

TEST REPORT

Test report no.: 1-8178/19-01-02



Testing laboratory

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Accredited Testing Laboratory:

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-03

Applicant

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Manufacturer

TQ-Systems GmbH

Mühlstraße 2, Gut Delling

82229 Seefeld / GERMANY

Test standard/s

FCC - Title 47 CFR
Part 87

FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 87 - Aviation Services

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

Test Item

Kind of test item: Mode-S Transponder

Model name: KTX2

FCC ID: 2ANFF-KTX2S

Frequency: TX: 1090 MHz, Rx: 1030 MHz

Antenna: external antenna

Power supply: 9 V to 33 V DC

Temperature range: -20°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:



Benedikt Gerber
Lab Manager
Radio Communications & EMC

Test performed:



Karsten Gerdaldy
Lab Manager
Radio Communications & EMC

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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. CTC 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.

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2.2 Application details

Date of receipt of order:	2019-02-27
Date of receipt of test item:	2019-03-05
Start of test:	2019-03-06
End of test:	2019-03-08
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

Test standard	Date	Description
FCC - Title 47 CFR Part 87		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 87 - Aviation Services

Guidance	Date	Description
ANSI C63.4-2014	-/-	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 Test environment

Temperature	:	T_{nom} +22 °C during room temperature tests T_{max} +55 °C during high temperature tests T_{min} -20 °C during low temperature tests
Relative humidity content	:	55 %
Barometric pressure	:	1021 hpa
Power supply	:	V_{nom} 28 V V_{max} 30 V V_{min} 12 V

5 Test item

5.1 General description

Kind of test item	:	Mode-S Transponder
Type identification	:	KTX2
S/N serial number	:	10000006
Hardware status	:	0100
Firmware status	:	0100
Frequency band	:	TX: 1090 MHz, Rx: 1030 MHz
Type of modulation	:	Mode A/C: PAM Mode S: DPSK
Number of channels	:	1
Antenna	:	external antenna
Power supply	:	9 V to 33 V DC / 12 V DC nom.
Temperature range	:	-20°C to +55°C

5.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup, EUT photos and plots are included in documents: 1-8179/19-01-01_AnnexA
1-8179/19-01-01_AnnexB
1-8179/19-01-01_AnnexC
1-8179/19-01-01_AnnexD
1-8179/19-01-01_AnnexE

6 Description of the test setup

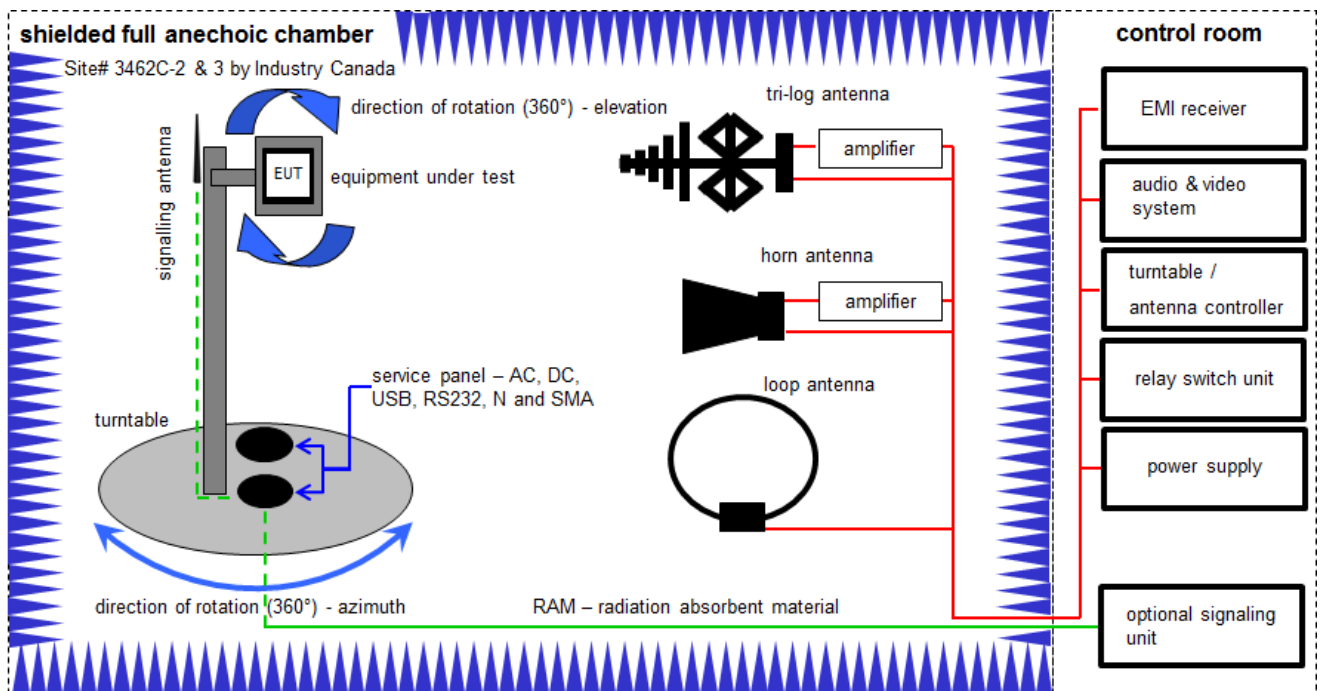
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling 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
vkl!	Attention: extended calibration interval			
NK!	Attention: not calibrated		*)	next calibration ordered / currently in progress

6.1 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter; loop 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)

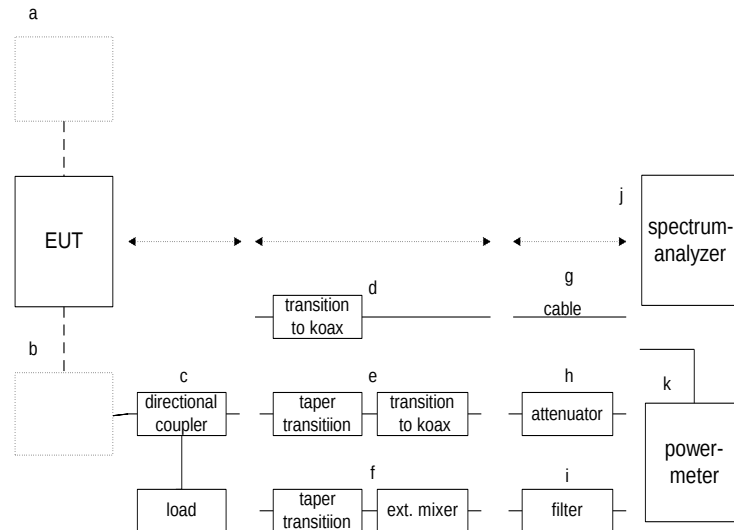
Example calculation:

$$OP \text{ [dBm]} = -65.0 \text{ [dBm]} + 50 \text{ [dB]} - 20 \text{ [dBi]} + 5 \text{ [dB]} = -30 \text{ [dBm]} \text{ (1 } \mu\text{W)}$$

Equipment table:

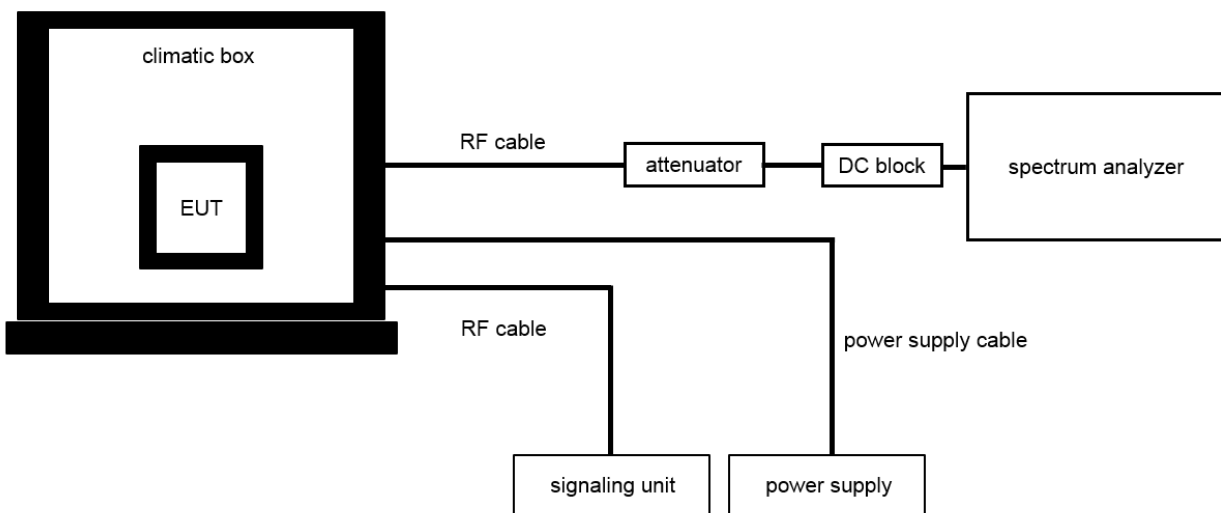
No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032	vKI!	07.07.2017	06.07.2019
2	n. a.	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vKI!	07.07.2017	06.07.2019
3	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04590	300001041	vKI!	14.12.2017	13.12.2020
4	n. a.	Tunable Band Reject Filter (FDD I)	WRCT1850/2170-5/40-10EEK	Wainwright	7	300003386	ne	-/-	-/-
5	n. a.	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
6	n. a.	Band Reject Filter	WRCG1850/1910-1835/1925-40/8SS	Wainwright	23	400000149	ne	-/-	-/-
7	n. a.	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne	-/-	-/-
8	n. a.	Band Reject Filter	WRCG824/849-810/863-60/9SS	Wainwright	6	300003791	ne	-/-	-/-
9	n. a.	Band Reject Filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	26	300003792	ne	-/-	-/-
10	n. a.	Band Reject Filter	WRCG1710/1755-1690/1775-90/14SS	Wainwright	7	300003793	ne	-/-	-/-
11	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	318	300003696	vKI!	23.05.2017	22.05.2020
12	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22051	300004483	ev	-/-	-/-
13	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
14	n. a.	Computer	Intel Core i3 3220/3,3 GHz, Prozessor		2V2403033A54 21	300004591	ne	-/-	-/-
15	n. a.	Highpass Filter	WHKX2.6/18G-10SS	Wainwright	12	300004651	ne	-/-	-/-
16	n. a.	Channel Notch Filter (1900)	WRCD 1879.5/1880.5-5EE	Wainwright	33	300002713	ne	-/-	-/-
17	n. a.	Channel Notch Filter (1800)	WRCD 1747/1748-5EE	Wainwright	1	300000116	ne	-/-	-/-
18	n. a.	Channel Notch Filter (900)	WRCD 901.9/903.1 EE	Wainwright	9	300000114	ne	-/-	-/-
19	n. a.	Channel Notch Filter (850)	WRCT 837-0.2/50-8EE	Wainwright	1	300003129	ne	-/-	-/-
20	n. a.	Channel Notch Filter (DECT)	WRCD 1887.82/1889.55-5EE	Wainwright	1	300003128	ne	-/-	-/-
21	n. a.	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO		300004682	ne	-/-	-/-
22	n. a.	Anechoic chamber		TDK		300003726	ne	-/-	-/-
23	n. a.	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	19.12.2018	18.12.2019
24	n. a.	Band Reject Filter	WRCJV12-5120-5150-5350-5380-40SS	Wainwright	5	300005168	ev	-/-	-/-
25	n. a.	Band Reject Filter	WRCJV12-5695-5725-5850-5880-40SS	Wainwright	5	300005169	ev	-/-	-/-
26	n. a.	Band Reject Filter	WRCJV16-5440-5470-5725-5755-40SS	Wainwright	9	300005170	ev	-/-	-/-
27	n. a.	RF Amplifier	AFS4-00100800-28-20P-4-R	MITEQ	2008992	300005204	ne	-/-	-/-
28	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011571	300005240	ev	-/-	-/-

6.2 Conducted measurements with peak power meter & spectrum analyzer



6.3 Frequency error

Conducted measurements normal & extreme conditions



OP = AV + CA
 (OP-output power; AV-analyzer value; CA-loss signal path)

Example calculation:

OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 mW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	R001	Spectrum Analyzer 20 Hz - 50 GHz	FSU50	R&S	200012	300003443	vKI!	19.02.2019	18.02.2021
2	n. a.	RF Peak Power Analyzer+ PPA Sensor	4500B + 58318	Boonton Electronics	12331 + 6276	300003871	k	18.12.2018	17.12.2019
3	C220	1.5m coaxial cable 2.4mm	Sucoflex 101	H&S	5183/1	-/-	ev	-/-	-/-
4	F132	High pass filter 1320	VHF-1320+	Mini-Circuits	31034	-/-	ev	-/-	-/-
5	F150	High pass filter 1500	VHF-1500+	Mini-Circuits	31022	-/-	ev	-/-	-/-
6	U023b	10 dB coaxial attenuator	CFADC401001	CernexWave	-/-	-/-	ev	-/-	-/-
7	U312	20 dB / 100 W coaxial attenuator	WA91-20-43	Weinschel Associates	A514	300004824	ev	-/-	-/-
8		Power splitter	11667B	HP	00616	300002421	ev	-/-	-/-
9		DC Power Supply	2X30V	Zentro	2010	300000505	ev	-/-	-/-
10	n. a.	Temperature Test Chamber	T-40/50	CTS GmbH	064023	300003540	ev	07.05.2018	06.05.2020

Additional equipment as provided by applicant:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	XPDR/TCAS/DME Signal Generator	IFR 6000	Aeroflex	1000685797	-/-	k	02/2019	02/2020
2	n. a.	AC/DC-Adapter	SNP-PA55	SKynet	155213004	-/-	-/-	-/-	-/-

7 Sequence of testing

7.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

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, it is placed on a table with 0.8 m height.
- 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 height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

*)Note: The sequence will be repeated three times with different EUT orientations.

7.2 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 $\pm 45^\circ$ 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.

7.3 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 Summary of measurement results

☒	No deviations from the technical specifications were ascertained
☐	There were deviations from the technical specifications ascertained

TC identifier	Description	verdict	date	Remark
RF-Testing	47 CFR 87	see table	2019-04-29	-/-

Test specification clause	Test Case	temperature / voltages	Mode	C	NC	NA	NP	Results (max.)
§2.1046 §87.131	Measurements required: RF power output / Power and emissions	Nominal	TX	☒	☐	☐	☐	PK: 53.9 dBm AV: 25.1 dBm
§2.1049 §87.135	Measurements required: Occupied bandwidth / Bandwidth of emissions	Nominal	TX	☒	☐	☐	☐	9.8 MHz
§2.1051 §87.139	Measurements required: Spurious emissions at antenna terminals / Spectrum mask / Conducted spurious emissions	Nominal	TX	☒	☐	☐	☐	
§2.1053 §87.139	Measurements required: Field strength of spurious radiation/ Radiated spurious emissions	Nominal	TX	☒	☐	☐	☐	
§2.1055 §87.133	Measurements required: Frequency stability / Frequency stability	Nominal Extreme	TX	☒	☐	☐	☐	183 ppm

Note:

C = compliant, NC = not compliant, NA = not applicable; NP = not performed

9 Detailed measurement results

9.1 Power and emissions

§2.1046 Measurements required: RF power output.

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in §2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

§87.131 Power and emissions.

Power must be determined by direct measurement.

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:

Note 7: maximum output power will be determined during the certification process

Measurement results:

Test Conditions		conducted output power (dBm)		
		A-Mode	C-Mode	S-Mode
Pos-Peak	T_{nom} / V_{nom}	53.9	53.9	53.8
AVG	T_{nom} / V_{nom}	17.0	15.0	25.1
Measurement uncertainty		± 1.5 dB		

Note:

see Annex E

9.2 Occupied bandwidth

§2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

§87.135 Bandwidth of emission.

(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.

Limits:

no limits defined

Measurement parameters:

Measurement parameters	
Detector:	Pos-Peak
Sweep time:	20 s
Resolution bandwidth:	200 kHz
Video bandwidth:	500 kHz
Span:	20 MHz
Trace-Mode:	Max-Hold

Measurement results:

Test Conditions		Occupied bandwidth (MHz)		
		A-Mode	C-Mode	S-Mode
Pos-Peak Max-Hold	$T_{\text{nom}} / V_{\text{nom}}$	9.8	9.7	9.3
Measurement uncertainty		span /1000		

Note:

see Annex E

9.3 Spectrum mask and conducted spurious emissions

§2.1051 Measurements required: Spurious emissions at antenna terminals.

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§87.139 Emission limitations.

(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the 1435-1525 MHz, 2345-2395 MHz, or 5091-5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

- (1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;
- (2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.
- (3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least $43 + 10 \log_{10} pY$ dB.

Measurement parameters:

Measurement parameters	
Detector:	AVG
Resolution bandwidth:	1 MHz
Video bandwidth:	$\geq \text{ResBW}$
Span:	see plots
Trace-Mode:	Max-Hold

Measurement results:

Spurious emissions (Carrier-on state)								
A-Mode			C-Mode			S-Mode		
F	BW	p	F	BW	p	F	BW	p
3270	1	-51.2	3270	1	-48.1	3270	1	-44.1
						6540	1	-60.0
Measurement uncertainty			$\pm 2\text{dB}$					

Where F = Frequency of spurious (MHz)
 BW = Measurement receiver bandwidth (MHz)
 p = Level of spurious (dBm)

Note:

see Annex E

9.4 Radiated spurious emissions

§2.1053 Measurements required: Field strength of spurious radiation.

(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.

§87.139 Emission limitations.

(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the 1435-1525 MHz, 2345-2395 MHz, or 5091-5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

- (1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;
- (2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.
- (3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least $43 + 10 \log_{10} pY$ dB.

Limits:

frequency range	max. spurious level
30 MHz – 11 GHz	-13 dBm / 1 MHz

Measurement parameters:

Measurement parameters	
Detector:	RMS
Sweep time:	1 s
Resolution bandwidth:	1 MHz
Video bandwidth:	≥ ResBW
Span:	see plots
Trace-Mode:	Max-Hold

Measurement results:

Spurious emissions (Carrier-on state)								
A-Mode			C-Mode			S-Mode		
F	BW	p	F	BW	p	F	BW	p
2180	1	-29.1	2180	1	-26.4	2180	1	-44.8
3270	1	-36.8	3270	1	-36.5	3270	1	-34.7
4360	1	-31.3	4360	1	-37.5	4360	1	-34.1
5450	1	-/-	5450	1	-48.3	5450	1	-48.5
6540	1	-46.3	6540	1	-44.2	6540	1	-46.3
7630	1	-35.0	7630	1	-23.4	7630	1	-28.9
8720	1	-41.1	8720	1	-45.6	8720	1	-41.9
9810	1	-37.4	9810	1	-37.5	9810	1	-33.7
10900	1	-34.2	10900	1	-31.3	10900	1	-29.8
11990	1	-38.2	11990	1	-37.6	11990	1	-37.3
Measurement uncertainty			± 3dB					

Where F = Frequency of spurious (MHz)
 BW = Measurement receiver bandwidth (MHz)
 p = Level of spurious (dBm)

Note:

See Annex E

Above table shows pos-peak values.

Peak-to-Average-Ratio for A-Mode: >35 dB, C-Mode: >35 dB, S-Mode: >25 dB

9.5 Frequency tolerance

§2.1055 Measurements required: Frequency stability.

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

- (1) From -30° to $+50^{\circ}$ centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
- (2) From -20° to $+50^{\circ}$ centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.
- (3) From 0° to $+50^{\circ}$ centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(c) In addition to all other requirements of this section, the following information is required for equipment incorporating heater type crystal oscillators to be used in mobile stations, for which type acceptance is first requested after March 25, 1974, except for battery powered, hand carried, portable equipment having less than 3 watts mean output power.

- (1) Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0° centigrade and $+30^{\circ}$ centigrade with no primary power applied.
- (2) Beginning at each temperature level specified in paragraph (c)(1) of this section, the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than 10° centigrade above the respective beginning ambient temperature level.
- (3) The elapsed time necessary for the frequency to stabilize within the applicable tolerance from each beginning ambient temperature level as determined from the tests specified in this paragraph shall be specified in the instruction book for the transmitter furnished to the user.
- (4) When it is impracticable to subject the complete transmitter to this test because of its physical dimensions or power rating, only its frequency determining and stabilizing portions need be tested.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:

- (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
- (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
- (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c), and (d) of this section. (For example measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment.)

§87.133 Frequency stability.

(a) Except as provided in paragraphs (c), (d), (f), and (g) of this section, the carrier frequency of each station must be maintained within these tolerances:

7) Band 470 to 2450 MHz: Aeronautical utility mobile stations on 1090 MHz: Tolerance of 1000 ppm

Limits:

Frequency tolerance	1000 ppm
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Measurement result:

Temperature [°C]	Voltage [V DC]	Reference Frequency [MHz]	Measured Frequency [MHz]	Deviation [kHz]	Deviation [ppm]
-20	28	1090	1090.0551	55.1	50.6
-10	28	1090	1090.0976	97.6	89.5
0	28	1090	1090.1321	132.1	121.2
10	28	1090	1090.1581	158.1	145.0
20	18	1090	1090.1788	178.8	164.0
20	28	1090	1090.1925	192.5	176.6
20	32	1090	1090.1925	192.5	176.6
30	28	1090	1090.1925	192.5	176.6
40	28	1090	1090.1994	199.4	182.9
50	28	1090	1090.1986	198.6	182.2

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/N₀	Carrier to noise-density ratio, expressed in dB-Hz

11 Document history

Version	Applied changes	Date of release
-/-	Initial release – DRAFT	2019-04-05
	editorial changes based on applicant's remark	2019-04-29

12 Accreditation Certificate – D-PL-12076-01-05

first page	last page
 Deutsche Akkreditierungsstelle GmbH Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition Accreditation  The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory CTC advanced GmbH Untertürkheimer Straße 6-10, 66117 Saarbrücken is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields: Telecommunication (FCC Requirements) The accreditation certificate shall only apply in connection with the notice of accreditation of 11.01.2019 with the accreditation number D-PL-12076-01 and is valid until 21.04.2021. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 5 pages. Registration number of the certificate: D-PL-12076-01-05 Frankfurt am Main, 11.01.2019  Dipl.-Biol. Uwe Zimmermann Head of Division See notes (continued)	Deutsche Akkreditierungsstelle GmbH Office Berlin Spittelmarkt 10 10117 Berlin Office Frankfurt am Main Europa-Allee 52 60327 Frankfurt am Main Office Braunschweig Bundesallee 100 38116 Braunschweig The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAKKS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf. No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAKKS. The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAKKS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations. The up-to-date state of membership can be retrieved from the following websites: EA: www.european-accreditation.org ILAC: www.ilac.org IAF: www.iaf.nu

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END OF TEST REPORT