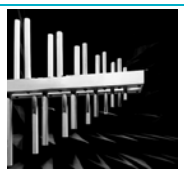
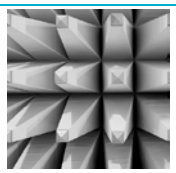

CTC advanced
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Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-0437/20-01-04

Testing laboratory

CTC advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: https://www.ctcadvanced.com
e-mail: mail@ctcadvanced.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

Applicant

KUNBUS GmbH
Heerweg 15C
73770 Denkendorf / GERMANY
Phone: -/-
Contact: Ralf Kaptur
e-mail: r.kaptur@kunbus.com
Phone: +49 (711) 40091 620

Manufacturer

KUNBUS GmbH
Heerweg 15C
73770 Denkendorf / GERMANY

Test standard/s

FCC - Title 47 CFR Part 15	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	**IO-Link Wireless Master Module Communication Module**
Model name:	**KE2640MODA2**
FCC ID:	**2AYYK-2640M2**
IC:	**26994-2640M2**
Frequency:	DTS band 2400 MHz to 2483.5 MHz
Technology tested:	IO-Link Wireless System Extensions
Antenna:	Onboard and external antennas
Power supply:	3.0 V DC by external power supply
Temperature range:	-30°C to +85°C

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:

cn=Michael Dorongovski, o=CTC advanced GmbH, ou=DOR-210422, email=Michael.Dorongovski@ctcadvanced.com, c=DE
2021.04.28 14:33:45 +02'00'

Michael Dorongovski
Lab Manager
Radio Communications

Test performed:

cn=David Lang, o=CTC advanced GmbH, ou=LNG-161129, email=david.lang@ctcadvanced.com, c=DE
2021.04.28 14:51:03 +02'00'

David Lang
Lab Manager
Radio Communications

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2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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In no case this test report can be considered as a Letter of Approval.

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2020-07-06
Date of receipt of test item:	2020-12-03
Start of test:*	2020-12-08
End of test:*	2020-12-10
Person(s) present during the test:	-/-

*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

2.3 Test laboratories sub-contracted

None

3 Test standard/s, references and accreditations

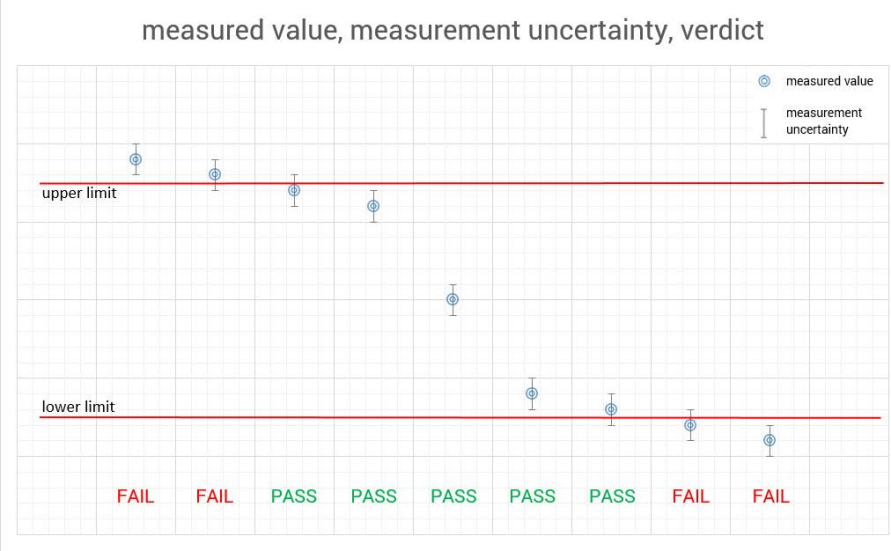
Test standard	Date	Description
FCC - Title 47 CFR Part 15		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 2	February 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices
RSS - Gen Issue 5 incl. Amendment 1	March 2019	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus

Guidance	Version	Description
KDB 558074 D01	v05r02	GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES
ANSI C63.4-2014	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Accreditation	Description
D-PL-12076-01-04	Telecommunication and EMC Canada https://www.dakks.de/as/ast/d/D-PL-12076-01-04e.pdf
D-PL-12076-01-05	Telecommunication FCC requirements https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf

4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



5 Test environment

Temperature :	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests No testing under extreme temperature conditions required. No testing under extreme temperature conditions required.
Relative humidity content :		55 %
Barometric pressure :		1021 hpa
Power supply :	V_{nom} V_{max} V_{min}	5.0 V DC via external power supply No testing under extreme voltage conditions required. No testing under extreme voltage conditions required.

6 Test item

6.1 General description

Kind of test item :	IO-Link Wireless Master Module Communication Module
Model name :	KE2640MODA2
HMN :	n/a
PMN :	IO-Link Wireless Master Module
HVIN :	KE2640MODA2
FVIN :	n/a
S/N serial number :	Rad. Master1 (external antenna), Master3 (onboard antenna) Cond. Master2
Hardware status :	PR100332R03
Software status :	1.2.0
Firmware status :	1.3
Frequency band :	DTS band 2400 MHz to 2483.5 MHz Tested frequencies: 2401 MHz (lowest), 2440 (middle) & 2480 (highest)
Type of radio transmission : Use of frequency spectrum :	Modulated carrier
Type of modulation :	GFSK
Number of channels :	75 (2403 MHz to 2478 MHz) plus two configuration channels (2401 MHz and 2480 MHz)
Antenna :	Onboard and external antennas; Three antenna configurations defined by the manufacturer: Antenna 0: 0 dBi reference antenna (used for conducted measurements) Antenna 1: OnBoard antenna 4.9 dBi*; Antenna 2: externlal dipole antenna 2.8 dBi*, *refer to data sheet (section 11)
Power supply :	3.0 V DC via external power supply; AC Adaptor for AC Emissions test as per section 12.12 provided by the test lab (Sony AC-UB10D).
Temperature range :	-30°C to +85°C

6.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup and EUT photos are included in test report: 1-0437/20-01-01_AnnexA
1-0437/20-01-01_AnnexD

7 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

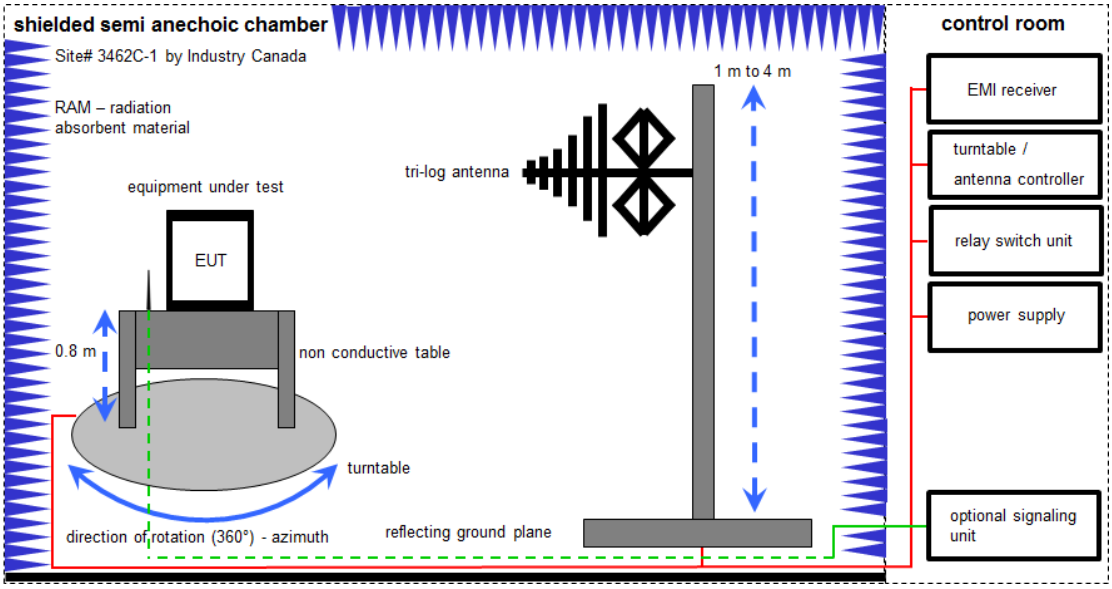
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

k	calibration / calibrated	EK	limited calibration
ne	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
ev	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
vlkl!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

7.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter
EMC32 software version: 10.59.00

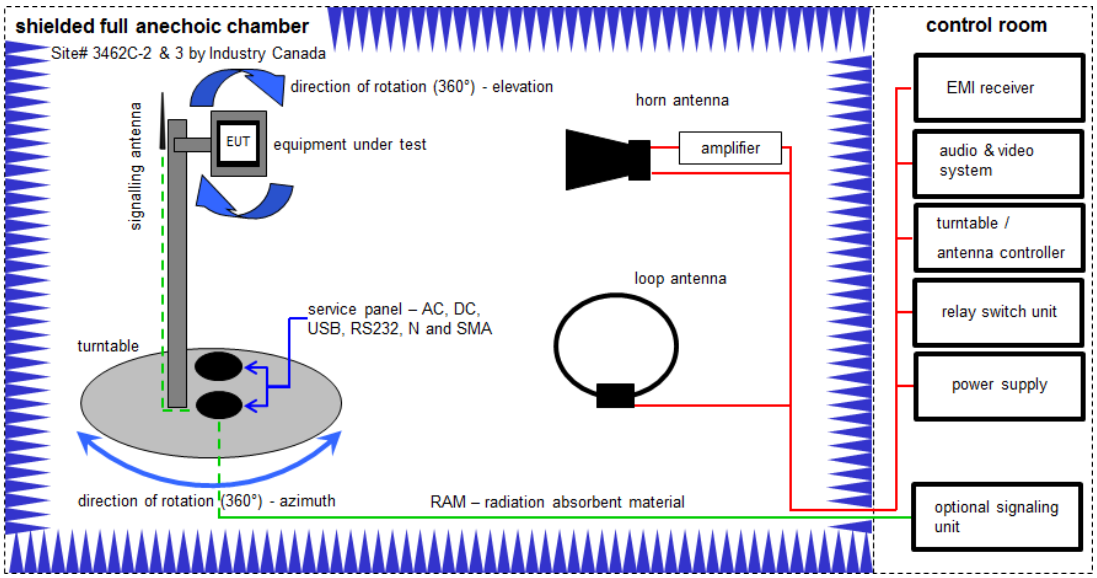
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	A	Semi anechoic chamber	3000023	MWB AG		300000551	ne	-/-	-/-
3	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
4	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
5	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
6	A	Turntable	2089-4.0	EMCO		300004394	ne	-/-	-/-
7	A	PC	TecLine	F+W		300004388	ne	-/-	-/-
8	A	Spectrum-Analyzer	FSU26	R&S	200809	300003874	k	09.12.2020	08.12.2021

7.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter / 1 meter

FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

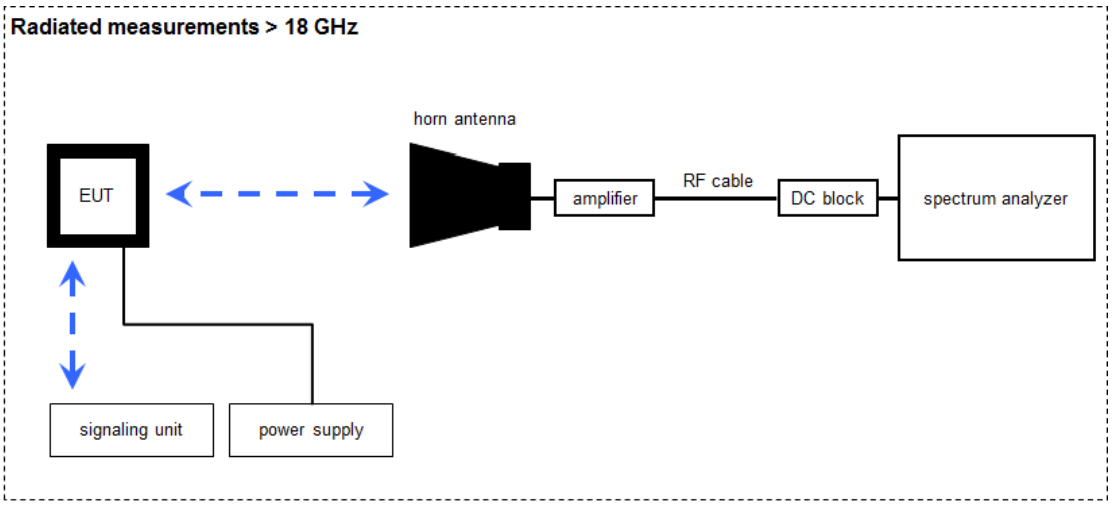
Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A,	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vlKl!	13.06.2019	12.06.2021
2	B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3696	300001604	vlKl!	27.02.2019	26.02.2021
3	B	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne	-/-	-/-
4	B	Band Reject Filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	26	300003792	ne	-/-	-/-
5	B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22051	300004483	ev	-/-	-/-
6	A, B	Computer	Intel Core i3 3220/3,3 GHz, Prozessor		2V2403033A5421	300004591	ne	-/-	-/-
7	B	Highpass Filter	WHKX2.6/18G-10SS	Wainwright	12	300004651	ne	-/-	-/-
8	A, B	NEXIO EMV-Software	BAT EMC V3.20.0.13	EMCO		300004682	ne	-/-	-/-
9	A, B	Anechoic chamber		TDK		300003726	ne	-/-	-/-
10	A, B	EMI Test Receiver 9kHz-26,5GHz*	ESR26	R&S	101376	300005063	k	10.12.2019	09.12.2020 *
11	B	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011571	300005240	ev	-/-	-/-

*Measurements with this instrument before end of calibration date.

7.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

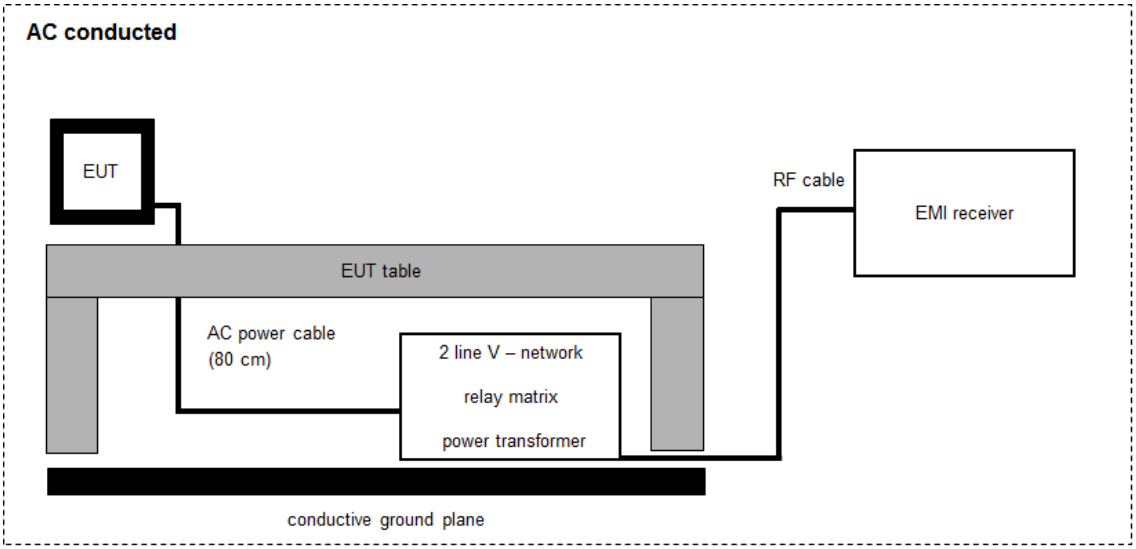
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Microwave System Amplifier, 0.5-26.5 GHz	83017A	HP	00419	300002268	ev	-/-	-/-
2	A	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda	01096	300000486	vlKl!	21.01.2020	20.01.2022
3	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	17.12.2019	16.12.2020
4	A	RF-Cable	ST18/SMAm/SMAm /48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
5	A	RF-Cable	ST18/SMAm/SMAm /48	Huber & Suhner	Batch no. 127377	400001183	ev	-/-	-/-
6	A	DC-Blocker 0.1-40 GHz	8141A	Inmet		400001185	ev	-/-	-/-

7.4 AC conducted



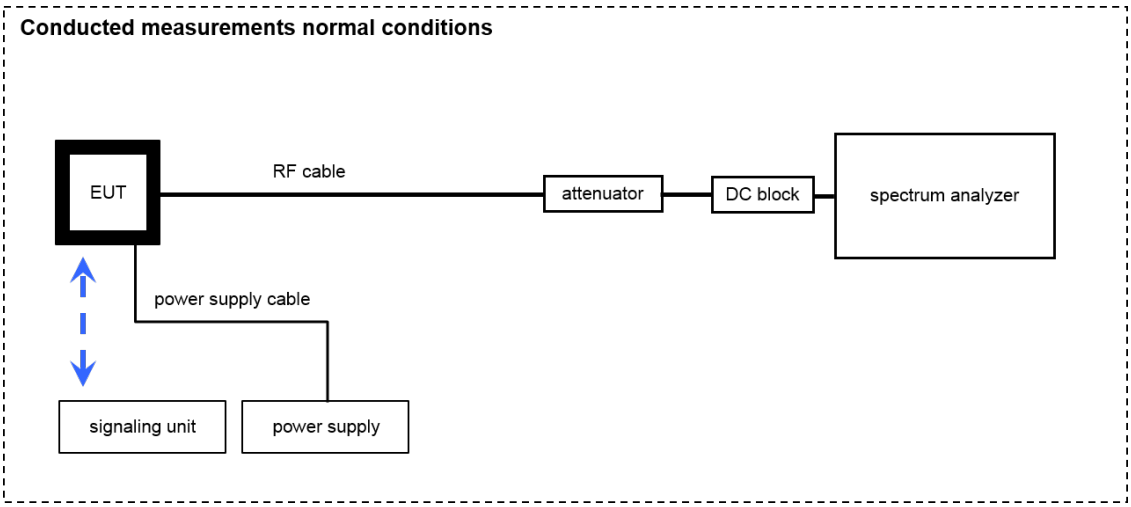
FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	892475/017	300002209	vIKI!	11.12.2019	10.12.2021
2	A	RF-Filter-section	85420E	HP	3427A00162	300002214	NK!	-/-	-/-
3	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	09.12.2020	08.12.2021
4	A	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
5	A	PC	TecLine	F+W		300003532	ne	-/-	-/-

7.5 Conducted measurements



OP = AV + CA
(OP-output power; AV-analyzer value; CA-loss signal path)

Example calculation:
OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 mW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Signal Analyzer 40 GHz	FSV40	R&S	101353	300004819	k	21.01.2020	20.01.2021
2	A	Control-PC of OSP	exone Variety		060931P1302P 00109	300004869	ne	-/-	-/-
3	A	RF-Cable WLAN-Tester Port 1	ST18/SMAm/SMAm /48	Huber & Suhner	Batch no. 1273777	400001249	ev	-/-	-/-
4	A	Tester Software RadioStar (C.BER2 for BT Conformance)	Version 1.0.0.X	CTC advanced GmbH	0001	400001380	ne	-/-	-/-

8 Sequence of testing

8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement*

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

*)Note: The sequence will be repeated three times with different EUT orientations.

8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.4 Sequence of testing radiated spurious above 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

Premeasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

9 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Antenna gain	± 3 dB
Spectrum bandwidth	± 21.5 kHz absolute; ± 15.0 kHz relative
Maximum output power	± 1 dB
Detailed conducted spurious emissions @ the band edge	± 1 dB
Band edge compliance radiated	± 3 dB
Band edge compliance conducted	± 1.5 dB
Spurious emissions conducted	± 3 dB
Spurious emissions radiated below 30 MHz	± 3 dB
Spurious emissions radiated 30 MHz to 1 GHz	± 3 dB
Spurious emissions radiated 1 GHz to 12.75 GHz	± 3.7 dB
Spurious emissions radiated above 12.75 GHz	± 4.5 dB
Spurious emissions conducted below 30 MHz (AC conducted)	± 2.6 dB

10 Summary of measurement results

☒	No deviations from the technical specifications were ascertained
☐	There were deviations from the technical specifications ascertained
☐	This test report is only a partial test report. The content and verdict of the performed test cases are listed below.

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS - 247, Issue 2	See table!	2021-04-28	-/-

Test specification clause	Test case	Guideline	Temperature & voltage conditions	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (4)	System gain	-/-	Nominal	TX	☒	☐	☐	☐	-/-
§15.247(e) RSS - 247 / 5.2 (b)	Power spectral density	KDB 558074 DTS clause: 8.4	Nominal	TX	☒	☐	☐	☐	-/-
§15.247(a)(2) RSS - 247 / 5.2 (a)	DTS bandwidth – 6 dB bandwidth	KDB 558074 DTS clause: 8.2	Nominal	TX	☒	☐	☐	☐	-/-
RSS Gen clause 4.6.1	Occupied bandwidth	-/-	Nominal	TX	☒	☐	☐	☐	-/-
§15.247(b)(3) RSS - 247 / 5.4 (4)	Maximum output power	KDB 558074 DTS clause: 8.3.1.1	Nominal	TX	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance cond. & rad.	KDB 558074 DTS clause: 8.7.2 or 8.7.3	Nominal	TX	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	TX spurious emissions conducted	KDB 558074 DTS clause: 8.5	Nominal	TX	☒	☐	☐	☐	-/-
§15.209(a) RSS - Gen	Spurious emissions radiated below 30 MHz	-/-	Nominal	TX	☒	☐	☐	☐	-/-
15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated 30 MHz to 1 GHz	-/-	Nominal	TX	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated above 1 GHz	-/-	Nominal	TX	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions below 30 MHz (AC conducted)	-/-	Nominal	TX	☒	☐	☐	☐	-/-

Notes:

C	Compliant	**NC**	Not compliant	**NA**	Not applicable	**NP**	Not performed

11 Additional comments

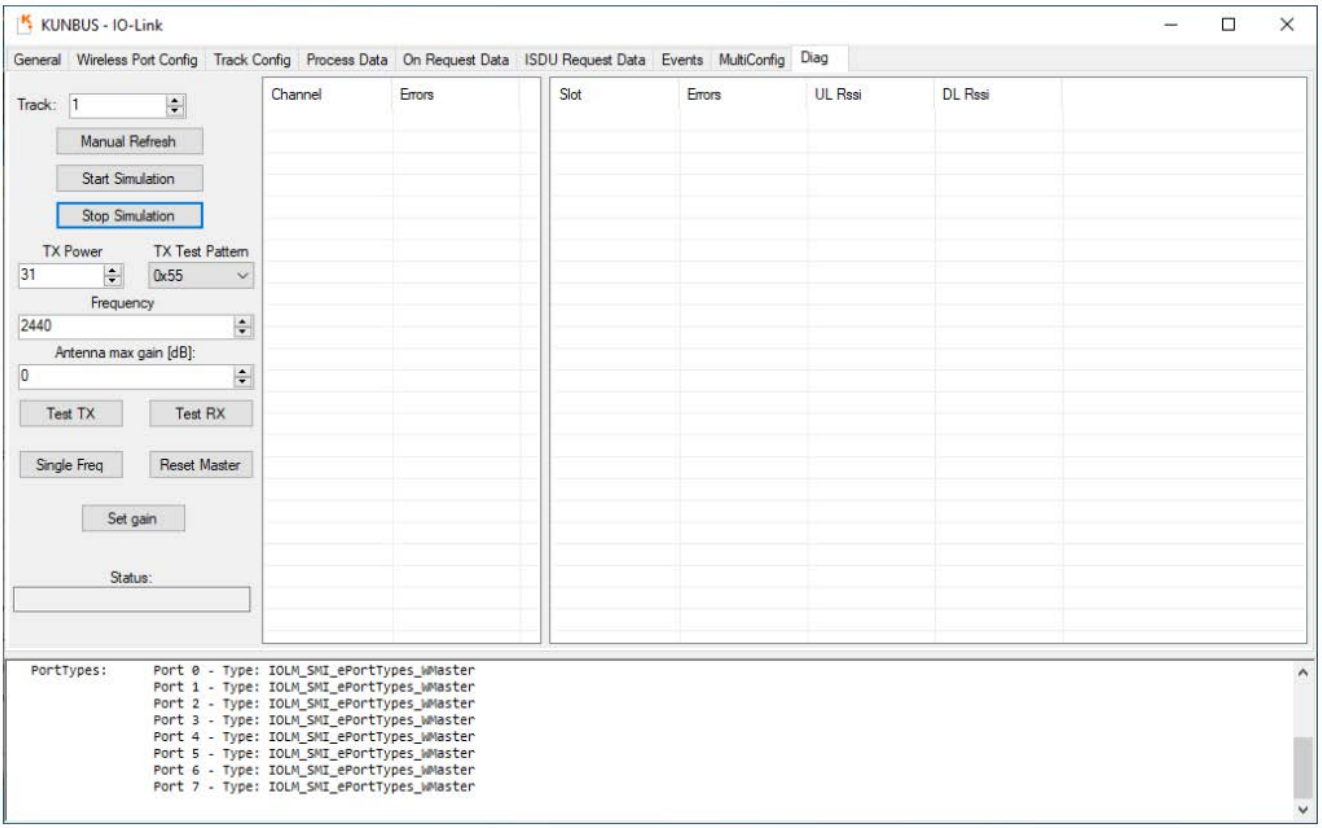
Reference documents: Customer_Questionnaire;
IOLW_RefBoards_OperationalDescription_v1_1.pdf,
Dipole antenna: ant-2_4-lpw-125-ds.pdf
Onboard antenna: OnBoard-SMD-2400-rev4.3-1.pdf

Co-applicable documents: 1-0437_20-01-04_log1_conducted.pdf (based on 0 dBi antenna gain),
1-0437_20-01-04_log2_conducted.pdf (based on 4.9 dBi antenna gain)
1-0437_20-01-04_log3_conducted.pdf (based on 2.8 dBi antenna gain)

Special test descriptions: Three conducted configurations have been tested completely with different power settings. Additionally the radiated tests were performed with two different antennas.

Configuration	Measurements	Antenna	Gain [dBi]	Power Setting	Antenna Gain Offset
1	Conducted	None	0	31	0
2	Conducted	Onboard SMD	4.9	31	5
3	Conducted	Dipole	2.8	31	3
4	Radiated	Onboard SMD	4.9	31	5
5	Radiated	Dipole	2.8	31	3

Configuration descriptions: The “IOL_Master_GUI_20201201” test software provided by the manufacturer was used to enable continuous transmit mode on the transceivers tested.



Test mode:	☒	Special software is used. EUT is transmitting pseudo random data by itself
EUT selection:	☐	Only one device available
	☐	Devices selected by the customer
	☒	Devices selected by the laboratory (Randomly)
Antennas and transmit operating modes:	☐	Operating mode 1 (single antenna) - *Equipment with 1 antenna,* - *Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used,* - *Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)*
	☐	Operating mode 2 (multiple antennas, no beamforming) - *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.*
	☐	Operating mode 3 (multiple antennas, with beamforming) - *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming.* *In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.*

12 Measurement results

12.1 System gain

Antenna Gain as declared by manufacturer (refer to section 11 for data sheet).

12.2 Power spectral density

Description:

Measurement of the power spectral density of a digital modulated system.

Measurement parameters	
External result file	1-0437_20-01-04_log1_conducted.pdf, 1-0437_20-01-04_log2_conducted.pdf, 1-0437_20-01-04_log3_conducted.pdf, FCC Part 15.247 Peak Power Spectral Density DTS
Test setup	See sub clause 7.5 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
Power spectral density	
For digitally modulated systems the transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0-second duration.	

Results: Antenna 0

	Frequency		
	2401 MHz	2440 MHz	2480 MHz
Power spectral density [dBm / 3kHz]	-8.3	-9.8	-11.0

Results: Antenna 1 (Onboard)

	Frequency		
	2401 MHz	**2440 MHz**	**2480 MHz**
Power spectral density [dBm / 3kHz]	-13.2	-14.4	-14.5

Results: Antenna 2 (Dipole)

	Frequency		
	2401 MHz	**2440 MHz**	**2480 MHz**
Power spectral density [dBm / 3kHz]	-10.9	-11.7	-12.8

12.3 DTS bandwidth – 6 dB bandwidth

Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement parameters	
External result file	1-0437_20-01-04_log1_conducted.pdf, 1-0437_20-01-04_log2_conducted.pdf, 1-0437_20-01-04_log3_conducted.pdf, FCC Part 15.247 Peak Power Spectral Density DTS FCC Part 15.247 Bandwidth 6dB DTS
Test setup	See sub clause 7.5 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
DTS bandwidth – 6 dB bandwidth	
Systems using digital modulation techniques may operate in the 2400–2483.5 MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.	

Results: Antenna 0

	Frequency		
	2401 MHz	**2440 MHz**	**2480 MHz**
6 dB bandwidth [kHz]	735	746	763

Results: Antenna 1 (Onboard)

	Frequency		
	2401 MHz	**2440 MHz**	**2480 MHz**
6 dB bandwidth [kHz]	735	743	760

Results: Antenna 2 (Dipole)

	Frequency		
	2401 MHz	**2440 MHz**	**2480 MHz**
6 dB bandwidth [kHz]	737	743	751

12.4 Occupied bandwidth – 99% emission bandwidth

Description:

Measurement of the 99% bandwidth of the modulated signal acc. RSS-GEN.

Measurement parameters	
External result file	1-0437_20-01-04_log1_conducted.pdf, 1-0437_20-01-04_log2_conducted.pdf, 1-0437_20-01-04_log3_conducted.pdf, FCC Part 15.247 Bandwidth 99PCT-20dB
Test setup	See sub clause 7.5 A
Measurement uncertainty	See sub clause 9

Usage:

-/-	IC
Occupied bandwidth – 99% emission bandwidth	
OBW is necessary for emission designator	

Results: Antenna 0

	Frequency		
	2401 MHz	**2440 MHz**	**2480 MHz**
99% bandwidth [kHz]	1051	1052	1057

Results: Antenna 1 (Onboard)

	Frequency		
	2401 MHz	**2440 MHz**	**2480 MHz**
99% bandwidth [kHz]	1047	1052	1056

Results: Antenna 2 (Dipole)

	Frequency		
	2401 MHz	**2440 MHz**	**2480 MHz**
99% bandwidth [kHz]	1052	1052	1057

12.5 Maximum output power

Description:

Measurement of the maximum output power conducted. EUT in single channel mode.

Measurement parameters	
External result file	1-0437_20-01-04_log1_conducted.pdf, 1-0437_20-01-04_log2_conducted.pdf, 1-0437_20-01-04_log3_conducted.pdf, FCC Part 15.247 Maximum Peak Conducted Output Power DTS
Test setup	See sub clause 7.5 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
Maximum output power	
Conducted: 1.0 W – antenna gain max. 6 dBi	

Results: Antenna 0

	Frequency		
	2401 MHz	2440 MHz	2480 MHz
Maximum output power conducted [dBm]	8.6	7.1	5.7

Results: Antenna 1 (Onboard)

	Frequency		
	2401 MHz	2440 MHz	2480 MHz
Maximum output power conducted [dBm]	3.6	2.4	2.0

Results: Antenna 2 (Dipole)

	Frequency		
	2401 MHz	**2440 MHz**	**2480 MHz**
Maximum output power conducted [dBm]	6.4	4.9	3.6

12.6 Band edge compliance radiated

Description:

Measurement of the radiated band edge compliance. The EUT is turned in the position that results in the maximum level at the band edge. Then a sweep over the corresponding restricted band is performed. The EUT is set to single channel mode and the transmit frequency 2401 MHz for the lower restricted band and 2480 MHz for the upper restricted band. Measurement distance is 3m.

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	Lower Band: 2300 – 2400 MHz higher Band: 2480 – 2500 MHz
Trace mode	Max hold
Test setup	See sub clause 7.2 B
Measurement uncertainty	See sub clause 9

Limits:

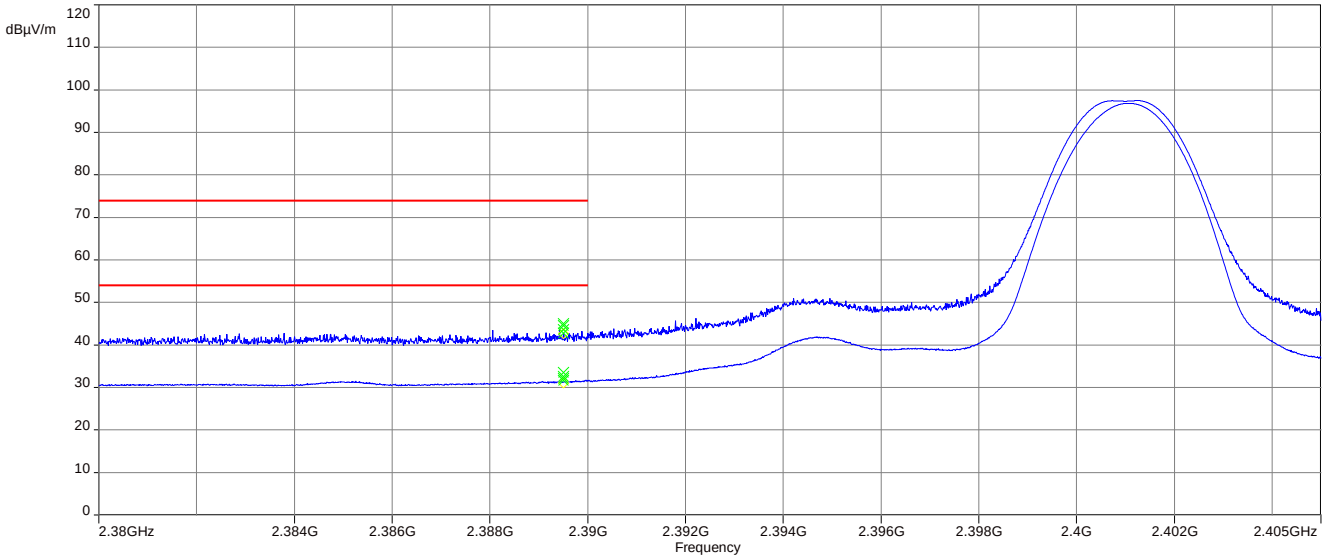
FCC	IC
Band edge compliance radiated	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).	
54 dBµV/m AVG 74 dBµV/m Peak	

Result: Antenna 1 (Onboard)

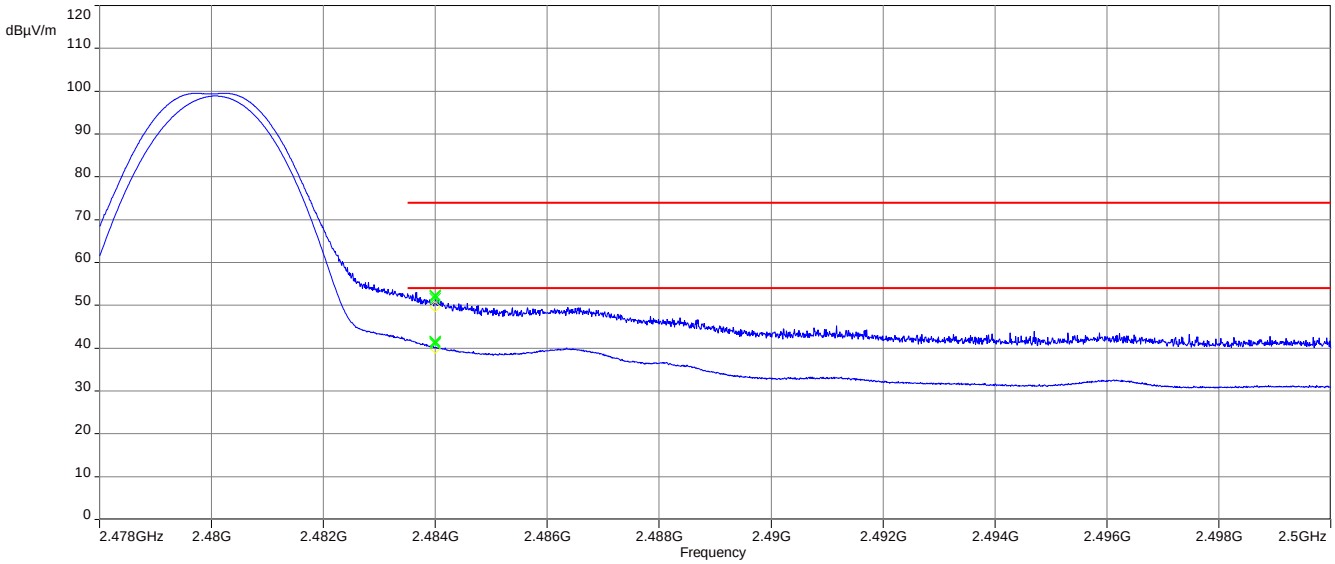
Scenario	Band edge compliance radiated [dBµV/m]
Lower restricted band	45.0 dBµV/m Peak 33.6 dBµV/m AVG
Upper restricted band	52.4 dBµV/m Peak 41.0 dBµV/m AVG

Plots:

Plot 1: Lower restricted band



Plot 2: Upper restricted band

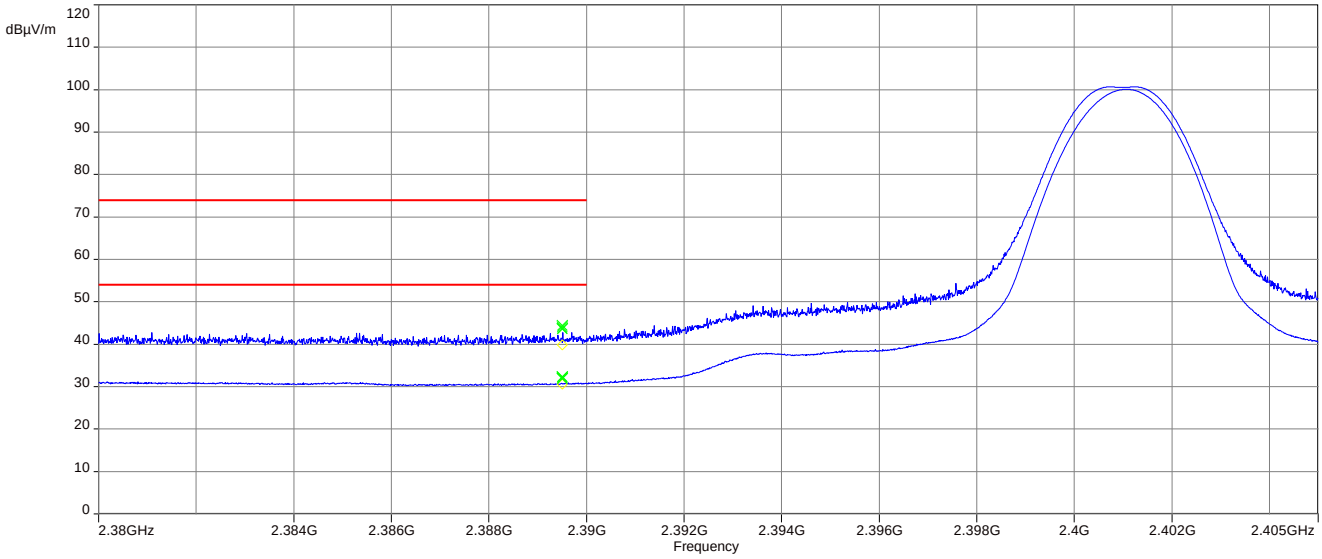


Result: Antenna 2 (Dipole)

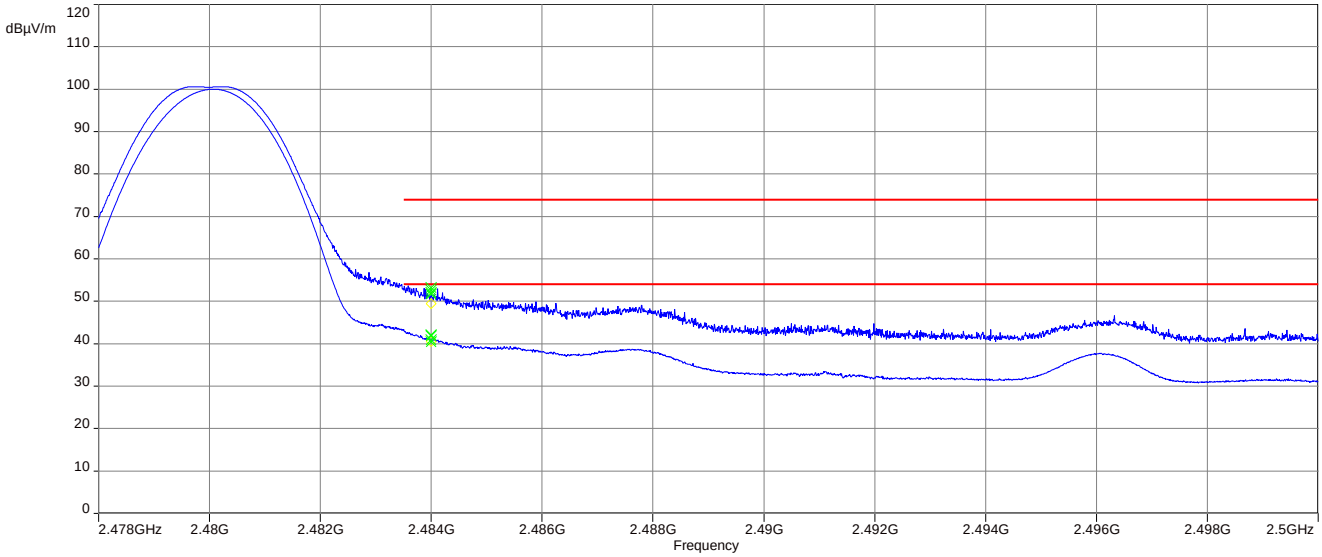
Scenario	Band edge compliance radiated [dBµV/m]
Lower restricted band	44.4 dBµV/m Peak 31.9 dBµV/m AVG
Upper restricted band	53.3 dBµV/m Peak 42.1 dBµV/m AVG

Plots:

Plot 1: Lower restricted band



Plot 2: Upper restricted band



12.7 Band edge compliance conducted

Description:

Measurement of the radiated band edge compliance with a conducted test setup.

Measurement parameters	
External result file	1-0437_20-01-04_log1_conducted.pdf, 1-0437_20-01-04_log2_conducted.pdf, 1-0437_20-01-04_log3_conducted.pdf, FCC Part 15.247 Restricted Band Edge Conducted Peak DTS
Test setup	See sub clause 7.5 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
-41.26 dBm	

Results: Antenna 0

	band edge compliance / dBm (included antenna gain)
Max. lower band edge power	-52.0
Max. upper band edge power	-50.1

Results: Antenna 1 (Onboard)

	band edge compliance / dBm (included antenna gain)
Max. lower band edge power	-51.2
Max. upper band edge power	-49.8

Results: Antenna 2 (Dipole)

	band edge compliance / dBm (included antenna gain)
Max. lower band edge power	-49.3
Max. upper band edge power	-51.4

12.8 TX spurious emissions conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2401 MHz, 2440 MHz and 2480 MHz.

Measurement parameters	
External result file	1-0437_20-01-04_log1_conducted.pdf, 1-0437_20-01-04_log2_conducted.pdf, 1-0437_20-01-04_log3_conducted.pdf, FCC Part 15.247 TX Spurious Conduced
Test setup	See sub clause 7.5 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
TX spurious emissions conducted	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required	

Results: Antenna 0

TX spurious emissions conducted					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2401		7.3	30 dBm	-/-	Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc	-/-	compliant
2440		5.6	30 dBm	-/-	Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc	-/-	compliant
2480		4.1	30 dBm	-/-	Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc	-/-	compliant

Results: Antenna 1 (Onboard)

TX spurious emissions conducted					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2401		2.7	30 dBm	-/-	Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc	-/-	compliant
2440		0.9	30 dBm	-/-	Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc	-/-	compliant
2480		1.0	30 dBm	-/-	Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc	-/-	compliant

Results: Antenna 1 (Dipole)

TX spurious emissions conducted					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2401		4.8	30 dBm	-/-	Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc	-/-	compliant
2440		3.7	30 dBm	-/-	Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc	-/-	compliant
2480		2.2	30 dBm	-/-	Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc	-/-	compliant

12.9 TX spurious emissions radiated below 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequencies are 2401 MHz, 2440 MHz and 2480 MHz. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

Measurement parameters	
Detector	Peak / Quasi peak
Sweep time	Auto
Resolution bandwidth	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth	F < 150 kHz: 1 kHz F > 150 kHz: 30 kHz
Span	9 kHz to 30 MHz
Trace mode	Max hold
Test setup	See sub clause 7.2 A
Measurement uncertainty	See sub clause 9

Limits:

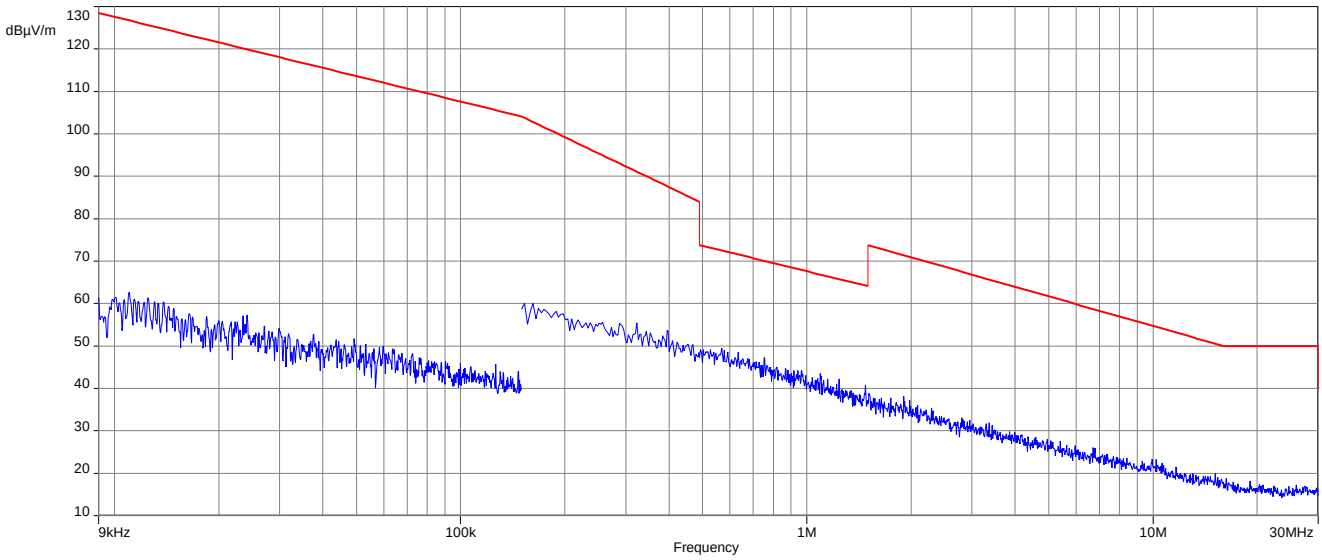
FCC / IC		
Frequency (MHz)	Field strength [dBµV/m]	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Results: Antenna 1 (Onboard)

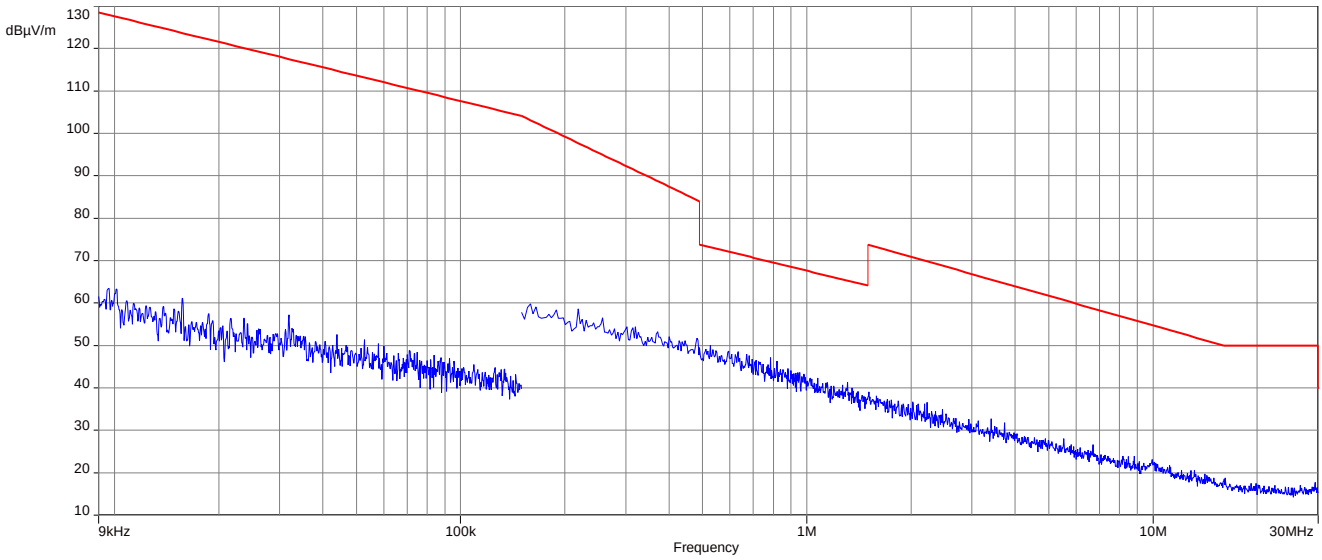
TX spurious emissions radiated below 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
All detected emissions are more than 20 dB below the limit.		

Plots: Antenna 1 (Onboard)

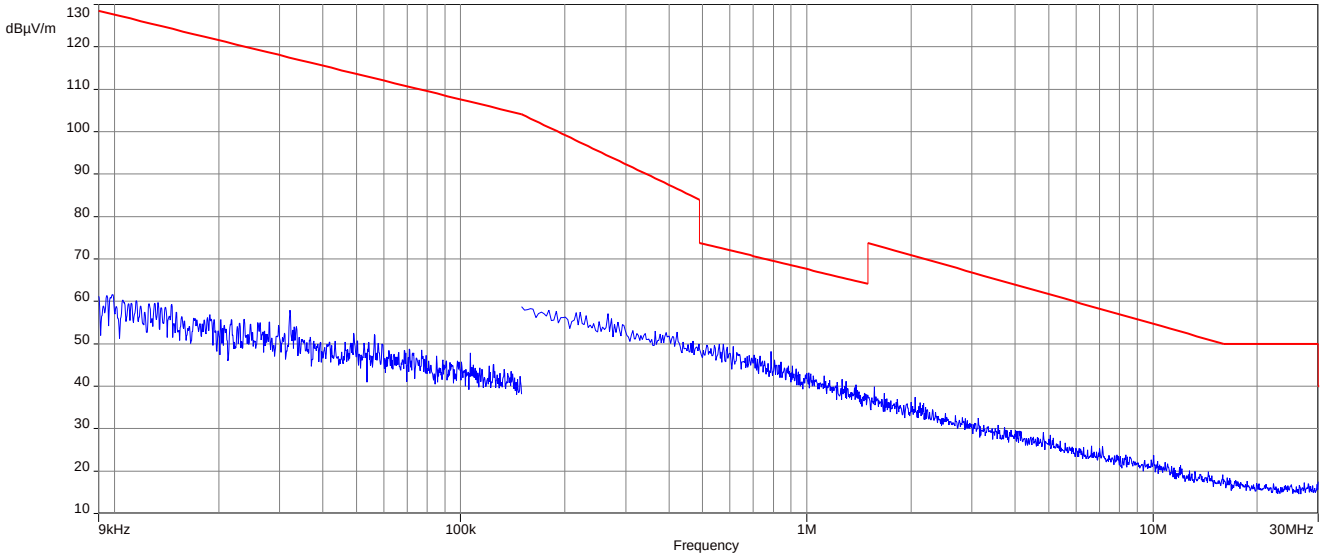
Plot 1: 9 kHz to 30 MHz, 2401 MHz, transmit mode



Plot 2: 9 kHz to 30 MHz, 2440 MHz, transmit mode



Plot 3: 9 kHz to 30 MHz, 2480 MHz, transmit mode

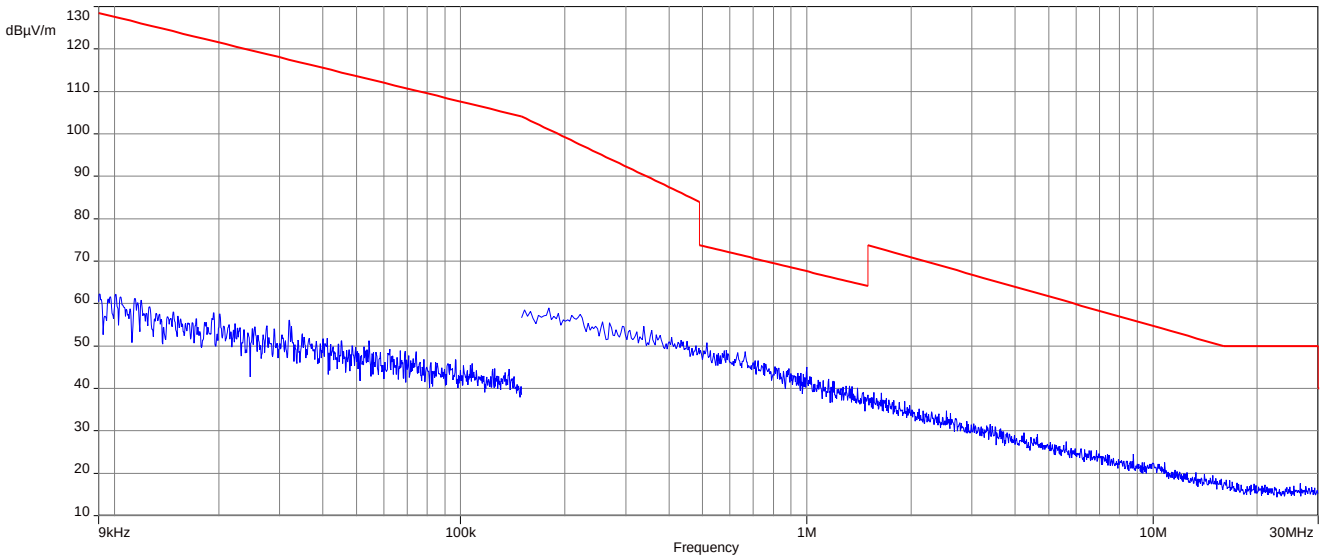


Results: Antenna 2 (Dipole)

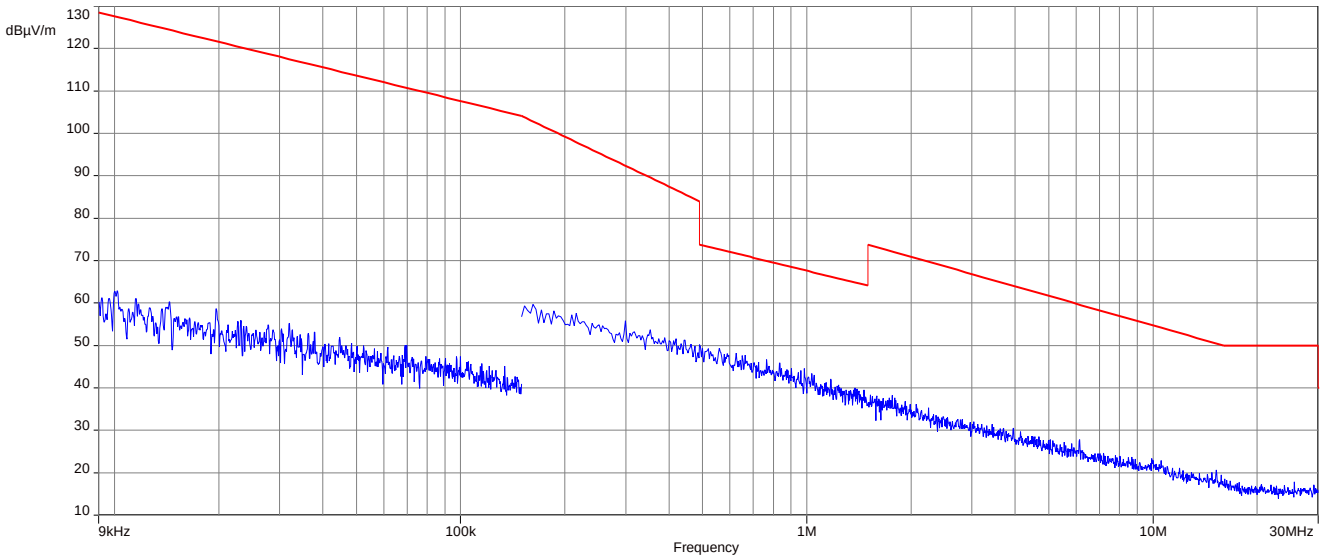
TX spurious emissions radiated below 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
All detected emissions are more than 20 dB below the limit.		

Plots: Antenna 2 (Dipole)

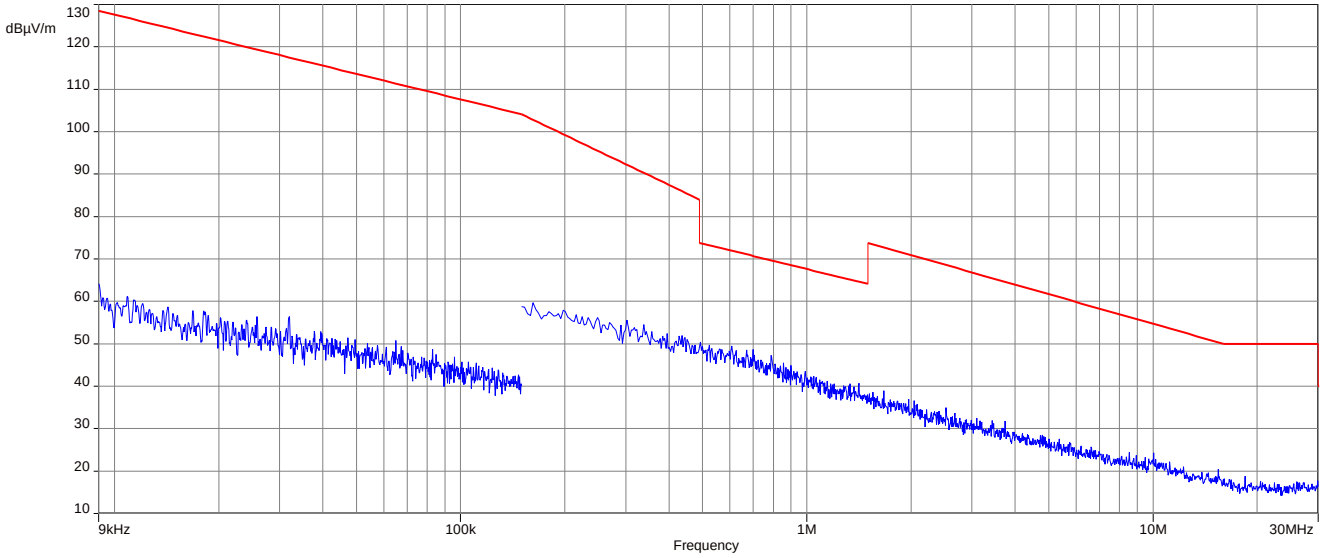
Plot 1: 9 kHz to 30 MHz, 2401 MHz, transmit mode



Plot 2: 9 kHz to 30 MHz, 2440 MHz, transmit mode



Plot 3: 9 kHz to 30 MHz, 2480 MHz, transmit mode



12.10 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2401 MHz, 2440 MHz and 2480 MHz.

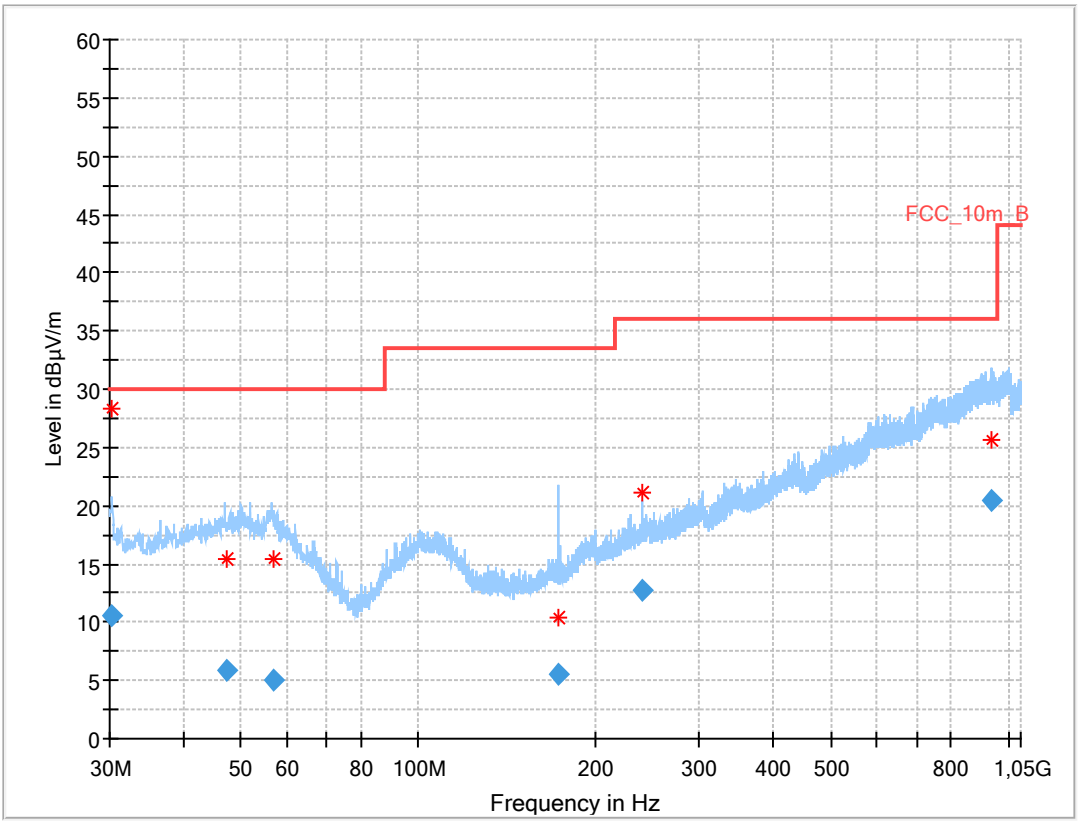
Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	120 kHz
Video bandwidth	3 x RBW
Span	30 MHz to 1 GHz
Trace mode	Max hold
Test setup	See sub clause 7.1 A
Measurement uncertainty	See sub clause 9

Limits:

FCC		IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
§15.209		
Frequency [MHz]	Field strength [dBµV/m]	Measurement distance
30 - 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10
Above 960	54.0	3

Plots: Antenna 1 - Onboard

Plot 1: 30 MHz to 1 GHz, TX mode, 2401 MHz, vertical & horizontal polarization

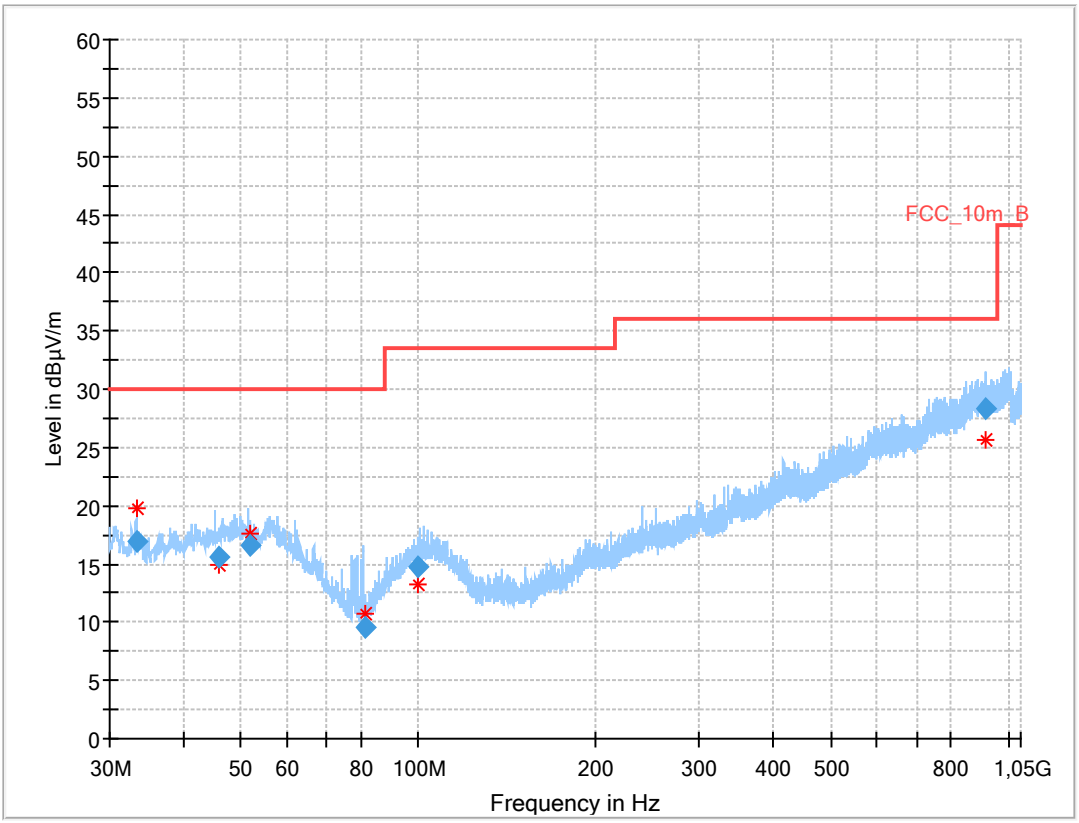


NOTE: Red stars are frequency points, Blue squares are measured QuasiPeak values

Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.200	10.57	30.0	19.4	1000	120.0	104.0	V	-20	12
47.217	5.88	30.0	24.1	1000	120.0	143.0	V	-45	14
56.812	5.05	30.0	25.0	1000	120.0	200.0	H	45	15
173.187	5.61	33.5	27.9	1000	120.0	200.0	V	270	10
240.005	12.82	36.0	23.2	1000	120.0	150.0	V	165	13
935.433	20.37	36.0	15.6	1000	120.0	194.0	H	225	24

Plot 2: 30 MHz to 1 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

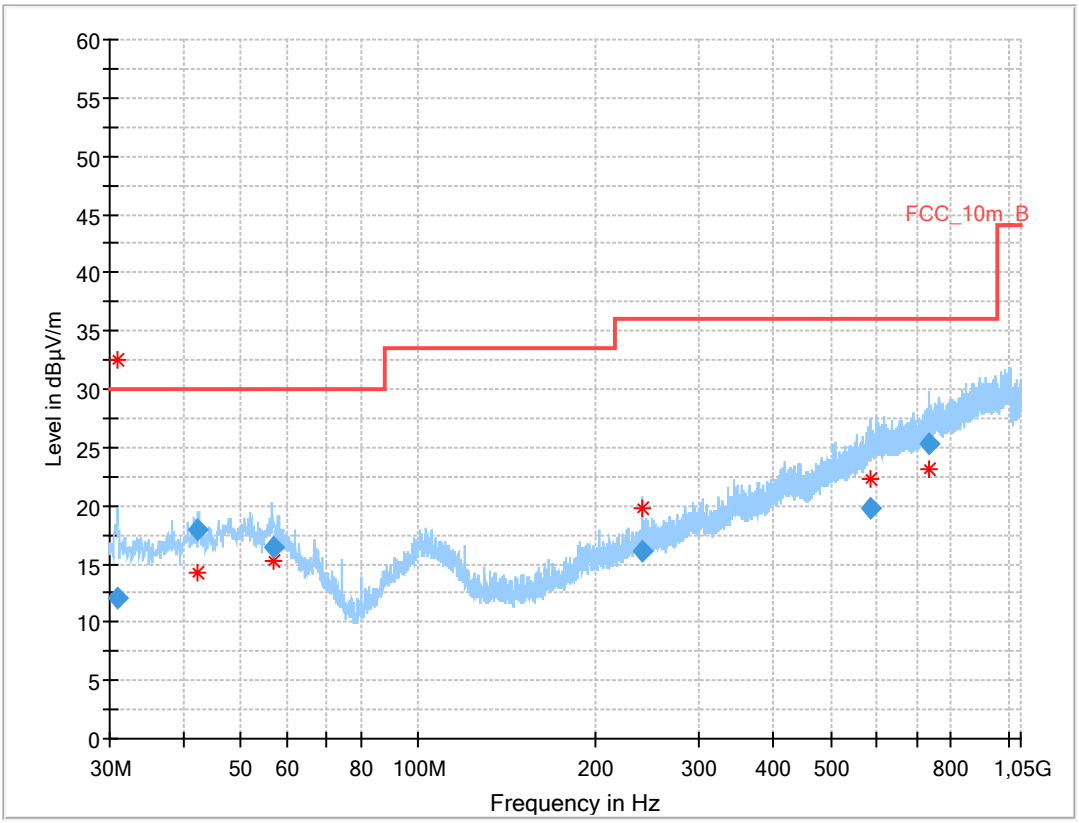


NOTE: Red stars are frequency points, Blue squares are measured QuasiPeak values

Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
33.448	17.00	30.0	13.0	1000	120.0	110.0	V	112	12
45.882	15.54	30.0	14.5	1000	120.0	164.0	V	247	14
52.016	16.58	30.0	13.4	1000	120.0	101.0	V	112	14
81.028	9.56	30.0	20.4	1000	120.0	170.0	H	157	7
100.192	14.81	33.5	18.7	1000	120.0	170.0	V	112	13
916.897	28.39	36.0	7.6	1000	120.0	114.0	V	157	24

Plot 3: 30 MHz to 1 GHz, TX mode, 2480 MHz, vertical & horizontal polarization



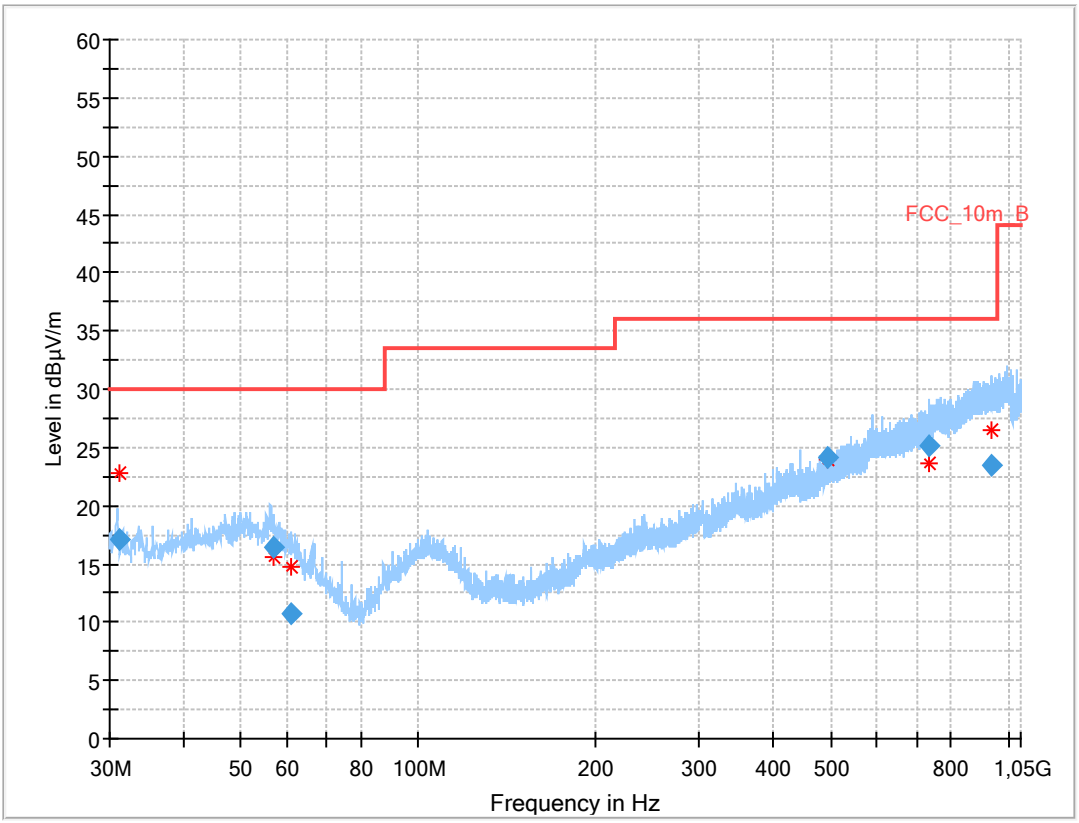
NOTE: Red stars are frequency points, Blue squares are measured QuasiPeak values

Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.922	12.10	30.0	17.9	1000	120.0	164.0	V	292	12
42.248	17.93	30.0	12.1	1000	120.0	146.0	H	-19	14
56.940	16.35	30.0	13.7	1000	120.0	170.0	V	170	15
240.010	16.17	36.0	19.8	1000	120.0	102.0	V	202	13
584.717	19.79	36.0	16.2	1000	120.0	170.0	V	157	20
735.100	25.26	36.0	10.7	1000	120.0	104.0	V	247	22

Plots: Antenna 2 - Dipole

Plot 1: 30 MHz to 1 GHz, TX mode, 2401 MHz, vertical & horizontal polarization

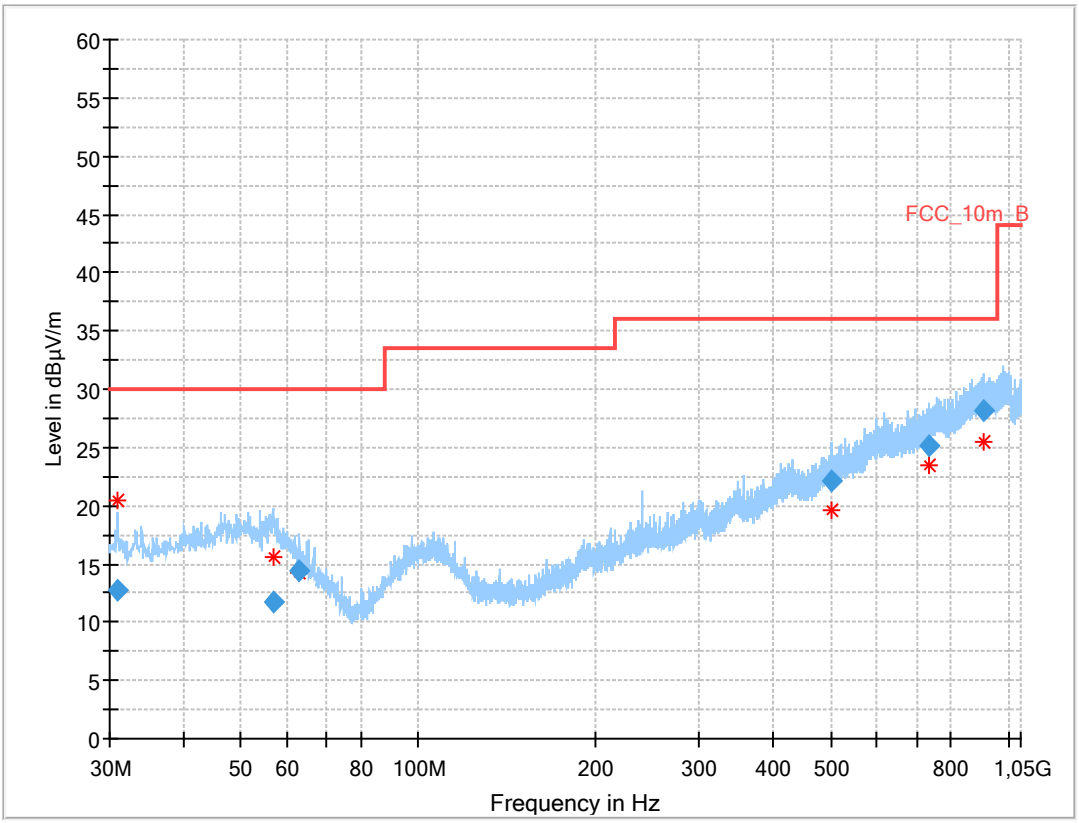


NOTE: Red stars are frequency points, Blue squares are measured QuasiPeak values

Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.050	17.17	30.0	12.8	1000	120.0	102.0	V	268	12
56.763	16.43	30.0	13.6	1000	120.0	170.0	H	69	15
60.996	10.81	30.0	19.2	1000	120.0	102.0	V	157	13
495.990	24.16	36.0	11.8	1000	120.0	98.0	V	-19	18
733.217	25.21	36.0	10.8	1000	120.0	170.0	V	247	22
935.011	23.49	36.0	12.5	1000	120.0	151.0	V	157	24

Plot 2: 30 MHz to 1 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

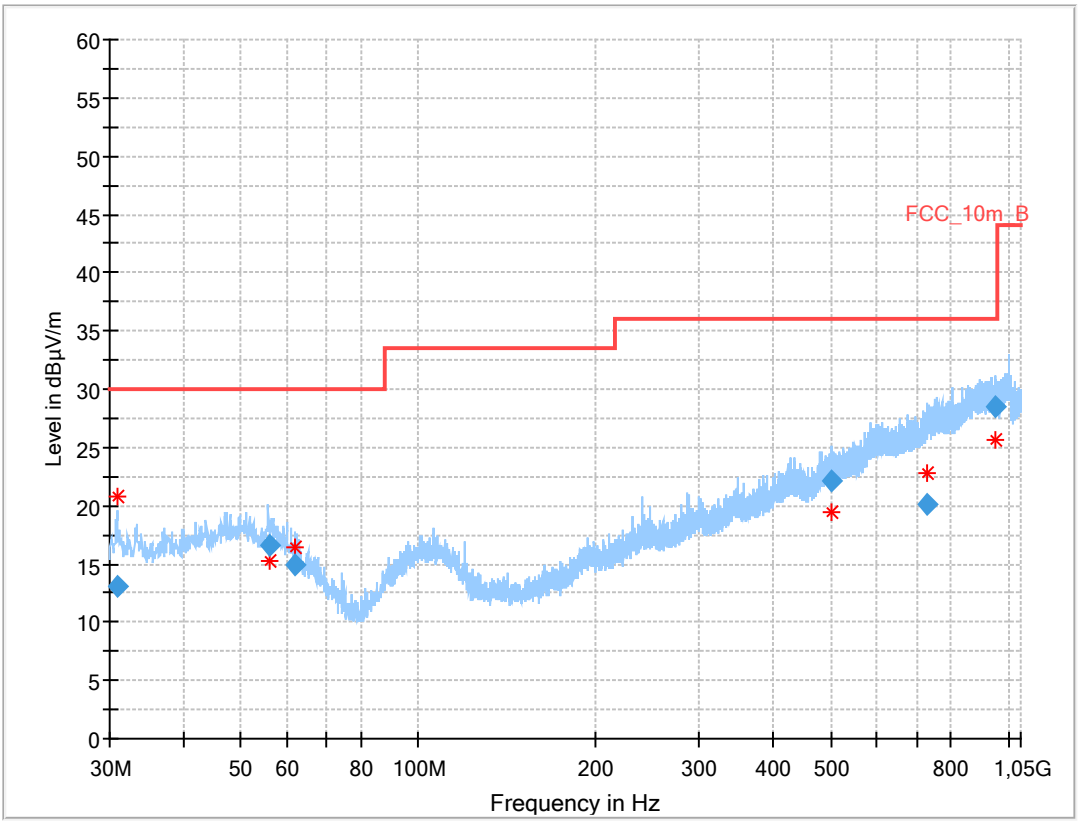


NOTE: Red stars are frequency points, Blue squares are measured QuasiPeak values

Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.974	12.69	30.0	17.3	1000	120.0	130.0	V	67	12
56.846	11.68	30.0	18.3	1000	120.0	170.0	V	292	15
62.998	14.39	30.0	15.6	1000	120.0	106.0	V	8	12
502.822	22.12	36.0	13.9	1000	120.0	170.0	V	157	18
734.047	25.19	36.0	10.8	1000	120.0	170.0	H	67	22
907.182	28.19	36.0	7.8	1000	120.0	126.0	V	67	24

Plot 3: 30 MHz to 1 GHz, TX mode, 2480 MHz, vertical & horizontal polarization



NOTE: Red stars are frequency points, Blue squares are measured QuasiPeak values

Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.967	13.06	30.0	16.9	1000	120.0	101.0	V	247	12
56.214	16.59	30.0	13.4	1000	120.0	158.0	H	159	15
61.978	14.98	30.0	15.0	1000	120.0	106.0	V	-22	12
503.404	22.07	36.0	13.9	1000	120.0	170.0	V	67	18
730.884	20.05	36.0	16.0	1000	120.0	170.0	H	-6	21
953.937	28.44	36.0	7.6	1000	120.0	170.0	V	-22	24

12.11 Spurious emissions radiated above 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2401 MHz, 2440 MHz and 2480 MHz.

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 x RBW
Span	1 GHz to 26 GHz
Trace mode	Max hold
Test setup	See sub clause 7.2 B (1 GHz - 18 GHz) See sub clause 7.3 A (18 GHz - 26 GHz)
Measurement uncertainty	See sub clause 9

Limits:

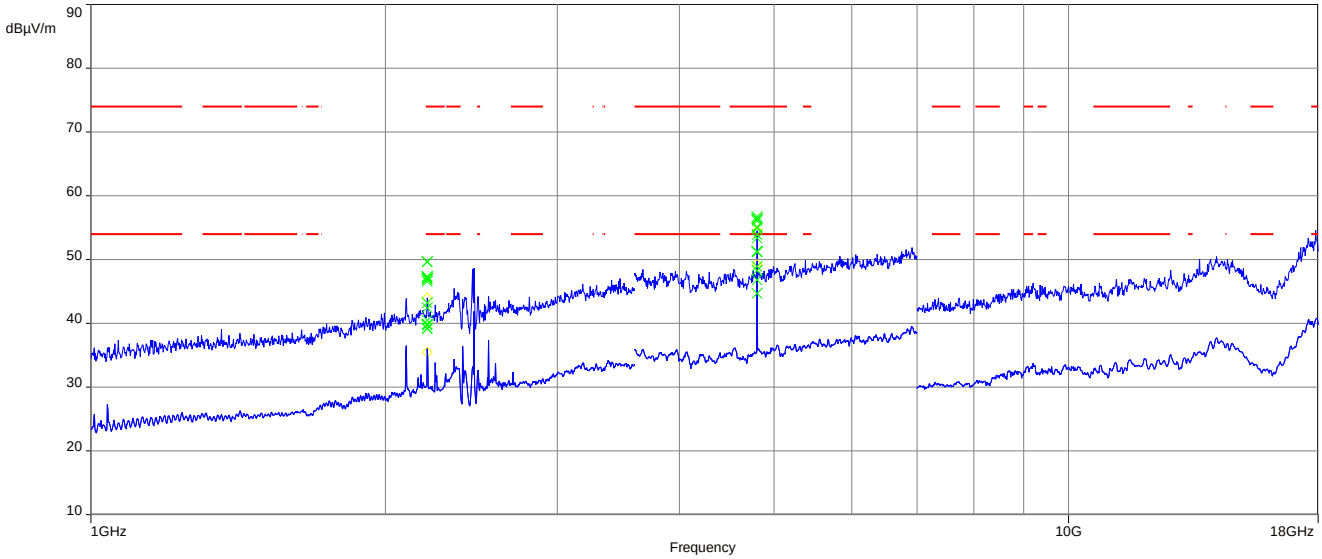
FCC		IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
§15.209		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
Above 960	54.0 (Average)	3
Above 960	74.0 (Peak)	3

Results: Transmitter mode – Antenna 1 (Onboard)

TX spurious emissions radiated [dBµV/m]								
2401 MHz			2440 MHz			2480 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
2209	Peak	49.7	4880	Peak	53.3	4960	Peak	48.9
	AVG	43.2		AVG	46.8		AVG	37.3
4801	Peak	56.7	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	51.3		AVG	-/-		AVG	-/-
-/-	Peak	-/-		Peak			Peak	
	AVG	-/-		AVG			AVG	

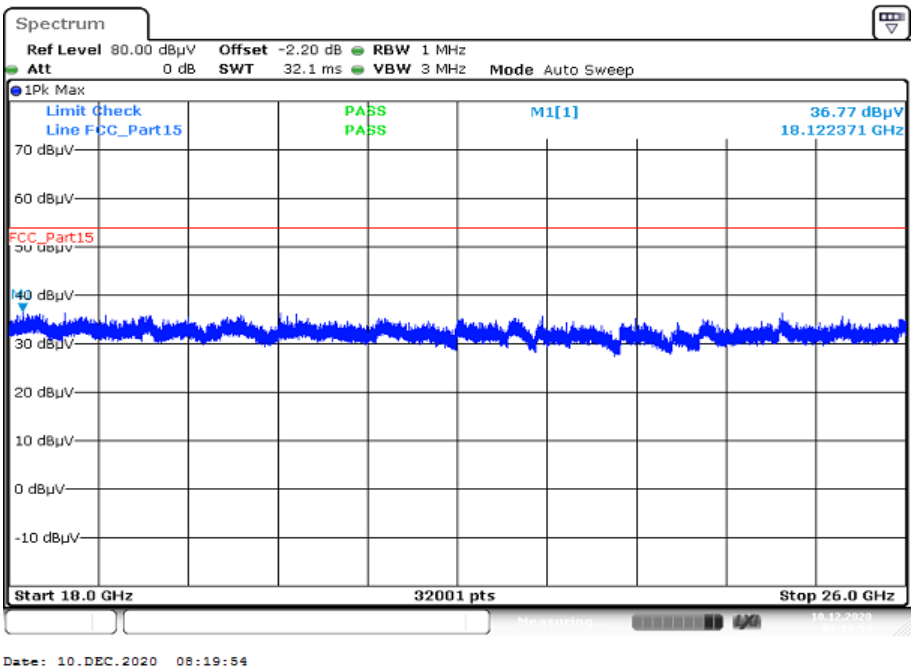
Plots: Transmitter mode – Antenna 1 (Onboard)

Plot 1: 1 GHz to 18 GHz, TX mode, 2401 MHz, vertical & horizontal polarization

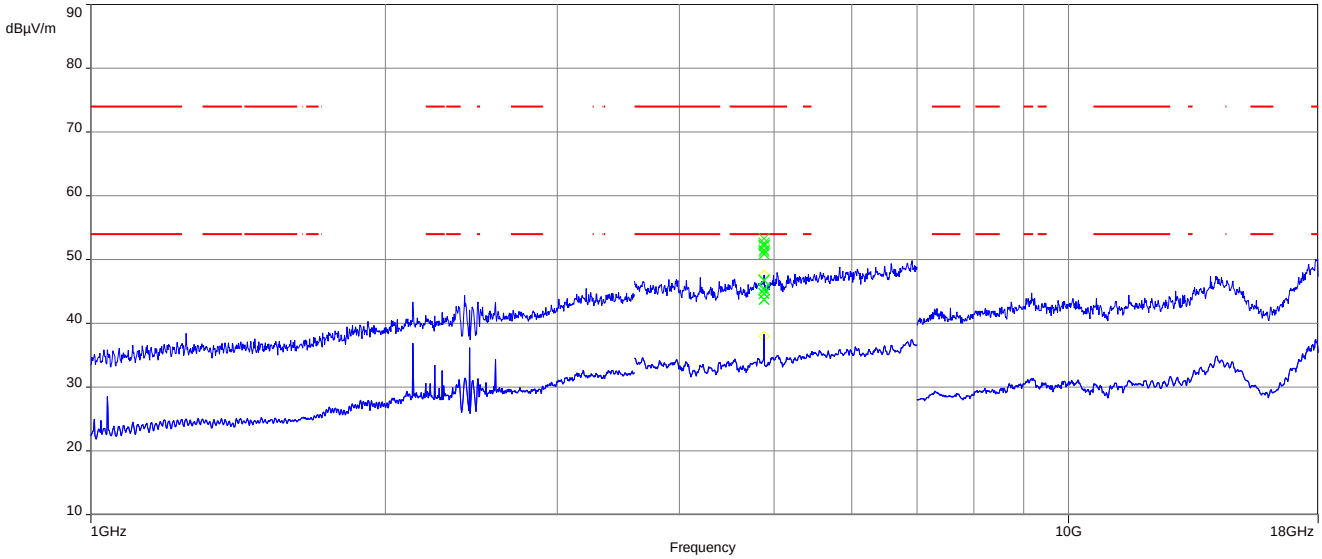


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 2: 18 GHz to 26 GHz, TX mode, 2401 MHz, vertical & horizontal polarization

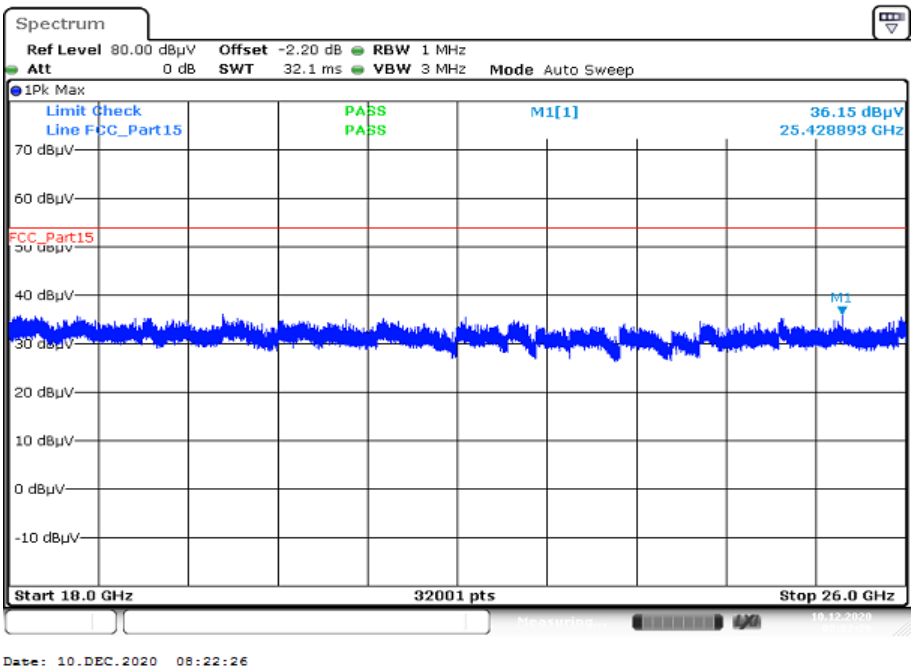


Plot 3: 1 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

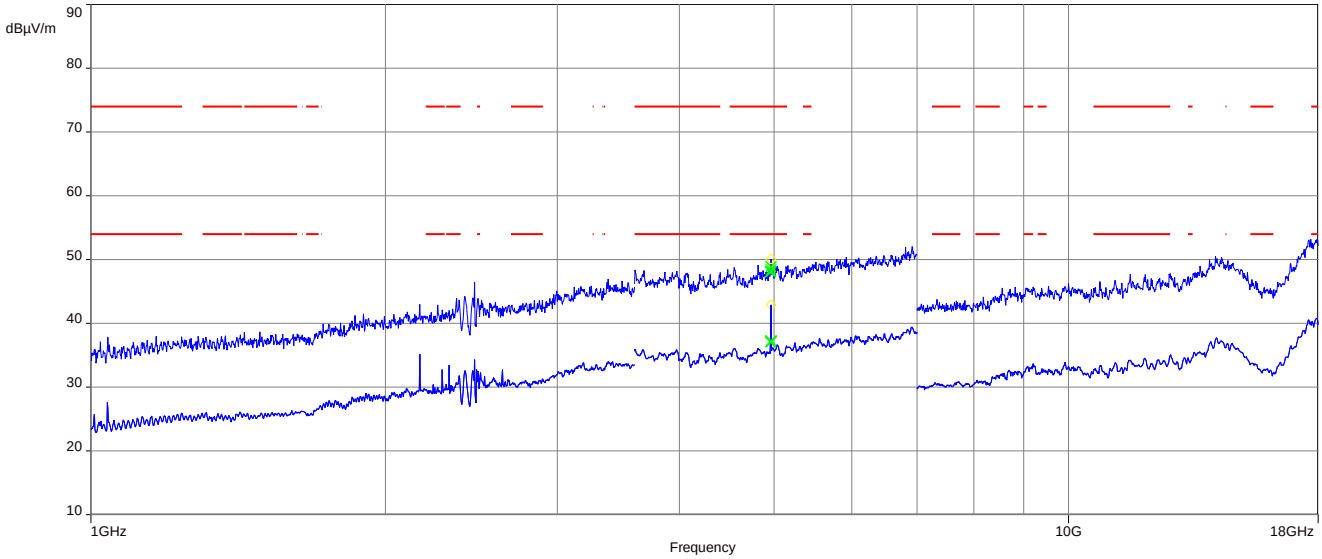


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 4: 18 GHz to 26 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

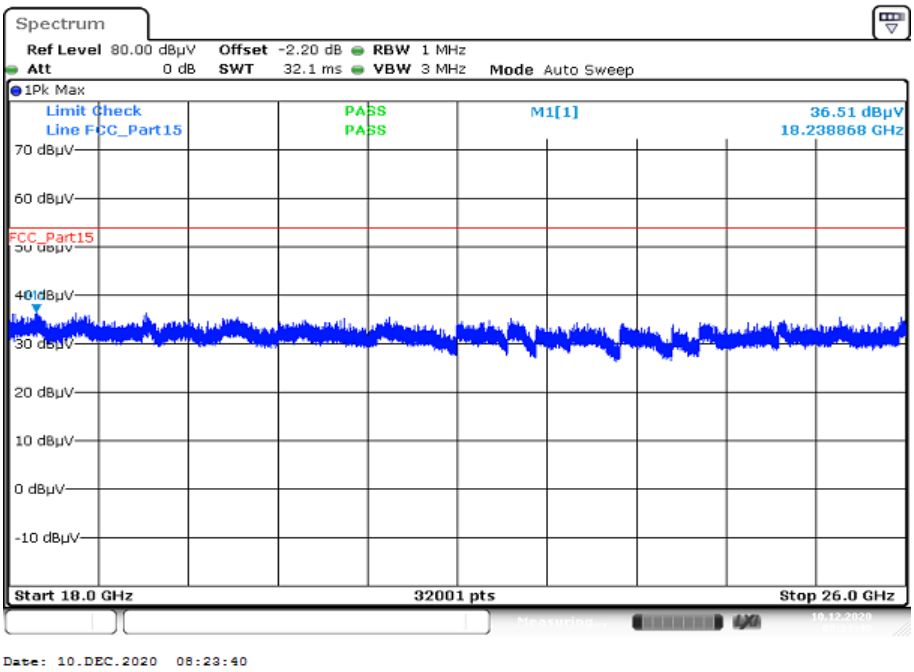


Plot 5: 1 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization



The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 6: 18 GHz to 26 GHz, TX mode, 2480 MHz, vertical & horizontal polarization

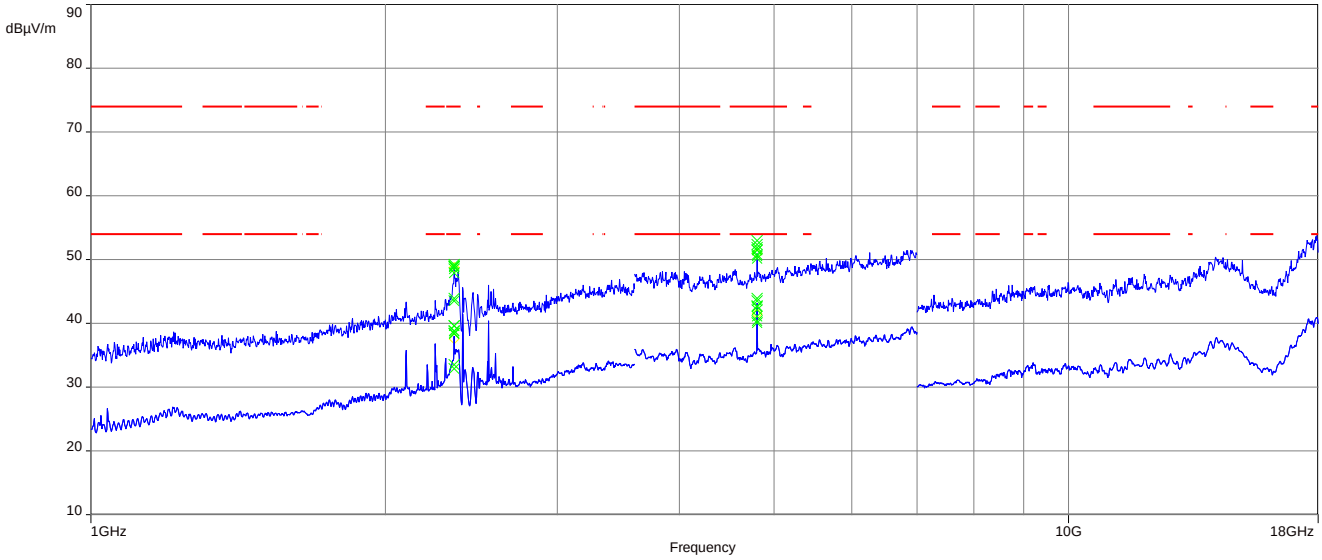


Results: Transmitter mode – Antenna 2 (Dipole)

TX spurious emissions radiated [dBµV/m]								
2401 MHz			2440 MHz			2480 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
2353	Peak	49.2	1220	Peak	46.3	4960	Peak	51.9
	AVG	39.6		AVG	33.0		AVG	43.4
4801	Peak	53.0	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	43.9		AVG	-/-		AVG	-/-
-/-			-/-			-/-		

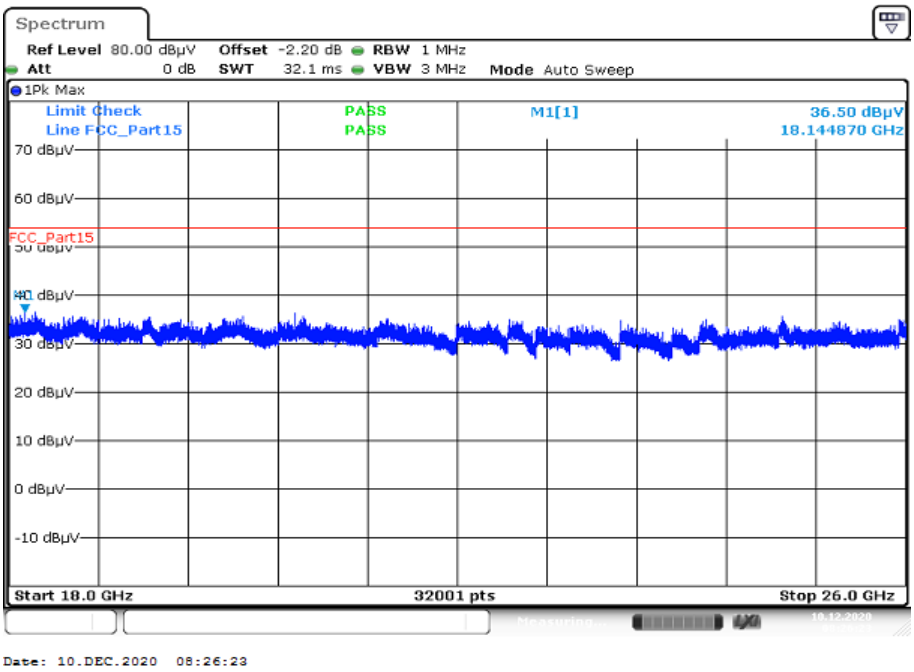
Plots: Transmitter mode – Antenna 2

Plot 1: 1 GHz to 18 GHz, TX mode, 2401 MHz, vertical & horizontal polarization

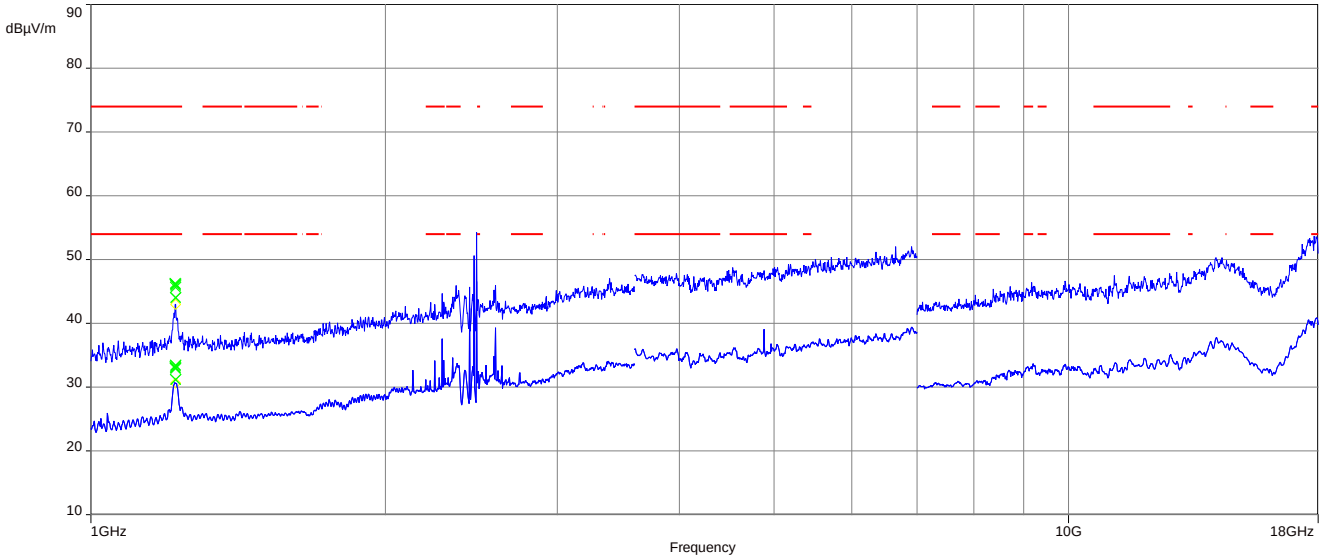


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 2: 18 GHz to 26 GHz, TX mode, 2401 MHz, vertical & horizontal polarization

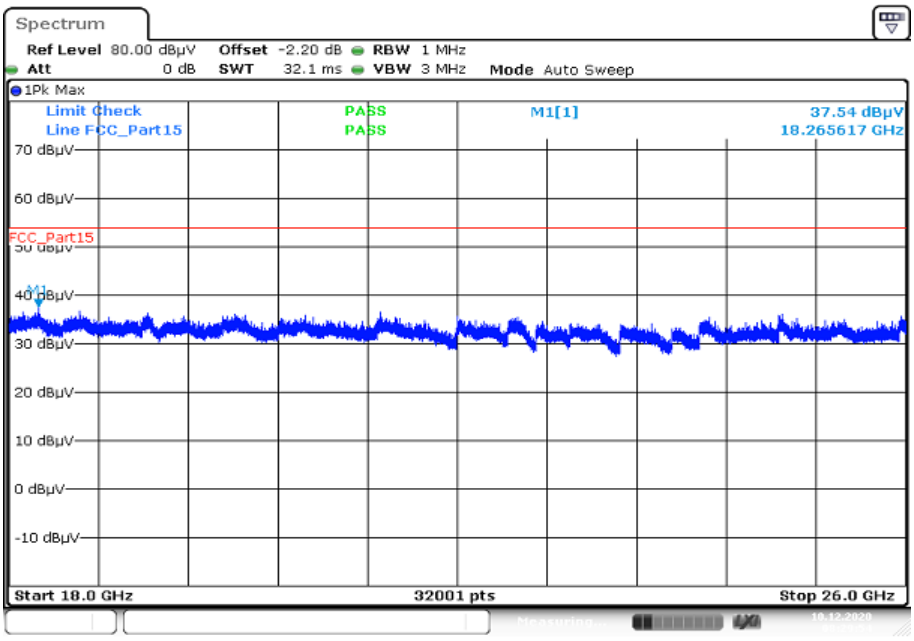


Plot 3: 1 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

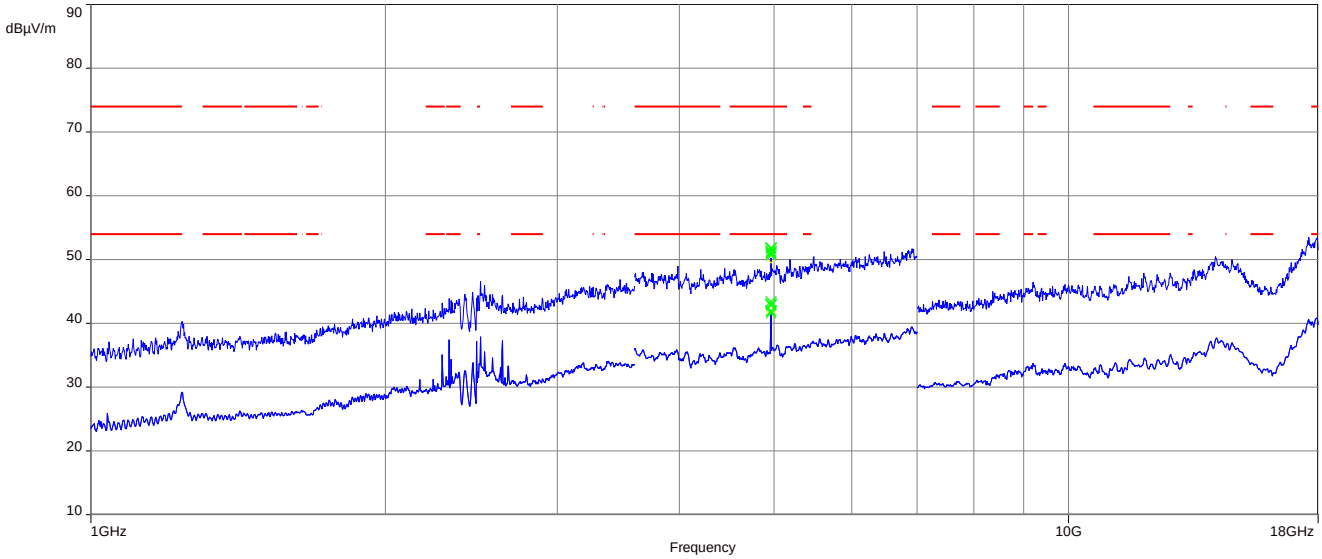


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 4: 18 GHz to 26 GHz, TX mode, 2440 MHz, vertical & horizontal polarization

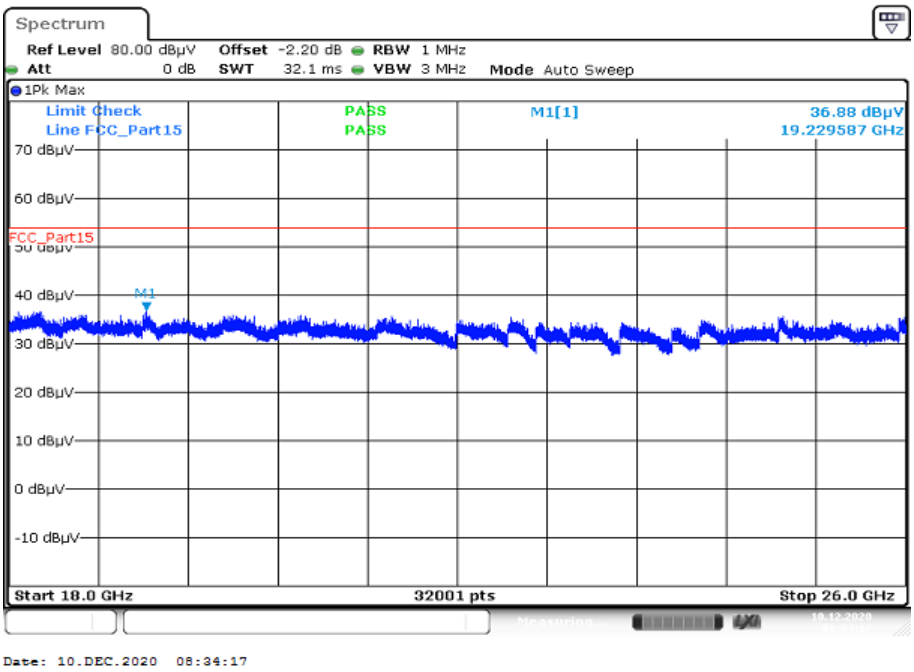


Plot 5: 1 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization



The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 6: 18 GHz to 26 GHz, TX mode, 2480 MHz, vertical & horizontal polarization



12.12 Spurious emissions conducted below 30 MHz (AC conducted)

Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequency is 2440 MHz. This measurement is representative for all channels and modes. If critical peaks are found frequency 2401 MHz and 2480 MHz will be measured too. The measurement is performed in the mode with the highest output power. Both power lines, phase and neutral line, are measured. Found peaks are remeasured with average and quasi peak detection to show compliance to the limits.

Measurement parameters	
Detector	Peak - Quasi peak / average
Sweep time	Auto
Resolution bandwidth	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace mode:	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

FCC		IC
Frequency [MHz]	Quasi-peak [dBµV/m]	Average [dBµV/m]
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

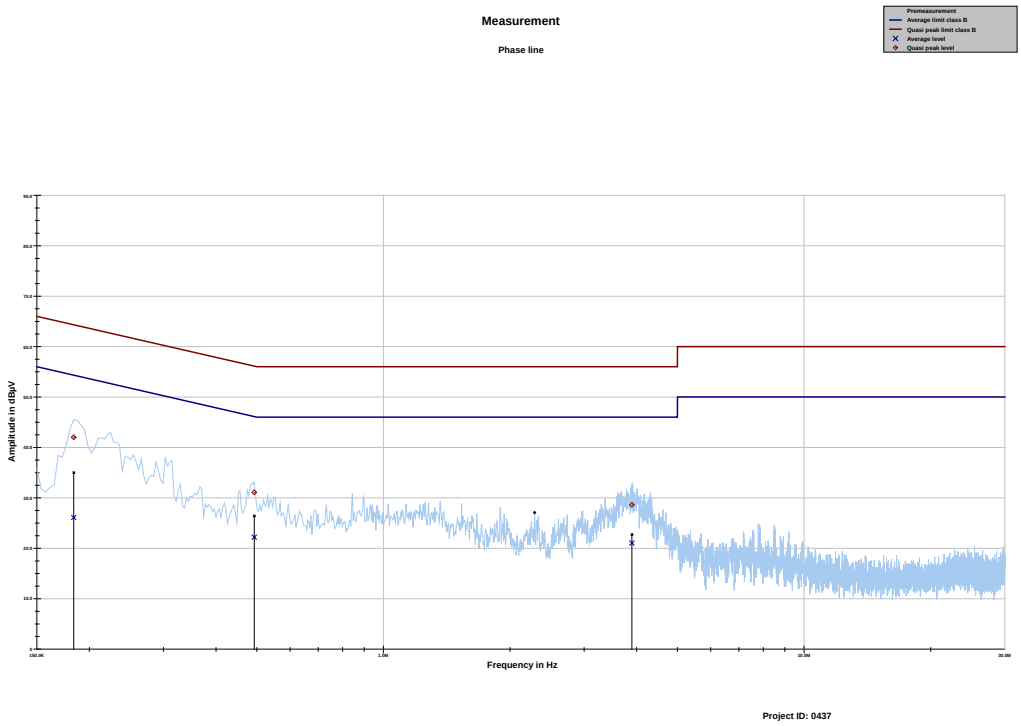
*Decreases with the logarithm of the frequency

Results:

Spurious emissions conducted < 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
No emissions detected		

Plots:

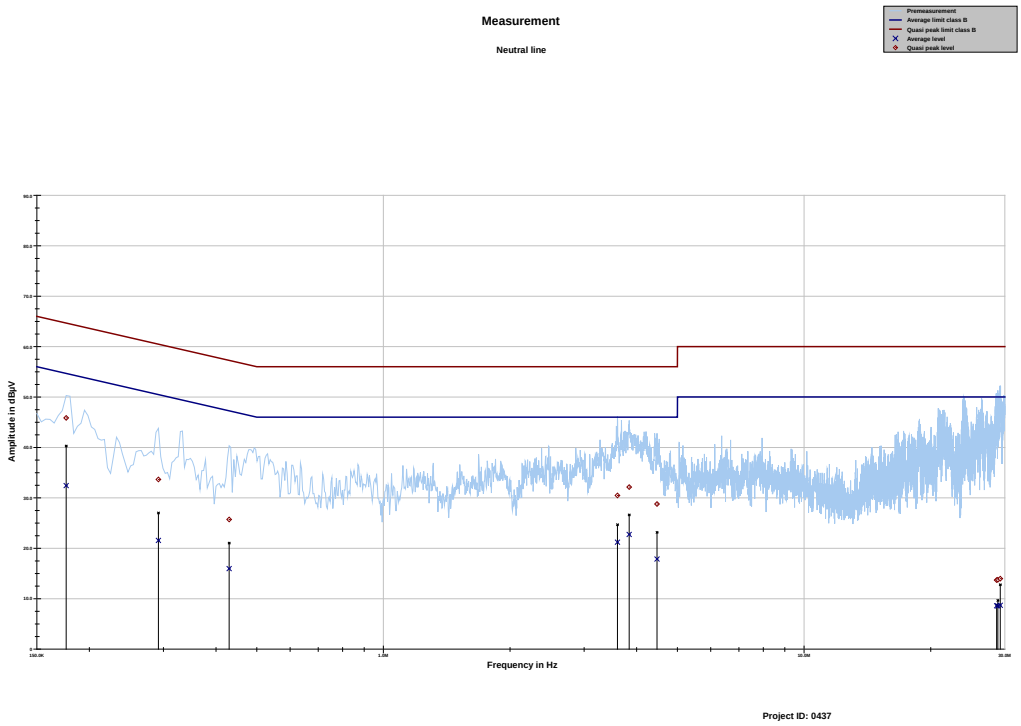
Plot 1: 150 kHz to 30 MHz, phase line



Final results:

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.183581	42.02	22.31	64.322	26.10	28.94	55.041
0.493275	31.09	25.02	56.112	22.18	24.01	46.192
3.896175	28.63	27.37	56.000	21.03	24.97	46.000

Plot 2: 150 kHz to 30 MHz, neutral line



Final results:

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.176119	45.84	18.82	64.667	32.43	22.82	55.254
0.291787	33.65	26.82	60.473	21.56	30.39	51.949
0.429844	25.71	31.55	57.256	15.97	32.04	48.004
3.601406	30.47	25.53	56.000	21.20	24.80	46.000
3.840206	32.14	23.86	56.000	22.74	23.26	46.000
4.470788	28.77	27.23	56.000	17.87	28.13	46.000
28.694063	13.70	46.30	60.000	8.59	41.41	50.000
28.888088	13.75	46.25	60.000	8.56	41.44	50.000
29.272406	13.97	46.03	60.000	8.68	41.32	50.000

13 Observations

No observations except those reported with the single test cases have been made.

14 Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
IC	Industry Canada
PMN	Product marketing name
HMN	Host marketing name
HVIN	Hardware version identification number
FVIN	Firmware version identification number
EMC	Electromagnetic Compatibility
HW	Hardware
SW	Software
Inv. No.	Inventory number
S/N or SN	Serial number
C	Compliant
NC	Not compliant
NA	Not applicable
NP	Not performed
PP	Positive peak
QP	Quasi peak
AVG	Average
OC	Operating channel
OCW	Operating channel bandwidth
OBW	Occupied bandwidth
OOB	Out of band
DFS	Dynamic frequency selection
CAC	Channel availability check
OP	Occupancy period
NOP	Non occupancy period
DC	Duty cycle
PER	Packet error rate
CW	Clean wave
MC	Modulated carrier
WLAN	Wireless local area network
RLAN	Radio local area network
DSSS	Dynamic sequence spread spectrum
OFDM	Orthogonal frequency division multiplexing
FHSS	Frequency hopping spread spectrum

15 Document history

Version	Applied changes	Date of release
-/-	Initial release	2021-04-28

16 Accreditation Certificate – D-PL-12076-01-04

first page	last page
DAkkS Deutsche Akkreditierungsstelle Deutsche Akkreditierungsstelle GmbH **Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV** Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition **Accreditation** The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory **CTC advanced GmbH** **Untertürkheimer Straße 6-10, 66117 Saarbrücken** is competent under the terms of DIN EN ISO/IEC 17025:2018 to carry out tests in the following fields: **Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards** The accreditation certificate shall only apply in connection with the notice of accreditation of 09.06.2020 with the accreditation number D-PL-12076-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 07 pages. Registration number of the certificate: **D-PL-12076-01-04** Frankfurt am Main, 09.06.2020 by order Dipl.-Ing. (FH) Rolf Egner Head of Division *The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH.* *https://www.dakks.de/en/content/accredited-bodies-dakks* See notes overleaf.	Deutsche Akkreditierungsstelle GmbH Office Berlin Spittelmarkt 10 10117 Berlin Office Frankfurt am Main Europa-Allee 52 60327 Frankfurt am Main Office Braunschweig Bundesallee 100 38116 Braunschweig The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkkS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf. No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkkS. The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkkS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations. The up-to-date state of membership can be retrieved from the following websites: EA: www.european-accreditation.org ILAC: www.ilac.org IAF: www.iaf.nu

Note: The current certificate annex is published on the website (link see below) of the Accreditation Body DAkkS or may be received by CTC advanced GmbH on request

https://www.dakks.de/as/ast/d/D-PL-12076-01-04e.pdf

17 Accreditation Certificate – D-PL-12076-01-05

first page	last page
DAkkS Deutsche Akkreditierungsstelle Deutsche Akkreditierungsstelle GmbH **Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV** Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition **Accreditation** The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory **CTC advanced GmbH** **Untertürkheimer Straße 6-10, 66117 Saarbrücken** is competent under the terms of DIN EN ISO/IEC 17025:2018 to carry out tests in the following fields: **Telecommunication (FCC Requirements)** The accreditation certificate shall only apply in connection with the notice of accreditation of 09.06.2020 with the accreditation number D-PL-12076-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 05 pages. Registration number of the certificate: **D-PL-12076-01-05** Frankfurt am Main, 09.06.2020 by order Dipl.-Ing. (FH) Ralf Egner Head of Division *The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH.* *https://www.dakks.de/en/content/accredited-bodies-dakks* See notes overleaf.	Deutsche Akkreditierungsstelle GmbH Office Berlin Spittelmarkt 10 10117 Berlin Office Frankfurt am Main Europa-Allee 52 60327 Frankfurt am Main Office Braunschweig Bundesallee 100 38116 Braunschweig The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkkS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf. No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkkS. The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkkS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations. The up-to-date state of membership can be retrieved from the following websites: EA: www.european-accreditation.org ILAC: www.ilac.org IAF: www.iaf.nu

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https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf

################################ END OF TEST REPORT ################################