DAkkS Deutsche Akkreditierungsstelle D-PL-21375-01-00

LENHARDT WORLDWIDE | TESTING | CERTIFICATION

Bundesnetzagentur BNetzA-CAB-21/21-21

Test Report

Test report no.: 25031309-45388-0
Date of issue: 2025-06-23

Test result: The test item **- passed -** and complies with the listed standards.

Applicant
Nordic ID Oy

Manufacturer
Nordic ID Oy

Test Item
IOX100

Radio Frequency Testing according to:

Title 47
FCC Regulations Subpart 15C
§15.247

ISED-Regulations
RSS-Gen, Issue 5
RSS-247, Issue 3

Tested by (name, function, signature)	*Piotr Sardyko* *Lab Manager RF*	signature
Approved by (name, function, signature)	*Andreas Bender* *Deputy Managing Director*	signature

Applicant and Test item details	
Applicant	Nordic ID Oy Joensuunkatu 7 Salo, 24100 Finland
Manufacturer	Nordic ID Oy Joensuunkatu 7 Salo, 24100 Finland
Test item description	UHF RFID Reader
Model/Type reference	IOX100

Technology	SRD, UHF RFID
FCC ID	SCC11611A
IC	5137A-11611A

Disclaimer and Notes

Within this test report, a ☒ point / ☐ comma is used as a decimal separator.
If otherwise, a detailed note is added adjected to its use.

Decision rule:
Decision rule based on simple acceptance without guard bands, binary statement, based on mutually agreed uncertainty tolerances with expansion factor k=2.

1 TABLE OF CONTENTS

2 GENERAL INFORMATION

2.1 Administrative details

Testing laboratory	**IBL-Lab GmbH** Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany Fon: +49 6894 38938-0 Fax: +49 6894 38938-99 URL: https://ib-lenhardt.com/ E-Mail: info@ib-lenhardt.com
Accreditation / Designation	The testing laboratory is accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025:2018. Scope of testing and registration number: • Attachment to the accreditation certificate D-PL-21375-01-00 ○ Electronics ○ Electromagnetic Compatibility ○ Radio ○ Electromagnetic Compatibility and Telecommunication (FCC requirements) ○ Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards ○ Automotive EMC Website DAkkS: https://www.dakks.de/ The Deutsche Akkreditierungsstelle GmbH (DAkkS) is also a signatory to the ILAC Mutual Recognition Arrangement. • Designations ○ FCC Testing Laboratory Designation No. DE0024 ○ ISED Company Number 27156 Testing Laboratory CAB Identifier DE0020 ○ Kraftfahrt-Bundesamt KBA-P 00120-23
Testing location	**IBL-Lab GmbH** Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany
Date of receipt of test samples	2025-06-10
Start – End of tests	2025-06-12 – 2025-06-18

2.2 Possible verdicts of the results

Test sample meets the requirements	P (PASS) – the measured value is below the acceptance limit, AL = TL
Test sample does not meet the requirements	F (FAIL) – the measured value is above the acceptance limit, AL = TL
Test case does not apply to the test sample	N/A (Not applicable)
Test case not performed	N/P (Not performed)

2.3 Observations

No additional observations other than the reported observations within this test report have been made.

2.4 Opinions and Interpretations

No appropriate opinions or interpretations according ISO/IEC 17025:2017 clause 7.8.7 are within this test report.

2.5 Revision History

-0 Initial Version

2.6 Further documents

List of further applicable documents belonging to the present test report:

Measurement plots:	25031309-45388-0_Annex A
EUT photographs:	25031309-45388-0_Annex B
Test setup photographs:	25031309-45388-0_Annex C

2.7 Formula for determination of correction values (E_C)

$E_C = E_R + AF + C_L + D_F - G_A$ (1)

$M = L_T - E_C$ (2)

E_C = Electrical field – corrected value
E_R = Receiver reading
M = Margin
L_T = Limit
AF = Antenna factor
C_L = Cable loss
D_F = Distance correction factor (if used)
G_A = Gain of pre-amplifier (if used)

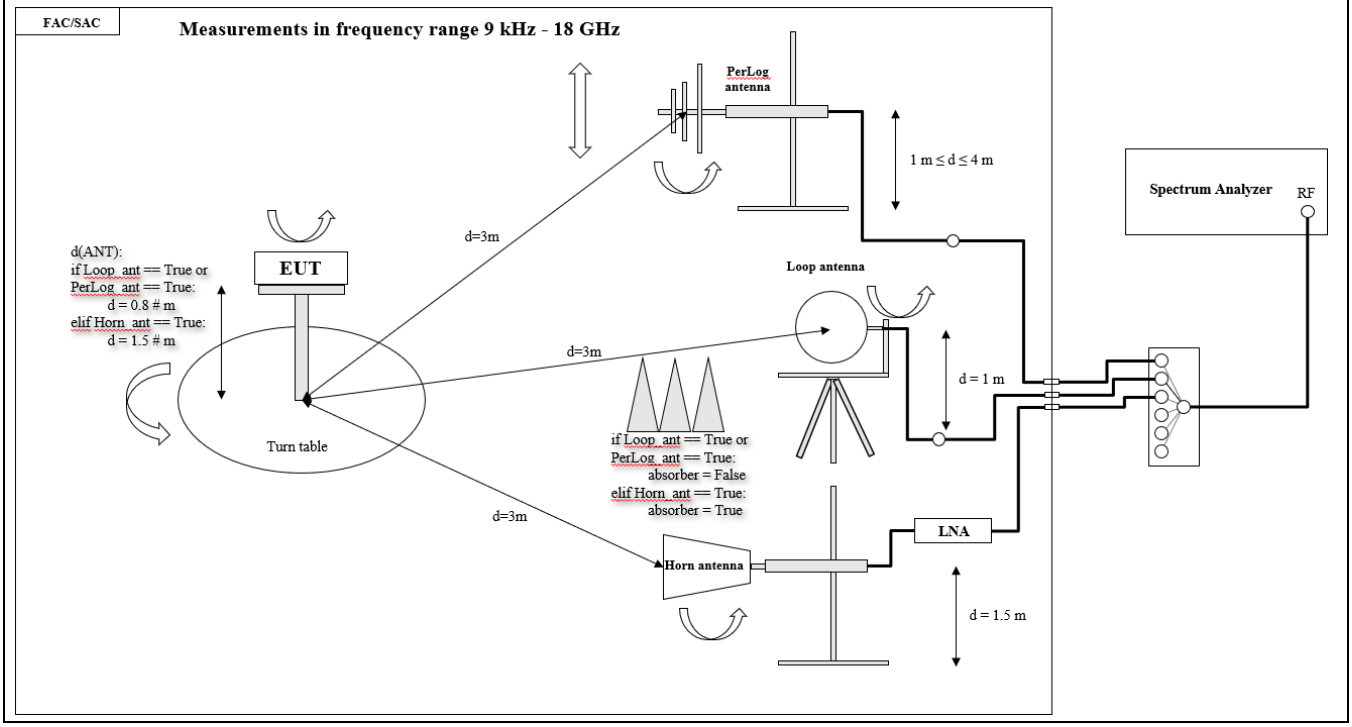
All units are dB-units, positive margin means value is below limit.

2.8 Software/Firmware used for measurements

All measurements were done directly with spectrum analyzer or SW R&S EMC32.
In some measurements (please see test equipment list for each test) R&S ESW 26 was used (please see chapter 8).
(Instrument) Firmware Version: **1.70**
In some measurements (please see test equipment list for each test) R&S FSW 50 was used (please see chapter 8).
(Instrument) Firmware Version: **4.61**
In some measurements SW R&S EMC32 was used.
Version: **11.10.00**

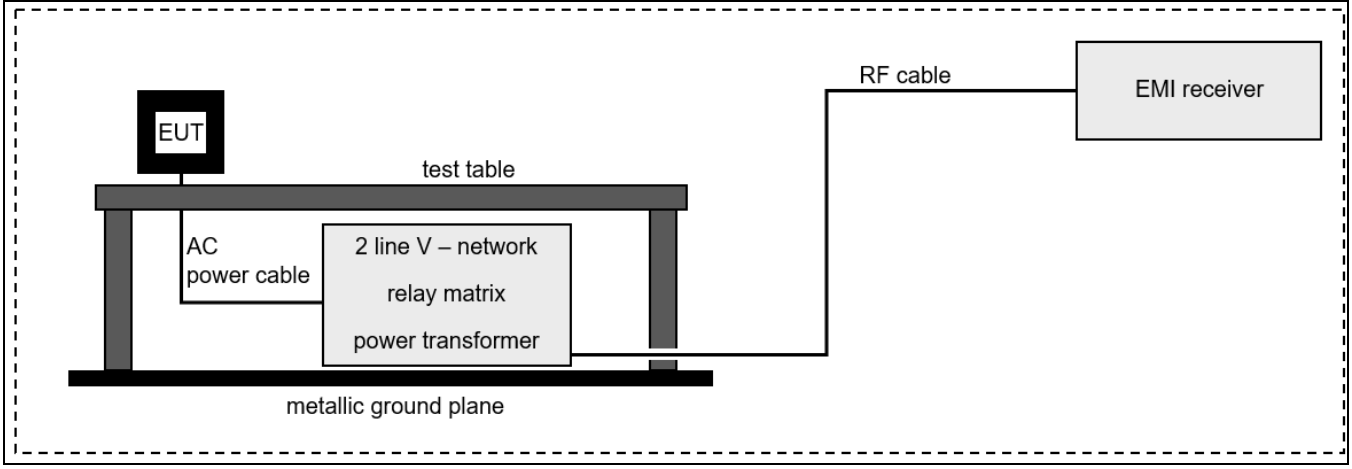
2.9 Block diagrams

Block diagram 1:



* depending on limit line different horn antennas, correspondingly different measurement distances, can be used.

Block diagram 2 (conducted emissions measurements):



3 ENVIRONMENTAL & TEST CONDITIONS

3.1 Environmental conditions of lab

Temperature	20°C ± 5°C
Relative humidity	25-75 % R.H.
Barometric Pressure	860-1060 mbar
Power supply	24V

4 TEST STANDARDS AND REFERENCES

Test standard (accredited)	
FCC CFR Title 47 Part 15 Subpart C:2016	---
RSS-247 Issue 3	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen Issue 5	General Requirements for Compliance of Radio Apparatus
ANSI C63.10: 2013	---

Test standard (not accredited)
None

Reference	**Description**
none	---

5 EQUIPMENT UNDER TEST (EUT)

5.1 Product Description*

IOX100 is a small sized UHF RFID reader with IO-link interface for powering and communications. Full range of RFID functionalities can be accessed using a Brady IRP protocol.

*: declared by the applicant

5.2 Technical Data of Equipment*

Frequency band:	[Tx and Rx: 902-928] MHz
Number of channels:	50 channels
Channel bandwidth:	500 kHz
Channel tested:	f_{low}: 902.75 MHz, f_{mid}: 914.75 MHz, f_{high}: 927.25 MHz
Spectrum Access Mechanism:	FHSS
Modulation type:	ASK
Adaptive Frequency Agility:	Yes
DSSS or FHSS techniques:	FHSS
RF mode:	TX/RX
Antenna Type:	Internal, one (Integrated circularly polarized UHF RFID antenna)
Antenna connector:	None
Equipment type:	Production model
Temperature range:	Tmin: -20 °C, Tmax: 65 °C
Test source voltage:	IO-Link USB-Master (24V)

*: declared by the applicant

5.3 Test Item (Equipment Under Test) Description*

Short designation	EUT Model	EUT Description	Serial number / designation	Hardware status	Software status
EUT A	IOX100 (conducted sample)	UHF RFID Reader	N251300006	1.0	17.3
EUT B	IOX100 (radiated sample)	UHF RFID Reader	N251300003	1.0	17.3

*: declared by the applicant

5.4 Auxiliary Equipment (AE) Description*

AE short designation	AE Name (if available)	AE Description	Serial number (if available)	Software (if used)
AE1	TMG USB IO-Link Master V2 SE	IO-Link USB master (+ Adapter + USB Cable)	-	-
AE2	BC-M12F5M12M5-22-2	Cable	815149	-
AE3	IOX100 Test Tool	SW (installed on Dell Latitude E7470 laptop with Windows 10)	-	V0.6.0.

*: declared by the applicant

5.5 Operating Modes Description*

EUT operating mode no.	Description of operating modes	Additional information
op. 1	f_{low}: 902.75 MHz. Tx modulated.	Continuous Tx
op. 2	f_{mid}: 914.75 MHz. Tx modulated.	Continuous Tx
op. 3	f_{high}: 927.25 MHz. Tx modulated.	Continuous Tx
op. 4	Normal RFID tag reading mode.	EUT will use all the available channels in the chosen region.

*: declared by the applicant

5.6 Set-ups Description

set. 1	EUT A + AE 1 + AE 2 + AE 3	Conducted tests.
set. 2	EUT B + AE 1 + AE 2 + AE 3	Radiated tests.

*: declared by the applicant

5.7 Test conditions

Temperature, [°C]		Voltage, [V]	
Tnom	20 ± 5	Vnom	24
Tmax	-	Vmax	-
Tmin	-	Vmin	-

5.8 Additional Information

Test items differences	EUT A is a conducted sample (SMA connector). EUT B is a radiated sample.
Additional application considerations to test a component or sub-assembly	-

6 SUMMARY OF TEST RESULTS

Test specification
FCC 15.247 / RSS-247 (Issue 3)

Section	§15.247 Spec Clause	RSS	Test Description	Set-up	Opera-ting mode	Verdict
7.1	§15.247(b)	RSS-247 5.4	Peak Output Power	1	1,2,3	**Pass**
7.2		RSS-Gen 6.7	99% Emission Bandwidth	1	1,2,3	**Pass**
7.3	§15.247(a)	RSS-247 5.1(a)	Minimum 20 dB RF Bandwidth	1	1,2,3	**Pass**
7.4	§15.247(d)	RSS-247 5.5	Out-of-Band Emissions - Conducted	1	1,2,3	**Pass**
7.5	§15.247(d)	RSS-Gen 8.9 and 8.10	Spurious Radiated Emissions	2	2	**Pass**
7.6	§15.247(a)	RSS-247 5.1(b)	Hopping Frequency Separation	1	4	**Pass**
7.7	§15.247(a)	RSS-247 5.1(c)	Number of Hopping Channels	1	4	**Pass**
7.8	§15.247(a)	RSS-247 5.1(c)	Average Time of Occupancy	1	4	**Pass**
7.9	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	2	4	**Pass**
-	-	RSS-Gen 7.1	Receiver Spurious Emissions	-	-	**N/A****

Notes
* The EUT has no receiver stand-alone mode.

Comments and observations
None

7 TEST RESULTS

7.1 Peak output power

Test equipment (Please see Chapter 8 for exact information of test equipment)
Radiated: R3
Description This is a conducted measurement. The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013. Please see measurement plots in Annex A for spectrum analyzer settings. See photos in Annex C for test Set-up.
Limits Part 15 Subpart C §15.247(b)(2) and RSS-247 5.4: For frequency hopping systems operating in the 902-928 MHz band: **1 watt for systems employing at least 50 hopping channels**; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.
Results

Set./ Op.	Peak output power, [dBm]	Limit Peak, [dBm]	Margin [dB]	Verdict
Set.1, Op. 1	27.5	30	2.5	Pass
Set.1, Op. 2	28.14	30	1.86	Pass
Set.1, Op. 3	27.92	30	2.08	Pass

* Please see measurement plots in Annex A.

7.2 99% Emission Bandwidth

Test equipment (Please see Chapter 8 for exact information of test equipment)

Radiated: R3

Description

This is a conducted measurement.
The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013.
Please see measurement plots in Annex A for spectrum analyzer settings.
See photos in Annex C for test Set-up.

Measurement information

RSS-Gen Clause 6.7:
The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.
In some cases, the “x dB bandwidth” is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum inband power level of the modulated signal, where the two points are on the outskirts of the in-band emission.
The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
• The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
• The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
• The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.
Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

Results

Set./ Op.	F_{low} 99 % OBW, [GHz]	F_{high} 99 % OBW, [GHz]	99 % OBW, [kHz]	Verdict
Set.1, Op. 1	902.70853	902.79157	83.04	Pass
Set.1, Op. 2	914.70861	914.79155	82.94	Pass
Set.1, Op. 3	927.20862	927.29157	82.95	Pass

* Please see measurement plots in Annex A.

7.3 Minimum 20 dB RF Bandwidth

Test equipment (Please see Chapter 8 for exact information of test equipment)

Radiated: R3

Description

This is a conducted measurement.
The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013.
Please see measurement plots in Annex A for spectrum analyzer settings.
See photos in Annex C for test Set-up.

Limits

Part 15 Subpart C §15.247(a) and RSS-247 5.1(a):
(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
(i) For frequency hopping systems operating in the 902-928 MHz band**:** if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.
The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Results

Set./ Op.	F_{low} 20 dB OBW, [GHz]	F_{high} 20 dB OBW, [GHz]	20 dB OBW, [kHz]	Verdict
Set.1, Op. 1	902.705	902.798	93	Pass
Set.1, Op. 2	914.705	914.795	90	Pass
Set.1, Op. 3	927.205	927.295	90	Pass

* Please see measurement plots in Annex A.

7.4 Out-of-Band Emissions - Conducted

Test equipment (Please see Chapter 8 for exact information of test equipment)
Radiated: R3
Description This is a conducted measurement. The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013. Please see measurement plots in Annex A for spectrum analyzer settings. See photos in Annex C for test Set-up.
Limits Part 15 Subpart C §15.247(d) and RSS-247 5.5: **In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits**. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).
Results: please see measurement plots in annex A
Verdict: Pass

7.5 Radiated field strength measurements

Test equipment
Frequency range 9 kHz – 30 MHz
Measurement in a semianechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex B). The measurement was done with software R&S EMC 32 V11.00.
Radiated: A1, C1, R1, SW2
Frequency range 30 MHz – 1 GHz
Measurement in a semianechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex B). The measurement was done with software R&S EMC 32 V11.00.
Radiated: A2, C1, R1, SW2
Frequency range 1 GHz – 12.75 GHz
Measurement in a fully anechoic room with the distance between the EUT and the reference point of the antenna 3 m (see photos in Annex B). The measurement was done directly with spectrum analyzer.
Radiated: A3, Amp2, Amp3, C1, R1, F2, F3, SW2
Description The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013. The measurement antenna was situated in 3 m distance to the EUT. RBW for frequency range 9 kHz- 30 MHz: 200 Hz, 9 kHz. RBW for frequency range 30 MHz- 1 GHz: 120 kHz. RBW for frequency range 1 GHz- 12.75 GHz: 1 MHz. See photos in Annex C for test Set-up and block diagram in Chapter 2.9.
Limits Part 15 Subpart C §15.247(d) and RSS-Gen 8.9 and 8.10: (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be **at least 20 dB below that in the 100 kHz bandwidth** within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. **Attenuation below the general limits specified in §15.209(a) is not required**. **In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).**
Results: please see measurement plots in annex A
Verdict: Pass

7.6 Hopping Frequency Separation

Test equipment (Please see Chapter 8 for exact information of test equipment)

Radiated: R3

Description

This is a conducted measurement.
The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013.
Please see measurement plots in Annex A for spectrum analyzer settings.
See photos in Annex C for test Set-up.

Limits

Part 15 Subpart C §15.247(a) and RSS-247 5.1(b):
(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
(1) **Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater**. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Results

Set./ Op.	Delta f to the middle frequency of the next channel, [kHz]	Limit, [kHz]	Margin [kHz]	Verdict
Set.1, Op. 4, fc low	500	25 kHz or 20 dB BW. Here: 93 kHz	407	Pass
Set.1, Op. 4, fc mid	500	25 kHz or 20 dB BW Here: 90 kHz	410	Pass
Set.1, Op. 4, fc high	500	25 kHz or 20 dB BW Here: 90 kHz	410	Pass

* Please see measurement plots in Annex A.

7.7 Number of Hopping Channels

Test equipment (Please see Chapter 8 for exact information of test equipment)

Radiated: R3

Description

This is a conducted measurement.
The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013.
Please see measurement plots in Annex A for spectrum analyzer settings.
See photos in Annex C for test Set-up.

Limits

Part 15 Subpart C §15.247(a) and RSS-247 5.1(c):
(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
(i) For frequency hopping systems operating in the 902-928 MHz band**: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies** and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Results

Set./ Op.	Number of hopping frequencies	Limit	Verdict
Set.1, Op. 4	50	≥50	Pass

* Please see measurement plots in Annex A.

7.8 Average Time of Occupancy

Test equipment (Please see Chapter 8 for exact information of test equipment)

Radiated: R3

Description

This is a conducted measurement.
The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2013.
Please see measurement plots in Annex A for spectrum analyzer settings.
See photos in Annex C for test Set-up.

Limits

Part 15 Subpart C §15.247(a) and RSS-247 5.1(c):
(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
(i) For frequency hopping systems operating in the 902-928 MHz band**: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use** at least 50 hopping frequencies and **the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period**; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Results

Set./ Op.	Number of peaks in 20 s period	Time length of one peak/burst, [ms]	Total duration time in 20 s period, [ms]	Limit, [ms]	Verdict
Set.1, Op. 4, fc low	3	30.4	100.2	≤400	Pass

* Please see measurement plots in Annex A.

7.9 Conducted emissions

Test equipment (Please see Chapter 8 for exact information of test equipment)

Radiated: R1, L1, C5, SW3

Description

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.
  In case of tabletop equipment it is placed on a non-conductive table with a hight of 80 cm.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, … are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

Pre-scan

- The EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software based on evaluated data during the pre-scan.
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C63.4).
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, and settings of measuring equipment is recorded.

Detailed requirements can be found in e.g. ANSI C63.4
Please see test set-up photos in Annex C and block diagram 2 in Chapter 2.9.

Limits

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.

Please see FCC Title 47 § 15.207 for more details.

Test Results

Set-up / Op.	Line	Verdict
2 / 4	L1	**Pass**
2 / 4	N	**Pass**

All Readings were done with Quasi-Peak and Average detector.

Comment:	---

Verdict	**- PASS -**	For plots please see Annex A to current report

8 MEASUREMENT EQUIPMENT

No	Equipment	Type	Manufacturer	Serial No.	Int. No.	Last Calibration	Next Calibration
Antennas (**A**):							
1.	Active Loop Antenna	HFH2-Z2E	Rohde & Schwarz	100108	LAB000108	2023-05-05	2026-05-05
2.	Ultrabroadband antenna	HL562E	Rohde & Schwarz	102005	LAB000150	2022-12-22	2025-12-22
3.	Double-Ridged Waveguide Horn Antenna	HF-907	Rohde & Schwarz	102899	LAB000151	2023-05-05	2026-05-05
4.	Rod Antenna	-	-	-	LAB000290	-	-
5.	Horn Antenna (2.6 GHz – 3.95 GHz)	PE9863/SF-10	Pasternack	-	LAB000312	2021-01-13	-
6.	Horn Antenna (3.95 GHz – 5.85 GHz)	PE9861/SF-10	Pasternack	-	LAB000264	2020-09-29	-
7.	Horn Antenna (10 GHz – 15 GHz)	PE9855 SF-20	Pasternack	-	LAB000263	2020-09-29	-
8.	Horn Antenna (12.4 GHz – 18 GHz)	62-HA20-A-SMF	TTE Europe	-	LAB000282	2020-09-29	-
9.	Horn Antenna (17.6 GHz – 26.7 GHz)	20240-20	Flann Microwave Ltd	266402	LAB000127	2020-06-29	-
10.	Horn Antenna (26.4 GHz – 40.1 GHz)	22240-20	Flann Microwave Ltd	270447	LAB000129	2020-06-29	-
11.	Horn Antenna (33 GHz – 50.1 GHz)	23240-20	Flann Microwave Ltd	273430	LAB000132	2020-07-01	-
12.	Horn Antenna (49.9 GHz – 75.8 GHz)	25240-20	Flann Microwave Ltd	272860	LAB000133	2020-07-01	-
13.	Horn Antenna (60.5 GHz – 91.5 GHz)	26240-20	Flann Microwave Ltd	273417	LAB000135	2020-07-01	-
14.	Horn Antenna (73.8 GHz – 114 GHz)	27240-20	Flann Microwave Ltd	273368	LAB000138	2020-07-01	-
15.	Horn Antenna (114 GHz – 173 GHz)	29240-20	Flann Microwave Ltd	273382	LAB000139	2020-07-01	-
16.	Horn Antenna (145 GHz – 220 GHz)	30240-20	Flann Microwave Ltd	273390	LAB000178	2020-08-01	-
17.	Horn Antenna (217 GHz – 330 GHz)	32240-20	Flann Microwave Ltd	273469	LAB000152	2020-08-01	-
18.	Horn Antenna (49.9 GHz – 75.8 GHz)	25240-20	Flann Microwave Ltd	272861	LAB000134	2020-07-01	-
19.	Horn Antenna (60.5 GHz – 91.5 GHz)	26240-20	Flann Microwave Ltd	273418	LAB000136	2020-08-01	-
Amplifiers (**Amp**)*:							
1.	Pre-Amplifier	BBV 9718 C	Schwarzbeck Mess-Elektronik OHG	84	LAB000169	-	-
2.	Low noise amplifier	BZ-01000900-111550-202320	B&Z Technologies	24336	LAB000296	-	-
3.	Low noise amplifier	BZ-08001800-180855-202020	B&Z Technologies	22105	LAB000297	-	-
4.	Low noise amplifier	BZ-18004000-270845-252525	B&Z Technologies	22449	LAB000298	-	-
Attenuator (**Att**)*:							
1.	Attenuator	25081-20 (49.9 GHz - 75.8 GHz)	Flann Microwave Ltd	234411	LAB000229	-	-

2.	Attenuator	27081-20 (73.8 GHz – 112 GHz)	Flann Microwave Ltd	270004	LAB000230	-	-
RF Cables (Cab)*:							
1.	Coaxial cable	LU7-022-1000	Rosenberger	33	LAB000153	-	-
2.	Coaxial cable	LU7-022-1000	Rosenberger	34	LAB000153	-	-
3.	Coaxial cable	SF101/1.5m	Huber & Suhner	503987/1	LAB000165	-	-
Chambers (C):							
1.	Semi/Fully Anecoic Chamber	SAC5	Albatross Projects GmbH	20168.PRB	LAB000235	2022-01-31	2025-01-31
2.	Climatic chamber	T-65/50	CTS GmbH	204002	LAB000110	2023-05-11	2024-05-11
3.	Shielding Cover	CMU-Z11	Rohde & Schwarz	100876	LAB000039	-	-
4.	Climatic chamber	T-70/350	CTS GmbH	194027	LAB000066	2023-06-30	2024-06-30
5.	Shielded room	Sputnik 1 (Schirmkabine)	Albatross Projects GmbH	-	LAB000257	-	-
Corner Reflector (CR):							
1.	Trihedral Corner Reflector	SAJ-080-S1	ERAVANT	04756-01	LAB000201	-	-
Directional coupler (DC):							
1.	Directional coupler	CPL-5230-10-SMA-79	Midwest Microwave	-	LAB000672	-	-
Distance meter (DM):							
1.	Laser distance meter	GLM 50 C	Bosch	-	-	-	-
2.	Laser distance meter	GLM 120 C	Bosch	-	-	-	-
Filter (F)*:							
1.	High-pass filter (84 GHz – 110 GHz)	10-WHPF-84.5-UG387	TTE	-	LAB000299	-	-
2.	High-pass filter (7 GHz – 23 GHz)	HPF 7-23	AtlantRF	-	LAB000444	-	-
3.	High-pass filter (3.3 GHz – 12.75 GHz)	HPF 3.3-11	AtlantRF	-	LAB000382	-	-
4.	High-pass filter (1.3 GHz – 12.75 GHz)	H1G713G1	Microwave Circuits Inc	46291	LAB000443	-	-
5.	High-pass filter (1.3 GHz – 12.75 GHz)	H1G713G1	Microwave Circuits Inc	1896-01	LAB000670	-	-
6.	Bandstop filter (30MHz – 3GHz for 900 MHz Band)	WRCG876/960-847/989-50/8SS	Wainwright Instruments GmbH	-	LAB000671	-	-
Harmonic mixers (H):							
1.	Harmonic Mixer	FS-Z60	Rohde & Schwarz	101350	LAB000375	2023-04-13	2024-04-13
2.	Harmonic Mixer	FS-Z75	Rohde & Schwarz	102015	LAB000112	2023-05-03	2024-05-03
3.	Harmonic Mixer	FS-Z90	Rohde & Schwarz	102020	LAB000113	2023-04-06	2024-04-06
4.	Harmonic Mixer	FS-Z110	Rohde & Schwarz	102000	LAB000114	2023-05-02	2024-05-02
5.	Harmonic Mixer	FS-Z170	Rohde & Schwarz	100996	LAB000126	2023-04-26	2024-04-26
6.	Harmonic Mixer	FS-Z220	Rohde & Schwarz	101039	LAB000116	2023-04-16	2024-04-06
7.	Harmonic Mixer	FS-Z325	Rohde & Schwarz	101015	LAB000117	2023-04-11	2024-04-11
LISN (L):							
1.	Two-line V-Network	ENV216	Rohde & Schwarz	102597	LAB000220	-	2024-09-07
2.	Two-line V-Network	ENV216	Rohde & Schwarz	102598	LAB000217	2023-06-01	2024-06-01
Multimeters (M):							
1.	Multimeter	U1242B	Keysight	MY59240021	LAB000187	2022-06-20	2024-06-20
2.	Multimeter	U1242B	Keysight	MY59160026	LAB000018	2023-09-20	2024-09-20
Multipliers (Mp):							
1.	Multiplier	SMZ75	Rohde & Schwarz	101307	-	2018-03-15	-
2.	Multiplier	SMZ110	Rohde & Schwarz	100001	-	2020-05-09	-
Power Supply (P):							
1.	Power Supply	PS 2042-10 B	Elektro-Automatic GmbH	2878350263	LAB000190	-	-

2.	Power Supply	PS 2042-10 B	Elektro-Automatic GmbH	2878350322	LAB000192	-	-
3.	Power Supply	E3640A	Agilent	MY40005693	LAB000036	-	-
Power meters (PM):							
1.	Power meter	NRP-Z81	Rohde & Schwarz	106194	LAB000120	2023-05-10	2024-05-10
2.	Power meter	NRP110T	Rohde & Schwarz	101151	LAB000119	2023-06-05	2024-06-05
Receivers and Spectrumanalyzers (R):							
1.	Test Receiver, SAC5	ESW-26	Rohde & Schwarz	101517	LAB000363	2024-01-22	2025-01-22
2.	Test Receiver	ESW-26	Rohde & Schwarz	101481	LAB000236	-	-
3.	Spectrum Analyzer 1 Hz – 50 GHz	FSW-50	Rohde & Schwarz	101450	LAB000111	2023-07-26	2024-07-26
4.	Spectrum Analyzer 2 Hz – 43 GHz	FSW-43	Rohde & Schwarz	101391	LAB000289	2023-06-02	2024-06-02
Signal Generators (SG):							
1.	Signal generator 8 kHz – 50 GHz	SMA100B	Rohde & Schwarz	103838	LAB000118	2021-06-30	2024-06-30
2.	Vector Signal Generator	SMW200A	Rohde & Schwarz	109775	LAB000870	2023-10-18	2026-10-18
Software (SW):							
No	Type	Name	Manufacturer	Version	Int. No.	Build	Rev
1.	Software	R&S Power Viewer	Rohde & Schwarz	11.3, 3.2.2020	-	7338	3230
2.	Software	R&S EMC32	Rohde & Schwarz	11.20	-	-	-
3.	Software	R&S Elektra EMC test software	Rohde & Schwarz	13.00	-	-	-

* The gain values of Amp and attenuation values of Cab and Att are remeasured annually internal.

9 MEASUREMENT UNCERTAINTIES

Test case	Measurement uncertainty*
Radiated field strength	≤ ± 6 dB
Occupied bandwidth	± 100 kHz
Time domain measurement	± 2.32 ms
DC and low frequency voltages	± 3 %
Temperature	± 1 °C
Humidity	± 3 %

*) The indicated expanded measurement uncertainty corresponds to the standard measurement uncertainty for the measurement results multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 %.

END OF THE REPORT

Annex A

Measurement plots

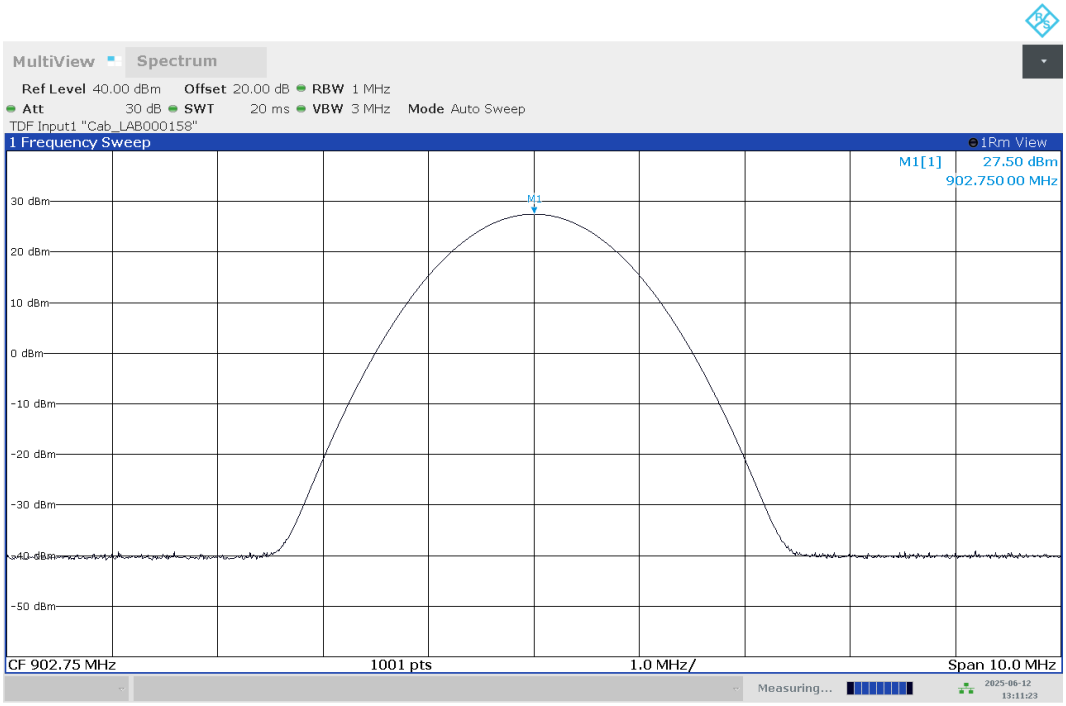
part of / in addition to

Test report no.: 25031309-45388-0

Table of contents:

1 Fundamental field strength

1.1 Set-up 1, Op. 1



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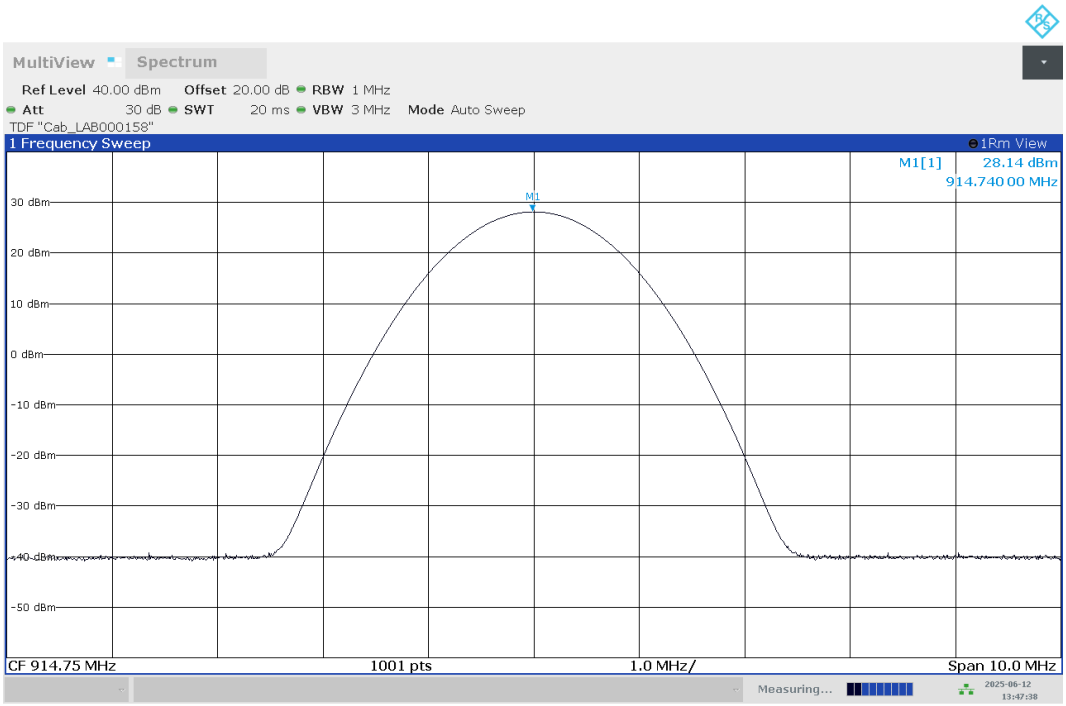
1.2 Set-up 1, Op. 2



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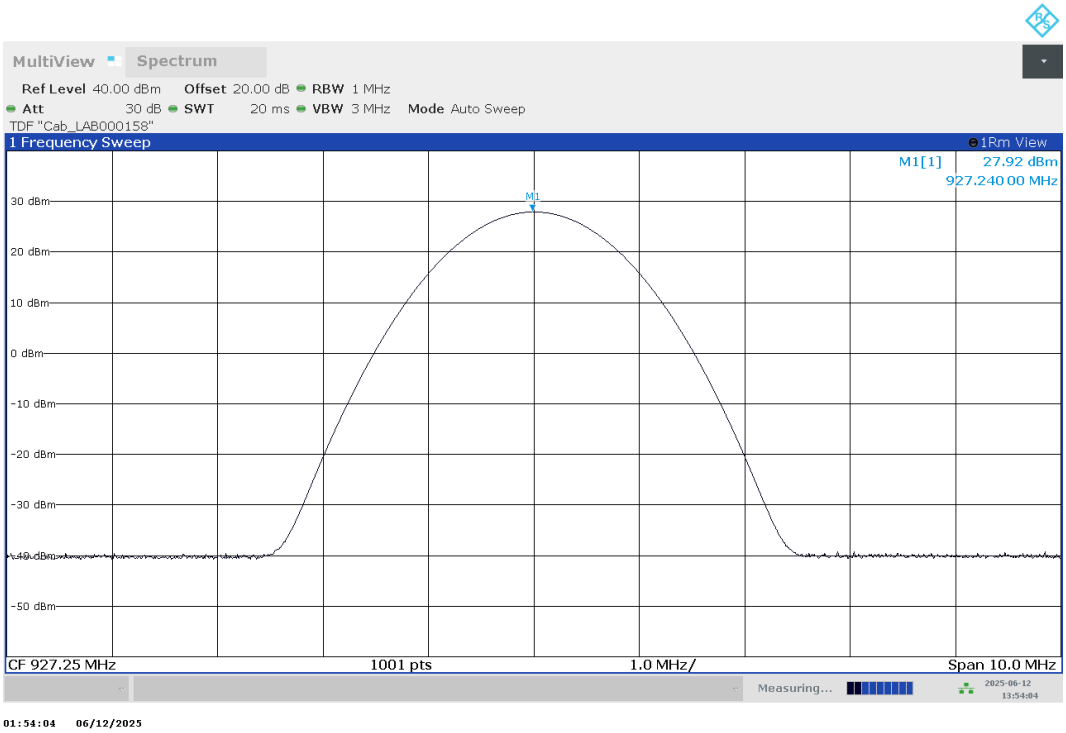
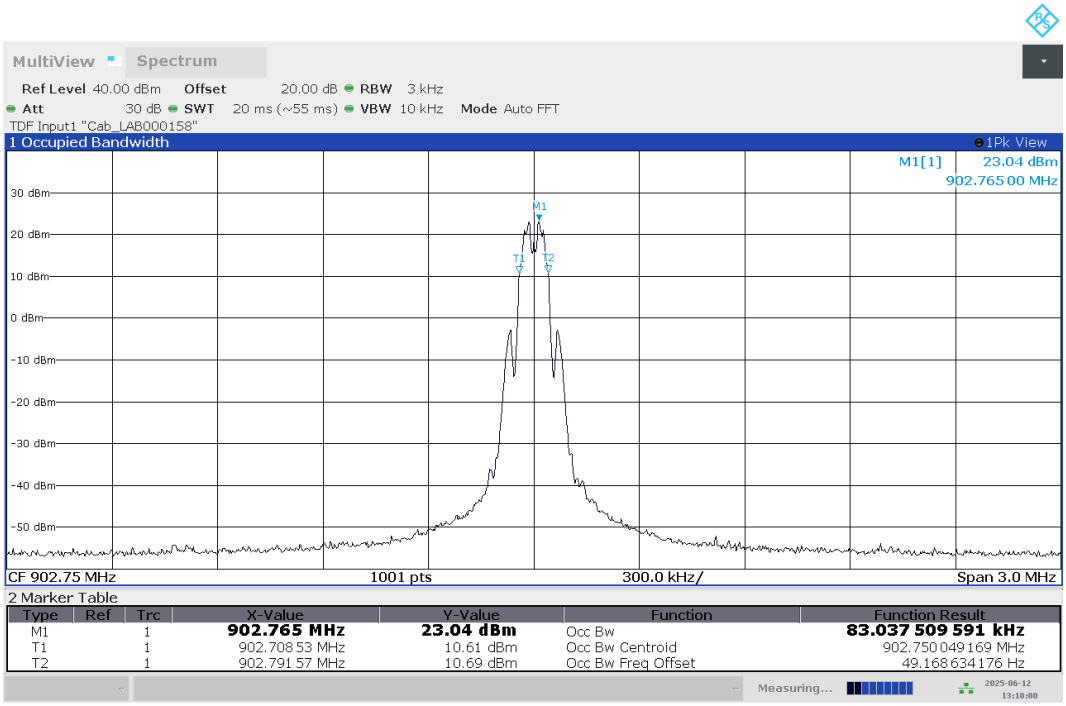
1.3 Set-up 1, Op. 3



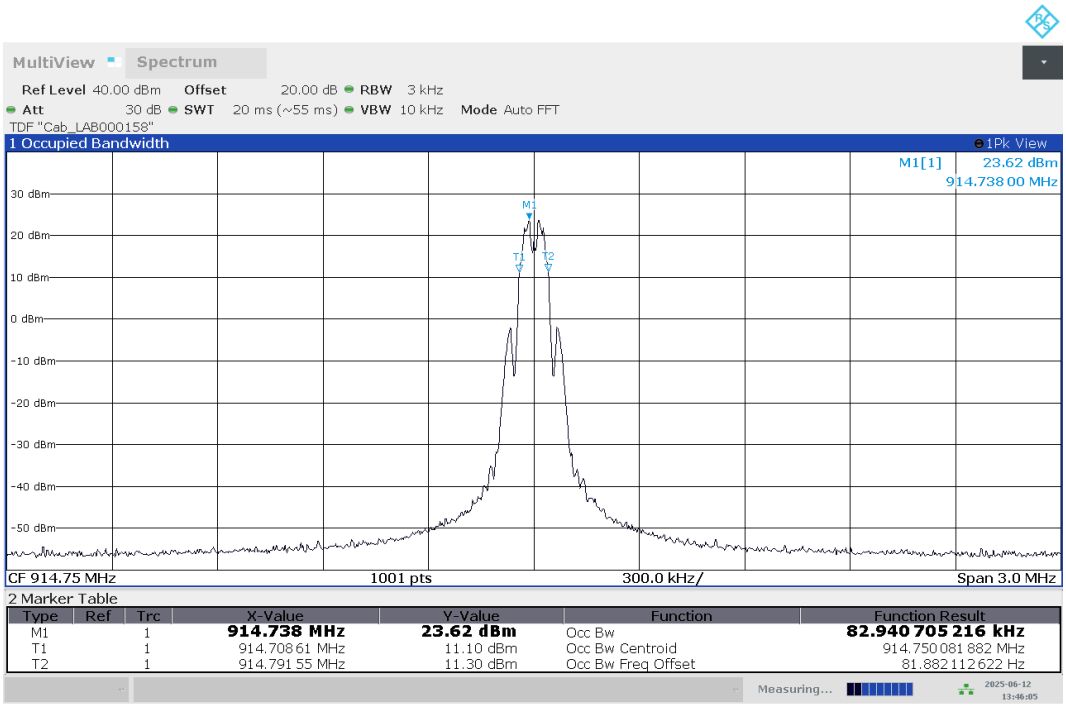
2 99% Emission Bandwidth

2.1 Set-up 1, Op. 1



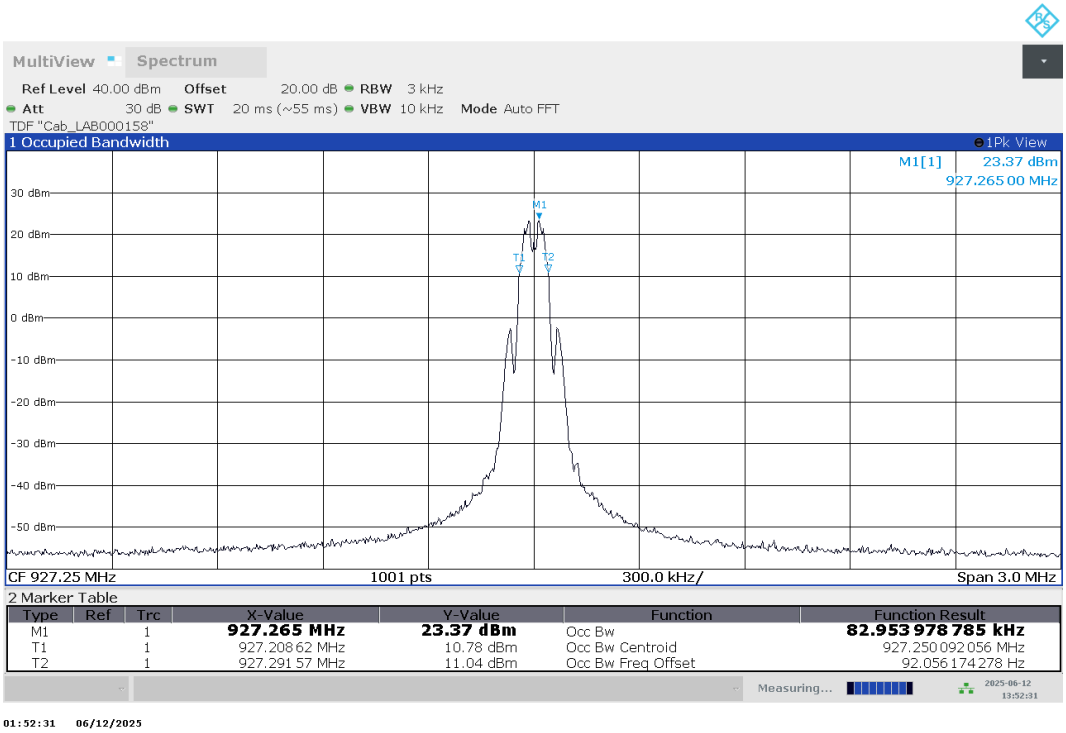
01:10:00 06/12/2025

2.2 Set-up 1, Op. 2



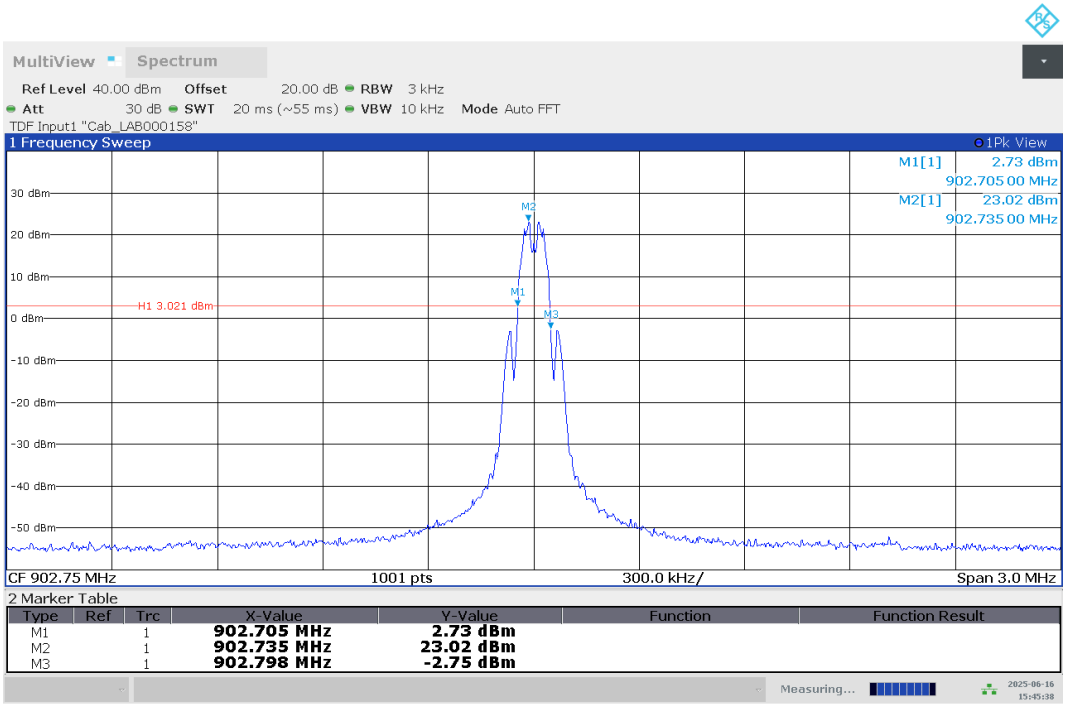
01:46:05 06/12/2025

2.3 Set-up 1, Op. 3

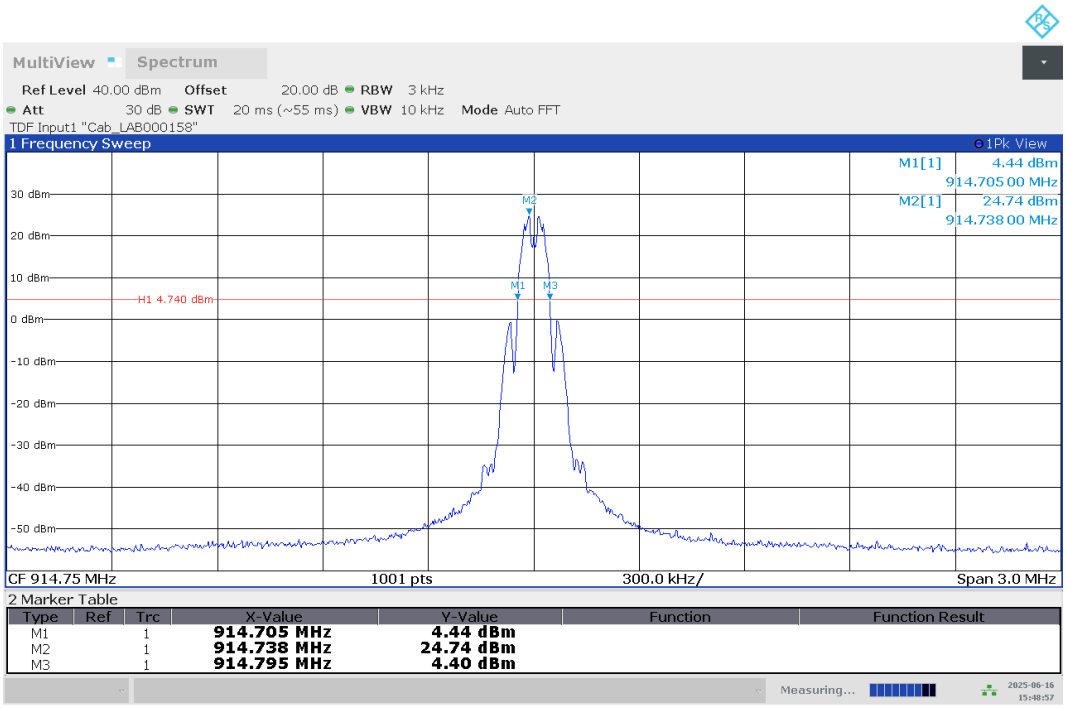


3 Minimum 20 dB RF Bandwidth

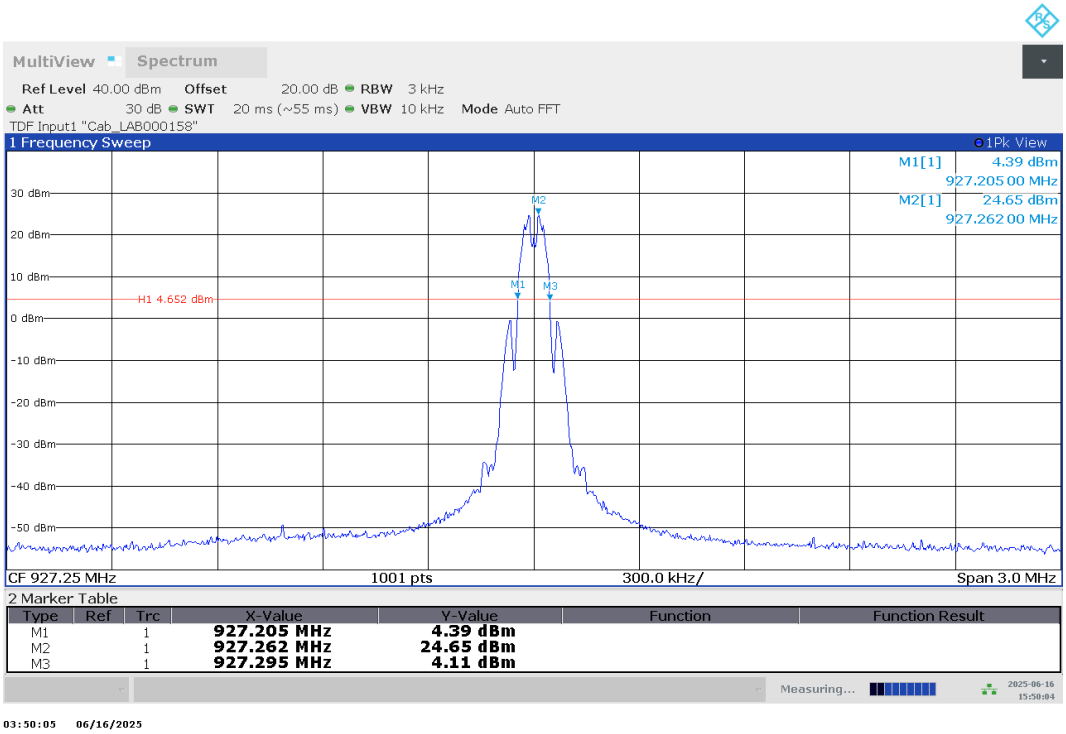
3.1 Set-up 1, Op. 1



3.2 Set-up 1, Op. 2

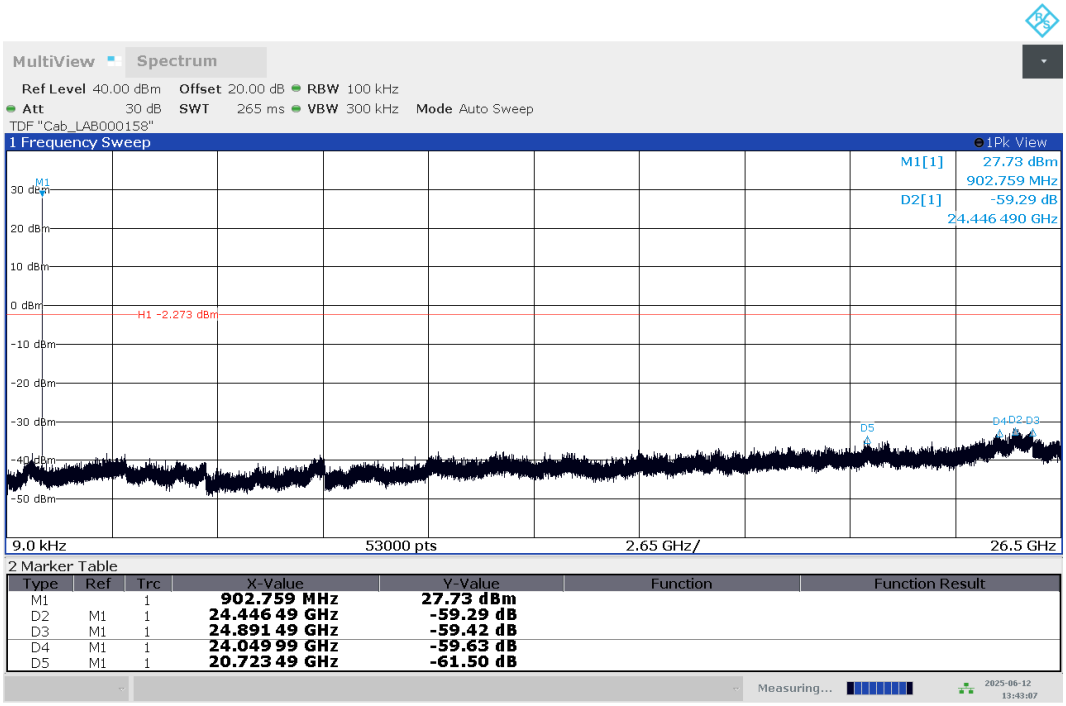


3.3 Set-up 1, Op. 3



4 Out-of-Band Emissions - Conducted

4.1 Set-up 1, Op. 1, frequency range 9 kHz – 26.5 GHz



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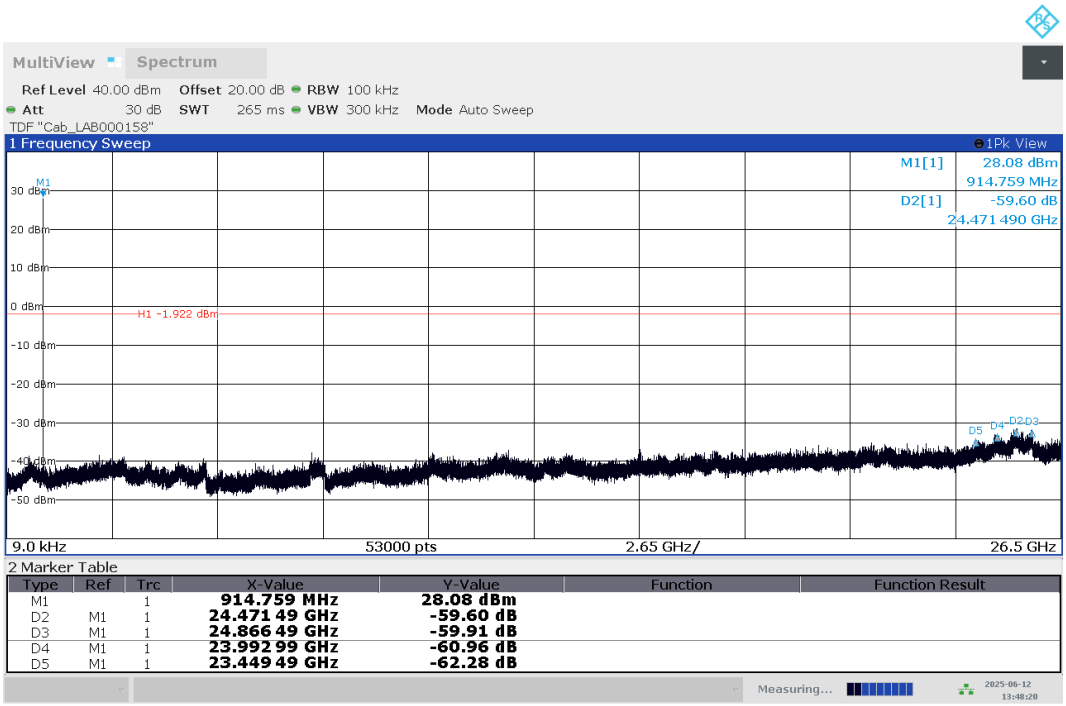
4.2 Set-up 1, Op. 2, frequency range 9 kHz – 26.5 GHz



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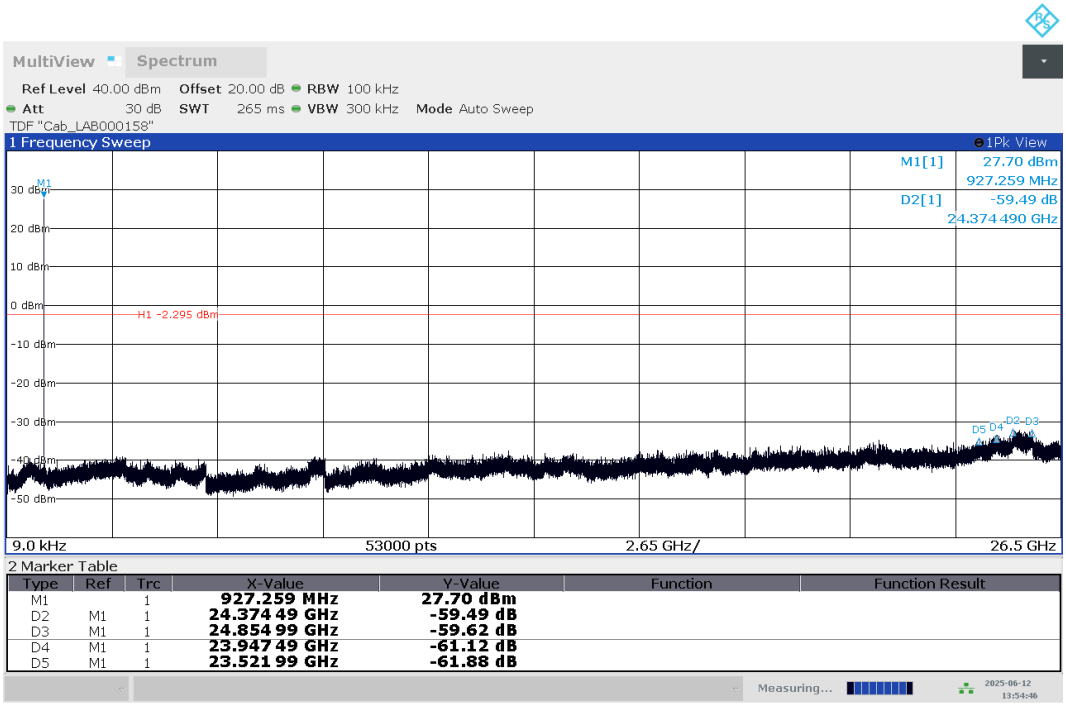
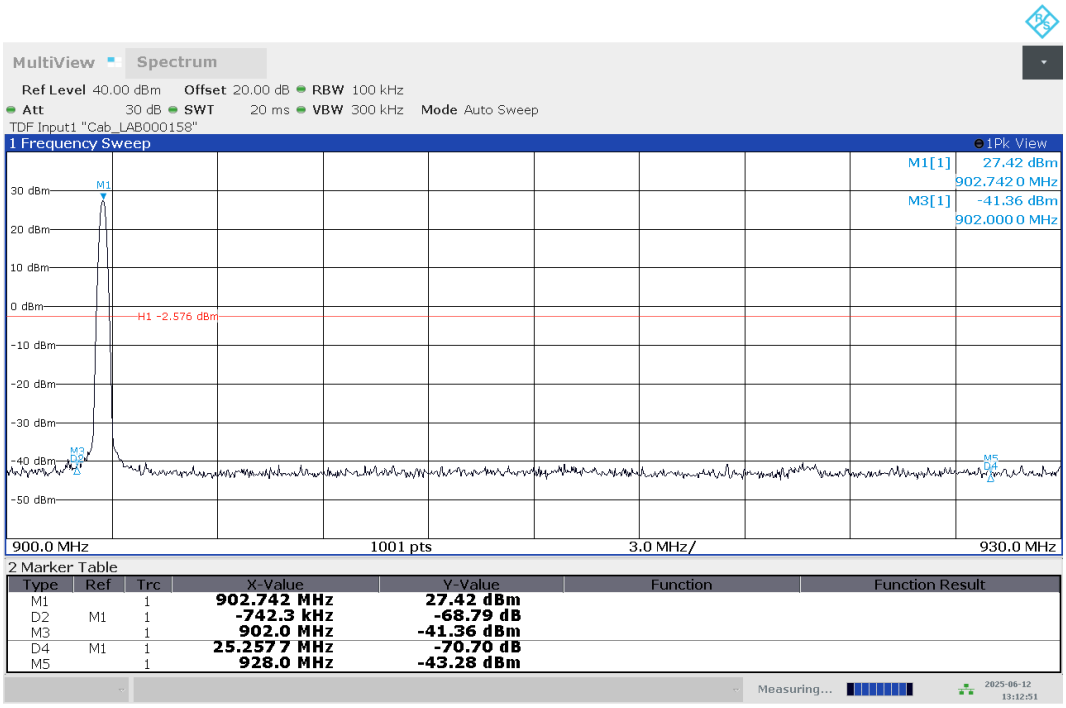
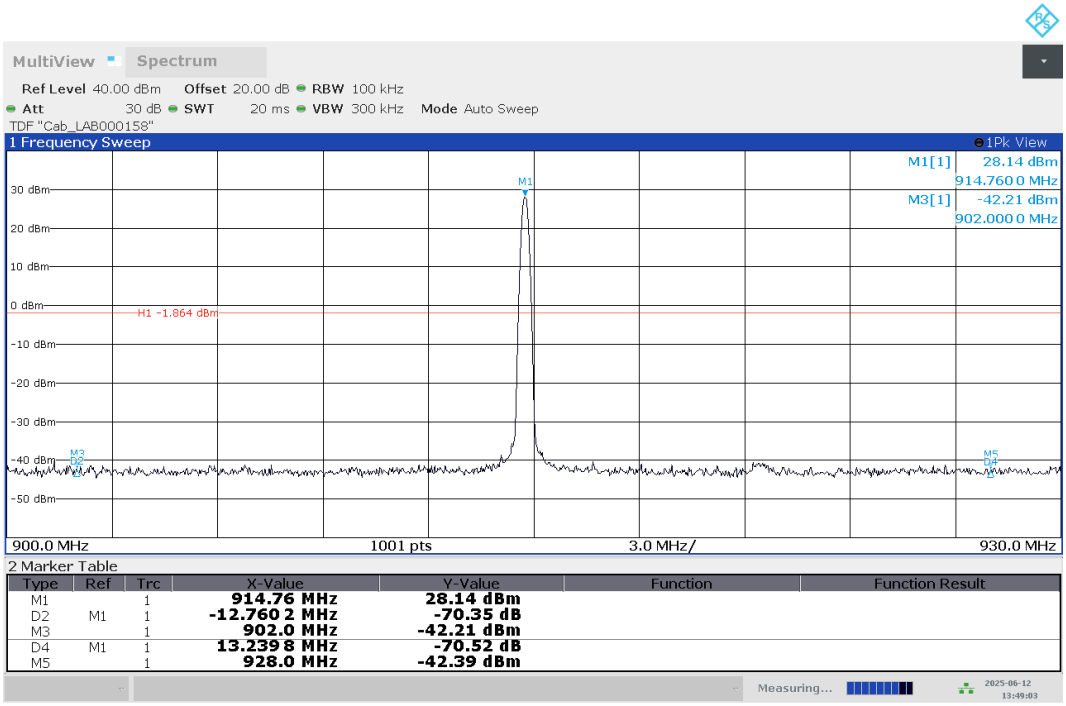
4.3 Set-up 1, Op. 3, frequency range 9 kHz – 26.5 GHz



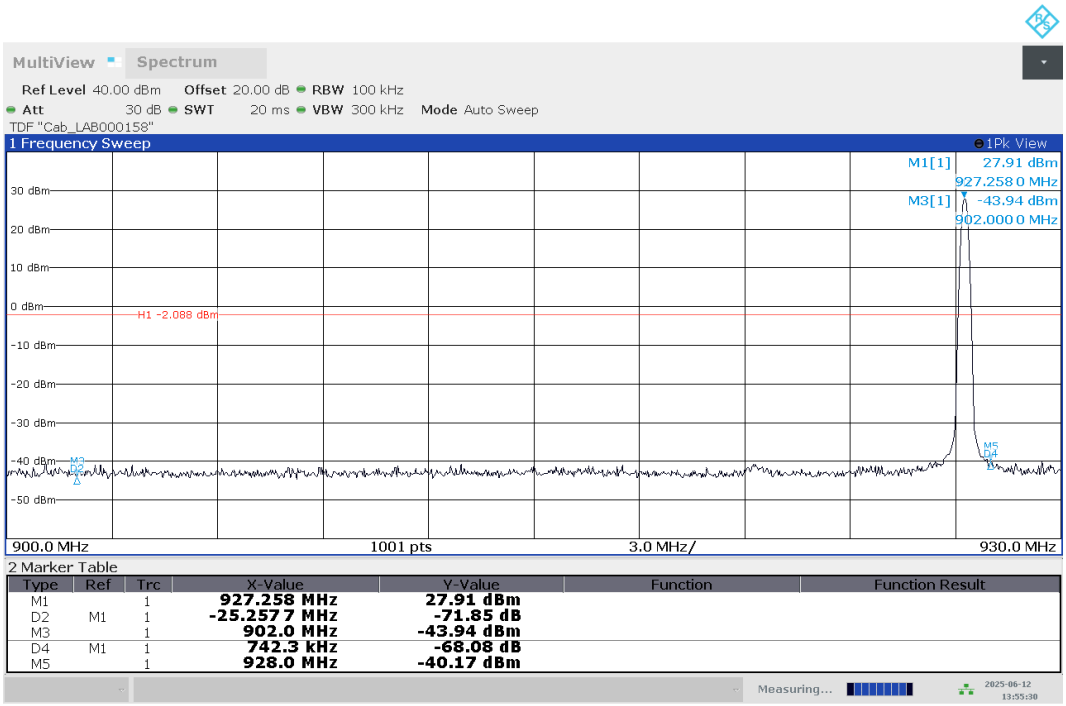
4.4 Set-up 1, Op. 1, frequency range 900 MHz – 930 MHz



4.5 Set-up 1, Op. 2, frequency range 900 MHz – 930 MHz



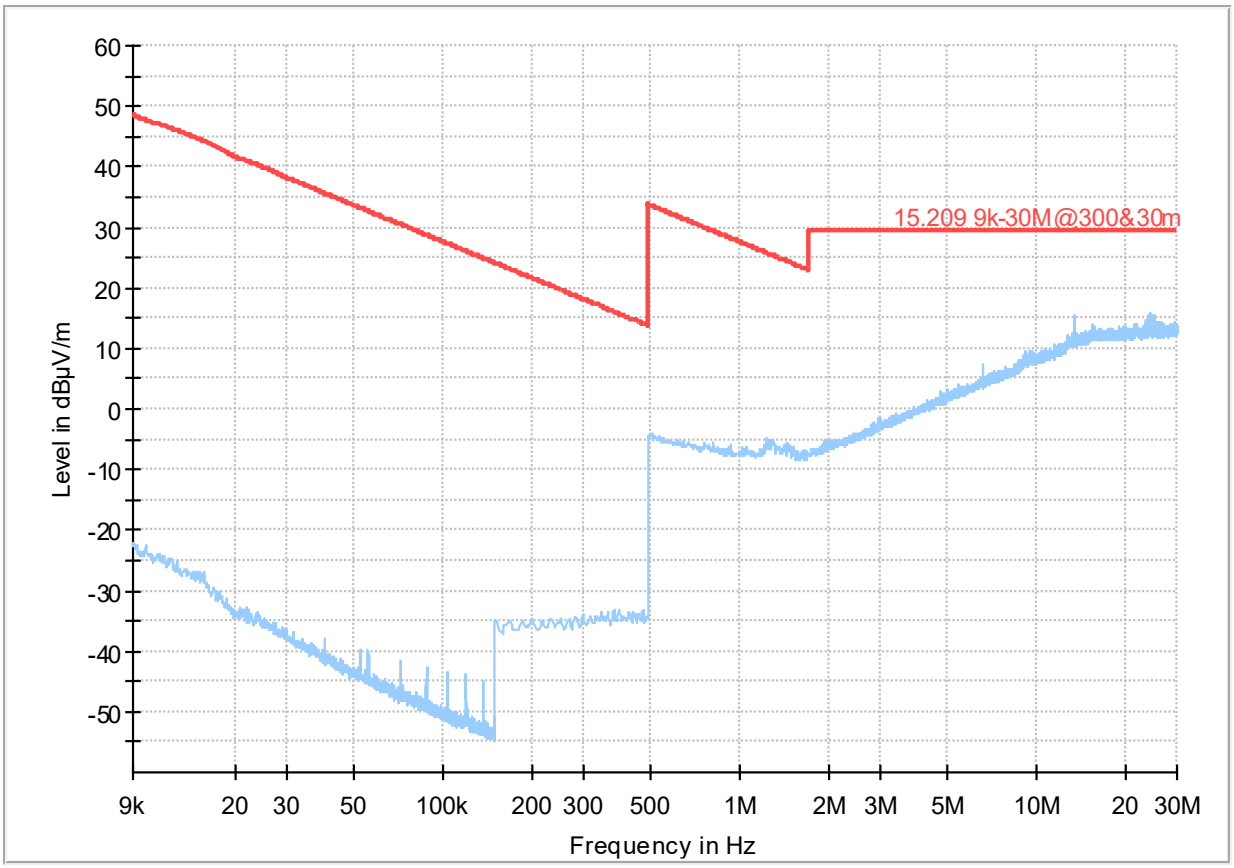
4.6 Set-up 1, Op. 3, frequency range 900 MHz – 930 MHz



5 General Limit - Radiated field strength emissions, 9 kHz - 18 GHz

5.1 Radiated field strength measurements (f < 30 MHz)

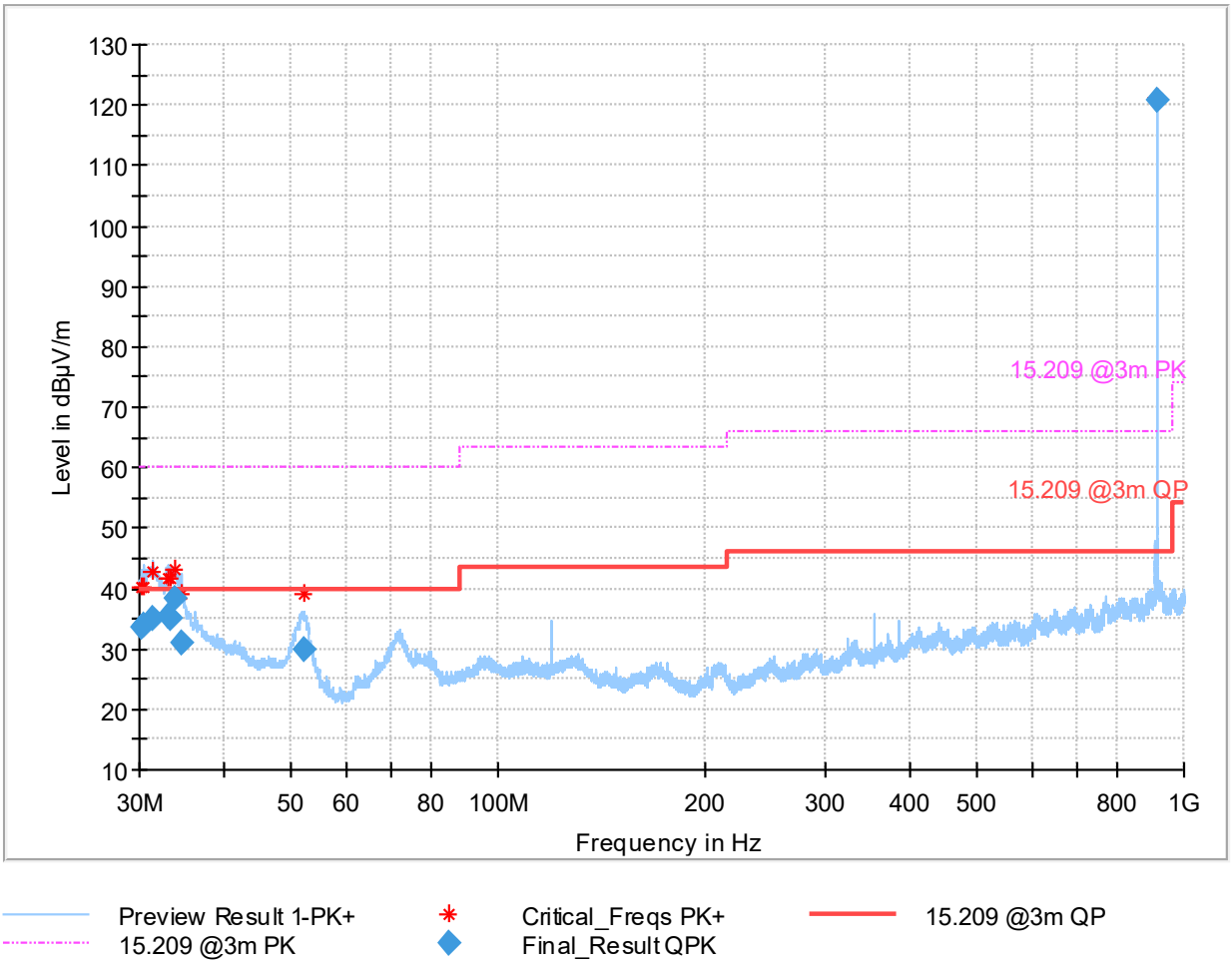
5.1.1 Set-up 2, 9 kHz – 30 MHz, Op. 2, EUTs lying + staying



Preview Result 1-PK+
15.209 9k-30M@300&30m
Critical_Freqs PK+
Final_Result QPK

5.2 Radiated field strength measurements (30 MHz < f < 1000 MHz)

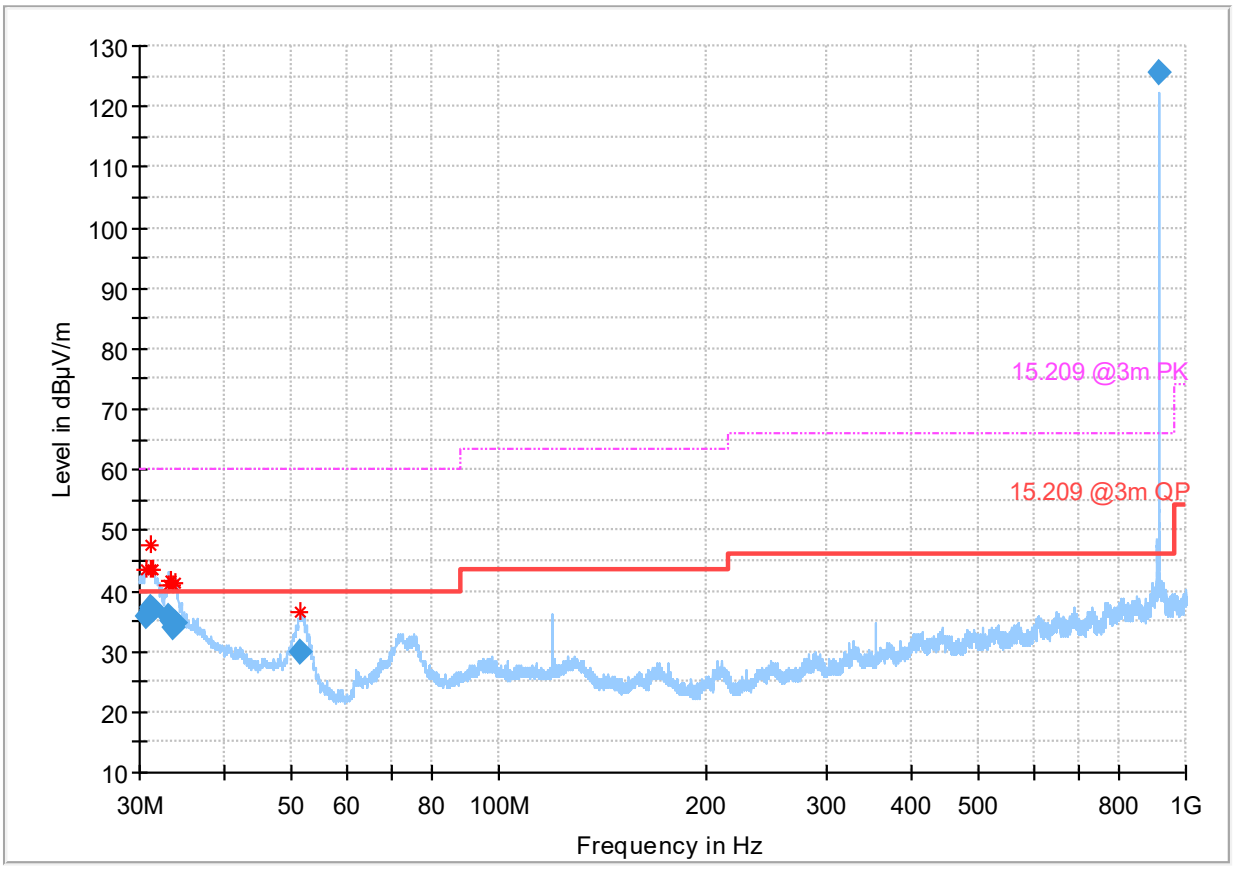
5.2.1 Lying, Set-up 2, Op. 2



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.175000	33.54	40.00	6.46	100.0	120.000	125.0	V	274.0
30.425000	34.07	40.00	5.93	100.0	120.000	118.0	V	17.0
31.325000	34.99	40.00	5.01	100.0	120.000	100.0	V	278.0
33.100000	35.44	40.00	4.56	100.0	120.000	100.0	V	316.0
33.400000	35.18	40.00	4.82	100.0	120.000	100.0	V	30.0
33.875000	38.17	40.00	1.83	100.0	120.000	104.0	V	281.0
34.550000	30.90	40.00	9.10	100.0	120.000	100.0	V	210.0
52.000000	29.86	40.00	10.14	100.0	120.000	207.0	V	11.0
914.750000	120.79	46.00	-74.79	100.0	120.000	100.0	H	300.0

5.2.2 Staying, Set-up 2, Op. 2

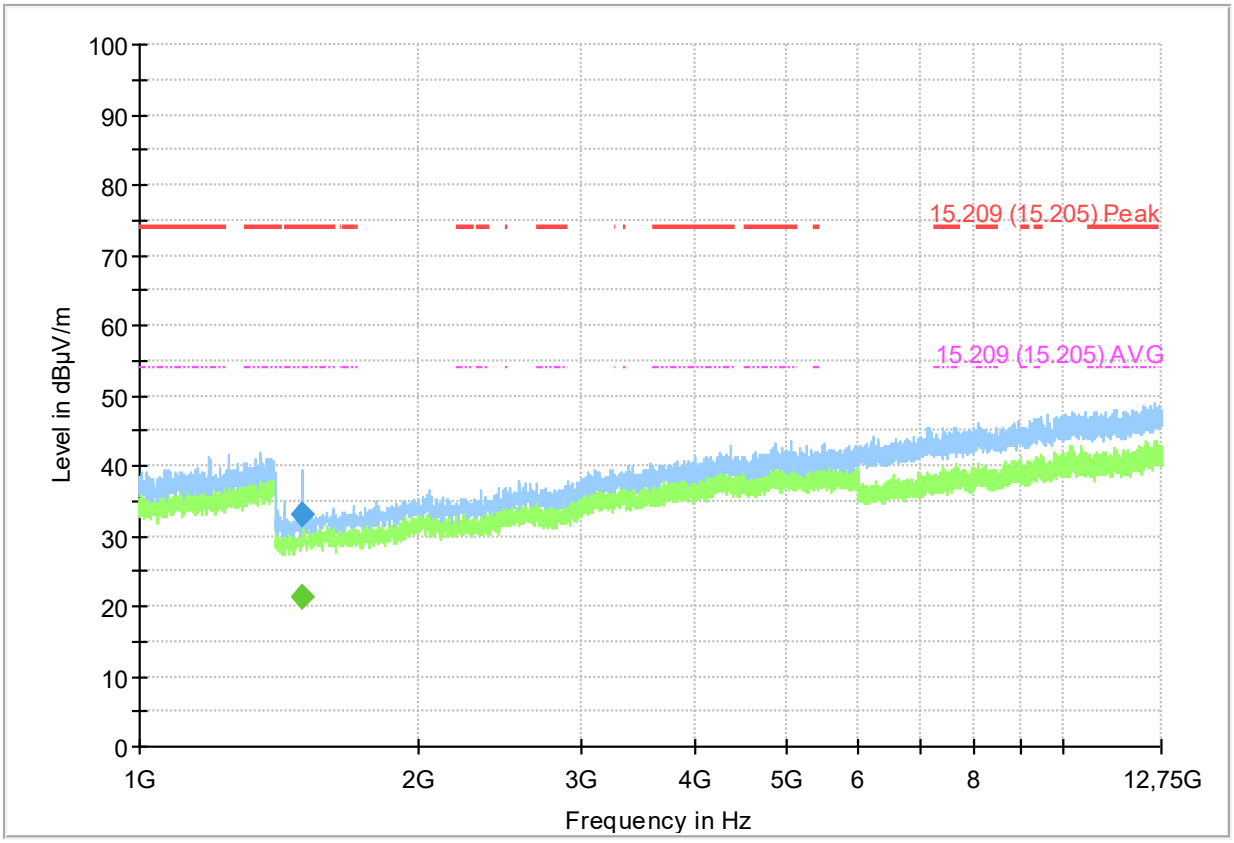


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.575000	35.95	40.00	4.05	100.0	120.000	100.0	V	163.0
31.100000	37.00	40.00	3.00	100.0	120.000	125.0	V	55.0
31.225000	37.07	40.00	2.93	100.0	120.000	180.0	V	30.0
31.450000	37.05	40.00	2.95	100.0	120.000	118.0	V	48.0
33.050000	35.72	40.00	4.28	100.0	120.000	100.0	V	334.0
33.375000	34.95	40.00	5.05	100.0	120.000	100.0	V	82.0
33.675000	33.98	40.00	6.02	100.0	120.000	100.0	V	28.0
33.875000	34.70	40.00	5.30	100.0	120.000	100.0	V	17.0
51.250000	29.93	40.00	10.07	100.0	120.000	104.0	V	87.0
914.750000	125.42	46.00	-79.42	100.0	120.000	104.0	V	343.0

5.3 Radiated field strength measurements (1 GHz < f < 12.75 GHz)

5.3.1 1000 MHz – 12.75 GHz, Set-up 2, Op. 2, lying + staying



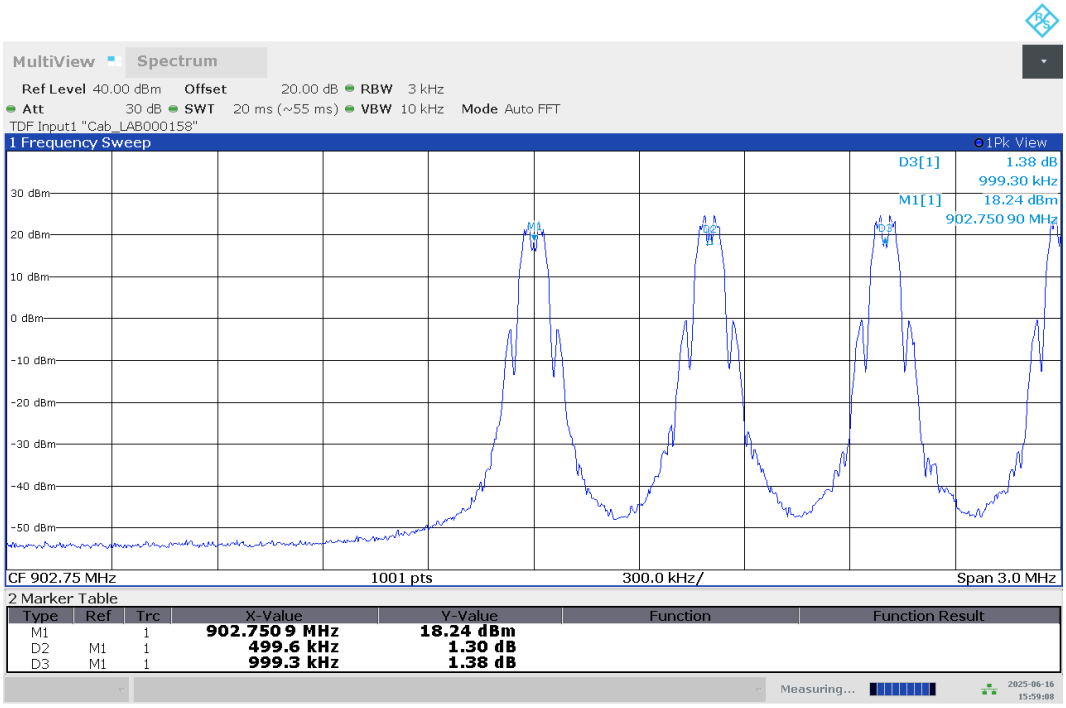
Preview Result 2-AVG
Critical_Freqs PK+
Final_Result PK+
Preview Result 1-PK+
15.209 (15.205) Peak
Final_Result RMS
Critical_Freqs AVG
15.209 (15.205) AVG

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1500.200000	---	21.41	54.00	32.59	1000.0	1000.000	150.0	V
1504.200000	33.17	---	74.00	40.83	1000.0	1000.000	150.0	V

6 Hopping Frequency Separation

6.1 Set-up 1, Op. 4, fc low



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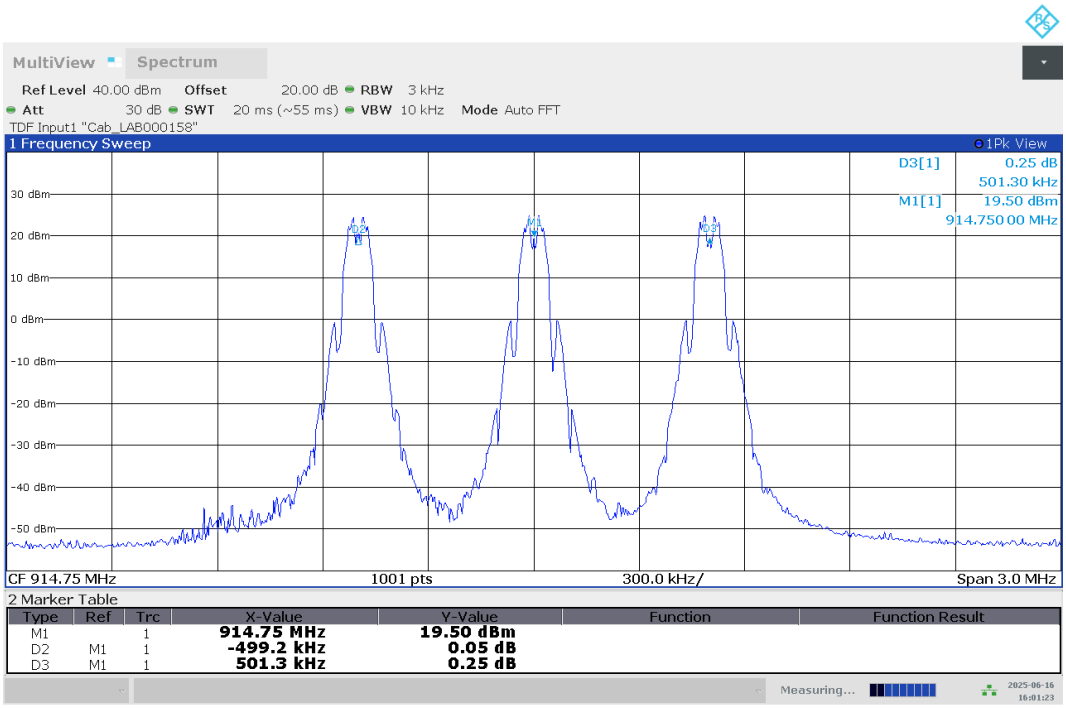
6.2 Set-up 1, Op. 4, fc mid



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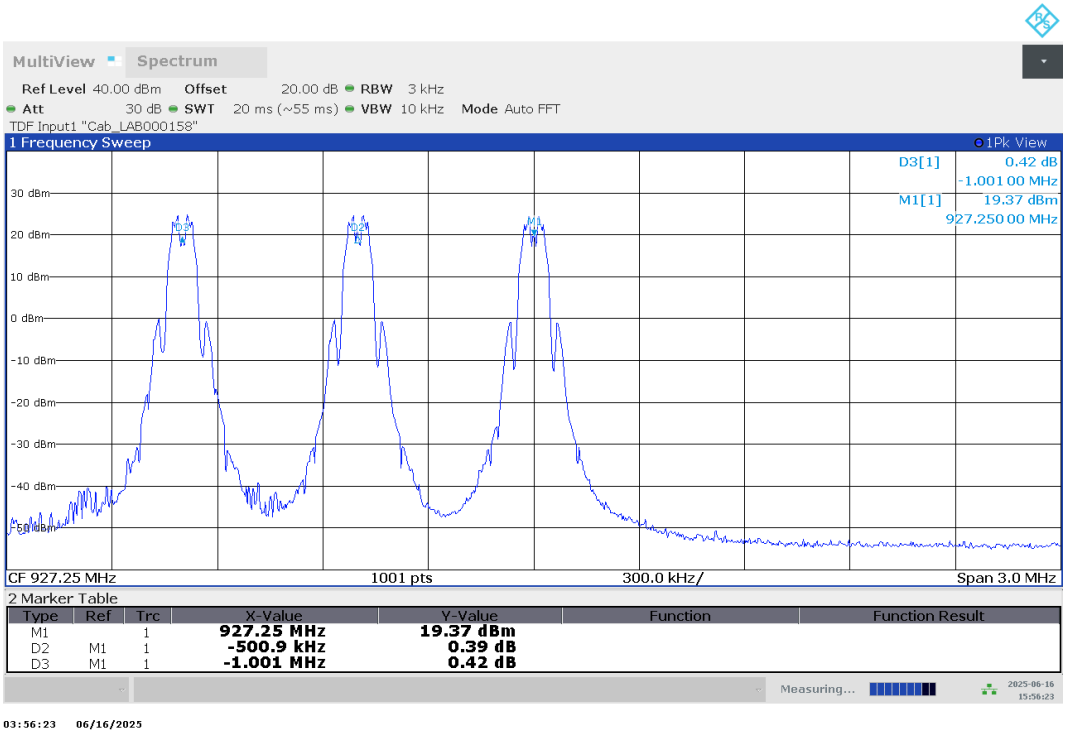
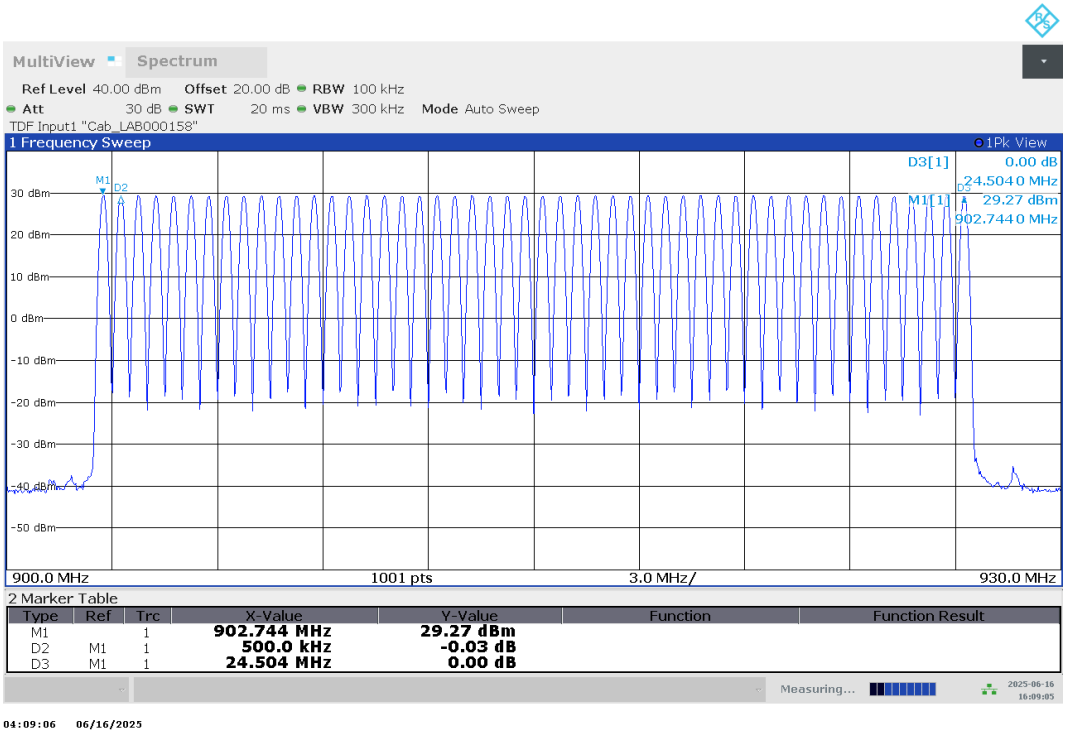
6.3 Set-up 1, Op. 4, fc high



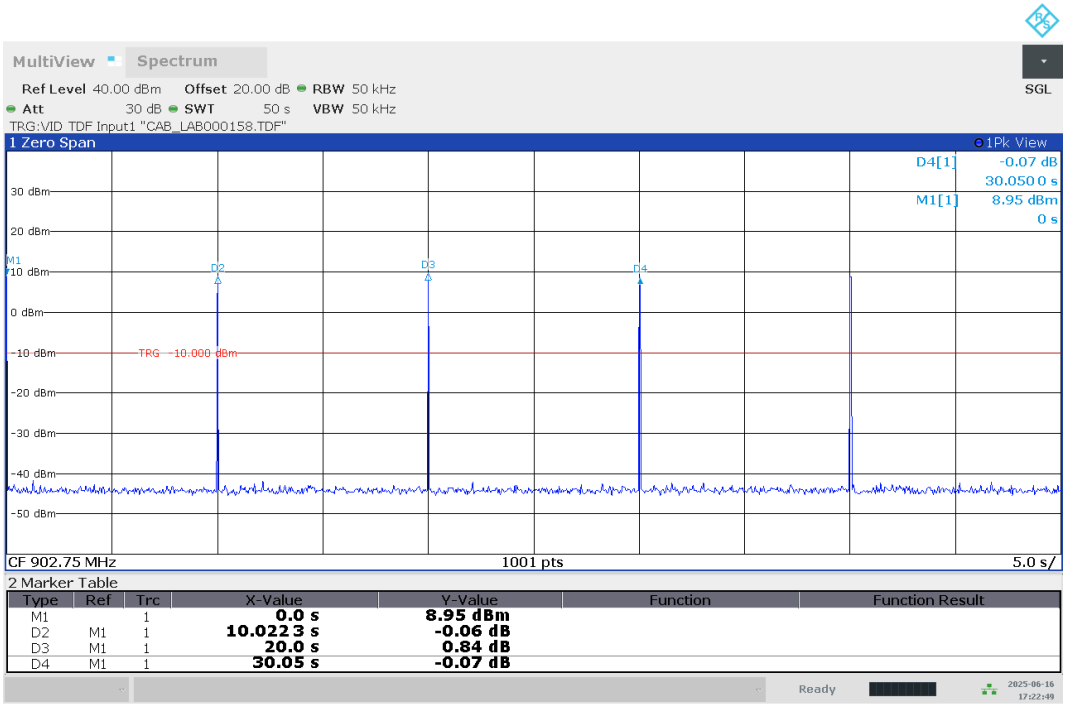
7 Number of Hopping Channels

7.1 Set-up 1, Op. 4

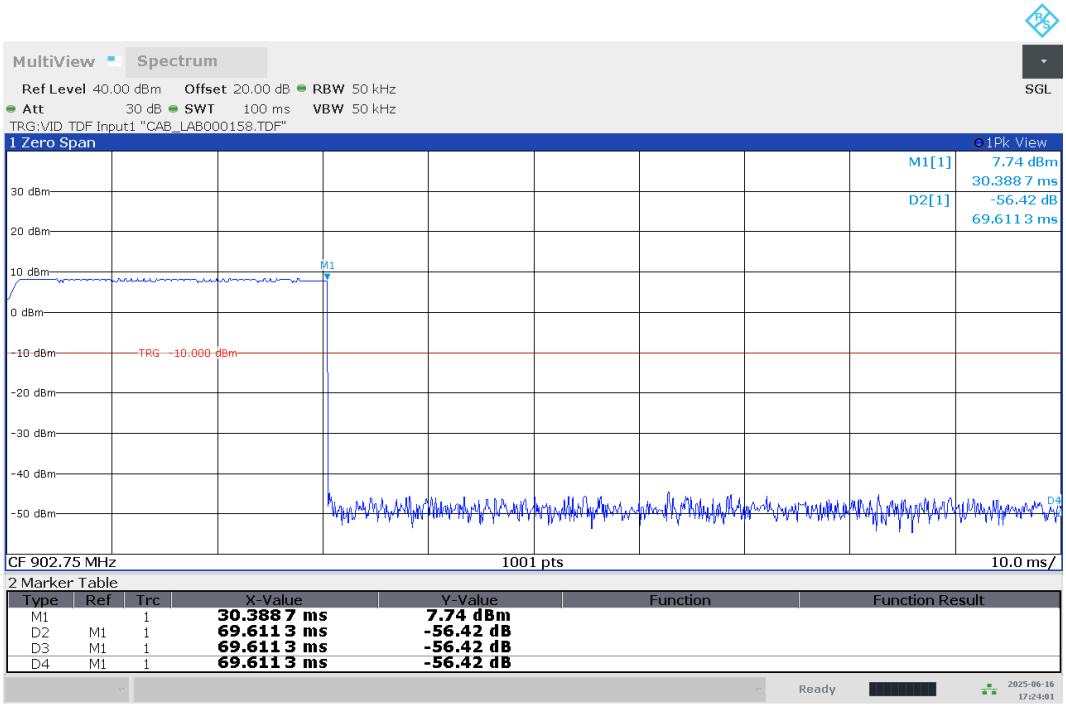


8 Average Time of Occupancy

8.1 Set-up 1, Op. 4, 50 s, low channel



8.2 Set-up 1, Op. 4, 100 ms, low channel

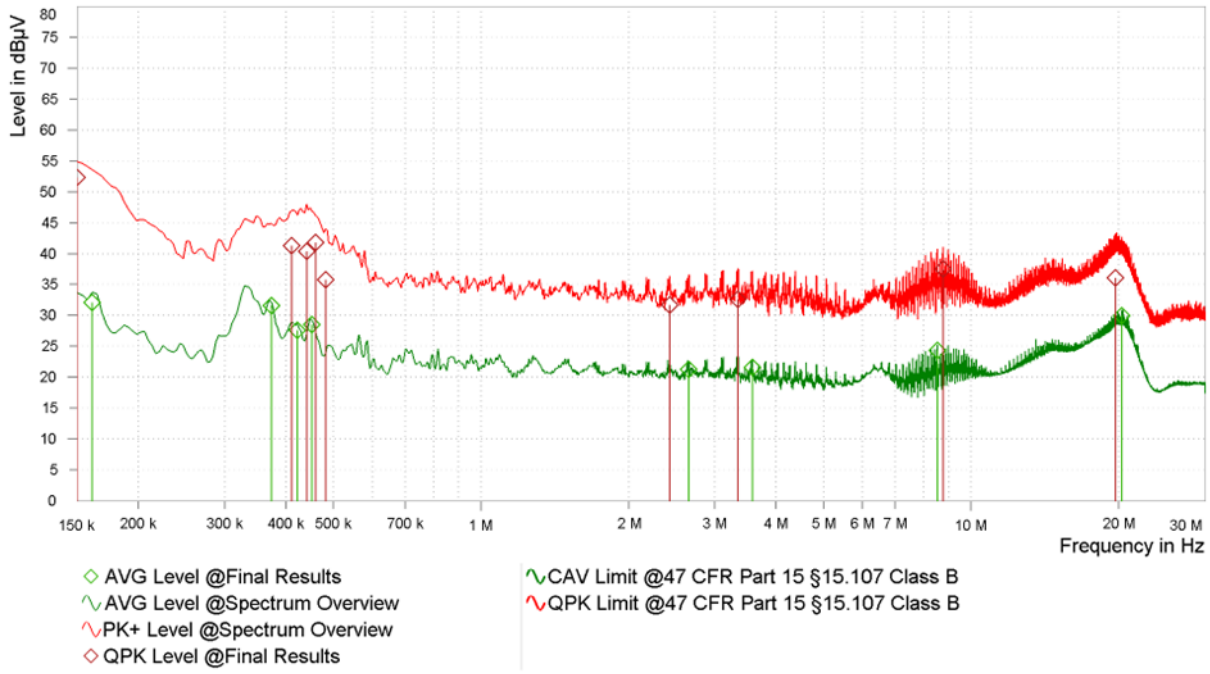


9 Conducted emissions

9.1 Set-up 2, Op. 4, L1

Rg	Frequency [MHz]	QPK Level [dBµV]	QPK Limit [dBµV]	QPK Margin [dB]	AVG Level [dBµV]	AVG: CAV Limit [dBµV]	AVG Margin [dB]	Correction [dB]	Line	Meas. BW [kHz]	Meas. Time [s]
1	0,150	52,97	66,00	13,03	30,94	56,00	25,06	9,85	L1	9,000	15,000
1	0,165				33,50	55,21	21,71	10,08	L1	9,000	15,000
1	0,187	45,05	64,15	19,10				10,02	L1	9,000	15,000
1	0,210				26,79	53,22	26,43	9,87	L1	9,000	15,000
1	0,340				33,39	49,20	15,81	10,04	L1	9,000	15,000
1	0,404	40,66	57,78	17,12				10,16	L1	9,000	15,000
1	0,419	43,27	57,47	14,21				10,17	L1	9,000	15,000
1	0,422				29,21	47,40	18,19	10,17	L1	9,000	15,000
1	0,445	42,28	56,97	14,69				10,17	L1	9,000	15,000
1	0,471	39,58	56,50	16,92				10,17	L1	9,000	15,000
1	6,325	32,49	60,00	27,51				10,10	L1	9,000	15,000
1	6,613				25,30	50,00	24,70	10,11	L1	9,000	15,000
1	9,213	35,23	60,00	24,77				10,21	L1	9,000	15,000
1	13,131	31,59	60,00	28,41				10,36	L1	9,000	15,000
1	19,918				30,16	50,00	19,84	10,52	L1	9,000	15,000
1	20,172	36,67	60,00	23,33				10,53	L1	9,000	15,000
1	20,840				29,93	50,00	20,07	10,55	L1	9,000	15,000

9.2 Set-up 2, Op. 4, N



Rg	Frequency [MHz]	QPK Level [dBµV]	QPK Limit [dBµV]	QPK Margin [dB]	AVG Level [dBµV]	AVG: CAV Limit [dBµV]	AVG Margin [dB]	Correction [dB]	Line	Meas. BW [kHz]	Meas. Time [s]
1	0,150	52,27	66,00	13,73				9,85	N	9,000	15,000
1	0,161				32,12	55,40	23,28	10,01	N	9,000	15,000
1	0,374				31,54	48,41	16,87	10,12	N	9,000	15,000
1	0,411	41,26	57,62	16,36				10,17	N	9,000	15,000
1	0,422				27,62	47,40	19,79	10,17	N	9,000	15,000
1	0,441	40,34	57,04	16,70				10,17	N	9,000	15,000
1	0,452				28,54	46,83	18,29	10,17	N	9,000	15,000
1	0,460	41,74	56,70	14,96				10,17	N	9,000	15,000
1	0,482	35,74	56,30	20,57				10,18	N	9,000	15,000
1	2,430	31,71	56,00	24,29				9,93	N	9,000	15,000
1	2,657				21,26	46,00	24,74	9,94	N	9,000	15,000
1	3,348	32,61	56,00	23,39				9,97	N	9,000	15,000
1	3,579				21,52	46,00	24,48	9,98	N	9,000	15,000
1	8,523				24,29	50,00	25,71	10,20	N	9,000	15,000
1	8,754	37,45	60,00	22,55				10,20	N	9,000	15,000
1	19,713	36,05	60,00	23,95				10,57	N	9,000	15,000
1	20,280				29,97	50,00	20,03	10,59	N	9,000	15,000