
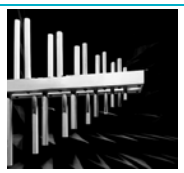
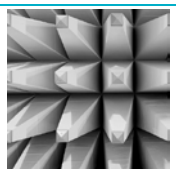

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-3409/17-01-02-A

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-01

Testing laboratory

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

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-12076-01-01

Applicant

TQ-Systems GmbH
Mühlstraße 2, Gut Delling
82229 Seefeld / GERMANY
Contact: Sebastian Glück
e-mail: sebastian.glueck@tq-group.com
Phone: +49 8153 9308-549

Manufacturer

TQ-Systems GmbH
Mühlstraße 2, Gut Delling
82229 Seefeld / GERMANY

Test standard/s

47 CFR Part 87	Title 47 of the Code of Federal Regulations; Chapter I; Part 87 - Aviation Services
RSS-141	Aeronautical Radiocommunication Equipment in the Frequency Band 117.975-137 MHz

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

Test Item

Kind of test item:	**VHF Communication Transceiver 8.33 MHz (118 – 136.995 MHz)**
Model name:	**KRT2 VHF Communication Transceiver**
FCC ID:	**2ANFFKRT2**
IC:	**23072-KRT2**
Frequency:	118.000 MHz to 136.995 MHz
Technology tested:	Proprietary
Antenna:	External antenna connector
Power supply:	9.0 V to 33.0 V DC by external battery
Temperature range:	-20°C to +55°C

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

Test report authorized:

p.o.

cn=Christoph Schneider, o=CTC advanced GmbH, ou=SND-161128, email=Christoph.Schneider@ctcadvanced.com, c=DE
2018.02.20 08:07:46 +01'00'

David Lang
Lab Manager
Radio Communications & EMC

Test performed:

cn=Yves Olsommer, o=CTC advanced GmbH, ou=OLS-170522, email=yves.olsommer@ctcadvanced.com, c=DE
2018.02.19 13:27:24 +01'00'

Yves Olsommer
Testing 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. 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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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.

This test report replaces the test report with the number 1-3409/17-01-02 and dated 2017-11-10.

2.2 Application details

Date of receipt of order:	2017-02-09
Date of receipt of test item:	2017-06-26
Start of test:	2017-06-26
End of test:	2017-11-07
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

Test standard	Date	Description
47 CFR Part 87	June 28, 2017	Title 47 of the Code of Federal Regulations; Chapter I; Part 87 - Aviation Services
47 CFR Part 2	July 12, 2017	Title 47 of the Code of Federal Regulations; Chapter I; Part 2 – Frequency allocations and radio treaty matters; general rules and regulations
RSS-141	June 2010	Aeronautical Radiocommunication Equipment in the Frequency Band 117.975-137 MHz
RSS-Gen	November 13, 2014	General Requirements for Compliance of Radio Apparatus

Guidance	Version	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

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +55 °C during high temperature tests -20 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	13.8 V DC by external battery 33.0 V 9.0 V

5 Test item

5.1 General description

Kind of test item	:	VHF Communication Transceiver 8.33 MHz (118 – 136.995 MHz)	
Type identification	:	KRT2 VHF Communication Transceiver	
HMN	:	-/-	
PMN	:	KRT2	
HVIN	:	285942 285945 286048	KRT2-S KRT2-L KRT2-P
FVIN	:	-/-	
S/N serial number	:	178022, 170177, 170173, 165108	
HW hardware status	:	-/-	
SW software status	:	-/-	
Frequency band	:	118.000 MHz to 136.995 MHz	
Type of radio transmission Use of frequency spectrum	: :	Modulated carrier	
Type of modulation	:	A3E	
Number of channels	:	2278	
Antenna	:	External antenna connector	
Power supply	:	9.0 V to 33.0 V DC by external battery	
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- and EUT-photos are included in test report: 1-3409/17-01-01_AnnexA
1-3409/17-01-01_AnnexB
1-3409/17-01-01_AnnexD

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).

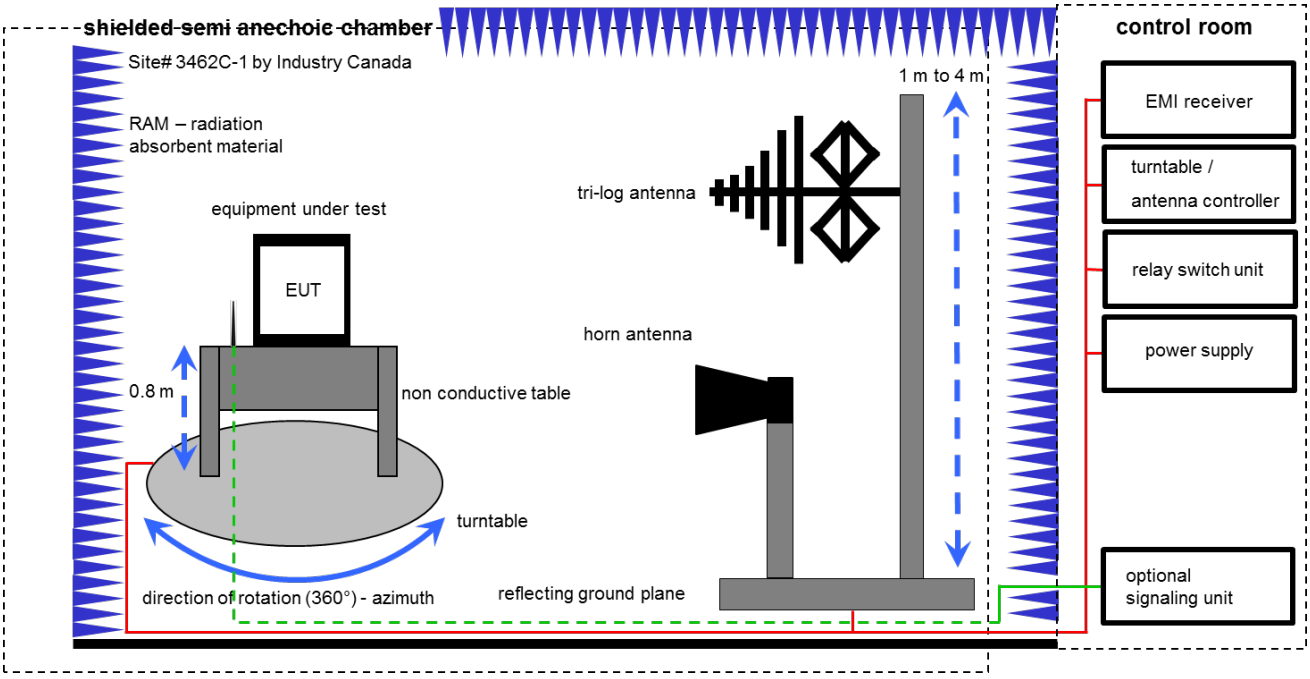
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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
vlkl!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

6.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.

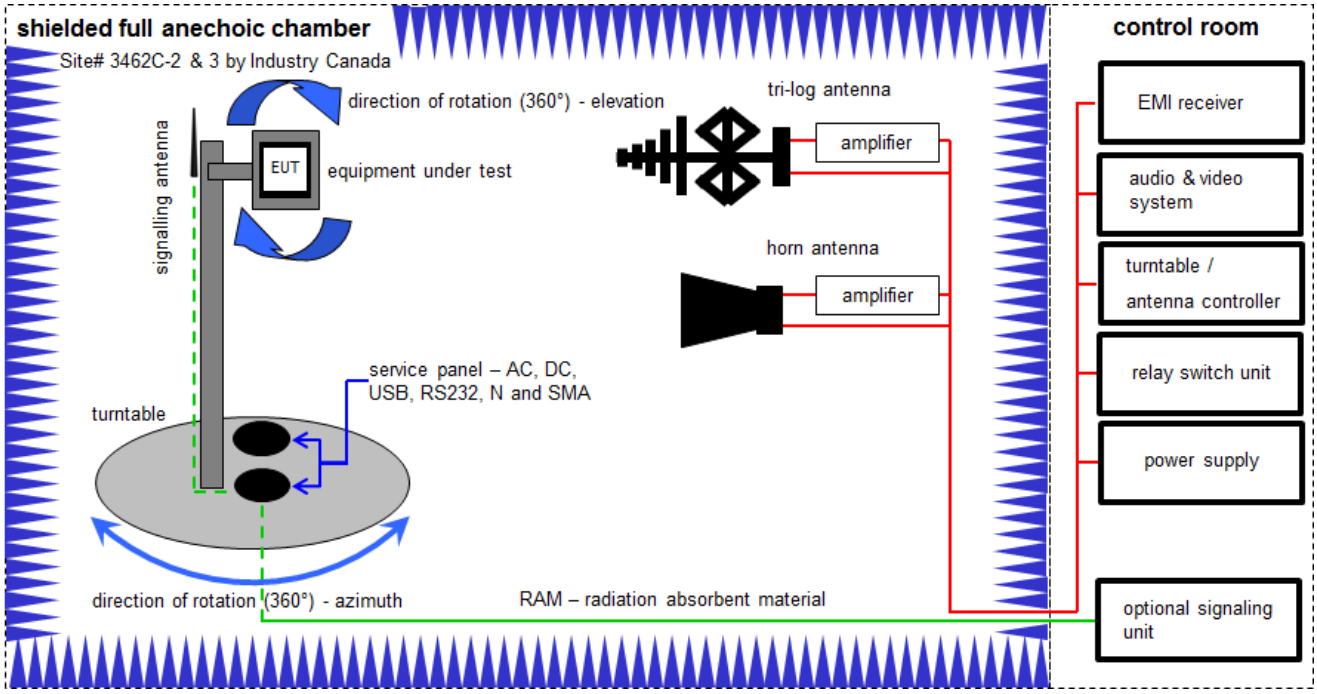


Measurement distance: tri-log antenna 10 meter
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)
Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A, B	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	A, B	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	A, B	Meßkabine 1	HF-Absorberhalle	MWB AG 300023	-/-	300000551	ne	-/-	-/-
4	A, B	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	01.02.2017	31.01.2018
5	A, B	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vlKI!	02.02.2016	01.02.2018
6	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
7	A, B	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
8	A, B	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
9	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	25.04.2016	25.04.2018
10	B	Double Ridge Broadband Horn Antenna 1-10 GHz	BBHA9120 B	Schwarzbeck	188	300003896	k	20.05.2015	20.05.2018

6.2 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter; loop antenna 3 meter / 1 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)

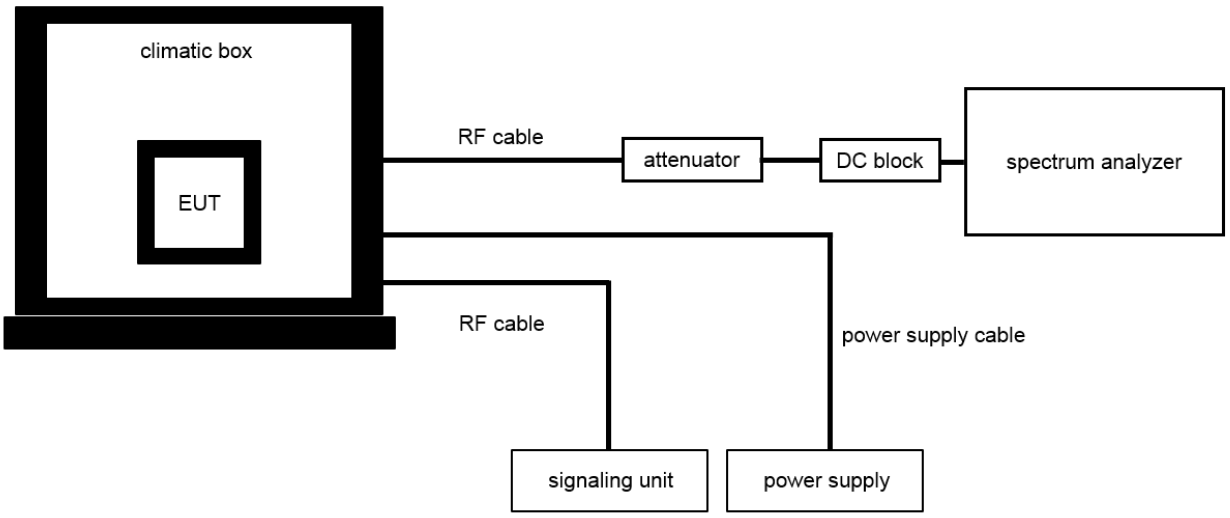
Example calculation:
OP [dBm] = -65.0 [dBm] + 50 [dB] - 20 [dBi] + 5 [dB] = -30 [dBm] (1 µW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032	vlKl!	07.07.2017	06.07.2019
2	A, B	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04590	300001041	vlKl!	20.01.2015	19.01.2018
3	B	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
4	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	318	300003696	k	23.05.2017	22.05.2020
5	B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22051	300004483	ev	-/-	-/-
6	A, B	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
7	A, B	Computer	Intel Core i3 3220/3,3 GHz, Prozessor	-/-	2V2403033A5421	300004591	ne	-/-	-/-
8	A, B	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO	-/-	300004682	ne	-/-	-/-
9	A, B	Anechoic chamber	-/-	TDK	-/-	300003726	ne	-/-	-/-

6.3 Conducted measurements normal and extreme conditions

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	A, B	Climatic Box	VT 4011	Voetsch Industrietechnik	5856623060001 0	300005363	ev	01.06.2017	31.05.2019
2	A, B, C	DC Power Supply, 60V, 10A	6038A	HP	3122A11097	300001204	vlKl!	21.01.2015	20.01.2018
3	B, C	Radiocom. Analyzer	CMTA 54	R&S	894043/010	300001175	NK!	06.06.2007	-/-
4	B	Multifunction synthesizer DC-600 kHz	8904A	HP	2822A01203	300001367	vlKl!	26.01.2017	25.01.2020
5	C	Audio Analyzer 2Hz - 300 kHz	UPD	R&S	841074/009	300001236	k	02.02.2016	02.02.2018
6	A, B	Signal- and Spectrum Analyzer	FSW26	R&S	101455	300004528	k	25.01.2017	24.01.2018

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, 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 height is 1.5 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 premeasurement are maximized by the software by rotating the turntable from 0° to 360°. In case of the 2-axis positioner is used the elevation axis is also rotated from 0° to 360°.
- 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.

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 ± 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.

7.3 Sequence of testing radiated spurious 1 GHz to 2 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
☐	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	FCC Part 87 RSS - 141, Issue 2 RSS-Gen Issue 4	See table!	2018-02-19	-/-

Test specification clause	Test case	Temperature conditions	Voltage conditions	C	NC	NA	NP	Remark
FCC Part 87.131 FCC Part 2.1046 (a) FCC Part 2.1033 (c)(8) RSS-141 - 4.1 RSS-Gen – 6.12	Transmitter output power	Nominal	Nominal	☒	☐	☐	☐	-/-
FCC Part 87.135 FCC Part 2.1049 FCC Part 2.1033 (c)(4) RSS-141 Table 1 – 5.1 RSS-Gen – 6.6	Occupied bandwidth	Nominal	Nominal	☒	☐	☐	☐	-/-
FCC Part 87.133 FCC Part 2.1055 RSS-141 Table 1– 5.1 RSS-Gen – 6.11	Transmitter frequency stability	Nominal	Nominal	☒	☐	☐	☐	
		Extreme	Extreme	☒	☐	☐	☐	
FCC Part 87.139(a) FCC Part 2.1051 RSS-141 – 4.2 RSS-141 – 5.2	Transmitter Unwanted Emissions	Nominal	Nominal	☒	☐	☐	☐	-/-
FCC Part 2.1047(a), Part 87.141 (F)	Audio low pass filter	Nominal	Nominal	☐	☐	☒	☐	Only for FM modulation
FCC Part 87.141 FCC Part 2.1047 (a, b) RSS-141 Table 1 – 5.1	Modulation characteristics	Nominal	Nominal	☒	☐	☐	☐	-/-
RSS-141 -5.3 RSS-Gen – 7.1	Receiver spurious emissions	Nominal	Nominal	☒	☐	☐	☐	-/-

Note: C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed

9 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Transmitter output power	± 3 dB
Occupied bandwidth	± 3 kHz to 10 kHz (depends on the used RBW)
Transmitter frequency stability	± 1 Hz to 1 kHz (depends on the used RBW)
Transmitter unwanted emissions (radiated or conducted)	Radiated: ± 3 dB Conducted: ± 0.5 dB
Modulation characteristics	-/-
Necessary bandwidth (BN) for analogue systems	± 1 kHz (depends on the used RBW)
Frequency modulation	± 3 kHz (depends on the used RBW)
Spurious emissions conducted below 30 MHz (AC conducted)	± 2.6 dB

10 Additional comments

Reference documents: None

Special test descriptions: None

Configuration descriptions: KRT2-S, KRT2-L and KRT2-P are identical in hardware and software related to the RF behavior. Only the construction forms from these models are different.

Test mode:

☒ No test mode available.
Test signal is applied to the transmitter. A 2500 Hz sinusoidal signal at a level sufficient to produce 50% modulation. The level of the input modulation signal is then increased by 16 dB..

☐ Special software is used.
EUT is transmitting pseudo random data by itself

Antennas and transmit operating modes:

☒ Operating mode 1 (single antenna)

- *Equipment with 1 antenna,*
- *Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used,*
- *Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)*

☐ Operating mode 2 (multiple antennas, no beamforming)

- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.*

☐ Operating mode 3 (multiple antennas, with beamforming)

- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming.*
  In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.

11 Measurement results

11.1 Transmitter output power

Measurement:

Measurement parameter	
Detector:	Peak (worst case) / Average (RMS)
Sweep time:	Auto / 20 s
Resolution bandwidth:	> emission bandwidth
Video bandwidth:	> resolution bandwidth
Span:	> 2 times emissions bandwidth
Trace mode:	Max. hold
EUT configuration:	Peak: Unmodulated carrier RMS: Amplitude modulated carrier
Test setup:	See sub clause 6.3 A / B
Measurement uncertainty:	See sub clause 9

Limit:

FCC	
For aeronautical advisory, multicom and aeronautical search and rescue	10 W / 40 dBm

Results:

The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range: $13.8\ \mathrm{Vdc} \cdot 1.18\ \mathrm{A} = 16.28\ \mathrm{W}$

Frequency / MHz	Transmitter output power / dBm*			
	8.33 kHz channel bandwidth		25 kHz channel bandwidth	
	Peak[1]	Average[2]	Peak[1]	Average[2]
118.000	38.2	38.7	37.4	38.1
127.475	38.1	37.5	38.1	38.5
136.975	37.3	38.0	38.2	38.7

*) Measured by connecting a spectrum analyzer with a 50 Ohm input, in addition with a 20 dB attenuator.

1) Unmodulated carrier
2) Amplitude modulated carrier

11.2 Occupied bandwidth

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	200 Hz (1 % to 5 % of the occupied bandwidth)
Video bandwidth:	1 kHz
Span:	100 kHz
Trace mode:	Max. hold
Analyzer function:	99% power occupied bandwidth function
EUT:	Modulated signal
Test setup:	See sub clause 6.3 A / B
Measurement uncertainty:	See sub clause 9

Limits:

FCC & IC			
Class of emission	**Emission designator**	**Authorized bandwidth (FCC)**	**Authorized bandwidth (IC)**
A3E	6K00A3E*	25 kHz	25 kHz
A3E	5K6A3E	8.33 kHz	25 kHz

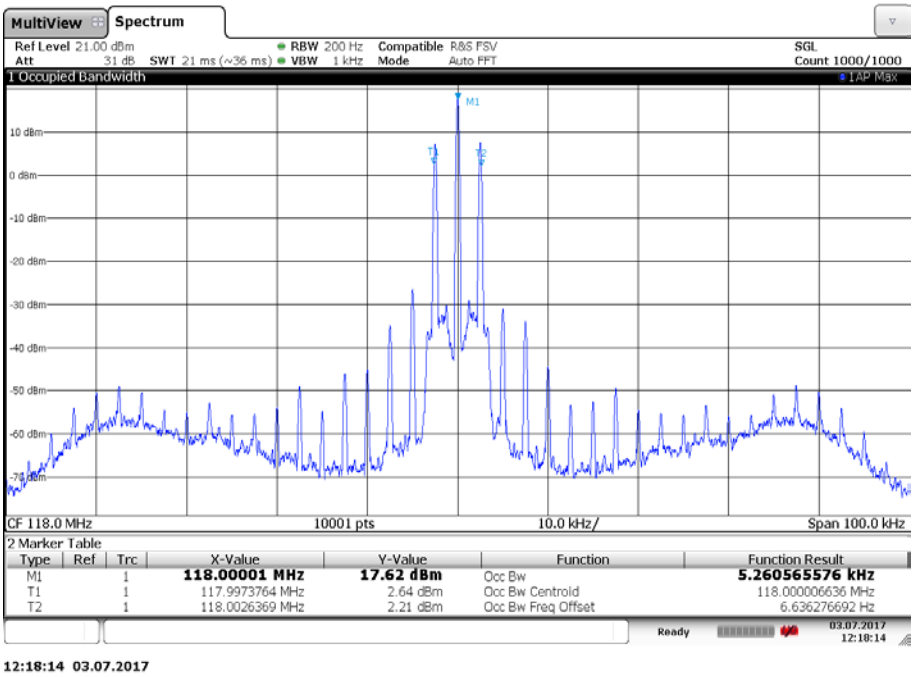
*) For transmitters approved after January 1, 1974

Results:

Frequency / MHz	Occupied bandwidth / kHz	
	8.33 kHz channel bandwidth	25 kHz channel bandwidth
118.000	5.26	5.26
127.475	5.26	5.26
136.975	5.28	5.28

Plots:

Plot 1: 8.33 kHz channel bandwidth, 118.000 MHz



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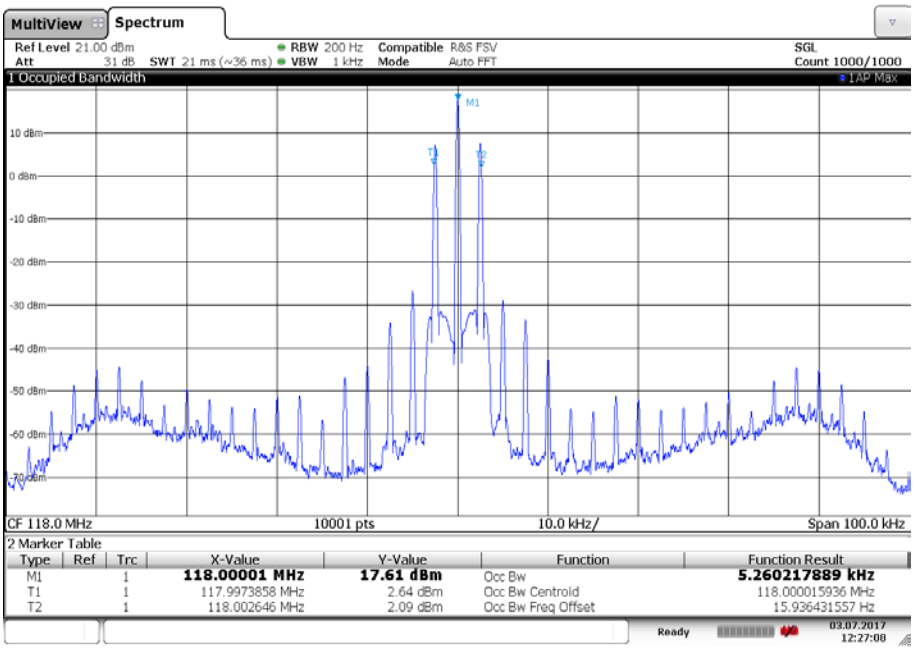
Plot 2: 25 kHz channel bandwidth**,** 118.000 MHz



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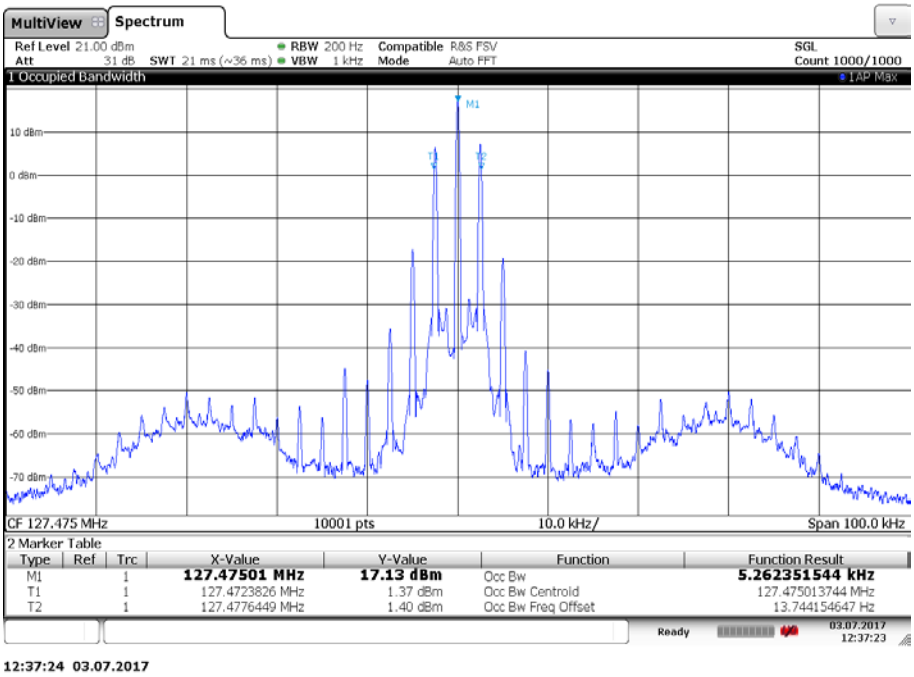
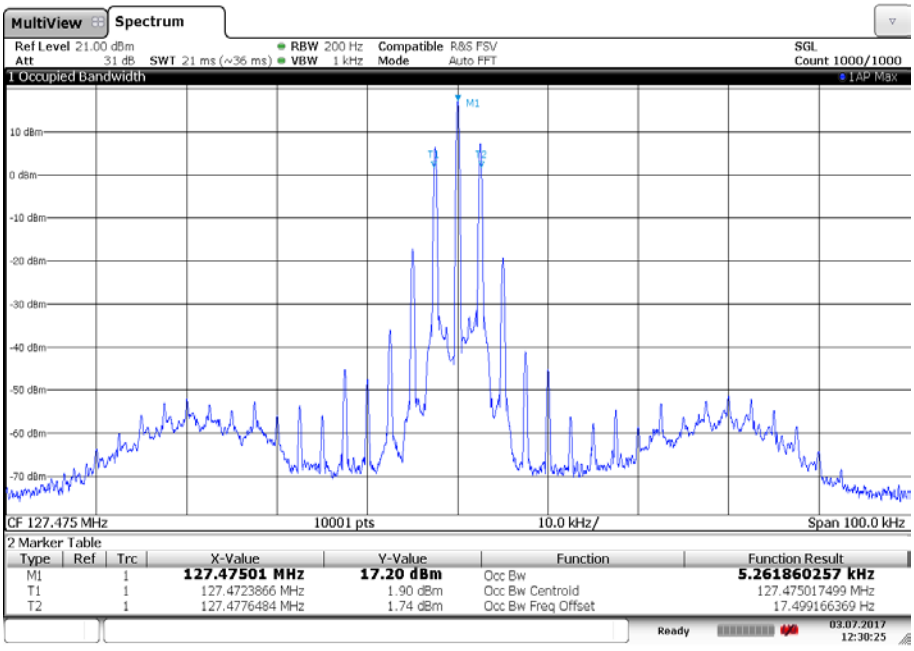
Plot 3: 8.33 kHz channel bandwidth**,** 127.475 MHz



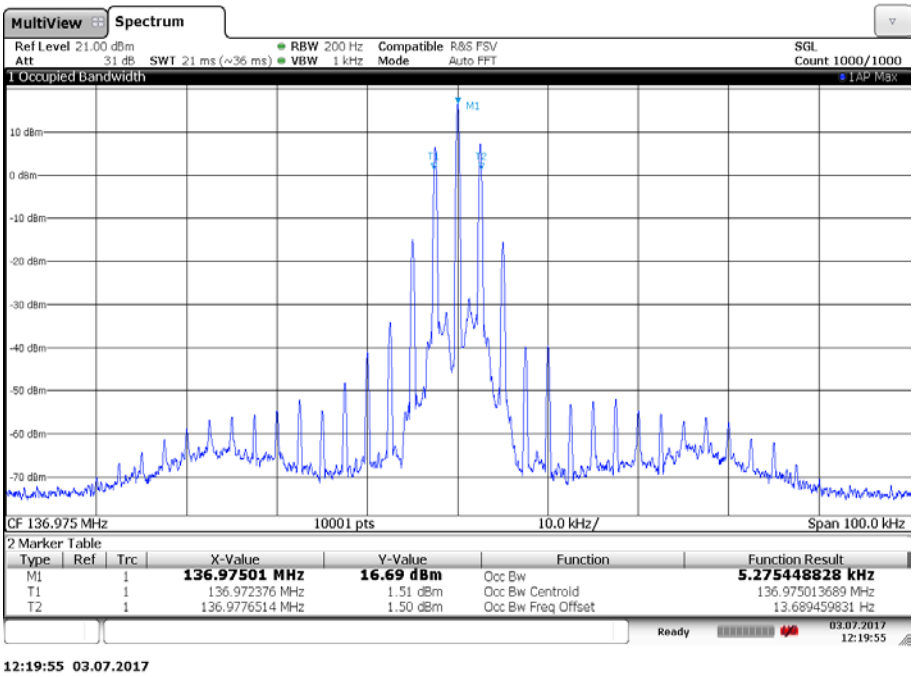
12:37:24 03.07.2017

Plot 4: 25 kHz channel bandwidth**,** 127.475 MHz



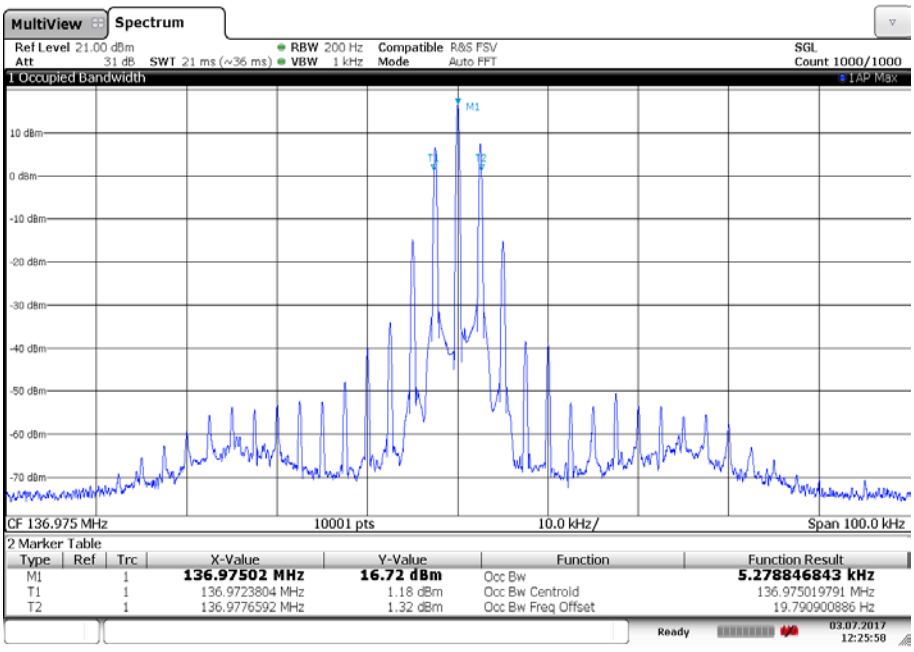
12:30:25 03.07.2017

Plot 5: 8.33 kHz channel bandwidth**,** 136.975 MHz



12:19:55 03.07.2017

Plot 6: 25 kHz channel bandwidth**,** 136. 975 MHz



12:25:59 03.07.2017

11.3 Transmitter frequency stability

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	10 Hz
Video bandwidth:	3 x resolution bandwidth
Span:	wide enough to follow the frequency drift
Trace mode:	Max hold
EUT:	CW signal or MC with measurement method description
Test setup:	See sub clause 6.3 A
Measurement uncertainty:	See sub clause 9

Limits:

FCC & IC
108 MHz – 137 MHz ± 20 ppm*

*) This tolerance is the maximum permitted after January 1, 1985 for new and replacement transmitters and to all transmitters after January 1, 1990.

Results: 8.33 kHz channel bandwidth, 118.000 MHz

Temperature / Voltage	Frequency (MHz)	Deviation	
		Hz	ppm
-30 °C / V_{nom}	118.000	-29	-0.25
-20 °C / V_{nom}	118.000	-28	-0.24
-10 °C / V_{nom}	118.000	11	0.09
0 °C / V_{nom}	118.000	9	0.08
+10 °C / V_{nom}	118.000	14	0.12
+20 °C / V_{nom}	118.000	8	0.07
+30 °C / V_{nom}	118.000	-13	-0.11
+40 °C / V_{nom}	118.000	-3	-0.03
+50 °C / V_{nom}	118.000	8	0.07
+20 °C / V_{nom} - 15%	118.000	4	0.03
+20 °C / V_{nom}	118.000	8	0.07
+20 °C / V_{nom} + 15%	118.000	11	0.09

Results: 25 kHz channel bandwidth, 127.475 MHz

Temperature / Voltage	Frequency (MHz)	Deviation	
		Hz	ppm
-30 °C / V_{nom}	127.475	-65	-0.48
-20 °C / V_{nom}	127.475	10	0.07
-10 °C / V_{nom}	127.475	24	0.18
0 °C / V_{nom}	127.475	20	0.15
+10 °C / V_{nom}	127.475	22	0.16
+20 °C / V_{nom}	127.475	7	0.05
+30 °C / V_{nom}	127.475	-10	-0.07
+40 °C / V_{nom}	127.475	12	0.09
+50 °C / V_{nom}	127.475	9	0.07
+20 °C / V_{nom} - 15%	127.475	1	0.01
+20 °C / V_{nom}	127.475	7	0.06
+20 °C / V_{nom} + 15%	127.475	-2	-0.02

Results: 8.33 kHz channel bandwidth, 136.975 MHz

Temperature / Voltage	Frequency (MHz)	Deviation	
		Hz	ppm
-30 °C / V_{nom}	136.975	-55	-0.40
-20 °C / V_{nom}	136.975	-7	-0.05
-10 °C / V_{nom}	136.975	8	0.06
0 °C / V_{nom}	136.975	12	0.09
+10 °C / V_{nom}	136.975	14	0.10
+20 °C / V_{nom}	136.975	15	0.11
+30 °C / V_{nom}	136.975	-14	-0.10
+40 °C / V_{nom}	136.975	-11	-0.08
+50 °C / V_{nom}	136.975	10	0.07
+20 °C / V_{nom} - 15%	136.975	15	0.13
+20 °C / V_{nom}	136.975	15	0.13
+20 °C / V_{nom} + 15%	136.975	16	0.14

11.4 Transmitter unwanted emissions

Measurement:

Measurement parameter		
Detector:	Peak (worst case) / Average (RMS)	
Sweep time:	Auto / 1 s	
Resolution bandwidth:	25 dBc and 35 dBc criteria:	300 Hz
	43 + 10 $\log_{10}$ (pY) criterion	3 kHz
Video bandwidth:	3 x resolution bandwidth	
Trace mode:	Max. hold	
EUT:	Modulated signal	
Test setup:	See sub clause 6.2 A / B, 6.3 B	
Measurement uncertainty:	See sub clause 9	

The transmitter shall be operated into the standard output termination across the antenna terminals and modulated with a 2500 Hz sinusoidal signal at a level sufficient to produce 50% modulation. The level of the input modulation signal is then increased by 16 dB.

Limits:

FCC & IC
• 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; • 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. • 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. Where pY is the mean power of the transmitter.

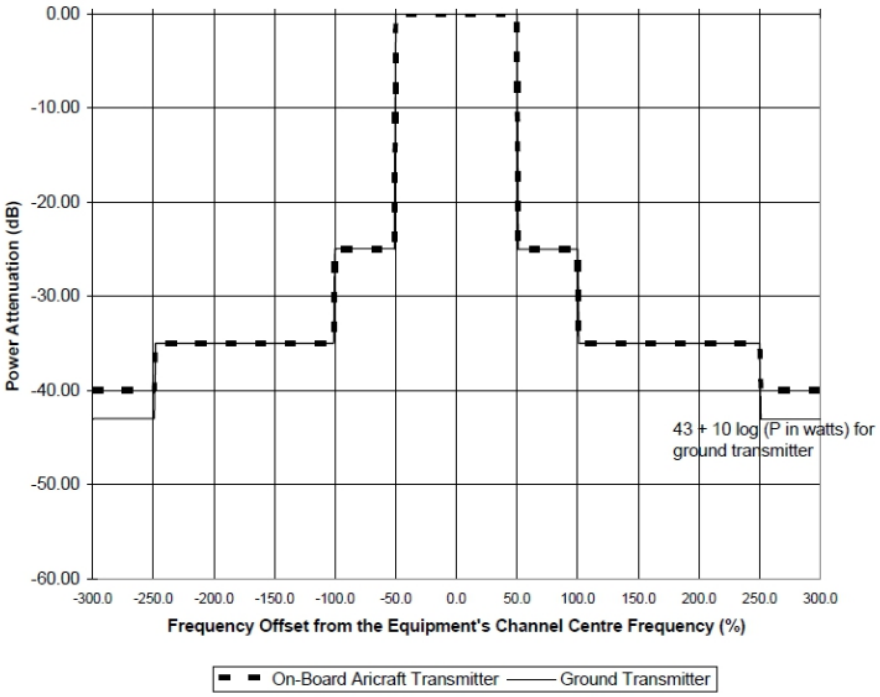


Figure 1: Unwanted Emissions Mask for Transmitters with A3E and A9W Emissions

The equipment's transmitted unwanted emission limits are plotted for a range of frequency offset percentage values. The x-axis represents the frequency offset from the equipment's channel frequency. The y-axis represents the power attenuation in dB. The solid line represents the unwanted emission mask for ground transmitters. The dashed line represents the unwanted emission mask for on-board aircraft transmitters.

Results:

Radiated			
carrier frequency / MHz	**unwanted emission frequency / MHz**	**Limit / dBm**	**level dB / dBm or remark**
All detected unwanted emissions are more than 20 dB below the spurious limit.			

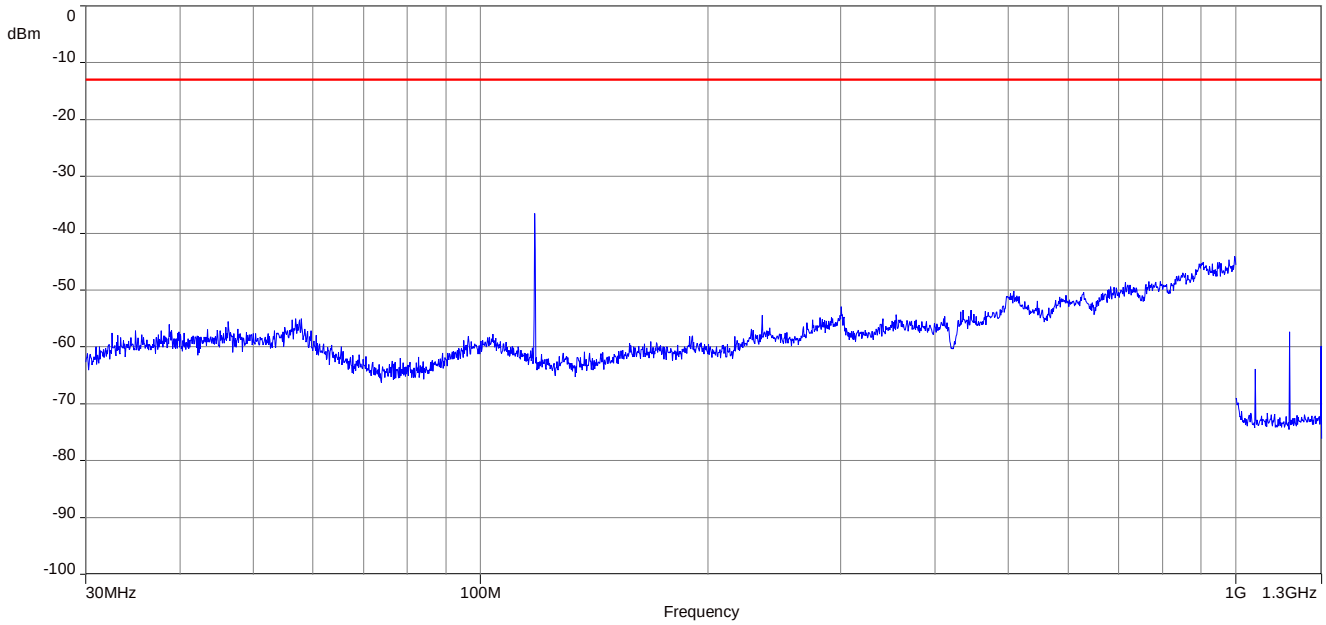
Where PP = Positive peak detector
RMS = Root mean square detector

Conducted			
carrier frequency / MHz	**unwanted emission frequency / MHz**	**Limit / dBm**	**level dB / dBm or remark**
118.000 MHz (KRT-2 with remote, S/N: 178022)	235.9	-13.0	-31.0 (PP)
127.485 MHz (KRT-2 with remote, S/N: 178022)	255.1		-31.6 (PP)
136.975 MHz (KRT-2 with remote, S/N: 178022)	274.0		-36.4 (PP)

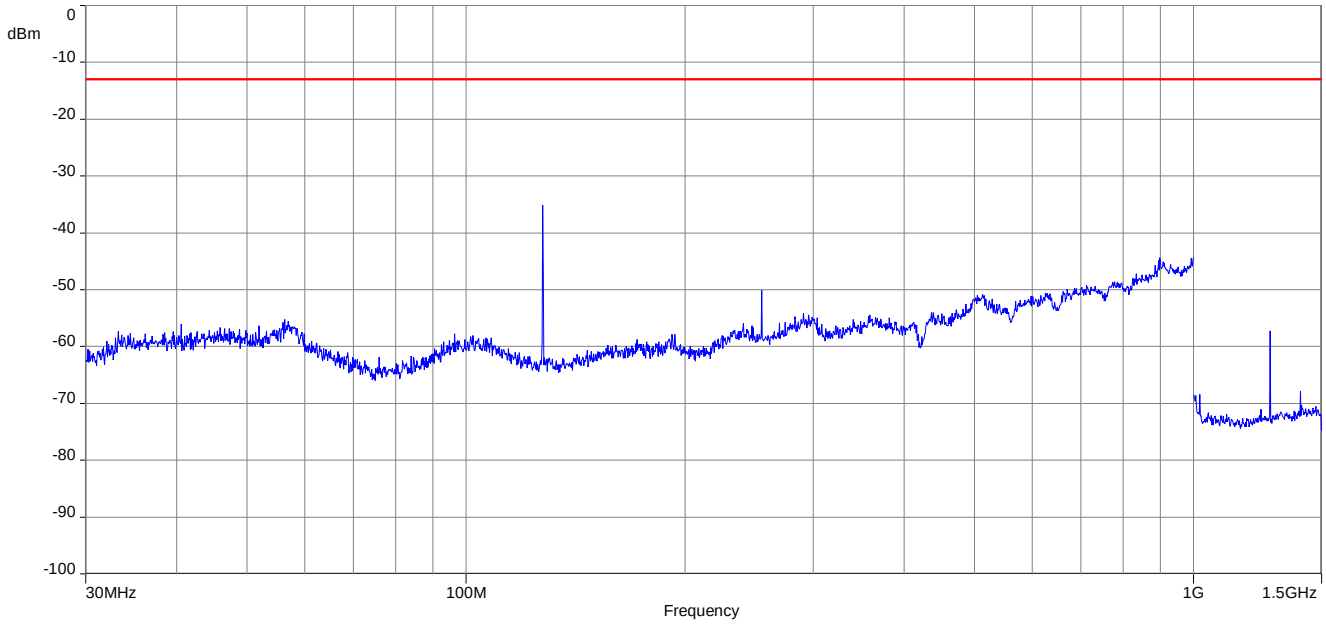
Where PP = Positive peak detector
RMS = Root mean square detector

Plots: Radiated, KRT-2, S/N: 178022 (external antenna connector with 50 Ohm termination)

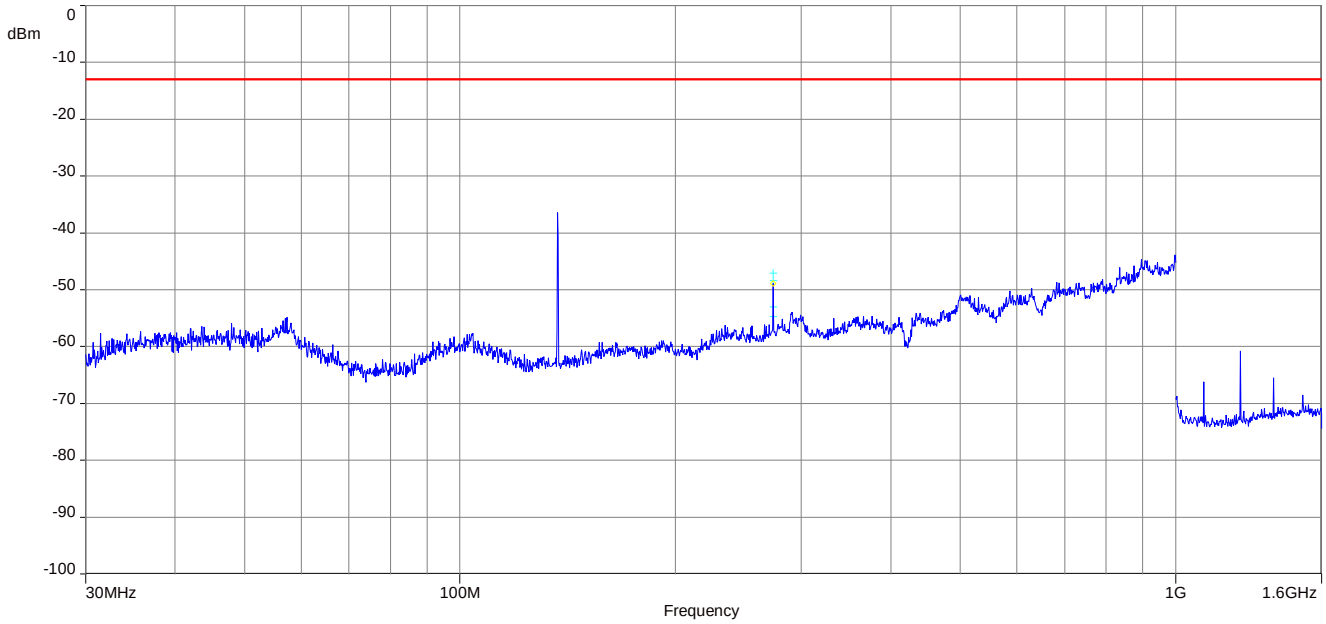
Plot 1: 118.000 MHz, 8.33 kHz channel bandwidth, with remote, spurious emissions, 30 MHz – 1.3 GHz



Plot 2: 127.485 MHz, 8.33 kHz channel bandwidth, with remote, spurious emissions, 30 MHz – 1.5 GHz

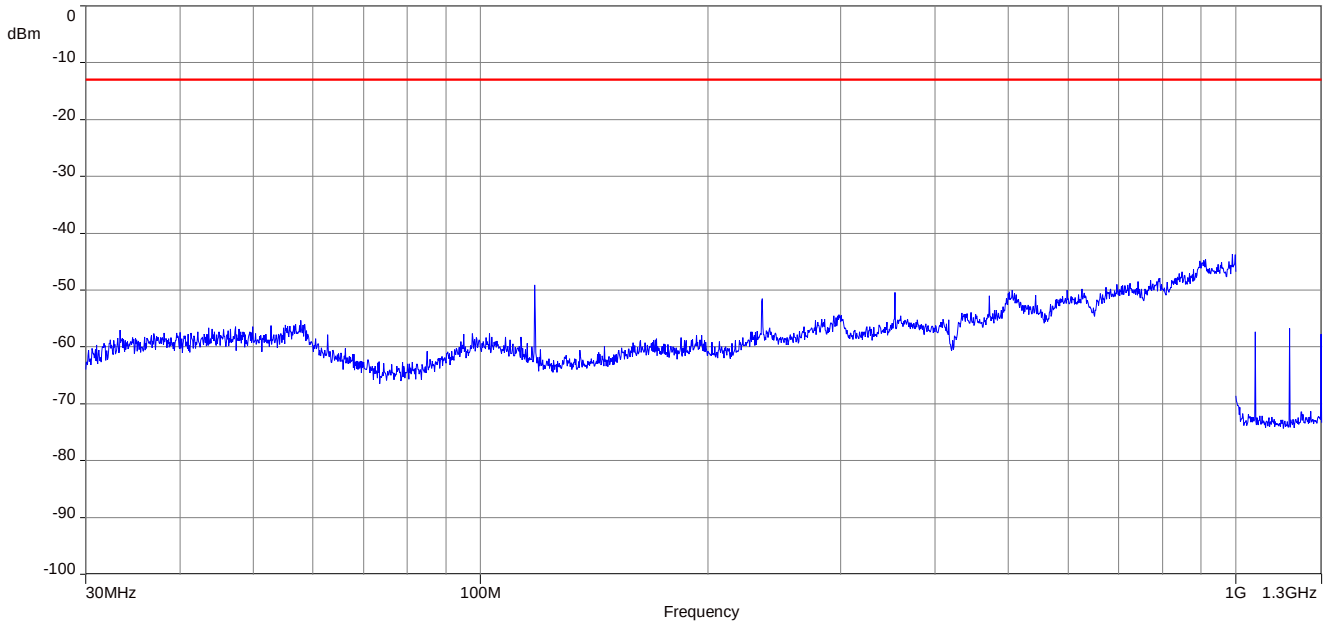


Plot 3: 136.975 MHz, 8.33 kHz channel bandwidth, with remote, spurious emissions, 30 MHz – 1.6 GHz

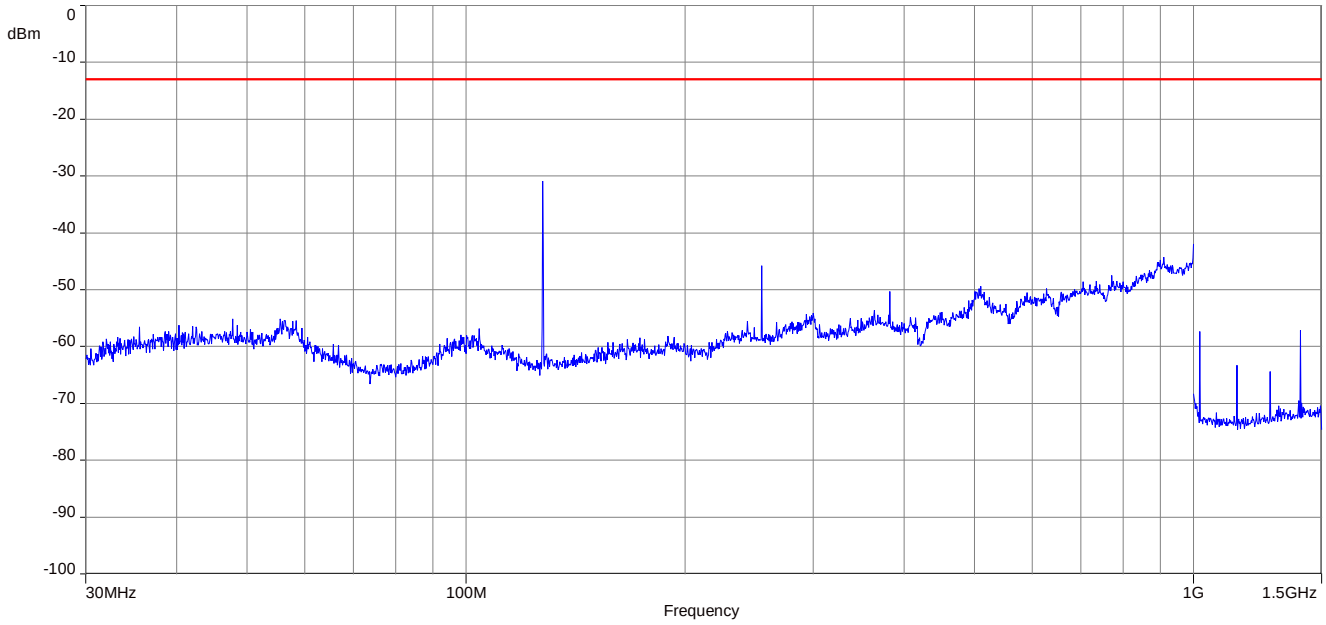


Plots: Radiated, KRT-2, S/N: 170177 (external antenna connector with 50 Ohm termination)

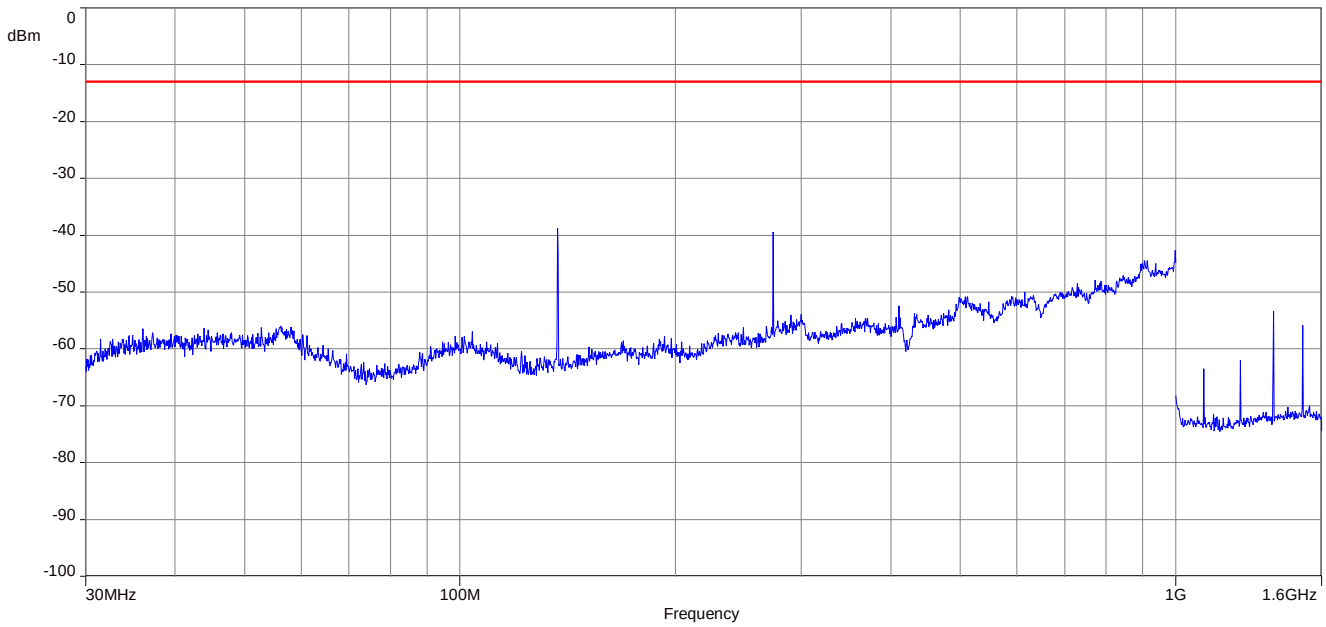
Plot 1: 118.000 MHz, 8.33 kHz channel bandwidth, with remote, spurious emissions, 30 MHz – 1.3 GHz



Plot 2: 127.485 MHz, 8.33 kHz channel bandwidth, without remote, spurious emissions, 30 MHz – 1.4 GHz

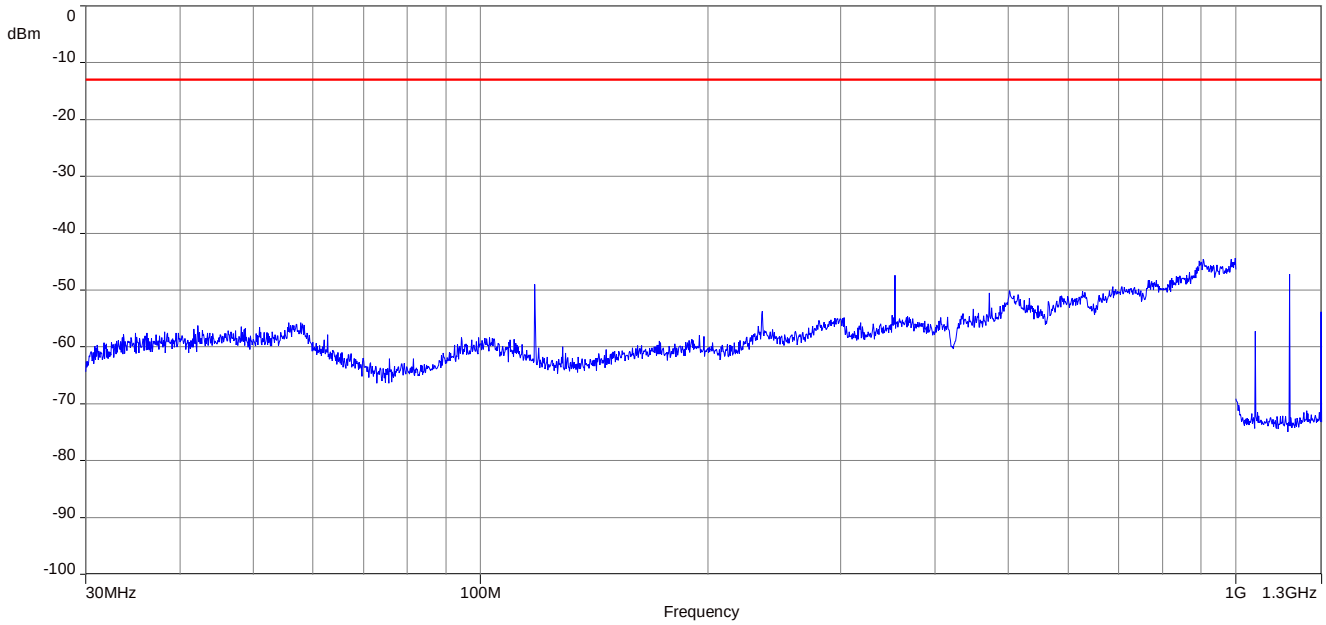


Plot 3: 136.975 MHz, 8.33 kHz channel bandwidth, with remote, spurious emissions, 30 MHz – 1.5 GHz

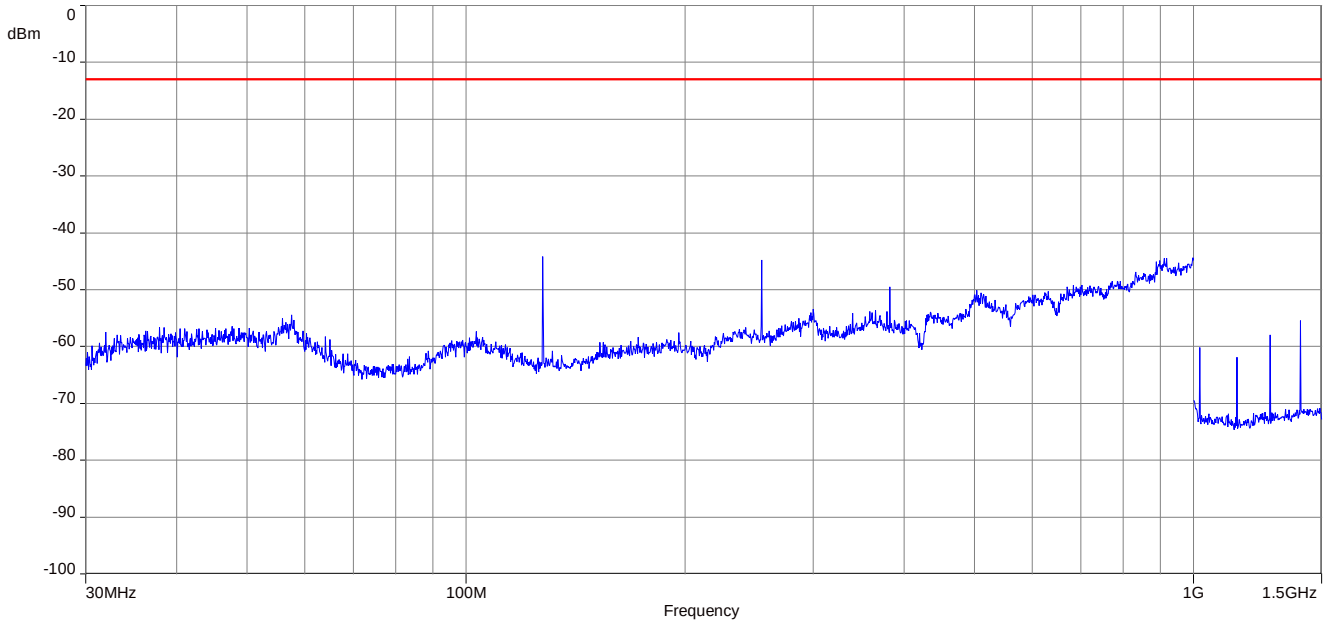


Plots: Radiated, KRT-2, S/N: 170173 (external antenna connector with 50 Ohm termination)

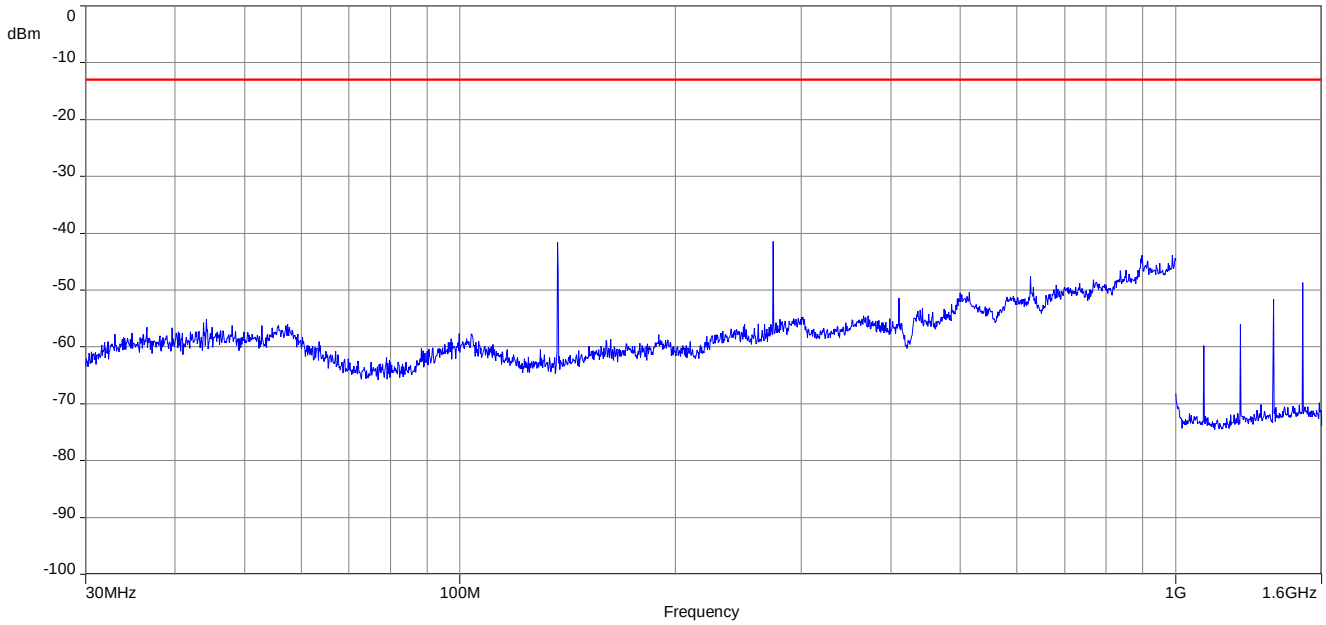
Plot 1: 118.000 MHz, 8.33 kHz channel bandwidth, with remote, spurious emissions, 30 MHz – 1.3 GHz



Plot 2: 127.485 MHz, 8.33 kHz channel bandwidth, with remote, spurious emissions, 30 MHz – 1.4 GHz

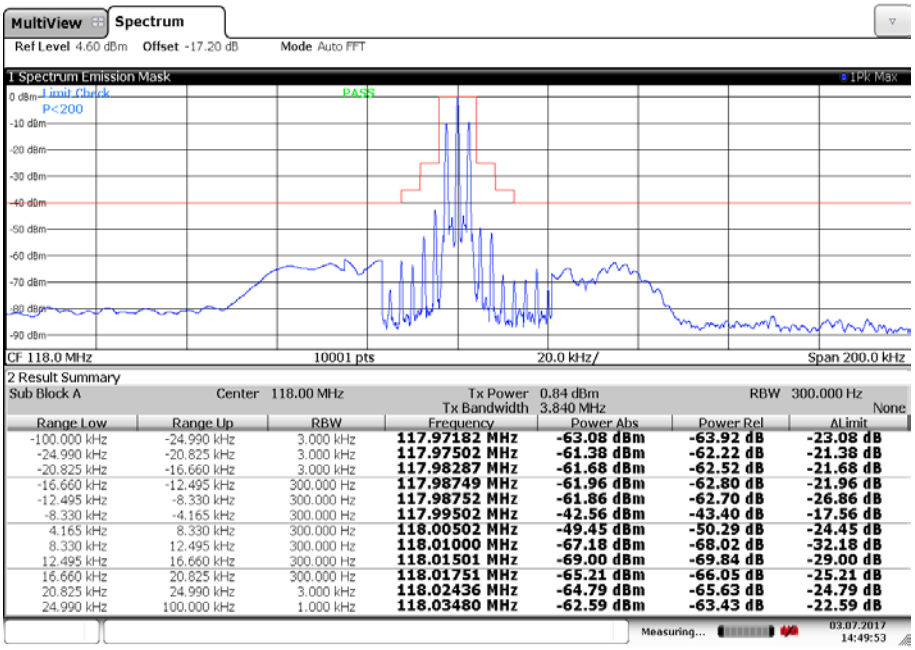


Plot 3: 136.975 MHz, 8.33 kHz channel bandwidth, with remote, spurious emissions, 30 MHz – 1.5 GHz

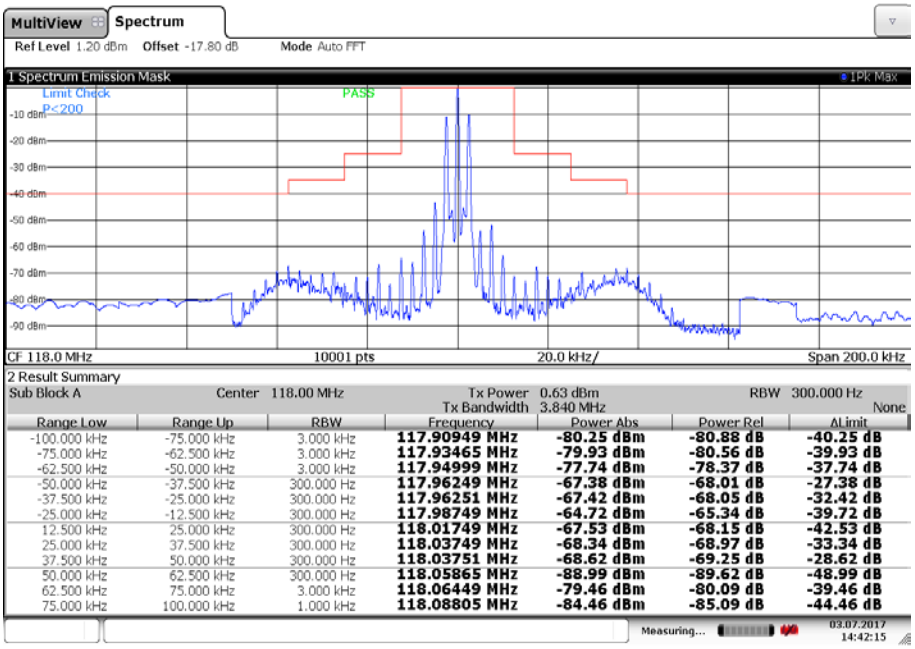


Plots: Conducted, KRT-2, S/N: 178022, Unwanted Emissions Mask

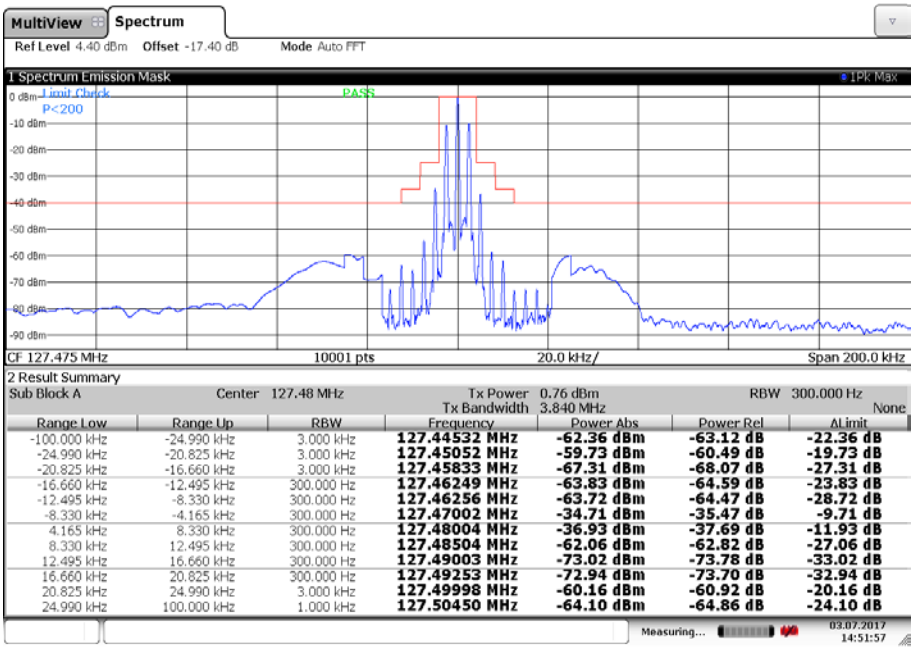
Plot 1: 118.000 MHz, 8.33 kHz channel bandwidth, Unwanted Emissions Mask



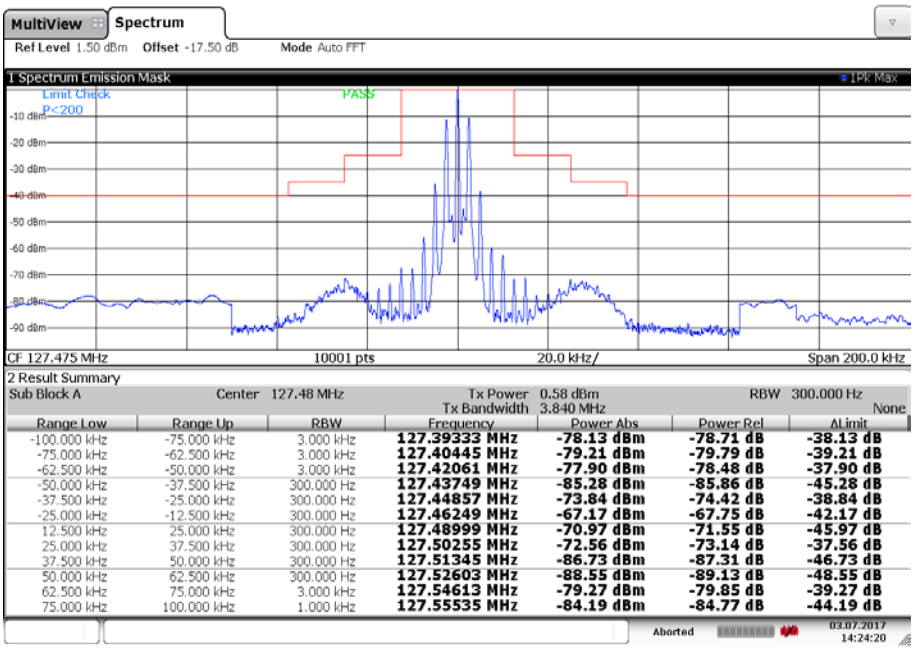
Plot 2: 118.000 MHz, 25 kHz channel bandwidth, Unwanted Emissions Mask



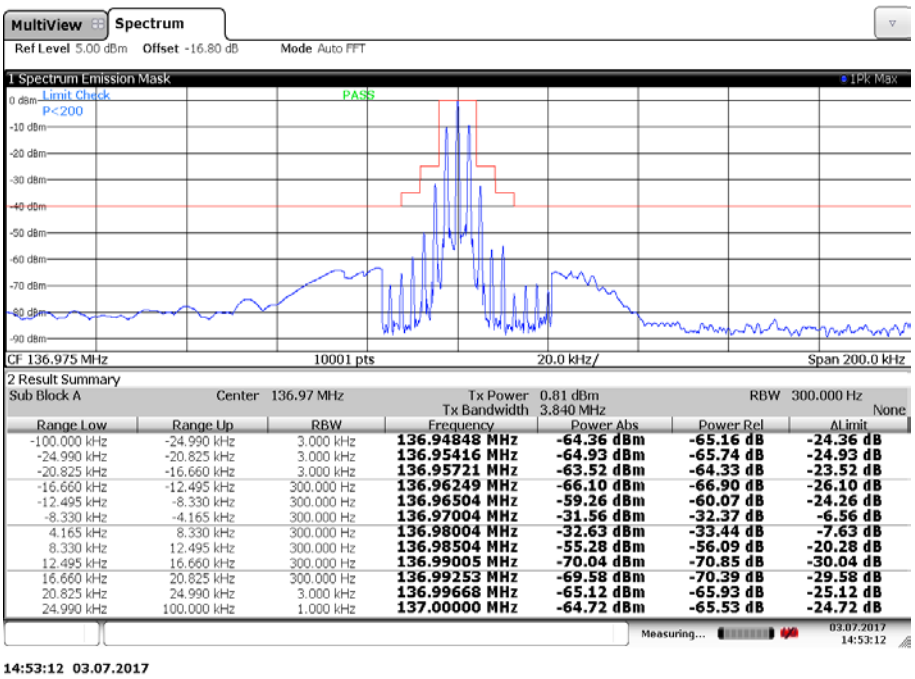
Plot 3: 127.485 MHz, 8.33 kHz channel bandwidth, Unwanted Emissions Mask



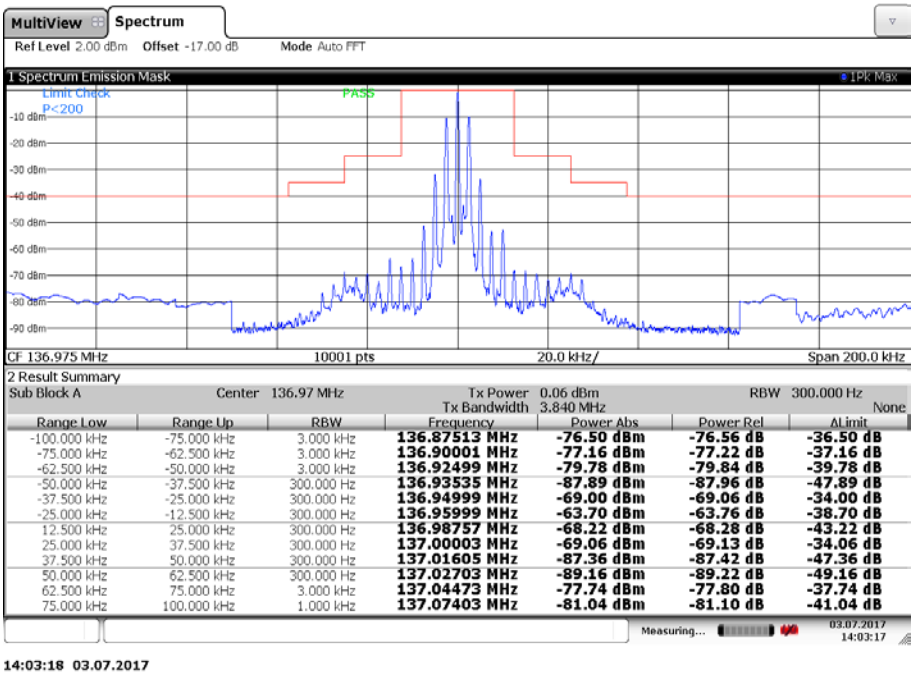
Plot 4: 127.485 MHz, 25 kHz channel bandwidth, Unwanted Emissions Mask



Plot 5: 136.975 MHz, 8.33 kHz channel bandwidth, Unwanted Emissions Mask

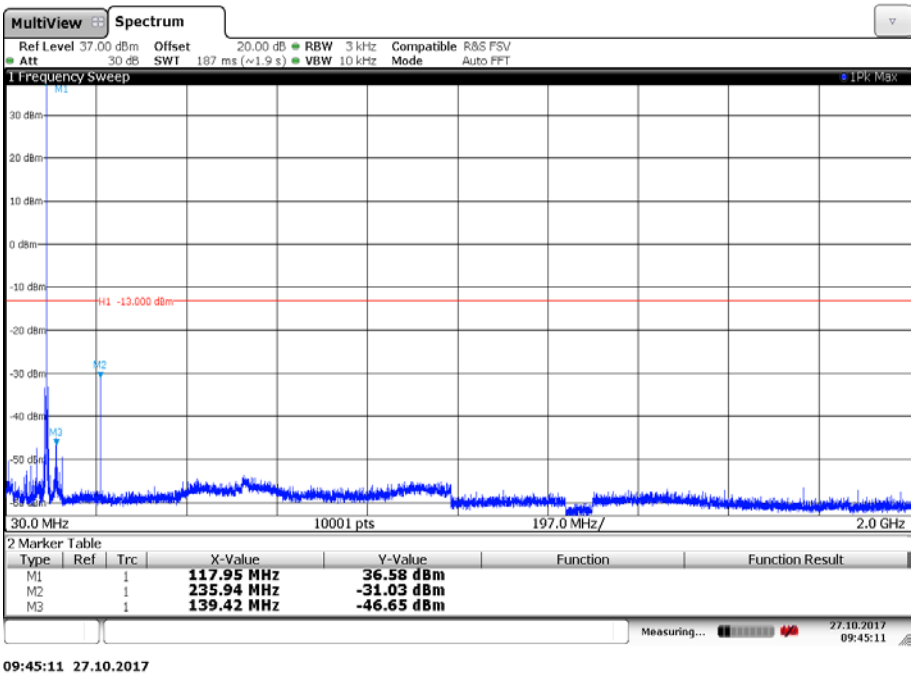


Plot 6: 136.975 MHz, 25 kHz channel bandwidth, Unwanted Emissions Mask

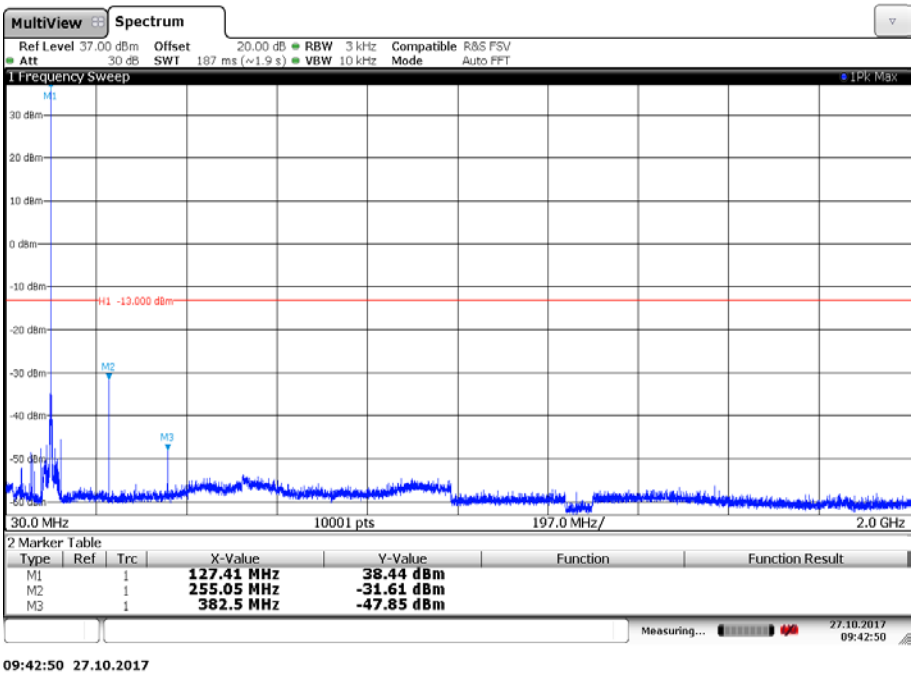


Plots: Conducted, KRT-2, S/N: 178022, Unwanted Emissions

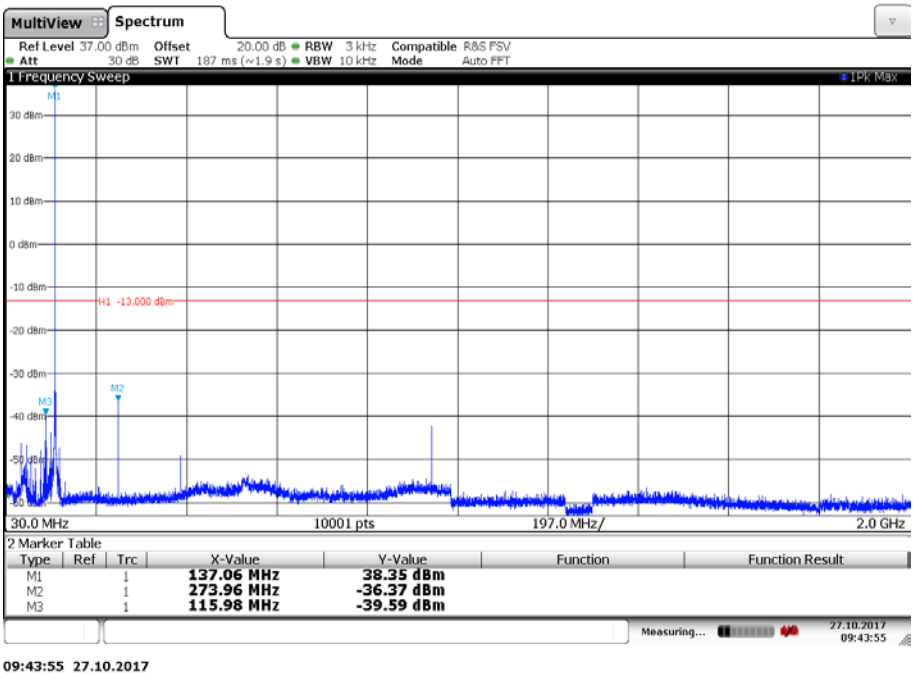
Plot 1: 118.000 MHz, 8.33 kHz channel bandwidth, 30 MHz to 2 GHz



Plot 2: 127.485 MHz, 8.33 kHz channel bandwidth, 30 MHz to 2 GHz



Plot 3: 136.975 MHz, 8.33 kHz channel bandwidth, 30 MHz to 2 GHz



11.5 Modulation characteristics

Method of measurement:

Measurement parameter	
Test setup:	See sub clause 6.3 C
Measurement uncertainty:	See sub clause 9

The audio frequency response was measured in accordance with ANSI/TIA-603-D; 2010, chapter 2.2.6.2.2 with the exception that for an AM modulated transmitter the input was varied for a constant modulation of 20 %.

Receiver audio response = $20 \cdot \log_{10}\left(\frac{V_{FREQ}}{V_{REF}}\right)$

Where: V_{REF}: audio output level with 1 kHz generator modulation to 20% of the maximum rated system deviation

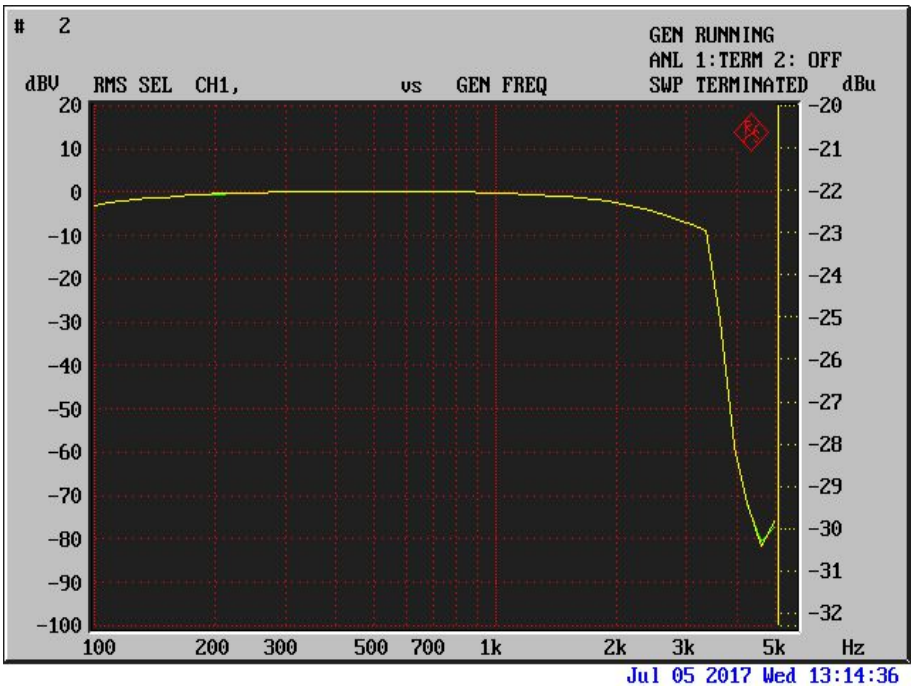
V_{FREQ}: audio output level when the modulation frequency is varied

A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.)

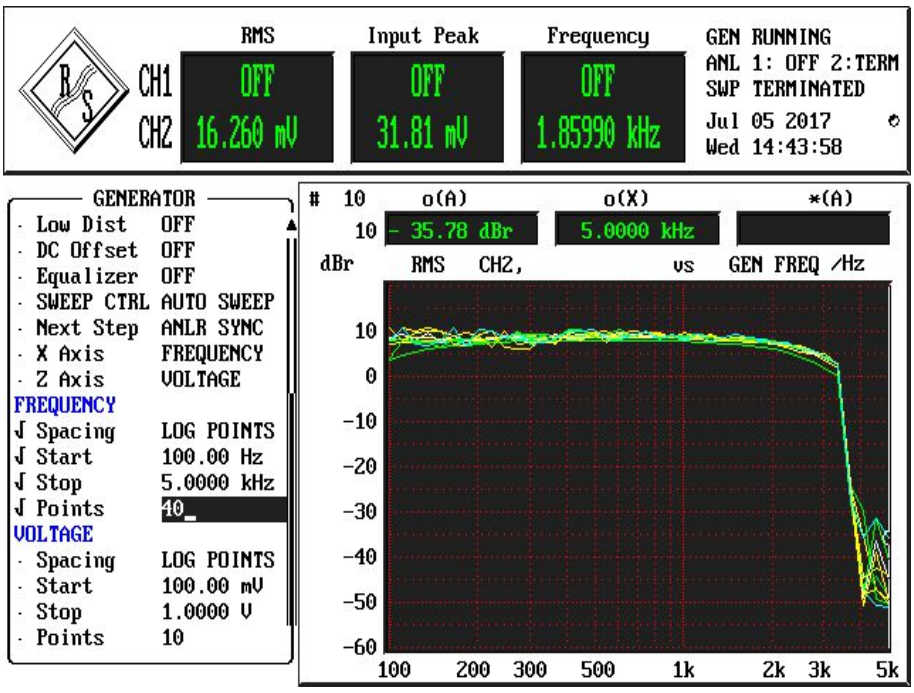
A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

Plots: KRT-2, S/N: 178022

Plot 1: Receiver audio response



Plot 2: 10 curves with voltage and frequency variation



11.6 Receiver unwanted emissions

Measurement:

Measurement parameter	
Detector:	Quasi peak / Average
Sweep time:	Auto
Resolution bandwidth:	120 kHz / 1 MHz
Video bandwidth:	3 x resolution bandwidth
Trace mode:	Max. hold
EUT:	RX-mode
Test setup:	See sub clause 6.1 A / B
Measurement uncertainty:	See sub clause 9

Limits:

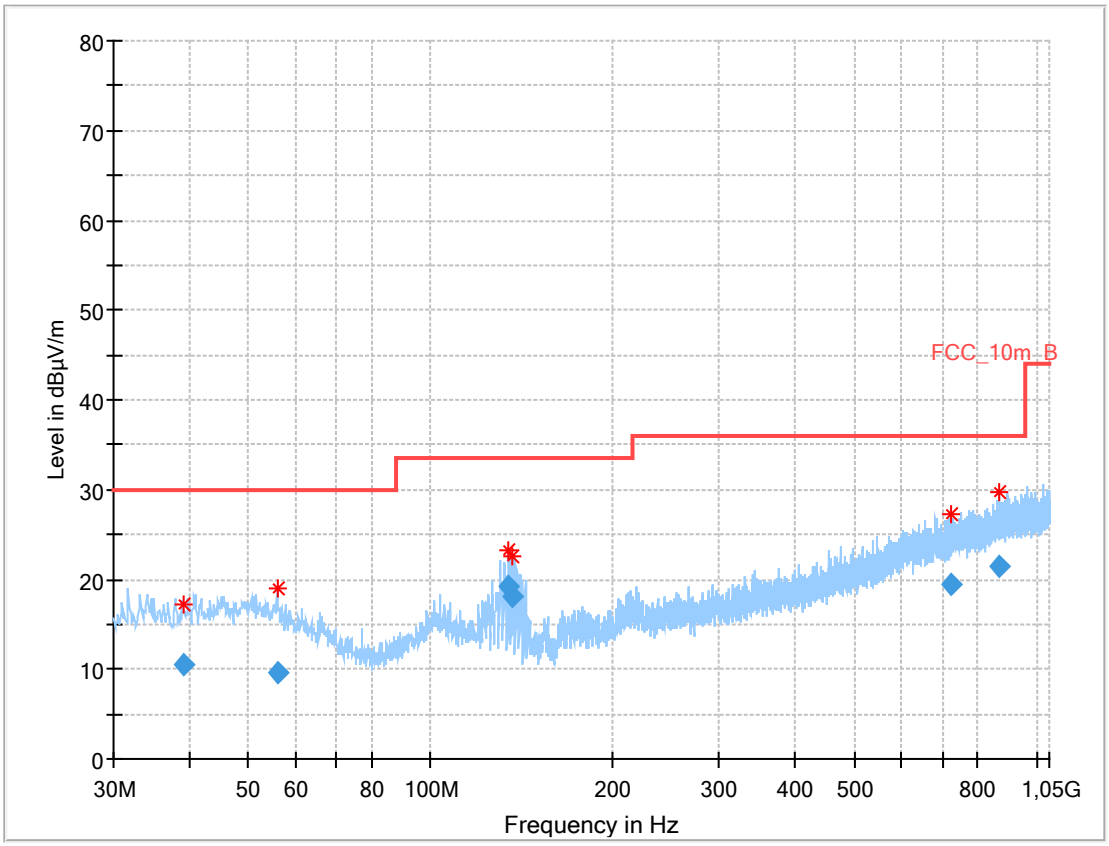
IC	
Frequency / MHz	**Field Strength / µv/m at 3 meters***
30-88	100
88-216	150
216-960	200
Above 960	500

*) Measurements for compliance with limits in the above table may be performed at distances other than 3 metres, in accordance with RSS-Gen Section 6.5.

Results: See table below plots!

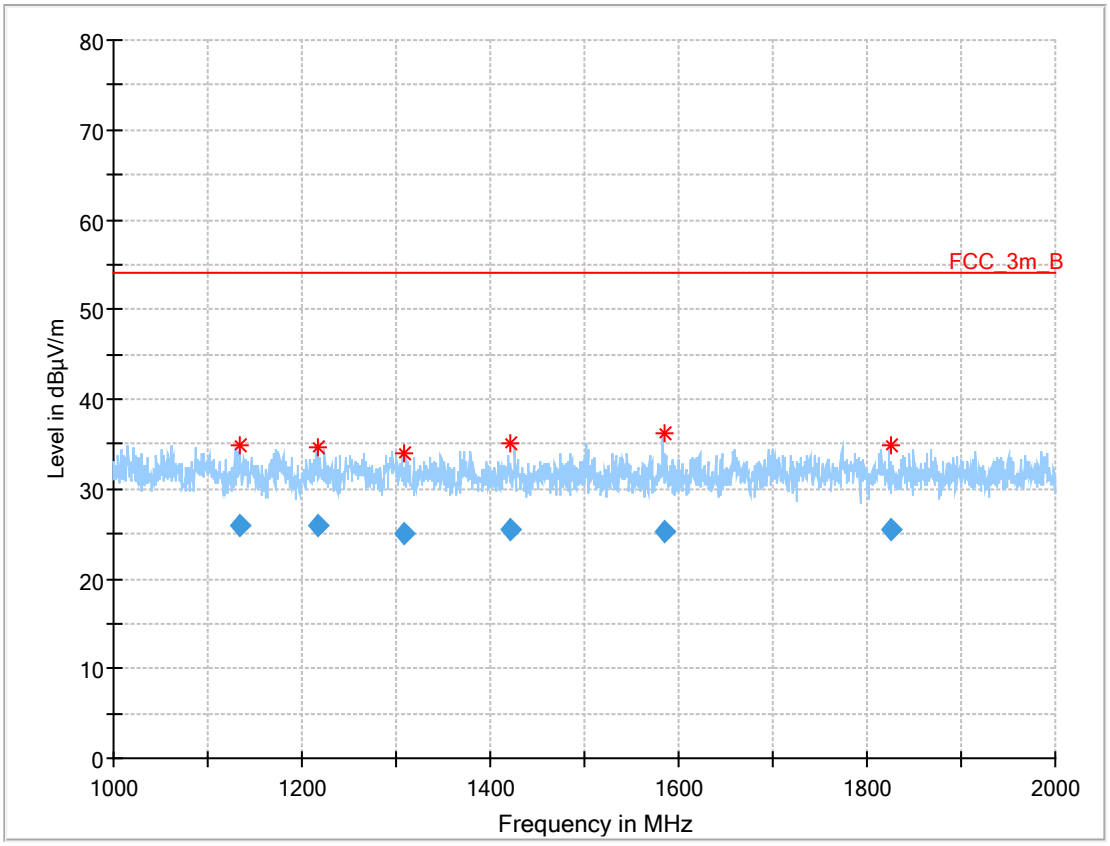
Plots: Radiated, KRT-2 with remote, S/N: 178022 (external antenna connector with 50 Ohm termination)

Plot 1: RX-mode, 30 MHz to 1 GHz, vertical & horizontal polarization



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
39.065	10.40	30.0	19.60	1000	120	170.0	V	90.0	13.1
56.070	9.57	30.0	20.43	1000	120	101.0	V	0.0	12.8
134.925	19.21	33.5	14.29	1000	120	98.0	V	0.0	9.2
136.899	18.02	33.5	15.48	1000	120	170.0	V	0.0	9.1
723.337	19.49	36.0	16.51	1000	120	100.0	V	180.0	22.1
869.347	21.35	36.0	14.65	1000	120	170.0	H	180.0	23.8

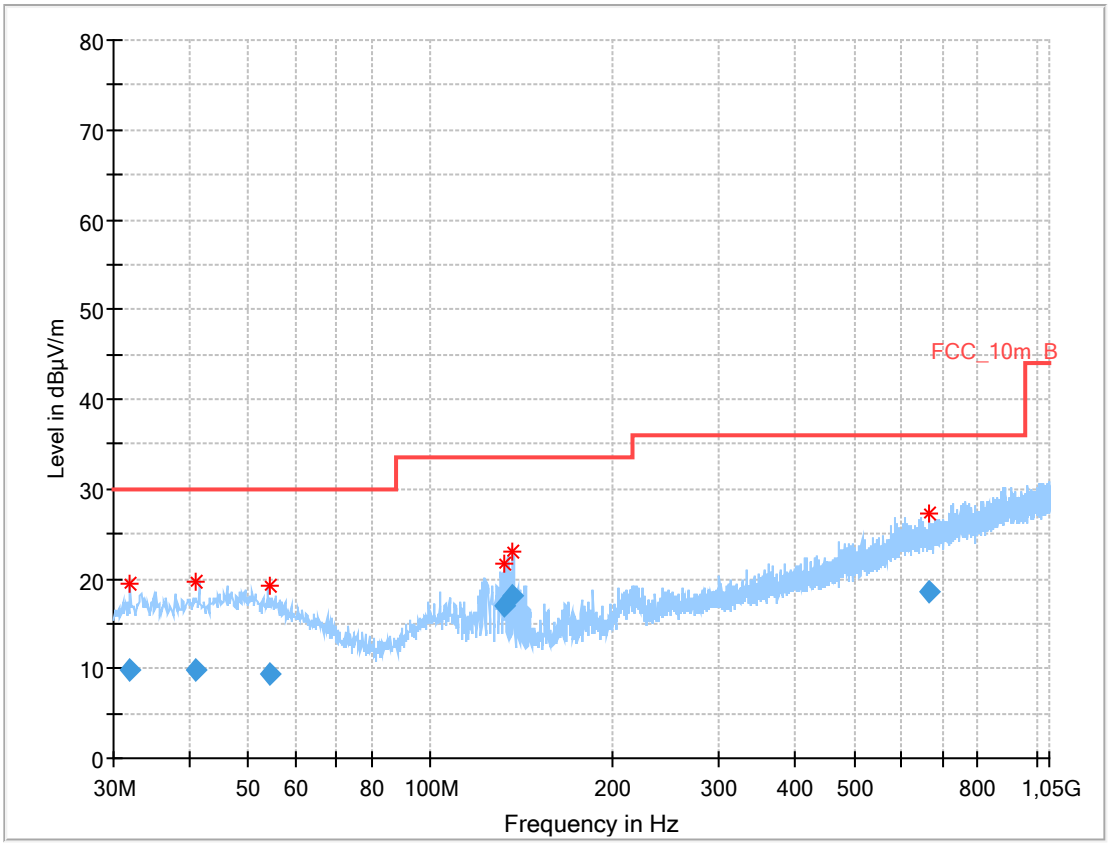
Plot 2: RX-mode, 1 GHz to 2 GHz, vertical & horizontal polarization



Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1133.902	25.97	54.0	28.03	1000	1000	100.0	V	96.0	-4.7
1217.820	25.84	54.0	28.16	1000	1000	100.0	V	177.0	-4.7
1308.632	24.93	54.0	29.07	1000	1000	100.0	H	59.0	-4.7
1421.567	25.52	54.0	28.48	1000	1000	100.0	V	328.0	-4.8
1585.413	25.24	54.0	28.76	1000	1000	100.0	H	157.0	-4.7
1824.870	25.44	54.0	28.56	1000	1000	100.0	V	150.0	-4.4

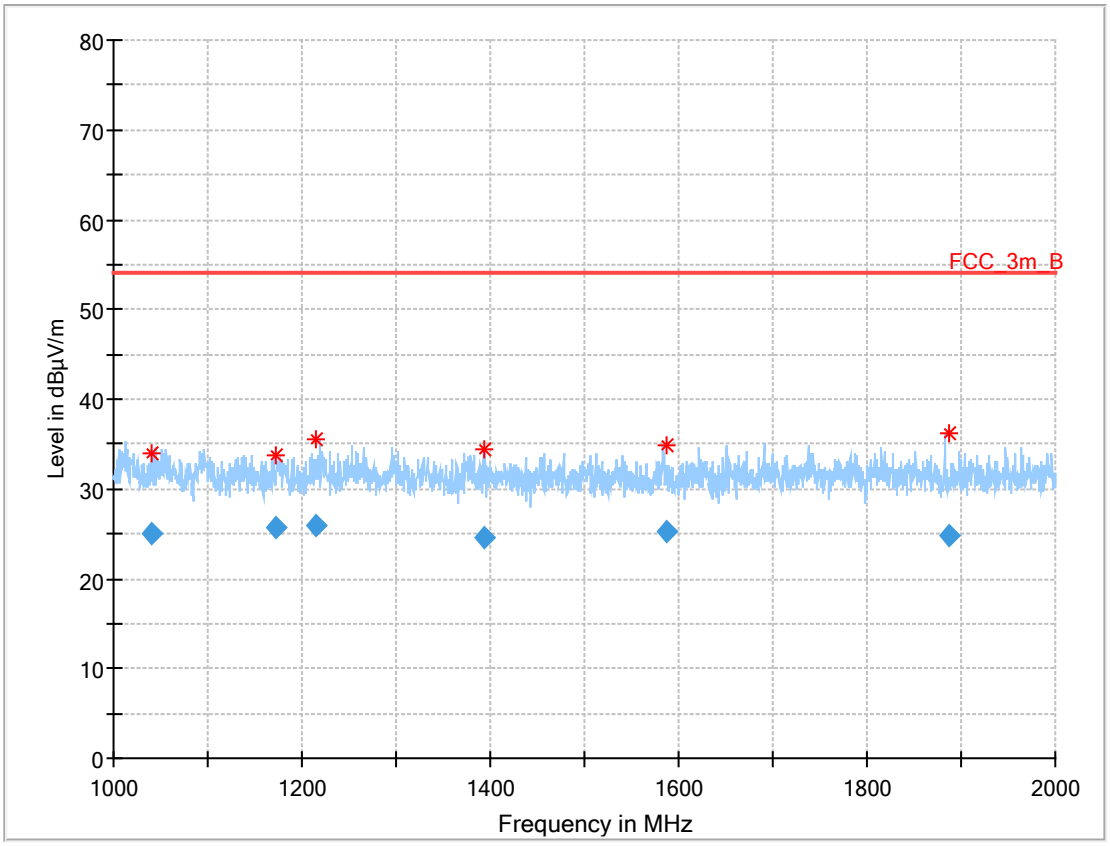
Plots: Radiated, KRT-2 with remote, S/N: 170177 (external antenna connector with 50 Ohm termination)

Plot 1: RX-mode, 30 MHz to 1 GHz, vertical & horizontal polarization



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.788	9.82	30.0	20.18	1000	120	101.0	V	10.0	12.1
41.083	9.92	30.0	20.08	1000	120	98.0	V	135.0	13.3
54.383	9.43	30.0	20.57	1000	120	170.0	H	27.0	13.2
132.769	17.01	33.5	16.49	1000	120	98.0	V	20.0	9.3
136.810	18.18	33.5	15.32	1000	120	98.0	V	-7.0	9.1
666.913	18.54	36.0	17.46	1000	120	170.0	H	244.0	21.3

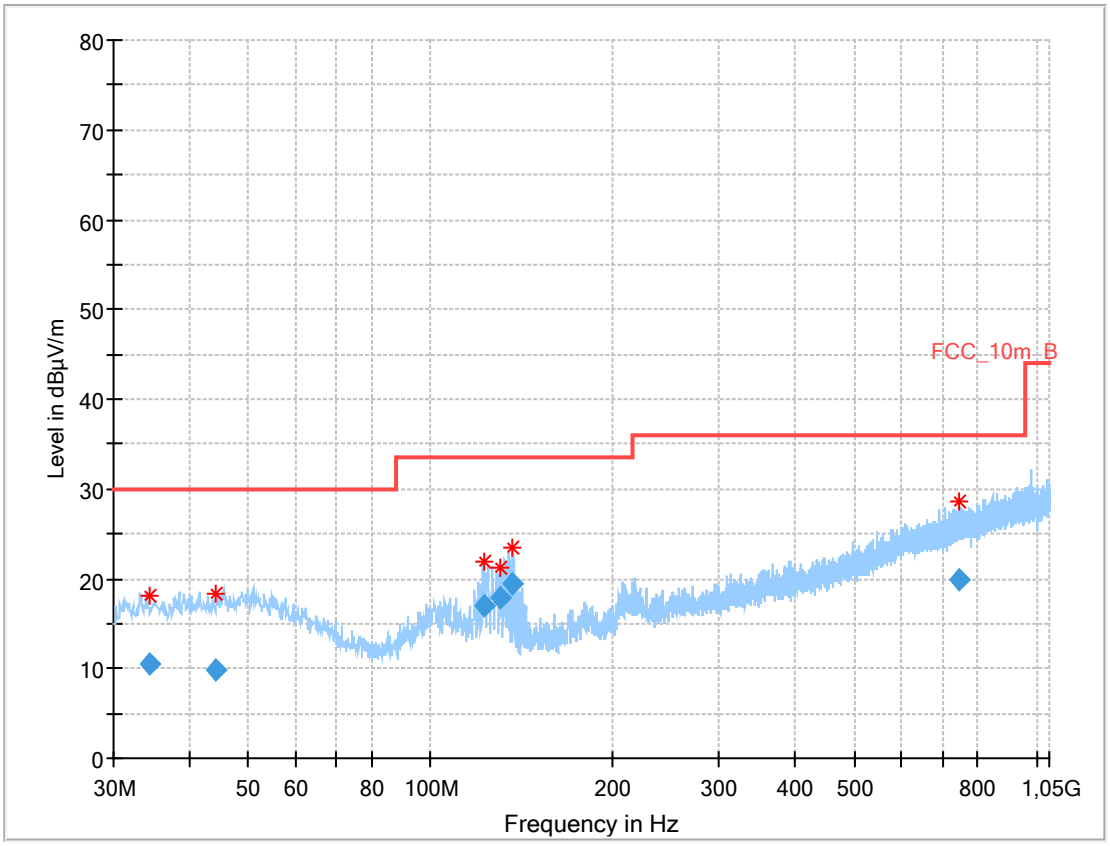
Plot 2: RX-mode, 1 GHz to 2 GHz, vertical & horizontal polarization



Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1040.924	25.13	54.0	28.87	1000	1000	100.0	V	327.0	-4.6
1172.363	25.61	54.0	28.39	1000	1000	100.0	H	28.0	-4.7
1215.381	25.93	54.0	28.07	1000	1000	100.0	V	320.0	-4.7
1393.917	24.63	54.0	29.37	1000	1000	100.0	H	12.0	-4.8
1587.938	25.21	54.0	28.79	1000	1000	100.0	H	-9.0	-4.7
1888.205	24.76	54.0	29.24	1000	1000	100.0	V	6.0	-4.3

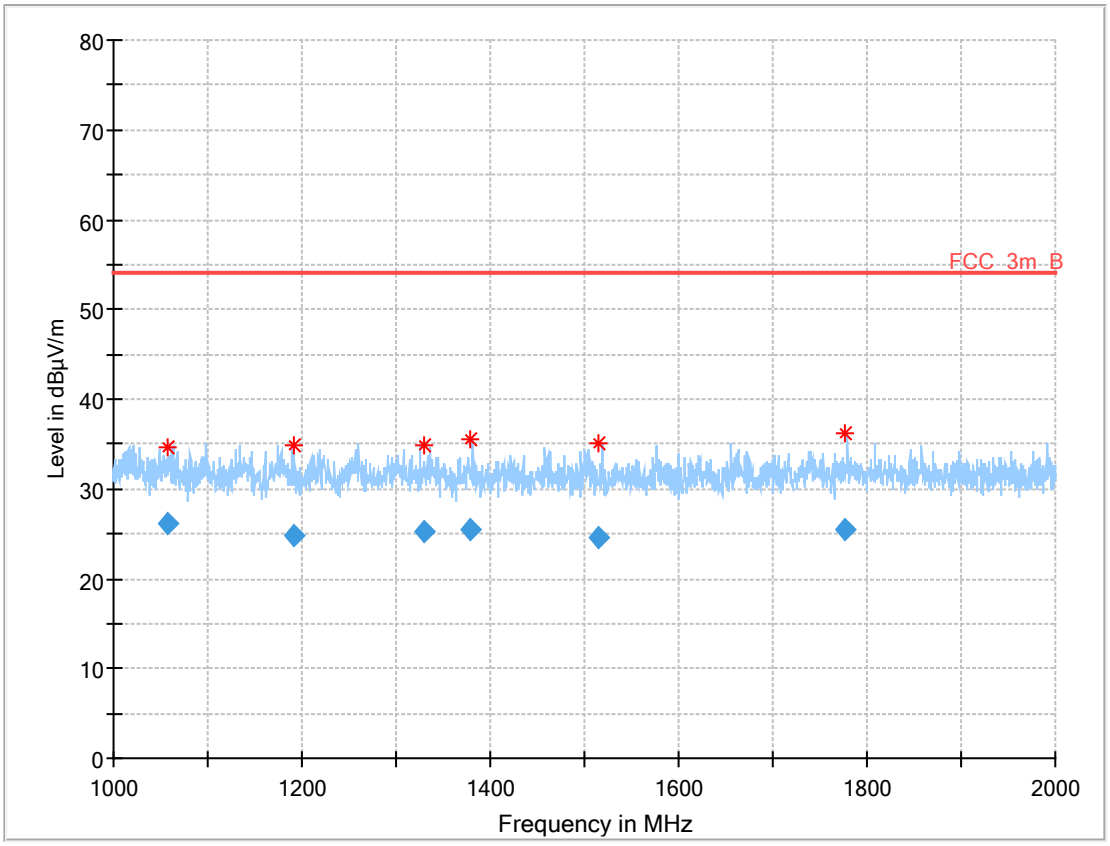
Plots: Radiated, KRT-2, S/N: 170177 (external antenna connector with 50 Ohm termination)

Plot 1: RX-mode, 30 MHz to 1 GHz, vertical & horizontal polarization



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.290	10.55	30.0	19.45	1000	120	101.0	V	319.0	12.5
44.085	9.73	30.0	20.27	1000	120	100.0	H	33.0	13.6
122.267	17.00	33.5	16.50	1000	120	170.0	V	340.0	10.1
130.751	17.81	33.5	15.69	1000	120	100.0	V	0.0	9.5
136.953	19.45	33.5	14.05	1000	120	101.0	V	340.0	9.1
743.859	19.83	36.0	16.17	1000	120	170.0	H	342.0	22.6

Plot 2: RX-mode, 1 GHz to 2 GHz, vertical & horizontal polarization



Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1056.460	26.04	54.0	27.96	1000	1000	100.0	V	351.0	-4.6
1191.126	24.71	54.0	29.29	1000	1000	100.0	V	156.0	-4.7
1329.704	25.21	54.0	28.79	1000	1000	100.0	H	85.0	-4.8
1379.378	25.41	54.0	28.59	1000	1000	100.0	V	126.0	-4.8
1515.166	24.69	54.0	29.31	1000	1000	100.0	H	51.0	-4.8
1776.079	25.55	54.0	28.45	1000	1000	100.0	V	8.0	-4.4

12 Observations

No observations except those reported with the single test cases have been made.

Annex A Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
ETSI	European Telecommunications Standard Institute
EN	European Standard
FCC	Federal Communication 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

Annex B Document history

Version	Applied changes	Date of release
-/-	Initial release	2017-11-10
A	Editorial corrections	2018-02-19

Annex C Accreditation Certificate

first page	last page

DAkkS Deutsche Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

Beliehene gemäß § 8 Absatz 1 AkkStelleG i.V.m. § 1 Absatz 1 AkkStelleGBV
Unterzeichnerin der Multilateralen Abkommen
von EA, ILAC und IAF zur gegenseitigen Anerkennung

Akkreditierung

Die Deutsche Akkreditierungsstelle GmbH bestätigt hiermit, dass das Prüflaboratorium

CTC advanced GmbH
Untertürkheimer Straße 6-10, 66117 Saarbrücken

die Kompetenz nach DIN EN ISO/IEC 17025:2005 besitzt, Prüfungen in folgenden Bereichen durchzuführen:

Funk
Mobilfunk (GSM / DCS) + OTA
Elektromagnetische Verträglichkeit (EMV)
Produktsicherheit
SAR / EMF
Umwelt
Smart Card Technology
Bluetooth®
Automotive
Wi-Fi-Services
Kanadische Anforderungen
US-Anforderungen
Akustik
Near Field Communication (NFC)

Die Akkreditierungsurkunde gilt nur in Verbindung mit dem Bescheid vom 25.11.2016 mit der Akkreditierungsnummer D-PL-12076-01 und ist gültig bis 17.01.2018. Sie besteht aus diesem Deckblatt, der Rückseite des Deckblatts und der folgenden Anlage mit insgesamt 63 Seiten.

Registrierungsnummer der Urkunde: **D-PL-12076-01-01**

Frankfurt, 25.11.2016

Im Auftrag Dipl.-Ing. (FH) Ralf Egner
Abteilungsleiter

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http://www.dakks.de/as/ast/d/D-PL-12076-01-03.pdf