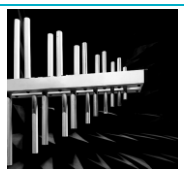
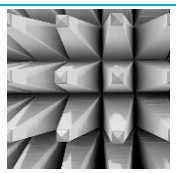




Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-5421_22-01-12

Testing laboratory

cetecom advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: https://www.cetecomadvanced.com
e-mail: mail@cetecomadvanced.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12047-01-00.
ISED Testing Laboratory Recognized Listing Number: DE0001
FCC designation number: DE0002

Applicant

HONEYWELL, SPOL. S R.O. Honeywell Aerospace
Turanka 100/1387
62700 Brno / CZECH REPUBLIC
Phone:
Contact: Kevin Watson
e-mail: kevin.watson@honeywell.com

Manufacturer

HONEYWELL, SPOL. S R.O. Honeywell Aerospace
Turanka 100/1387
62700 Brno / CZECH REPUBLIC

Test standard/s

47 CFR Part 87	Title 47 of the Code of Federal Regulations; Chapter I; Part 87 - Aviation Services
RSS – 170, Issue 4	Mobile Earth Stations (MESs) and Ancillary Terrestrial Component (ATC) Equipment Operating in the Mobile-Satellite Service (MSS) Bands

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	**Satcom Transceiver 5G**
Model name:	**VersaWave + 5G**
FCC ID:	**K6KSATCOM5G**
IC:	**1257B-SATCOM5G**
Frequency:	RX: 1518.0 MHz – 1559.0 MHz / TX: 1626.5 MHz – 1660.5 MHz
Antenna:	Omni-directional LGA active antenna / BGAN Inmarsat C7 antenna
Power supply:	27 V to 30 V DC
Temperature range:	-40°C to +55°C

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:

Thomas Vogler
cn=Thomas Vogler, o=cetecom advanced GmbH, ou=VOG-230609, email=thomas.vogler@cetecomadvanced.com, c=DE
2024.02.28 15:37:44 +01'00'

Thomas Vogler
Lab Manager
Radio Communications & EMC

Test performed:

M. Walla
cn=Meheza Walla, o=cetecom advanced GmbH, ou=WAL-230706, email=Meheza.Walla@cetecomadvanced.com, c=DE
2024.02.28 14:44:42 +01'00'

Meheza Walla
Lab Manager
Radio Communications & EMC

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of cetecom advanced GmbH.
The testing service provided by cetecom advanced GmbH has been rendered under the current "General Terms and Conditions for cetecom advanced GmbH".
cetecom advanced GmbH will not be liable for any loss or damage resulting from false, inaccurate, inappropriate or incomplete product information provided by the customer.
Under no circumstances does the cetecom advanced GmbH test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.
Under no circumstances does the cetecom advanced GmbH test report include or imply any product or service warranties from cetecom advanced GmbH, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by cetecom advanced GmbH.
All rights and remedies regarding vendor's products and services for which cetecom advanced GmbH has prepared this test report shall be provided by the party offering such products or services and not by cetecom advanced GmbH.
In no case this test report can be considered as a Letter of Approval.

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2023-07-17
Date of receipt of test item:	2023-07-28
Start of test:*	2023-07-31
End of test:*	2023-10-09
Person(s) present during the test:	Mr. Watson Kevin and Mr. Tesar Jaroslav (only for test setup configuration)

*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

2.3 Test laboratories sub-contracted

None

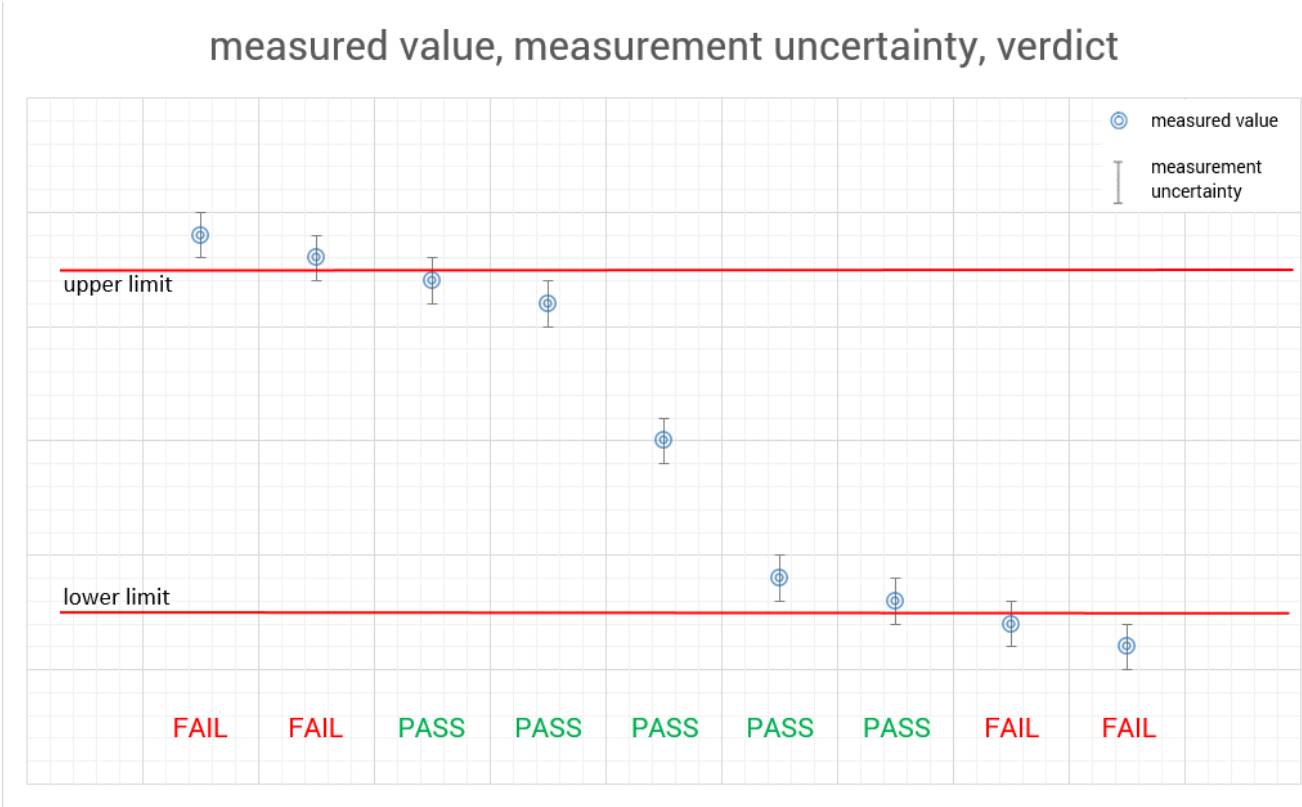
3 Test standard/s

Test standard	Date	Description
47 CFR Part 87		Title 47 of the Code of Federal Regulations; Chapter I; Part 87 - Aviation Services
RSS - 170 Issue 4	09-2022	Mobile Earth Stations (MESs) and Ancillary Terrestrial Component (ATC) Equipment Operating in the Mobile-Satellite Service (MSS) Bands

Guidance	Version	Description
ANSI C63.10-2013	-/-	American national standard of procedures for compliance testing of unlicensed wireless devices
ANSI C63.4-2017	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.26-2015	-/-	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



5 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +55 °C during high temperature tests -40 °C during low temperature tests
Relative humidity content	:		45 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	28 V DC 30 V 27 V

6 Test item

6.1 General description

Kind of test item	:	Satcom Transceiver 5G
Model name:	:	VersaWave + 5G
HMN	:	-/-
PMN	:	Satcom 5G
HVIN	:	Satcom 5G
FVIN	:	-/-
S/N serial number	:	00018
Hardware status	:	90600736 REV A
Software status	:	90600929 REV A
Frequency band	:	RX: 1518.0 MHz – 1559.0 MHz / TX: 1626.5 MHz – 1660.5 MHz
Type of radio transmission **Use of frequency spectrum**	: :	FDMA/TDMA/FDD
Type of modulation	:	QPSK, 16QAM, 32QAM, 64QAM
Channel bandwidth (B)	:	21 ~ 190 kHz
Type of radio transmission	:	G1W, D1W
TX output power cond.	:	35.1 dBm (measured value) CLASS 7 38.8 dBm (measured value) CLASS 15
TX output powered rad. (EIRP)	:	46.1 dBm (measured value) CLASS 7 44.6 dBm (calculated value) CLASS 15
Antenna	:	1) Omni-directional LGA active antenna 2) BGAN Inmarsat C7 antenna
Antenna Gain	:	1) 5.23 dBic 2) 11 dBic
Power supply	:	27 V to 30 V DC
Temperature range	:	-40°C to +55°C

6.2 List of components

No.	Equipment	Manufacturer	(Part number / version / model)	Serial number	Software version	tested (Y/N)
1	Small SATCOM SDU	Honeywell	90600736	00018	-/-	Y
2	Amplifier AMP1595-13BK	Aeroantenna Technology, Inc.	AMP1595-13BK	3108	-/-	Y
3	Physical Layer tester	Square PEG Communications	PLTM-02	02057	-/-	N

6.3 Antenna system(s)

Description	PN	Polarization	Gain	Datasheet / Pattern / Test Report
BendixKing Aerowave 100	89000015-009	RHCP	5.23 dBic	-/-
BGAN Inmarsat C7 antenna	90600820	RHCP	11 dBic	-/-

Note:
Verification of Antenna pattern or antenna test reports is not part of this test report.
Above listed antennas should be compliant to test standard(s) listed under section 3!

6.4 Operating conditions

Operating condition 1: f_l* = 1626.6 MHz , f_m* = 1643.5 MHz, f_h* = 1660.4 MHz

Operating condition 2: Carrier Off State / TX-Off

Operating condition 3: Continuous wave (for frequency stability tests)

* Frequencies varying due to different bearer types and different modulations (see table below)

Note: f_l = lowest operating frequency, f_m = middle frequency of the band, f_h = highest operating frequency

#	Bearer Identifier	Systems designator	CLASS 15	CLASS 7
1	R5T1XD	50K0D1W	Yes	Yes
2	R5T2XD	100KD1W	Yes	Yes
3	R5T4.5XD	200KD1W	Yes	Yes
4	R20T1XD	50K0D1W	Yes	Yes
5	R20T2XD	100KD1W	Yes	Yes
6	R20T4.5XD	200KD1W	Yes	Yes
7	R5T2QD	100KG1W	Yes	Yes
8	R5T4.5QD	200KG1W	Yes	Yes
9	R20T0.5QD	25K0G1W	Yes	Yes
10	R20T1QD	50K0G1W	Yes	Yes
11	R20T2QD	100KG1W	Yes	Yes
12	R20T4.5QD	200KG1W	Yes	Yes
13	FR80T2.5X16	100KD7W	No	Yes
14	FR80T5X16	200KD7W	No	Yes
15	FR80T2.5X32	100KD7W	No	Yes
16	FR80T2.5X64	100KD7W	No	Yes
17	FR80T5X32	200KD7W	No	Yes
18	FR80T5X64	200KD7W	No	Yes

6.5 Additional information

EUT external photos are included in test report: 1-5421/22-01-01_AnnexA

EUT internal photos are included in test report: 1-5421/22-01-01_AnnexB

Test setup photos are included in test report: 1-5421/22-01-01_AnnexC

Measurement results are included in test report 1-5421/22-01-01_AnnexE

7 Description of the test setup

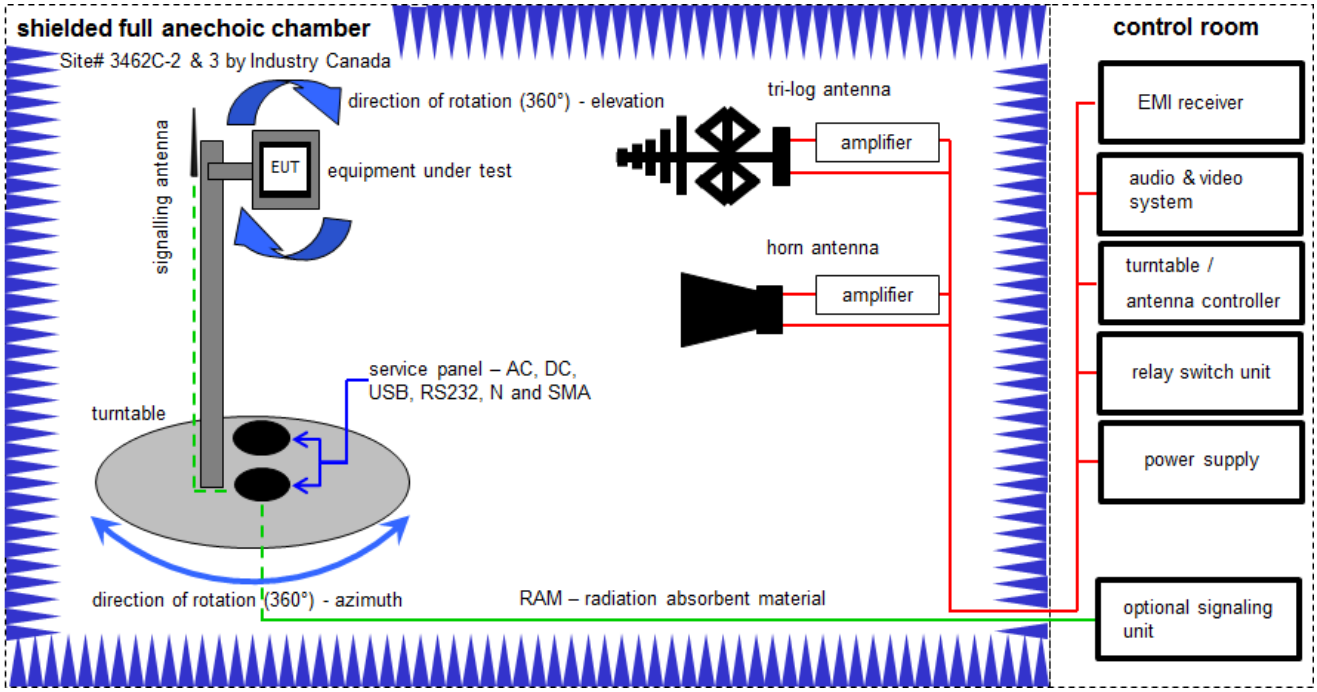
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signalling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

k	calibration / calibrated		EK	limited calibration
ne	not required (k, ev, izw, zw not required)		zw	cyclical maintenance (external cyclical maintenance)
ev	periodic self verification		izw	internal cyclical maintenance
Ve	long-term stability recognized		g	blocked for accredited testing
vlkl!	Attention: extended calibration interval			
NK!	Attention: not calibrated		*)	next calibration ordered / currently in progress

7.1 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter

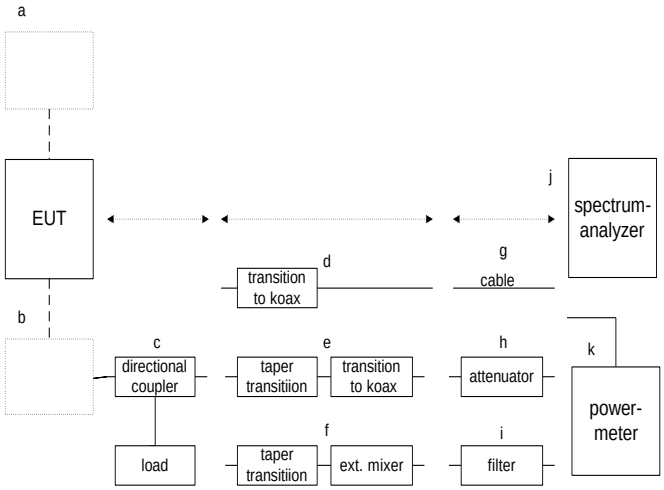
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -65.0 [dBm] + 50 [dB] - 20 [dBi] + 5 [dB] = -30 [dBm] (1 µW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
2	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	20.03.2023	31.03.2025
3	n. a.	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
4	n. a.	Highpass Filter	WHKX2.9/18G-12SS	Wainwright	1	300003492	ev	-/-	-/-
5	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	07.12.2022	31.12.2023
6	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	295	300003787	vIKI!	23.05.2023	31.05.2025
7	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
8	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
9	n. a.	NEXIO EMV-Software	BAT EMC V3.19.1.21	EMCO		300004682	ne	-/-	-/-
10	n. a.	PC	ExOne	F+W		300004703	ne	-/-	-/-
11	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011572	300005241	ev	-/-	-/-

7.2 Conducted measurements (RF-Laboratory)



Setup 1.1 x..x

For inband measurements: hgj + hgk
(10 dB + 10 dB att + power splitter + 6dB att + cable and analyzer or power meter)
([U330 = U311 + 10ATT+PS + 6 dB] + C220)

For out-of-band and spurious measurements: higj
(10 dB + 10 dB att + power splitter + 6dB att + cable + band reject filter and analyzer)
([U331 = U311 + 10ATT+PS + BRF + 6 dB] + C220)

For spurious measurements > 3 GHz: higj:
(10 dB + 10 dB att + power splitter + 6dB att + cable + high pass filter and analyzer)
([U332 = U311 + 10ATT+PS + HPF + 6 dB] + C220)

RF-Laboratory Equipment:

No.	Lab / Item	Equipment	Type	Manufact.	Serial No.	INV. No	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	HF-Cable	SUCOFLEX 101	Huber&Suhner	3054/1		ev	-/-	-/-
2	n. a.	High Power Attenuator 10 dB	WA-91-10-34	Weinschel	A244	300004265	ev	-/-	-/-
3	n. a.	Power spliter	11667B	HP	00621	300000193	ev	-/-	-/-
4	n. a.	Power Meter	438A	HP	2804U01015	300000357	vIKI!	08.12.2021	31.12.2023
5	n. a.	Power Sensor, 10MHz to 26.5GHz, -30 to +20 dBm	8485A	HP	2238A00798	300000511	vIKI!	19.01.2023	18.01.2025
6	n. a.	Signal- and Spectrum Analyzer 3Hz - 50GHz	PXA N9030A	KEYSIGHT	US51350267	300004338	k	13.04.2023	30.04.2024
7	n. a.	Temperature and Climatic Test Chamber	VT4011	Voetsch	58566230600010	300005363	ev	09.05.2022	31.05.2024
8	n. a.	High Pass Filter	SHC2600/12750-1.5-KK	Trilithic INC.	9833011	400001484	ev	-/-	-/-
9	n. a.	Band Reject Filter Low	WRCGV14-1616-1626-1661-1671-70SS	Wainwright	1	300005614	ev	-/-	-/-
10	n. a.	Band Reject Filter High	WRCGV16-1658-1664-1679-1685-80SS	Wainwright	1	300005616	ev	-/-	-/-
11	n. a.	Attenuator 10dB / 5W	MCL BW-N10W	Mini Circuits	1143	---	ev	-/-	-/-

8 Sequence of testing

8.1 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.2 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.3 Sequence of testing radiated spurious above 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

Premeasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

9 Measurement results

9.1 Summary

☒	**No deviations from the technical specifications were ascertained**
☐	There were deviations from the technical specifications ascertained
☐	This test report is only a partial test report. The content and verdict of the performed test cases are listed below.

TC identifier	Description	verdict	date	Remark
RF-Testing	CFR 47 Part 87	see table	2024-02-27	-/-

Test Specification Clause	Test Case	State	C	NC	NA	NP	Remark
§2.1046 §87.131 RSS-170, 5.5	RF power output Power limits	TX-On	☒	☐	☐	☐	(EIRP) 28.8 W [CLASS15] 40.7 W [CLASS7]
§2.1049 §87.139 (i)(3)	Emissions masks	TX-On	☒	☐	☐	☐	
§2.1049 §87.135 RSS-170, 5.2	99% Occupied bandwidth	TX-On	☒	☐	☐	☐	
§2.1051 §87.139 (a) §87.139 (i)(1) RSS-170, 5.8	Spurious emissions at antenna terminals Emission limitations (conducted emissions)	TX-On	☒	☐	☐	☐	
§2.1053	Field strength of spurious radiation Emission limitations (radiated emissions)	TX-On	☒	☐	☐	☐	
RSS-170, 5.9 & 5.10	Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service Carrier-Off State Emissions	TX-Off	☒	☐	☐	☐	see Note
§2.1055 §87.133 (a) RSS-170, 5.3	Frequency stability Frequency tolerances	TX-On	☒	☐	☐	☐	see Note
§15.107	Unintentional Radiators: AC conducted limits	-/-	☐	☐	☒	☐	DC powered
§15.109	Unintentional Radiators: Radiated emission limits	-/-	☒	☐	☐	☐	Refer to 1-5421_22-01-18.pdf

Note:

C	Compliant	**NC**	Not compliant	**NA**	Not applicable	**NP**	Not performed

9.2 Overview

I. RF power output / Power limits

Test setup(s): section 8.2

The power is measured at the transmitter output terminals and the type of power is determined according to the emission designator as follows:

(i) Mean power (pY) for amplitude modulated emissions and transmitting both sidebands using unmodulated full carrier.

(ii) Peak envelope power (pX) for all emission designators other than those referred to in paragraph (i) of this note.

Limits: **§87.131**

Class of Station	Frequency	Authorized emissions	Maximum power
Aircraft earth	UHF	G1D, G1E, G1W	60W

Power may not exceed 60 watts per carrier, as measured at the input of the antenna subsystem, including any installed diplexer. The maximum EIRP may not exceed 2000W per carrier.

Limits: **RSS-170 5.5**

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

Note: The measurement was performed at the antenna amplifier output.

Result: **The measurement is passed.**

Measurement results:

CLASS 15 Output Power Conducted with Power meter (measured)

Modulation Scheme	max. Bandwidth	Transmitter conducted output power [dBm]			Transmitter radiated output power / EIRP [dBm]		
		f_{low}	f_{mid}	f_{high}	f_{low}	f_{mid}	f_{high}
R5T1X	42 kHz	38.3	37.1	**38.8**	44.1	42.9	**44.6**
R5T2X	84 kHz	38.0	36.7	38.4	43.8	42.5	44.2
R5T45X	189 kHz	37.8	36.5	38.2	43.6	42.3	44.0
R20T1X	42 kHz	38.0	36.8	38.5	43.8	42.6	44.3
R20T2X	84 kHz	38.0	36.7	38.4	43.8	42.5	44.2
R20T45X	189 kHz	38.1	36.6	38.3	43.9	42.4	44.1
R5T2Q	84 kHz	37.8	36.4	38.1	43.6	42.2	43.9
R5T45Q	189 kHz	37.8	36.3	38.1	43.6	42.1	43.9
R20T05Q	21 kHz	38.0	36.5	38.2	43.8	42.3	44.0
R20T1Q	42 kHz	38.0	36.6	38.2	43.8	42.4	44.0
R20T2Q	84 kHz	38.0	36.5	38.2	43.8	42.3	44.0
R20T45Q	189 kHz	38.0	36.5	38.3	43.8	42.3	44.1

Note: The customer will include a SMA connector on the amplifier on the test antenna. Therefore, we added 0.6dB which is the insertion loss of the SMA to the calculated EIRP

Summary:

Maximum conducted output power:

38.8 dBm = 8.8 dBW = **7.6 W**

Maximum radiated output power (EIRP):

44.6 dBm = 14.6 dBW = **28.8 W**

5.23 dBic @ f_l* = 1626.6 MHz , f_m* = 1643.5 MHz, f_h* = 1660.4 MHz

CLASS 7 Output Power Conducted with Power meter (measured)

Modulation Scheme	max. Bandwidth	Transmitter conducted output power [dBm]			Transmitter radiated output power / EIRP [dBm]		
		f_{low}	f_{mid}	f_{high}	f_{low}	f_{mid}	f_{high}
R5T1X	42 kHz	34.0	**35.1**	34.7	45.0	**46.1**	45.7
R5T2X	84 kHz	33.7	34.9	34.5	44.7	45.9	45.5
R5T45X	189 kHz	33.7	34.8	34.3	44.7	45.8	45.3
R20T1X	42 kHz	33.8	35.0	34.5	44.8	46.0	45.5
R20T2X	84 kHz	33.8	35.0	34.4	44.8	46.0	45.4
R20T45X	189 kHz	33.8	34.8	34.4	44.8	45.8	45.4
R5T2Q	84 kHz	33.6	34.6	34.1	44.6	45.6	45.1
R5T45Q	189 kHz	33.6	34.7	34.0	44.6	45.7	45.0
R20T05Q	21 kHz	33.7	34.7	34.2	44.7	45.7	45.2
R20T1Q	42 kHz	33.7	34.7	34.2	44.7	45.7	45.2
R20T2Q	84 kHz	33.7	34.7	34.2	44.7	45.7	45.2
R20T45Q	189 kHz	33.8	34.7	34.2	44.8	45.7	45.2
FR80T2.5X16	95 kHz	33.8	34.9	34.3	44.8	45.9	45.3
FR80T5X16	190 kHz	33.8	34.9	34.3	44.8	45.9	45.3
FR80T2.5X32	95 kHz	33.8	34.8	34.4	44.8	45.8	45.4
FR80T2.5X64	95 kHz	33.8	34.8	34.4	44.8	45.8	45.4
FR80T5X32	190 kHz	33.8	34.8	34.4	448	45.8	45.4
FR80T5X64	190 kHz	33.8	34.8	34.4	44.8	45.8	45.4

Summary:

Maximum conducted output power:

35.1 dBm = 5.1 dBW = **3.2 W**

Maximum radiated output power (EIRP):

46.1 dBm = 16.1 dBW = **40.7 W**

11 dBic @ f_l* = 1626.6 MHz , f_m* = 1643.5 MHz, f_h* = 1660.4 MHz

II. Emission masks

Test setup(s): section 8.2

Limits: **§87.131 (i)(3)**

While transmitting a single modulated signal at the rated output power of the transmitter, the emissions must be attenuated below the maximum emission level by at least:

Frequency Offset (normalized to SR)	Attenuation (dB)
±0.75 × SR	0
±1.40 × SR	20
±2.95 × SR	40

Where:

SR = Symbol Rate,

SR = 1 × channel rate for BPSK,

SR = 0.5 × channel rate for QPSK.

The mask shall be defined by drawing straight lines through the above points.

Plots:

CLASS 15, See Annex E / 2, plots 44 to 52, 71 to 79, 99 to 106.
CLASS 7, See Annex E / 3, plots 183 to 188, 202 to 207, 221 to 226.

Result: **The measurement is passed.**

III. Occupied bandwidth

Test setup(s): section 8.2

(a) Occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 percent of the total mean power of a given emission.

(b) The authorized bandwidth is the maximum occupied bandwidth authorized to be used by a station.

(c) The necessary bandwidth for a given class of emission is the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

Measurement results:

Modulation Scheme CLASS 15	99% Occupied bandwidth [kHz]			Limit [kHz]
	f_{low}	f_{mid}	f_{high}	
R5T1XD	37.7	37.7	37.8	42 kHz
R20T1XD	37.6	37.4	37.5	
R20T1QD	37.4	37.4	37.4	
R5T2XD	75.6	75.6	75.8	84 kHz
R5T2QD	75.1	75.1	75.1	
R20T2XD	75.2	75.3	75.2	
R20T2QD	75.1	75.1	74.8	
R5T4.5XD	168.2	168.0	167.3	189 kHz
R20T4.5XD	167.5	168.2	167.0	
R5T4.5QD	167.7	168.0	167.5	
R20T4.5QD	167.1	167.2	167.1	
R20T0.5QD	18.7	18.7	18.7	21 kHz

Modulation Scheme CLASS 7	99% Occupied bandwidth [kHz]			Limit [kHz]
	f_{low}	f_{mid}	f_{high}	
R5T1XD	37.5	37.4	37.2	42 kHz
R20T1XD	37.2	37.5	37.3	
R20T1QD	37.3	37.4	37.2	
R5T2XD	74.9	75.2	74.9	84 kHz
R5T2QD	74.9	74.9	74.8	
R20T2XD	75.0	75.2	74.6	
R20T2QD	74.5	74.9	74.7	
R5T4.5XD	166.3	166.1	167.1	189 kHz
R20T4.5XD	166.5	167.8	167.1	
R5T4.5QD	166.8	166.6	166.9	
R20T4.5QD	166.5	166.9	166.9	
R20T0.5QD	18.8	18.6	18.5	21 kHz
FR80T2.5X16	88.1	88.4	87.4	95 kHz
FR80T2.5X32	87.8	88.3	87.9	
FR80T2.5X64	87.7	88.1	87.9	
FR80T5X16	174.2	174.3	174.0	190 kHz
FR80T5X32	174.0	173.8	174.4	
FR80T5X64	173.9	174.4	173.8	

Limits: **§87.135**

Limits: **RSS-170 5.2**

Frequency range	f(lowest) > 1626.5 MHz	f(highest) < 1660.5 MHz

Plots:

CLASS 15, See Annex E / 2, plots 1 to 36.
CLASS 7, See Annex E / 3, plots 120 to 173.

Result: **The measurement is passed.**

IV. Emissions limitations (conducted emissions)

Test setup(s): section 8.2

In case of conflict with other provisions of §87.139, the provisions of this paragraph shall govern for aircraft earth stations. When using G1D, G1E, or G1W emissions in the 1646.5-1660.5 MHz frequency band, the emissions must be attenuated as shown below.

At rated output power, while transmitting a modulated single carrier, the composite spurious and noise output shall be attenuated by at least:

Limits: **§87.139 (i)(1)**

Frequency (MHz)	Attenuation (dB)[1]
0.01 to 1525	−135 dB/4 kHz
1525 to 1559	−203 dB/4 kHz
1559 to 1585	−155 dB/MHz
1585 to 1605	−143 dB/MHz
1605 to 1610	−117 dB/MHz
1610 to 1610.6	−95 dB/MHz
1610.6 to 1613.8	−80 dBW/MHz[3]
1613.8 to 1614	−95 dB/MHz
1614 to 1626.5	−70 dB/4 kHz
1626.5 to 1660	−70 dB/4 kHz[2 3 4]
1660 to 1670	−49.5 dBW/20 kHz[2 3 4]
1670 to 1735	−60 dB/4 kHz
1735 to 12000	−105 dB/4 kHz
12000 to 18000	−70 dB/4 kHz

[1]These values are expressed in dB referenced to the carrier for the bandwidth indicated, and relative to the maximum emission envelope level, except where the attenuation is shown in dBW, the attenuation is expressed in terms of absolute power referenced to the bandwidth indicated.

[2]Attenuation measured within the transmit band excludes the band ±35 kHz of the carrier frequency.

[3]This level is not applicable for intermodulation products.

[4]The upper limit for the excess power for any narrow-band spurious emission (excluding intermodulation products within a 30 kHz measurement bandwidth) shall be 10 dB above the power limit in this table.

Note:

Frequency response of rejection filter AT1595-13 as declared by the manufacturer:

TX Path Frequenc [MHz]	Attenuation [dB]
0.10 to 1026.5	120
1026.5 to 1525	110
1525 to 1559	117
1559 to 1585	107
1585 to 1605	108
1605 to 1614	91
1614 to 1735	4.5
1735 to 18000	118

Filter response data delivered by the customer were also used as correction data during the measurements.

Plots:

CLASS 15, See Annex E / 2, plots 53 to 61, 80 to 88, 107 to 115.
CLASS 7, See Annex E / 3, plots 189 to 195, 208 to 214, 227 to 233.

Limits: **§87.139 (a) / RSS-170 5.8**

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

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

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

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

Plots:

CLASS 15, See Annex E / 2, plots 37 to 43, 62 to 70, 89 to 97.
CLASS 7, See Annex E / 3, plots 177 to 182, 196 to 201, 215 to 220.

Result: The measurement is passed.

V. Emissions limits (radiated emissions)

Test setup(s): section 7.1

Limits: **§2.1053**

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.

(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.

(2) All equipment operating on frequencies higher than 25 MHz.

(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.

(4) Other types of equipment as required, when deemed necessary by the Commission.

Measurement results:

Radiated Spurious Emissions [dBm]								
Low frequency			Middle frequency			High channel		
F [GHz]	Detector	Level [dBm]	F [GHz]	Detector	Level [dBm]	F [GHz]	Detector	Level [dBm]
No critical peaks detected.			No critical peaks detected.			No critical peaks detected.		
Measurement uncertainty			± 3 dB					

Plots:

see also Annex E / 4, plots 238 to 247.

Result: **The measurement is passed.**

VI. Protection of aeronautical radionavigation-satelitte service

Test setup(s): section 7.1

Limits: **RSS-170 5.9**

Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service.
(g) Mobile earth stations manufactured more than six months after FEDERAL REGISTER publication of the rule changes adopted in FCC 03–283 with assigned uplink frequencies in the 1610–1626.5 MHz band shall suppress the power density of emissions in the 1605–1610 MHz band-segment to an extent determined by linear interpolation from -70 dBW/MHz at 1605 MHz to -46 dBW/MHz at 1610 MHz, averaged over any 2 millisecond active transmission interval. The e.i.r.p of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed a level determined by linear interpolation from -80 dBW at 1605 MHz to -20 dBW at 1610 MHz, averaged over any 2 millisecond active transmission interval.

Measurement results:

Radiated Spurious Emissions [dBm]								
Low frequency			Middle frequency			High channel		
F [GHz]	Detector	Level [dBm]	F [GHz]	Detector	Level [dBm]	F [GHz]	Detector	Level [dBm]
No critical peaks detected.			No critical peaks detected.			No critical peaks detected.		
Measurement uncertainty			± 3 dB					

Plots:

CLASS 15, See Annex E / 2, plots 116 to 119.
CLASS 7, See Annex E / 3, plots 234 to 237.

Result: **The measurement is passed.**

VII. Transmitter frequency tolerance

Test setup(s): section 8.2, setup 1.1hgj

Limits: **§87.133 (a)**

Frequency band-470 to 2450 MHz (lower limit exclusive, upper limit inclusive), and categories of stations:	Tolerance[1]	Tolerance[2]
Aeronautical stations	100	20
Aircraft stations	100	20
Aircraft earth station		**320 Hz[3]**

[1]This tolerance is the maximum permitted until January 1, 1990, for transmitters installed before January 2, 1985, and used at the same installation. Tolerance is indicated in parts in 10^6 unless shown as Hertz (Hz).

[2]This tolerance is the maximum permitted after January 1, 1985 for new and replacement transmitters and to all transmitters after January 1, 1990. Tolerance is indicated in parts in 10^6 unless shown as Hertz (Hz).

[3]For purposes of certification, a tolerance of 160 Hz applies to the reference oscillator of the AES transmitter. This is a bench test.

Limits: **RSS-170 5.3**

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

Measurement results:

The customer use a command for the test: MTR 19 – Transmitter Frequency Accuracy and Stability

This MTR commands the UT to send a number of bursts to the BPLT, which then measures the frequency offset against the tolerance specified in the ini file. The script computes the percentage of bursts that fall outside the tolerance and compares this with the requirement specified in the MTR.
The UT is synchronized to an LESP bearer with impairments applied.

The test passes if 99.7% or greater of all the bursts received by the BPLT have a frequency offset less than or equal to the offset specified in the ini file.

Result: **The measurement is passed.**

Temperature [°C]	Voltage [V DC]	Reference Frequency [MHz]	Deviation [Hz]	Deviation [ppm]
-40	28	fl: 1626. 600 000	-176	-0.1
-30	28		-185	-0.1
-20	28		-178	-0.1
-10	28		-152	-0.1
0	28		-167	-0.1
10	28		-156	-0.1
20	27		-187	-0.1
20	28		-167	-0.1
20	30		-183	-0.1
30	28		-153	-0.1
40	28		-182	-0.1
50	28		-150	-0.1
55	28		-183	-0.1

Temperature [°C]	Voltage [V DC]	Reference Frequency [MHz]	Deviation [Hz]	Deviation [ppm]
-40	28	fm: 1643. 500 000	-179	-0.1
-30	28		-183	-0.1
-20	28		-182	-0.1
-10	28		-150	-0.1
0	28		-165	-0.1
10	28		-178	-0.1
20	27		-168	-0.1
20	28		-188	-0.1
20	30		-187	-0.1
30	28		-163	-0.1
40	28		-180	-0.1
50	28		-182	-0.1
55	28		-183	-0.1

Temperature [°C]	Voltage [V DC]	Reference Frequency [MHz]	Deviation [Hz]	Deviation [ppm]
-40	28	fh: 1660. 400 000	-179	-0.1
-30	28		-183	-0.1
-20	28		-182	-0.1
-10	28		-150	-0.1
0	28		-165	-0.1
10	28		-178	-0.1
20	27		-168	-0.1
20	28		-188	-0.1
20	30		-187	-0.1
30	28		-163	-0.1
40	28		-180	-0.1
50	28		-182	-0.1
55	28		-183	-0.1

10 Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
GUE	GNSS User Equipment
ETSI	European Telecommunications Standards Institute
EN	European Standard
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
IC	Industry Canada
PMN	Product marketing name
HMN	Host marketing name
HVIN	Hardware version identification number
FVIN	Firmware version identification number
EMC	Electromagnetic Compatibility
HW	Hardware
SW	Software
Inv. No.	Inventory number
S/N or SN	Serial number
C	Compliant
NC	Not compliant
NA	Not applicable
NP	Not performed
PP	Positive peak
QP	Quasi peak
AVG	Average
OC	Operating channel
OCW	Operating channel bandwidth
OBW	Occupied bandwidth
OOB	Out of band
DFS	Dynamic frequency selection
CAC	Channel availability check
OP	Occupancy period
NOP	Non occupancy period
DC	Duty cycle
PER	Packet error rate
CW	Clean wave
MC	Modulated carrier
WLAN	Wireless local area network
RLAN	Radio local area network
DSSS	Dynamic sequence spread spectrum
OFDM	Orthogonal frequency division multiplexing
FHSS	Frequency hopping spread spectrum
GNSS	Global Navigation Satellite System
C/N_0	Carrier to noise-density ratio, expressed in dB-Hz

11 Document history

Version	Applied changes	Date of release
-/-	Initial release - DRAFT	2023-12-21
-/-	Minor changes, CLASS 15 Antenna gain @ 5.23 dBic updated	2024-02-27