FCC Measurement/Technical Report on

SARA-S520BM10

FCC ID: XPYUBX24KM03
IC: 8595A-UBX24KM03

Test Report Reference: MDE_UBLOX_2412_FCC_02_rev01

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche
Akkreditierungsstelle
D-PL-12140-01-00

Note:
The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

Table of Contents

1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization
Certification for an Intentional Radiator.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 25, (10-1-23 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 25, Subpart C – Technical Standards

§ 25.202 Frequencies, frequency tolerance, and emission limits
§ 25.204 Power and out-of-band emission limits for earth stations
§ 25.216 Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service

The tests were performed with reference to:

- ANSI C63.26: 2015

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for Satellite Communications Devices from FCC and ISED Canada

Measurement	FCC reference	ISED reference
RF Output Power Verification	§ 25.204 (a)	RSS-170 Issue 4: 5.5
Occupied Bandwidth	§ 2.1049	RSS-GEN Issue 5 & AMD 1 & AMD 2, 6.7
Emissions Mask – within 250% of Authorized Bandwidth	§ 25.202 (f)(1), (2)	RSS-170 Issue 4: 5.8 (a), (b)
Transmitter spurious conducted emissions	§ 25.202 (f)(3)	RSS-170 Issue 4: 5.8 (c)
Transmitter spurious radiated emissions	§ 25.202 (f)(3)	RSS-170 Issue 4: 5.8 (c)
Transmitter spurious radiated emissions in (1559-1610MHz) Band	§25.216 (c), (h) FCC 03-283	RSS-170 Issue 4: 5.9.2
Carrier-Off spurious radiated emissions in (1559-1610MHz) band	§25.216 (i) FCC 03-283	RSS-170 Issue 4: 5.10
Frequency Stability	§ 25.202 (d)	RSS-170 Issue 4: 5.3

1.3 MEASUREMENT SUMMARY

47 CFR CHAPTER I FCC PART 25 Subpart C **§ 25.204 (a)**

RF Output Power Verification

The measurement was performed according to ANSI C63.26, chapter 5.2.3.3 **Final Result**

OP-Mode Operating mode, Channel, Voltage, Measurement Method	Setup	Date	FCC	IC
TX-CM, high, NAC, conducted	S01_AH02	2024-11-27	Passed	Passed
TX-CM, low, NAC, conducted	S01_AH02	2024-11-27	Passed	Passed
TX-CM, mid, NAC, conducted	S01_AH02	2024-11-27	Passed	Passed

47 CFR CHAPTER I FCC PART 2 Subpart J **§ 2.1049**

Occupied Bandwidth

The measurement was performed according to ANSI C63.26, chapter 5.4.3 and 5.4.4 **Final Result**

OP-Mode Operating mode, Measurements Type, Channel, Voltage, Measurement Method	Setup	Date	FCC	IC
TX-CM, 99% OBW, high, NAC, conducted	S01_AH01	2024-10-30	Performed	Performed
TX-CM, 99% OBW, low, NAC, conducted	S01_AH01	2024-10-30	Performed	Performed
TX-CM, 99% OBW, mid, NAC, conducted	S01_AH01	2024-10-30	Performed	Performed
TX-CM, 26dB OBW, high, NAC, conducted	S01_AH01	2024-10-30	Performed	Performed
TX-CM, 26dB OBW, low, NAC, conducted	S01_AH01	2024-10-30	Performed	Performed
TX-CM, 26dB OBW, mid, NAC, conducted	S01_AH01	2024-10-30	Performed	Performed

47 CFR CHAPTER I FCC PART 25 Subpart C **§ 25.202 (f)(1), (2)**

Emissions Mask – within 250% of Authorized Bandwidth

The measurement was performed according to ANSI C63.26, chapter 5.5.3 **Final Result**

OP-Mode Operating mode, Channel, Voltage, Measurement Method	Setup	Date	FCC	IC
TX-CM, high, NAC, conducted	S01_AH01	2024-11-04	Passed	Passed
TX-CM, low, NAC, conducted	S01_AH01	2024-11-04	Passed	Passed
TX-CM, mid, NAC, conducted	S01_AH01	2024-11-04	Passed	Passed

47 CFR CHAPTER I FCC PART 25 Subpart C **§ 25.202 (f)(3)**

Transmitter spurious conducted emissions

The measurement was performed according to ANSI C63.26, chapter 5.7.4 **Final Result**

OP-Mode Operating mode, Channel, Voltage, Measurement Method	Setup	Date	FCC	IC
TX-CM, high, NAC, conducted	S01_AH01	2024-10-31	Passed	Passed
TX-CM, low, NAC, conducted	S01_AH01	2024-10-31	Passed	Passed

47 CFR CHAPTER I FCC PART 25 Subpart C **§ 25.202 (f)(1), (2)**

Emissions Mask – within 250% of Authorized Bandwidth
The measurement was performed according to ANSI C63.26, chapter 5.5.3 **Final Result**

OP-Mode Operating mode, Channel, Voltage, Measurement Method	Setup	Date	FCC	IC
TX-CM, mid, NAC, conducted	S01_AH01	2024-10-31	Passed	Passed

47 CFR CHAPTER I FCC PART 25 Subpart C **§ 25.202 (f)(3)**

Transmitter spurious radiated emissions
The measurement was performed according to ANSI C63.26, chapter 5.5.3 **Final Result**

OP-Mode Operating mode, Channel, Voltage, Measurement range, Measurement Method	Setup	Date	FCC	IC
TX-CM, high, 1 – 18 GHz, NAC, radiated	S02_AH01	2024-10-27	Passed	Passed
TX-CM, high, 30 MHz – 1 GHz, NAC, radiated	S02_AH01	2024-10-23	Passed	Passed
TX-CM, low, 1 – 18 GHz, NAC, radiated	S02_AH01	2024-10-28	Passed	Passed
TX-CM, low, 30 MHz – 1 GHz, NAC, radiated	S02_AH01	2024-10-23	Passed	Passed
TX-CM, mid, 1 – 18 GHz, NAC, radiated	S02_AH01	2024-10-28	Passed	Passed
TX-CM, mid, 30 MHz – 1 GHz, NAC, radiated	S02_AH01	2024-10-23	Passed	Passed

47 CFR CHAPTER I FCC PART 25 Subpart C **§25.216 (c), (h)**

Transmitter spurious radiated emissions in (1559-1610MHz) Band
The measurement was performed according to ANSI C63.26, chapter 5.5.3 **Final Result**

OP-Mode Operating mode, Channel, Voltage, Measurement Method	Setup	Date	FCC	IC
TX-CM, high, NAC, radiated	S02_AH01	2024-10-27	Passed	Passed
TX-CM, low, NAC, radiated	S02_AH01	2024-10-28	Passed	Passed
TX-CM, mid, NAC, radiated	S02_AH01	2024-10-28	Passed	Passed

47 CFR CHAPTER I FCC PART 25 Subpart C **§25.216 (i)**

Carrier-Off spurious radiated emissions in (1559-1610MHz) band
The measurement was performed according to ANSI C63.26, chapter 5.5.3 **Final Result**

OP-Mode Operating mode, Channel, Voltage, Measurement Method	Setup	Date	FCC	IC
Carrier-off, -, NAC, radiated	S02_AH01	2024-10-29	Passed	Passed

47 CFR CHAPTER I FCC PART 25 Subpart C § 25.202 (d)

Frequency Stability

The measurement was performed according to ANSI C63.26, chapter 5.6.3

OP-Mode Operating mode, Channel, Temperature, Voltage, Measurement Method	**Setup**	**Date**	**Final Result FCC**	**IC**
TX-CM, mid, 20°, NDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, 20°, HDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, 20°, LDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, 50°, NDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, 40°, NDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, 30°, NDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, 10°, NDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, 0°, NDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, -10°, NDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, -20°, NDC, conducted	S01_AI01	2024-10-31	Passed	Passed
TX-CM, mid, -30°, NDC, conducted	S01_AI01	2024-10-31	Passed	Passed

N/A: Not applicable
N/P: Not performed

2 REVISION HISTORY / SIGNATURES

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2024-12-05	--	valid
rev01	2024-12-10	Software description changed	valid

COMMENT: -

(responsible for accreditation scope)
Marco Kullik

(responsible for testing and report)
Mhd Mouaz Saad

3 ADMINISTRATIVE DATA

3.1 TESTING LABORATORY

Company Name:	7layers GmbH
Address:	Borsigstr. 11 40880 Ratingen Germany

The test facility is accredited by the following accreditation organisation:

Laboratory accreditation no:	DAkkS D-PL-12140-01-00
FCC Designation Number:	DE0015
FCC Test Firm Registration:	929146
ISED CAB Identifier	DE0007; ISED#: 3699A
Responsible for accreditation scope:	Marco Kullik
Report Template Version:	2024-11-21

3.2 PROJECT DATA

Responsible for testing and report:	Mhd Mouaz Saad
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2024-12-10
Testing Period:	2024-10-23 to 2024-11-27

3.3 APPLICANT DATA

Company Name:	u-blox AG
Address:	Zürcherstrasse 68 8800 Thalwil Switzerland
Contact Person:	Giulio Comar

3.4 MANUFACTURER DATA

Company Name: Address: Contact Person:	please see Applicant Data

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Multimode module: LTE CAT-M1 and ORBCOMM satellite connectivity with GNSS positioning		
Product name	SARA-S520BM10		
Type	SARA-S520BM10		
Declared EUT data by the supplier			
General product description	The EUT is supporting LTE CAT-M1 and ORBCOMM satellite connectivity with GNSS positioning. It supports the following relevant bands for FCC/ISED approval: CAT-M1: - eFDD2 / LTE eFDD4 / eFDD5 / eFDD8 / eFDD12 / eFDD13 / eFDD25 / eFDD26 / eFDD66 /eFDD71 /eFDD85 Satellite: L-band - Uplink: 1626.5 - 1660.5 MHz Downlink: 1525 - 1559 MHz		
Power Supply Type	3.8 VDC / 120-230 V (AC via AUX04)		
Nominal Voltage / Frequency	- 120-230 V / 60-50 Hz (AC via AUX04) - 3.8 VDC		
Test Voltage / Frequency	**NAC**: (AC via AUX04) : 120 V / 60 Hz		
	Normal (**NDC**)	High (**HDC**)	Low (**LDC**)
	3.8 [VDC]	4.37 [VDC]	3.23 [VDC]
Antenna type / Gain	External / 4.5 [dBi]		
OP-Modes	- TX-CM: Transmitter send Continuous modulated signal(Duty cycle = 99%) - Carrier-off: EUT in Standby mode		
Occupied bandwidth	2 kHz		
EUT ports (connected cables during testing):	- GNSS/SatCom antenna port - Cellular antenna port - USB connector (via AUX03) - DC port (via AUX03) - AC/DC port(via AUX03)		
Special software used for testing	m-center (Manufacturer: u-blox)		

4.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
EUT H	ah01	Standard Sample
Sample Parameter	**Value**	
Serial No.	351004470013738	
HW Version	UBX-443E03	
SW Version	SatCom: S01.00	
Comment	-	

Sample Name	Sample Code	Description
EUT I	ai01	Standard Sample
Sample Parameter	**Value**	
Serial No.	351004470013779	
HW Version	UBX-443E03	
SW Version	SatCom: S01.00	
Comment	-	

Sample Name	Sample Code	Description
EUT J	ah02	Standard Sample
Sample Parameter	**Value**	
Serial No.	351004470013738	
HW Version	UBX-443E03	
SW Version	SatCom: S01.00	
Comment	-	

NOTE:The short description is used to simplify the identification of the EUT in this test report.

4.3 ANCILLARY EQUIPMENT

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Device	Details (Manufacturer, Type Model, OUT Code)	Description
-	-	-

4.4 AUXILIARY EQUIPMENT

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it.
But nevertheless Auxiliary Equipment can influence the test results.

Device	**Details (Manufacturer, Type Model, HW, SW, S/N)**	**Description**
AUX01	Taoglass, Phoenix II, GSA.8835.A.101111	Cellular antenna
AUX02	Orbcomm, ST100368-NSA in combination with RF cable SKYWAVE ST301044-ESC REV A (SMA male connectors, length 2.52m, attenuation 0.6dB in Uplink frequency range: 1626.5-1660.5 MHz)	Satellite antenna
AUX03	Evaluation Board Ublox EVB-WL3	Evaluation Board
AUX04	AC/DC Adapter (UNIFIVE, UUX324-1215, -, F04-0269354)	AC/DC Adapter

4.5 EUT SETUPS

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup	Combination of EUTs	Description and Rationale
S01_AH01	EUT H, AUX01, AUX03, AUX04	Conducted setup
S01_AH02	EUT J, AUX01, AUX03, AUX04	Conducted setup
S02_AH01	EUT H, AUX01, AUX02, AUX03, AUX04	Radiated setup
S01_AI01	EUT I, AUX01, AUX03	Conducted setup

4.6 OPERATING MODES / TEST CHANNELS

This chapter describes the operating modes of the EUTs used for testing.

Operating Channels frequencies	**Low**	**Mid**	**High**
	1626.5 [MHz]	1643.5 [MHz]	1660.5 [MHz]

4.7 PRODUCT LABELLING

4.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

4.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

5 TEST RESULTS

5.1 RF OUTPUT POWER VERIFICATION

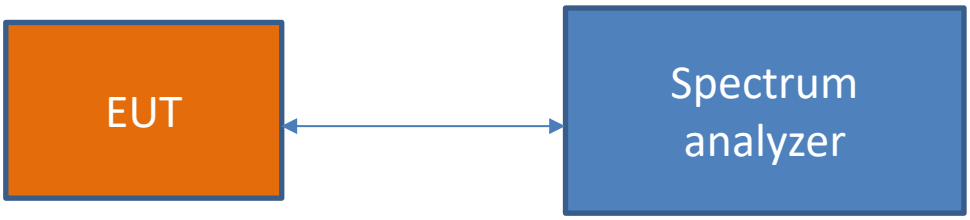
Standard **FCC PART 25 Subpart C**

The test was performed according to:
ANSI C63.26, chapter 5.2.3.3

5.1.1 TEST DESCRIPTION

The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.
The reference level of the spectrum analyser was set higher than the output power of the EUT.

The EUT was connected to the test setup according to the following diagram:



Test Setup FCC; Conducted emissions

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

5.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 25, § 22.913

(a) In bands shared coequally with terrestrial radio communication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station, other than an ESV, operating in frequency bands between 1 and 15 GHz, shall not exceed the following limits except as provided for in paragraph (c) of this section:

+ 40 dBW in any 4 kHz band for $\theta \leq 0°$

+ 40 + 3θ dBW in any 4 kHz band for $0° < \theta \leq 5°$

where θ is the angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

RSS-170; 5.5 Mobile Earth Stations (MESs)

The application for MES certification shall state the MES e.i.r.p. that is necessary for satisfactory communication. The maximum permissible e.i.r.p. will be the stated e.i.r.p. plus a 2 dB margin. If a detachable antenna is used, the certification application shall state the recommended antenna type and manufacturer, the antenna gain and the maximum transmitter output power at the antenna terminal.

5.1.3 TEST PROTOCOL

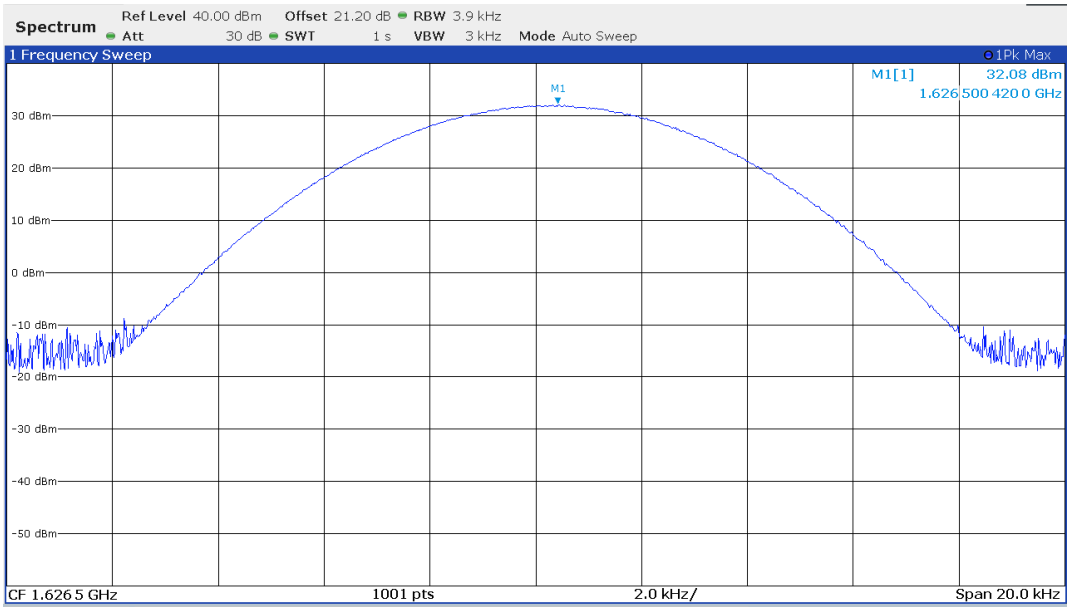
Ambient temperature: 23 °C
Relative humidity: 38 %

OP-Mode	Channel	Frequency [MHz]	Conducted Peak Power [dBm]	EIRP [dBm]	EIRP Limit [dBm]	Margin to Limit [dB]
TX-CM	low	1626.5	32.08	36.58	70	33.4
TX-CM	mid	1643.5	32.57	37.07	70	32.9
TX-CM	high	1660.5	32.35	36.85	70	33.2

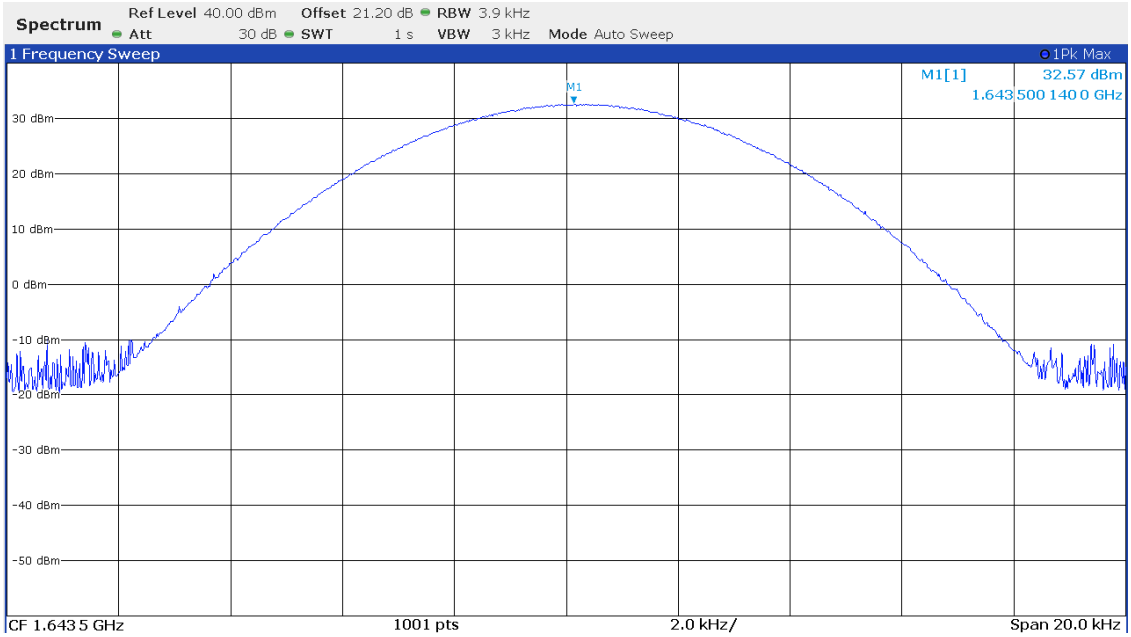
Remark: Please see next sub-clause for the measurement plot.

5.1.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

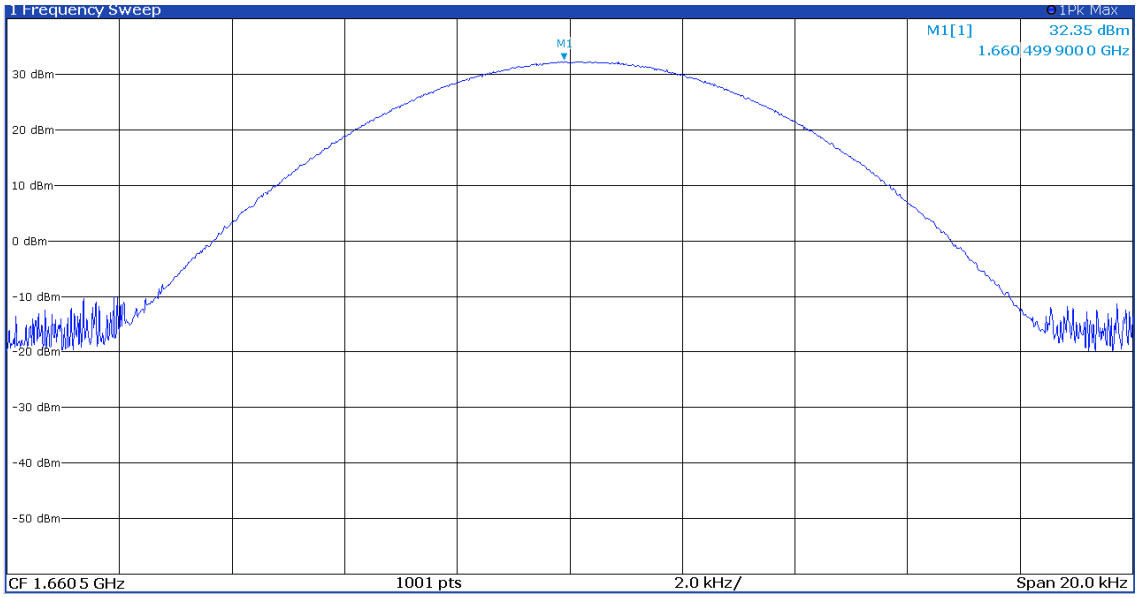
Operating-Mode = TX-CM, Operating Channel = low,
(S01_AH02)



Operating-Mode = TX-CM, Operating Channel = mid,
(S01_AH02)



Operating-Mode = TX-CM, Operating Channel = high,
(S01_AH02)



5.1.5 TEST EQUIPMENT USED

- Radio Lab

5.2 OCCUPIED BANDWIDTH

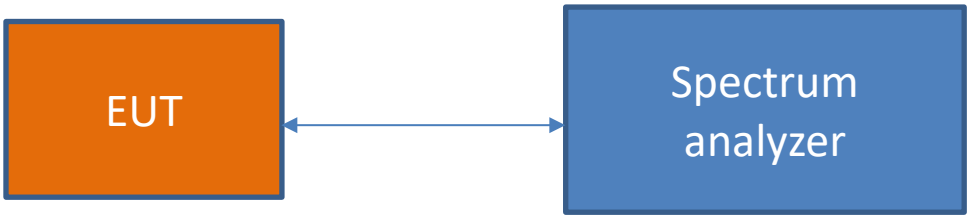
Standard **FCC PART 2 Subpart J**

The test was performed according to:
ANSI C63.26, chapter 5.4.3 and 5.4.4

5.2.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.

The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.



Test Setup FCC; Conducted emissions

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

5.2.2 TEST REQUIREMENTS / LIMITS

No applicable limit (For reporting purposes only).

5.2.3 TEST PROTOCOL

Ambient temperature: 23 °C
Relative humidity: 38 %

Occupied Bandwidth (99%)

OP-Mode	Channel	Lower Frequency of 99% OBW fL [MHz]	Upper Frequency of 99% OBW fH [MHz]	99% Bandwidth [kHz]
TX-CM	low	1626.499462	1626.500717	1.25
TX-CM	mid	1643.499543	1643.500717	1.17
TX-CM	high	1660.499518	1660.500692	1.17

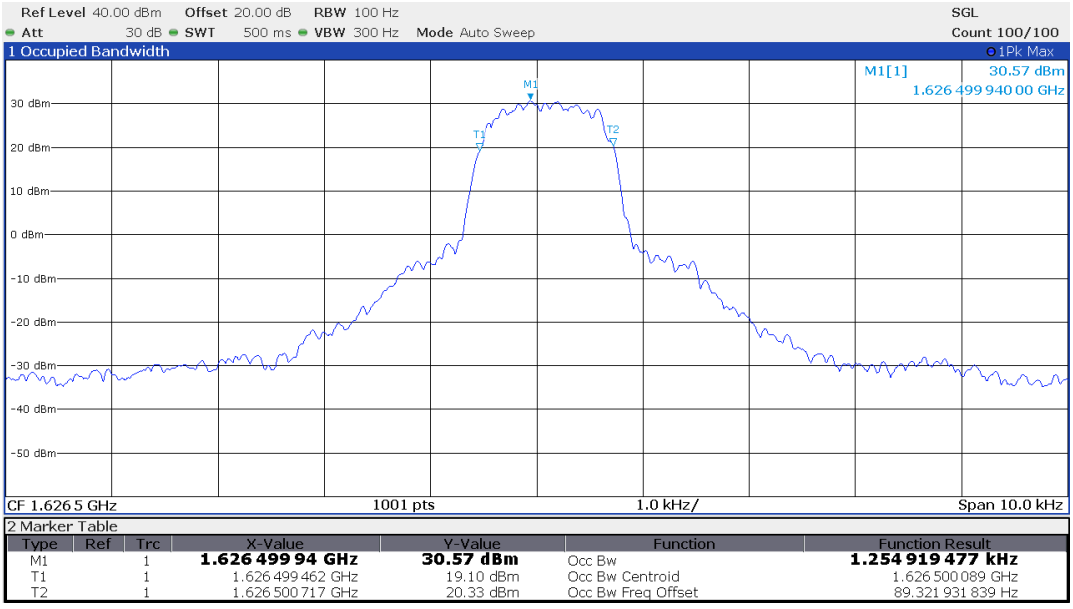
Occupied Bandwidth (26 dB)

OP-Mode	Channel	Lower -26 dBc Frequency fL [MHz]	Upper -26 dBc Frequency fH [MHz]	26dB Bandwidth [kHz]
TX-CM	low	1626.499421	1626.500859	1.44
TX-CM	mid	1643.499401	1643.500829	1.43
TX-CM	high	1660.499401	1660.500829	1.43

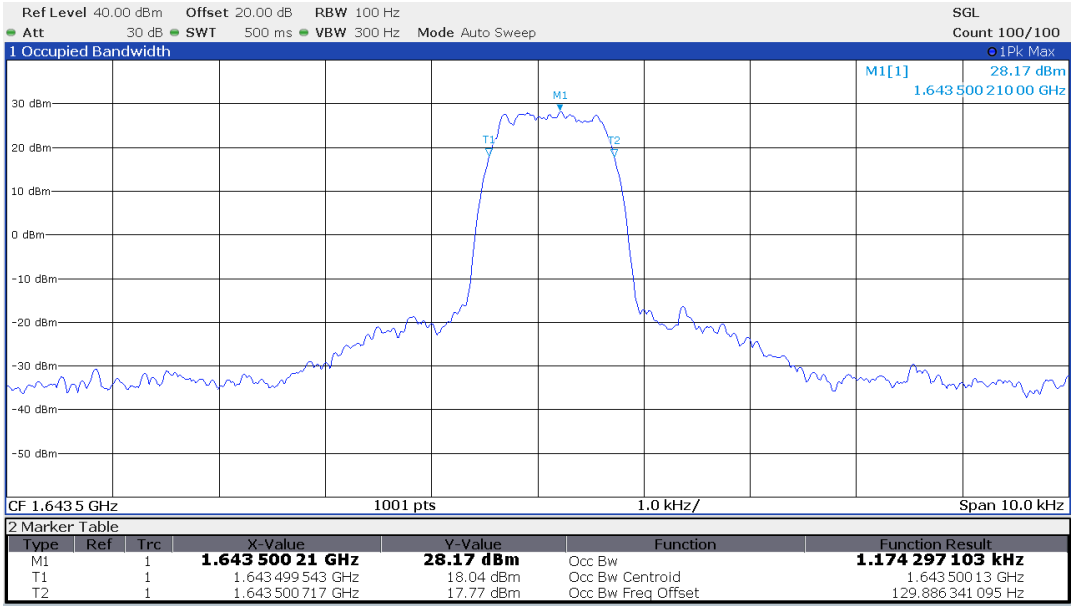
Remark: Please see next sub-clause for the measurement plot.

5.2.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

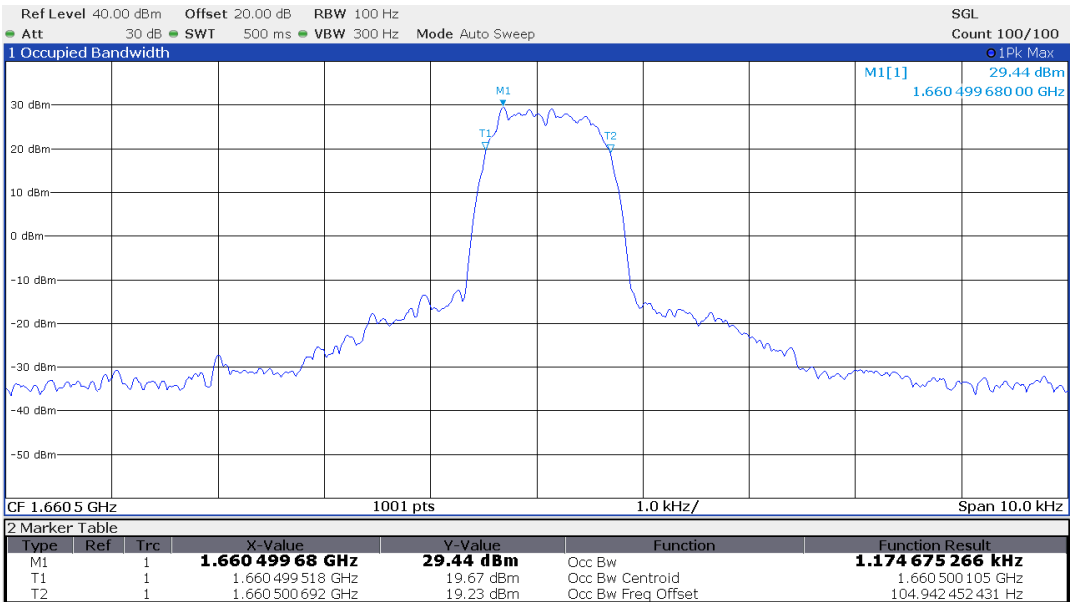
Operating-Mode = TX-CM, Operating Channel = low,
Occupied Bandwidth (99%) (S01_AH01)



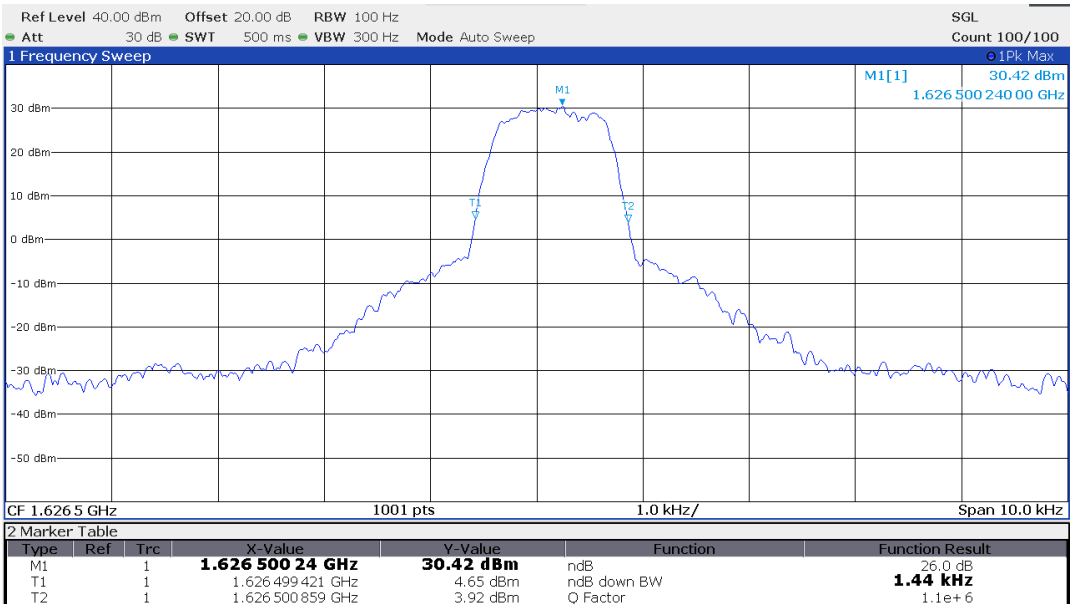
Operating-Mode = TX-CM, Operating Channel = mid,
Occupied Bandwidth (99%) (S01_AH01)



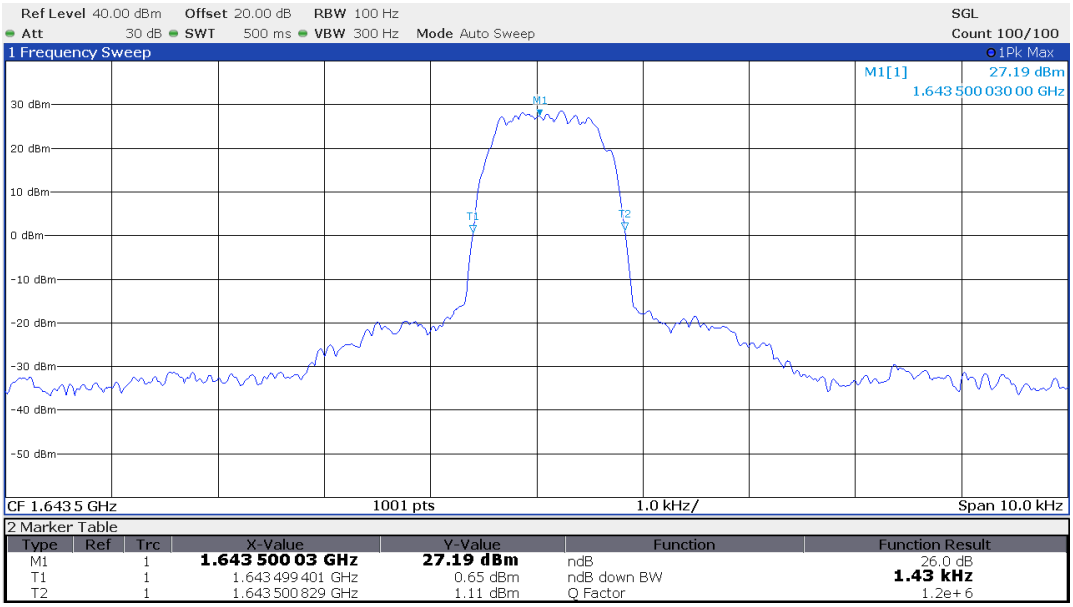
Operating-Mode = TX-CM, Operating Channel = high,
Occupied Bandwidth (99%) (S01_AH01)



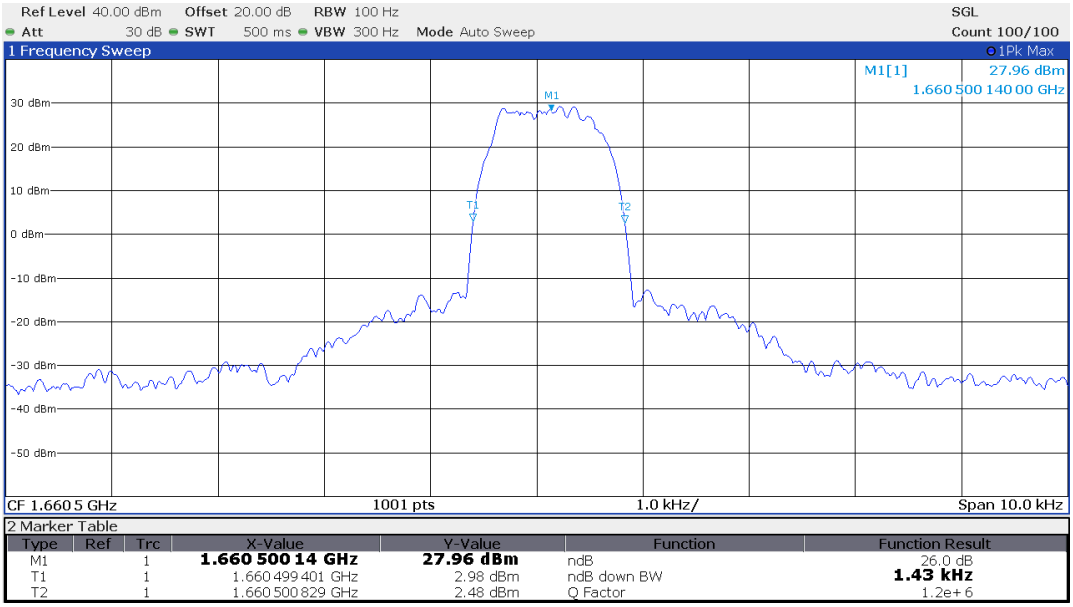
Operating-Mode = TX-CM, Operating Channel = low,
Occupied Bandwidth (26 dB) (S01_AH01)



Operating-Mode = TX-CM, Operating Channel = mid,
Occupied Bandwidth (26 dB) (S01_AH01)



Operating-Mode = TX-CM, Operating Channel = high,
Occupied Bandwidth (26 dB) (S01_AH01)



5.2.5 TEST EQUIPMENT USED

- Radio Lab

5.3 EMISSIONS MASK – WITHIN 250% OF AUTHORIZED BANDWIDTH

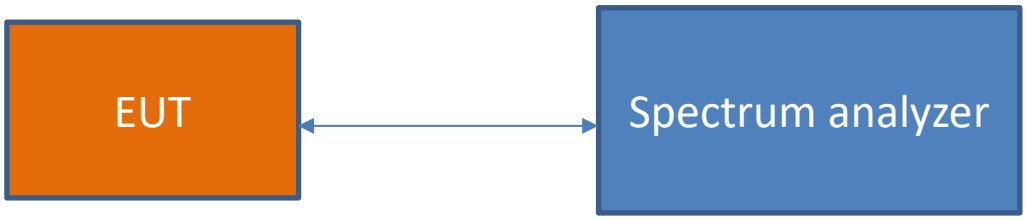
Standard **FCC PART 25 Subpart C**

The test was performed according to:
ANSI C63.26, chapter 5.5.3

5.3.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the spurious emissions measurements.

The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.



Test Setup FCC; Conducted emissions

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

5.3.2 TEST REQUIREMENTS / LIMITS

FCC Part 25.202 (f); Emission limitations:

Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;

RSS-170; 5.8 Unwanted emission limits for MESs in all frequency bands

The average power of unwanted emissions shall be attenuated below the average output power, P (dBW), of the transmitter, as specified below:

a. 25 dB in any 4 kHz, the frequency of which is offset from the channel centre frequency by more than 50%, up to and including 100% of the occupied bandwidth or necessary bandwidth, whichever is greater
b. 35 dB in any 4 kHz, the frequency of which is offset from the channel centre frequency by more than 100%, up to and including 250% of the occupied bandwidth or necessary bandwidth, whichever is greater

5.3.3 TEST PROTOCOL

Ambient temperature: 21 °C
Relative humidity: 40 %

OP-Mode	Operating Channel [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [Hz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
TX-CM	1626.5	1626.4978	-26.31	PEAK	100	28.66	-6.34	19.97
TX-CM	1626.5	1626.4989	-17.56	PEAK	100	28.66	3.66	21.22
TX-CM	1626.5	1626.5012	-16	PEAK	100	28.66	3.66	19.66
TX-CM	1626.5	1643.4979	-23.93	PEAK	100	28.66	-6.34	17.59
TX-CM	1643.5	1643.4979	-23.93	PEAK	100	29.63	-5.37	18.56
TX-CM	1643.5	1643.4988	-10.31	PEAK	100	29.63	4.63	14.94
TX-CM	1643.5	1643.5012	-9.48	PEAK	100	29.63	4.63	14.11
TX-CM	1643.5	1643.502	-20.07	PEAK	100	29.63	-5.37	14.7
TX-CM	1660.5	1660.4979	-25.24	PEAK	100	29.17	-5.83	19.41
TX-CM	1660.5	1660.4988	-15.49	PEAK	100	29.17	4.17	19.66
TX-CM	1660.5	1660.501	-12.12	PEAK	100	29.17	4.17	16.29
TX-CM	1660.5	1660.502	-19.79	PEAK	100	29.17	-5.83	13.96

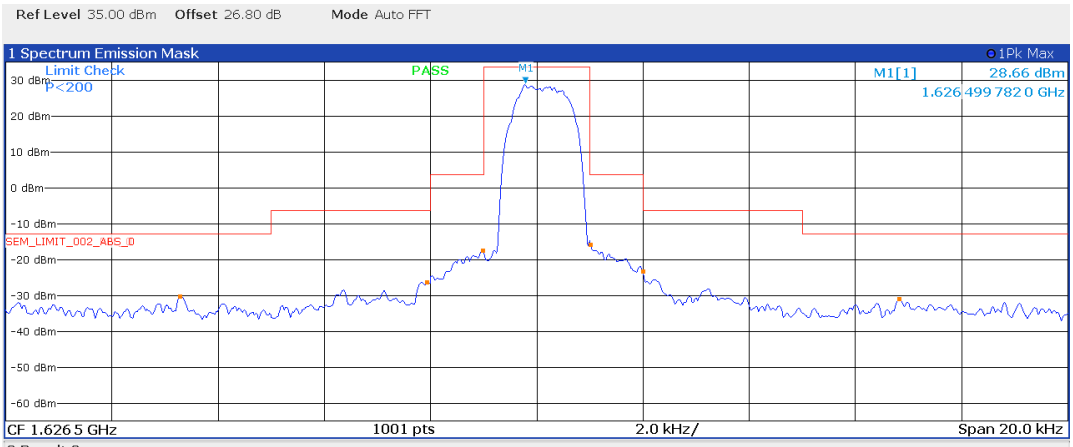
Remark: Please see next sub-clause for the measurement plot.

Comment:

- performing these while using RBW = 4 kHz was not possible, because the nominal Bandwidth is only (2 kHz), which mean that the IF-Filter will encase the whole (50% - 250 %) Limits. Therefore, RBW = 100 Hz was used.

5.3.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

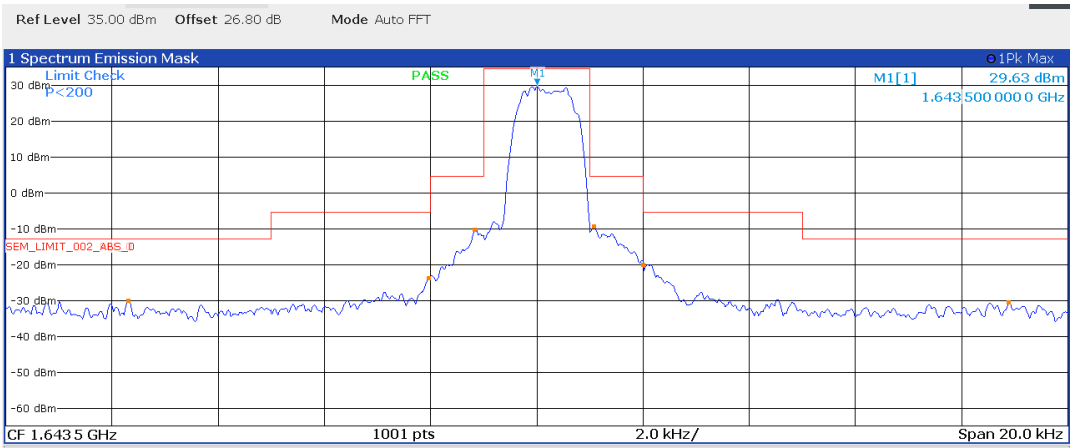
Operating-Mode = TX-CM, Operating Channel = low,
(S01_AH01)



2 Result Summary

Sub Block A	Center 1.63 GHz		Peak Power 28.66 dBm		RBW 100.000 Hz	None
Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-10.000 kHz	-5.000 kHz	100.000 Hz	**1.626 49 GHz**	**-30.27 dBm**	**-58.93 dB**	**-17.27 dB**
-5.000 kHz	-2.000 kHz	100.000 Hz	**1.626 50 GHz**	**-26.31 dBm**	**-54.97 dB**	**-19.97 dB**
-2.000 kHz	-1.000 kHz	100.000 Hz	**1.626 50 GHz**	**-17.56 dBm**	**-46.22 dB**	**-21.22 dB**
1.000 kHz	2.000 kHz	100.000 Hz	**1.626 50 GHz**	**-16.00 dBm**	**-44.66 dB**	**-19.66 dB**
2.000 kHz	5.000 kHz	100.000 Hz	**1.626 50 GHz**	**-23.39 dBm**	**-52.05 dB**	**-17.05 dB**
5.000 kHz	10.000 kHz	100.000 Hz	**1.626 51 GHz**	**-31.14 dBm**	**-59.80 dB**	**-18.14 dB**

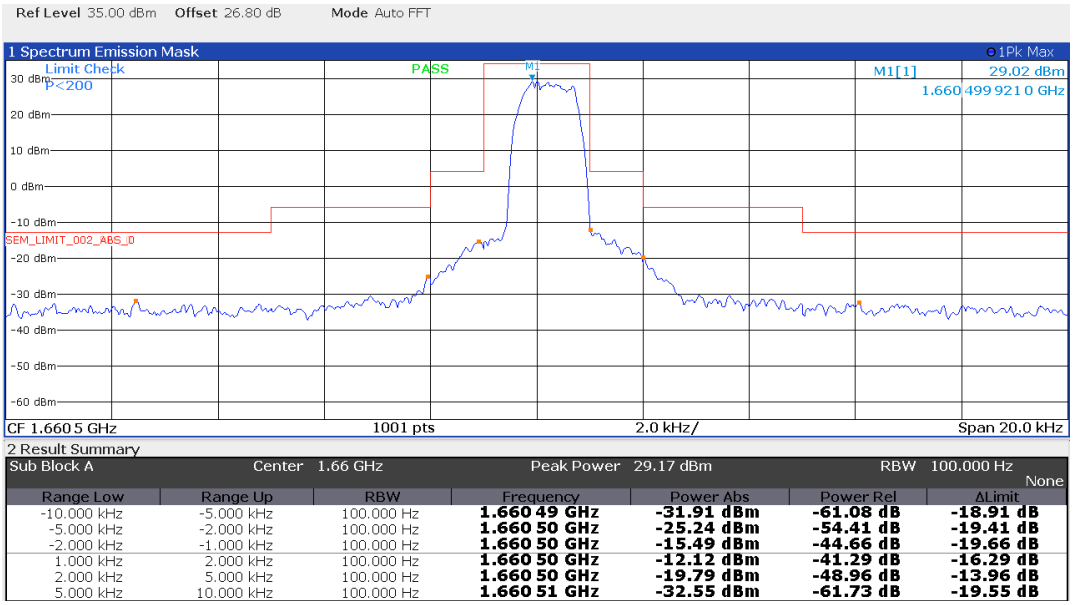
Operating-Mode = TX-CM, Operating Channel = mid,
(S01_AH01)



2 Result Summary

Sub Block A	Center 1.64 GHz		Peak Power 29.63 dBm		RBW 100.000 Hz	None
Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-10.000 kHz	-5.000 kHz	100.000 Hz	**1.643 49 GHz**	**-30.08 dBm**	**-59.72 dB**	**-17.08 dB**
-5.000 kHz	-2.000 kHz	100.000 Hz	**1.643 50 GHz**	**-23.93 dBm**	**-53.56 dB**	**-18.56 dB**
-2.000 kHz	-1.000 kHz	100.000 Hz	**1.643 50 GHz**	**-10.31 dBm**	**-39.94 dB**	**-14.94 dB**
1.000 kHz	2.000 kHz	100.000 Hz	**1.643 50 GHz**	**-9.48 dBm**	**-39.11 dB**	**-14.11 dB**
2.000 kHz	5.000 kHz	100.000 Hz	**1.643 50 GHz**	**-20.07 dBm**	**-49.70 dB**	**-14.70 dB**
5.000 kHz	10.000 kHz	100.000 Hz	**1.643 51 GHz**	**-30.59 dBm**	**-60.22 dB**	**-17.59 dB**

Operating-Mode = TX-CM, Operating Channel = high,
(S01_AH01)



Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-10.000 kHz	-5.000 kHz	100.000 Hz	**1.660 49 GHz**	**-31.91 dBm**	**-61.08 dB**	**-18.91 dB**
-5.000 kHz	-2.000 kHz	100.000 Hz	**1.660 50 GHz**	**-25.24 dBm**	**-54.41 dB**	**-19.41 dB**
-2.000 kHz	-1.000 kHz	100.000 Hz	**1.660 50 GHz**	**-15.49 dBm**	**-44.66 dB**	**-19.66 dB**
1.000 kHz	2.000 kHz	100.000 Hz	**1.660 50 GHz**	**-12.12 dBm**	**-41.29 dB**	**-16.29 dB**
2.000 kHz	5.000 kHz	100.000 Hz	**1.660 50 GHz**	**-19.79 dBm**	**-48.96 dB**	**-13.96 dB**
5.000 kHz	10.000 kHz	100.000 Hz	**1.660 51 GHz**	**-32.55 dBm**	**-61.73 dB**	**-19.55 dB**

5.3.5 TEST EQUIPMENT USED

- Radio Lab

5.4 TRANSMITTER SPURIOUS CONDUCTED EMISSIONS

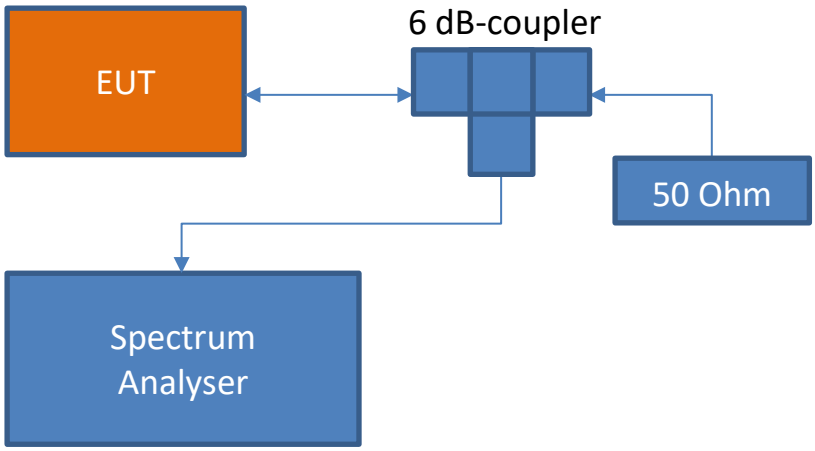
Standard **FCC PART 25 Subpart C**

The test was performed according to:
ANSI C63.26, chapter 5.7.4

5.4.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the spurious emissions measurements.

The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.



Test Setup FCC; Spurious Emissions

5.4.2 TEST REQUIREMENTS / LIMITS

FCC Part 25.202 (f); Emission limitations:

Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts.

RSS-170; 5.8 Unwanted emission limits for MESs in all frequency bands

The average power of unwanted emissions shall be attenuated below the average output power, P (dBW), of the transmitter, as specified below:

c. 43 + 10 log p (watts) in any 4 kHz, the frequency of which is offset from the channel centre frequency by more than 250% of the occupied bandwidth or necessary bandwidth, whichever is greater

5.4.3 TEST PROTOCOL

Ambient temperature: 24 °C
Relative humidity: 38 %

OP-Mode	Operating Channel [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
TX-CM	1626.5	3253	-39.0	PEAK	100	30.3	-13	26.0
TX-CM	1626.5	8132.4	-39.9	PEAK	100	30.3	-13	26.9
TX-CM	1643.5	3287	-37.6	PEAK	100	29.7	-13	24.6
TX-CM	1643.5	82175	-39.9	PEAK	100	29.3	-13	26.9
TX-CM	1660.5	3321	-36.2	PEAK	100	29.3	-13	23.2
TX-CM	1660.5	8302.5	-43.4	PEAK	100	29.6	-13	30.4

Remark: Please see next sub-clause for the measurement plot.

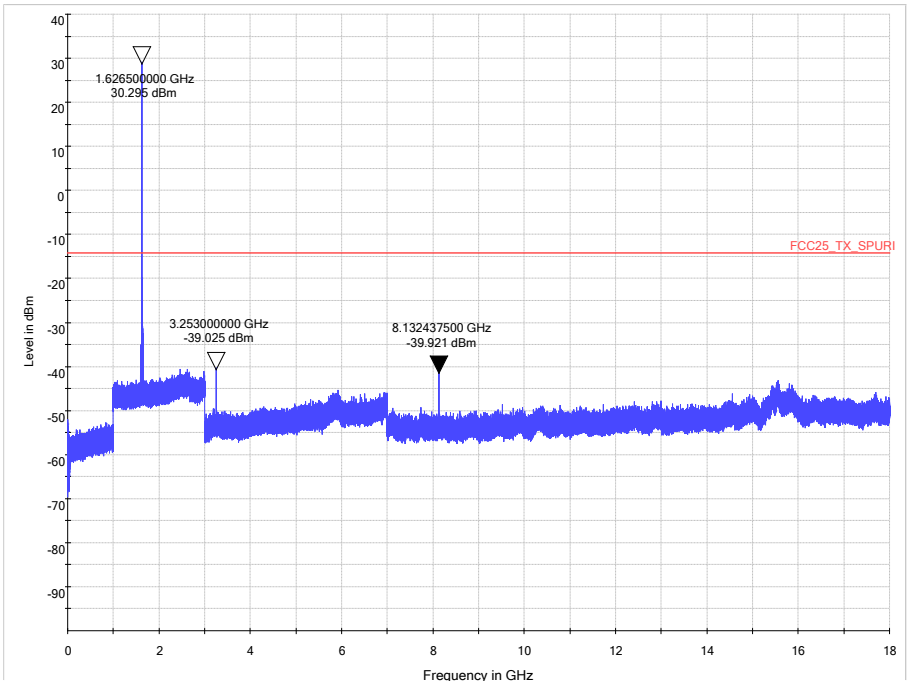
Comment:

- Used analyser settings:

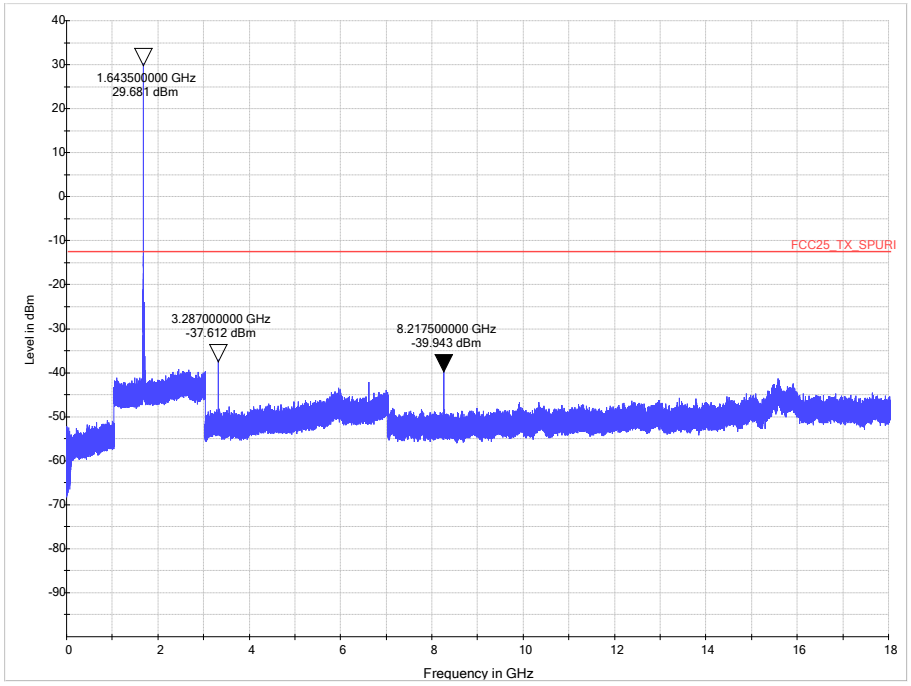
Frequency Rang [MHz]	Detector	RBW [kHz]	VBW [kHz]	Sweep Points	Sweep time [s]
0.009 – 0.15	PEAK	1	3	1401	20
0.15 – 30	PEAK	10	30	32001	20
30 – 1000	PEAK	100	300	32001	20
1000 – 3000 3000 – 5000 : : 16000 – 18000	PEAK	100	300	32001	20

5.4.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

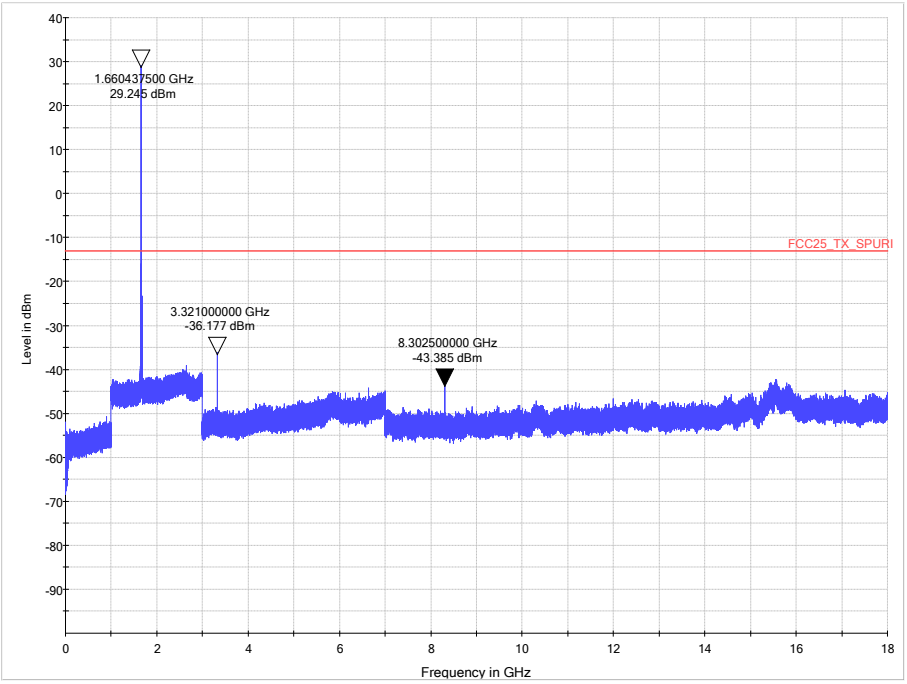
Operating-Mode = TX-CM, Operating Channel = low,
(S01_AH01)



Operating-Mode = TX-CM, Operating Channel = mid,
(S01_AH01)



Operating-Mode = TX-CM, Operating Channel = high,
(S01_AH01)



5.4.5 TEST EQUIPMENT USED

- Radio Lab

5.5 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC PART 25 Subpart C**

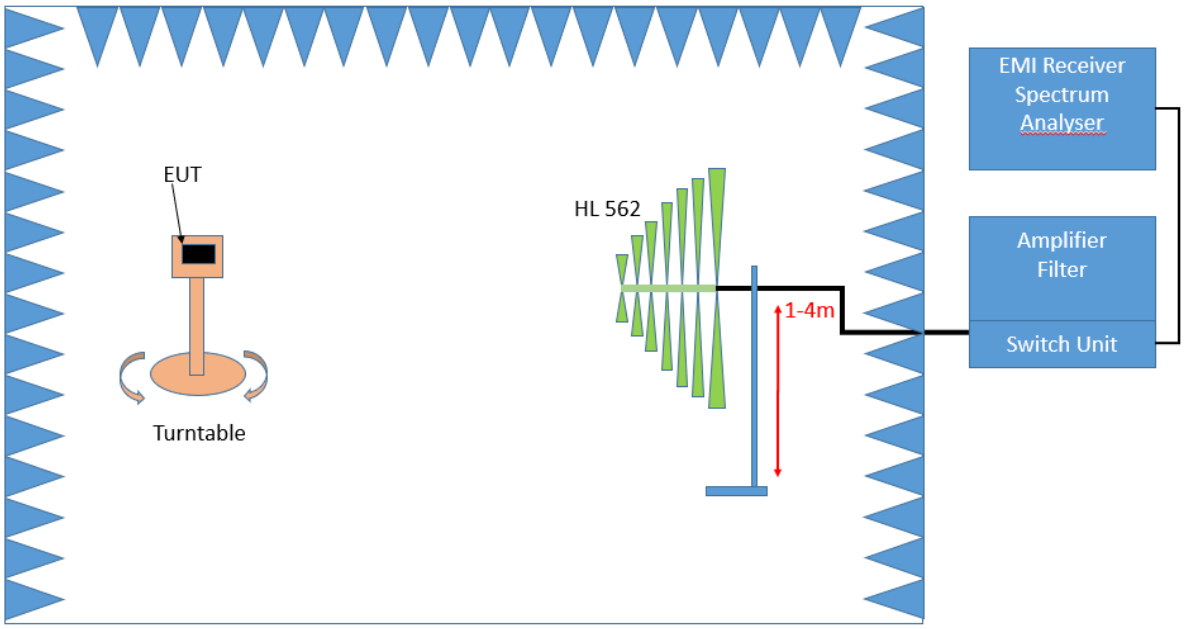
The test was performed according to:
ANSI C63.26, chapter 5.5.3

5.5.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C63.26 in a typical installation configuration.
The measurement procedure is implemented into the EMI test software EMC32 from R&S.
Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes.
A pre-check is performed while the EUT is powered from a DC power source.

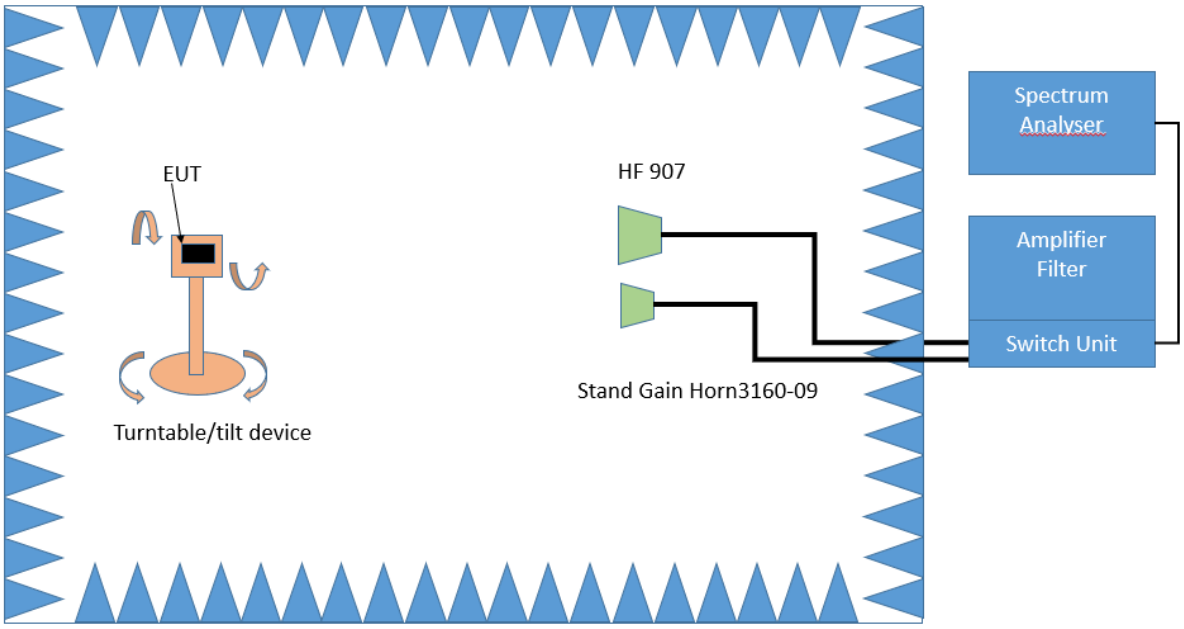
The measurements were performed with the test setup according to the following diagram:

Frequency Range: 30 MHz – 1 GHz:



Test Setup; Spurious Emission Radiated (SAC), 30 MHz- 1GHz

Frequency Range: 1 GHz – 26.5 GHz



Test Setup; Spurious Emission Radiated (FAC), 1 GHz-26.5 GHz

1. Measurement above 30 MHz and up to 1 GHz

The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 3 m
- Detector: Peak
- RBW: 10 kHz
- VBW: 30 kHz
- Sweep time: 60 seconds
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak
- Measured frequencies: in step 1 determined frequencies
- RBW: 10 kHz
- VBW: 30 kHz
- Sweep time: 100 ms
- Turntable angle range: ± 45 ° around the determined value
- Height variation range: ± 100 cm around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with Peak detector
With the settings determined in step 2, the final measurement will be performed:
Spectrum analyser settings for step 3:
- Detector: Peak
- Measured frequencies: in step 1 determined frequencies
- RBW: 10kHz
- VBW:30 kHz
- Sweep time: 1 s

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

2. Measurement above 1 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
Step 1:
The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.
All steps were performed with one height (1.5 m) of the receiving antenna only.
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.
The turn table step size (azimuth angle) for the preliminary measurement is 45 °.
- Antenna distance: 3 m
- Detector: Peak
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: 35 s
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Polarisation: Horizontal + Vertical

Step 2:
Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size ± 45° for the elevation axis is performed.
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
EMI receiver settings (for all steps):
- Detector: Peak,
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: 100 ms

Step 3:
Spectrum analyser settings for step 3:
- Detector: Peak
- Measured frequencies: in step 1 determined frequencies
- RBW: 10 kHz
- VBW: 30 kHz
- Sweep Time: 1 s

5.5.2 TEST REQUIREMENTS / LIMITS

FCC Part 25.202 (f); Emission limitations:

Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts.

RSS-170; 5.8 Unwanted emission limits for MESs in all frequency bands

The average power of unwanted emissions shall be attenuated below the average output power, P (dBW), of the transmitter, as specified below:

d. 43 + 10 log p (watts) in any 4 kHz, the frequency of which is offset from the channel centre frequency by more than 250% of the occupied bandwidth or necessary bandwidth, whichever is greater

5.5.3 TEST PROTOCOL

Ambient temperature: 20 - 28 °C
Relative humidity: 30 - 40 %

OP-Mode	Operating Channel [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
TX-CM	1626.5	-	-	PEAK	10	29.2	-13	> 6
TX-CM	1643.5	-	-	PEAK	10	27.6	-13	> 6
TX-CM	1660.5	-	-	PEAK	10	27.1	-13	> 6

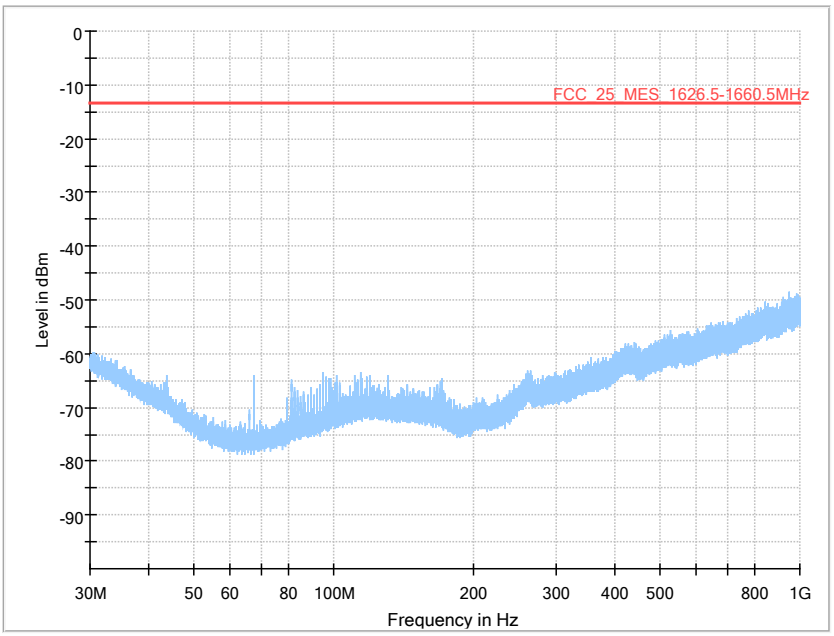
Remark: Please see next sub-clause for the measurement plot.

Comment:

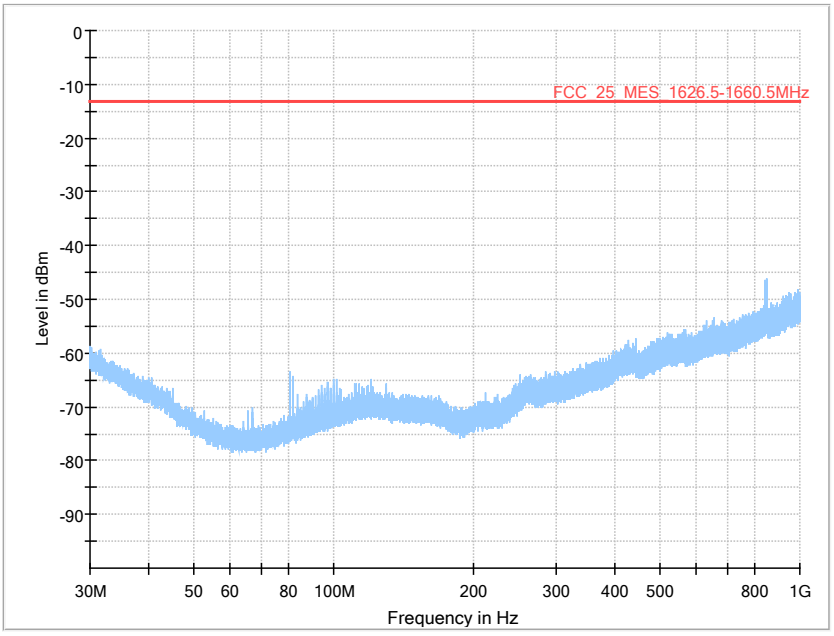
- At least spurious emissions that exceed the limit values given in the table below or that come within 6 dB below these values are listed in the table above.
- Such values have not been found.

5.5.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

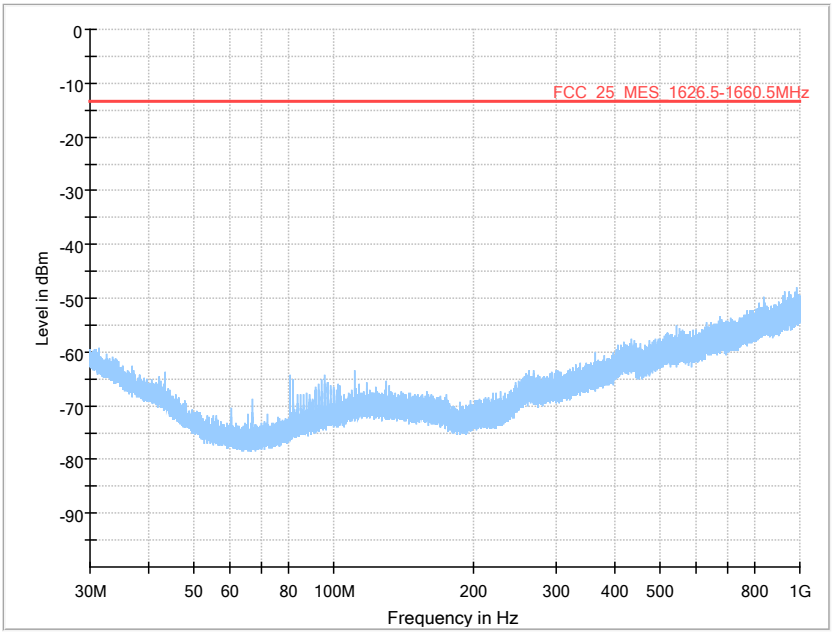
Operating-Mode = TX-CM, Operating Channel = low, Measurement range = 30 MHz – 1 GHz (S02_AH01)



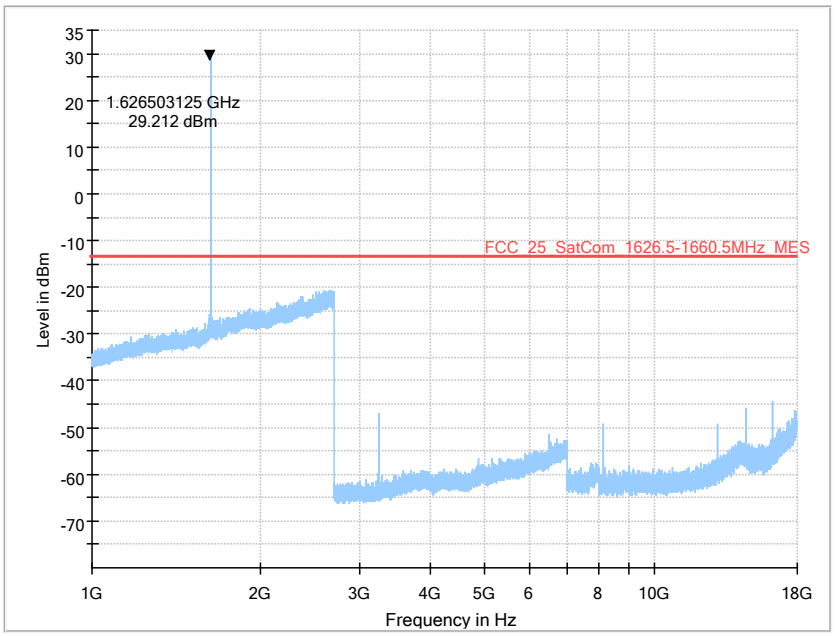
Operating-Mode = TX-CM, Operating Channel = mid, Measurement range = 30 MHz – 1 GHz (S02_AH01)



Operating-Mode = TX-CM, Operating Channel = high, Measurement range = 30 MHz – 1 GHz (S02_AH01)

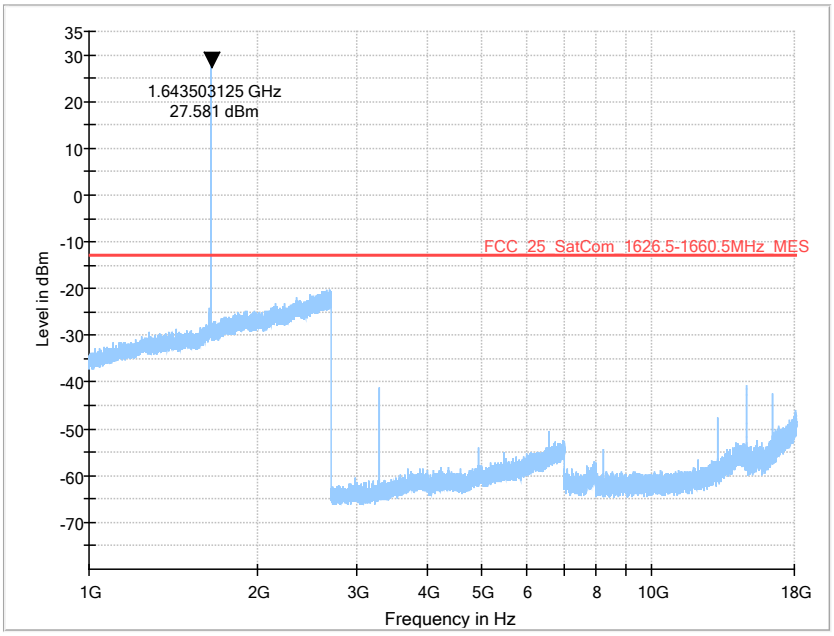


Operating-Mode = TX-CM, Operating Channel = low, Measurement range = 1 GHz – 18 GHz (S02_AH01)



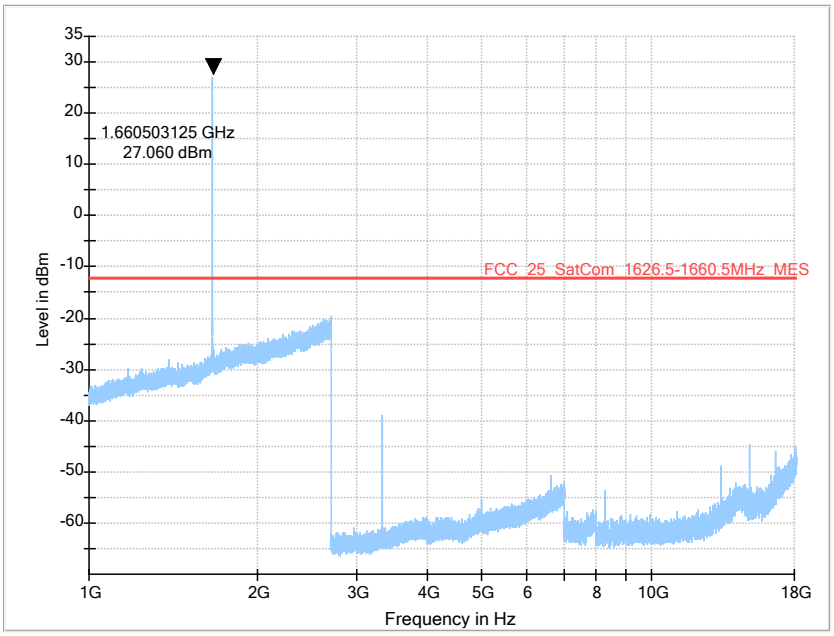
Note: The Peak at 1626.5 MHz is the wanted Signal

Operating-Mode = TX-CM, Operating Channel = mid, Measurement range = 1 GHz – 18 GHz (S02_AH01)



Note: The Peak at 1643.5 MHz is the wanted Signal

Operating-Mode = TX-CM, Operating Channel = high, Measurement range = 1 GHz – 18 GHz (S02_AH01)



Note: The Peak at 1660.5 MHz is the wanted Signal

5.5.5 TEST EQUIPMENT USED

- Radiated Emissions FAR
- Radiated Emissions SAC up to 1 GHz

5.6 TRANSMITTER SPURIOUS RADIATED EMISSIONS IN (1559-1610MHZ) BAND

Standard **FCC PART 25 Subpart C**

The test was performed according to:
ANSI C63.26, chapter 5.5.3

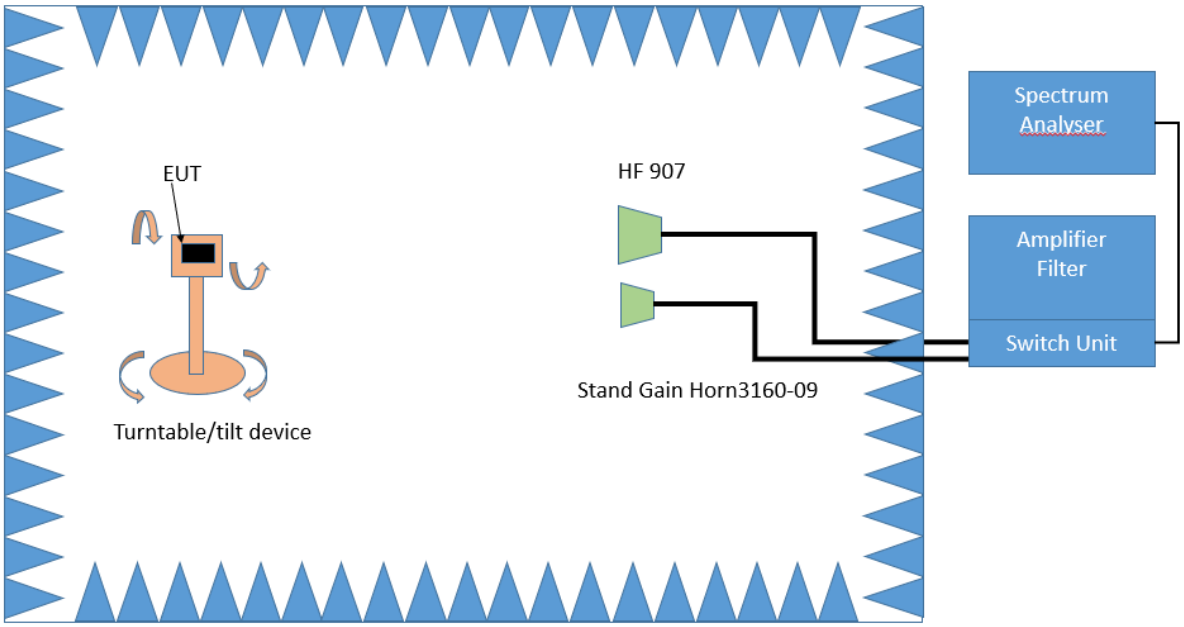
5.6.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C63.26 in a typical installation configuration.
The measurement procedure is implemented into the EMI test software EMC32 from R&S.
Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes.
A pre-check is performed while the EUT is powered from a DC power source.

A search for the direction of maximum output power level is performed in Clause 5.5 from this report. the finale measurements are performed in the direction of maximum output power level on Spectrum analyser.

The measurements were performed with the test setup according to the following diagram:

Frequency Range: 1 GHz – 26.5 GHz



Test Setup; Spurious Emission Radiated (FAC), 1 GHz-26.5 GHz

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

5.6.2 TEST REQUIREMENTS / LIMITS

FCC Part 25.216; Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service.

(c) The e.i.r.p. density of emissions from mobile earth stations placed in service after July 21, 2002 with assigned uplink frequencies between 1610 MHz and 1660.5 MHz shall not exceed −70 dBW/MHz, averaged over any 2 millisecond active transmission interval, in the band 1559-1605 MHz. The e.i.r.p. of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed −80 dBW, averaged over any 2 millisecond active transmission interval, in the 1559-1605 MHz band.

(h) Mobile earth stations manufactured more than six months after Federal Register publication of the rule changes adopted in FCC 03-283 with assigned uplink frequencies in the 1626.5-1660.5 MHz band shall suppress the power density of emissions in the 1605-1610 MHz band-segment to an extent determined by linear interpolation from −70 dBW/MHz at 1605 MHz to −46 dBW/MHz at 1610 MHz, averaged over any 2 millisecond active transmission interval. The e.i.r.p of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed a level determined by linear interpolation from −80 dBW at 1605 MHz to −56 dBW at 1610 MHz, averaged over any 2 millisecond active transmission interval.

RSS-170; 5.9 Additional unwanted emission limits for MESs to protect radionavigation-satellite service

MESs with transmitting frequencies in the bands 1610-1626.5 MHz and 1626.5-1660.5 MHz shall comply with the unwanted emission limits specified in this section, where applicable, in addition to the limits in section 5.8.

5.9.2 Band 1626.5-1660.5 MHz
For MESs with transmitting frequencies between 1610 MHz and 1626.5 MHz, the e.i.r.p. density of unwanted emissions shall not exceed the limits shown below, which are the same as those for the band 1605-1610 MHz, averaged over any 2 ms active transmission interval:

a. -70 dBW/MHz at 1605 MHz, linearly interpolated to -46 dBW/MHz at 1610 MHz, for broadband emissions
b. -80 dBW/kHz at 1605 MHz, linearly interpolated to -56 dBW/kHz at 1610 MHz, for discrete emissions

5.6.3 TEST PROTOCOL

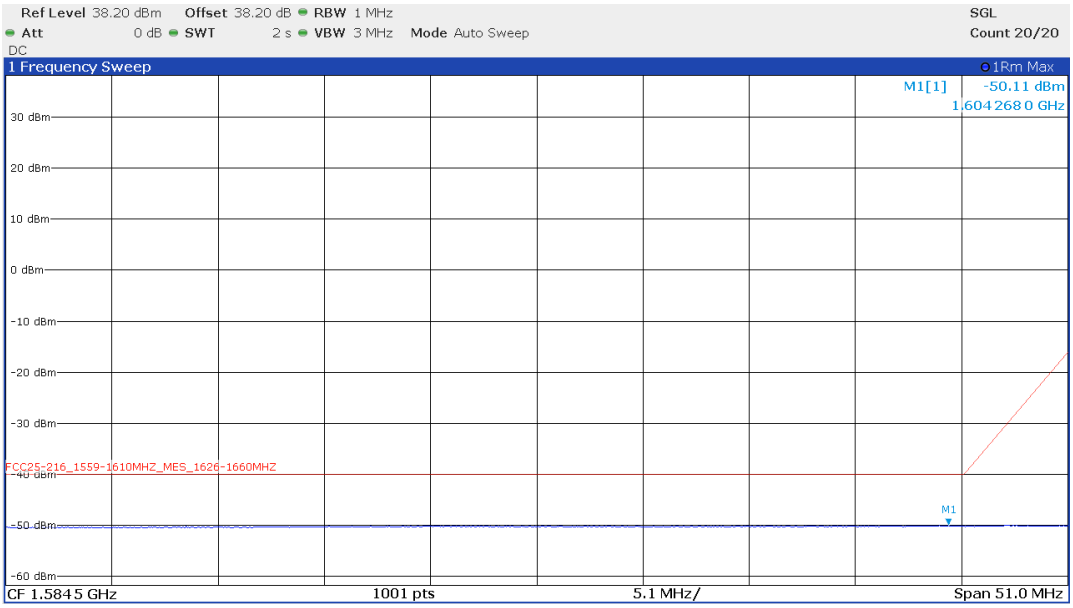
Ambient temperature: 20 - 28 °C
Relative humidity: 30 - 40 %

OP-Mode	Operating Channel [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
TX-CM	1626.5	-	-	RMS	1000	-40	> 6
TX-CM	1643.5	-	-	RMS	1000	-40	> 6
TX-CM	1660.5	-	-	RMS	1000	-40	> 6

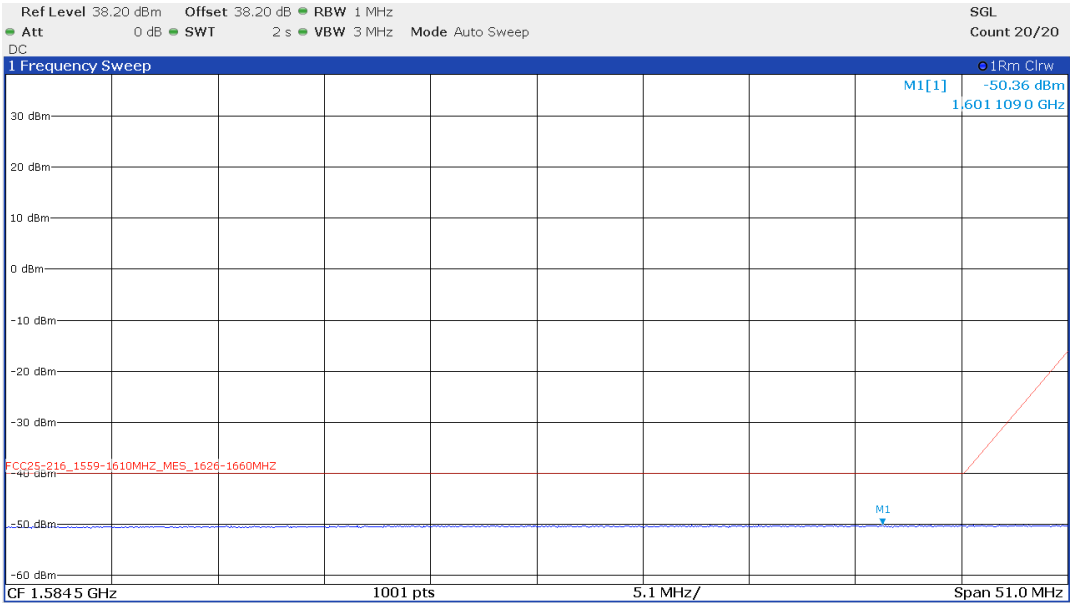
Remark: Please see next sub-clause for the measurement plot.

5.6.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

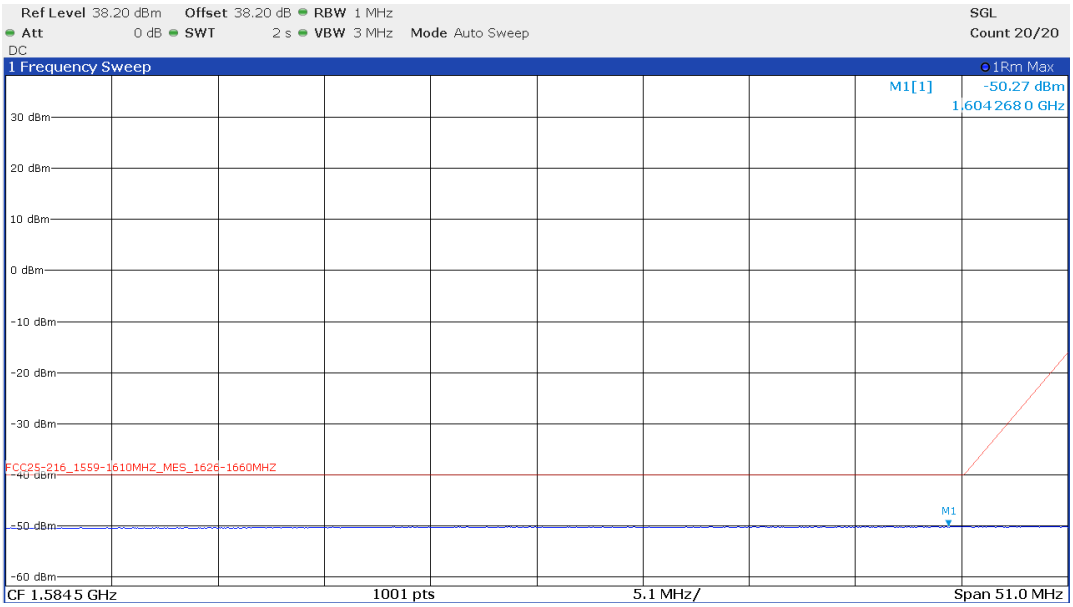
Operating-Mode = TX-CM, Operating Channel = low,
(S02_AH01)



Operating-Mode = TX-CM, Operating Channel = mid,
(S02_AH01)



Operating-Mode = TX-CM, Operating Channel = high,
(S02_AH01)



5.6.5 TEST EQUIPMENT USED

- Radiated Emissions FAR

5.7 CARRIER-OFF SPURIOUS RADIATED EMISSIONS IN (1559-1610MHZ) BAND

Standard **FCC PART 25 Subpart C**

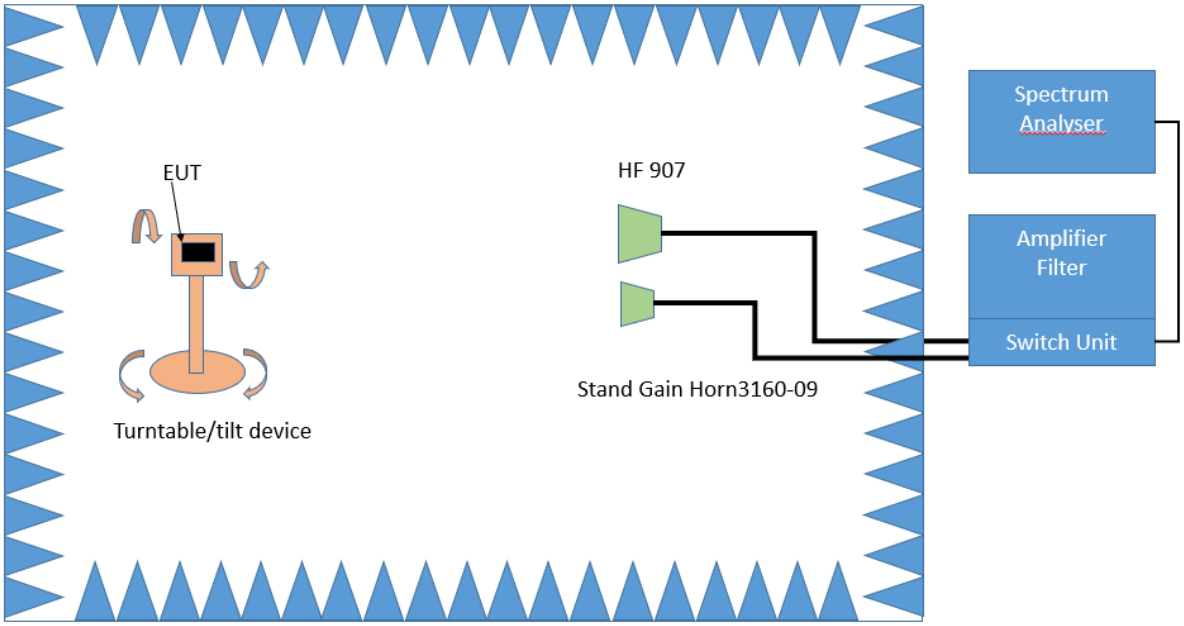
The test was performed according to:
ANSI C63.26, chapter 5.5.3

5.7.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C63.26 in a typical installation configuration.
The measurement procedure is implemented into the EMI test software EMC32 from R&S.
Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes.
A pre-check is performed while the EUT is powered from a DC power source.

The measurements were performed with the test setup according to the following diagram:

Frequency Range: 1 GHz – 26.5 GHz



Test Setup; Spurious Emission Radiated (FAC), 1 GHz-26.5 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
Step 1:
The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.
All steps were performed with one height (1.5 m) of the receiving antenna only.
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.
The turn table step size (azimuth angle) for the preliminary measurement is 45 °.

- Antenna distance: 1 m
- Detector: Peak
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: 35 s
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Polarisation: Horizontal + Vertical

Step 2:
Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size ± 45° for the elevation axis is performed.
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
EMI receiver settings (for all steps):
- Detector: Peak,
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: 100 ms

Step 3:
The Spectrum Analyzer settings can be directly found in the measurement diagrams.

5.7.2 TEST REQUIREMENTS / LIMITS

FCC Part 25.216; Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service.

(e) The e.i.r.p density of carrier-off state emissions from mobile earth stations manufactured more than six months after Federal Register publication of the rule changes adopted in FCC 03-283 with assigned uplink frequencies between 1 and 3 GHz shall not exceed −80 dBW/MHz in the 1559-1610 MHz band averaged over any two millisecond interval.

RSS-170; 5.10 Carrier-off state emissions

MESs with transmitting frequencies between 1 GHz and 3 GHz shall not exceed -80 dBW/MHz, which is the e.i.r.p. density of carrier-off state emissions in the band 1559-1610 MHz.

5.7.3 TEST PROTOCOL

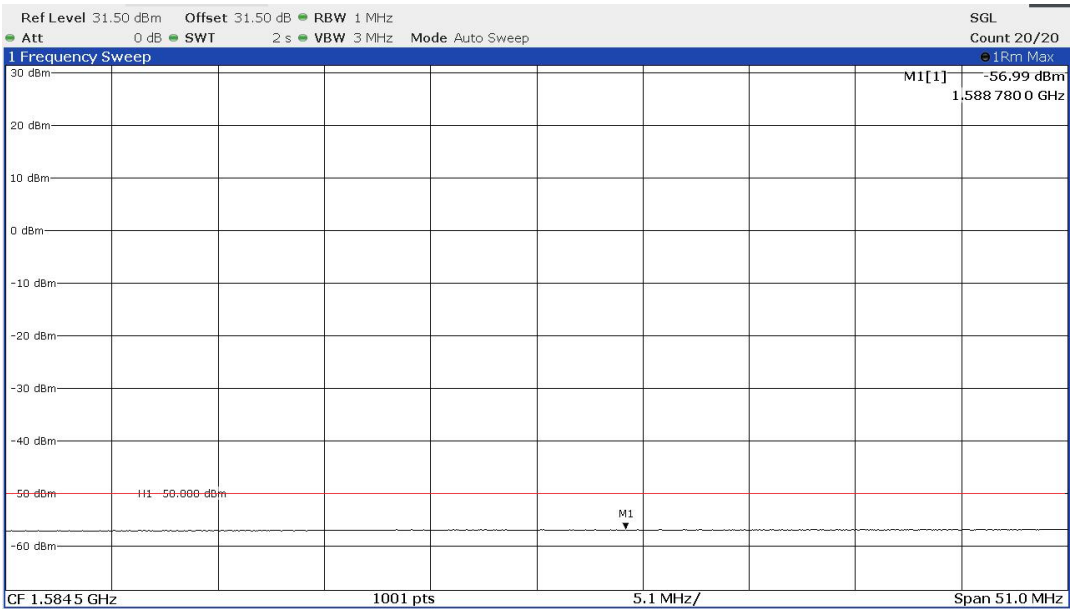
Ambient temperature: 20 - 28 °C
Relative humidity: 30 - 40 %

OP-Mode	Operating Channel [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
Carrier-off	-	-	-	RMS	1000	-50	> 6

Remark: Please see next sub-clause for the measurement plot.

5.7.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

Operating-Mode = Carrier-off, Operating Channel = -,
(S02_AH01)



5.7.5 TEST EQUIPMENT USED

- Radiated Emissions FAR

5.8 FREQUENCY STABILITY

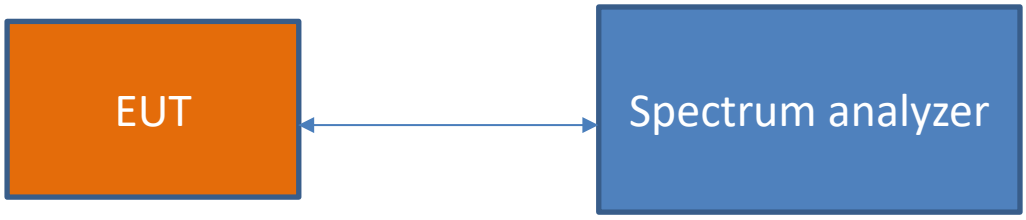
Standard **FCC PART 25 Subpart C**

The test was performed according to:
ANSI C63.26, chapter 5.6

5.8.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the Frequency Stability measurements.

The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered.



Test Setup FCC; Conducted emissions

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

The measurement procedure:

1. The EUT is placed in a room at ambient temperature, and the transmitting frequency error is measured.

2. The EUT is then turned off and placed inside a temperature chamber set to 50°C. The temperature is allowed to fully stabilize.

3. Once the temperature has stabilized, the transmitting frequency error is measured at 50°C. The EUT is then turned off, and the temperature is decreased by 10 degrees Celsius.

4. The EUT is turned back on and allowed to stabilize at the new temperature. Then, the transmitting frequency error measurement is repeated.

5. This process of decreasing the temperature by 10°C, allowing it to stabilize, and then measuring the transmitting frequency error is repeated until the temperature reaches -30°C.

6. The measurements were also performed under normal room temperature conditions, with the DC voltage varied by ±15% of the nominal value.

5.8.2 TEST REQUIREMENTS / LIMITS

FCC Part 25.202 (d); Emission limitations:

Frequency tolerance, Earth stations: The carrier frequency of each earth station transmitter authorized in these services shall be maintained within 0.001 percent of the reference frequency.

RSS-170; 5.3 Frequency stability

For MES equipment, the carrier frequency shall not drift from the reference frequency by more than ±10 ppm.

5.8.3 TEST PROTOCOL

Ambient temperature: 20 - 28 °C
Relative humidity: 30 - 40 %

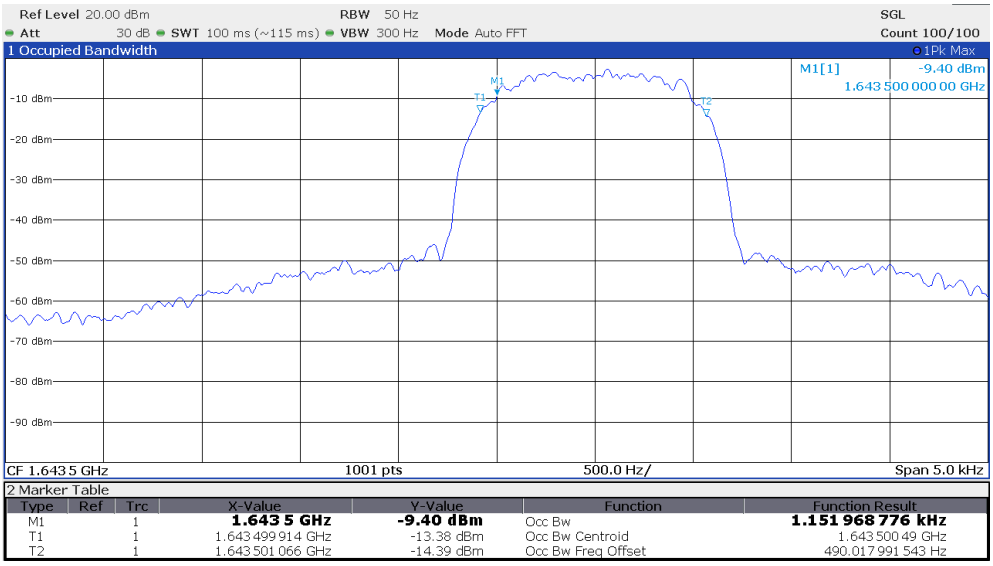
Mid CH. = 1643.5 MHz

Temperature [°C]	Voltage [V]	F low @ 99%BW [GHz]	F high @ 99%BW [GHz]	Frequency Reading [MHz]	Delta [Hz]	Frequency Stability [ppm]	Limits [ppm]	Verdict
20	Normal	1.64349915	1.643500297	1643.499724				
50		1.64349911	1.64350027	1643.49969	33.49999997	0.020383328	10	Passed
40		1.643499215	1.643500371	1643.499793	69.50000011	0.0422878	10	Passed
30		1.643499212	1.643500362	1643.499787	63.50000012	0.038637055	10	Passed
10		1.643499244	1.643500388	1643.499816	92.49999994	0.056282324	10	Passed
0		1.643499342	1.643500516	1643.499929	205.4999998	0.125038028	10	Passed
-10		1.643499576	1.643500741	1643.500159	434.9999999	0.264679039	10	Passed
-20		1.643499772	1.643500923	1643.500348	623.9999998	0.379677517	10	Passed
-30		1.643499914	1.643501066	1643.50049	766.5000001	0.46638272	10	Passed
20	115%	1.643499139	1.643500277	1643.499708	15.50000002	0.009431092	10	Passed
	85%	1.643499135	1.643500277	1643.499706	17.50000001	0.010648007	10	Passed

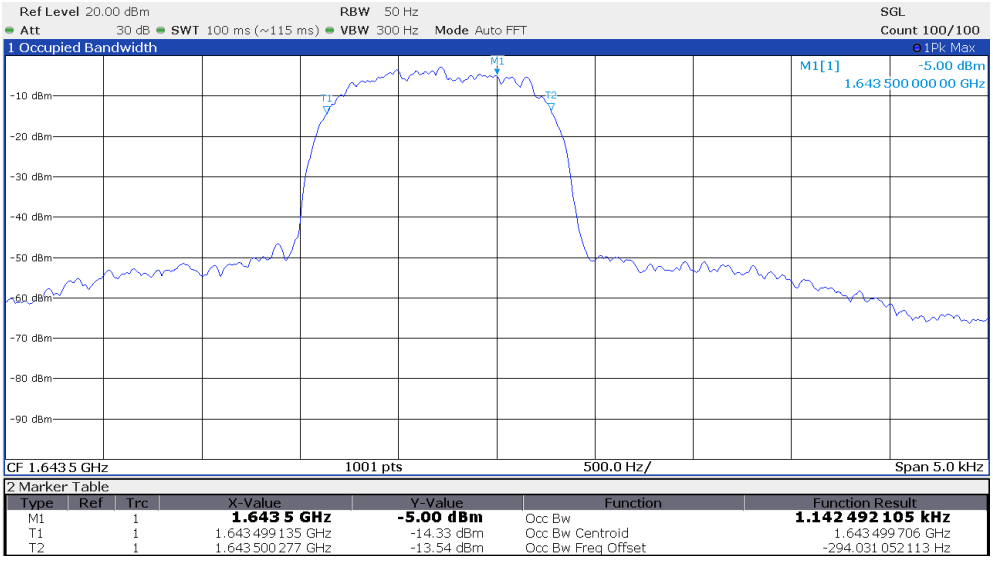
Remark: Please see next sub-clause for the measurement plot.

5.8.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

Operating-Mode = TX-CM, Operating Channel = mid, temperature = - 30°C, Voltage = 3.8 VDC, (S01_AI01)



Operating-Mode = TX-CM, Operating Channel = mid, temperature = 20 °C, Voltage = 3.23 VDC, (S01_AI01)



5.8.5 TEST EQUIPMENT USED

- Radio Lab

6 TEST EQUIPMENT

6.1 TEST EQUIPMENT HARDWARE

1 Radiated Emissions FAR
Radiated Emissions Tests in a fully anechoic room

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	Innco Systems CO3000	Controller for bore sight mast FAC		CO3000/1460/54740522/P	N/A	N/A
1.2	AMF-7D00101800-30-10P-R	Broadband Amplifier 100 MHz - 18 GHz	Miteq		N/A	N/A
1.3	Anechoic Chamber 03	FAR, 8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	N/A	N/A
1.4	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08
1.5	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785	N/A	N/A
1.6	FSW43	Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	103779	2023-04	2025-04
1.7	EP 1200/B, NA/B1	AC Source, Amplifier with integrated variable Oscillator	Spitzenberger & Spies GmbH & Co. KG	B6278	N/A	N/A
1.8	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069	N/A	N/A
1.9	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright Instruments GmbH	09	N/A	N/A
1.10	MA3000/0800-XP-ET-compact	Bore Sight Antenna Mast			N/A	N/A
1.11	TT 1.5 WI	Turn Table	Maturo GmbH	-	N/A	N/A
1.12	CS-RUB6	Rubidium Frequency Standard	Rohde & Schwarz GmbH & Co. KG	100451	2023-05	2025-05
1.13	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675	N/A	N/A
1.14	Opus 20 THI (8120.00)	ThermoHygro Datalogger	Lufft Mess- und Regeltechnik GmbH	115.0318.0802.033	2023-08	2025-08
1.15	TD1.5-10kg	EUT Tilt Device (Rohacell)	Maturo GmbH	TD1.5-10kg/024/3790709	N/A	N/A
1.16	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324	N/A	N/A
1.17	HF 906	Double-ridged horn	Rohde & Schwarz	357357/002	2022-07	2025-07

2 Radiated Emissions SAC up to 1 GHz

Radiated emission tests up to 1 GHz in a semi anechoic room

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	N5000/NP	Filter for EUT, 2 Lines, 250 V, 16 A	ETS-LINDGREN	241515	N/A	N/A
2.2	Opus10 TPR (8253.00)	T/P Logger 13	Lufft Mess- und Regeltechnik GmbH	13936	2023-12	2025-12
2.3	ESW44	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	101603		
2.4	Anechoic Chamber 01	SAC/FAR, 10.58 m x 6.38 m x 6.00 m	Frankonia Germany EMC Solution GmbH	none	N/A	N/A
2.5	HL 562E ULTRALOG	Biconical-log-per Antenna (30 MHz - 6 GHz)	Rohde & Schwarz GmbH & Co. KG	102299	2024-07	2027-07
2.6	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08
2.7	Opus10 THI (8152.00)	T/H Logger 10	Lufft Mess- und Regeltechnik GmbH	12488	2023-12	2025-12
2.8	EP 1200/B, NA/B1	AC Source, Amplifier with integrated variable Oscillator	Spitzenberger & Spies GmbH & Co. KG	B6278	N/A	N/A
2.9	DS 420S	Turn Table 2 m diameter	HD GmbH	420/573/99	N/A	N/A
2.10	CS-RUB6	Rubidium Frequency Standard	Rohde & Schwarz GmbH & Co. KG	100451	2023-05	2025-05
2.11	AM 4.0	Antenna Mast 4 m	Maturo GmbH	AM4.0/180/1192 0513	N/A	N/A

3 Radio Lab
Conducted Radio Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.1	CMWC	Control PC for the CMX500	Rohde & Schwarz GmbH & Co. KG	103129-gL	N/A	N/A
3.2	1575	Broadband Resistive Power Divider DC to 40 GHz	API Weinschel, Inc.	4070	N/A	N/A
3.3	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2023-08	2025-08
3.4	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08
3.5	SMP03	Signal Generator 2 GHz - 27 GHz	Rohde & Schwarz	833680/003	N/A	N/A
3.6	Temperature Chamber KWP 120/70	Temperature Chamber Weiss 01	Weiss	59226012190010	2024-07	2026-07
3.7	SMB100A	Signal Generator 100 kHz - 40 GHz	Rohde & Schwarz Vertriebs-GmbH	181486	2023-01	2026-01
3.8	SMBV100B	Vector Signal Generator	Rohde & Schwarz Messgerätebau GmbH	102458	2022-12	2025-12
3.9	Chroma 6404	AC Source	Chroma ATE INC.	64040001304	N/A	N/A
3.10	CMW500	Callbox OIL-RE, SUA-160 MHz	Rohde & Schwarz GmbH & Co. KG	168926-LH	2024-07	2027-07
3.11	Temperature Chamber VT 4002	Temperature Chamber Vötsch 03	Vötsch	58566002150010	2024-07	2026-07
3.12	A8455-4	4 Way Power Divider (SMA)		-	N/A	N/A
3.13	FSW43	Signal Analyser	Rohde & Schwarz GmbH & Co. KG	102013	2023-07	2025-07
3.14	CS-RUB6	Rubidium Frequency Standard	Rohde & Schwarz GmbH & Co. KG	100451	2023-05	2025-05
3.15	Opus10 THI (8152.00)	T/H Logger 03	Lufft Mess- und Regeltechnik GmbH	7482	2023-12	2025-12
3.16	CMW500	Callbox OIL-RE, SUA-160 MHz	Rohde & Schwarz GmbH & Co. KG	168925-vc	2023-06	2026-06
3.17	Temperature Chamber VT 4002	Temperature Chamber Vötsch 05	Vötsch	58566080550010	2024-07	2026-07

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”

6.2 TEST EQUIPMENT SOFTWARE

Semi-Anechoic Chamber:	
Software	Version
EMC32 Measurement Software	10.60.10
INNCO Mast Controller	1.02.62
INNCO Mast Height	34.10
INNCO Mast Elevation	36.11
MATURO Controller	1.24
MATURO Mast	12.19
MATURO Turn-Table	30.10
Fully-Anechoic Chamber:	
Software	Version
EMC32 Measurement Software	10.60.10
MATURO Controller	1.30
MATURO Turn-Unit	11.10
MATURO Mast	12.10
MATURO Turntable	12.11
INNCO Controller	1.03.02
INNCO Mast Height	34.10
INNCO Mast Elevation	36.11
TS 8997	
WMS32 Measurement Software	11.60.00 (till 2024-03-19), 11.70.00 + Hotfix 01
Conducted AC Emissions:	
Software	Version
EMC32 Measurement Software	10.60.20

7 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

7.1 LISN R&S ESH3-Z5 (150 KHZ – 30 MHZ)

Frequency		Corr.	LISN insertion loss ESH3-Z5	cable loss (incl. 10 dB atten-uator)
MHz		dB	dB	dB
0.15		10.1	0.1	10.0
5		10.3	0.1	10.2
7		10.5	0.2	10.3
10		10.5	0.2	10.3
12		10.7	0.3	10.4
14		10.7	0.3	10.4
16		10.8	0.4	10.4
18		10.9	0.4	10.5
20		10.9	0.4	10.5
22		11.1	0.5	10.6
24		11.1	0.5	10.6
26		11.2	0.5	10.7
28		11.2	0.5	10.7
30		11.3	0.5	10.8

Sample calculation

U_{LISN} (dB µV) = U (dB µV) + Corr. (dB)
U = Receiver reading
LISN Insertion loss = Voltage Division Factor of LISN
Corr. = sum of single correction factors of used LISN, cables, switch units (if used)
Linear interpolation will be used for frequencies in between the values in the table.

7.2 ANTENNA R&S HFH2-Z2 (9 KHZ – 30 MHZ)

Frequency	AF HFH-Z2)	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-40 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
0.009	20.50	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.01	20.45	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.015	20.37	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.02	20.36	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.025	20.38	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.03	20.32	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.05	20.35	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.08	20.30	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.1	20.20	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.2	20.17	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.3	20.14	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.49	20.12	-79.6	0.1	0.1	0.1	0.1	-80	300	3
0.490001	20.12	-39.6	0.1	0.1	0.1	0.1	-40	30	3
0.5	20.11	-39.6	0.1	0.1	0.1	0.1	-40	30	3
0.8	20.10	-39.6	0.1	0.1	0.1	0.1	-40	30	3
1	20.09	-39.6	0.1	0.1	0.1	0.1	-40	30	3
2	20.08	-39.6	0.1	0.1	0.1	0.1	-40	30	3
3	20.06	-39.6	0.1	0.1	0.1	0.1	-40	30	3
4	20.05	-39.5	0.2	0.1	0.1	0.1	-40	30	3
5	20.05	-39.5	0.2	0.1	0.1	0.1	-40	30	3
6	20.02	-39.5	0.2	0.1	0.1	0.1	-40	30	3
8	19.95	-39.5	0.2	0.1	0.1	0.1	-40	30	3
10	19.83	-39.4	0.2	0.1	0.2	0.1	-40	30	3
12	19.71	-39.4	0.2	0.1	0.2	0.1	-40	30	3
14	19.54	-39.4	0.2	0.1	0.2	0.1	-40	30	3
16	19.53	-39.3	0.3	0.1	0.2	0.1	-40	30	3
18	19.50	-39.3	0.3	0.1	0.2	0.1	-40	30	3
20	19.57	-39.3	0.3	0.1	0.2	0.1	-40	30	3
22	19.61	-39.3	0.3	0.1	0.2	0.1	-40	30	3
24	19.61	-39.3	0.3	0.1	0.2	0.1	-40	30	3
26	19.54	-39.3	0.3	0.1	0.2	0.1	-40	30	3
28	19.46	-39.2	0.3	0.1	0.3	0.1	-40	30	3
30	19.73	-39.1	0.4	0.1	0.3	0.1	-40	30	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -40 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values

7.3 ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

(d_{Limit} = 3 m)

Frequency	AF R&S HL562	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18.6	0.6	0.29	0.04	0.23	0.02	0.0	3	3
50	6.0	0.9	0.39	0.09	0.32	0.08	0.0	3	3
100	9.7	1.2	0.56	0.14	0.47	0.08	0.0	3	3
150	7.9	1.6	0.73	0.20	0.59	0.12	0.0	3	3
200	7.6	1.9	0.84	0.21	0.70	0.11	0.0	3	3
250	9.5	2.1	0.98	0.24	0.80	0.13	0.0	3	3
300	11.0	2.3	1.04	0.26	0.89	0.15	0.0	3	3
350	12.4	2.6	1.18	0.31	0.96	0.13	0.0	3	3
400	13.6	2.9	1.28	0.35	1.03	0.19	0.0	3	3
450	14.7	3.1	1.39	0.38	1.11	0.22	0.0	3	3
500	15.6	3.2	1.44	0.39	1.20	0.19	0.0	3	3
550	16.3	3.5	1.55	0.46	1.24	0.23	0.0	3	3
600	17.2	3.5	1.59	0.43	1.29	0.23	0.0	3	3
650	18.1	3.6	1.67	0.34	1.35	0.22	0.0	3	3
700	18.5	3.6	1.67	0.42	1.41	0.15	0.0	3	3
750	19.1	4.1	1.87	0.54	1.46	0.25	0.0	3	3
800	19.6	4.1	1.90	0.46	1.51	0.25	0.0	3	3
850	20.1	4.4	1.99	0.60	1.56	0.27	0.0	3	3
900	20.8	4.7	2.14	0.60	1.63	0.29	0.0	3	3
950	21.1	4.8	2.22	0.60	1.66	0.33	0.0	3	3
1000	21.6	4.9	2.23	0.61	1.71	0.30	0.0	3	3

(d_{Limit} = 10 m)

30	18.6	-9.9	0.29	0.04	0.23	0.02	-10.5	10	3
50	6.0	-9.6	0.39	0.09	0.32	0.08	-10.5	10	3
100	9.7	-9.2	0.56	0.14	0.47	0.08	-10.5	10	3
150	7.9	-8.8	0.73	0.20	0.59	0.12	-10.5	10	3
200	7.6	-8.6	0.84	0.21	0.70	0.11	-10.5	10	3
250	9.5	-8.3	0.98	0.24	0.80	0.13	-10.5	10	3
300	11.0	-8.1	1.04	0.26	0.89	0.15	-10.5	10	3
350	12.4	-7.9	1.18	0.31	0.96	0.13	-10.5	10	3
400	13.6	-7.6	1.28	0.35	1.03	0.19	-10.5	10	3
450	14.7	-7.4	1.39	0.38	1.11	0.22	-10.5	10	3
500	15.6	-7.2	1.44	0.39	1.20	0.19	-10.5	10	3
550	16.3	-7.0	1.55	0.46	1.24	0.23	-10.5	10	3
600	17.2	-6.9	1.59	0.43	1.29	0.23	-10.5	10	3
650	18.1	-6.9	1.67	0.34	1.35	0.22	-10.5	10	3
700	18.5	-6.8	1.67	0.42	1.41	0.15	-10.5	10	3
750	19.1	-6.3	1.87	0.54	1.46	0.25	-10.5	10	3
800	19.6	-6.3	1.90	0.46	1.51	0.25	-10.5	10	3
850	20.1	-6.0	1.99	0.60	1.56	0.27	-10.5	10	3
900	20.8	-5.8	2.14	0.60	1.63	0.29	-10.5	10	3
950	21.1	-5.6	2.22	0.60	1.66	0.33	-10.5	10	3
1000	21.6	-5.6	2.23	0.61	1.71	0.30	-10.5	10	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

7.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24.4	-19.4	0.99	0.31	-21.51	0.79		
2000	28.5	-17.4	1.44	0.44	-20.63	1.38		
3000	31.0	-16.1	1.87	0.53	-19.85	1.33		
4000	33.1	-14.7	2.41	0.67	-19.13	1.31		
5000	34.4	-13.7	2.78	0.86	-18.71	1.40		
6000	34.7	-12.7	2.74	0.90	-17.83	1.47		
7000	35.6	-11.0	2.82	0.86	-16.19	1.46		

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31.0	-23.4	0.47	1.87	0.53	-27.58	1.33	
4000	33.1	-23.3	0.56	2.41	0.67	-28.23	1.31	
5000	34.4	-21.7	0.61	2.78	0.86	-27.35	1.40	
6000	34.7	-21.2	0.58	2.74	0.90	-26.89	1.47	
7000	35.6	-19.8	0.66	2.82	0.86	-25.58	1.46	

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35.6	-57.3	0.56	1.28	-62.72	2.66	0.94	1.46
8000	36.3	-56.3	0.69	0.71	-61.49	2.84	1.00	1.53
9000	37.1	-55.3	0.68	0.65	-60.80	3.06	1.09	1.60
10000	37.5	-56.2	0.70	0.54	-61.91	3.28	1.20	1.67
11000	37.5	-55.3	0.80	0.61	-61.40	3.43	1.27	1.70
12000	37.6	-53.7	0.84	0.42	-59.70	3.53	1.26	1.73
13000	38.2	-53.5	0.83	0.44	-59.81	3.75	1.32	1.83
14000	39.9	-56.3	0.91	0.53	-63.03	3.91	1.40	1.77
15000	40.9	-54.1	0.98	0.54	-61.05	4.02	1.44	1.83
16000	41.3	-54.1	1.23	0.49	-61.51	4.17	1.51	1.85
17000	42.8	-54.4	1.36	0.76	-62.36	4.34	1.53	2.00
18000	44.2	-54.7	1.70	0.53	-62.88	4.41	1.55	1.91

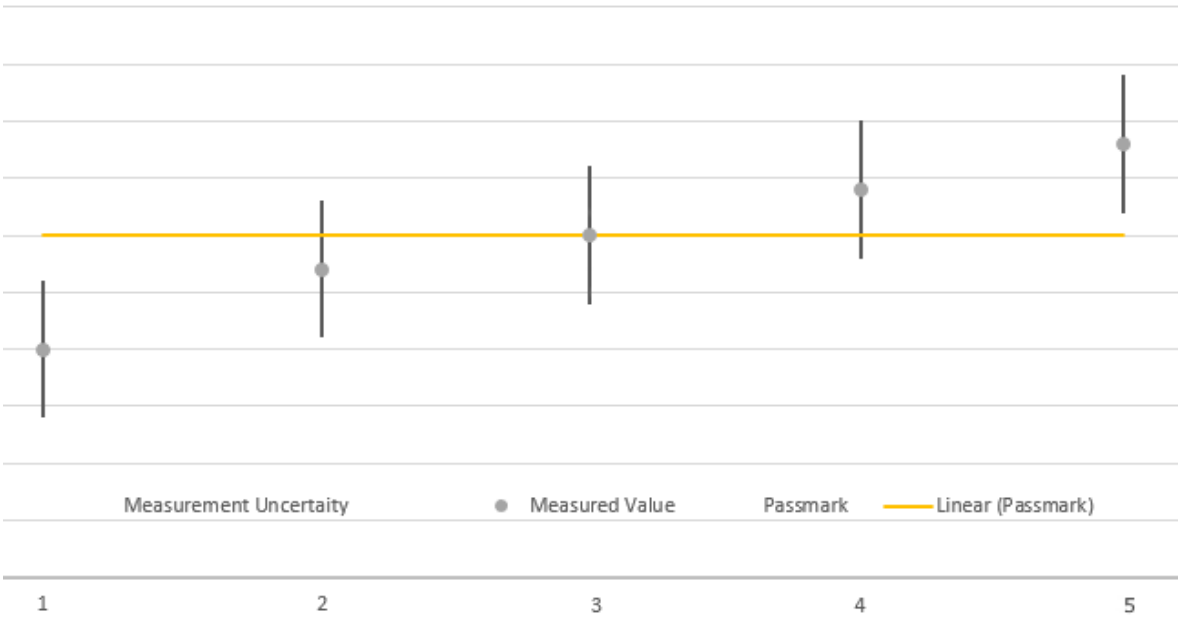
Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

8 MEASUREMENT UNCERTAINTIES

Test Case(s)	Parameter	Uncertainty
- RF Output Power	Power	± 1.5 dB
- Emission and Occupied Bandwidth	Power Frequency	± 2.2 dB ± 21 Hz
- Spurious Emissions, radiated	Power	± 6 dB
- Spurious Emissions, conducted	Power	± 3 dB
- Frequency Stability	Frequency	± 8.5 Hz

The measurement uncertainties for all parameters are calculated with an expansion factor (coverage factor) k = 1.96. This means, that the true value is in the corresponding interval with a probability of 95 %.



The verdicts in this test report are given according the above diagram:

Case	Measured Value	Uncertainty Range	Verdict
1	below pass mark	below pass mark	Passed
2	below pass mark	within pass mark	Passed
3	on pass mark	within pass mark	Passed
4	above pass mark	within pass mark	Failed
5	above pass mark	above pass mark	Failed

That means, the laboratory applies, as decision rule (see ISO/IEC 17025:2017), the so-called shared risk principle.

9 PHOTO REPORT

Please see separate photo report.

**********END OF TEST REPORT**********