

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

**Test Report acc. to FCC Title 47 CFR Part 95 M
relating to
Hexagon Geosystems Services AG, Zweigniederlassung Hexagon Mining
QR4000**

**Title 47 - Telecommunication
Part 95 - Personal Radio Services
Subpart M – The 76 – 81 GHz Band Radar Service
Measurement Procedure:
ANSI C63.26-2015**



Deutsche
Akkreditierungsstelle
D-PL-12053-01-03

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

MANUFACTURER

Manufacturer name	Hexagon Geosystems Services AG, Zweigniederlassung Hexagon Mining
Manufacturer's grantee code	---
Manufacturer's address	Baarerstr. 133, 6300, Switzerland
Phone	+41 71 727 34 29
Fax	---
Email	Daniel-peter.hess@hexagon.com

TESTING LABORATORY

Test engineer	Mr. Ralf Trepper
Testing laboratory name	TÜV NORD Hochfrequenztechnik GmbH & Co. KG
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RELEVANT STANDARD

Title	47 - Telecommunication
Part	95 – Personal Radio Services
Subpart	Subpart M – 76 – 81 GHz Band Radar Service
Measurement procedure	ANSI C63.26-2015

EQUIPMENT UNDER TEST (EUT)

Equipment category	Transport and traffic telematics
Trade name	HEXAGON
Type designation	QR4000
Serial no.	96157301764
Variants	---

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Test result summary

The following table summarizes the results for the tested EUT corresponding with the essential requirements. Full testing may not be required. If partial testing was performed, this shall be indicated in the relevant column (N.t.^x, not tested, see clause 9) of the table below.

Clause	Rule Part	Requirements headline	Test result		
7.1	§ 15.203	Antenna requirement	Pass	Fail	N.t.*
7.2	§ 15.207	Conducted Limits	Pass	Fail	N.t. ²
7.3	§95.3367	76 – 81 GHz Band Radar Service radiated power limits	Pass	Fail	N.t.*
7.4	§95.3379	Radiated emission limits, general requirements	Pass	Fail	N.t.*
7.5	§95.3379	Radiated emission limit above 40 GHz	Pass	Fail	N.t.*
7.6	§95.3379	Occupied Bandwidth	Pass	Fail	N.t.*
7.7	§95.3379	Frequency Tolerance	Pass	Fail	N.t.*
7.8	§95.3385	76 – 81 GHz Band Radar Service RF exposure evaluation	Pass	Fail	N.t.*

* As far as in this report statements on conformity are made, decision rules according to DIN EN ISO/IEC 17025:2018, 7.8.6 have been applied. For more information see clause 9.

The equipment passed all the performed tests

☒ Yes☐ No

Signature		
Name	Mr. Anup Shrestha	Mr. Ralf Trepper
Designation	RF Test engineer	Laboratory Manager
Date of issue	2024-07-31	2024-07-31

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Table of contents

1	Revision History	6
2	Introduction	7
3	Administrative Data	8
3.1	Testing laboratory	8
3.2	Applicant's details	8
3.3	Manufacturer's details	8
4	Equipment under test (EUT).....	9
4.1	EUT: short description	9
4.2	Additional Equipment: Short description	10
4.3	EUT operating mode	10
4.4	Additional declaration and description of EUT	10
4.5	Modifications	11
5	Conclusions, observations and comments	12
6	Operational description.....	13
6.1	EUT details.....	13
6.2	EUT configuration	13
6.3	EUT measurement description	13
7.1	Antenna requirement	14
7.1.1	Regulation	14
7.1.2	Result	14
7.2	Conducted limits.....	15
7.2.1	Regulation	15
7.2.2	Test procedures	15
7.2.3	Result	16
7.3	76-81 GHz Band Radar Service radiated power limits.....	17
7.3.1	Regulation	17
7.3.2	Test procedure	17
7.3.3	Test setup	17
7.3.4	Test Results	18
7.4	Radiated emission limits, general requirements	21
7.4.1	Regulation	21
7.4.2	Test procedure.....	21
7.4.3	Test setup	22
7.4.4	Calculation of the field strength	24
7.4.5	Test Results	24
7.5	Radiated emission limit above 40 GHz	45
7.5.1	Regulation	45
7.5.2	Test procedure	45
7.5.3	Equations to calculate power density	46
7.5.4	Test Results	47
7.6	Occupied Bandwidth.....	71
7.6.1	Regulation	71
7.6.2	Test procedure	71
7.6.3	Test Result	71
7.7	Frequency Tolerance.....	72
7.7.1	Regulation.....	72
7.7.2	Test Procedure	72

V. 1.24

EUT: QR4000	FCC ID: ZKS-QR4000	FCC Title 47 CFR Part 95 M	Date of issue: 2024-08-20
7.7.3	Test Setup		73
7.7.3	Test Results		74
7.8	76-81 GHz Band Radar Service RF exposure evaluation.....		79
7.8.1	Regulation		79
7.8.2	Test result		79
8.	Measurement Uncertainty		80
8.1	Decision rule		80
9.	Additional information to the test report		81
10.	List of test equipment		82
11.	Cable list		87

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

1 Revision History

Revision	Date of issue	Creator	Content of change
00	2024.07.31	A Shrestha	Initial release
01	2024-08-20	R. Trepper	Replacement of the manufacturer name

Table 0-1: Revision History

Note: If the document has been changed by revision number, all previous documents are no longer valid and must be destroyed.

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

2 Introduction

This test report **is not an expert opinion** and consists of:

- Test result summary
- List of contents
- Introduction and further information
- Equipment application data
- Detailed test information
- List of measurement equipment with calibration validity
- Photographs and further test results (plots, graphs, etc.)

The tests were carried out in a representative assembly and in accordance with the test methods and/or requirements stated in:

Item	Applied Standard
Radio test	FCC Title 47 CFR Part 95 Subpart M Section 95.3301 - 95.3385 Technical requirements for the radar systems operating in the 76 – 81 GHz band
Radio test	ANSI C63.26-2015 American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

3 Administrative Data

3.1 Testing laboratory

TÜV NORD Hochfrequenztechnik GmbH & Co. KG

LESKANPARK, Building 10

Waltherstr. 49-51

51069 Cologne

Germany

Phone: +49 221 8888 950

Accredited by:

DAkKS Deutsche Akkreditierungsstelle GmbH**DAkKS accreditation number: D-PL-12053-01**

3.2 Applicant's details

Company name	: Hexagon Geosystems Services AG, Zweigniederlassung Hexagon Mining
Address	: Baarerstr. 133
	6300
Country	: Switzerland
Contact person	: Mr. Daniel Hess
Telephone	: +41 71 727 34 29
Fax	: ---
Email	: Daniel-peter.hess@hexagon.com
Date of order	: 2024-05-13
Date of receipt	: 2024-05-14
Period of testing time	: 2024-06-06 - 2024-07-06

3.3 Manufacturer's details

Manufacturer's name	: (please see Applicant's details)
Address	: (please see Applicant's details)

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

4 Equipment under test (EUT)

4.1 EUT: short description

EUT Type designation	QR4000
Type of equipment	Transport and traffic telematics
Trademark	HEXAGON
S/N Serial no.	96157301764
A/N: Article no	961573
HW Hardware status	DRVEGRD 152
SW Software status	8

ITU emission class	FCC ID

For issuing this report, the following product documentation was used:

Description	Date	Identifications
External photographs of the Equipment Under Test (EUT)	2024-07-31	Annex no. 1
Internal photographs of the Equipment Under Test (EUT)	2024-07-31	Annex no. 2
Channel occupancy / bandwidth	2024-07-31	Annex no. 3
Label sample	2024-07-31	Annex no. 4
Functional description / User manual	2024-07-31	Annex no. 5
Test setup photos	2024-07-31	Annex no. 6
Block diagram	2024-07-31	Annex no. 7
Operational description	2024-07-31	Annex no. 8
Schematics	2024-07-31	Annex no. 9
Parts list	2024-07-31	Annex no. 10

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

4.2 Additional Equipment: Short description

Additional Equipment	Type
Hexagon Smart Switch	QX4200, S/N:97586800677

4.3 EUT operating mode

EUT operating mode no.	Description of operating modes	Additional information
OP 1	Continuous FMCW signal	---

4.4 Additional declaration and description of EUT(Application's declaration: ☐= not selected, ☒= selected)

EUT	☐ tabletop unit ☐ floor-standing ☐ wall-mounted ☐ base station ☐ built in ☐ mobile ☒ vehicular mounted	Typical use ☐ fixed use ☐ portable use ☒ vehicular use	
Operating frequency bands over which the equipment is intended to operate	76 GHz – 77 GHz		
Generated or used frequencies	76.125 GHz, 76.365 GHz, 76.605 GHz, 76.845 GHz (carrier frequencies) 40 MHz, 25 MHz (crystal frequencies)		
Power line			
☐ AC	☐ L1, ☐ L2, ☐ L3, ☐ N, ☐ PE	<u>--- V/ AC</u> ☐ 50 Hz ☐ 60 Hz	
☒ DC	<u>12V DC / 24 V/ DC</u>		
EUT grounding: ☒ none ☐ with power supply ☐ additional			
Ports			
Port type	Function	Shielding	Total cable length used during the test
DC Input	QX4200 Power supply	☒ screened ☐ unscreened	0.8 m
ETH1-T1	Power supply and data communication	☒ screened ☐ unscreened	0.8 m
ETH2	Data communication	☒ screened ☐ unscreened	2.0 m

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

4.5 Modifications

Modification	☐ applicable	☒ not applicable
1	---	
2	---	

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

5 Conclusions, observations and comments

The results of the tests as stated in this report are exclusively applicable to the EUT as identified in this report. TÜV NORD Hochfrequenztechnik GmbH & Co. KG cannot be held liable for properties of the EUT that have not been observed during these tests.

TÜV NORD Hochfrequenztechnik GmbH & Co. KG assumes the sample to comply with the requirements of FCC Title 47 CFR Part 15, for the respective test sector, if the test results turn out positive.

Comments: ---

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

6 Operational description

6.1 EUT details

The EUT is a 4D-Radar module that comprises a radar sensor and its housing cover. The housing cover includes a back plate attached with mounting brackets and a cable. The radar sensor sends a relative coordinate of obstacles as data points over its automotive ethernet interface. The 4D-Radar is a rugged, industrial solution offering improved mechanical robustness and adapted mounting options.

6.2 EUT configuration

After powering up with a nominal voltage of 24V DC, the EUT starts to function. The EUT is initialized in less than 4 seconds. After the EUT is powered up and initialized, the visualization of sensor data (target lists, object list, cycle time, etc.) is possible using the Driver Recorder software. It also provides data logging, associated video documentation, play back and analysis functions.

6.3 EUT measurement description

Radiated measurements

The EUT was tested in a typical fashion. During preliminary emission tests, the EUT was operated in the continuous measuring mode for worst-case emission mode investigation. Therefore, the final qualification testing was completed with the EUT operated in continuous measuring mode. All tests were performed with the EUT's typical voltage: 24.0 V DC.

To establish the maximum radiation, firstly, there have been viewed all orthogonal adjustments of the test samples, secondly the test sample have been rotated at all adjustments around the own axis between 0° and 360°, and thirdly, the antenna polarization between horizontal and vertical had been varied.

Radiated measurements from 9 kHz – 30 MHz, 30MHz – 1 GHz and above 1 GHz were performed using a small loop antenna, Linear polarized Logarithmic Periodic Broadband Antenna, stacked Logarithmic-Periodic Broadband Antenna for linear polarized and horn antennas respectively with a measuring distance of 3 m inside SAC.

Radiated measurements above 1 GHz is made by placing loose-laid RF absorber material on the ground plane.

Additionally, radiated emission measurements above 1 GHz are made using calibrated linearly polarized antennas, which may have a smaller beam width (main lobe) than do the antennas used for frequencies below 1 GHz. The measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal.

Environmental Conditions during the tests

Temperature: 24 – 28°C // Relative Humidity: 26 – 43 % // Air Pressure: 993 – 1011 hPa

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.1 Antenna requirement

7.1.1 Regulation

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

7.1.2 Result

Antenna Type	Antenna description	Frequency	Gain dBi	Number of Antennas
Integrated Tx antenna	Patch array antenna	76 GHz – 77 GHz	17.5	6
Integrated Rx antenna	Patch array antenna	76 GHz – 77 GHz	---	8

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
Test setup photos / test results are attached	☒ Yes	☐ No	Annexe no.: 2

7.2 Conducted limits

7.2.1 Regulation

According to FCC §15.207 (a), except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Conducted Limits		
Frequency of Emission	Quasi-Peak (QP)	Average (AV)
MHz	dB μ V	dB μ V
0.15 - 0.5	66 to 56*	56 to 46*
0.5 - 5	56	46
5 -30	60	50
*Decreases with the logarithm of the frequency		

(b) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

1) For carrier current system containing their fundamental emission within the frequency band 535–1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.

(2) For all other carrier current systems: 1000 μ V within the frequency band 535–1705 kHz, as measured using a 50 μ H/50 ohms LISN.

(3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits in §15.205, §15.209, §15.221, §15.223, or §15.227, as appropriate.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

7.2.2 Test procedures

The EUT and the additional equipment (if required) are connected to the main power through a line impedance stabilization network (LISN). The LISN must be appropriate to ANSI C63.10-2013.

Additional equipment must also be connected to a second LISN with the same specifications described in the above section (if required).

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.2.3 Result

Test location and equipment

Test site	EMV Laboratory TÜV NORD Hochfrequenztechnik				
Receiver	☐ 665				
Additional equipment	☐ 272	☐ 60	☐ 71a	☐ 551	☐ 672
Cable	☐ KISN2				

Environmental conditions

Environmental conditions	Temperature [°C]	Air pressure [hPa]	Rel. humidity [%]

Measurement results

Conducted emissions - Tested with external AC PoE power supply

Measurement uncertainty $< \pm 2$ dB

****The average limit is not met when using a quasi-peak detector, therefore measurement with the average detector is unnecessary.**

The equipment passed the performed tests ☐ Yes ☐ No ☒ N.t.²

Test setup photos / test results are attached ☐ Yes ☒ No

7.3 76-81 GHz Band Radar Service radiated power limits

7.3.1 Regulation

According to FCC §95.3367, the fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:

(a) The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).

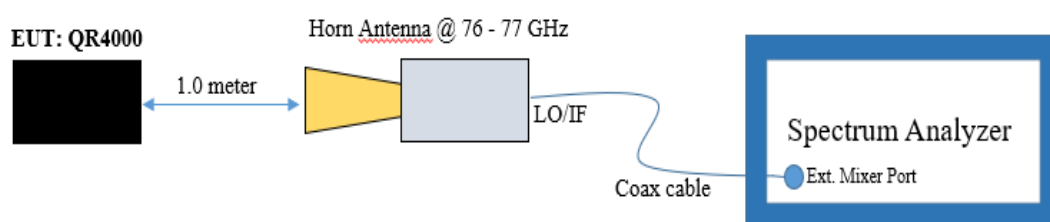
(b) The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

7.3.2 Test procedure

Maximum measurement distance for the final radiated measurements above 40 GHz was determined according to ANSI C63.10-2013 section 9.8. To achieve maximum level of emission, maximizing procedure was applied according to ANSI C63.10-2013 section 9.8 where initially an exploratory search for emissions was carried out to determine the approximate direction at which each observed emission emanates from the EUT. Secondly, for each emission observed a final measurement was executed to find the final position, polarization, and orientation at which the maximum level of emission was observed. Measurement of the fundamental emission was done using a spectrum analyser according to the procedure ANSI C63.10-2013 section 9.10.

7.3.3 Test setup

Radiated measurements setup (Radiated output power)



EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.3.4 Test Results

Waveforms	Transmitter fundamental radiation (§95.3367) #Peak Power#				
	Centre Freq. GHz	Detector	EIRP Peak Power dBm	EIRP Limit dBm	Margin dB
Waveform 0	CF0 @ 76.365	PK	34.9 @ 76.402 GHz	55.0	20.1
	CF1 @ 76.605	PK	33.9 @ 76.642 GHz	55.0	21.1
Waveform 1	CF0 @ 76.125	PK	37.3 @ 76.057 GHz	55.0	17.7
	CF3 @ 76.845	PK	34.9 @ 76.950 GHz	55.0	20.1
Measurement uncertainty: 60 GHz to 90 GHz: ± 6 dB					

Waveforms	Transmitter fundamental radiation (§95.3367) #Average Power#				
	Centre Freq. GHz	Detector	EIRP Average Power dBm	EIRP Limit dBm	Margin dB
Waveform 0	CF0 @ 76.365	AV	25.7 @ 76.415 GHz	50.0	24.3
	CF1 @ 76.605	AV	24.5 @ 76.659 GHz	50.0	25.5
Waveform 1	CF0 @ 76.125	AV	26.8 @ 76.145 GHz	50.0	23.2
	CF3 @ 76.845	AV	23.9 @ 76.864 GHz	50.0	26.1
Measurement uncertainty: 60 GHz to 90 GHz: ± 6 dB					

Test location and equipment

Test site	☐ 660 Semi Anechoic Chamber ☒ Radio laboratory			
Receiver	☐ 665	☐ 696	☒ 666	
Test equipment	☒ 562	☒ 28a	☒ 674	☒ 385
Cable	☒ K163			

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
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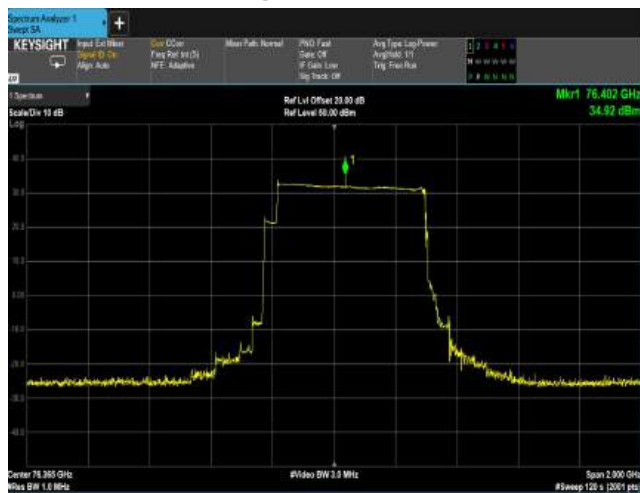
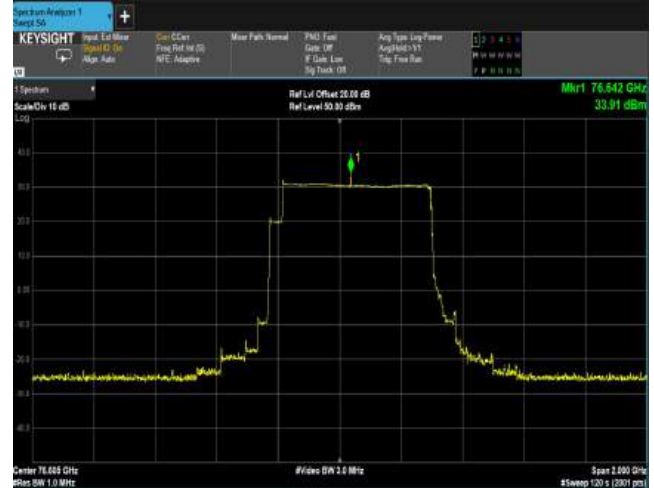
Test setup photos	☒ Yes	☐ No	Annex no. 6
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EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

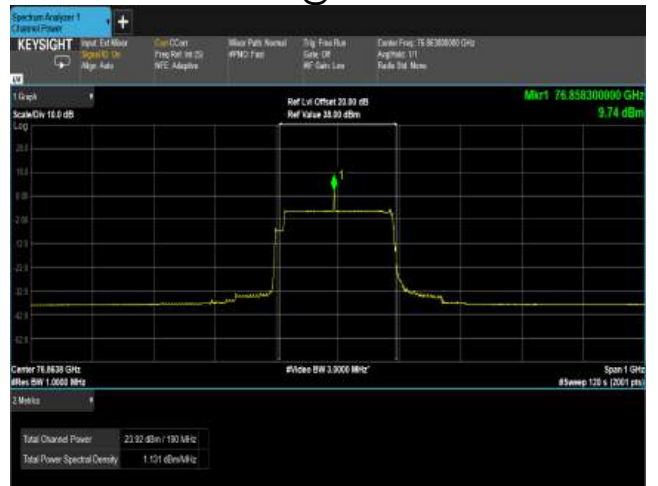
Measurement plots (Peak Power)**WF0 @ 76.365 GHz****WF0 @ 76.605 GHz****WF1 @ 76.125 GHz****WF1 @ 76.845 GHz**

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Measurement plots (Average Power)**WF0 @ 76.365 GHz****WF0 @ 76.605 GHz****WF1 @ 76.125 GHz****WF1 @ 76.845 GHz**

7.4 Radiated emission limits, general requirements

7.4.1 Regulation

According to FCC §95.3379 (a), the power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table.

Intentional radiator- radiated emission limits		
Frequency	Field Strength	Measurement distance
MHz	$\mu\text{V} / \text{m}$	m
0.009-0.490	$2400/F(\text{kHz})$	300
0.490-1.705	$24000/F(\text{kHz})$	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
above 960	500	3

(i) In the emissions table in paragraph (a) (1) of this section, the tighter limit applies at the band edges.

(ii) The limits in the table in paragraph (a) (1) of this section are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(iii) The emissions limits shown in the table in paragraph (a)(1) of this section are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW.

7.4.2 Test procedure

The measurement of harmonic and spurious emissions at or below 40 GHz was performed in accordance with the standard test methods ANSI C63.10-2013 section 6.3 – 6.6 and section 9.13. The measurement above 40 GHz was carried out in accordance with the test procedure ANSI C63.10-2013 section 9.12. The measurements were done using a quasi-peak detector. For the frequencies above 1 GHz, all the radiated emission measurements were carried out using an average detector.

EUT: QR4000

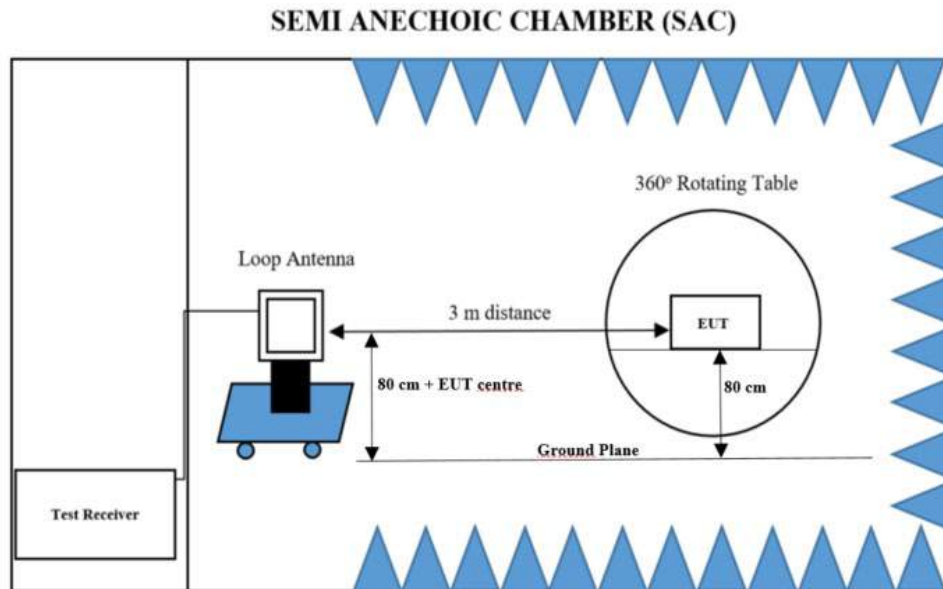
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

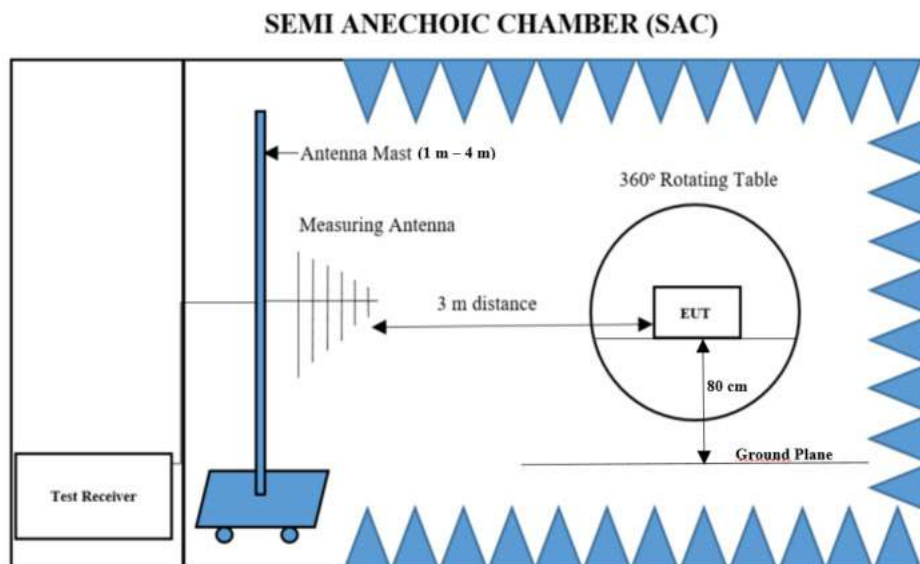
Date of issue: 2024-08-20

7.4.3 Test setup

Radiated measurements setup (9 kHz – 30 MHz)



Radiated measurements setup (30 MHz – 1 GHz)

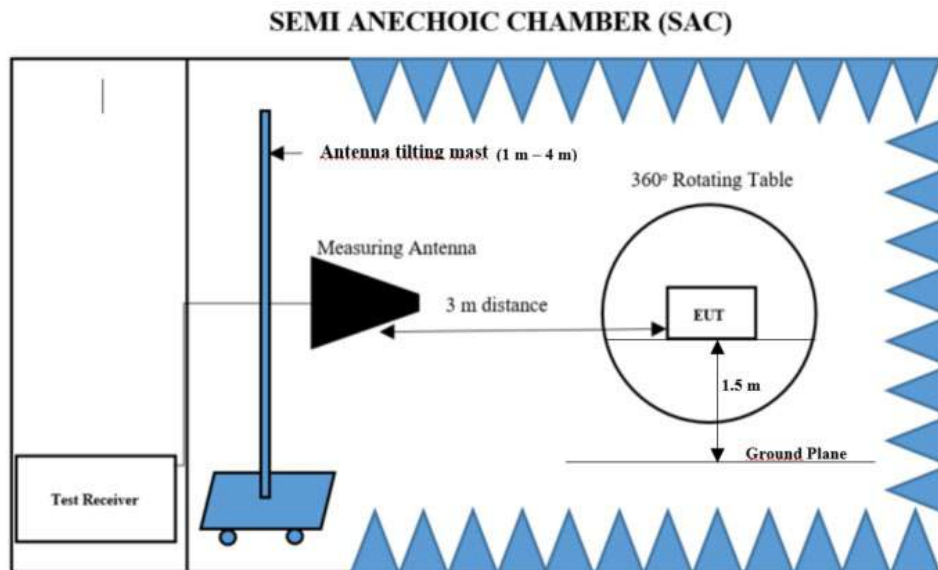


EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Radiated measurements setup (1 GHz – 40 GHz)

Radiated measurements from 9 kHz – 30 MHz, 30 MHz – 1 GHz, 1 GHz – 18 GHz and 18 GHz – 40 GHz were performed using a small loop antenna, Linear polarized Logarithmic Periodic Broadband Antenna, stacked Logarithmic-Periodic Broadband Antenna for linear polarized and horn antenna respectively with a measuring distance of 3 m inside SAC as shown in the above test setup diagrams. Above 40 GHz, the measuring antenna is scanned around the entire perimeter of the EUT in both horizontal and vertical polarization, at the distance of 3.0 m from 40 GHz – 50 GHz, 1.0 m from 50 GHz – 75 GHz, 0.5 m from 75 GHz – 231 GHz.

The measurement procedure for harmonics and spurious emissions at or below 40 GHz is taken from ANSI C63.10-2013.

Radiated emissions test characteristics	
Frequency range	30 MHz - 40,000 MHz
Test distance	3 m*
Test instrumentation resolution bandwidth	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (1000 MHz - 40,000 MHz)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

*According to Section 15.31 (f) (1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.4.4 Calculation of the field strength

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor (without the use of a pre-amplifier)

Corrected Level = Receiver Level + Correction Factor – Pre-amplifier (with the use of a pre-amplifier)

Receiver Level : Receiver reading without correction factors

Correction Factor : Antenna factor + cable loss

For example:

The receiver reading is 32.7 dB μ V. The antenna factor for the measured frequency is +2.5 dB (1/m) and the cable factor for the measured frequency is 0.71 dB, giving a field strength of 35.91dB μ V/m.

The 35.91dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

Level in μ V/m = Common Antilogarithm (35.91/20) = 62.44

For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f) (1) the field strength is calculated by adding additionally an extrapolation factor of 20 dB/decade (inverse linear distance for field strength measurements).

7.4.5 Test Results

Test location and equipment

Test site	☐ 660 ☒ 706 Semi Anechoic Chamber				
	☒ 708	☒ 709	☒ 707		
Receiver	☒ 696	☐ 666	☐ 502		
Antenna	☒ 697	☒ 442	☒ 445a	☒ 406	☐ 515
	☐ 384	☐ 385			
Additional equipment	☒ 698	☐ 102a	☒ 560	☐ 401	☐ 506
	☐ Test fixture		☒ 223a	☒ 443	
Cable	☒ K205	☒ K203	☒ K198	☒ K199	☐ K94
	☒ K171	☐ K207			

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
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Test setup photos	☒ Yes	☐ No	Annex no.
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EUT: QR4000

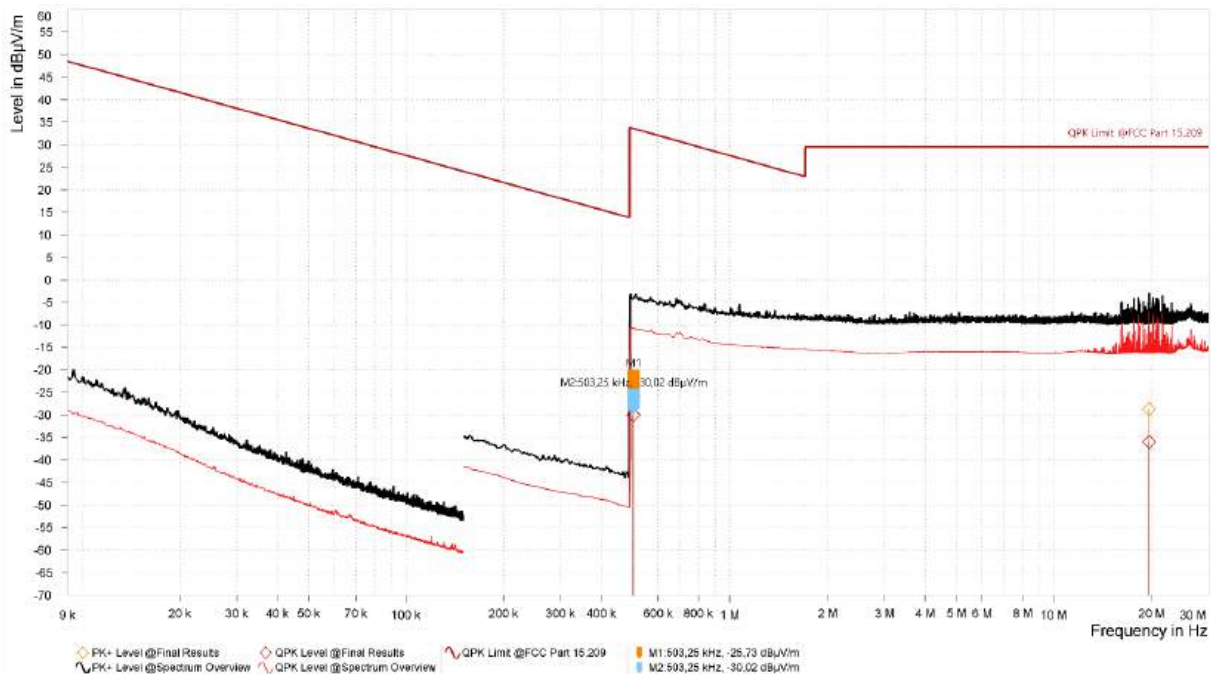
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Measurement results**Waveform 0, Centre frequency @ 76.365 GHz**9 kHz – 30 MHz

Freq. [MHz]	QPK Level [dBμV/m]	QPK Limit [dBμV/m]	QPK Margin [dB]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
0.503	-30.02	33.57	63.59	-25.73	33.57	59.30	-18.26	H	52	1.00	0.200
19.709	-35.99	29.50	65.49	-28.69	29.50	58.19	-18.63	H	30	1.00	0.200



EUT: QR4000

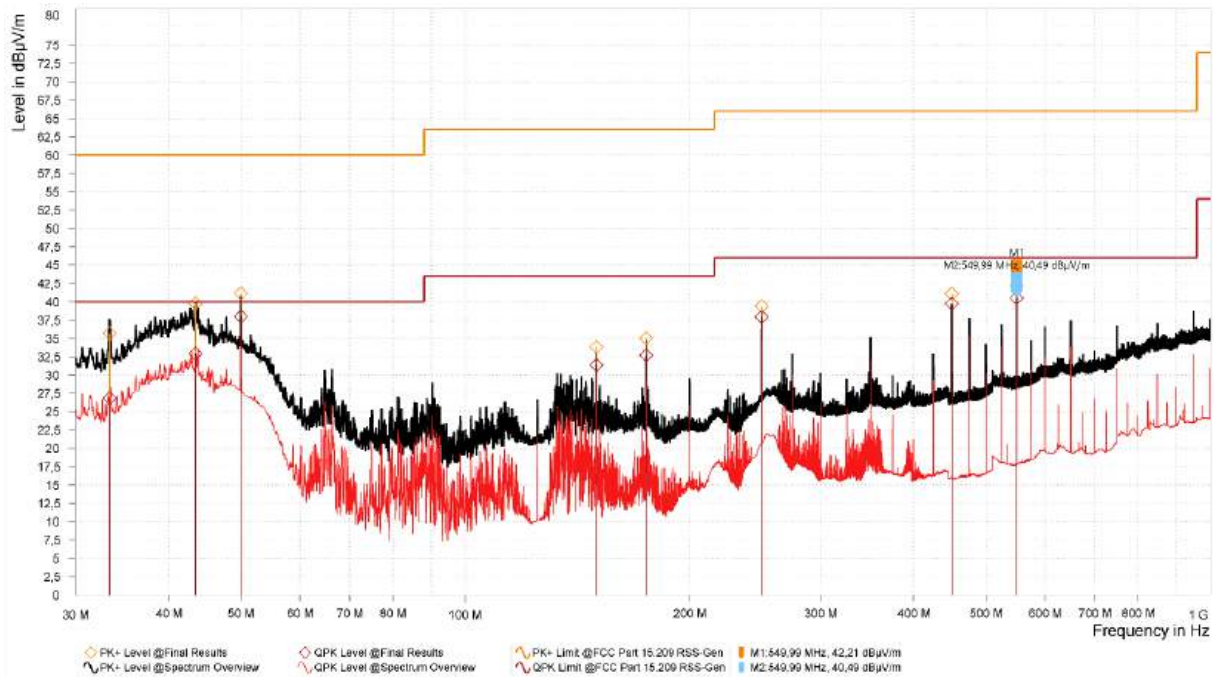
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FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

30 MHz – 1 GHz

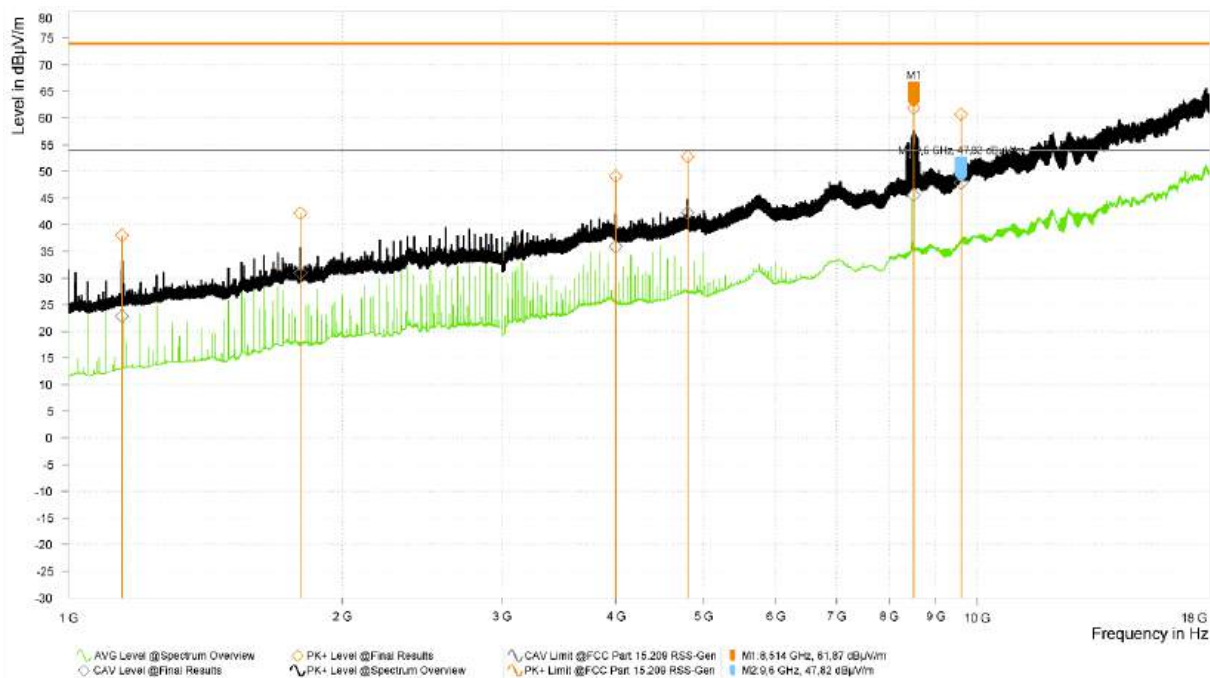
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33.330	26.84	40.00	13.16	35.67	60.00	24.33	17.25	V	-180	1.09	120
43.470	32.90	40.00	7.10	39.78	60.00	20.22	18.15	V	161	1.00	120
50.010	37.99	40.00	2.01	41.15	60.00	18.85	18.36	V	-180	1.10	120
150.000	31.36	43.50	12.14	33.83	63.50	29.67	17.93	H	21	1.09	120
174.990	32.69	43.50	10.81	35.01	63.50	28.49	17.34	H	-158	1.10	120
249.990	37.93	46.00	8.07	39.39	66.00	26.61	16.65	H	-23	2.40	120
450.000	39.75	46.00	6.25	41.11	66.00	24.89	22.26	H	-68	1.09	120
549.990	40.49	46.00	5.51	42.21	66.00	23.79	24.11	H	-25	1.00	120



EUT: QR4000 FCC ID: ZKS-QR4000 FCC Title 47 CFR Part 95 M Date of issue: 2024-08-20

1 GHz – 18 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
1144.825	37.99	74.00	36.01	22.88	54.00	31.12	-3.62	V	109	3.75	1000
1800.000	42.14	74.00	31.86	31.00	54.00	23.00	2.58	V	179	1.00	1000
3999.975	49.08	74.00	24.92	35.90	54.00	18.10	12.56	V	144	1.21	1000
4799.975	52.76	74.00	21.24	42.23	54.00	11.77	14.61	V	131	2.73	1000
8513.900	61.87	74.00	12.13	45.59	54.00	8.41	24.83	V	-154	1.12	1000
9599.975	60.74	74.00	13.26	47.82	54.00	6.18	27.42	V	144	1.72	1000



EUT: QR4000

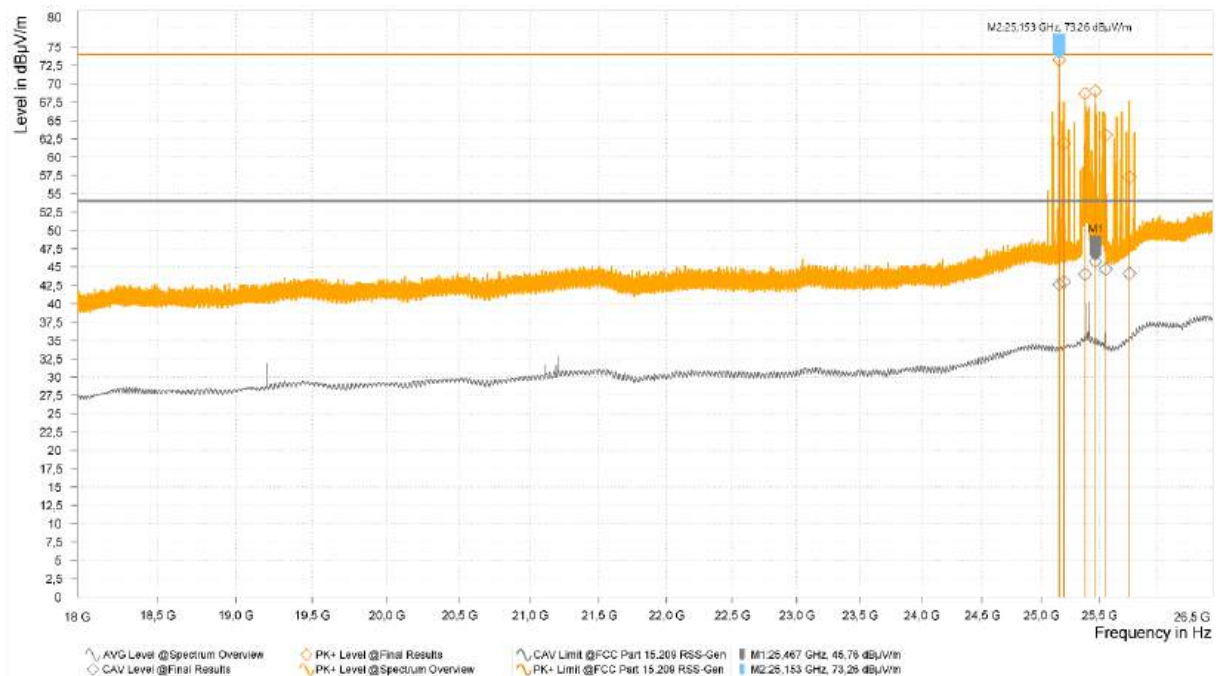
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

18 GHz – 26.5 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
25153.175	73.26	74.00	0.74	42.65	54.00	11.35	23.99	H	43	1.87	1000
25193.675	61.83	74.00	12.17	42.97	54.00	11.03	24.08	H	23	2.34	1000
25377.000	68.65	74.00	5.35	44.02	54.00	9.98	24.36	H	-31	1.64	1000
25467.325	69.03	74.00	4.97	45.76	54.00	8.24	24.38	V	13	1.57	1000
25555.295	62.99	74.00	11.01	44.71	54.00	9.29	24.46	H	-60	1.26	1000
25761.945	57.26	74.00	16.74	44.10	54.00	9.90	25.04	V	-30	2.34	1000



EUT: QR4000

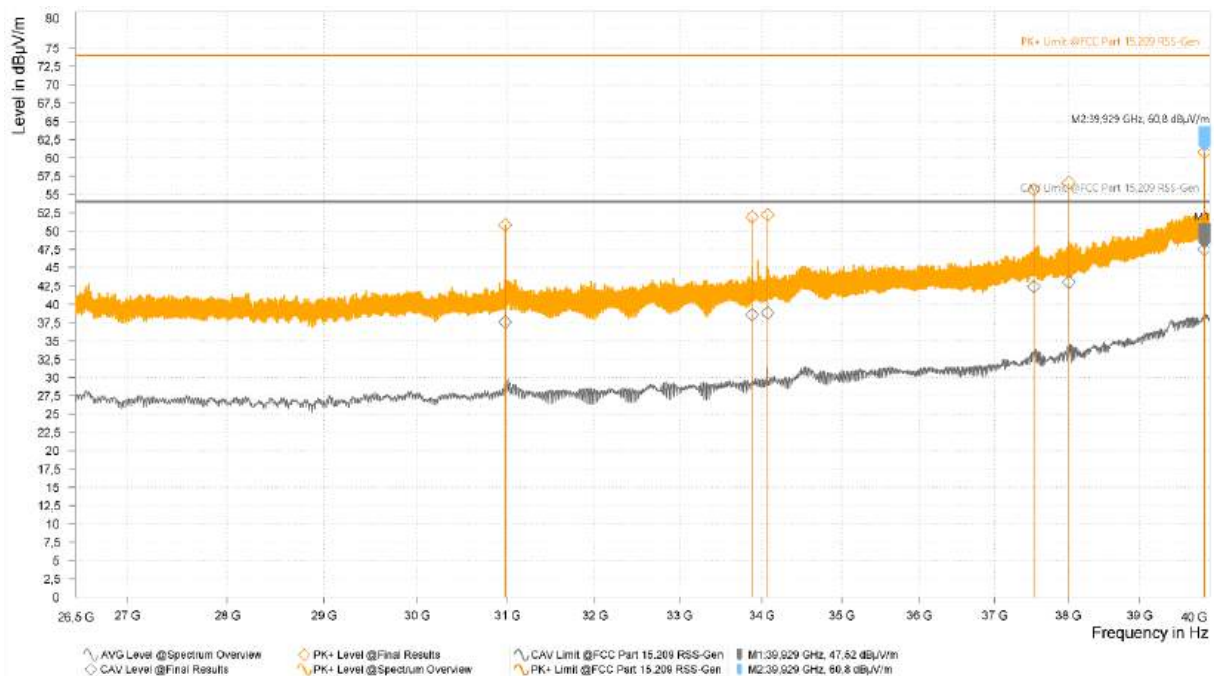
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

26.5 GHz – 40 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
30973.640	50.81	74.00	23.19	37.60	54.00	16.40	28.09	H	13	1.20	1000
33882.490	51.92	74.00	22.08	38.59	54.00	15.41	30.17	V	10	1.98	1000
34073.620	52.22	74.00	21.78	38.81	54.00	15.19	30.48	V	6	1.98	1000
37531.990	55.67	74.00	18.33	42.41	54.00	11.59	34.64	V	-147	2.46	1000
38012.980	56.60	74.00	17.40	43.03	54.00	10.97	35.42	H	37	2.16	1000
39929.340	60.80	74.00	13.20	47.52	54.00	6.48	42.34	H	0	2.45	1000



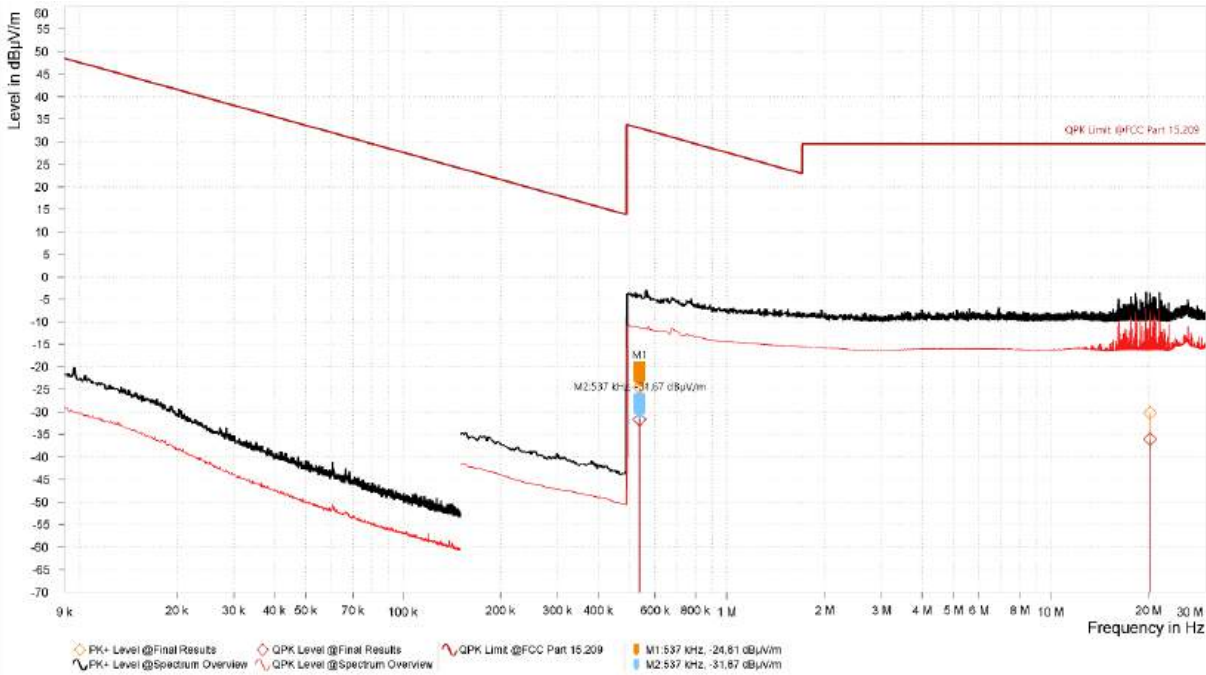
V. 1.24

EUT: QR4000 FCC ID: ZKS-QR4000 FCC Title 47 CFR Part 95 M Date of issue: 2024-08-20

Waveform 0, Centre frequency @ 76.605 GHz

9 kHz – 30 MHz

Freq. [MHz]	QPK Level [dBµV/m]	QPK Limit [dBµV/m]	QPK Margin [dB]	PK+ Level [dBµV/m]	PK+ Limit [dBµV/m]	PK+ Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
0.537	-31.67	33.00	64.67	-24.61	33.00	57.61	-18.26	H	-163	1.00	0.200
20.261	-36.03	29.50	65.53	-30.22	29.50	59.72	-18.60	H	-58	1.00	0.200



EUT: QR4000

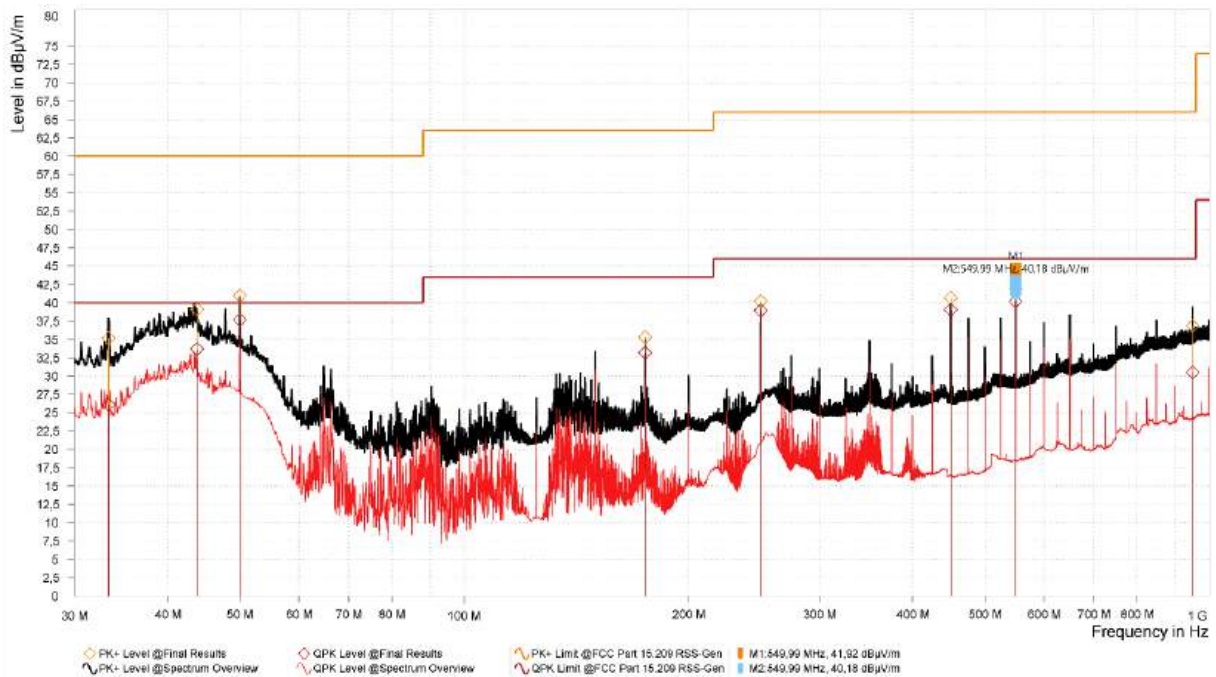
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FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

30 MHz – 1 GHz

Freq. [MHz]	QPK Level [dBµV/m]	QPK Limit [dBµV/m]	QPK Margin [dB]	PK+ Level [dBµV/m]	PK+ Limit [dBµV/m]	PK+ Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
33.330	26.10	40.00	13.90	35.16	60.00	24.84	17.25	V	94	1.21	120
43.800	33.70	40.00	6.30	39.08	60.00	20.92	18.17	V	-141	1.00	120
50.010	37.70	40.00	2.30	40.97	60.00	19.03	18.36	V	171	1.09	120
174.990	33.17	43.50	10.33	35.30	63.50	28.20	17.34	H	-143	1.21	120
249.990	38.91	46.00	7.09	40.21	66.00	25.79	16.65	H	151	2.81	120
450.000	39.04	46.00	6.96	40.66	66.00	25.34	22.26	H	-69	1.09	120
549.990	40.18	46.00	5.82	41.92	66.00	24.08	24.11	H	-62	1.00	120
950.010	30.48	46.00	15.52	36.84	66.00	29.16	30.38	H	-171	1.36	120



EUT: QR4000

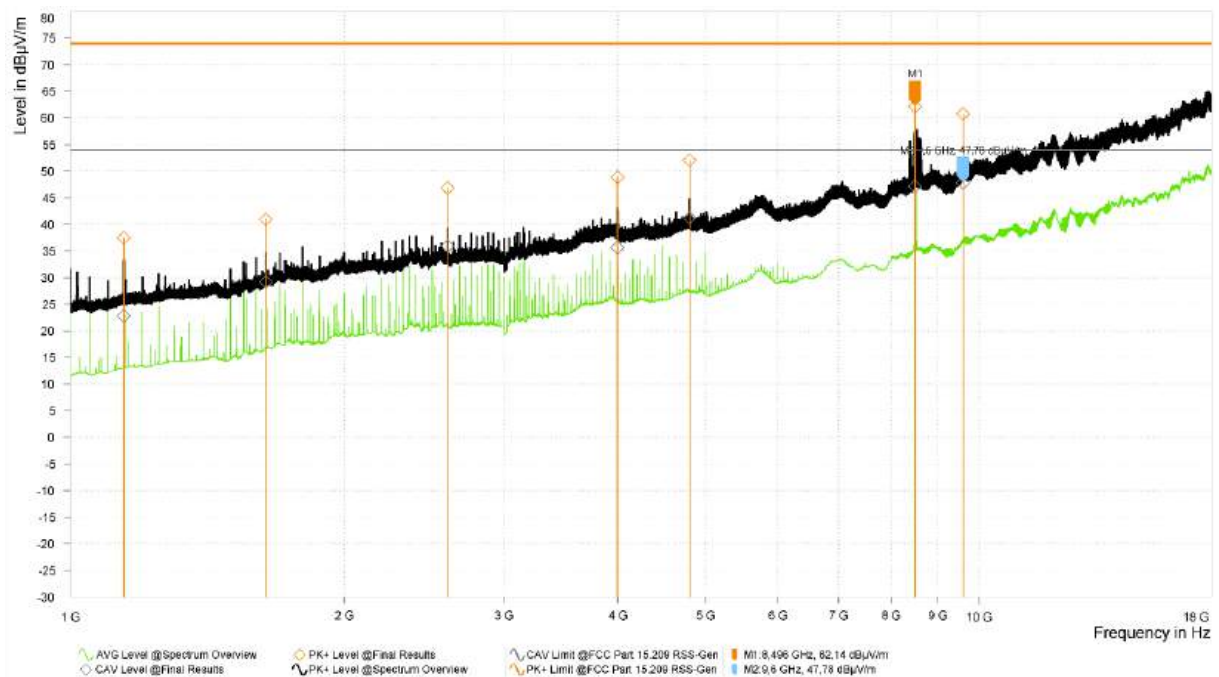
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FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

1 GHz – 18 GHz

Freq. [MHz]	PK+ Level [dBµV/m]	PK+ Limit [dBµV/m]	PK+ Margin [dB]	CAV Level [dBµV/m]	CAV Limit [dBµV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
1143.925	37.48	74.00	36.52	22.82	54.00	31.18	-3.64	V	109	4.00	1000
1640.000	40.98	74.00	33.02	29.22	54.00	24.78	1.10	V	146	1.32	1000
2600.000	46.82	74.00	27.18	35.95	54.00	18.05	7.07	V	162	1.13	1000
3999.100	48.87	74.00	25.13	35.67	54.00	18.33	12.56	V	133	2.42	1000
4800.000	52.07	74.00	21.93	41.25	54.00	12.75	14.61	V	-119	3.89	1000
8496.475	62.14	74.00	11.86	47.15	54.00	6.85	24.82	V	-154	1.21	1000
9599.975	60.77	74.00	13.23	47.78	54.00	6.22	27.42	V	145	1.62	1000



EUT: QR4000

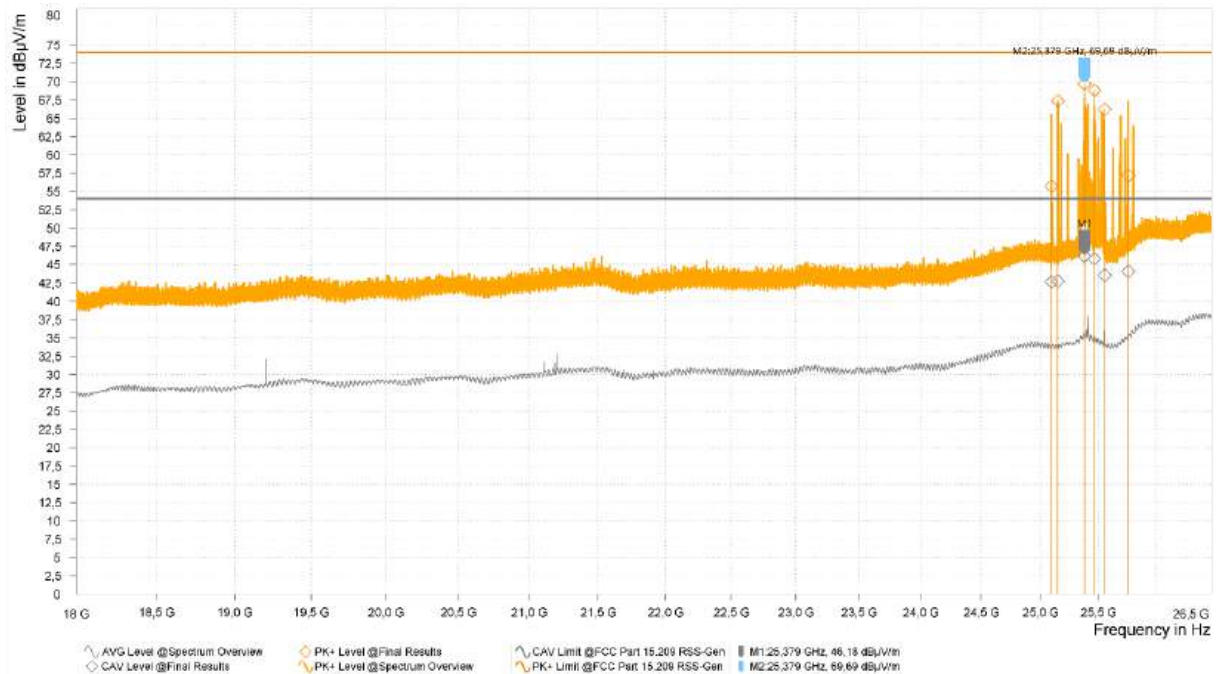
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FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

18 GHz – 26.5 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
25095.475	55.73	74.00	18.27	42.66	54.00	11.34	23.88	H	-3	2.72	1000
25152.175	67.33	74.00	6.67	42.75	54.00	11.25	23.99	H	-37	1.26	1000
25379.490	69.69	74.00	4.31	46.18	54.00	7.82	24.36	H	-31	1.65	1000
25467.325	68.83	74.00	5.17	45.79	54.00	8.21	24.38	H	-32	1.19	1000
25555.295	66.20	74.00	7.80	43.58	54.00	10.42	24.46	H	-32	1.34	1000
25761.300	57.18	74.00	16.82	44.10	54.00	9.90	25.04	V	-30	1.49	1000



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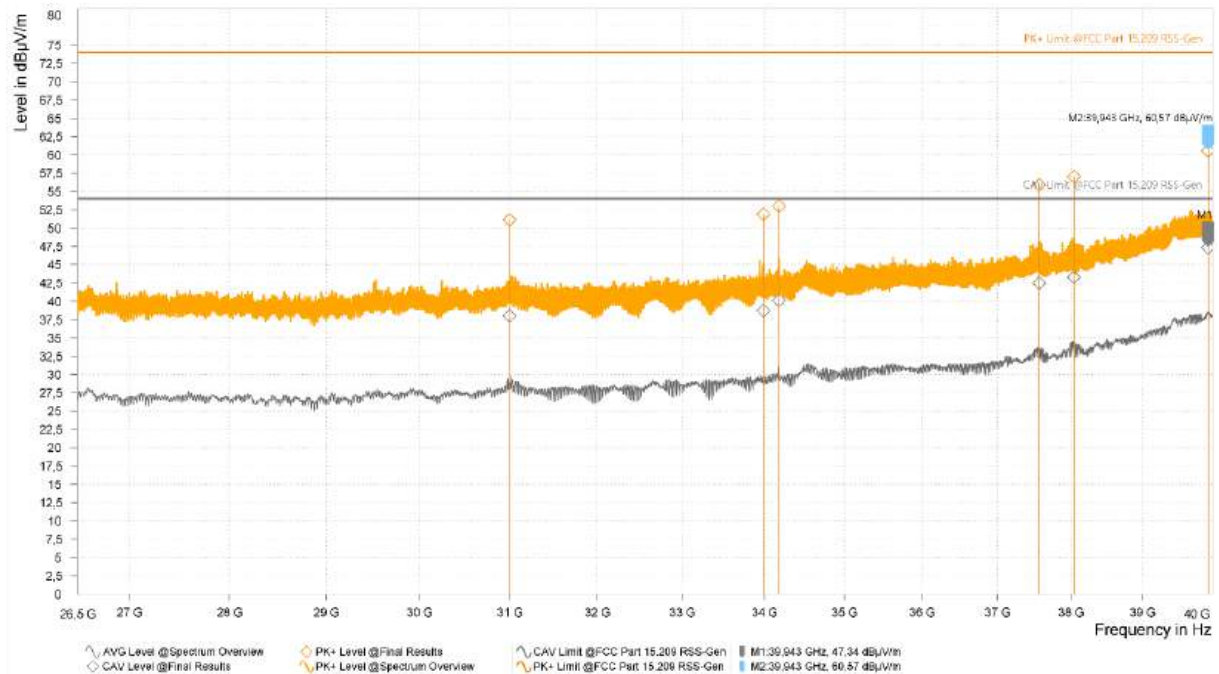
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FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

26.5 GHz – 40 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
30997.060	51.12	74.00	22.88	38.03	54.00	15.97	28.41	V	-154	1.26	1000
33989.140	51.90	74.00	22.10	38.73	54.00	15.27	30.31	V	8	2.04	1000
34180.300	53.01	74.00	20.99	40.11	54.00	13.89	30.60	V	0	1.09	1000
37566.600	55.89	74.00	18.11	42.50	54.00	11.50	34.68	H	-78	1.81	1000
38042.670	57.00	74.00	17.00	43.29	54.00	10.71	35.51	V	-146	2.76	1000
39943.450	60.57	74.00	13.43	47.34	54.00	6.66	42.37	H	-79	1.33	1000



EUT: QR4000

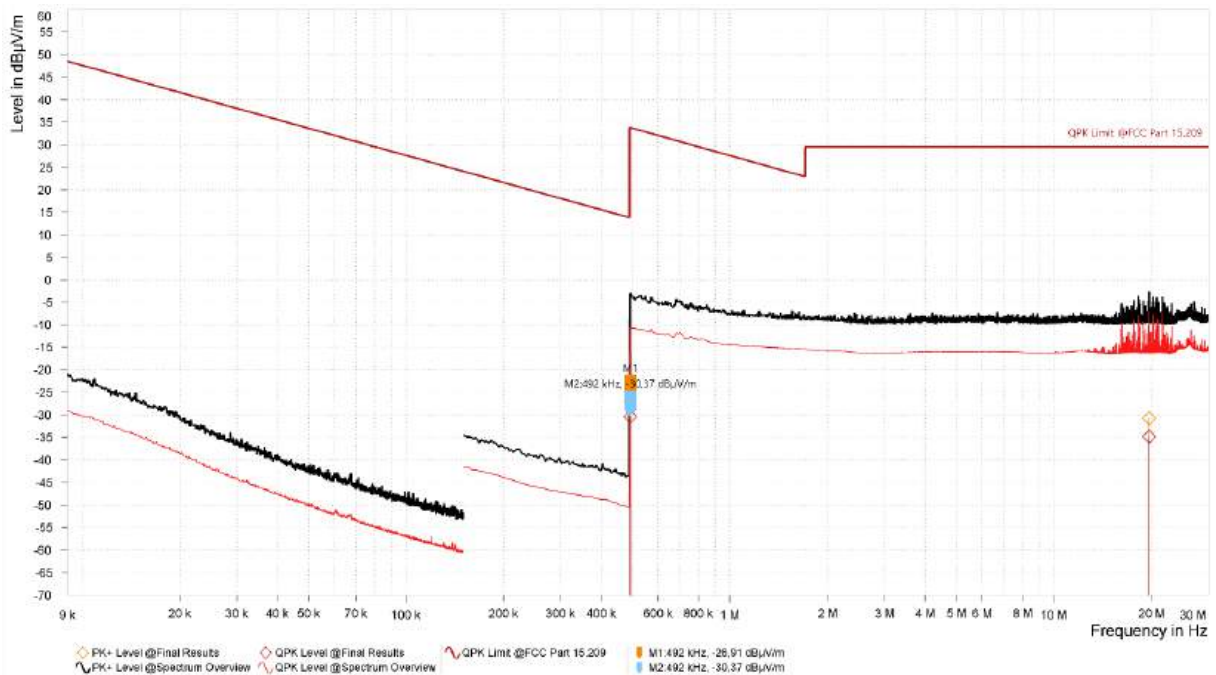
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Waveform 1, Centre frequency @ 76.125 GHz9 kHz – 30 MHz

Freq. [MHz]	QPK Level [dBµV/m]	QPK Limit [dBµV/m]	QPK Margin [dB]	PK+ Level [dBµV/m]	PK+ Limit [dBµV/m]	PK+ Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
0.492	-30.37	33.76	64.14	-26.91	33.76	60.67	-18.26	V	91	1.00	0.200
19.709	-34.80	29.50	64.30	-30.78	29.50	60.28	-18.63	H	-28	1.00	0.200



EUT: QR4000

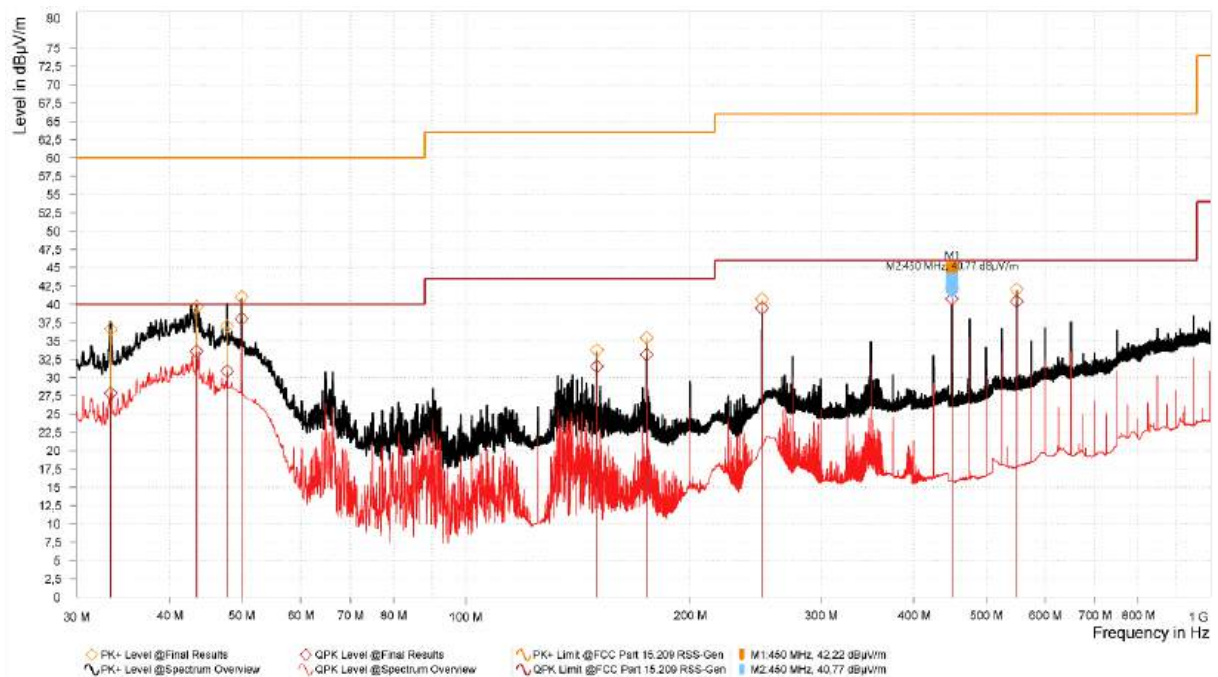
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FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

30 MHz – 1 GHz

Freq. [MHz]	QPK Level [dBµV/m]	QPK Limit [dBµV/m]	QPK Margin [dB]	PK+ Level [dBµV/m]	PK+ Limit [dBµV/m]	PK+ Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
33.360	27.83	40.00	12.17	36.60	60.00	23.40	17.25	V	172	1.00	120
43.500	33.55	40.00	6.45	39.68	60.00	20.32	18.15	V	-167	1.00	120
47.790	30.84	40.00	9.16	37.05	60.00	22.95	18.38	V	160	1.10	120
50.010	38.04	40.00	1.96	41.02	60.00	18.98	18.36	V	-186	1.00	120
150.000	31.50	43.50	12.00	33.73	63.50	29.77	17.93	H	37	1.10	120
174.990	33.11	43.50	10.39	35.42	63.50	28.08	17.34	H	-152	1.21	120
249.990	39.46	46.00	6.54	40.68	66.00	25.32	16.65	H	161	2.71	120
450.000	40.77	46.00	5.23	42.22	66.00	23.78	22.26	H	-68	2.26	120
549.990	40.38	46.00	5.62	42.03	66.00	23.97	24.11	H	-31	1.00	120



EUT: QR4000

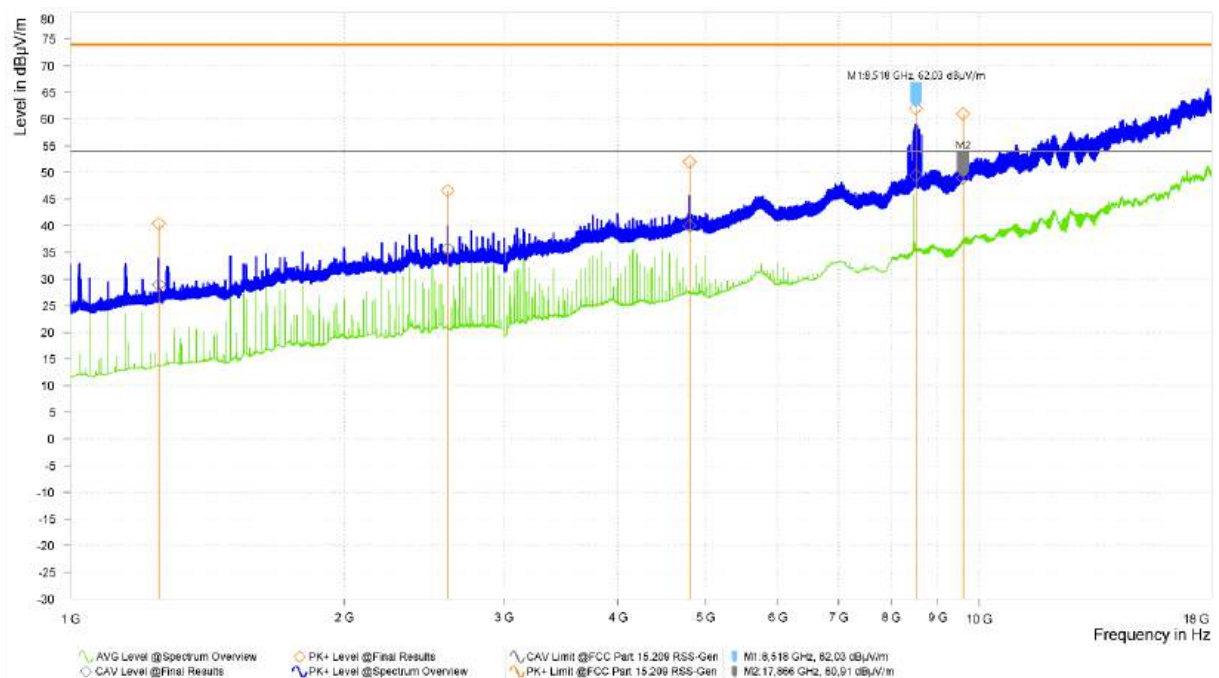
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FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

1 GHz – 18 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
1250.025	40.42	74.00	33.58	28.94	54.00	25.06	-2.44	V	-95	1.00	1000
2600.000	46.55	74.00	27.45	35.69	54.00	18.31	7.07	V	159	1.13	1000
4799.975	51.99	74.00	22.01	39.97	54.00	14.03	14.61	V	-150	1.41	1000
8518.425	62.03	74.00	11.97	49.41	54.00	4.59	24.83	V	-155	1.31	1000
9599.975	61.01	74.00	12.99	48.97	54.00	5.03	27.42	V	180	1.41	1000



EUT: QR4000

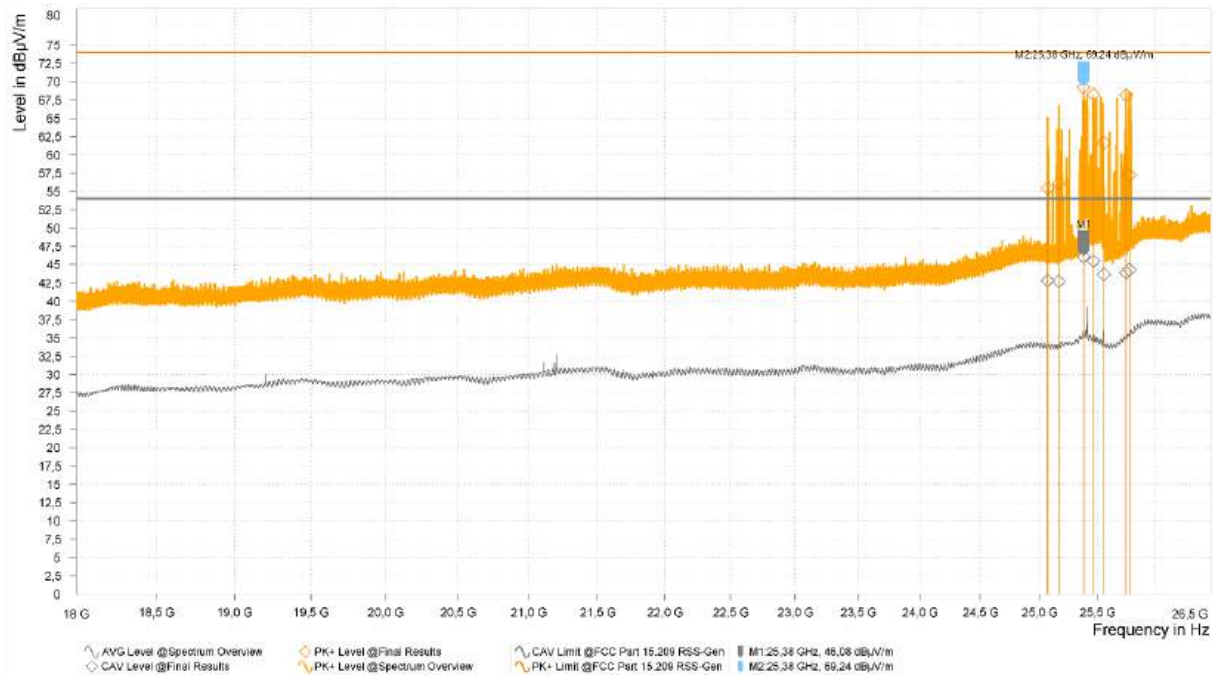
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

18 GHz – 26.5 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
25069.635	55.45	74.00	18.55	42.81	54.00	11.19	23.84	H	-1	1.41	1000
25165.815	56.12	74.00	17.88	42.70	54.00	11.30	24.02	H	-22	1.11	1000
25379.530	69.24	74.00	4.76	46.08	54.00	7.92	24.36	H	-31	1.64	1000
25467.365	68.22	74.00	5.78	45.49	54.00	8.51	24.38	H	-31	1.65	1000
25555.330	61.65	74.00	12.35	43.69	54.00	10.31	24.46	H	-32	1.41	1000
25749.750	68.16	74.00	5.84	43.93	54.00	10.07	25.00	V	30	1.41	1000
25779.775	57.21	74.00	16.79	44.34	54.00	9.66	25.10	V	-12	2.03	1000



V. 1.24

EUT: QR4000

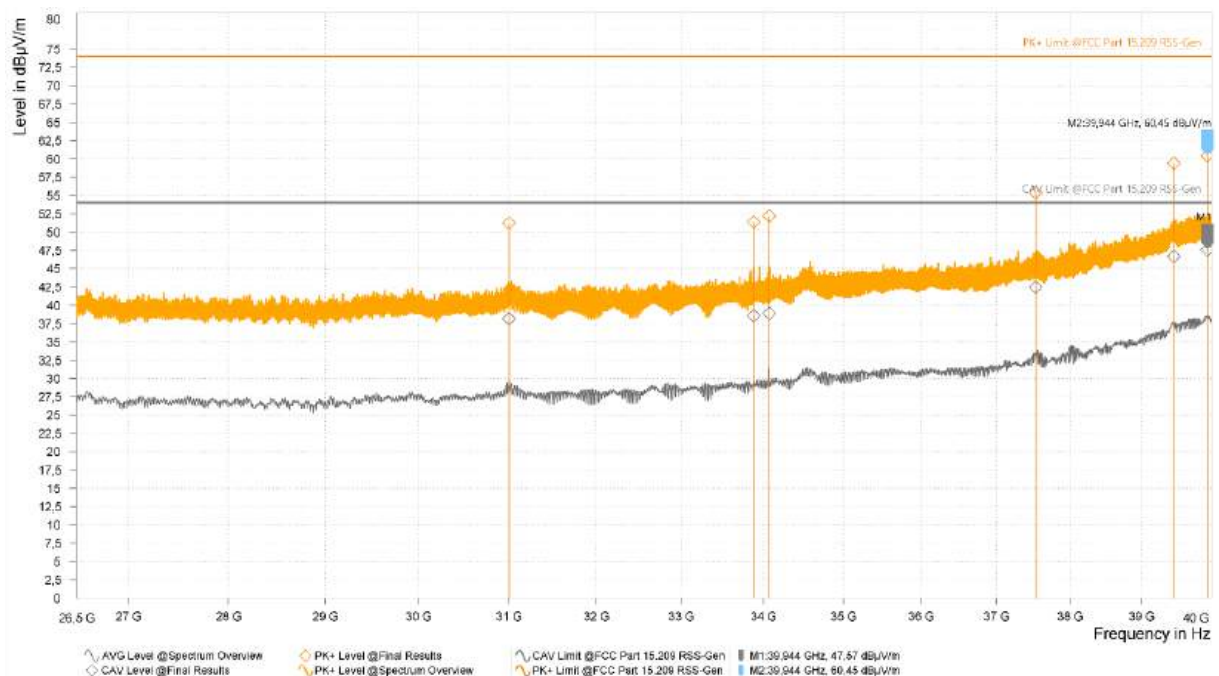
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FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

26.5 GHz – 40 GHz

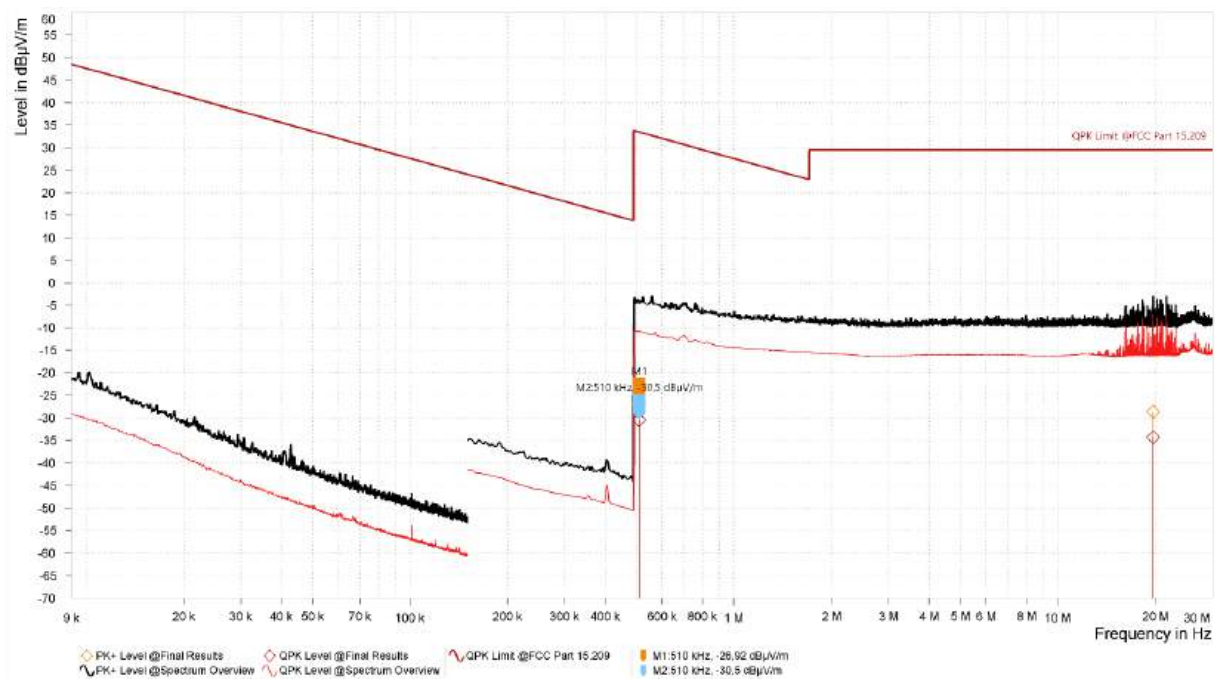
Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
31002.220	51.25	74.00	22.75	38.16	54.00	15.84	28.43	H	-47	1.14	1000
33882.490	51.39	74.00	22.61	38.59	54.00	15.41	30.17	V	9	1.98	1000
34073.620	52.20	74.00	21.80	38.91	54.00	15.09	30.48	V	7	1.98	1000
37531.960	55.38	74.00	18.62	42.48	54.00	11.52	34.64	V	30	2.64	1000
39462.700	59.41	74.00	14.59	46.68	54.00	7.32	40.86	V	39	1.38	1000
39944.230	60.45	74.00	13.55	47.57	54.00	6.43	42.37	V	-86	2.22	1000



Waveform 1, Centre frequency @ 76.845 GHz

9 kHz – 30 MHz

Freq. [MHz]	QPK Level [dBµV/m]	QPK Limit [dBµV/m]	QPK Margin [dB]	PK+ Level [dBµV/m]	PK+ Limit [dBµV/m]	PK+ Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
0.510	-30.50	33.45	63.95	-26.92	33.45	60.37	-18.26	H	16	1.00	0.200
19.709	-34.34	29.50	63.84	-28.66	29.50	58.16	-18.63	H	15	1.00	0.200



EUT: QR4000

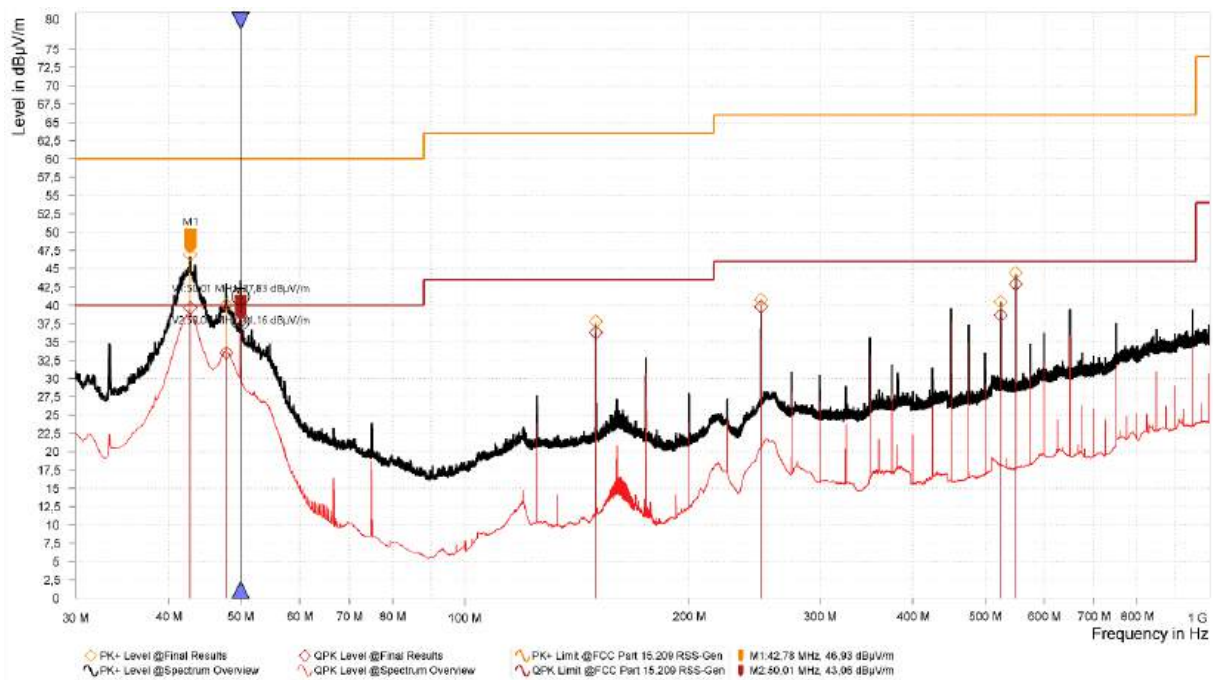
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

30 MHz – 1 GHz

Freq. [MHz]	QPK Level [dBμV/m]	QPK Limit [dBμV/m]	QPK Margin [dB]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
42.780	39.63	40.00	0.37	46.93	60.00	13.07	18.10	V	-143	1.00	120
47.850	33.48	40.00	6.52	40.06	60.00	19.94	18.38	V	-111	1.51	120
50.010	37.83	40.00	2.17	41.16	60.00	18.84	18.36	V	-143	1.00	120
150.000	36.25	43.50	7.25	37.78	63.50	25.72	17.93	H	118	1.10	120
249.990	39.80	46.00	6.20	40.79	66.00	25.21	16.65	H	44	1.37	120
525.000	38.66	46.00	7.34	40.47	66.00	25.53	24.00	H	21	1.00	120
549.990	42.89	46.00	3.11	44.45	66.00	21.55	24.11	H	37	1.00	120



EUT: QR4000

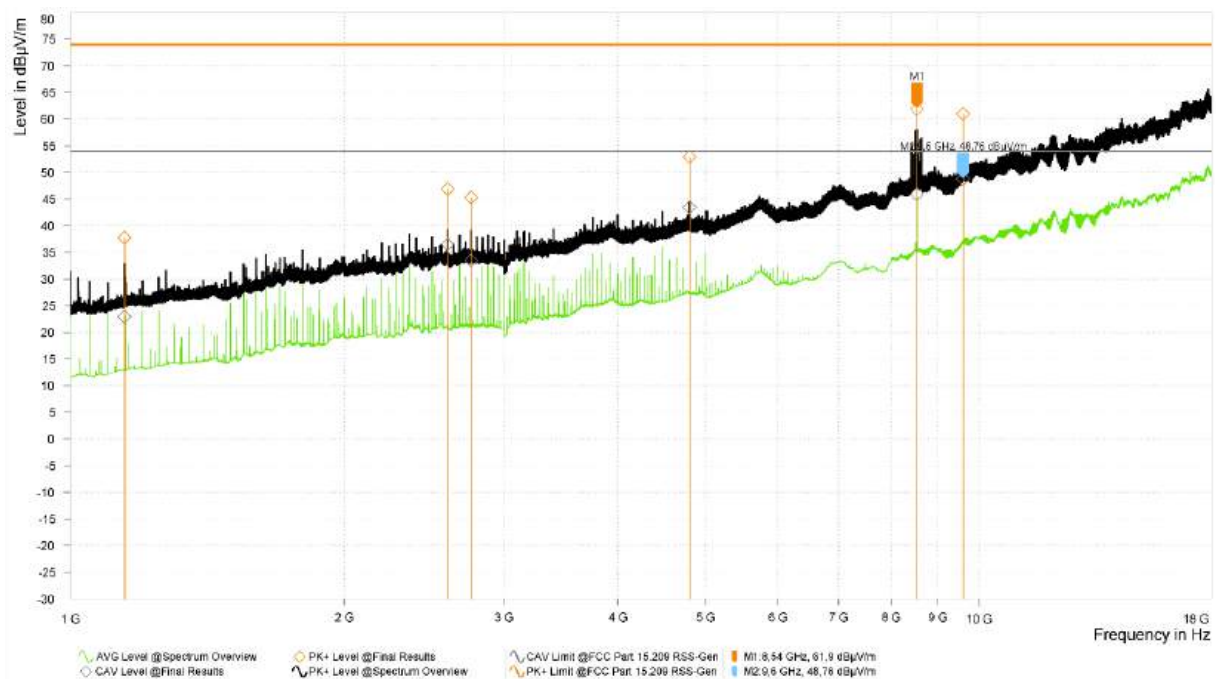
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

1 GHz – 18 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
1145.825	37.78	74.00	36.22	22.95	54.00	31.05	-3.60	V	-59	3.76	1000
2600.000	46.88	74.00	27.12	36.51	54.00	17.49	7.07	V	162	1.00	1000
2759.975	45.31	74.00	28.69	33.50	54.00	20.50	7.46	V	172	2.82	1000
4799.975	52.93	74.00	21.07	43.48	54.00	10.52	14.61	V	136	2.82	1000
8539.825	61.90	74.00	12.10	45.97	54.00	8.03	24.82	V	-155	1.41	1000
9599.975	61.01	74.00	12.99	48.76	54.00	5.24	27.42	V	155	1.21	1000



EUT: QR4000

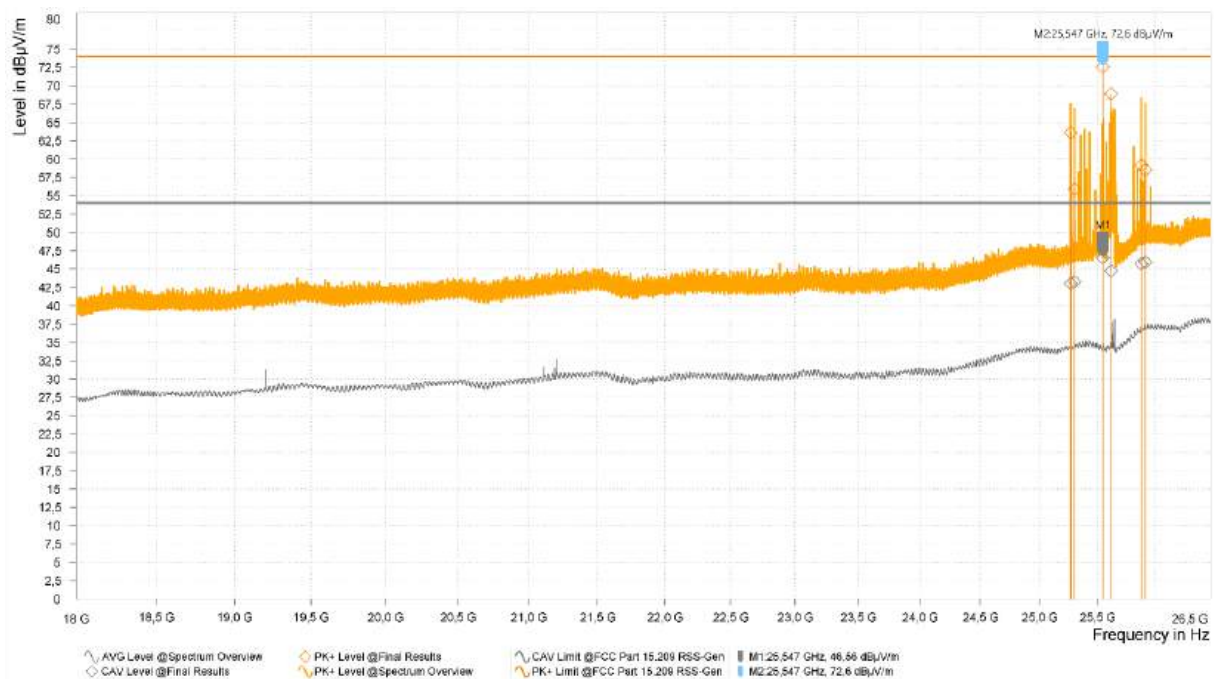
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

18 GHz – 26.5 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
25267.215	63.58	74.00	10.42	43.05	54.00	10.95	24.20	H	-6	1.49	1000
25301.225	55.91	74.00	18.09	43.27	54.00	10.73	24.26	H	-6	2.64	1000
25547.335	72.60	74.00	1.40	46.56	54.00	7.44	24.45	V	8	1.57	1000
25619.995	68.90	74.00	5.10	44.73	54.00	9.27	24.60	V	12	1.00	1000
25884.490	59.16	74.00	14.84	45.74	54.00	8.26	25.54	V	-30	2.57	1000
25921.425	58.56	74.00	15.44	45.95	54.00	8.05	25.70	V	-25	2.72	1000



EUT: QR4000

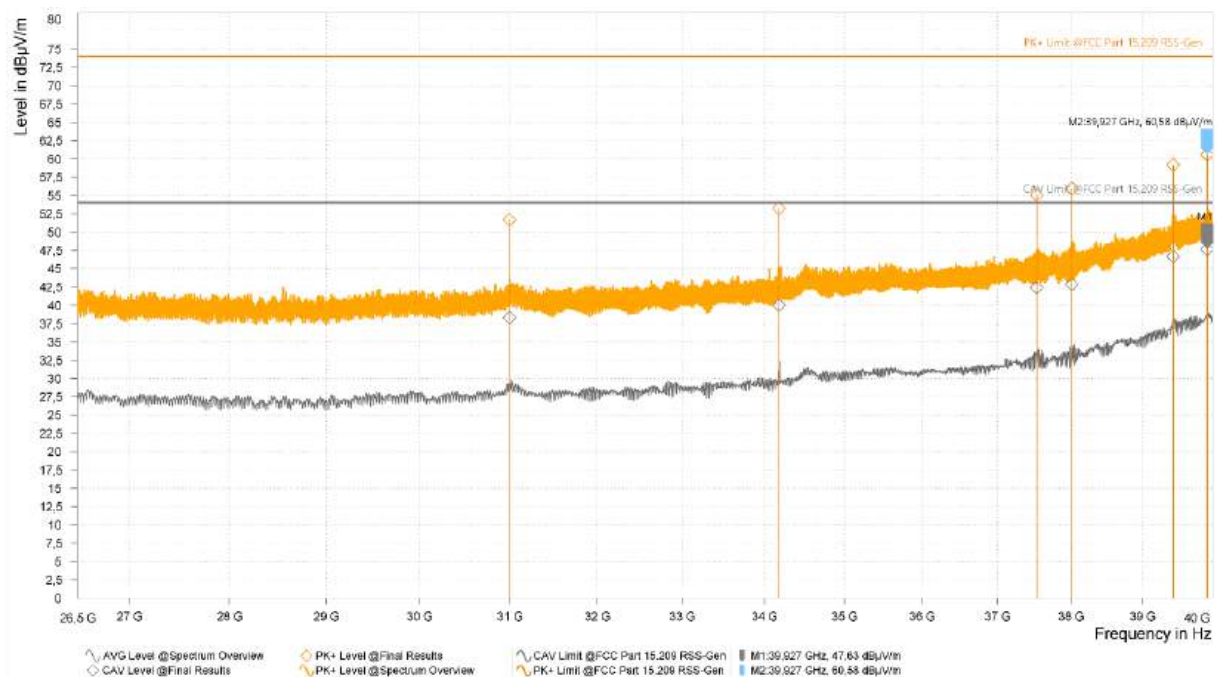
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

26.5 GHz – 40 GHz

Freq. [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	CAV Level [dBμV/m]	CAV Limit [dBμV/m]	CAV Margin [dB]	Corr. [dB]	Pol.	Azimuth [deg]	Ant. Height [m]	Meas. BW [kHz]
30996.700	51.69	74.00	22.31	38.30	54.00	15.70	28.40	V	103	1.62	1000
34180.300	53.24	74.00	20.76	40.02	54.00	13.98	30.60	V	0	1.09	1000
37531.990	55.09	74.00	18.91	42.41	54.00	11.59	34.64	H	-80	1.14	1000
38012.380	55.94	74.00	18.06	42.84	54.00	11.16	35.42	V	-86	2.38	1000
39435.190	59.16	74.00	14.84	46.70	54.00	7.30	40.71	V	90	2.51	1000
39926.820	60.58	74.00	13.42	47.63	54.00	6.37	42.33	H	-132	3.00	1000



V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.5 Radiated emission limit above 40 GHz

7.5.1 Regulation

According to FCC §95.3379 (a)

(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.

(3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

7.5.2 Test procedure

The measurement of harmonic and spurious emissions above 40 GHz was performed in accordance with the standard test methods ANSI C63.10-2013 sections 9.8, 9.9 and 9.12. For the frequencies above 1 GHz, all the radiated emission measurements were carried out using an average detector.

The measurement procedure for harmonics and spurious emissions above 40 GHz is taken from ANSI C63.10-2013.

Radiated emissions test characteristics	
Frequency range	9 kHz - 231,000 MHz
Test distance	10m, 3 m*
Test instrumentation resolution bandwidth	9 kHz (20 kHz – 30 MHz)
	120 kHz (30 MHz – 1.000 MHz)
	1 MHz (1000 MHz – 231.000 MHz)
Receive antenna height	1 m (20 kHz – 30 MHz)
Receive antenna polarization	0° - 90° (20 kHz – 30 MHz)
Receive antenna scan height	1 m - 4 m (30 MHz - 18,000 MHz)
	1 m – 2.5 m (18,000 MHz – 40.000 MHz)
	1 m – 1.5 m (40,000 MHz – 231.000 MHz)
Receive antenna polarization	vertical/horizontal (Above 30 MHz)

*According to Section 15.31 (f) (1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.5.3 Equations to calculate power density

Convert the EIRP in dBm to the EIRP in watts using Equation

$$EIRP_{Linear} = 10^{[(EIRP_{Log} - 30)/10]}$$

Where:

EIRP Linear is the equivalent isotropically radiated power, in watts

EIRP Log is the equivalent isotropically radiated power, in dBm

Calculate the power density at the distance specified by the limit from the EIRP in watts using Equation:

$$PD = \frac{EIRP_{Linear}}{4\pi d^2} \quad (1)$$

Where,

PD is the power density at the distance specified by the limit, in W/m²
EIRP_{Linear} is the equivalent isotropically radiated power, in watts
D is the distance at which the power density limit is specified, in m

According to FCC §95.3379 (2) (i), the radiated emission limit outside the 76 - 81 GHz band between 40 GHz and 200 GHz is 600 pW/cm² at 3 meters from the exterior surface of the radiating structure. As per above equation (1)

$$EIRP_{Linear} = PD * 4\pi d^2 = 0.000006 * 4 * \pi * 9 = 0.0006786 \text{ W}$$
$$EIRP_{dBm} = -1.69$$

According to FCC §95.3379 (2) (ii), the radiated emission limit outside the 76 - 81 GHz band above 200 GHz is 1000 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure. As per above equation (1)

$$EIRP_{Linear} = PD * 4\pi d^2 = 0.00001 * 4 * \pi * 9 = 0.001131 \text{ W}$$
$$EIRP_{dBm} = 0.53$$

EUT: QR4000

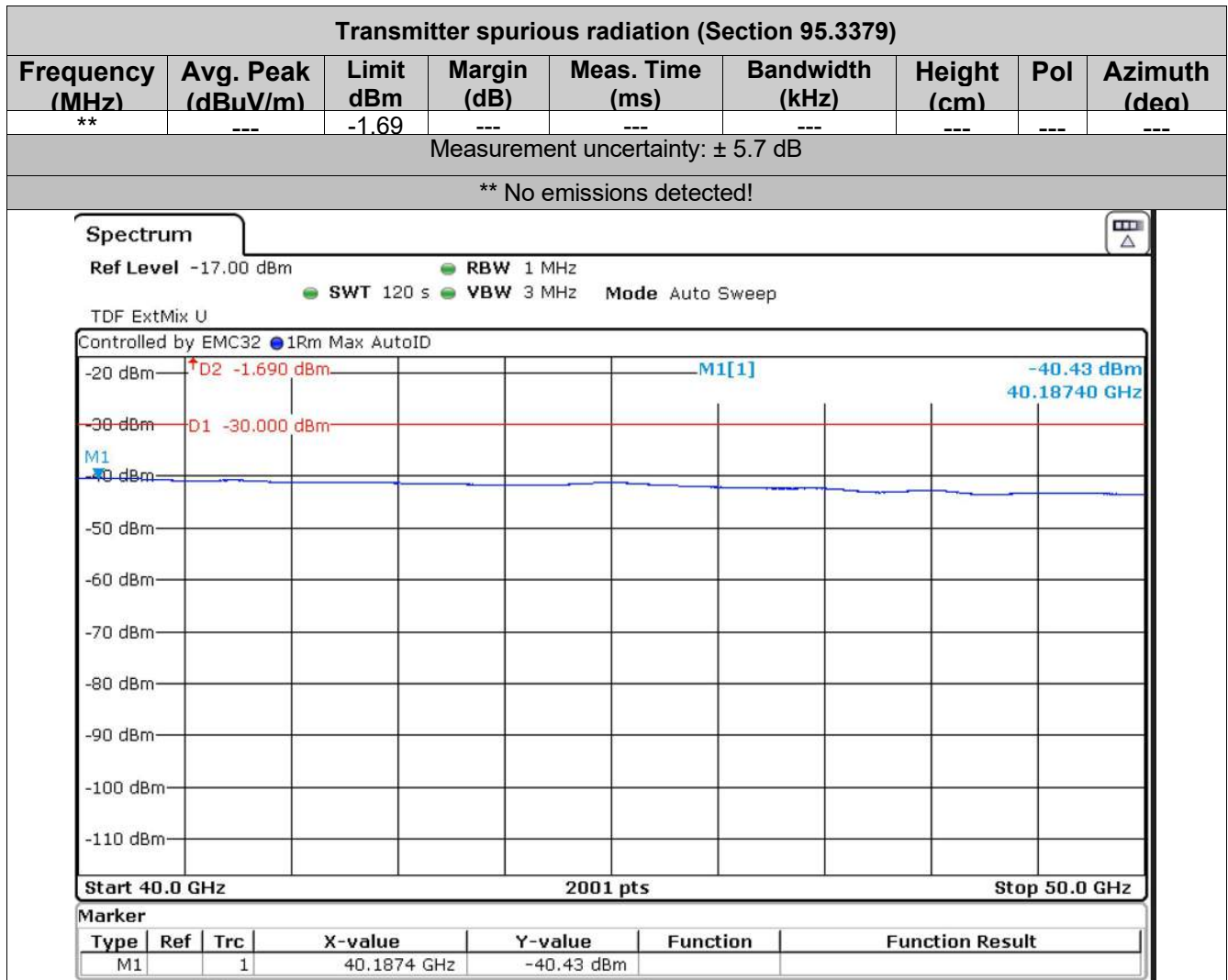
FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.5.4 Test Results

Waveform 0, Centre frequency @ 76.365 GHz

40 GHz – 50 GHz

Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☒ 707	☒ 708	☒ 709	
Receiver	☐ 665	☐ 666	☒ 502	
Antenna	☐ 406	☒ 442	☐ 454a	☒ 518
Additional equipment	☒ 515			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

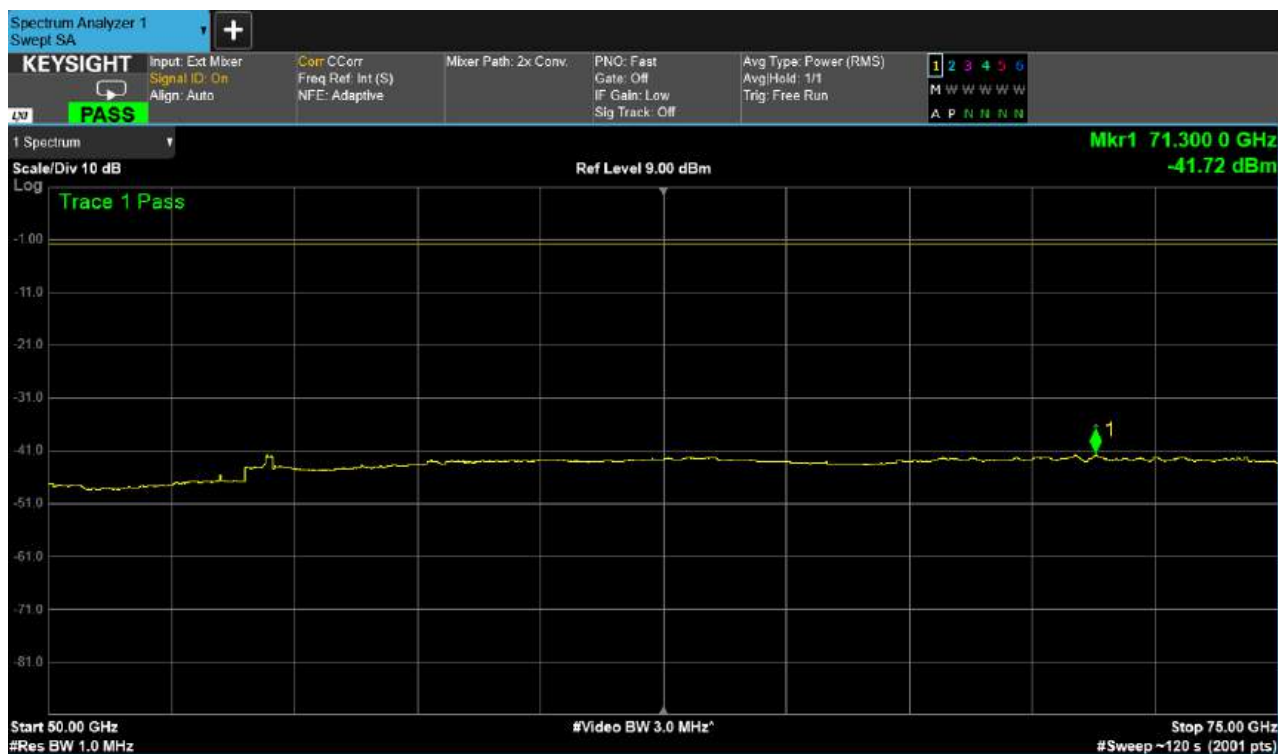
FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

50 GHz – 75 GHz

Transmitter spurious radiation (Section 95.3379)

Frequency	Average Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB
**	---	---	---	---	---	---	---	-1.69	---

Measurement uncertainty: ± 6.8 dB**** No emissions detected!**

Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☒ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 384
Additional equipment	☒ 673			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests

☒ Yes☐ No☐ N.t.*

Test setup photos

☒ Yes☐ No

Annex no. 6

V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

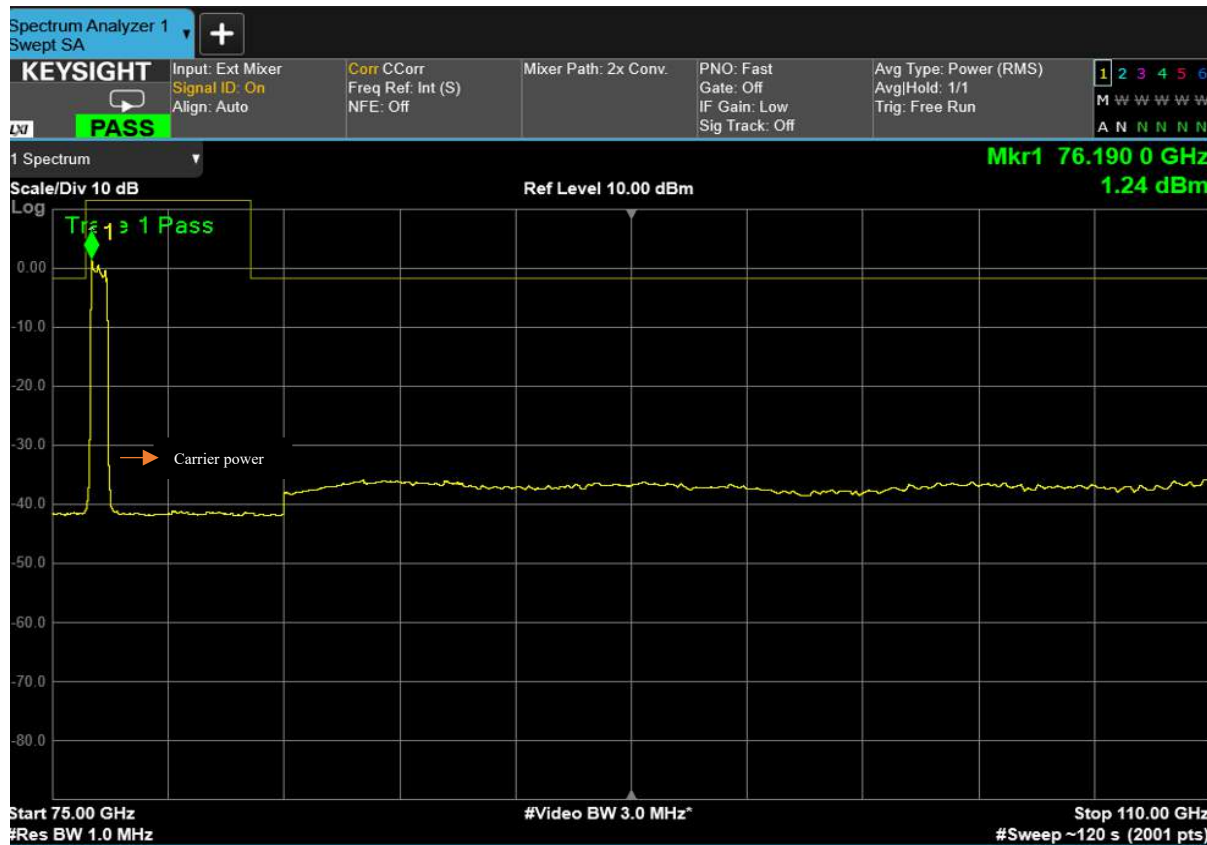
FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

75 GHz – 110 GHz

Transmitter spurious radiation (Section 95.3379)

Frequency	Average Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB
**	---	---	---	---	---	---	---	-1.69	---

Measurement uncertainty: ± 6.8 dB**** No emissions detected!**

Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber
	☐ 707 ☒ 708 ☐ 709
Receiver	☐ 665 ☒ 666 ☐ 502
Antenna	☐ 406 ☐ 442 ☐ 454a ☒ 385
Additional equipment	☒ 674
Cable	☐ K189 ☐ K193 ☐ K195 ☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
Test setup photos	☒ Yes	☐ No	Annex no. 6

V. 1.24

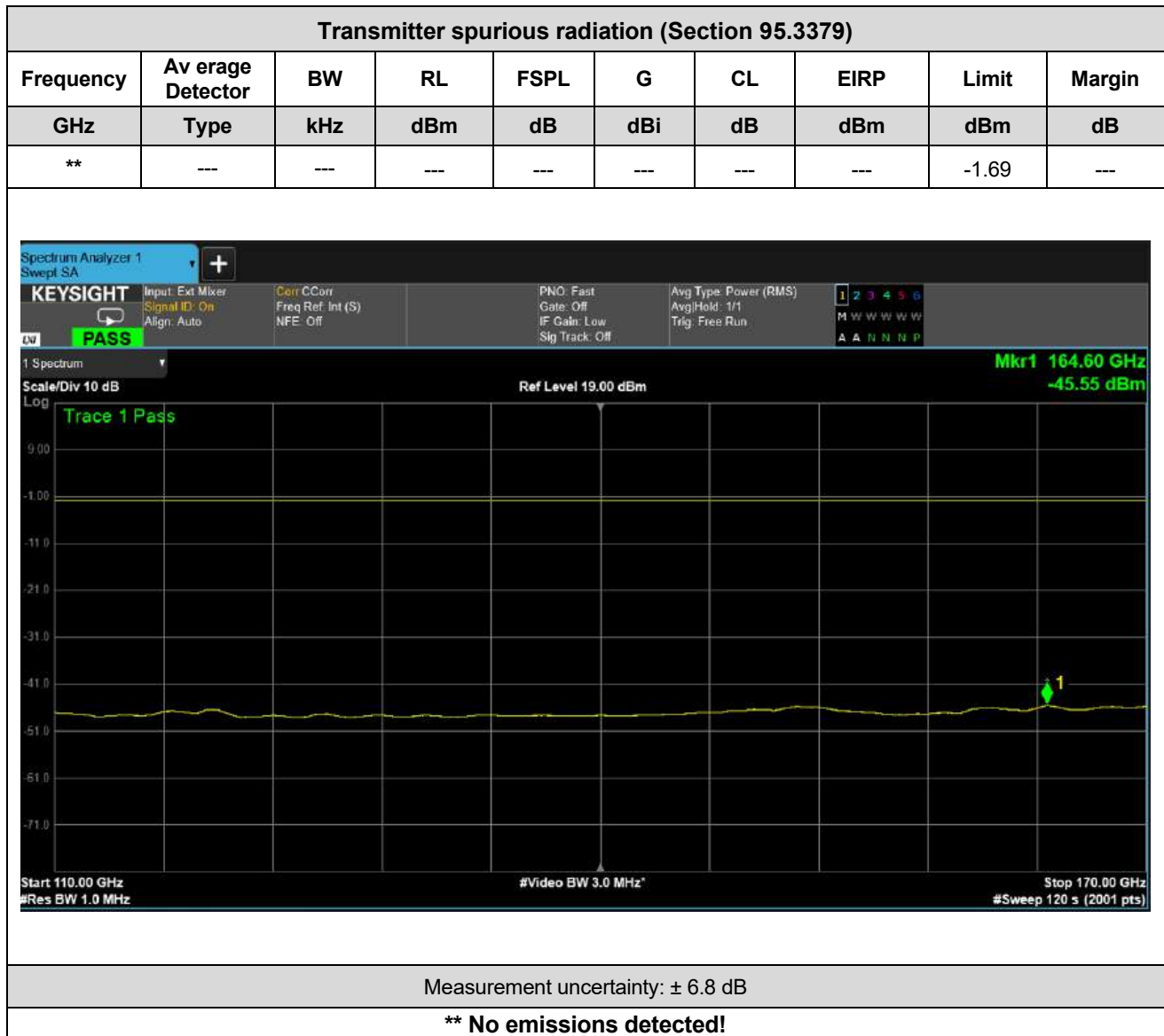
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

110 GHz – 170 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 687
Additional equipment	☒ 675			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
Test setup photos	☒ Yes	☐ No	Annex no. 6

V. 1.24

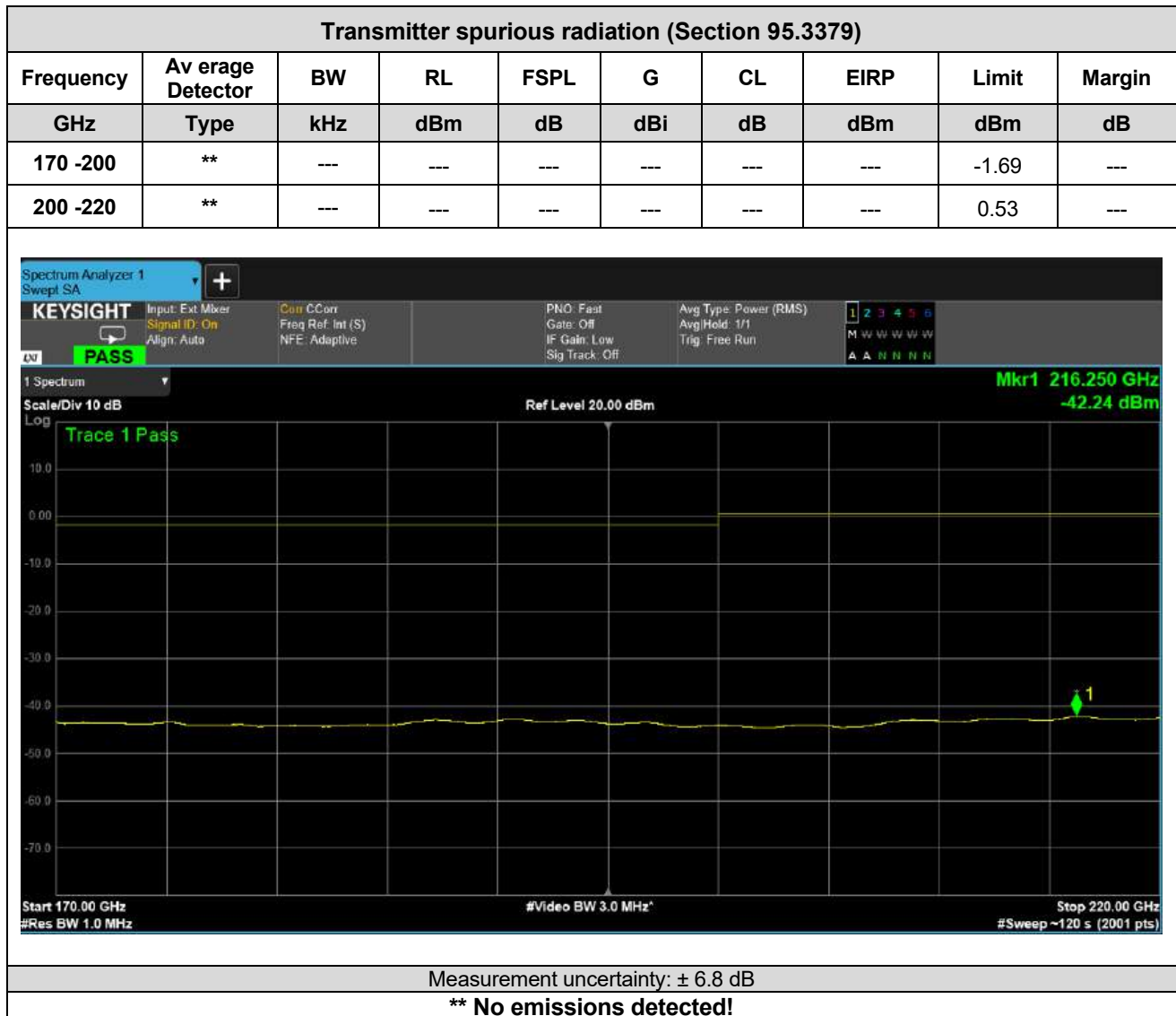
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

170 GHz – 220 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 688
Additional equipment	☒ 677			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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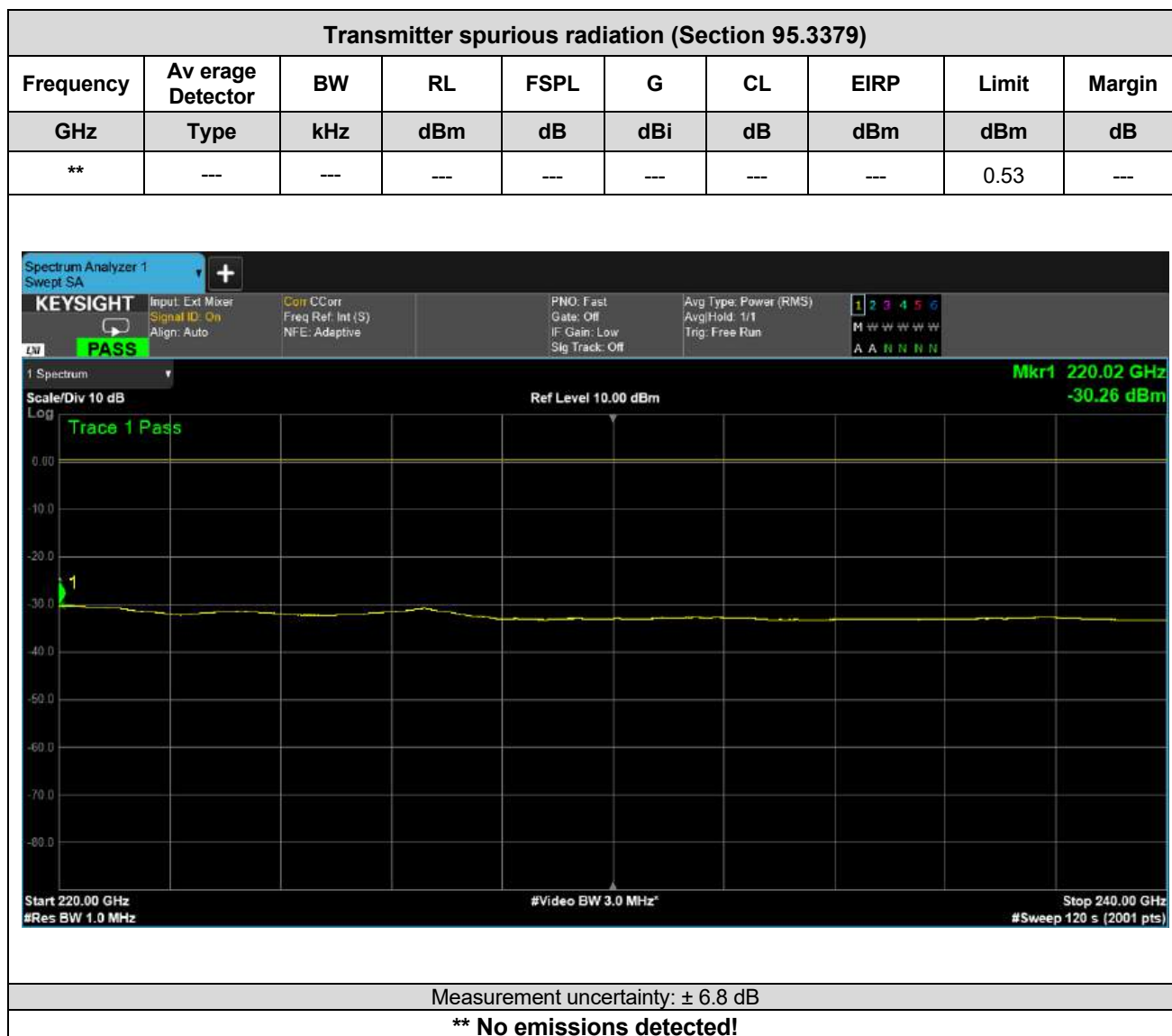
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

220 GHz – 240 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 689
Additional equipment	☒ 679			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

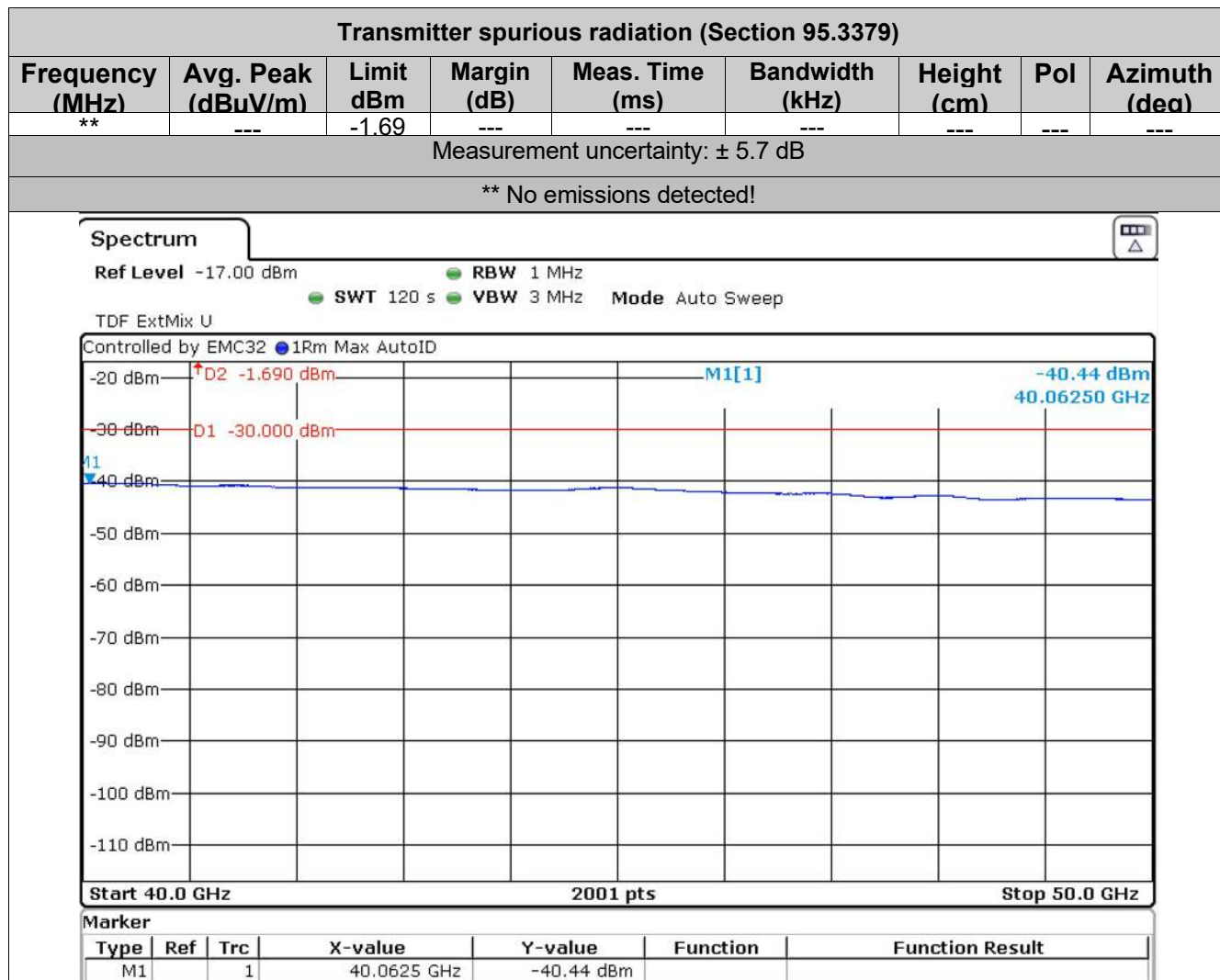
The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
Test setup photos	☒ Yes	☐ No	Annex no. 6

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Waveform 0, Centre frequency @ 76.605 GHz40 GHz – 50 GHz**Test location and equipment**

Test site	☒ 706 Semi Anechoic Chamber			
	☒ 707	☒ 708	☒ 709	
Receiver	☐ 665	☐ 666	☒ 502	
Antenna	☐ 406	☒ 442	☐ 454a	☒ 518
Additional equipment	☒ 515			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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EUT: QR4000

FCC ID: ZKS-QR4000

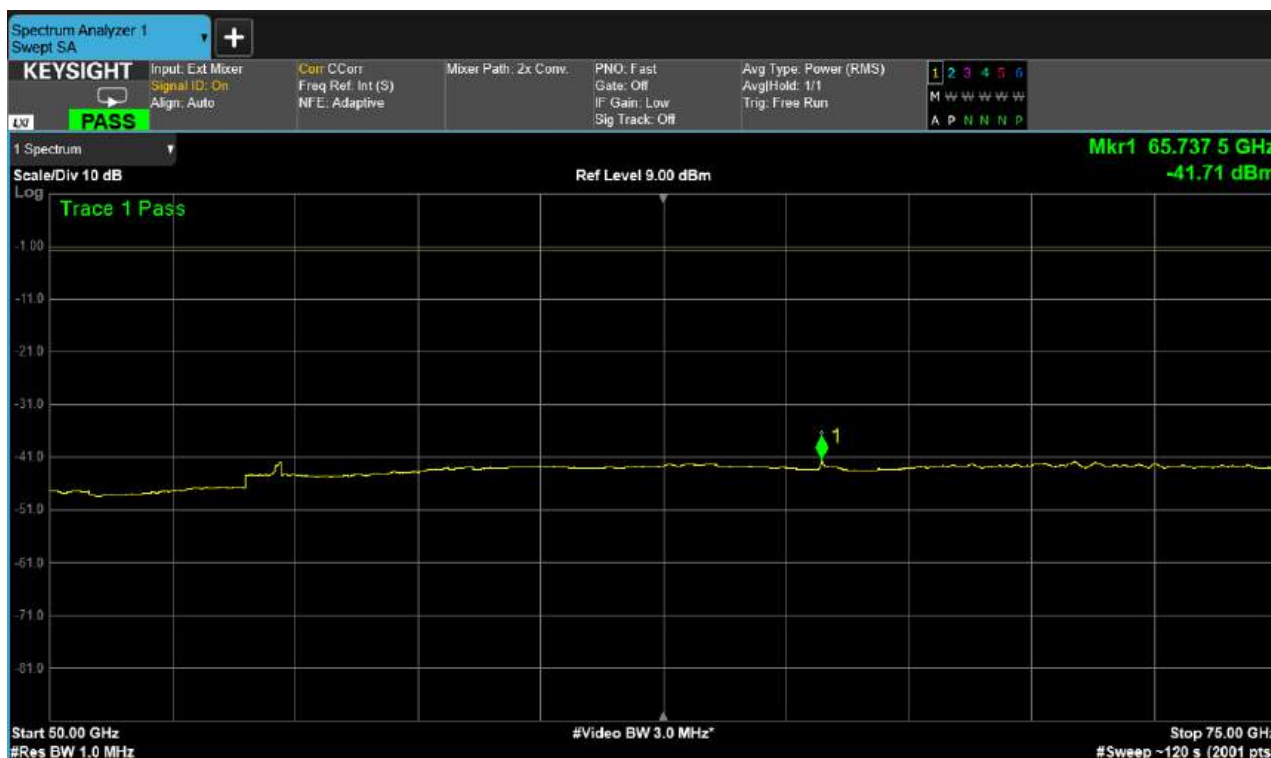
FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

50 GHz – 75 GHz

Transmitter spurious radiation (Section 95.3379)

Frequency	Average Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB
**	---	---	---	---	---	---	---	-1.69	---

Measurement uncertainty: ± 6.8 dB**** No emissions detected!**

Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☒ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 384
Additional equipment	☒ 673			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests

☒ Yes☐ No☐ N.t.*

Test setup photos

☒ Yes☐ No

Annex no. 6

V. 1.24

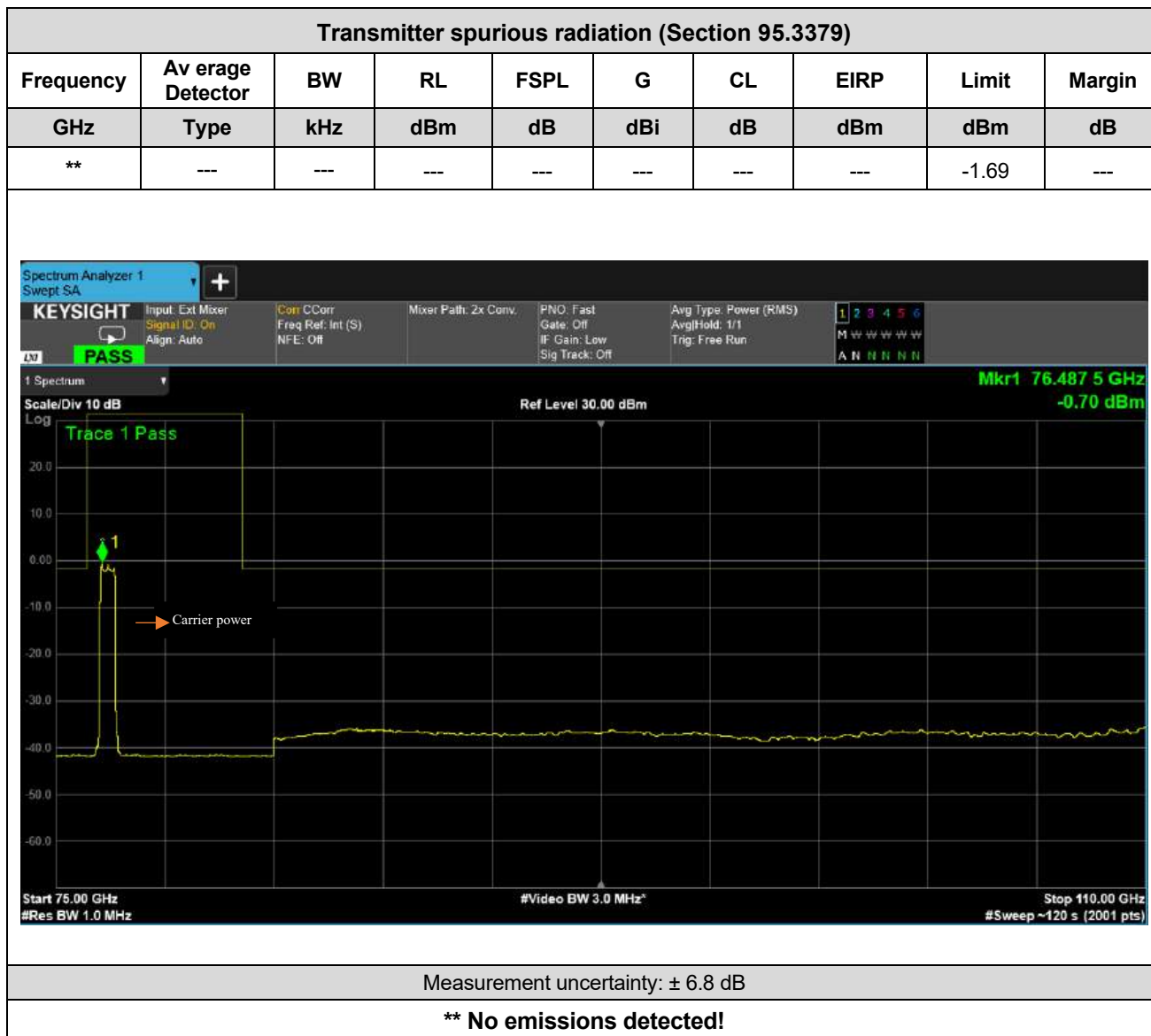
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

75 GHz – 110 GHz



Test location and equipment

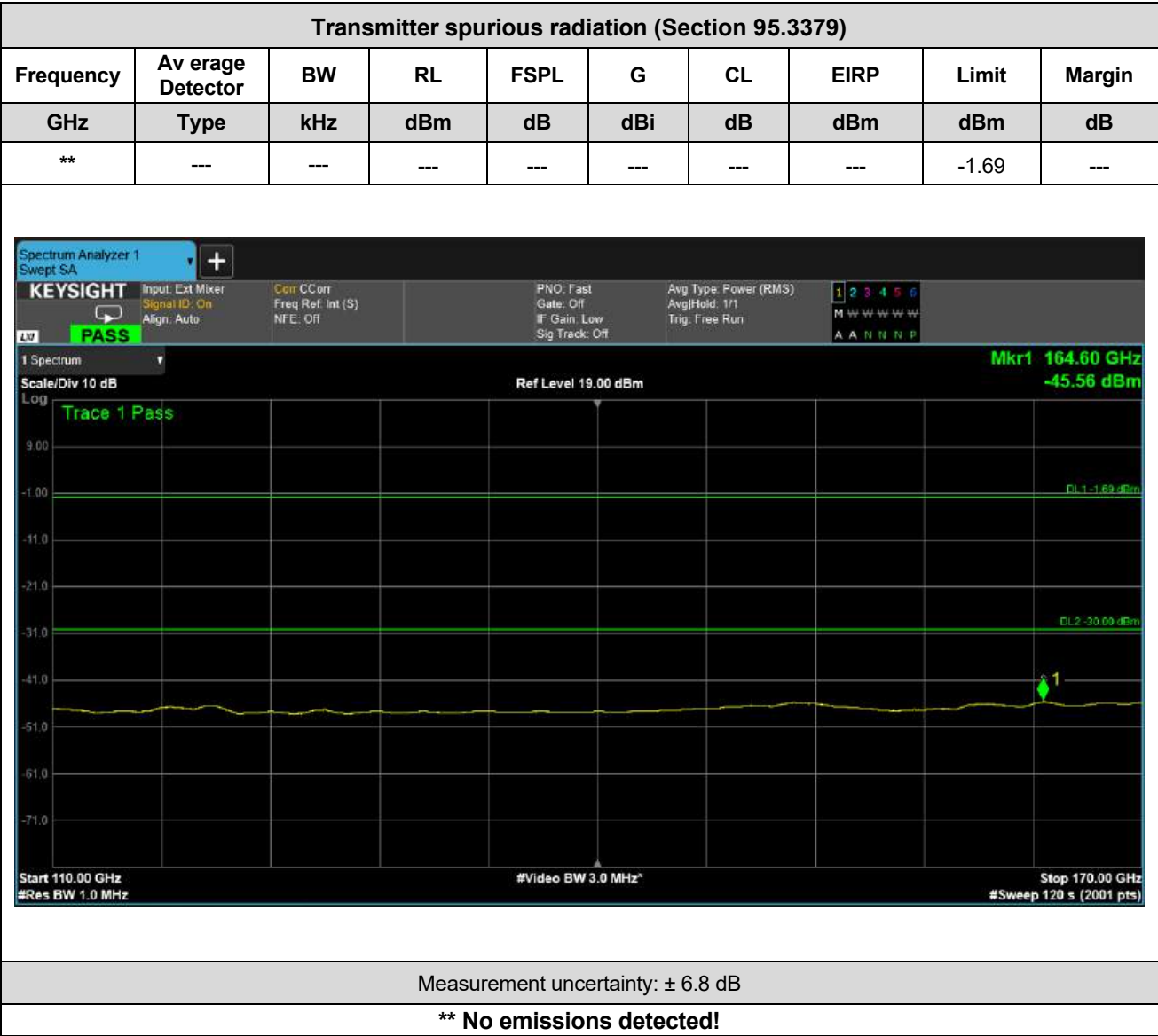
Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 385
Additional equipment	☒ 674			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
Test setup photos	☒ Yes	☐ No	Annex no. 6

V. 1.24

EUT: QR4000 FCC ID: ZKS-QR4000 FCC Title 47 CFR Part 95 M Date of issue: 2024-08-20

110 GHz – 170 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 687
Additional equipment	☒ 675			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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EUT: QR4000

FCC ID: ZKS-QR4000

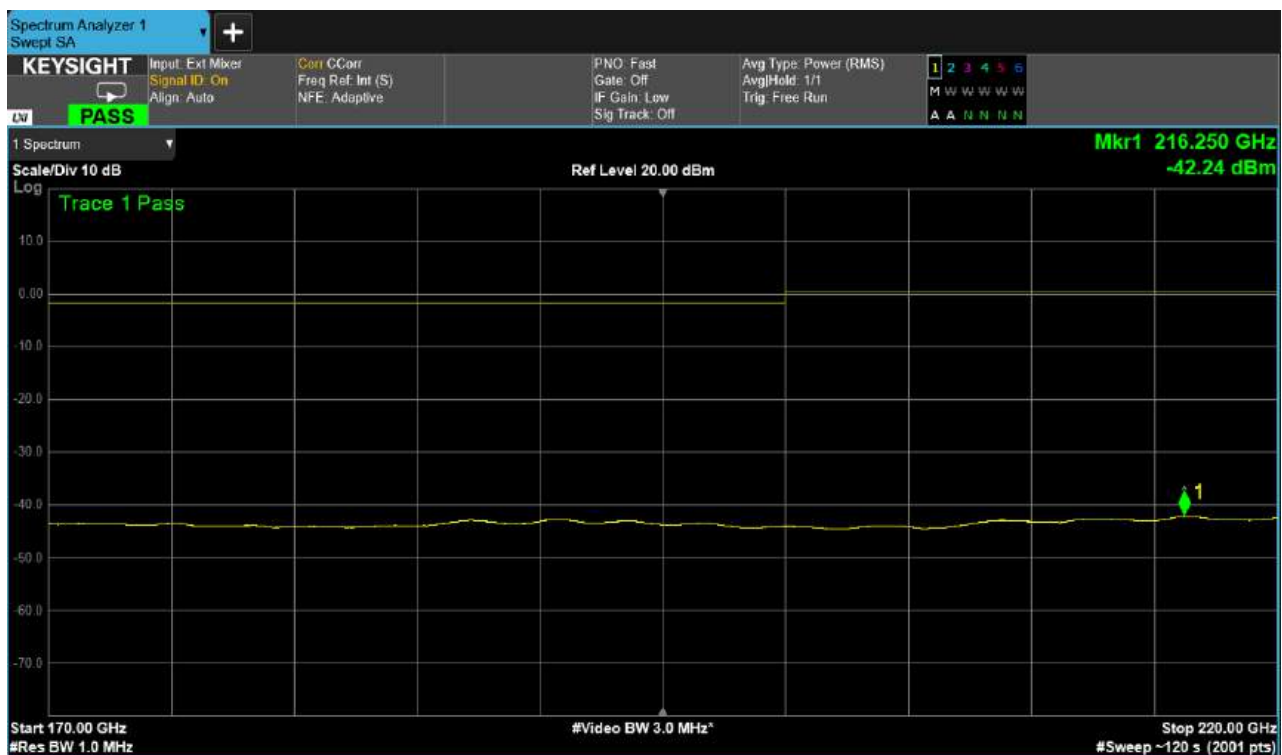
FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

170 GHz – 220 GHz

Transmitter spurious radiation (Section 95.3379)

Frequency	Average Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB
170 -200	**	---	---	---	---	---	---	-1.69	---
200 -220	**	---	---	---	---	---	---	0.53	---

Measurement uncertainty: ± 6.8 dB**** No emissions detected!**

Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber
	☐ 707 ☒ 708 ☐ 709
Receiver	☐ 665 ☒ 666 ☐ 502
Antenna	☐ 406 ☐ 442 ☐ 454a ☒ 688
Additional equipment	☒ 677
Cable	☐ K189 ☐ K193 ☐ K195 ☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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V. 1.24

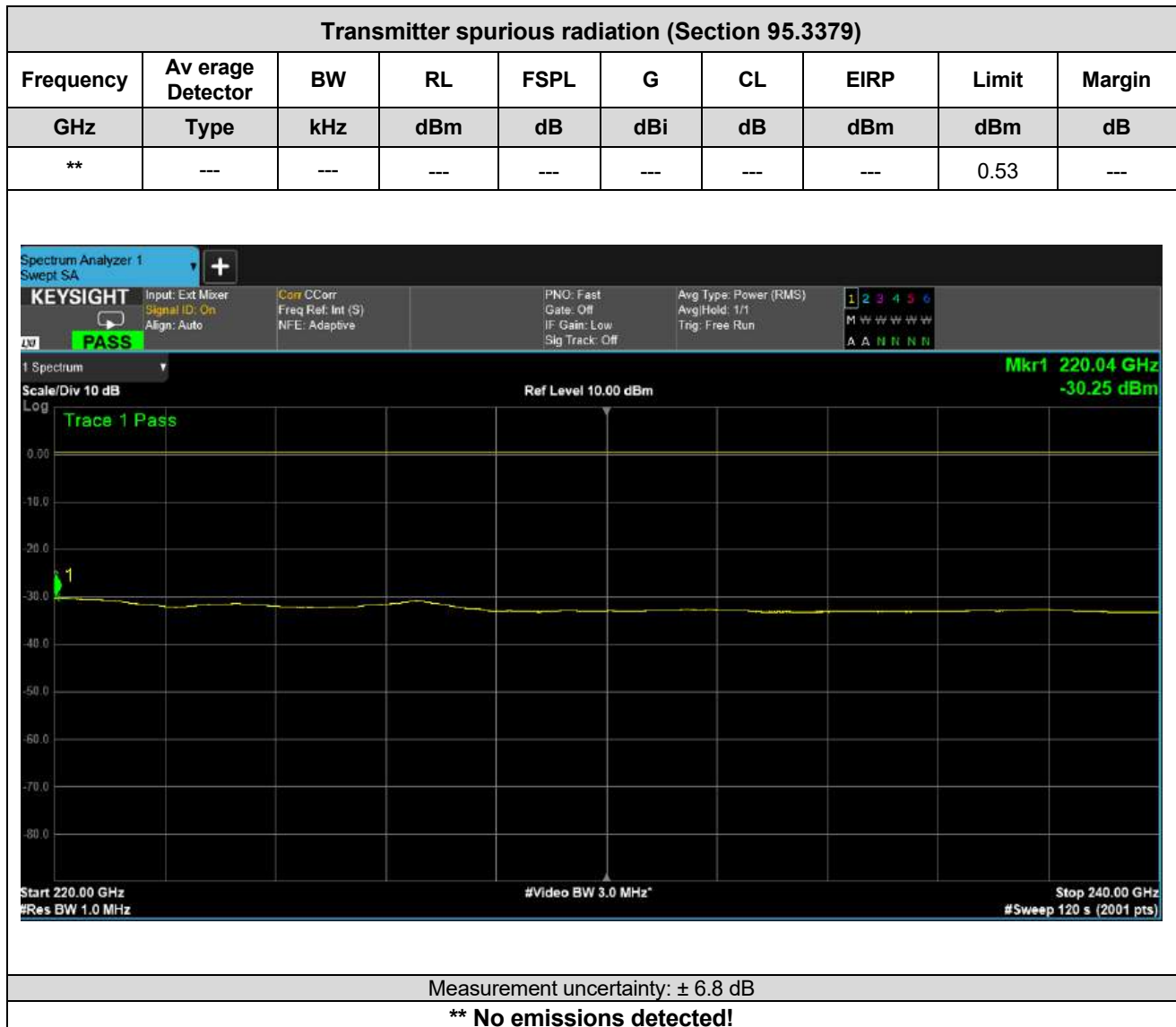
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

220 GHz – 240 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 689
Additional equipment	☒ 679			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
--	---	-----------------------------	--

Test setup photos	☒ Yes	☐ No	Annex no. 6
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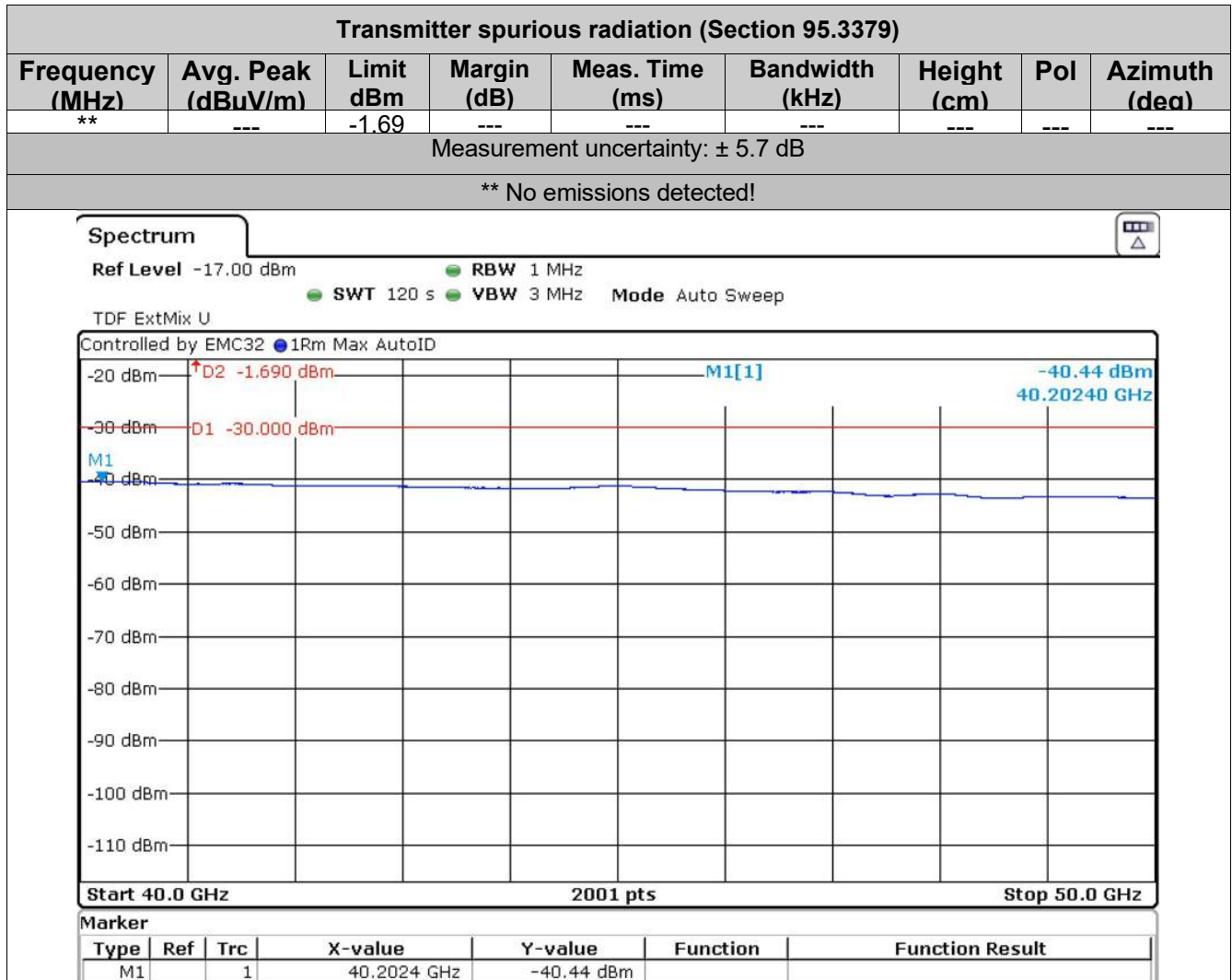
V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Waveform 1, Centre frequency @ 76.125 GHz40 GHz – 50 GHz**Test location and equipment**

Test site	☒ 706 Semi Anechoic Chamber			
	☒ 707	☒ 708	☒ 709	
Receiver	☐ 665	☐ 666	☒ 502	
Antenna	☐ 406	☒ 442	☐ 454a	☒ 518
Additional equipment	☒ 515			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
--	---	-----------------------------	--

Test setup photos	☒ Yes	☐ No	Annex no. 6
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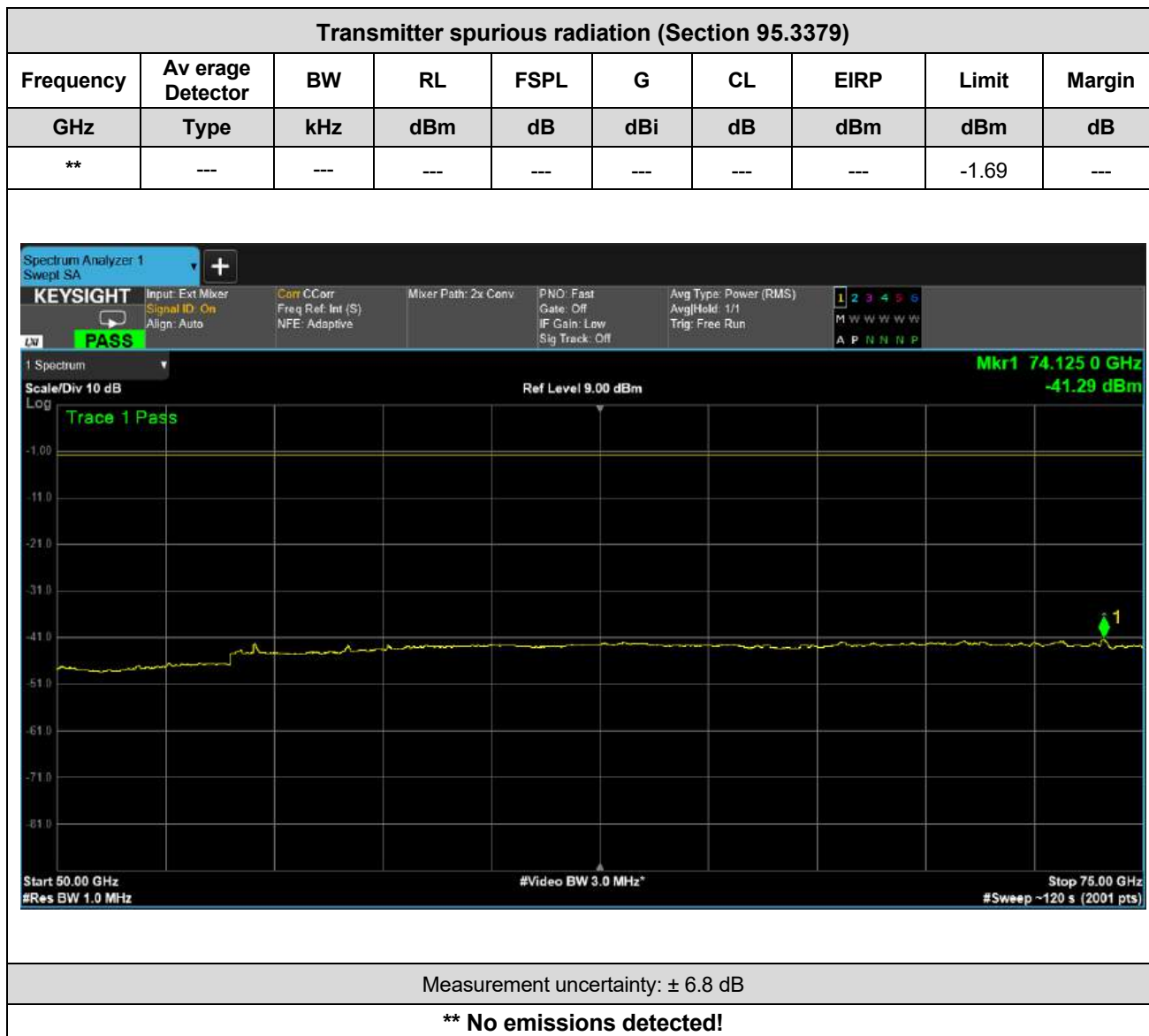
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

50 GHz – 75 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☒ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 384
Additional equipment	☒ 673			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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V. 1.24

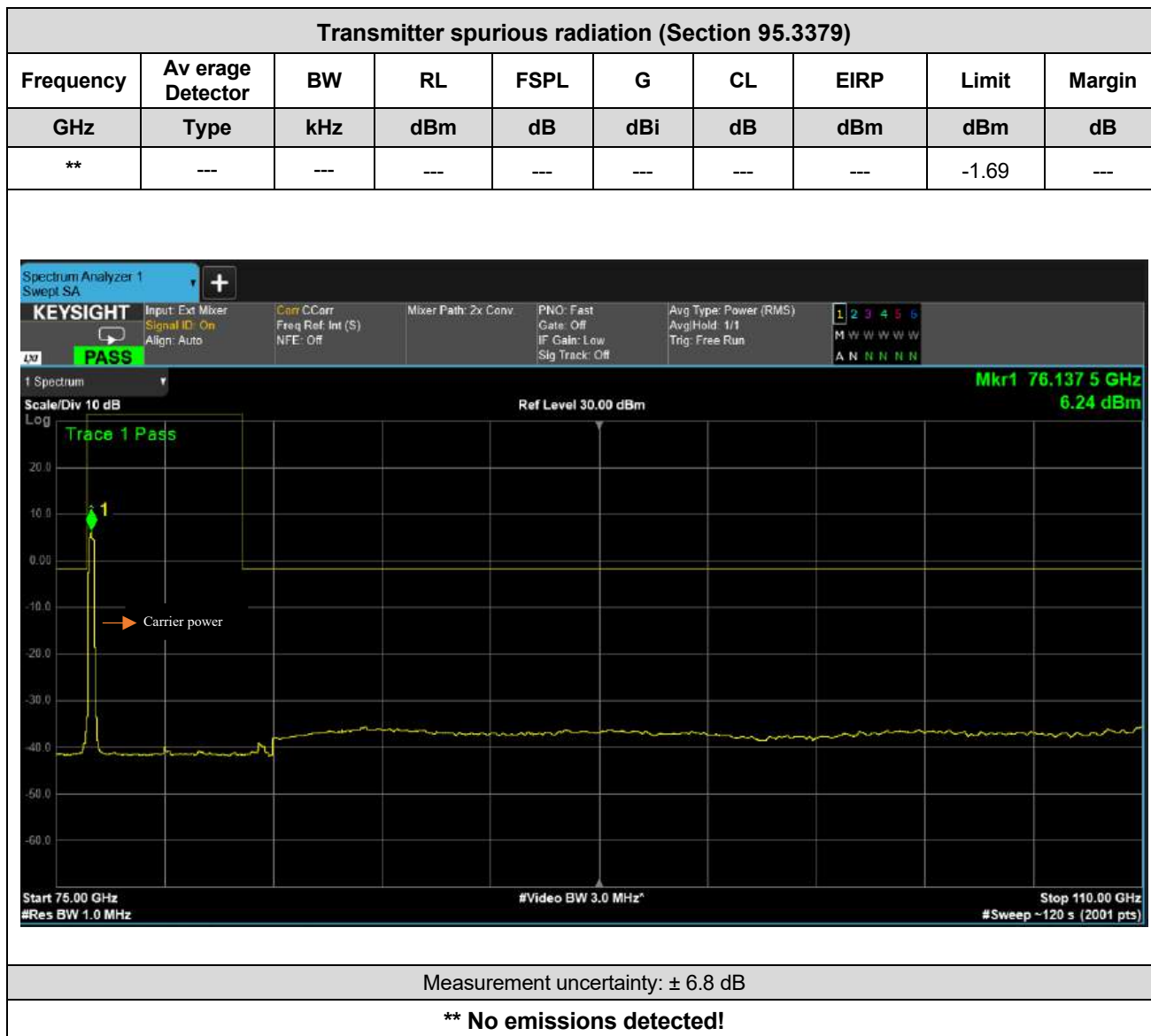
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

75 GHz – 110 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 385
Additional equipment	☒ 674			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
Test setup photos	☒ Yes	☐ No	Annex no. 6

V. 1.24

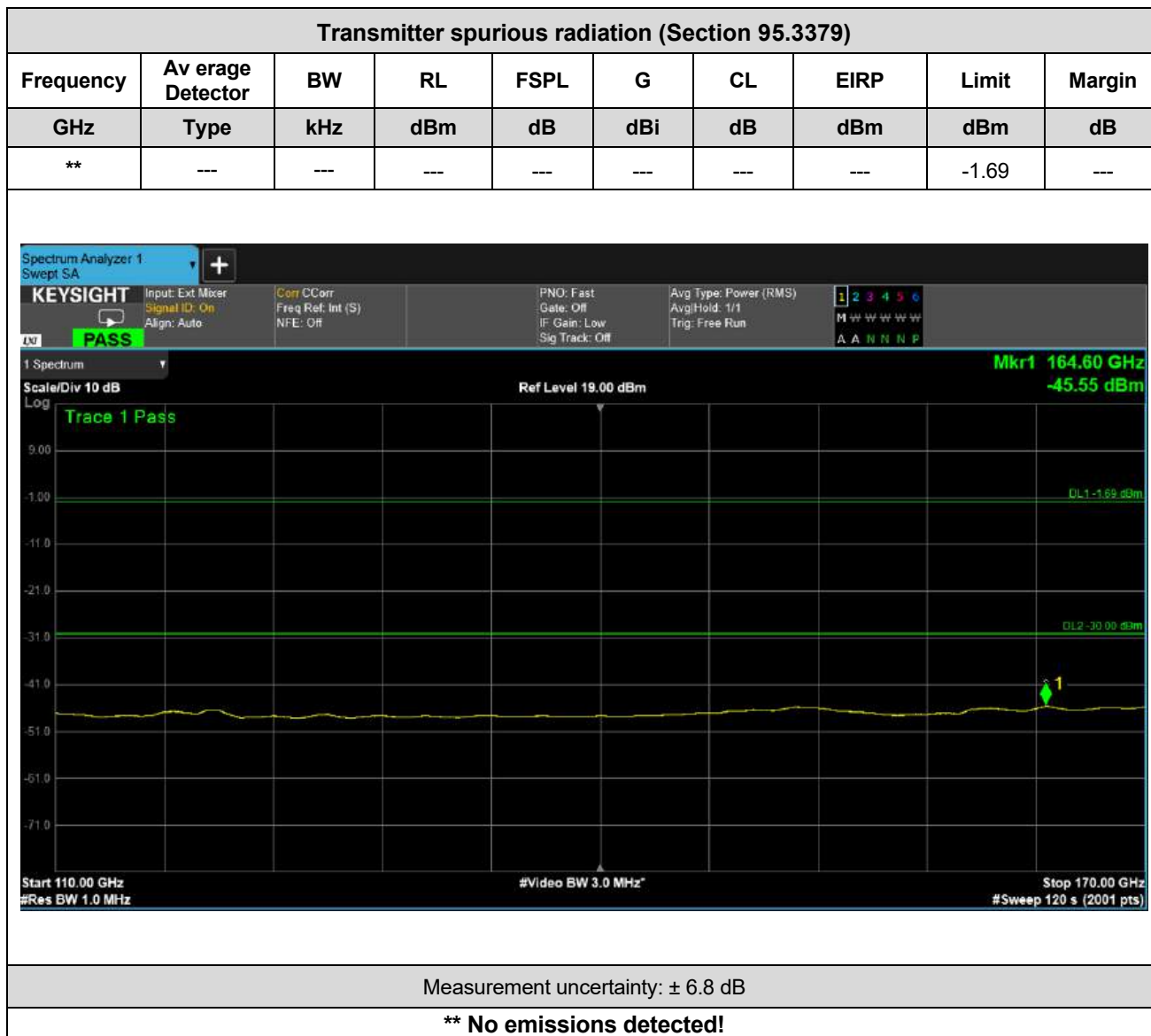
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

110 GHz – 170 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 687
Additional equipment	☒ 675			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
Test setup photos	☒ Yes	☐ No	Annex no. 6

V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

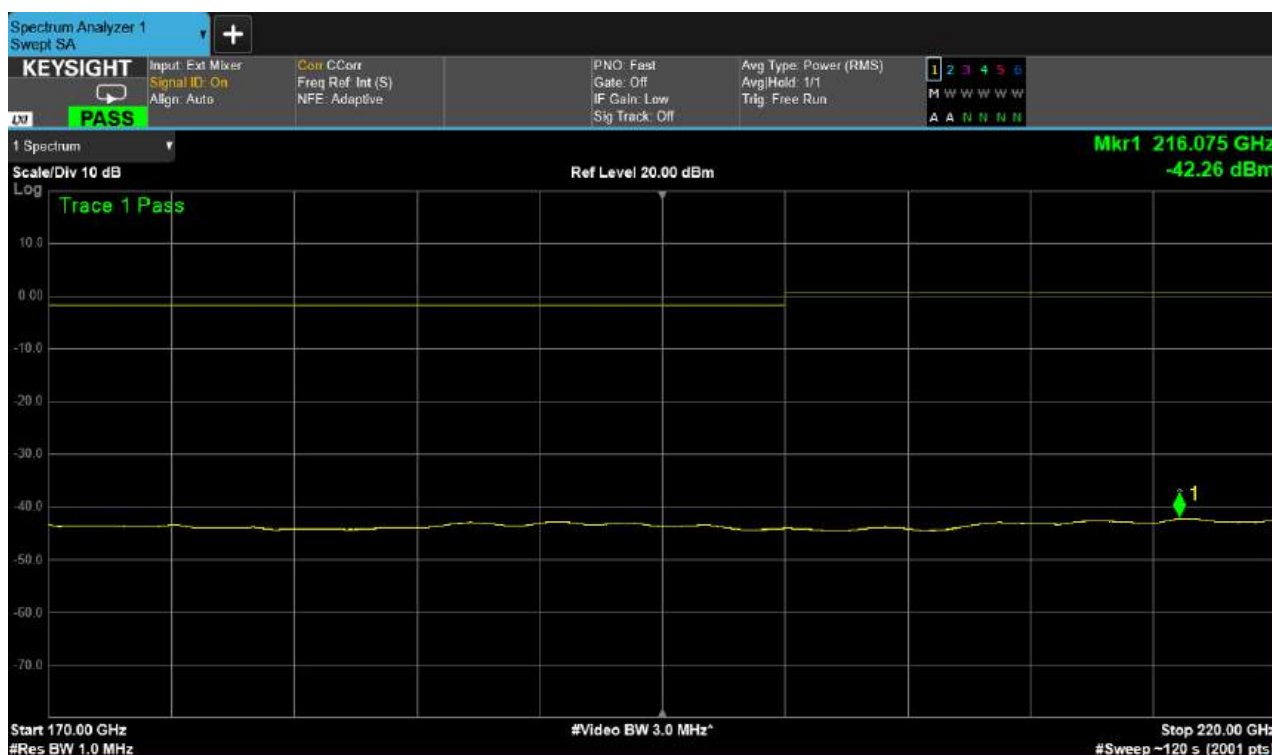
FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

170 GHz – 220 GHz

Transmitter spurious radiation (Section 95.3379)

Frequency	Average Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB
170 -200	**	---	---	---	---	---	---	-1.69	---
200 -220	**	---	---	---	---	---	---	0.53	---

Measurement uncertainty: ± 6.8 dB**** No emissions detected!**

Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber
	☐ 707 ☒ 708 ☐ 709
Receiver	☐ 665 ☒ 666 ☐ 502
Antenna	☐ 406 ☐ 442 ☐ 454a ☒ 688
Additional equipment	☒ 677
Cable	☐ K189 ☐ K193 ☐ K195 ☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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V. 1.24

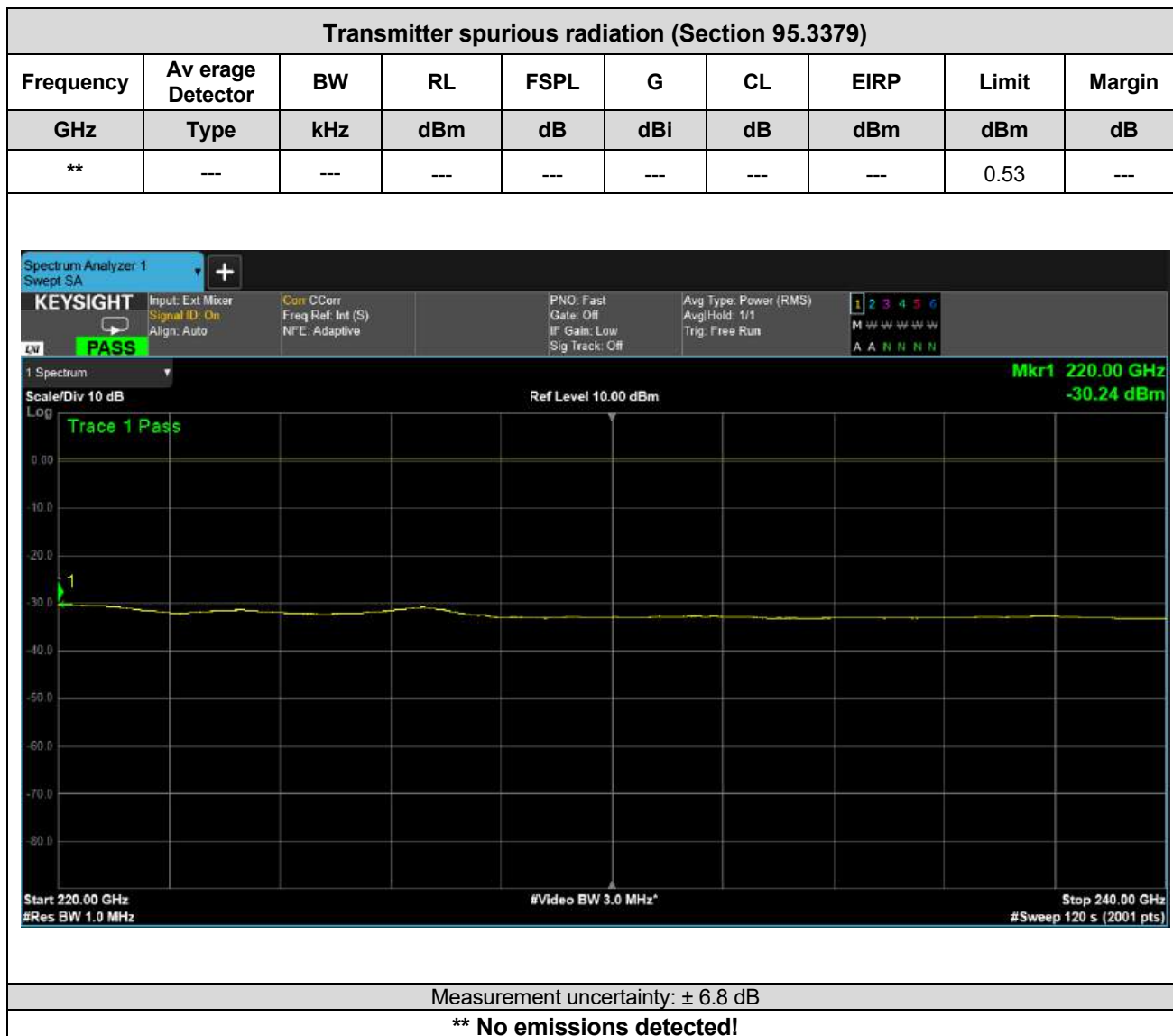
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

220 GHz – 240 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 689
Additional equipment	☒ 679			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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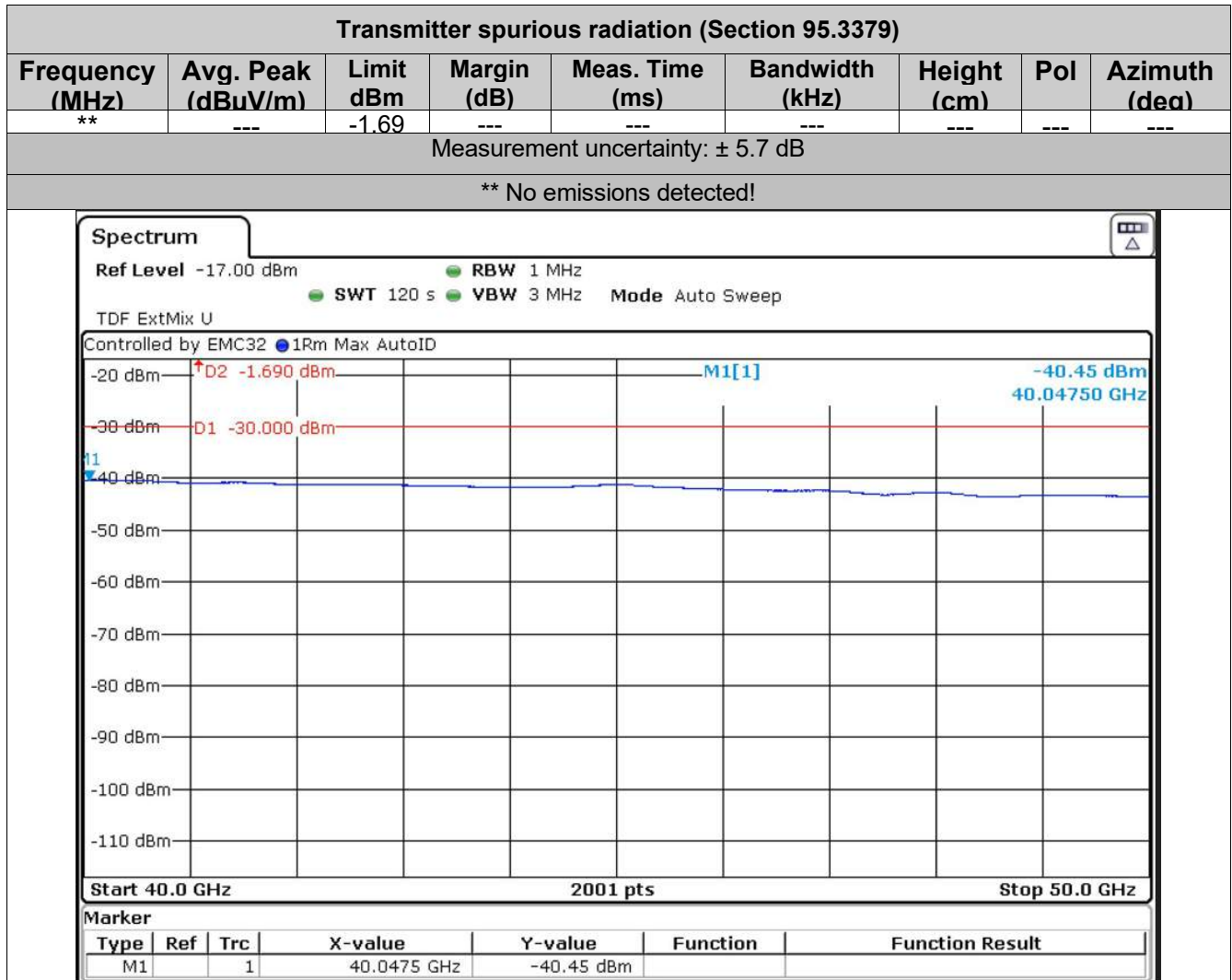
V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Waveform 1, Centre frequency @ 76.845 GHz40 GHz – 50 GHz**Test location and equipment**

Test site	☒ 706 Semi Anechoic Chamber			
	☒ 707	☒ 708	☒ 709	
Receiver	☐ 665	☐ 666	☒ 502	
Antenna	☐ 406	☒ 442	☐ 454a	☒ 518
Additional equipment	☒ 515			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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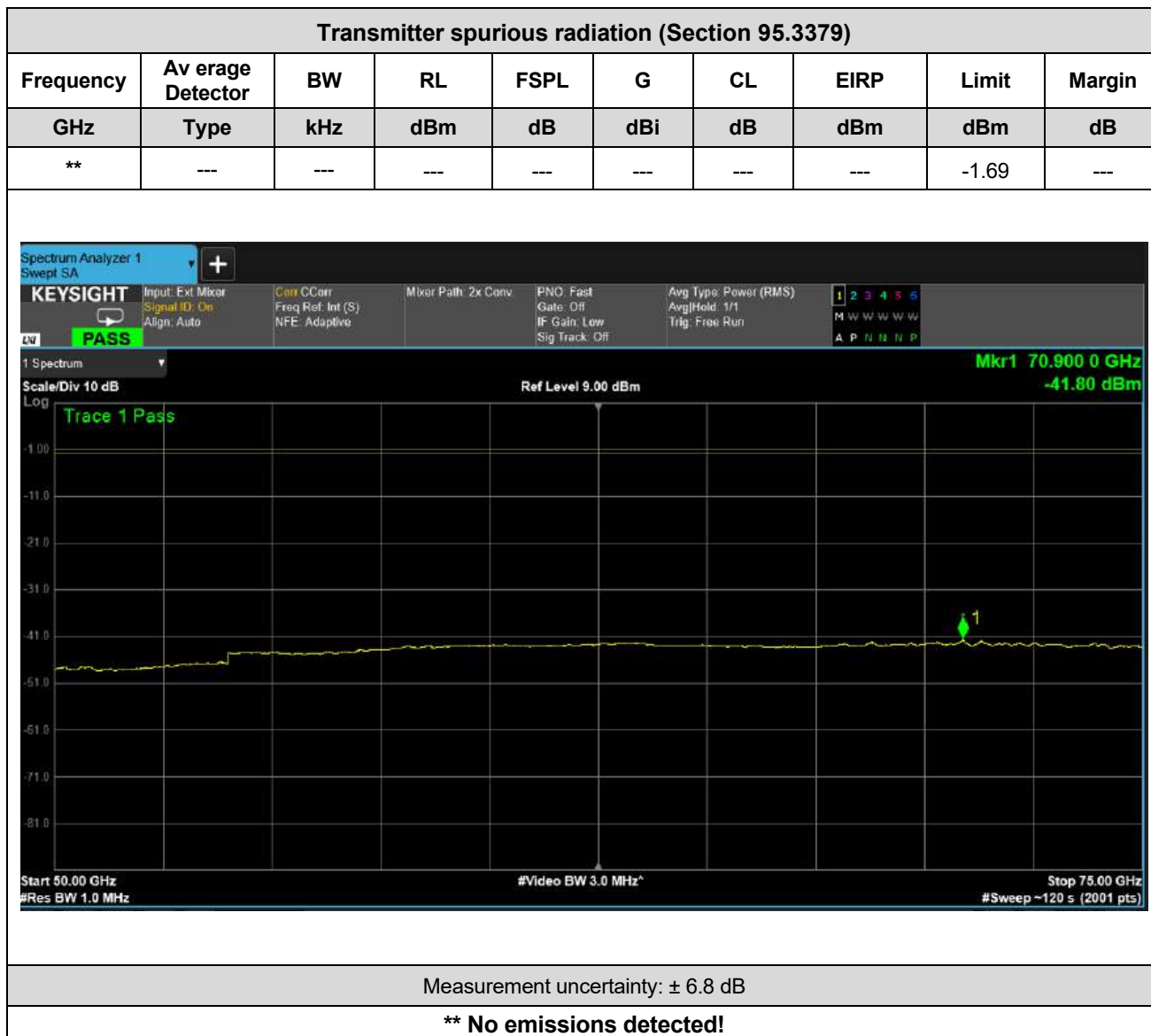
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

50 GHz – 75 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☒ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 384
Additional equipment	☒ 673			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
Test setup photos	☒ Yes	☐ No	Annex no. 6

V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

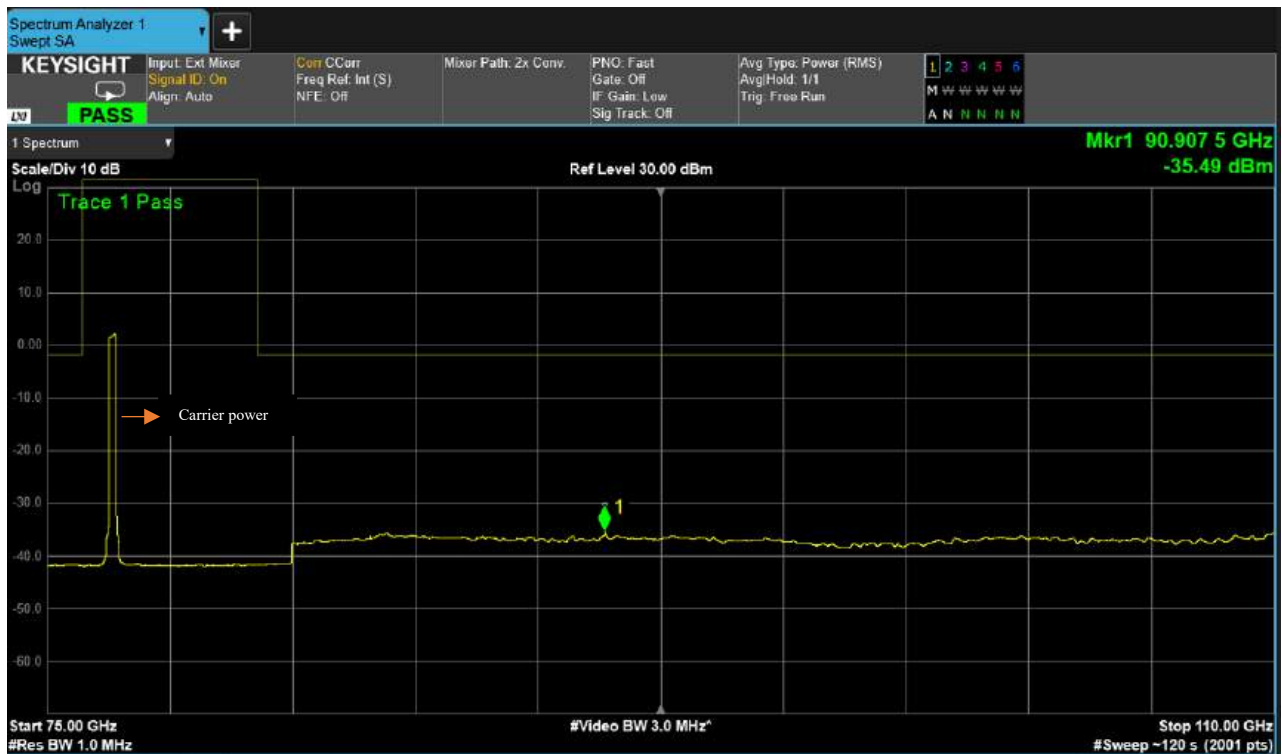
FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

75 GHz – 110 GHz

Transmitter spurious radiation (Section 95.3379)

Frequency	Average Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB
**	---	---	---	---	---	---	---	-1.69	---

Measurement uncertainty: ± 6.8 dB**** No emissions detected!**

Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber
	☐ 707 ☒ 708 ☐ 709
Receiver	☐ 665 ☒ 666 ☐ 502
Antenna	☐ 406 ☐ 442 ☐ 454a ☒ 385
Additional equipment	☒ 674
Cable	☐ K189 ☐ K193 ☐ K195 ☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

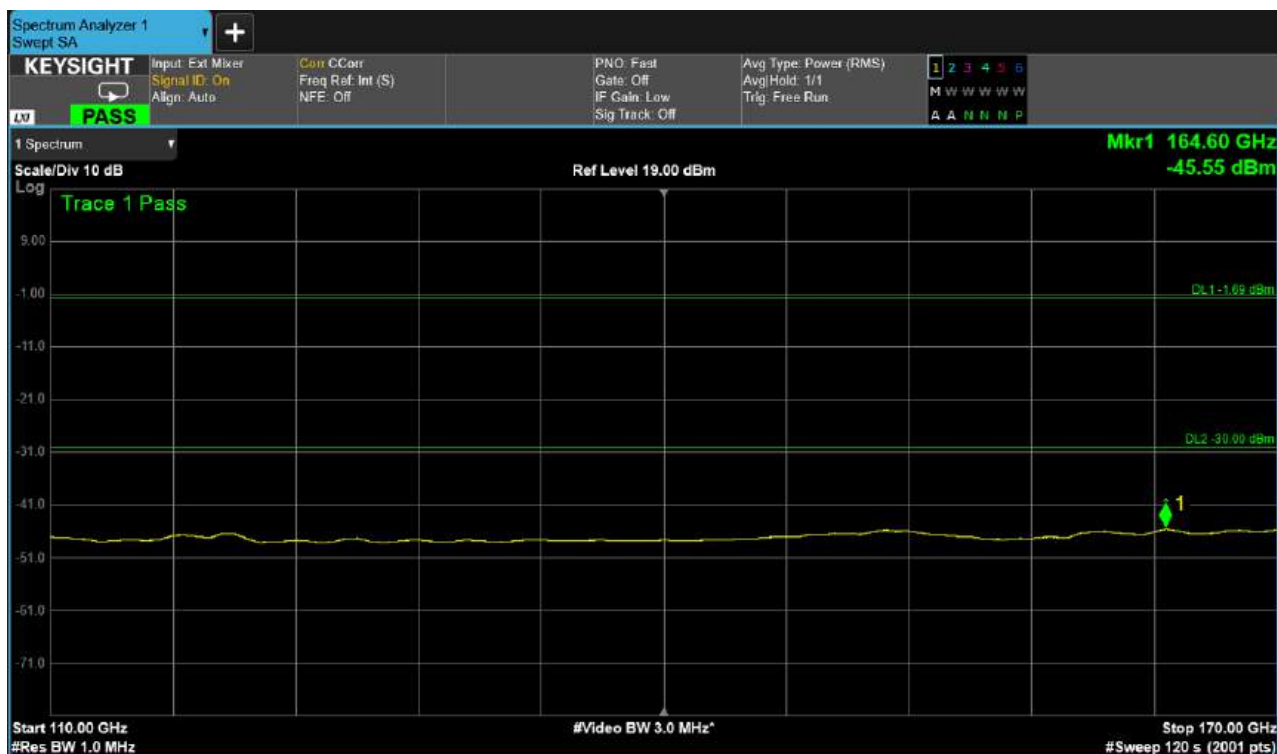
FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

110 GHz – 170 GHz

Transmitter spurious radiation (Section 95.3379)

Frequency	Average Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB
**	---	---	---	---	---	---	---	-1.69	---

Measurement uncertainty: ± 6.8 dB**** No emissions detected!**

Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 687
Additional equipment	☒ 675			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

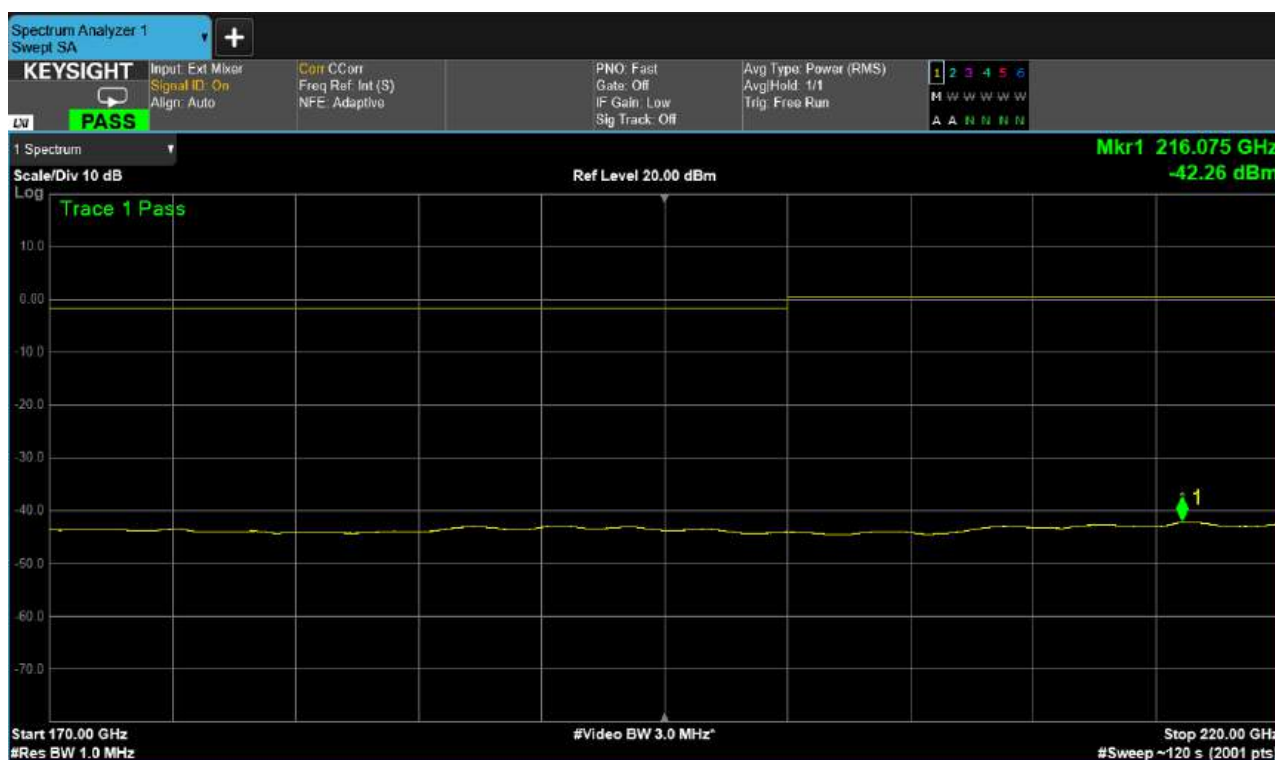
FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

170 GHz – 220 GHz

Transmitter spurious radiation (Section 95.3379)

Frequency	Average Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB
170 -200	**	---	---	---	---	---	---	-1.69	---
200 -220	**	---	---	---	---	---	---	0.53	---

Measurement uncertainty: ± 6.8 dB**** No emissions detected!**

Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 688
Additional equipment	☒ 677			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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V. 1.24

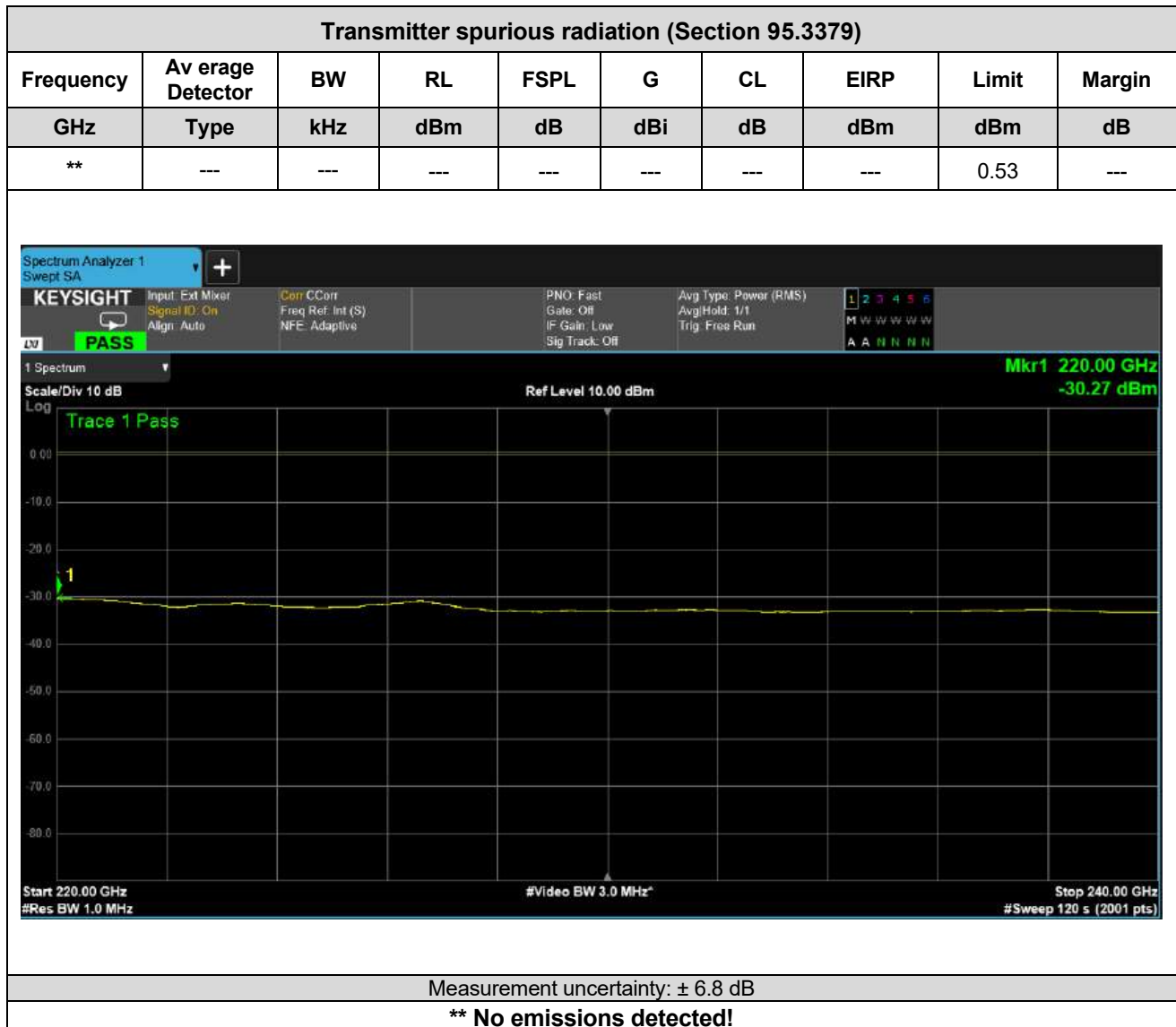
EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

220 GHz – 240 GHz



Test location and equipment

Test site	☒ 706 Semi Anechoic Chamber			
	☐ 707	☒ 708	☐ 709	
Receiver	☐ 665	☒ 666	☐ 502	
Antenna	☐ 406	☐ 442	☐ 454a	☒ 689
Additional equipment	☒ 679			
Cable	☐ K189	☐ K193	☐ K195	☒ K163

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
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Test setup photos	☒ Yes	☐ No	Annex no. 6
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V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.6 Occupied Bandwidth

7.6.1 Regulation

According to FCC § 95.3379 (b) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 °C with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

7.6.2 Test procedure

Occupied Bandwidth (99 % Bandwidth) and 26 dB bandwidth were measured. The Occupied Bandwidth was measured directly from the spectrum analyzer's in-built measurement function with correct analyzer settings (RBW, VBW, detector, span and etc). For 6 dB Bandwidth, the measurement settings and procedure were carried out in accordance with the ANSI C63.10-2013 section 9.3. The bandwidth measurements were also performed in extreme environmental conditions.

7.6.3 Test Result

#Waveform 0#

Centre Frequency GHz	Measured 99% BW MHz	Measured 6dB BW MHz
@ 76.402	496.8	483.9
@ 76.642	497.1	483.9

#Waveform 1#

Centre Frequency GHz	Measured 99% BW MHz	Measured 6dB BW MHz
@ 76.193	183.4	178.7
@ 76.859	183.9	178.3

Test location and equipment

Test site	☐ 660 Semi Anechoic Chamber			
	☐ 667	☐ 668	☐ 669	☒ 102a
Receiver	☐ 665 ☒ 666			
Antenna	☐ 406	☐ 442	☐ 454a	☒ 385
Additional equipment	☐ 562	☐ 28a	☒ 674	☒ 226
Cable	☐ K189	☐ K193	☐ K195	☒ K164

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t.*
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Test setup photos / test results are attached	☒ Yes	☐ No	Annexe no.: 3, 6
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EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.7 Frequency Tolerance

7.7.1 Regulation

According to FCC § 95.3379 (b) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 °C with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

7.7.2 Test Procedure

Frequency stability with respect to ambient temperature:

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. If possible, a dummy load should be connected to the EUT, because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn the EUT on, and tune it to one of the number of frequencies required.

Couple the intentional radiator output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable and placing the measurement antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator, if necessary.

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. Turn the EUT on, and couple its output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable.

Adjust the location of the measurement antenna and the controls on the measuring instrument to obtain a suitable signal level (i.e., a level that will not overload the measuring instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

Tune the EUT to any one of the number of frequencies specified. Turn the EUT off, and place it inside an environmental chamber if appropriate. Allow the chamber to stabilize at +20 °C before proceeding. Turn on the EUT, and record the operating frequency of the intentional radiator at startup and two, five, and ten minutes after startup. Turn the EUT off and allow it to cool to the ambient temperature, and then repeat this procedure for the number of the frequencies specified. Four measurements are made at each operating frequency.

Frequency stability with respect to input voltage:

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. If possible, a dummy load should be connected to the EUT, because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn the EUT on, and tune it to one of the number of frequencies required.

Couple the intentional radiator output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable and placing the measurement antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator, if necessary.

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Adjust the location of the measurement antenna and the controls on the measuring instrument to obtain a suitable signal level (i.e., a level that will not overload the measuring instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT). Turn the EUT off, and place it inside an Environmental temperature chamber. For devices that are normally operated continuously, the EUT may be energized while inside the test chamber. For devices that have oscillator heaters, energize only the heater circuit while the EUT is inside the chamber.

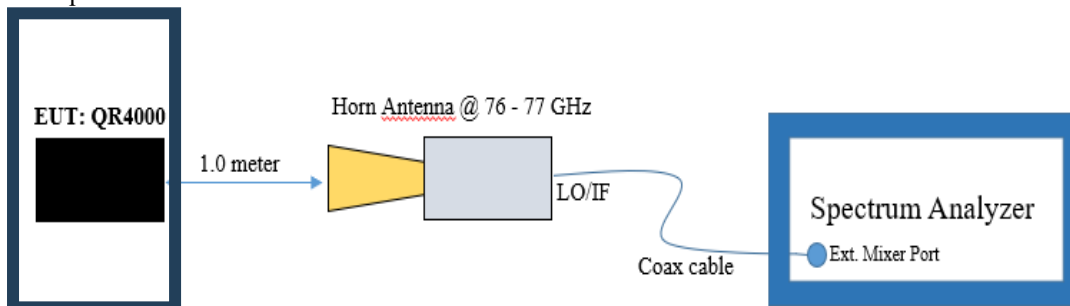
Set the temperature control on the chamber to the highest specified EUT operating temperature, and allow the temperature inside the chamber to stabilize at the set temperature before starting frequency measurements.

While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup and two, five, and ten minutes after the EUT is energized. Four measurements in total are made.

Repeat the above procedure until the number of frequencies specified has been measured. After all measurements have been made at the highest specified temperature, turn the EUT off. Repeat the above measurement process for the EUT with the test chamber set at the lowest temperature specified by the regulatory or procuring agency. Measurements shall be made at the number of frequencies specified.

7.7.3 Test Setup

Temperature Chamber



EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.7.3 Test Results

Waveform 0 @ 76.365 (lower frequency)

Test conditions	Frequency tolerance			
	Frequency (GHz)			
$T_{nom} = +22^{\circ} \text{ C}$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$V_{min} = 7 \text{ V DC}$	76.16373	76.65948	76.0	81.0
$V_{nom} = 24 \text{ V DC}$	76.16322	76.66000	76.0	81.0
$V_{max} = 32 \text{ V DC}$	76.16385	76.66117	76.0	81.0
Measurement uncertainty		$\pm 5 \cdot 10^{-8}$		

Test conditions	Frequency tolerance			
	Frequency Measured (GHz)			
$V_{nom} = 24 \text{ V DC}$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$T_{min} -40^{\circ} \text{ C}$	76.16597	76.66216	76.0	81.0
$T_{min} -20^{\circ} \text{ C}$	76.16701	76.66187	76.0	81.0
$T_{min} -10^{\circ} \text{ C}$	76.16653	76.66257	76.0	81.0
$T_{min} 0^{\circ} \text{ C}$	76.16491	76.66065	76.0	81.0
$T_{min} +10^{\circ} \text{ C}$	76.16374	76.66054	76.0	81.0
$T_{min} +20^{\circ} \text{ C}$	76.16276	76.66113	76.0	81.0
$T_{min} +30^{\circ} \text{ C}$	76.16239	76.65957	76.0	81.0
$T_{min} +40^{\circ} \text{ C}$	76.16341	76.66118	76.0	81.0
$T_{min} +50^{\circ} \text{ C}$	76.16235	76.65934	76.0	81.0
$T_{min} +85^{\circ} \text{ C}$	76.16248	76.66049	76.0	81.0
Measurement uncertainty		$\pm 5 \cdot 10^{-8}$		

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Waveform 0 @ 76.605 (upper frequency)

Test conditions	Frequency tolerance			
	Frequency Measured (GHz)			
$T_{nom} = +22^{\circ} \text{ C}$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$V_{min} = 7 \text{ V DC}$	76.40401	76.90087	76.0	81.0
$V_{nom} = 24 \text{ V DC}$	76.40436	76.90146	76.0	81.0
$V_{max} = 32 \text{ V DC}$	76.40381	76.90078	76.0	81.0
Measurement uncertainty $\pm 5 \cdot 10^{-8}$				

Test conditions	Frequency tolerance			
	Frequency Measured (GHz)			
$V_{nom} = 24 \text{ V DC}$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$T_{min} -40^{\circ} \text{ C}$	76.40502	76.90369	76.0	81.0
$T_{min} -20^{\circ} \text{ C}$	76.40540	76.90188	76.0	81.0
$T_{min} -10^{\circ} \text{ C}$	76.40544	76.90204	76.0	81.0
$T_{min} 0^{\circ} \text{ C}$	76.40463	76.90160	76.0	81.0
$T_{min} +10^{\circ} \text{ C}$	76.40438	76.90020	76.0	81.0
$T_{min} +20^{\circ} \text{ C}$	76.40286	76.90085	76.0	81.0
$T_{min} +30^{\circ} \text{ C}$	76.40273	76.89935	76.0	81.0
$T_{min} +40^{\circ} \text{ C}$	76.40303	76.89963	76.0	81.0
$T_{min} +50^{\circ} \text{ C}$	76.40164	76.89907	76.0	81.0
$T_{min} +85^{\circ} \text{ C}$	76.40019	76.90062	76.0	81.0
Measurement uncertainty $\pm 5 \cdot 10^{-8}$				

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Waveform 1 @ 76.125 (lower frequency)

Test conditions	Frequency tolerance			
	Frequency Measured (GHz)			
$T_{nom} = +22^{\circ} \text{ C}$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$V_{min} = 7 \text{ V DC}$	76.04965	76.23387	76.0	81.0
$V_{nom} = 24 \text{ V DC}$	76.05000	76.23340	76.0	81.0
$V_{max} = 32 \text{ V DC}$	76.04999	76.23358	76.0	81.0
Measurement uncertainty $\pm 5 \cdot 10^{-8}$				

Test conditions	Frequency tolerance			
	Frequency Measured (GHz)			
$V_{nom} = 24 \text{ V DC}$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$T_{min} -40^{\circ} \text{ C}$	76.05143	76.23620	76.0	81.0
$T_{min} -20^{\circ} \text{ C}$	76.05170	76.23572	76.0	81.0
$T_{min} -10^{\circ} \text{ C}$	76.05150	76.23491	76.0	81.0
$T_{min} 0^{\circ} \text{ C}$	76.05138	76.23538	76.0	81.0
$T_{min} +10^{\circ} \text{ C}$	76.05062	76.23516	76.0	81.0
$T_{min} +20^{\circ} \text{ C}$	76.05034	76.23474	76.0	81.0
$T_{min} +30^{\circ} \text{ C}$	76.05010	76.23328	76.0	81.0
$T_{min} +40^{\circ} \text{ C}$	76.05009	76.23457	76.0	81.0
$T_{min} +50^{\circ} \text{ C}$	76.04957	76.23353	76.0	81.0
$T_{min} +85^{\circ} \text{ C}$	76.05016	76.23341	76.0	81.0
Measurement uncertainty $\pm 5 \cdot 10^{-8}$				

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Waveform 1 @ 76.845 (upper frequency)

Test conditions	Frequency tolerance			
	Frequency Measured (GHz)			
$T_{nom} = +22^{\circ} \text{ C}$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$V_{min} = 7 \text{ V DC}$	76.76956	76.95382	76.0	81.0
$V_{nom} = 24 \text{ V DC}$	76.76958	76.95346	76.0	81.0
$V_{max} = 32 \text{ V DC}$	76.76980	76.95387	76.0	81.0
Measurement uncertainty $\pm 5 \cdot 10^{-8}$				

Test conditions	Frequency tolerance			
	Frequency Measured (GHz)			
$V_{nom} = 24 \text{ V DC}$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$T_{min} -40^{\circ} \text{ C}$	76.77204	76.95611	76.0	81.0
$T_{min} -20^{\circ} \text{ C}$	76.77175	76.95590	76.0	81.0
$T_{min} -10^{\circ} \text{ C}$	76.77185	76.95520	76.0	81.0
$T_{min} 0^{\circ} \text{ C}$	76.77146	76.95647	76.0	81.0
$T_{min} +10^{\circ} \text{ C}$	76.77003	76.95515	76.0	81.0
$T_{min} +20^{\circ} \text{ C}$	76.76995	76.95503	76.0	81.0
$T_{min} +30^{\circ} \text{ C}$	76.76982	76.95509	76.0	81.0
$T_{min} +40^{\circ} \text{ C}$	76.76952	76.95472	76.0	81.0
$T_{min} +50^{\circ} \text{ C}$	76.76951	76.95380	76.0	81.0
$T_{min} +85^{\circ} \text{ C}$	76.76973	76.95367	76.0	81.0
Measurement uncertainty $\pm 5 \cdot 10^{-8}$				

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Test site	☐ 660 Semi Anechoic Chamber			
	☐ 667	☐ 668	☐ 669	☒ 102a
Receiver	☐ 665 ☒ 666			
Antenna	☐ 406	☐ 442	☐ 454a	☒ 385
Additional equipment	☐ 562	☐ 28a	☒ 674	☒ 226
Cable	☐ K189	☐ K193	☐ K195	☒ K164

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
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Test setup photos / test results are attached	☒ Yes	☐ No	Annexe no.: 3, 6
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EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

7.8 76-81 GHz Band Radar Service RF exposure evaluation

7.8.1 Regulation

According to FCC §95.3385, regardless of the power density levels permitted under this subpart, devices operating under the provisions of this subpart are subject to the radiofrequency radiation exposure requirements specified in §§1.1307(b), 2.1091, and 2.1093 as appropriate. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

7.8.2 Test result

MPE calculation to the FCC ID: NBG01RS6

These equations are generally accurate in the far field of an antenna but will over predict power density in the near field, where they could be used for making a “worst case” prediction.

$$S = PG/4\pi R^2 \quad \text{or} \quad S = \text{EIRP} / (4\pi R^2)$$

Where:

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units e.g. mW)

G = power gain of the antenna in the direction of interest relative to the isotropic radiator

R = distance to the centre of radiation of the antenna (appropriate units e.g. cm)

EIRP = equivalent isotropically radiated power

Calculation:

Waveforms	Operating Frequency	EIRP		Power density (S) @ 30 cm	
				Calculated	Limit
	GHz	dBm	mW	mW/ cm ²	
Waveform 0 @ lower frequency	76.402	34.9	3090.3	0.27	1.0
Waveform 1 @ lower frequency	76.642	33.9	2454.7	0.22	1.0
Waveform 0 @ upper frequency	76.057	37.3	5370.3	0.47	1.0
Waveform 1 @ upper frequency	76.950	34.9	3090.3	0.27	1.0

The equipment passed the performed tests	☒ Yes	☐ No	☐ N.t. ^x
Test setup photos / test results are attached	☐ Yes	☒ No	

8. Measurement Uncertainty

The total uncertainty of measurement is the result of the mathematically-statistically distribution of the individual measurement uncertainty (MU) of the used measurement equipment. It is supposed that all individual deviations accidentally but not inevitable normally distributed. The total deviation is supposed to be normally distributed (RSS=Root-Sum-of-the-Squares deviation corresponds to a measurement uncertainty which will be not exceeded with a probability of 68 %). Measurement uncertainty Δ , which will be not exceeded with a probability of 95 %, is 2 x RSS. For the following measurements and tests are the values as from the laboratory given:

Measurement /Test	Frequency range	Value of expanded MU			State
Conducted emission disturbing voltage (LISN)	9 kHz – 150 kHz	±	3,70	dB	Apr. 08.2023
	150 kHz – 30 MHz	±	3,31	dB	Apr. 08.2023
Radiated emission (3 m SAC)	9 kHz – 30 MHz	±	3,34	dB	Apr. 08.2023
	30 MHz – 1 GHz	±	4,18	dB	Apr. 08.2023
	1 GHz – 40 GHz	±	4,60	dB	Apr. 08.2023

Table 8-1: Uncertainty of measurement unless otherwise specified.

8.1 Decision rule

As far as in this report statements on conformity are made, decision rules according to DIN EN ISO/IEC 17025:2018, 7.8.6 have been applied. If the report does not state otherwise, procedure 1 according to IEC Guide 115 ed.2.0 2021 (uncertainty of measurement calculated) has been applied on measurement and test procedures which are the base of this report.

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

9. Additional information to the test report

N.t. ¹	Not tested, because not applicable to the EUT
N.t. ²	Not tested, because not ordered

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

10. List of test equipment

State July 17, 2024					
Marking	Manufacturer	SW/Type/Serial-No.	Last Cal./Val.	Next Cal. /Val. (± 1 month)	No.
1 Measuring Instruments					
Attenuator	Tektronix	011-0085-00	Mar 24	Mar 27	61
Attenuator	Radiall	---	Nov 22	Nov 25	62
Attenuator 3dB	Suhner	6803/17	Nov 22	Nov 25	137
Attenuator 3dB / 18 GHz	Suhner	3dB/18GHz	Nov 22	Nov 25	299
Attenuator 6dB / 18 GHz	Suhner	6dB/18GHz	Nov 22	Nov 25	344
Attenuator 20dB / 20GHz	Parzich	40AH-20	Nov 22	Nov 25	354
Attenuator 3dB / 12,4 GHz	Narda	TB 50902-1, S/N: 35005	Mar 24	Mar 27	183a
Attenuator 6dB / 12,4 GHz	Narda	TB 50902-2, S/N: 36328	Mar 24	Mar 27	183b
Attenuator 10dB / 12,4 GHz	Narda	S/N: 36500	Mar 24	Mar 27	183c
Attenuator 20dB / 12,4 GHz	Narda	8491A, S/N: 6218	Mar 24	Mar 27	183d
Terminator	KDI	T173CS	Nov 22	Nov 25	490
Variable transformer	RFT	LS 002	---	---	154a
Variable transformer	Schunt+Ben	---	---	---	155
Power sensor	Marconi	6914	Dec 22	Dec 24	258
Power sensor	Rohde & Schwarz	NRP18SN	Apr 24	Apr 26	651
3-Path Diode Power Sensor 10 MHz to 8 GHz	Rohde & Schwarz	NRP8S	Dec 22	Dec 24	663
3-Path Diode Power Sensor 10 MHz to 18 GHz	Rohde & Schwarz	NRP18S-20	Dec 22	Dec 24	664
Diode Power Sensor 100 kHz – 6 GHz	Rohde & Schwarz	NRV-Z5 S/N: 829562/008	Nov 22	Nov 24	390
Coaxial Directional Coupler	Narda	3003-20	Feb 24	Feb 27	370/342
Coaxial directional coupler	Mini Circuits	ZFDC-20-5	Jun 24	Jun 26	434
Coaxial directional coupler	Narda+Suhner	4246B-20	Sep 22	Sep 25	472/492
Coaxial directional coupler	Narda	3045C-10	Sep 22	Sep 25	110a
Coaxial directional coupler	Narda	3044B-10	Sep 22	Sep 25	21a
Coaxial directional coupler	Narda	3044B-30	Sep 22	Sep 25	327
Coaxial directional coupler	Narda	3022 / 50204	Sep 22	Sep 25	303
Coaxial High Pass Filter	Mini circuits	NHP-700	Jun 24	Jun 27	435
Coaxial High Pass Filter	Mini circuits	NHP-200	Jun 24	Jun 27	405
Coaxial High Pass Filter	Mini circuits	NHP-25+	Jun 24	Jun 27	455
High Pass Filter	Mini circuits	VHF-3500+	Sep 22	Sep 25	451
High Pass Filter	Mini circuits	VHF-1200+	Jun 24	Jun 27	452
High Pass Filter	Morita Tech	MT-SCHLC-500/T300-0/0	Mar 24	Mar 27	703
High Pass Filter	Morita Tech	MT-SCHPFF-1000-T855-0/0	Mar 24	Mar 27	704
High Pass Filter	Morita Tech	MT-SCHPF-2000/ T1720-0/0	Mar 24	Mar 27	705
Bandpass Filter	Schomandl	BN86871	Nov 21	Nov 24	66
Bandpass Filter	Schomandl	BN68673	Nov 21	Nov 24	67
Band Reduction Filter	Morita Tech	MT-SC12FVRC-5250/X200-0/0	Mar 24	Mar 27	701
Band Reduction Filter	Morita Tech	MT-SCBRF-5597.5/255-0/0	Mar 24	Mar 27	702
Low Pass Filter	Mini circuits	SLP550	Jun 24	Jun 27	273
Low Pass Filter	Mini circuits	SLP550	Jun 24	Jun 27	274
RF Current Probe 9 kHz – 30 MHz	Rohde & Schwarz	ESH2-Z1	Aug 21	Aug 24	42
Passive Test Probe – 9 kHz – 30 MHz	TÜV NORD	VDE 0876	Val. before use	Val. before use	45
Coaxial Fixed Attenuator DC – 1 GHz	Texscan	HFP50/10	Aug 23	Aug 26	60
8 Wire Impedance Stabilisation Network	Schwarzbeck	CAT5 8158	Jan 24	Jan 26	71a
T-Section - 50 W	Rohde & Schwarz	BN 42441/50	Nov 21	Nov 24	93

V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

RF Current Injection Clamp 0.15 – 1GHz	Lüthi GmbH	EM 101	Jan 23	Jan 25	156
Absorbing Clamp MDS 30MHz – 1GHz	Lüthi GmbH	MDS-21	Jan 23	Jan 26	160
Insertion Unit	Rohde & Schwarz	URV5-Z4	Jul 22	Jul 24	162
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 35	Nov 21	Nov 24	164
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 60	Nov 21	Nov 24	165
Fixed Attenuator - DC – 1.5GHz	Bird	Mod/ 8343-060	May 23	May 26	177
CDN up to 230 MHz	MEB	KEN-M 2 /M 3	Oct 22	Oct 24	262
Coupling Filter	HAEFELY	FP 16/3-1	Jan 23	Jan 25	366
Impulse limiter 10 dB	Rohde & Schwarz	ESH3 Z2	Jun 24	Jun 26	272
Fixed Attenuator - DC – 18 GHz 30 dB	MTS	---	Mar 24	Mar 26	276
Termination Resistor 50 W	Radiall	404011	Nov 21	Nov 24	309
Branching device (4x) 50W	Rohde & Schwarz	892228/20	Sep 22	Sep 25	320
Dummy-Load - 2 – 18 GHz	Narda	MODEL 367NF	Jan 23	Jan 26	343
DC Block Adapter - 0.045 – 26.5 GHz	Hewlett-Packard	11742A	Mar 24	Mar 27	356
RF Probe 0.02 – 1000 MHz	Rohde & Schwarz	URY-Z7	Aug 22	Aug 25	368
150W attenuator	Weinschel	49-20-33	Nov 22	Nov 25	374
Fixed Coaxial Attenuator - DC – 18 GHz	Weinschel	23-6-34	Mar 23	Mar 26	375
Attenuator 60 dB (10 MHz – 8 GHz)	---	---	Mar 23	Mar 26	376
Insertion Unit 100V 100 kHz – 2 GHz	Rohde & Schwarz	URY-Z4	Jun 24	Jun 26	417
Panoramic Adapter (Monitoring)	Schwarzbeck	PAN1550	---	---	429
DC-BLOCK - DC – 6.0 GHz 50 W	Mini Circuits	BLK-6-N+	Nov 21	Nov 24	462
DC-BLOCK – 0,1 GHz – 5.0 GHz	MicroLab/FRX	HR-D18	Mar 24	Mar 27	90b
Terminating resistor 50Ω SMA	---	---	Jan 23	Jan 26	493
Terminating resistor 50Ω SMA	---	SC 60-601-0000-31	Jan 23	Jan 26	497
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-10	Jan 23	Jan 26	504
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-10	Jan 23	Jan 26	505
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-3	Jan 23	Jan 26	507
Electric Dummy Load	RA-NAV Lab.	DA-75U	---	---	526
Power Splitter / Combiner	Mini Circuits	ZESC-2-11	Nov 22	Nov 25	527
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	Mar 23	Mar 26	529
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	Mar 23	Mar 26	530
RF-Attenuator - 6 dB	Haefely	---	Mar 23	Mar 26	540
RF-Attenuator - 1– 120 MHz 12 dB	Haefely	---	Mar 23	Mar 26	541
RF-Attenuator - 1– 120 MHz 39 dB	Haefely	---	Mar 23	Mar 26	542
LISN 9kHz – 30 MHz	Schwarzbeck	NNLA 8120 (SN: 8120499A)	Oct 22	Oct 24	551
HV Probe P6013A	Tektronix	P6013A	Jul 22	Jul 24	559
VLISN 5μH	Schwarzbeck	8125-1944	Apr 24	Apr 26	585
VLISN 5μH	Schwarzbeck	8125-1945	Apr 24	Apr 26	586
20dB Attenuator, up to 18 GHz	Mini Circuit	BW-N20W5+	Nov 22	Nov 25	594
Step Attenuator - DC-18 GHz 0 to 11 dB	Hewlett-Packard	8494B	Nov 22	Nov 25	604
Analyser Reference System	Spitzenberger & Spies	PAS 1000 SyCore + ARS 16/1	Jun 24	Jun 26	606a/b/c
Capacitive Coupling Clamp 5 kV	Schlöder	SFT 415	Jul 23	Jul 26	608
RF Probes for 50 Ω Receivers	Schwarzbeck	TK 9416	Jun 22	Jun 24	612
Current probe TRMS	BEHA APROB	CHB35	Nov 22	Nov 24	652
Semi Anechoic Chamber	COMTEST	SAC-3m	Apr 23	Apr 25	660
Maturo Turntable	Maturo	TT2.0SI (SN: TT2.05SI/817 SW: 1.0.0.4473)	---	---	667
Maturo Antenna Mast	Maturo	TAM4.5-E-10kg (SN: 10011/216/2588.01)	---	---	668
Maturo Controller	Maturo	FCU3.0/009/2588.01 (SN: 10014/2019)	---	---	669
EMC-Semi Anechoic Chamber (SAC)	Frankonia	SAC-5 Plus L-Dome Design	Jan 24	Jan 26	706
Frankonia Boresight Antenna Mast	Frankonia	FBM 1-4 SN: 0212	---	---	707
Frankonia Turntable	Frankonia	FTM 3-2 SN: FC06.1-2022-277	---	---	708

V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Frankonia Positioning Controller	Frankonia	FC06.1B SN: FC06.1-2022-277	---	---	709
Current probe 20 Hz – 100 MHz	Rohde & Schwarz	EZ-17 (0816.2063.03)	May 23	May 26	670
Coupling Decoupling Network	AMETEK	CDN ST08A	Oct 22	Oct 24	672
BONN HF Switch Matrix DC – 8 GHz	BONN Elektronik	BAS 0080-3	---	---	682
External Directional Coupler	BONN Elektronik	BDC 1060-40/500	Feb 24	Feb 26	683
BI-Directional Coax. Coup. 50-1000 MHz	Narda	3020A	Nov 24	Nov 26	141
Vertical coupling plate	TÜV NORD HFT	---	---	---	265
Measuring table	TÜV NORD HFT	---	---	---	106
Data line coupling network	EM Test AG	CNV 504/ 508	---	---	285
OSP230 BASE Unit 2HU with TS	OSP230	S/N: 102031	June 23 Factory cal.	June 25	698

2 Generators

EFT/Burst Generator	Schlöder	SFT 1400	Sep 22	Sep 24	46a
ESD Generator	Schlöder	SESD 216	Feb 24	Feb 26	653
ESD Simulator	Schlöder	SESD200 S/N: 802653	Sep 23	Sep 25	112a
Signal Generator	Rohde & Schwarz	SMB100A SW 4.20.028.58	Sep 22	Sep 24	571
RF Generator	Rohde & Schwarz	SGT100A	Jun 24	Jun 26	636
Signal Generator	Rohde & Schwarz	SMG	Jun 24	Jun 26	136a
Signal Generator	Marconi	2042	Jul 22	Jul 24	6
Signal Generator	Marconi	2024	Jul 22	Jul 24	213
Puls Generator	EM Test	MPG 200	Apr 23	Apr 25	181
Surge Generator	H+H	MIG063 IN S-T	Jun 23	Jun 25	561
Wideband Radio Communication Tester	Rohde & Schwarz	CMW500 S/N: 171332	Aug 22 Factory cal.	Aug 24	691

3. Antennas

Active Loop Antenna 8.3 kHz – 30 MHz	Rohde & Schwarz	HFH2-Z2E S/N: 101171	May 23	May 25	697
Biconical Ant. 30-300 MHz	Schwarzbeck	VHA9103/BBA9106	Jun 24	Jun 26	80/616
Biconical Ant. 20-300 MHz	Schwarzbeck	VHBB 9124 / BBA9106	Jan 23 Factory cal.	Jan 25	692
Biconical Ant. 20-300 MHz	Schwarzbeck	VHBB 9124 / BBA9106	Jan 23 Factory cal.	Jan 25	693
Biconical Antenna 9 kHz – 300 MHz	Schwarzbeck	EFS9218 / 9218-194	Jul 23	Jul 25	523
Double Ridged Horn	Schwarzbeck	BBHA9120C	Apr 24	Apr 26	169
Double Ridged Horn	Schwarzbeck	BBHA 9120A	Jun 24	Jun 26	284
Tri-Log Broadband	Schwarzbeck	VULB9168	Jun 23	Jun 25	406
Broadband Horn 14-40 GHz	Schwarzbeck	BBHA9170	Apr 24	Apr 26	442
Log Per Antenna 0.7-20 GHz	Schwarzbeck	STLP9148	Jun 23	Jun 25	445a
Log Per Antenna 0.2 – 3.5 GHz	Schwarzbeck	VUSLP 9111B	Jan 23 Factory cal.	Jan 25	694
Log Per Antenna 0.2 – 3.5 GHz	Schwarzbeck	VUSLP 9111B	Jan 23 Factory cal.	Jan 25	695
Log Per Antenna 1 GHz – 18 GHz	Rohde & Schwarz	S/N 352886/009	Jun 23 (Val. only)	Jun 25	700
Bilog Ant.	CHASE	CBL6111	Jun 24	Jun 26	167
Spectrum analyser Mixer 220 – 325 GHz	Radiometer Physics	SAM325 / 20029	Oct 23	Oct 25	591
Dual Mode Potter Horn 220-325 GHz	Radiometer Physics	325-WR2	---	---	592
Dual Mode Potter Horn 75-110 GHz	Radiometer Physics	---	---	---	649
Gain Horn Antenna 50-75 GHz	Dorado	GH-15-20	---	---	511
Standard Gain Horn 1.7 – 2.6 GHz	Narda	645	---	---	514
W-band active Sextupler with input drive amplifier	Spacek Labs Inc.	AW-6XW-0	---	---	221a
60 to 65 GHz active frequency quadrupler	Spacek Labs Inc.	A625-4XW-0	---	---	222a

V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Harmonic Mixer 40-60 GHz	Rohde & Schwarz	FS-Z60/ 100037	Oct 23	Oct 25	515
Gain Horn Antenna 40-60 GHz	Dorado	GH-19-20 / 070106	---	---	518
Spectrum analyser Mixer 90-140 GHz	Radiometer Physics	SAM140 / 20006	Oct 23	Oct 25	545
Dual Mode Potter Horn 90-140 GHz	Radiometer Physics	140-WR8	---	---	547
Spectrum analyser Mixer 140-220GHz	Radiometer Physics	SAM220 / 20002	Oct 23	Oct 25	546
Dual Mode Potter Horn 140-220 GHz	Radiometer Physics	220-WR5.1	---	---	548
Harmonic Mixer 60-90 GHz	Rohde & Schwarz	FS-Z90 / 100062	Oct 23	Oct 25	501
Dual Mode Potter Horn 60-90 GHz	Radiometer Physics	90-W12	---	---	549
Gain Horn 33-55 GHz	Dorado	040810	---	---	383
Gain Horn 50-75 GHz	Dorado	031003	---	---	384
Gain Horn 75-110 GHz	Dorado	040808	---	---	385
Standard Gain Ant. 26.5-40 GHz	Maury Microwave	U211C	---	---	532/628
Waveguide Harmonic Mixer 50 – 75 GHz	Keysight	M1971V	Mar 24	Mar 26	673
Waveguide Harmonic Mixer 75 – 110 GHz	Keysight	M1971W	Mar 24	Mar 26	674
Stacked Log.-Per. Antenna 70 MHz – 10 GHz	Schwarzbeck	STLP 9129	---	---	662
Spectrum/Signal Analyzer Extension Module 110 GHz – 170 GHz (WR-6.5)	Virginia Diodes, Inc.	SAX 637	Jun 22	Jun 24	675
Spectrum/Signal Analyzer Extension Module 140 GHz – 220 GHz (WR-5.1)	Virginia Diodes, Inc.	SAX 636	Jun 22	Jun 24	677
Spectrum/Signal Analyzer Extension Module 220 GHz – 330 GHz (WR-3.4)	Virginia Diodes, Inc.	SAX 635	Jun 22	Jun 24	679
Conical Gain Horn Ant. 110 GHz – 170 GHz [21 dBi]	Virginia Diodes, Inc.	Conical Antenna WR-6.5	---	---	687
Conical Gain Horn Ant. 140 GHz – 220 GHz [21 dBi]	Virginia Diodes, Inc.	Conical Antenna WR-5.1	---	---	688
Diagonal Gain Horn Ant. 220 GHz – 330 GHz [26 dBi]	Virginia Diodes, Inc.	Diagonal Antenna WR-3.4	---	---	689

4. Amplifier

RF-Power Amplifier 250 kHz – 150 MHz	ENI	3100LA	---	---	123
RF pre-amplifier 100kHz-1.3GHz	HP	8447E	Sep 20	Sep 24	166a
Mitteq amplifier 26.5-40 GHz	Mitteq	---	Mar 24	Mar 26	223a
RF pre-amplifier 1-18GHz	Narda	---	Mar 24	Mar 26	345
Mitteq Amplifier 18-26GHz	Mitteq	---	Jun 23	Jun 26	433
Microwave amplifier 12-28GHz	Schwarzbeck	BBV9719	Mar 24	Mar 26	443
Microwave amplifier 0.5-18GHz	Schwarzbeck	BBV9718	Mar 24	Mar 26	444
RF-Power Amplifier 10kHz-1000 MHz	Poetschke	8100 (Band 1) BHED (Band 2) BHED (Band 3)	---	---	684
RF-Power Amplifier 800 MHz – 4,2 GHz	Amplifier Research	10S1G4	---	---	685
RF-Power Amplifier 4 GHz – 8 GHz	Amplifier Research	35S4G8A	---	---	686
RF-Power Amplifier 0.69 GHz – 6 GHz	Rohde & Schwarz	BBA150-D110/E60	---	---	690

5. Power supplies

Programmable Power Supply	Fluke	PM 2813	---	---	28a
Power Supply	HP	---	---	---	125
Power Supply	Sorensen	LM 30-6	---	---	134a
Power Supply	HP	6034L	---	---	226
Regulated Power Supply	Farnell	AP60-50	---	---	408
Power Supply	EA	PSI 8080-40-DT	---	---	560
Power Supply	HP	6032A	---	---	644

6. Meters

Microwave Frequency Counter	Hewlett-Packard	5351B	Jun 23	Jun 25	432
Temperature test cabinet	Heraeus Vötsch	VMT04/35	---	---	102a
Temperature and Climate Test Chamber	Weiß Umwelttechnik, WKL 34/40	S.N.: 5667998 // SW: Simpac 1.4.4.0	Mar 24	Mar 26	562
Temperature test cabinet	Brabender	TTE 32/40 H	---	---	87

V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Web Sensor with PoE- temperature, humidity / digital pressure gauge	COMET	T7610 S.N.: 24960098	Jan 24	Jan 26	711
Web Sensor with PoE- temperature, humidity / digital pressure gauge	COMET	T7610 S.N.: 24960099	Jan 24	Jan 26	712
Digital-Hygro-Thermometer	Greisinger	GFTH95	Feb 23	Feb 25	57a
Volt & RF Power Meter	Rohde & Schwarz	URV35	Jun 22	Jun 25	161
Power Meter	Marconi	6960/ S.N: 1214	Dec 22	Dec 25	139a
Spectrum Analyzer - 9 kHz – 18 GHz	Rohde & Schwarz	FSL18	Cal. before use	Cal. before use	171a
Multimeter	Gossen Metrawatt	Metrahit pro	Jan 24	Jan 26	215a
Humidity/Temperature Measuring device	TESTO	Testo 625	Jan 24	Jan 26	259a
Volt & RF Power Meter	Rohde & Schwarz	URV35	Cal. before use	Cal. before use	271
Multimeter	Gossen Metrawatt	Metrahit 26S	Oct 22	Oct 24	313
Level and Power Meter - 9 kHz – 3 GHz	Rohde & Schwarz	URY	Jun 24	Jun 26	307
Temperature test device	Ahlhorn	Almemo 2390-5 PT100	Apr 23	Apr 26	401/402
Digital-Vacuum-/Barometer	Greisinger	GDH12AN	Jan 22	Jan 25	558
Digital Storage Oscilloscope	Tektronix	TDS 2012C	Nov 22	Nov 24	568
Miniature Flat, Zero-Biased Schottky Detector –0.1– 18 GHz	Narda	4503A-03	Val. before use	Val. before use	613
Digital-Vacuum-/Barometer	Greisinger	GDH-200-14	Jan 24	Jan 27	632
Network Analyser 9 kHz -6 GHz	Rohde & Schwarz	ZVL6 (SN: 101268)	Sep 22	Sep 24	534
Signal Analyser 10 Hz – 30 GHz	Rohde & Schwarz	FSV 30 S/N: 100932	Oct 23	Oct 25	502
EMI Test receiver ESW26	Rohde & Schwarz	R&S ESW26 (SN: 101383/26 SW: R&S ESW2.10)	Jan 24	Jan 26	665
EMI Test Receiver ESW44	Rohde & Schwarz	R&S ESW44 SN: 103281	May 23	May 25	696
Signal analyser Keysight 50GHz	Keysight	UXA N9040B (SN: MY57213006 SW: A.27.02/2020 1.0)	Mar 24	Mar 26	666

7. test/control software

EMC32	Rohde & Schwarz	V10.60.20	---	---	---
Maturo mcApp	Maturo	SW: V3.4.9.4537 (19.04.04)	---	---	---
SPS EMC	Spitzenberger & Spies	SW: V4.1.3	---	---	---
EMV-Soft	Schlöder GmbH	SW: V11.95	---	---	---
ISMISO	EM Test AG	SW: V3.63	---	---	---
ELEKTRA	Rohde & Schwarz	SW: V 5.01.0	---	---	---

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

11. Cable list

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
3	N	0,5 - 8000	3	Cellflex
4	N	0,5 - 8000	3	Cellflex
12a	N	10 – 265000	6	Huber + Suhner
14a	BNC	10 – 1000	1.00	Telemeter
17a	APC3.5	10 – 26500	2.13	Huber + Suhner
18a	APC3.5	10 – 26500	2.13	Huber + Suhner
22	BNC	10 – 1000	1.50	---
27	BNC	10 – 1000	1.00	Fabrica Milanese Cond.
35	N	10 – 2000	1.10	Fujikura
40	BNC	---	0.50	Aircell
44	SMA	---	0.50	Huber + Suhner
45	SMA	10 – 18000	0.50	Huber + Suhner
48	SMA	---	0.50	Huber + Suhner
49	N	10 – 18000	1.00	Huber + Suhner
50	N	10 – 18000	1.00	Huber + Suhner
51	N	10 – 18000	1.00	Huber + Suhner
58	N	10 – 18000	2.00	Huber + Suhner
59	N	10 – 18000	1.00	Huber + Suhner
60	N	10 – 18000	2.00	Huber + Suhner
61	N	10 – 18000	1.00	Huber + Suhner
62	SMA	---	0.50	Huber + Suhner
63	SMA	10 – 18000	0.50	Huber + Suhner
64	SMA	10 – 18000	0.50	Huber + Suhner
65	APC3.5	10 – 26500	0.60	---
66	APC3.5	10 – 26500	0.60	---
67	APC3.5	10 – 26500	0.60	---
68	APC3.5	10 – 26500	0.60	---
76	SMA	10 – 30000	3.00	Gore
79	BNC/N	10 – 1000	5.00	---
80	SMA	---	0.25	Huber + Suhner
87	SMA	10 – 18000	0.15	Huber + Suhner
88	SMA	10 – 18000	0.15	Huber + Suhner
89	SMA	10 – 18000	0.15	Huber + Suhner
90	SMA	10 – 18000	0.15	Huber + Suhner
94	BNC	---	1.10	---
100	N	10 – 26500	6.00	Rosenberg
101	N	10 – 18000	2.90	Huber + Suhner
102	SMA	10 – 18000	2.00	Huber + Suhner
112	BNC	10 – 1000	0.50	---
114	SMA	10 – 18000	0.25	Huber + Suhner
116	SMA	10 – 18000	0.25	Huber + Suhner
119	N	10 – 20000	8.00	Jyebao
121	SMA	10 – 18000	1.50	Huber + Suhner
122	SMA	10 – 18000	2.00	Huber + Suhner
123	SMA	10 – 18000	2.00	Huber + Suhner
145	SMA	10 – 26500	8.00	Huber + Suhner
147	APC3.5	10 – 40000	1.50	Jyebao
148	APC3.5	10 – 40000	3.00	Jyebao
154	BNC	10 – 1000	1.00	---
158	SMA	10 – 26500	2.00	Huber + Suhner
161	SMA	10 – 18000	1.00	Huber + Suhner
162	APC3.5	10 – 26500	2.00	Huber + Suhner
163	APC3.5	10 – 26500	2.00	Huber + Suhner
164	APC3.5	10 – 26500	2.00	Huber + Suhner
165	APC2.9	10 – 26500	2.00	Huber + Suhner

V. 1.24

EUT: QR4000

FCC ID: ZKS-QR4000

FCC Title 47 CFR Part 95 M

Date of issue: 2024-08-20

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
167	APC3.5	10 – 40000	1.00	Jyebao
168	APC3.5	10 – 40000	1.00	Jyebao
169	APC3.5	10 – 40000	1.00	Jyebao
170	APC3.5	10 – 40000	1.00	Jyebao
171	APC3.5	10 – 40000	1.00	Jyebao
172	SAM	---	0.90	Huber + Suhner
173	APC	10 – 26500	2.00	Huber + Suhner
174	APC	10 – 26500	---	Huber + Suhner
175	SMA	10 – 18000	0.40	Huber + Suhner
188	N	10 – 18000	5.00	Huber + Suhner
189	PC-PC	10 – 26500	6.00	Jyebao
190	PC-PC	10 – 26500	6.00	Jyebao
192	N-N	10 – 18000	3.0	Jyebao
193	N-N	10 – 18000	3.0	Jyebao
194	N-SMA	10 – 18000	2.0	Jyebao
195	N-SMA	10 – 18000	2.0	Jyebao
196	7/16-N	10 – 7000	5.0	TRU
197	N-7/16	10 – 7000	2.5	TRU
198	SMA – N	10 – 18000	1.5	Huber + Suhner
199	N-N	10 – 18000	2.5	Huber + Suhner
200	SMA – N	10 – 18000	1.5	Huber + Suhner
201	7/16 – 7/16	10 – 7000	3.0	RFS
202	N-N	10 – 18000	6.0	Huber + Suhner
203	N-N	10 – 18000	2.5	Huber + Suhner
204	N-N	10 – 18000	2.5	TRU
205	N-N	10 – 18000	7.0	Huber + Suhner
206	PC2.9 – PC2.9	10 – 40000	3.0	Huber + Suhner
207	PC2.9 – PC2.9	10 – 40000	7.0	Huber + Suhner
208	PC2.9 – PC2.9	10 – 40000	1.2	Teledyne Storm Microwave
209	PC2.9 – PC2.9	10 – 40000	1.2	Teledyne Storm Microwave
210	PC2.9 – PC2.9	10 – 40000	1.2	Teledyne Storm Microwave
211	---	10 – 40000	0.9	Junkosha
212	---	10 – 40000	0.9	Junkosha
213	BNC - BNC	0,1 - 4000	1	Huber + Suhner
214	BNC - BNC	0,1 - 4000	1	Huber + Suhner
215	BNC - BNC	0,1 - 4000	3	Huber + Suhner
216	BNC - BNC	0,1 - 4000	1	Agilent
217	BNC - BNC	0,1 - 2000	0,5	Sytronic
357	BNC - BNC	0,1 - 2000	1,5	---
EMV 1	BNC	---	2.00	Henn
EMV 2	BNC	10 – 1000	2.00	Henn
EMV 4	BNC	---	9.70	Henn
EMV 5	BNC	---	3.80	Henn
EMV 6	BNC/N	10 – 1000	5.00	Lüthi
EMV 7	BNC	10 – 1000	1.50	Henn
EMV 8	BNC	10 – 1500	1.70	Henn
EMV 9	BNC	10 – 1000	1.70	Henn
EMV 11	BNC	---	5.20	Hasselt
EMV 12	BNC	10 – 1000	2.40	Hasselt
EMV 13	BNC	10 – 1000	4.10	Hasselt
EMV 14	BNC	10 – 1000	2.50	Hasselt
EMV 15	BNC	---	0.90	Henn
EMV 16	Fischer	---	2.00	---
EMV 18a	Fischer	---	1.00	---
EMV 19a	Fischer	---	1.50	---
KISN2	BNC	10 – 2000	4.80	---

End of test report

V. 1.24