

Prüfbericht-Nr.: <i>Test report no.:</i>	DE24L3OV 002	Auftrags-Nr.: <i>Order no.:</i>	1173499 110	Seite 1 von 47 <i>Page 1 of 47</i>
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	-	Auftragsdatum: <i>Order date:</i>	2024-08-30	
Auftraggeber: <i>Client:</i>	Gutermann Technology GmbH, Gottlieb-Daimler-Str. 10, 88214 Ravensburg, Deutschland			
Prüfgegenstand: <i>Test item:</i>	Radio Logger			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	ZS850-L22			
Auftrags-Inhalt: <i>Order content:</i>	Prüfung der Funkparameter nach FCC & ISED <i>Test of radio parameters acc. to FCC & ISED</i>			
Prüfgrundlage: <i>Test specification:</i>	Vollprüfung / Complete test FCC CFR 47 Part 15 Subpart C- §15.247 ISED RSS-247:2023 Issue 3			
Wareneingangsdatum: <i>Date of sample receipt:</i>	2024-10-28	For reasons of confidentiality, no photos of the EUT are included in this report. For EUT and test setup photos please see the Photo Documentation to this report Number.		
Prüfmuster-Nr.: <i>Test sample no.:</i>	A003850445-001 to 033			
Prüfzeitraum: <i>Testing period:</i>	2024-11-18 - 2025-04-03			
Ort der Prüfung: <i>Place of testing:</i>	Nürnberg <i>Nuremberg</i>			
Prüflaboratorium: <i>Testing laboratory:</i>	Wireless Labor <i>Wireless Test Lab</i>			
Prüfergebnis*: <i>Test result*:</i>	Pass			
geprüft von: <i>tested by:</i>	 03.04.2025		genehmigt von: <i>authorized by:</i>	 4/3/2025
Datum: <i>Date:</i>	Signiert von: Matthias Kraeutlein		Ausstellungsdatum: <i>Issue date:</i>	Signiert by: Shriniwas Naikar
Stellung / Position:	Sachverständige(r)/Expert		Stellung / Position:	Sachverständige(r)/Expert
Sonstiges / <i>Other:</i>	Dieser Prüfbericht DE24L3OV -002 ersetzt den Prüfbericht DE24L3OV -001 (siehe Änderungsverzeichnis) / The test report DE24L3OV -002 replaces the test report DE24L3OV -001 (see change history).			
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>		Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>		
* Legende: P(ass) = entspricht o.g. Prüfgrundlage(n) F(ail) = entspricht nicht o.g. Prüfgrundlage(n) N/A = nicht anwendbar N/T = nicht getestet * Legend: P(ass) = passed a.m. test specification(s) F(ail) = failed a.m. test specification(s) N/A = not applicable N/T = not tested				
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Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 2 von 47
Page 2 of 47

Produktbeschreibung
Product description

1	Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben. Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden. <i>The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system.</i> <i>Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.</i>
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3	Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben. Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt. <i>Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report.</i> <i>Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.</i>
4	Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnissen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. Zu weiteren Informationen bezüglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019. <i>The decision rule for statements of conformity, based on numerical measurement results, in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report. For additional information to the resulting risk based of this decision rule please refer to ILAC G8:2019.</i>
5	Wenn auf dem Bericht kein Akkreditierungshinweis aufgebracht ist, wurde der Bericht nicht im akkreditierten Bereich erstellt und ist folglich auch nicht vom EA MLA abgedeckt. Unabhängig davon wurde der Bericht auf Basis der allgemeinen Regeln der ISO/IEC 17000er Reihe erstellt. Mit "#" gekennzeichnete Prüfungen sind nicht Bestandteil der Akkreditierung D-PL-14169-03-00. <i>If there is no accreditation notice on the report, the report has not been produced in the accredited area and is consequently not covered by the EA MLA. Regardless of this, the report has been prepared based on the general rules of the ISO/IEC 17000 series. Tests marked with "#" are not covered by the accreditation D-PL-14169-03-00.</i>

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 3 von 47
Page 3 of 47

Produktbeschreibung
Product description

1	Test item	Radio Logger
2	Typ-No.	ZS850-L22
3	Test sample obtaining	☒ Sampling by customer ☐ Sampling by TÜV Rheinland Group ☐ others:
4	Identical Type	MLS-L22
5	Supported radio technologies evaluated in this report	Proprietary Radio
6	Serial-No.	-
7	Description of EUT	ZONESCAN 850 Logger allows to find leaks in water pipes underground. It measures the acoustic signal on the pipe and sends the data, through radio, to the cloud or specific device to be analysed. The server on the cloud, or an Android device on the field, collects the acoustic data and calculates the existence of the leak and its position.
8	Max RF output power (measured)	17.76 dBm
9	Operating Frequency (declared)	902-928 MHz
10	Channel Bandwidth (measured)	88.27786 kHz
11	Number of Channels	50
12	Modulation	FSK
13	Rated Voltage / Frequency	3,67V DC Battery Powered
14	FCC-ID of the product	FCC ID: ZSS-ZS850915L
15	IC of the product	IC: 9789A-ZS850915L
16	Radio Chip / Antenna Type	☐ Radio module with an antenna on module PCB ☐ Radio module with dedicated antenna ☒ Radio chip with user-accessible antenna connector
17	Antenna Name	ANT-ROD-65+ANT-BASE-06, ANT-ZS-FLEX-65, ANT-ZS-STUB
18	Antenna Type	☐ Integral antenna (designed as a fixed part of the EUT) ☐ Dedicated antenna (removable, obligation to be used) ☒ Permanent antenna connector
19	Antenna number of chains	1
20	Antenna Gain (measured)	ANT-ROD-65 0.94 dBi ANT-ZS-FLEX-65 0.34 dBi ANT-ZS-STUB -0.31 dBi
21	Software / Firmware Version	GDR0185001
22	Hardware Version	ZS850-L22 & MLS-L22 (Unique model type considered as Hardware version)
23	Provided Samples	A003850445-001 to 033
24	Conducted measurements sample	A003850445-030 (cond. sample)
25	Radiated measurements sample	A003850445-022 (rad. sample)
26	Companion Device used for radio connection with the EUT	EUT in Test Mode. Therefore, no Companion Device was used.
27	Auxiliary equipment used to set up the EUT	Test Jig with Customer Laptop
28	Data Cable	USB
29	Temperature Range	-30°C – 70°C
30	Environment	Indoor and Outdoor

Prüfbericht-Nr.: DE24L3OV 002

Seite 4 von 47

Test report no.:

Page 4 of 47

Absatz Clause	Anforderungen - Prüfungen / Requirements - Tests	Bemerkungen/ Remarks	Ergebnis Result
FCC 15.247 (a)(1) RSS-247 sec. 5.1	20 dB Bandwidth	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.247 (a)(1) RSS-247 sec. 5.1	Number of Hopping Frequencies	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.247 (a)(1) RSS-247 sec. 5.1	Time of Occupancy	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.247 (a)(1) RSS-247 sec. 5.1	Carrier Frequency Separation	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.247 (b) RSS-247 sec. 5.4	Maximum Output Power	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.247 (e) RSS-247 sec. 5.2 (b)	Power Spectral Density	Does not apply for FHSS equipment	P ☐ F ☐ N/A ☒ N/T ☐
FCC 15.247 (a)(2) RSS-247 sec. 5.2 (a)	6dB Bandwidth	Does not apply for FHSS equipment	P ☐ F ☐ N/A ☒ N/T ☐
FCC 15.247 (d) RSS-247 sec. 5.5	Unwanted Emissions	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.207 RSS-Gen sec. 8.8	AC Power Conducted Emissions	EUT is powered by an internal battery (non-rechargeable)	P ☐ F ☐ N/A ☒ N/T ☐

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 5 von 47
Page 5 of 47

Prüfdokumentation
Test documentation

Contents

1	Registration	6
2	EUT Classification	6
2.1	Wireless technologies and frequencies supported by the EUT	6
2.2	Standard specific classification of the EUT	6
2.3	System Type	6
3	Test conditions and configurations	6
3.1	Normal environmental test conditions	6
3.2	Equipment modifications	7
3.3	Antenna assemblies	7
3.4	Test Modes	7
3.5	Measurement Uncertainty	8
4	Test results in detail	9
4.1	20 dB bandwidth and 99% Bandwidth	9
4.2	Number of hopping frequencies	12
4.3	Time of occupancy	14
4.4	Carrier Frequency Separation	17
4.5	Maximum Output Power	19
4.6	Unwanted emissions	24
5	Test Setup Photo	44
6	Application form	45
7	Equipment List	46
7.1	Hardware	46
7.2	Software	46
8	Change history	47

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 6 von 47
Page 6 of 47

Prüfdokumentation Test documentation

1 Registration

The measurement facilities for conducted and radiated disturbance measurements of the TÜV Rheinland LGA Products have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules. Measurement data will be accepted in conjunction with applications for Certification under Parts 15 and 18 of the Commission's Rules.

FCC Registration Number: 939976

Bundesnetzagentur Registration Number: BNetzA-CAB-17/21-16

The measurement facilities are also recognized by Innovation, Science and Economic Development (ISED) Canada to test to Canadian radio equipment requirements.

Company Number: 11235A

CAB Identifier: DE0018

2 EUT Classification

2.1 Wireless technologies and frequencies supported by the EUT.

The named technologies are only those falling in the specification of the applied standard.

Frequency Range Op.Band [MHz]		Used Center Frequency Range [MHz]		OCW [kHz]	Maximum conducted Output Power		TX	RX	Evaluated in this report
f _{Low}	f _{High}	f _{Low}	f _{High}		[mW]	[dBm]			
902	928	904	918.7	250	59.70	17.76	☒	☒	☒

SISO: Single Input Single Output

2.2 Standard specific classification of the EUT

2.2.1 Applied standards

FCC CFR 47 Part 15 Subpart C - §15.247

ISED RSS-247:2023 Issue 3

2.2.2 Test Methods and Guidance Documents

ANSI C63.10:2013

KDB 558074 D01 DTS Measurement Guidance v05

2.3 System Type

FHSS (Frequency Hopping Spread Spectrum)

2.3.1 Type of equipment

Tabletop Equipment

3 Test conditions and configurations

3.1 Normal environmental test conditions

Environmental condition	Parameter	Range during test
Temperature	°C	21-24
Relative humidity	%	20-60
Supply voltage	V	3.6

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 7 von 47
Page 7 of 47

Prüfdokumentation
Test documentation

3.2 Equipment modifications

No modifications were found to be necessary to perform the tests or to achieve compliance.

3.3 Antenna assemblies

EUT is equipped with a standard antenna connector, so tests were done in conducted and radiated mode.

3.4 Test Modes

The EUT was rotated in all orientations (elevation and azimuth) with the help of a positioning device.

The following configurations were used for the test cases:

Mode description	Mode configuration
All Modes	No auxiliary equipment was connected to the EUT.
Mode 1: TX-Mode Unmodulated	TX Unmodulated
Mode 2: TX-Mode Modulated	TX PN9
Mode 3: TX-Mode Hopping	FCC TX Hopping
Mode 4: N/A	

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 8 von 47
Page 8 of 47

Prüfdokumentation
Test documentation

3.5 Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to ETSI TR 100 028-1/-2 and ETSI TS 103 051 (radiated measurements) and is documented in the quality system acc. to ISO/IEC 17025:2017.

Furthermore, component and process variability of devices similar to that tested may result in additional deviation.

The stated values are the expanded uncertainty values, the measured value lies within the assigned range of values with a probability of 95% ($k = 1.96$).

The manufacturer has the sole responsibility of continued compliance of the device.

Test	Value	Unit	Range
Frequency Error	$2.7 \cdot 10^{-8}$	Hz	-
Frequency Stability under low voltage conditions			
Time	$1.1 \cdot 10^{-9}$	s	-
Conducted Carrier Power	1.0	dB	9k-1GHz
Conducted Spurious Emissions (RX/TX)	1.7	dB	1GHz-6GHz
	2.8	dB	6GHz-40GHz
Occupied Bandwidth (OBW)	0.1	%	-
TX Power Spectral Density	4.2	mW	9kHz - 6GHz
	1.6	dB	9kHz - 6GHz
Dwell Time	$4.6 \cdot 10^{-7}$	Hz	-
Frequency Separation			-
Measurement of conducted emissions at the power supply connection to LISN	2.3	dB	9kHz – 150kHz
	2.2	dB	150kHz – 30MHz
Measurement of the field strength at distance 3m	1.6	dB	9k-150kHz
	4.5	dB	30-1000MHz
	5	dB	1-6GHz
	5.3	dB	6-40GHz
Temperature	0.8	K	-
Humidity	4	%	-
Voltage (AC/DC)	1.0	%	-

Measured value	Limit	Extended measurement uncertainty ($k=1.96$)	Confidence interval (95%)
19 dBm @ 2.48GHz	20 dBm	1.7 dB	17.3 dBm – 20.7 dBm

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 9 von 47
Page 9 of 47

Prüfdokumentation
Test documentation

4 Test results in detail

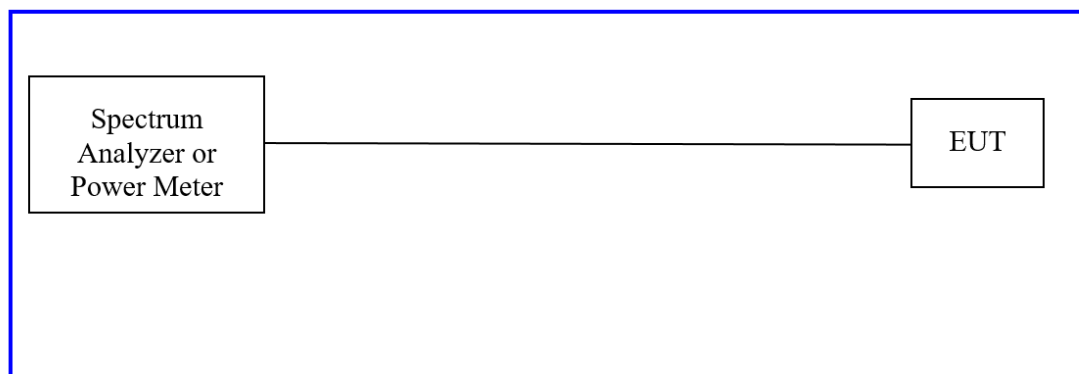
4.1 20 dB bandwidth and 99% Bandwidth

4.1.1 Requirements / Limits

	Condition	Limit
☒	Frequency hopping systems operating in the 902-928 MHz band.	The 20 dB bandwidth of the hopping channel is less than 250 kHz.
☐		The 20 dB bandwidth of the hopping channel is 250 kHz or greater.
☐	Frequency hopping systems operating in the 5725-5850 MHz band.	<i>FCC Part 15, Subpart C, §15.247 (a) (1) (i)</i> 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
☐		<i>FCC Part 15, Subpart C, §15.247 (a) (1) (i)</i> 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.
☐	Frequency hopping systems operating in the 2400-2483.5 MHz band.	<i>FCC Part 15, Subpart C, §15.247 (a) (1) (ii)</i> The system shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.
☐		<i>FCC Part 15, Subpart C, §15.247 (a) (1) (iii)</i> The system shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

4.1.2 Test Method

Conducted method was used to measure the 20 dB bandwidth and 99% bandwidth. The 20 dB bandwidth was measured according to ANSI C63.10:2013 clause 6.9.2, and 99% bandwidth was measured according to ANSI C63.10:2013 clause 6.9.3. The EUT was connected to the spectrum analyzer via a coax cable with a known loss.



Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 10 von 47
Page 10 of 47

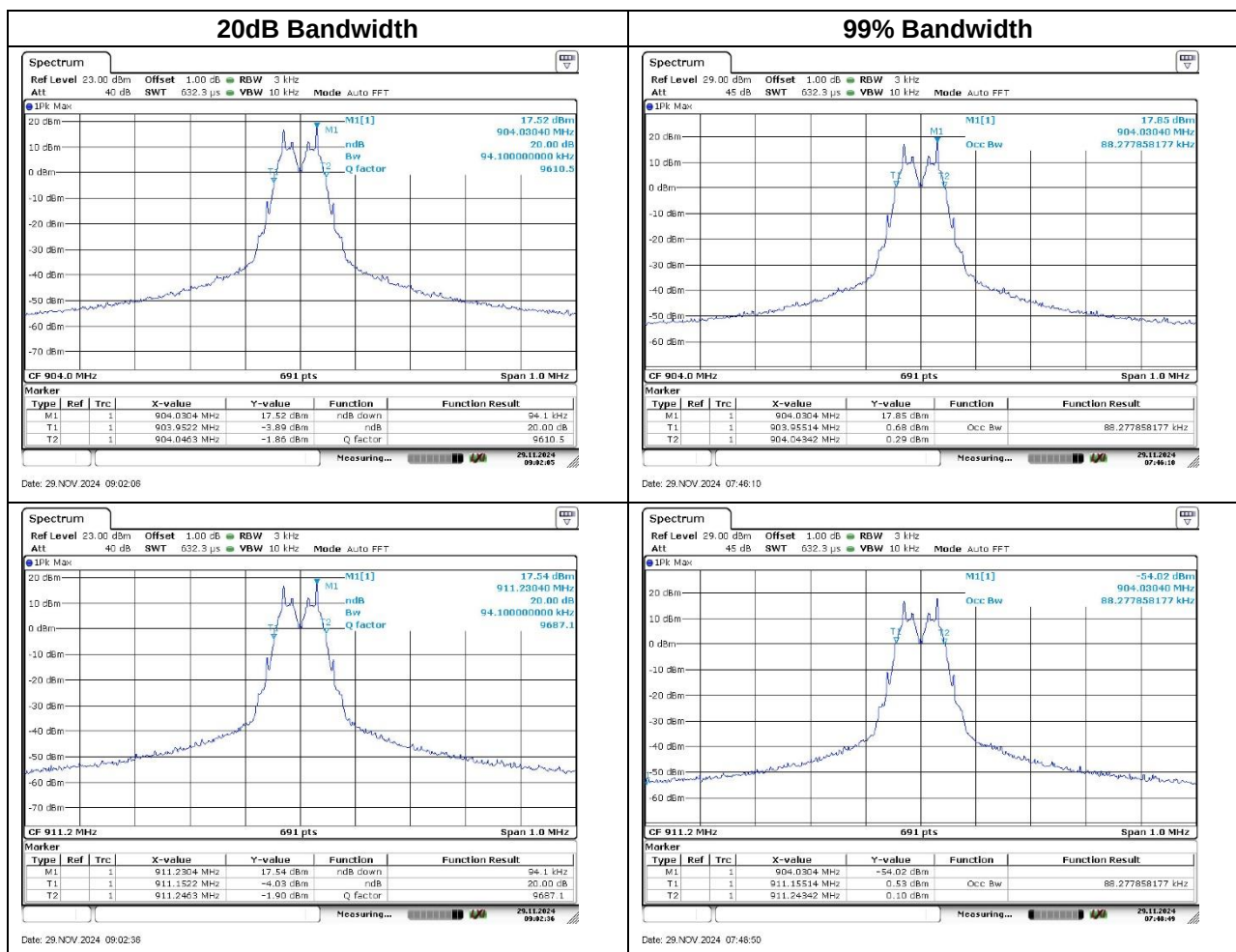
Prüfdokumentation Test documentation

4.1.3 Test Setup (20dB Bandwidth and 99% Bandwidth)

4.1.3.1 Conducted measurements

EUT		A003850445-030 (cond. sample)
Chamber details		Shielded room
Companion device		EUT in Test Mode. Therefore, no Companion Device was used.
Operation mode		☐ 1: TX-Mode Unmodulated ☒ 2: TX-Mode Modulated ☐ 3: TX-Mode Hopping ☐ 4: N/A
Spectrum Analyzer	Centre Frequency	904, 911.2 & 918.7 MHz
	Resolution Bandwidth	3kHz
	Video Bandwidth	10 kHz
	Span	1 MHz
	Sweep time	Auto
Further parameters		-
Test engineer		Matthias Kräutlein

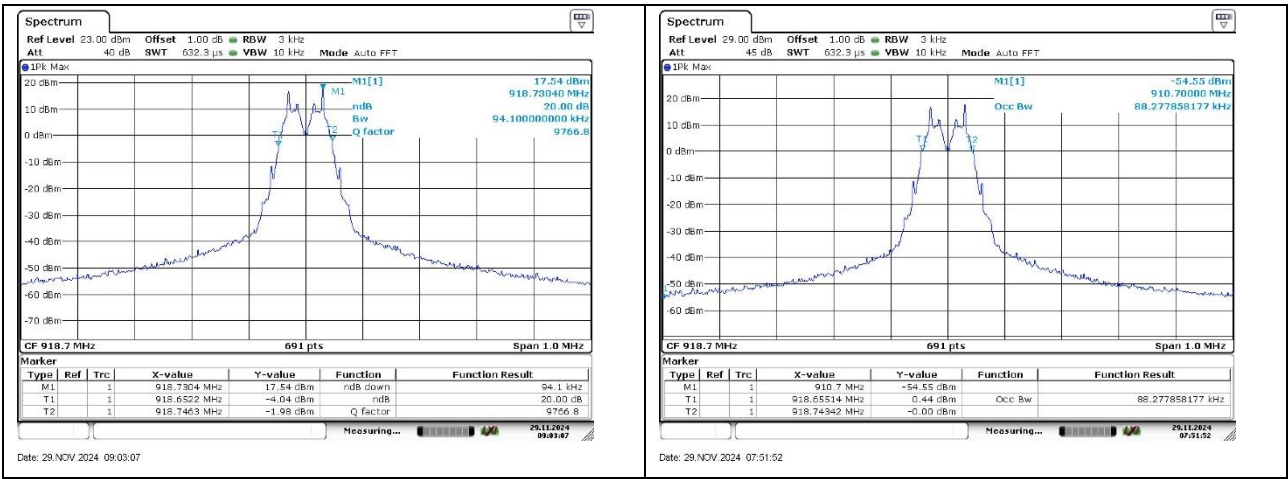
4.1.4 Test Results



Prüfbericht-Nr.: DE24L3OV 002
 Test report no.:

Seite 11 von 47
 Page 11 of 47

Prüfdokumentation
 Test documentation



4.1.4.1 20dB Bandwidth

Frequency	20 dB Bandwidth (kHz)	Limit (kHz)	Test Result
904 MHz	94.1	500 kHz	Pass
911.2 MHz	94.1		
918.7 MHz	94.1		

4.1.4.2 99% Bandwidth

Frequency	Bandwidth (kHz)
904 MHz	88.27786
911.2 MHz	88.27786
918.7 MHz	88.27786

4.1.5 Final test result

Final test result	Pass
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Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 12 von 47
Page 12 of 47

Prüfdokumentation
Test documentation

4.2 Number of hopping frequencies

4.2.1 Requirements / Limits

The requirements of the number of hopping frequencies is specified in FCC CFR 47 Part 15 Subpart C-§15.247 (a) (1); ISSED RSS-247 5.1.

4.2.2 Test Method

Conducted method was used to measure the number of hopping frequencies according to ANSI C63.10:2013 clause 7.8.3; ISSED RSS-247 5.1. The EUT was connected to the spectrum analyzer via a coax cable with a known loss.

4.2.3 Test Setup

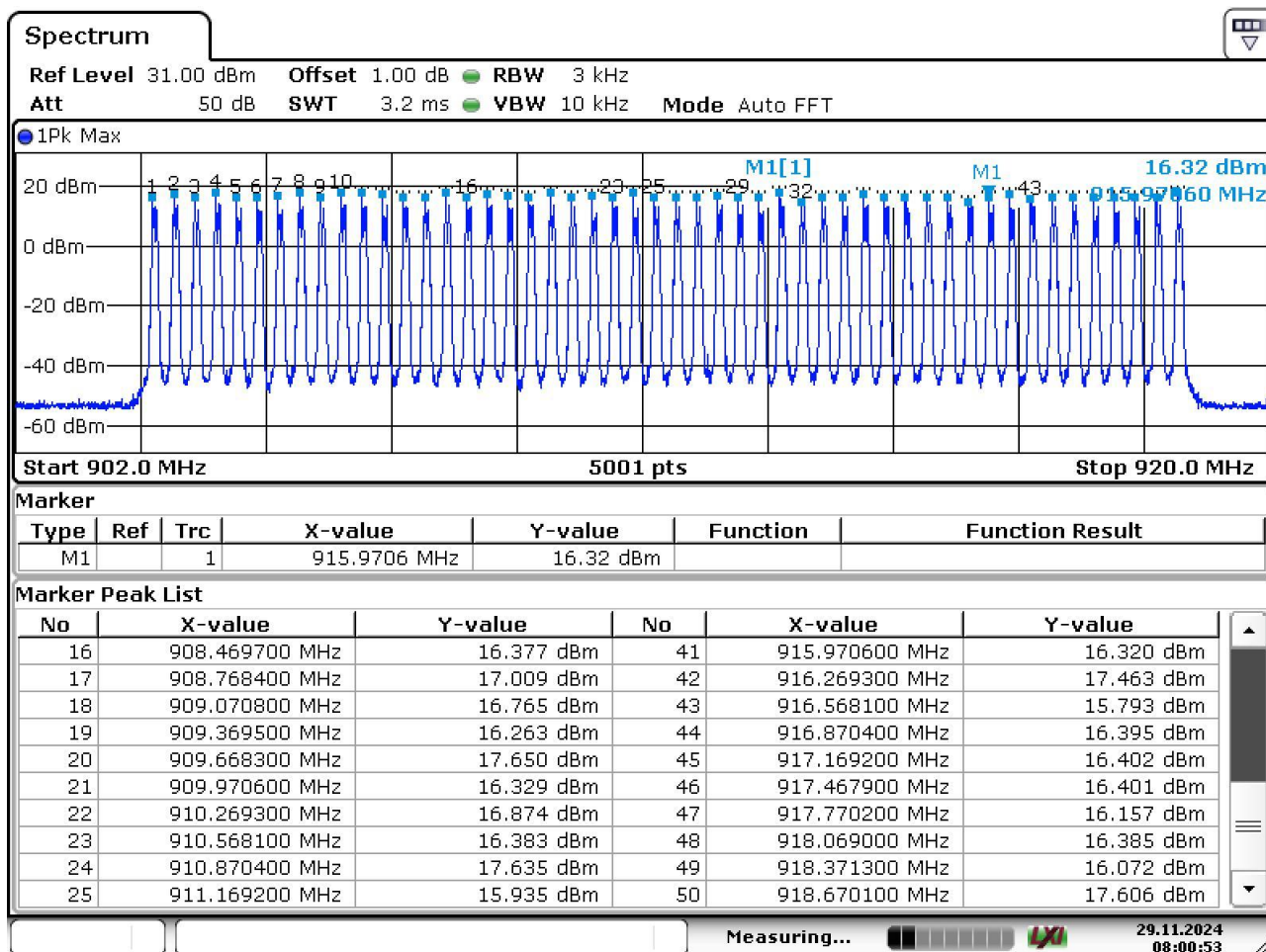
EUT		A003850445-030 (cond. sample)
Chamber details		☐ 3m Fully Anechoic Chamber (FAC) ☐ 10m Semi Anechoic Chamber (SAC) ☒ Shielded room
Measurement positioning		Distance: EUT height: Antenna height: ☐ 3m ☐ 1.5m ☐ 1.5m ☐ 10m ☐ 0.8m ☐ 1m to 4m – height scan ☒ N/A
Companion device		EUT in Test Mode. Therefore, no Companion Device was used.
Operation mode		☐ 1: TX-Mode Unmodulated ☐ 2: TX-Mode Modulated ☒ 3: TX-Mode Hopping ☐ 4: N/A
Spectrum Analyzer	Centre Frequency	911.2 MHz
	Resolution Bandwidth	3kHz
	Video Bandwidth	10 kHz
	Span	18 MHz
	Sweep time	3.2 ms
Further parameters		-
Test engineer		Matthias Kräutlein

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 13 von 47
Page 13 of 47

Prüfdokumentation Test documentation

4.2.4 Test Results (Number of hopping frequencies)



Date: 29.NOV.2024 08:00:53

Total number of hopping frequencies	Minimum requirement	Test Result
50	25	Pass

4.2.5 Final test result (Number of hopping frequencies)

Final test result	Pass
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Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 14 von 47
Page 14 of 47

Prüfdokumentation
Test documentation

4.3 Time of occupancy

4.3.1 Requirements / Limits

The requirements of the average time of occupancy on any frequency are specified in 4.1.1.

4.3.2 Test Method

Conducted method was used to measure the average time of occupancy according to ANSI C63.10:2013 clause 7.8.4. The EUT was connected to the spectrum analyzer via a coax cable with a known loss.

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements (20 seconds).

4.3.3 Test Setup

EUT		A003850445-030 (cond. sample)
Chamber details		☐ 3m Fully Anechoic Chamber (FAC) ☐ 10m Semi Anechoic Chamber (SAC) ☒ Shielded room
Measurement positioning		Distance: EUT height: Antenna height: ☐ 3m ☐ 1.5m ☐ 1.5m ☐ 10m ☐ 0.8m ☐ 1m to 4m – height scan ☒ N/A
Companion device		EUT in Test Mode. Therefore, no Companion Device was used.
Operation mode		☐ 1: TX-Mode Unmodulated ☐ 2: TX-Mode Modulated ☒ 3: TX-Mode Hopping ☐ 4: N/A
Spectrum Analyzer	Centre Frequency	911.2 MHz
	Resolution Bandwidth	100 kHz
	Video Bandwidth	300 kHz
	Span	0 Hz
	Sweep time	20 s
Further parameters		-
Test engineer		Matthias Kräutlein

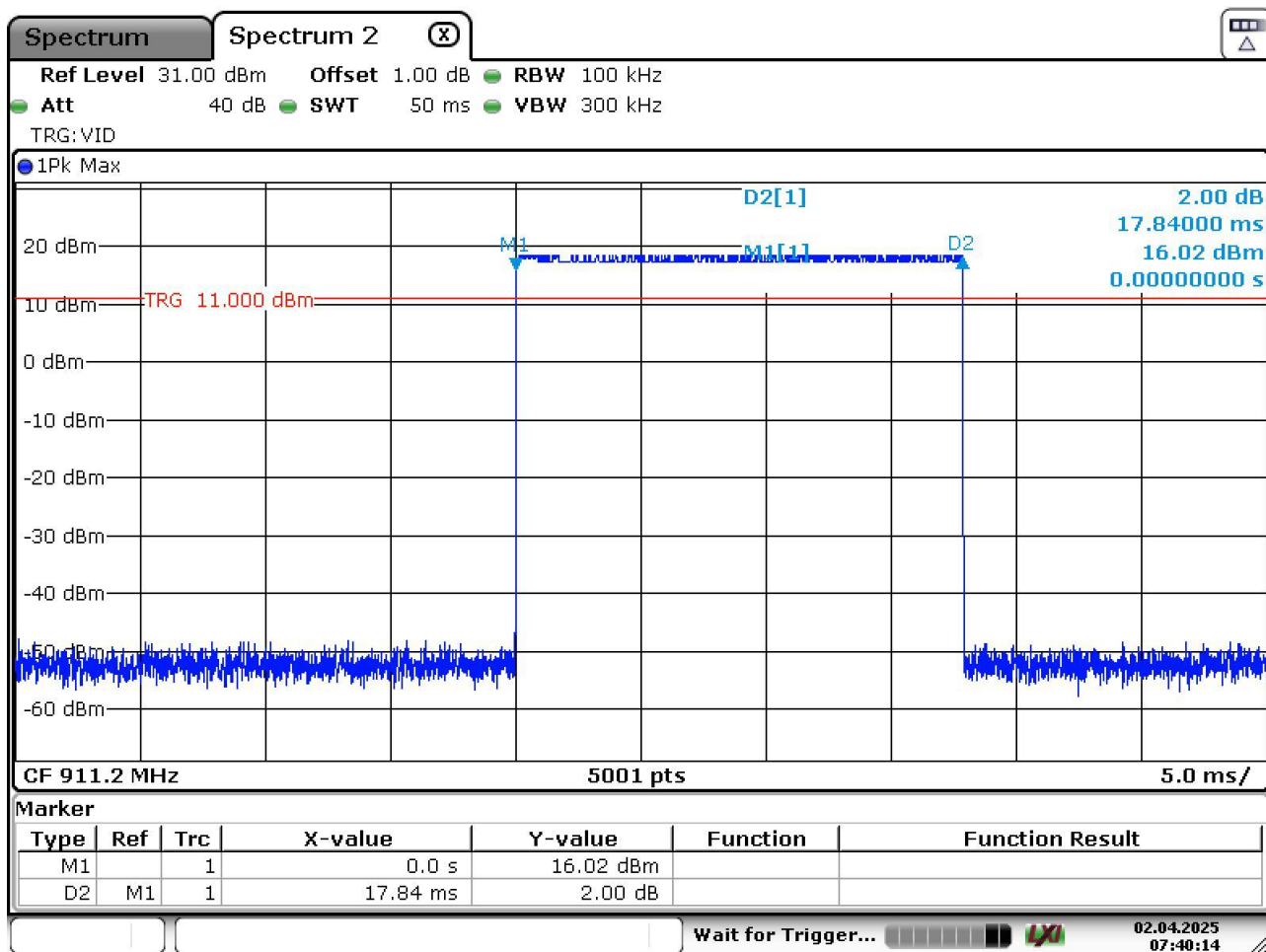
Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 15 von 47
Page 15 of 47

Prüfdokumentation Test documentation

4.3.4 Test Results (Time of occupancy)

Transmit time per hop:



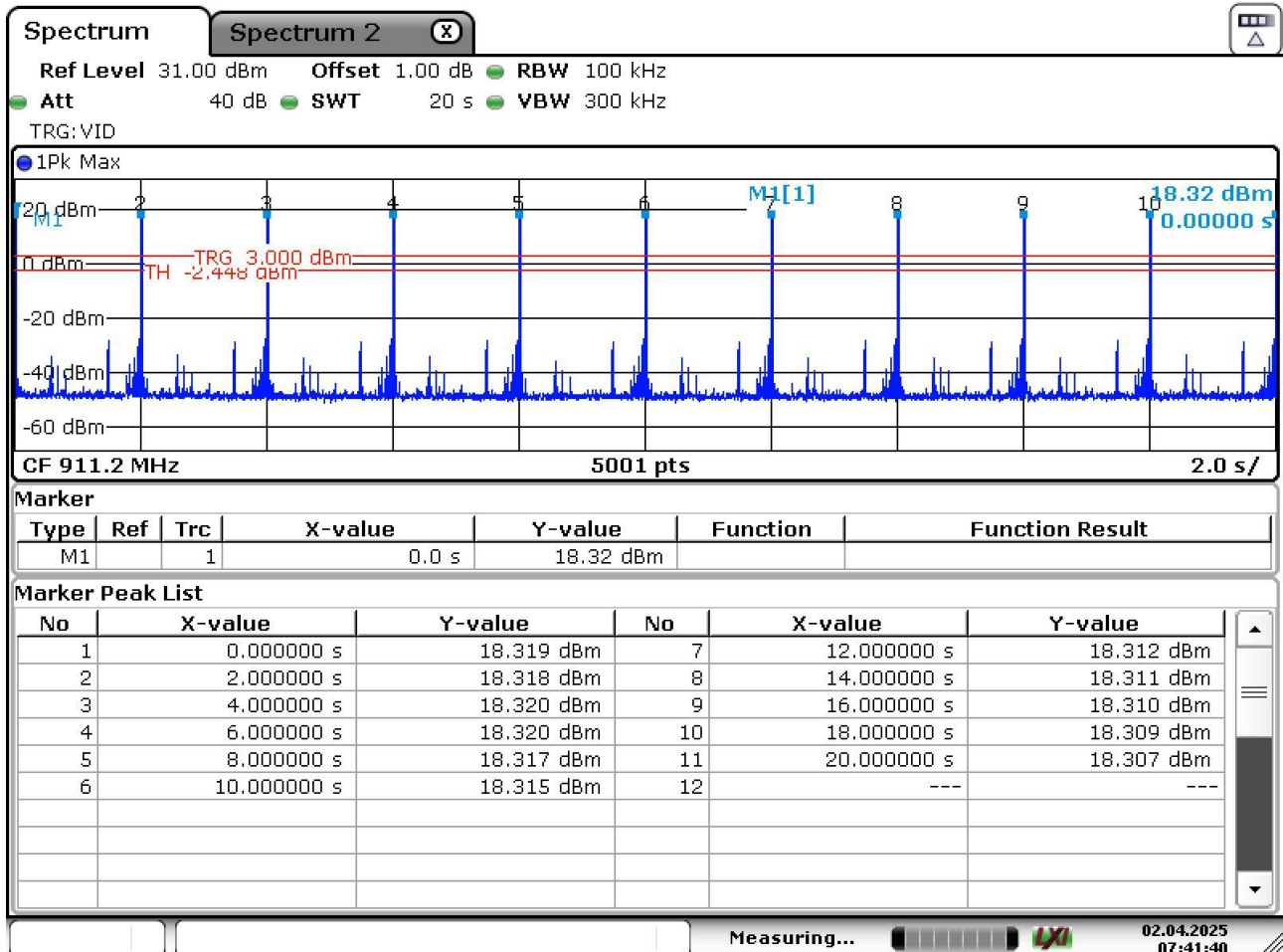
Date: 2.APR.2025 07:40:14

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 16 von 47
Page 16 of 47

Prüfdokumentation Test documentation

Number of hops in 20 seconds:



Date: 2.APR.2025 07:41:41

Transmit time per hop [ms]	Number of hops in 20 seconds	Average time of occupancy [ms]	Limit	Test Result
17.84	11	196.24	0.4s	pass

4.3.5 Final test result (Time of occupancy)

Final test result	Pass
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Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 17 von 47
Page 17 of 47

Prüfdokumentation
Test documentation

4.4 Carrier Frequency Separation

4.4.1 Requirements / Limits

☒	<i>FCC Part 15, Subpart C, §15.247 (a) (1)</i> 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.
☐	<i>FCC Part 15, Subpart C, §15.247 (a) (1)</i> 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.

4.4.2 Test Method

Conducted method was used to measure the minimum frequency separation according to ANSI C63.10-2013 clause 7.8.2. The EUT was connected to the spectrum analyzer via a coax cable with a known loss

4.4.3 Test Setup

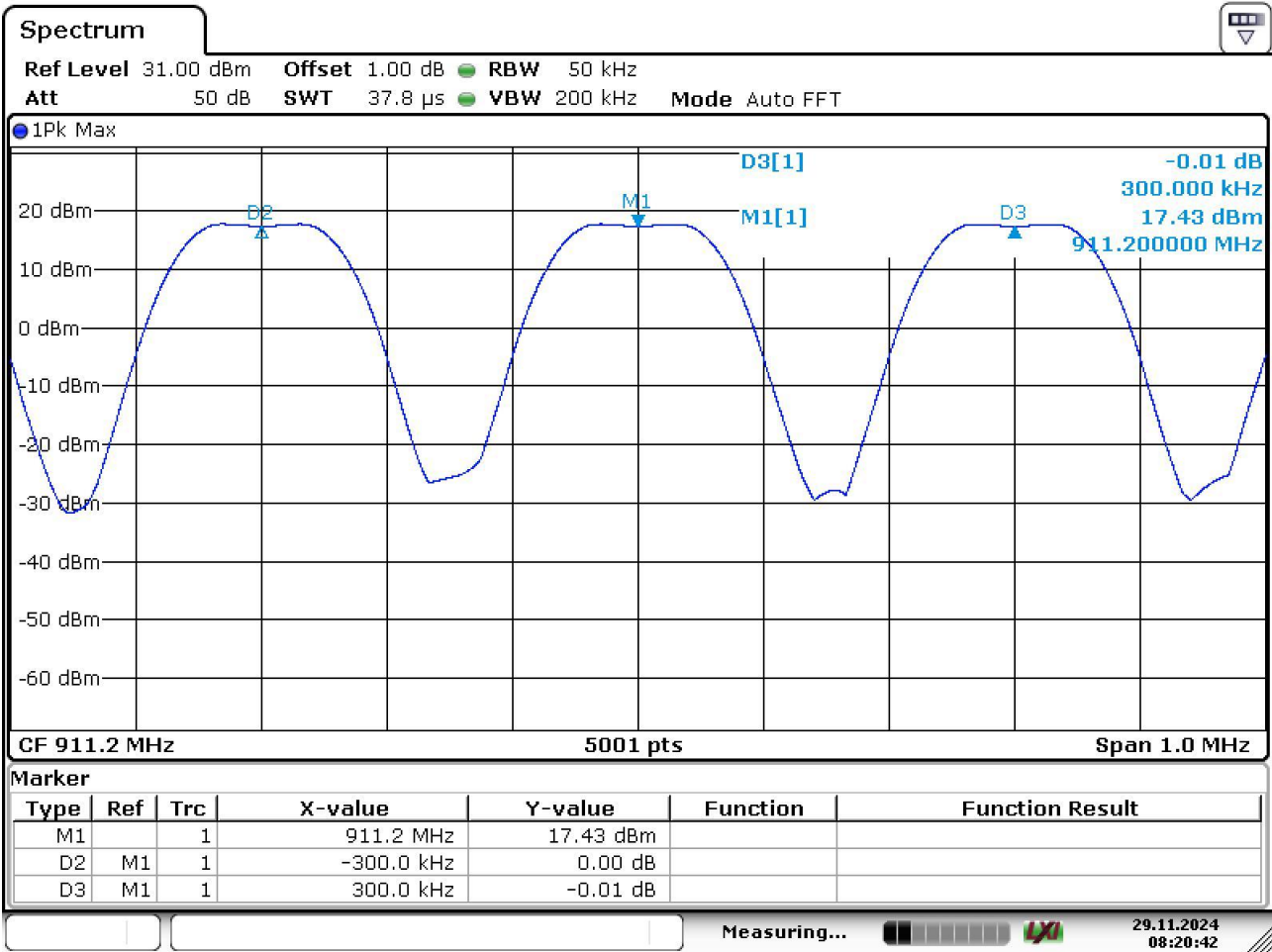
EUT		A003850445-030 (cond. sample)
Chamber details		☐ 3m Fully Anechoic Chamber (FAC) ☐ 10m Semi Anechoic Chamber (SAC) ☒ Shielded room
Measurement positioning		Distance: EUT height: Antenna height: ☐ 3m ☐ 1.5m ☐ 1.5m ☐ 10m ☐ 0.8m ☐ 1m to 4m – height scan ☒ N/A
Companion device		EUT in Test Mode. Therefore, no Companion Device was used.
Operation mode		☐ 1: TX-Mode Unmodulated ☐ 2: TX-Mode Modulated ☒ 3: TX-Mode Hopping ☐ 4: N/A
Spectrum Analyzer	Centre Frequency	911.2 MHz
	Resolution Bandwidth	50 kHz
	Video Bandwidth	200 kHz
	Span	1 MHz
	Sweep time	Auto
Further parameters		-
Test engineer		Matthias Kräutlein

Prüfbericht-Nr.: DE24L3OV 002
 Test report no.:

Seite 18 von 47
 Page 18 of 47

Prüfdokumentation
 Test documentation

4.4.4 Test Results (Carrier Frequency Separation)



Date: 29.NOV.2024 08:20:42

Channel Separation (kHz)	Minimum requirement (kHz)	Test Result
300 kHz	94.1	Pass

4.4.5 Final test result (Carrier Frequency Separation)

Final test result	Pass
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Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 19 von 47
Page 19 of 47

Prüfdokumentation
Test documentation

4.5 Maximum Output Power

4.5.1 Requirements / Limits

The maximum output power limit is expressed in terms of either maximum peak conducted output power or maximum conducted output power.

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the full signal bandwidth.

The maximum conducted output power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

Condition		Limit
☐	Systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands	FCC Part 15, Subpart C, §15.247 (b) (3) 1 watt = 30dBm. Maximum conducted peak output power: 30 dBm (excluding antenna gain, if antennas with directional gains that do not exceed 6 dBi are used).
☐	Frequency hopping systems operating 2400-2483.5 MHz band.	Employing less than 75 non-overlapping hopping channels
☐		Employing at least 75 non-overlapping hopping channels
☐	Frequency hopping systems operating 5725-5850 MHz band.	FCC Part 15, Subpart C, §15.247 (b) (1) 1 watt = 30dBm.
☐	Frequency hopping systems operating 902-928 MHz band.	Employing less than 50 but at least 25 hopping channels
☒		Employing at least 50 hopping channels
☐	Antenna gain greater than 6dBi	FCC Part 15, Subpart C, §15.247 (b) (4) The conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3), as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 20 von 47
Page 20 of 47

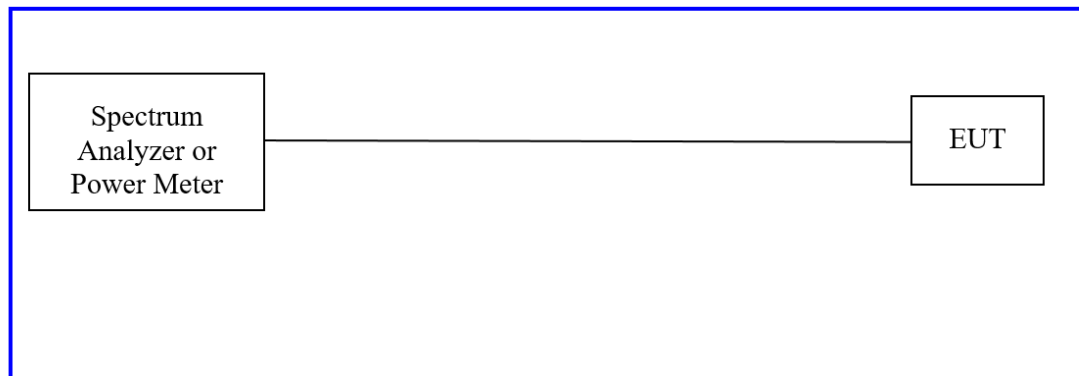
Prüfdokumentation
Test documentation

4.5.2 Test Method (Maximum Output Power)

4.5.2.1 Conducted measurements

Measurements were done according to ANSI C63.10:2013 clause 11.9.1.1 peak power (RBW > DTS bandwidth).

The EUT was connected to the spectrum analyzer via a coax cable with a known loss.



Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 21 von 47
Page 21 of 47

Prüfdokumentation
Test documentation

4.5.3 Test setup (Maximum Output Power)

4.5.3.1 Conducted measurements

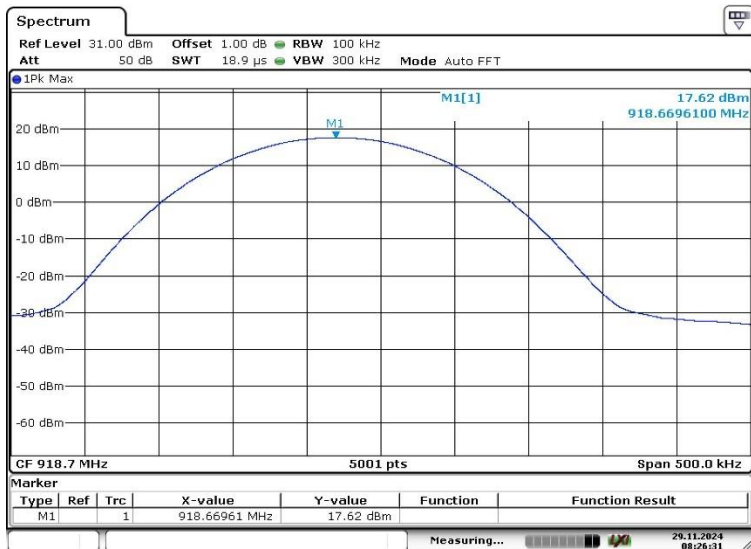
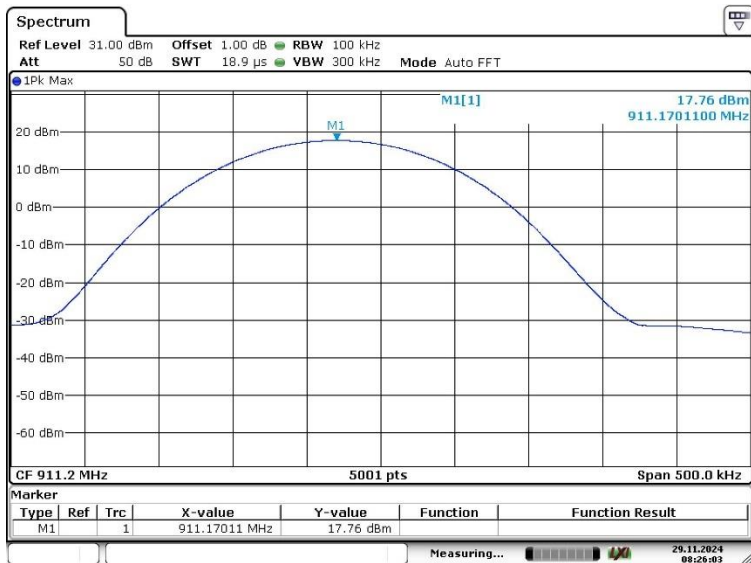
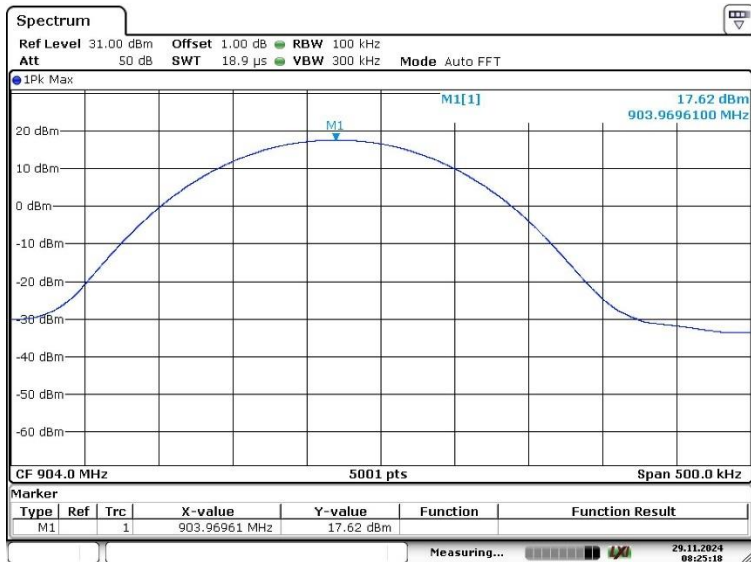
EUT		A003850445-030 (cond. sample)
Chamber details		Shielded room
Companion device		EUT in Test Mode. Therefore, no Companion Device was used.
Operation mode		☐ 1: TX-Mode Unmodulated ☒ 2: TX-Mode Modulated ☐ 3: TX-Mode Hopping ☐ 4: N/A
Spectrum Analyzer	Resolution Bandwidth	100 kHz
	Video Bandwidth	300 kHz
	Sweep Time	Auto couple
	Trace	Max hold
	Detector	Peak
Further parameters		-
Test engineer		Matthias Kräutlein

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 22 von 47
Page 22 of 47

Prüfdokumentation Test documentation

4.5.4 Test results (Maximum Output Power)



Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 23 von 47
Page 23 of 47

Prüfdokumentation
Test documentation

ANT-ZS-STUB

Frequency [MHz]	P _{Out} Peak [dBm] conducted	Antenna Gain [dBi]	P _{out} Peak [dBm] EIRP
904.0	17.62	-0.31	17.31
911.2	17.76	-0.31	17.45
918.7	17.62	-0.31	17.31

ANT-ZS-FLEX-65

Frequency [MHz]	P _{Out} Peak [dBm] conducted	Antenna Gain [dBi]	P _{out} Peak [dBm] EIRP
904.0	17.62	0.34	17.96
911.2	17.76	0.34	18.1
918.7	17.62	0.34	17.96

ANT-ROD-65

Frequency [MHz]	P _{Out} Peak [dBm] conducted	Antenna Gain [dBi]	P _{out} Peak [dBm] EIRP
904.0	17.62	0.94	18.56
911.2	17.76	0.94	18.7
918.7	17.62	0.94	18.56

4.5.5 Final test result (Maximum Output Power)

Final test result	Pass
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Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 24 von 47
Page 24 of 47

Prüfdokumentation
Test documentation

4.6 Unwanted emissions

4.6.1 Requirements / Limits

☒	FCC Part 15, Subpart C, §15.247 (d); [RSS-247 sec. 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. Attenuation below the general limits specified in § 15.209(a) [RSS-Gen sec. 8.9] is not required. Radiated emissions which fall in the restricted bands, as defined in § 15.205(a) [RSS-Gen sec.8.10], must comply with the radiated emission limits specified in § 15.209(a) [RSS-Gen sec. 8.9].
☐	FCC Part 15, Subpart C, §15.247 (d); [RSS-247 sec. 5.5]: If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this test shall be 30 dB instead of 20 dB.

FCC Part 15, Subpart C, §15.209; [RSS-Gen sec. 8.9]; Radiated Emission Limits

Frequency [MHz]	Measurement distance [m]	Limit [μV/m]	Limit [dBμV/m]	Limit @3m [dBμV/m]	Detector
0.009 – 0.09	300	2400/F(kHz)	48.5 ... 28.5	128.5 ... 108.5	AVG(Pk)
0.09 – 0.11	300	2400/F(kHz)	28.5 ... 26.8	108.5 ... 106.8	QP
0.11 – 0.49	300	2400/F(kHz)	26.8 ... 13.8	106.8 ... 93.8	AVG(Pk)
0.49 – 1.705	30	24000/F(kHz)	33.8 ... 23.0	73.8 ... 63.0	QP
1.705 – 30	30	30	29.5	69.5	QP
30 – 88	3	100	40.0	40.0	QP
88 – 216	3	150	43.5	43.5	QP
216 – 960	3	200	46.0	46.0	QP
960 - 1000	3	500	54.0	54.0	QP
1000 - 40000	3	500	54.0	54.0	AVG(Pk)

Used conversion factor $\mu\text{V/m} \rightarrow \text{dB}\mu\text{V/m}$: $\text{Limit} [\text{dB}\mu\text{V/m}] = 20 \log (\text{Limit} [\mu\text{V/m}] / 1\mu\text{V/m})$

At frequencies below 30MHz, the measured values are corrected with an inverse linear distance extrapolation factor (40dB/decade) according to FCC 15.31 (f)(2).

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90kHz, 110–490kHz and above 1000MHz. Radiated emission limits in these three bands are based on measurements employing a linear average detector.

FCC Part 15, Subpart C, §15.35(b) [RSS-Gen sec. 8.1]:

..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

ANSI C63.10:2013 clause 5.5:

The spectrum shall be investigated from the lowest radio frequency signal generated in the device and up to at least the 10th harmonic of the highest fundamental frequency or to 40 GHz whichever is lower.

However, frequencies below 9 kHz do not need to be investigated.

Prüfdokumentation
Test documentation

4.6.2 Radiated measurements with general limit (Unwanted emissions)

4.6.2.1 Test Method

Radiated unwanted Emissions were tested against the general limits specified in § 15.209(a) [RSS-Gen sec. 8.9]. Emissions that fall inside the frequency band in which the intentional radiator is operating were excluded.

Emissions that exceed the general limits were additionally tested for the further requirements of §15.247 (d); [RSS-247 sec. 5.5]

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT. The different measurement setups for each frequency range are shown below.

For the final testing, the placement of EUT and cables were the same as for preliminary testing. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, then the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked. For the measurements in the frequency range 30 MHz to 1 GHz for each measured frequency the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation.

For measurement above 1 GHz the turntable was set continues rotation and positioner step sizes were set to a range of 22° and the antenna height is fixed.

For the measurements in the frequency ranges (90-110kHz, 490 kHz-1 GHz) quasi-peak detector is used, while average and peak detectors are used in other ranges.

Final testing was performed on an SVSWR compliant test site.

The final average electric field value (E_{final}) is calculated in the final measurement table using the following equation:

$$E_{final} = \text{RawRec} + \text{Corr.}$$

While

$$\text{Corr.} = \text{Trd. Corr.} + \text{Sig Path} + \text{Preamp}$$

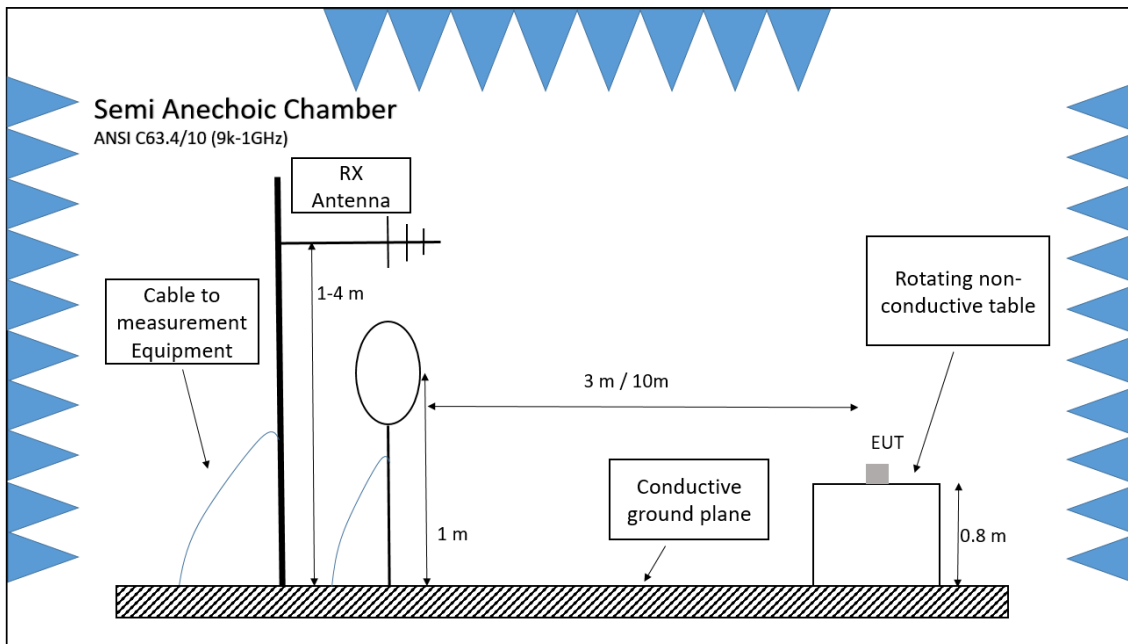
Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 26 von 47
Page 26 of 47

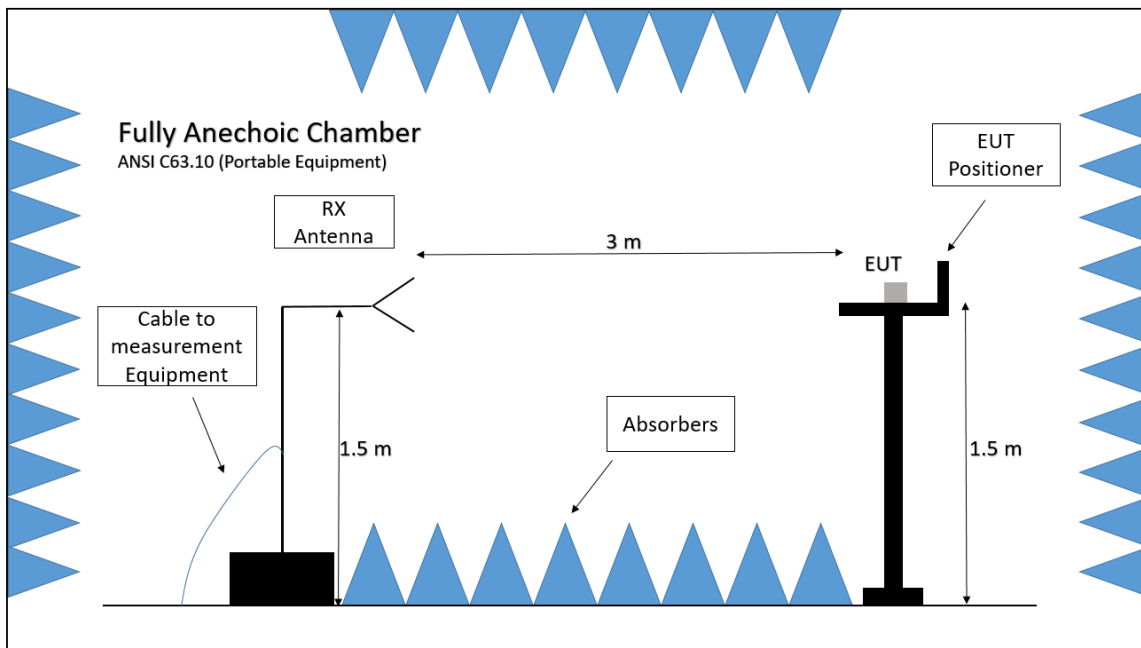
Prüfdokumentation Test documentation

4.6.2.2 EUT positioning (Radiated measurements with general limit; Unwanted emissions)

4.6.2.2.1 EUT positioning below 1GHz



4.6.2.2.2 EUT positioning above 1GHz



Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 27 von 47
Page 27 of 47

Prüfdokumentation
Test documentation

4.6.2.3 Measurement Setup (Radiated measurements with general limit; Unwanted emissions)

4.6.2.3.1 Measurement Setup 9kHz - 30MHz

Test Site	SAC (Semi Anechoic Chamber)
Receiving Antenna	Loop antenna (HFH 2)
Receiving Antenna Height	1m (center of Loop antenna)
Receiving Antenna Polarization	Parallel and perpendicular to the EUT (EUT without Loop antenna) According to ANSI C63.10:2013 clause 6.4.6
EUT Table	1.0m x 1.5m non-conductive table 80cm above the floor
EUT Turn Table Step Size	22.5° during exploratory tests Linear during maximizations for final measurements
Receiver Configurations	Average and peak detectors (9-90kHz and 110-490kHz) Quasi Peak detector (90-110kHz and 490kHz-30MHz)
	RBW: 200Hz (9 - 150kHz) and 9 kHz (150kHz – 30MHz)
	Step Size: 50Hz (9-150kHz) and 2.25kHz (150k-30MHz)
	Sweep Time: 100ms (FFT) during exploratory tests Sweep Time: 1s for final measurements

4.6.2.3.2 Measurement Setup 30MHz - 1GHz

Test Site	Semi-anechoic chamber
Receiving Antenna	Hybrid Antenna VULB 9168
Receiving Antenna height	Varied (1m to 4m, step size 1m) during exploratory tests Linear during maximizations for final measurements
Receiving Antenna Polarization	Horizontal and Vertical
EUT Table	1.0m x 1.5m non-conductive table 80cm above the floor
EUT Turn Table Step Size	45° during exploratory tests Linear during maximizations for final measurements
Receiver Configurations	Average and peak detector
	RBW :120 kHz
	Step Size: 30kHz (30-1000MHz)
	Sweep Time: 20ms (FFT) during exploratory tests Sweep Time: 1s for final measurements

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 28 von 47
Page 28 of 47

Prüfdokumentation
Test documentation

4.6.2.3.3 Measurement Setup above 1GHz

Test Site	Fully-anechoic chamber
Receiving Antenna	Horn Antenna HF907 (1-18GHz), 3116C-PA (18-40GHz)
Receiving Antenna Height	1.5m
Receiving Antenna Polarization	Horizontal – Vertical
EUT Positioner	40cm x 60cm non-conductive positioner 1.5m above the floor Step size elevation angle 22°
Spectrum Analyzer	Average and peak detectors
	RBW: 1 MHz
	Sweep Time: 60s during exploratory tests Sweep Time: 10s for final measurements

4.6.2.4 Test Setup (Radiated measurements with general limit; Unwanted emissions)

EUT	A003850445-022 (rad. sample)
Companion device	EUT in Test Mode. Therefore, no Companion Device was used.
Operation mode	☐ 1: TX-Mode Unmodulated ☒ 2: TX-Mode Modulated ☐ 3: TX-Mode Hopping ☐ 4: N/A
Further parameters	-
Test engineer	Matthias Kräutlein

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

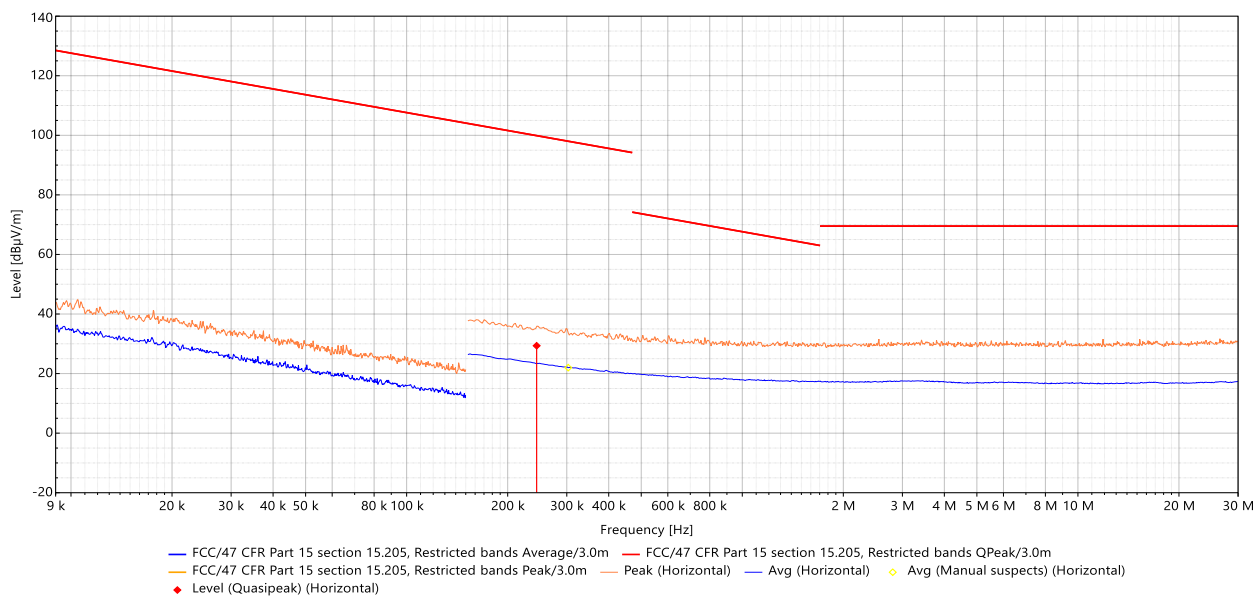
Seite 29 von 47
Page 29 of 47

Prüfdokumentation Test documentation

4.6.2.5 Test results (Radiated measurements with general limit; Unwanted emissions)

4.6.2.5.1 9 kHz to 30 MHz, lowest Channel

#10



Frequency (Hz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pos	Azimuth (°)	Height (m)	Correction (dB)	RBW (Hz)	M. time (s)	Comments
243.99 k	29.3	99.9	-70.5	H	5.2	1.00	19.7	9 k	1.0	Pass

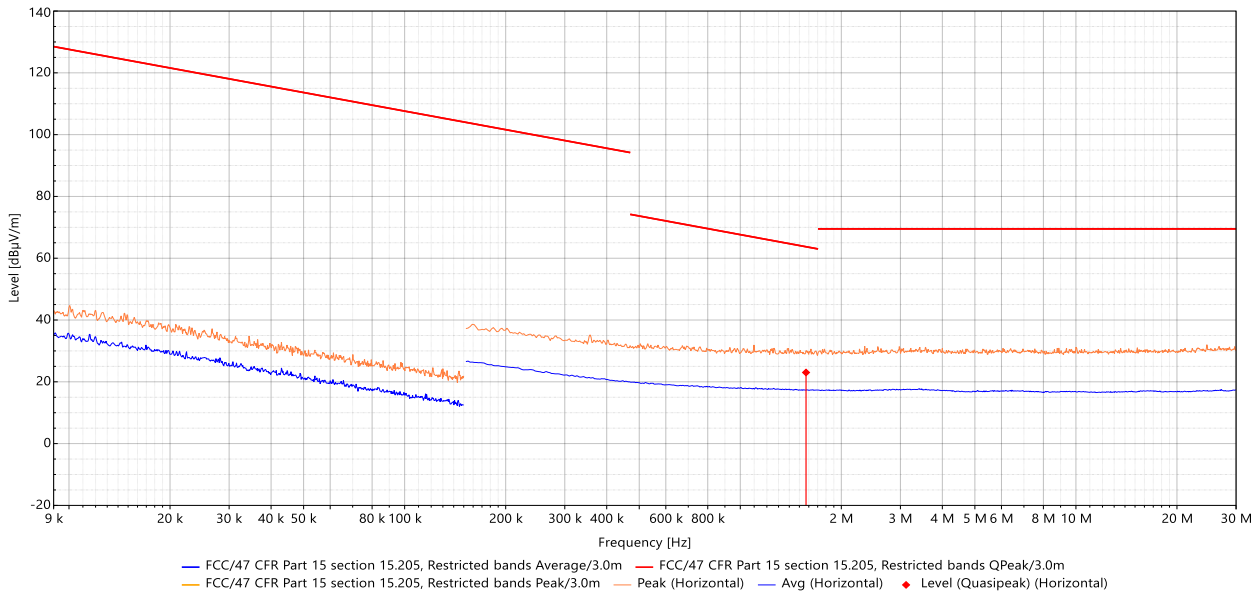
Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 30 von 47
Page 30 of 47

Prüfdokumentation
Test documentation

4.6.2.5.2 Perpendicular Polarization

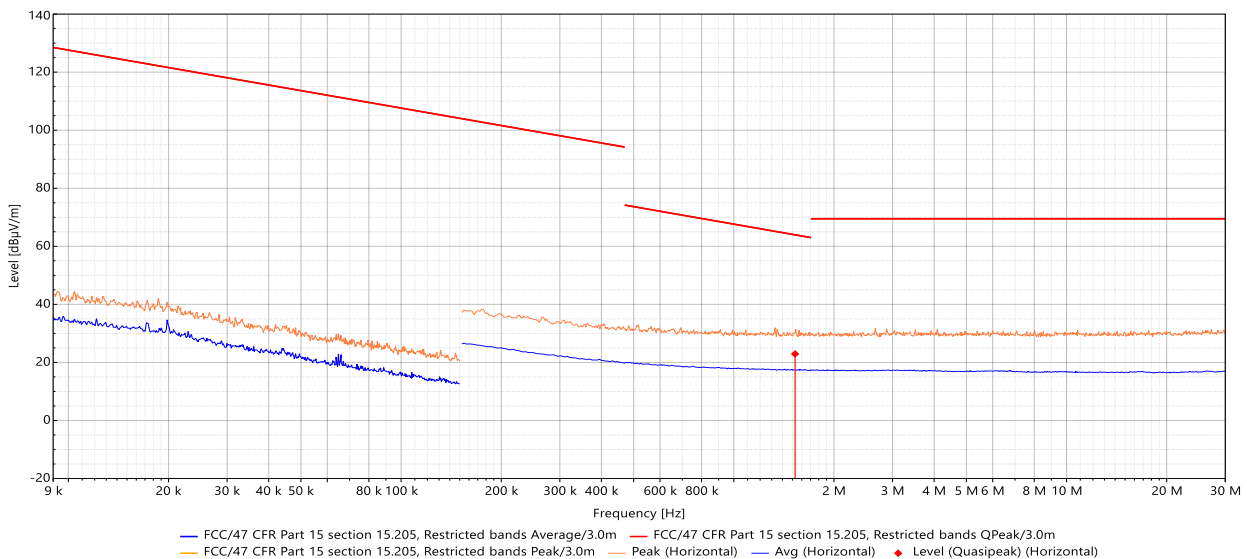
#15



Frequency (Hz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pos	Azimuth (°)	Height (m)	Correction (dB)	RBW (Hz)	M. time (s)	Comments
1.57 M	23.0	63.7	-40.7	H	232.8	1.00	19.5	9 k	1.0	Pass

4.6.2.5.3 Parallel Polarization

#12



Frequency (Hz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pos	Azimuth (°)	Height (m)	Correction (dB)	RBW (Hz)	M. time (s)	Comments
1.528 M	22.9	63.9	-41.0	H	138.9	1.00	19.6	9 k	1.0	Pass

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

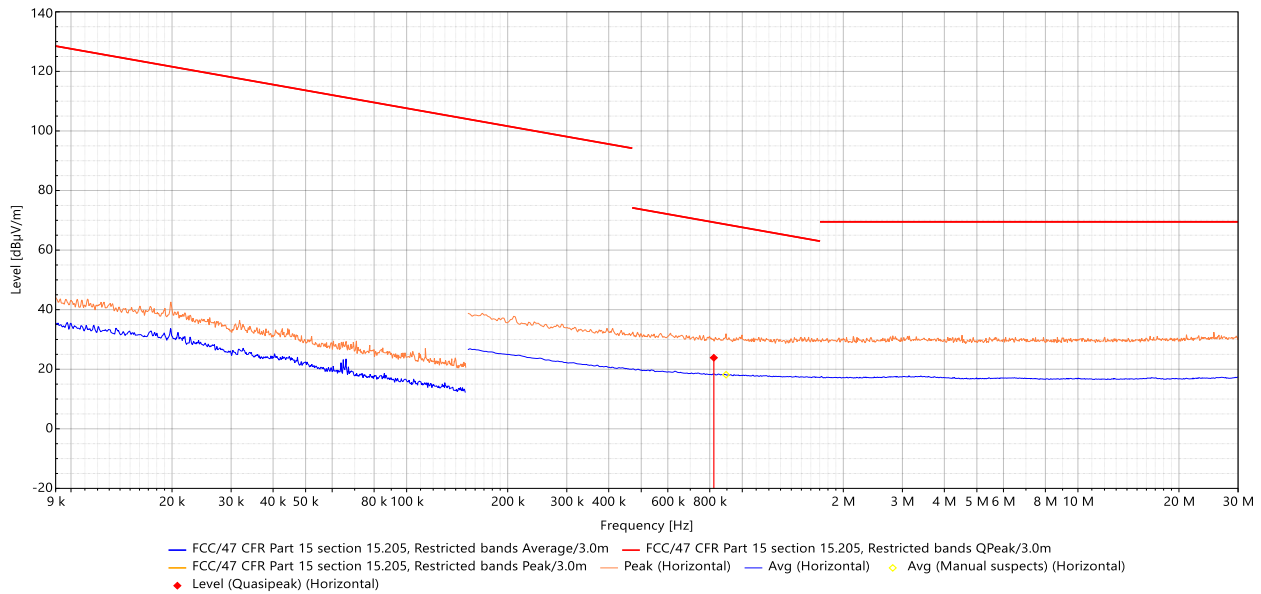
Seite 31 von 47
Page 31 of 47

Prüfdokumentation Test documentation

4.6.2.6 9 kHz to 30 MHz, highest Channel

4.6.2.6.1 Perpendicular Polarization

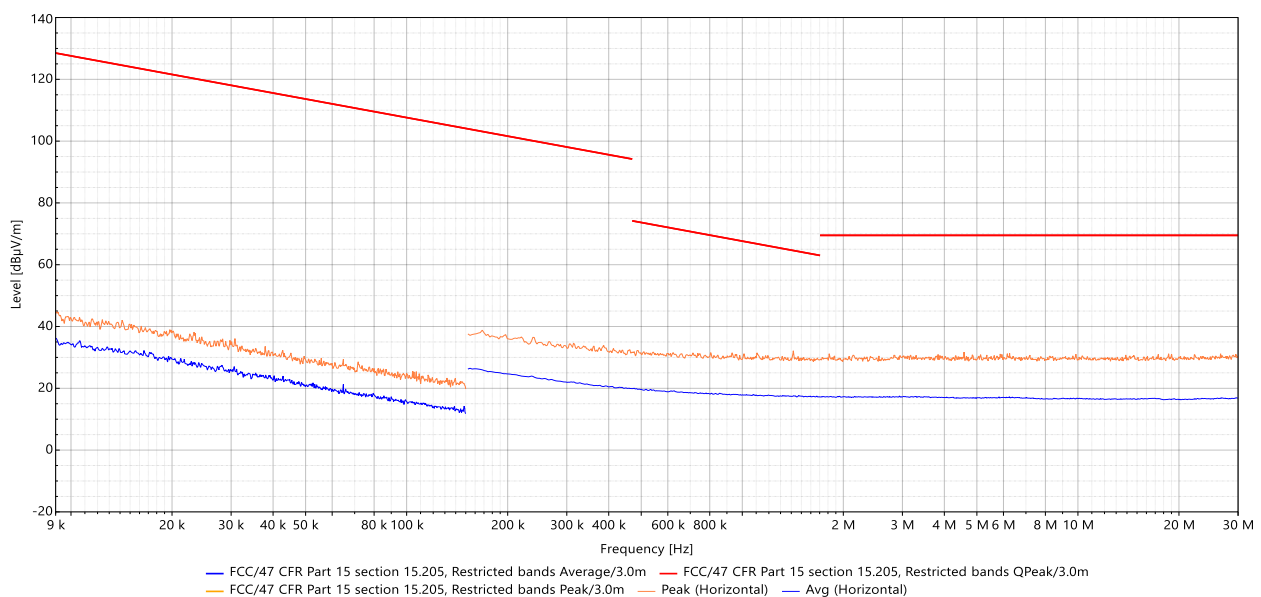
#9



Frequency (Hz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pos	Azimuth (°)	Height (m)	Correction (dB)	RBW (Hz)	M. time (s)	Comments
822.73 k	23.9	69.3	-45.5	H	25.9	1.00	19.6	9 k	1.0	Pass

4.6.2.6.2 Parallel Polarization

#11



Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

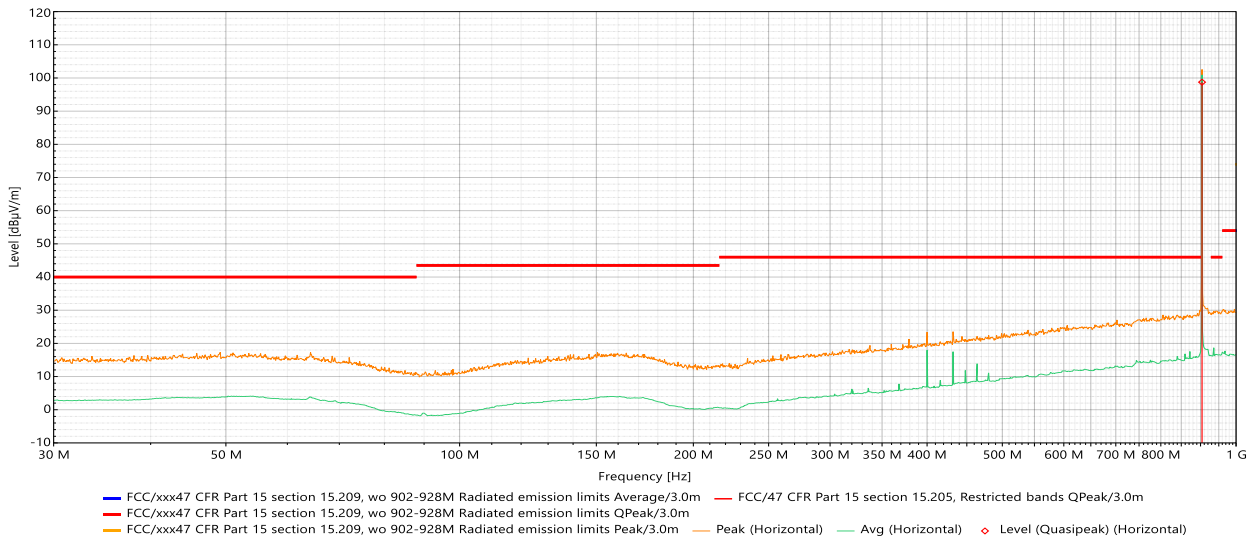
Seite 32 von 47
Page 32 of 47

Prüfdokumentation Test documentation

4.6.2.7 30 MHz to 1 GHz, lowest Channel

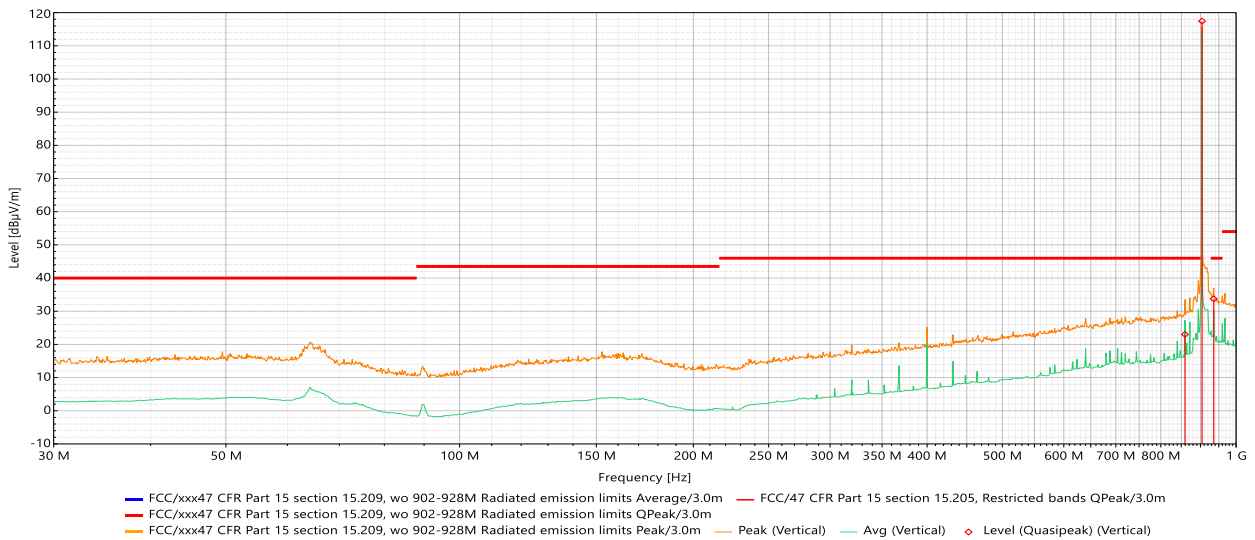
4.6.2.7.1 Horizontal Polarization

#17



4.6.2.7.2 Vertical Polarization

#17



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Height (m)	Corr. (dB)
859.527	23.0	46.0	-23.0	V	285.4	1.33	0.8
936.02	33.7	46.0	-12.3	V	100	1.07	2.0
904.032	TX			H	59.9	1.28	1.7
904.03				V	136.0	1.15	1.7

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

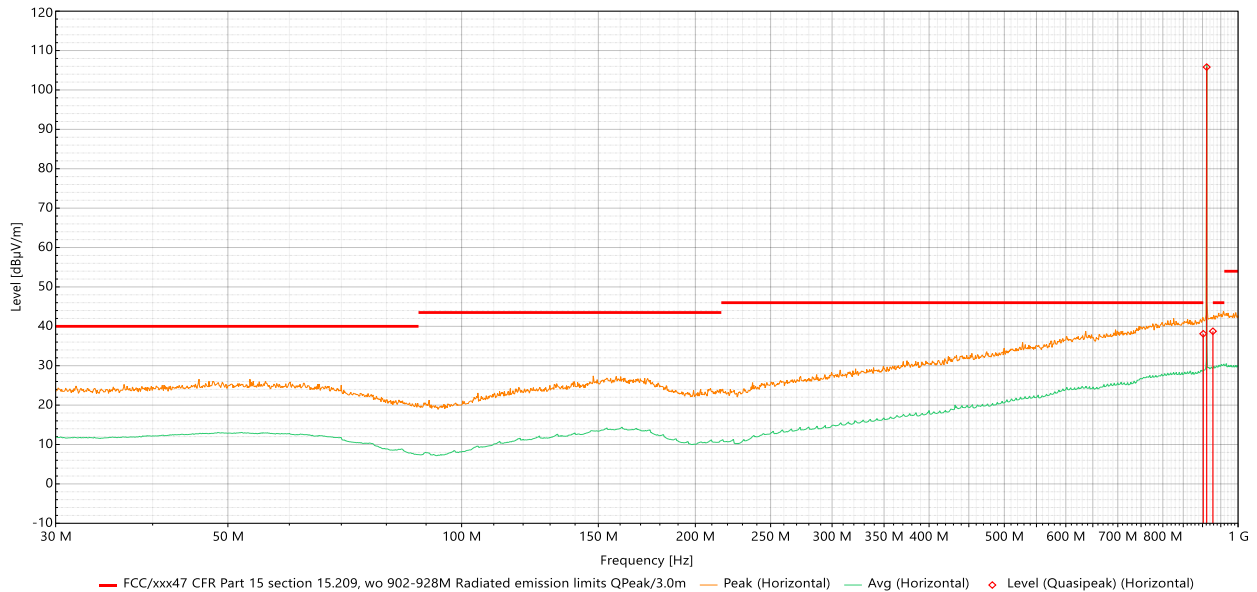
Seite 33 von 47
Page 33 of 47

Prüfdokumentation Test documentation

4.6.2.8 30 MHz to 1 GHz, middle Channel

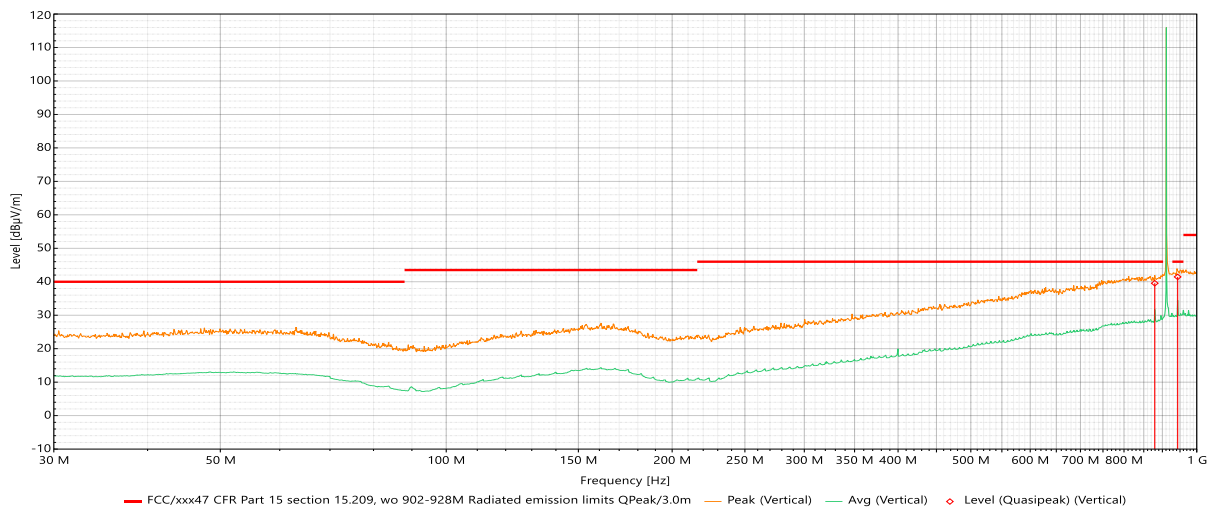
4.6.2.8.1 Horizontal Polarization

#19



4.6.2.8.2 Vertical Polarization

#19



Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Azimuth (deg)	Height (m)	RBW (kHz)	Corr. (dB)
901.911	38.1	46.0	-7.9	H	193.6	3.28	100	28.1
928.119	38.7	46.0	-7.3	H	294.8	3.52	100	28.4
879.17	39.6	46.0	-6.4	V	101.8	1.06	100	27.5
943.169	41.5	46.0	-4.5	V	124.5	1.16	100	28.6

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

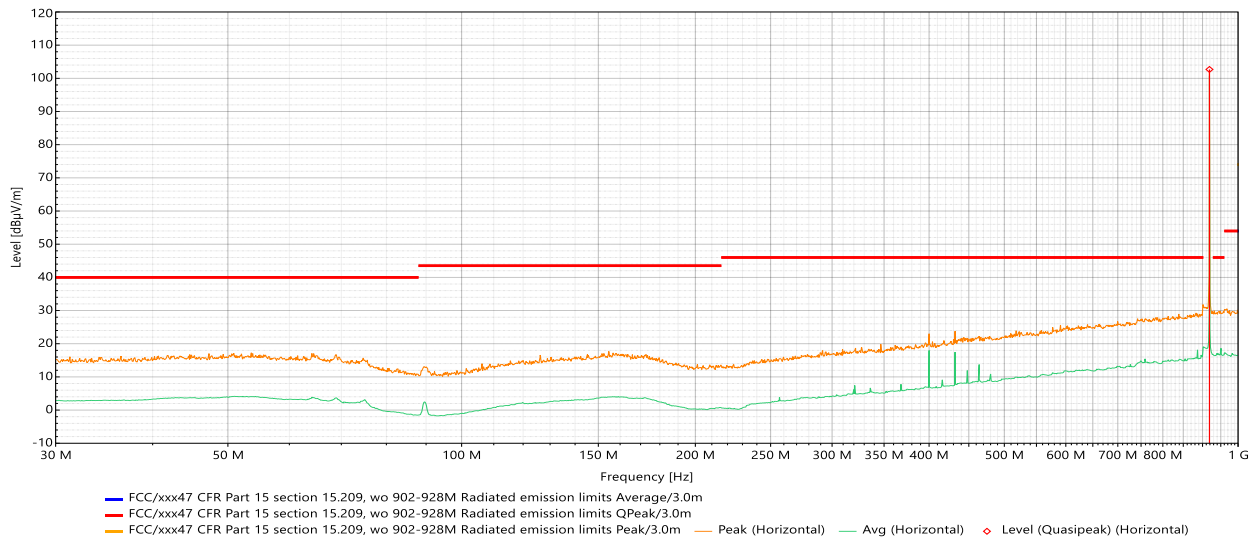
Seite 34 von 47
Page 34 of 47

Prüfdokumentation
Test documentation

4.6.2.9 30 MHz to 1 GHz, highest Channel

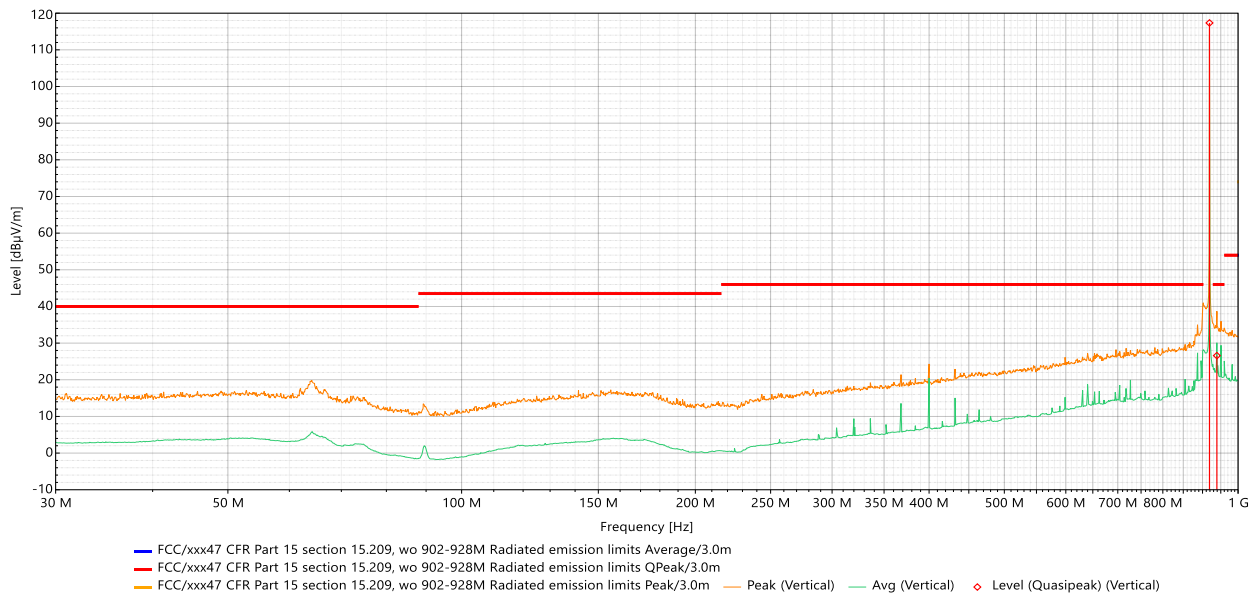
4.6.2.9.1 Horizontal Polarization

#18



4.6.2.9.2 Vertical Polarization

#18



Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Azimuth (deg)	Height (m)	Corr. (dB)
918.669 M	TX			H	61.3	1.14	1.9
939.07 M	26.6	46.0	-19.4	V	182.7	1.03	2.1

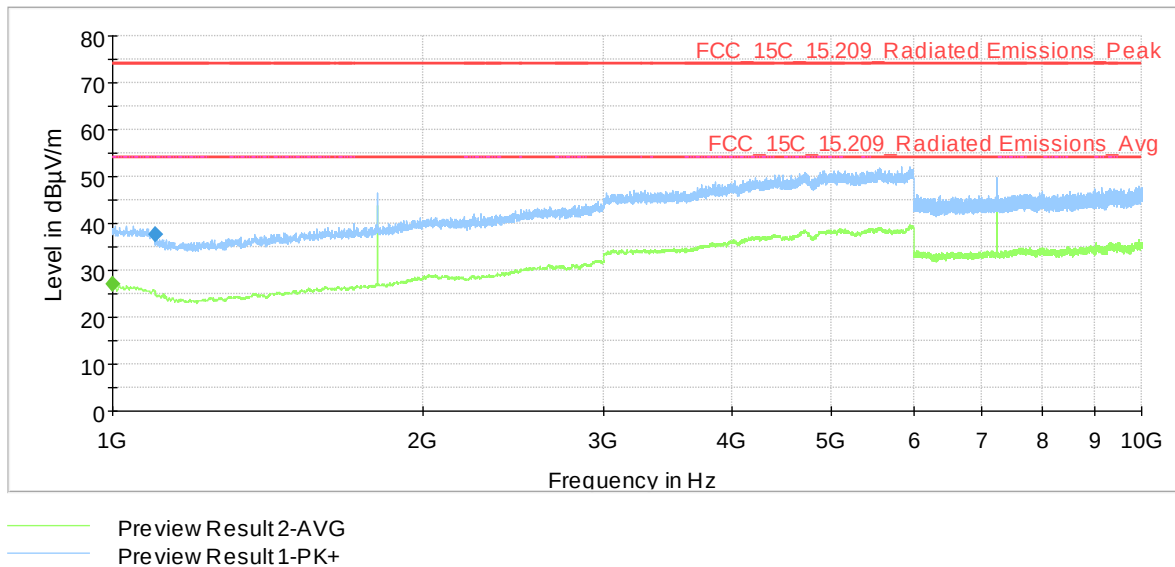
Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 35 von 47
Page 35 of 47

Prüfdokumentation Test documentation

4.6.2.10 1 to 10 GHz, Lowest Channel

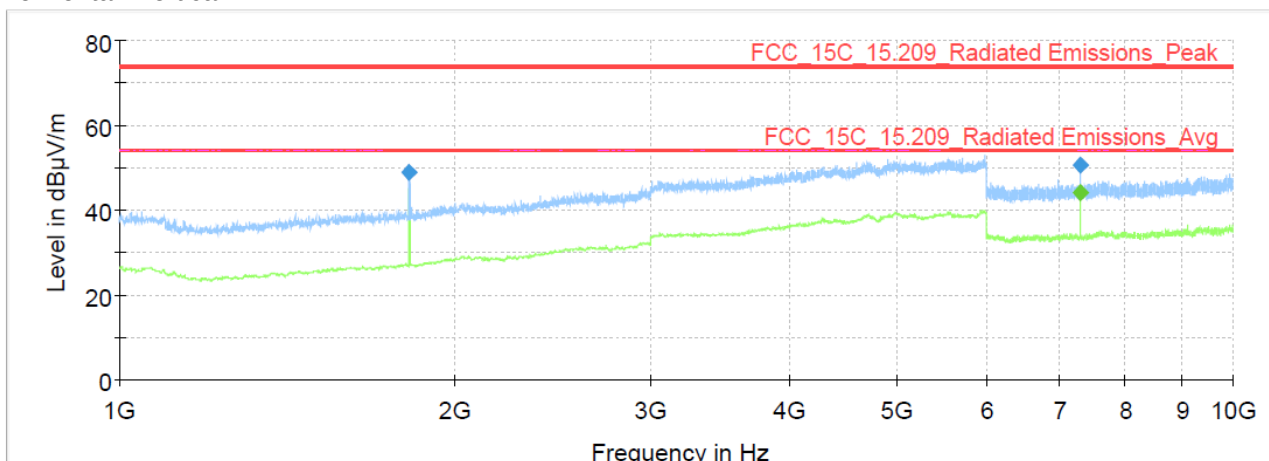
Horizontal+Vertical



Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Band width (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1000.000	---	26.98	54.00	27.02	500.0	1000	150.0	H	208.0	90.0	3.9
1100.000	37.68	---	74.00	36.32	500.0	1000	150.0	H	285.0	90.0	4.5

4.6.2.11 1 to 10 GHz, Middle Channel

Horizontal+Vertical



Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Band width (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1822.500	49.00	---	74.00	25.00	500.0	1000	150.0	H	138.0	0.0	-3.8
7289.232	50.58	---	74.00	23.42	500.0	1000	150.0	H	134.0	45.0	-3.1
7289.371	---	44.25	54.00	9.75	500.0	1000	150.0	H	134.0	45.0	-3.1

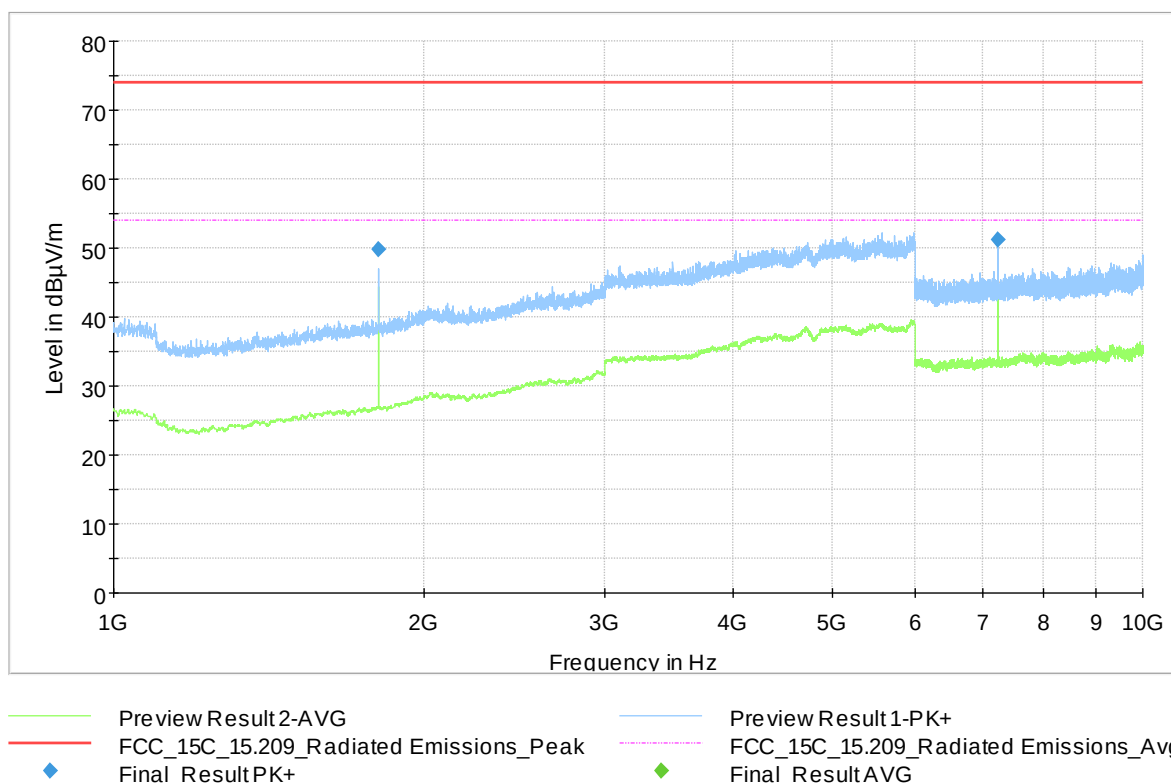
Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 36 von 47
Page 36 of 47

Prüfdokumentation Test documentation

4.6.2.12 1 to 10 GHz, Highest Channel

Horizontal+Vertical



Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Band width (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1807.861316	49.86	---	74.00	24.14	500.0	1000	150.0	H	212.0	90.0	-3.9
7231.722625	51.20	---	74.00	22.80	500.0	1000	150.0	H	266.0	90.0	-2.9

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 37 von 47
Page 37 of 47

Prüfdokumentation
Test documentation

4.6.3 Band Edge Measurement (Unwanted emissions)

4.6.3.1 Test Method

Unwanted emissions close to the operating band were additionally tested here.

Antenna connector is prepared, so conducted method was used according to ANSI C63.10:2013 clause 6.10. The maximum in-band antenna gain, or 2 dBi, whichever is greater was used outside the operating band.

The EUT was connected to the spectrum analyzer via a coax cable with a known loss. The measurements were done with EUT configured to the lowest and highest channels, and in hopping mode (in case of FHSS device).

4.6.3.2 Test Setup

EUT		A003850445-030 (cond. sample)
Chamber details		Shielded room
Companion device		EUT in Test Mode. Therefore, no Companion Device was used.
Operation mode		☐ 1: TX-Mode Unmodulated ☒ 2: TX-Mode Modulated ☒ 3: TX-Mode Hopping ☐ 4: N/A
Spectrum Analyzer	Resolution Bandwidth	100 kHz
	Video Bandwidth	300 kHz
	Sweep time	Auto coupled
Further parameters		-
Test engineer		Matthias Kräutlein

Prüfbericht-Nr.: DE24L3OV 002
 Test report no.:

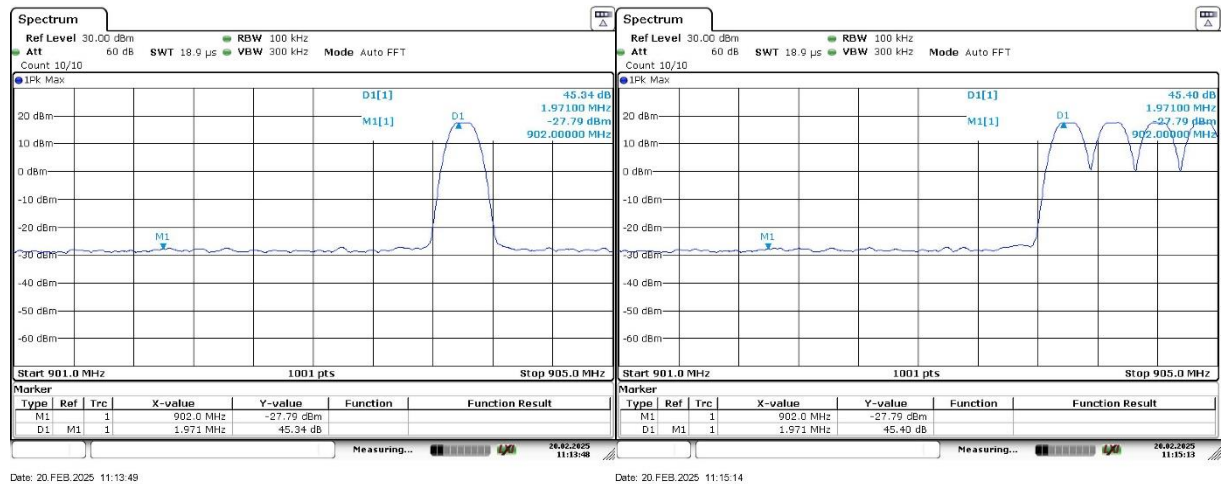
Seite 38 von 47
 Page 38 of 47

Prüfdokumentation
 Test documentation

4.6.3.3 Test results (Unwanted emissions; Band Edge Measurement)

4.6.3.3.1 Lowest Channel

Inband Peak



Fixed Frequency

Hopping

Frequency [MHz]	Level [dBm]
903.971	17.55

Measurements

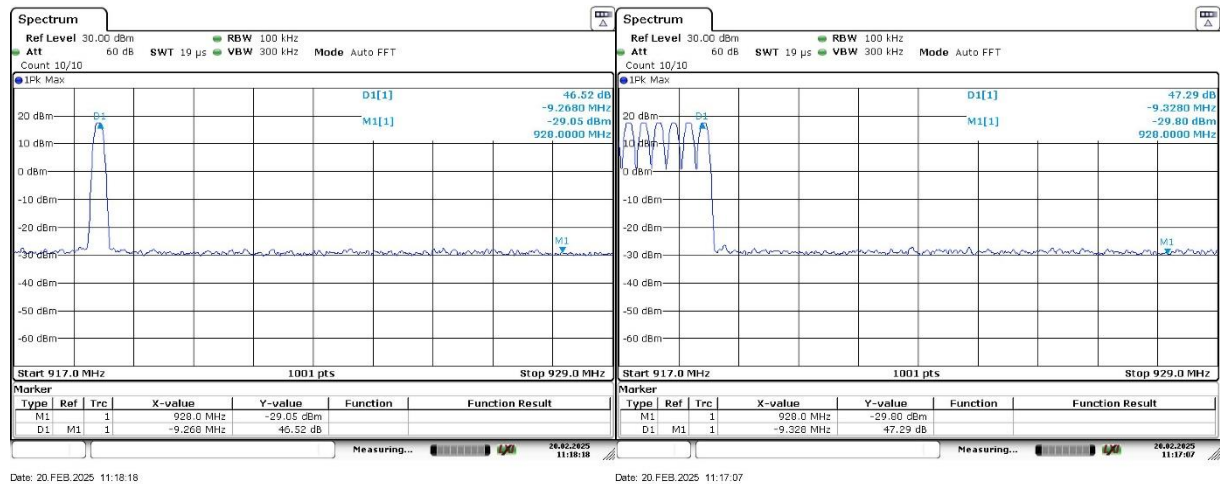
Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
902	-27.79	25.34	-2.45	Pass

Prüfbericht-Nr.: DE24L3OV 002
 Test report no.:

Seite 39 von 47
 Page 39 of 47

Prüfdokumentation
 Test documentation

4.6.3.3.2 Highest Channel



Fixed Frequency
 Inband Peak

Hopping

Frequency [MHz]	Level [dBm]
918.732	17.47

Measurements

Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
928	-29.05	26.52	-2.53	Pass

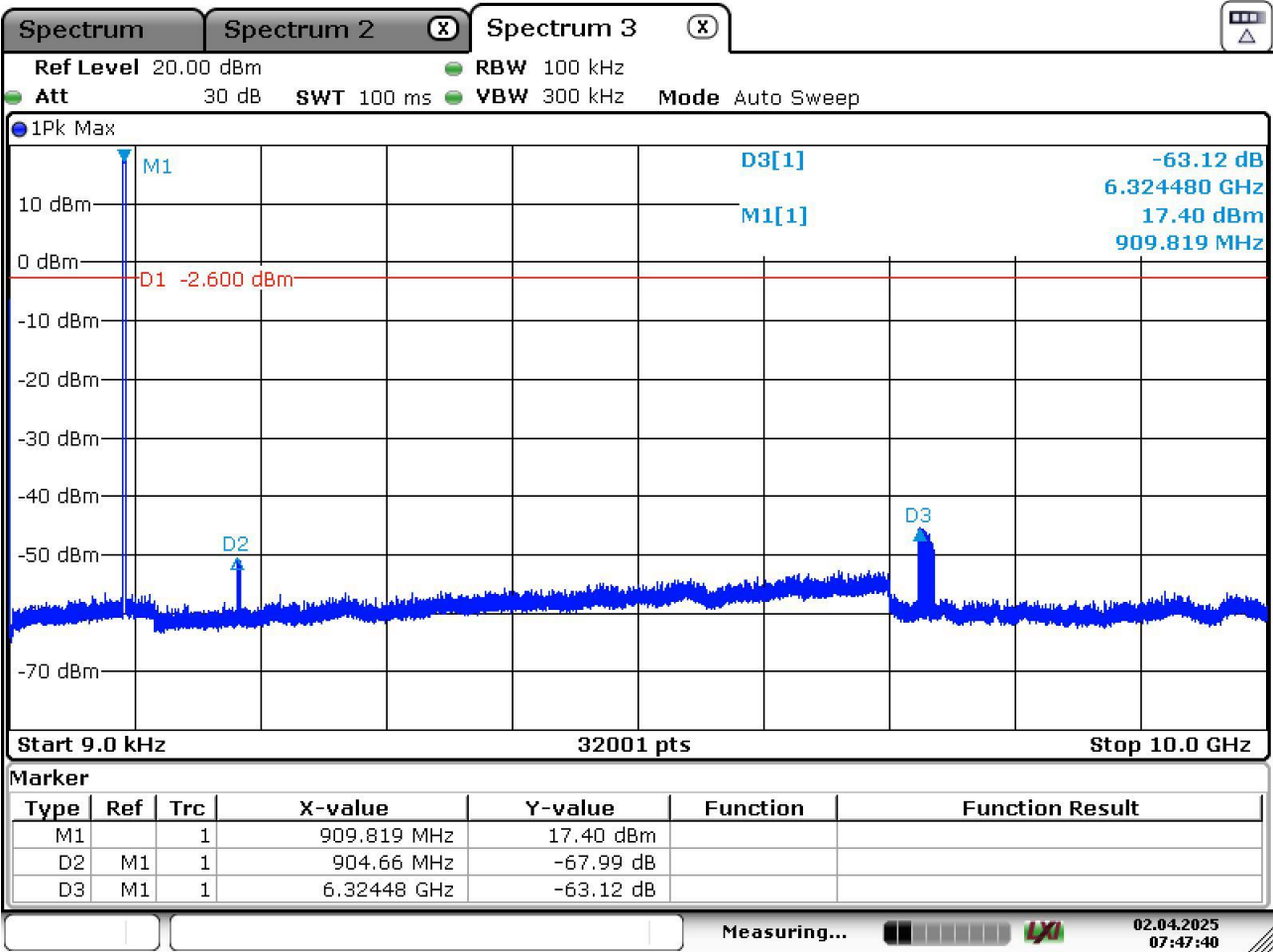
Prüfbericht-Nr.: DE24L3OV 002
 Test report no.:

Seite 40 von 47
 Page 40 of 47

Prüfdokumentation
 Test documentation

Conducted spurious emission

4.6.3.3.3 Hopping Mode



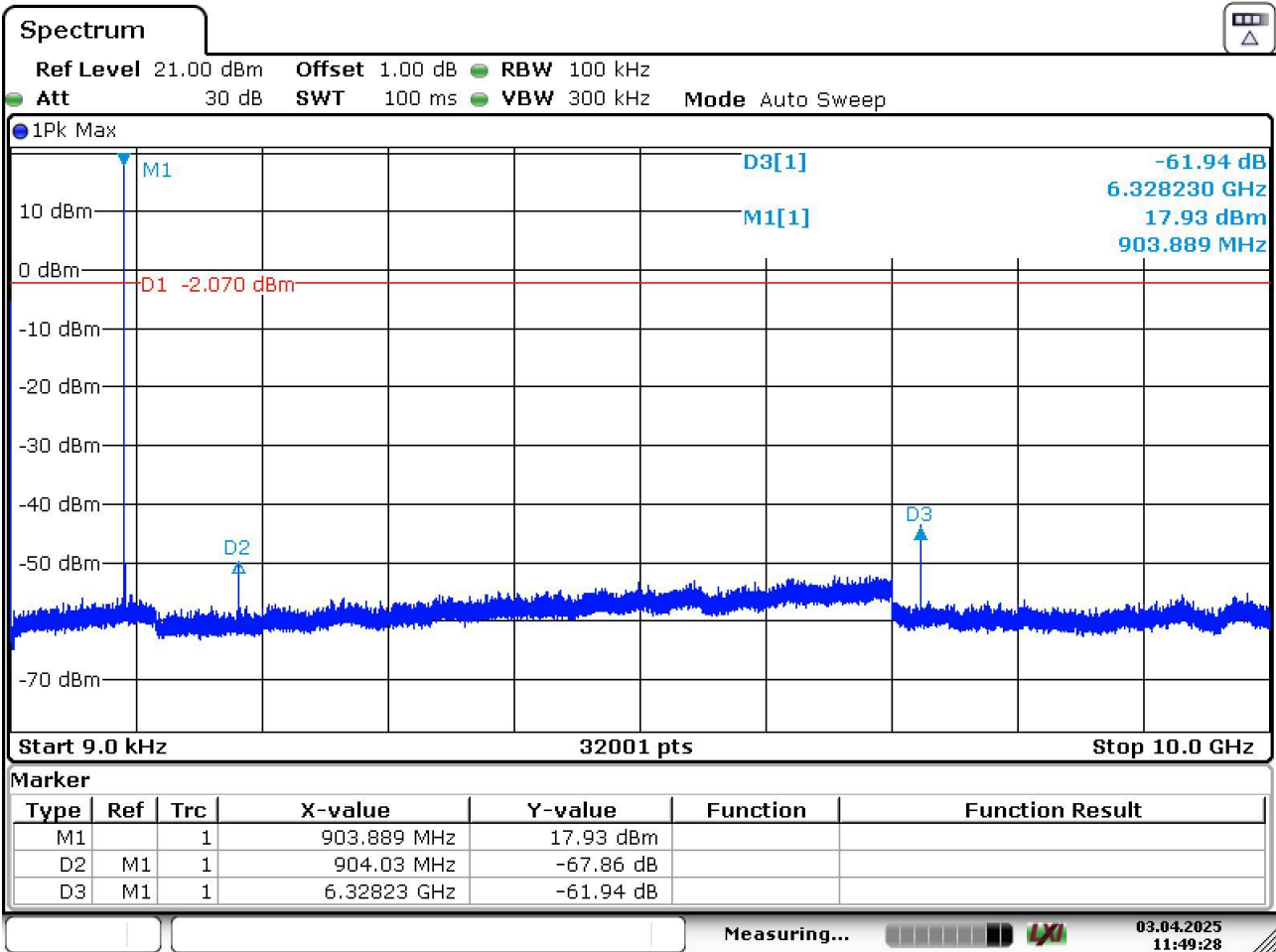
Date: 2.APR.2025 07:47:40

Prüfbericht-Nr.: DE24L3OV 002
 Test report no.:

Seite 41 von 47
 Page 41 of 47

Prüfdokumentation
 Test documentation

4.6.3.3.4 Lowest Channel



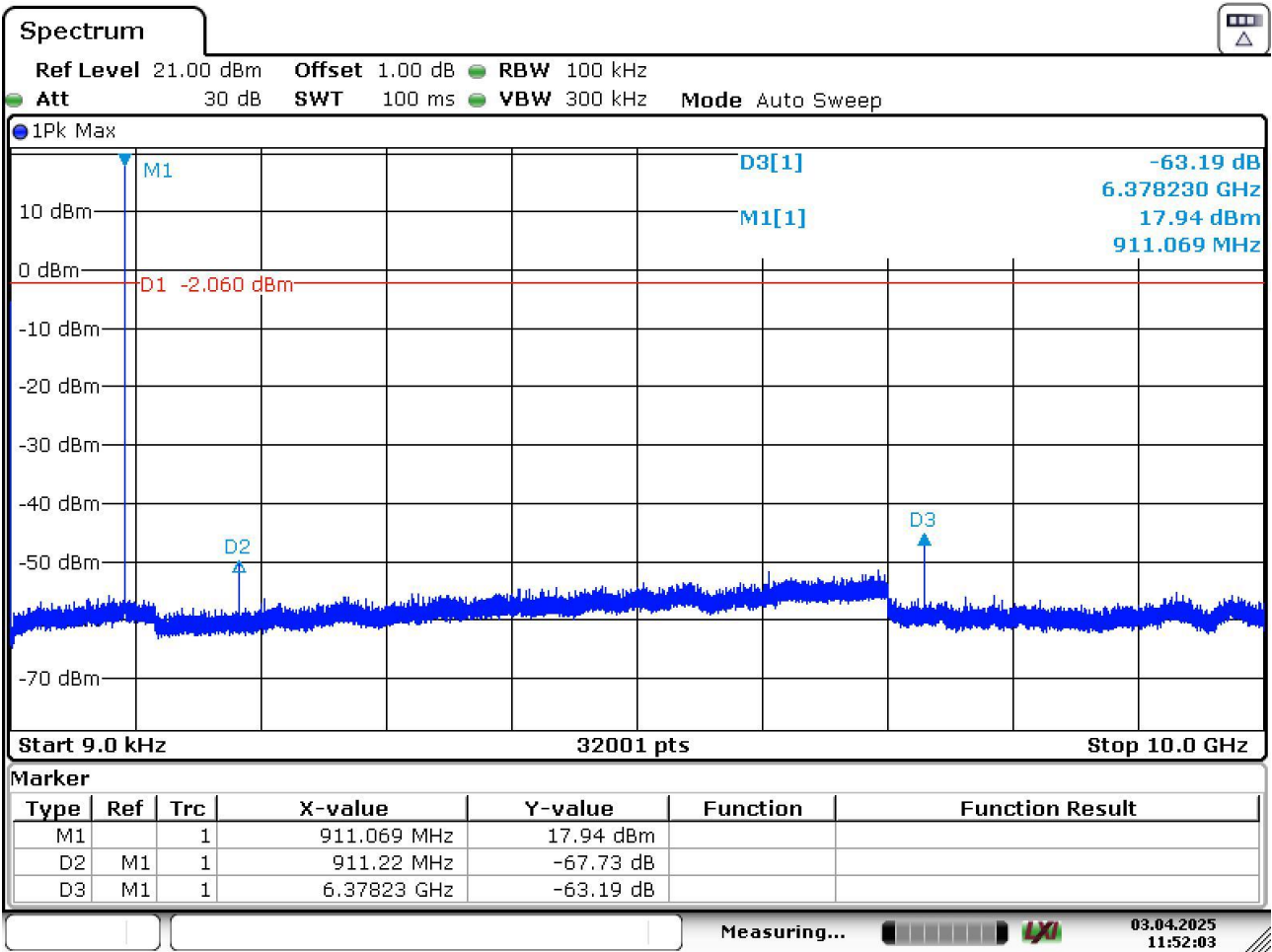
Date: 3.APR.2025 11:49:27

Prüfbericht-Nr.: DE24L3OV 002
 Test report no.:

Seite 42 von 47
 Page 42 of 47

Prüfdokumentation
 Test documentation

4.6.3.3.5 Middle Channel



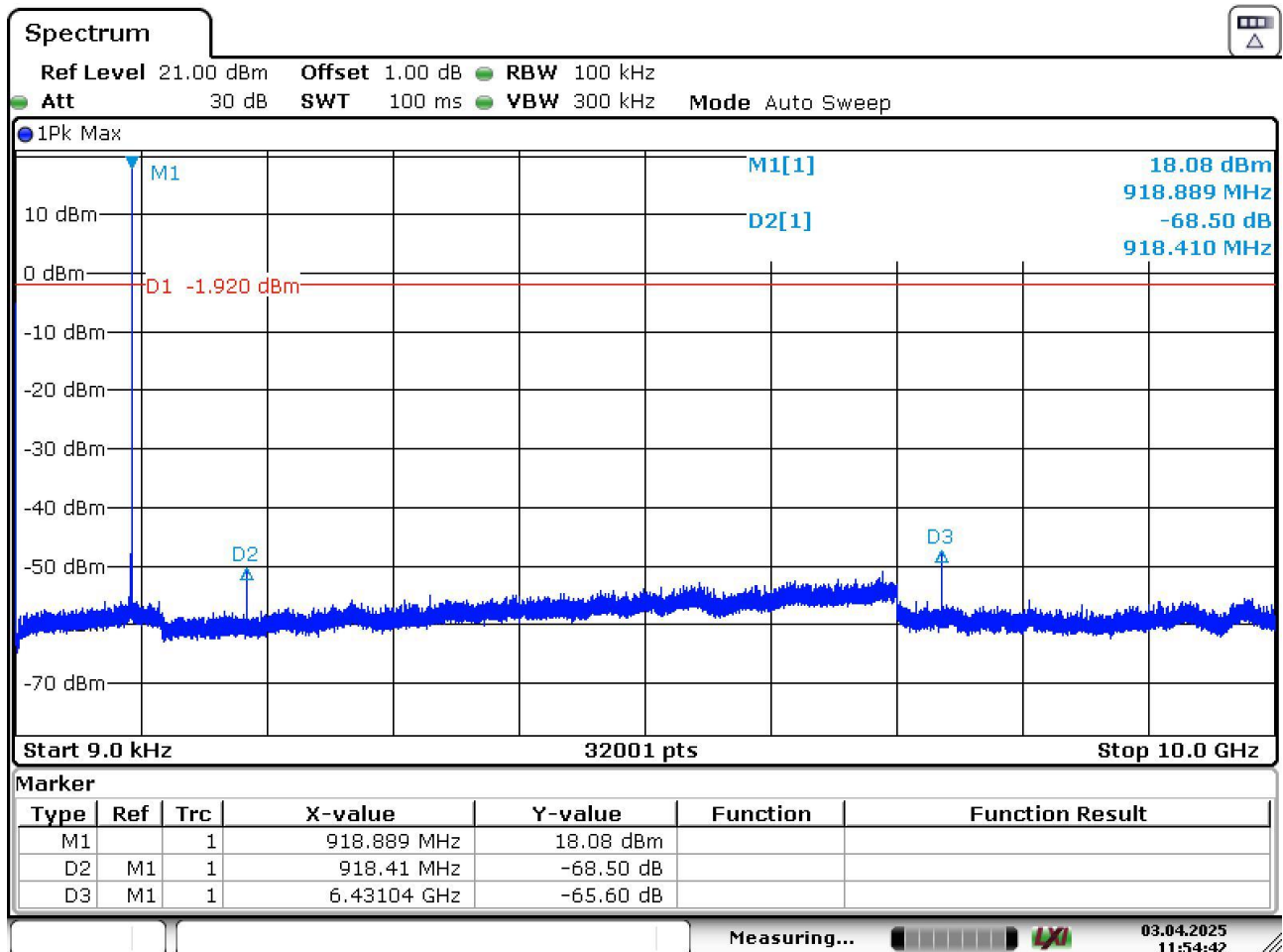
Date: 3.APR.2025 11:52:03

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 43 von 47
Page 43 of 47

Prüfdokumentation Test documentation

4.6.3.3.6 Highest Channel



Date: 3.APR.2025 11:54:42

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 44 von 47
Page 44 of 47

Fotodokumentation
Photo documentation

5 Test Setup Photo

For reasons of confidentiality, no photos of the EUT are included in this report.
For EUT and test setup photos please see the Photo Documentation to this report Number.

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 45 von 47
Page 45 of 47

Zusatzdokumentation
Additional documentation

6 Application form

The following information was provided by the customer and form the basis for the execution of the tests and the assessment of conformity. The given information can affect the results of both.

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 46 von 47
Page 46 of 47

Liste der verwendeten Prüfmittel
List of used test equipment

7 Equipment List

7.1 Hardware

Prüfmittel Test equipment		Prüfmittel-Nr. / ID- Nr. Equipment-No. / ID- No.	Letzte Kalibrierung Last calibration	Nächste Kalibrierung Next calibration
Spectrum Analyzer: FSV-30	Rohde & Schwarz	9000268	16.07.2021	10.08.2025
Temperature & Humidity Chamber: PL-3-KPH	Espec	2731999	11.02.2025	11.02.2028
Fully Anechoic Room	Albatross Projects GmbH	2959749	13.02.2025	* 13.02.2026
Signal Analyzer FSU 26	Rohde & Schwarz	2844118	04.08.2023	04.08.2025
RSE-Filtersystem	Rohde & Schwarz	9002802	06.02.2025	* 06.02.2026
Antenna HF907 1-18GHz	Rohde & Schwarz	2856263	01.09.2024	10.09.2027
Semi-Anechoic Chamber 30-1000 MHz	Siemens	2729645	15.06.2022	15.06.2025
Receiver ESU 8	Rohde & Schwarz	2728844	23.02.2024	18.07.2025
Antenna HFH 2 (Loop) 9kHz-30MHz	Rohde & Schwarz	2728893	09.07.2024	05.08.2027
Antenna VULB 9168 30MHz – 1GHz	Schwarzbeck	2728136	05.10.2023	05.10.2026

*Equipment only verified and not calibrated

7.2 Software

Test Software	Developer	Version
EMC32	Rohde & Schwarz	10.60.20
BAT-EMC	NEXIO	2022.0.8.0

Prüfbericht-Nr.: DE24L3OV 002
Test report no.:

Seite 47 von 47
Page 47 of 47

Änderungsverzeichnis
Change history

8 Change history

Revision Number	List of revisions
001	Initial Release
002	Reviewer comments updated.

Ende des Prüfberichts
End of Test Report