FCC Measurement/Technical Report on

LARA-L6004 / LARA-L6004D
2G / 3G / LTE module

FCC ID: XPYUBX21BE01
IC: 8595A-UBX21BE01

Test Report Reference: MDE_UBLOX_2302_FCC_02

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche Akkreditierungsstelle
D-PL-12140-01-01
D-PL-12140-01-02
D-PL-12140-01-03

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

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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, cond.	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 10 MHz, 50, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 15 MHz, 1, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 15 MHz, 75, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 20 MHz, 1, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 20 MHz, 100, cond.	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 5 MHz, 1, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 5 MHz, 25, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 10 MHz, 1, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 10 MHz, 50, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 1, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 36, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 75, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 20 MHz, 1, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 20 MHz, 100, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 1, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 12, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 25, conducted	S01_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 10 MHz, 1, cond.	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 10 MHz, 50, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 15 MHz, 1, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 15 MHz, 75, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 20 MHz, 1, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 20 MHz, 100, cond.	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 5 MHz, 1, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 16QAM, mid channel, 5 MHz, 25, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 10 MHz, 1, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 10 MHz, 50, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 1, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 36, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 15 MHz, 75, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 20 MHz, 1, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 20 MHz, 100, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 1, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 12, conducted	S02_CA02	2023-07-21	Passed	Passed
E-UTRA, eTDD 41 QPSK, mid channel, 5 MHz, 25, conducted	S02_CA02	2023-07-21	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

7 layers GmbH, Borsigstr. 11
40880 Ratingen, Germany
Phone +49 (0)2102 749 0

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

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:	please see Applicant Data
Address:	
Contact Person:	

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

Kind of Device product description	2G / 3G / LTE Data Module
Product name	LARA-L6004 / LARA-L6004D
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	DE1015161ca02	RF Sample
Sample Parameter	**Value**	
Serial No.	354224630075008	
HW Version	UBX-379ED0	
SW Version	04.20,A00.01	
Comment	LARA-L6004D	

Sample Name	**Sample Code**	**Description**
EUT B	DE1015172ca02	RF Sample
Sample Parameter	**Value**	
Serial No.	352420380019681	
HW Version	UBX-379ED0	
SW Version	04.20,A00.01	
Comment	LARA-L6004	

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_CA02	EUT A	conducted sample
S02_CA02	EUT B	conducted sample

4.6 OPERATING MODES / TEST CHANNELS

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

		LOW	**MID**	**HIGH**	**LOW**	**MID**	**HIGH**	**LOW**	**MID**	**HIGH**
LTE eTDD 41	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

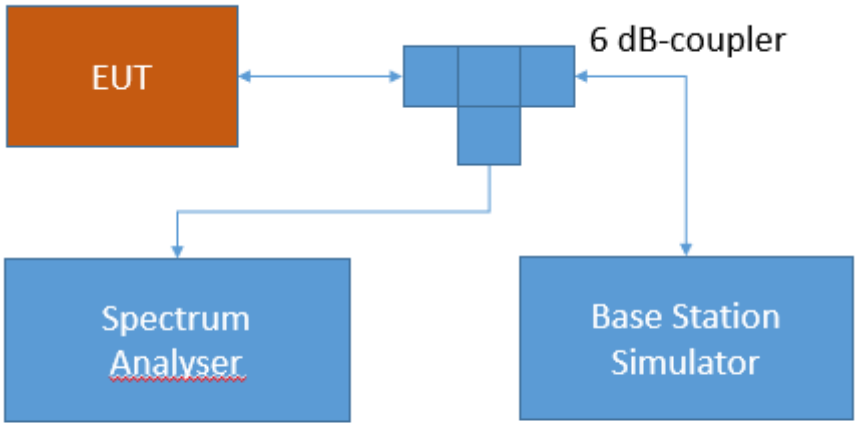
Standard **FCC PART 27 Subpart C**

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:

(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: 26 °C
Relative humidity: 45 %

S01_CA02

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	21.81	2 (EIRP)	2 (EIRP)	11.19	11.19
LTE eTDD 41 QPSK	mid	12	5	20.92	2 (EIRP)	2 (EIRP)	12.08	12.08
LTE eTDD 41 QPSK	mid	25	5	20.95	2 (EIRP)	2 (EIRP)	12.05	12.05
LTE eTDD 41 16QAM	mid	1	5	21.63	2 (EIRP)	2 (EIRP)	11.37	11.37
LTE eTDD 41 16QAM	mid	25	5	19.96	2 (EIRP)	2 (EIRP)	13.04	13.04
LTE eTDD 41 QPSK	mid	1	10	21.94	2 (EIRP)	2 (EIRP)	11.06	11.06
LTE eTDD 41 QPSK	mid	50	10	21.01	2 (EIRP)	2 (EIRP)	11.99	11.99
LTE eTDD 41 16QAM	mid	1	10	20.84	2 (EIRP)	2 (EIRP)	12.16	12.16
LTE eTDD 41 16QAM	mid	50	10	20.29	2 (EIRP)	2 (EIRP)	12.71	12.71
LTE eTDD 41 QPSK	mid	1	15	22.26	2 (EIRP)	2 (EIRP)	10.74	10.74
LTE eTDD 41 QPSK	mid	36	15	20.99	2 (EIRP)	2 (EIRP)	12.01	12.01
LTE eTDD 41 QPSK	mid	75	15	21.05	2 (EIRP)	2 (EIRP)	11.95	11.95
LTE eTDD 41 16QAM	mid	1	15	20.68	2 (EIRP)	2 (EIRP)	12.32	12.32
LTE eTDD 41 16QAM	mid	75	15	20.43	2 (EIRP)	2 (EIRP)	12.57	12.57
LTE eTDD 41 QPSK	mid	1	20	21.94	2 (EIRP)	2 (EIRP)	11.06	11.06
LTE eTDD 41 QPSK	mid	100	20	20.94	2 (EIRP)	2 (EIRP)	12.06	12.06
LTE eTDD 41 16QAM	mid	1	20	21.65	2 (EIRP)	2 (EIRP)	11.35	11.35
LTE eTDD 41 16QAM	mid	100	20	20.51	2 (EIRP)	2 (EIRP)	12.49	12.49

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

S02_AC02

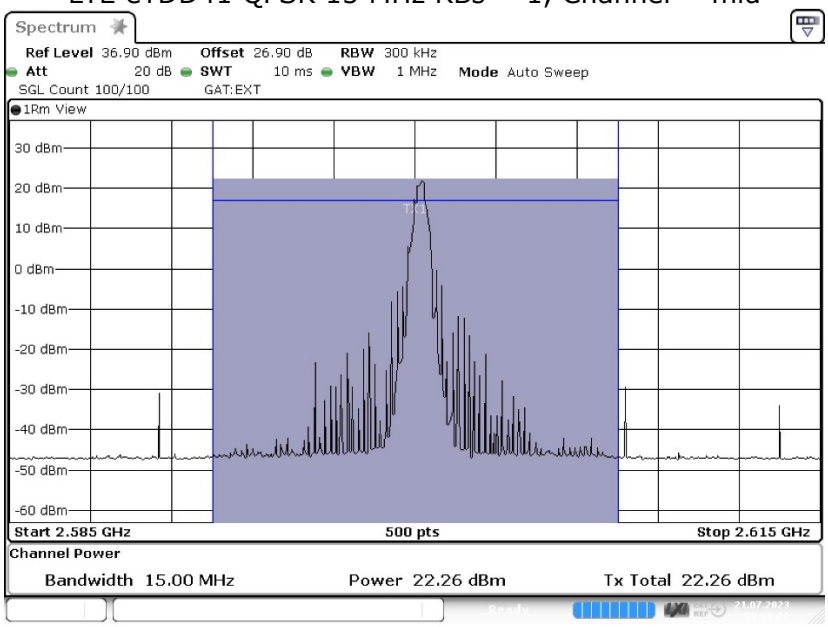
Radio Technology	Ch	Re-source Blocks	Band-width [MHz]	RMS Cond. Power (dBm)	FCC Limit (W)	IC Limit (W)	Max. Antenna Gain FCC (dBi)	Max. Antenna Gain IC (dBi)
LTE eTDD 41 QPSK	mid	1	5	21.53	2 (EIRP)	2 (EIRP)	11.47	11.47
LTE eTDD 41 QPSK	mid	12	5	20.67	2 (EIRP)	2 (EIRP)	12.33	12.33
LTE eTDD 41 QPSK	mid	25	5	20.65	2 (EIRP)	2 (EIRP)	12.35	12.35
LTE eTDD 41 16QAM	mid	1	5	20.52	2 (EIRP)	2 (EIRP)	12.48	12.48
LTE eTDD 41 16QAM	mid	25	5	19.79	2 (EIRP)	2 (EIRP)	13.21	13.21
LTE eTDD 41 QPSK	mid	1	10	21.66	2 (EIRP)	2 (EIRP)	11.34	11.34
LTE eTDD 41 QPSK	mid	50	10	20.74	2 (EIRP)	2 (EIRP)	12.26	12.26
LTE eTDD 41 16QAM	mid	1	10	20.67	2 (EIRP)	2 (EIRP)	12.33	12.33
LTE eTDD 41 16QAM	mid	50	10	20.16	2 (EIRP)	2 (EIRP)	12.84	12.84
LTE eTDD 41 QPSK	mid	1	15	21.97	2 (EIRP)	2 (EIRP)	11.03	11.03
LTE eTDD 41 QPSK	mid	36	15	20.72	2 (EIRP)	2 (EIRP)	12.28	12.28
LTE eTDD 41 QPSK	mid	75	15	20.80	2 (EIRP)	2 (EIRP)	12.20	12.20
LTE eTDD 41 16QAM	mid	1	15	20.32	2 (EIRP)	2 (EIRP)	12.68	12.68
LTE eTDD 41 16QAM	mid	75	15	20.16	2 (EIRP)	2 (EIRP)	12.84	12.84
LTE eTDD 41 QPSK	mid	1	20	21.69	2 (EIRP)	2 (EIRP)	11.31	11.31
LTE eTDD 41 QPSK	mid	100	20	20.68	2 (EIRP)	2 (EIRP)	12.32	12.32
LTE eTDD 41 16QAM	mid	1	20	21.54	2 (EIRP)	2 (EIRP)	11.46	11.46
LTE eTDD 41 16QAM	mid	100	20	20.28	2 (EIRP)	2 (EIRP)	12.72	12.72

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.

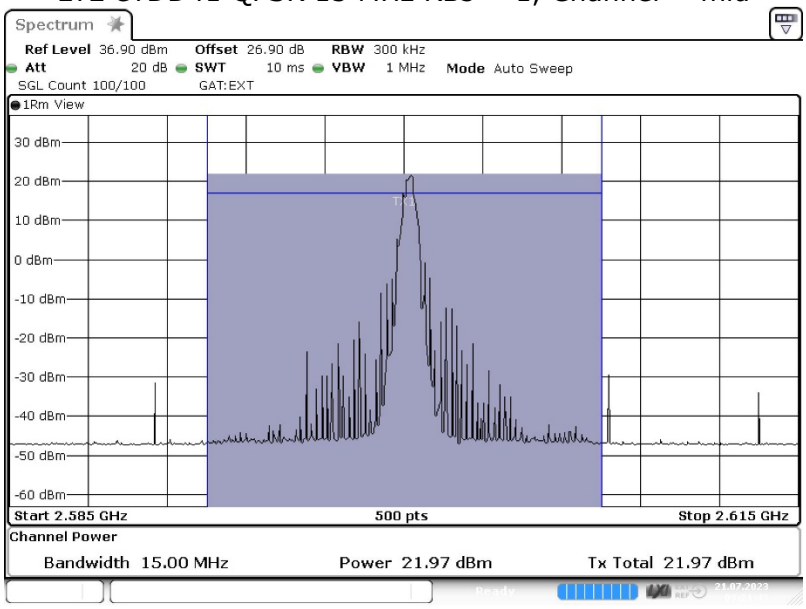
5.1.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

S01_CA02
LTE eTDD41 QPSK 15 MHz RBs = 1, Channel = mid



Date: 21.JUL.2023 09:06:30

S02_CA02
LTE eTDD41 QPSK 15 MHz RBs = 1, Channel = mid



Date: 21.JUL.2023 09:21:43

5.1.5 TEST EQUIPMENT USED

- Radio Lab

6 TEST EQUIPMENT

6.1 TEST EQUIPMENT HARDWARE

1 Radio Lab
Conducted Radio Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	1575	Broadband Resistive Power Divider DC to 40 GHz	API Weinschel, Inc.	4070		
1.2	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2022-06	2024-06
1.3	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2022-06	2024-06
1.4	SMP03	Signal Generator 2 GHz - 27 GHz	Rohde & Schwarz	833680/003		
1.5	Temperature Chamber KWP 120/70	Temperature Chamber Weiss 01	Weiss	59226012190010	2022-05	2024-05
1.6	SMB100A	Signal Generator 100 kHz - 40 GHz	Rohde & Schwarz Vertriebs-GmbH	181486	2023-01	2026-01
1.7	Chroma 6404	AC Source	Chroma ATE INC.	64040001304		
1.8	EX520	Digital Multimeter 07	Extech Instruments Corp	06110393		
1.9	Temperature Chamber VT 4002	Temperature Chamber Vötsch 03	Vötsch	58566002150010	2022-05	2024-05
1.10	A8455-4	4 Way Power Divider (SMA)		-		
1.11	Opus10 THI (8152.00)	T/H Logger 03	Lufft Mess- und Regeltechnik GmbH	7482	2021-09	2023-09
1.12	SMIQ 03B	Vector Signal Generator	Rohde & Schwarz	100583		
1.13	Temperature Chamber VT 4002	Temperature Chamber Vötsch 05	Vötsch	58566080550010	2022-05	2024-05
1.14	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.
MHz		dB
0.15		10.1
5		10.3
7		10.5
10		10.5
12		10.7
14		10.7
16		10.8
18		10.9
20		10.9
22		11.1
24		11.1
26		11.2
28		11.2
30		11.3

LISN insertion loss ESH3-Z5	cable loss (incl. 10 dB atten-uator)
dB	dB
0.1	10.0
0.1	10.2
0.2	10.3
0.2	10.3
0.3	10.4
0.3	10.4
0.4	10.4
0.4	10.5
0.4	10.5
0.5	10.6
0.5	10.6
0.5	10.7
0.5	10.7
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.