

TEST REPORT

Test report no.: 1-7731/18-01-02



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

Trackman

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Test standard/s

FCC - Title 47 CFR
Part 15

FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices

RSS 210 – Issue 9

Spectrum Management and Telecommunications Radio Standards Specification
Licence-Exempt Radio Apparatus: Category I Equipment

RSS - Gen Issue 5

Spectrum Management and Telecommunications Radio Standards Specification -
General Requirements for Compliance of Radio Apparatus

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

Test Item

Kind of test item: Radar Modul 10.5 GHz

Model name: TMC3J

FCC ID: SFX-TMC3J

IC: 10140A-TMC3J

Frequency: 10.50 – 10.55 GHz

Antenna: Integrated patch antenna

Power supply: 125 V AC

Temperature range: -15°C to +50°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:



Karsten Gerald
Lab Manager
Radio Communications & EMC

Test performed:



Meheza Walla
Lab Manager
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1 Table of contents

1	Table of contents	2
2	General information	3
2.1	Notes and disclaimer	3
2.2	Application details	3
2.3	Test laboratories sub-contracted	3
3	Test standard/s and references	4
4	Test environment	4
5	Test item	5
5.1	General description	5
5.2	Additional information	5
6	Description of the test setup	6
6.1	Shielded semi anechoic chamber	7
6.2	Shielded fully anechoic chamber	9
6.3	Radiated measurements > 18 GHz	10
6.4	AC Conducted	11
7	Sequence of testing	12
7.1	Sequence of testing radiated spurious 9 kHz to 30 MHz	12
7.2	Sequence of testing radiated spurious 30 MHz to 1 GHz	13
7.3	Sequence of testing radiated spurious 1 GHz to 18 GHz	14
7.4	Sequence of testing radiated spurious above 18 GHz	15
8	Summary of measurement results	16
9	Measurement results	17
9.1	Field strength of emissions (wanted signal)	17
9.2	Occupied bandwidth (99% bandwidth)	20
9.3	Field strength of emissions (band edge)	21
9.4	Field strength of emissions (radiated spurious)	23
9.5	Conducted spurious emissions < 30 MHz	44
10	Glossary	47
11	Document history	48
12	Accreditation Certificate	48

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:	2019-01-14
Date of receipt of test item:	2019-01-18
Start of test:	2019-01-22
End of test:	2019-02-01
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 15		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS 210 – Issue 9 (Annex F)	08-2016	Spectrum Management and Telecommunications Radio Standards Specification Licence-Exempt Radio Apparatus: Category I Equipment
RSS - Gen Issue 5	04-2018	Spectrum Management and Telecommunications Radio Standards Specification - 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
ANSI C63.10-2013	-/-	American national standard of procedures for compliance testing of unlicensed wireless devices

4 Test environment

Temperature	:	T _{nom}	+22 °C during room temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		not relevant for this kind of testing
Power supply	:	V _{nom}	125 V AC

5 Test item

5.1 General description

Kind of test item	:	Radar Modul 10.5 GHz
Type identification	:	TMC3J
HMN	:	NA
PMN	:	Baseball Stadium
HVIN	:	TMC3J
FVIN	:	NA
S/N serial number	:	18310003 (EUT) 18310004
Hardware status	:	NA
Software status	:	NA
Frequency band	:	10.50 – 10.55 GHz
Type of modulation	:	CW (each frequency consist of 2 simultaneous CW signals)
Number of Channels	:	2
Antenna	:	Integrated patch antenna
Power supply	:	125 V AC
Temperature range	:	-15°C to +50°C

NA = Not applicable

5.2 Additional information

Special test software was used to change from normal operation mode to test mode (low / middle / high) as required by CFR 47 Part 15.31(m). Each frequency consist of 2 simultaneous CW signals.

Low Channel will be F1=10.509 GHz and F2=10.517 GHz

Middle Channel will be F1 = 10.521 GHz and F2 = 10.529 GHz

High Channel will be F1=10.533 GHz and F2=10.541 GHz

Test setup and EUT photos are included in test report:

1-7731/18-01-01_AnnexA

1-7731/18-01-01_AnnexB

1-7731/18-01-01_AnnexC

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).

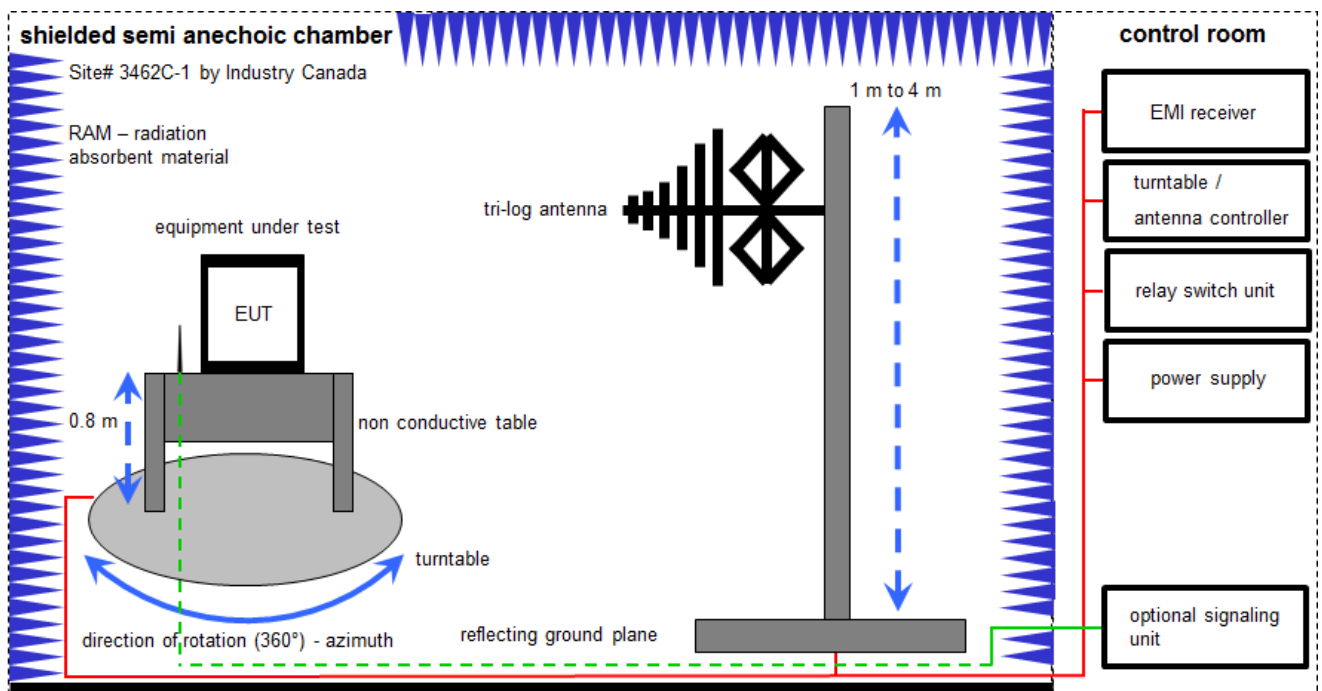
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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 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)

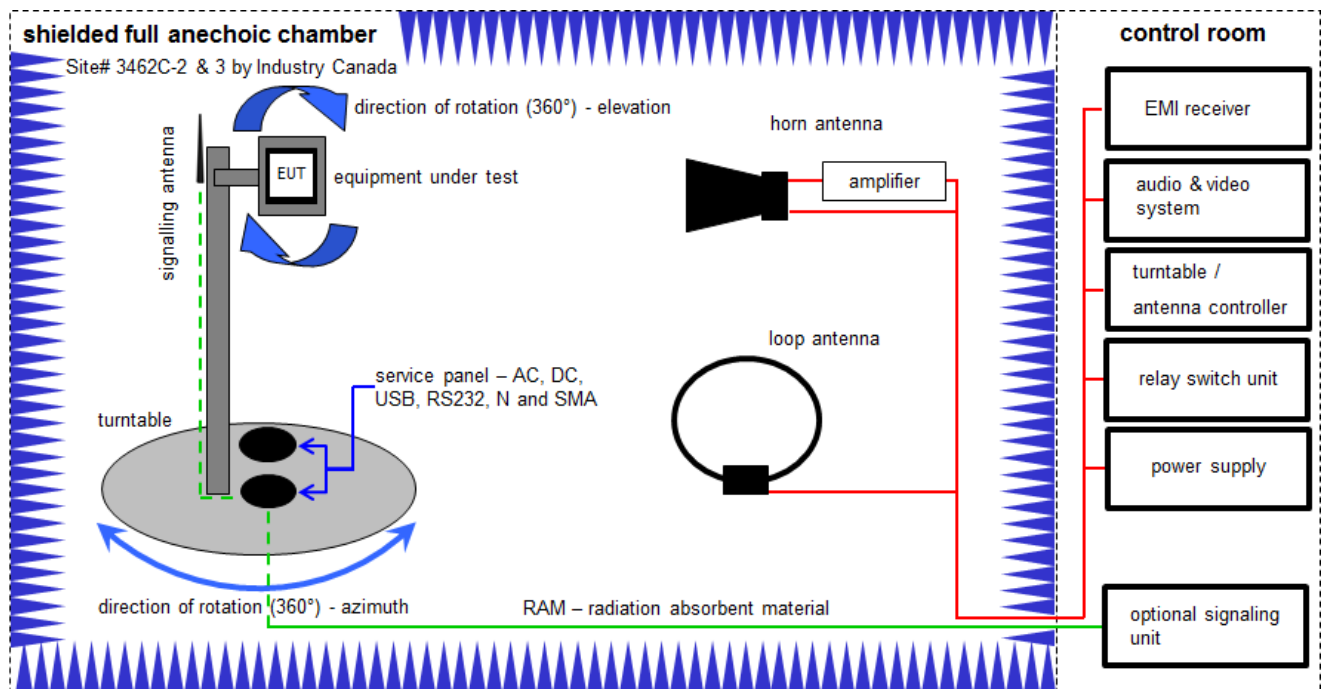
Example calculation:

$$FS [dB\mu V/m] = 12.35 [dB\mu V/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dB\mu V/m] (35.69 \mu V/m)$$

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	45	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	50	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	93	Meßkabine 1	HF-Absorberhalle	MWB AG 300023		300000551	ne	-/-	-/-
4	n. a.	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	12.12.2018	11.12.2019
5	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vKI!	15.01.2018	14.01.2020
6	n. a.	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
7	n. a.	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
8	n. a.	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
9	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	371	300003854	vKI!	24.11.2017	23.11.2020
10	n. a.	Spectrum-Analyzer	FSU26	R&S	200809	300003874	k	17.12.2018	16.12.2019

6.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter / 1 meter

$$FS = UR + CA + AF$$

(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

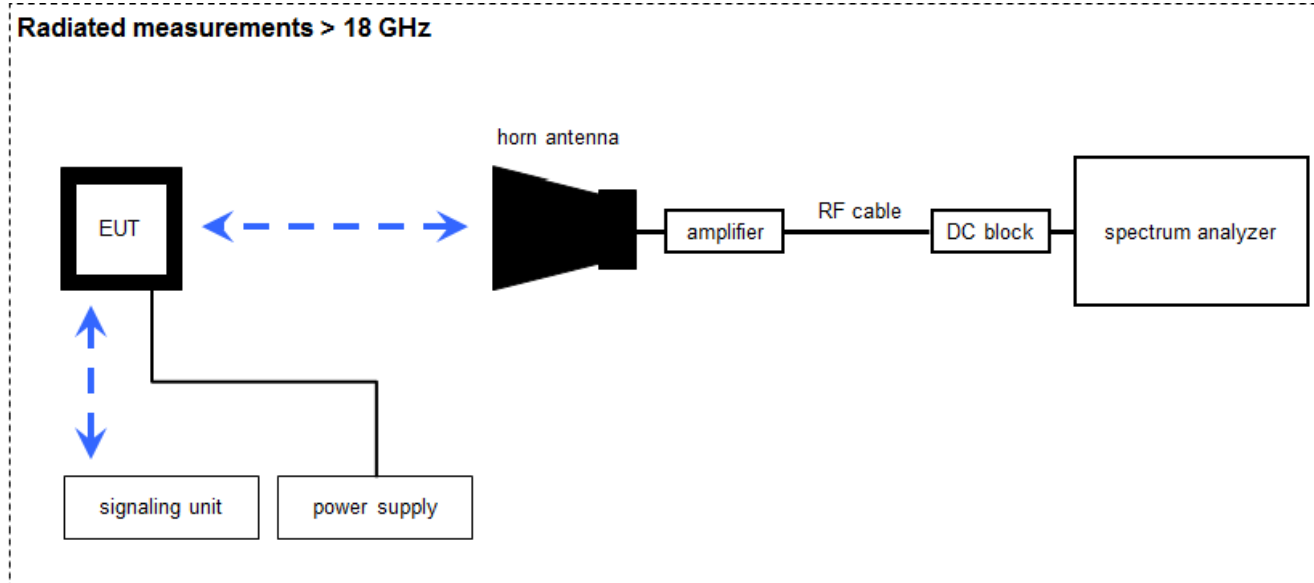
Example calculation:

$$FS \text{ [dB}\mu\text{V/m]} = 40.0 \text{ [dB}\mu\text{V/m]} + (-35.8) \text{ [dB]} + 32.9 \text{ [dB/m]} = 37.1 \text{ [dB}\mu\text{V/m]} (71.61 \mu\text{V/m})$$

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vKI!	12.12.2017	11.12.2020
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.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
4	19	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vKI!	14.02.2017	13.02.2019
5	n. a.	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
6	9	Variable isolating transformer	MPL IEC625 Bus Variable isolating transformer	ErFi	91350	300001155	ne	-/-	-/-
7	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	14.09.2018	13.12.2019
8	n. a.	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
9	n. a.	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
10	n. a.	Broadband Amplifier 5-13 GHz	CBLU5135235	CERNEX	22010	300004491	ev	-/-	-/-
11	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
12	n. a.	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO		300004682	ne	-/-	-/-
13	n. a.	PC	ExOne	F+W		300004703	ne	-/-	-/-
14	n. a.	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011572	300005241	ev	-/-	-/-

6.3 Radiated measurements > 18 GHz



$$OP = AV + D - G$$

(OP-rad. output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain)

Example calculation:

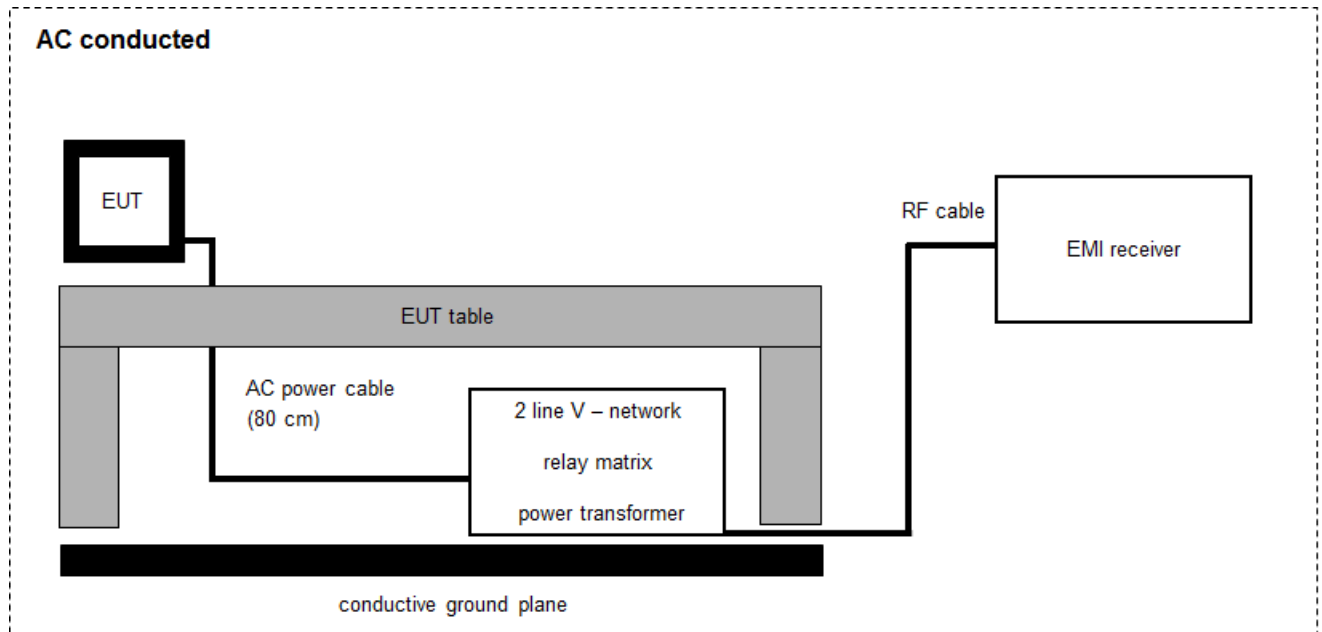
$$OP \text{ [dBm]} = -54.0 \text{ [dBm]} + 64.0 \text{ [dB]} - 20.0 \text{ [dBi]} = -10 \text{ [dBm]} \text{ (100 } \mu\text{W)}$$

Note: conversion loss of mixer is already included in analyzer value.

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A027	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000486	vKI!	13.12.2017	12.12.2019
2	CR 79	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	7911	300001751	ne	-/-	-/-
3	A023	Std. Gain Horn Antenna 39.3-59.7 GHz	2424-20	Flann	75	300001979	ne	-/-	-/-
4	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	-/-	-/-
5	n. a.	Spectrum Analyzer	FSW85	Rohde & Schwarz	101333	300005568	k	29.06.2018	28.06.2019

6.4 AC Conducted



$$FS = UR + CF + VC$$

(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

Example calculation:

$$FS [dB\mu V/m] = 37.62 [dB\mu V/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dB\mu V/m] \quad (244.06 \mu V/m)$$

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	101	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	892475/017	300002209	vKI!	13.12.2017	12.12.2019
2	67	RF-Filter-section	85420E	HP	3427A00162	300002214	NK!	-/-	-/-
3	27	EM-Injection Clamp	FCC-203i	emv	232	300000626	ev	-/-	-/-
4	n. a.	Magnetfeldantenne	MS 100	EM-Test	----	300002659	ev	-/-	-/-
5	n. a.	AC-Spannungsquelle variabel	MV2616-V	EM-Test	0397-12	300003259	vKI!	18.12.2017	17.12.2019
6	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vKI!	15.01.2018	14.01.2020
7	n. a.	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
8	n. a.	Power Supply DC	NGSM 32/10	Rohde & Schwarz	3939	400000192	vKI!	31.01.2017	30.01.2020
9	n. a.	MXE EMI Receiver 20 Hz to 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	12.12.2018	11.12.2019

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.

7.4 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.

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	47 CFR Part 15 RSS 210, Issue 9, Annex F	see table	2019-02-18	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	C	NC	NA	NP	Results (max.)
§15.245 (b) RSS-210 F1 RSS-Gen	Field strength of emissions (wanted signal)	Nominal	Nominal	☒	☐	☐	☐	125.3 dBµV
§2.1049	Occupied bandwidth (99% bandwidth)	Nominal	Nominal	☒	☐	☐	☐	9.5 MHz
§15.209 (a) §15.245 (a) §15.245 (b)(3) RSS-210 F1 (a) RSS-210 F1 (b) RSS-210 F1 (c) RSS-210 F1 (e) RSS-Gen	Field strength of emissions (band edge / spurious / harmonics)	Nominal	Nominal	☒	☐	☐	☐	complies
§15.207 (a) ICES-003	Conducted emissions < 30 MHz	Nominal	Nominal	☒	☐	☐	☐	Complies (Class A)

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

9 Measurement results

9.1 Field strength of emissions (wanted signal)

Description:

Measurement of the maximum radiated field strength of the wanted signal.

Measurement:

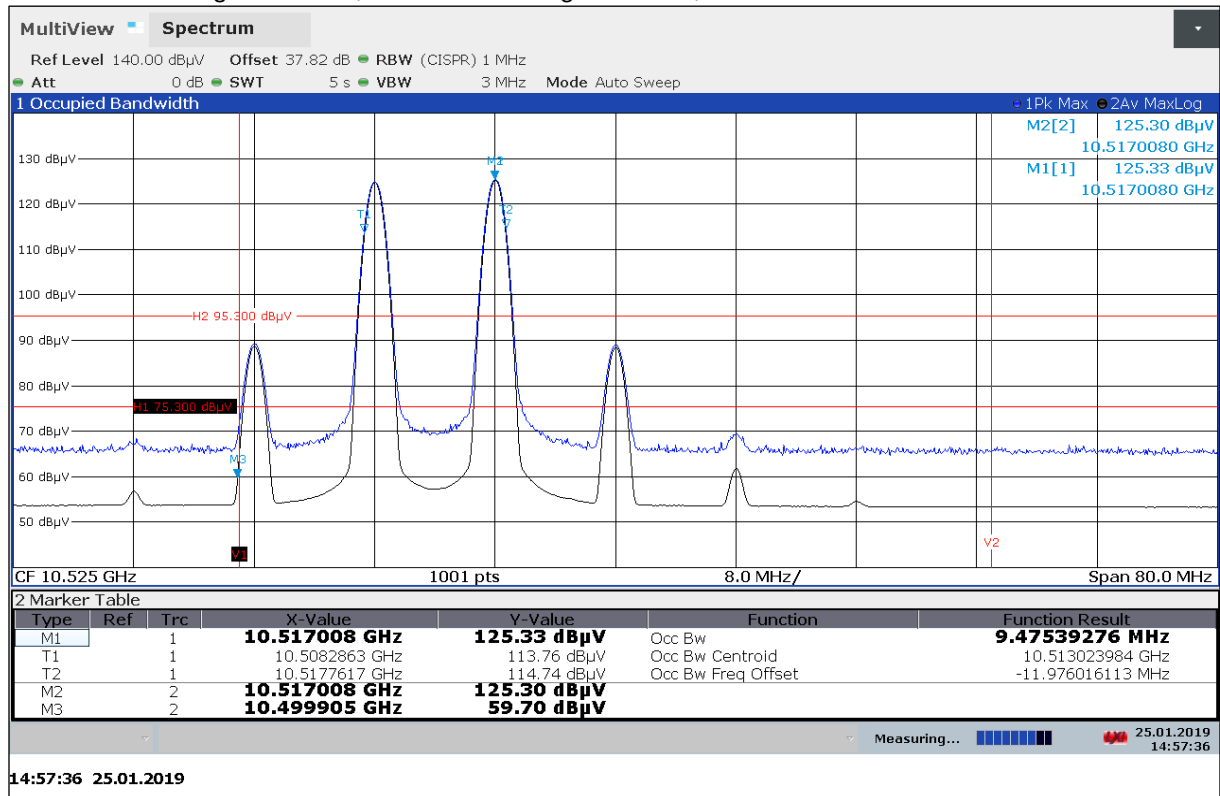
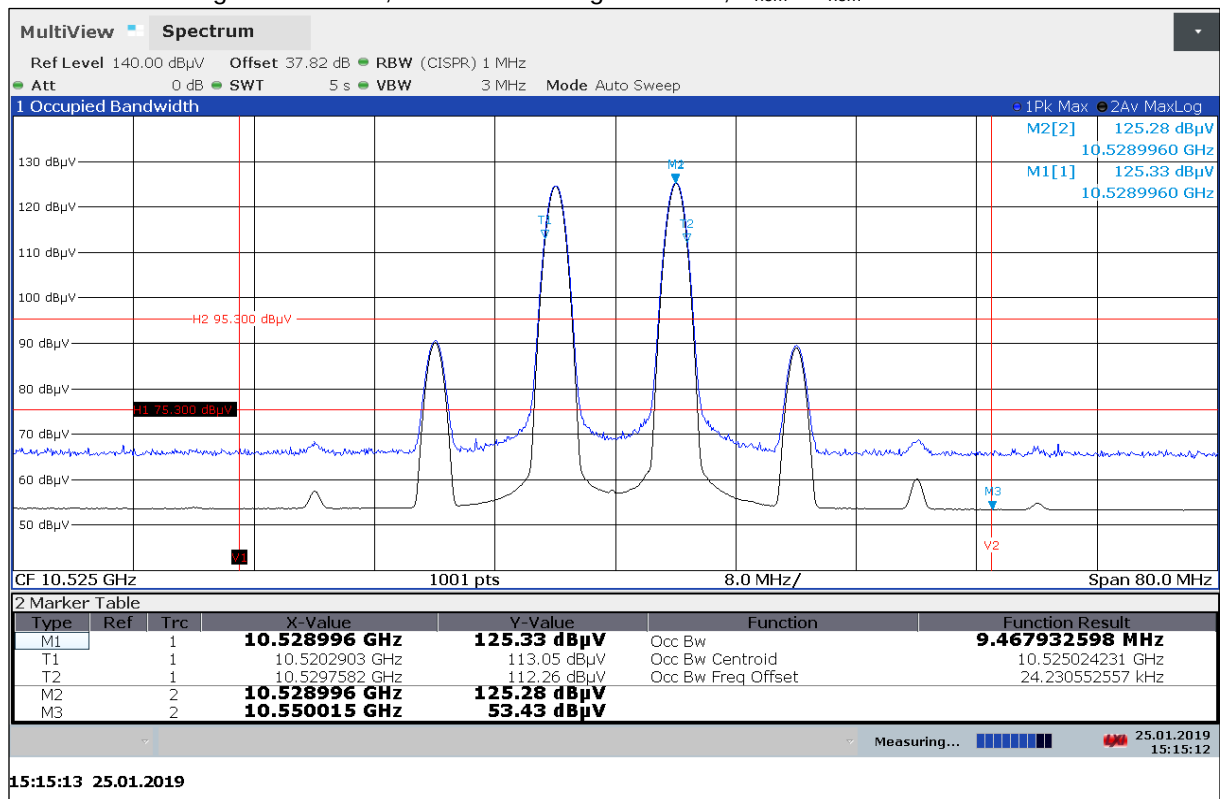
Measurement parameter	
Detector:	Pos-Peak/Avg
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	See plots
Trace-Mode:	Max Hold

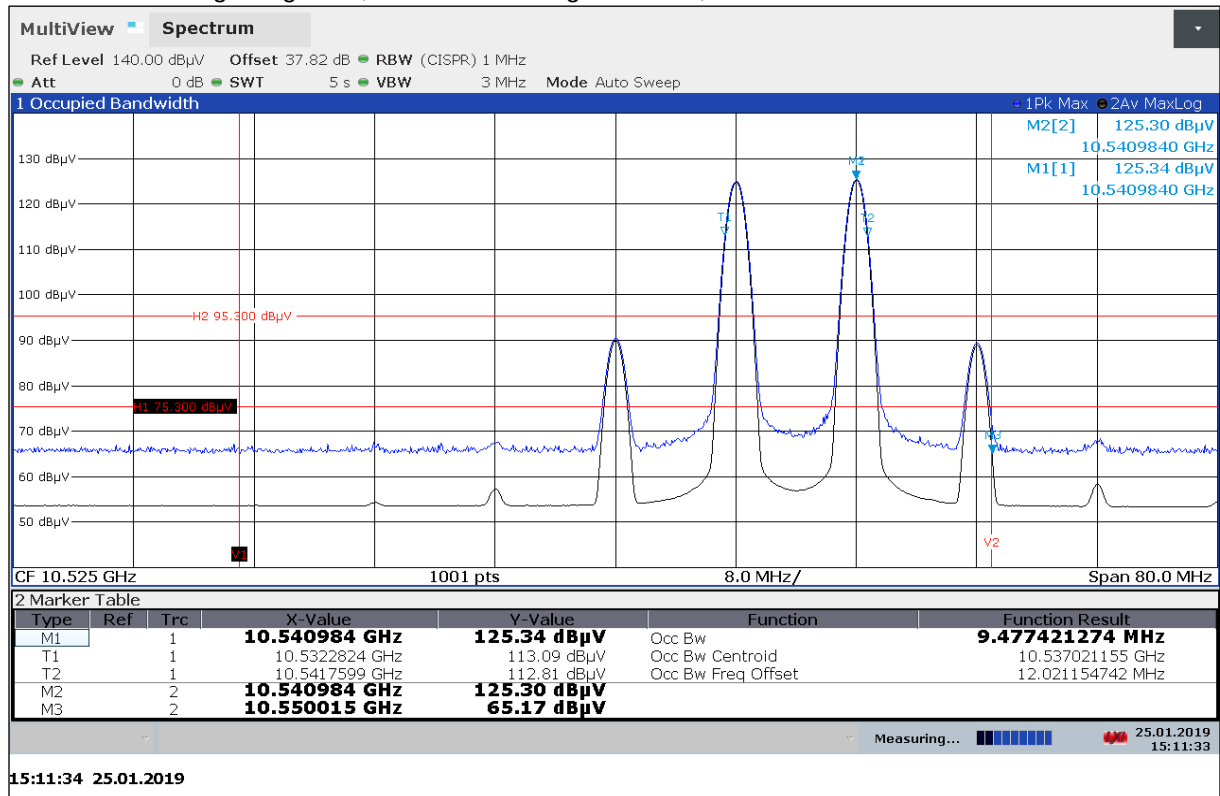
Limits:

FCC		IC
CFR Part 15.245 (b)		RSS - 210, F.1 (a)
Field strength of emissions		
The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:		
Frequency [GHz]	Field Strength [dB μ V/m]	Measurement distance [m]
10.500 – 10.550	128 (Average) / 148 (Peak)	3

Result:

Test condition T_{nom} / V_{nom}	Maximum field strength [dB μ V/m @ 3 m]
Low Channel	125.33 (Peak) / 125.30 (Average)
Middle Channel	125.33 (Peak) / 125.28 (Average)
High Channel	125.34 (Peak) / 125.30 (Average)
Measurement uncertainty	± 3 dB

Plot No. 1: Field Strength Low Ch., Peak and Average detector, T_{nom} / V_{nom} Plot No. 2: Field Strength Middle Ch., Peak and Average detector, T_{nom} / V_{nom} 

Plot No. 3: Field Strength High Ch., Peak and Average detector, $T_{\text{nom}} / V_{\text{nom}}$ 

9.2 Occupied bandwidth (99% bandwidth)

Definition:

The occupied bandwidth is defined as the 99% bandwidth.

Measurement:

The EUT is powered on and set up to transmit its normal signal modulation sequence(s).
 A spectrum analyzer with the following settings is used:

The test was performed under normal and extreme test conditions.

Measurement parameter	
Detector:	Pos-Peak / Average
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	See plots
Trace-Mode:	Max Hold

Limits:

FCC	IC
CFR Part 15.245 (b)	RSS - 210, F.1 (a)
Fundamental frequency	
10.500 GHz – 10.550 GHz (50 MHz):	

Results:

Test condition T_{nom} / V_{nom}	99% Occupied bandwidth [MHz]
Low Channel	9.48
Middle Channel	9.47
High Channel	9.48
Measurement uncertainty	$\pm \text{span}/1000$

9.3 Field strength of emissions (band edge)

Limits:

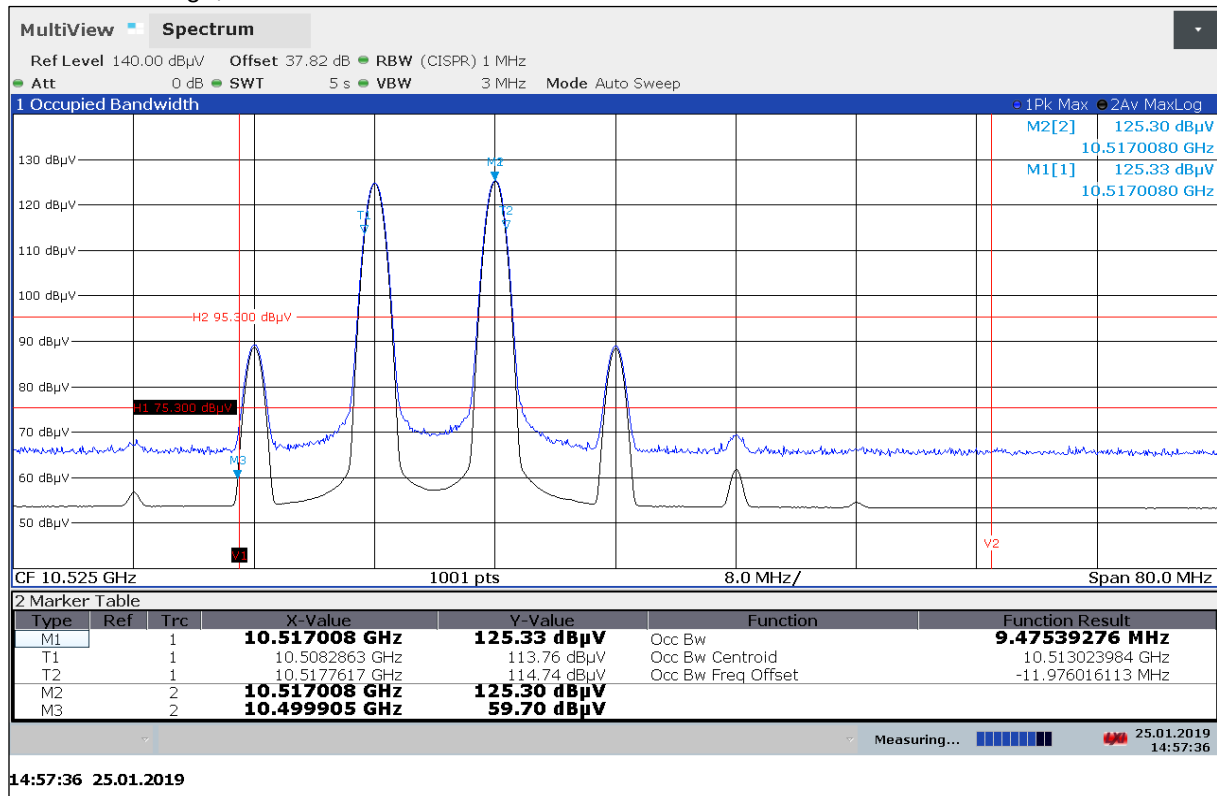
FCC §15.245 (b) / RSS-210 F.1 (a)(b)(e)

Frequency range	f(lowest) > 10.500 GHz	f(highest) < 10.550 GHz
-----------------	------------------------	-------------------------

FCC	IC
CFR Part 15.245(b)(3)	RSS-210 F1 (e)

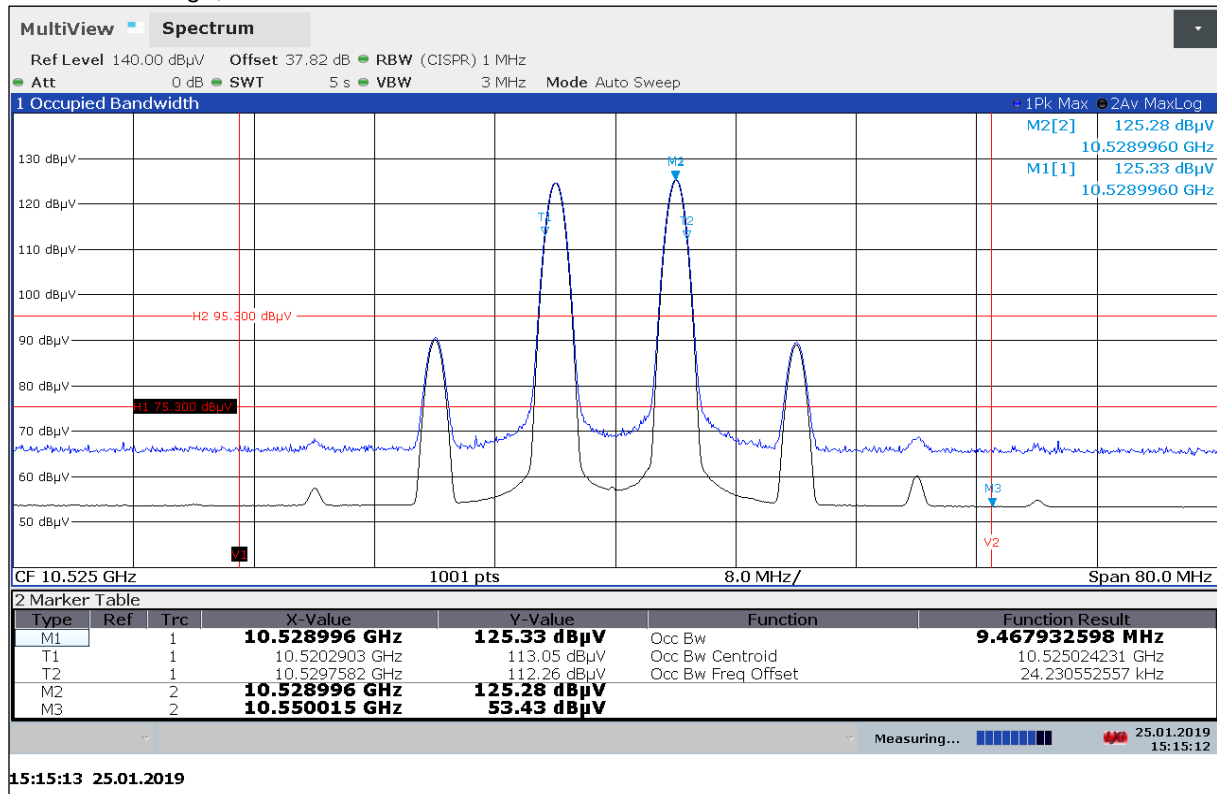
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209 or RSS-Gen, whichever is the lesser attenuation. **PEAK → 95.3 dBμV/m / Average → 75.3 dBμV/m**

Plot No. 4: Band Edge, Low Ch.



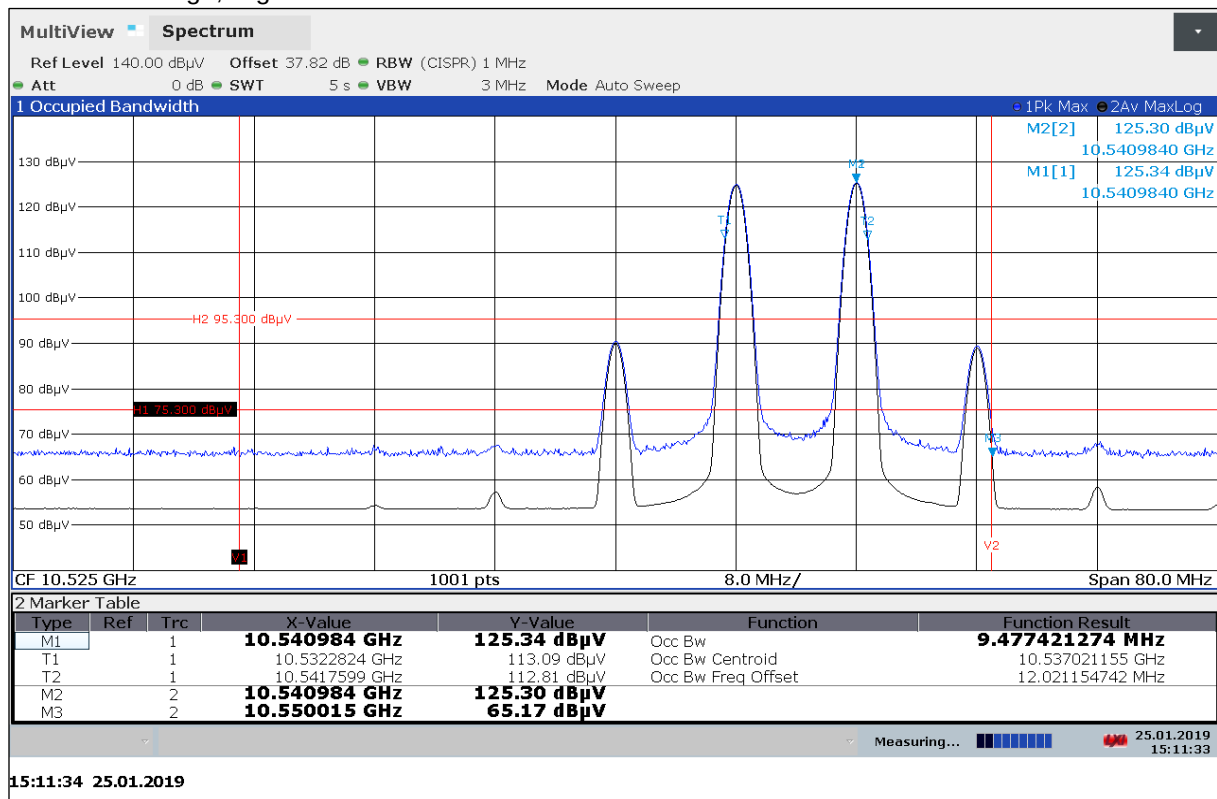
Peak Value: Noise floor (Limit 95.3 dBμV/m) / Average Value: 59.70 dBμV/m (Limit 75.3 dBμV/m)

Plot No. 5: Band Edge, Middle Ch.



Peak Value: Noise floor (Limit 95.3 dBµV/m) / Average Value: Noise floor (Limit 75.3 dBµV/m)

Plot No. 6: Band Edge, High Ch.



Peak Value: Noise floor (Limit 95.3 dBµV/m) / Average Value: 65.17 (Limit 75.3 dBµV/m)

9.4 Field strength of emissions (radiated spurious)

Description:

Measurement of the radiated spurious emissions in transmit mode.

Measurement:

Measurement parameter	
Detector:	F < 1 GHz: Quasi-Peak F > 1 GHz: Pos-Peak / Average
Sweep time:	Auto
Video bandwidth:	Auto
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 1 MHz
Trace-Mode:	Max-Hold

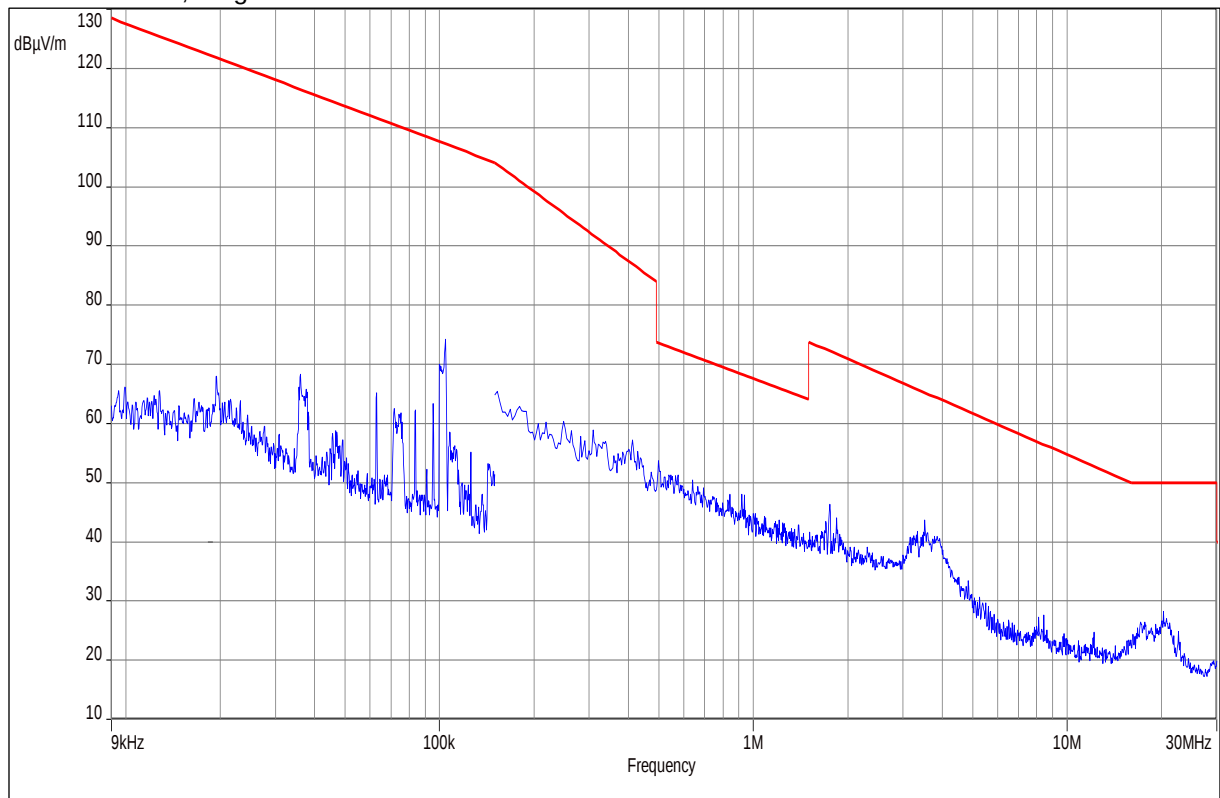
Limits:

FCC	IC	
CFR Part 15.209 (a) / CFR Part 15.245 (b)(1)	RSS-210 F.1 (a)(b)(c) / RSS - GEN	
Field strength of harmonics		
The field strength of harmonics from intentional radiators shall comply with the following:		
Harmonics: PEAK→ 108 dBμV/m / Average → 88 dBμV/m (at a distance of 3 m)		
Harmonic emissions falling into restricted bands listed in RSS-Gen and which are at and above 17.7 GHz shall not exceed the following field strength limits measured at a distance of 3 m: PEAK→ 97.5 dBμV/m / Average → 77.5 dBμV/m		
CFR Part 15.209 (a) / CFR Part 15.245 (b)(3)	RSS-210 F.1 (e) / RSS - GEN	
Radiated Spurious Emissions		
Emissions radiated outside of the specified frequency bands, except for harmonic emissions shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits specified in RSS-Gen, whichever is less stringent PEAK→ 95.3 dBμV/m / Average → 75.3 dBμV/m		
Frequency (MHz)	Field Strength (dBμV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10
Above 960	54.0	3

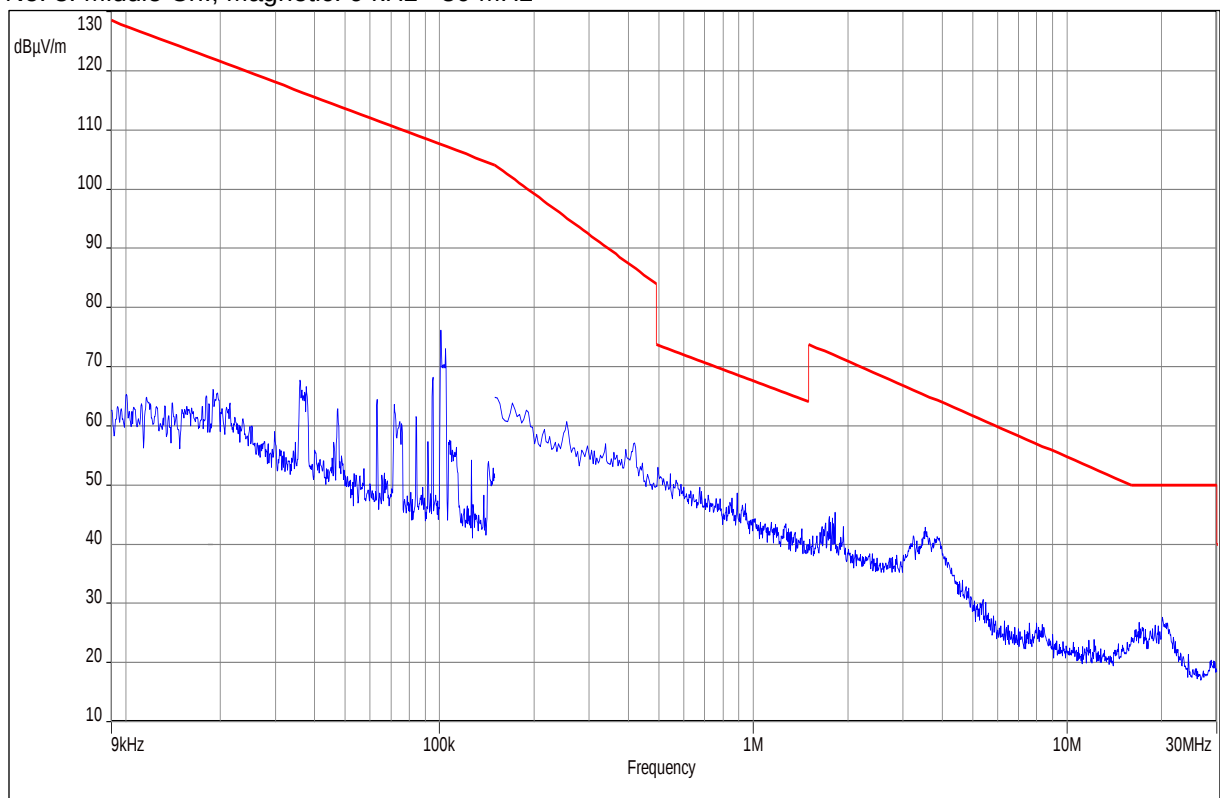
Results:

TX Spurious Emissions Radiated [dB μ V/m]								
Low Channel			Middle Channel			High Channel		
Frequency [GHz]	Detector	Level [dB μ V/m]	Frequency [GHz]	Detector	Level [dB μ V/m]	Frequency [GHz]	Detector	Level [dB μ V/m]
See plots			See plots			See plots		
Measurement uncertainty			± 3 dB					

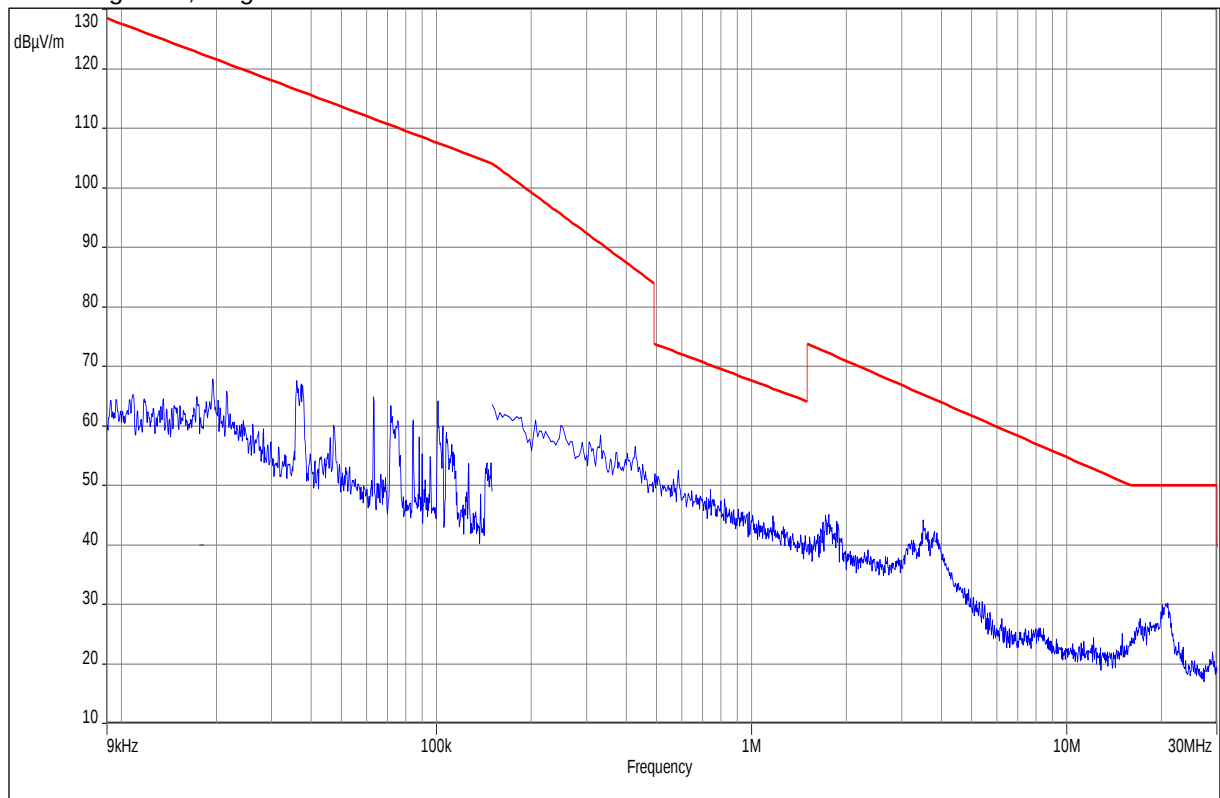
Plot No. 7: Low Ch., Magnetic: 9 kHz - 30 MHz



Plot No. 8: Middle Ch., Magnetic: 9 kHz - 30 MHz

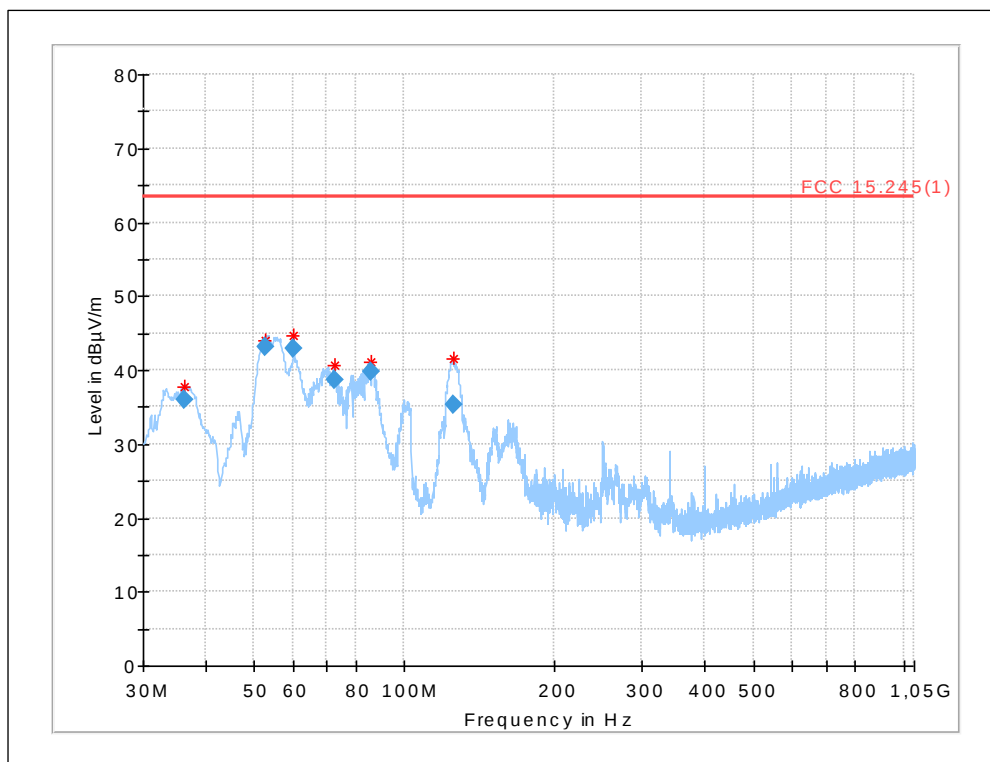


Plot No. 9: High Ch., Magnetic: 9 kHz - 30 MHz



Plot No. 10: Low Ch., 30 MHz to 1 GHz, horizontal / vertical polarization

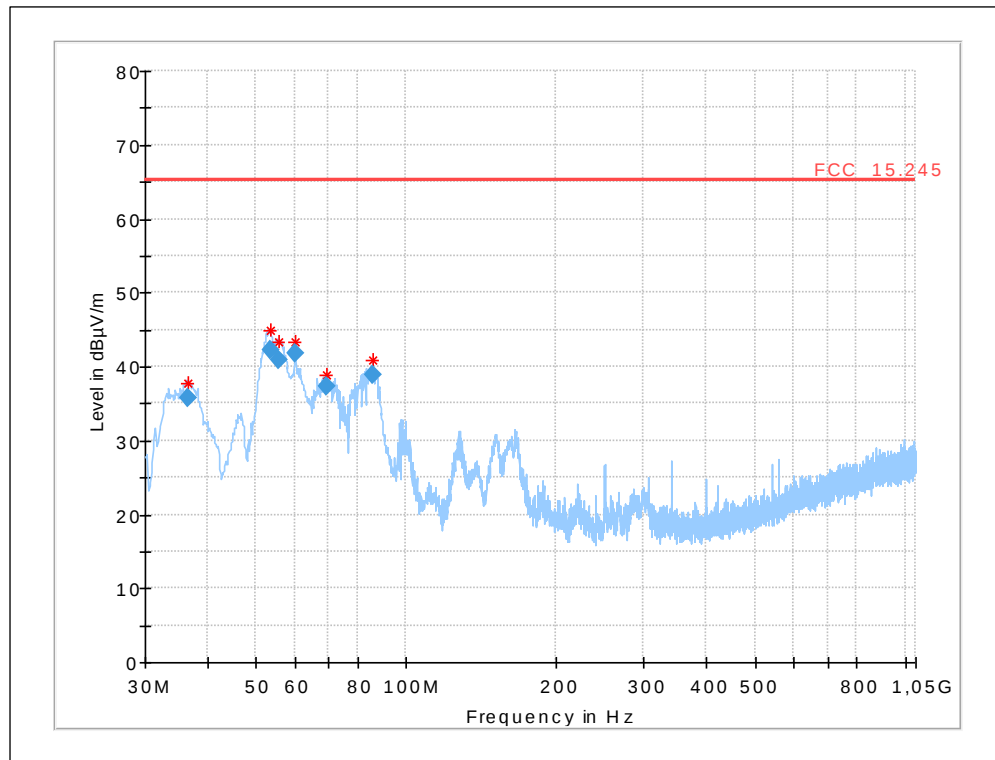
EUT:	Trackman TMC3J and Connection Box ver. 5
Test description:	FCC part 15.245 @ 10 m
Operating condition:	TX low channel
Operator name:	Hennemann
Comment:	48 V DC powered by connection box (115 V / 60 Hz AC); Connection Box on the table; ETH of USB converter not connected



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
36.240	35.90	65.3	29.40	1000	120	100.0	V	-35.0
52.772	43.24	65.3	22.06	1000	120	100.0	V	352.0
59.984	42.94	65.3	22.36	1000	120	274.0	V	25.0
72.436	38.76	65.3	26.54	1000	120	273.0	V	65.0
85.740	39.75	65.3	25.55	1000	120	200.0	V	45.0
125.104	35.38	65.3	29.92	1000	120	200.0	V	135.0

Plot No. 11: Middle Ch., 30 MHz to 1 GHz, horizontal / vertical polarization

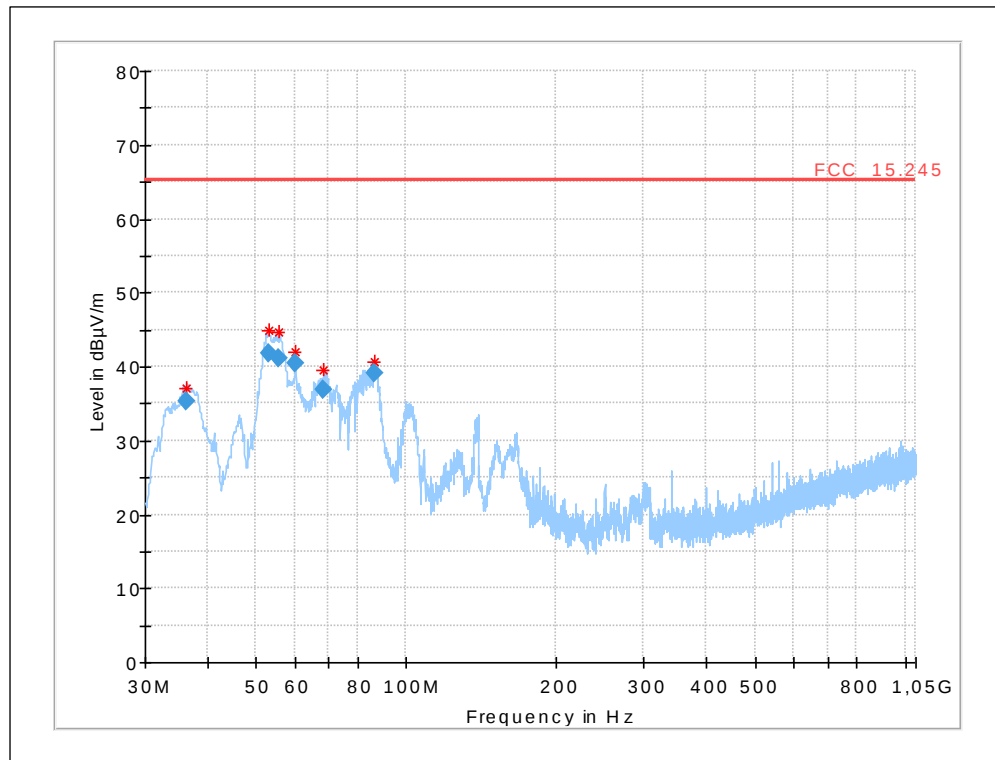
EUT:	Trackman TMC3J and Connection Box ver. 5
Test description:	FCC part 15.245 @ 10 m
Operating condition:	TX middle channel
Operator name:	Hennemann
Comment:	48 V DC powered by connection box (115 V / 60 Hz AC); Connection Box on the table; ETH of USB converter not connected



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
36.546	35.83	65.3	29.47	1000	120	98.0	V	0.0
53.335	42.29	65.3	23.01	1000	120	98.0	V	0.0
55.665	40.99	65.3	24.31	1000	120	100.0	V	0.0
60.011	41.75	65.3	23.55	1000	120	101.0	V	90.0
69.489	37.27	65.3	28.03	1000	120	170.0	V	90.0
85.509	38.89	65.3	26.41	1000	120	100.0	V	0.0

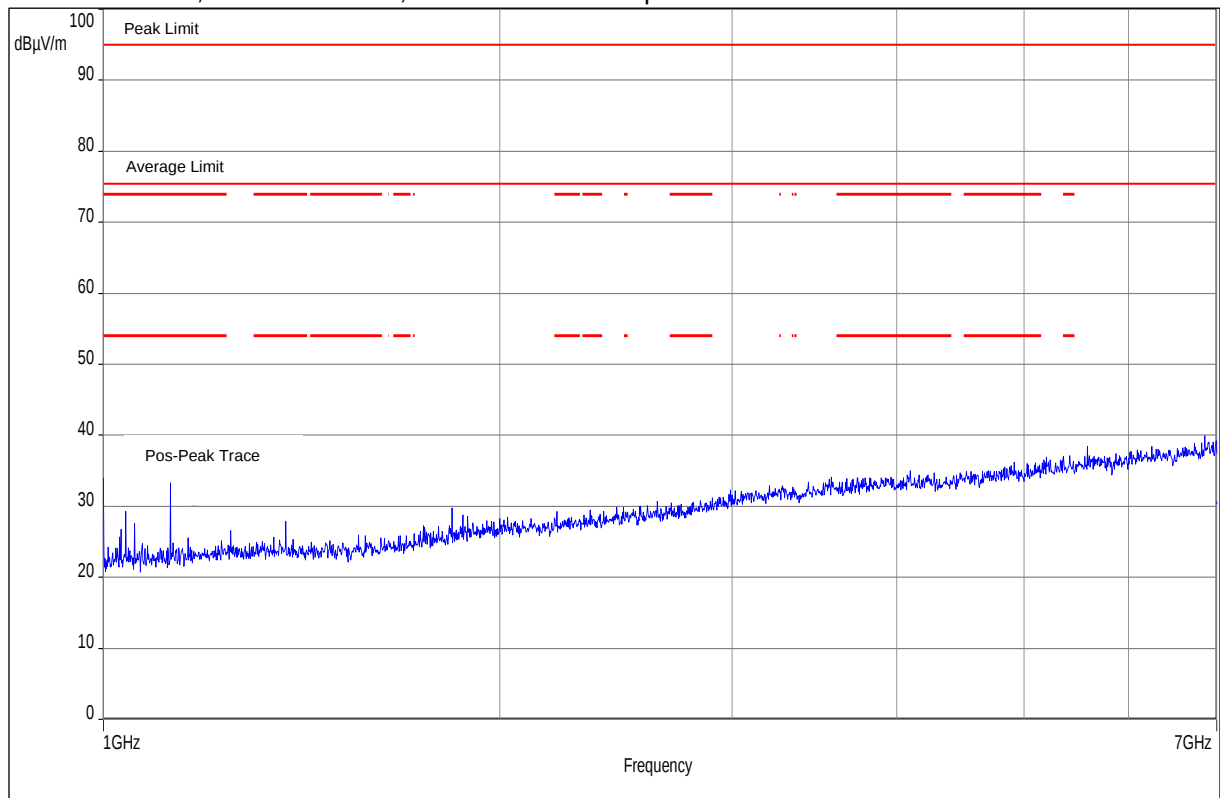
Plot No. 12: High Ch., 30 MHz to 1 GHz, horizontal / vertical polarization

EUT:	Trackman TMC3J and Connection Box ver. 5
Test description:	FCC part 15.245 @ 10 m
Operating condition:	TX high channel
Operator name:	Hennemann
Comment:	48 V DC powered by connection box (115 V / 60 Hz AC); Connection Box on the table; ETH of USB converter not connected

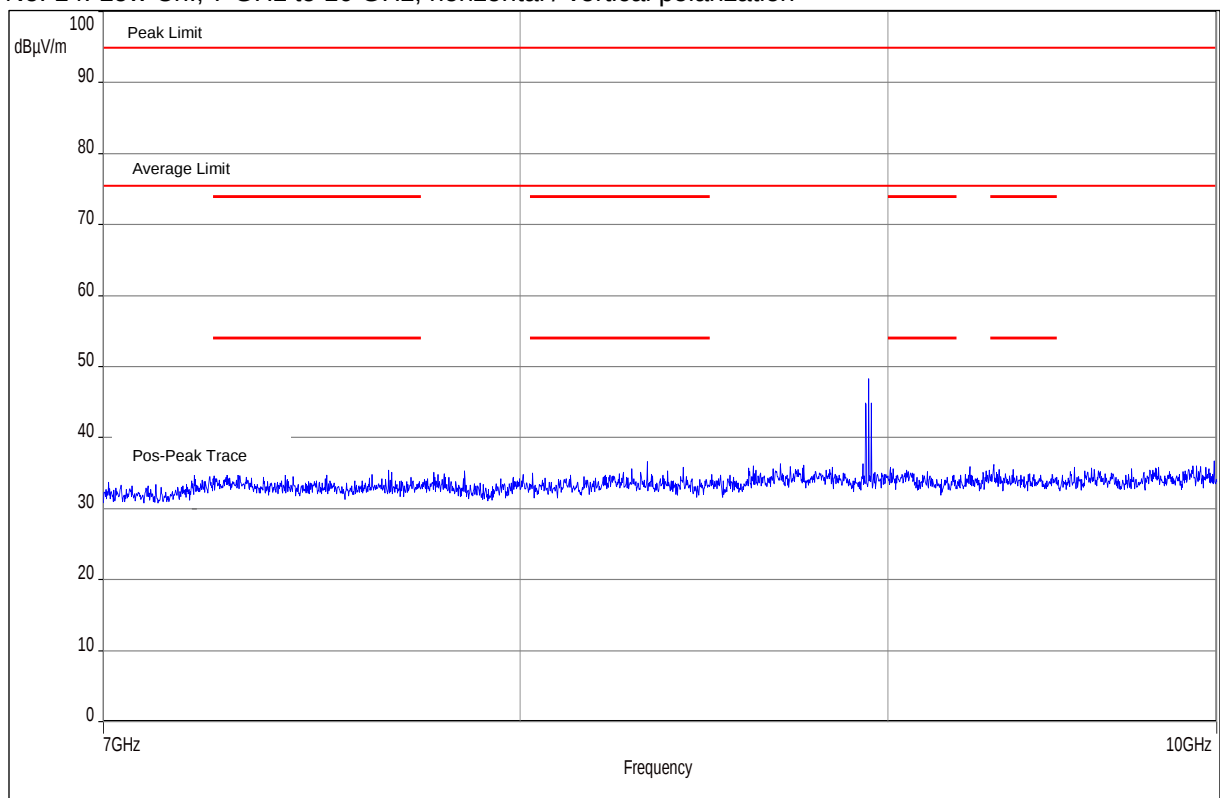


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
36.263	35.24	65.3	30.06	1000	120	98.0	V	0.0
53.169	41.69	65.3	23.61	1000	120	100.0	V	0.0
55.622	41.20	65.3	24.10	1000	120	98.0	V	0.0
60.017	40.51	65.3	24.79	1000	120	98.0	V	90.0
68.428	36.89	65.3	28.41	1000	120	170.0	V	90.0
86.553	39.19	65.3	26.11	1000	120	101.0	V	90.0

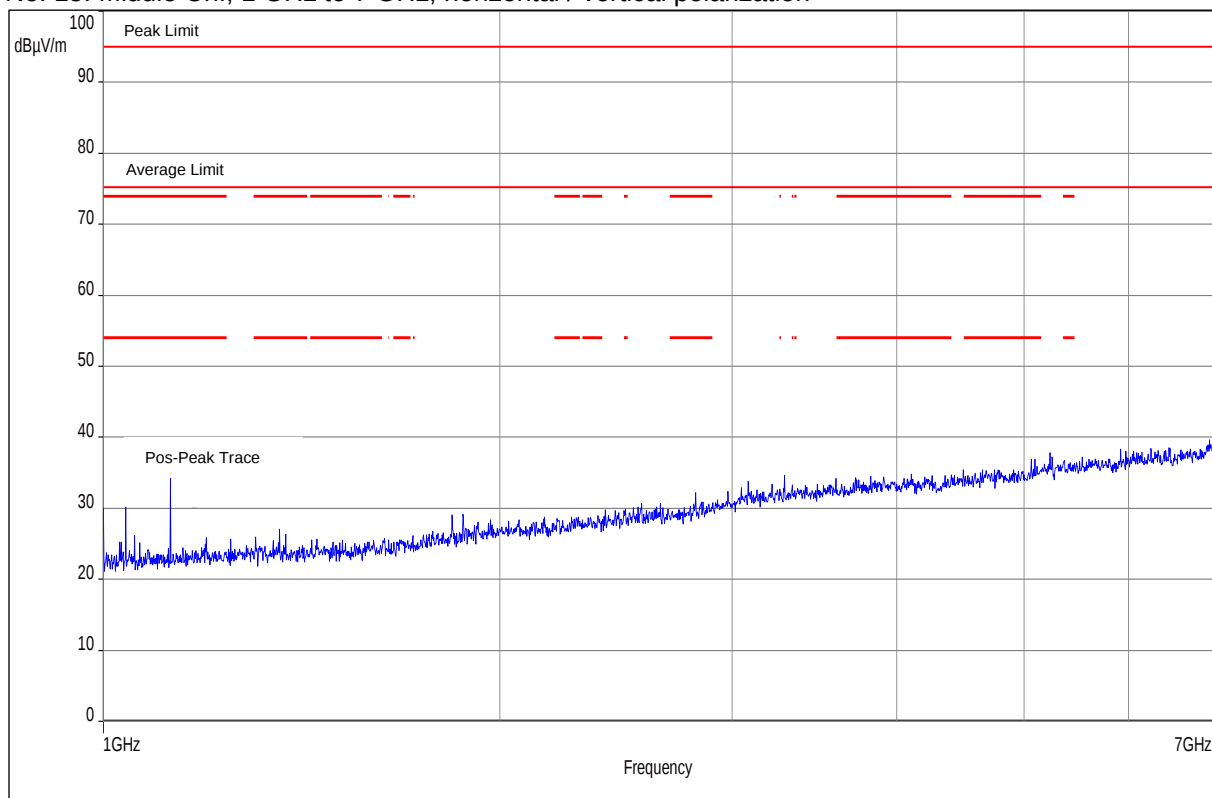
Plot No. 13: Low Ch., 1 GHz to 7 GHz, horizontal / vertical polarization



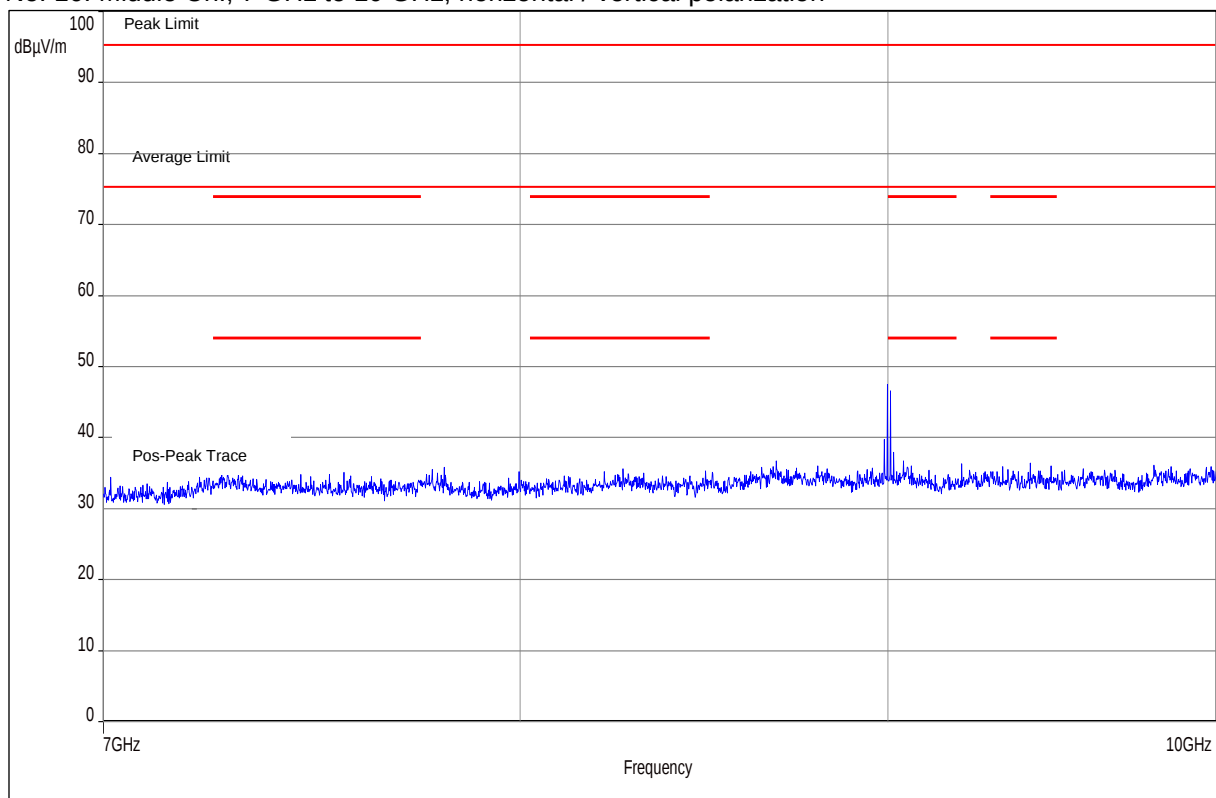
Plot No. 14: Low Ch., 7 GHz to 10 GHz, horizontal / vertical polarization



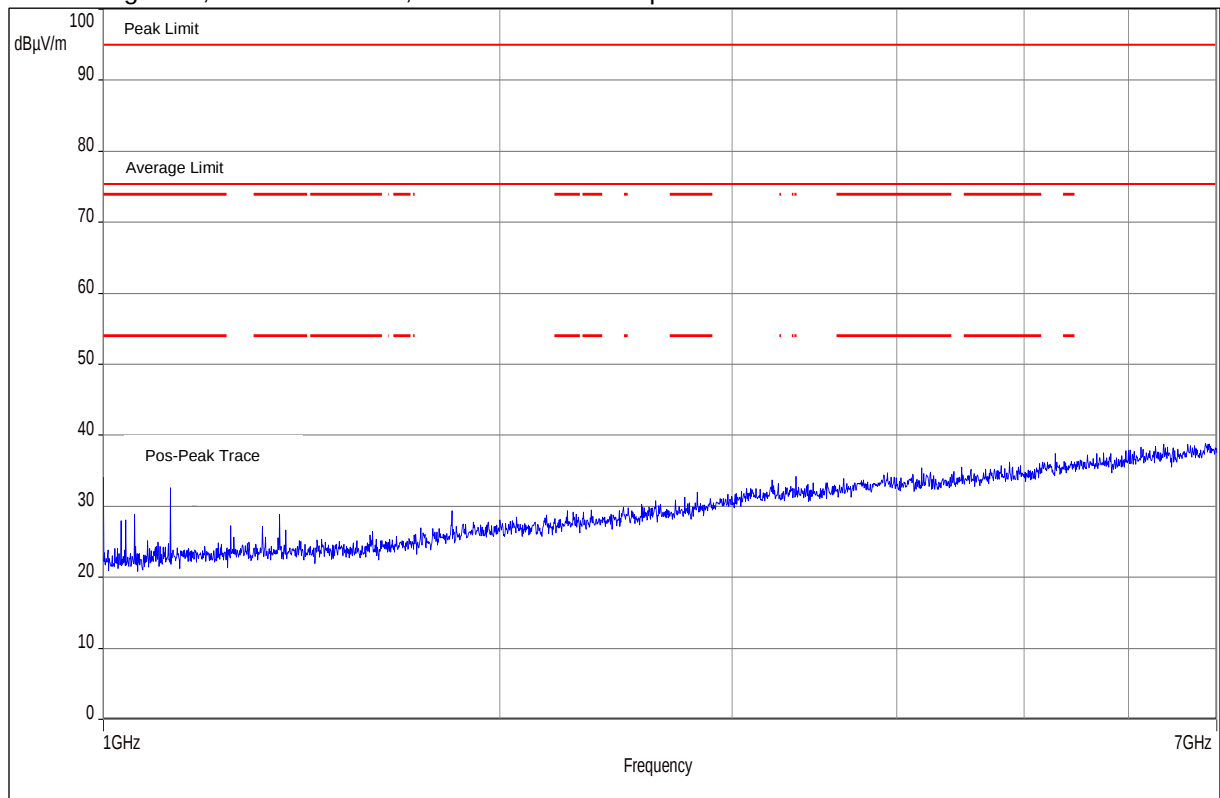
Plot No. 15: Middle Ch., 1 GHz to 7 GHz, horizontal / vertical polarization



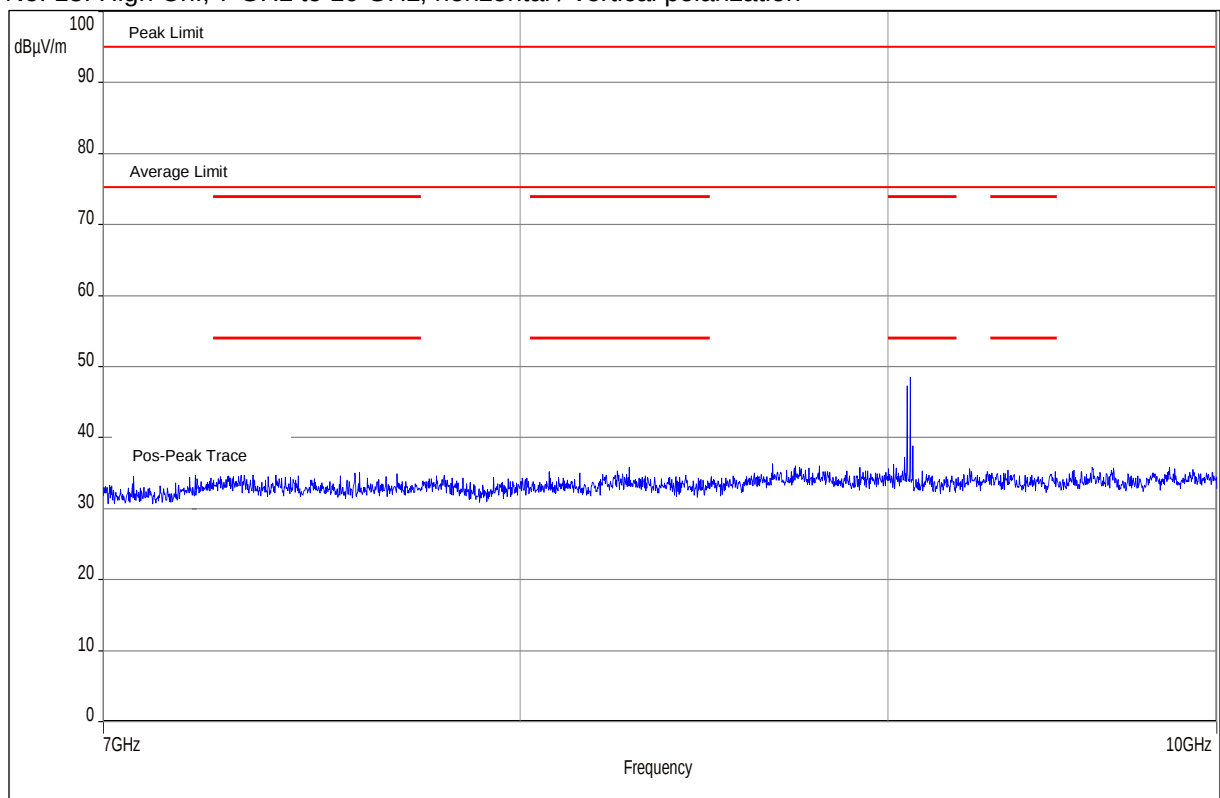
Plot No. 16: Middle Ch., 7 GHz to 10 GHz, horizontal / vertical polarization



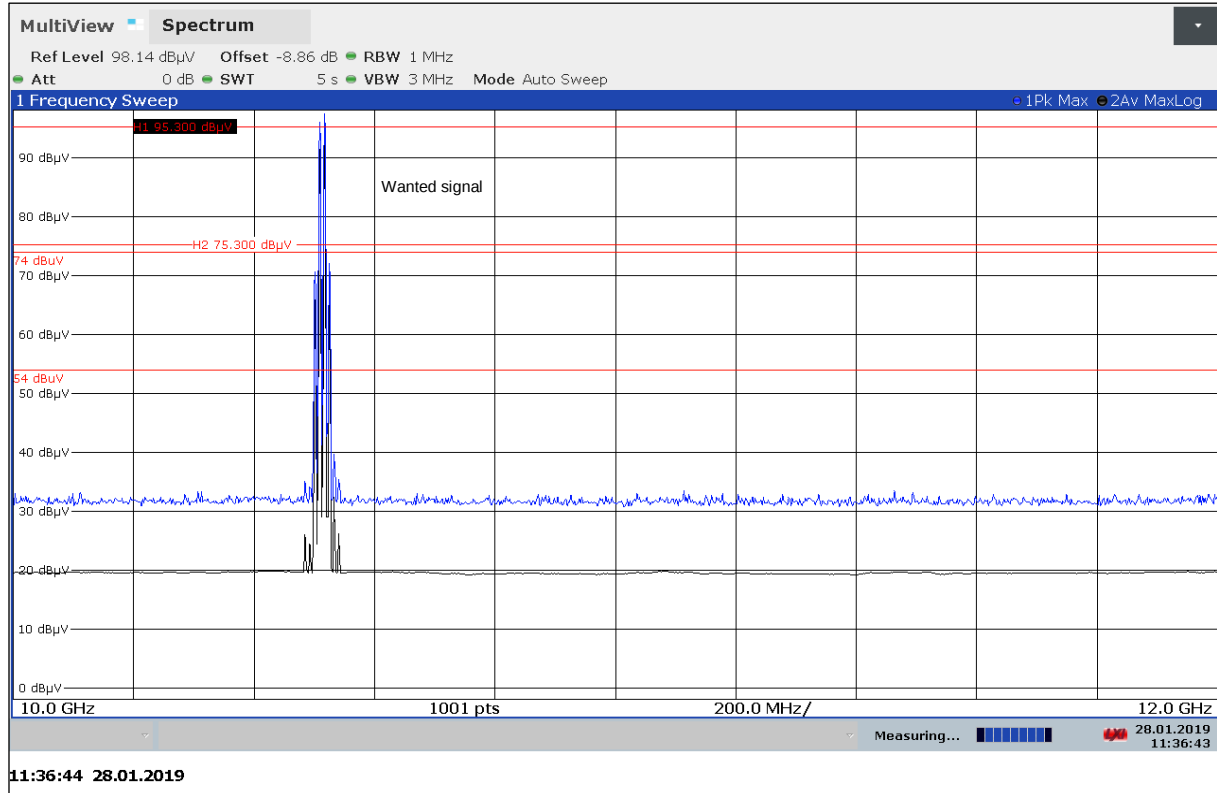
Plot No. 17: High Ch., 1 GHz to 7 GHz, horizontal / vertical polarization



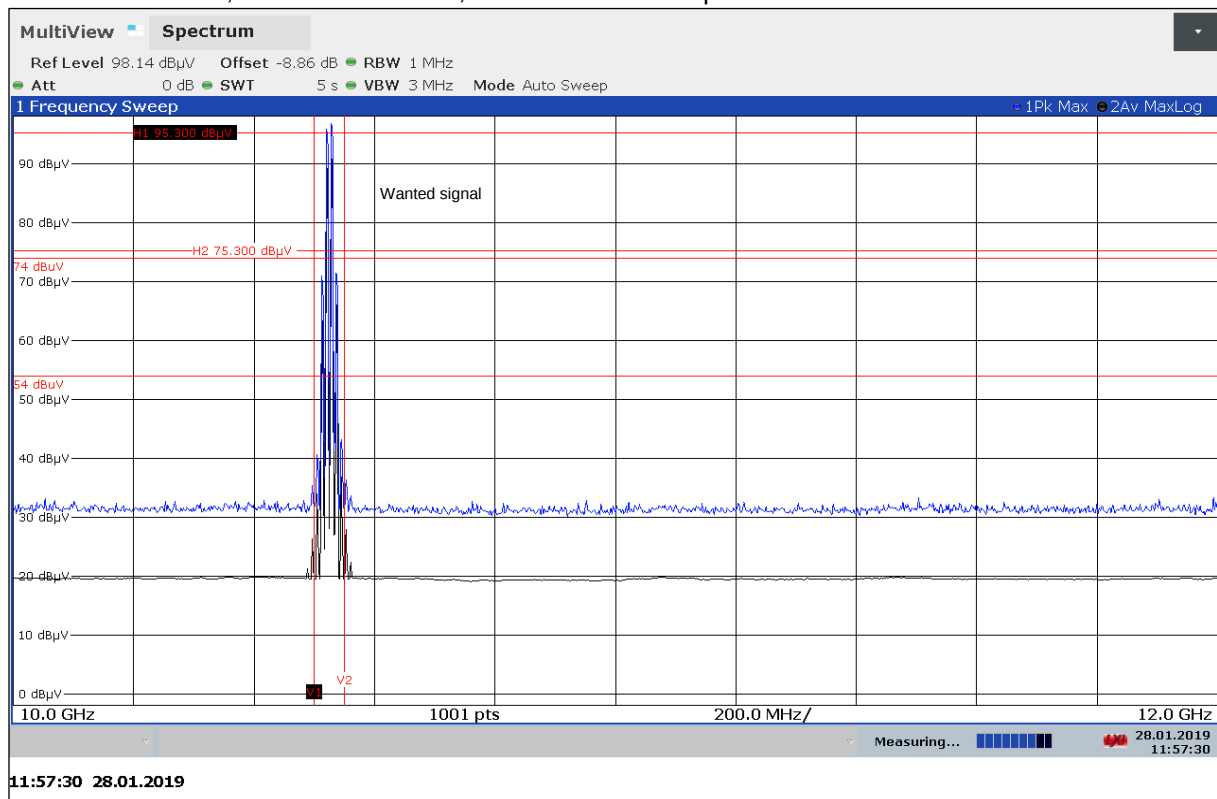
Plot No. 18: High Ch., 7 GHz to 10 GHz, horizontal / vertical polarization



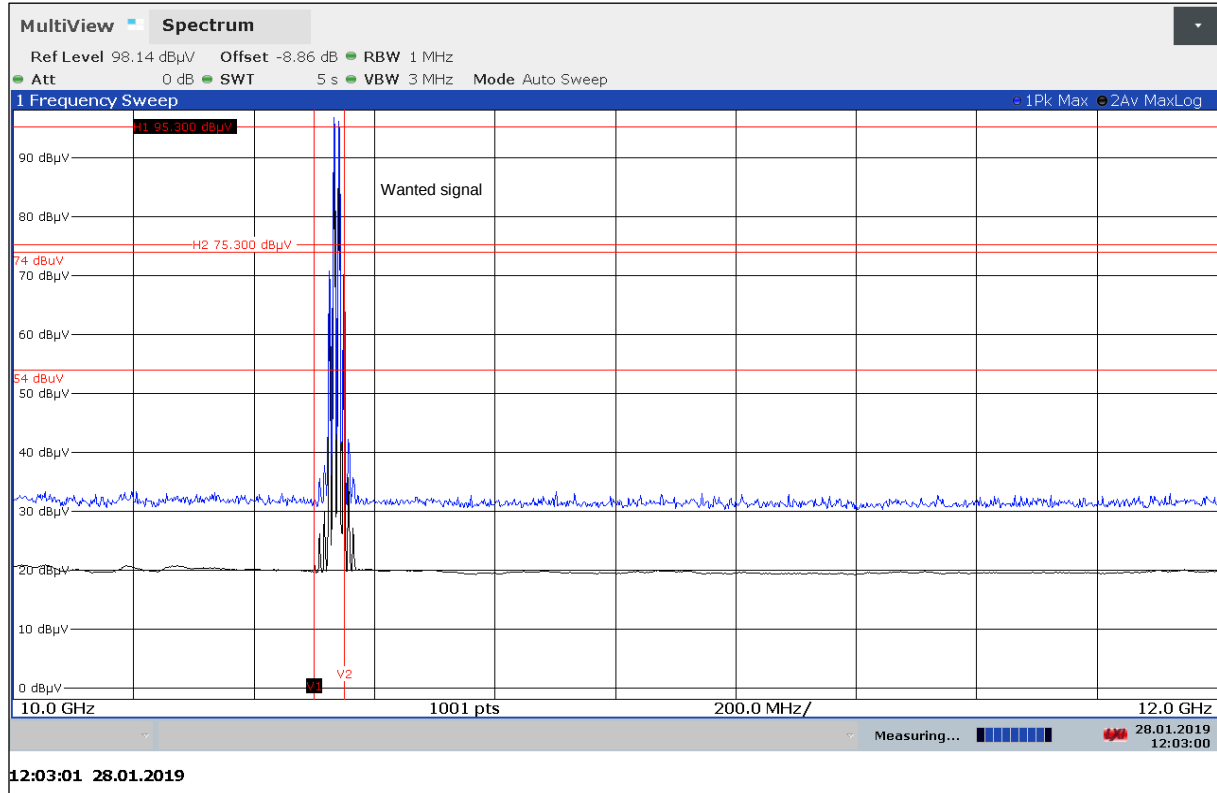
Plot No. 19: Low Ch., 10 GHz to 12 GHz, horizontal / vertical polarization



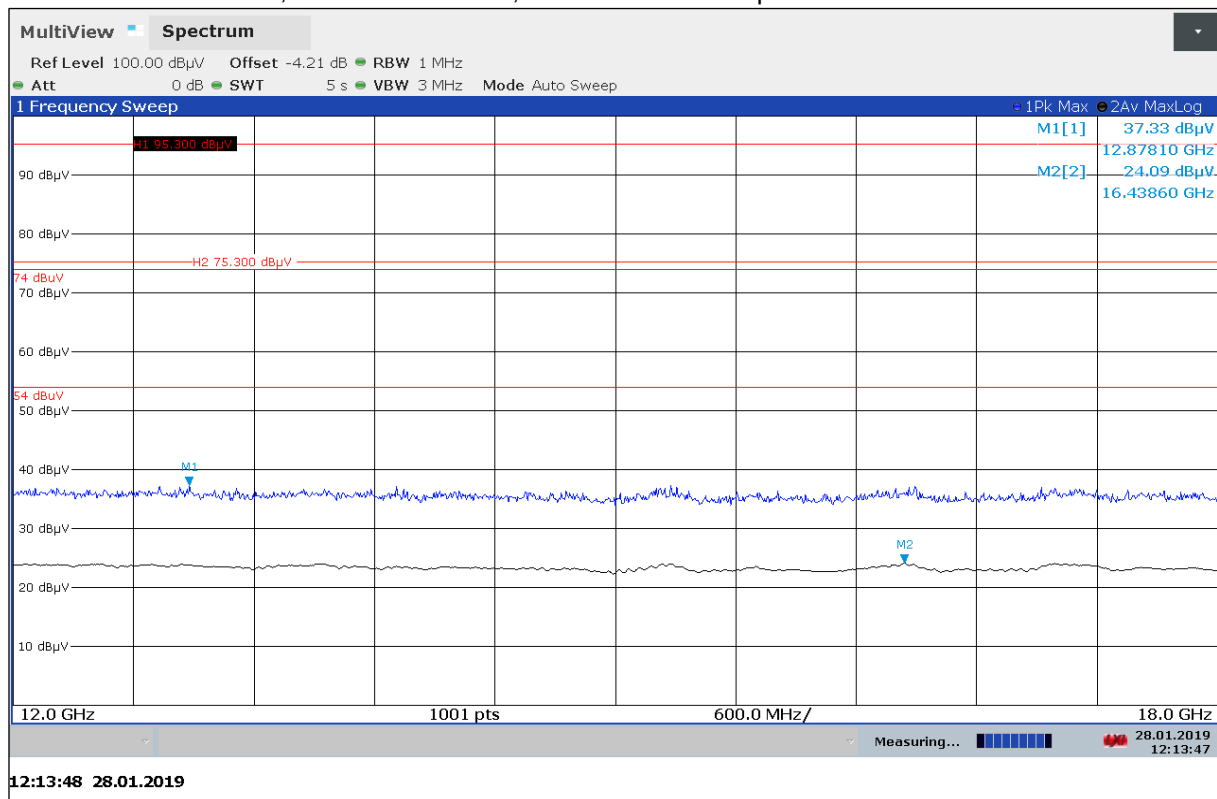
Plot No. 20: Middle Ch., 10 GHz to 12 GHz, horizontal / vertical polarization



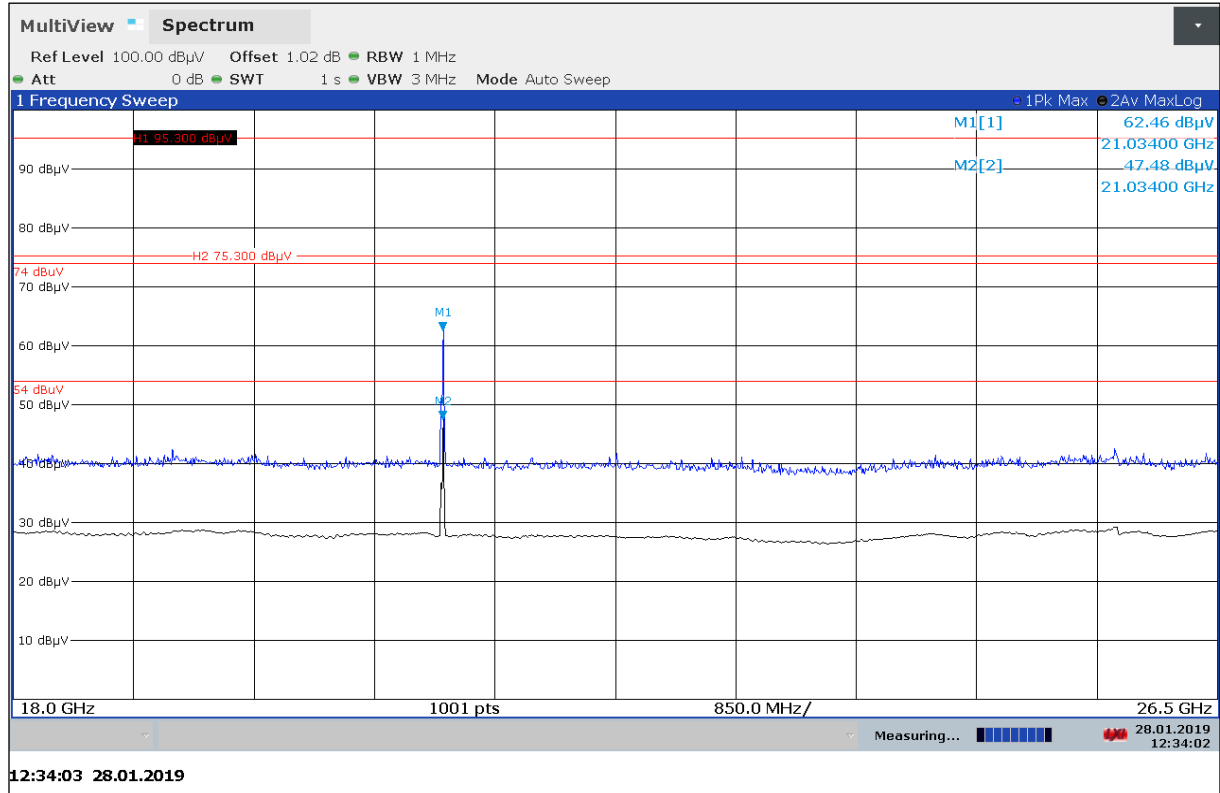
Plot No. 21: High Ch., 10 GHz to 12 GHz, horizontal / vertical polarization



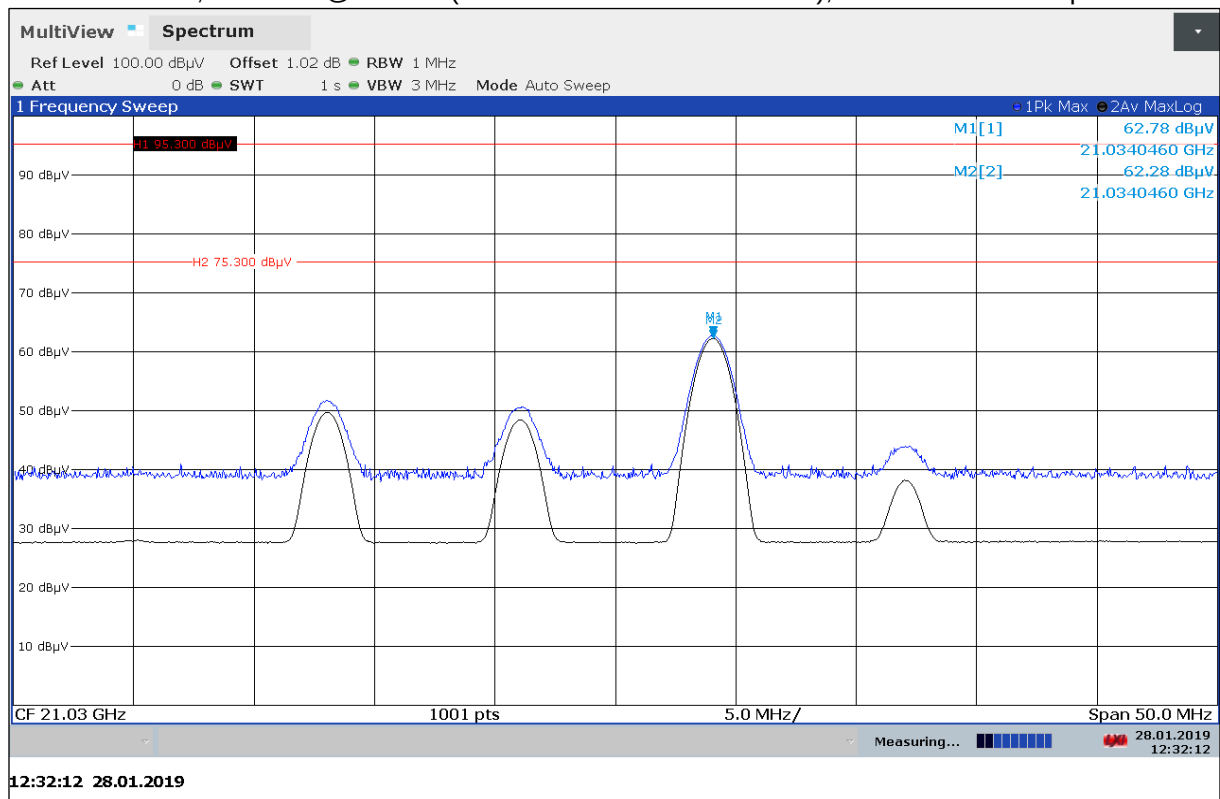
Plot No. 22: Valid for all Ch., 12 GHz to 18 GHz, horizontal / vertical polarization



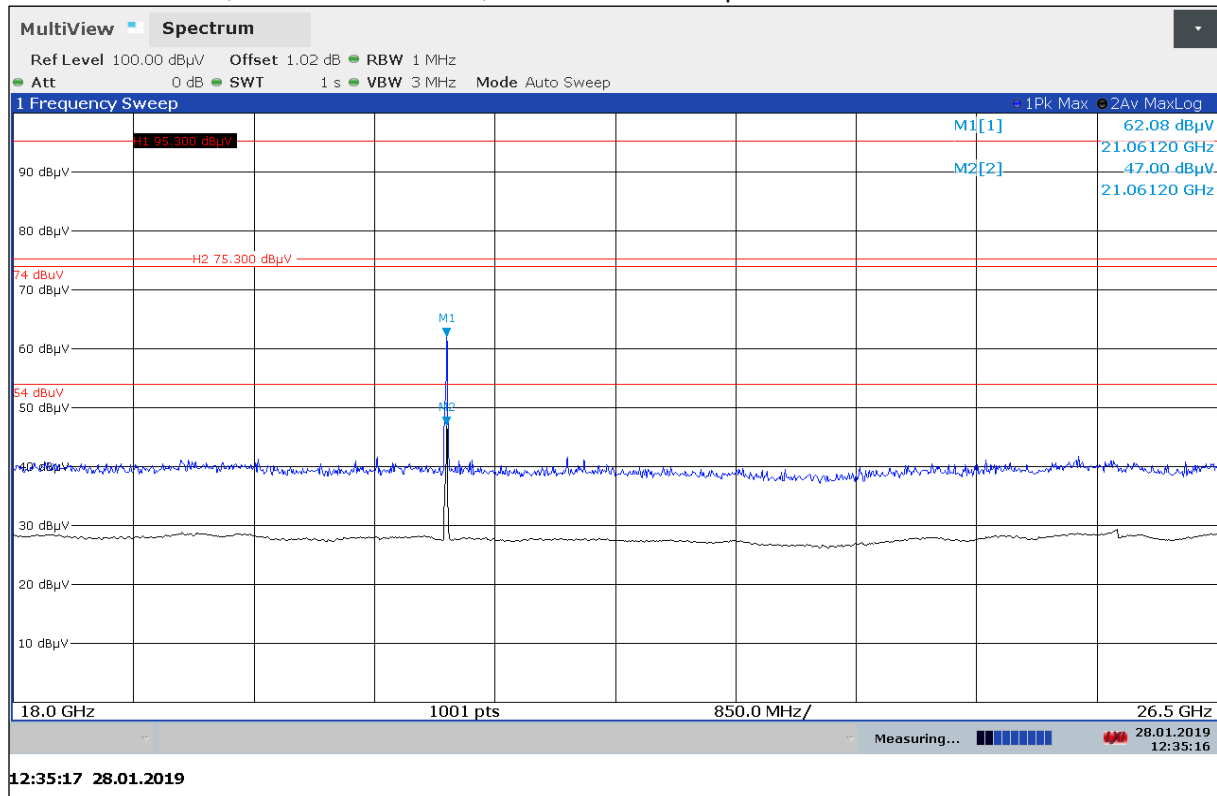
Plot No. 23: Low Ch., 18 GHz to 26.5 GHz, horizontal / vertical polarization



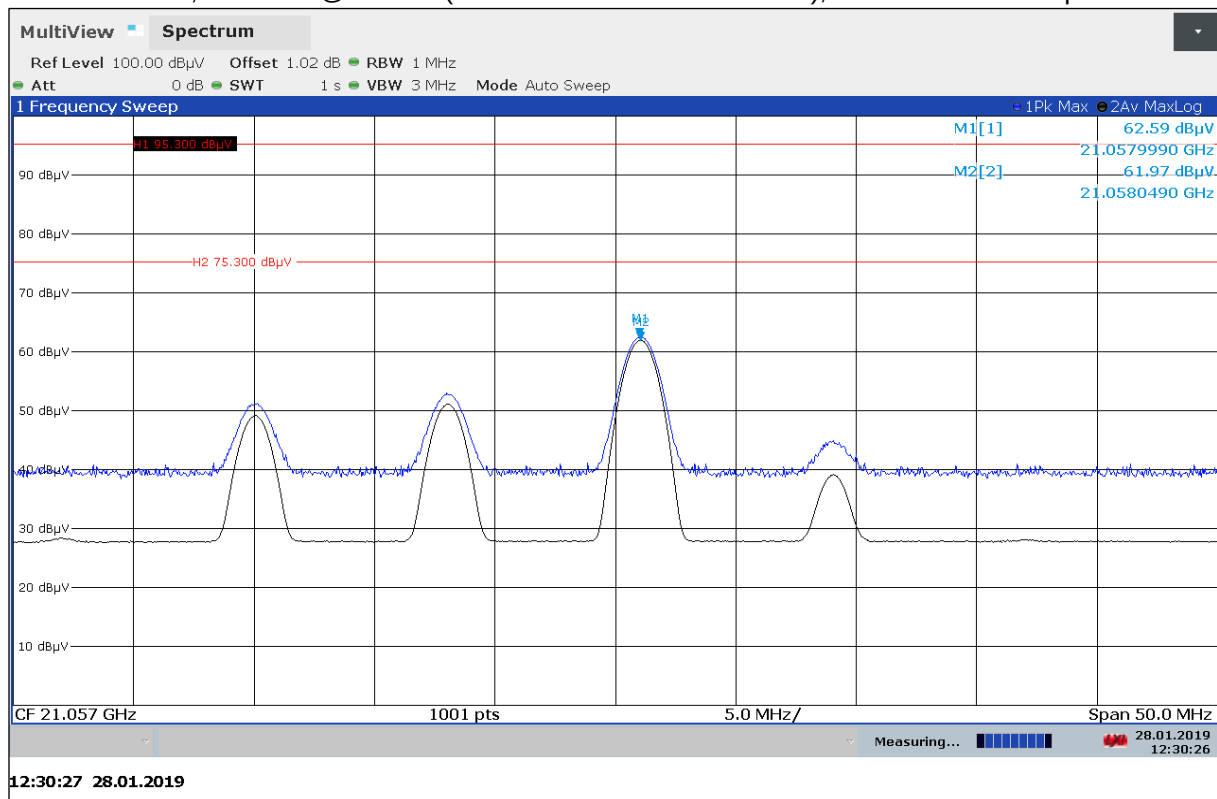
Plot No. 24: Low Ch., Harmonic@21 GHz (restricted band 17.7-21.4 GHz), horizontal / vertical polarization



Plot No. 25: Middle Ch., 18 GHz to 26.5 GHz, horizontal / vertical polarization

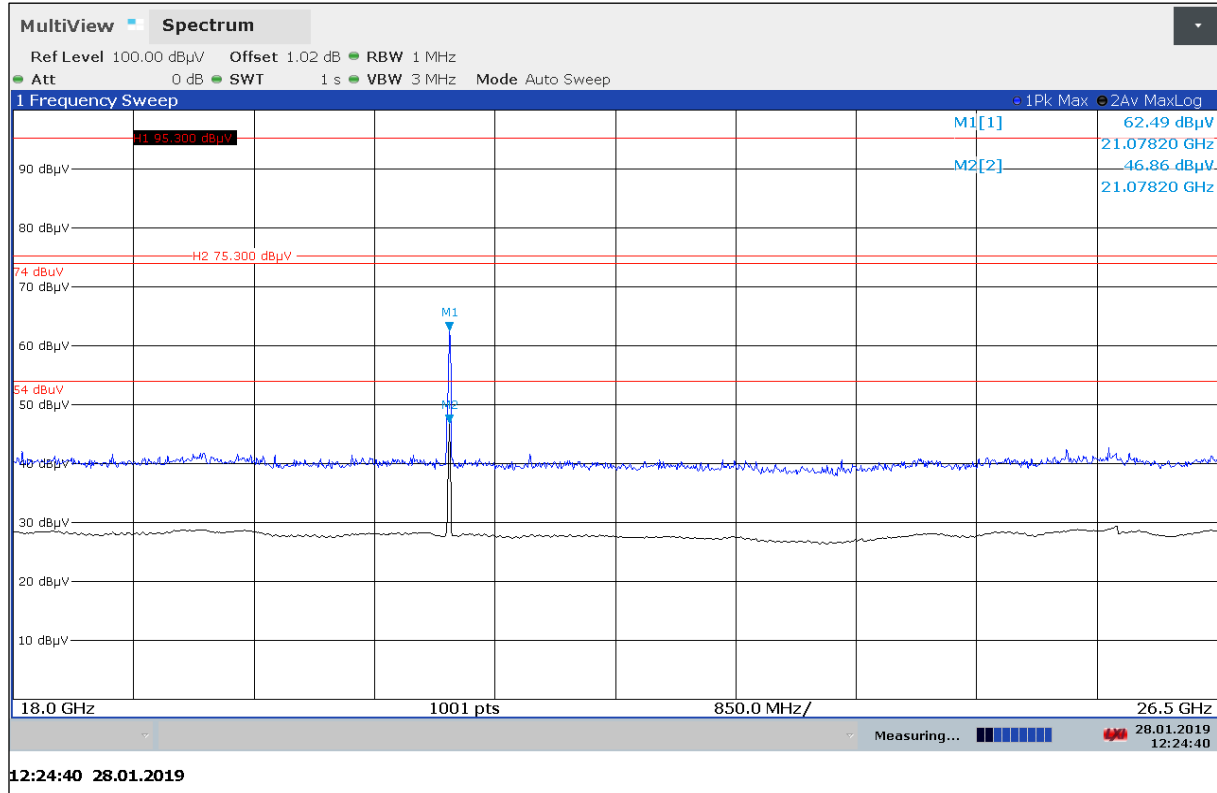


Plot No. 26: Mid Ch., Harmonic@21 GHz (restricted band 17.7-21.4 GHz), horizontal / vertical polarization

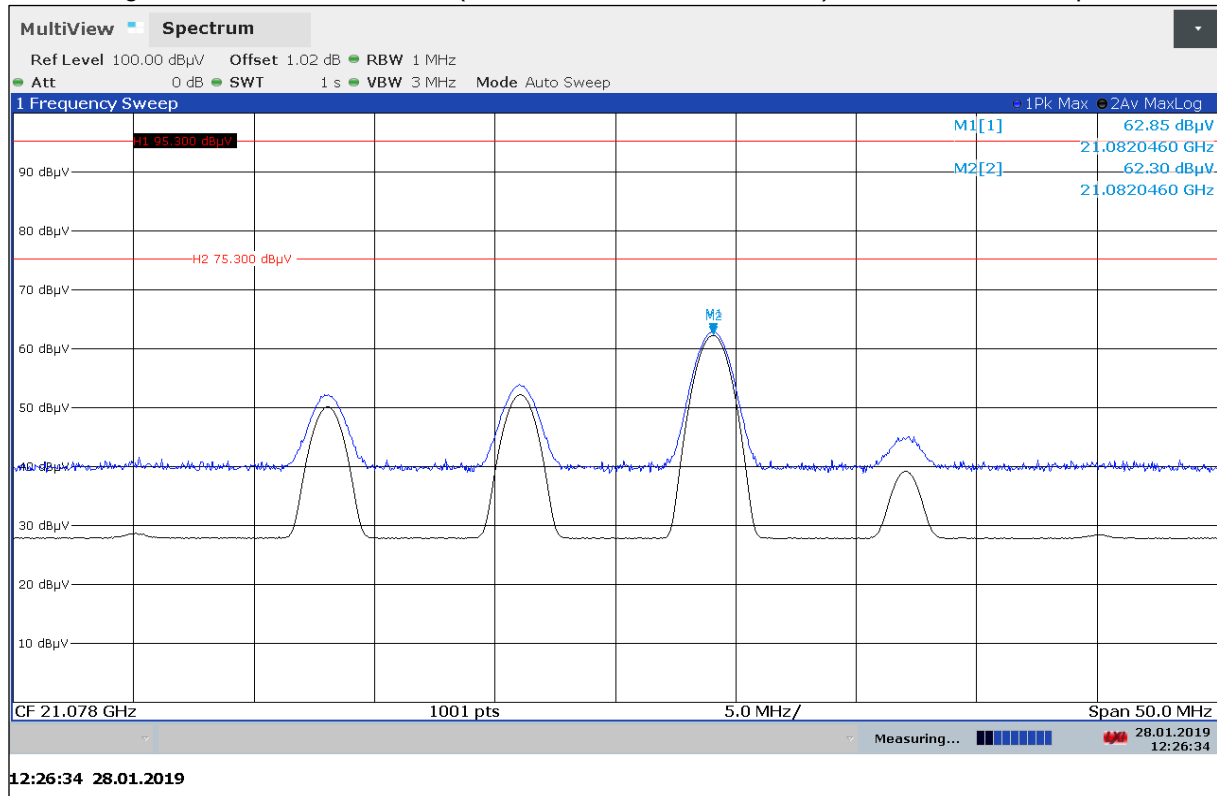


Peak Value: 62.59 dBμV/m (Limit 97.5 dBμV/m) / Average 61.97 dBμV/m (Limit 77.5 dBμV/m)

Plot No. 27: High Ch., 18 GHz to 26.5 GHz, horizontal / vertical polarization

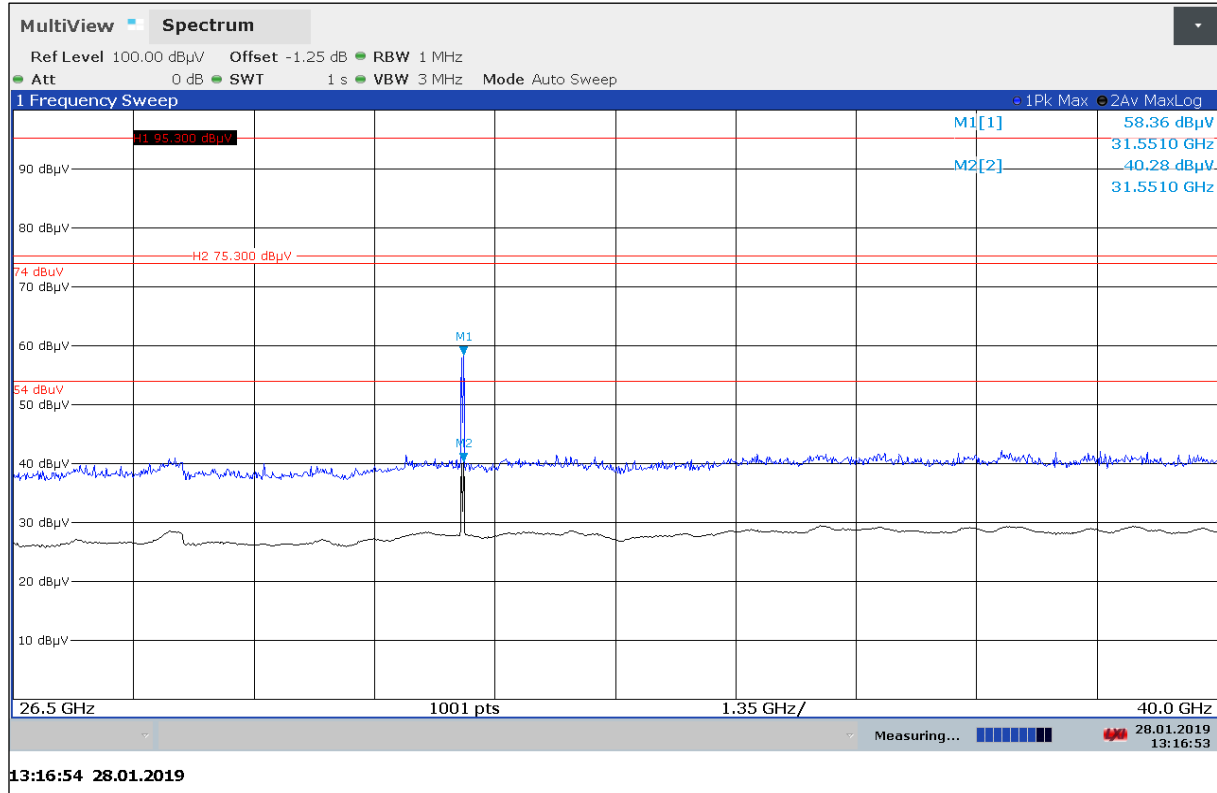


Plot No. 28: High Ch., Harmonic@21 GHz (restricted band 17.7-21.4 GHz), horizontal / vertical polarization

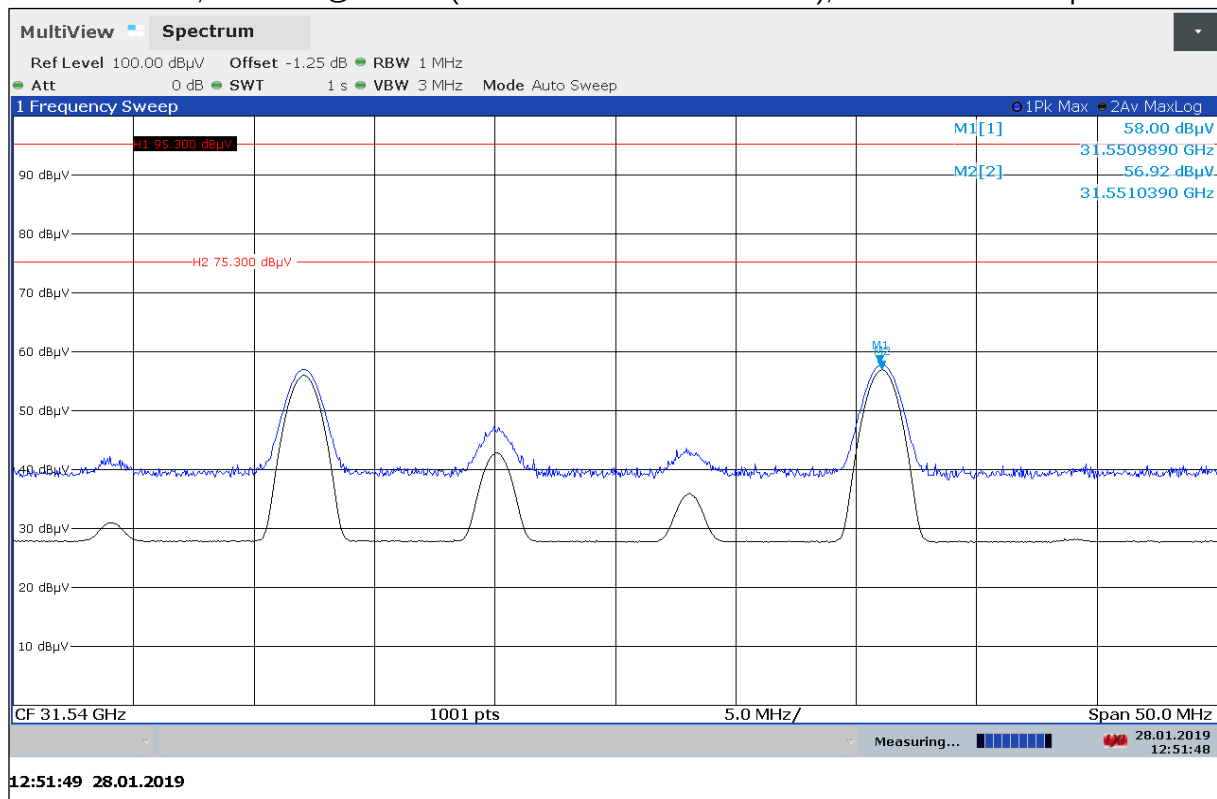


Peak Value: 62.85 dBμV/m (Limit 97.5 dBμV/m) / Average 62.30 dBμV/m (Limit 77.5 dBμV/m)

Plot No. 29: Low Ch., 26.5 GHz to 40 GHz, horizontal / vertical polarization

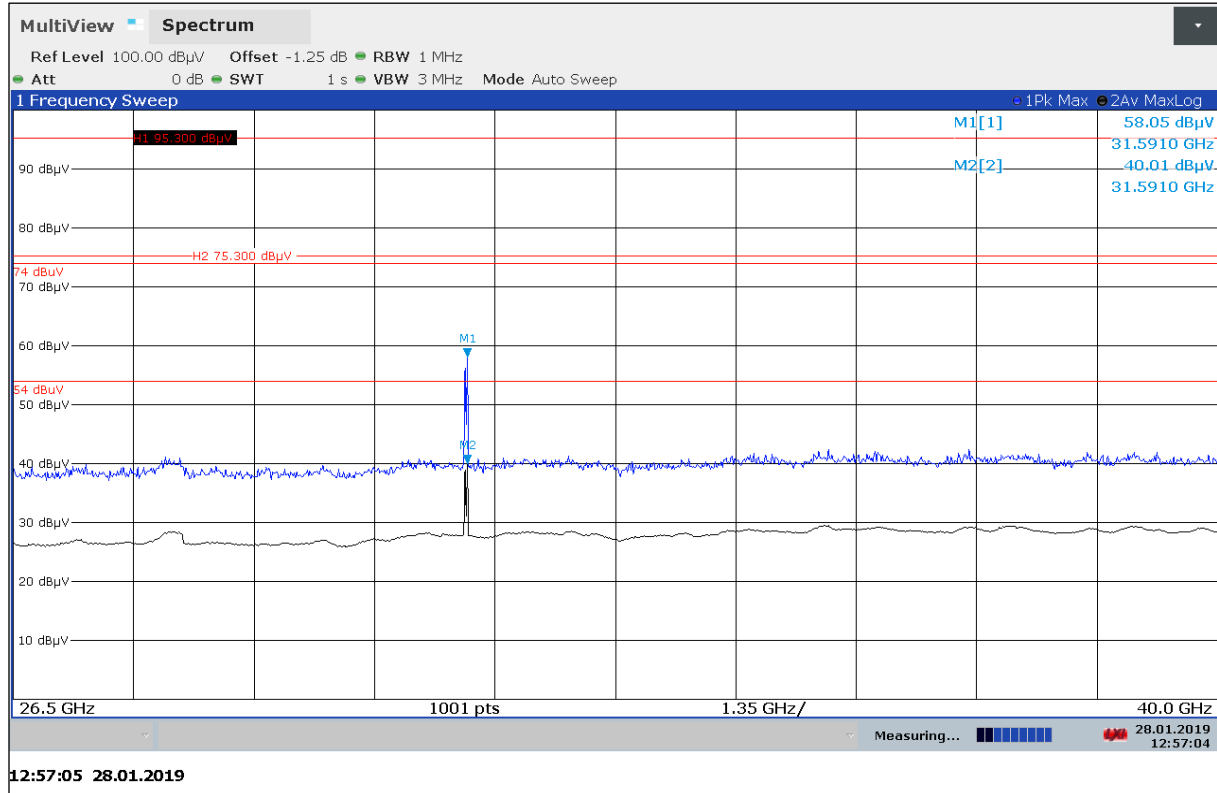


Plot No. 30: Low Ch., Harmonic@31 GHz (restricted band 31.2-31.8 GHz), horizontal / vertical polarization

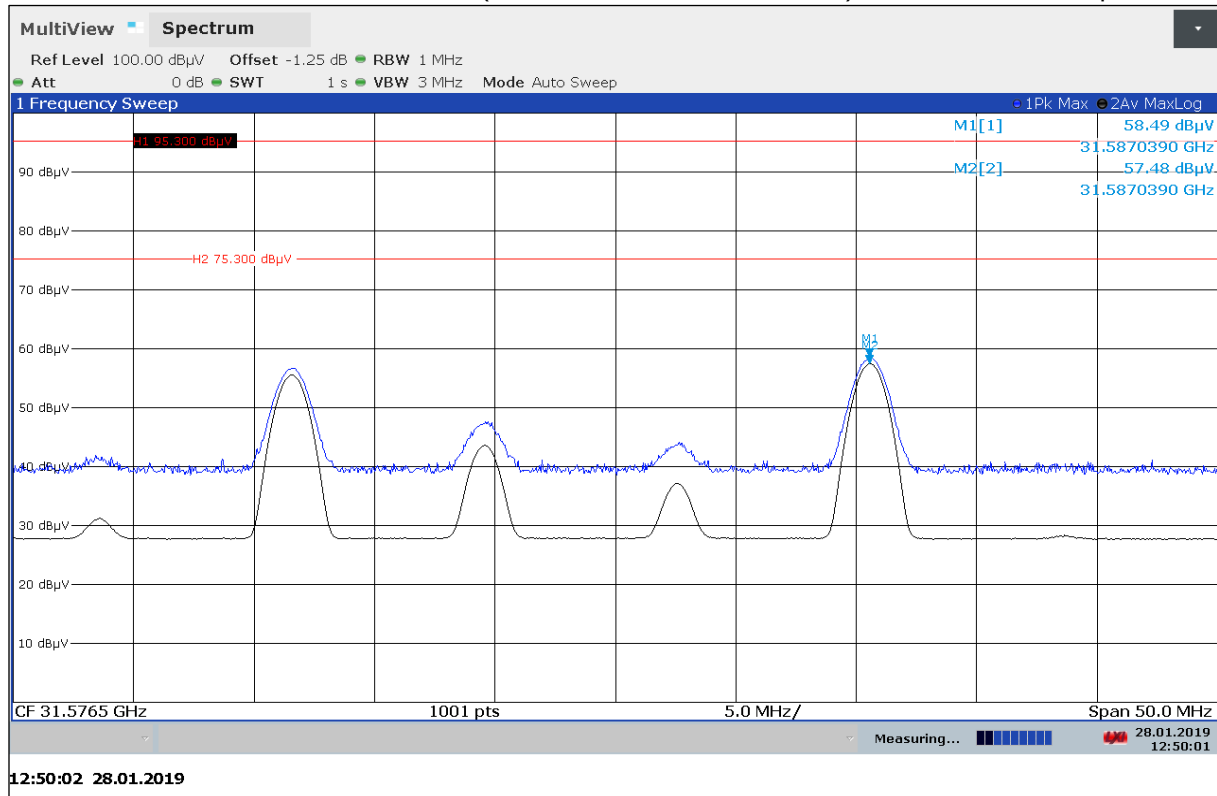


Peak Value: 58.00 dBμV/m (Limit 97.5 dBμV/m) / Average 56.92 dBμV/m (Limit 77.5 dBμV/m)

Plot No. 31: Middle Ch., 26.5 GHz to 40 GHz, horizontal / vertical polarization

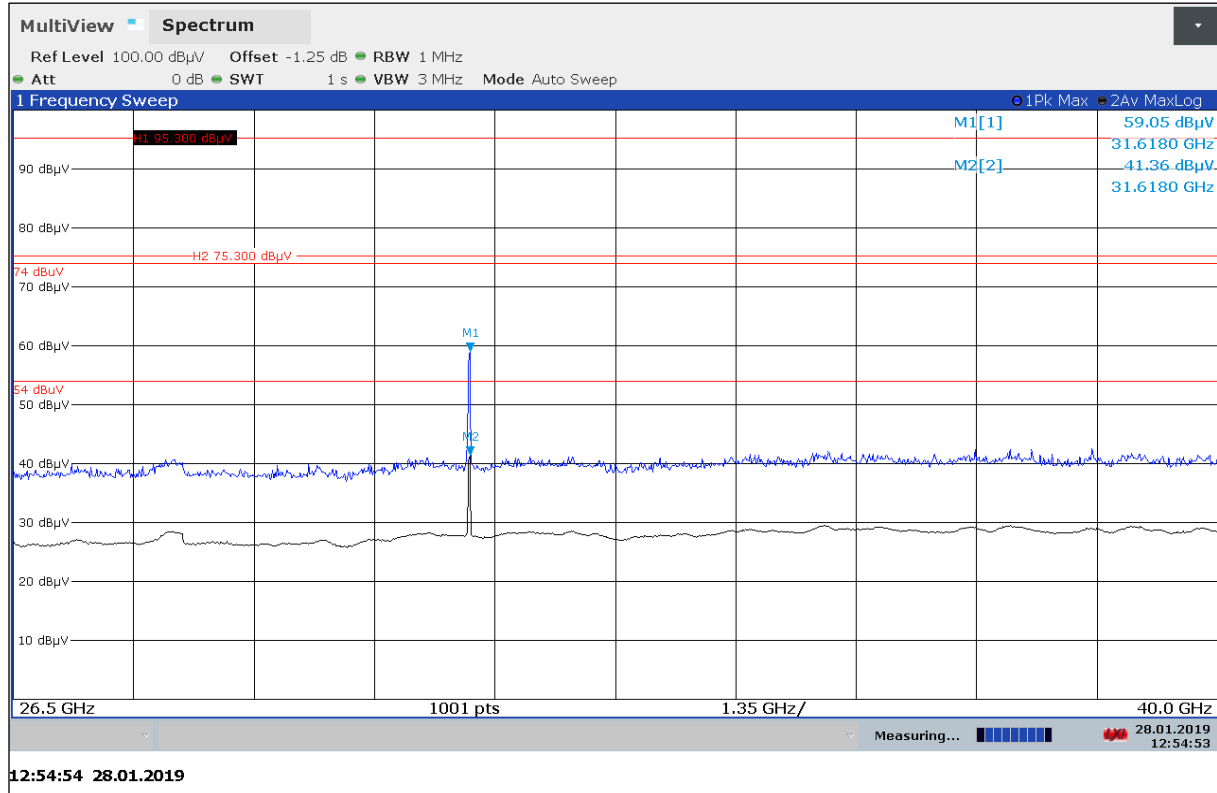


Plot No. 32: Middle Ch., Harmonic@31 GHz (restricted band 31.2-31.8 GHz), horizontal / vertical polarization

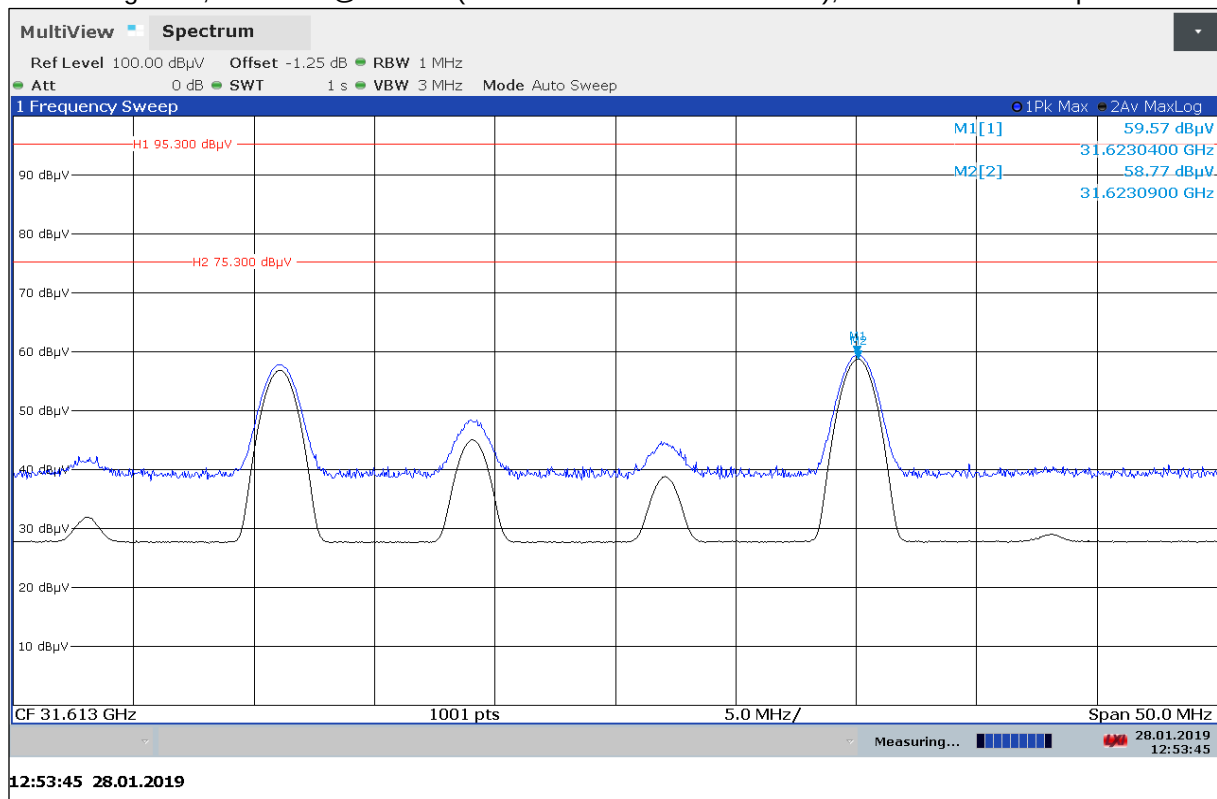


Peak Value: 58.49 dBμV/m (Limit 97.5 dBμV/m) / Average 57.48 dBμV/m (Limit 77.5 dBμV/m)

Plot No. 33: High Ch., 26.5 GHz to 40 GHz, horizontal / vertical polarization

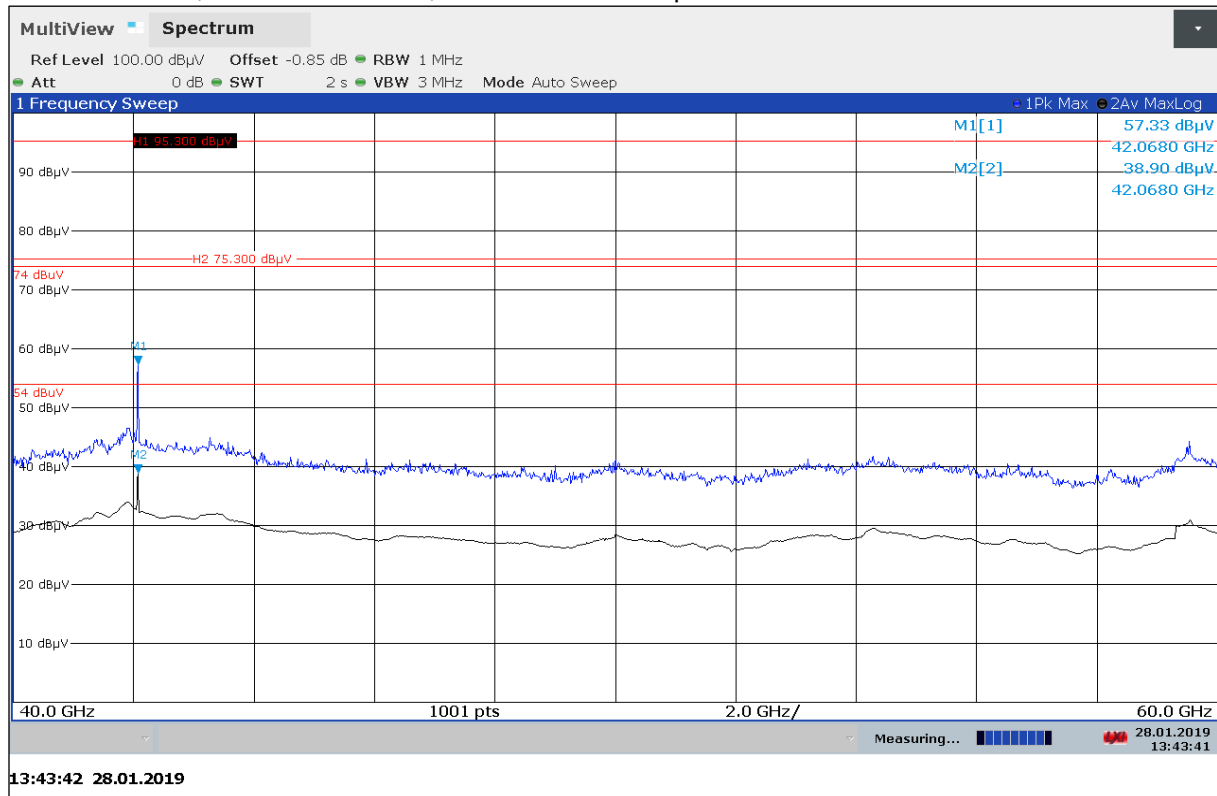


Plot No. 34: High Ch., Harmonic@31 GHz (restricted band 31.2-31.8 GHz), horizontal / vertical polarization

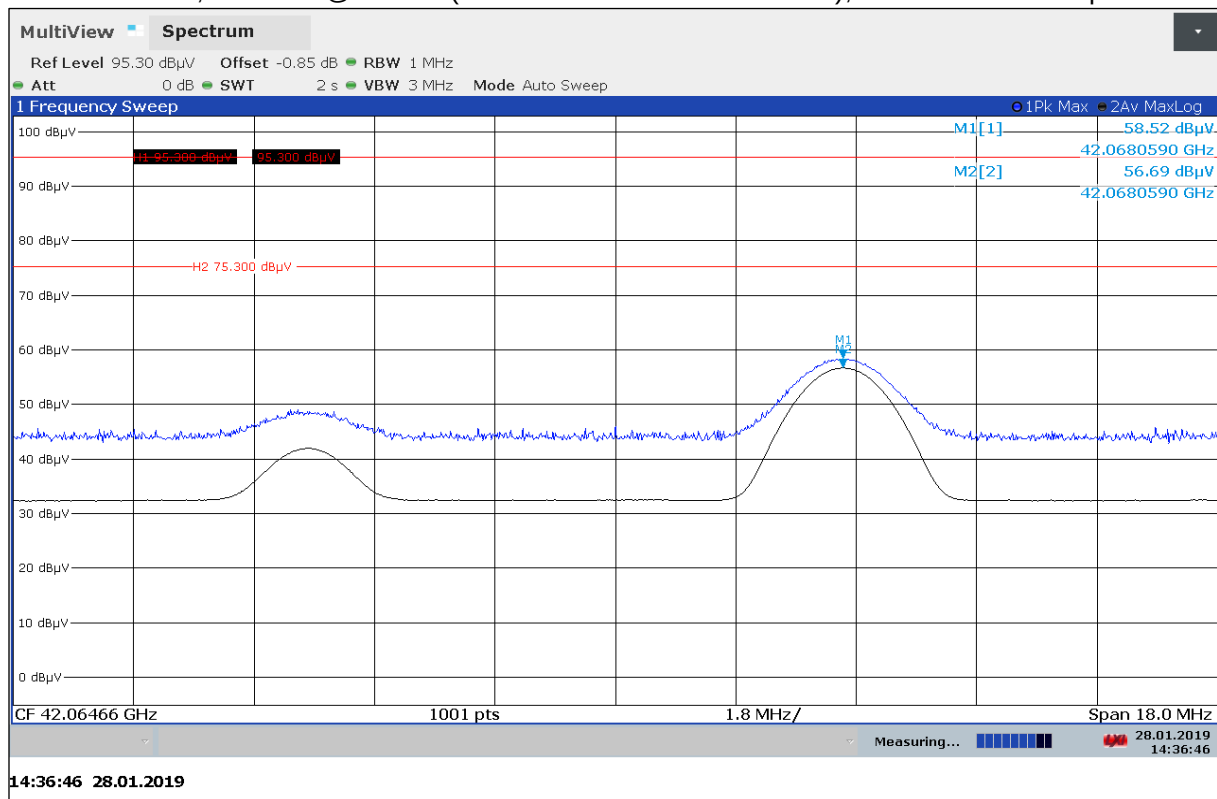


Peak Value: 59.57 dBμV/m (Limit 97.5 dBμV/m) / Average 58.77 dBμV/m (Limit 77.5 dBμV/m)

Plot No. 35: Low Ch., 40 GHz to 60 GHz, horizontal / vertical polarization

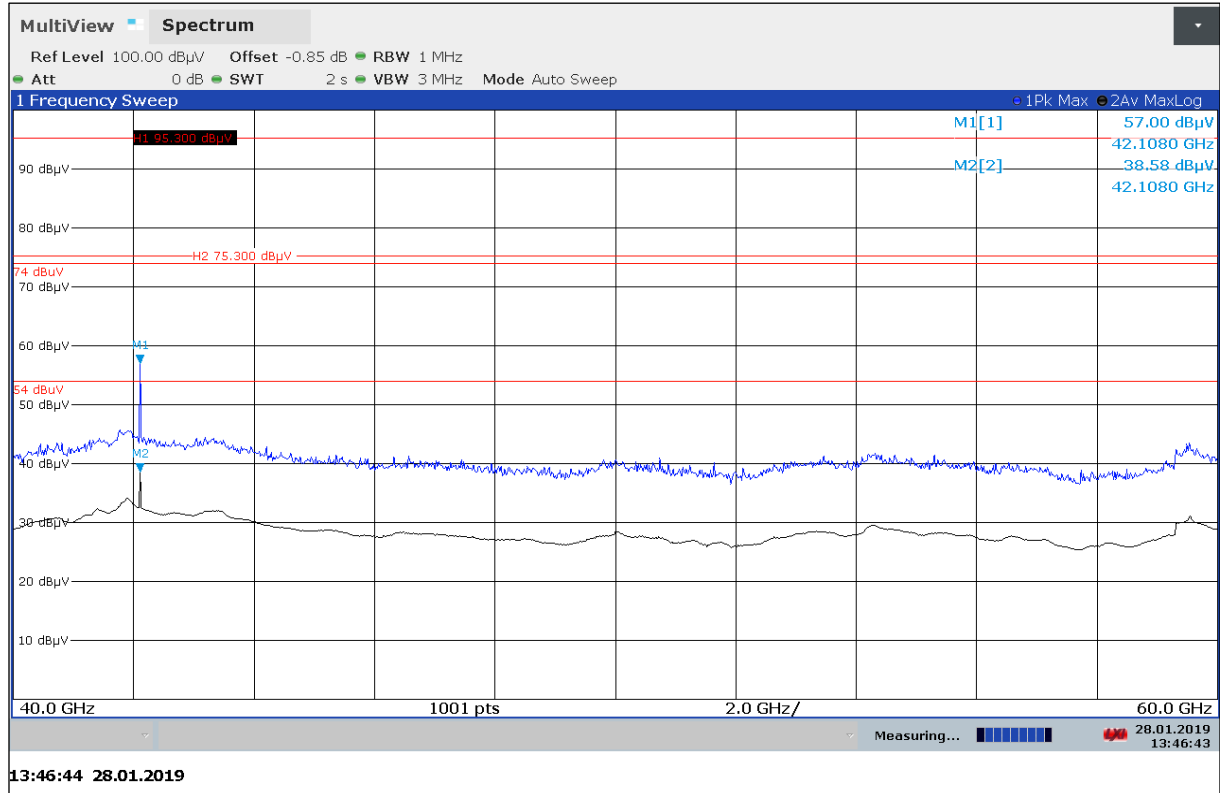


Plot No. 36: Low Ch., Harmonic@42 GHz (restricted band above 38.6 GHz), horizontal / vertical polarization

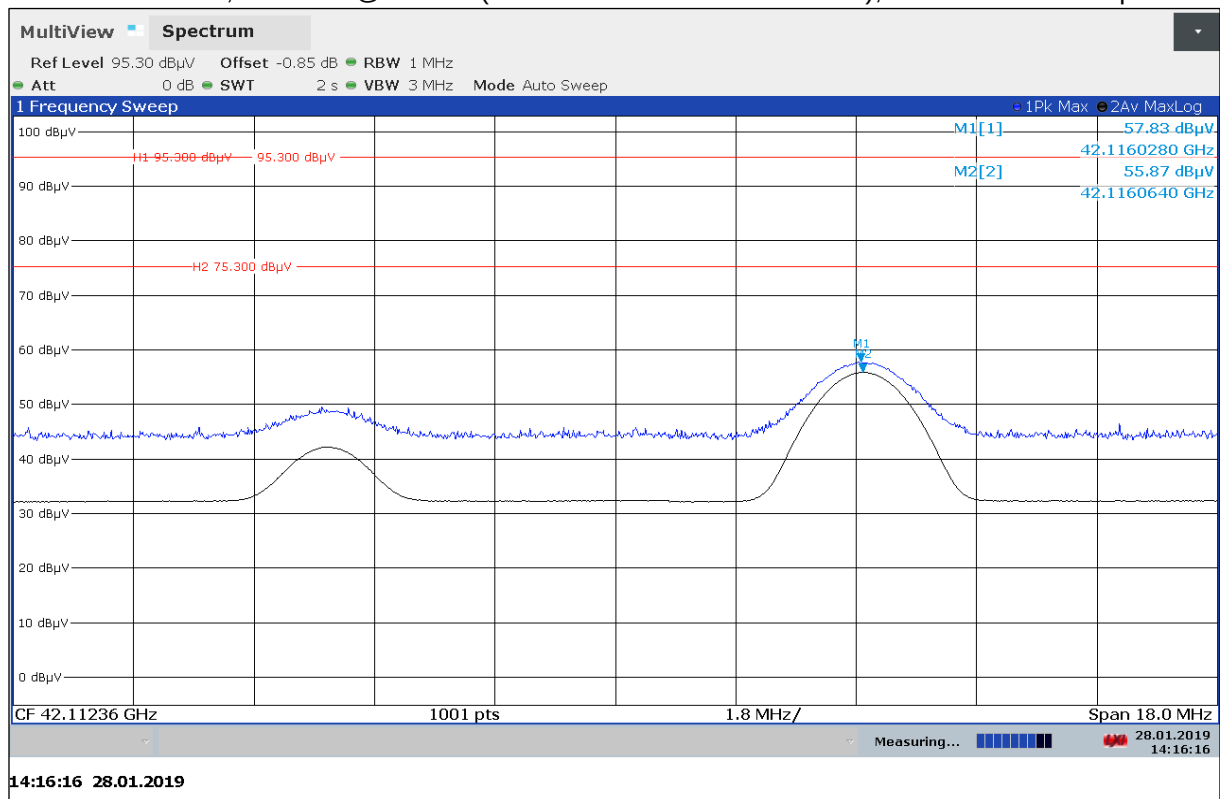


Peak Value: 58.52 dBμV/m (Limit 97.5 dBμV/m) / Average 56.69 dBμV/m (Limit 77.5 dBμV/m)

Plot No. 37: Middle Ch., 40 GHz to 60 GHz, horizontal / vertical polarization

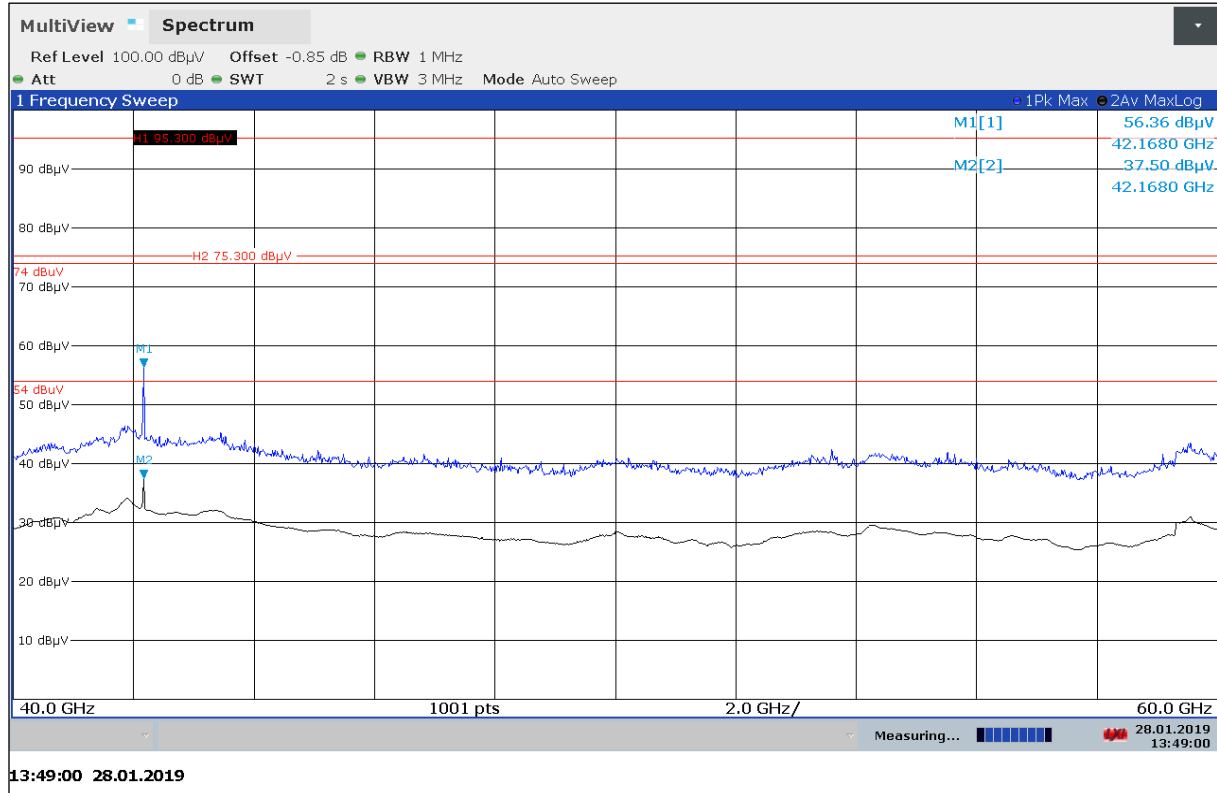


Plot No. 38: Middle Ch., Harmonic@42 GHz (restricted band above 38.6 GHz), horizontal / vertical polarization

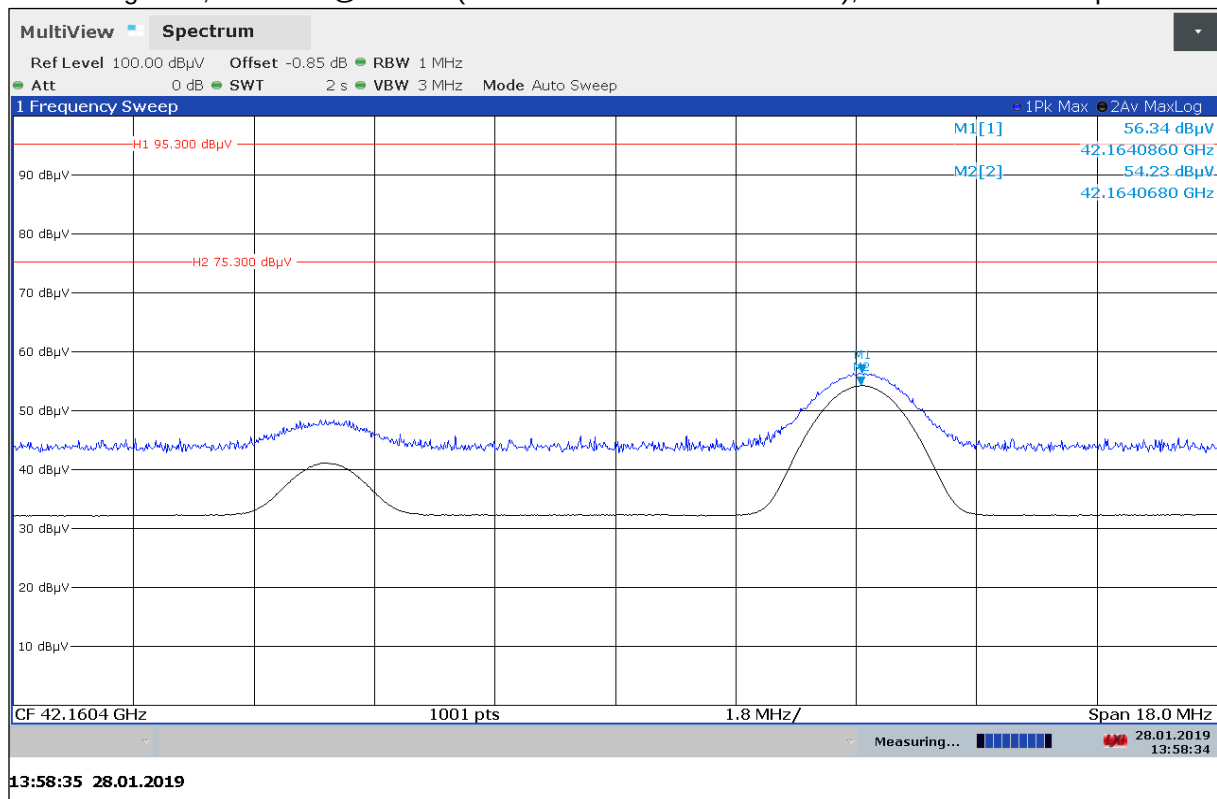


Peak Value: 57.83 dBμV/m (Limit 97.5 dBμV/m) / Average 55.87 dBμV/m (Limit 77.5 dBμV/m)

Plot No. 39: High Ch., 40 GHz to 60 GHz, horizontal / vertical polarization



Plot No. 40: High Ch., Harmonic@42 GHz (restricted band above 38.6 GHz), horizontal / vertical polarization



Peak Value: 56.34 dBμV/m (Limit 97.5 dBμV/m) / Average 54.23 dBμV/m (Limit 77.5 dBμV/m)

9.5 Conducted spurious emissions < 30 MHz

Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. Both power lines, phase and neutral line, are measured. Found peaks are re-measured with average and quasi peak detection to show compliance to the limits.

Measurement:

Measurement parameter	
Detector:	Peak - Quasi Peak / Average
Sweep time:	Auto
Video bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Resolution bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace-Mode:	Max Hold

Limits:

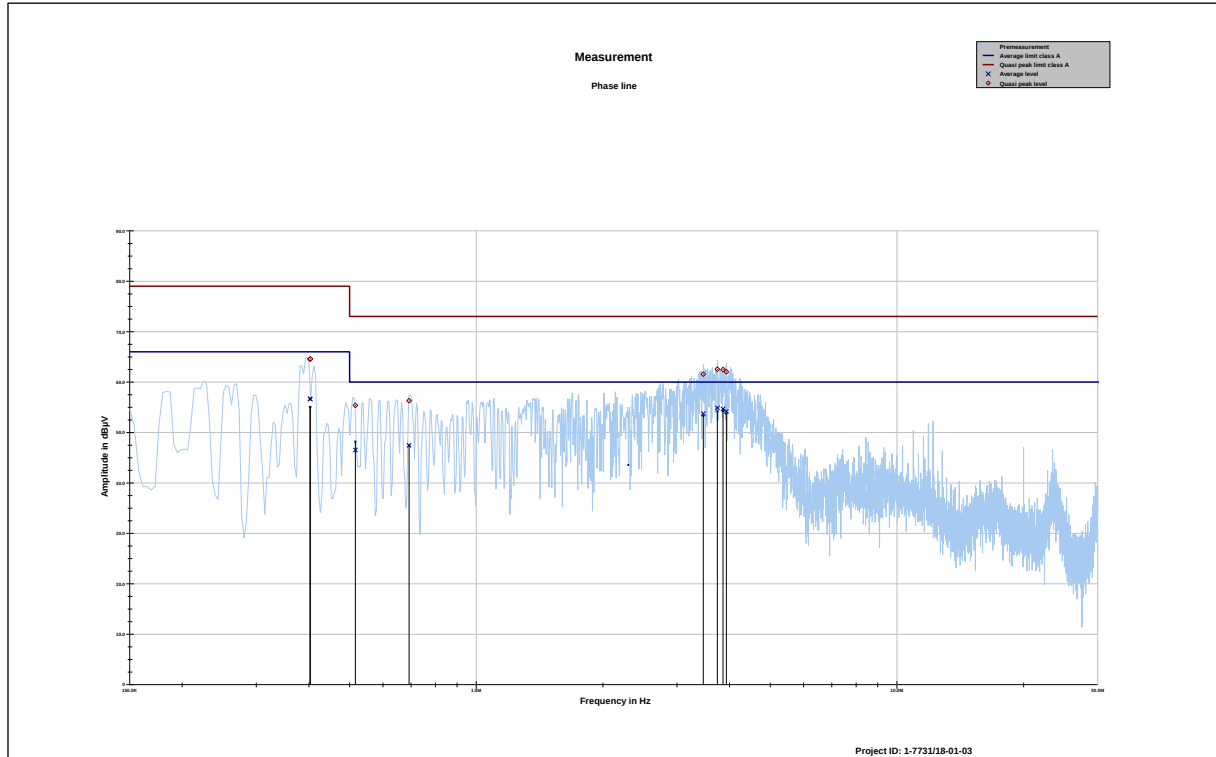
FCC		IC
CFR Part 15.207(a)		RSS-Gen 8.8
Conducted Spurious Emissions < 30 MHz		
Frequency (MHz)	Quasi-Peak (dBμV/m)	Average (dBμV/m)
0.15 – 0.5	79 to 69* (Class A) 66 to 56* (Class B)	79 to 69* (Class A) 56 to 46* (Class B)
0.5 – 5	73 (Class A) 56 (Class B)	63 (Class A) 46 (Class B)
5 – 30.0	73 (Class A) 60 (Class B)	63 (Class A) 50 (Class B)

*Decreases with the logarithm of the frequency

Measurement results:

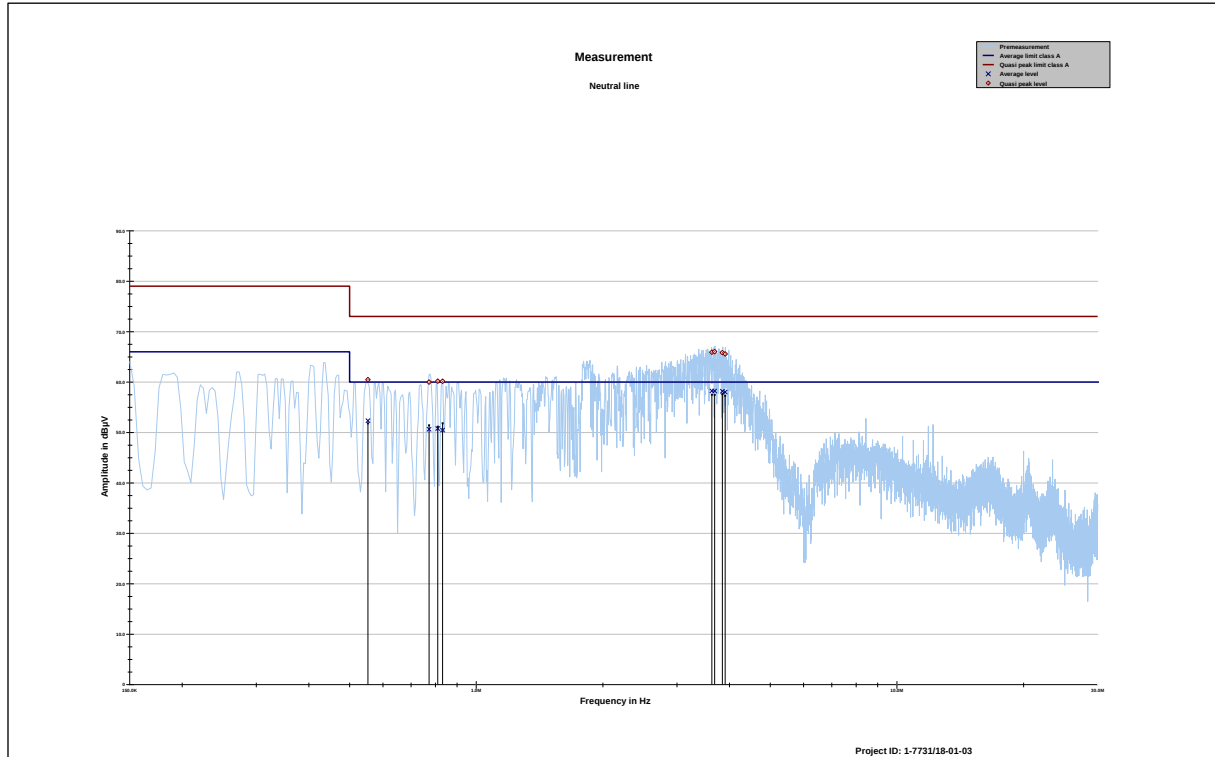
See plots below.

Plot No. 41: Phase line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.402605	64.53	14.47	79.000	56.67	9.33	66.000
0.403601	64.58	14.42	79.000	56.61	9.39	66.000
0.516057	55.37	17.63	73.000	46.51	13.49	60.000
0.692616	56.31	16.69	73.000	47.44	12.56	60.000
3.465969	61.57	11.43	73.000	53.73	6.27	60.000
3.742888	62.54	10.46	73.000	54.85	5.15	60.000
3.859945	62.46	10.54	73.000	54.65	5.35	60.000
3.932991	62.05	10.95	73.000	54.18	5.82	60.000

Plot No. 42: Neutral line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.552772	60.47	12.53	73.000	52.33	7.67	60.000
0.772710	60.00	13.00	73.000	50.64	9.36	60.000
0.810107	60.17	12.83	73.000	50.78	9.22	60.000
0.831664	60.16	12.84	73.000	50.47	9.53	60.000
3.632019	65.92	7.08	73.000	58.24	1.76	60.000
3.687394	66.03	6.97	73.000	58.22	1.78	60.000
3.846221	65.82	7.18	73.000	58.17	1.83	60.000
3.906179	65.56	7.44	73.000	58.02	1.98	60.000

10 Glossary

EUT	Equipment under test
DUT	Device 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
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
-/-	DRAFT	2019-02-11
	minor editorial changes	2019-02-18

12 Accreditation Certificate

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 The accreditation certificate shall only apply in connection with the notice of accreditation of 02.06.2017 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 43 pages. Registration number of the certificate: D-PL-12076-01-03 Frankfurt, 02.06.2017  Displ. Ing. (FH) Ralf Böker Head of Division See notes enclosed	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

Note: The current certificate annex is published on the website (link see below) of the Accreditation Body DAkKS or may be received by CTC advanced GmbH on request

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

END OF TEST REPORT