EMI – TEST REPORT

- FCC Part 15.247, RSS-247 -

Type / Model Name : Calf Monitoring System – Sensor CMS-4

Product Description : SRD - Transceiver

Applicant : Futuro Farming GmbH

Address : Franz-Mayer-Strasse 1
93053 Regensburg
GERMANY

Manufacturer : Futuro Farming GmbH

Address : Franz-Mayer-Strasse 1
93053 Regensburg
GERMANY

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

Test Report No. : T46462-00-03JP	21. June 2021 Date of issue

Deutsche Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Contents

1 TEST STANDARDS 3

2 EQUIPMENT UNDER TEST 4

2.1 Information provided by the Client 4
2.2 Sampling 4
2.3 Photo documentation of the EUT 4
2.4 Short description of the equipment under test (EUT) 4
2.5 Operation frequency and channel plan 4
2.6 Tested operating modes 4
2.7 Antenna 5
2.8 Power supply system utilised 5
2.9 Peripheral devices and interface cables 5
2.10 Determination of worst-case conditions for final measurement 5

3 TEST RESULT SUMMARY 6

3.1 Final assessment 6

4 TEST ENVIRONMENT 7

4.1 Address of the test laboratory 7
4.2 Environmental conditions 7
4.3 Statement of the measurement uncertainty 7
4.1 Conformity Decision Rule 8
4.2 Measurement protocol for FCC and ISED 8

5 TEST CONDITIONS AND RESULTS 12

5.1 Occupied bandwidth 12
5.2 Maximum peak output power conducted 16
5.3 Spurious emissions conducted 18
5.5 Unwanted emissions, radiated 26
5.6 Duty cycle correction factor 31
5.7 Carrier frequency separation 33
5.8 Number of hopping channels 35
5.9 Average time of occupancy 37

6 USED TEST EQUIPMENT AND ACCESSORIES 40

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

1 TEST STANDARDS

The tests were performed according to following standards:

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

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

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
RSS-Gen, Issue 5, March 2019 Amd 1	General Requirements for Compliance of Radio Apparatus
RSS-247, Issue 2, February 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-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
KDB 558074 D01 v05r02	Guidance for compliance measurements on DTS; FHSS and hybrid system devices operating under Section 15.247 of the FCC rules, April 2, 2019.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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 T46462-00-03JP attachment B and T46462-00-03JP attachment C.

2.4 Short description of the equipment under test (EUT)

The EuT is a part of the Futuro Farming Calf Monitoring System. The sensor is collecting the data from the calf and transmits it to the collector. The EUT uses Hopping technology.

Number of tested samples:	2 (one radiated sample , one with temporary 50 Ohm connector)
Serial number:	none
Firmware version:	see part 2.10.1 Test Software
HVIN/PMN:	CMS-4-NA

EUT configuration:
(The CDF filled by the applicant can be viewed at the test laboratory.)

2.5 Operation frequency and channel plan

The operating frequency band is 902 MHz to 928 MHz.
Following hopp frequencies are used:

915.6	915.8	916.0	916.2	916.4	916.6
916.8	917.0	917.2	917.4	917.6	917.8
918.0	918.2	918.4	918.6	918.8	919.0
919.2	919.4	919.6	919.8	920.0	920.2
920.4	920.6	920.8	921.0	921.2	921.4
921.6	921.8	922.0	922.2	922.4	922.6
922.8	923.0	923.2	923.4	923.6	923.8
924.0	924.2	924.4	924.6	924.8	925.0
925.2	925.4	925.6	925.8	926.0	926.2
926.4	926.6	926.8	927.0	927.2	927.4

Note: the green marked frequencies were tested. All values in MHz

2.6 Tested operating modes

- Continuous transmit mode on definded frequencies (915.6 MHz. 921.4 MHz and 927.5MHz)
- Hopping mode (all 60 Channels are used)

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

2.7 Antenna

The following antennas were tested with the EUT:

Model	Type of antenna	Gain
Integral antenna	PCB antenna	-4,3 dBi

2.8 Power supply system utilised

Power supply voltage. V_{nom} : 3,6 V / DC (Battery supplied)

2.9 Peripheral devices and interface cables

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

- -- Model : --
- -- Model : --
- -- Model : --

2.10 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.

2.10.1 Test software

Test software was used to set the module in specific operation modes. The test software was supplied by client.

Used software:

- Specific firmware for maximum possible duty cycle CC1310_Sensor_FHT_500ms_200Byte
- Smart Studio 7 (Build 2.16.0) published by Texas Instruments
  Settings:
  - 50kbps, 2-GFSK, 25kHz deviation

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

3 TEST RESULT SUMMARY

The EuT is a hoppin system. Operating in the 902 MHz – 928 MHz band.

FCC Rule Part	RSS Rule Part	Description	Result
15.207	RSS-Gen. 8.8	AC power line conducted emissions	not applicable
15.209	RSS Gen, 8.9	Radiated Emission Limits, General Limits	passed
15.247(a)(1)(i)	RSS Gen, 6.7 RSS-247, 5.1c	Occupied bandwidth	passed
15.247(a)(1)	RSS-247, 5.1b	Hopping frequency separation	passed
15.247(a)(1)	RSS-247, 5.1c	Number of hopping channels	passed
15.247(a)(1)	RSS-247, 5.1c	Average time of occupancy	passed
15.247(b)(2)	RSS-247, 5.4a	Peak conducted output power	passed
15.247(d)	RSS-247, 5.5	Spurious RF conducted emission	passed

Note: conducted emission is not applicable the EuT is battery supplied

3.1 Final assessment

Select final Assessment

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

Testing commenced on : 03 August 2020

Testing concluded on : 30 September 2020

Checked by:

Klaus Gegenfurtner
2021.06.21 12:55:51
+02'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Jürgen Pessinger
2021.06.21
10:51:26 +02'00'

Jürgen Pessinger

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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 / 2011 + A1 / 2014 „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.

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 30000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Output power ERP, radiated	1000 MHz to 7000 MHz	95%	± 2.71 dB
Field strength of the fundamental	1000 MHz to 7000 MHz	95%	± 2.71 dB
Power spectral density	2400 MHz to 3000 MHz	95%	± 0.62 dB
Spurious Emissions, conducted	9 kHz to 10000 MHz	95%	± 2.15 dB
Spurious Emissions, conducted	10000 MHz to 40000 MHz	95%	± 3.47 dB
Spurious Emissions, radiated	9 kHz to 30 MHz	95%	± 3.53 dB
Spurious Emissions, radiated	30 MHz to 1000 MHz	95%	± 4.44 dB
Spurious Emissions, radiated	1000 MHz to 30000 MHz	95%	± 2.34 dB
Spurious Emissions, radiated	30000 MHz to 40000 MHz	95%	± 5.13 dB

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

4.1 Conformity Decision Rule

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

4.2 Measurement protocol for FCC and ISED

4.2.1 General information

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

FCC: DE 0011
ISED: DE0009

4.2.2 General Standard information

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

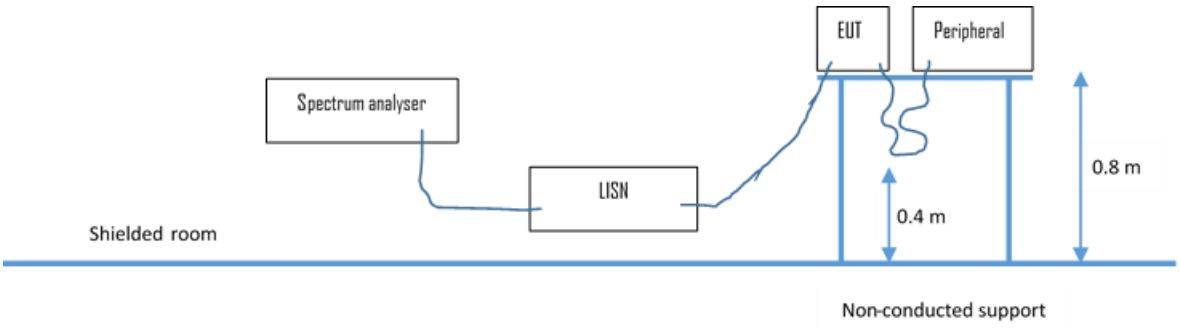
4.2.2.1 Justification

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

4.2.3 Details of test procedures

4.2.3.1 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)

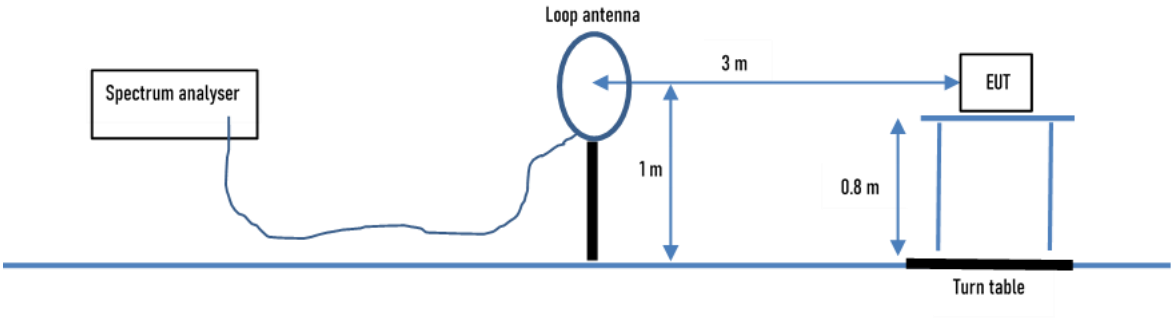
Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 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.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

4.2.3.2 Radiated emission

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

Test setup according ANSI C63.10

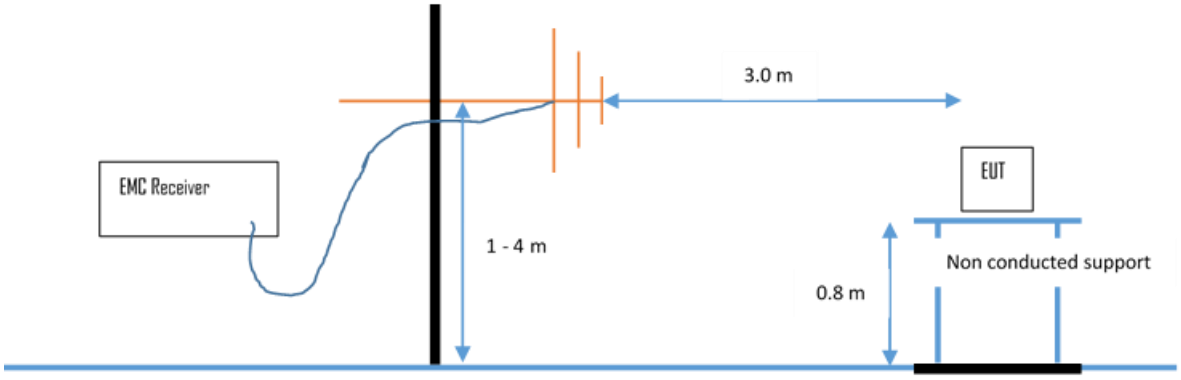


Emissions from the EUT are measured in the frequency range of 9 MHz to 30 MHz using a tuned receiver and a calibrated loop antenna. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Cables to simulators/testers (if used in this test) are routed 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.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

4.2.3.2.2 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.

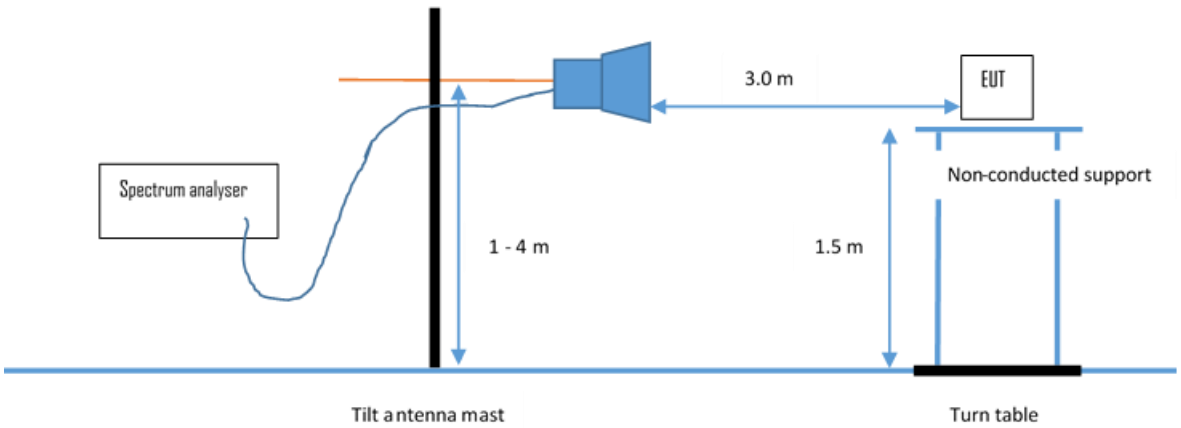
The resolution bandwidth setting:
30 MHz – 1000 MHz: RBW: 120 kHz

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

4.2.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

Test setup according ANSI C63.10.

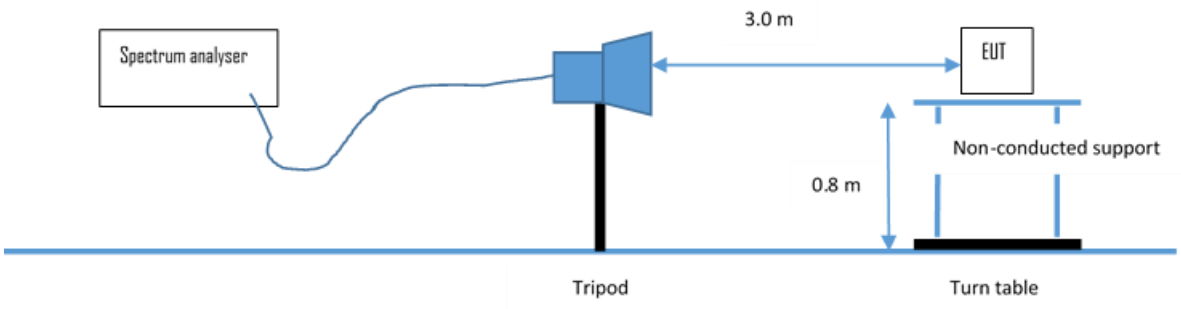


Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 18 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 1.5 metre above the ground plane. 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

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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.

4.2.3.2.4 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.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5 TEST CONDITIONS AND RESULTS

5.1 Occupied bandwidth

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

5.1.1 Description of the test location

Test location: Shielded Room S4

5.1.2 Photo documentation of the test set-up

For test setup photos see T46462-00-03JP ATTACHMENT A

5.1.1 Applicable standard

FCC Part 15, Section 15.247(a)(1)(i), RSS-Gen 6.6 and RSS-247 5.1c

5.1.2 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10.
Spectrum analyser settings: refer to attached plots

20dB bandwidth			
Operating frequency [MHz]	Bandwidth [kHz]	limit [kHz]	Result
915.6	101.15	500	Pass
921.4	101.65	500	Pass
927.4	101.40	500	Pass

99% bandwidth			
Operating frequency [MHz]	Bandwidth [kHz]	limit [kHz]	Result
915.6	91.49	None defined	NA
921.4	92.73	None defined	NA
927.4	92.37	None defined	NA

Bandwidth limit according to FCC Part15C, Section 15.247(a)(1)(i) and RSS-247 5.1c:

Frequency	Limit -20 dB bandwidth
(MHz)	(kHz)
902-928	≤ 500

The requirements are **FULFILLED.**

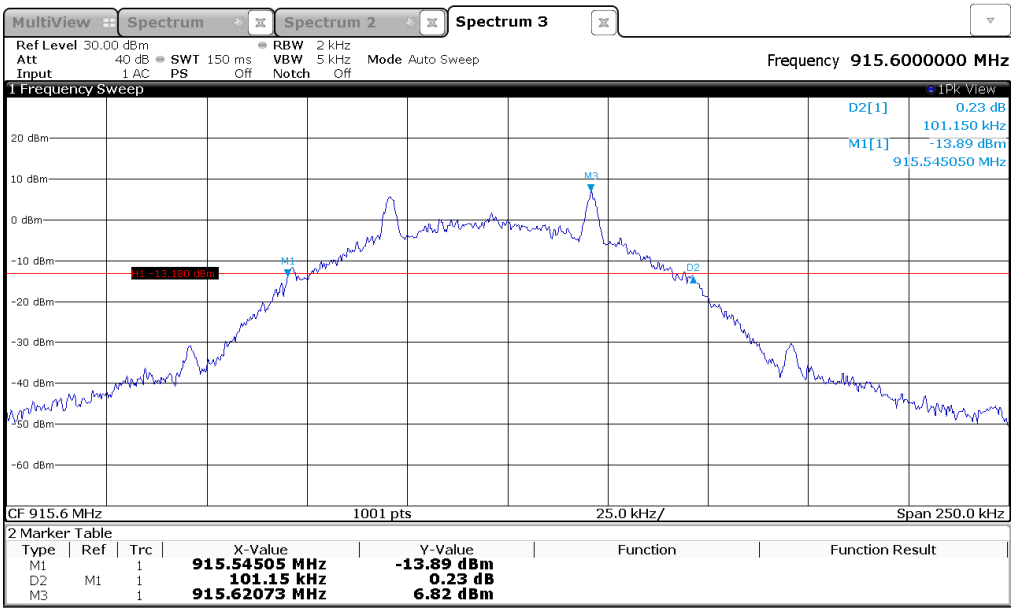
Remarks: For detailed test results please see the following test protocols.

Conducted sample used.

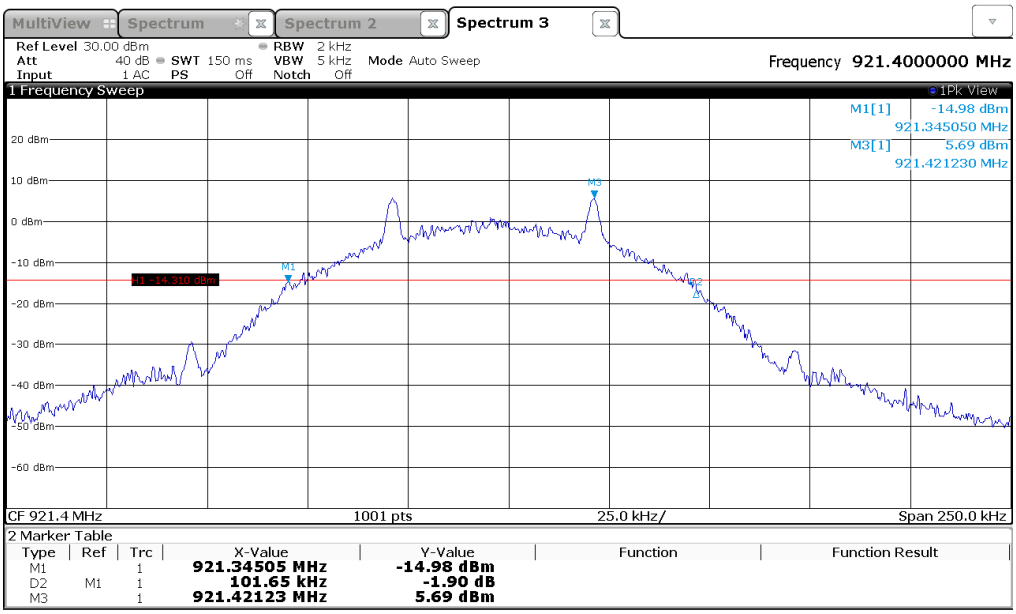
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.1.3 Test protocols – 20dB bandwidth

915.6MHz

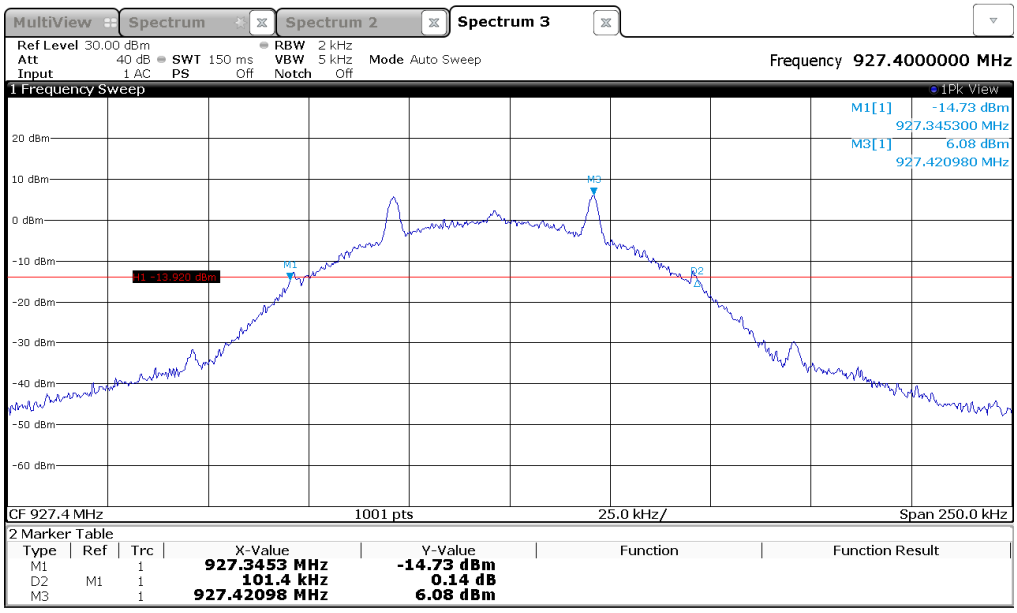


921.4MHz



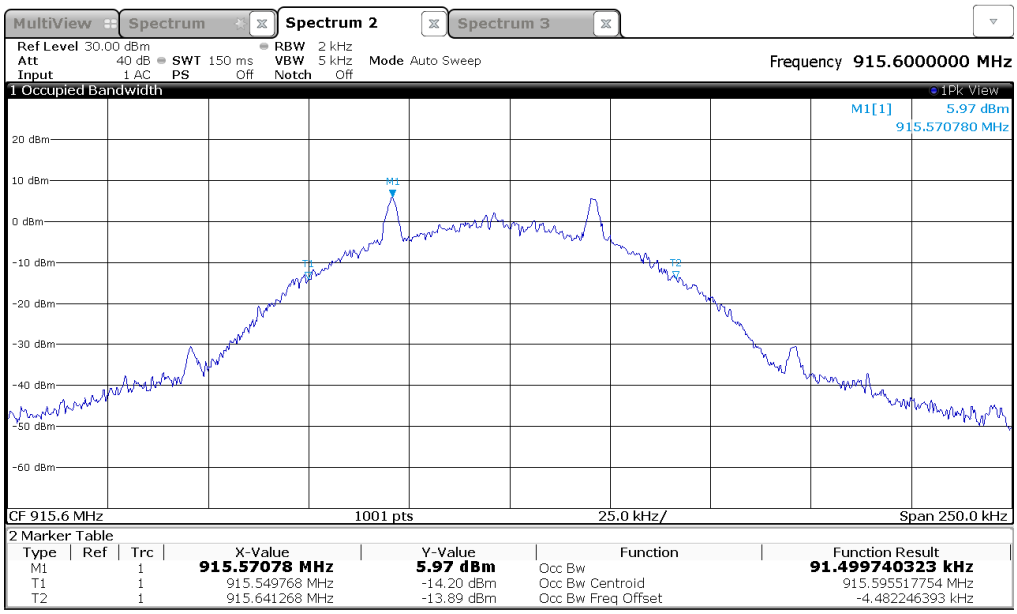
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

927.4MHz



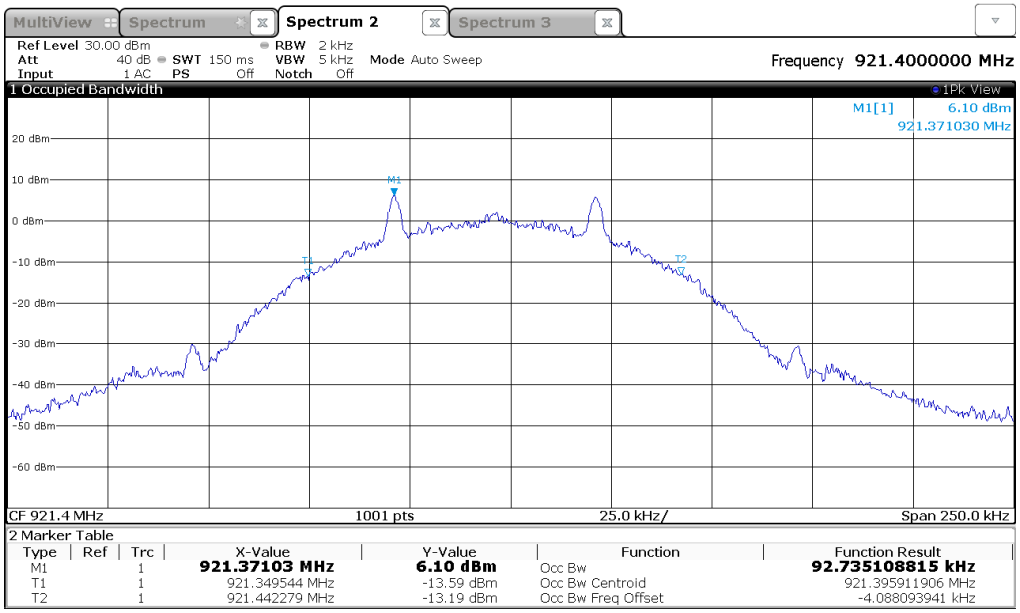
5.1.4 Test protocols – 99% bandwidth

915.6MHz

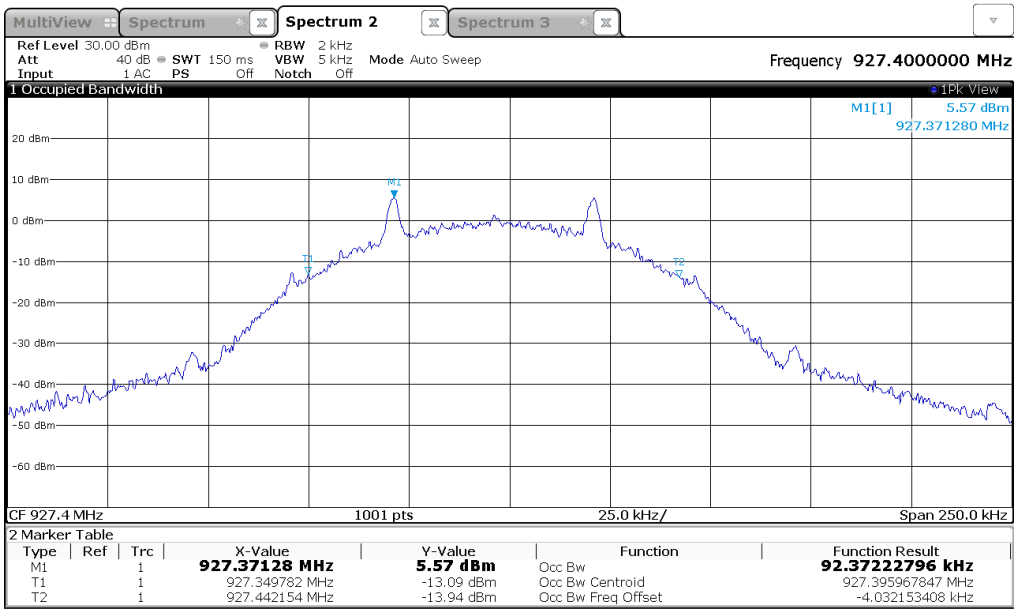


The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

921.4MHz



927.4MHz



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.2 Maximum peak output power conducted

For test instruments and accessories used see section 6 Part **CPC 2**.

5.2.1 Description of the test location

Test location: AREA4

5.2.2 Photo documentation of the test set-up

For test setup photos see T46462-00-03JP ATTACHMENT A

5.2.3 Applicable standard

FCC Part 15, Section 15.247(b)(2) and RSS-247 5.4a:

5.2.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10.
Spectrum analyser settings:
RBW: 200 kHz, VBW: 500 kHz, Detector: Peak, Trace Mode: Max hold, Span: 500 kHz

5.2.5 Test result

Maximum peak conducted power						
Operating frequency [MHz]	Measured value [dBm]	Correction factor* [dB]	Conducted power [dBm]	Conducted power limit [dBm]	Delta [dB]	Result
915.6	10.0	0.6	10.6	30	-19.4	Pass
921.4	9.8	0.6	10.4	30	-19.9	Pass
927.4	8.5	0.6	9.1	30	-20.9	Pass

*measurement cable attenuation

Equivalent isotropically radiated power						
Operating frequency [MHz]	Conducted power [dBm]	Antenna gain [dBi]	Resulting e.i.r.p. power [dBm]	e.i.r.p. limit [dBm]	Delta [dB]	Result
915.6	10.6	-4.3	6.3	36	-29.7	Pass
921.4	10.4	-4.3	6.1	36	-29.9	Pass
927.4	9.1	-4.3	4.8	36	-31.2	Pass

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Maximum peak conducted power limit according to FCC Part 15, Section 15.247(b)(2) and RSS-247 5.4a:

Frequency (MHz)	Peak conducte Power Limit	
	(dBm)	(Watt)
902-928	30*	1.0*

Equivalent isotropically radiated power limit according to RSS-247 5.4a:

Frequency (MHz)	e.i.r.p. limit	
	(dBm)	(Watt)
902-928	36*	4.0*

*Applicable for equipment with 50 or more hopping channels.

The requirements are **FULFILLED.**

Remarks: Conducted sample used

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.3 Spurious emissions conducted

For test instruments and accessories used see section 6 Part **SEC1-3**.

5.3.1 Description of the test location

Test location: Shielded Room S4

5.3.2 Photo documentation of the test set-up

For test setup photos see T46462-00-03JP ATTACHMENT A

5.3.3 Applicable standard

According to FCC Part 15, Section 15.247(d) and RSS-247 5.5:

5.3.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10.
Spectrum analyser settings: refer to attached plots

5.3.5 Test result

All emissions are below the limit. Details can be found in the attached test plots.

Peak-Limit according to FCC Part 15C. Section 15.247(d):
In any 100 kHz bandwidth outside the frequency band 2400 – 2483.50 MHz. 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 limit specified in Section 15.209(a).

The requirements are **FULFILLED.**

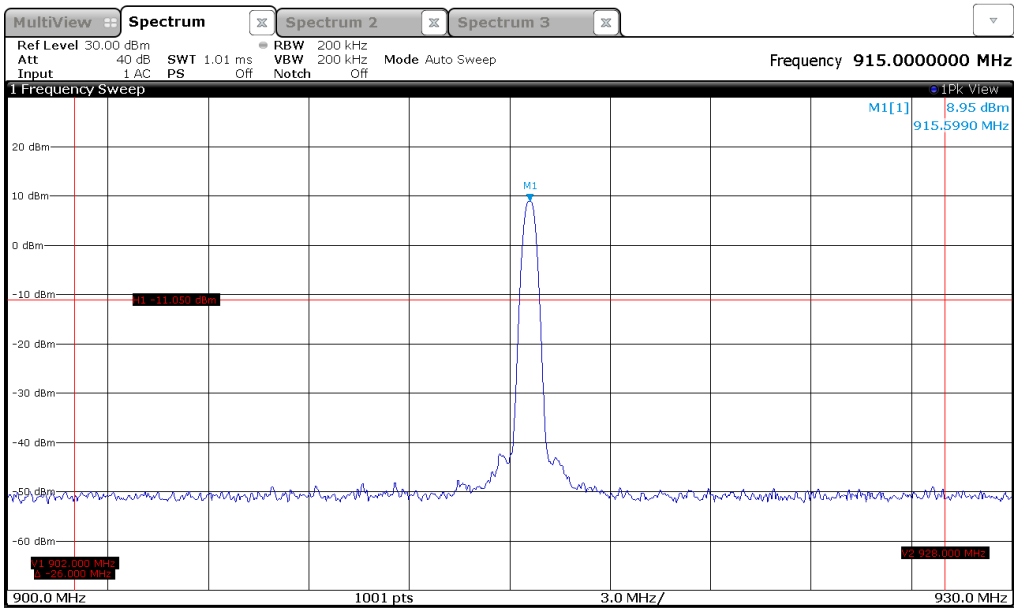
Remarks: For detailed test results please see the following test protocols.

Conducted sample used

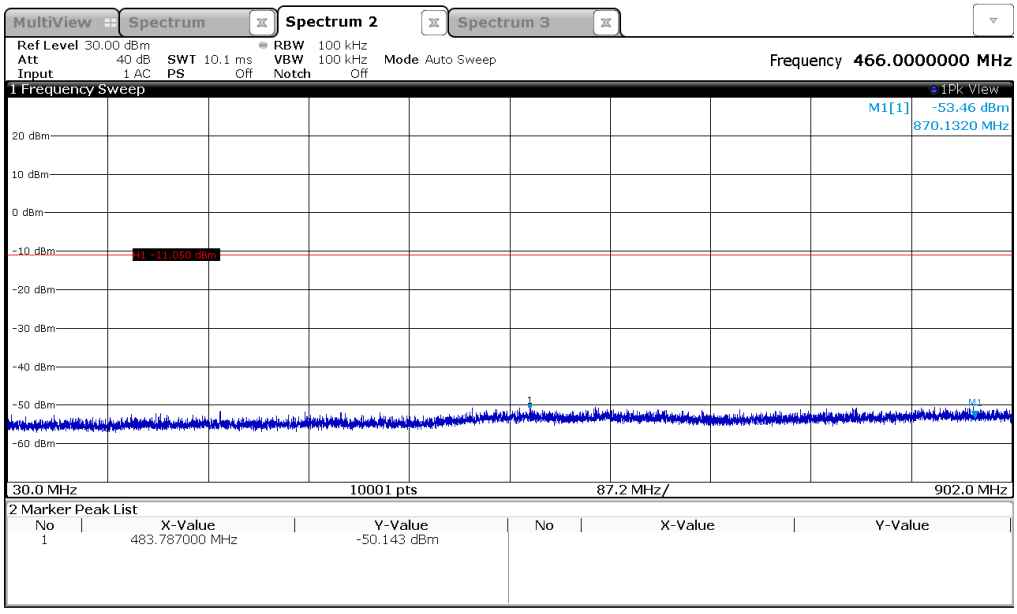
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.3.6 Test protocol

Determination of the reference level, TX 915.6 MHz

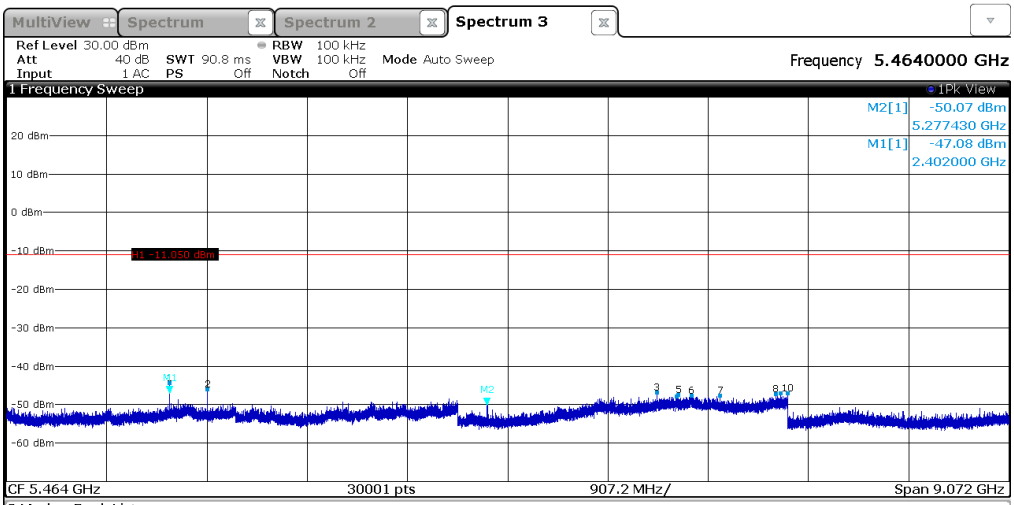


30 MHz – 902 MHz, TX 915.6 MHz



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

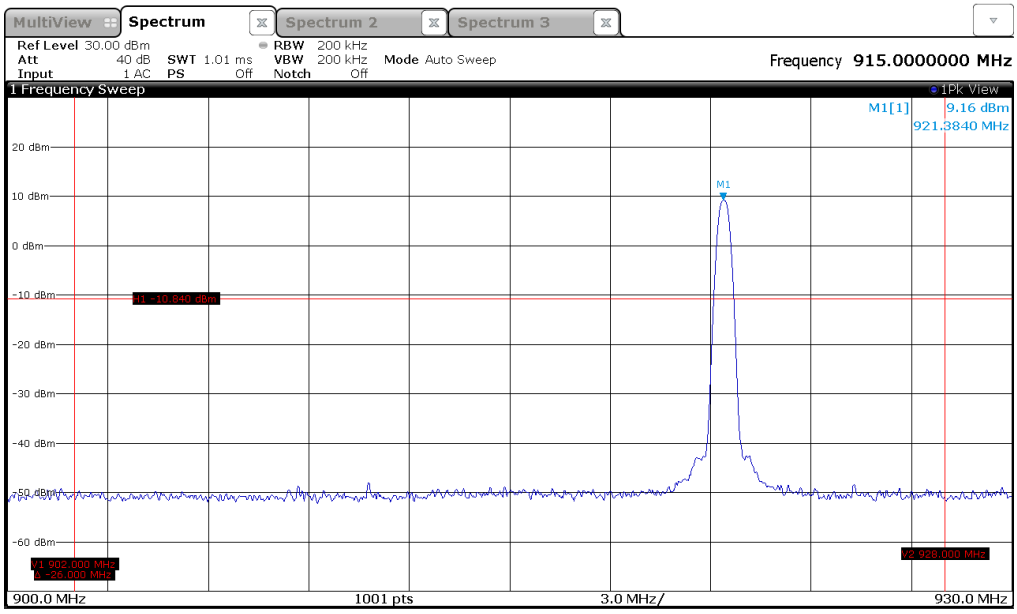
928 MHz – 10 GHz, TX 915.6 MHz



2 Marker Peak List

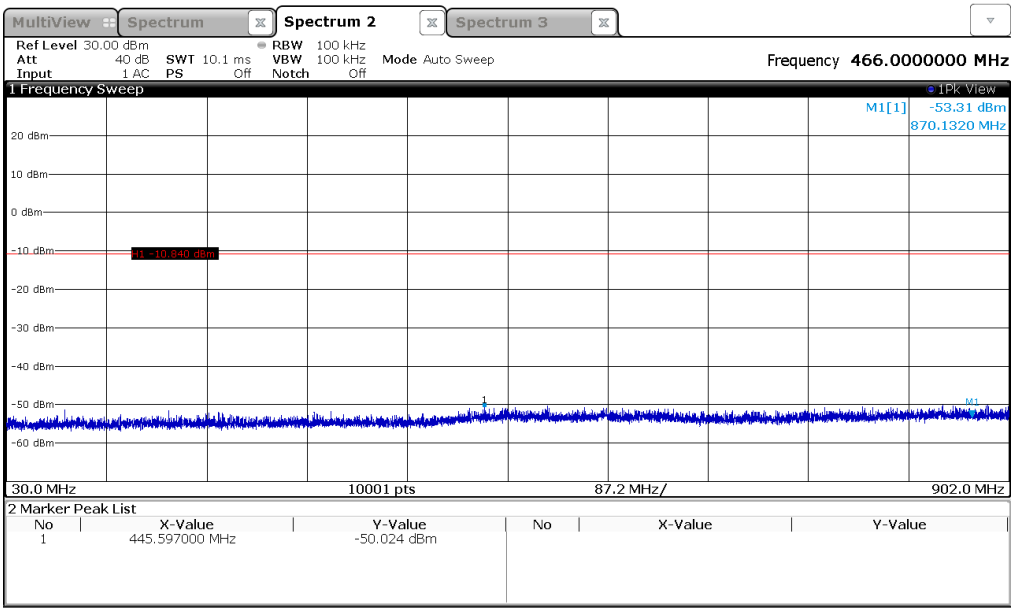
No	X-Value	Y-Value	No	X-Value	Y-Value
1	2.402300 GHz	-44.294 dBm	6	7.125630 GHz	-47.735 dBm
2	2.746720 GHz	-46.024 dBm	7	7.385390 GHz	-47.745 dBm
3	6.814170 GHz	-46.931 dBm	8	7.887960 GHz	-47.193 dBm
4	6.993190 GHz	-47.793 dBm	9	7.933320 GHz	-47.112 dBm
5	7.008610 GHz	-47.548 dBm	10	7.994100 GHz	-47.015 dBm

Determination of the reference level, TX 921.4 MHz

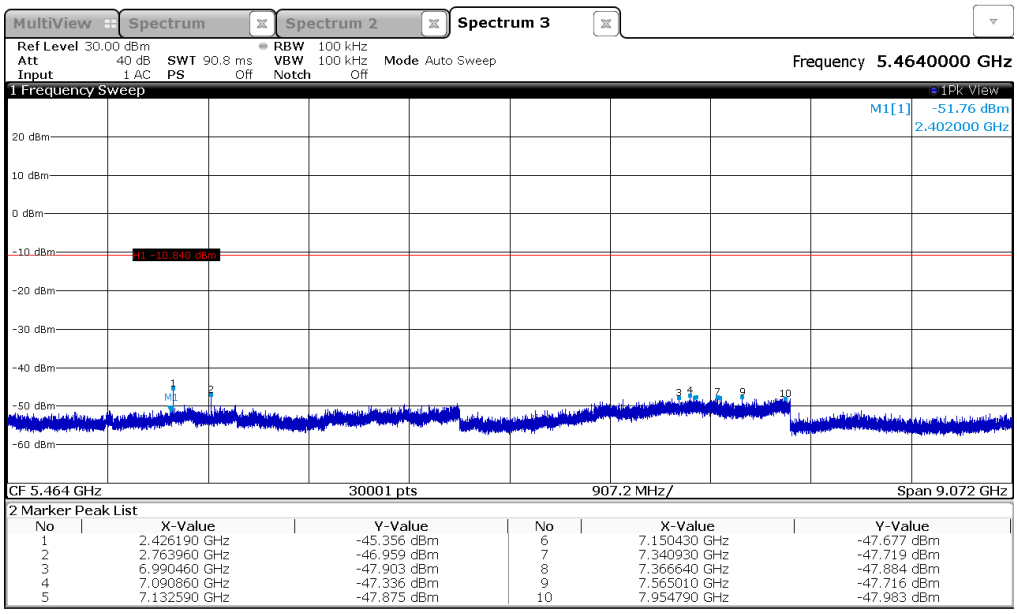


The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

30 MHz – 902 MHz, TX 921.4 MHz

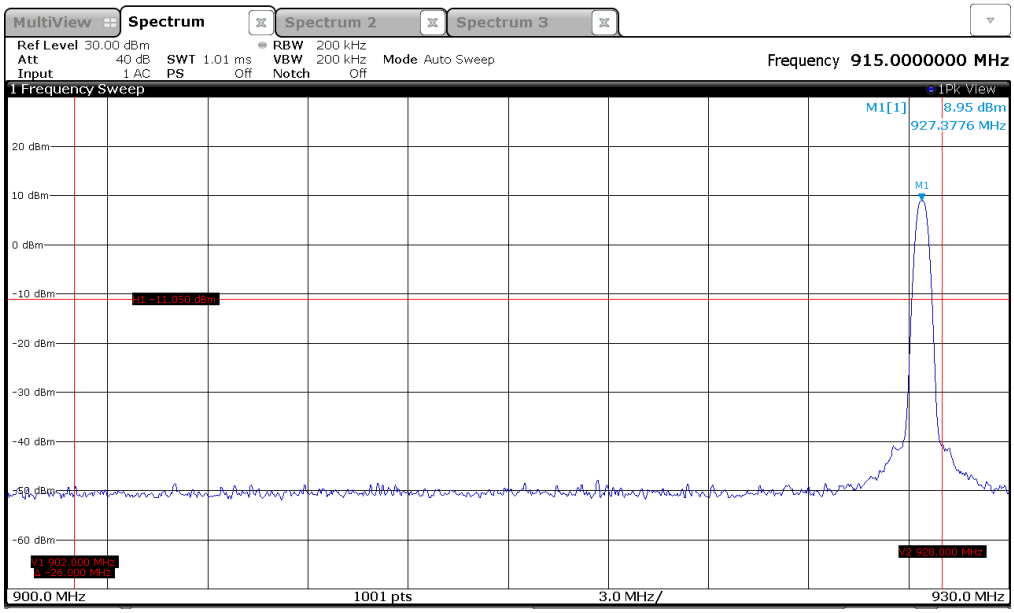


928 MHz – 10 GHz, TX 921.4 MHz

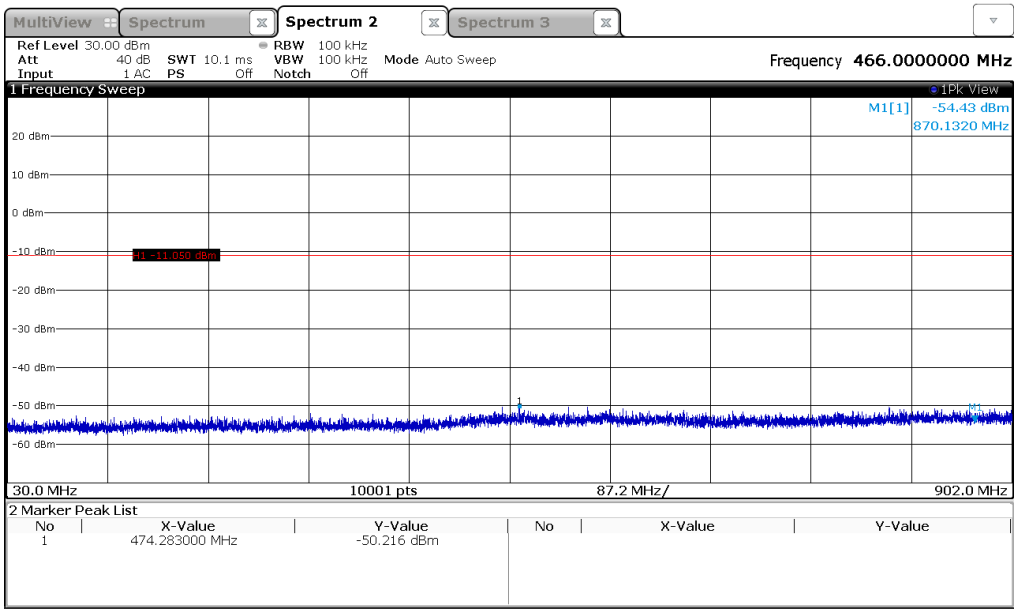


The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Determination of the reference level, TX 927.4 MHz

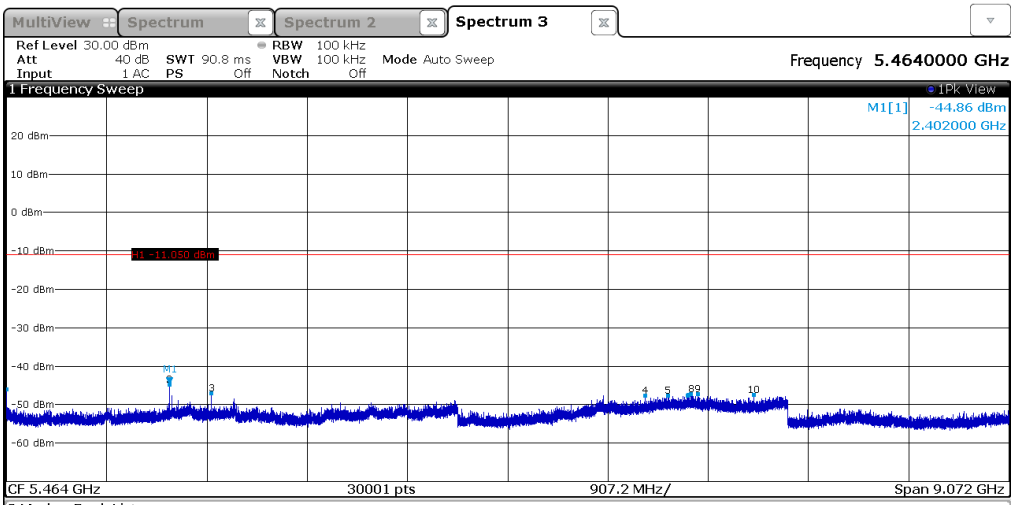


30 MHz – 902 MHz, TX 927.4 MHz



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

928 MHz – 10 GHz, TX 927.4 MHz

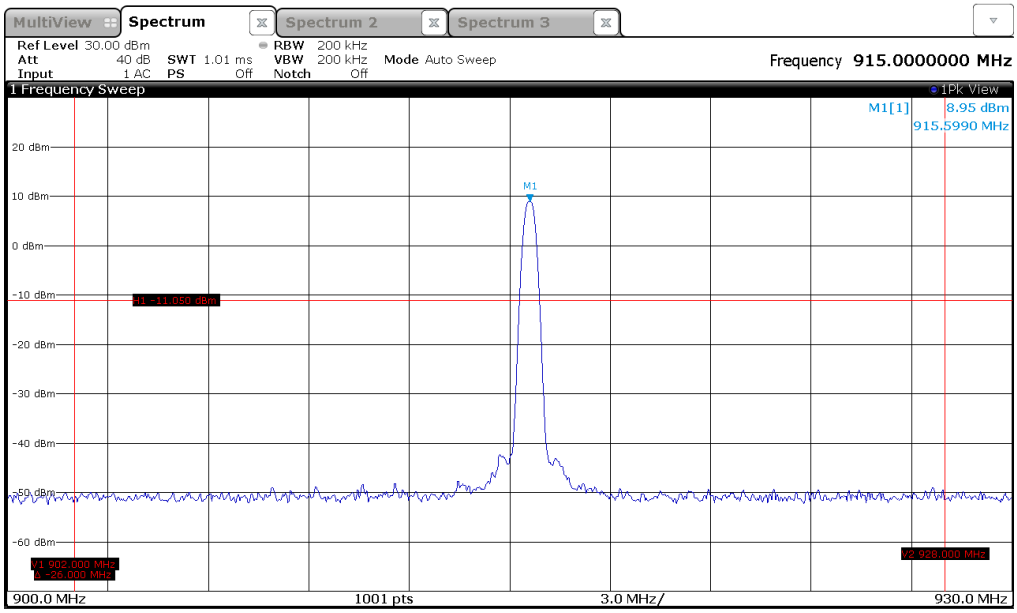


2 Marker Peak List

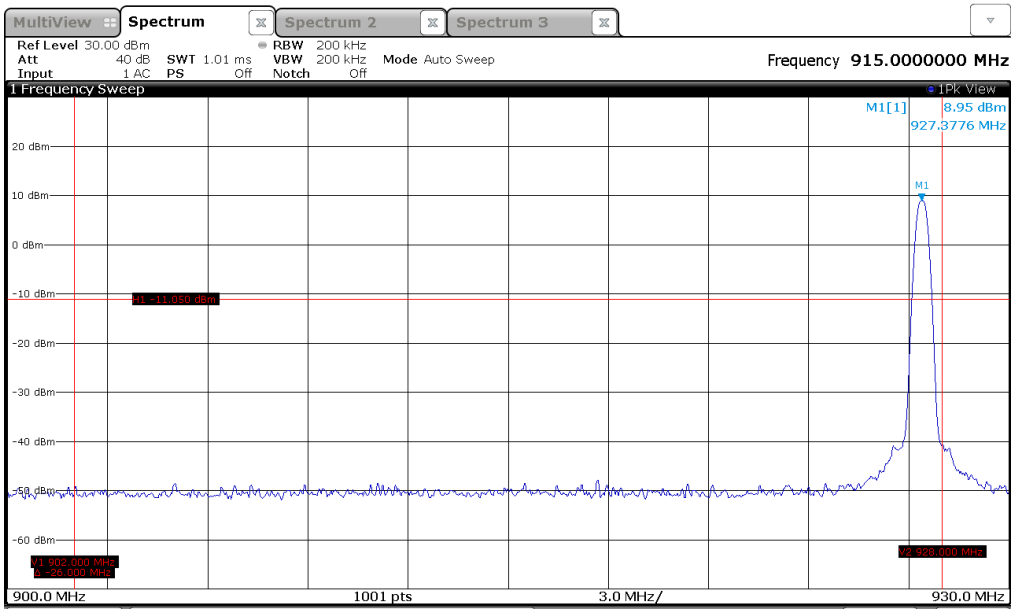
No	X-Value	Y-Value	No	X-Value	Y-Value
1	928.150000 MHz	-45.998 dBm	6	7.095700 GHz	-47.598 dBm
2	2.402000 GHz	-44.860 dBm	7	7.099630 GHz	-47.519 dBm
3	2.782100 GHz	-47.076 dBm	8	7.122610 GHz	-47.254 dBm
4	6.706220 GHz	-47.631 dBm	9	7.184300 GHz	-47.201 dBm
5	6.912150 GHz	-47.635 dBm	10	7.694430 GHz	-47.544 dBm

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Bandedge emission – non hopping mode – lowest channel

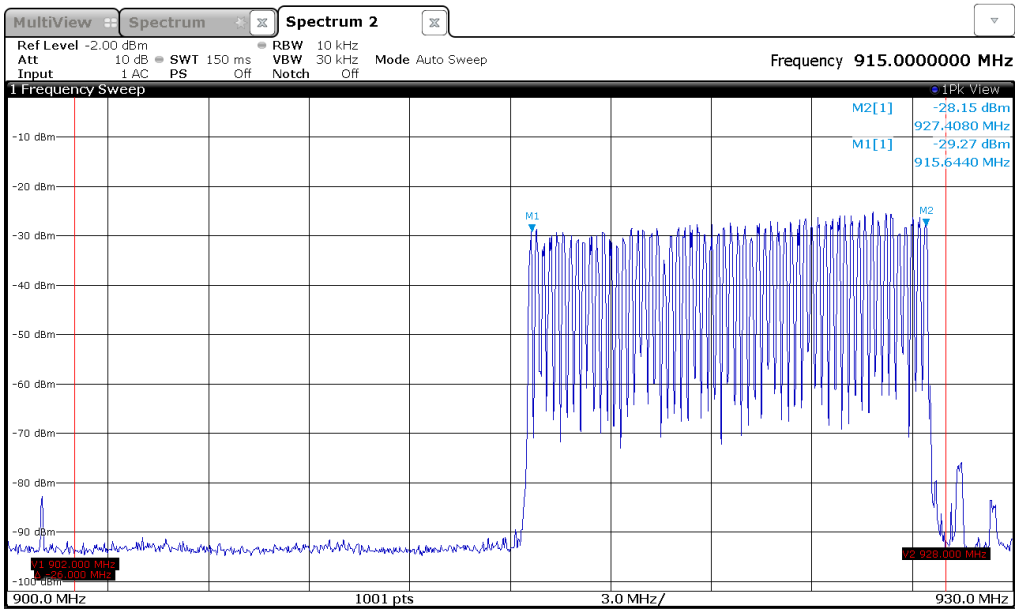


Bandedge emission – non hopping mode – highest channel



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Bandedge emission – hopping mode – all channels



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.5 Unwanted emissions, 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

For test setup photos see T46462-00-03JP ATTACHMENT A

5.5.3 Applicable standard

According to FCC Part 15, Section 15.209 and RSS-GEN 8.9

5.5.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10.

Spectrum analyser settings:
30 MHz – 1000 MHz: RBW: 120 kHz
1000 MHz – 10 GHz: RBW: 1 MHz, VBW: 3 MHz, Sweep: Auto, Detector function: Peak

5.5.5 Test result 30 MHz < f < 1 GHz

Hopping mode (all 60 Channels are used)

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	QP Level Vert. (dBµV/m)	QP Level Hor. (dBµV/m)	QP Limit (dBµV/m)	Dlimit (dB)
56,90	8,3	3,0	13,4	14,4	21,7	17,4	40,0	-18,3
66,90	6,1	1,2	12,4	13,2	18,5	14,4	40,0	-21,5
148,50	8,9	6,7	15,8	15,0	24,7	21,7	43,5	-18,8
198,85	7,2	4,9	13,2	12,7	20,4	17,6	43,5	-23,1
208,31	13,8	12,7	13,5	13,0	27,3	25,7	43,5	-16,2
445,50	4,3	10,1	20,5	20,8	24,8	30,9	46,0	-15,1

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

RX mode (all channels used)

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	QP Level Vert. (dBµV/m)	QP Level Hor. (dBµV/m)	QP Limit (dBµV/m)	Dlimit (dB)
66,90	5,8	2,3	12,4	13,2	18,2	15,5	40,0	-21,8
148,50	8,4	5,7	15,8	15,0	24,2	20,7	43,5	-19,3
198,85	7,0	5,1	13,2	12,7	20,2	17,8	43,5	-23,3
445,50	5,0	8,9	20,5	20,8	25,5	29,7	46,0	-16,3

5.5.6 Test result 1GHz < f < 10 GHz

Continuous TX mode 915.6 MHz

Frequency (MHz)	Reading Pk Vert. (dBµV)	Reading Pk Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Pk Vert. (dBµV/m)	Level Pk Hor. (dBµV/m)	AV Limit (dBµV/m)	Dlimit (dB)
1831,70	73,4	64,5	-16,2	-16,2	***57,1***	48,2	54,0	***3,1***
1894,60	--	63,9	--	-15,6	--	48,3	54,0	-5,7
1942,60	59,8	--	-14,5	--	45,3	--	54,0	-8,7
2745,80	73,5	65,9	-12,8	-12,8	***60,8***	53,1	54,0	***6,8***
3662,80	--	57,4		-12,1	--	45,3	54,0	-8,7
4578,40	52,3	46,1	1,8	1,8	***54,1***	47,9	54,0	***0,1***
6406,60	47,5	--	6,3	--	53,8	--	54,0	-0,2
7323,70	41,7	45,7	6,7	6,7	48,4	52,4	54,0	-1,6
8240,80	--	45,7	--	7,0	--	52,7	54,0	-1,3
9211,80	36,5	39,3	7,1	7,1	43,6	46,4	54,0	-7,6

All PK values keep the PK limit of 74dBµV/m

Continous TX mode 915.6 MHz – DC correction factor applied to PK values above the AV limit

Frequency (MHz)	Level Pk Vert. (dBµV/m)	Level Pk Hor. (dBµV/m)	DC correction factor* (dB)	Level AV Vert. (dBµV/m)	Level AV Hor. (dBµV/m)	AV Limit (dBµV/m)	Dlimit (dB)
1831,70	57,1	48,2	-8,1	49,0	40,1	54,0	-5,0
2745,80	60,8	53,1	-8,1	52,7	45,0	54,0	-1,3
4578,40	54,1	47,9	-8,1	46,0	39,8	54,0	-8,0

*Refer to subclause 5.6 of this report

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

RX mode 915.6 MHz

Frequency (MHz)	Reading Pk Vert. (dBµV)	Reading Pk Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	AV Limit (dBµV/m)	Dlimit (dB)
1373,10	54,5	55,5	-18,5	-18,5	36,0	37,0	54,0	-17,0
1885,60	56,8	61,4	-15,7	-15,7	41,1	45,8	54,0	-8,2
2868,60	51,9	52,2	-13,2	-13,2	38,8	39,1	54,0	-14,9
4692,30	39,1	41,1	2,2	2,2	41,3	43,3	54,0	-10,7
6322,70	36,2	39,1	6,0	6,0	42,2	45,1	54,0	-8,9
8330,70	36,7	38,6	7,2	7,2	43,9	45,8	54,0	-8,2

Continuous TX mode 921.4 MHz

Frequency (MHz)	Reading Pk Vert. (dBµV)	Reading Pk Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	AV Limit (dBµV/m)	Dlimit (dB)
1843,70	70,0	62,7	-16,1	-16,1	53,9	46,6	54,0	-0,1
2763,70	72,0	63,9	-12,8	-12,8	***59,2***	51,1	54,0	***5,2***
4608,40	47,1	44,1	2,0	2,0	49,1	46,1	54,0	-4,9
6448,60	40,9	38,9	6,3	6,3	47,1	45,2	54,0	-6,9

All PK values keep the PK limit of 74dBµV/m

Continous TX mode 921.4 MHz – DC correction factor applied to PK values above the AV limit

Frequency (MHz)	Level Pk Vert. (dBµV/m)	Level Pk Hor. (dBµV/m)	DC correction factor* (dB)	Level AV Vert. (dBµV/m)	Level AV Hor. (dBµV/m)	AV Limit (dBµV/m)	Dlimit (dB)
2763,70	59,2	51,1	-8,1	51,1	43,0	54,0	-2,9

*Refer to subclause 5.6 of this report

RX mode 921.4 MHz

Frequency (MHz)	Reading Pk Vert. (dBµV)	Reading Pk Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	AV Limit (dBµV/m)	Dlimit (dB)
1346,10	56,1	54,0	-18,4	-18,4	37,7	35,6	54,0	-16,3
1885,60	56,8	61,4	-15,7	-15,7	41,1	45,7	54,0	-8,3
2973,50	53,7	50,5	-12,5	-12,5	41,2	38,0	54,0	-12,8
4248,80	41,4	39,2	1,0	1,0	42,4	40,3	54,0	-11,6
6310,70	38,5	36,7	6,0	6,0	44,5	42,7	54,0	-9,5
8001,00	38,4	36,4	7,4	7,4	45,8	43,8	54,0	-8,2

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Continuous TX mode 927.4 MHz

Frequency (MHz)	Reading Pk Vert. (dBµV)	Reading Pk Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	AV Limit (dBµV/m)	Dlimit (dB)
1855,60	66,9	71,9	-15,8	-15,8	51,1	***56,1***	54,0	***2,1***
1882,60	--	59,3	--	-15,7	--	43,6	54,0	-10,4
2781,70	72,2	65,3	-12,8	-12,8	***59,4***	52,6	54,0	***5,4***
3710,80	54,7	55,5	-12,0	-12,0	42,7	43,5	54,0	-10,5
4638,40	44,8	46,4	2,1	2,1	46,9	48,5	54,0	-5,5
6490,50	40,1	43,0	6,2	6,2	46,4	49,2	54,0	-4,8

All PK values keep the PK limit of 74dBµV/m

Continous TX mode 921.4 MHz – DC correction factor applied to PK values above the AV limit

Frequency (MHz)	Level Pk Vert. (dBµV/m)	Level Pk Hor. (dBµV/m)	DC correction factor* (dB)	Level AV Vert. (dBµV/m)	Level AV Hor. (dBµV/m)	AV Limit (dBµV/m)	Dlimit (dB)
1855,60	51,1	56,1	-8,1	43,0	48,0	54,0	-6,0
2781,70	59,4	52,6	-8,1	51,3	44,5	54,0	-2,7

*Refer to subclause 5.6 of this report

RX mode 927.4 MHz

Frequency (MHz)	Reading Pk Vert. (dBµV)	Reading Pk Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	AV Limit (dBµV/m)	Dlimit (dB)
1373,10	56,5	56,0	-18,5	-18,5	38,0	37,5	54,0	-16,0
1885,60	55,4	57,9	-15,7	-15,7	39,7	42,2	54,0	-11,8
2868,60	55,2	52,6	-13,2	-13,2	42,0	39,5	54,0	-12,0
4260,70	41,5	39,8	1,0	1,0	42,5	40,9	54,0	-11,5
6832,20	38,7	36,8	6,6	6,6	45,3	43,4	54,0	-8,7
8480,50	38,4	36,3	7,5	7,5	45,9	43,8	54,0	-8,1

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Radiated limits according to FCC Part 15 Section 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
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

Radiated limits according to RSS-GEN 8.9 Table 5:

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:
If average detector is specified there is also a peak limit which is 20dB above the average limit.

The requirements are **FULFILLED.**

Remarks: Radiated sample is used. For frequencies were the peak value is above the average limit duty cycle correction was used. For calculation of duty cycle correction factor see subclause 5.6 of this report. Radiated sample used.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.6 Duty cycle correction factor

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

5.6.1 Description of the test location

Test location: Shielded Room S4

5.6.2 Photo documentation of the test set-up

For test setup photos see T46462-00-03JP ATTACHMENT A

5.6.3 Applicable standard

According to FCC Part 15A, Section 15.35(c) and RSS-GEN 8.2

5.6.4 Description of Measurement

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

$$\delta(dB) = 20 \log ((t_1 + t_2 + \ldots + t_n) / T)$$

δ(dB) duty cycle correction factor expressed in dB
t_1 duration of pulse 1 in the defined time period T
t_2 duration of pulse 2 in the defined time period T
t_n duration of pulse n in the defined time period T
T period of one complete puls train or 100ms if the complete puls train is longer 100ms

5.6.5 Test result

t_1 [ms]	t_2 [ms]	t_3 [ms]	t_4 [ms]	*T* [ms]
39.2	0	0	0	100

RESULT δ(dB) = -8.1

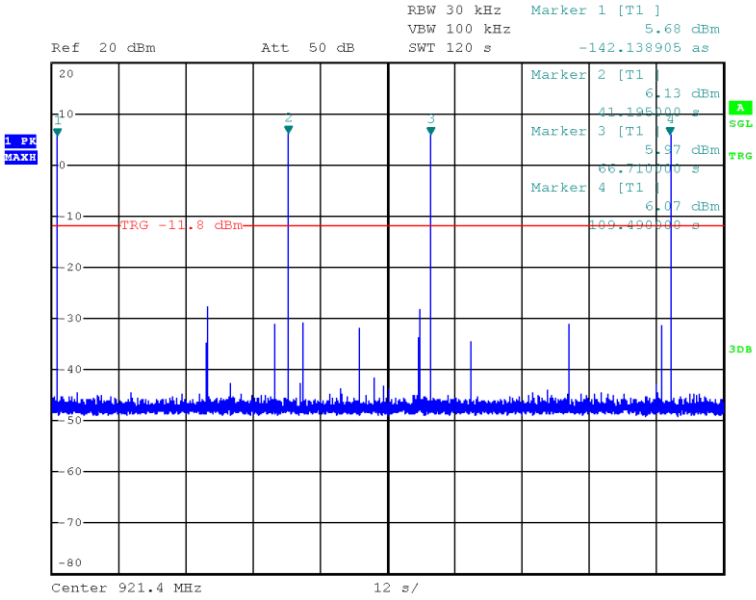
Remarks: Maximum duty cycle used for calculation. Conducted sample used.

Pulse train is longer than 100ms therefore 100ms were used as described in FCC 15.35

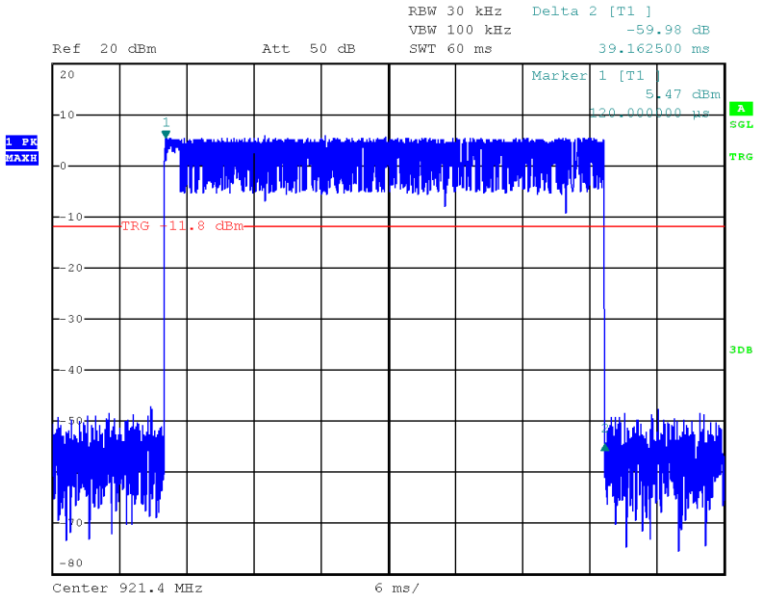
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.6.6 Test protocol

Determination of T = 100ms



Determination of t_1 = 39.2ms



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.7 Carrier frequency separation

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

5.7.1 Description of the test location

Test location: AREA4

5.7.2 Photo documentation of the test set-up

For test setup photos see T46462-00-03JP ATTACHMENT A

5.7.3 Applicable standard

FCC Part 15, Section 15.247(a)(1) and RSS-247 5.1b

5.7.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10.
Spectrum analyser settings: refer to attached plots

5.7.5 Test result

Reference channel [MHz]	Channel separation down [kHz]	Channel separation up [kHz]	Applied limit [kHz]
921.398	200.8	200.8	101

Limit according to FCC Part 15, Section 15.247(a)(1) and RSS-247 5.1b:

Frequency	Limit channel separation
(MHz)	(kHz)
All systems	> 25 kHz or 20 dB bandwidth, whichever is greater

The requirements are **FULFILLED.**

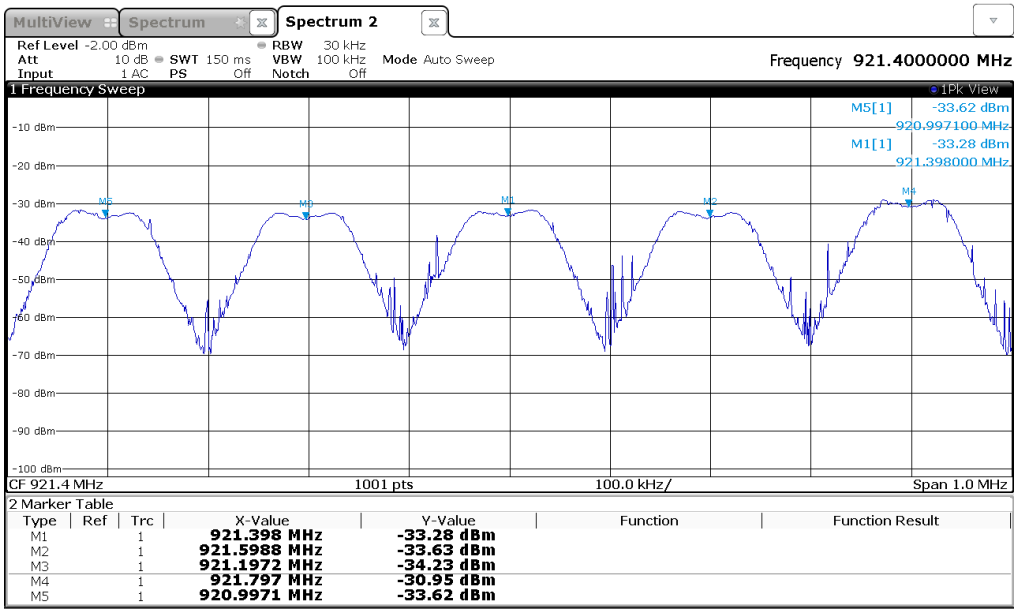
Remarks: For detailed test results please see the following test protocols.

Conducted sample used.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.7.6 Test protocol

Channel separation



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.8 Number of hopping channels

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

5.8.1 Description of the test location

Test location: AREA4

5.8.2 Photo documentation of the test set-up

For test setup photos see T46462-00-03JP ATTACHMENT A

5.8.3 Applicable standard

FCC Part 15, Section 15.247(a)(1)(i) and RSS-247 5.1c

5.8.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10.
Spectrum analyser settings: refer to attached plots

5.8.5 Test result

Hopping channel frequency range	Quantity of hopping channels value	Quantity of hopping channels minimum limit
915.6-927.4 MHz	60	50

Limit according to FCC Part 15C. Section 15.247(1):

Frequency range (MHz)	minimum Quantity of Hopping Channels	
	20dB Bandwidth < 250kHz	20dB Bandwidth > 250kHz
902 - 928	50	25

The requirements are **FULFILLED.**

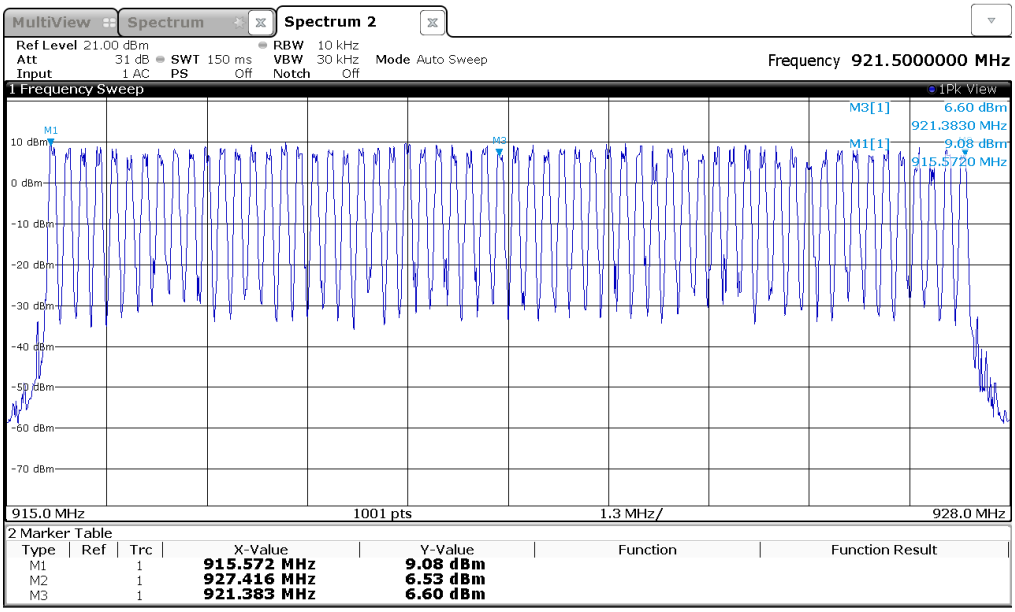
Remarks: For detailed test results please see the following test protocols.

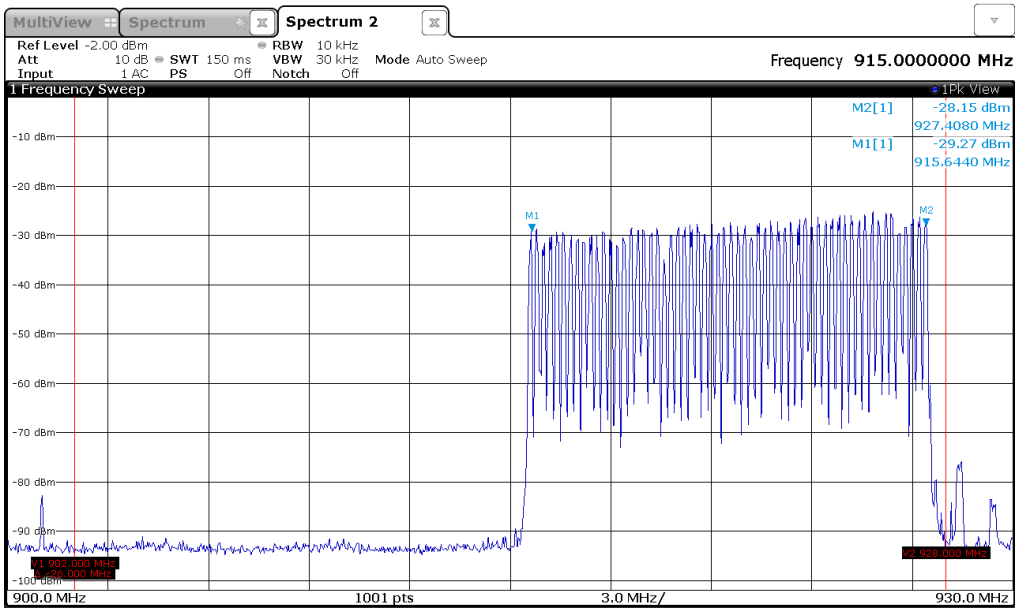
Conducted sample used.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.8.6 Test protocol

Number of hopping channels





The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.9 Average time of occupancy

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

5.9.1 Description of the test location

Test location: AREA4

5.9.2 Photo documentation of the test set-up

For test setup photos see T46462-00-03JP ATTACHMENT A

5.9.3 Applicable standard

FCC Part 15, Section 15.247(a)(1)(i) and RSS-247 5.1c:

5.9.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10.
Spectrum analyser settings: refer to attached plots

5.9.5 Test result

Channel frequency (MHz)	Pulse Time (ms)	Number of Bursts (in 1 time period)	Dwell time (pulse time x number of bursts) (ms)
915,6	39,2	1	39,2
921,4	39,2	1	39,2
927,4	39,2	1	39,2

Limit according to FCC Part 15, Section 15.247(a)(1)(i) and RSS-247 5.1c:

Frequency band	Hopping channels	time of one period	Limit dwell time, AV
(MHz)		(s)	(ms)
902-928	≥ 50	20	< 400

The requirements are **FULFILLED.**

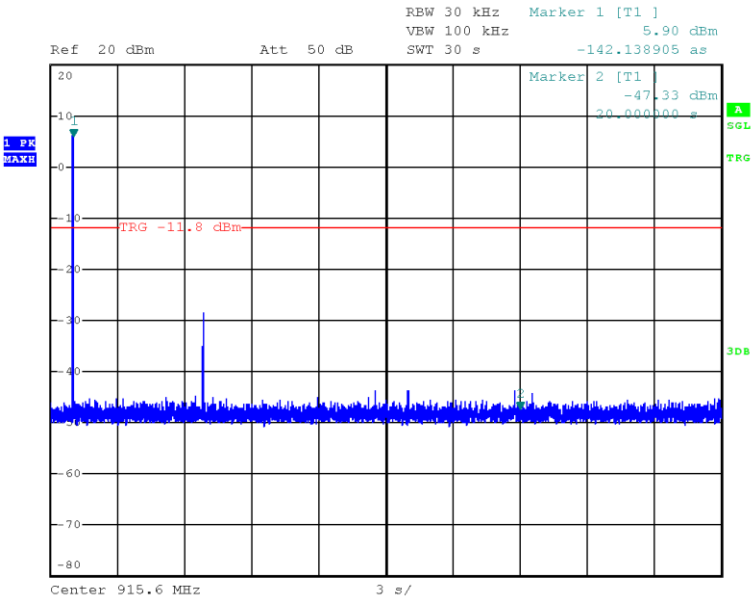
Remarks: For detailed test results please refer to following test protocols.

Conducted sample used.

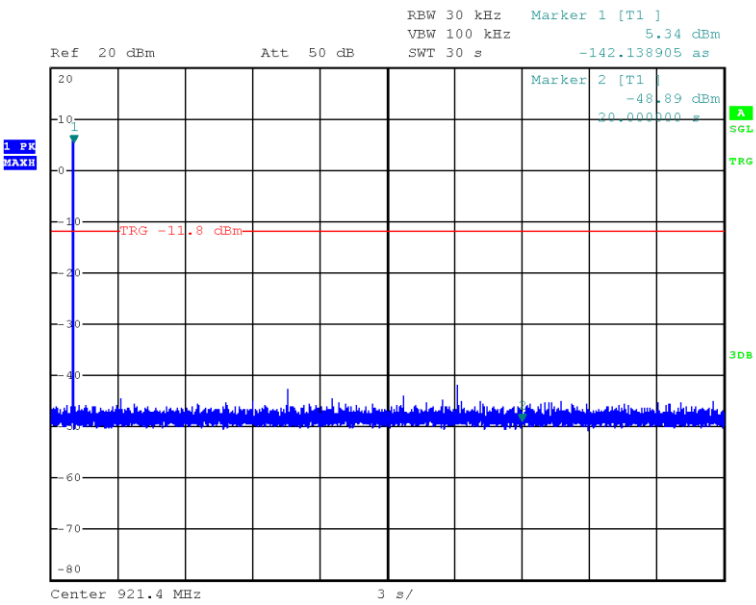
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

5.9.6 Test protocol

No of burst per time period
915.6MHz

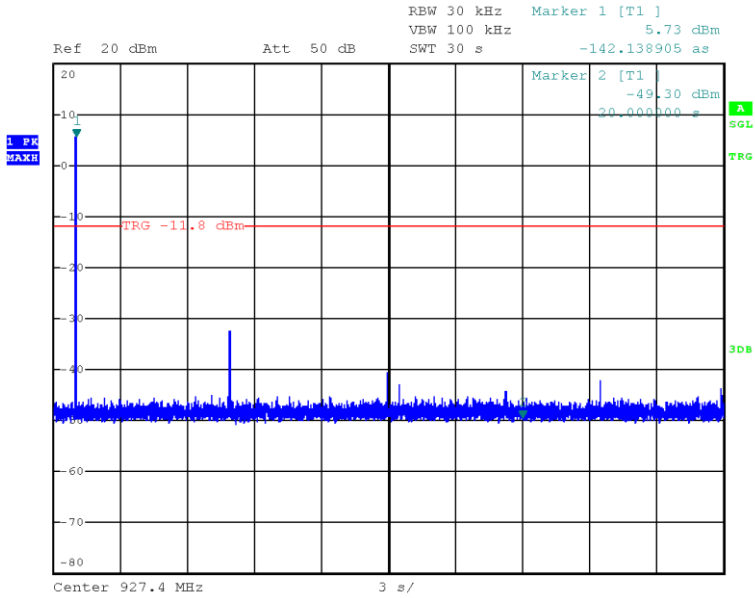


No of burst per time period
921.4MHz

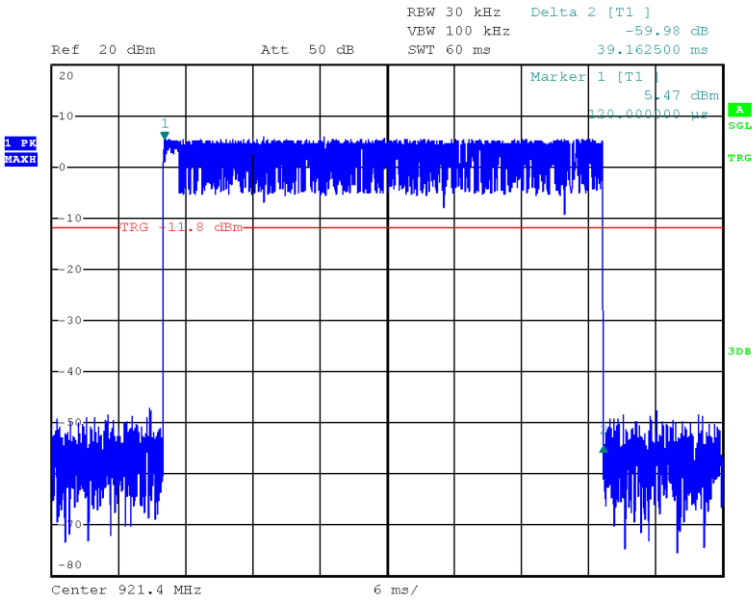


The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

No of burst per time period
927.4MHz



Time per burst pulse



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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.
CPC 2	ESW26	02-02/03-17-002	16/01/2021	16/01/2020		
DC	ESCI	02-02/03-15-001	24/06/2021	24/06/2020		
MB	ESW26	02-02/03-17-002	16/01/2021	16/01/2020		
SEC 1-3	ESW26	02-02/03-17-002	16/01/2021	16/01/2020		
SER 2	ESVS 30	02-02/03-05-006	15/07/2021	15/07/2020		
	VULB 9168	02-02/24-05-005	19/09/2020	19/07/2019		
	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 3	FSW43	02-02/11-15-001	02/04/2021	02/04/2020		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	18/06/2021	18/06/2020		
	18N-20	02-02/50-17-003				
	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				
	BAT-EMC 3.19.1.24	02-02/68-13-001				

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.