R F – T E S T R E P O R T

- FCC Part 15.247, RSS-247 -

Type / Model Name	:	TIRU3
Product Description	:	Interrogation Unit
		PMN: TIRU3, HVIN: TIRU3
Applicant	:	Tempris GmbH
Address	:	Industriestr. 7
		83607 HOLZKIRCHEN, GERMANY
Manufacturer	:	Tempris GmbH
Address	:	Industriestr. 7
		83607 HOLZKIRCHEN, GERMANY

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Test Report No. : 80095922-00 Rev_1	20. August 2021 Date of issue

Deutsche Akkreditierungsstelle
D-PL-12030-01-03
D-PL-12030-01-04

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FCC ID: RXBTIRU3 IC: 25462 - TIRU3

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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2020)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September 2020)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.247	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
ETSI TR 100 028 V1.3.1: 2001-03	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2
KDB 558074 D01 v05	Guidance for compliance measurements on DTS; FHSS and hybrid system devices operating under Section 15.247 of the FCC rules, April 2, 2019.

ISED Canada Rules and Regulations (May 2021)

RSS-Gen, Issue 5 + Amendment 1 + 2	General Requirements for Compliance of Radio Apparatus
RSS-247, Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
ETSI TR 100 028 V1.3.1: 2001-03,	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2

2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

2.3 Photo documentation of the EUT – Detailed photos see ATTACHMENT A

2.4 General remarks

This test report replaces the test reports T45651-03-00SK and 80095922-00 Rev_0 issued by CSA Group Bayern GmbH.

2.5 Equipment type

Unlicensed wireless device

2.6 Short description of the equipment under test (EUT)

The EUT is a wireless temperature monitor using DTS with a combination of AM (modulation depth: 100%, modulation frequency: 10000 - 13900 kHz) and PM (digitally PRN spreaded and filtered nPSK bit stream) in the frequency range 2438.25 MHz to 2445.75 MHz together with a temperature sensor.
The sensor uses the operating frequency as power supply. The crystal oscillator in the sensor is stimulated by an AM frequency on the RF carrier. This oscillator is tuned by the temperature and the resulting frequency modulates the reflecting carrier with the temperature information. The EUT reads the frequency deviation and displays the resulting temperature.
The firmware allows the user to switch the transmission on or off. The transmit stimulus power is set to P23 by firmware.

Items	Description
Modulation	Vector modulation (AM + PM)
Frequency range	2400 MHz to 2483.5 MHz
Channel numbers	1

Number of tested samples: 1
Serial number: 336
Firmware version: TLM 10.1.060

2.7 Variants of the EUT

There are no variants.

2.8 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel	Frequency (MHz)
1	2442

2.9 Transmit operating modes

The transmission can be switched on or off. There are no further operating modes.

2.10 Antenna

The following antennas shall be used with the EUT:

Number	Characteristic	Model number	Plug	Frequency range (GHz)	Gain (dBi)	Cable loss (dB)	Effective gain (dBi)	Input impedance (Ω)
1	directional	ANT-PH1	R-SMA	2.4 - 2.4835	8.5	1.0	7.5	50

2.11 Power supply system utilised

Power supply voltage, V_{nom} : 120 VAC, 60 Hz, 56 VDC (PoE)

2.12 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- Notebook Model : Terra mobile 1513A
- Antenna Model : ANT-PH1
- PoEPLUS supply Model : Phihong POE36U-1AT-R

Antenna cable (1.80 m) Model : EL-SPEC, LL1030AF-FRNC-B

Ethernet cable (0.40 m) Model : DIGITUS, SFTP CAT5e

Ethernet cable (1.80 m) Model : DIGITUS, SFTP CAT5e

2.13 Determination of worst-case conditions for final measurement

Measurements are made in all three orthogonal axes and the settings of the EUT are changed to locate at which position and at what setting of the EUT produce the maximum of the emissions. All antenna ports were evaluated and the worst case was used for testing. For the further measurement the EUT is set in X position, measurements were performed at antenna port A1.

The tests are carried out in the following frequency band:

2400 MHz – 2483.5 MHz

For the final test the following channels and test modes are selected:

Available channel	Tested channels	Power setting	Modulation
1	1	P23	AM + PM

- TX modulated

2.13.1 Test jig

No test jig is used.

2.13.2 Test software

The measurements are performed with the application software.

3 TEST RESULT SUMMARY

2.4 GHz device using digital modulation:

Operating in the 2400 MHz – 2483.5 MHz:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	passed
15.247(a)(2)	RSS-247, 5.2(a)	-6 dB EBW	passed
15.247(b)(3)	RSS-247, 5.4(d)	Maximum peak conducted output power	passed
15.247(b)(4)	RSS-247, 5.4(d)	Defacto limit	passed
15.247(d)	RSS-247, 5.5	Unwanted emission, radiated	passed
15.247(d)	RSS-Gen, 8.10	Emissions in restricted bands	passed
15.247(e)	RSS-247, 5.2(b)	PSD	passed
15.35(c)	RSS-Gen, 6.10	Pulsed operation	passed
15.203	-	Antenna requirement	passed
	RSS-Gen, 6.6	99 % Bandwidth	passed

The mentioned RSS Rule Parts in the above table are related to:
RSS-Gen, Issue 5 + Amendment 1 + Amendment 2, February 2021
RSS-247, Issue 2, February 2017

3.1 Final assessment

The equipment under test fulfills the requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 19 March 2021

Testing concluded on : 16 August 2021

Checked by:

Jürgen Pessinger
2021.08.20
15:11:53 +02'00'

Jürgen Pessinger
Radio Team

Tested by:

Sabine Kugler
2021.08.20 15:03:08
+02'00'

Sabine Kugler
Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15 - 35 °C
Humidity:	30 - 60 %
Atmospheric pressure:	86 - 106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

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Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
EBW and OBW	2400 MHz to 3000 MHz	95%	± 2.5 x 10^{-7}
Maximum peak conducted output power	2400 MHz to 3000 MHz	95%	± 0.62 dB
Power spectral density	2400 MHz to 3000 MHz	95%	± 0.62 dB
Conducted Spurious Emissions	9 kHz to 10000 MHz	95%	± 2.15 dB
Conducted Spurious Emissions	10000 MHz to 40000 MHz	95%	± 3.47 dB
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	± 3.53 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	± 3.71 dB
Radiated Spurious Emissions	1000 MHz to 10000 MHz	95%	± 2.34 dB
Field strength of the fundamental	100 kHz to 100 MHz	95%	± 3.53 dB

4.4 Conformity Decision Rule

The conformity decision rule is based on the ILAC G8 published at the time of reporting.

4.5 Measurement protocol for FCC and ISED

4.5.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

FCC: DE 0011
ISED: DE0009

4.5.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

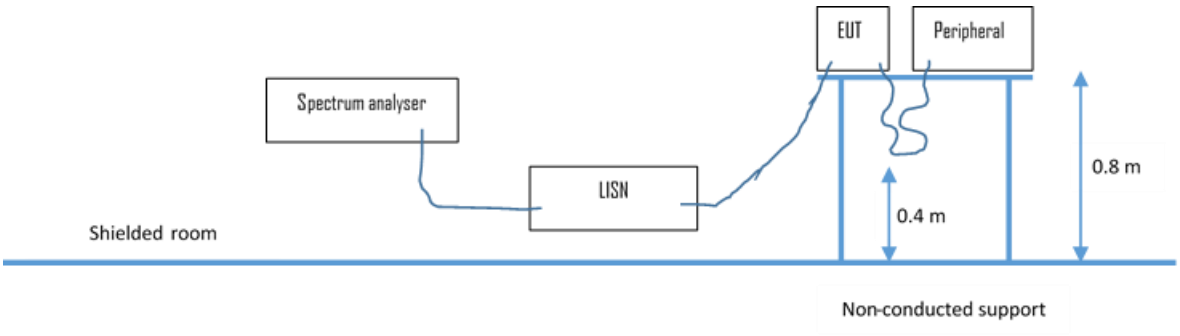
4.5.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions.

4.5.3 Details of test procedures

4.5.3.1 Conducted emission

Test setup according ANSI C63.10



The final level, expressed in dBμV, is arrived at by taking the reading directly from the Spectrum analyser. This level is compared to the limit.

To convert between dBμV and μV, the following conversions apply:

dBμV = 20(log μV)

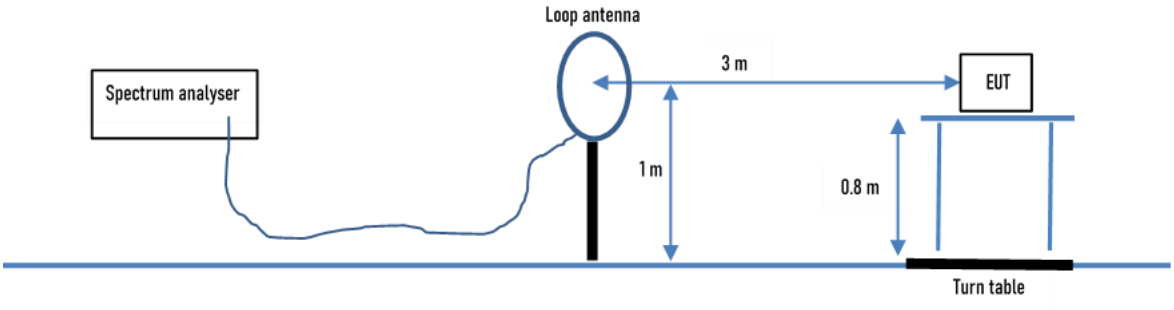
μV = Inverse log(dBμV/20)

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50 Ω / 50 μH (CISPR 16) characteristics. The receiver is protected by means of an impedance matched pulse limiter connected directly to the RF input. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emission is re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

4.5.3.2 Radiated emission

4.5.3.2.1 OATS1 test site (9 kHz - 30 MHz):

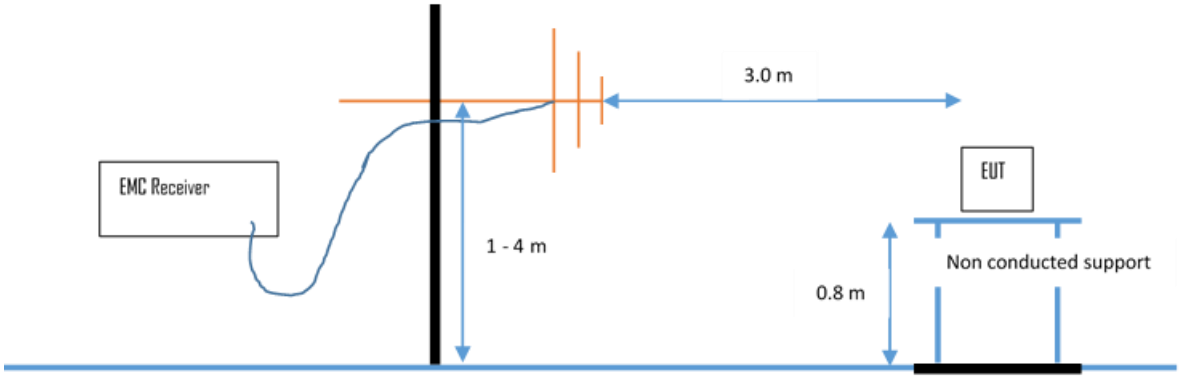
Test setup according ANSI C63.10



Emissions from the EUT are measured in the frequency range of 9 MHz to 30 MHz using a tuned receiver and a calibrated loop antenna. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied along the site axis and the EUT is rotated 360 degrees.

4.5.3.2.2 OATS1 test site (30 MHz - 1 GHz):

Test setup according ANSI C63.10.



Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees. The final level in dBµV/m is calculated by taking the reading from the EMI receiver (Level dBµV) and adding the correction factors and cable loss factor (dB). The FCC limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

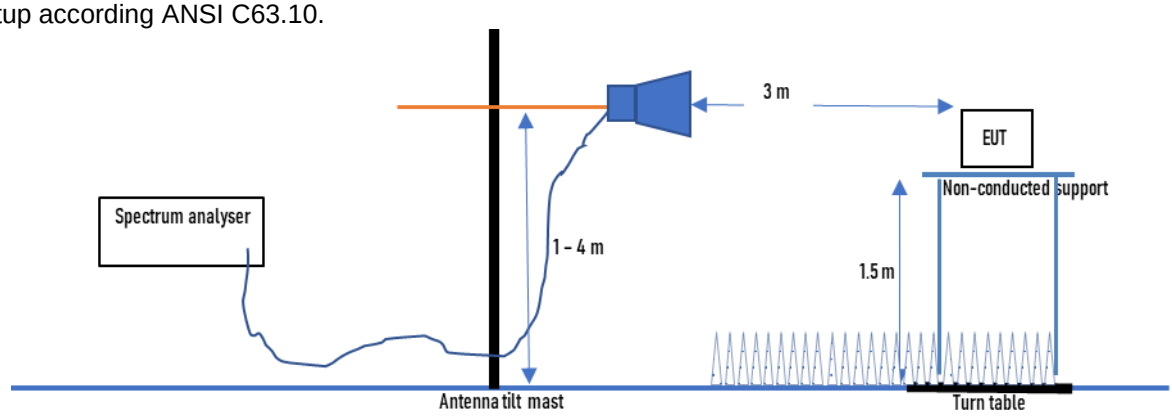
The resolution bandwidth setting:
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level (dBµV/m)	-	Limit (dBµV/m)	=	Delta (dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

4.5.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

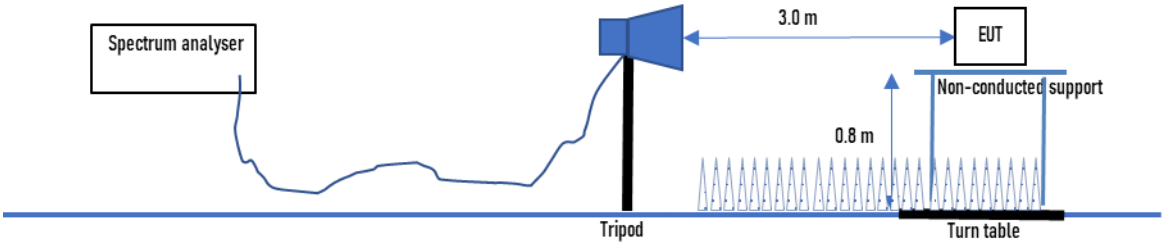
Test setup according ANSI C63.10.



Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 18 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 1.5 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the center, forming a bundle 30 cm to 40 cm long. Measurements are made in in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The

measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements.

4.5.3.2.4 Anechoic chamber 1 (18 GHz – 40 GHz)



Emissions from the EUT are measured in the frequency range 18 GHz up to 40 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 0.8 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the center, forming a bundle 30 cm to 40 cm long. Measurements are made in in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty. The limit are adopted.

5 TEST CONDITIONS AND RESULTS

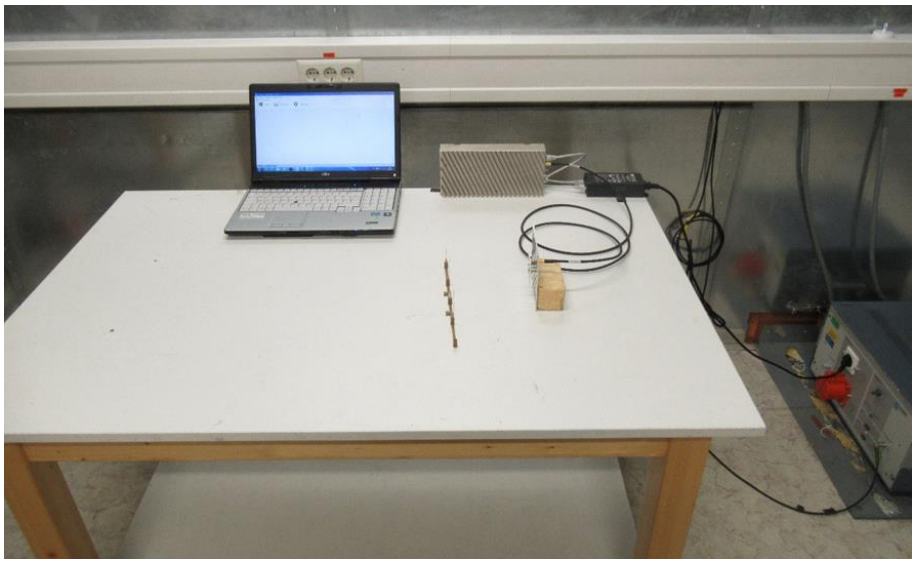
5.1 AC power line conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

5.1.1 Description of the test location

Test location: Shielded Room S2

5.1.2 Photo documentation of the test set-up



5.1.3 Applicable standard

According to FCC Part 15, Section 15.207(a):
Except as shown in paragraphs (b) and (c) of this Section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the given limits.

5.1.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10 described under item 4.4.3. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin -6.26 dB at 18.09 MHz

Limit according to FCC Part 15, Section 15.207(a):

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

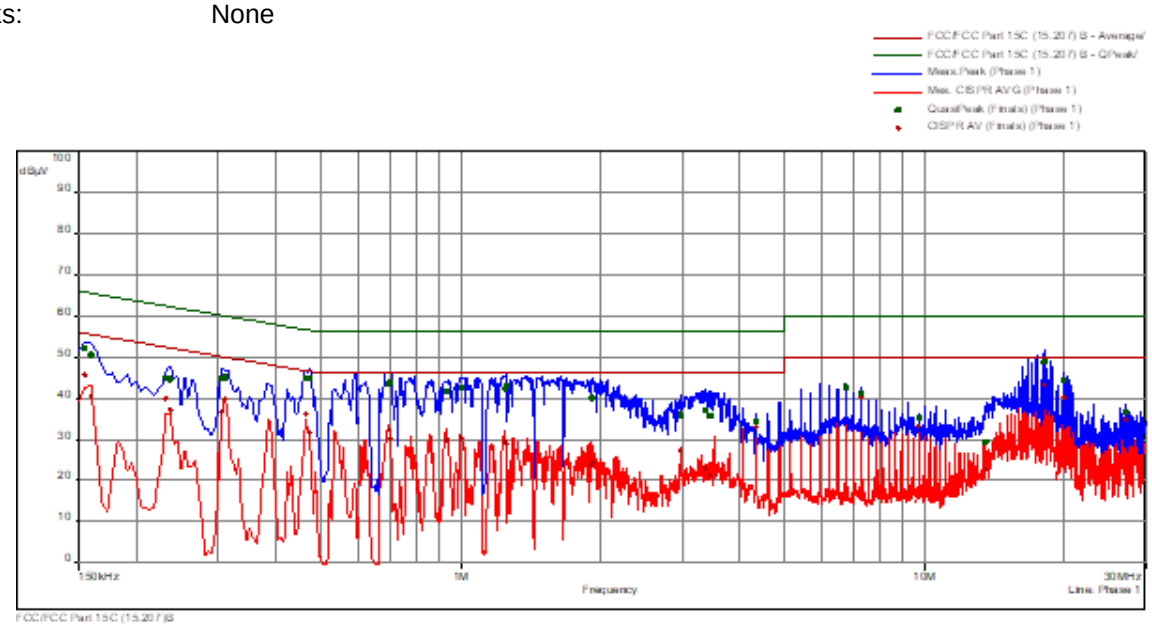
* Decreases with the logarithm of the frequency

The requirements are **FULFILLED.**

Remarks: For detailed test result please refer to following test protocols

5.1.6 Test protocol

Test point L1 Result: passed
Operation mode: TX modulated
Remarks: None



freq	SR	QP	margin	limit	AV	margin	limit	line	corr
MHz		dB(µV)	dB	dB	dB(µV)	dB	dB		dB
0.155	1	52.0	-13.7	65.8	45.7	-10.1	55.8	Phase 1	10.1
0.159	1	50.5	-15.0	65.5	40.5	-15.0	55.5	Phase 1	10.1
0.231	1	45.0	-17.4	62.4	39.8	-12.6	52.4	Phase 1	10.1
0.236	1	44.6	-17.6	62.3	37.1	-15.1	52.3	Phase 1	10.1
0.305	2	45.0	-15.2	60.1	36.7	-13.4	50.1	Phase 1	10.1
0.309	2	45.1	-14.9	60.0	39.9	-10.1	50.0	Phase 1	10.1
0.462	2	44.8	-11.9	56.7	36.1	-10.6	46.7	Phase 1	10.2
0.471	2	44.7	-11.8	56.5	31.5	-15.0	46.5	Phase 1	10.2
0.699	3	43.6	-12.4	56.0	32.2	-13.8	46.0	Phase 1	10.2
0.704	3	44.1	-11.9	56.0	30.3	-15.7	46.0	Phase 1	10.2
0.933	3	41.5	-14.5	56.0	29.8	-16.3	46.0	Phase 1	10.2
1.001	3	42.7	-13.3	56.0	30.4	-15.6	46.0	Phase 1	10.2
1.245	4	42.3	-13.7	56.0	29.5	-16.5	46.0	Phase 1	10.2
1.250	4	43.0	-13.0	56.0	28.9	-17.1	46.0	Phase 1	10.2
1.916	4	40.0	-16.0	56.0	23.9	-22.1	46.0	Phase 1	10.3
1.920	4	40.1	-15.9	56.0	24.3	-21.7	46.0	Phase 1	10.3
2.976	5	35.9	-20.1	56.0	27.3	-18.7	46.0	Phase 1	10.4
3.359	5	37.2	-18.8	56.0	23.1	-22.9	46.0	Phase 1	10.4
3.449	5	35.8	-20.2	56.0	21.4	-24.6	46.0	Phase 1	10.4
4.326	5	34.3	-21.7	56.0	32.9	-13.1	46.0	Phase 1	10.4
6.758	6	42.8	-17.2	60.0	42.5	-7.5	50.0	Phase 1	10.6
7.298	6	41.1	-18.9	60.0	40.3	-9.7	50.0	Phase 1	10.6
9.731	7	35.4	-24.6	60.0	33.2	-16.8	50.0	Phase 1	10.7
13.560	7	29.5	-30.5	60.0	22.7	-27.3	50.0	Phase 1	11.1
18.110	7	48.9	-11.1	60.0	43.2	-6.8	50.0	Phase 1	11.4
19.997	8	44.3	-15.7	60.0	40.2	-9.8	50.0	Phase 1	11.5
27.161	8	36.6	-23.4	60.0	34.6	-15.4	50.0	Phase 1	11.7

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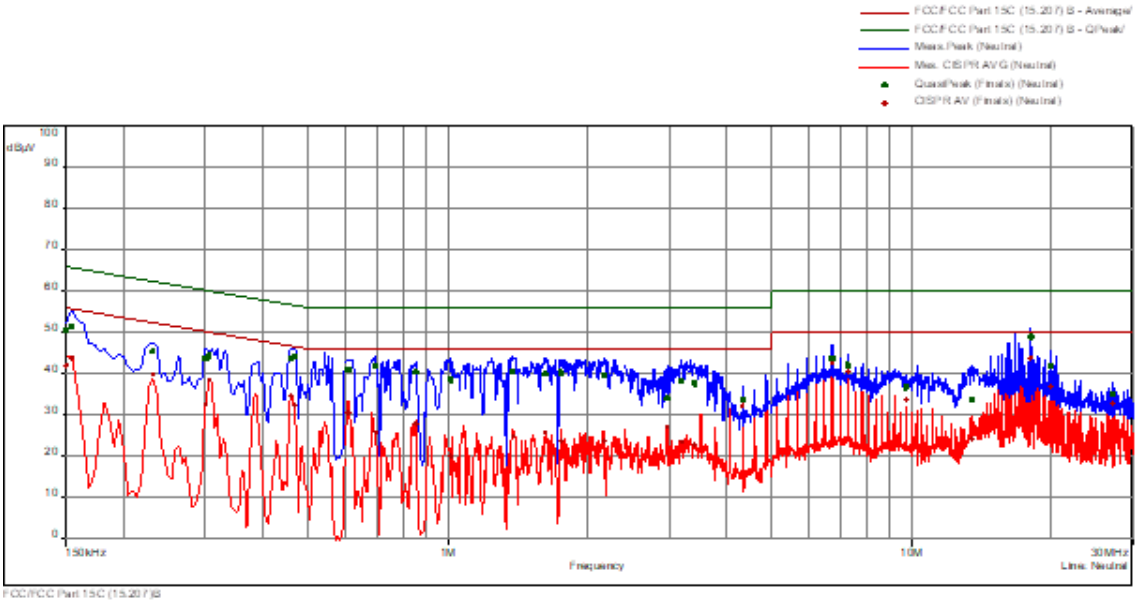
Test point: N
Operation mode: TX modulated
Remarks: None

Result: passed



freq	SR	QP	margin	limit	AV	margin	limit	line	corr
MHz		dB(µV)	dB	dB	dB(µV)	dB	dB		dB
0.150	9	50.7	-15.3	66.0	42.1	-14.0	56.0	Neutral	10.1
0.155	9	51.4	-14.3	65.8	43.8	-12.0	55.8	Neutral	10.1
0.231	9	45.4	-17.0	62.4	40.0	-12.4	52.4	Neutral	10.1
0.300	10	43.7	-16.6	60.2	32.8	-17.5	50.2	Neutral	10.1
0.305	10	44.4	-15.7	60.1	38.5	-11.6	50.1	Neutral	10.1
0.458	10	43.8	-12.9	56.7	34.7	-12.0	46.7	Neutral	10.2
0.467	10	44.1	-12.5	56.6	32.3	-14.2	46.6	Neutral	10.2
0.609	11	41.2	-14.9	56.0	30.6	-15.4	46.0	Neutral	10.2
0.699	11	41.9	-14.2	56.0	25.9	-20.1	46.0	Neutral	10.2
0.852	11	40.4	-15.6	56.0	27.8	-18.2	46.0	Neutral	10.2
1.014	11	38.6	-17.4	56.0	20.0	-26.0	46.0	Neutral	10.2
1.380	12	40.6	-15.4	56.0	24.8	-21.2	46.0	Neutral	10.3
1.619	12	40.0	-16.0	56.0	25.8	-20.2	46.0	Neutral	10.3
1.749	12	40.3	-15.7	56.0	23.7	-22.3	46.0	Neutral	10.3
2.172	12	39.6	-16.4	56.0	23.8	-22.2	46.0	Neutral	10.3
2.972	13	34.0	-22.0	56.0	27.1	-18.9	46.0	Neutral	10.3
3.188	13	38.2	-17.8	56.0	23.6	-22.4	46.0	Neutral	10.4
3.404	13	37.6	-18.4	56.0	23.0	-23.0	46.0	Neutral	10.4
4.322	13	33.9	-22.2	56.0	32.2	-13.8	46.0	Neutral	10.4
6.749	14	43.6	-16.4	60.0	42.6	-7.4	50.0	Neutral	10.6
7.289	14	42.1	-17.9	60.0	40.6	-9.4	50.0	Neutral	10.6
9.717	15	36.7	-23.3	60.0	33.6	-16.4	50.0	Neutral	10.7
13.506	15	33.8	-26.2	60.0	24.4	-25.6	50.0	Neutral	10.9
18.087	15	49.0	-11.0	60.0	43.7	-6.3	50.0	Neutral	11.2
19.974	16	41.9	-18.1	60.0	37.1	-12.9	50.0	Neutral	11.3
27.161	16	35.2	-24.8	60.0	33.0	-17.0	50.0	Neutral	11.2

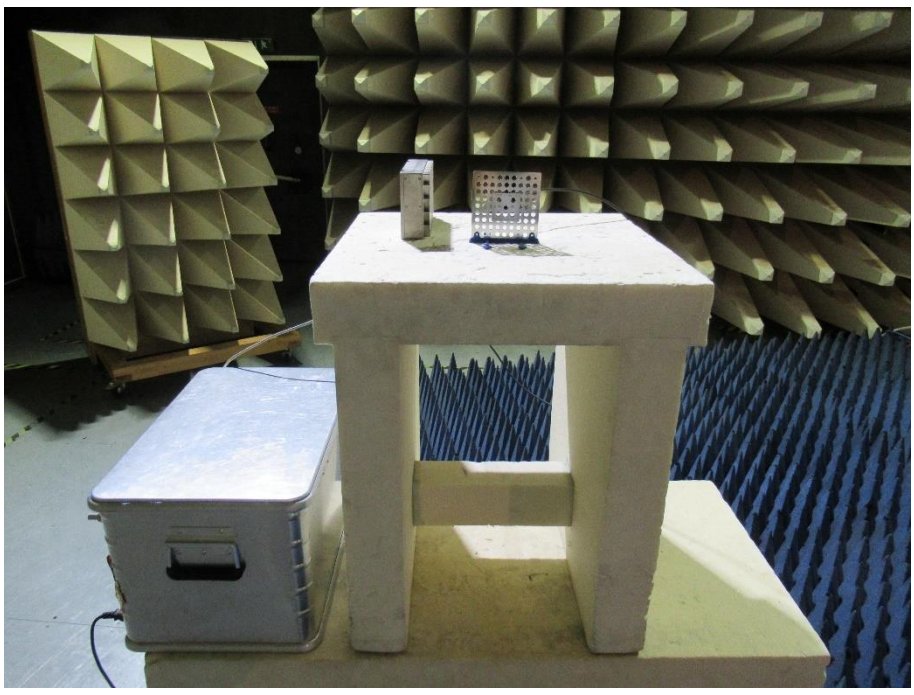
5.2 EBW and OBW

For test instruments and accessories used see section 6 Part **MB**.

5.2.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.2.2 Photo documentation of the test set-up



5.2.3 Applicable standard

According to FCC Part 15, Section 15.247(a)(2):
Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 – 2483.5 MHz and 5725 – 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.2.4 Description of Measurement

The bandwidth was measured at an amplitude level reduced from the reference level of a modulated channel by a ratio of -6 dB. The reference level is the level of the highest signal amplitude observed at the transmitter at either the fundamental frequency or the first order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. An alternative is to use the bandwidth measurement of the analyser.

Spectrum analyser settings for EBW:
RBW: 1-5% EBW, VBW: 3 RBW, Detector: Max peak, Sweep time: auto, Span: > 2 EBW;
Spectrum analyser settings for OBW:
RBW: 1-5% OBW, VBW: 3 RBW, Detector: Max peak, Sweep time: auto, Span: > 2 OBW;

5.2.5 Test result

6dB bandwidth			
Centre *f*	f_1	f_2	Measured EBW
(MHz)	(MHz)	(MHz)	(MHz)
2441.839	2439.430	2444.247	4.817

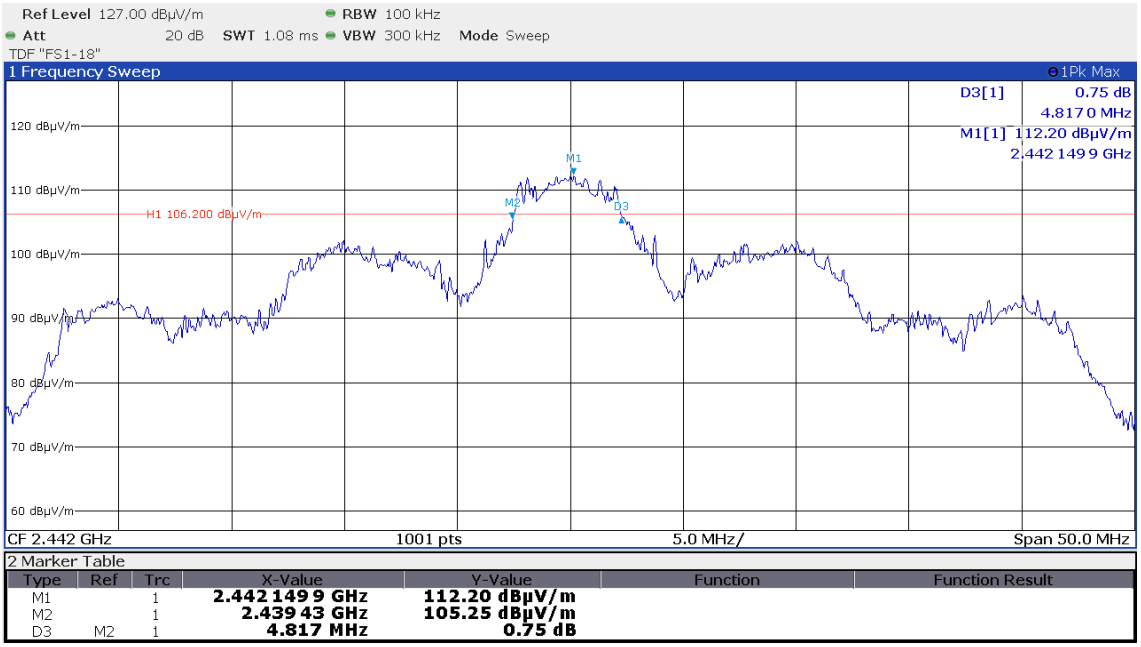
99% bandwidth			
Centre *f*	f_1	f_2	Measured OBW
(MHz)	(MHz)	(MHz)	(MHz)
2441.678	2421.706	2461.649	39.944

The requirements are **FULFILLED.**

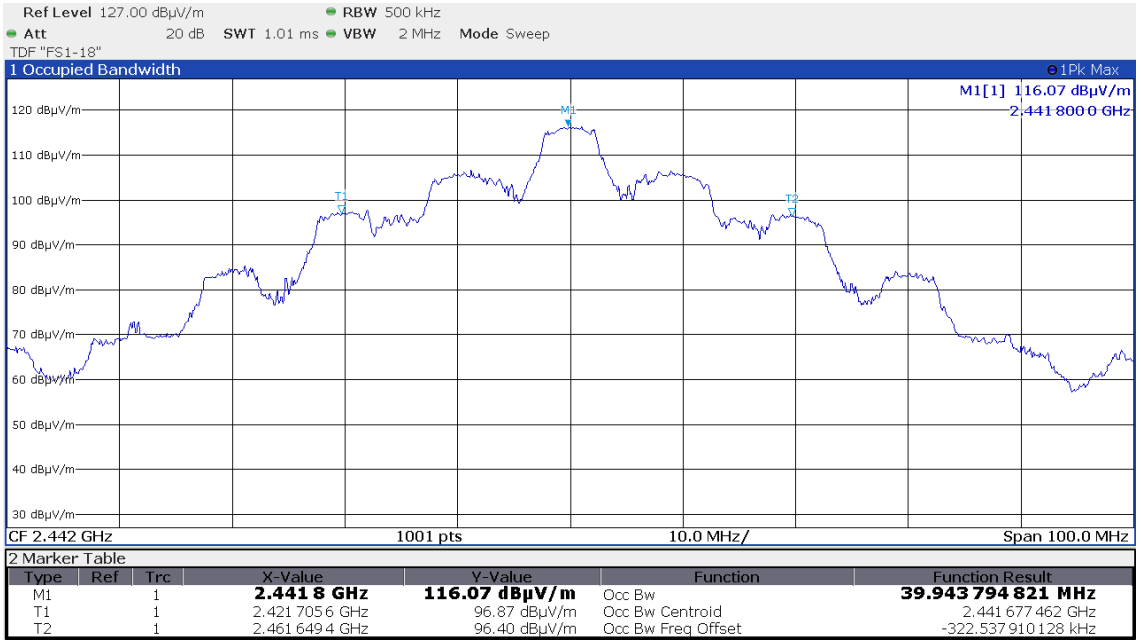
Remarks: For detailed test results please refer to following test protocols. The RSS Gen defines no limit for the occupied bandwidth!

5.2.6 Test protocols

6dB EBW



99% OBW



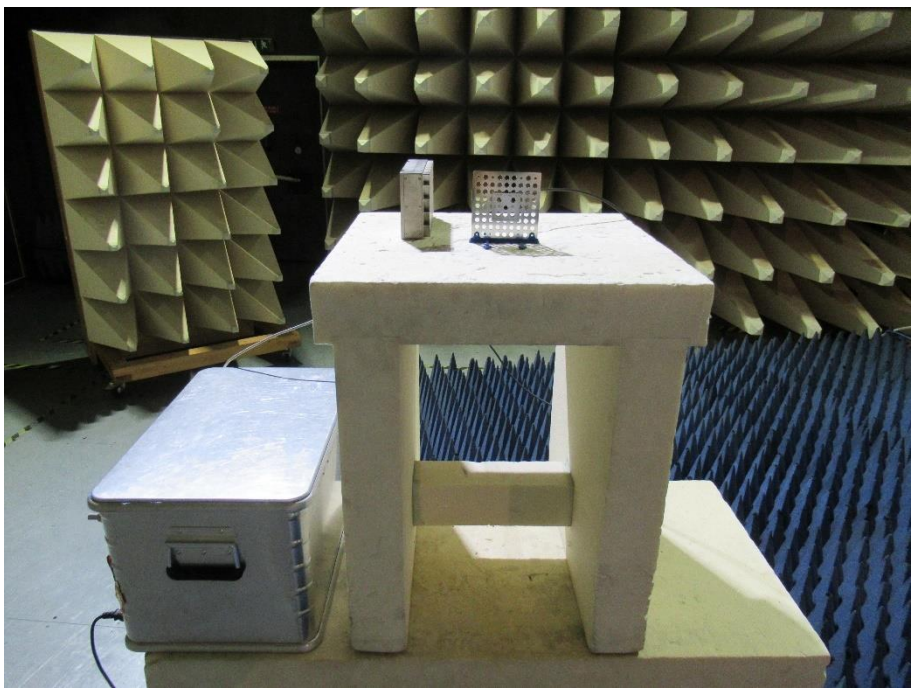
5.3 Maximum peak conducted output power

For test instruments and accessories used see section 6 Part **CPR 3**.

5.3.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 15, Section 15.247(b)(3):
For systems using digital modulation in the 2400 – 2483.5 MHz the maximum peak output power of the transmitter shall not exceed 1 Watt. The limit is based on transmitting antennas of directional gain that do not exceed 6 dBi.

5.3.4 Description of Measurement

The maximum peak conducted output power is measured using a spectrum analyser following the procedure set out in ANSI C64.10, item 11.9.1.1. The EUT is set in TX mode while measuring.

5.3.5 Test result

Measurement of radiated output power:

	Test results radiated			
P23, Ant PH1	Fieldstrength E (dBµV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
2442 MHz	119.2	23.9	36.0	-12.1

Calculated peak conducted output power:

For calculation the following formula is used: A = P – G;
Where:
A is peak conducted output power
P is the output power as EIRP
G is the antenna gain

	Test results conducted				
P23, Ant PH1	P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
2442 MHz	23.9	7.5	16.4	30.0	-13.6

Defacto Limit:

Antenna	Gx	Cond. limit	max. G	A [P23]	Limit P_{out}	Reduction	P set
	(dBi)	(dBm)	(dBi)	(dBm)	(dBm)	(dB)	2.4 GHz
ANT-PH1	7.5	30.0	6.0	16.4	28.5	-12.1	P23

FCC ID: RXBTIRU3 IC: 25462 - TIRU3

Peak Power Limit according to FCC Part 15, Section 15.247 (b)(3):

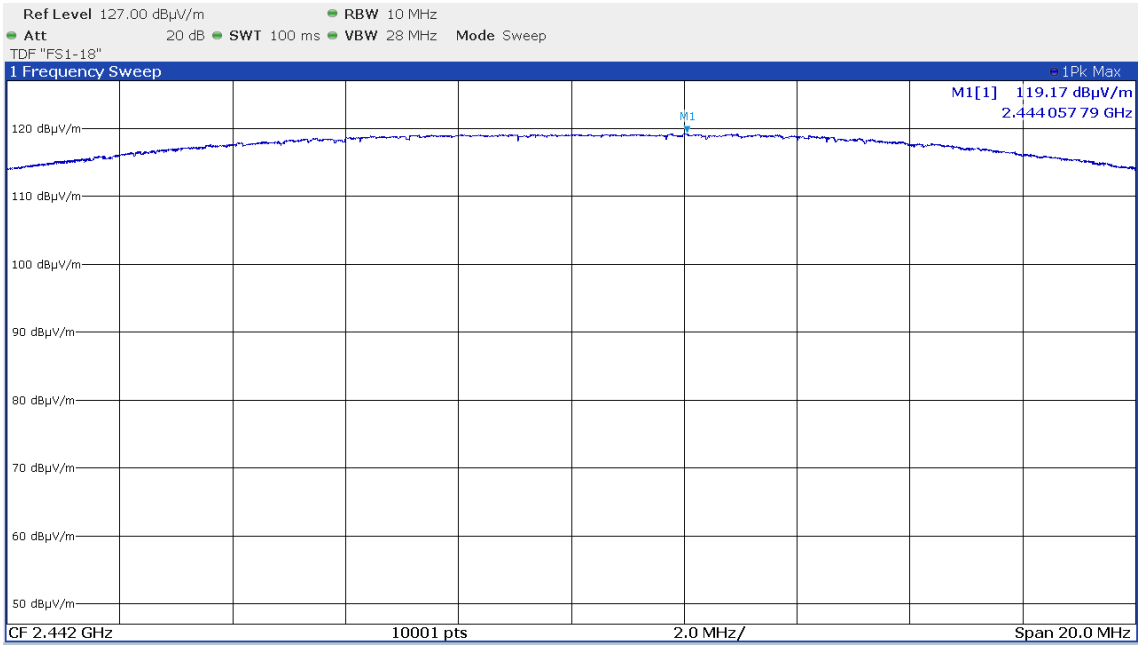
Frequency (MHz)	Conducted Power Limit	
	(dBm)	(Watt)
2400-2483.5	30	1.0

Frequency (MHz)	Radiated Limit (EIRP)	
	(dBm)	(Watt)
2400-2483.5	36	4.0

The requirements are **FULFILLED.**

Remarks: For the Defacto Limit evaluation please see 5.8

5.3.6 Test protocol



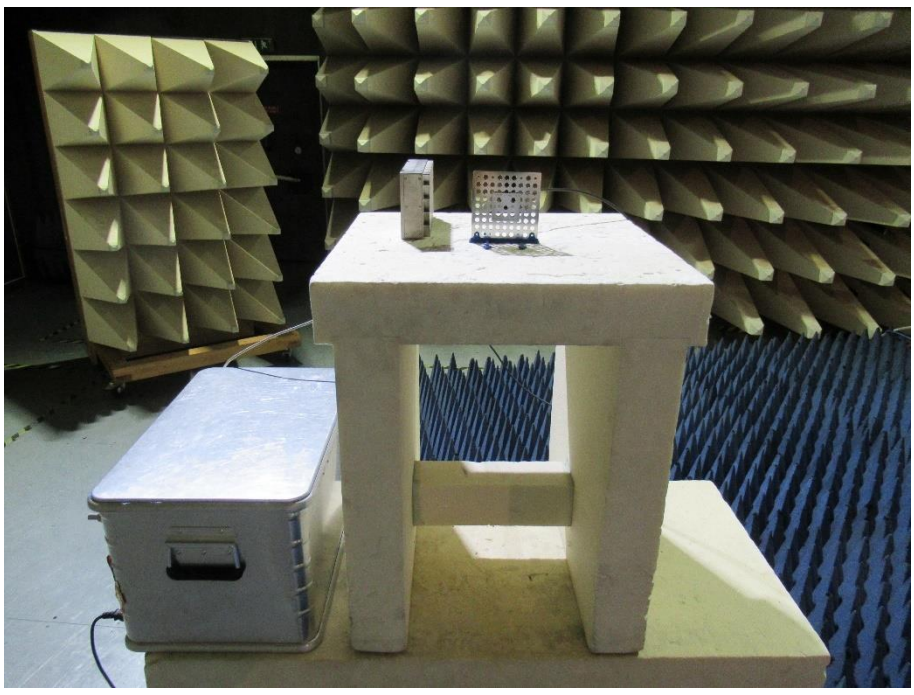
5.4 Power spectral density

For test instruments and accessories used see section 6 Part **MB**.

5.4.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.4.2 Photo documentation of the test set-up



5.4.3 Applicable standard

According to FCC Part 15, Section 15.247(e):
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.4.4 Description of Measurement

The measurement is performed using the procedure set out in ANSI C64.10, item 11.10.21. The power measurement was done as peak power measurement. Therefore, the PKPSD is measured. The max peak was located and with the spectrum analyser and a marker set to peak.

Spectrum analyser settings:
RBW: 3 kHz, VBW: 10 kHz, Detector: Peak, Sweep time: 10 s,

5.4.5 Test result

	Test results radiated			
P23, Ant PH1	Fieldstrength E (dBµV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
2442 MHz	102.7	7.4	8.0	-0.6

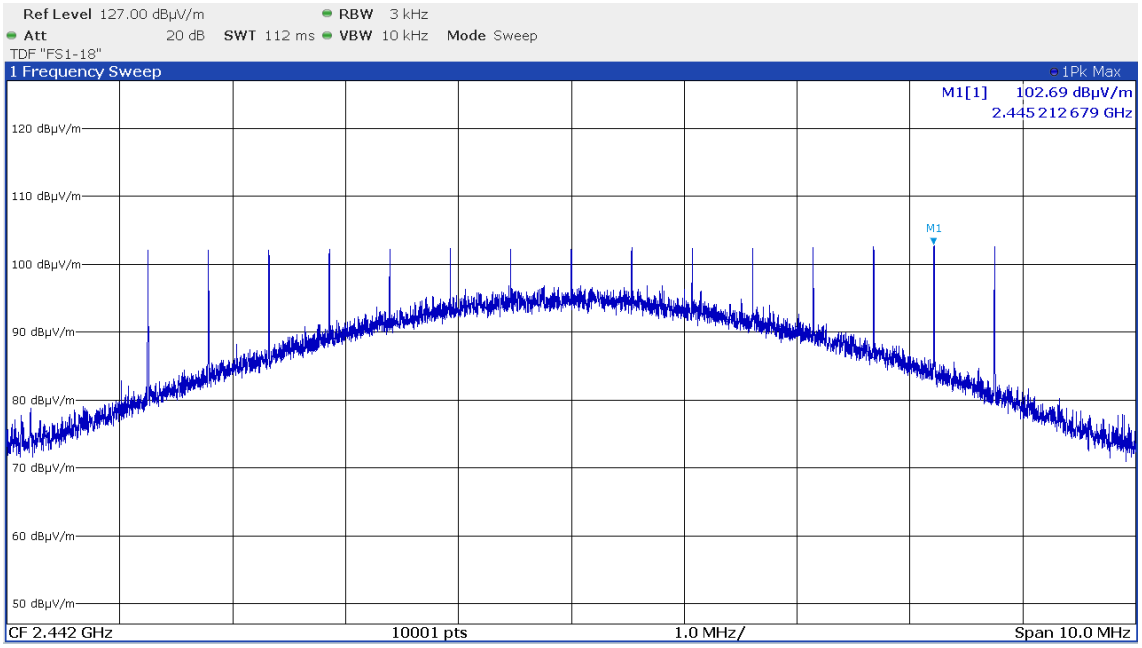
Power spectral density limit according to FCC Part 15, Section 15.247(e):

Frequency (MHz)	Power spectral density limit (dBm/3 kHz)
2400 - 2483.5	8

The requirements are **FULFILLED.**

Remarks: For detailed test results please refer to following test protocols.

5.4.6 Power spectral density plots



5.5 Unwanted emissions in restricted bands, radiated

For test instruments and accessories used see section 6 Part **SER 2, SER 3**.

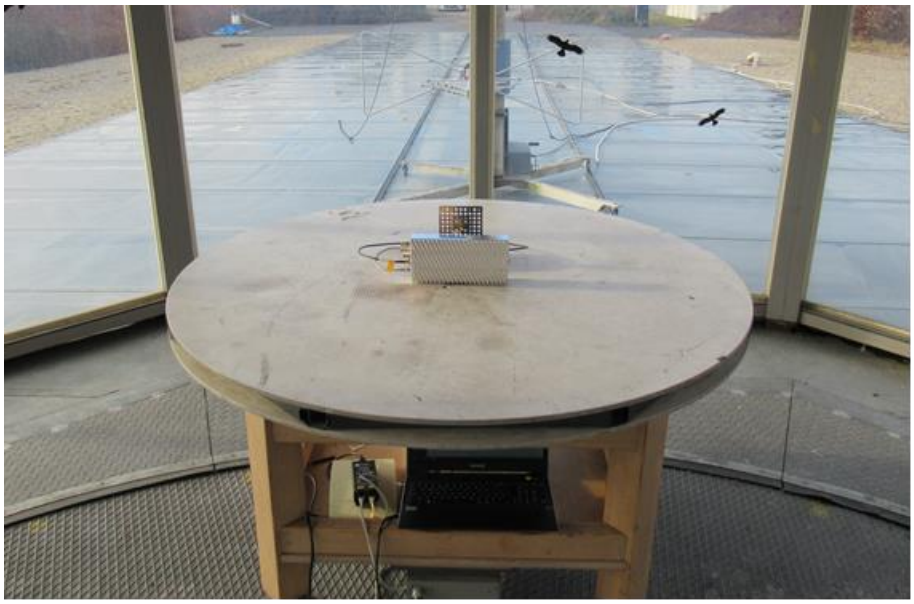
5.5.1 Description of the test location

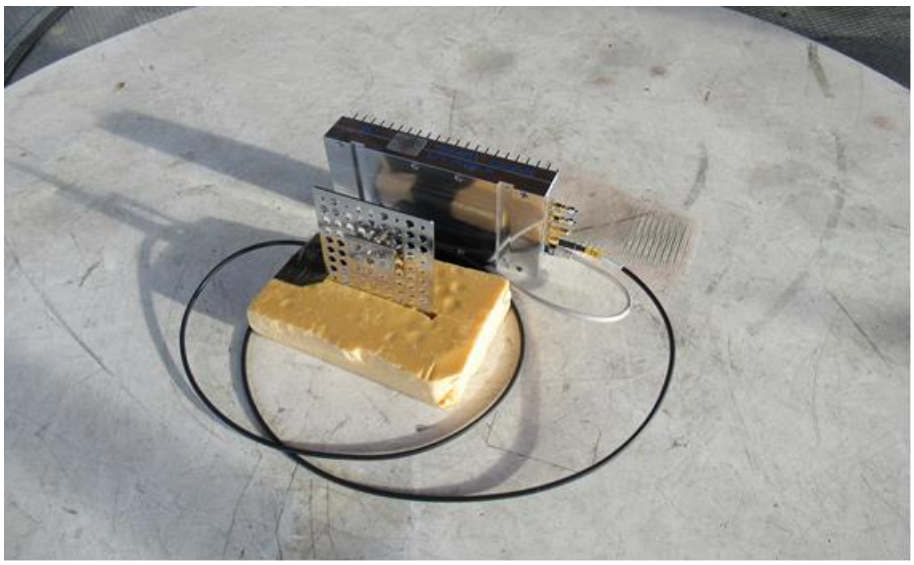
Test location: OATS 1
Test location: Anechoic chamber 1

Test distance: 3 m

5.5.2 Photo documentation of the test set-up

30 MHz – 1 GHz:





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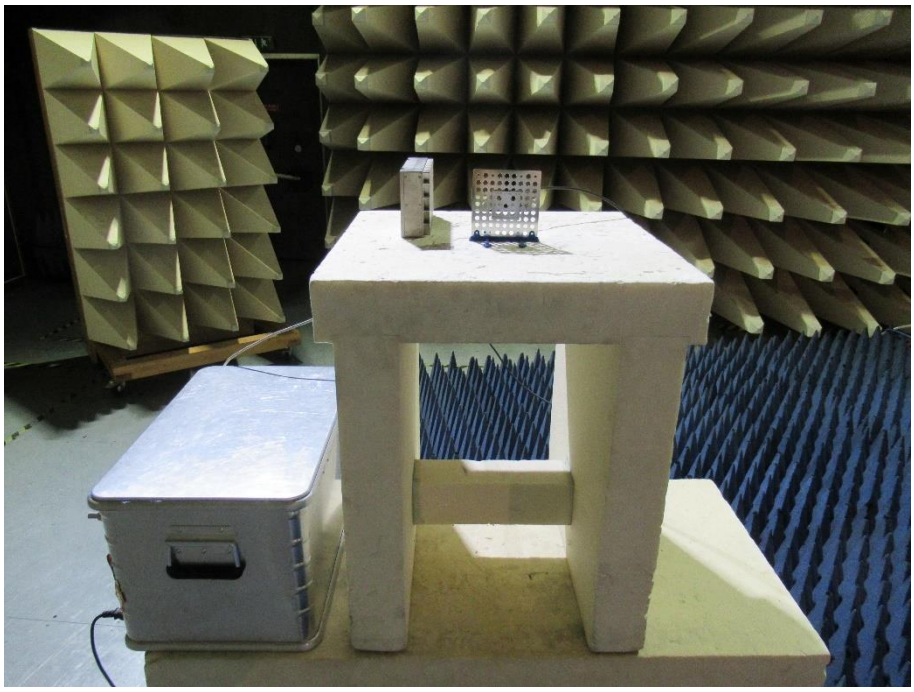
1 GHz – 18 GHz:



18 GHz – 25 GHz:

According to FCC Part 15, Section 15.205(a):
In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

5.5.3 Description of Measurement

The restricted bands are measured radiated. The span of the spectrum analyser is set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation. The restricted bands are measured falling emissions into it and the nearest restricted band are checked for emissions also the restricted band for the harmonics of the carrier.

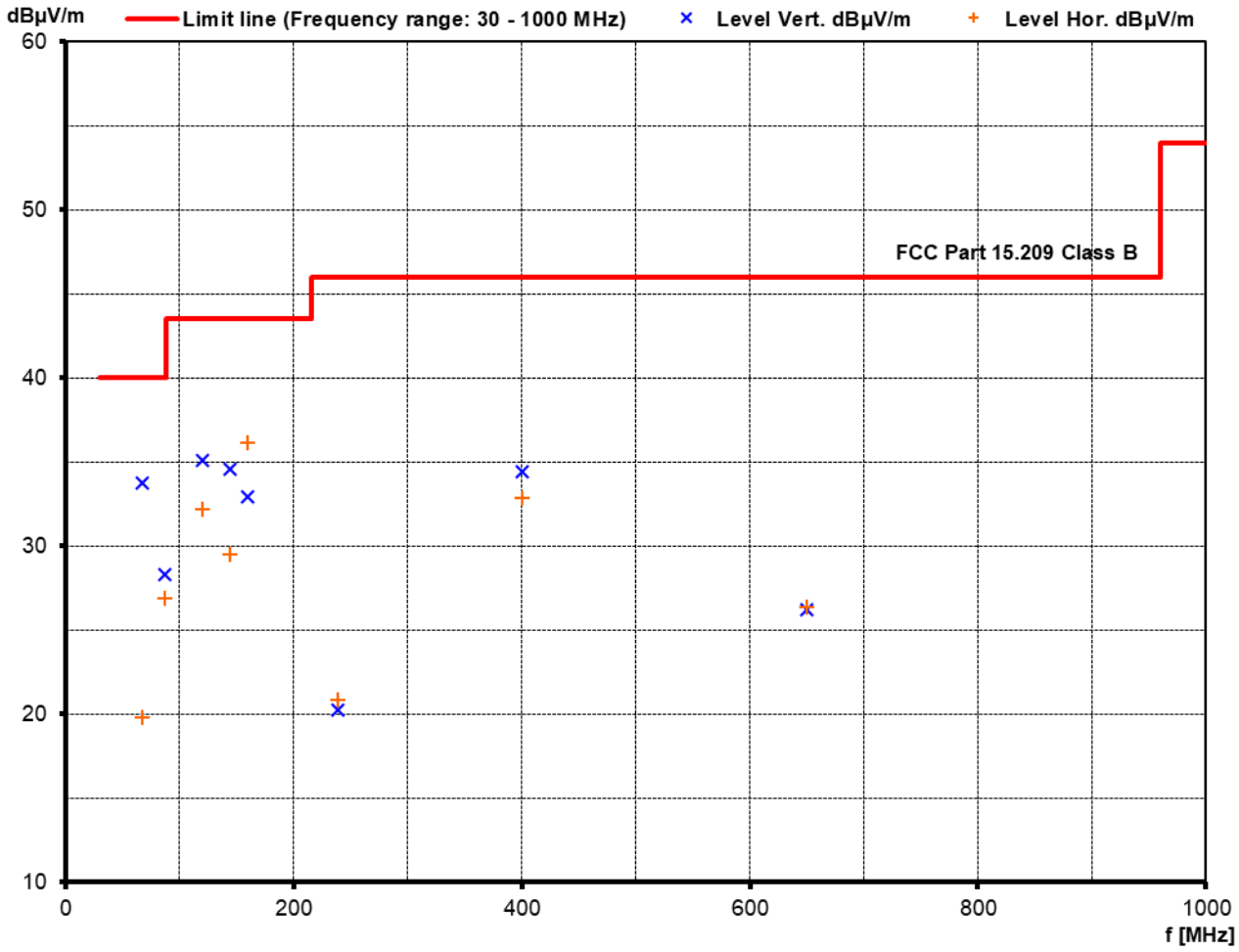
Spectrum analyser settings:

30 MHz – 1000 MHz:	RBW: 120 kHz
1000 MHz – 25 GHz:	RBW: 1 MHz, VBW: 3 MHz, Sweep: Auto, Detector function: Peak

5.5.1 Test result

f < 1 GHz

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
66.80	17.6	3.0	16.1	16.8	33.7	19.8	40.0	-6.3
87.00	14.5	13.8	13.8	13.1	28.3	26.9	40.0	-11.7
120.00	17.7	15.3	17.4	16.9	35.1	32.2	43.5	-8.4
144.00	15.2	11.0	19.4	18.5	34.6	29.5	43.5	-8.9
160.00	13.2	17.0	19.7	19.1	32.9	36.1	43.5	-7.4
239.00	1.9	2.7	18.3	18.2	20.2	20.9	46.0	-25.1
400.00	11.2	9.4	23.2	23.5	34.4	32.9	46.0	-11.6
650.00	-2.7	-3.0	28.9	29.4	26.2	26.4	46.0	-19.6



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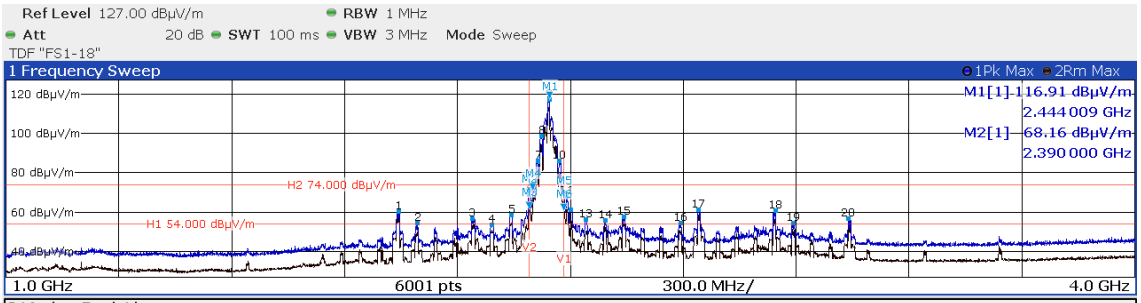
f > 1 GHz



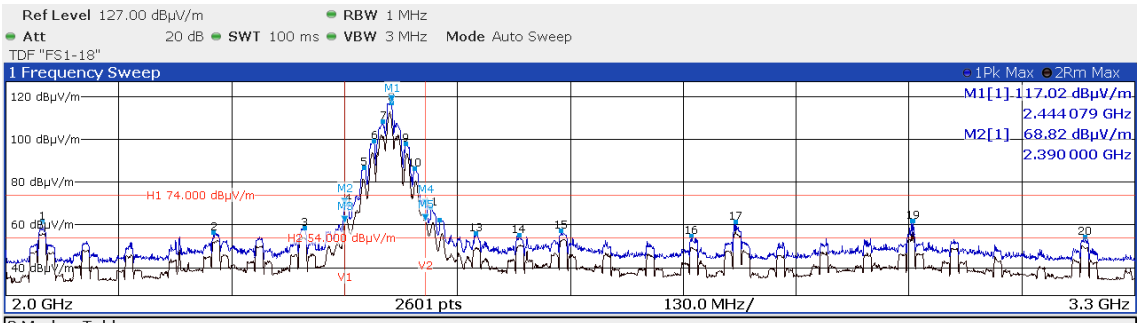
2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	2.044 580 GHz	60.428 dBµV/m	11	2.490 000 GHz	67.881 dBµV/m
2	2.094 070 GHz	54.321 dBµV/m	12	2.502 000 GHz	61.456 dBµV/m
3	2.238 540 GHz	56.837 dBµV/m	13	2.541 490 GHz	56.090 dBµV/m
4	2.291 530 GHz	53.744 dBµV/m	14	2.593 480 GHz	55.616 dBµV/m
5	2.343 530 GHz	58.600 dBµV/m	15	2.641 980 GHz	57.782 dBµV/m
6	2.391 520 GHz	68.980 dBµV/m	16	2.792 950 GHz	54.613 dBµV/m
7	2.414 010 GHz	86.016 dBµV/m	17	2.839 440 GHz	61.269 dBµV/m
8	2.424 010 GHz	98.732 dBµV/m	18	3.045 410 GHz	60.712 dBµV/m
9	2.444 010 GHz	116.910 dBµV/m	19	3.091 900 GHz	54.346 dBµV/m
10	2.470 000 GHz	86.111 dBµV/m	20	3.238 380 GHz	56.810 dBµV/m

3 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.444 009 GHz**	**116.91 dBµV/m**		
M2		1	**2.39 GHz**	**68.16 dBµV/m**		
M3		2	**2.39 GHz**	**61.06 dBµV/m**		
M4		1	**2.4 GHz**	**70.71 dBµV/m**		
M5		1	**2.483 5 GHz**	**67.22 dBµV/m**		
M6		2	**2.483 5 GHz**	**60.41 dBµV/m**		

Detail: 2 GHz – 3.3 GHz:



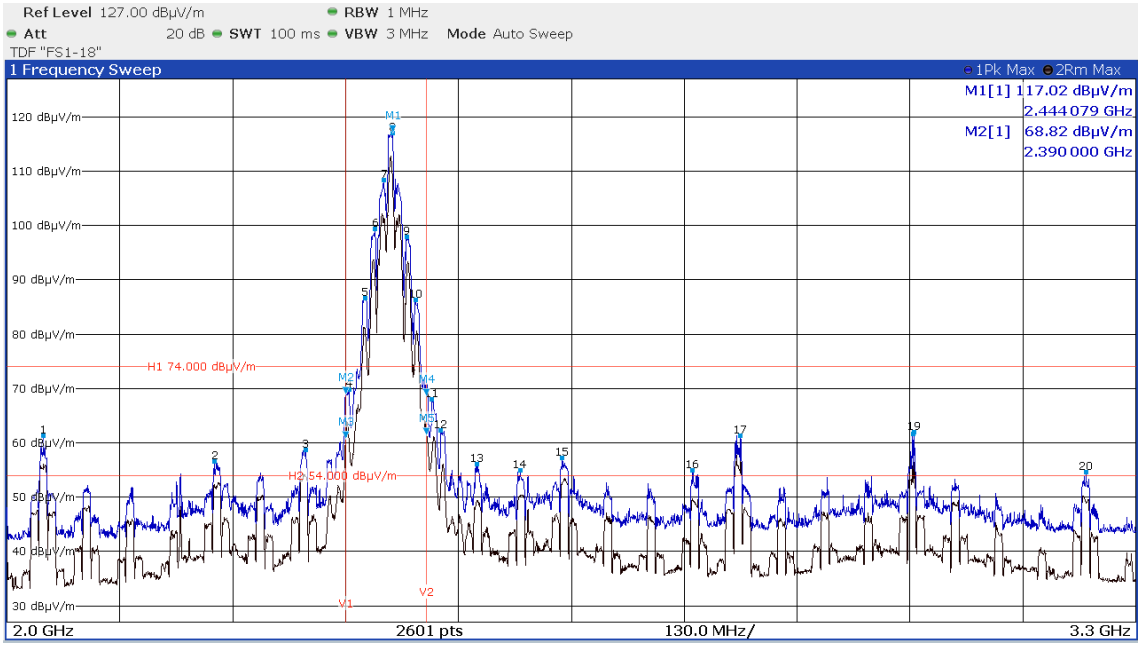
2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.444 079 GHz**	**117.02 dBµV/m**		
M2		1	**2.39 GHz**	**68.82 dBµV/m**		
M3		2	**2.39 GHz**	**60.71 dBµV/m**		
M4		1	**2.483 5 GHz**	**68.44 dBµV/m**		
M5		2	**2.483 5 GHz**	**61.25 dBµV/m**		

3 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	2.042 230 GHz	61.329 dBµV/m	11	2.489 560 GHz	68.059 dBµV/m
2	2.239 160 GHz	56.643 dBµV/m	12	2.499 560 GHz	62.276 dBµV/m
3	2.344 120 GHz	58.668 dBµV/m	13	2.541 540 GHz	56.139 dBµV/m
4	2.394 100 GHz	69.743 dBµV/m	14	2.591 020 GHz	55.016 dBµV/m
5	2.412 090 GHz	86.625 dBµV/m	15	2.639 500 GHz	57.247 dBµV/m
6	2.424 090 GHz	99.356 dBµV/m	16	2.789 450 GHz	54.958 dBµV/m
7	2.434 080 GHz	108.361 dBµV/m	17	2.840 430 GHz	61.251 dBµV/m
8	2.444 080 GHz	117.018 dBµV/m	18	3.043 350 GHz	61.716 dBµV/m
9	2.460 070 GHz	97.870 dBµV/m	19	3.044 850 GHz	61.954 dBµV/m
10	2.470 570 GHz	86.272 dBµV/m	20	3.242 770 GHz	54.553 dBµV/m

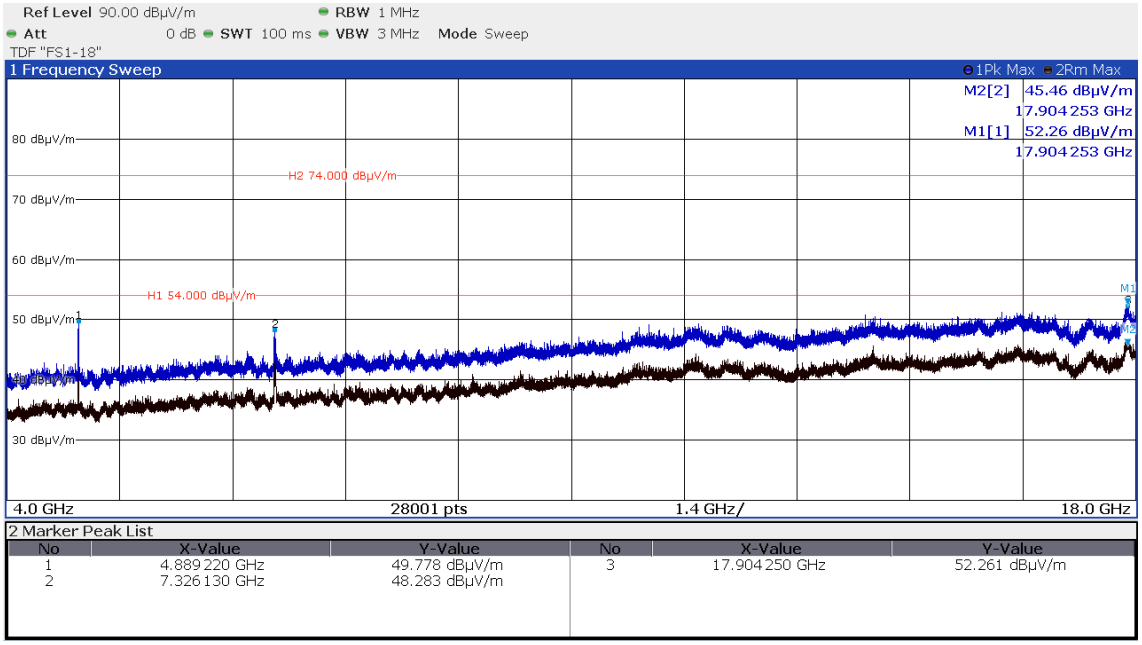
FCC ID: RXBTIRU3 **IC: 25462 - TIRU3**

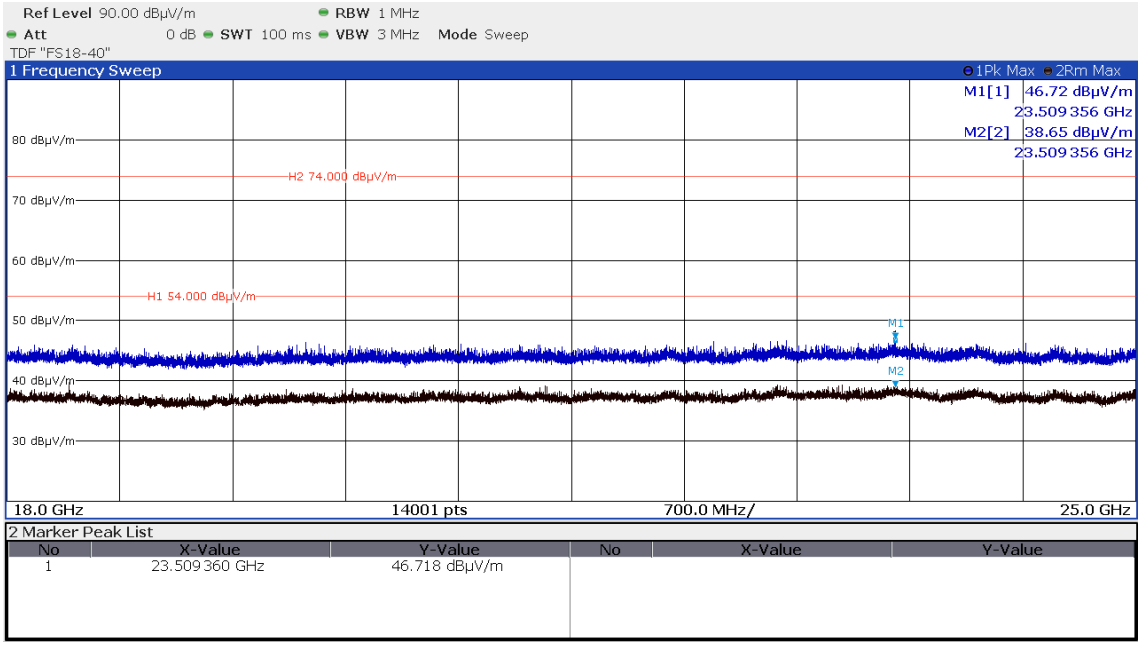


Correction for pulse operation (see section 5.6):

Frequency *f*	Peak emission	Peak limit	Peak margin	Correction factor K_E	Average value	Average limit	Average margin
(MHz)	(dBµV/m)	(dBµV/m)	(dB)	(dB)	(dBµV/m)	(dBµV/m)	(dB)
2042.23	61.3	74.0	-12.7	-17.7	43.6	54.0	-10.4
2239.16	56.6	74.0	-17.4	-17.7	38.9	54.0	-15.1
2344.12	58.7	74.0	-15.3	-17.7	41.0	54.0	-13.0
2390.00	68.8	74.0	-5.2	-17.7	51.1	54.0	-2.9
2483.50	68.4	74.0	-5.6	-17.7	50.7	54.0	-3.3
2489.56	68.1	74.0	-5.9	-17.7	50.4	54.0	-3.6
2499.56	62.3	74.0	-11.7	-17.7	44.6	54.0	-9.4
2541.54	56.1	74.0	-17.9	-17.7	38.4	54.0	-15.6
2591.02	55.0	74.0	-19.0	-17.7	37.3	54.0	-16.7
2639.50	57.2	74.0	-16.8	-17.7	39.5	54.0	-14.5
2789.45	55.0	74.0	-19.0	-17.7	37.3	54.0	-16.7
2840.43	61.3	74.0	-12.7	-17.7	43.6	54.0	-10.4
3043.35	61.7	74.0	-12.3	-17.7	44.0	54.0	-10.0
3044.85	62.0	74.0	-12.0	-17.7	44.3	54.0	-9.7
3242.77	54.6	74.0	-19.4	-17.7	36.9	54.0	-17.1

FCC ID: RXBTIRU3 IC: 25462 - TIRU3





Radiated limits according to FCC Part 15 Section 15.209(a) for spurious emissions which fall in restricted bands:

Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µV/m)	dB(µV/m)	(metres)
0.009-0.490	2400/F (kHz)		300
0.490-1.705	24000/F (kHz)		30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

FCC ID: RXBTIRU3 IC: 25462 - TIRU3

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

RSS-Gen, Table 6 – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	12.57675 - 12.57725	399.9 - 410	7.250 - 7.750
0.495 - 0.505	13.36 - 13.41	608 - 614	8.025 – 8.500
2.1735 - 2.1905	16.42 - 16.423	960 - 1427	9.0 - 9.2
3.020 - 3.026	16.69475 - 16.69525	1435 - 1626.5	9.3 - 9.5
4.125 - 4.128	16.80425 - 16.80475	1645.5 - 1646.5	10.6 - 12.7
4.17725 - 4.17775	25.5 - 25.67	1660 - 1710	13.25 - 13.4
4.20725 - 4.20775	37.5 - 38.25	1718.8 - 1722.2	14.47 - 14.5
5.677 - 5.683	73 - 74.6	2200 - 2300	15.35 - 16.2
6.215 - 6.218	74.8 - 75.2	2310 - 2390	17.7 - 21.4
6.26775 - 6.26825	108 – 138	2483.5 - 2500	22.01 - 23.12
6.31175 - 6.31225	149.9 - 150.05	2655 - 2900	23.6 - 24.0
8.291 - 8.294	156.52475 - 156.52525	3260 – 3267	31.2 - 31.8
8.362 - 8.366	156.7 - 156.9	3332 - 3339	36.43 - 36.5
8.37625 - 8.38675	162.0125 - 167.17	3345.8 - 3358	Above 38.6
8.41425 - 8.41475	167.72 - 173.2	3500 - 4400	
12.29 - 12.293	240 – 285	4500 - 5150	
12.51975 - 12.52025	322 - 335.4	5350 - 5460	

The requirements are **FULFILLED.**

Remarks: The measurement was performed up to the 10th harmonic.

All peak emissions were below the limits of Section 15.209, therefore no additional measurements according to Section 15.247(d) were performed.

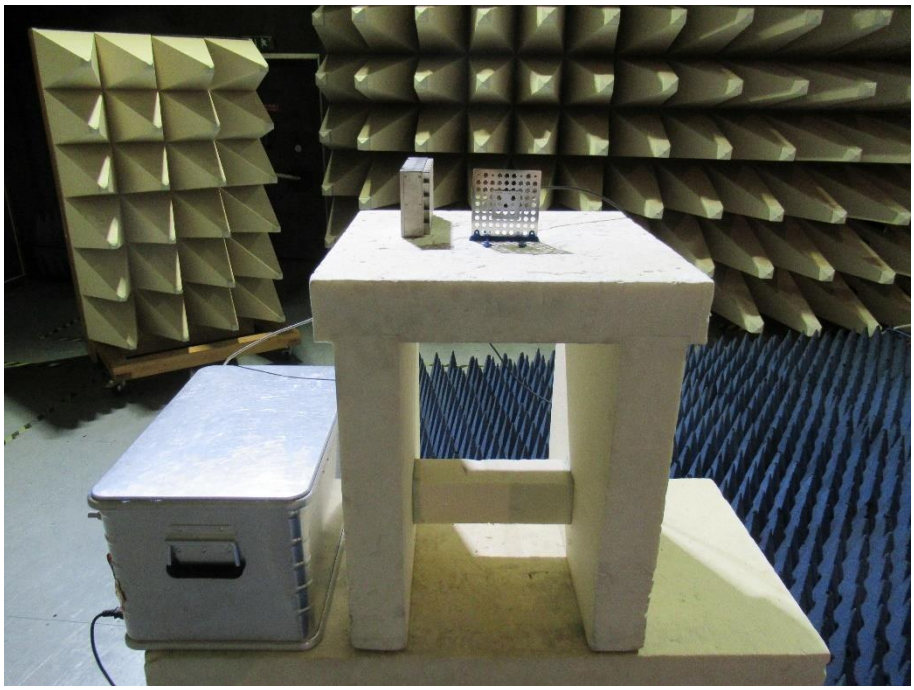
5.6 Correction for pulse operation (duty cycle)

For test instruments and accessories used see section 6 Part **MB**.

5.6.1 Description of the test location

Test location: Anechoic chamber 1

5.6.2 Photo documentation of the test set-up



5.6.1 Applicable standard

According to FCC Part 15A, Section 15.35(c):
When the radiated emission limits are expressed in terms of average value and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1s. In cases where the pulse train exceeds 0.1s, the measured field strength shall be determined from the average absolute voltage during a 0.1s interval during which the field strength is at its maximum. The exact method of calculating the average field strength shall be submitted.

5.6.2 Description of Measurement

The duty cycle factor (dB) is calculated applying the following formula:

$$K_E = 20 \log (T_{on} / T_{conn})$$

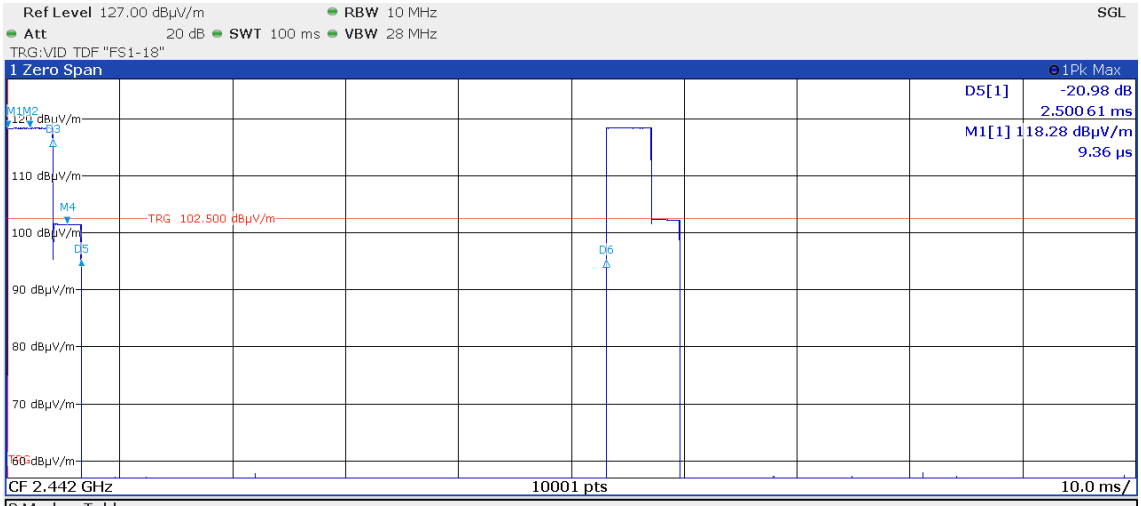
K_E: pulse operation correction factor
T_{on} on air duration
T_{conn} connection interval duration

5.6.3 Test result

$K_E = 20 \log (6.5*2 / 100) = -17.7$ dB

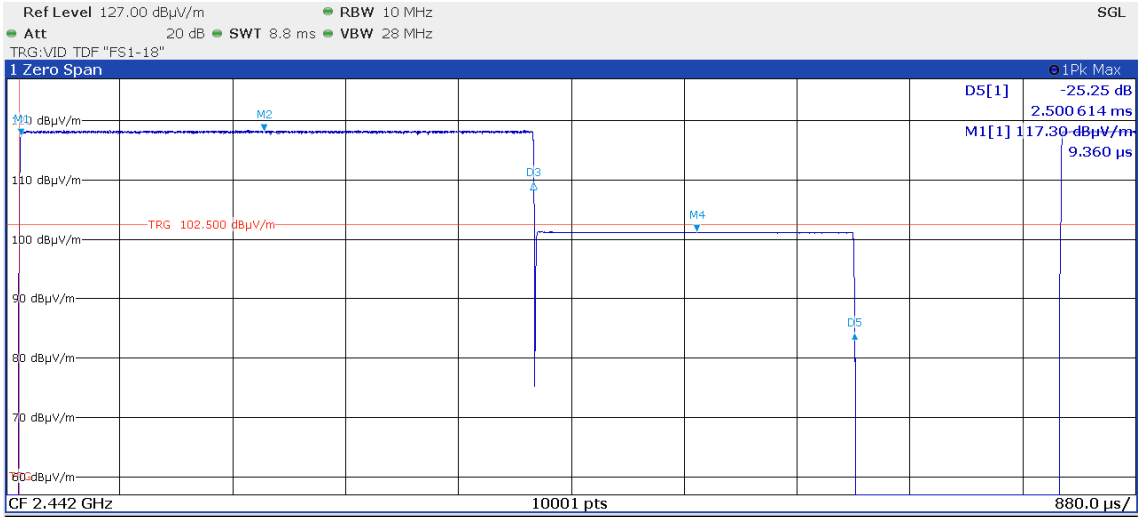
Remarks: For detailed test results please see the following test protocol.

5.6.4 Test protocol



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	9.36 µs	118.28 dBµV/m		
M2		1	1.906 49 ms	118.34 dBµV/m		
D3	M1	1	4.001 71 ms	-1.76 dB		
M4		1	5.282 32 ms	101.44 dBµV/m		
D5	D3	1	2.500 61 ms	-20.98 dB		
D6	M1	1	52.979 34 ms	-22.97 dB		



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	9.36 µs	117.30 dBµV/m		
M2		1	1.906 487 ms	118.03 dBµV/m		
D3	M1	1	4.001 706 ms	-7.66 dB		
M4		1	5.282 32 ms	101.10 dBµV/m		
D5	D3	1	2.500 614 ms	-25.25 dB		

5.7 Antenna application

According to FCC Part 15C, Section 15.203:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

The EUT has an external antenna which is connected by an R-SMA port; unique connectors are needed for replacing the antenna which prevents manipulation by a user. No external power amplifier can be connected. The requirements of part 15.203 and 15.204 are met.

All supplied antennas meet the requirements of part 15.203 and 15.204.

Remarks: None

5.8 Defacto EIRP-Limit

According to FCC Part 15C, Section 15.247(b)(4):
The conducted output power limit specified in paragraph (b) of 15.247 is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2) and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Defacto conducted RF output power limit:

$$Pout = 30 - (Gx - 6);$$

Antenna	Gx	Cond. limit	max. G	A [P23]	Limit P_{out}	Reduction	P set
	(dBi)	(dBm)	(dBi)	(dBm)	(dBm)	(dB)	2.4 GHz
ANT-PH1	7.5	30.0	6.0	16.4	28.5	-12.1	P23

The requirements are **FULFILLED.**

Remarks: No power reduction results from the defacto limit.

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
A 4	BAT-EMC 3.20.0.23	01-02/68-13-001				
	ESCI	02-02/03-15-001	21/06/2022	21/06/2021		
	ESH 2 - Z 5	02-02/20-05-004	31/10/2021	31/10/2019	26/10/2021	26/04/2021
	N-4000-BNC	02-02/50-05-138				
	N-1500-N	02-02/50-05-140				
	ESH 3 - Z 2	02-02/50-05-155	13/11/2022	13/11/2019	26/10/2021	26/04/2021
CPR 3	FSW43	02-02/11-15-001	06/04/2022	06/04/2021		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	28/06/2022	28/06/2021		
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
MB	FSW43	02-02/11-15-001	06/04/2022	06/04/2021		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	28/06/2022	28/06/2021		
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
SER 2	ESVS 30	02-02/03-05-006	09/07/2022	09/07/2021		
	VULB 9168	02-02/24-05-005	18/12/2021	18/12/2020	07/07/2022	07/07/2021
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
	50F-003 N 3dB	02-02/50-21-010				
SER 3	FSW43	02-02/11-15-001	06/04/2022	06/04/2021		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	LNA-40-18004000-33-5P	02-02/17-20-002				
	3117	02-02/24-05-009	28/06/2022	28/06/2021		
	BBHA 9170	02-02/24-05-013	19/05/2023	19/05/2020	04/02/2022	04/02/2021
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
	KMS116-GL140SE-KMS116-	02-02/50-20-026				
	BAT-EMC 3.20.0.23	02-02/68-13-001				

- End of test report -