
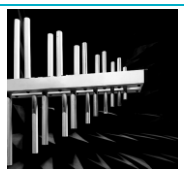
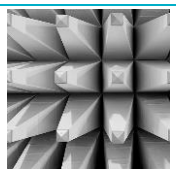

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-03

Test report no.: 1-0421/20-01-08

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: https://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 (2018-03) 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

FEIG ELECTRONIC GmbH
Lange Str. 4
35781 Weilburg/GERMANY
Phone: +49 6471 31 09-0
Contact: Reinhard Monno
e-mail: reinhard.monno@feig.de
Phone: +49 6471-3109.428

Manufacturer

FEIG ELECTRONIC GmbH
Lange Str. 4
35781 Weilburg/GERMANY

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 - 247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices

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

Test Item

Kind of test item:	**UHF RFID Reader**
Model name:	**LRU3000A/3500A**
FCC ID:	**PJMLRU3000A**
IC ID:	**6633A-LRU3000A**
Frequency:	DTS band 902 – 928 MHz
Technology tested:	RFID
Antenna:	Up to 4 external antennas
Power supply:	LRU3000: 24.0V DC by external power supply LRU3500: 48.0 V DC by POE
Temperature range:	-25°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:

cn=David Lang, o=CTC advanced GmbH, ou=LNG-161129, email=david.lang@ctcadvanced.com, c=DE
2020.12.22 13:26:00 +01'00'

David Lang
Lab Manager
Radio Communications

Test performed:

cn=Michael Dorongovski, o=CTC Advanced GmbH, ou=RCE-201118, email=Michael.Dorongovski@ctcadvanced.com, c=DE
2020.12.22 13:13:53 +01'00'

Michael Dorongovski
Lab Manager
Radio Communications

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.
The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CTC advanced GmbH.
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In no case this test report can be considered as a Letter of Approval.

2.2 Application details

Date of receipt of order:	2020-06-19
Date of receipt of test item:	2020-06-22
Start of test:	2020-07-13
End of test:	2020-12-21
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

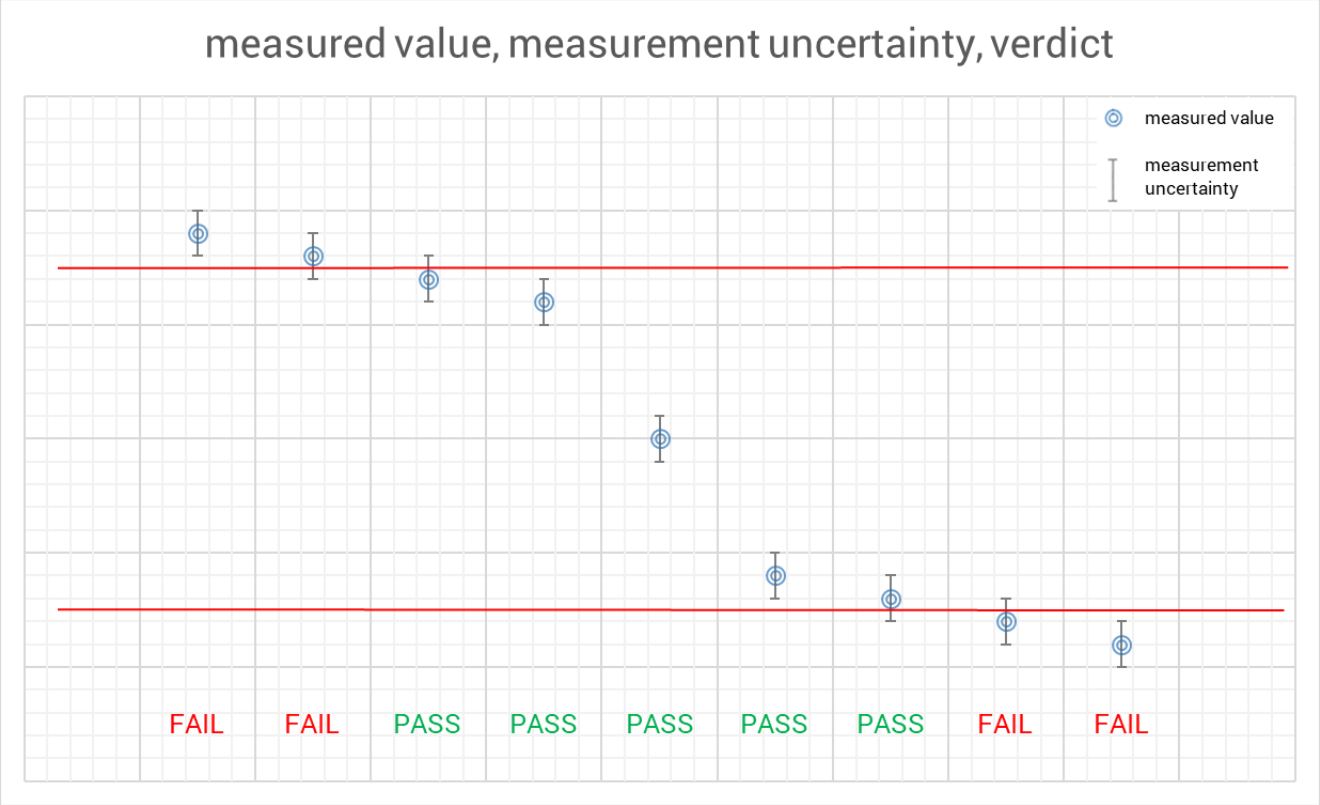
3 Test standard/s

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 - 247 Issue 2	February 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices
RSS - Gen Issue 5 incl. Amendment 1	March 2019	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 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, see chapter 9 but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



5 Test environment

Temperature:	T_{nom}	+23 °C during room temperature tests
	T_{max}	No tests under extreme environmental conditions required.
	T_{min}	No tests under extreme environmental conditions required.
Relative humidity:		45 %
Air pressure:		not relevant for this kind of testing
Power supply:	V_{nom}	24.0 V DC by external power supply
	V_{max}	No tests under extreme environmental conditions required.
	V_{min}	No tests under extreme environmental conditions required.

6 Test item

6.1 General description

Kind of test item	:	UHF RFID Reader
Type identification	:	LRU3000A/3500A
HMN	:	n/a
PMN	:	ID ISC.LRU3000-FCC ID ISC.LRU3500-FCC
HVIN	:	FE784
FVIN	:	n/a
S/N serial number	:	7243410
Hardware status	:	FE784
Software status	:	-/-
Firmware status	:	-/-
Frequency band	:	DTS band 902 – 928 MHz
Type of radio transmission Use of frequency spectrum	: :	FHSS
Type of modulation	:	PR-ASK
Number of channels	:	50
Antenna	:	Up to 4 external antennas
Power supply	:	LRU3000A: 24.0 V DC by external power supply LRU3500A: 48.0 V DC by POE
Temperature range	:	-25°C to +55°C

6.2 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: 1-0421/20-01-01_AnnexA
1-0421/20-01-01_AnnexB
1-0421/20-01-01_AnnexD

7 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and 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).

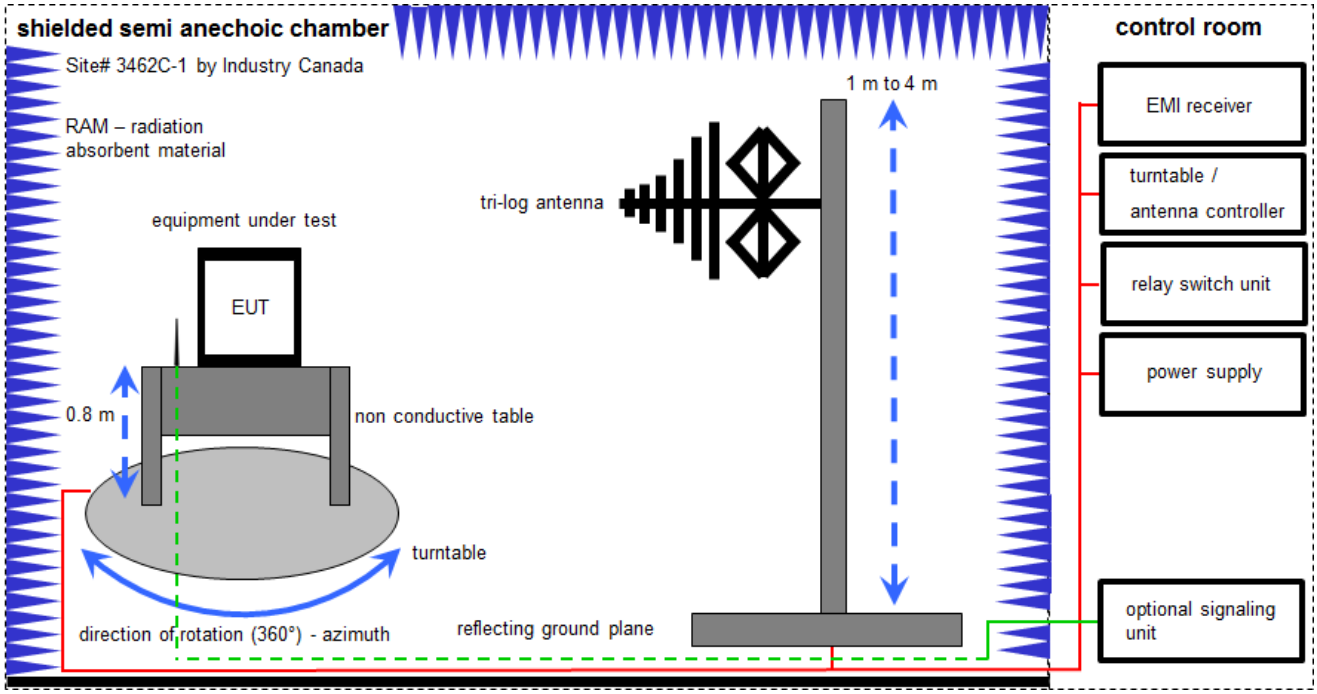
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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

7.1 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; EMC32 software version: 10.30.0

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)

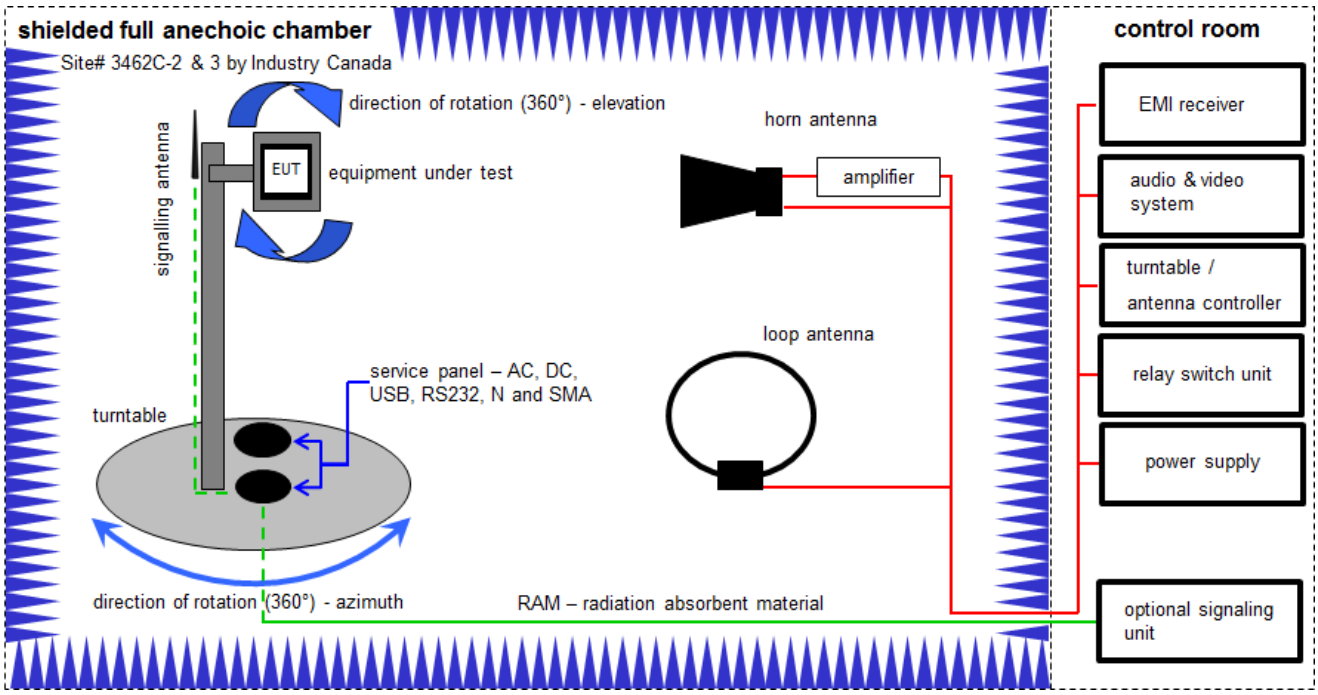
Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	EMI Test Receiver	ESR 3	R&S	102587	300005771	k	21.05.2019 10.12.2020	20.11.2020 09.06.2022
2	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	Ve	17.01.2020	16.01.2022
3	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
4	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
5	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
6	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	19.02.2019	18.02.2021

7	A	Spectrum-Analyzer	FSU26	R&S	200809	300003874	k	16.12.2019 09.12.2020	15.12.2020 08.12.2021
8	A	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
9	A	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
10	A	Meßkabine 1	HF-Absorberhalle	MWB AG 300023	-/-	300000551	ne	-/-	-/-

NOTE: The tests were performed when all equipment was calibrated.

7.2 Shielded fully anechoic chamber



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

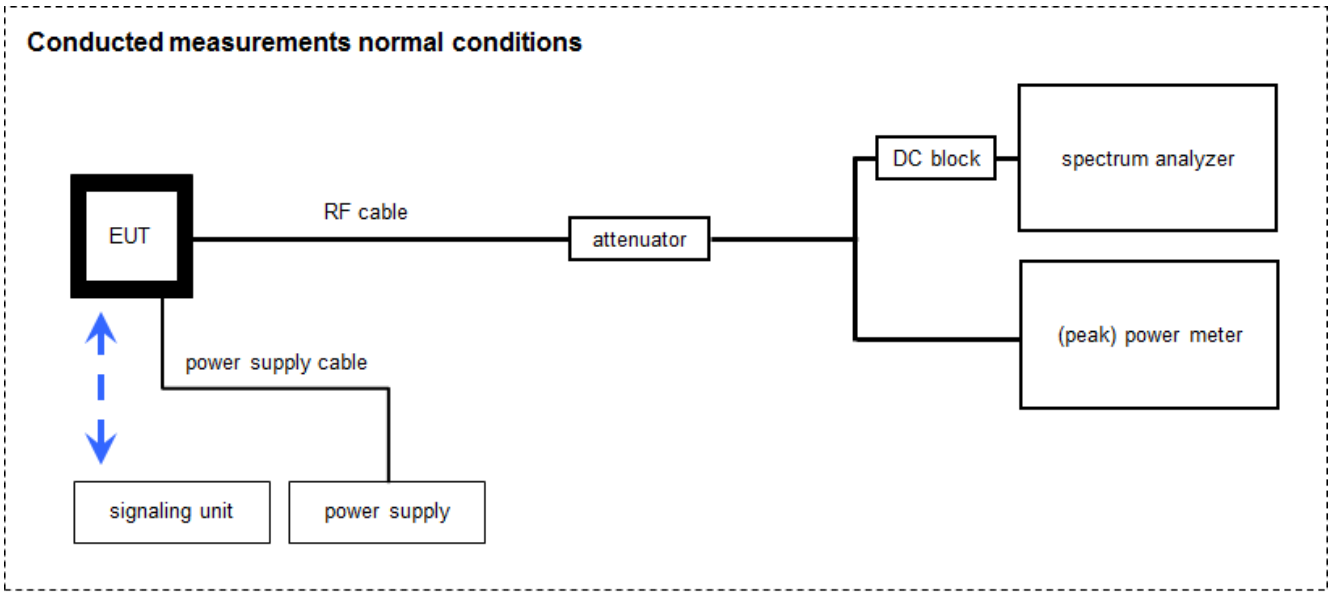
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A, B	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vIKI!	12.12.2017 09.12.2020	11.12.2020 08.12.2021
2	A	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	13.06.2019	12.06.2021
3	A, B	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
4	B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	27.02.2019	26.02.2021
5	A, B	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
6	A, B	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	11.12.2019 11.12.2020	10.12.2020 10.12.2021
7	B	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
8	B	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
9	B	High Pass Filter	VHF-3500+	Mini Circuits	-/-	400000193	ne	-/-	-/-
10	B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
11	A, B	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-

7.3 Conducted measurements with peak power meter & spectrum analyzer



WLAN tester version: 1.1.13; LabView2015

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	PC	ExOne	F+W		300004703	ne	-/-	-/-
2	B	EMI Test Receiver 9 kHz - 3 GHz incl. Preselector	ESPI3	R&S	101713	300004059	k	09.12.2019 10.12.2020	08.12.2020 09.12.2021
3	A	Spectrumanalyzer	FSV30	R&S	100763	300003950	k	15.01.2020	14.01.2021
4	C	Spectrum Analyzer	FSV30	Rohde & Schwarz	103809	300005359	vlKI!	08.12.2020	07.12.2021
5	A, B, C	DC Power Supply 0 – 32V	1108-32	Heiden Elektronik	001702	300001392	vlKI!	17.12.2019	16.12.2022

8 Sequence of testing

8.1 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.

8.2 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.

8.3 Sequence of testing radiated spurious 1 GHz to 12.75 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.

9 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Antenna gain	± 3 dB
Carrier frequency separation	± 21.5 kHz
Number of hopping channels	-/-
Spectrum bandwidth	± 21.5 kHz absolute; ± 15.0 kHz relative
Maximum output power	± 1 dB
Detailed conducted spurious emissions @ the band edge	± 1 dB
Band edge compliance radiated	± 3 dB
Spurious emissions conducted	± 3 dB
Spurious emissions radiated below 30 MHz	± 3 dB
Spurious emissions radiated 30 MHz to 1 GHz	± 3 dB
Spurious emissions radiated 1 GHz to 12.75 GHz	± 3.7 dB
Spurious emissions radiated above 12.75 GHz	± 4.5 dB

10 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	CFR Part 15 RSS - 247, Issue 2	See table below	2020-12-22	Tests according to customer demand

Test specification clause	Test case	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (d)	Antenna gain	Nominal	Nominal	-/-	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (b)	Carrier frequency separation	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (d)	Number of hopping channels	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(a)(1) (iii) RSS - 247 / 5.1 (d)	Time of occupancy (dwell time)	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (a)	Spectrum bandwidth of a FHSS system bandwidth	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(b)(1) RSS - 247 / 5.4 (b)	Maximum output power	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Detailed spurious emissions @ the band edge - conducted	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance radiated	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Spurious emissions conducted	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.209(a) RSS - Gen	Spurious emissions radiated below 30 MHz	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated 30 MHz to 1 GHz	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated above 1 GHz	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-

§15.107(a) §15.207	Conducted emissions below 30 MHz (AC conducted)	Nominal	Nominal	-/-	☐	☐	☒	☐	-/-

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

11 RF measurements

11.1 Additional comments

Reference documents: None

Special test descriptions: The EUT has 4 antenna ports. These ports can be used single or in a time division multiplexed mode where only one port is active in a time slot. All ports are equal in the RF performance (see Chapter 12.5). All measurements were performed in single port mode on Port 1.

Configuration descriptions: The EUT is designed to be used in combination with different antennas. All conducted measurements were performed with the highest output power supported by the EUT (1.0 Watt = 30 dBm, conducted output power limit).
The maximum antenna gain of the used antennas is 6.0 dBi when used together with the applicable cable length which is ensured by the professional installation of the devices.
The radiated tests were performed with the -Feig ID ANT.U600/270-FCC antenna which has the highest gain.
All tests were performed on the LRU3000A with 24 V DC power supply.

Antenna configuration: - Allowed antenna configurations for the EUT are:

Antenna Type	Permitted Cable Attenuation
ID ISC.ANT.U600/270-FCC (10.5 dBic)	Min. 5,0 m of cable type Belden H155 (0,3 dB/m) or min. 3,0 m of cable type RG58 (0,5 dB/m)
ID ISC.ANT.U270/270-FCC (9.0 dBic)	No requirements.
ID ANT.U580/290-FCC (11.0 dBic)	min. 6,0 m of cable type Belden H155 (0,3 dB/m)
ID ANT.U290/290-FCC (9.0 dBic)	min. 2,0 m of cable type Belden H155 (0,3 dB/m)
IS ISC.ANT.U170/170 (4.0 dBic)	No requirements.

Test mode: ☒ Special software was used. (ISOStart)
EUT is transmitting pseudo random data by itself

12 Measurement results

12.1 Carrier Frequency Separation

Description:

Measurement of the carrier frequency separation of a hopping system. We use PR-ASK-modulation to show compliance. EUT in hopping mode.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	10 kHz
Video bandwidth	3 MHz
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 7.3 B
Measurement uncertainty	See sub clause 9

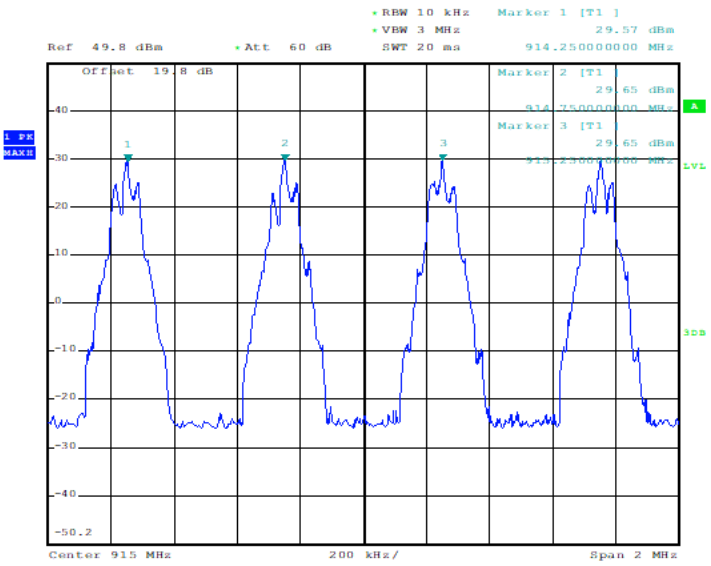
Limits:

FCC	IC
Carrier frequency separation	
Minimum 25 kHz or two-thirds of the 20 dB bandwidth of the hopping system whichever is greater. The two-thirds of the 20 dB bandwidth for IC is only valid for the ISM band 2400 – 2483.5 MHz.	

Result: The channel separation is 500 kHz.

Plots:

Plot 1: Frequency separation



12.2 Number of Hopping Channels

Description:

Measurement of the total number of used hopping channels. The number of hopping channels is constant for all modulation-modes. We use PR-ASK -modulation to show compliance. EUT in hopping mode.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	See plots
Video bandwidth	See plots
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 7.3 B
Measurement uncertainty	See sub clause 9

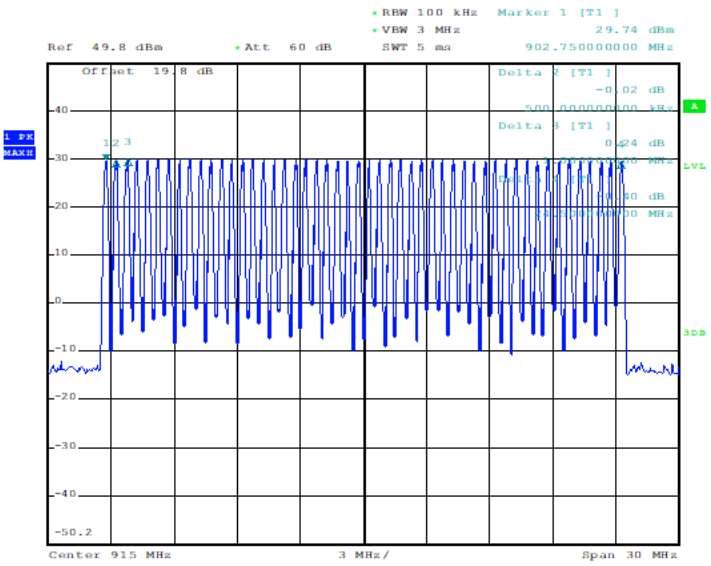
Limits:

FCC	IC
Number of hopping channels	
At least 25 non overlapping hopping channels. If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels.	

Result: The EUT uses 50 channels.

Plots:

Plot 1: Number of channels



12.3 Average Time of Occupancy (dwell time)

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	See plots
Video bandwidth	See plots
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 7.3 B
Measurement uncertainty	See sub clause 9

Limits:

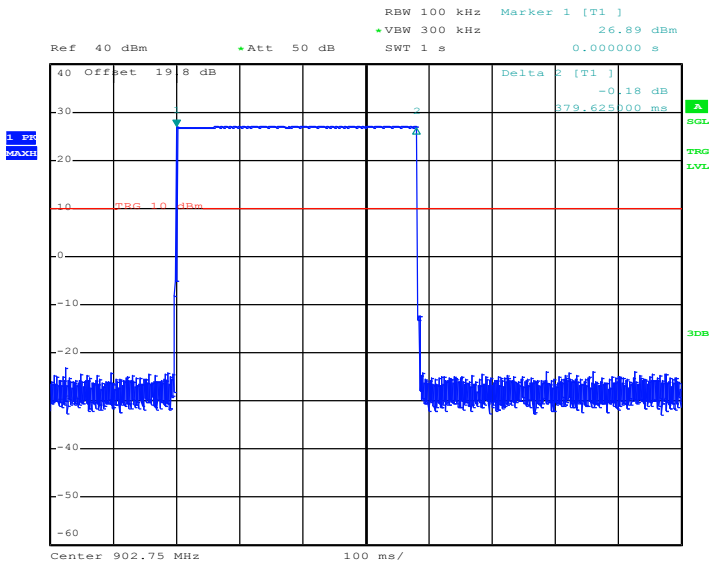
FCC	IC
Average time of occupancy	
For frequency hopping systems operating in the 902-928 MHz band: If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 10 second period.	

Result: The time slot length is = 380.0 ms
Number of hops / channel @ 20s = 1

Within 20 s period, the average time of occupancy in 20 s: 380.0 ms

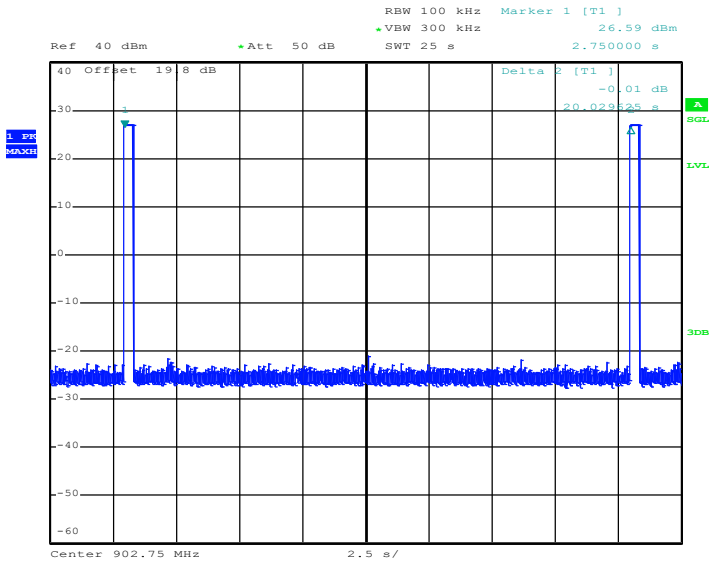
Plots:

Plot 1: Time slot length = 379.6 ms



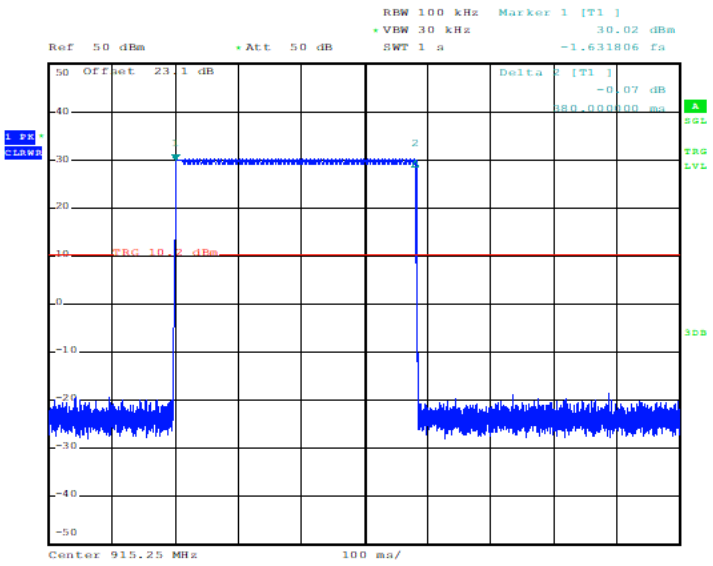
Date: 4.JAN.2003 02:32:38

Plot 2: hops / channel @ 20s = 1

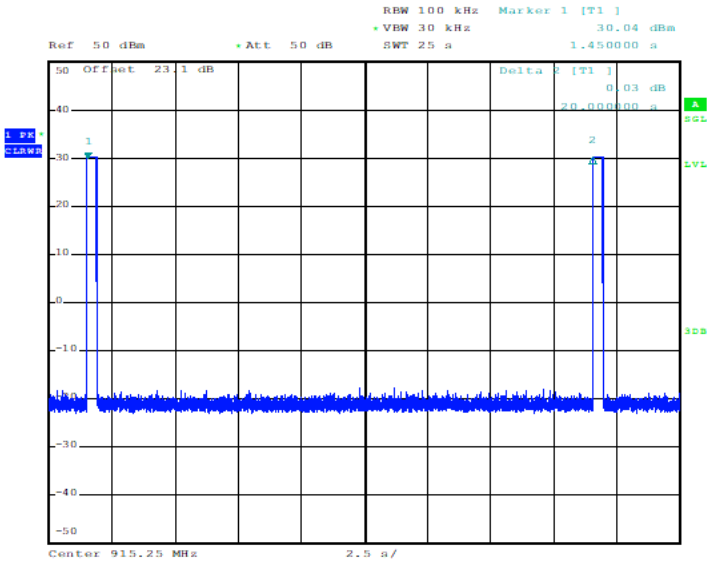


Date: 4.JAN.2003 02:40:07

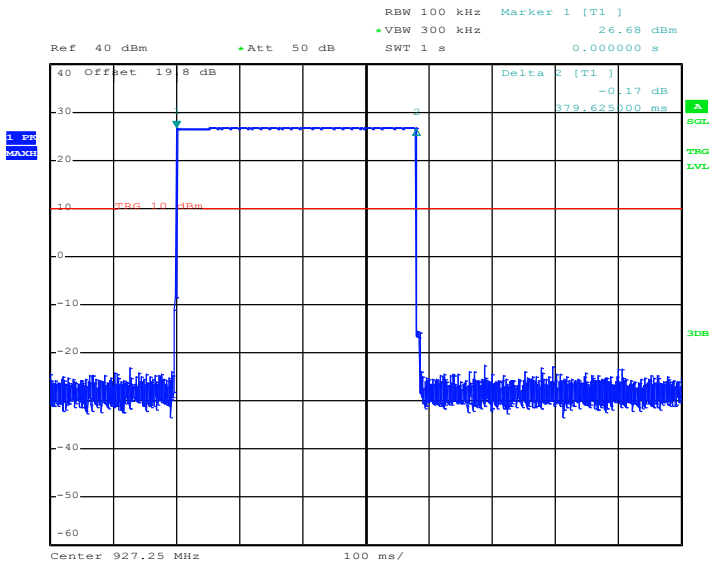
Plot 3: Time slot length = 380.0 ms



Plot 4: hops / channel @ 20s = 1

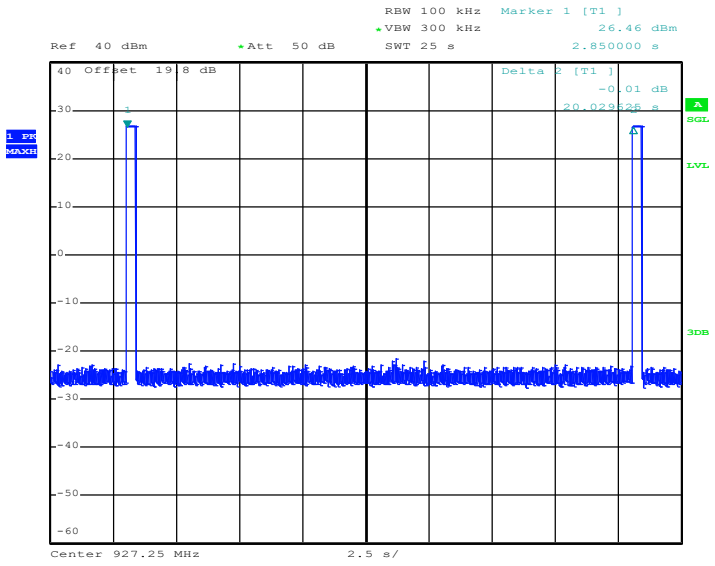


Plot 5: Time slot length = 379.6 ms



Date: 4.JAN.2003 02:33:53

Plot 6: hops / channel @ 20s = 1



Date: 4.JAN.2003 02:38:18

12.4 Spectrum bandwidth of a FHSS system

Description:

Measurement of the 20dB bandwidth and 99% bandwidth of the modulated signal. The measurement is performed according to the "Measurement Guidelines" (DA 00-705, March 30, 2000). EUT in single channel mode.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	5 kHz
Video bandwidth	30 kHz
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 7.3 B
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
Spectrum bandwidth of a FHSS system	
The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.	

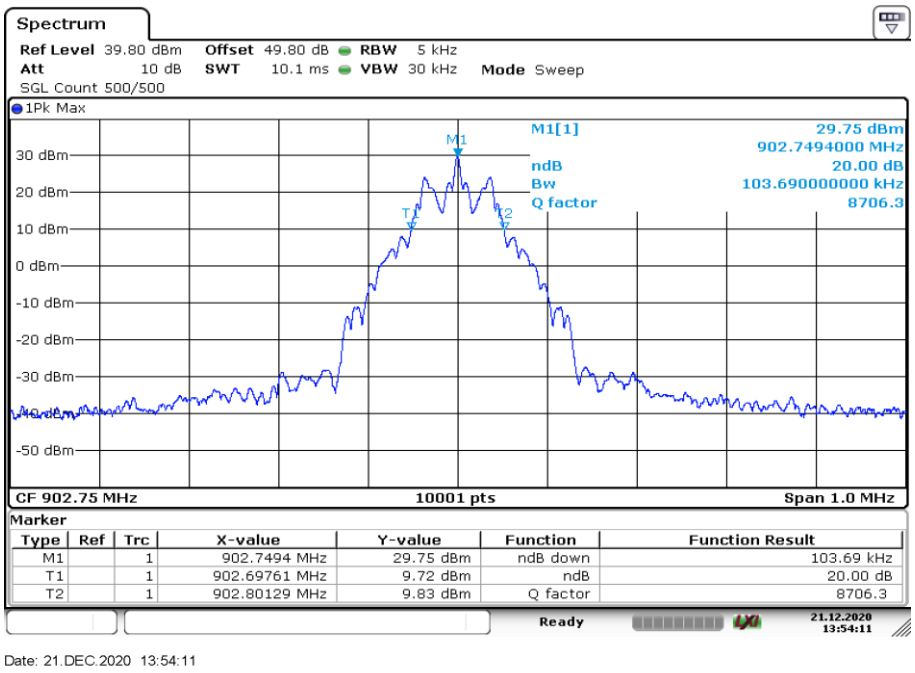
Result:

Test Conditions		20dB BANDWIDTH [kHz]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	103.7	104.0	103.8

Test Conditions		99% BANDWIDTH [kHz]		
		Low channel	Middle channel	High channel
T_{nom}	V_{nom}	121.6	122.3	122.2

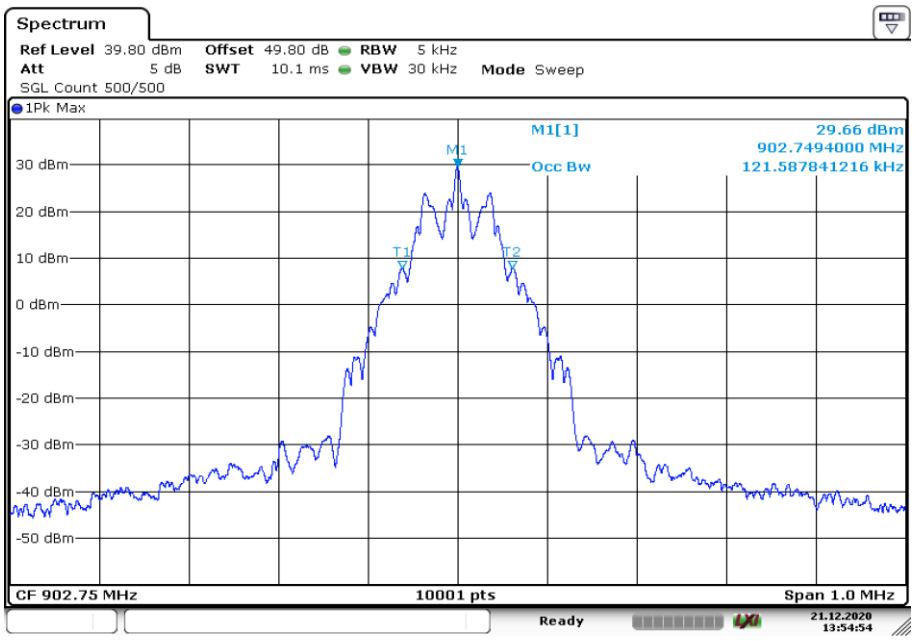
Plots:

Plot 1: Low Channel 20 dB-Bandwidth



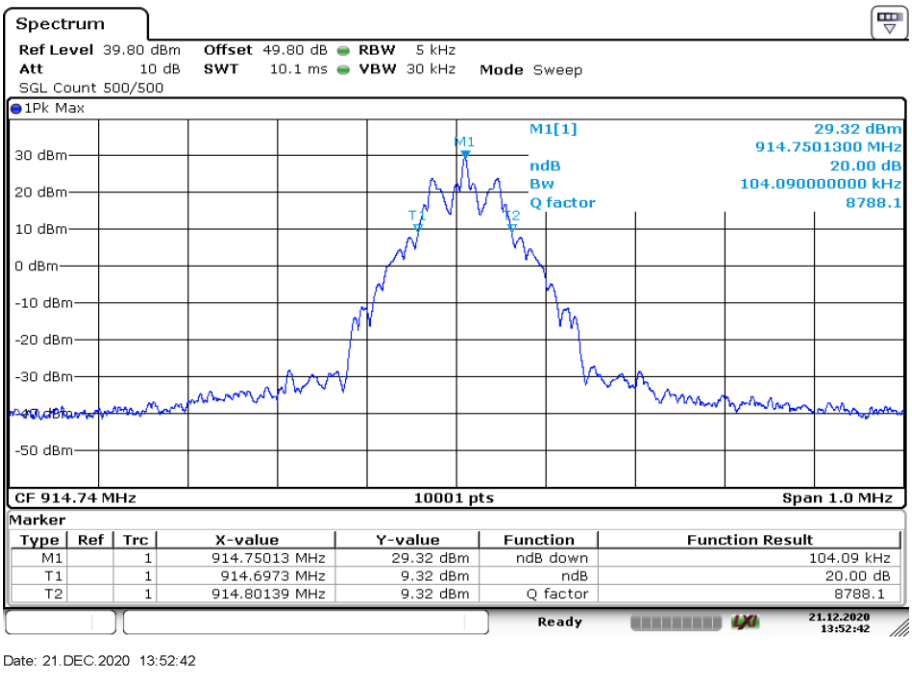
Date: 21.DEC.2020 13:54:11

Plot 2: Low Channel OBW 99



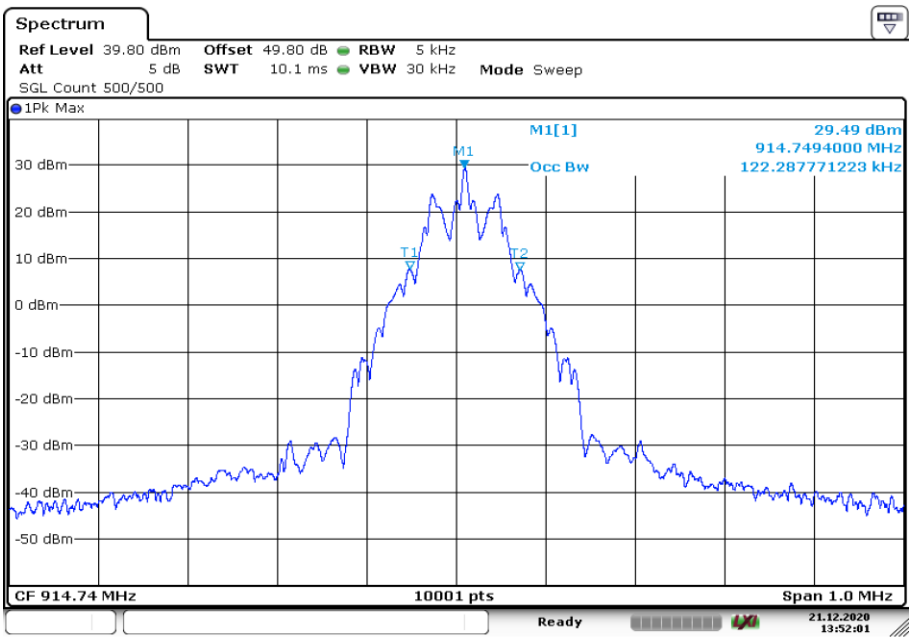
Date: 21.DEC.2020 13:54:54

Plot 3: Mid Channel 20 dB-Bandwidth



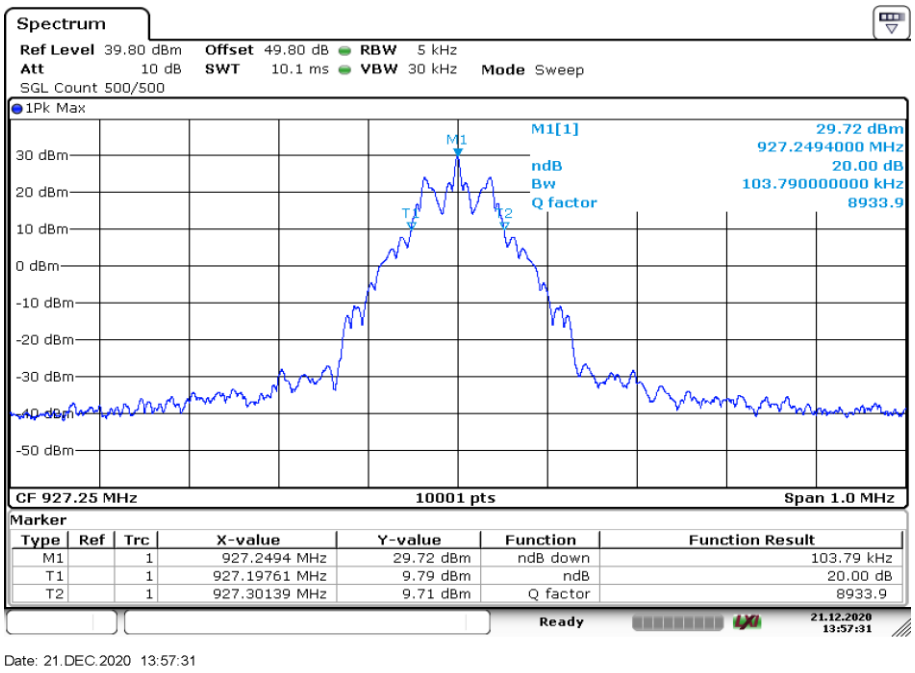
Date: 21.DEC.2020 13:52:42

Plot 4: Mid Channel OBW 99



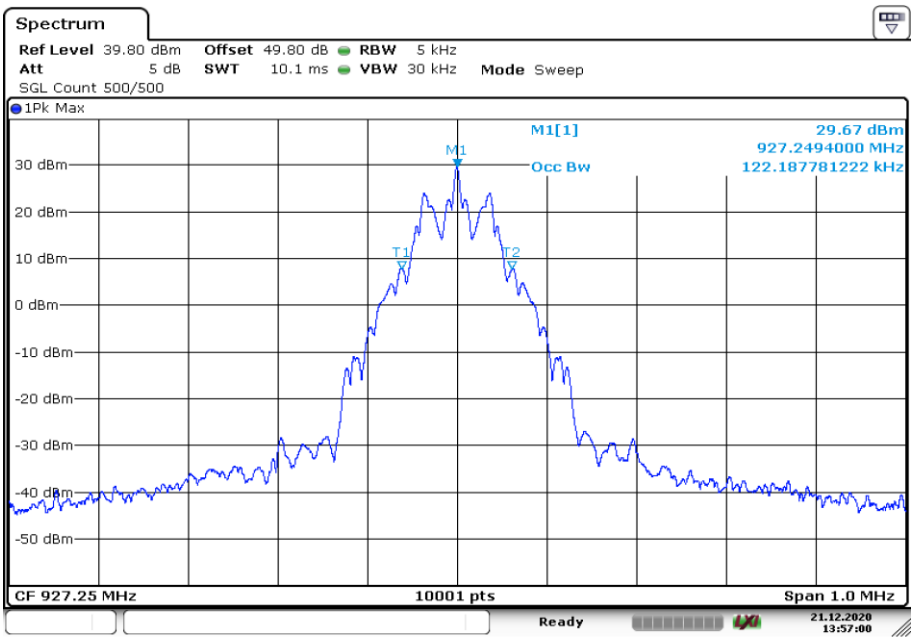
Date: 21.DEC.2020 13:52:02

Plot 5: High Channel 20 dB-Bandwidth



Date: 21.DEC.2020 13:57:31

Plot 6: High Channel OBW 99



Date: 21.DEC.2020 13:57:00

12.5 Maximum Peak Output Power

Measurement:

Measurement parameter	
Parameter	See plots
Used equipment:	See chapter 7.3 C
Measurement uncertainty:	See chapter 9

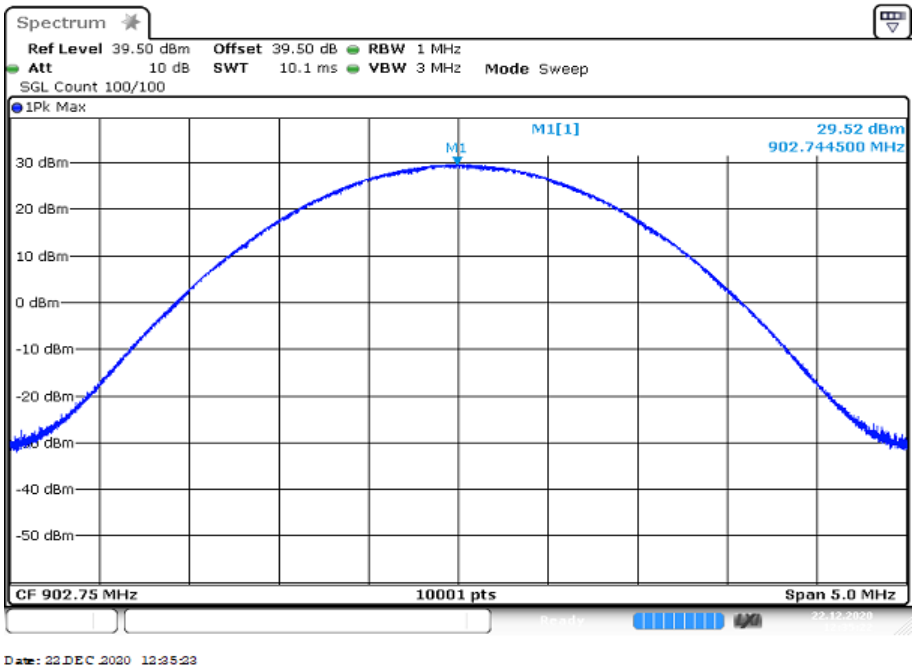
Limits:

FCC	IC
Maximum Output Power Conducted	
For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.	

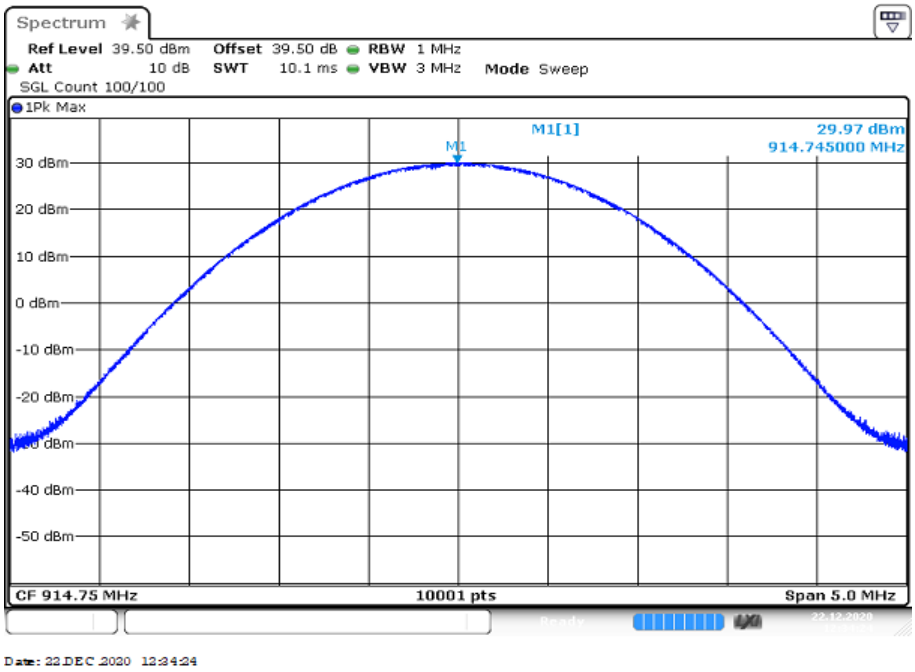
Result:

	Maximum Peak Output Power Conducted [dBm]		
	Low channel	Middle channel	High channel
Port 1	29.52	29.97	29.64
Port 2	29.43	29.86	29.63
Port 3	29.59	29.93	29.64
Port 4	29.99	29.78	29.52

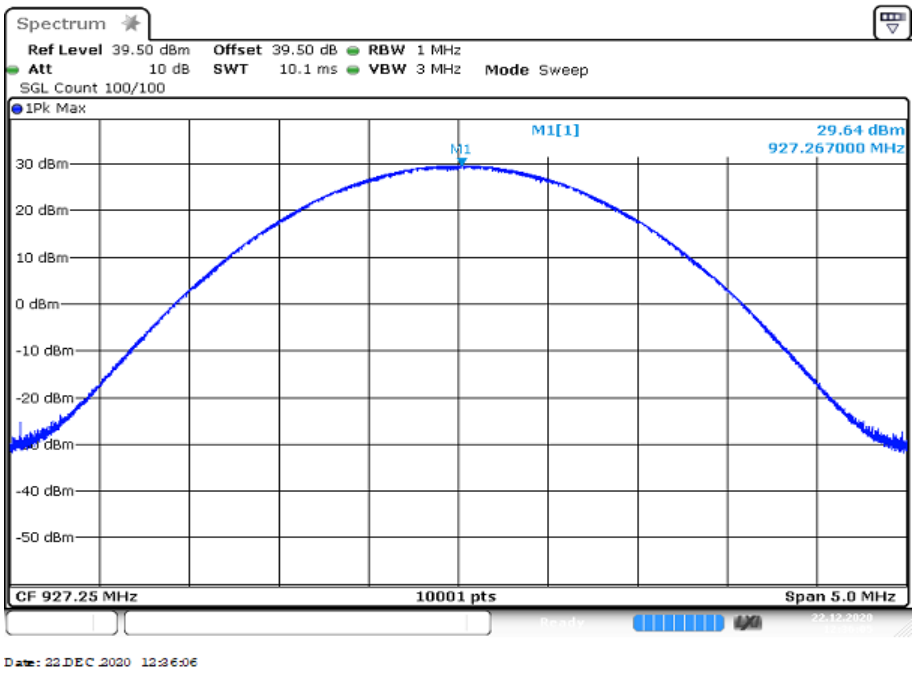
Plot 1: Lowest channel, Port 1



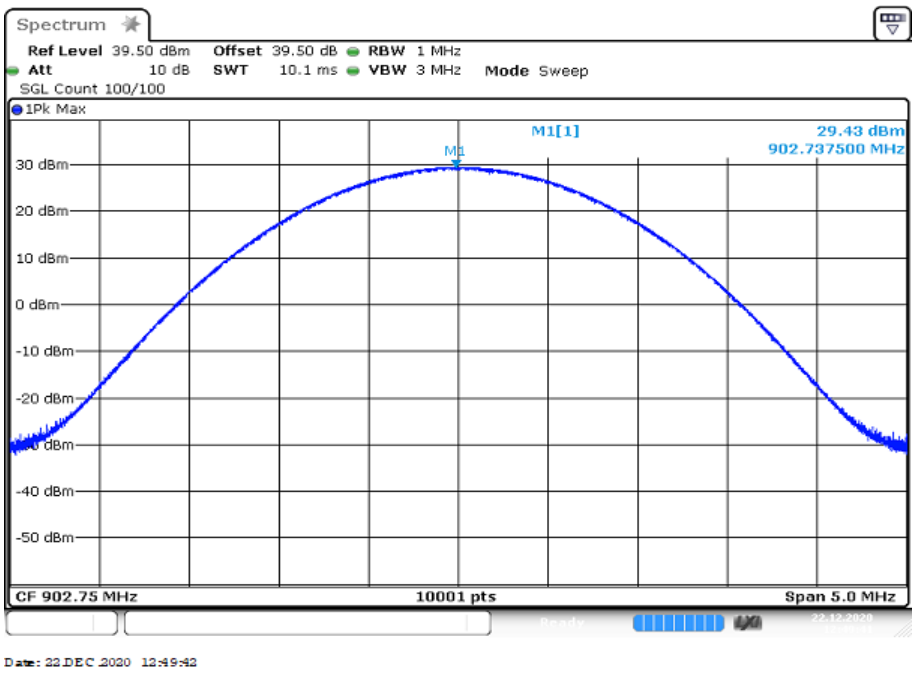
Plot 2: Middle channel, Port 1



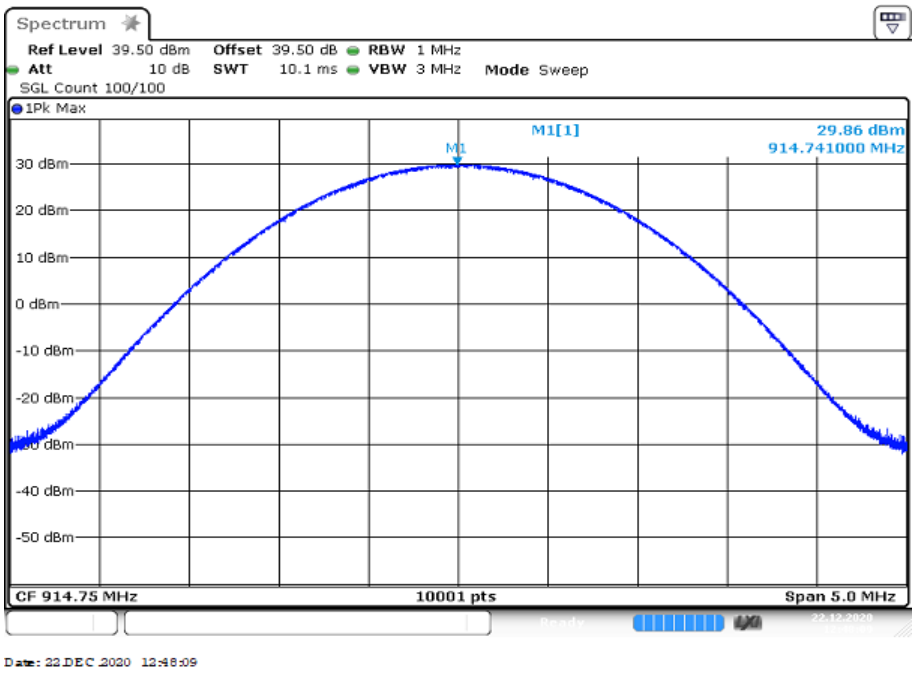
Plot 3: Highest channel, Port 1



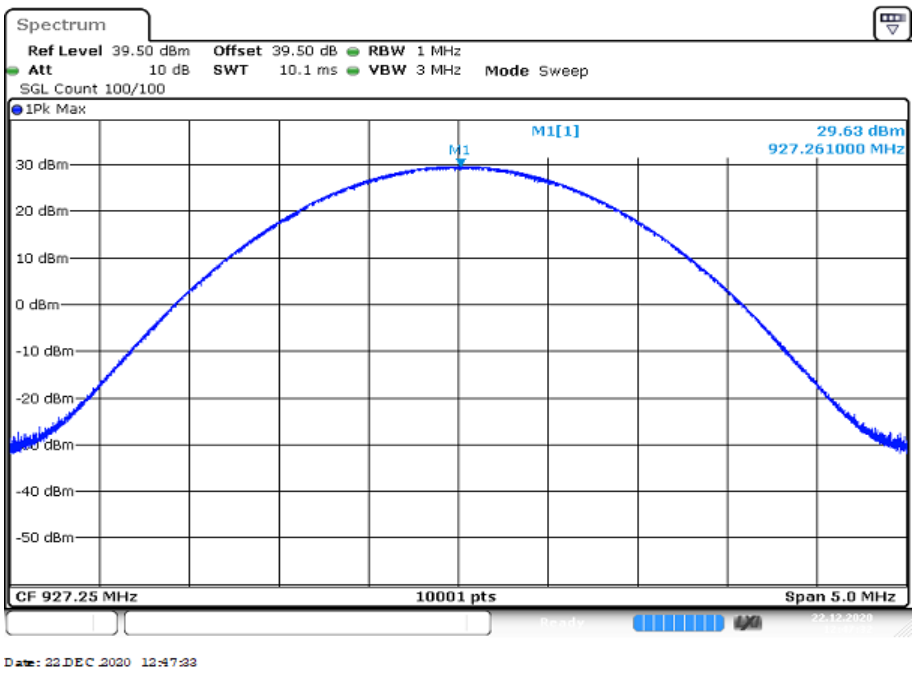
Plot 4: Lowest channel, Port 2



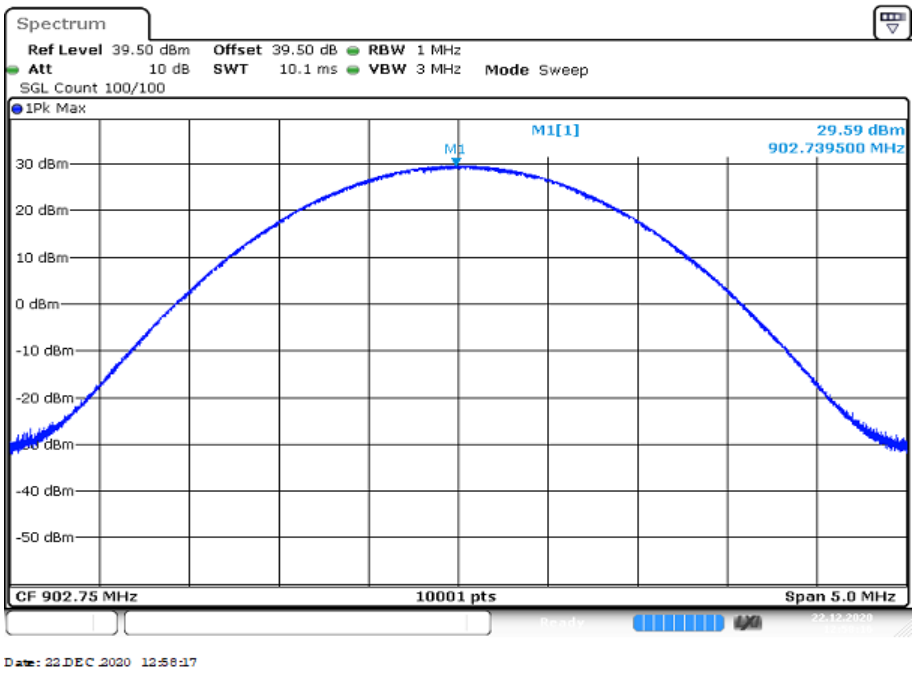
Plot 5: Middle channel, Port 2



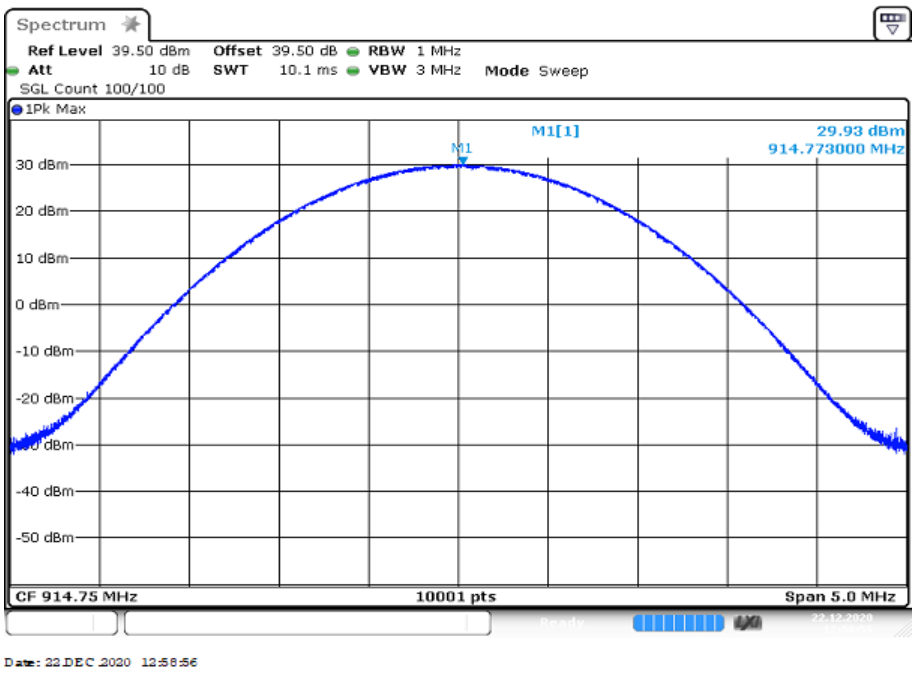
Plot 6: Highest channel, Port 2



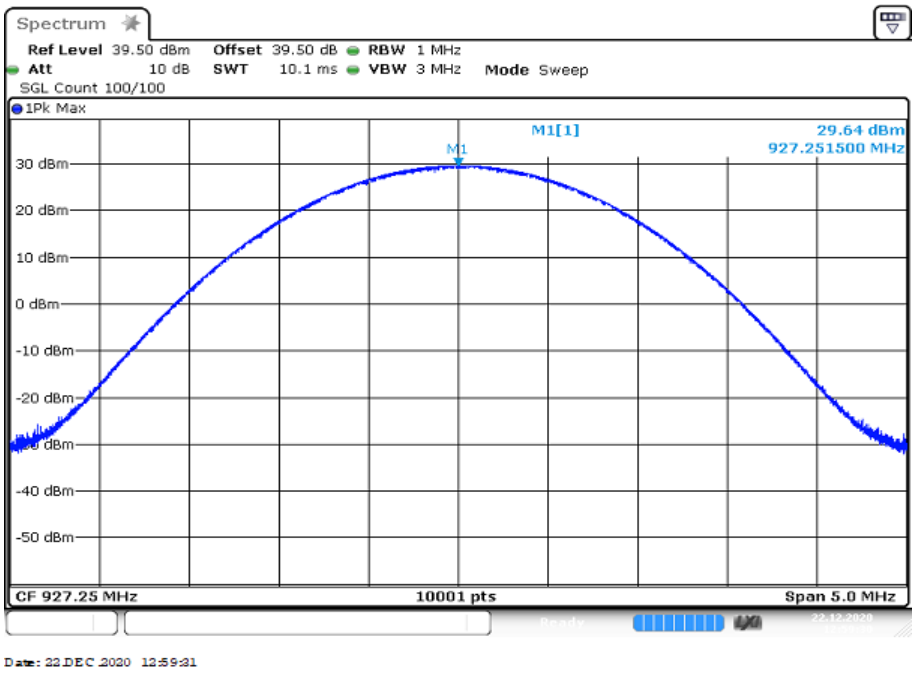
Plot 7: Lowest channel, Port 3



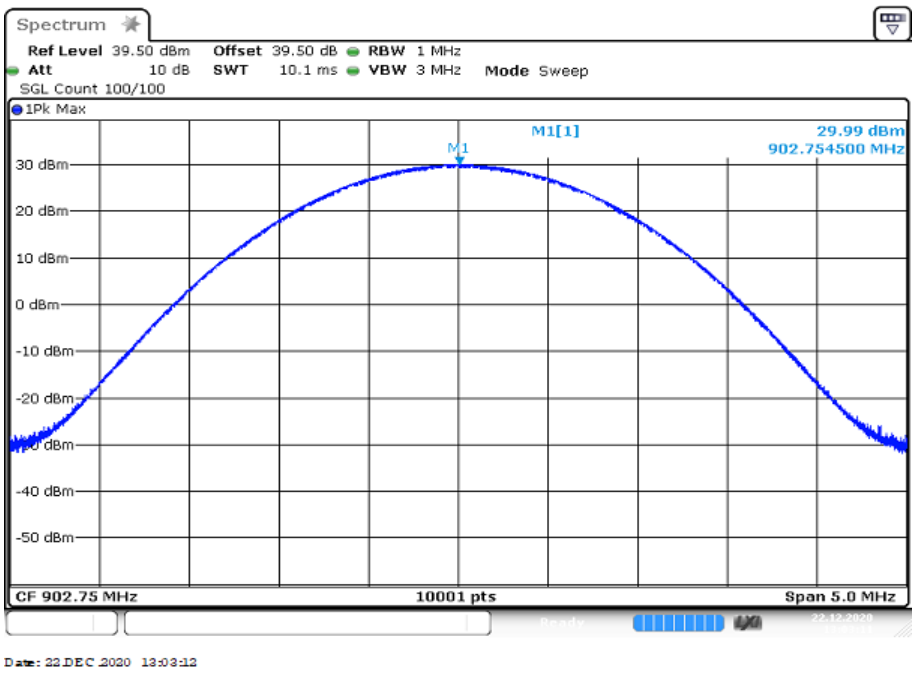
Plot 8: Middle channel, Port 3



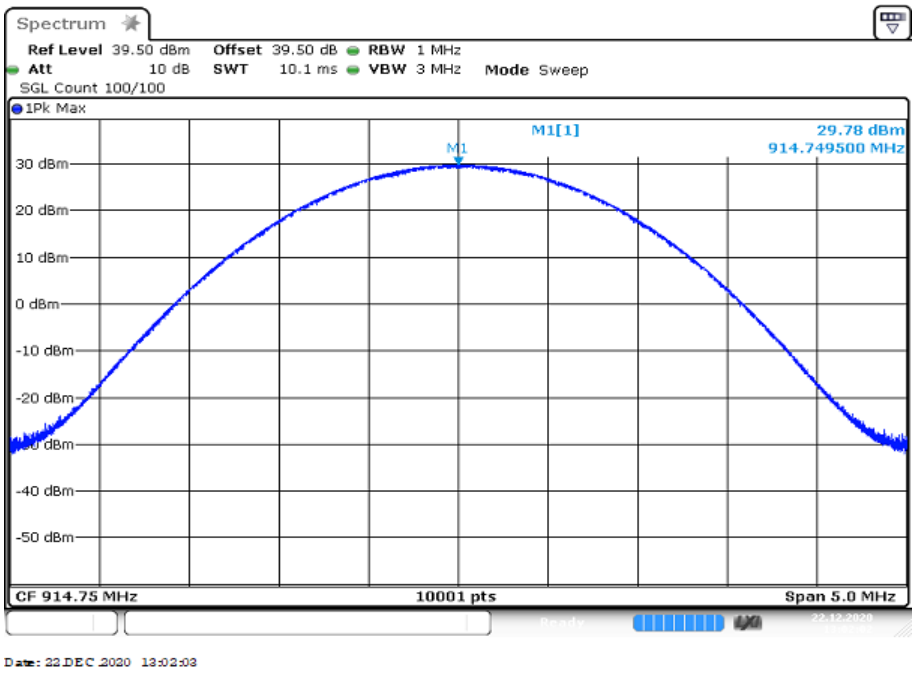
Plot 9: Highest channel, Port 3



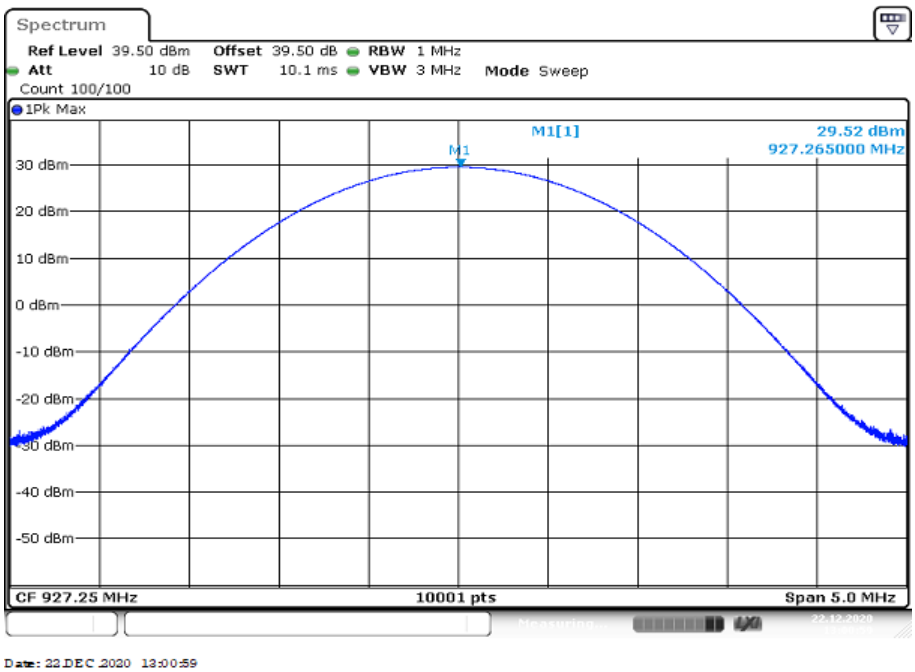
Plot 10: Lowest channel, Port 4



Plot 11: Middle channel, Port 4



Plot 12: Highest channel, Port 4



12.6 Detailed spurious emissions @ the band edge – conducted and radiated

Description:

Measurement of the conducted band edge compliance. EUT is measured at the lower and upper band edge in single channel and hopping mode.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz / 500 kHz
Span	Lower Band Edge: 902 MHz Upper Band Edge: 928 MHz
Trace mode	Max hold
Test setup	See sub clause 7.3 B
Measurement uncertainty	See sub clause 9

Limits:

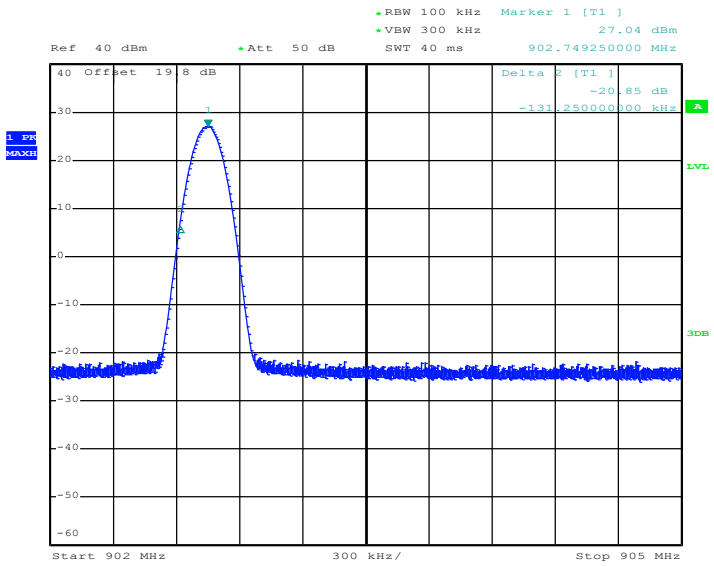
FCC	IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.	

Results conducted:

Scenario	Spurious band edge conducted [dB]	
Modulation	lowest channel	highest channel
Lower band edge – hopping on	> 20 dB	> 20 dB
Upper band edge – hopping on	> 20 dB	> 20 dB

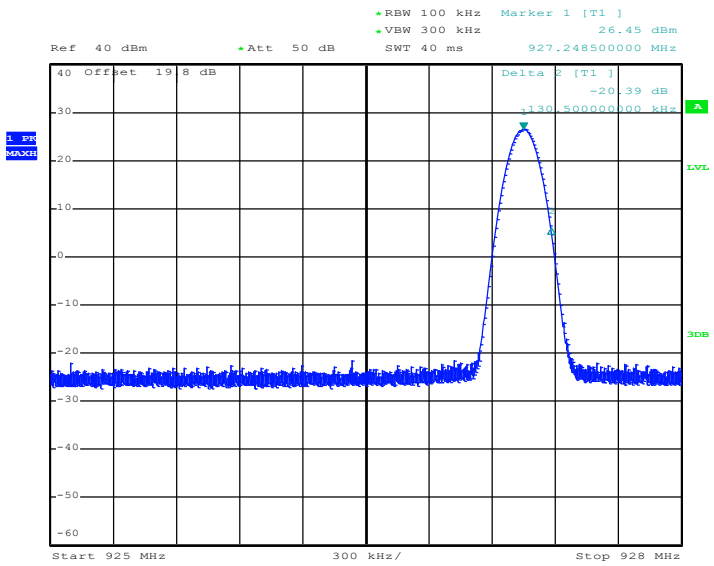
Plots:

Plot 1: 20 dB – hopping off low channel



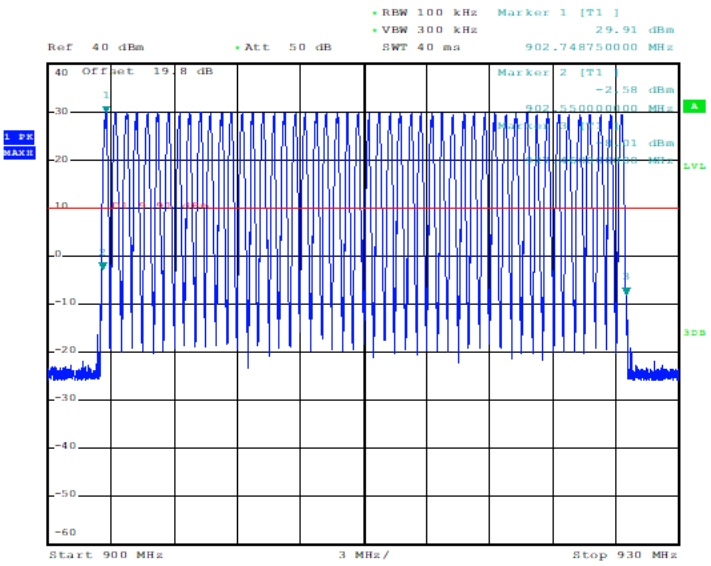
Date: 4.JAN.2003 02:20:35

Plot 2: 20 dB – hopping off high channel



Date: 4.JAN.2003 02:07:31

Plot 3: 20 dB – hopping on



Left marker frequency: 902.55 MHz
Right marker frequency: ´927.47 MHz
As even 30 dBc requirement is fulfilled, the 20 dBc requirement is also fulfilled.

Results radiated:

No restricted band in the range ± 2 channel bandwidths of the Band-edges of the specified emission band! (608 MHz – 614 MHz and 960 MHz – 1240 MHz).

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

12.7 Spurious Emissions Conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode. The measurement is repeated for low, mid and high channel.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	F < 1 GHz: 1 MHz F > 1 GHz: 1 MHz
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 100 kHz
Span:	9 kHz to 12.75 GHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 7.3 A
Measurement uncertainty:	See chapter 9

Limits:

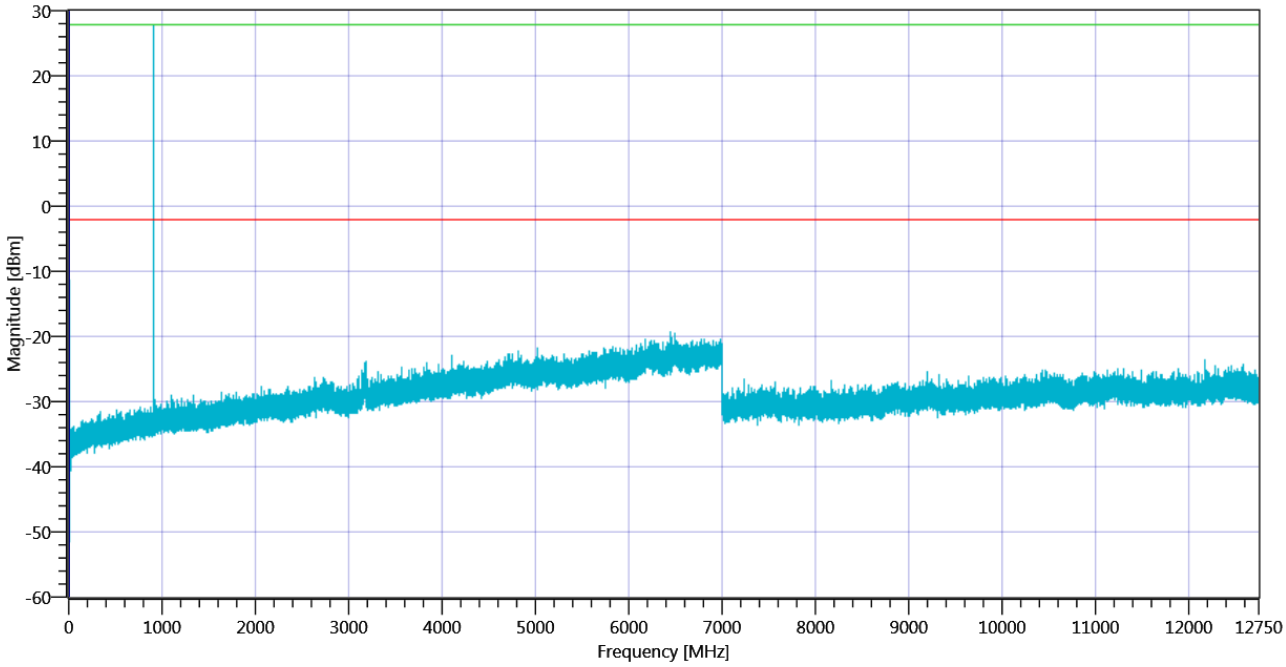
FCC	IC
TX spurious emissions conducted	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required	

Result:

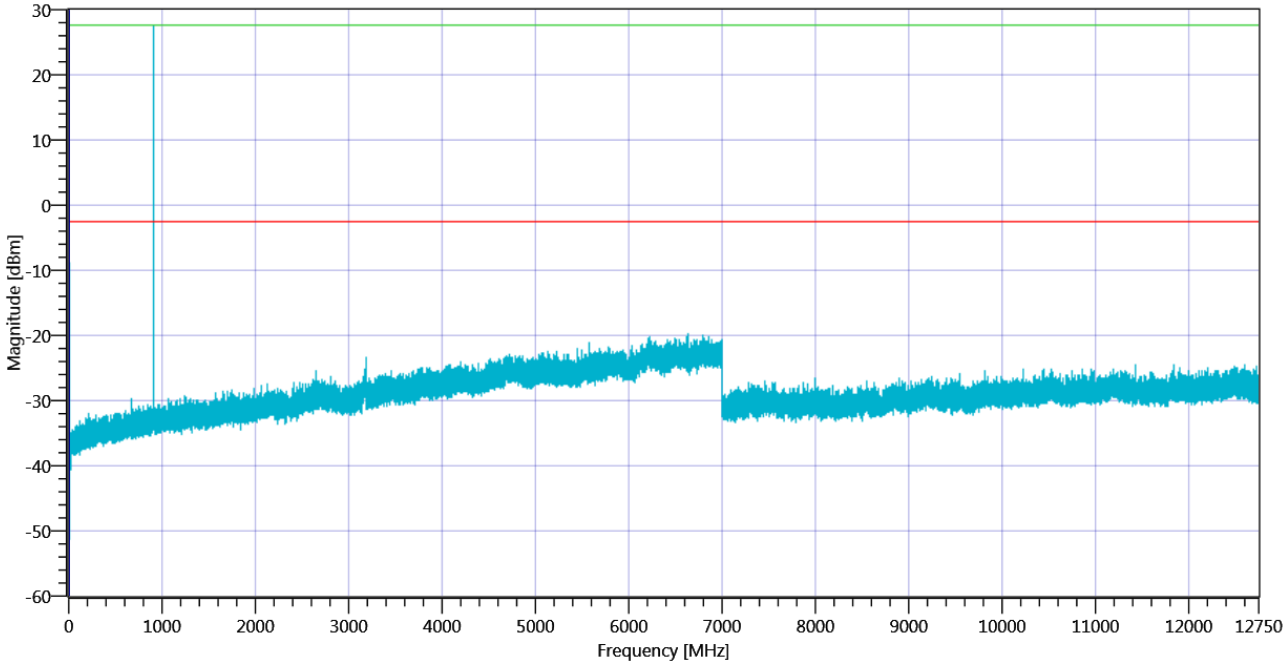
Emission Limitation					
Frequency [MHz]		Amplitude of emission [dBm]	Limit max. allowed emission power	actual attenuation below frequency of operation [dB]	Results
902.75		27.8	30 dBm		Operating frequency
No emissions detected.			-20 dBc		
914.75		27.5	30 dBm		Operating frequency
No emissions detected.			-20 dBc		
927.25		27.1	30 dBm		Operating frequency
No emissions detected.			-20 dBc		

Plots:

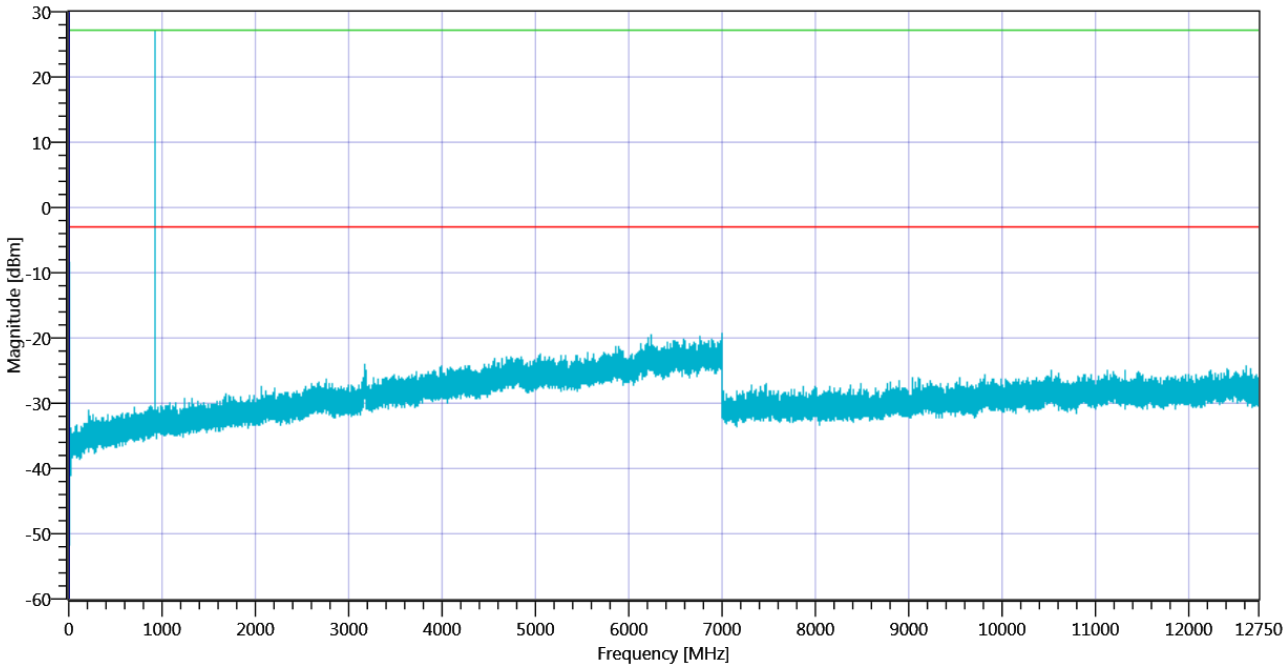
Plot 1: Low channel, 9 kHz – 12.75 GHz



Plot 2: Middle channel, 9 kHz – 12.75 GHz



Plot 3: High channel, 9 kHz – 12.75 GHz



12.8 Spurious Emissions Radiated < 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit channels are 00; 39 and 78. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

Measurement:

Measurement parameter	
Detector:	Peak / Quasi Peak
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
Used equipment:	See chapter 7.2 A
Measurement uncertainty:	See sub clause 9

Limits:

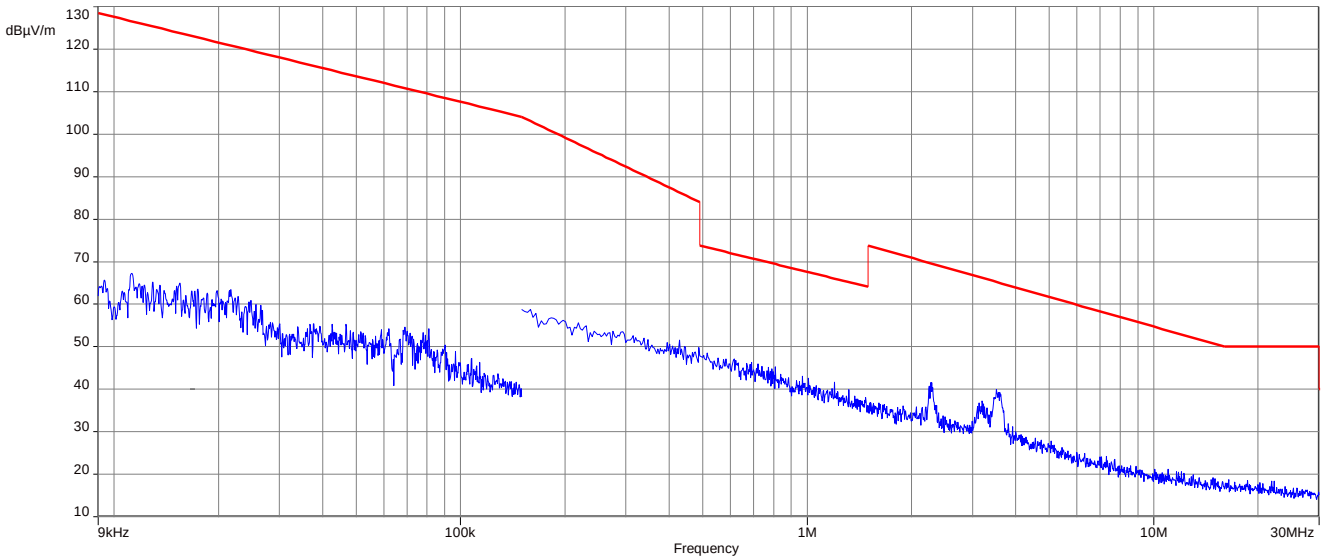
FCC		IC
TX spurious emissions radiated < 30 MHz		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Result:

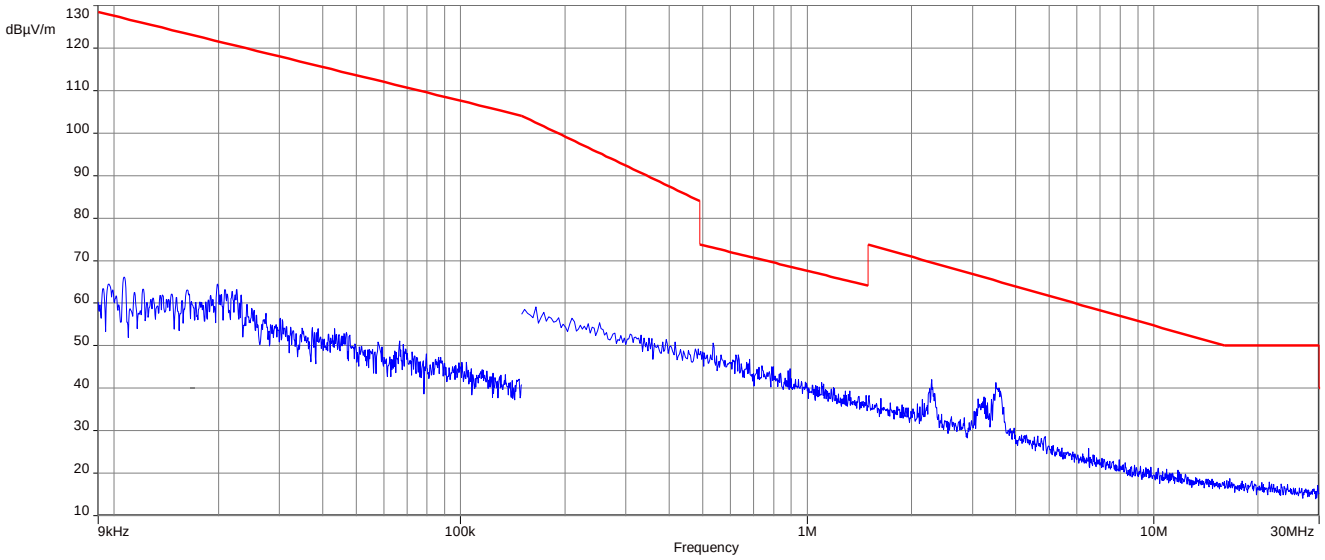
SPURIOUS EMISSIONS LEVEL [dBµV/m]								
Lowest channel			Middle channel			Highest channel		
Frequency [MHz]	Detector	Level [dBµV/m]	Frequency [MHz]	Detector	Level [dBµV/m]	Frequency [MHz]	Detector	Level [dBµV/m]
All emissions were more than 10 dB below the limit.								

Plots:

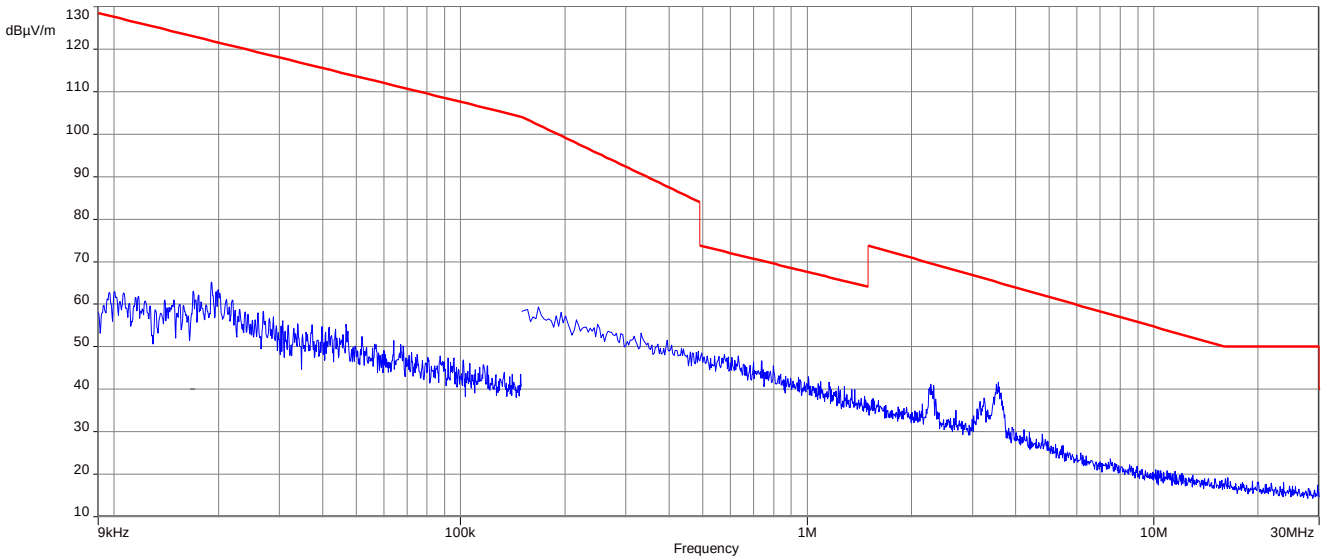
Plot 1: TX-Mode low channel



Plot 2: TX-Mode mid channel



Plot 3: TX-Mode high channel



12.9 Spurious Emissions Radiated > 30 MHz

12.9.1 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at channel low, mid and high.

Measurement:

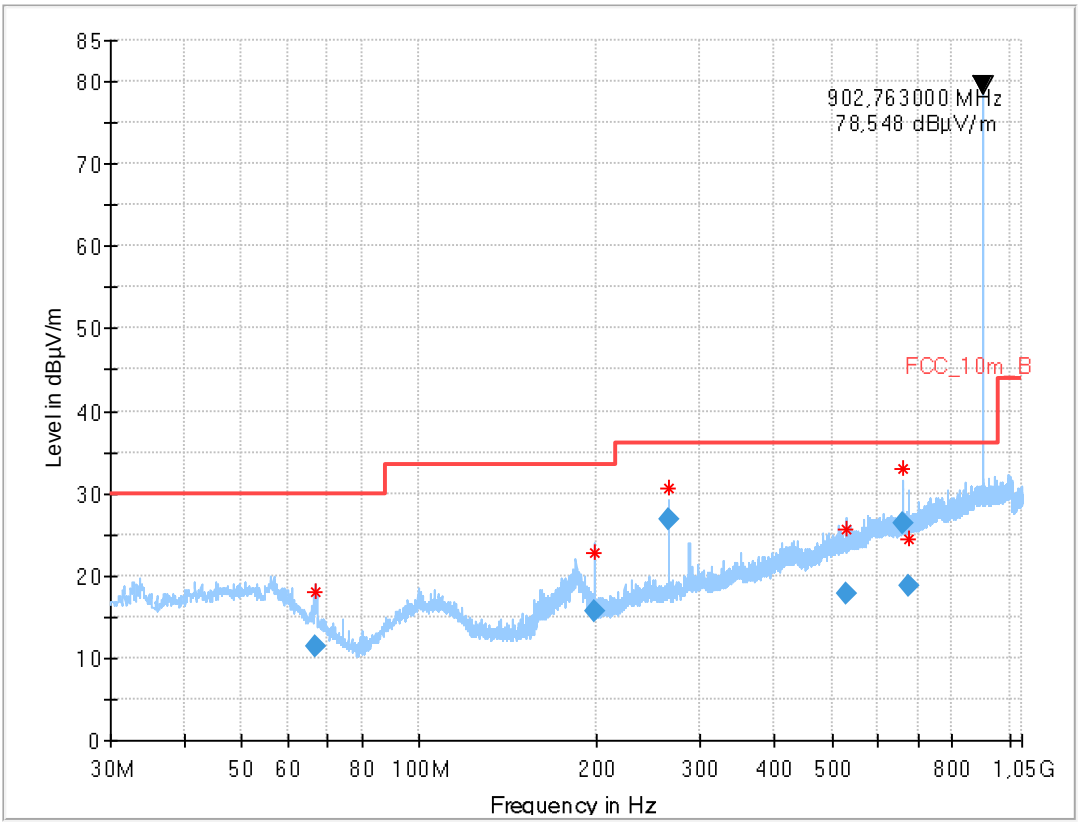
Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	3 x VBW
Video bandwidth	120 kHz
Span	30 MHz to 1 GHz
Trace mode	Max hold
Measured modulation	PR-ASK
Test setup	See sub clause 7.1 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC	
Band-edge Compliance of conducted and radiated emissions		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
Frequency (MHz)	Field Strength (dBµV/m)	Measurement distance
30 - 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10
Above 960	54.0	3

Plots:

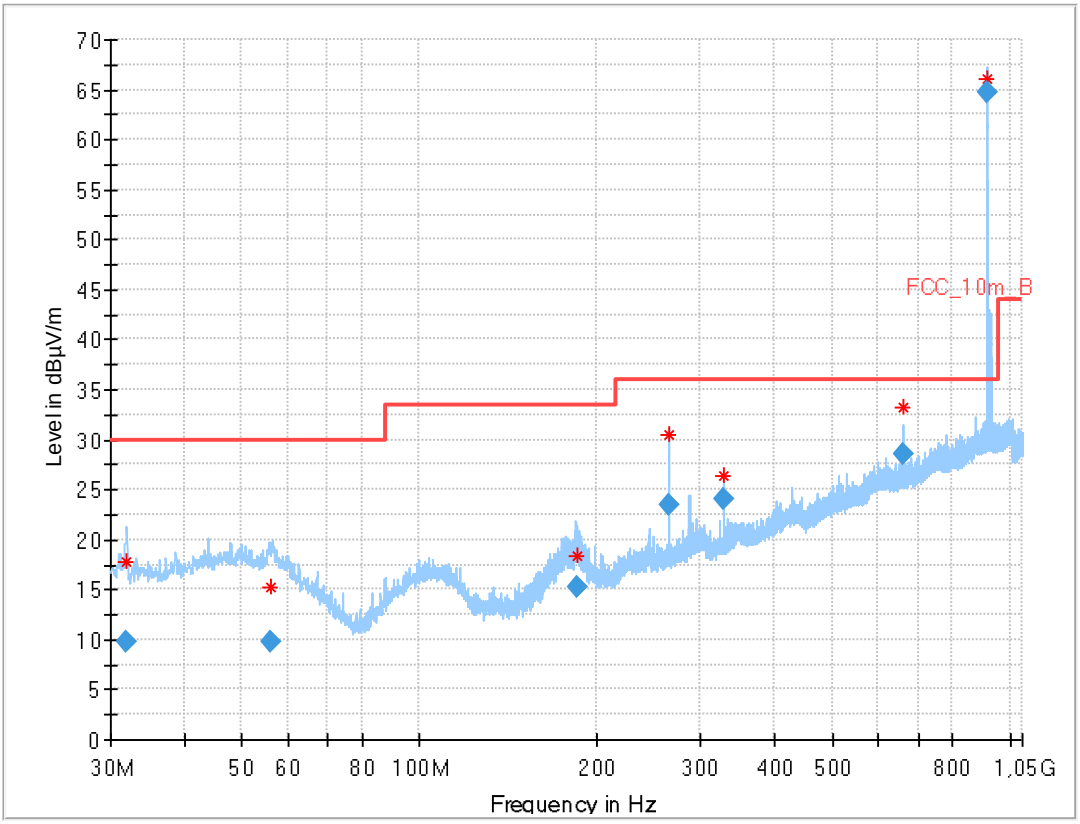
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation (lowest channel)



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
66.553	11.42	30.0	18.6	1000	120.0	287.0	V	344	11
198.154	15.65	33.5	17.9	1000	120.0	142.0	V	252	12
264.197	26.73	36.0	9.3	1000	120.0	124.0	V	160	13
528.371	17.69	36.0	18.3	1000	120.0	400.0	V	-45	19
660.507	26.32	36.0	9.7	1000	120.0	168.0	V	45	21
675.822	18.75	36.0	17.3	1000	120.0	200.0	V	-45	21

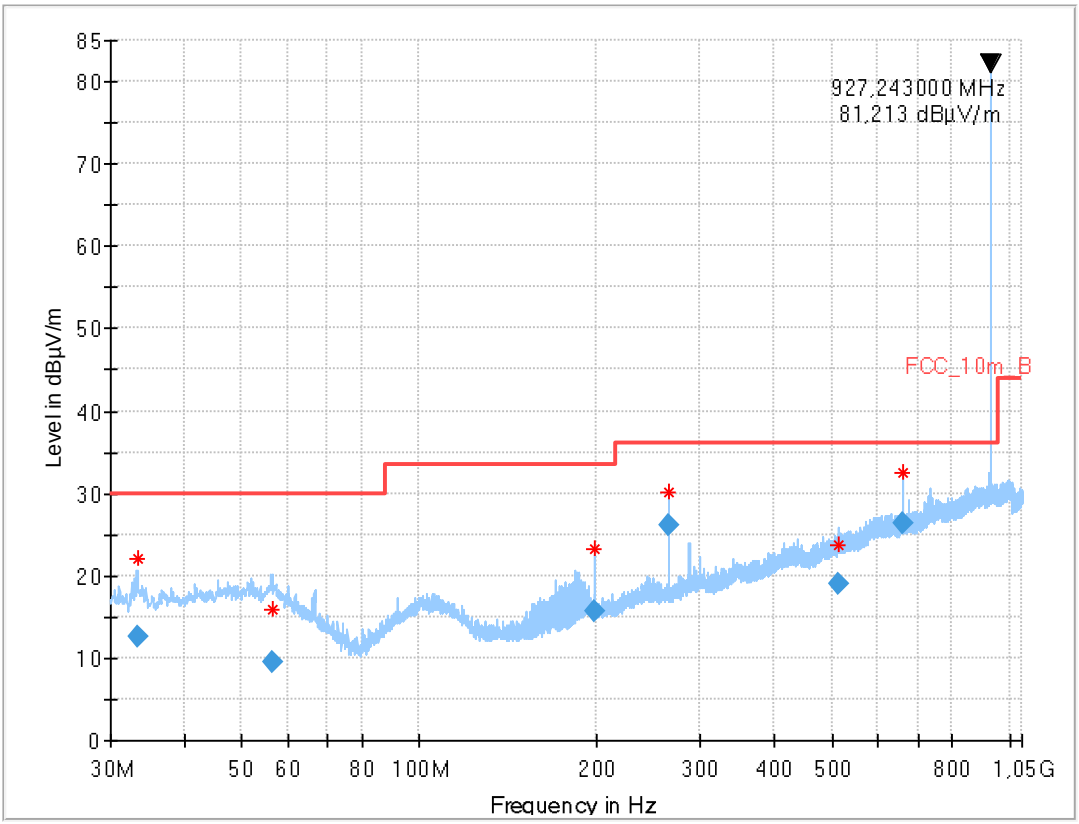
Plot 2: 30 MHz – 1 GHz, horizontal & vertical polarisation (middle channel)



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.767	9.77	30.0	20.2	1000	120.0	135.0	V	-45	12
56.156	9.82	30.0	20.2	1000	120.0	200.0	V	225	15
184.559	15.24	33.5	18.3	1000	120.0	103.0	V	90	11
264.234	23.46	36.0	12.5	1000	120.0	400.0	H	166	13
327.675	24.06	36.0	11.9	1000	120.0	286.0	H	-12	15
660.482	28.56	36.0	7.4	1000	120.0	165.0	H	191	21
914.683	64.76	36.0	-28.8	1000	120.0	100.0	H	0	24

Plot 3: 30 MHz – 1 GHz, horizontal & vertical polarisation (highest channel)



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
33.386	12.54	30.0	17.5	1000	120.0	120.0	V	-38	12
56.338	9.48	30.0	20.5	1000	120.0	319.0	V	90	15
198.150	15.74	33.5	17.8	1000	120.0	200.0	V	321	12
264.215	26.13	36.0	9.9	1000	120.0	155.0	V	166	13
512.009	18.92	36.0	17.1	1000	120.0	104.0	V	180	19
660.439	26.46	36.0	9.5	1000	120.0	100.0	V	41	21

12.9.2 Spurious emissions radiated above 1 GHz

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 x RBW
Span	1 GHz to 12,75 GHz
Trace mode	Max hold
Measured modulation	PR-ASK
Test setup	See sub clause 7.2 B (1 GHz – 12.75 GHz)
Measurement uncertainty	See sub clause 9

Limits:

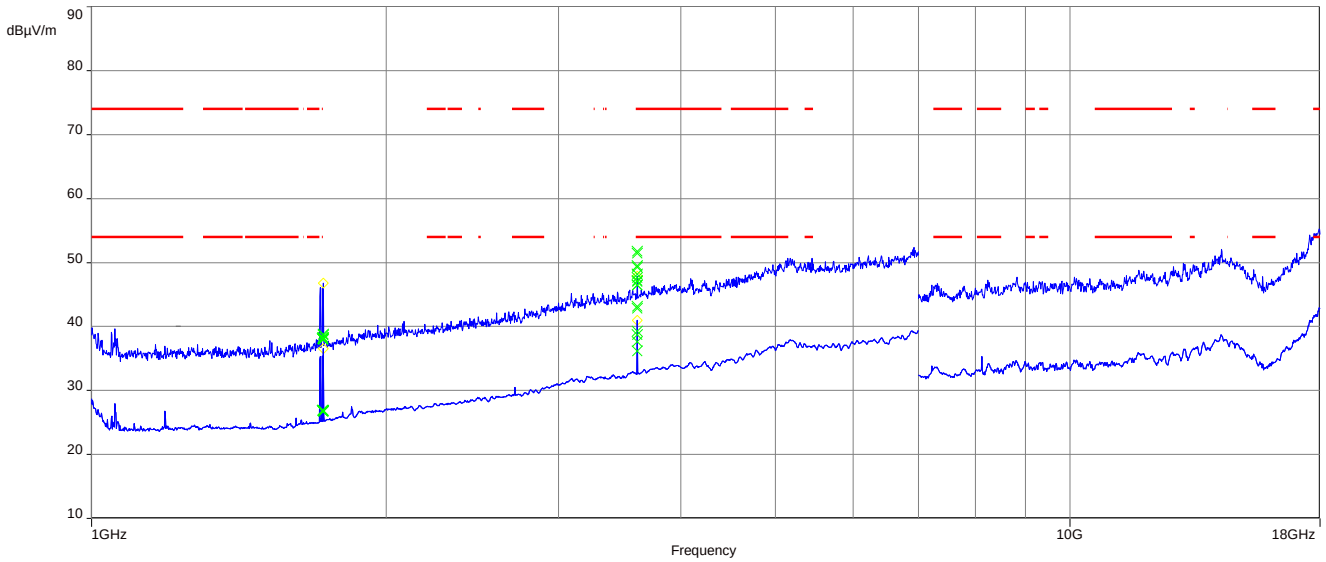
FCC	IC	
TX spurious emissions radiated		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
§15.209		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
Above 960	54.0	3

Result:

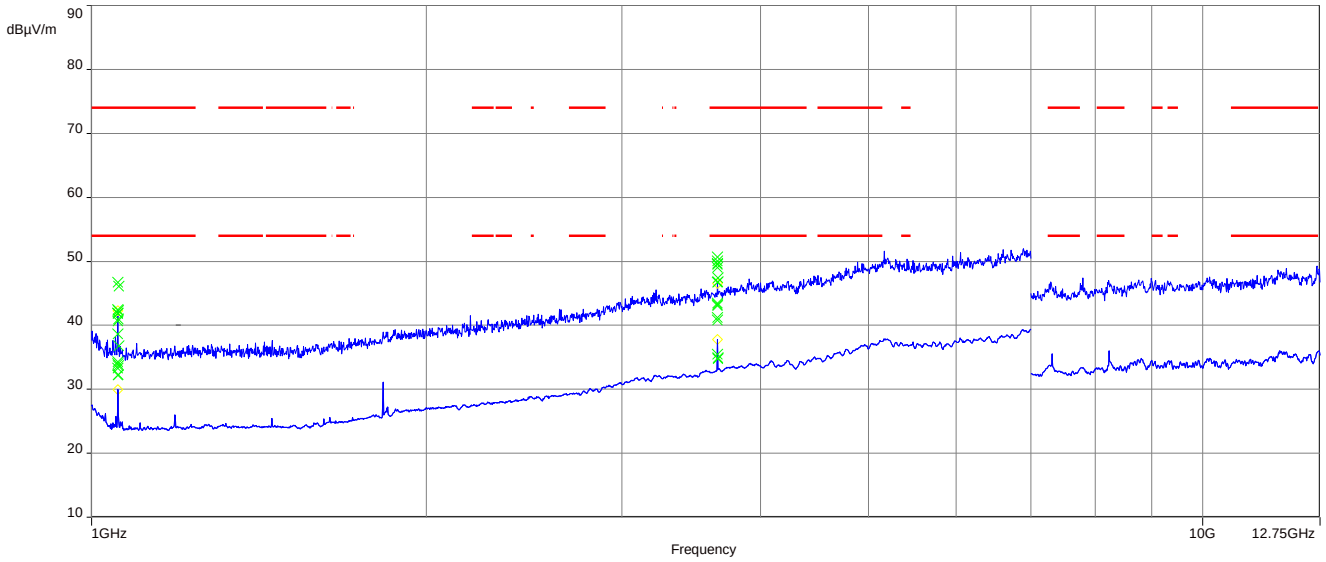
TX spurious emissions radiated [dBµV/m]								
Lowest channel			Middle channel			Highest channel		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
3611	Peak	51.8	1056	Peak	46.7	1056	Peak	44.8
	AVG	47.0		AVG	38.6		AVG	33.3
-/-	Peak	-/-	3659	Peak	50.7	1854	Peak	55.0
	AVG	-/-		AVG	43.2		AVG	51.7
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-

Plots:

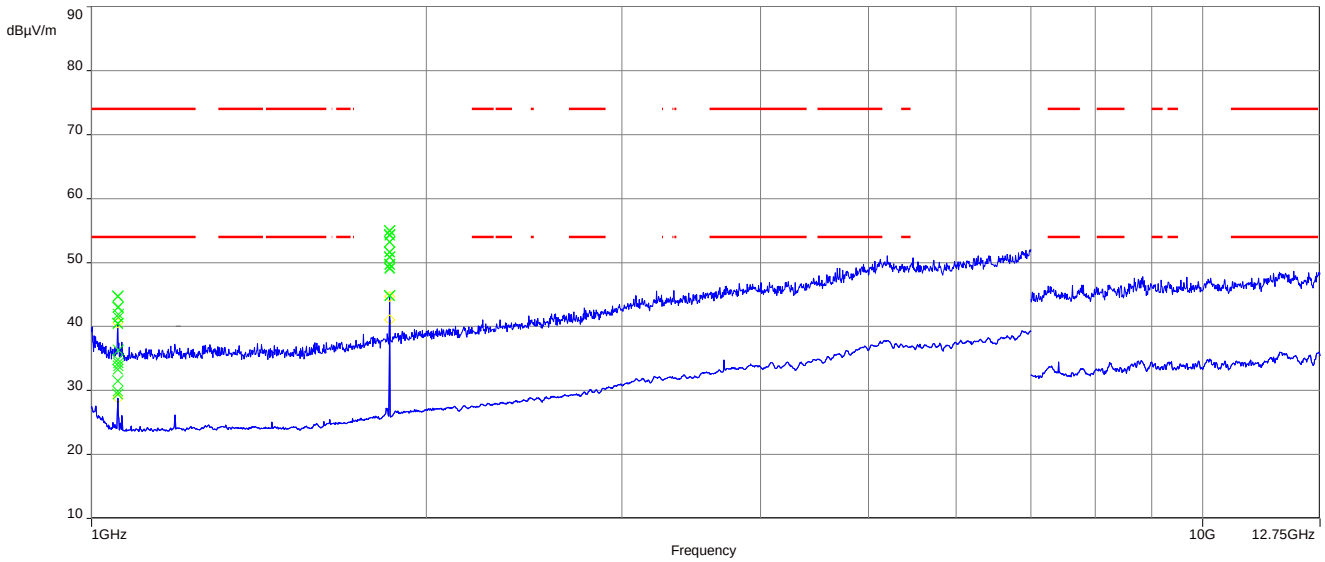
Plot 1: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (lowest channel)



Plot 2: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (middle channel)



Plot 3: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (highest channel)



13 Observations

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

14 Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
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

15 Document history

Version	Applied changes	Date of release
-/-	Initial release	2020-12-22

16 Accreditation Certificate – D-PL-12076-01-04

first page	last page
	

DAkkS Deutsche Akkreditierungsstelle

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 17025:2018 to carry out tests in the following fields:

Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards

The accreditation certificate shall only apply in connection with the notice of accreditation of 09.06.2020 with the accreditation number D-PL-12076-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 07 pages.

Registration number of the certificate: **D-PL-12076-01-04**

Frankfurt am Main, 09.06.2020

by order Dipl.-Ing. (FH) Ralf Egner
Head of Division

The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH.
https://www.dakks.de/en/content/accredited-bodies-dakks
See notes overleaf.

Deutsche Akkreditierungsstelle GmbH

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10117 Berlin

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Europa-Allee 52
60327 Frankfurt am Main

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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-12076-01-04e.pdf

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

first page	last page
	

DAkkS Deutsche Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

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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 17025:2018 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 09.06.2020 with the accreditation number D-PL-12076-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 05 pages.

Registration number of the certificate: **D-PL-12076-01-05**

Frankfurt am Main, 09.06.2020

by order Dipl.-Ing. (FH) Ralf Egner
Head of Division

The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH.
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https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf

################################## END OF TEST REPORT ##################################