FCC Measurement/Technical Report on

LARA-R6001 / LARA-R6001D
2G / 3G / LTE module

FCC ID: XPYUBX21BE01
IC: 8595A-UBX21BE01

Test Report Reference: MDE_UBLOX_2302_FCC_01

Test Laboratory:
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Deutsche
Akkreditierungsstelle
D-PL-12140-01-01
D-PL-12140-01-02
D-PL-12140-01-03

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization
Certification for a cellular mobile device.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 27, (10-1-21 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 27; Miscellaneous Wireless Communications Services
Subpart C – Technical standards

§ 27.50 – Power and duty cycle limits
§ 27.53 – Emission limits
§ 27.54 – Frequency stability

The tests were selected and performed with reference to:

- FCC Public Notice 971168 applying "Measurement guidance for certification of licensed digital transmitters" 971168 D01 v03r01, 2018-04-09
- ANSI C63.26: 2015

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for Cellular Mobile Devices from FCC and ISED Canada

Measurement	FCC reference	ISED reference
RF Output Power	§ 2.1046 § 27.50	RSS-GEN Issue 5, 6.12 RSS-130 Issue 2, 4.6.2/4.6.3 RSS-139 Issue 4, 5.5 RSS-199 Issue 4, 5.5
Peak to Average-Ratio	§ 27.50	RSS-130 Issue 2: 4.6.1 RSS 139 Issue 4: 5.5 RSS-199 Issue 4, 5.5
Emission and Occupied bandwidth	§ 2.1049	RSS-GEN Issue 5, 6.7
Spurious Emission at Antenna Terminals	§ 2.1051 § 27.53	RSS-GEN Issue 5, 6.13 RSS-130 Issue 2: 4.7.1/4.7.2 RSS-139 Issue 4, 5.6 RSS-199 Issue 4, 5.6
Band Edge Compliance	§ 2.1051 § 27.53	RSS-GEN Issue 5, 6.13 RSS-130 Issue 2: 4.7.1/4.7.2 RSS-139 Issue 4, 5.6 RSS-199 Issue 4, 5.6
Frequency stability	§ 2.1055 § 27.54	RSS-GEN Issue 5, 6.11 RSS-130 Issue 2: 4.5 RSS-139 Issue 4: 5.4 RSS-199 Issue 4, 5.4
Field strength of spurious radiation	§ 2.1053 § 27.53	RSS-GEN Issue 5, 6.13 RSS-130 Issue 2: 4.7.1/4.7.2 RSS-139 Issue 4: 5.6 RSS-199 Issue 4, 5.6

1.3 MEASUREMENT SUMMARY

47 CFR CHAPTER I FCC PART 27 Subpart C **§ 2.1046 § 27.50**

RF Output Power
The measurement was performed according to ANSI C63.26: 2015; 5.2.4.1, Wideband Signal: 5.2.4.4 **Final Result**

OP-Mode Technology, Radio Technology, Operating Frequency, ChBW, Ressource Blocks, Measurement method	Setup	Date	FCC	IC
E-UTRA, eTDD 41 16QAM, mid channel, 10 MHz, 1, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 10 MHz, 12, conducted	S01_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 15 MHz, 1, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 15 MHz, 18, conducted	S01_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 20 MHz, 1, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 20 MHz, 18, conducted	S01_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 5 MHz, 1, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 10 MHz, 1, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 10 MHz, 50, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 1, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 36, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 75, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 20 MHz, 1, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 20 MHz, 100, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 1, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 12, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 10 MHz, 1, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 10 MHz, 12, conducted	S02_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 15 MHz, 1, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 15 MHz, 18, conducted	S02_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 20 MHz, 1, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 20 MHz, 18, conducted	S02_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 5 MHz, 1, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 5 MHz, 25, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 10 MHz, 1, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 10 MHz, 50, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 1, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 36, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 75, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 20 MHz, 1, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 20 MHz, 100, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 1, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 12, conducted	S02_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 25, conducted	S02_AA01	2023-07-19	Passed	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C **§ 2.1051 § 27.53**

Spurious emissions at antenna terminals
The measurement was performed according to ANSI C63.26: 2015; 5.7.4 **Final Result**

OP-Mode Technology, Radio Technology, Operating Frequency, ChBW, Ressource Blocks, Measurement method	Setup	Date	FCC	IC
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 1, conducted	S01_AA01	2023-07-31	Passed	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C **§ 2.1053 § 27.53**

Field strength of spurious radiation
The measurement was performed according to ANSI C63.26: 2015; 5.5.2.3.1 **Final Result**

OP-Mode Technology, Radio Technology, Operating Frequency, ChBW, Ressource Blocks, Measurement method	Setup	Date	FCC	IC
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 1, radiated	S01_AA01	2023-07-31	Passed	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C **§ 2.1051 § 27.53**

Band edge compliance
The measurement was performed according to ANSI C63.26: 2015; 5.7.3 **Final Result**

OP-Mode Technology, Radio Technology, Operating Frequency, ChBW, Ressource Blocks, Measurement method	Setup	Date	FCC	IC
E-UTRA, eTDD 41 16QAM, high channel, 10 MHz, 12, conducted	S01_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, high channel, 15 MHz, 18, conducted	S01_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, high channel, 20 MHz, 18, conducted	S01_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, high channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, low channel, 10 MHz, 12, conducted	S01_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, low channel, 15 MHz, 18, conducted	S01_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, low channel, 20 MHz, 18, conducted	S01_AA01	2023-07-31	Passed	Passed
E-UTRA, eTDD 41 16QAM, low channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, high channel, 10 MHz, 50, conducted	S01_AA01	2023-07-17	Passed	Passed
E-UTRA, eTDD 41 QPSK, high channel, 15 MHz, 75, conducted	S01_AA01	2023-07-17	Passed	Passed
E-UTRA, eTDD 41 QPSK, high channel, 20 MHz, 100, conducted	S01_AA01	2023-07-17	Passed	Passed
E-UTRA, eTDD 41 QPSK, high channel, 5 MHz, 25, conducted	S01_AA01	2023-07-17	Passed	Passed
E-UTRA, eTDD 41 QPSK, low channel, 10 MHz, 50, conducted	S01_AA01	2023-07-17	Passed	Passed
E-UTRA, eTDD 41 QPSK, low channel, 15 MHz, 75, conducted	S01_AA01	2023-07-17	Passed	Passed
E-UTRA, eTDD 41 QPSK, low channel, 20 MHz, 100, conducted	S01_AA01	2023-07-17	Passed	Passed
E-UTRA, eTDD 41 QPSK, low channel, 5 MHz, 25, conducted	S01_AA01	2023-07-17	Passed	Passed

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Subpart C

Peak to Average Ratio
The measurement was performed according to ANSI C63.26: 2015; 5.2.3.4 (broadband noise-like signal using CCDF [LTE, CAT-M1, NB-IoT]) 5.2.6 (alternative procedure for PAPR [GSM, EDGE, WCDMA, HSDPA, HSUPA])

Final Result

OP-Mode Technology, Radio Technology, Operating Frequency, ChBW, Ressource Blocks, Measurement method	**Setup**	**Date**	**FCC**	**IC**
E-UTRA, eTDD 41 16QAM, high channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, low channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, high channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, low channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 25, conducted	S01_AA01	2023-07-19	Passed	Passed

N/A: Not applicable
N/P: Not performed

2 REVISION HISTORY / SIGNATURES

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2023-08-11	--	valid
--	--	--	--

COMMENT:
Not all applicable tests were performed. Based on applicant's documentation 7layers has proposed and the applicant has agreed with the FCB/TCB to perform spot checks only.

(responsible for accreditation scope)
Dipl.-Ing. Marco Kullik

(responsible for testing and report)
B.Sc. Jens Dörwald

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3 ADMINISTRATIVE DATA

3.1 TESTING LABORATORY

Company Name:	7layers GmbH
Address:	Borsigstr. 11 40880 Ratingen Germany

The test facility is accredited by the following accreditation organisation:

Laboratory accreditation no:	DAkkS D-PL-12140-01-01| -02 | -03
FCC Designation Number:	DE0015
FCC Test Firm Registration:	929146
ISED CAB Identifier	DE0007; ISED#: 3699A
Responsible for accreditation scope:	Dipl.-Ing. Marco Kullik
Report Template Version:	2022-05-25

3.2 PROJECT DATA

Responsible for testing and report:	B.Sc. Jens Dörwald
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2023-08-11
Testing Period:	2023-07-17 to 2023-07-31

3.3 APPLICANT DATA

Company Name:	u-blox AG
Address:	Zürcherstrasse 68 8800 Thalwil Switzerland
Contact Person:	Mr. Giulio Comar

3.4 MANUFACTURER DATA

Company Name: Address: Contact Person:	please see Applicant Data

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

Kind of Device product description	2G / 3G / LTE Data Module
Product name	LARA-R6001 / LARA-R6001D
Type	-
Declared EUT data by the supplier	
General product description	The EUT is a 2G / 3G / LTE module. It supports the following relevant bands for FCC Approval: GSM / EGDE: 850 / 1900 WCDMA: FDD2 / FDD5 LTE: eFDD2 / eFDD4 / eFDD5 / eFDD7 / eFDD8 / eFDD12 / eFDD13 / eFDD26 / eTDD38 / eTDD41
Voltage Level	3.8 V
Voltage Type	DC

4.2 EUT MAIN COMPONENTS

Sample Name	**Sample Code**	**Description**
EUT A	DE1015151cb01	Standard Sample
Sample Parameter	**Value**	
Serial No.	353500724411485	
HW Version	UBX-379E00	
SW Version	04.17 A00.01	
Comment	LARA-R6001D	

Sample Name	**Sample Code**	**Description**
EUT B	DE1015143ca01	Standard Sample
Sample Parameter	**Value**	
Serial No.	358110420726734	
HW Version	UBX-379E00	
SW Version	04.17 A00.01	
Comment	LARA-R6001	

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

4.3 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.

Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
-	-	-

4.4 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.

Device	**Details (Manufacturer, Type Model, HW, SW, S/N)**	**Description**
-	-	-

4.5 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	**Combination of EUTs**	**Description and Rationale**
S01_AA01	EUT A	radiated & conducted sample
S02_AA01	EUT B	conducted sample

4.6 OPERATING MODES / TEST CHANNELS

This chapter describes the operating modes of the EUTs used for testing.

LTE eTDD 41		**LOW**	**MID**	**HIGH**	**LOW**	**MID**	**HIGH**	**LOW**	**MID**	**HIGH**
	Cell BW [MHz]	5	5	5	10	10	10	15	15	15
	CH no.	39675	40620	41565	39700	40620	41540	39725	40620	41515
	f [MHz]	2498.5	2593.0	2687.5	2501.0	2593.0	2685.0	2503.5	2593.0	2682.5
		LOW	**MID**	**HIGH**	**LOW**	**MID**	**HIGH**	**LOW**	**MID**	**HIGH**
	Cell BW [MHz]	20	20	20	-	-	-	-	-	-
	CH no.	39750	40620	41490	-	-	-	-	-	-
	f [MHz]	2506.0	2593.0	2680.0	-	-	-	-	-	-

4.7 PRODUCT LABELLING

4.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

4.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

5 TEST RESULTS

5.1 RF OUTPUT POWER

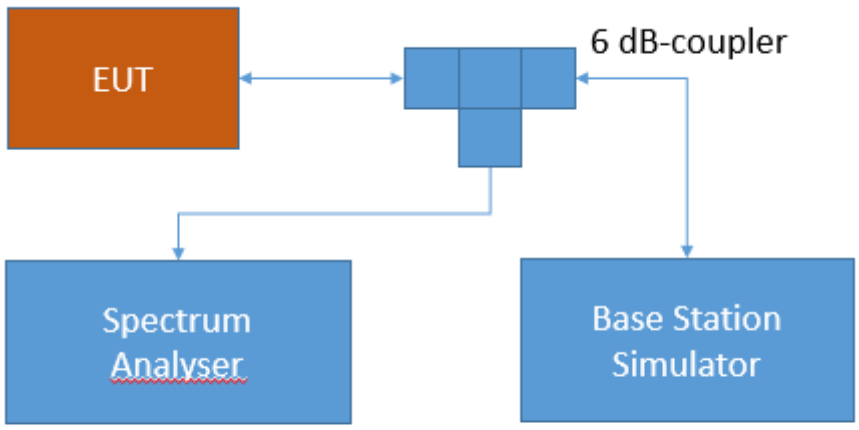
Standard **FCC PART 27 Subpart C**

The test was performed according to:
ANSI C63.26: 2015; 5.2.4.1, Wideband Signal: 5.2.4.4

5.1.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable RF Output power test case per § 2.1046 and RSS-GEN 6.12. The limit and the requirements come from the applicable rule part and ISED RSS-Standard for the operating band of the cellular device.

The EUT was connected to the test setup according to the following diagram:



Test Setup FCC Part 22/24/27/90 Cellular;
RF Output power

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

5.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§ 27.50 - Power limits and duty cycle

Band 7 / 41:

(h) The following power limits shall apply in the BRS and EBS:

(2) Mobile and other user stations. Mobile stations are limited to 2.0 watts EIRP. All user stations are limited to 2.0 watts transmitter output power.

RSS-199; 4.4 Transmitter output power and equivalent isotropically power (e.i.r.p.)

The transmitter output power shall be measured in terms of average value.

For mobile subscriber equipment, the e.i.r.p. shall not exceed 2 W. For fixed subscriber equipment, the transmitter output power shall not exceed 2 W and the e.i.r.p. shall be limited to 40 W.

For equipment with multiple antennas, the transmitter output power and e.i.r.p shall be measured according to ANSI C63.26-2015.

5.1.3 TEST PROTOCOL

Ambient temperature: 25 °C
Relative humidity: 44 %

S01_AA01

Radio Technology	Ch.	Re-source Blocks	Band-width [MHz]	RMS Cond. Power (dBm)	FCC Limit (W)	IC Limit (W)	Max. Antenna Gain FCC (dBi)	Max. Antenna Gain IC (dBi)
LTE eTDD 41 QPSK	mid	1	5	22.18	2 (EIRP)	2 (EIRP)	10.82	10.82
LTE eTDD 41 QPSK	mid	12	5	21.36	2 (EIRP)	2 (EIRP)	11.64	11.64
LTE eTDD 41 QPSK	mid	25	5	21.36	2 (EIRP)	2 (EIRP)	11.64	11.64
LTE eTDD 41 16QAM	mid	1	5	21.08	2 (EIRP)	2 (EIRP)	11.92	11.92
LTE eTDD 41 16QAM	mid	25	5	20.34	2 (EIRP)	2 (EIRP)	12.66	12.66
LTE eTDD 41 QPSK	mid	1	10	22.36	2 (EIRP)	2 (EIRP)	10.64	10.64
LTE eTDD 41 QPSK	mid	50	10	21.42	2 (EIRP)	2 (EIRP)	11.58	11.58
LTE eTDD 41 16QAM	mid	1	10	21.19	2 (EIRP)	2 (EIRP)	11.81	11.81
LTE eTDD 41 16QAM	mid	12	10	20.80	2 (EIRP)	2 (EIRP)	12.20	12.20
LTE eTDD 41 QPSK	mid	1	15	22.73	2 (EIRP)	2 (EIRP)	10.27	10.27
LTE eTDD 41 QPSK	mid	36	15	21.51	2 (EIRP)	2 (EIRP)	11.49	11.49
LTE eTDD 41 QPSK	mid	75	15	21.48	2 (EIRP)	2 (EIRP)	11.52	11.52
LTE eTDD 41 16QAM	mid	1	15	20.99	2 (EIRP)	2 (EIRP)	12.01	12.01
LTE eTDD 41 16QAM	mid	18	15	21.29	2 (EIRP)	2 (EIRP)	11.80	11.80
LTE eTDD 41 QPSK	mid	1	20	22.27	2 (EIRP)	2 (EIRP)	10.73	10.73
LTE eTDD 41 QPSK	mid	100	20	21.36	2 (EIRP)	2 (EIRP)	11.64	11.64
LTE eTDD 41 16QAM	mid	1	20	21.84	2 (EIRP)	2 (EIRP)	11.16	11.16
LTE eTDD 41 16QAM	mid	18	20	21.17	2 (EIRP)	2 (EIRP)	11.83	11.83

COMMENT:
The maximum antenna-gain refers only to the power limits for FCC and ISED.

S02_AA01

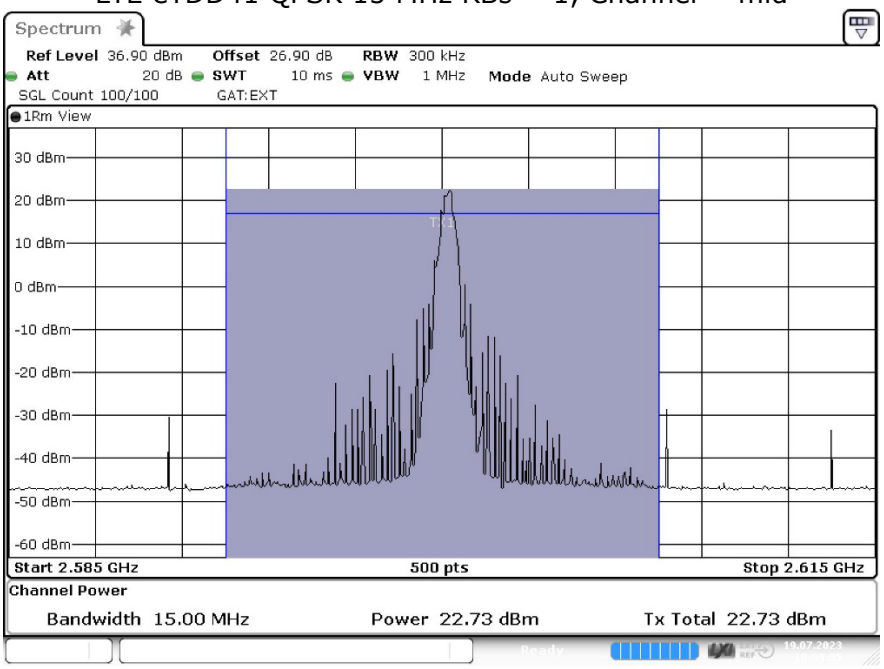
Radio Technology	Ch.	Re-source Blocks	Band-width [MHz]	RMS Cond. Power (dBm)	FCC Limit (W)	IC Limit (W)	Max. Antenna Gain FCC (dBi)	Max. Antenna Gain IC (dBi)
LTE eTDD 41 QPSK	mid	1	5	21.74	2 (EIRP)	2 (EIRP)	11.26	11.26
LTE eTDD 41 QPSK	mid	12	5	21.08	2 (EIRP)	2 (EIRP)	11.92	11.92
LTE eTDD 41 QPSK	mid	25	5	21.05	2 (EIRP)	2 (EIRP)	11.95	11.95
LTE eTDD 41 16QAM	mid	1	5	20.75	2 (EIRP)	2 (EIRP)	12.25	12.25
LTE eTDD 41 16QAM	mid	25	5	20.12	2 (EIRP)	2 (EIRP)	12.88	12.88
LTE eTDD 41 QPSK	mid	1	10	22.10	2 (EIRP)	2 (EIRP)	10.90	10.90
LTE eTDD 41 QPSK	mid	50	10	21.08	2 (EIRP)	2 (EIRP)	11.92	11.92
LTE eTDD 41 16QAM	mid	1	10	21.01	2 (EIRP)	2 (EIRP)	11.99	11.99
LTE eTDD 41 16QAM	mid	12	10	21.31	2 (EIRP)	2 (EIRP)	11.69	11.69
LTE eTDD 41 QPSK	mid	1	15	22.40	2 (EIRP)	2 (EIRP)	10.60	10.60
LTE eTDD 41 QPSK	mid	36	15	21.15	2 (EIRP)	2 (EIRP)	11.85	11.85
LTE eTDD 41 QPSK	mid	75	15	21.24	2 (EIRP)	2 (EIRP)	11.76	11.76
LTE eTDD 41 16QAM	mid	1	15	20.84	2 (EIRP)	2 (EIRP)	12.16	12.16
LTE eTDD 41 16QAM	mid	18	15	21.05	2 (EIRP)	2 (EIRP)	11.95	11.95
LTE eTDD 41 QPSK	mid	1	20	21.95	2 (EIRP)	2 (EIRP)	11.05	11.05
LTE eTDD 41 QPSK	mid	100	20	21.11	2 (EIRP)	2 (EIRP)	11.89	11.89
LTE eTDD 41 16QAM	mid	1	20	21.72	2 (EIRP)	2 (EIRP)	11.28	11.28
LTE eTDD 41 16QAM	mid	18	20	21.04	2 (EIRP)	2 (EIRP)	11.96	11.96

COMMENT:
The maximum antenna-gain refers only to the power limits for FCC and ISED.

Remark: Please see next sub-clause for the measurement plot.

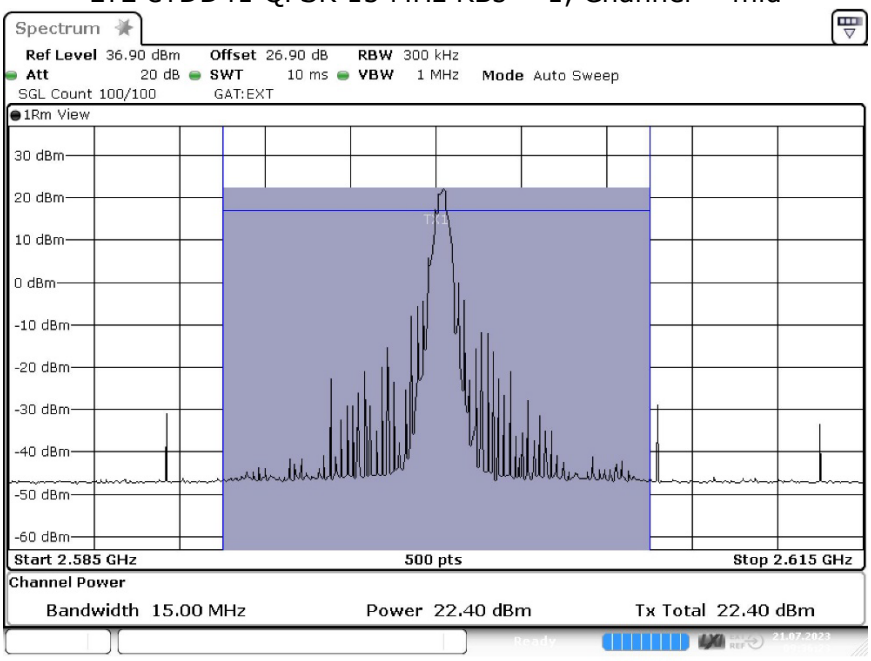
5.1.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

S01_AA01
LTE eTDD41 QPSK 15 MHz RBs = 1, Channel = mid



Date: 19.JUL.2023 10:09:55

S02_AA01
LTE eTDD41 QPSK 15 MHz RBs = 1, Channel = mid



Date: 21.JUL.2023 09:36:23

5.1.5 TEST EQUIPMENT USED

- Radio Lab

5.2 SPURIOUS EMISSIONS AT ANTENNA TERMINALS

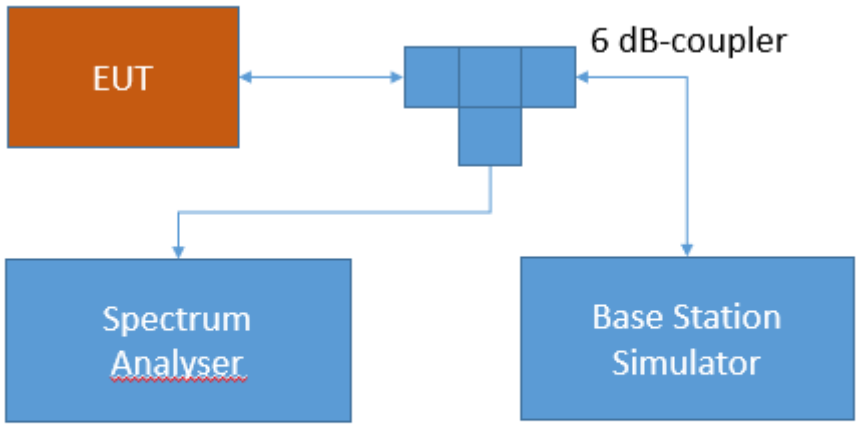
Standard **FCC PART 27 Subpart C**

The test was performed according to:
ANSI C63.26: 2015; 5.7.4

5.2.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable conducted spurious emission test case per § 2.1051 and RSS-GEN 6.13. The limit comes from the applicable rule part and ISED RSS-Standard for the operating band of the cellular device.

The EUT was connected to the test setup according to the following diagram:



Test Setup FCC Part 22/24/27/90 Cellular;
Spurious Emissions at antenna terminal

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

5.2.2 TEST REQUIREMENTS / LIMITS

FCC Part 2.1051; Measurement required: Spurious emissions at antenna terminal:

The radio frequency voltage or powers 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 §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

FCC Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 – Emission limits

Band 7 / 41:

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(4) For mobile digital stations, the attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

RSS-199; 4.5 Transmitter unwanted emissions

In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 1% of the occupied bandwidth for base station and fixed subscriber equipment, and 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz, or 1% or 2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emission limits:

b. for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

$40 + 10 \log_{10} p$ from the channel edges to 5 MHz away

$43 + 10 \log_{10} p$ between 5 MHz and X MHz from the channel edges, and

$55 + 10 \log_{10} p$ at X MHz and beyond from the channel edges

In addition, the attenuation shall not be less than $43 + 10 \log_{10} p$ on all frequencies between 2490.5 MHz and 2496 MHz, and $55 + 10 \log_{10} p$ at or below 2490.5 MHz.

In (b), p is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

5.2.3 TEST PROTOCOL

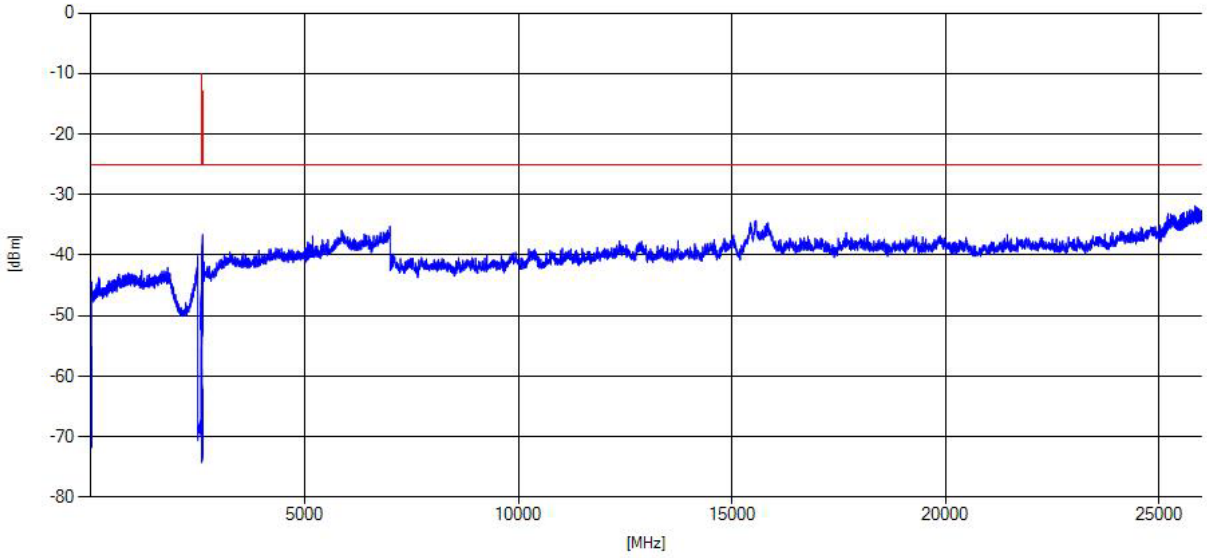
Ambient temperature: 25 °C
Relative humidity: 44 %

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
LTE eTDD41	mid	rms	maxhold	-	-	-	-13	>20

Remark: Please see next sub-clause for the measurement plot.

5.2.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

S01_AA01
LTE eTDD41 QPSK 10 MHz RBs = 1, Channel = mid



5.2.5 TEST EQUIPMENT USED

- Radio Lab

5.3 FIELD STRENGTH OF SPURIOUS RADIATION

Standard **FCC PART 27 Subpart C**

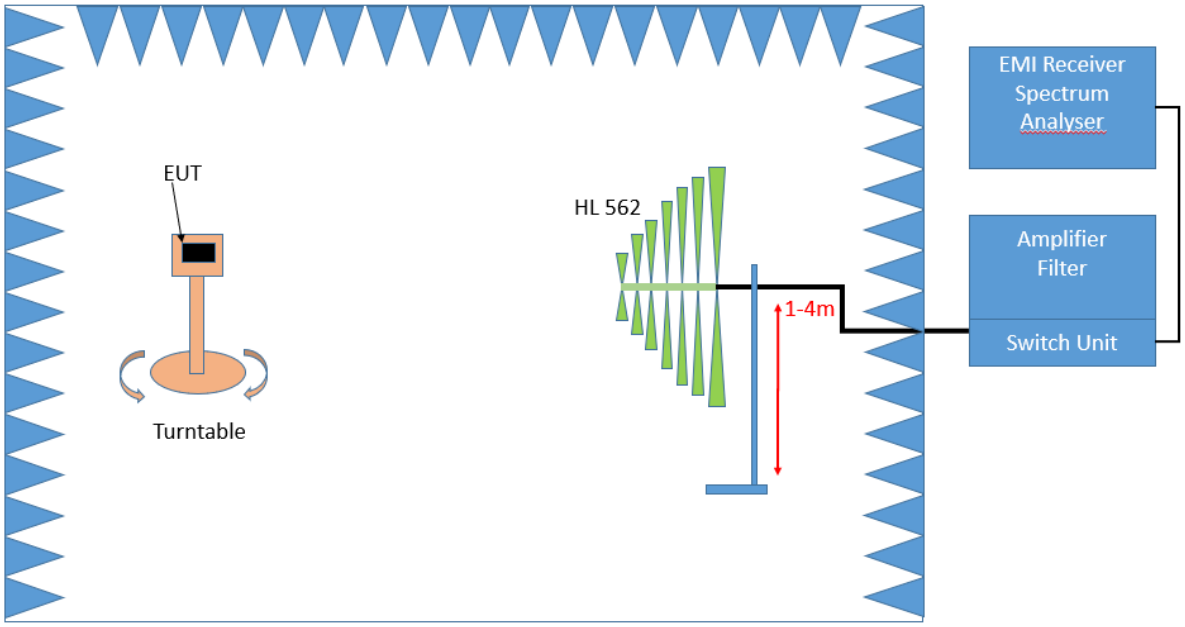
The test was performed according to:
ANSI C63.26: 2015; 5.5.2.3.1

5.3.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable radiated spurious emission measurements per § 2.1053 and RSS-GEN 6.13. The limit and requirements come from the applicable rule part and ISED RSS-Standard for the operating band of the cellular device.

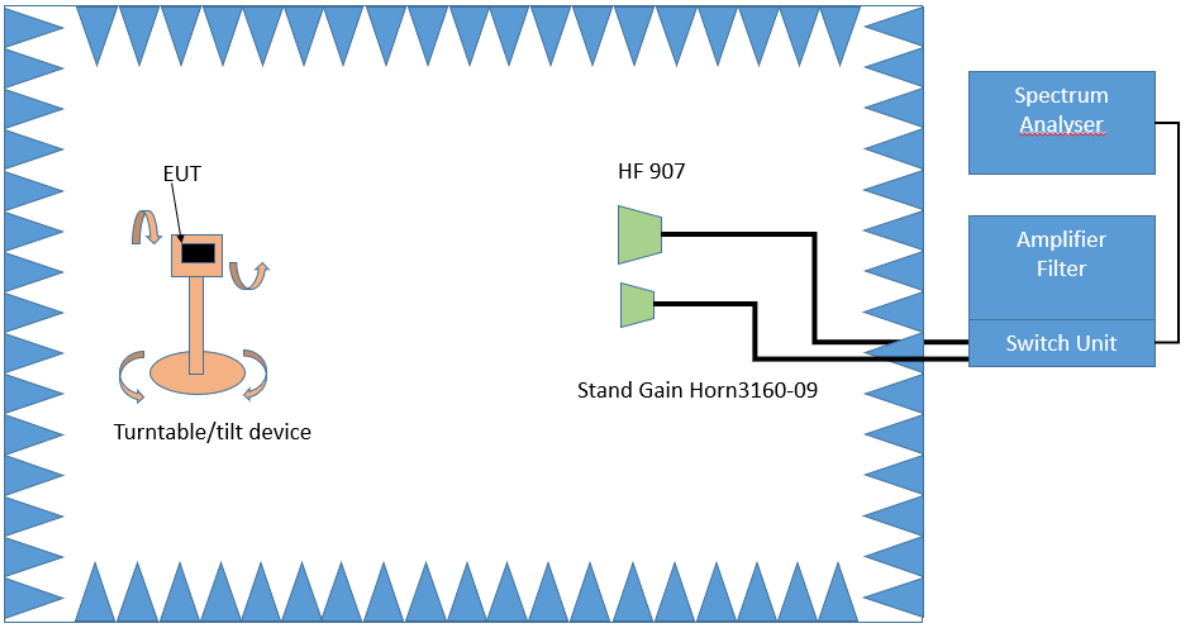
The EUT was connected to the test setup according to the following diagram:

Frequency Range: 30 MHz – 1 GHz:



Test Setup; Spurious Emission Radiated (SAC), 30 MHz- 1GHz

Frequency Range: 1 GHz – 26.5 GHz



Test Setup; Spurious Emission Radiated (FAC), 1 GHz-26.5 GHz

The test set-up was made in accordance to the general provisions of ANSI C63.26 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software EMC32 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered from a DC power source.

1. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 3 m
- Detector: Peak
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: coupled
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action,

the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.
- Detector: Peak
- Measured frequencies: in step 1 determined frequencies
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: coupled
- Turntable angle range: ± 45 ° around the determined value
- Height variation range: ± 100 cm around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with RMS detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: RMQ
- Measured frequencies: in step 1 determined frequencies
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: 1 s

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

3. Measurement above 1 GHz
The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
Step 1:
The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.
All steps were performed with one height (1.5 m) of the receiving antenna only.
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.
The turn table step size (azimuth angle) for the preliminary measurement is 45 °.
- Antenna distance: 3 m
- Detector: Peak
- RBW: 1 MHz
- VBW: 3 MHz
- Sweep time: coupled
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Polarisation: Horizontal + Vertical

Step 2:
Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size ± 45° for the elevation axis is performed.
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
EMI receiver settings (for all steps):
- Detector: Peak,
- RBW: 1 MHz

- VBW: 3 MHz
- Sweep time: coupled

Step 3:

Spectrum analyser settings for step 3:
- Detector: RMS
- Measured frequencies: in step 1 determined frequencies
- RBW: 1 MHz
- VBW: 3 MHz
- Sweep Time: 1 s

5.3.2 TEST REQUIREMENTS / LIMITS

FCC Part 2.1053; Measurement 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 §2.1049, as appropriate.

FCC Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 – Emission limits

Band 7 / 41:

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(4) For mobile digital stations, the attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

RSS-199; 4.5 Transmitter unwanted emissions

In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 1% of the occupied bandwidth for base station and fixed subscriber equipment, and 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz, or 1% or 2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emission limits:

b. for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

$40 + 10 \log_{10} p$ from the channel edges to 5 MHz away

$43 + 10 \log_{10} p$ between 5 MHz and X MHz from the channel edges, and

$55 + 10 \log_{10} p$ at X MHz and beyond from the channel edges

In addition, the attenuation shall not be less than $43 + 10 \log_{10} p$ on all frequencies between 2490.5 MHz and 2496 MHz, and $55 + 10 \log_{10} p$ at or below 2490.5 MHz.

In (b), p is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

5.3.3 TEST PROTOCOL

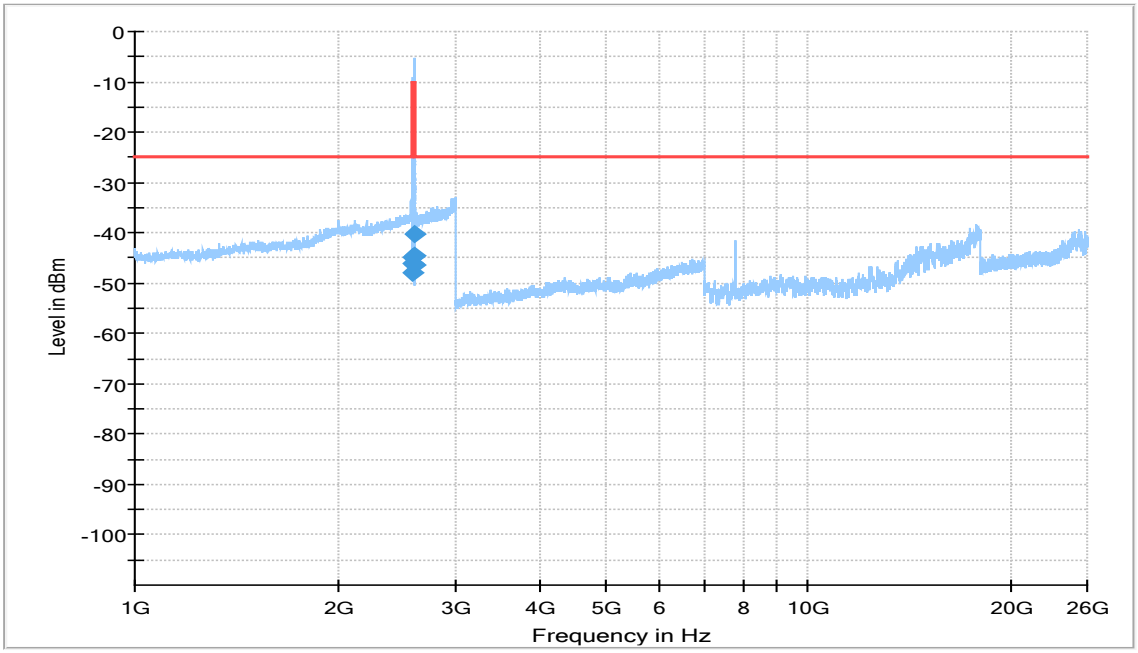
Ambient temperature: 28 °C
Relative humidity: 39 %

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
LTE eTDD41	mid	rms	maxhold	-	-	-	-13	>20

Remark: Please see next sub-clause for the measurement plot.

5.3.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

S01_AA01
LTE eTDD41 QPSK 10 MHz RBs = 1, Channel = mid



Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
2584.202	-47.8	-13.00	34.76	1000.0	1000.000	150.0	V	-90.0	90.0
2587.381	-46.0	-10.00	35.98	1000.0	1000.000	150.0	V	-93.0	91.0
2589.500	-44.8	-10.00	34.83	1000.0	1000.000	150.0	V	68.0	79.0
2596.500	-40.1	-10.00	30.14	1000.0	1000.000	150.0	H	-63.0	-5.0
2597.711	-44.6	-10.00	34.57	1000.0	1000.000	150.0	V	-142.0	87.0
2600.535	-46.4	-13.00	33.42	1000.0	1000.000	150.0	H	-61.0	-9.0

5.3.5 TEST EQUIPMENT USED

- Radiated Emissions FAR Cellular

5.4 BAND EDGE COMPLIANCE

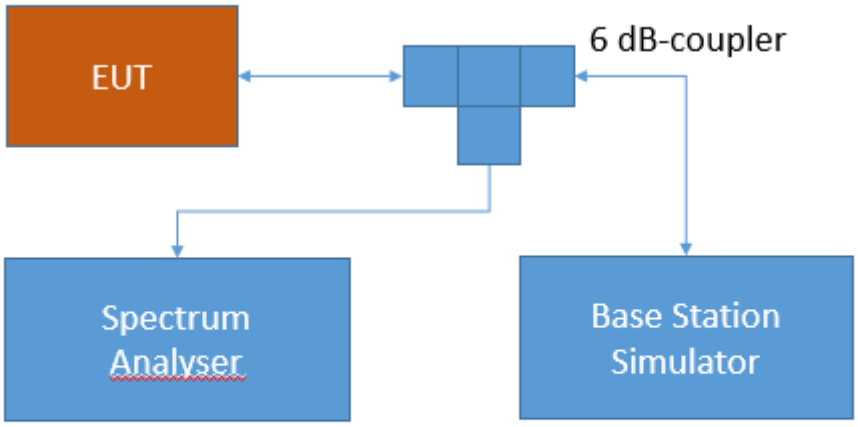
Standard **FCC PART 27 Subpart C**

The test was performed according to:
ANSI C63.26: 2015; 5.7.3

5.4.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable conducted spurious emission test case per § 2. 1051 and RSS-GEN 6.13. The limit comes from the applicable rule part and ISED RSS-Standard for the operating band of the cellular device.

The EUT was connected to the test setup according to the following diagram:



Test Setup FCC Part 22/24/27/90 Cellular;
Band edge compliance

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

5.4.2 TEST REQUIREMENTS / LIMITS

FCC Part 2.1051; Measurement required: Spurious emissions at antenna terminal:

The radio frequency voltage or powers 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 §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

FCC Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 - Emission limits

Band 7 / 41:

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(4) For mobile digital stations, the attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

RSS-199; 4.5 Transmitter unwanted emissions

In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 1% of the occupied bandwidth for base station and fixed subscriber equipment, and 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz, or 1% or 2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emission limits:

b. for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

$40 + 10 \log_{10} p$ from the channel edges to 5 MHz away

$43 + 10 \log_{10} p$ between 5 MHz and X MHz from the channel edges, and

$55 + 10 \log_{10} p$ at X MHz and beyond from the channel edges

In addition, the attenuation shall not be less than $43 + 10 \log_{10} p$ on all frequencies between 2490.5 MHz and 2496 MHz, and $55 + 10 \log_{10} p$ at or below 2490.5 MHz.

In (b), p is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

5.4.3 TEST PROTOCOL

Ambient temperature: 25 °C
Relative humidity: 44 %

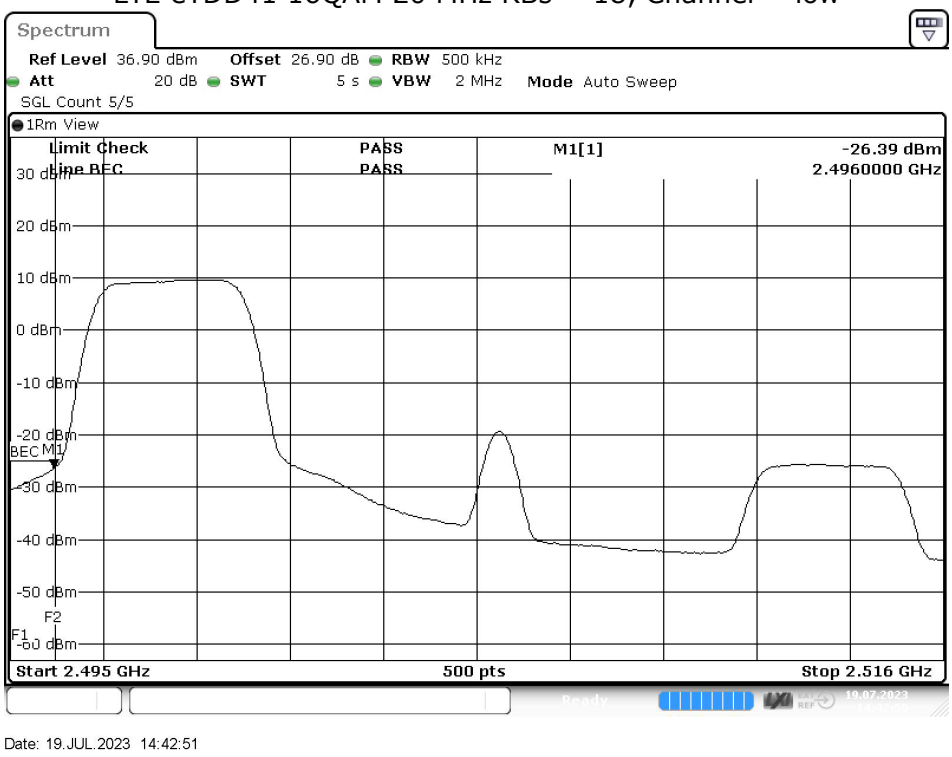
Radio Technology	Channel	Re-source Blocks	Band-width [MHz]	Peak [dBm]	Average [dBm]	RMS [dBm]	Limit /dBm	Margin to Limit /dB
LTE eTDD 41 QPSK	low	25	5	-14.22	-35.83	-30.18	-13	17.18
LTE eTDD 41 QPSK	high	25	5	-9.95	-37.46	-30.47	-13	17.47
LTE eTDD 41 16QAM	low	25	5	-12.87	-37.26	-30.41	-13	17.41
LTE eTDD 41 16QAM	high	25	5	-11.62	-39.23	-31.78	-13	18.78
LTE eTDD 41 QPSK	low	50	10	-10.77	-35.77	-31.27	-13	18.27
LTE eTDD 41 QPSK	high	50	10	-6.94	-38.88	-33.39	-13	20.39
LTE eTDD 41 16QAM	low	12	10	-6.62	-32.05	-26.91	-13	13.91
LTE eTDD 41 16QAM	high	12	10	-4.60	-33.78	-28.26	-13	15.26
LTE eTDD 41 QPSK	low	75	15	-13.05	-35.88	-32.05	-13	19.05
LTE eTDD 41 QPSK	high	75	15	-8.19	-39.63	-35.01	-13	22.01
LTE eTDD 41 16QAM	low	18	15	-3.87	-32.09	-27.45	-13	14.45
LTE eTDD 41 16QAM	high	18	15	-4.13	-34.04	-28.17	-13	15.17
LTE eTDD 41 QPSK	low	100	20	-9.27	-35.43	-31.91	-13	18.91
LTE eTDD 41 QPSK	high	100	20	-14.17	-38.90	-35.64	-13	22.64
LTE eTDD 41 16QAM	low	18	20	-1.56	-31.11	-26.39	-13	13.39
LTE eTDD 41 16QAM	high	18	20	-0.51	-33.89	-28.92	-13	15.92

Remark: Please see next sub-clause for the measurement plot.

5.4.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

S01_AA01

LTE eTDD41 16QAM 20 MHz RBs = 18, Channel = low



Date: 19.JUL.2023 14:42:51

5.4.5 TEST EQUIPMENT USED

- Radio Lab

5.5 PEAK TO AVERAGE RATIO

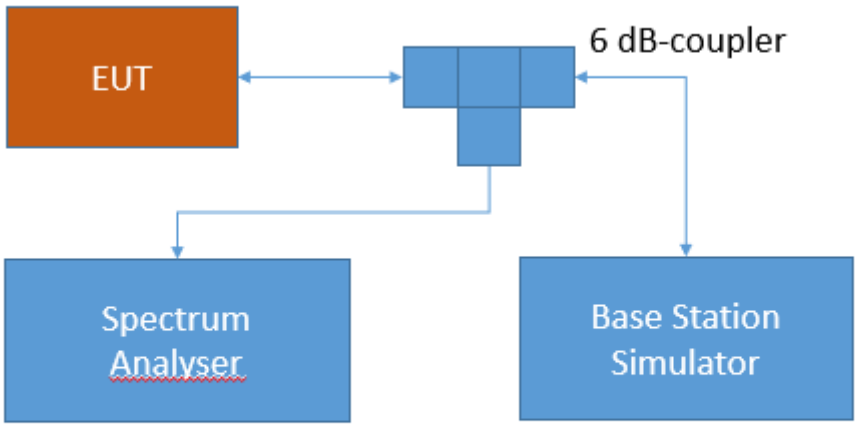
Standard **FCC PART 27 Subpart C**

The test was performed according to:
ANSI C63.26: 2015; 5.2.3.4 (broadband noise-like signal using CCDF [LTE, CAT-M1, NB-IoT])
5.2.6 (alternative procedure for PAPR [GSM, EDGE, WCDMA, HSDPA, HSUPA])

5.5.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance of the EUT to the peak-to-average limits and requirements of the applicable rule part and ISED RSS-Standard for the operating band of the cellular device.

The EUT was connected to the test setup according to the following diagram:



Test Setup FCC Part 22/24/27/90 Cellular;
Peak-average ratio

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams. The internal CCDF (complementary cumulative distribution function) of the spectrum analyser is used for this measurement

5.5.2 TEST REQUIREMENTS / LIMITS

FCC Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§ 27.50 - Power limits and duty cycle

Band 7 / 41:

No applicable PAPR limit.

RSS-199; 4.4 Transmitter output power and equivalent isotropicall power (e.i.r.p.)

In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time and shall use a signal corresponding to the highest PAPR during periods of continuous transmission.

For equipment with multiple antennas, the transmitter output power and e.i.r.p shall be measured according to ANSI C63.26-2015.

5.5.3 TEST PROTOCOL

Ambient temperature: 25 °C
Relative humidity: 44 %

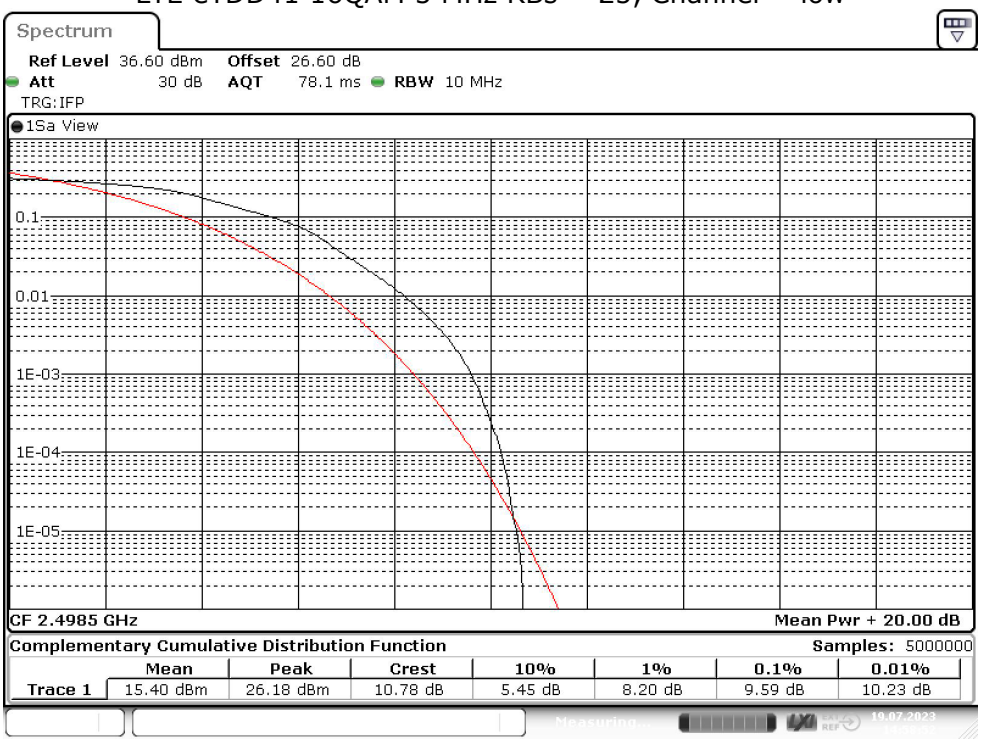
Radio Technology	Channel	Re-source Blocks	Bandwidth [MHz]	Peak to Average Ratio	Limit (IC) [dB]
LTE eTDD 41 QPSK	low	25	5	8.84	13
LTE eTDD 41 QPSK	mid	25	5	9.59	13
LTE eTDD 41 QPSK	high	25	5	9.04	13
LTE eTDD 41 16QAM	low	25	5	9.94	13
LTE eTDD 41 16QAM	mid	25	5	8.87	13
LTE eTDD 41 16QAM	high	25	5	9.71	13

Remark: Please see next sub-clause for the measurement plot.

5.5.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

S01_AA01

LTE eTDD41 16QAM 5 MHz RBs = 25, Channel = low



Date: 19.JUL.2023 14:58:52

5.5.5 TEST EQUIPMENT USED

- Radio Lab

6 TEST EQUIPMENT

6.1 TEST EQUIPMENT HARDWARE

1 Radiated Emissions FAR Cellular
Radiated Emissions in a fully anechoic room for Cellular

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	Opus10 TPR (8253.00)	T/P Logger 13	Lufft Mess- und Regeltechnik GmbH	13936	2021-10	2023-10
1.2	Innco Systems CO3000	Controller for bore sight mast FAC		CO3000/1460/54740522/P		
1.3	AMF-7D00101800-30-10P-R	Broadband Amplifier 100 MHz - 18 GHz	Miteq			
1.4	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
1.5	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		
1.6	Anechoic Chamber 03	FAR, 8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB		
1.7	MCU	Controller Maturo	Maturo GmbH	4390315		
1.8	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2022-06	2024-06
1.9	PONTIS Con4101	PONTIS Camera Controller		6061510370		
1.10	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
1.11	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
1.12	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
1.13	MA3000/0800-XP-ET-compact	Bore Sight Antenna Mast				
1.14	TT 1.5 WI	Turn Table	Maturo GmbH	-		
1.15	HL 562 ULTRALOG	Biconical-log-per Antenna (30 MHz - 3 GHz)	Rohde & Schwarz GmbH & Co. KG	100609	2022-06	2025-06
1.16	CMW500	Callbox OIL-RE, SUW	Rohde & Schwarz GmbH & Co. KG	155999-Ei	2023-01	2026-01
1.17	CMU 200	"CMU1" Universal Radio Communication Tester	Rohde & Schwarz GmbH & Co. KG	102366	2021-02	2024-02
1.18	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.19	CMW500	Callbox OIL-RE, SUA	Rohde & Schwarz GmbH & Co. KG	163529-bw	2023-01	2026-01
1.20	JUN-AIR Mod. 6-15	Air Compressor	JUN-AIR Deutschland GmbH	612582		
1.21	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
1.22	Opus 20 THI (8120.00)	ThermoHygro Datalogger	Lufft Mess- und Regeltechnik GmbH	115.0318.0802.033		
1.23	CMW500	Callbox OIL-RE, SUA-160 MHz	Rohde & Schwarz GmbH & Co. KG	167766-By	2022-05	2025-05
1.24	TD1.5-10kg	EUT Tilt Device (Rohacell)	Maturo GmbH	TD1.5-10kg/024/3790709		
1.25	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324		
1.26	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2021-09	2024-09

2 Radio Lab
Conducted Radio Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	1575	Broadband Resistive Power Divider DC to 40 GHz	API Weinschel, Inc.	4070		
2.2	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2022-06	2024-06
2.3	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2022-06	2024-06
2.4	SMP03	Signal Generator 2 GHz - 27 GHz	Rohde & Schwarz	833680/003		
2.5	Temperature Chamber KWP 120/70	Temperature Chamber Weiss 01	Weiss	59226012190010	2022-05	2024-05
2.6	SMB100A	Signal Generator 100 kHz - 40 GHz	Rohde & Schwarz Vertriebs-GmbH	181486	2023-01	2026-01
2.7	Chroma 6404	AC Source	Chroma ATE INC.	64040001304		
2.8	EX520	Digital Multimeter 07	Extech Instruments Corp	06110393		
2.9	Temperature Chamber VT 4002	Temperature Chamber Vötsch 03	Vötsch	58566002150010	2022-05	2024-05
2.10	A8455-4	4 Way Power Divider (SMA)		-		
2.11	Opus10 THI (8152.00)	T/H Logger 03	Lufft Mess- und Regeltechnik GmbH	7482	2021-09	2023-09
2.12	SMIQ 03B	Vector Signal Generator	Rohde & Schwarz	100583		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.13	Temperature Chamber VT 4002	Temperature Chamber Vötsch 05	Vötsch	58566080550010	2022-05	2024-05
2.14	CMW500	Callbox OIL-RE, SUA-160 MHz	Rohde & Schwarz GmbH & Co. KG	167766-By	2022-05	2025-05

The calibration interval is the time interval between "Last Calibration" and "Calibration Due"

6.2 TEST EQUIPMENT SOFTWARE

Semi-Anechoic Chamber:	
Software	Version
EMC32 Measurement Software	10.60.10
INNCO Mast Controller	1.02.62
MATURO Mast Controller	12.19
MATURO Turn-Table Controller	30.10
Fully-Anechoic Chamber:	
Software	Version
EMC32 Measurement Software	10.60.10
MATURO Turn-Unit Cotrolller	11.10
MATURO Mast Controller	12.10
MATURO Turntable Controller	12.11
Conducted AC Emissions:	
Software	Version
EMC32 Measurement Software	10.60.20

7 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

7.1 LISN R&S ESH3-Z5 (150 KHZ – 30 MHZ)

Frequency		Corr.	LISN insertion loss ESH3-Z5	cable loss (incl. 10 dB atten-uator)
MHz		dB	dB	dB
0.15		10.1	0.1	10.0
5		10.3	0.1	10.2
7		10.5	0.2	10.3
10		10.5	0.2	10.3
12		10.7	0.3	10.4
14		10.7	0.3	10.4
16		10.8	0.4	10.4
18		10.9	0.4	10.5
20		10.9	0.4	10.5
22		11.1	0.5	10.6
24		11.1	0.5	10.6
26		11.2	0.5	10.7
28		11.2	0.5	10.7
30		11.3	0.5	10.8

Sample calculation

U_{LISN} (dB µV) = U (dB µV) + Corr. (dB)
U = Receiver reading
LISN Insertion loss = Voltage Division Factor of LISN
Corr. = sum of single correction factors of used LISN, cables, switch units (if used)
Linear interpolation will be used for frequencies in between the values in the table.

7.2 ANTENNA R&S HFH2-Z2 (9 KHZ – 30 MHZ)

Frequency	AF HFH-Z2)	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-40 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
0.009	20.50	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.01	20.45	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.015	20.37	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.02	20.36	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.025	20.38	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.03	20.32	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.05	20.35	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.08	20.30	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.1	20.20	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.2	20.17	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.3	20.14	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.49	20.12	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.490001	20.12	-39.6	0.1	0.1	0.1	0.1	-40	30	3
0.5	20.11	-39.6	0.1	0.1	0.1	0.1	-40	30	3
0.8	20.10	-39.6	0.1	0.1	0.1	0.1	-40	30	3
1	20.09	-39.6	0.1	0.1	0.1	0.1	-40	30	3
2	20.08	-39.6	0.1	0.1	0.1	0.1	-40	30	3
3	20.06	-39.6	0.1	0.1	0.1	0.1	-40	30	3
4	20.05	-39.5	0.2	0.1	0.1	0.1	-40	30	3
5	20.05	-39.5	0.2	0.1	0.1	0.1	-40	30	3
6	20.02	-39.5	0.2	0.1	0.1	0.1	-40	30	3
8	19.95	-39.5	0.2	0.1	0.1	0.1	-40	30	3
10	19.83	-39.4	0.2	0.1	0.2	0.1	-40	30	3
12	19.71	-39.4	0.2	0.1	0.2	0.1	-40	30	3
14	19.54	-39.4	0.2	0.1	0.2	0.1	-40	30	3
16	19.53	-39.3	0.3	0.1	0.2	0.1	-40	30	3
18	19.50	-39.3	0.3	0.1	0.2	0.1	-40	30	3
20	19.57	-39.3	0.3	0.1	0.2	0.1	-40	30	3
22	19.61	-39.3	0.3	0.1	0.2	0.1	-40	30	3
24	19.61	-39.3	0.3	0.1	0.2	0.1	-40	30	3
26	19.54	-39.3	0.3	0.1	0.2	0.1	-40	30	3
28	19.46	-39.2	0.3	0.1	0.3	0.1	-40	30	3
30	19.73	-39.1	0.4	0.1	0.3	0.1	-40	30	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -40 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values

7.3 ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

(d_{Limit} = 3 m)

Frequency	AF R&S HL562	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18.6	0.6	0.29	0.04	0.23	0.02	0.0	3	3
50	6.0	0.9	0.39	0.09	0.32	0.08	0.0	3	3
100	9.7	1.2	0.56	0.14	0.47	0.08	0.0	3	3
150	7.9	1.6	0.73	0.20	0.59	0.12	0.0	3	3
200	7.6	1.9	0.84	0.21	0.70	0.11	0.0	3	3
250	9.5	2.1	0.98	0.24	0.80	0.13	0.0	3	3
300	11.0	2.3	1.04	0.26	0.89	0.15	0.0	3	3
350	12.4	2.6	1.18	0.31	0.96	0.13	0.0	3	3
400	13.6	2.9	1.28	0.35	1.03	0.19	0.0	3	3
450	14.7	3.1	1.39	0.38	1.11	0.22	0.0	3	3
500	15.6	3.2	1.44	0.39	1.20	0.19	0.0	3	3
550	16.3	3.5	1.55	0.46	1.24	0.23	0.0	3	3
600	17.2	3.5	1.59	0.43	1.29	0.23	0.0	3	3
650	18.1	3.6	1.67	0.34	1.35	0.22	0.0	3	3
700	18.5	3.6	1.67	0.42	1.41	0.15	0.0	3	3
750	19.1	4.1	1.87	0.54	1.46	0.25	0.0	3	3
800	19.6	4.1	1.90	0.46	1.51	0.25	0.0	3	3
850	20.1	4.4	1.99	0.60	1.56	0.27	0.0	3	3
900	20.8	4.7	2.14	0.60	1.63	0.29	0.0	3	3
950	21.1	4.8	2.22	0.60	1.66	0.33	0.0	3	3
1000	21.6	4.9	2.23	0.61	1.71	0.30	0.0	3	3

(d_{Limit} = 10 m)

30	18.6	-9.9	0.29	0.04	0.23	0.02	-10.5	10	3
50	6.0	-9.6	0.39	0.09	0.32	0.08	-10.5	10	3
100	9.7	-9.2	0.56	0.14	0.47	0.08	-10.5	10	3
150	7.9	-8.8	0.73	0.20	0.59	0.12	-10.5	10	3
200	7.6	-8.6	0.84	0.21	0.70	0.11	-10.5	10	3
250	9.5	-8.3	0.98	0.24	0.80	0.13	-10.5	10	3
300	11.0	-8.1	1.04	0.26	0.89	0.15	-10.5	10	3
350	12.4	-7.9	1.18	0.31	0.96	0.13	-10.5	10	3
400	13.6	-7.6	1.28	0.35	1.03	0.19	-10.5	10	3
450	14.7	-7.4	1.39	0.38	1.11	0.22	-10.5	10	3
500	15.6	-7.2	1.44	0.39	1.20	0.19	-10.5	10	3
550	16.3	-7.0	1.55	0.46	1.24	0.23	-10.5	10	3
600	17.2	-6.9	1.59	0.43	1.29	0.23	-10.5	10	3
650	18.1	-6.9	1.67	0.34	1.35	0.22	-10.5	10	3
700	18.5	-6.8	1.67	0.42	1.41	0.15	-10.5	10	3
750	19.1	-6.3	1.87	0.54	1.46	0.25	-10.5	10	3
800	19.6	-6.3	1.90	0.46	1.51	0.25	-10.5	10	3
850	20.1	-6.0	1.99	0.60	1.56	0.27	-10.5	10	3
900	20.8	-5.8	2.14	0.60	1.63	0.29	-10.5	10	3
950	21.1	-5.6	2.22	0.60	1.66	0.33	-10.5	10	3
1000	21.6	-5.6	2.23	0.61	1.71	0.30	-10.5	10	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

7.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24.4	-19.4	0.99	0.31	-21.51	0.79		
2000	28.5	-17.4	1.44	0.44	-20.63	1.38		
3000	31.0	-16.1	1.87	0.53	-19.85	1.33		
4000	33.1	-14.7	2.41	0.67	-19.13	1.31		
5000	34.4	-13.7	2.78	0.86	-18.71	1.40		
6000	34.7	-12.7	2.74	0.90	-17.83	1.47		
7000	35.6	-11.0	2.82	0.86	-16.19	1.46		

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31.0	-23.4	0.47	1.87	0.53	-27.58	1.33	
4000	33.1	-23.3	0.56	2.41	0.67	-28.23	1.31	
5000	34.4	-21.7	0.61	2.78	0.86	-27.35	1.40	
6000	34.7	-21.2	0.58	2.74	0.90	-26.89	1.47	
7000	35.6	-19.8	0.66	2.82	0.86	-25.58	1.46	

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35.6	-57.3	0.56	1.28	-62.72	2.66	0.94	1.46
8000	36.3	-56.3	0.69	0.71	-61.49	2.84	1.00	1.53
9000	37.1	-55.3	0.68	0.65	-60.80	3.06	1.09	1.60
10000	37.5	-56.2	0.70	0.54	-61.91	3.28	1.20	1.67
11000	37.5	-55.3	0.80	0.61	-61.40	3.43	1.27	1.70
12000	37.6	-53.7	0.84	0.42	-59.70	3.53	1.26	1.73
13000	38.2	-53.5	0.83	0.44	-59.81	3.75	1.32	1.83
14000	39.9	-56.3	0.91	0.53	-63.03	3.91	1.40	1.77
15000	40.9	-54.1	0.98	0.54	-61.05	4.02	1.44	1.83
16000	41.3	-54.1	1.23	0.49	-61.51	4.17	1.51	1.85
17000	42.8	-54.4	1.36	0.76	-62.36	4.34	1.53	2.00
18000	44.2	-54.7	1.70	0.53	-62.88	4.41	1.55	1.91

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

7.5 ANTENNA EMCO 3160-09 (18 GHZ – 26.5 GHZ)

Frequency	AF EMCO 3160-09	Corr.	cable loss 1 (inside chamber)	cable loss 2 (pre-amp)	cable loss 3 (inside chamber)	cable loss 4 (switch unit)	cable loss 5 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB
18000	40.2	-23.5	0.72	-35.85	6.20	2.81	2.65
18500	40.2	-23.2	0.69	-35.71	6.46	2.76	2.59
19000	40.2	-22.0	0.76	-35.44	6.69	3.15	2.79
19500	40.3	-21.3	0.74	-35.07	7.04	3.11	2.91
20000	40.3	-20.3	0.72	-34.49	7.30	3.07	3.05
20500	40.3	-19.9	0.78	-34.46	7.48	3.12	3.15
21000	40.3	-19.1	0.87	-34.07	7.61	3.20	3.33
21500	40.3	-19.1	0.90	-33.96	7.47	3.28	3.19
22000	40.3	-18.7	0.89	-33.57	7.34	3.35	3.28
22500	40.4	-19.0	0.87	-33.66	7.06	3.75	2.94
23000	40.4	-19.5	0.88	-33.75	6.92	3.77	2.70
23500	40.4	-19.3	0.90	-33.35	6.99	3.52	2.66
24000	40.4	-19.8	0.88	-33.99	6.88	3.88	2.58
24500	40.4	-19.5	0.91	-33.89	7.01	3.93	2.51
25000	40.4	-19.3	0.88	-33.00	6.72	3.96	2.14
25500	40.5	-20.4	0.89	-34.07	6.90	3.66	2.22
26000	40.5	-21.3	0.86	-35.11	7.02	3.69	2.28
26500	40.5	-21.1	0.90	-35.20	7.15	3.91	2.36

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

7.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

Frequency	AF EMCO 3160-10	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
GHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
26.5	43.4	-11.2	4.4				-9.5	3	1.0
27.0	43.4	-11.2	4.4				-9.5	3	1.0
28.0	43.4	-11.1	4.5				-9.5	3	1.0
29.0	43.5	-11.0	4.6				-9.5	3	1.0
30.0	43.5	-10.9	4.7				-9.5	3	1.0
31.0	43.5	-10.8	4.7				-9.5	3	1.0
32.0	43.5	-10.7	4.8				-9.5	3	1.0
33.0	43.6	-10.7	4.9				-9.5	3	1.0
34.0	43.6	-10.6	5.0				-9.5	3	1.0
35.0	43.6	-10.5	5.1				-9.5	3	1.0
36.0	43.6	-10.4	5.1				-9.5	3	1.0
37.0	43.7	-10.3	5.2				-9.5	3	1.0
38.0	43.7	-10.2	5.3				-9.5	3	1.0
39.0	43.7	-10.2	5.4				-9.5	3	1.0
40.0	43.8	-10.1	5.5				-9.5	3	1.0

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

8 MEASUREMENT UNCERTAINTIES

Test Case(s)	Parameter	Uncertainty
- Field strength of spurious radiation	Field Strength	± 5.5 dB
- Emission and Occupied Bandwidth	Power Frequency	± 2.9 dB ± 11.2 kHz
- RF Output Power - Peak to Average Ratio	Power	± 2.2 dB
- Band Edge Compliance - Spurious Emissions at Antenna Terminal	Power Frequency	± 2.2 dB ± 11.2 kHz
- Frequency Stability	Frequency	± 25 Hz

9 PHOTO REPORT

Please see separate photo report.