EMI – TEST REPORT

- FCC 15.209, RSS-210 -

Type / Model Name	:	KAP-R
Product Description	:	Kion Access Permission (access device)
Applicant	:	TQ-Systems GmbH
Address	:	Gut Delling
		Mühlstrasse 2
		82229 Seefeld, Germany
Manufacturer	:	TQ-Systems GmbH
Address	:	Gut Delling
		Mühlstrasse 2
		82229 Seefeld, Germany

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

Test Report No. : 80153542-04 Rev_1	04. October 2023 Date of issue

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

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2021)

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 2021)

Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements

RSS Rules and Regulations

RSS-Gen Issue 5, March 2018 Amendment 1 (March 2019) Amendment 2 (February 2021)	General Requirements and Information for the Certification of Radiocommunication Equipment
RSS-210 Issue 10, December 2019 Amendment (April 2020)	Low Power Licence – Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices

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 Short description of the equipment under test (EUT)

KAP-R is a component to be built in a forklift for key access permission.

KAP-R (Kion Access Permission) is used in a vehicle as an access device. The KAP-R can be used as a standalone version (without fleet management) or in combination (with fleet management) with the radio unit KCU (Kion Communication Unit).

Number of tested samples:	1
Serial number:	Prototype (test sample)
HVIN:	KAP-R
PMN:	KAPR20

EUT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- Only modulation LF (125 kHz); Modulation Type ASK [command r7]

EUT configuration:

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

-	Test boxes	Model:	AE12-TS / AE12-LB
-	Laptop DELL	Model:	SN: 7QL1S32
-	Power supply	Model:	CSA-ID.: 02-02/50-20-008

2.5 Power supply system utilised

Power supply voltage : 6.0 – 36.0 V DC (EUT)

All tests were carried out with a supply voltage of 24.0 V DC (test box “AE12-TS”, supply EUT over test box), unless otherwise stated. Exceptions are described in the detailed test conditions.

3 TEST RESULT SUMMARY

FCC Rule Part	RSS Rule Part	Description	Result
15.207	RSS Gen, 8.8*)	AC power line conducted emissions	not tested[1]
15.209	RSS Gen, 8.9*)	Spurious emissions	passed
15.215	RSS-Gen, 6.7*)	Occupied bandwidth	passed

[1] battery powered DC, vehicular use

"RSS-210 7.2 General field strength limits" reference to RSS-Gen*)

3.1 Revision history of test report

Test report No	Rev.	Issue Date	Changes
80153542-04	0	04 May 2023	Initial test report
80153542-04	1	04 October 2023	Referencing RSS-210 in Chapter 1: Test Standards; Added modulation type ASK in Chapter 2: EUT operation mode; Added remark requirement "AC power line conducted emissions" in Chapter 3: Test result summary; Measurement information corrected: specification detector AV (in the frequency range: 0.009 – 0.490 MHz) / Change of information, test distance: 30 m (in the frequency range: 0.490-1.705 MHz) in Chapter 5.1 Spurious emissions; insert chapter 5.3 Bandwidth: 99% Bandwidth

The test report with the highest revision number replaces the previous test reports.

3.2 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 : 23 March 2023

Testing concluded on : 23 March 2023

Checked by:

Klaus Gegenfurtner
I confirm the correctness and integrity of this document
2023.10.05 10:51:14 +02'00'

Klaus Gegenfurtner
Team Lead Radio

Tested by:

Markus Friedl
I am the author of this document.
2023.10.04 22:34:40 +02'00'

Markus Friedl
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 on basis of the ETSI Technical Report TR 100 028 Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1 and Part 2. The results are documented in the quality system acc. to DIN EN ISO/IEC 17025. 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.

Measurement Type	**Range**	**Confidence Level (%)**	**Calculated Uncertainty**
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
20 dB Bandwidth	Center frequency of EuT	95%	± 2.5 10^{-7}
99% Occupied Bandwidth	Center frequency of EuT	95%	± 2.5 10^{-7}
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
Peak conducted output power	902 MHz to 928 MHz	95%	± 0.35 dB
Conducted Spurious Emissions	9 kHz to 10000 MHz	95%	± 2.15 dB

4.4 Conformity Decision Rule

The applied conformity decision rule is based on ILAC G8:09/2019 clause 4.2.1 Binary Statement for Simple Acceptance Rule (w = 0).
Details can be found in the procedure CSA_B_V50_29.

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".

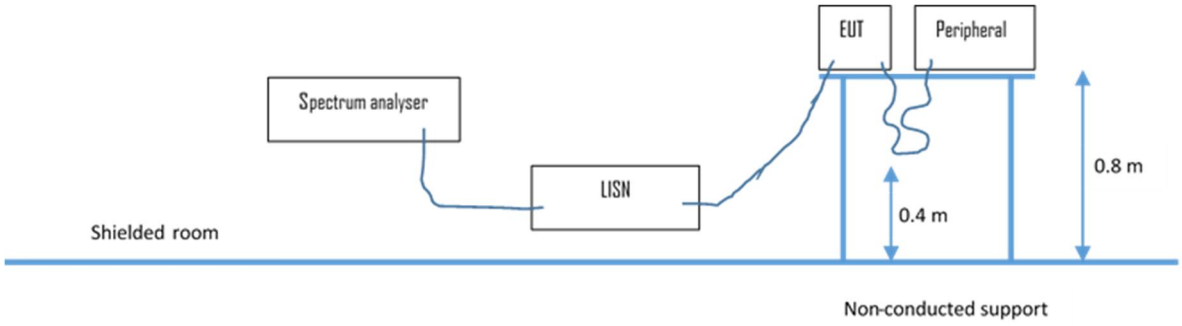
4.5.2.1 Justification

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 dBmV, is arrived at by taking the reading directly from the Spectrum analyser. This level is compared to the limit.

To convert between dBmV and mV, the following conversions apply:

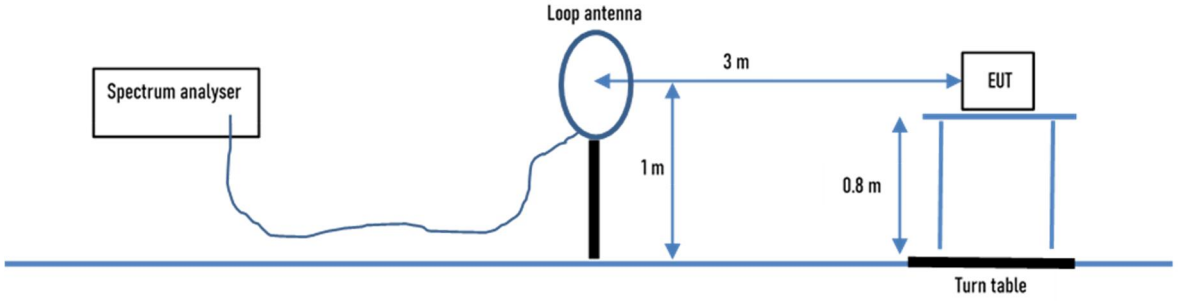
dBmV = 20(log mV)
mV = Inverse log(dBmV/20)

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 W / 50 mH (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):

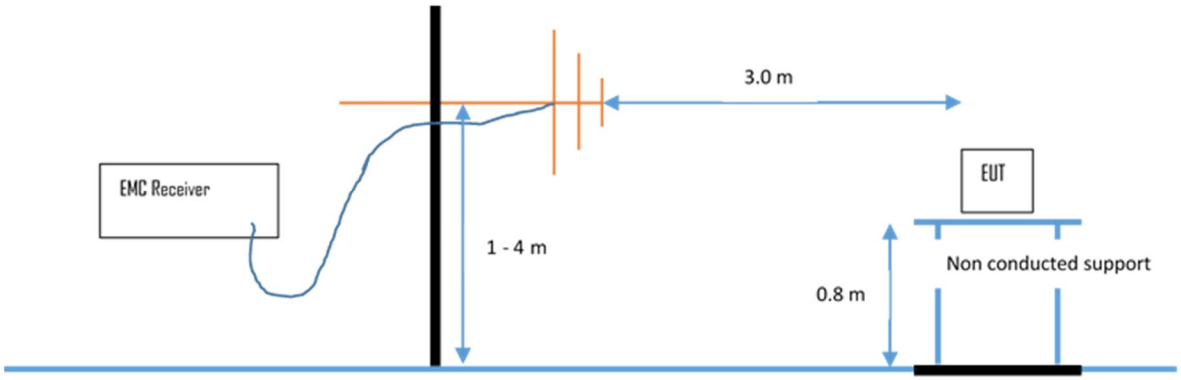
Test setup according ANSI C63.10



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

5 TEST CONDITIONS AND RESULTS

5.1 Spurious emissions

For test instruments and accessories used see section 6 Part **SER 1, SER 2**.

5.1.1 Description of the test location

Test location: OATS 1
Test distance: 3 metres

5.1.2 Photo documentation of the test set-up

See ATTACHMENT B to this test report.

5.1.3 Applicable standard

FCC Part 15, Section 15.209(a) and RSS-210 7.2 reference to RSS Gen, 8.9.

5.1.4 Description of Measurement

The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI C63.10.

The resolution bandwidth during the measurement is as follows:
9 kHz – 150 kHz: RBW: 200 Hz
150 kHz – 30 MHz: RBW: 9 kHz
30 MHz – 1000 MHz: RBW: 120 kHz
Detector: QP (In frequency range 9-90 kHz and 110-490 kHz a linear average detector is used)

5.1.5 Test result < 30MHz

FCC

0.009 – 0.490 MHz

f (MHz)	Level AV@3m (dBµV)	Ant. factor (dB/m)	Field strength AV@3m dB(µV/m)	Distance corr. 3m to 300m (dB)	Corrected level AV@300m dB(µV/m)	Corrected level AV@300m (µV/m)	Limit @ 300m (µV/m)	Delta (µV/m)
0.125	35.0	20	55.0	-80	-25.0	0.056	19.2	-19.14
0.250	32.6	20	52.6	-80	-27.4	0.043	9.6	-9.56
0.375	25.7	20	45.7	-80	-34.3	0.019	6.4	-6.38

0.490 – 1.705 MHz

f (MHz)	Level QP@3m (dBµV)	Ant. factor (dB/m)	Field strength QP@3m dB(µV/m)	Distance corr. 3m to 30m (dB)	Corrected level QP@30m dB(µV/m)	Corrected level QP@30m (µV/m)	Limit @ 30m (µV/m)	Delta (µV/m)
0.500	10.8	20	30.8	-40	-9.2	0.347	48	-47.65

1.705 – 30.0 MHz

f (MHz)	Level QP@3m (dBµV)	Ant. factor (dB/m)	Field strength QP@3m dB(µV/m)	Distance corr. 3m to 30m (dB)	Corrected level QP@30m dB(µV/m)	Limit @30m dB(µV/m)	Delta (dB)
2.0	7.2	20	27.2	-40	-12.8	29.5	-42.3
4.0	29.5	20	49.5	-40	9.5	29.5	-20.0
8.0	13.9	20	33.9	-40	-6.1	29.5	-35.6
16.0	5.9	20	25.9	-40	-14.1	29.5	-43.6

ISED

0.009 – 0.490 MHz

f (MHz)	Level AV@3m (dBµA)	Ant. factor (dB/m)	Field strength AV@3m dB(µA/m)	Distance corr. 3m to 300m (dB)	Corrected level AV@300m dB(µA/m)	Corrected level AV@300m (µA/m)	Limit @300m (µA/m)	Delta (µA/m)
0.125	-16.5	20	3.5	-80	-76.5	0.0001496	0.05096	-0.0508
0.250	-18.9	20	1.10	-80	-78.9	0.0001135	0.02548	-0.0254
0.375	-25.8	20	-5.8	-80	-85.8	0.0000513	0.01699	-0.0169

0.490 – 1.705 MHz

f (MHz)	Level QP@3m (dBµA)	Ant. factor (dB/m)	Field strength QP@3m dB(µA/m)	Distance corr. 3m to 30m (dB)	Corrected level QP@30m dB(µA/m)	Corrected level QP@30m (µA/m)	Limit @30m (µA/m)	Delta (µA/m)
0.500	-40.7	20	-20.7	-40	-60.7	0.0009226	0.1274	-0.1265

1.705 – 30.0 MHz

f (MHz)	Level QP@3m (dBµA)	Ant. factor (dB/m)	Field strength QP@3m dB(µA/m)	Distance corr. 3m to 30m (dB)	Corrected level QP@30m dB(µA/m)	Limit @30m dB(µA/m)	Delta (dB)
2.0	-44.3	20	-24.3	-40	-64.3	-22	-42.3
4.0	-22.0	20	-2.0	-40	-42.0	-22	-20.0
8.0	-37.6	20	-17.6	-40	-57.6	-22	-35.6
16.0	-45.6	20	-25.6	-40	-65.6	-22	-43.6

5.1.6 Test result 30 MHz < 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)
30.00	7.8	5.1	15.5	17.1	23.3	22.2	40.0	-16.7
33.00	7.4	4.9	15.9	17.2	23.3	22.1	40.0	-16.7
35.00	8.2	5.0	16.1	17.2	24.3	22.2	40.0	-15.7
40.00	6.3	5.1	16.8	18.0	23.1	23.1	40.0	-16.9
60.00	6.3	5.1	17.0	18.1	23.3	23.2	40.0	-16.7
73.50	6.1	5.4	15.2	15.8	21.3	21.2	40.0	-18.7
75.00	6.9	5.4	15.0	15.5	21.9	20.9	40.0	-18.1
80.00	6.5	5.5	14.2	14.6	20.7	20.1	40.0	-19.3
110.00	6.4	5.5	16.3	15.4	22.7	20.9	43.5	-20.8
113.00	6.8	5.7	16.6	15.8	23.4	21.5	43.5	-20.1
115.00	6.8	5.4	16.8	16.1	23.6	21.5	43.5	-19.9

Note: The correction factor includes cable loss and antenna factor.

Limit according to FCC Part 15 Subpart 15.209(a)

Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µV/m)	dB(µV/m)	(metres)
0.009 - 0.490	2400/F(kHz)	--	300(Note 1)
0.490 - 1.705	24000/F (kHz)	--	30
1.705 - 30.0	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

Limit according to RSS-Gen clause 8.9

Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µA/m)	dB(µA/m)	(metres)
0.009 - 0.490	6.37/F(kHz)	--	300 (Note 1)
0.490 - 1.705	63.7/F (kHz)	--	30
1.705 - 30.0	0.08	-22	30
Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µV/m)	dB(µV/m)	(metres)
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

The requirements are **FULFILLED.**

Remarks: Measurement has been performed up to 1000 MHz.

See remarks: 5.1.2 Photo documentation of the test set-up (ATTACHMENT B)

5.3 Bandwidth

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

5.3.1 Description of the test location

Test location: AREA4

5.3.2 Photo documentation of the test set-up

See ATTACHMENT B to this test report.

5.3.3 Applicable standard

According to FCC Part 15, Section 15.215(c) and RSS-210 7.2 reference to RSS-Gen, 6.7.

5.3.4 Test result

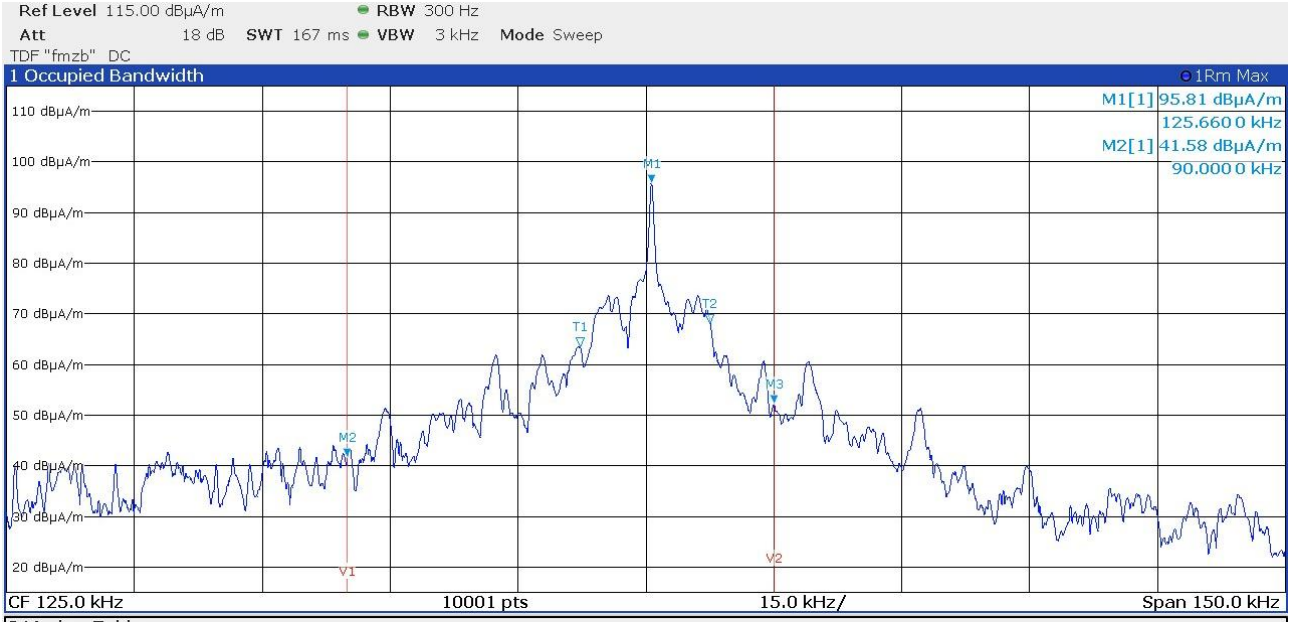
Measured Bandwidth	result (kHz)	Limit (kHz)
99%	15.24	--

The requirements are **FULFILLED.**

Remarks: For detailed test result please refer to following test protocol.

5.3.5 Test protocol

99% Bandwidth



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**125.66 kHz**	**95.81 dBµA/m**	Occ Bw	**15.237 928 879 kHz**
T1		1	117.302 1 kHz	63.41 dBµA/m	Occ Bw Centroid	124.921 036 544 kHz
T2		1	132.54 kHz	68.12 dBµA/m	Occ Bw Freq Offset	-78.963 455 99 Hz
M2		1	**90.0 kHz**	**41.58 dBµA/m**		
M3		1	**140.0 kHz**	**52.22 dBµA/m**		

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.
SER 1	ESR 7	02-02/03-17-001	05/08/2023	05/08/2022		
	HFH 2 - Z 2	02-02/24-15-001	31/03/2023	31/03/2022		
	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				
SER 2	VULB 9168	01-02/24-20-001	22/02/2024	22/02/2023		
	ESVS 30	02-02/03-05-006	27/07/2023	27/07/2022		
	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 3 dB	02-02/50-21-010				
MB	FSW43	02-02/11-15-001	22/04/2023	22/04/2022		
	HFRAE 5161 _ 50 kHz-120	02-02/24-11-004				