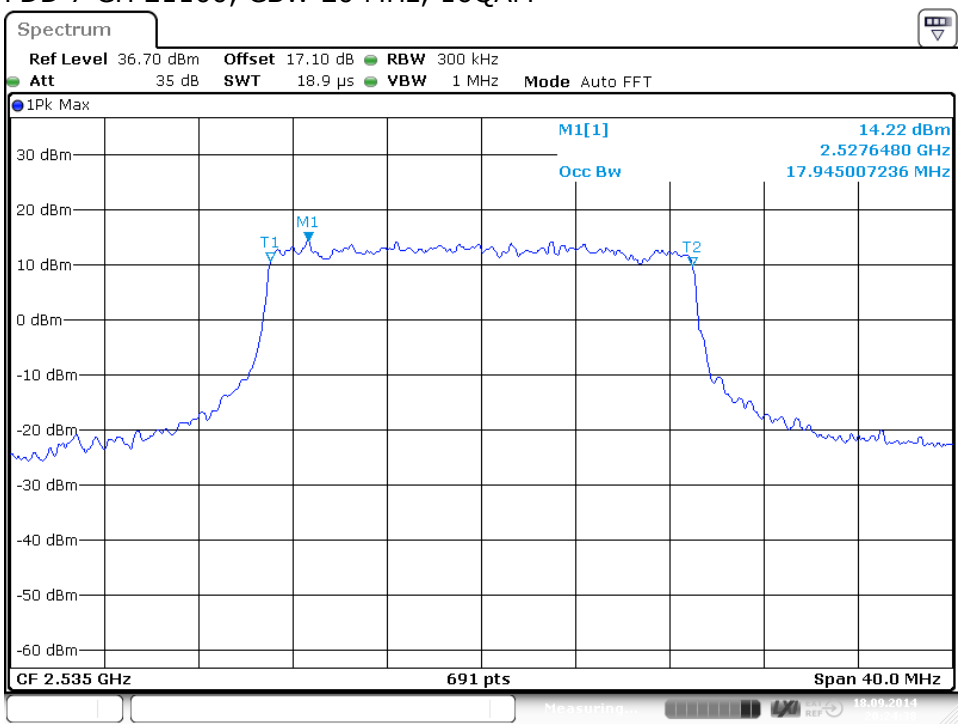
FDD 7 CH 21100, CBW 20 MHz, QPSK



Date: 18.SEP.2014 20:25:28

Original measurement

FDD 7 CH 21100, CBW 20 MHz, 16QAM

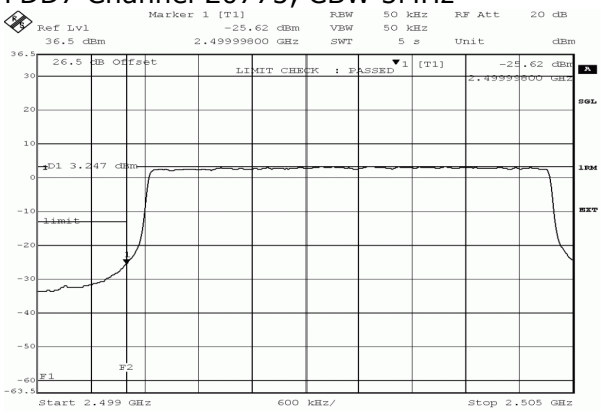


Date: 18.SEP.2014 20:24:38

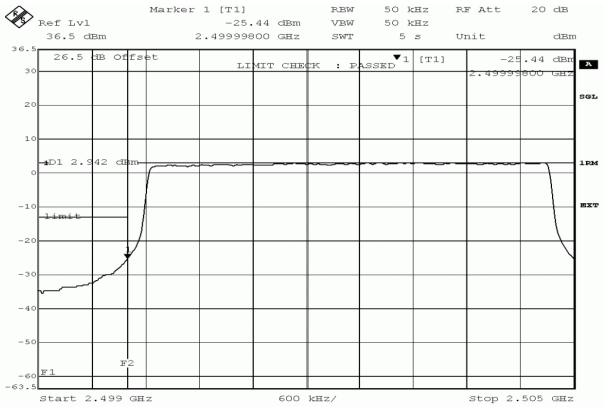
Original measurement

8.5 Band edge compliance

FDD7 Channel 20775, CBW 5MHz

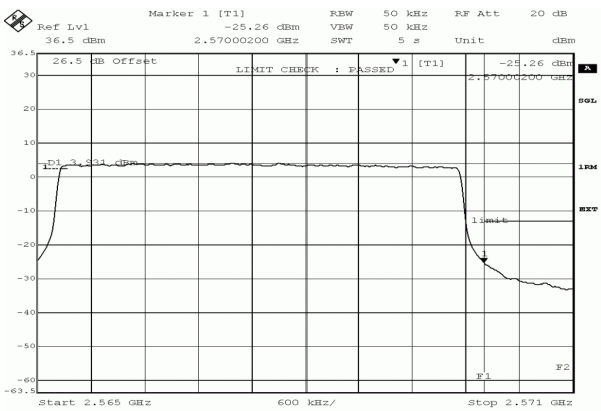


Title: band edge compliance measurement
Comment A: DE1015004, eFDD7 5MHz BW, band edge compliance, channel 20775 (2502.5MHz)
Date: 19.SEP.2014 11:03:25

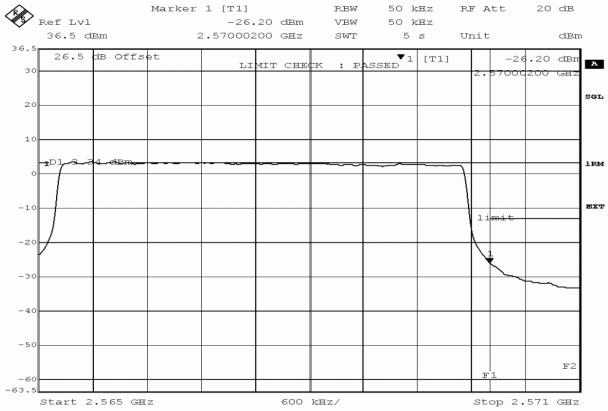


Title: band edge compliance measurement
Comment A: DE1015016, eFDD7 5MHz BW, band edge compliance, channel 20775 (2502.5MHz)
Date: 21.APR.2015 12:54:15

FDD7 Channel 21425, CBW 5MHz



Title: band edge compliance measurement
Comment A: DE1015004, eFDD7 5MHz BW, band edge compliance, channel 21425 (2567.5MHz)
Date: 19.SEP.2014 11:00:55



Title: band edge compliance measurement
Comment A: DE1015016, eFDD7 5MHz BW, band edge compliance, channel 21425 (2567.5MHz)
Date: 21.APR.2015 13:00:01