



TEST REPORT

of the accredited test laboratory

TÜV Nr.: **2023-IN-AT-TICL-E-EX-0-000131-FG-003-Rev2**

Applicant: YUNEX GmbH
Otto-Hahn-Ring 6
D-81739 München

Product: ITS On Board Unit 'OBU2X'
Test report for simultaneous transmission of LTE with BLE
and C-V2X

FCC ID 2BGULOBU2X
IC ID Not decided yet

Manufacturer: Yunex LLC
9225 Bee Cave Road
Austin, TX 78733

Output power Various (see page 6) **power supply:** 24V DC
Frequency range: Various (see page 6) **Channel** Various (see
separation: page 6)

Accredited Standards: FCC: 47 CFR Part 22 (eCFR 19.06.2023);
FCC: 47 CFR Part 24 (eCFR 19.06.2023);
FCC: 47 CFR Part 27 (eCFR 19.06.2023);
FCC: 47 CFR Part 90 (eCFR 19.06.2023)
FCC: 47 CFR Part 15 (eCFR 19.06.2023;
ICES-003 Issue 7, November 15, 2021

TÜV AUSTRIA GMBH
Test laboratory for EMC

Ing. Andreas Malek

**examined by / Testing
Laboratory**
TÜV AUSTRIA GMBH

09.09.2024

Ing. Michael Emminger

**approved by / Testing
Laboratory**
TÜV AUSTRIA GMBH

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Contents

	Designation	PAGE
1.	Applicant	3
2.	Description of EUT	4
3.	Standards / Final result	5
4.	Test results	
4.1	Test object data	6
4.2	Spurious Emissions	8-18
4.3	Radiated emission according to FCC Part 15B	19-22
Appendix	Designation	PAGES
1	Test equipment used	5
2	Photodocumentation	17

1. Applicant

Company: YUNEX GmbH

Department: ---

Address: Otto-Hahn-Ring 6; D- 81739 München

Contact person: Mr. Thomas Jatschka

EUT received on: 19.06.2023

Tests were performed on: 21.06.2023 till 23.06.2023

2. Description of EUT

EUT: ITS On Board Unit 'OBU2X'

Manufacturer: Yunex LLC
9225 Bee Cave Road
Austin, TX 78733

Description: YUNEX GmbH provided the following configuration for the measurements:

Prototype

Operating mode: The measurements were carried out at the following running states:
Transmitting simultaneously LTE+BLE+C-V2X (see page 6)

Technical data EUT: Rated voltage: 12 – 24 VDC
Rated current: max 1,5A
Rated frequency: DC

Mains voltage during the tests: 24VDC

Climatic conditions in the emc laboratory: Relative humidity: 58%
Temperature: 23°C

3. Standards / Final result

Name	Title	Deviation	Result
FCC: 47 CFR Part 22 (eCFR 19.06.2023)	PUBLIC MOBILE SERVICES	*)	OK
FCC: 47 CFR Part 24 (eCFR 19.06.2023)	PERSONAL COMMUNICATIONS SERVICES	*)	OK
FCC: 47 CFR Part 27 (eCFR 19.06.2023)	MISSCELLANEOUS WIRELESS COMMUNICATION SERVICES	*)	OK
FCC: 47 CFR Part 90 (eCFR 19.06.2023)	PRIVATE LAND MOBILE RADIO SERVICES	*)	OK
FCC: 47 CFR Part 15 (eCFR 19.06.2023)	RADIO FREQUENCY DEVICES	none	OK
ICES-003 Issue 7, November 15, 2021	Digital Apparatus	none	OK
Result: Opinions and interpretation of testing laboratory OK: EUT passed NOK: EUT failed			

*) Only measurements of spurious emissions were performed to show correct integration of the LTE module and compliance during simultaneous transmission with BLE and C-V2X.
 A minimum distance of 40cm between the OBU and the external antenna is necessary to comply with all requirements during simultaneous transmission.

4. Test results

4.1 TEST OBJECT DATA

This On Board Unit for C-V2X Operation contains various transmitter parts:
C-V2X at 5915 MHz center frequency with 20 MHz channel bandwidth (test report
2023-IN-AT-TICL-E-EX-0-000131-FG-002-Rev3)
Bluetooth/BLE see test report 2023-IN-AT-TICL-E-EX-0-000131-FG-001-Rev2 and
an LTE module FCC-ID: RI7ME910G1W3

Simultaneous transmission operation was checked under the following operating conditions:

1. LTE Band 2 + BLE + C-V2X
2. LTE Band 4 + BLE + C-V2X
3. LTE Band 5 + BLE + C-V2X
4. LTE U.S.Band 8 + BLE + C-V2X
5. LTE Band 12 + BLE + C-V2X
6. LTE Band 13 + BLE + C-V2X
7. LTE Band 25 + BLE + C-V2X
8. LTE Band 26 + BLE + C-V2X
9. LTE Band 66 + BLE + C-V2X
10. LTE Band 85 + BLE + C-V2X
11. All radios receiving (Part 15B measurement)

The LTE transmissions were provoked by a CMW500 set to maximum Duty cycle in LTE CAT-M1 and all transmissions operating at the highest available transmit power. For LTE Transmissions the upload channel was reduced to one resource block to achieve the smallest possible bandwidth giving the highest (worst case) power spectral density.

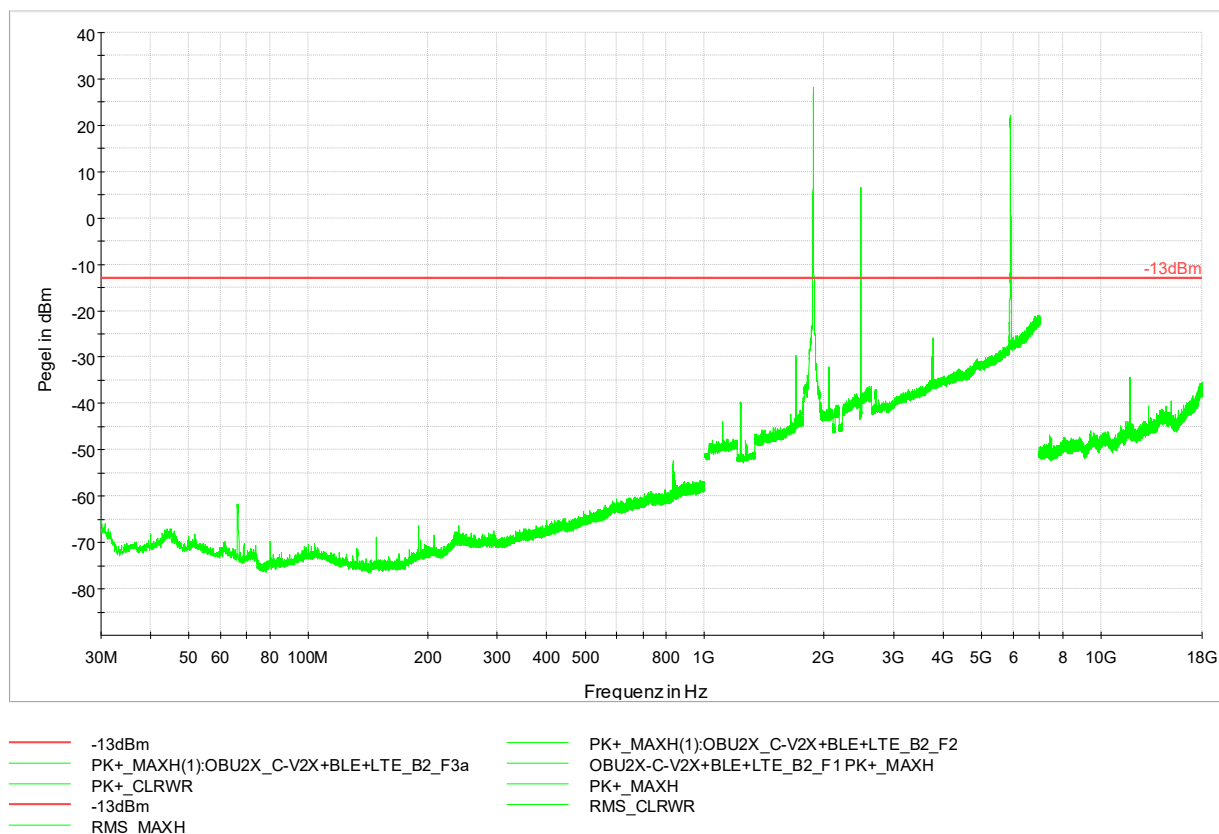
If no additional emissions due to simultaneous transmission were found, only center channel frequency of the mobile radio frequency band was used for the test. In case of additional emissions found or in case of doubt additional measurements were performed at the corner frequencies of the mobile radio frequency bands.

All measurements were performed with Peak detector, as long as no limit was exceeded.

4.2 Spurious Emissions

FCC, §24.238 (a)

Operating mode: LTE Band 2 + BLE + C-V2X



The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable. Device PASSED the test.

LIMIT FCC §24.238 (a)

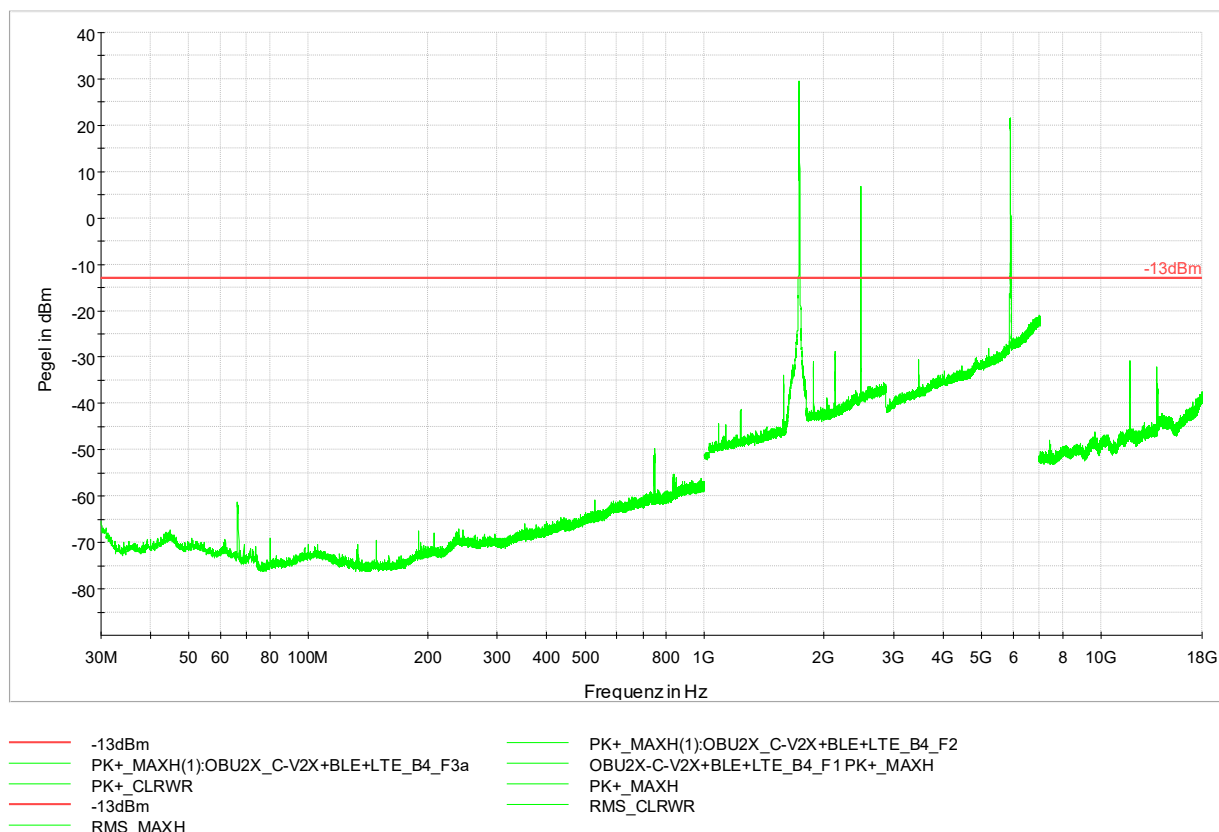
(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Spurious Emissions

FCC, §27.53 (h)

Operating mode: LTE Band 4 + BLE + C-V2X



The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable. Device PASSED the test.

LIMIT

FCC §27.53 (h)

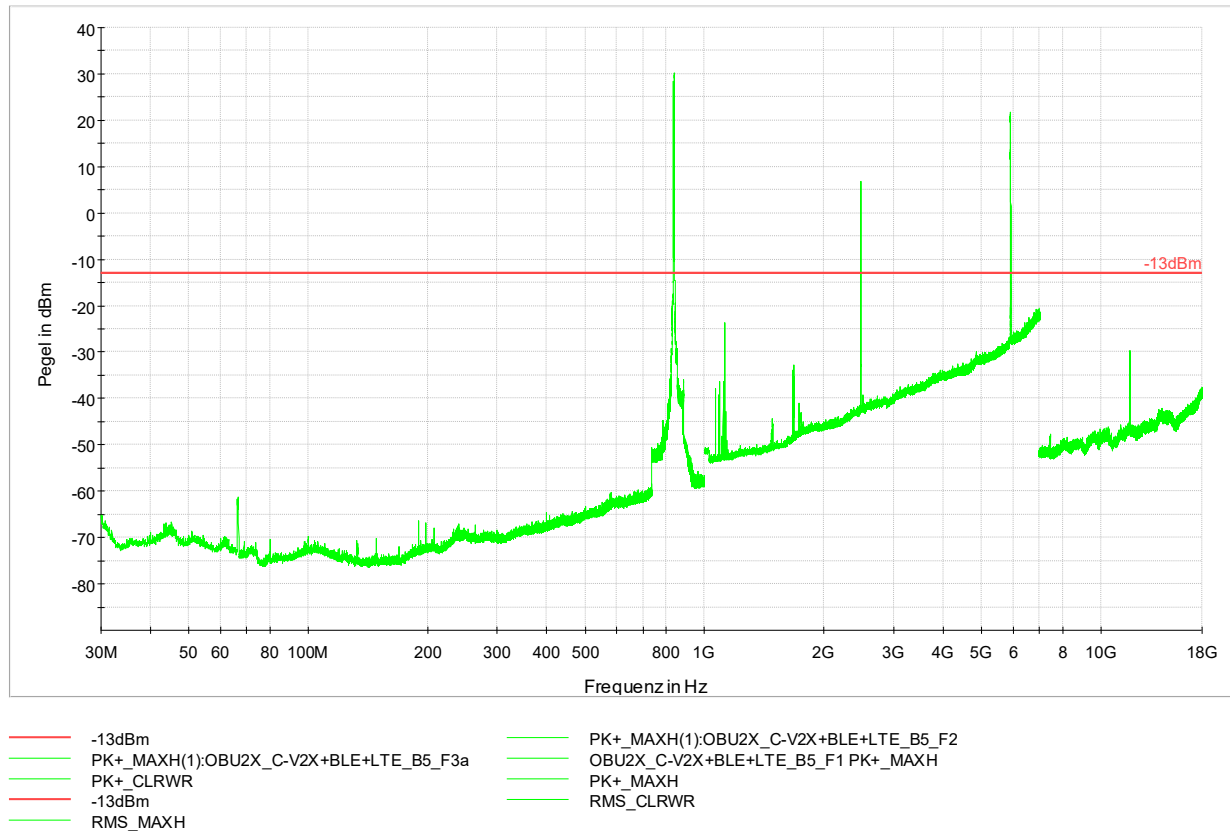
(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10} (P)$ dB.

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Spurious Emissions

FCC, §22.917 (a)

Operating mode: LTE Band 5 + BLE + C-V2X



The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable. Device PASSED the test.

LIMIT FCC §22.917 (a)

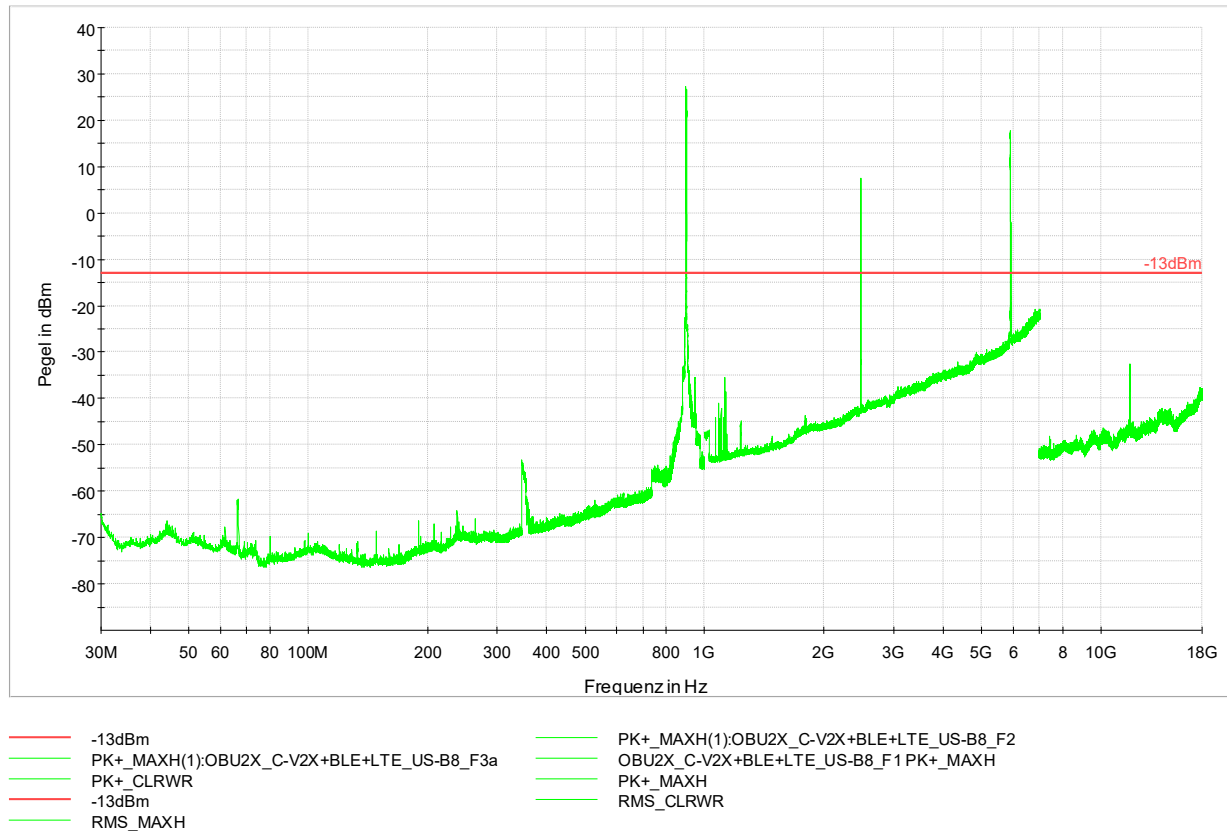
(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Spurious Emissions

FCC, §27.53 (h)

Operating mode: LTE U.S. Band 8 + BLE + C-V2X



The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable. Device PASSED the test.

LIMIT FCC §27.1509

The power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) in watts by at least the following amounts:

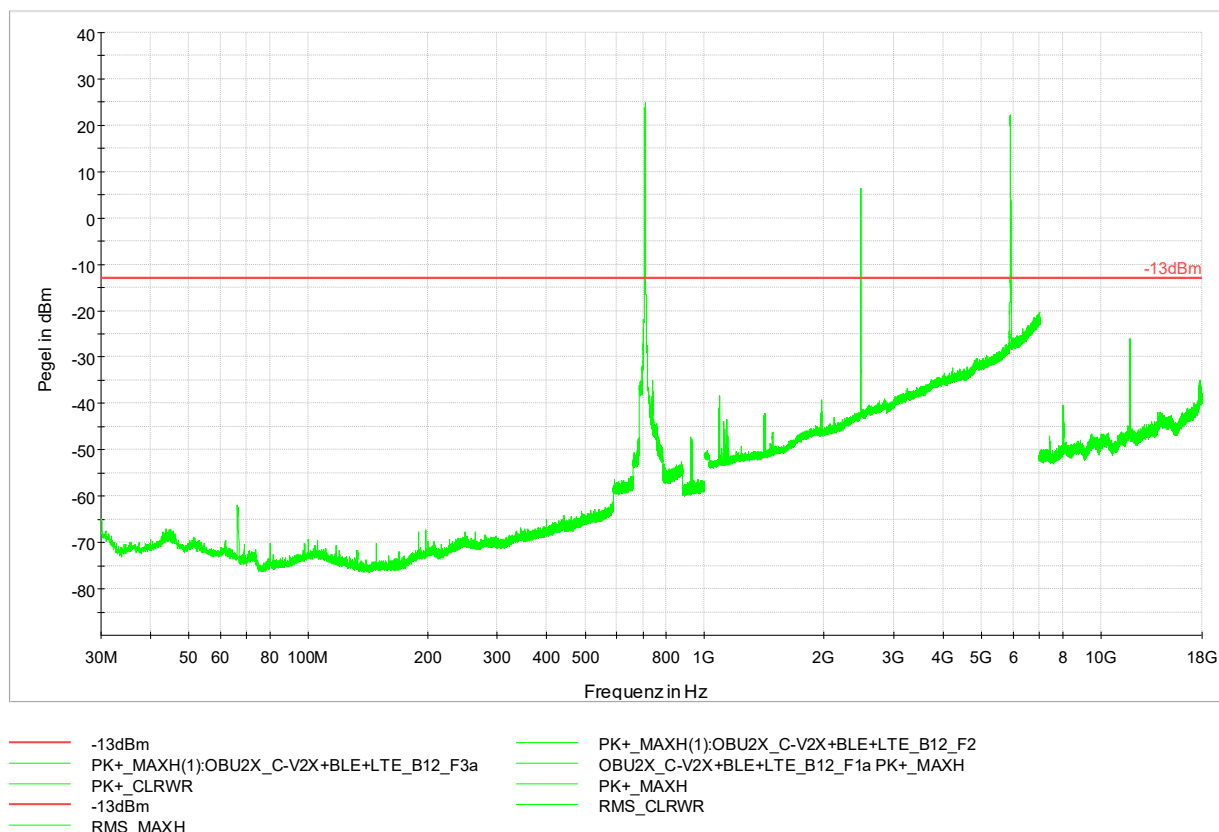
(a) For 900 MHz broadband operations in 897.5–900.5 MHz band by at least $43 + 10 \log (P)$ dB.

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Spurious Emissions

FCC, §27.53 (g)

Operating mode: LTE Band 12 + BLE + C-V2X



The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable. Device PASSED the test.

LIMIT

FCC §27.53 (g)

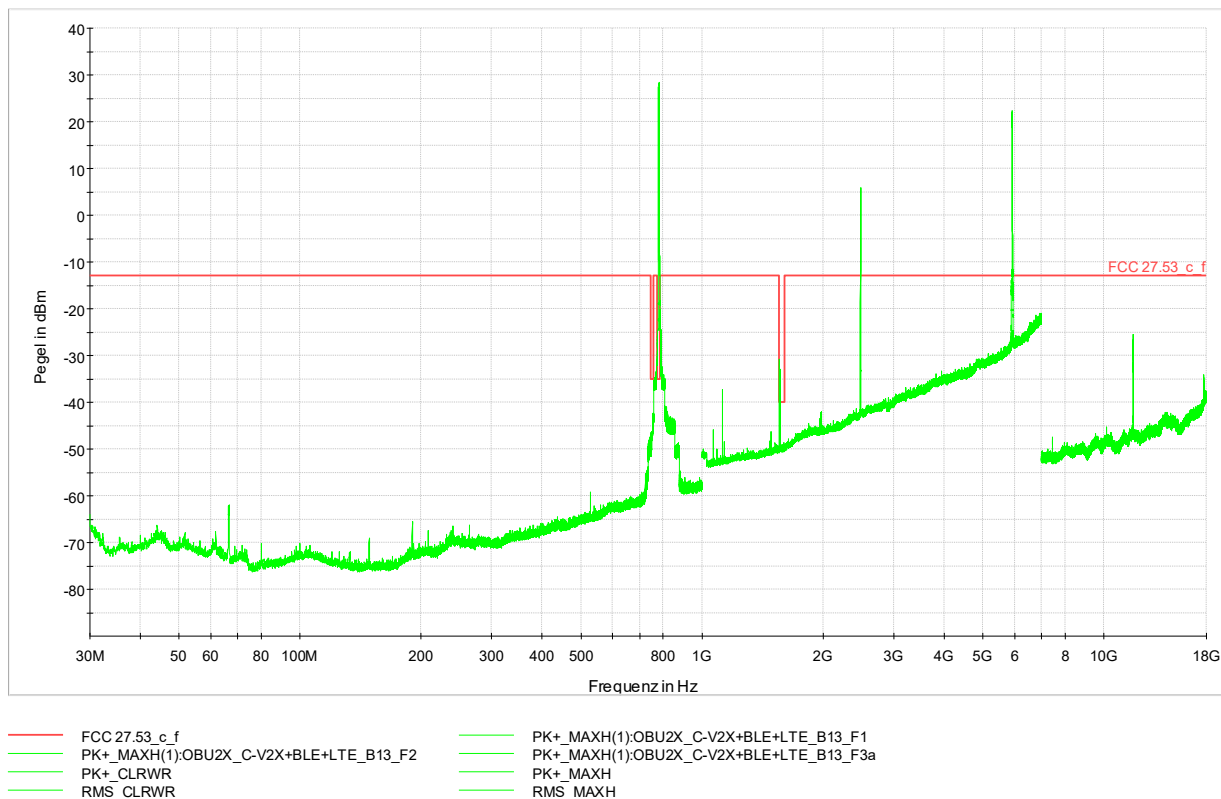
For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $43 + 10 \log(P)$ dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Spurious Emissions

FCC, §27.53 (c)
FCC, §27.53 (f)

Operating mode: LTE Band 13 + BLE + C-V2X



As the limit was exceeded at 1566 MHz with Peak detector, additional measurements with RMS detector were performed, see next page.

The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable.

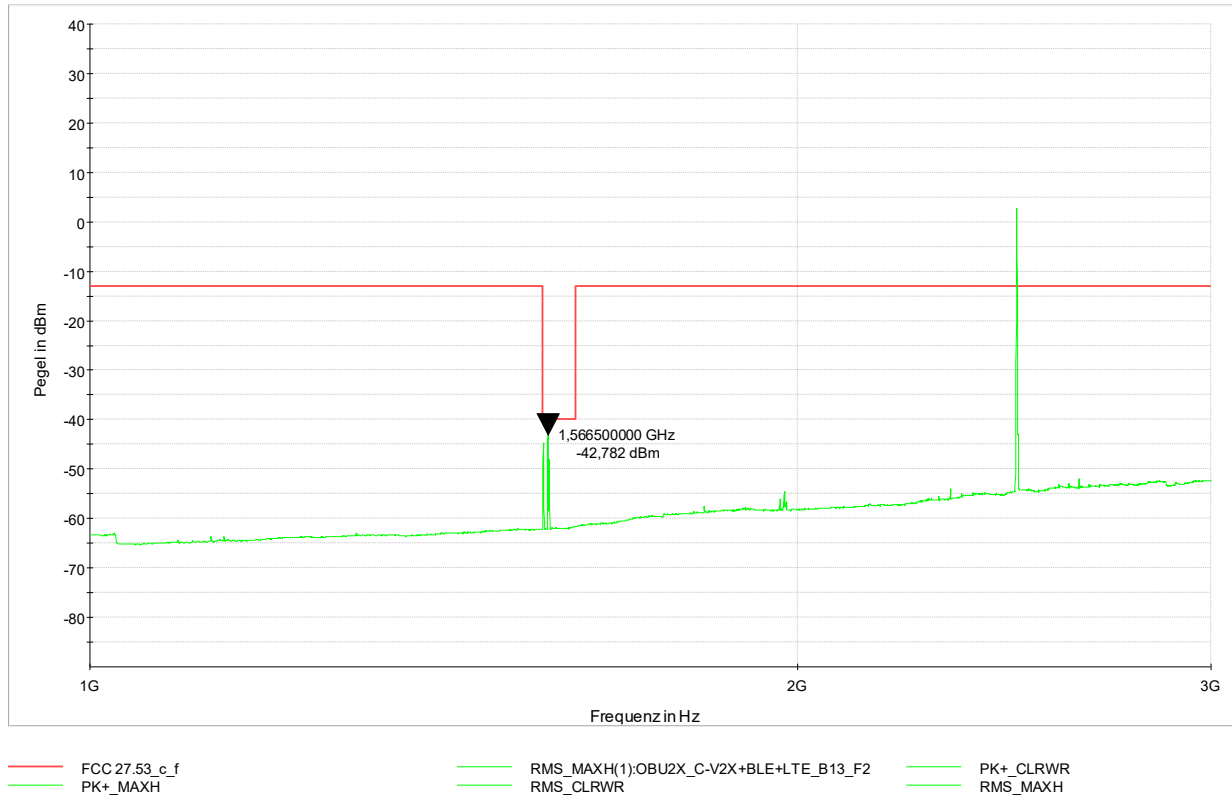
Limit see page 14

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Spurious Emissions

FCC, §27.53 (c)
FCC, §27.53 (f)

Operating mode: LTE Band 13 + BLE + C-V2X (additional RMS detector measurement)



Device PASSED the test.

Limit see page 14

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Limit FCC §27.53 (c)

For operations in the 746-758 MHz band and the 776-788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

- (1) On any frequency outside the 746-758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB;
- (2) On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB;
- (3) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than $76 + 10 \log (P)$ dB in a 6.25 kHz band segment, for base and fixed stations;
- (4) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than $65 + 10 \log (P)$ dB in a 6.25 kHz band segment, for mobile and portable stations;
- (5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;
- (6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

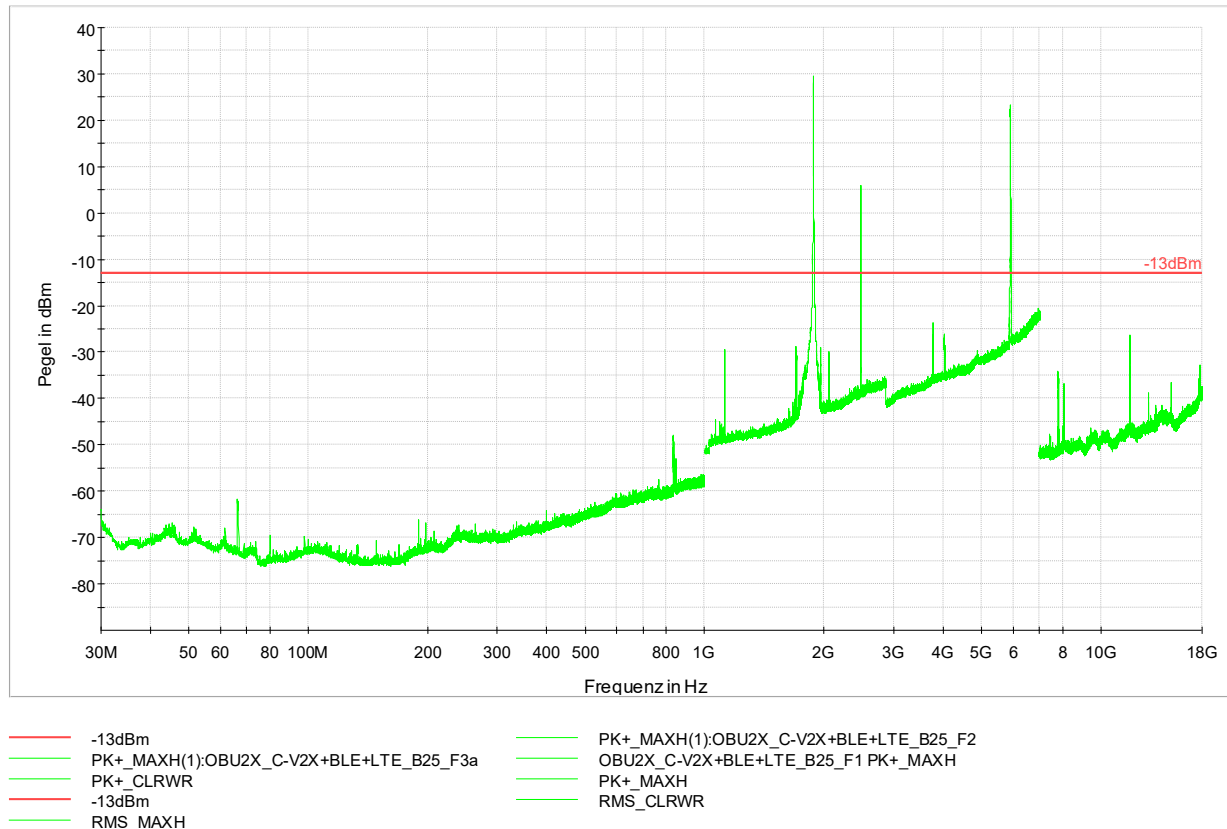
Limit FCC §27.53 (f)

For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

Spurious Emissions

FCC, §24.238 (a)

Operating mode: LTE Band 25 + BLE + C-V2X



The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable. Device PASSED the test.

LIMIT FCC §24.238 (a)

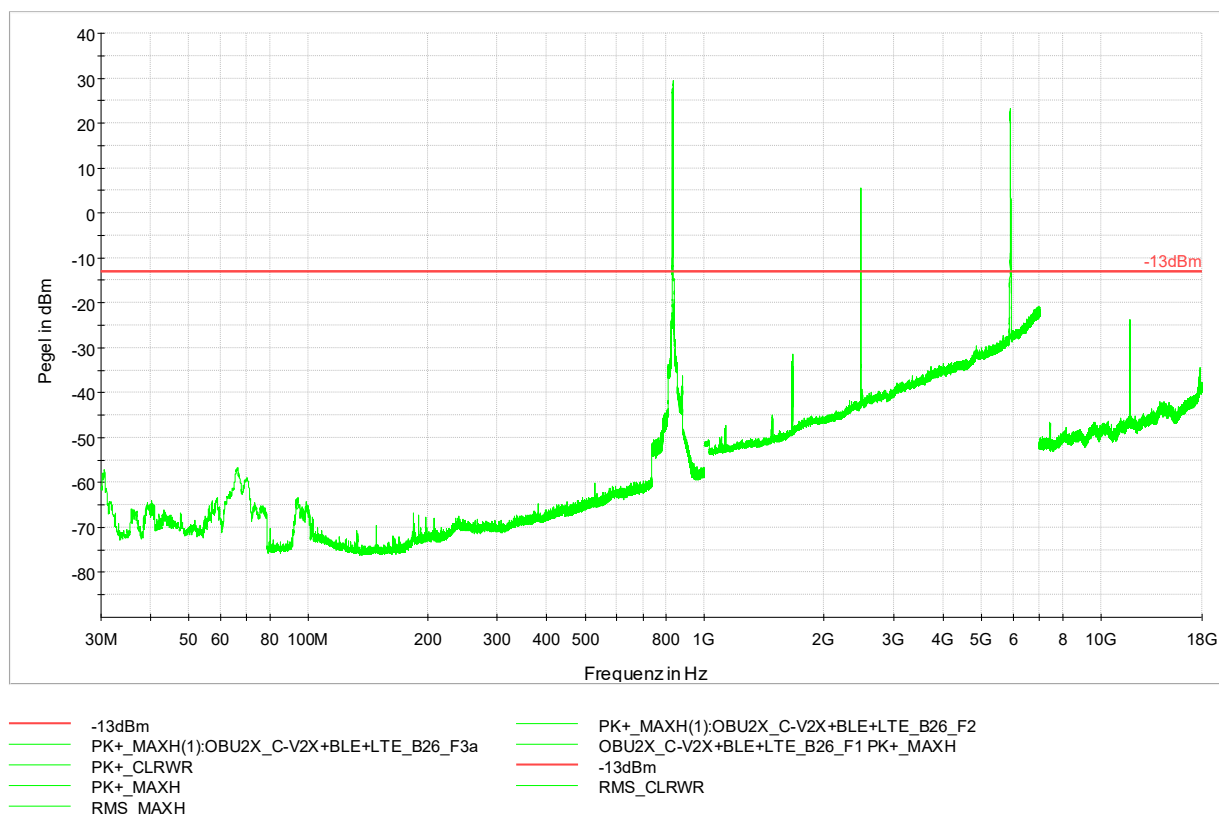
(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Spurious Emissions

FCC, §90.669 (a)
FCC, §22.917 (a)

Operating mode: LTE B26 + BLE + C-V2X



The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable. Device PASSED the test.

LIMIT FCC §90.669 (a)

(a) On any frequency in an MTA licensee's spectrum block that is adjacent to a non-MTA frequency, the power of any emission shall be attenuated below the transmitter power (P) by at least 43 plus 10 log₁₀(P) decibels or 80 decibels, whichever is the lesser attenuation.

LIMIT FCC §22.917 (a)

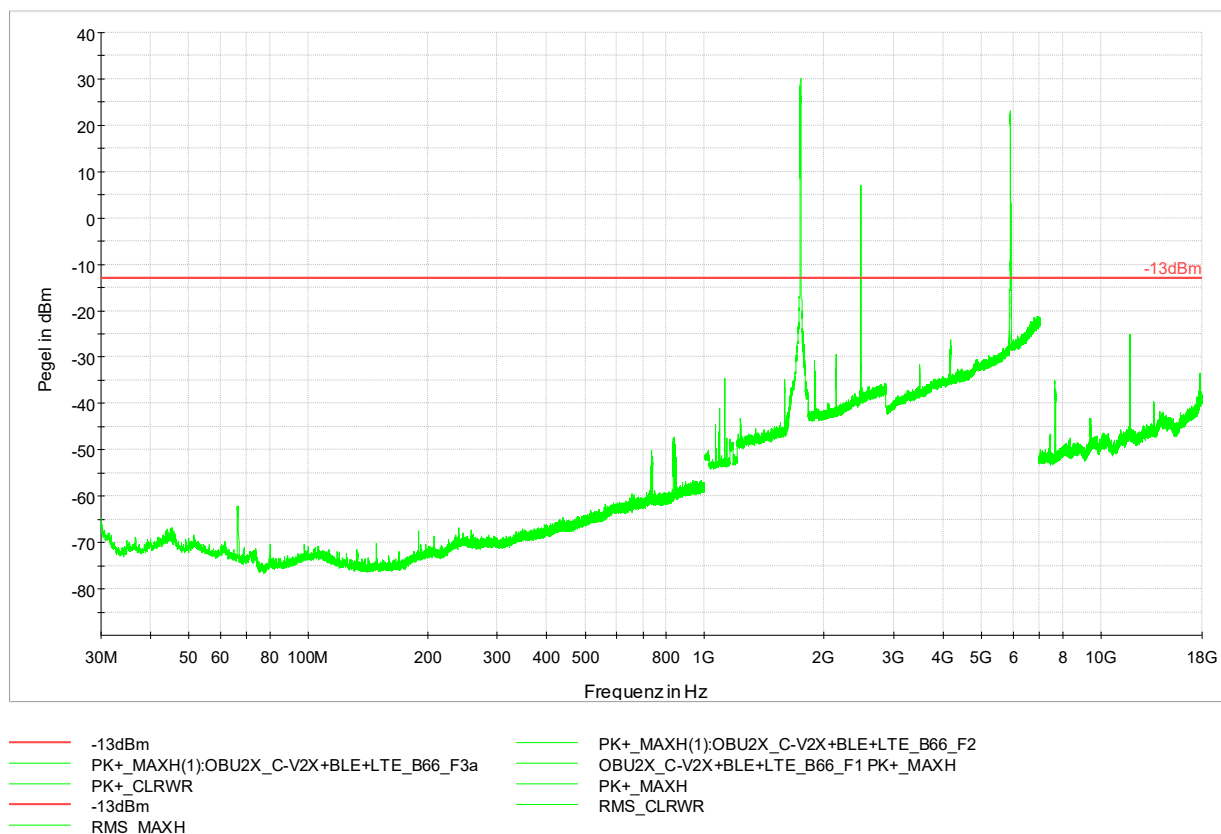
(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Spurious Emissions

FCC, §27.53 (h)

Operating mode: LTE Band 66 + BLE + C-V2X



The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable. Device PASSED the test.

LIMIT

FCC §27.53 (h)

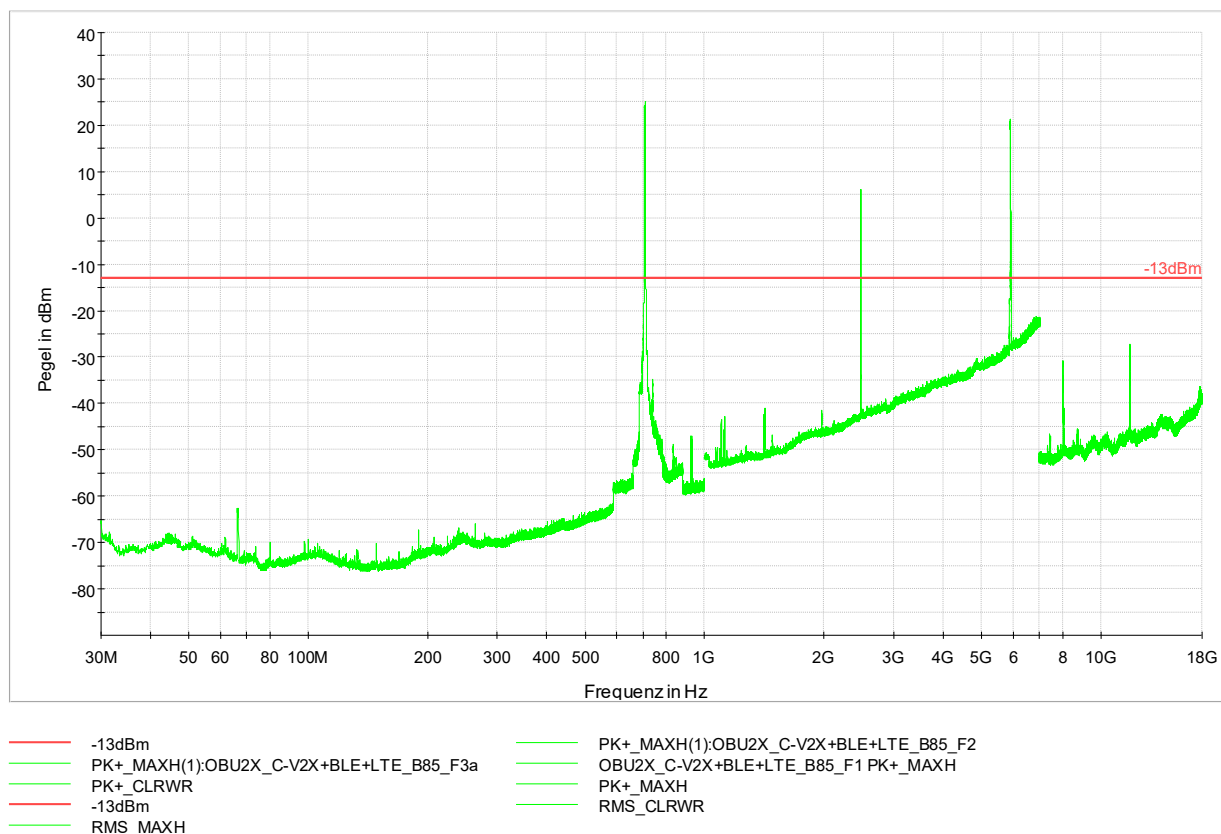
(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10} (P)$ dB.

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

Spurious Emissions

FCC, §27.53 (g)

Operating mode: LTE Band 85 + BLE + C-V2X



The emissions above the limit line are the intended transmissions of the Bluetooth, C-V2X and LTE module transmitters for which the displayed limit is not applicable. Device PASSED the test.

LIMIT

FCC §27.53 (g)

For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $43 + 10 \log (P)$ dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

Measuring equipment used: NT-100; NT-110; NT-125; NT-131/1; NT-207/1; NT-208/1; NT-337/1; NT-456

4. 3.) Radiated emission according to FCC Part 15B

Class B Limits

	$\leq 1 \text{ GHz} \rightarrow$ Quasi Peak Limit $> 1 \text{ GHz} \rightarrow$ Average Limit (Peak Limit 20 dB above average Limit)		
Frequency range	Limit	Bandwidth	Measurement distance
30 – 88 MHz	100 $\mu\text{V/m}$	120 kHz	3 m
88 – 216 MHz	150 $\mu\text{V/m}$	120 kHz	3 m
216 – 960 MHz	200 $\mu\text{V/m}$	120 kHz	3 m
960 MHz - 1000 MHz	500 $\mu\text{V/m}$	120 kHz	3 m
Above 1000 MHz	500 $\mu\text{V/m}$	1 MHz	3 m

ICES-003 Issue 7 Class B Limits

	$\leq 1 \text{ GHz} \rightarrow$ Quasi Peak Limit $> 1 \text{ GHz} \rightarrow$ Average Limit (Peak Limit 20 dB above average Limit)		
Frequency range	Limit	Bandwidth	Measurement distance
30 – 88 MHz	40 dB $\mu\text{V/m}$	120 kHz	3 m
88 – 216 MHz	43,5 dB $\mu\text{V/m}$	120 kHz	3 m
216 – 230 MHz	46 dB $\mu\text{V/m}$	120 kHz	3 m
230 – 960 MHz	47 dB $\mu\text{V/m}$	120 kHz	3 m
960 MHz - 1000 MHz	54 dB $\mu\text{V/m}$	120 kHz	3 m

Measuring apparatus parameters 30 to 1000 MHz

Parameter	Preview measurement	Final measurement	Parameter	Preview measurement	Final measurement
Start frequency	30 MHz	30 MHz	Detector	Quasi Peak	Quasi Peak
Stop frequency	1000 MHz	1000 MHz	Measuring time	1 s	1 s
Stepsize	30 kHz	30 kHz	RF-attenuation	0dB	0dB
IF- Bandwidth	120 kHz	120 kHz	Preamplifier	20 dB	20 dB

Measuring apparatus parameters 1 GHz to 18 GHz

Parameter	Preview measurement	Final measurement	Parameter	Preview measurement	Final measurement
Start frequency	1 GHz	1 GHz	Detector	Max Peak / Average	Max Peak / Average
Stop frequency	18 GHz	18 GHz	Measuring time	100 ms	100 ms
Stepsize	250 kHz	250 kHz	RF-attenuation	0dB	0dB
IF- Bandwidth	1 MHz	1 MHz	Preamplifier	20 dB	20 dB

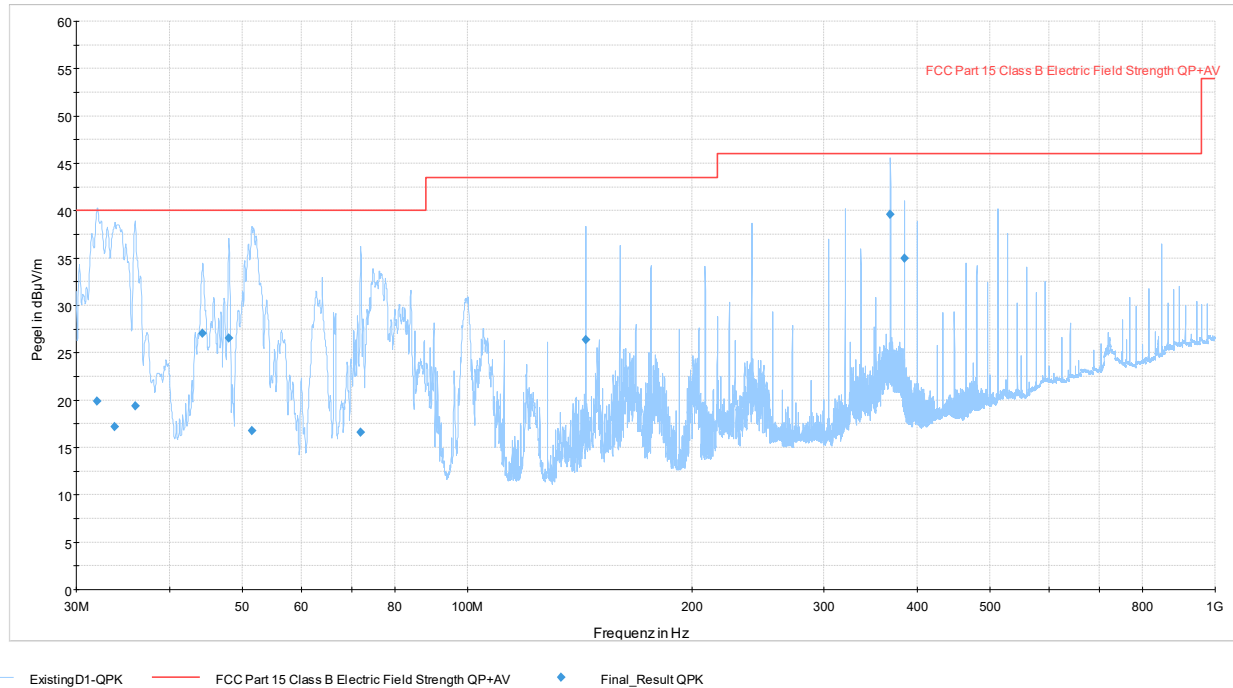
Measurement uncertainty

30-200 MHz horizontal: Expanded uncertainty $U_c = 4,06$ dB (Uncertainty budget = 5,06 dB)
30-200 MHz vertical: Expanded uncertainty $U_c = 4,19$ dB (Uncertainty budget = 5,17 dB)
0,2-1 GHz horizontal: Expanded uncertainty $U_c = 4,43$ dB (Uncertainty budget = 5,45 dB)
0,2-1 GHz vertical: Expanded uncertainty $U_c = 5,64$ dB (Uncertainty budget = 6,48 dB)
1-18 GHz: Expanded uncertainty $U_c = 4,40$ dB (Uncertainty budget = 5,17 dB)

Operating mode	Measuring result
Normal operation, all radios receiving only, CAN Bus and RS-485 connection active	OK

Test result

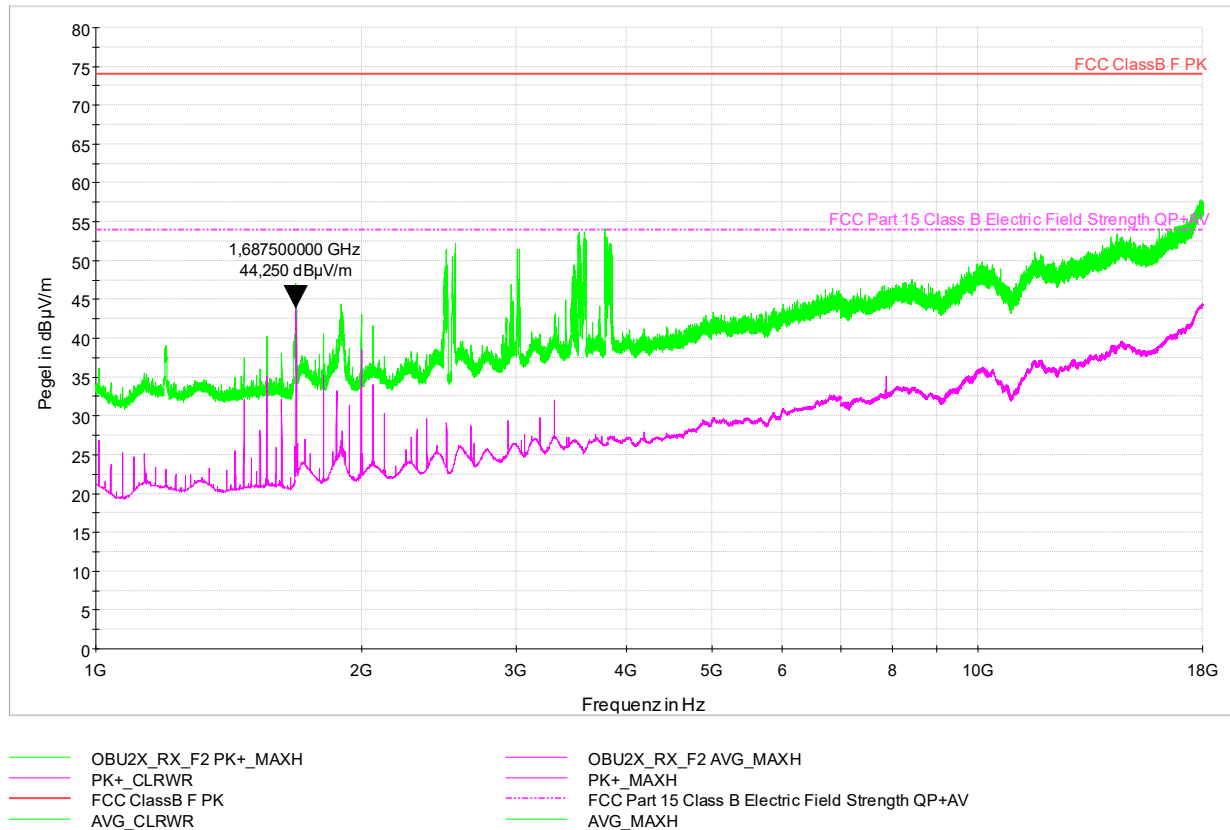
4. 3.1.) Measurement diagram with QP-Detector (30 MHz - 1000 MHz)



Frequency MHz	QuasiPeak dBµV/m	Limit dBµV/m	Margin dBµV/m	Height cm	Pol	Azimuth deg
32,01	19,92	40,00	20,08	114	V	-34
33,78	17,20	40,00	22,80	124	V	-32
36,00	19,37	40,00	20,63	100	V	21
44,28	27,04	40,00	12,96	104	V	45
48,00	26,51	40,00	13,49	144	V	31
51,54	16,77	40,00	23,23	200	V	-43
72,00	16,64	40,00	23,36	110	V	-21
144,00	26,40	43,50	17,10	105	V	171
368,01	39,64	46,00	6,36	100	V	172
384,00	34,98	46,00	11,02	104	V	84

4. 3.2.) Measurement diagram with Peak- and Average Detector (1 GHz – 6 GHz)

Measurement radiated with Peak-Detector (green line) and Average detector (magenta line):



The graphic shows both Peak- and Average-detector requirements. The green measurement line with Peak-Detector is below the red limit line for the PK limit labeled “FCC ClassB F PK”. The magenta measurement line with Average detector is below the dashed magenta limit line for the Average limit labeled “FCC Part 15 Class B Electric Field Strength QP + AV”. Device PASSED the test.

Appendix 1

Test equipment used

☐	Anechoic Chamber with 3m measurement distance	NT-100	☐	Ant. tripod for EN61000-4-3 Model TP1000A	NT-156
☐	Stripline according to ISO 11452-5	NT-108	☐	Power quality analyzer Fluke 1760 (complete set)	NT-160 - NT-173
☐	MA4000 - Antenna mast 1 - 4 m height	NT-110/1	☐	Spectrumanalyzer – FSP7 9 kHz – 7 GHz	NT-200
☐	DS - Turntable 0 - 400 ° Azimuth	NT-111/1	☐	ESCI - Test receiver 9 kHz - 7 GHz	NT-203/1
☐	CO3000 Controller Mast+Turntable	NT-112/1	☐	ESR – Test receiver 20 Hz – 26,5 GHz	NT-207/1
☐	HUF-Z3 - Log. Per. Antenna 200 - 1000 MHz	NT-121	☐	Digital Radio Tester CMW500	NT-208/1
☐	FMZB1513 - Loop Antenna 9 kHz - 30 MHz	NT-122/1	☐	Noise-gen., ITU-R 559-2 20 Hz – 20 kHz	NT-209
☐	HFH-Z6 - Rod Antenna 9 kHz - 30 MHz	NT-123	☐	CMTA - Radiocommunication analyzer ; 0,1 - 1000 MHz	NT-210
☐	Dipole Antenna VHA9103 30 - 300 MHz	NT-124/1a	☐	3271 - Spectrum analyzer 100 Hz - 26,5 GHz	NT-211
☐	Dipole Antenna UHA9105 300 - 1000 MHz	NT-124/1b	☐	Digital Radio Tester Aeroflex 3920	NT-212/1
☐	3115 - Horn Antenna 1 - 18 GHz (immunity)	NT-125	☐	Mixer M28HW 26,5 GHz - 40 GHz	NT-214
☐	3116 - Horn Antenna 18 - 40 GHz	NT-126	☐	RubiSource T&M Timing reference	NT-216
☐	SAS-200/543 - Bicon. Antenna 20 MHz - 300 MHz	NT-127	☐	Radiocommunicationanalyzer SWR 1180 MD	NT-217
☐	AT-1080 - Log. Per. Antenna 80 - 1000 MHz	NT-128	☐	Mixer FS-Z60 40 GHz – 60 GHz	NT-218/1
☐	HK-116 - bicon. Antenna 20 MHz - 300 MHz	NT-129	☐	Mixer FS-Z90 60 GHz – 90 GHz	NT-219/1
☐	HK-116 - bicon. Antenna 20 MHz - 300 MHz	NT-130	☐	DSO9104 Digital scope	NT-220/1
☐	3146 - Log. Per. Antenna 200 – 1000 MHz	NT-131	☐	TPS 2014 Digital scope	NT-222
☐	VULB 9163 Trilog Antenna 30 – 3000 MHz	NT-131/1	☐	Artificial Ear according to IEC 60318	NT-224
☐	Loop Antenna H-Field	NT-132	☐	1 kHz Sound calibrator	NT-225
☐	Horn Antenna 500 MHz - 2900 MHz	NT-133	☐	SRM-3006 Spectrumanalyzer	NT-233/1a
☐	Horn Antenna 500 MHz - 6000 MHz	NT-133/1	☐	E-field probe SRM 75 MHz – 3 GHz	NT-234
☐	Log. per. Antenna 800 MHz - 2500 MHz	NT-134	☐	Field Meter NBM-500 incl. E- and H-Field probes	NT-240a-e
☐	Log. per. Antenna 800 MHz - 2500 MHz	NT-135	☐	Magnetometer HP-01	NT-241/1
☐	BiConiLog Antenna 26 MHz – 2000 MHz	NT-137	☐	EFA-3 H-field- / E-field probe	NT-243
☐	Conical Dipol Antenna PCD8250	NT-138	☐	EHP-50F H-field- / E-field probe	NT-243/1
☐	HF 906 - Horn Antenna 1 - 18 GHz (emission)	NT-139	☐	Field Meter EMR-200 100 kHz – 3 GHz	NT-244
☐	HZ-1 Antenna tripod	NT-150	☐	E-field probe 100 kHz – 3 GHz	NT-245
☐	BN 1500 Antenna tripod	NT-151	☐	H-field probe 300 kHz – 30 MHz	NT-246

Division:
Industry & Energy

Test report number:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 1 of 5

Date: 09.09.2024

Appendix 1 (continued)

Test equipment used

☐ E-field probe 3 MHz – 18 GHz	NT-247	☐ Prana N-MT 500 - RF-Amplifier 80 - 1000 MHz / 500 W	NT-332/1
☐ H-field probe 27 MHz – 1 GHz	NT-248	☐ BBA150 RF-Amplifier 1 GHz - 6 GHz	NT-333/1
☐ ELT-400 1 Hz – 400 kHz	NT-249	☐ APA01 – RF-Amplifier 0,5 GHz – 2,5 GHz	NT-334
☐ MDS 21 - Absorbing clamp 30 - 1000 MHz	NT-250	☐ Preamplifier 1 GHz - 4 GHz	NT-335
☐ FCC-203I EM Injection clamp	NT-251	☐ Preamplifier for GPS MKU 152 A	NT-336
☐ FCC-203I-DCN Ferrite decoupling network	NT-252	☐ Preamplifier 1 GHz – 18 GHz	NT-337/1
☐ PR50 Current Probe	NT-253	☐ DC Block 10 MHz – 18 GHz Model 8048	NT-338
☐ i310s Current Probe	NT-254/1	☐ 2-97201 Electronic load	NT-341
☐ Fluke 87 V True RMS Multimeter	NT-260	☐ TSX3510P - Power supply 0-30 V / 0 - 10 A	NT-344
☐ Model 2000 Digital Multimeter	NT-261	☐ TSX3510P - Power supply 0-30 V / 0 - 10 A	NT-345
☐ Fluke 87 V Digital Multimeter	NT-262/1	☐ VDS 200 Mobil-impuls-generator	NT-350
☐ ESH2-Z5-U1 Artificial mains network 4x25A	NT-300	☐ LD 200 Mobil-impuls-generator	NT-351
☐ ESH3-Z5-U1 Artificial mains network 2x10A	NT-301	☐ MPG 200 Mobil-Impuls-Generators	NT-352
☐ ESH3-Z6-U1 Artificial mains network 1x100A	NT-302	☐ EFT 200 Mobil-impuls-generator	NT-353
☐ ESH3-Z6-U1 Artificial mains network 1x100A	NT-302a	☐ AN 200 S1 Artificial Network	NT-354
☐ EZ10 T-Artificial Network	NT-305	☐ FP-EFT 32M 3 ph. Coupling filter (Burst)	NT-400/1
☐ SMG - Signal generator 0,1 - 1000 MHz	NT-310	☐ PHE 4500 - Mains impedance network	NT-401
☐ SMA100A - Signal generator 9 kHz - 6 GHz	NT-310/1	☐ IP 6.2 Coupling filter for data lines (Surge)	NT-403
☐ RefRad Reference generator	NT-312	☐ TK 9421 High Power Volt. Probe 150 kHz - 30 MHz	NT-409
☐ SMP 02 Signal generator 10 MHz - 20 GHz	NT-313	☐ ESH2-Z3 - Probe 9 kHz - 30 MHz	NT-410
☐ 40 MHz Arbitrary Generator TGA1241	NT-315	☐ CN-EFT1000 - Capacitive clamp (Burst)	NT-411/1
☐ Artificial mains network NSLK 8127-PLC	NT-316	☐ Highpass-Filter 100 MHz – 3 GHz	NT-412
☐ PSURGE 4.1 Surge generator	NT-324	☐ Highpass-Filter 600 MHz – 4 GHz	NT-413
☐ IMU4000 Immunity test system	NT-325/1a-e	☐ Highpass-Filter 1250 MHz – 4 GHz	NT-414
☐ VCS 500-M6 Surge-Generator	NT-326	☐ Highpass-Filter 1800 MHz – 16 GHz	NT-415
☐ Oscillatory Wave Simulator incl. Coupling networks	NT-328a+b+c		
☐ BTA-250 - RF-Amplifier 9 kHz - 220 MHz / 250 W	NT-330		

Division:
Industry & Energy

Test report number:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 2 of 5

Date: 09.09.2024

Appendix 1 (continued)

Test equipment used

☐	RF-Attenuator 10 dB DC – 18 GHz / 50 W	NT-417/1	☐	SW 9605 - Current probe 150 kHz – 30 MHz	NT-465/1
☐	RF-Attenuator 6 dB DC – 18 GHz / 50 W	NT-418	☐	95242-1 – Current probe 1 MHz – 400 MHz	NT-468
☐	RF-Attenuator 3 dB DC – 18 GHz / 50 W	NT-419	☐	94106-1L-1 – Current probe 100 kHz – 450 MHz	NT-471
☐	RF-Attenuator 20 dB DC - 1000 MHz / 25 W	NT-421	☐	WHKX12-2700-3000-18000 3 GHz Highpass filter	NT-472
☐	RF-Attenuator 30 dB DC - 1000 MHz / 1 W	NT-423	☐	WHKX10-3870-4500-18000 4,5 GHz Highpass filter	NT-473
☐	RF-Attenuator 30 dB	NT-424	☐	CDN S9 USB3.0 Coupling decoupling network	NT-474
☐	RF-Attenuator 6 dB DC - 1000 MHz / 1 W	NT-425	☐	CDN S2 XLR3-1 Coupling decoupling network	NT-475
☐	RF-Attenuator 6 dB DC - 1000 MHz / 1 W	NT-426	☐	CDN S8 RJ45 Coupling decoupling network	NT-476
☐	RF-Attenuator 6 dB	NT-428	☐	GA 1240 Power amplifier according to EN 61000-4-16	NT-480
☐	RF-Attenuator 0 dB - 81 dB	NT-429	☐	Coupling networks according to EN 61000-4-16	NT-481 - NT-483
☐	WRU 27 - Band blocking 27 MHz	NT-430	☐	Van der Hoofden Test Head	NT-484
☐	WHJ450C9 AA - High pass 450 MHz	NT-431	☐	WRCJV12-5820-5850-5950-5980 5,9 GHz Band Reject Filter	NT-490
☐	WHJ250C9 AA - High pass 250 MHz	NT-432	☐	WHKX10-5670-6300-18000 6 GHz Highpass filter	NT-491
☐	RF-Load 150 W	NT-433	☐	WHK12-935-1000-7000 1 GHz Highpass filter	NT-492
☐	Impedance transducer 1:4 ; 1:9 ; 1:16	NT-435	☐	EMC Video/Audiosystem	NT-511/1
☐	RF-Attenuator DC – 18 GHz 6 dB	NT-436	☐	EMC32 Version 10.60.20 Test software	NT-520/1
☐	RF-Attenuator DC – 18 GHz 6 dB	NT-437	☐	SRM-TS Version 1.3 software for SRM-3000	NT-522
☐	RF-Attenuator DC – 18 GHz 10 dB	NT-438	☐	SRM-TS Version 1.3.1 software for SRM-3006	NT-522/1
☐	RF-Attenuator DC – 18 GHz 20 dB	NT-439	☐	Spitzenberger und Spies Test software V4.1	NT-525
☐	I+P 7780 Directional coupler 100 - 2000 MHz	NT-440	☐	Vertical coupling plane (ESD)	NT-531
☐	ESH3-Z2 - Pulse limiter 9 kHz - 30 MHz	NT-441	☐	Test cable #4 for EN 61000-4-6	NT-553
☐	Power Divider 6 dB/1 W/50 Ohm	NT-443	☐	Test cable #3 for conducted emission	NT-554
☐	Directional coupler 0,1 MHz – 70 MHz	NT-444	☐	Test cable #5+#6 ESD-cable (2x470k)	NT-555 + NT-556
☐	Directional coupler 0,1 MHz – 70 MHz	NT-445	☐	Test cable #8 Sucoflex 104EA	NT-559
☐	Tube imitations according to EN 55015	NT-450	☐	Test cable #9 (for outdoor measurements)	NT-580
☐	FCC-801-M3-16A Coupling decoupling network	NT-458	☐	Test cable #10 (for outdoor measurements)	NT-581
☐	FCC-801-M2-50A Coupling decoupling network	NT-459	☐	Test cable #13 Sucoflex 104PE	NT-584
☐	FCC-801-M5-25 Coupling decoupling network	NT-460	☐	Test cable #21 for SRM-3000	NT-592
☐	FCC-801-T4 Coupling decoupling network	NT-463	☐	Shield chamber	NT-600
☐	FCC-801-C1 Coupling decoupling network	NT-464	☐	Climatic chamber	M-1200

Division:
Industry & Energy

Test report number:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 3 of 5

Date: 09.09.2024

Appendix 1 (continued)

Test equipment used

☐	Anechoic Chamber 3 m / 5 m measuring distance	EMV-100	☐	HF- Amplifier 9 kHz-225 MHz BBL200	EMV-300/1
☐	Turntabel 6 m diameter	EMV-101	☐	HF- Amplifier 80 -1000 MHz BBA150	EMV-301
☐	Antenna mast + controller	EMV-102+ EMV-103	☐	HF- Amplifier 0,8 - 6 GHz BBA150	EMV-302
☐	EMC Video/Audiosystem	EMV-104	☐	High Power Ant. 20-200 MHz HPBA-2510	EMV-303/1
☐	EMC Software EMC32 Version 10.60.20	EMV-105	☐	High Power Ant. 20-200 MHz S12018-21	EMV-303/2
☐	Hornantenna 1 – 18 GHz HF 907	EMV-110	☐	Log.per Antenna 80-2700 MHz STLP 9128 E special	EMV-304
☐	Antennapre.amp. 1 – 18 GHz BBV 9718 D	EMV-111/1	☐	Log.per Antenna 0,7 – 9 GHz STLP9149	EMV-305
☐	Trilog Antenna 30-3000 MHz VULB9163	EMV-112	☐	HF- Amplifier 9 kHz-250 MHz BBA150 (low noise)	EMV-306
☐	Monopol 9 kHz – 30 MHz VAMP 9243	EMV-113	☐	ISO11451-2 TLS 10 kHz – 30 MHz	EMV-307
☐	Antennapre.amp 18 – 40 GHz BBV 9721	EMV-114	☐	Load Dump Generator LD 200N	EMV-350
☐	Hornantenna 200 – 2000 MHz AH-220	EMV-115	☐	Ultra Compact Symulator UCS 200N100	EMV-351
☐	DC Artificial Network PVDC 8300	EMV-150	☐	Automotive Power fail module PFM 200N100.1	EMV-352
☐	AC Artificial Network NNLK 8121 RC	EMV-151	☐	Voltage Drop Symulator VDS 200Q100	EMV-353
☐	AC Artificial Network NNLK 140	EMV- 153a-d	☐	Arb. Generator AutoWave	EMV-354
☐	EMI Receiver ESW44	EMV-200/1	☐	Ultra Compact Symulator UCS 500N7	EMV-355
☐	Signalgenerator 9 kHz – 40 GHz N5173B	EMV-201	☐	Coupling decoupling network CNI 503B7 / 32 A	EMV-356
☐	GPS Frequency normal B-88	EMV-202	☐	Coupling decoupling network CNI 503B7 / 63 A	EMV-357
☐	DC Power supply N5745A	EMV-203	☐	Telecom Surge Generator TSurge 7	EMV-358
☐	Spektrum Analyzator FSV40	EMV-205	☐	Coupling decoupling network CNI 508N2	EMV-359
☐	Thd Multimeter Model 2015	EMV-206	☐	Coupling decoupling network CNV 504N2.2	EMV-360
☐	Poweramplifier PAS15000	EMV- 207/abc	☐	Immunity generator NSG4060/NSG4060-1	EMV-361
☐	Inrush Current Source	EMV- 208/abc	☐	Coupling network CDND M316-2	EMV-362
☐	Arb.-generator Sycore	EMV-209	☐	Coupling network CT419-5	EMV-363
☐	Harmonics/Flicker analyzer ARS 16/3	EMV-210	☐	ESD Generator NSG 437	EMV-364
☐	Power Supply Regatron AC	EMV-214	☐	Pulse Limiter VTSD 9561-F BNC	EMV-405
☐	Power Supply Regatron DC	EMV-215	☐	Transient emission BSM200N40+BS200N100	EMV- 450+451
☐	Harmonics/Flicker analyser Zimmer	EMV-216	☐	Cap. Coupling Clamp HFK	EMV-455
☐	Flicker Impedanz Newtons4th 753	EMV-218	☐	Mag. Field System MS100N+MC26100+MC2630	EMV- 456-458
☐	Comemso	EMV-219			

Division:
Industry & Energy

Test report number:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 4 of 5

Date: 09.09.2024

Appendix 1 (continued)

Test equipment used

Division:
Industry & Energy

Test report number:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 5 of 5

Date: 09.09.2024

☐	Coupling network CDN M2-100A	EMV-459
☐	Coupling network CDN M3-32A	EMV-460
☐	Coupling network CDN M5-100A	EMV-461
☐	Current Clamp CIP 9136A	EMV-462
☐	DC Artificial Network HV-AN 150	EMV-464+465
☐	Coupling Clamp EM 101	EMV-466
☐	Decoupling Clamp FTC 101	EMV-467
☐	Power attenuator 10 dB / 250 Watt	EMV-469/2
☐	HV AMN NNHV 8123 800A	EMV-472
☐	HV AMN NNHV 8123 800A	EMV-473

Appendix 2 Photodocumentation

Division:
Industry & Energy

Description: Front view

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 1 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

Division:
Industry & Energy

Description: Rear view

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 2 of 17

Date: 09.09.2024



Appendix 2 Photodocumentation

Division:
Industry & Energy

Description: Battery compartment opened

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 3 of 17

Date: 09.09.2024



Appendix 2 Photodocumentation

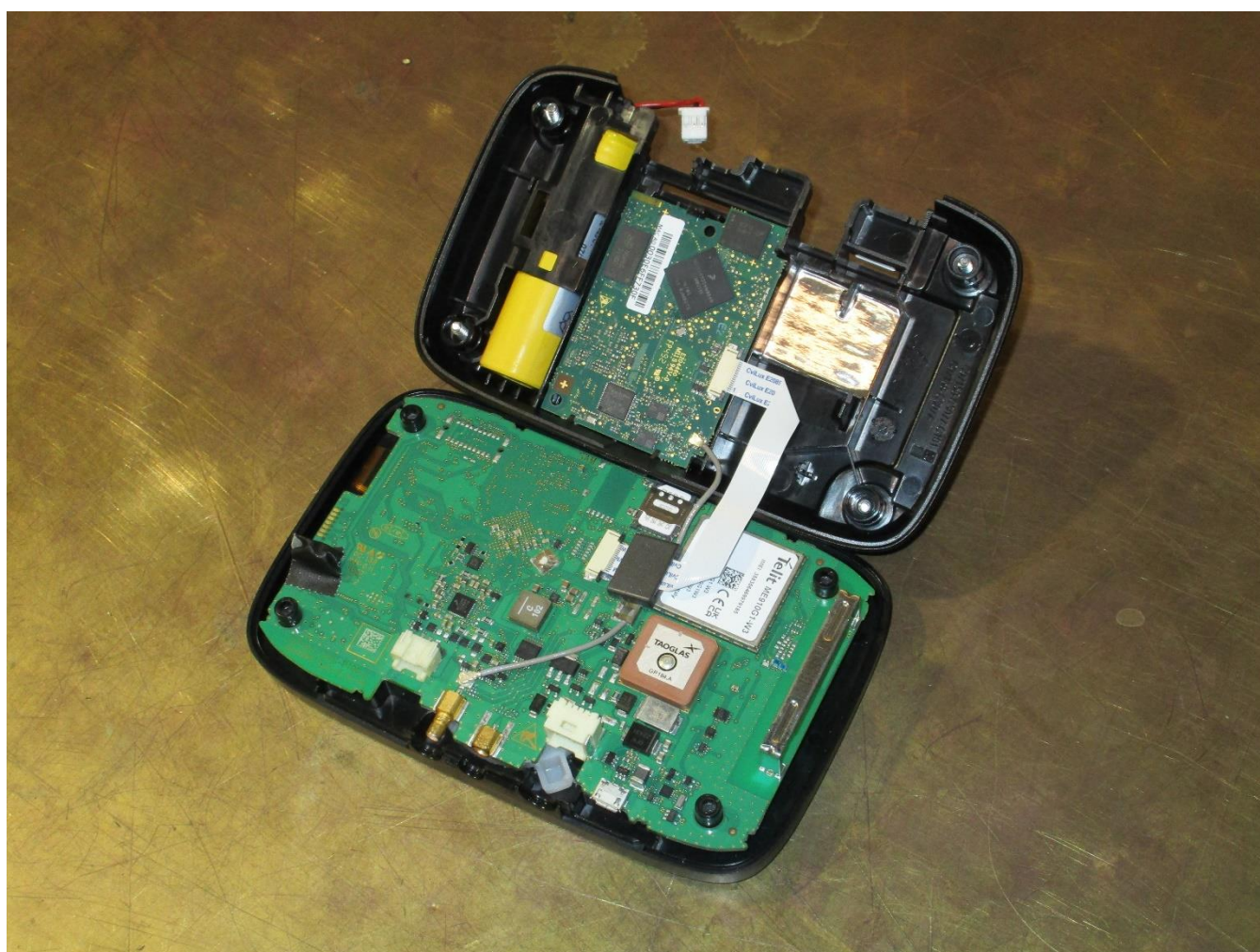
Division:
Industry & Energy

Description: Case opened

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 4 of 17

Date: 09.09.2024



Appendix 2 Photodocumentation

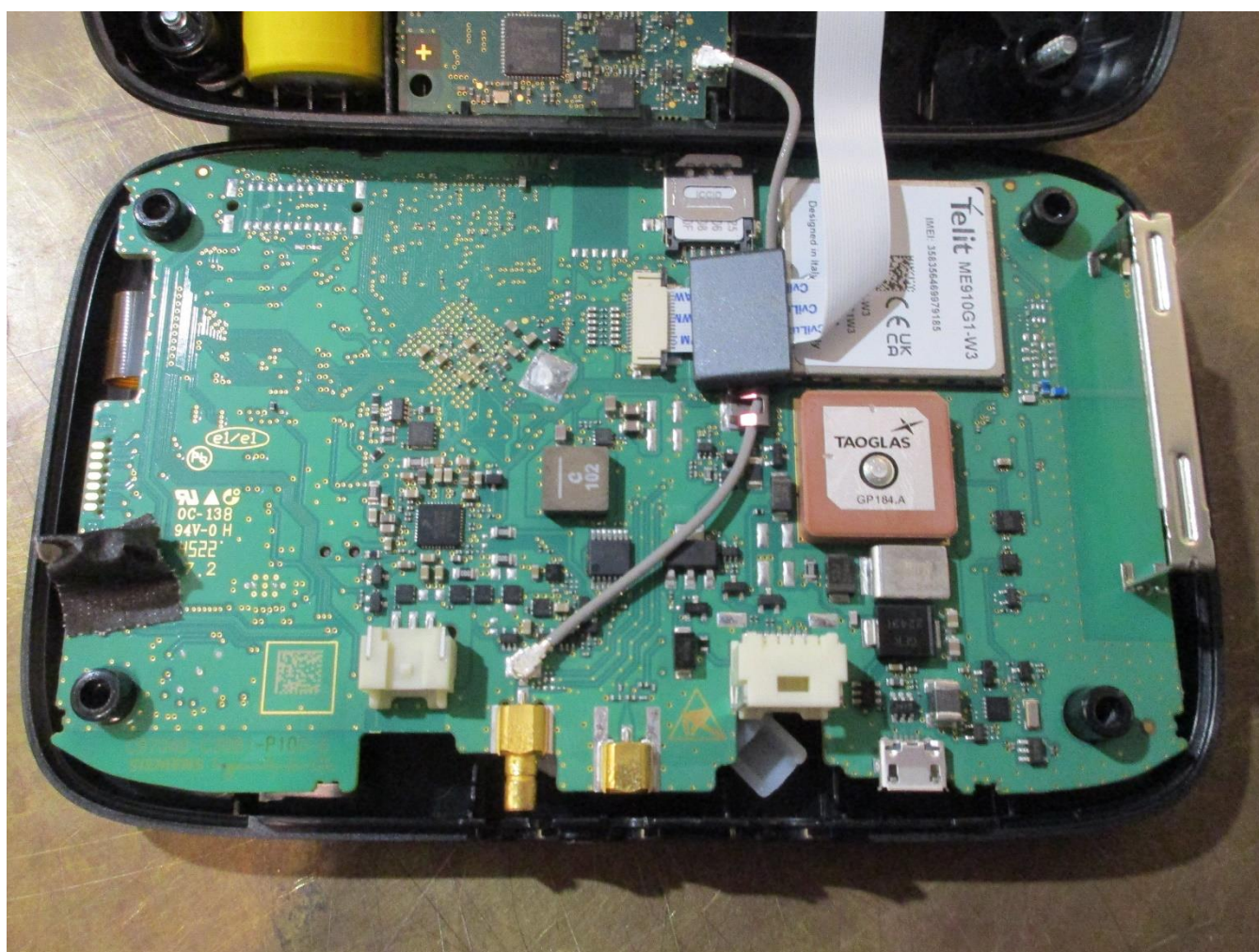
Division:
Industry & Energy

Description: Main PCB view #1

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 5 of 17

Date: 09.09.2024



Appendix 2 Photodocumentation

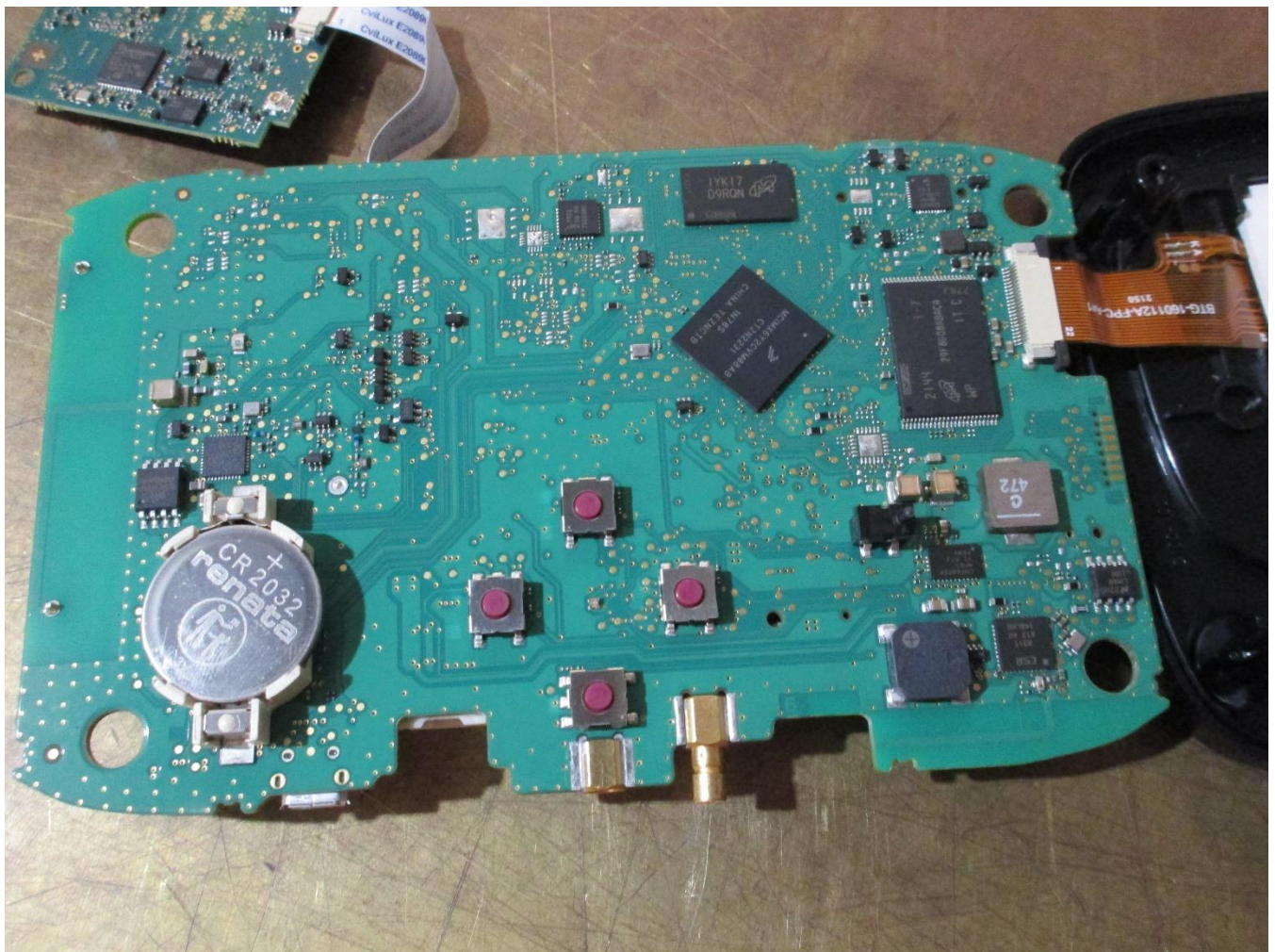
Division:
Industry & Energy

Description: Main PCB view #2

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 6 of 17

Date: 09.09.2024



Appendix 2 Photodocumentation

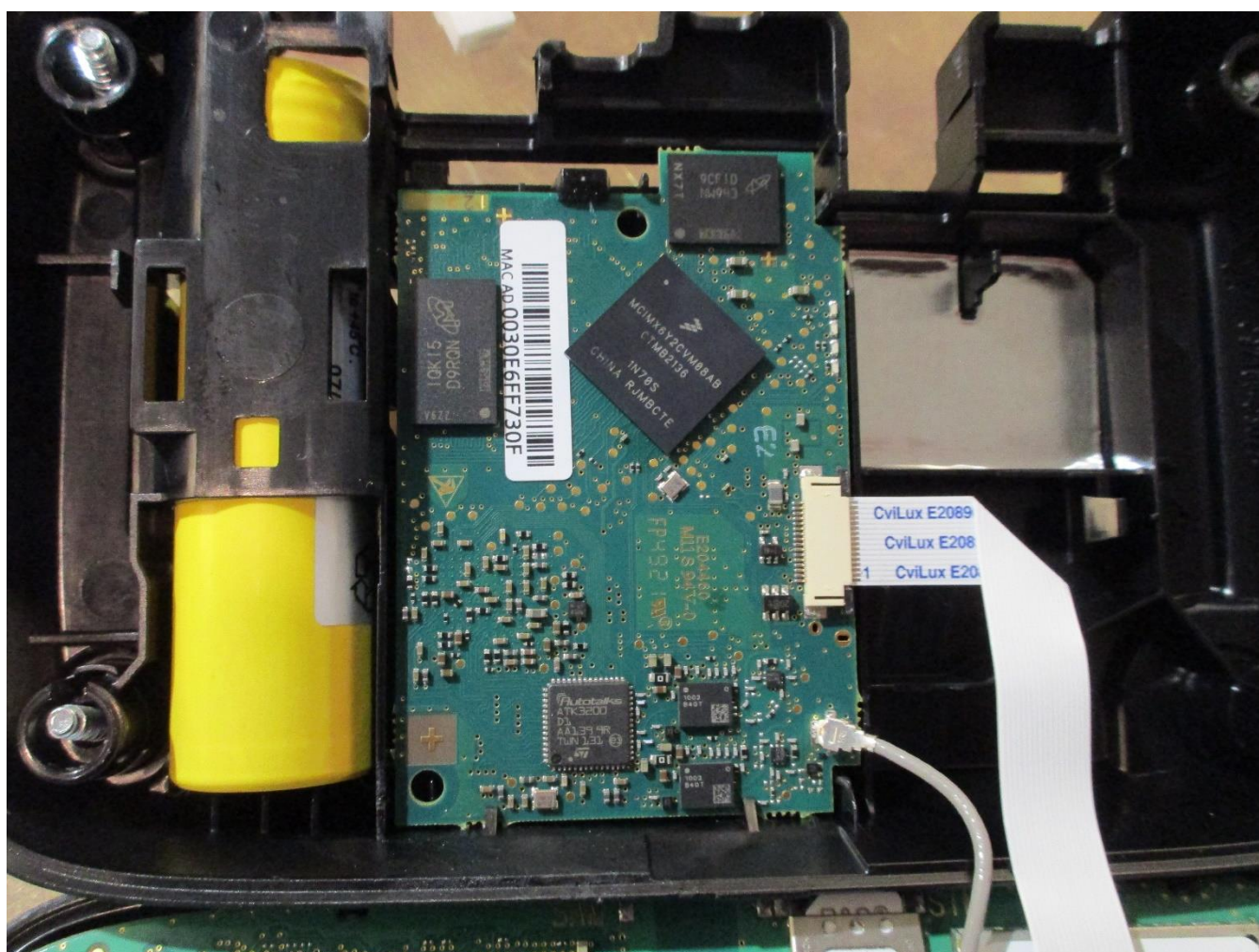
Division:
Industry & Energy

Description: C-V2X PCB view #1

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 7 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

Description: C-V2X PCB view #2

Division:
Industry & Energy

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 8 of 17

Date: 09.09.2024



Appendix 2 Photodocumentation

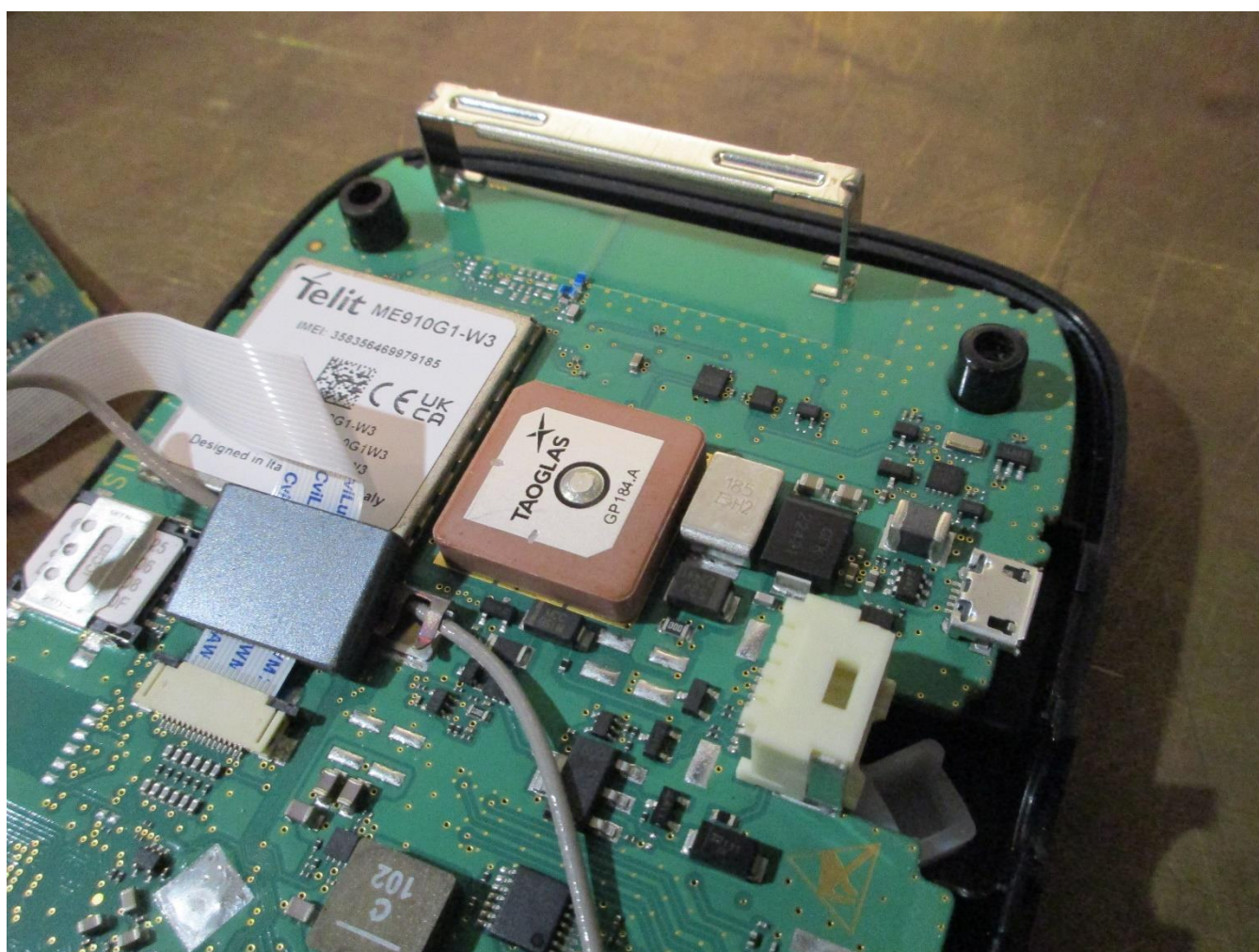
Division:
Industry & Energy

Description: RF Part with GNSS and LTE Antenna

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 9 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

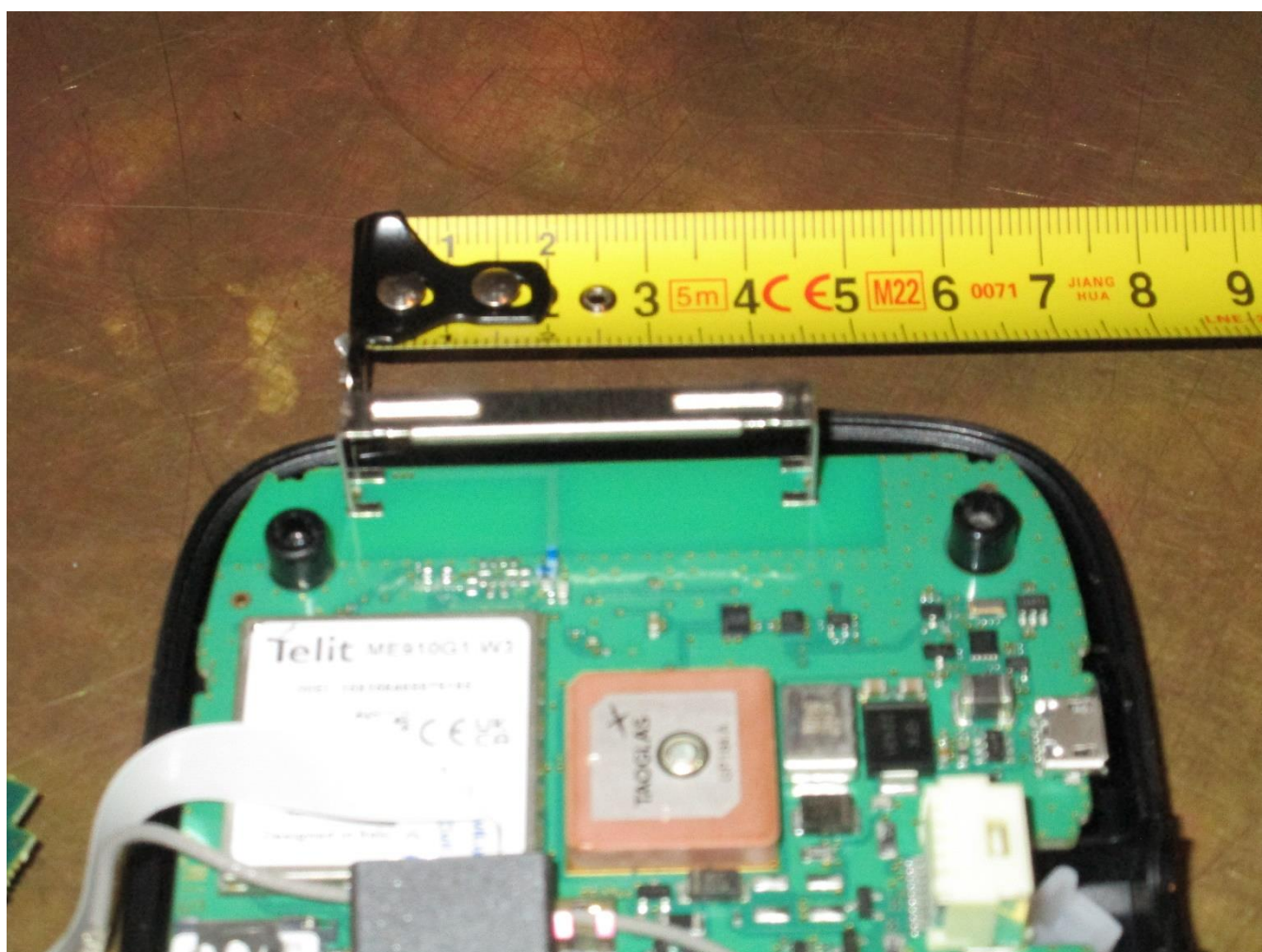
Division:
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Description: LTE Antenna detail view

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 10 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

Division:
Industry & Energy

Description: C-V2X Antenna detail view

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 11 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

Division:
Industry & Energy

Description: Test setup 30 MHz - 1000 MHz

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 12 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

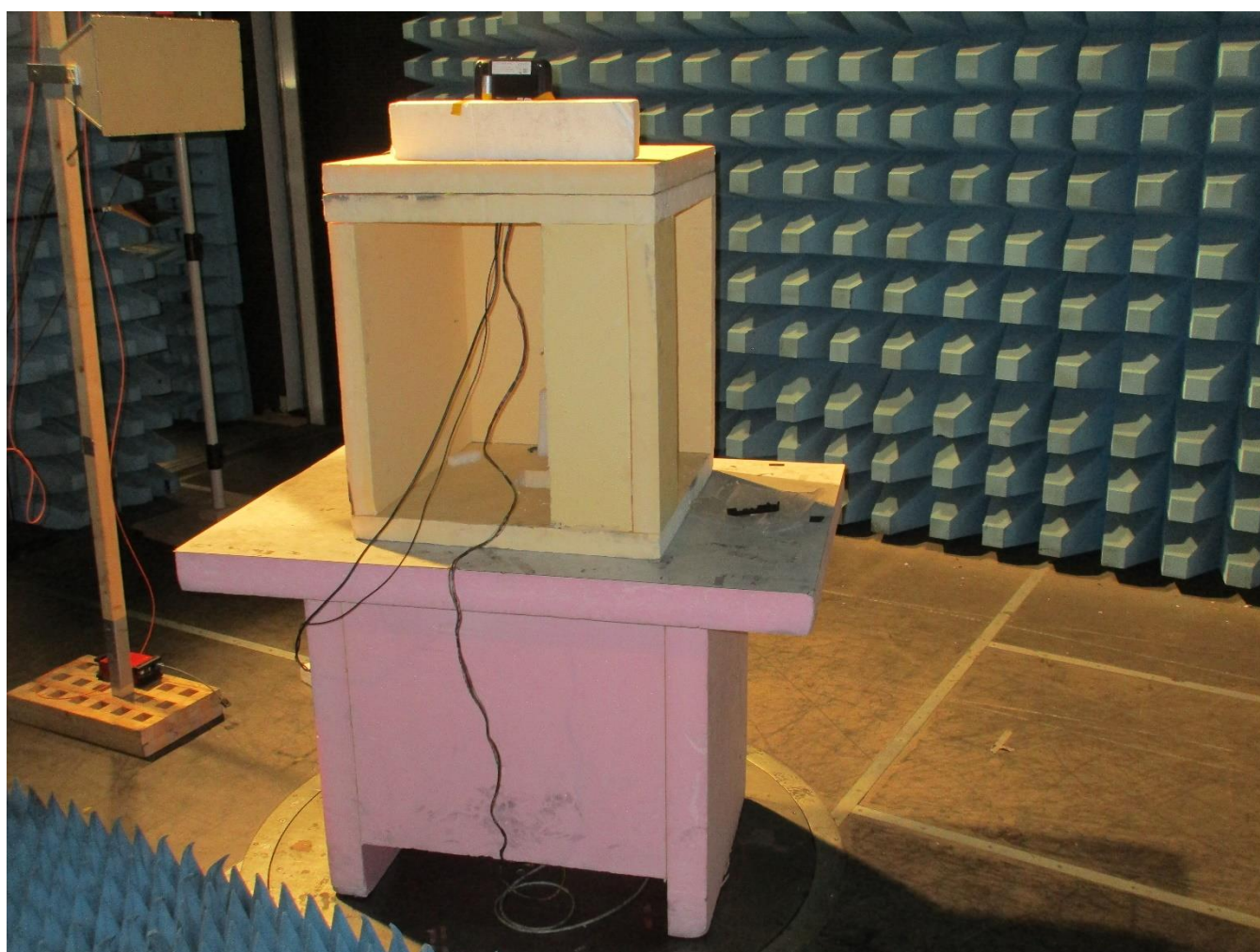
Division:
Industry & Energy

Description: Test setup above 1 GHz view #1

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 13 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

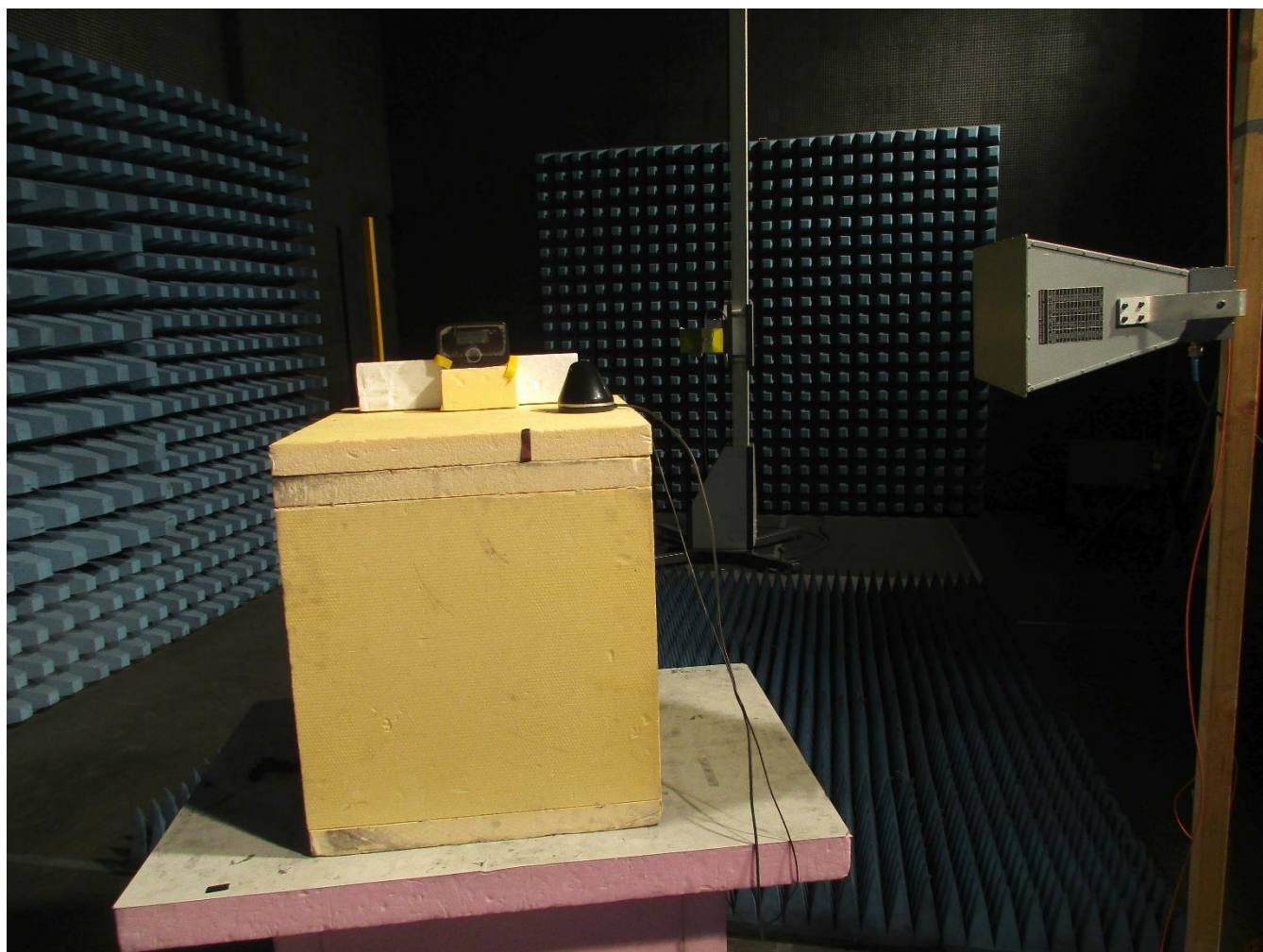
Division:
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Description: Test setup above 1 GHz view #2

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 14 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

Division:
Industry & Energy

Description: Minimum distance of external antenna
for simultaneous transmission

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 15 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

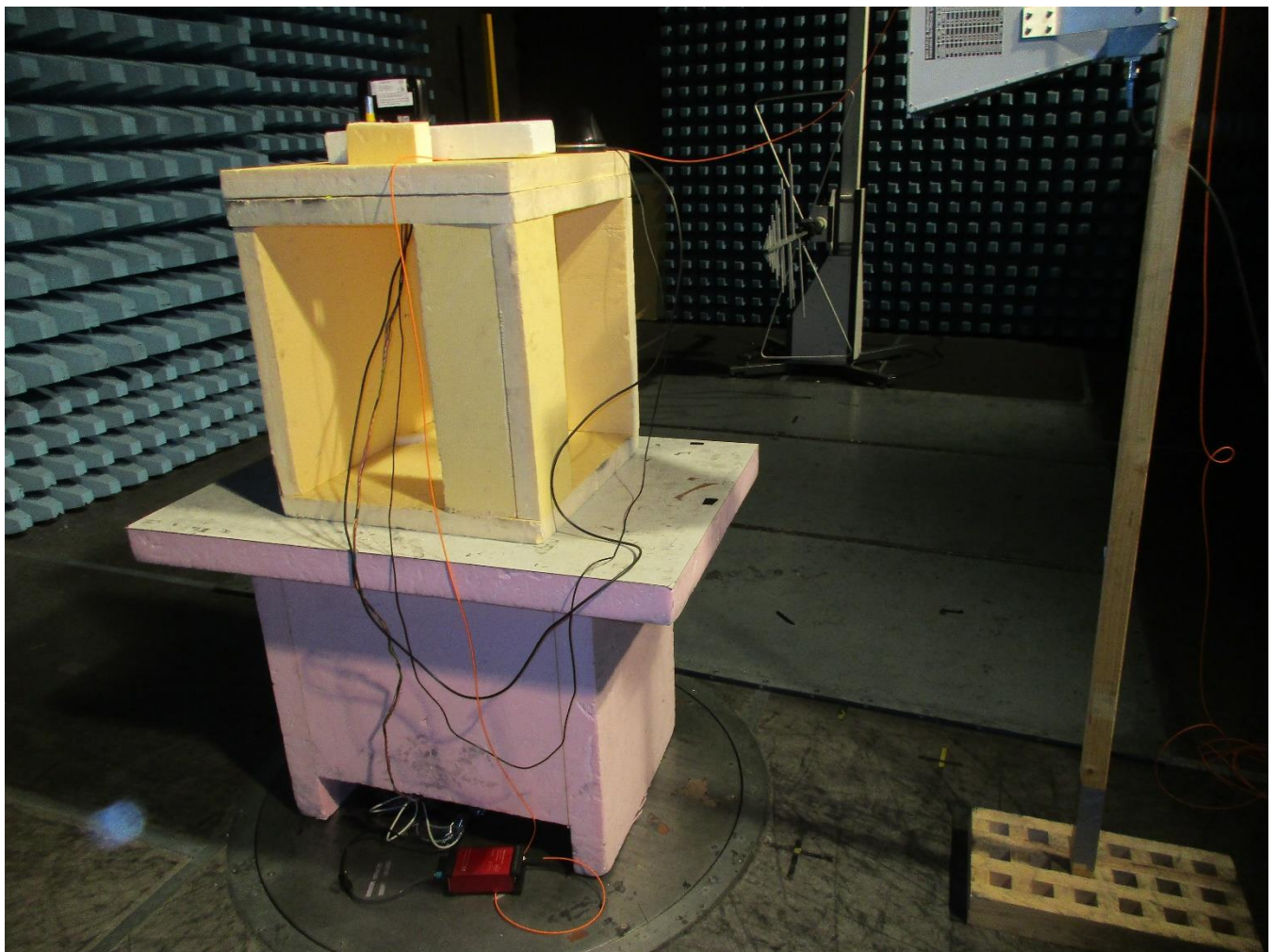
Division:
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Description: Test setup FCC Part 15 B - view #1

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 16 of 17

Date: 09.09.2024



Appendix 2

Photodocumentation

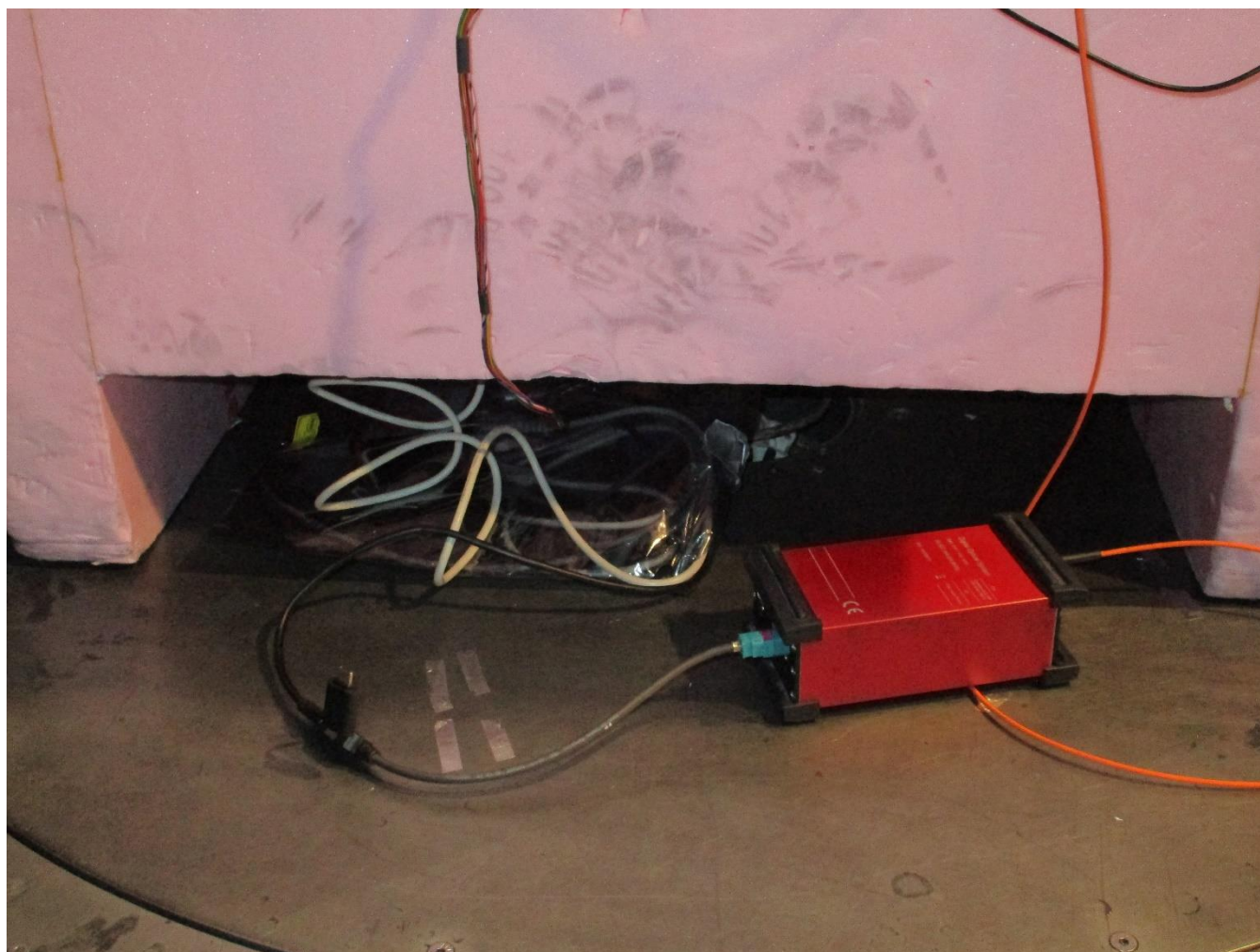
Division:
Industry & Energy

Description: Test setup FCC Part 15 B - view #2

Test report reference:
2023-IN-AT-TICL-E-EX-0-
000131-FG-003-Rev2

Page: 17 of 17

Date: 09.09.2024



--- END OF TEST REPORT ---

