



RF - TEST REPORT

- Jp ARIB-T91 -

Type / Model Name : PKA3BA

Product Description : Keyless Access System

Applicant : Robert Bosch GmbH

Address : Robert-Bosch-Platz 1

70839 GERLINGEN, GERMANY

Manufacturer : Robert Bosch GmbH

Address : Robert-Bosch-Platz 1

70839 GERLINGEN, GERMANY

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

POSITIVE

Test Report No. : 80268859-01 Rev_2

16. December 2025

Date of issue



Deutsche
Akkreditierungsstelle
D-PL-12030-01-00

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1 TEST STANDARDS

The tests were performed according to following standards:

ARIB STD-T91 Ver. 4.0, 5. August 2022

UWB (Ultra Wideband) Radio Systems

Radio Law (Law No. 131 of May 1950).

Amended last by Law 21 of 2005.

Ordinance Regulating Radio Equipment

Chapter IV, Section 4.25 Radio Equipment of Radio Stations of Ultra Wide-band Wireless System (UWB) (Article 49.27)

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

2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

2.3 General remarks

None.

2.4 Photo documentation of the EUT – Detailed photos see attachment A

2.5 Equipment type

Ultra Wideband Wireless System

The emission designator is X1D.

2.6 Short description of the equipment under test (EUT)

Perfect Keyless System (PK System) has the main feature to give ability to use a digital key on a mobile or similar device for vehicle access. It supports access via a combination of BLE, UWB and NFC radio-frequency technologies, following the definitions of the Car Connectivity Consortium. Perfectly Keyless provides information about the presence and location of authorized mobile devices and Keyfobs to a Vehicle ECU (VECU). The Vehicle ECU implements existing standard key functions (PEPS, RKE, Approach detection) so the existing look and feel of the vehicle is maintained. The devices are connected with the rest of the vehicle via a CAN bus as specified by the Customer Vehicle Architecture. Typically, the PK system consists of several devices. The EUT is one device of this system.

Number of tested samples:	2
Serial number:	PKA3BA DUT-112 (Tx) PKA3BA DUT-119 (Rx)
SW version:	00.06.14.6H
HW version:	H10

2.7 Variants of the EUT

There are no variants.

2.8 Operation frequency and channel plan

The operating frequency is 7587.5 MHz to 8400 MHz.

Channel plan for UWB:

Channel number	Frequency (MHz)
9	7987.2

2.9 Transmit operating modes

Modulation: Impulse radio modulation according to IEEE 802.15.4z BPRF/HPRF UWB PHY

The EUT uses two different frame types, namely RAD and CCC.

2.10 Antenna

The following antennas shall be used with the EUT:

Number	Characteristic	Type	Plug	f-range (GHz)	Max. Gain (dBi)
1	Omni	Integrated antenna	PCB	7.5 – 8.5	0.9
2	Omni	Integrated antenna	PCB	7.5 – 8.5	2.1
3	Omni	Integrated antenna	PCB	7.5 – 8.5	2.3

Antenna 1 is used for transmission only, antennas 2 and 3 are used for receiving only. According to the applicant antennas 2 and 3 are identical in construction (PCB layout) and characteristics.

2.11 Power supply system utilised

Power supply voltage range: : 12 V DC

2.12 Peripheral devices and interface cables

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

- CAN-USB adaptor Model : Vector VN1610
- Notebook Model : Lenovo ThinkPad RT-D-0098D

2.13 Determination of worst-case conditions for final measurement

The device has a special firmware allowing to set channels for conducted tests. The EUT shows a fixed power setting to perform the test modes TX continuous, modulated and RX continuous for the channels listed in section 2.8.

2.13.1 Test jig

The measurements are performed with the entire device. No special test jig was used.

2.13.2 Test software

Special software is used for setting the EUT in a continuous Tx and Rx mode. The power setting is P=40 for RAD frame type and P=36 for CCC frame type.

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

3 Test result summary

ORRE Article Reference	Report chapter	Test items	Test Results
Chapter I – General Provisions, Section 2 Quality of Emissions			
5	5.1	Frequency tolerance and OBW	passed
7	5.2	Spurious emissions	passed
Chapter II Transmitting Equipment, Section 3 Transmitting Antenna			
14	5.7	Antenna power tolerance	passed
Chapter III – Receiving Equipment			
24 (17)	5.3	Limit on secondary radiated emissions	passed
Chapter IV – Radio Equipment of Radio Stations of Ultra Wide-band Wireless System (UWB)			
49.27-3 (3)	5.4	Antenna power – mean power value	passed
49.27-3 (3)	5.5	Antenna power – peak power value	passed
49.27 6)	---	Antenna gain	not applicable
49.27-3 (4)	5.6	Frequency bandwidth	passed

3.1 Revision history of test report

Test report No	Rev.	Issue Date	Changes
80268859-01	0	06 November 2025	Initial test report
	1	27 November 2025	Section 3: correction of references (outdoor UWB device) Section 5.7: (new): adding antenna power tolerance consideration
	2	16 December 2025	Section 2.4: emission designator added Section 4.5.1.1: clarification version of used standard

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

3.2 Final assessment

The equipment under test **fulfills** the RF requirements cited in clause 1 test standards.

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

Testing commenced on : 07 October 2025

Testing concluded on : 08 October 2025

Checked by:


Klaus
Gegenfurtner
2025.12.16
10:17:05 +01'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:


I am the author
of this document
2025.12.16
10:08:52 +01'00'

Franz-Xaver Schrettenbrunner
Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Straubinger Strasse 100
94447 PLATTILING
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 5-35 ° C

Humidity: 45-85 %

Atmospheric pressure: 86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor $k = 2$. The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 2011 + A1 / 2014 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement uncertainty table	
Measurement output power, conducted	± 1.5 dB
Measurement output power, radiated	± 3.0 dB
Measurement PSD, conducted	± 1.5 dB
Measurement PSD, radiated	± 3.0 dB
Measurement spurious emissions, conducted	± 3.0 dB
Measurement spurious emissions, radiated	± 6.0 dB
Measurement frequency	$\pm 1 \times 10^{-8}$

4.4 Conformity Decision Rule

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

4.5 Measurement protocol

4.5.1 General information

4.5.1.1 Test methodology

Conducted and radiated disturbance testing is performed according to the procedures of TELECOM-ITALY "Characteristics Test Methods for Radio Equipment Used for Radio Station of Ultra-Wideband Radio System" (2019).

Radiated measurements of the EIRP in the range 30 MHz to 1000 MHz are performed at 10 m distance because only this distance is calibrated regularly.

4.5.1.2 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum disturbances from the unit.

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

5 TEST CONDITIONS AND RESULTS

5.1 Frequency tolerance and Occupied Bandwidth

For test instruments and accessories used see section 6 Part FE.

5.1.1 Description of the test location

Test location: Shielded Room SR6

5.1.2 Photo documentation of the test set-up



5.1.3 Applicable standard

According to ARIB STD-T91, Volume 2, section 3.2 (5):

The permissible values for the occupied frequency bandwidth are as follows: The OBW frequencies should be above 7.587 GHz and below 8.4 GHz.

5.1.4 Description of Measurement

The EUT is operated in continuous transmission mode. The transmitter output is connected to the spectrum analyser through an attenuator. The centre frequency of the spectrum analyser is set to the fundamental frequency.

Spectrum analyser settings:

RBW: 1 MHz,

Det.: pos. Peak

VBW: 1 MHz,

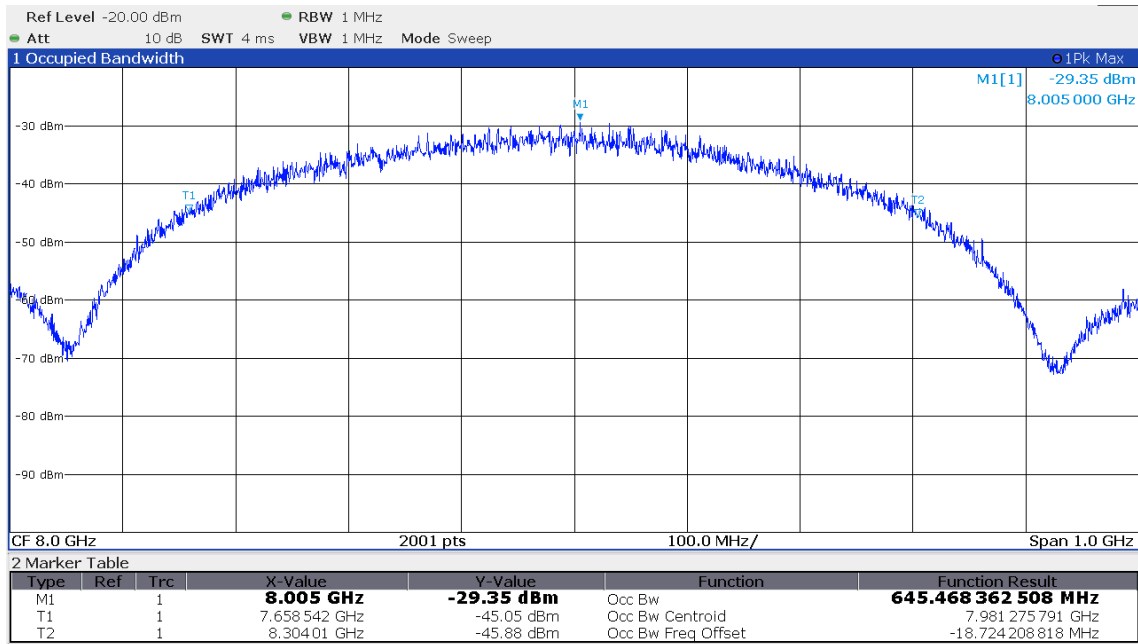
trace: max. hold

SPAN: 1 GHz

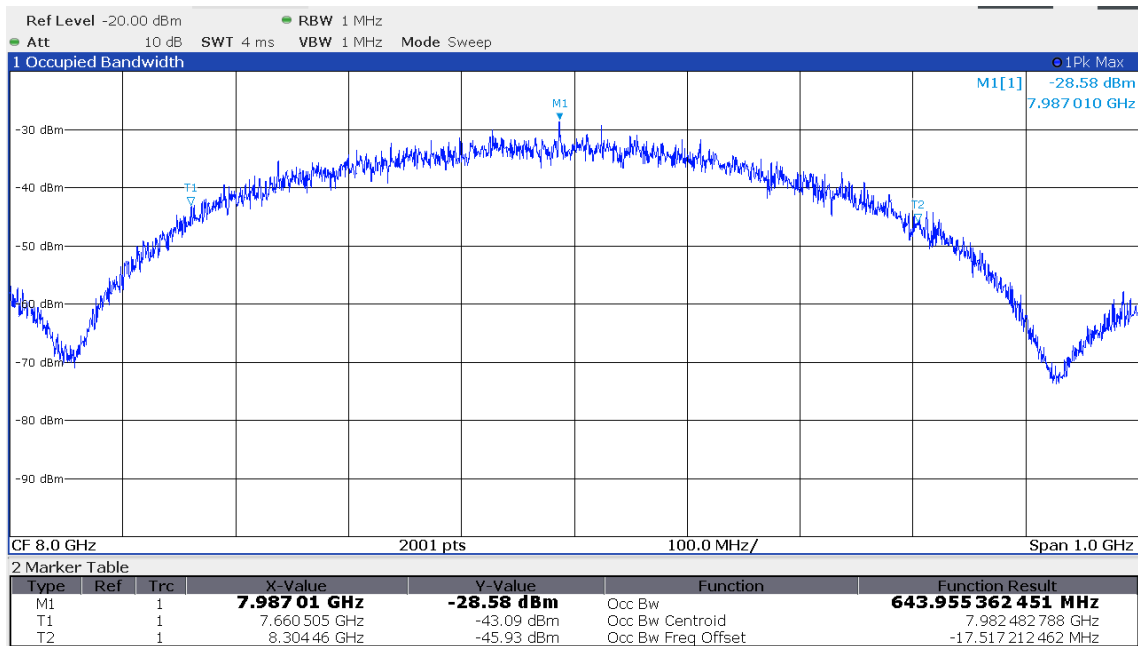
sweep: cont.

5.1.5 Test result

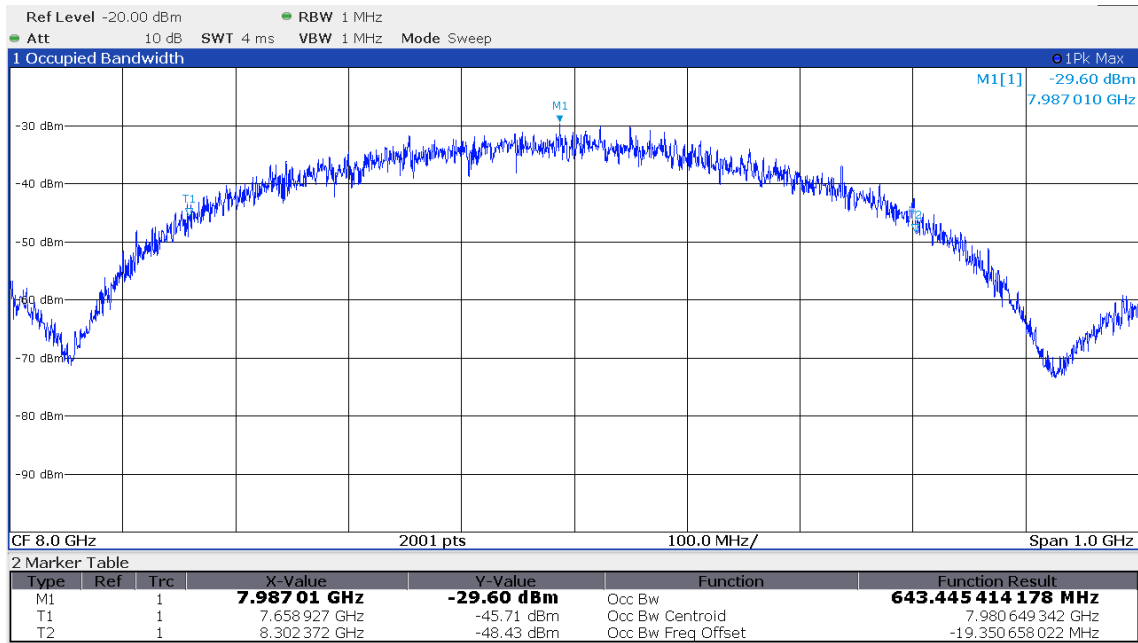
RAD frame type V_{nom}



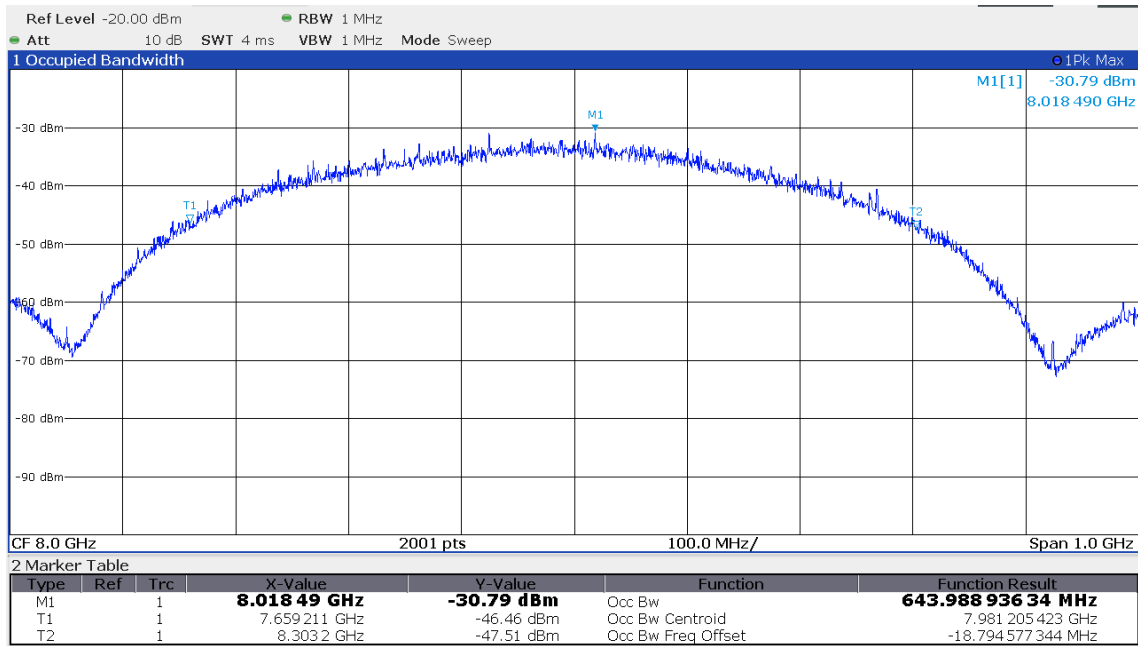
RAD frame type V_{min}



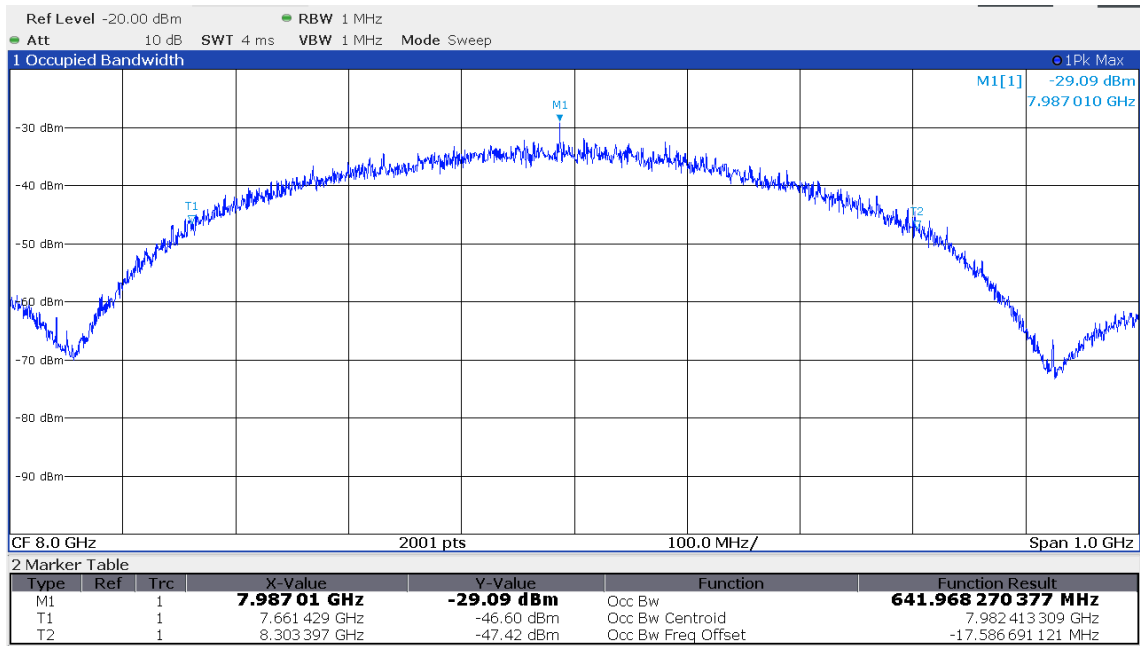
RAD frame type $V_{\max}$



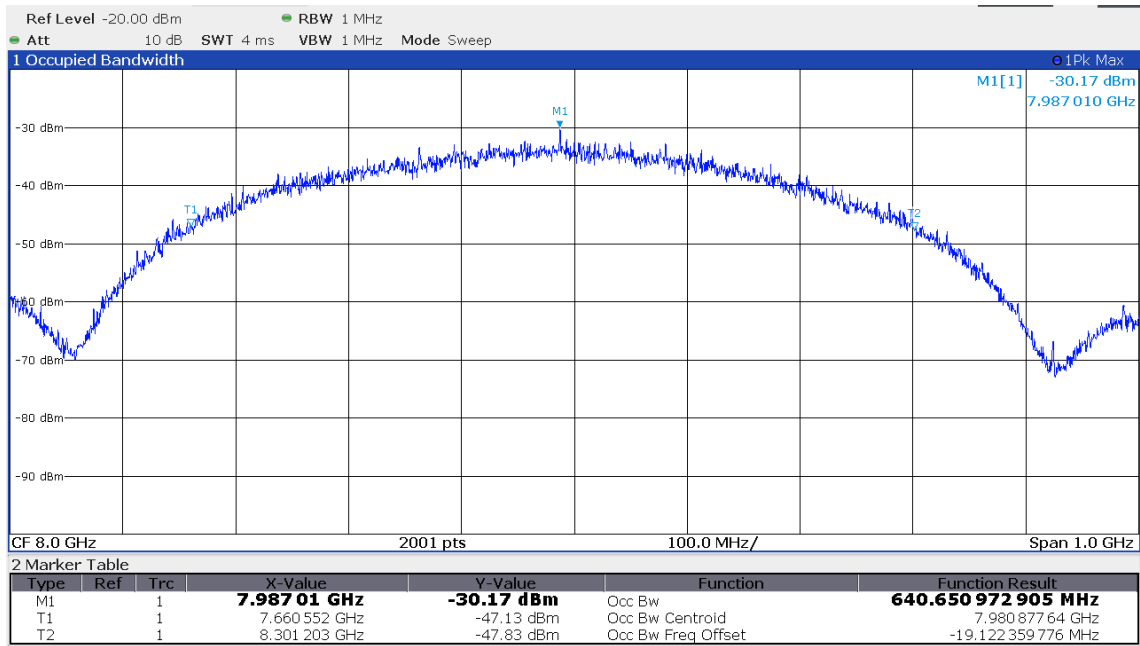
CCD frame type V_{nom}



CCD frame type $V_{\min}$



CCD frame type $V_{\max}$



CH	Frame type	V	f _c (GHz)	f _L T1 (GHz)	Lower limit (GHz)	f _H T2 (GHz)	Upper Limit (GHz)	OBW (MHz)	result
9	RAD	V _{nom}	7.9813	7.6585	7.587	8.3040	8.4	645.5	passed
		V _{min}	7.9825	7.6605		8.3045		644.0	passed
		V _{max}	7.9806	7.6589		8.3024		643.5	passed
	CCC	V _{nom}	7.9812	7.6592		8.3032		644.0	passed
		V _{min}	7.9824	7.6614		8.3034		642.0	passed
		V _{max}	7.9809	7.6606		8.3012		640.7	passed

Limit according to ARIB STD-T91, Volume 2, section 3.2:

Lower limit 7.587 GHz

Upper limit 8.4 GHz

The requirements are **FULFILLED**.

Remarks: None.

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

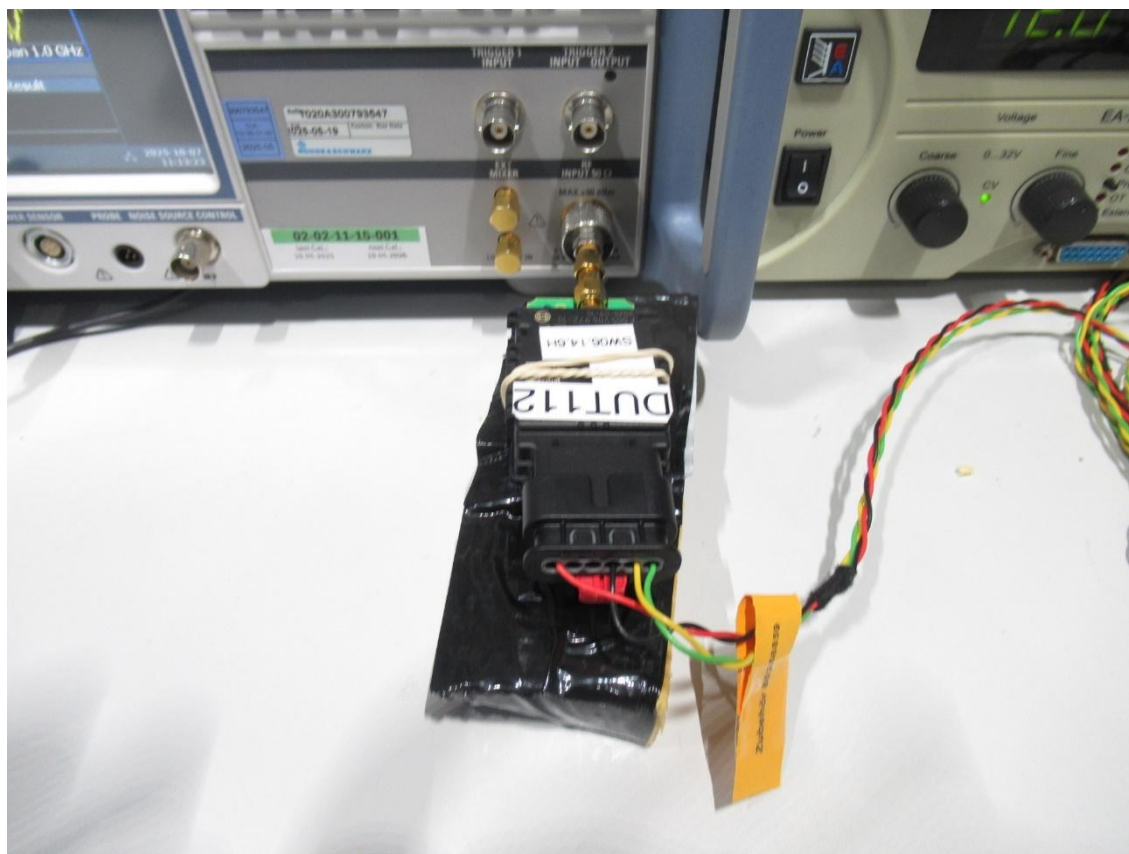
5.2 Spurious emissions conducted

For test instruments and accessories used, see section 6 Part **SEC 1-3**.

5.2.1 Description of the test location

Test location: Shielded Room SR6

5.2.2 Photo documentation of the test set-up



5.2.3 Applicable standard

The permissible values for the spurious emissions are given in the table according to ARIB STD-T91, Volume 2, section 3.2 (6).

Note: For the operating band 7.587 GHz – 8.4 GHz, the limits of the average power and peak power of ARIB STD-T91, Volume 2, section 3.2 (2) apply.

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

5.2.4 Description of Measurement

A Spectrum analyser is connected to the output of the transmitter while the EUT was in continuous transmit mode at the assigned frequency.

Analyser settings (average power):

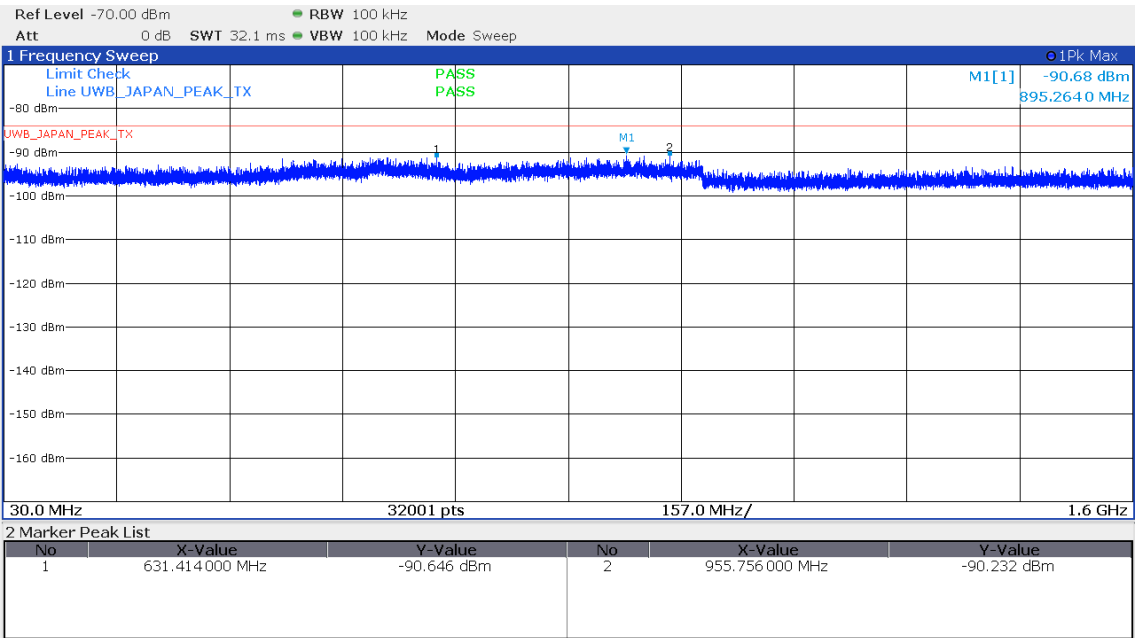
f < 1.6 GHz RBW = 1 MHz VBW = 3 MHz Detector: RMS
f > 1.6 GHz RBW = 1 MHz VBW = 3 MHz Detector: RMS

Analyser settings (peak power):

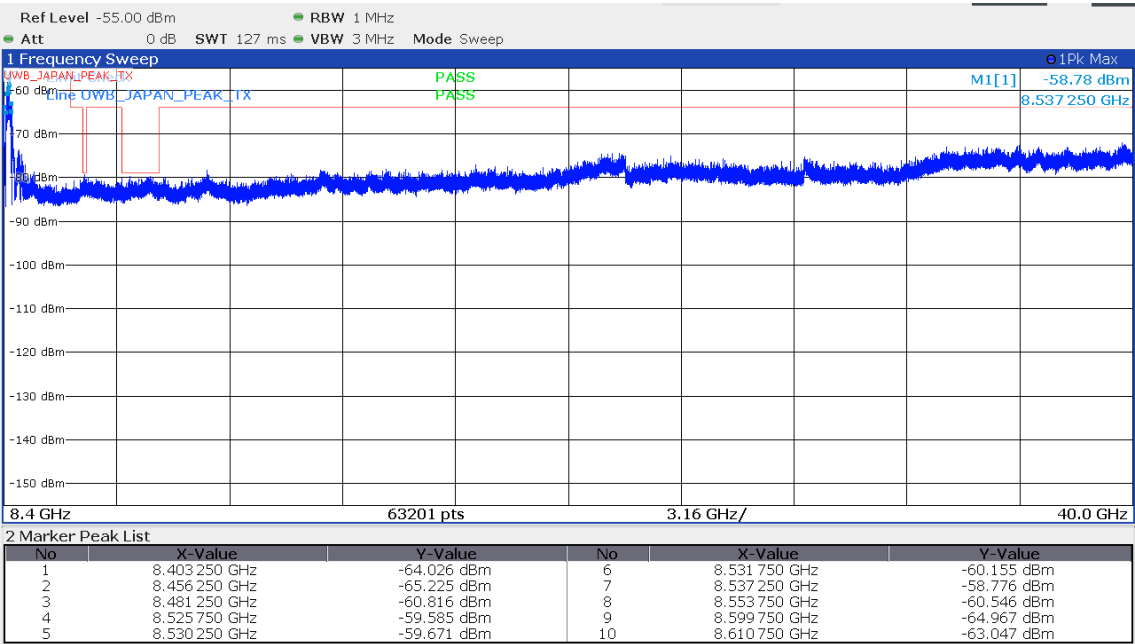
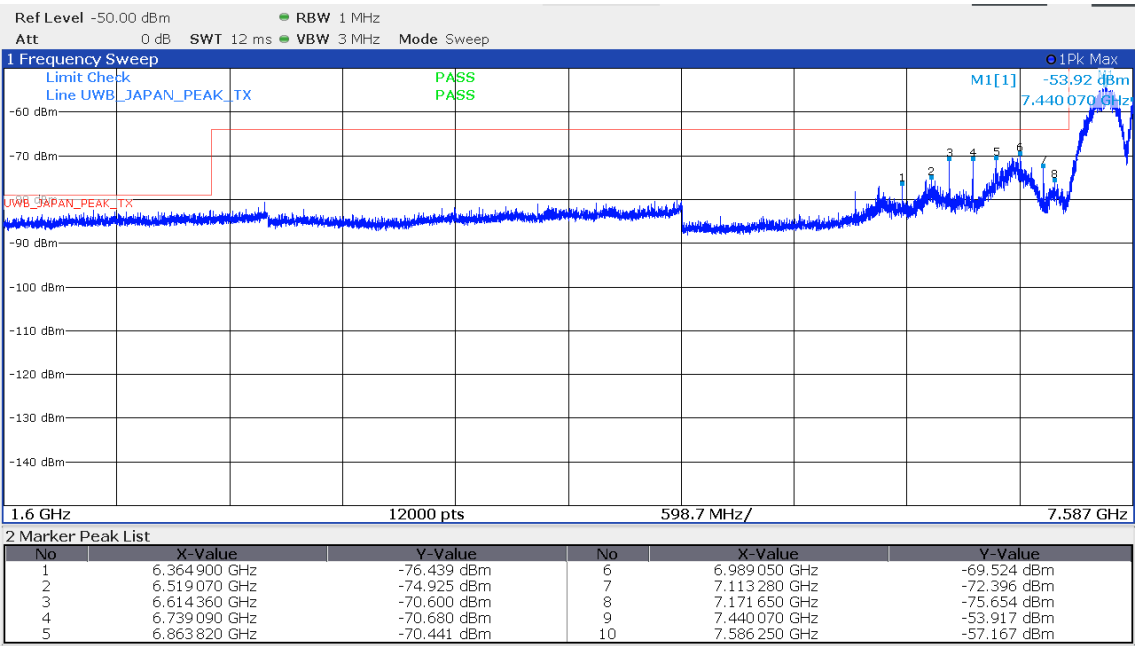
f < 1.6 GHz RBW = 100 kHz VBW = 300 kHz Detector: Peak
f > 1.6 GHz RBW = 1 MHz VBW = 3 MHz Detector: Peak

5.2.5 Test result

RAD frame type peak

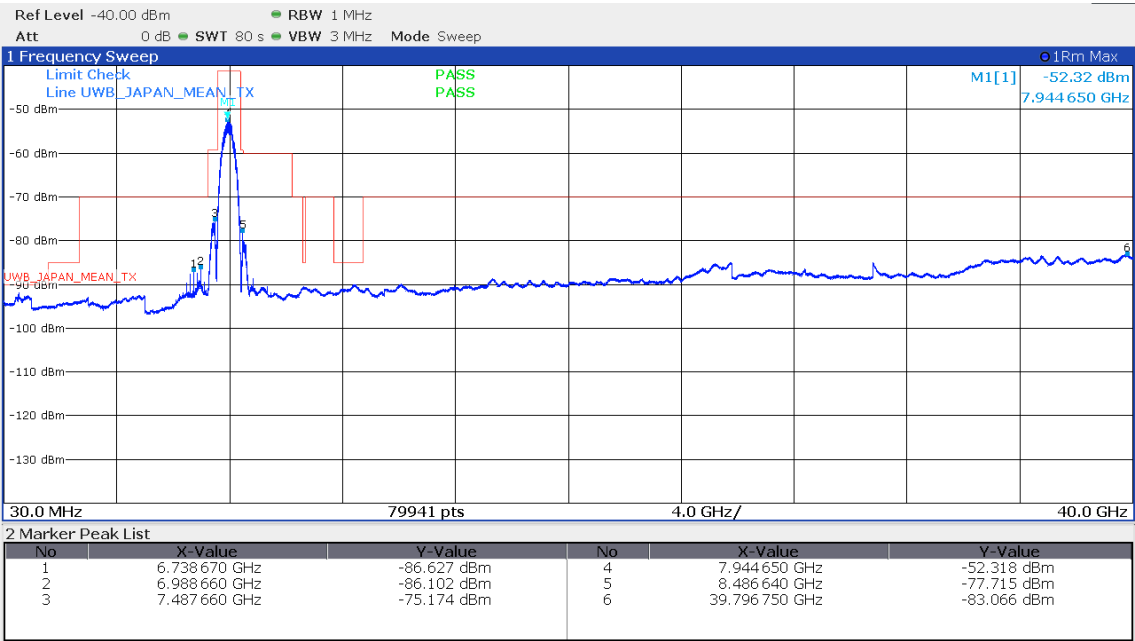


Note: RBW is reduced to increase dynamic range

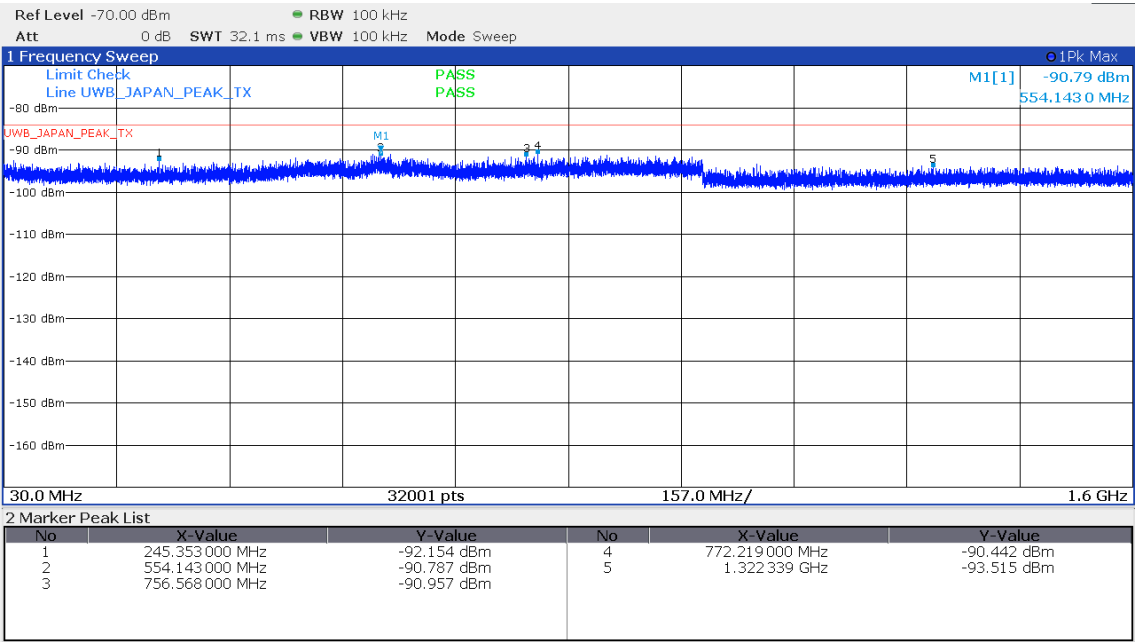


The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

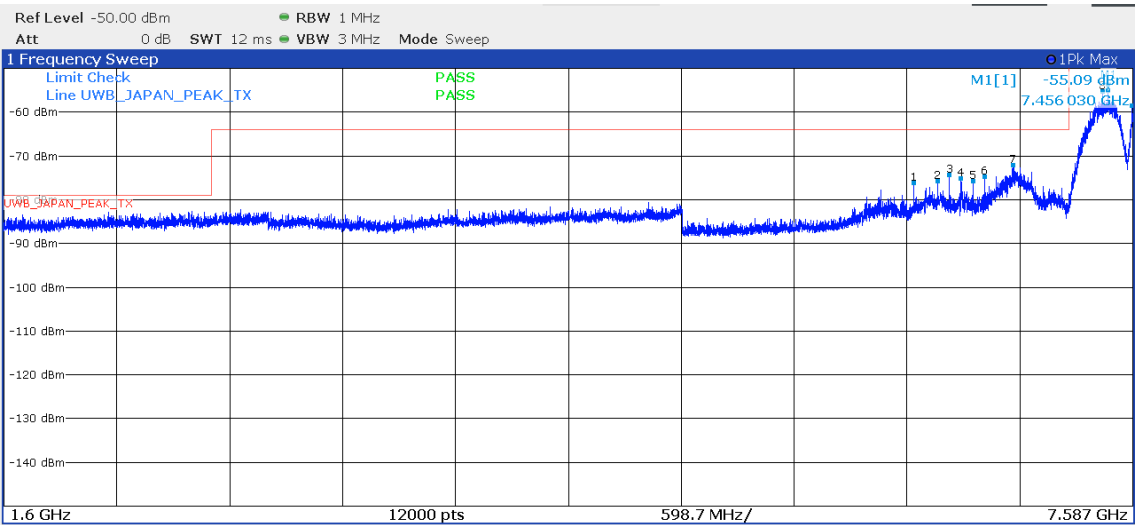
RAD frame type average



CCC frame type peak

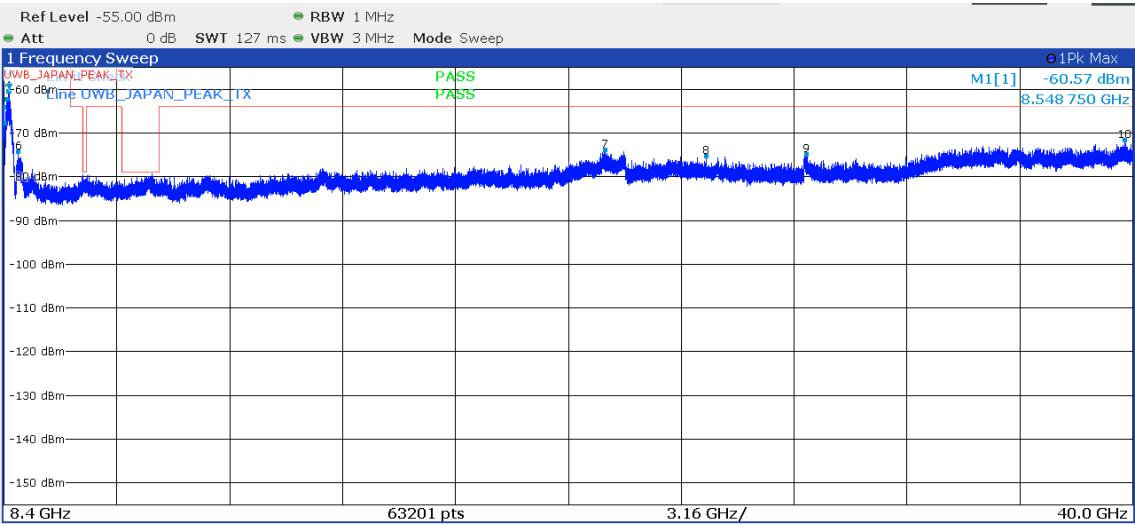


Note: RBW is reduced to increase dynamic range



2 Marker Peak List

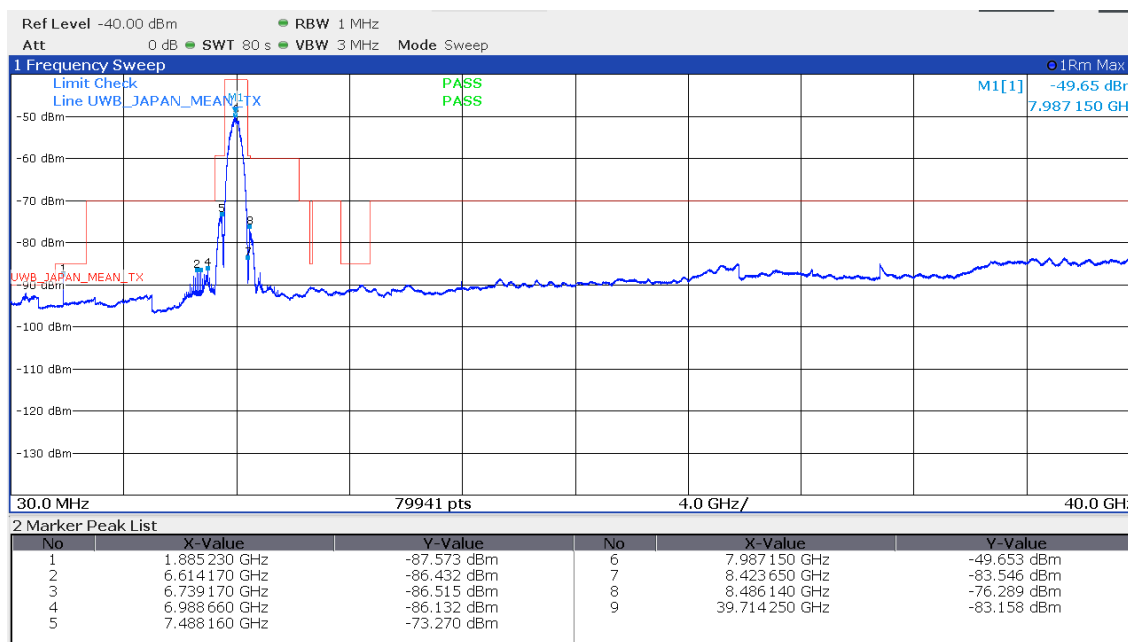
No	X-Value	Y-Value	No	X-Value	Y-Value
1	6.427 270 GHz	-76.143 dBm	6	6.801 460 GHz	-74.673 dBm
2	6.551 500 GHz	-75.717 dBm	7	6.950 130 GHz	-72.062 dBm
3	6.614 360 GHz	-74.279 dBm	8	7.425 600 GHz	-55.316 dBm
4	6.676 730 GHz	-75.055 dBm	9	7.456 030 GHz	-55.093 dBm
5	6.739 090 GHz	-75.715 dBm	10	7.581 760 GHz	-58.560 dBm



2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	8.401 750 GHz	-64.069 dBm	6	8.797 240 GHz	-74.218 dBm
2	8.424 250 GHz	-67.708 dBm	7	25.223 480 GHz	-73.826 dBm
3	8.467 250 GHz	-62.342 dBm	8	28.059 440 GHz	-75.279 dBm
4	8.518 250 GHz	-60.533 dBm	9	30.852 890 GHz	-74.938 dBm
5	8.548 750 GHz	-60.566 dBm	10	39.771 250 GHz	-71.688 dBm

CCC frame type average



Limit according to ARIB STD-T91, Volume 2, section 3.2 (6):

frequency (GHz)	limit	
	average power per 1MHz (dBm)	peak power per 1MHz (dBm)
< 1.6	-90	-84
1,6 – 2,7	-85	-79
2,7 – 7,25	-70	-64
7,25– 8.5	-59.3	-35
8.5 -10.25	-60	-35.7
10.25 -10.6	-70	-64
10.6 -10.7	-85	-79
10.7 – 11.7	-70	-64
11.7 – 12.75	-85	-79
> 12.75	-70	-64

The requirements are **FULFILLED**.

Remarks: None.

5.3 Limit on secondary radiated emissions

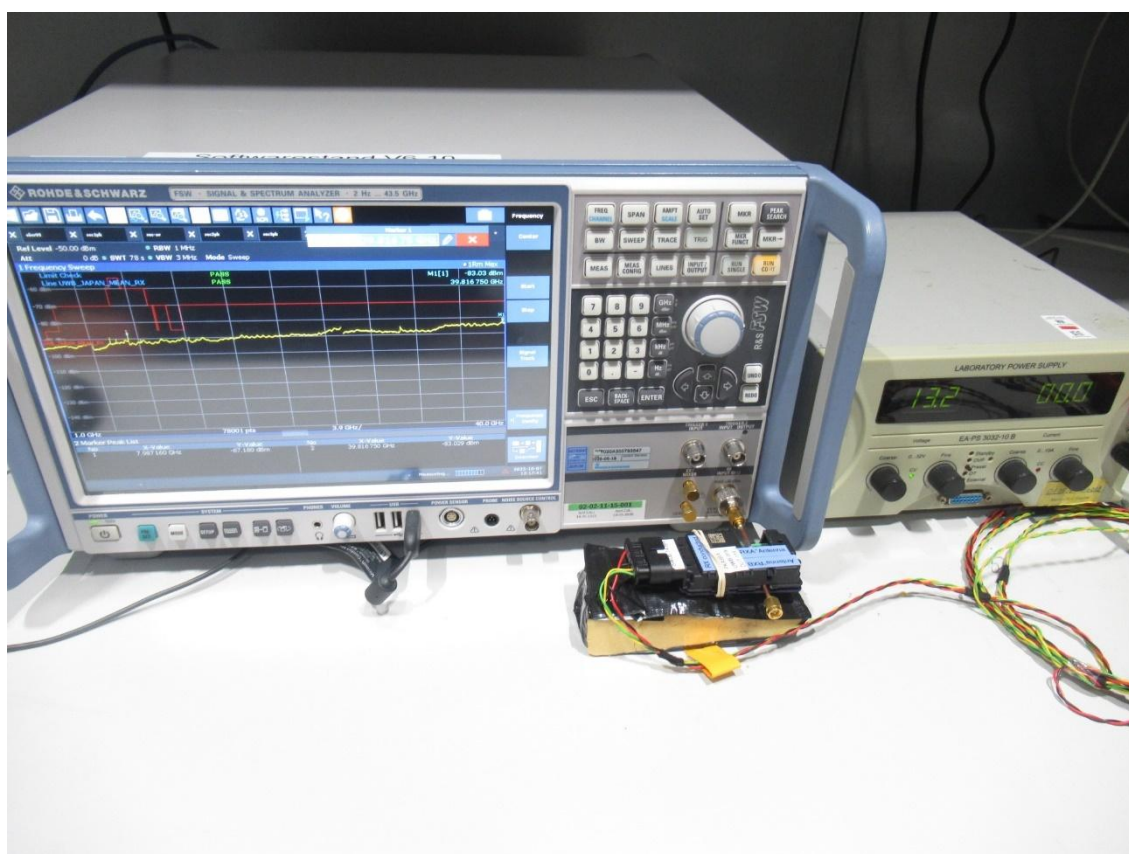
Test instruments and accessories used see section 6 Part **SEC 1-3**.

5.3.1 Description of the test location

Test location: Shielded Room SR6

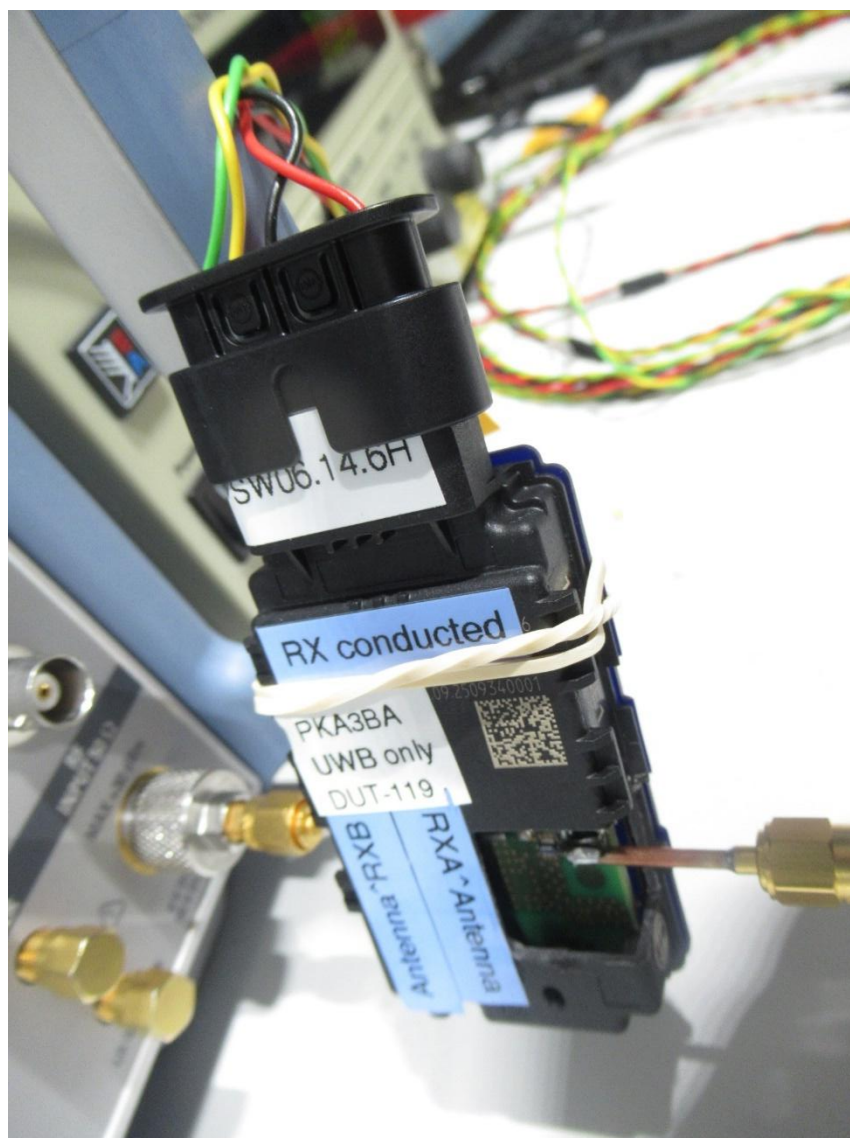
5.3.2 Photo documentation of the test set-up

Rx antenna port 1



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

Rx antenna port 2



5.3.3 Applicable standard

The permissible values for the spurious emissions are given in the table according to ARIB STD-T91, Volume 2, section 3.3.

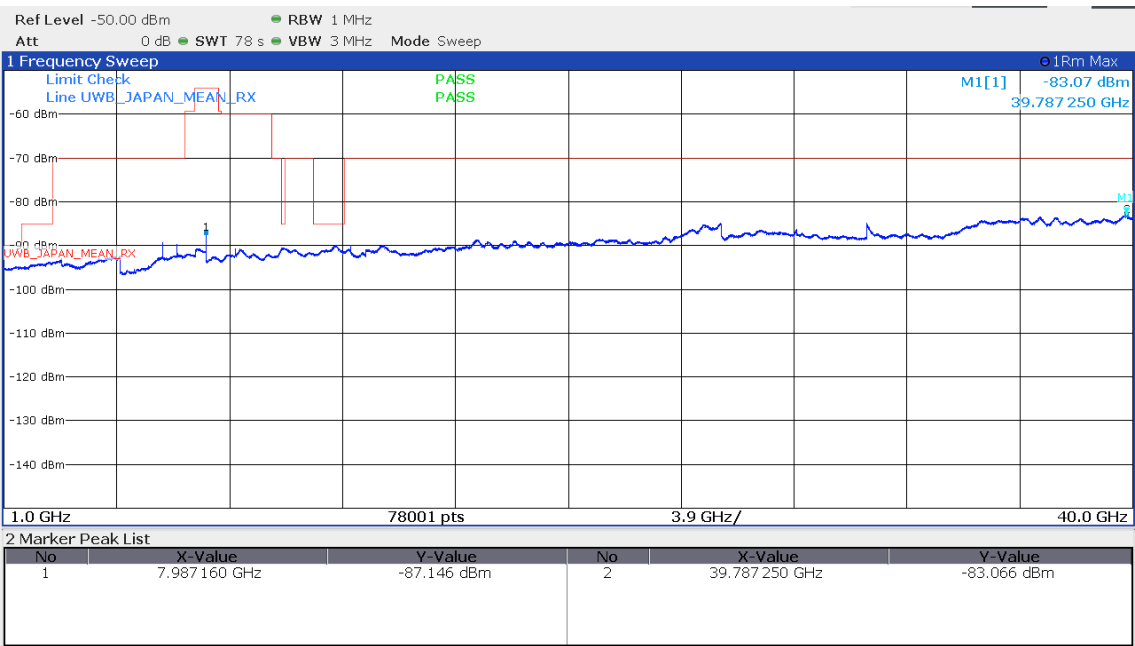
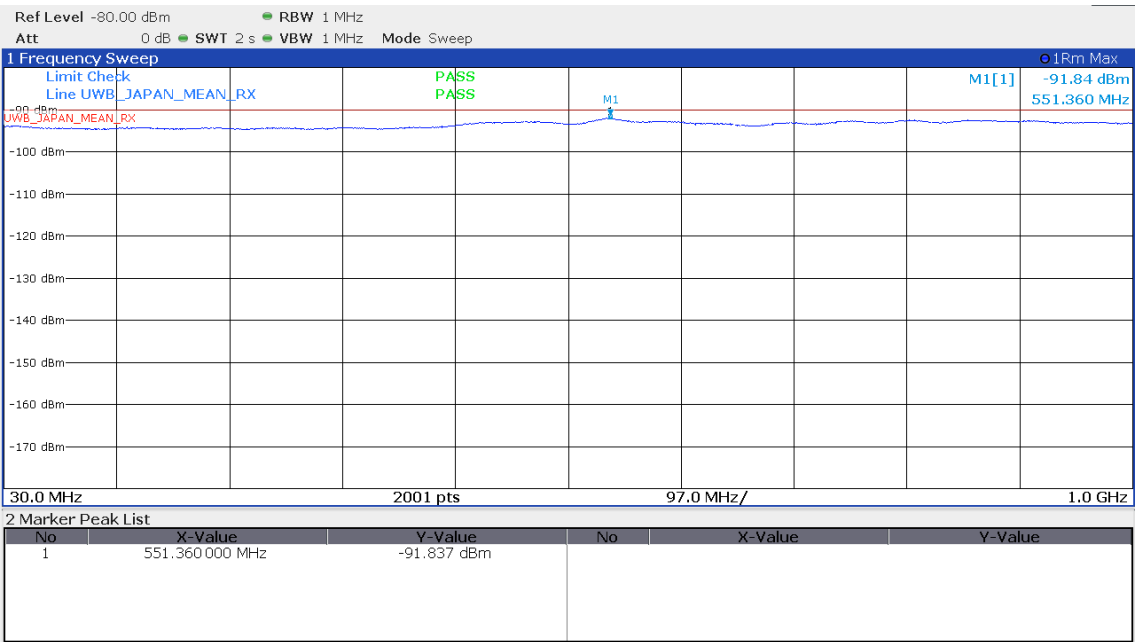
5.3.4 Description of Measurement

A Spectrum analyser is connected to the output of the transmitter while the EUT was in continuous receive mode at the assigned frequency.

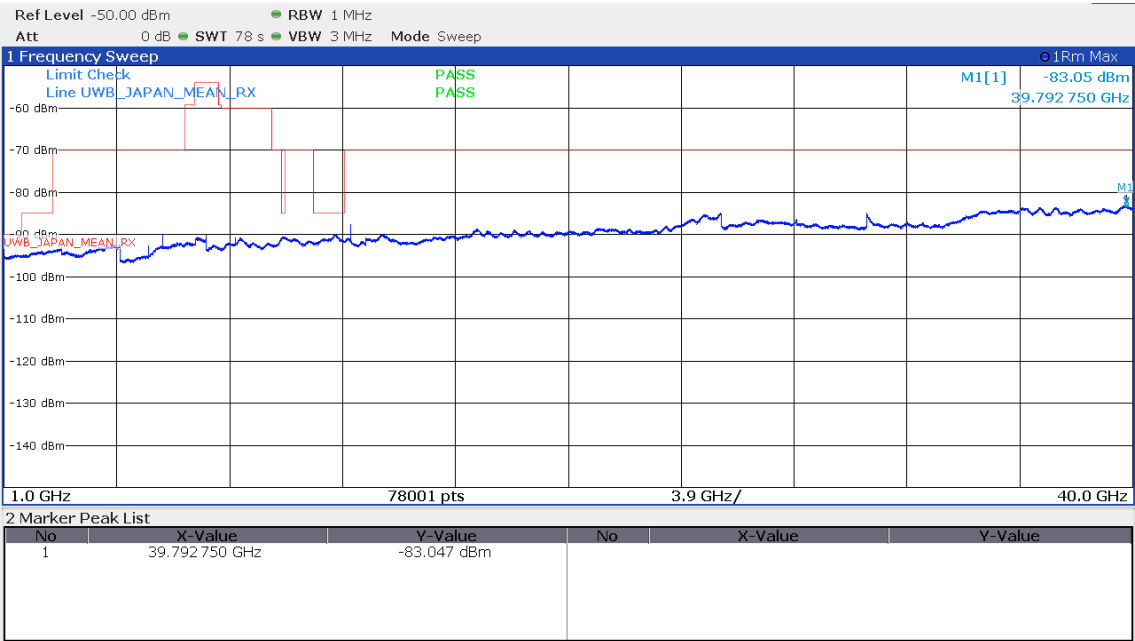
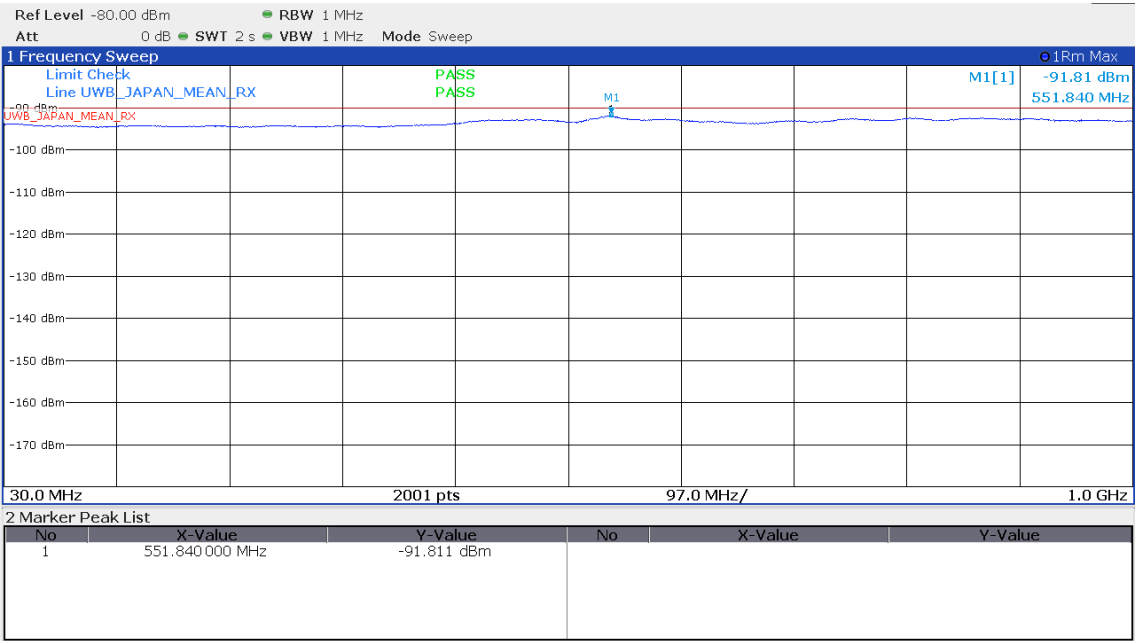
Analyser Settings RBW = 1 MHz VBW = 3 MHz Detector: RMS

5.3.5 Test result

Rx antenna port 1



Rx antenna port 2



Limit according to ARIB STD-T91, Volume 2, section 3.3:

frequency (GHz)	average power per 1MHz (dBm)
< 1.6	-90
1,6 – 2,7	-85
2,7 – 7,25	-70
7,25 – 7,587	-59,3
7,587– 8,4	-54
8,4 -8,5	-59,3
8,5 -10,25	-60
10,25 -10,6	-70
10,6 – 10,7	-85
10,7 – 11,7	-70
11,7 – 12,75	-85
> 12.75 GHz	-70

The requirements are **FULFILLED**.

Remarks: None.

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

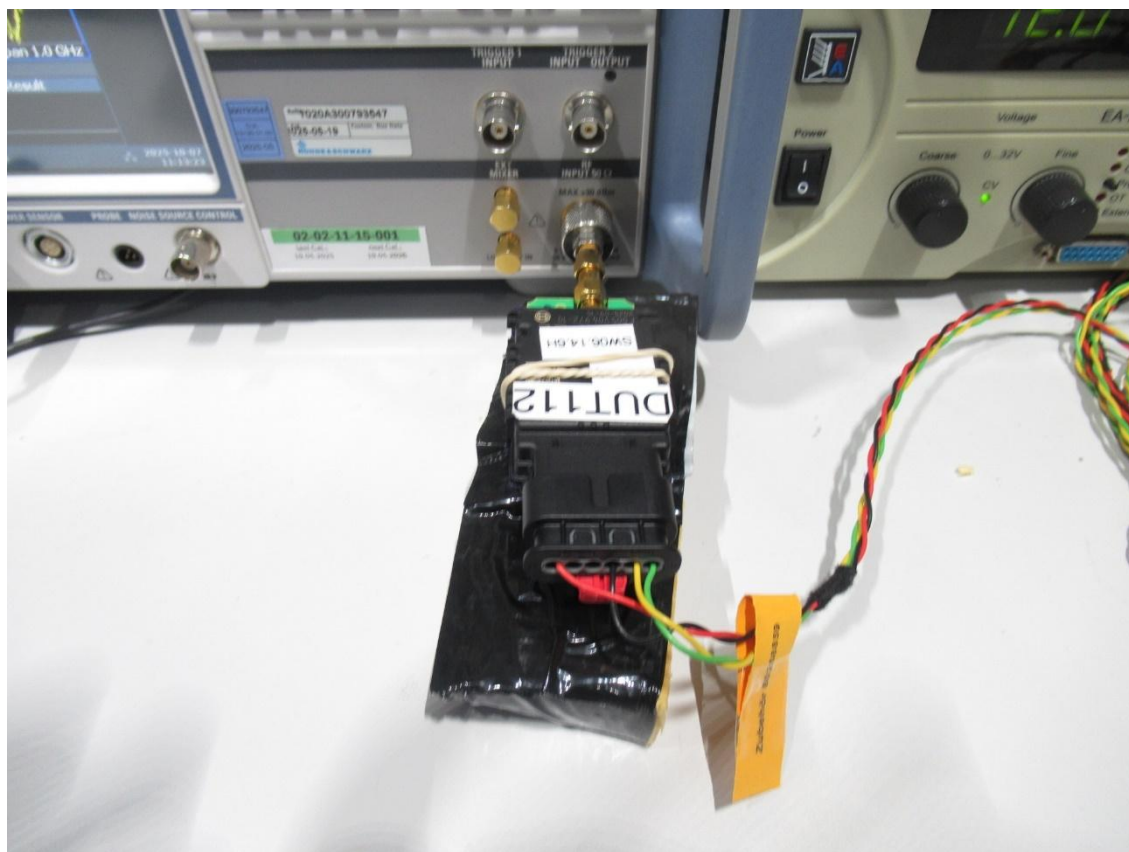
5.4 Antenna power – mean power value

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

5.4.1 Description of the test location

Test location: Shielded Room SR6

5.4.2 Photo documentation of the test set-up



5.4.3 Applicable standard

According to ARIB STD-T91, Volume 2, section 3.2 (2):

The permissible values for the average antenna power are as follows:

- ≤ -41.3 dBm/MHz in the operating frequency range
- ≤ -51.3 dBm/MHz between 7.587 GHz and 7.662 GHz

5.4.4 Description of Measurement

The transmitter output is connected to the spectrum analyser. The range of the spectrum analyser is set to the operating frequency range for searching the maximal power. In a second step the centre frequency is set to the value which is identified as maximum power level.

Analyser settings (search for maximum):

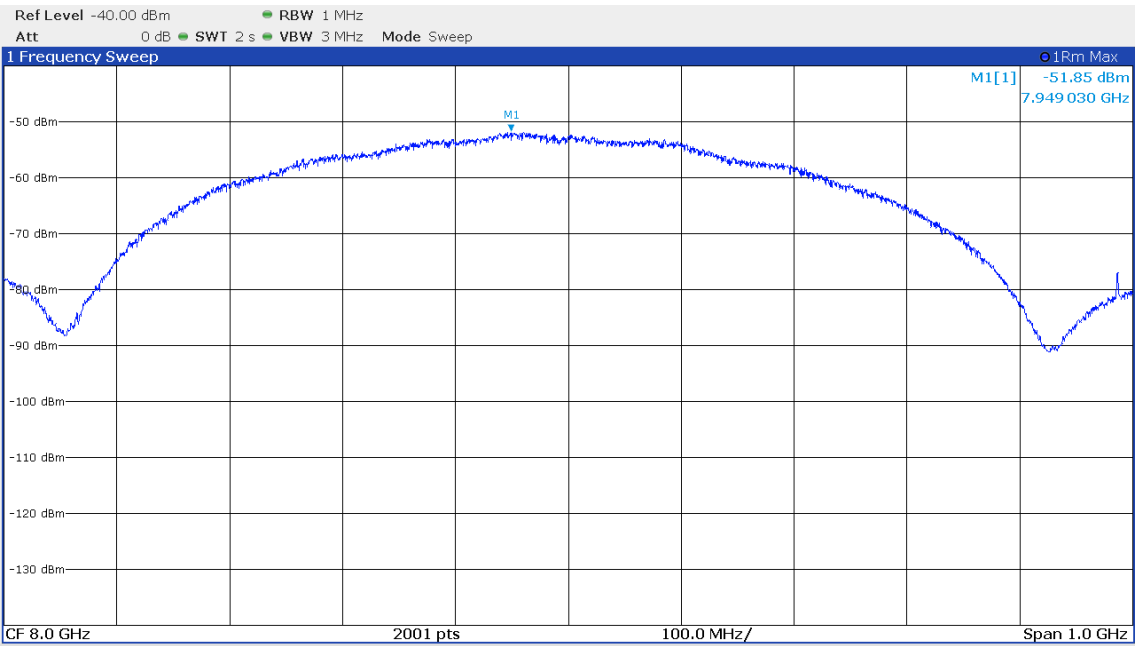
RBW: 1 MHz, VBW: 3 MHz, Detector: Peak

Analyser settings (measurement):

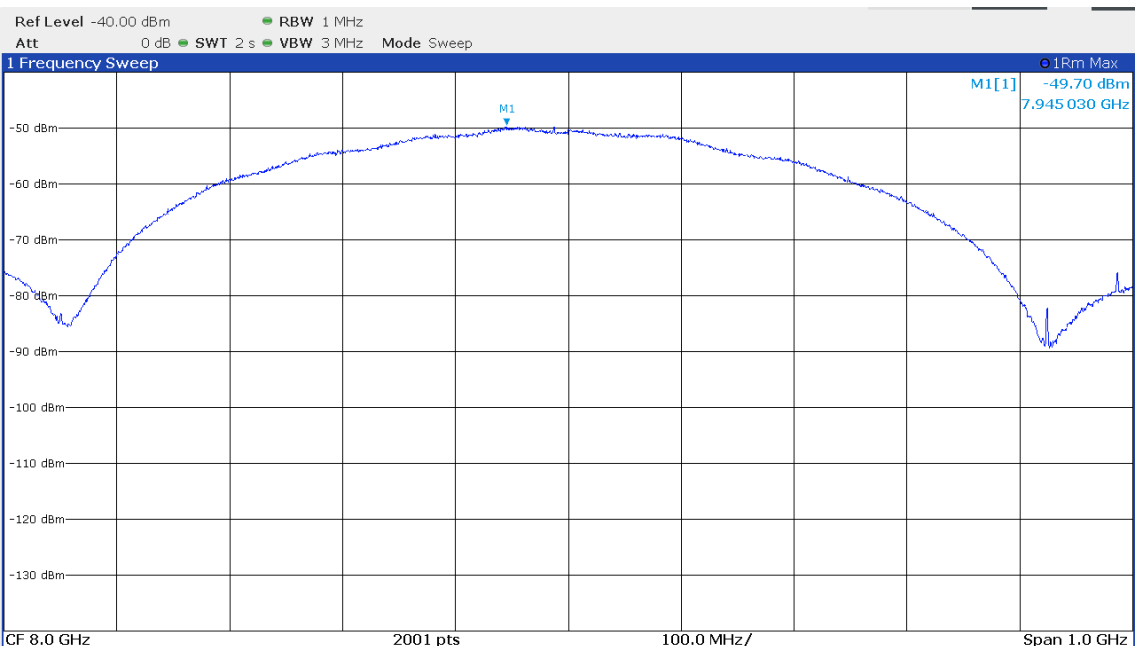
RBW: 1 MHz, VBW: 3 MHz, Detector: RMS

5.4.5 Test result

RAD frame type



CCC frame type



CH	Frame type	P cond. (dBm/MHz)	Gain dBi	EIRP (dBm/MHz)	Limit (dBm/MHz)	result
9	RAD	-51.9	0.9	-51.0	-41.3	passed
9	CCC	-49.7	0.9	-48.8	-41.3	passed

Limit according to ARIB STD-T91, Volume 2, section 3.2 (2):

operation frequency range	Limit
7.587 GHz – 8.4 GHz	≤ -41.3 dBm/MHz

The requirements are **FULFILLED**.

Remarks: None.

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

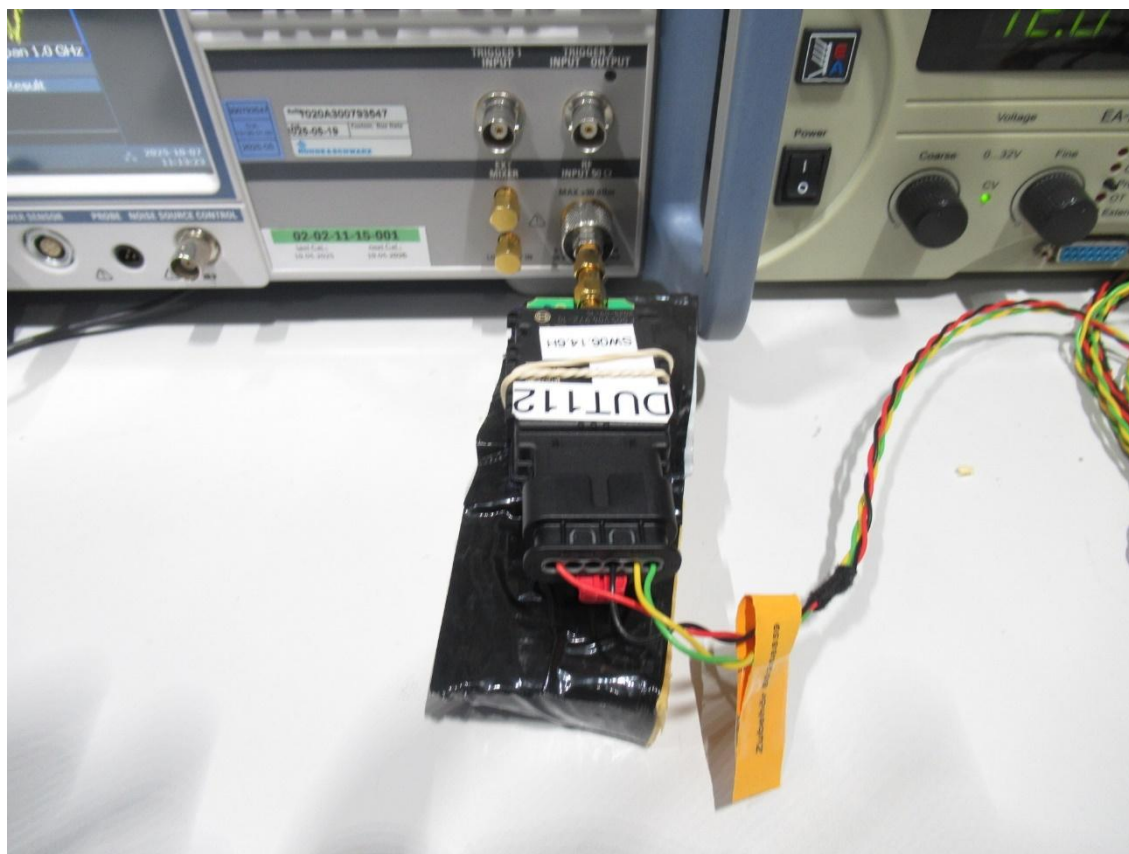
5.5 Antenna power – peak power value

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

5.5.1 Description of the test location

Test location: Shielded Room SR6

5.5.2 Photo documentation of the test set-up



5.5.3 Applicable standard

According to ARIB STD-T91, Volume 2, section 3.2 (2):

The permissible values for the peak antenna power are as follows:

- ≤ 0 dBm / 50 MHz in the operating frequency range

5.5.4 Description of Measurement

The transmitter output is connected to the spectrum analyser. The range of the spectrum analyser is set to the operating frequency range for searching the maximal power. In a second step the centre frequency is set to the value which is identified as maximum power level.

Analyser settings (search for maximum):

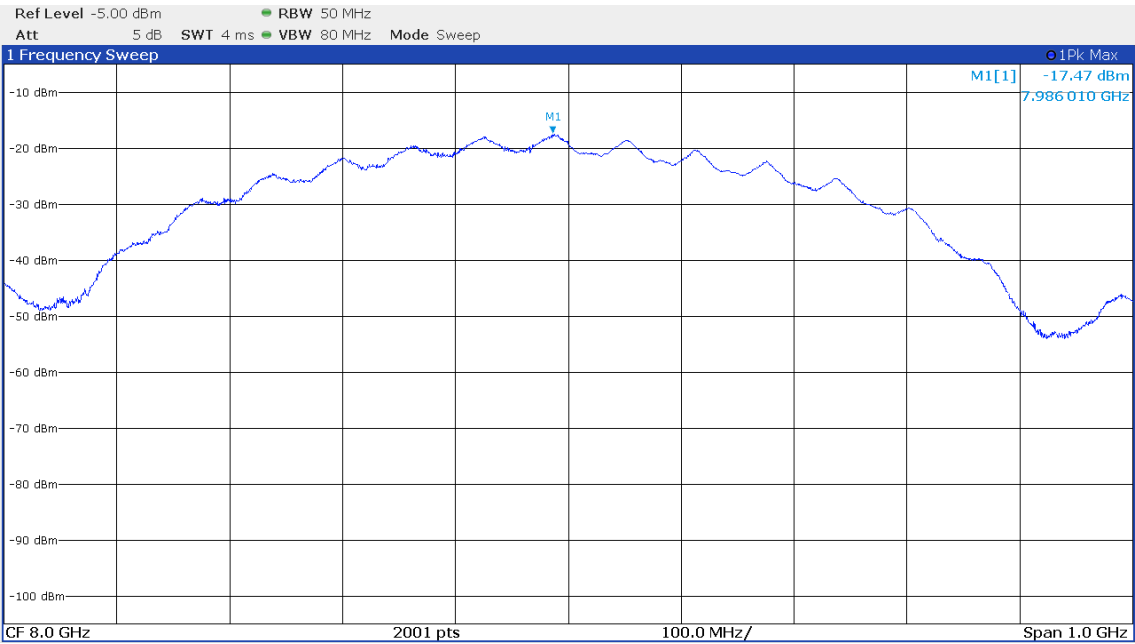
RBW: 1 MHz, VBW: 3 MHz, Detector: Peak

Analyser settings (measurement):

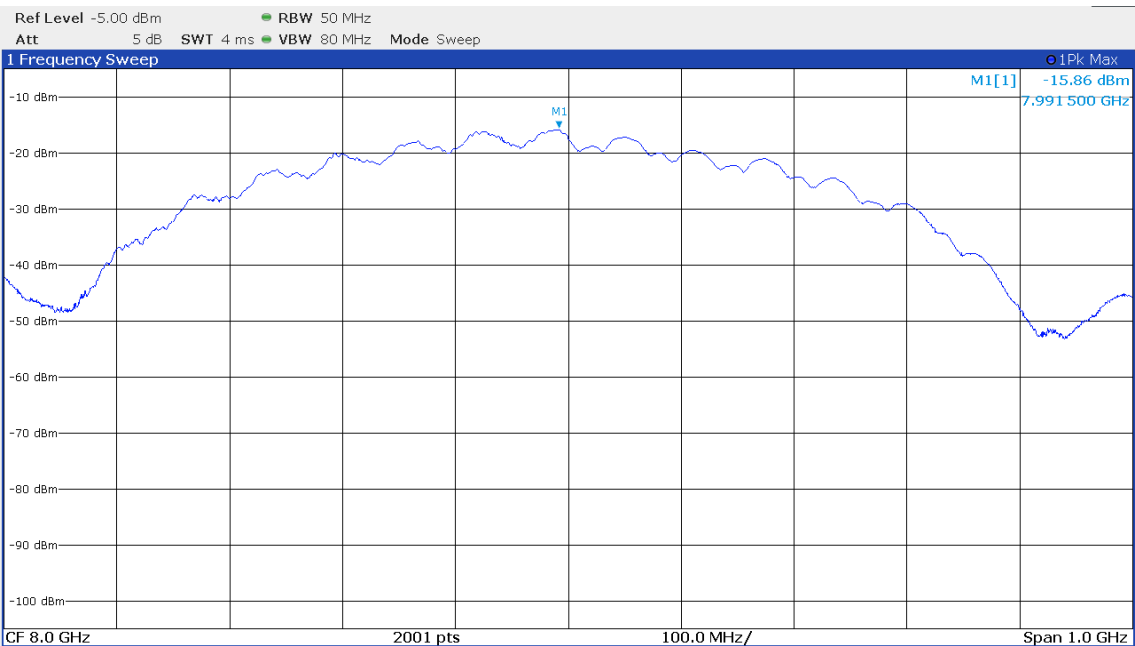
RBW: 50 MHz, VBW: 80 MHz, Detector: Peak

5.5.5 Test result

RAD frame type



CCC frame type



CH	Frame type	P cond. (dBm/50MHz)	Gain dBi	EIRP (dBm/50MHz)	Limit (dBm/50MHz)	result
9	RAD	-17.5	0.9	-16.6	0.0	passed
9	CCC	-15.9	0.9	-15.0	0.0	passed

Limit according to ARIB STD-T91, Volume 2, section 3.2 (2):

operation frequency range	Limit
7.587 GHz – 8.4 GHz	≤ 0 dBm / 50 MHz

The requirements are **FULFILLED**.

Remarks: None.

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

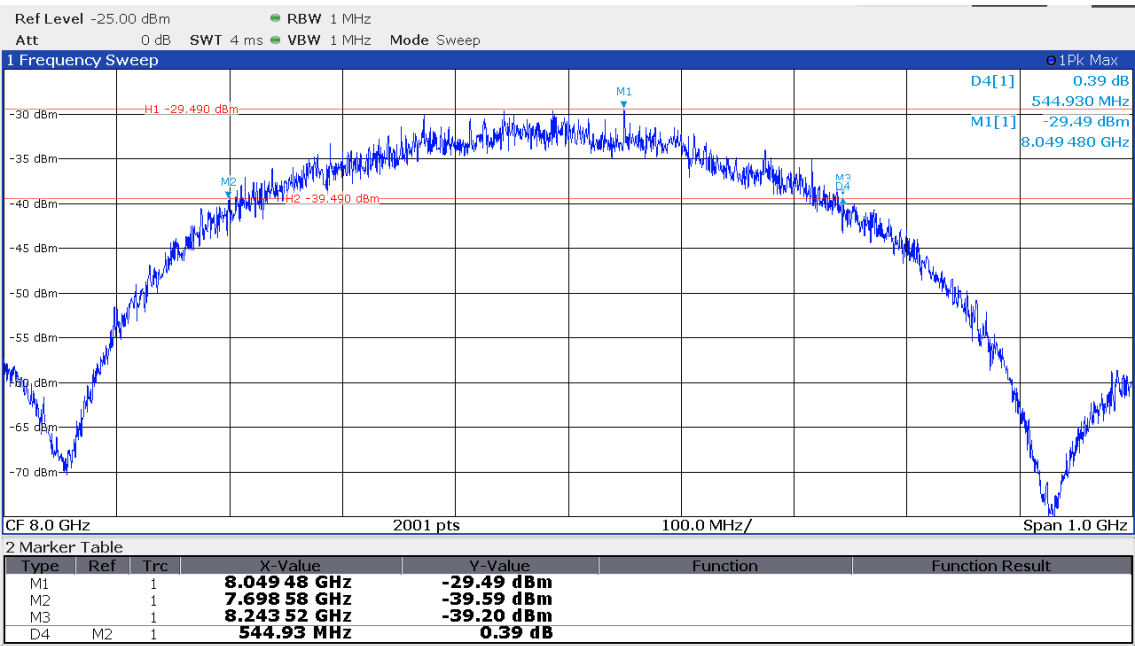
For test instruments and accessories used see section 6 Part **MB**.

Test location: Shielded Room SR6

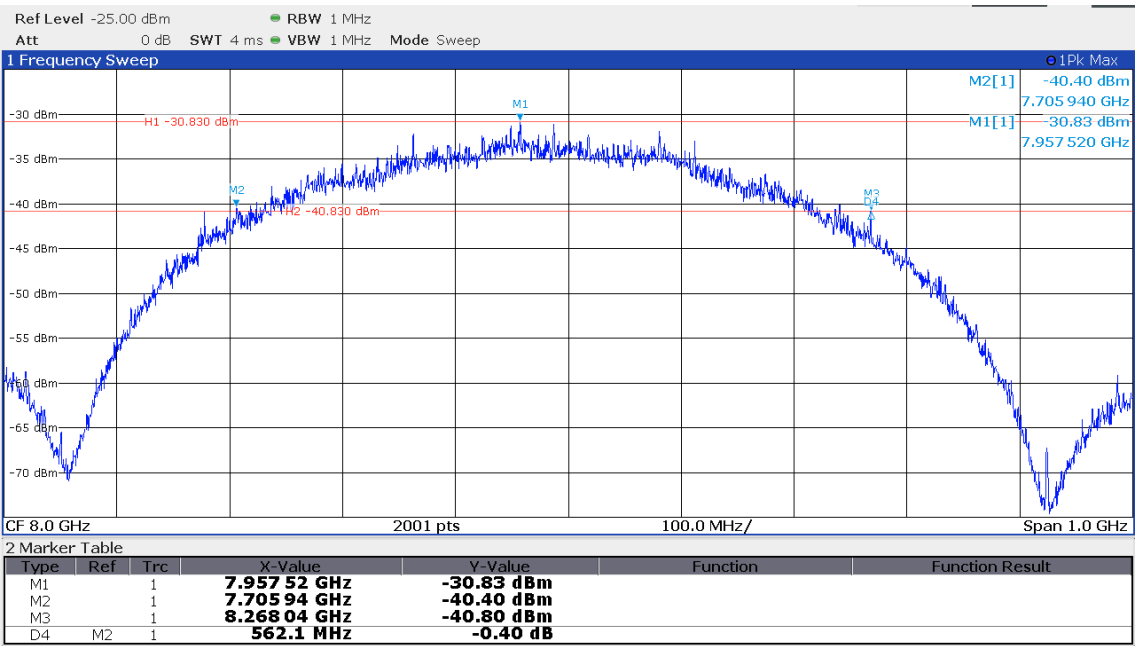
Span: 813 MHz

5.6.5 Test result

RAD frame type



CCC frame type



Frame type	f _c (GHz)	f _{lower} (GHz)	f _{upper} (GHz)	BW (MHz)	limit (MHz)	result
RAD	8.0195	7.6986	8.2435	544.9	≥ 450	passed
CCC	7.9575	7.7059	8.2680	562.1	≥ 450	passed

Limit according to ARIB STD-T91, Volume 2, section 3.2 (4):

operation frequency range	Limit
7.587 GHz – 8.4 GHz	≥ 450 MHz

The requirements are **FULFILLED**.

Remarks: None.

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

5.7 Antenna power tolerance

5.7.1 Applicable standard

According to Ordinance Regulating Radio Equipment, Chapter II, Section 1, Article 14, Item 7(5):
The tolerance for antenna power of the transmitter shall be as stipulated in the table below.

5.7.2 Calculation of the tolerance

RAD frames:

Rated mean antenna power level	$P_R =$	12.6	(nW/MHz)
Measured output power max	$P_{Max} =$	6.5	(nW/MHz)
Maximum deviation +	$P_{Max} - P_R =$	-6.1	(nW/MHz)
Maximum power tolerance +		-48.4	%

Rated peak antenna power level	$P_R =$	31.6	(μ W/50MHz)
Measured output power max	$P_{Max} =$	17.8	(μ W/50MHz)
Maximum deviation +	$P_{Max} - P_R =$	-13.8	(μ W/50MHz)
Maximum power tolerance +		-43.7	%

CCC frames:

Rated mean antenna power level	$P_R =$	22.4	(nW/MHz)
Measured output power max	$P_{Max} =$	10.7	(nW/MHz)
Maximum deviation +	$P_{Max} - P_R =$	-11.7	(nW/MHz)
Maximum power tolerance +		-52.2	%

Rated peak antenna power level	$P_R =$	31.6	(μ W/50MHz)
Measured output power max	$P_{Max} =$	25.7	(μ W/50MHz)
Maximum deviation +	$P_{Max} - P_R =$	-5.9	(μ W/50MHz)
Maximum power tolerance +		-18.7	%

Limit according to Ordinance Regulating Radio Equipment, Chapter II, Section 1, Article 14, Item 7(3):

The measured antenna power has to be up to +20 % of declared power

The requirements are **FULFILLED**.

Remarks: None.

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

6.1 Full name of calibration companies

- Rohde & Schwarz GmbH & Co. KG

6.2 Calibration information

The calibrations are conducted in foreign countries, which is equivalent to calibration conducted by the NICT or a designated calibration agency under Article 102-18-1 of the Radio Act.

6.3 Test systems

Test ID	Model Type	Kind of Equipment	Equipment No.	Next Calib.	Last Calib.	Calibrated by
CPC 3	FSW43	Spectrum Analyzer	02-02/11-15-001	19/05/2026	19/05/2025	Rohde & Schwarz
FE	FSW43	Spectrum Analyzer	02-02/11-15-001	19/05/2026	19/05/2025	Rohde & Schwarz
MB	FSW43	Spectrum Analyzer	02-02/11-15-001	19/05/2026	19/05/2025	Rohde & Schwarz
SEC 1-3	FSW43	Spectrum Analyzer	02-02/11-15-001	19/05/2026	19/05/2025	Rohde & Schwarz