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FCC Designation Number	IE0002
IC Site Registration	IE0001
Date	19 th March 2024
EUT Description	RFID Module
FCC ID	SCCNUR31W
IC ID	5137A-NUR31W
Authorised by	Paul Reilly
Authorised Signature:	

TEST SUMMARY

The equipment complies with the requirements according to the following standards.

15.-247 Section	RSS-247 Section	TEST PARAMETERS	Test Result
15.247(a)	5.1(a)	20dB bandwidth of hopping Channel	Pass
15.247(b)	5.4	Output power	Pass
15.247(d)	5.5	Conducted Spurious Emissions	Pass
	RSS Gen 6.7	99% bandwidth	Pass
15.205 15.209	RSS Gen 8.9 and 8.10	Radiated Spurious Emissions for restricted bands	Pass

RSS 247 Issue 3 Aug 2023
RSS-Gen Issue 5 Amd2 Feb 2021

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Contents

1	EUT DESCRIPTION	4
1.1	EUT OPERATION.....	5
1.2	MODIFICATIONS.....	5
1.3	DATE OF TEST.....	5
1.4	DESCRIPTION OF TEST MODES	5
1.5	DESCRIPTION OF TEST METHODS	5
2	EMISSIONS MEASUREMENTS	6
2.1	CONDUCTED EMISSIONS MEASUREMENTS	6
2.2	RADIATED EMISSIONS MEASUREMENTS	6
3	CONDUCTED MEASUREMENTS ON THE ANTENNA PORT.....	7
3.1	BANDWIDTH	7
3.1.1	20dB bandwidth	7
3.1.2	99% bandwidth	8
3.2	OUTPUT POWER CONDUCTED	10
3.3	SPURIOUS EMISSIONS EUT	11
3.3.1	Conducted Spurious Emissions (100KHz bandwidth)	11
3.3.2	Conducted Emissions Band Edge	12
4	RADIATED EMISSIONS	13
4.1	RADIATED SPURIOUS EMISSIONS WITH HH8X ANTENNA.....	13
4.1.1	Radiated Spurious Emission for 902.75MHz with Antenna HH8X	13
4.1.2	Radiated Spurious Emission for 914.75MHz with Antenna HH8X	14
4.1.3	Radiated Spurious Emission for 927.25MHz with Antenna HH8X	15
4.2	OUTPUT POWER RADIATED WITH EXTERNAL ANTENNA	16
4.2.1	Results for Radiated Power on Antenna HH8X.....	16
5	LIST OF TEST EQUIPMENT	17
6	MEASUREMENT UNCERTAINTIES	18
	APPENDIX A: CONDUCTED MEASUREMENTS SPURIOUS EMISSIONS	19
	APPENDIX B: CONDUCTED TESTS FOR BAND EDGES.....	22
	APPENDIX C: RADIATED SPURIOUS EMISSIONS WITH HH8X ANTENNA	25
	APPENDIX D: TEST SETUP	30
	APPENDIX E: BLOCK DIAGRAMS OF TEST SETUP.....	31

1 EUT Description

Type:	RFID Module
Test Standards:	47 CFR, Part 15.247
Type of radio:	Stand-alone
Transmitter Type:	RFID FHSS
Operating Frequency Range(s):	902.75-927.25 MHz
Number of Channels:	50
Channel Separation:	500KHz
Antenna:	External
Antenna Gain Max:	6dBi
Antenna impedance	50ohms
HVIN	NUR3-1W
FVIN	v1.01.00
Test Standards	15.247 RSS-247
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2013 KDB 558074 V5 R02

The EUT was an RFID module using frequency hopping in the 902-928MHz frequency band.

Software used to control the EUT

Test software (NUR RD tester version 2.0.5.2) from Nordic ID, running on a standard Windows laptop was used control the EUT during test.

This application is downloadable from Nordic Semiconductor for the purposes of testing the EUT radio interface.

1.1 EUT Operation

Operating Conditions during Test:

The EUT (RFID module) Sample K234601166 was fitted to a host PCB to allow powering and control of the module. Conducted measurements were carried out with the analyser connected to the SMA connector fitted on the host PCB.

The same sample was used for all tests.

The EUT was operated in test mode where the channel and modulation were set via USB connection from the host PCB to a laptop.

The host was powered from a USB adapter by MW model MWUSB3UK for all tests.

External antenna used for Radiated test:

- HH8X antenna (max gain 3.3dBi) Impedance 50ohms

Environmental conditions

	Temperature	Relative Humidity
Test	°C	%
Radiated Emissions <1GHz	20	45
Radiated Emissions >1GHz	22	47
Conducted Emissions	22	50

1.2 Modifications

No modifications were required in order to pass the test specifications.

1.3 Date of Test

The tests were carried out on 28th and, 29th of February and 1st, 4th, 12th, 13th, and 14th of March 2024.

1.4 Description of Test modes

Channel List

Channel	Freq MHz
Low Ch 0	902.75
Mid Ch 24	914.75
High Ch 49	927.25

1.5 Description of Test methods

Tests were performed manually, and no special test software was used.

Preliminary tests were carried out on all ports on the host PCB and this report contains the worst-case results.

2 Emissions Measurements

2.1 Conducted Emissions Measurements

Radio Conducted measurements were carried out on the EUT as per section 1.1 above.

All results were measured as conducted on the antenna except radiated spurious emissions.

2.2 Radiated Emissions Measurements

The EUT was centred on a motorized turntable, which allows 360-degree rotation.

Emissions below 1GHz were measured using an antenna positioned at a distance of 3 metres from the EUT (as measured from the closest point of the EUT). The radiated emissions were maximised by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 metres. In this case the resolution bandwidth was 100kHz. A bi-conical antenna was used for frequencies below 300MHz, and a log periodic antenna was used for the 300MHz to 1GHz frequency range

Emissions in the 1GHz-3.6GHz range were measured using a horn antenna located at 3 metres distance from the EUT in a fully anechoic chamber. The radiated emissions were maximised by configuring the EUT and by rotating the EUT and by raising and lowering the antenna from 1 to 4 metres. In this case the resolution bandwidth was 1MHz and video bandwidth was 3MHz. for peak measurements. The Video bandwidth was changed to 10Hz for Average measurements (as per ANSI 63.10 2013 Section 4.1.4.2.3)

Emissions above 3.6GHz were measured using a horn antenna located at 3 metre distance from the EUT in a fully anechoic chamber. The radiated emissions were maximised by configuring the EUT and by rotating the EUT. In this case the resolution bandwidth was 1MHz and video bandwidth was 3MHz. for peak measurements. The Video bandwidth was changed to 10Hz for Average measurements (as per ANSI 63.10 2013 Section 4.1.4.2.3).

3 **Conducted Measurements on the Antenna port**

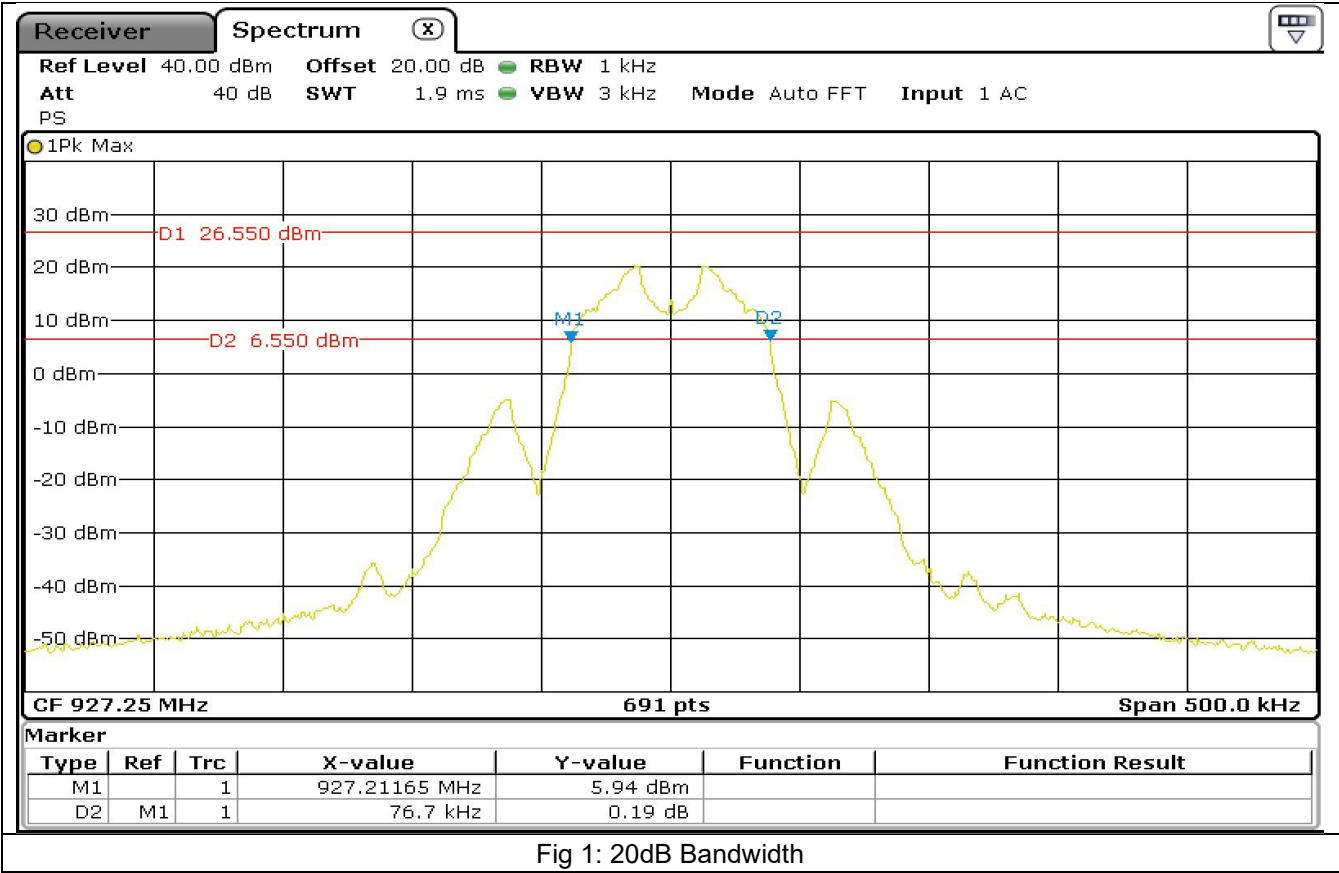
3.1 **Bandwidth**

3.1.1 **20dB bandwidth**

Requirement FCC 15.247(a) IC RSS-247 5.1a

The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

As per Ansi63.10 Section 7.8.7



Channel	Frequency	20dB Bandwidth
	MHz	KHz
Low	902.75	76.7
Mid	914.75	76.7
High	927.25	76.7

Limit

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Result: Pass

3.1.2 99% bandwidth

Test Method

As per Ansi 63.10 Section 6.9.3

Ansi 63.10 Section 6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure

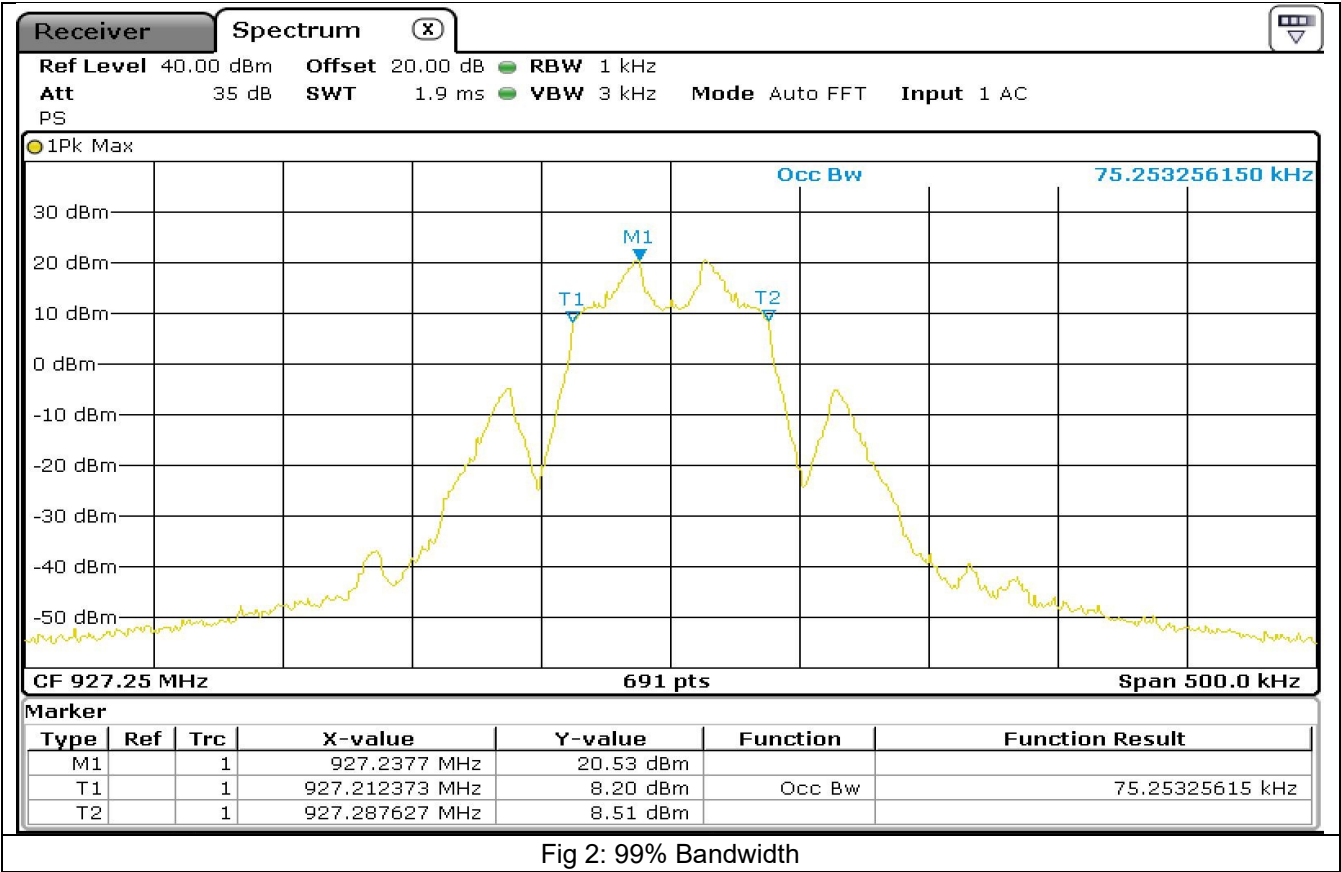
The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

The following procedure shall be used for measuring 99% power bandwidth:

- a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log (OBW/RBW)]$ below the reference level. Specific guidance is given in 4.1.5.2.
- d) Step a) through step c) might require iteration to adjust within the specified range.
- e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
- f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.
- g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.
- h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

TEST PROCEDURE

The test was performed as a conducted measurement.

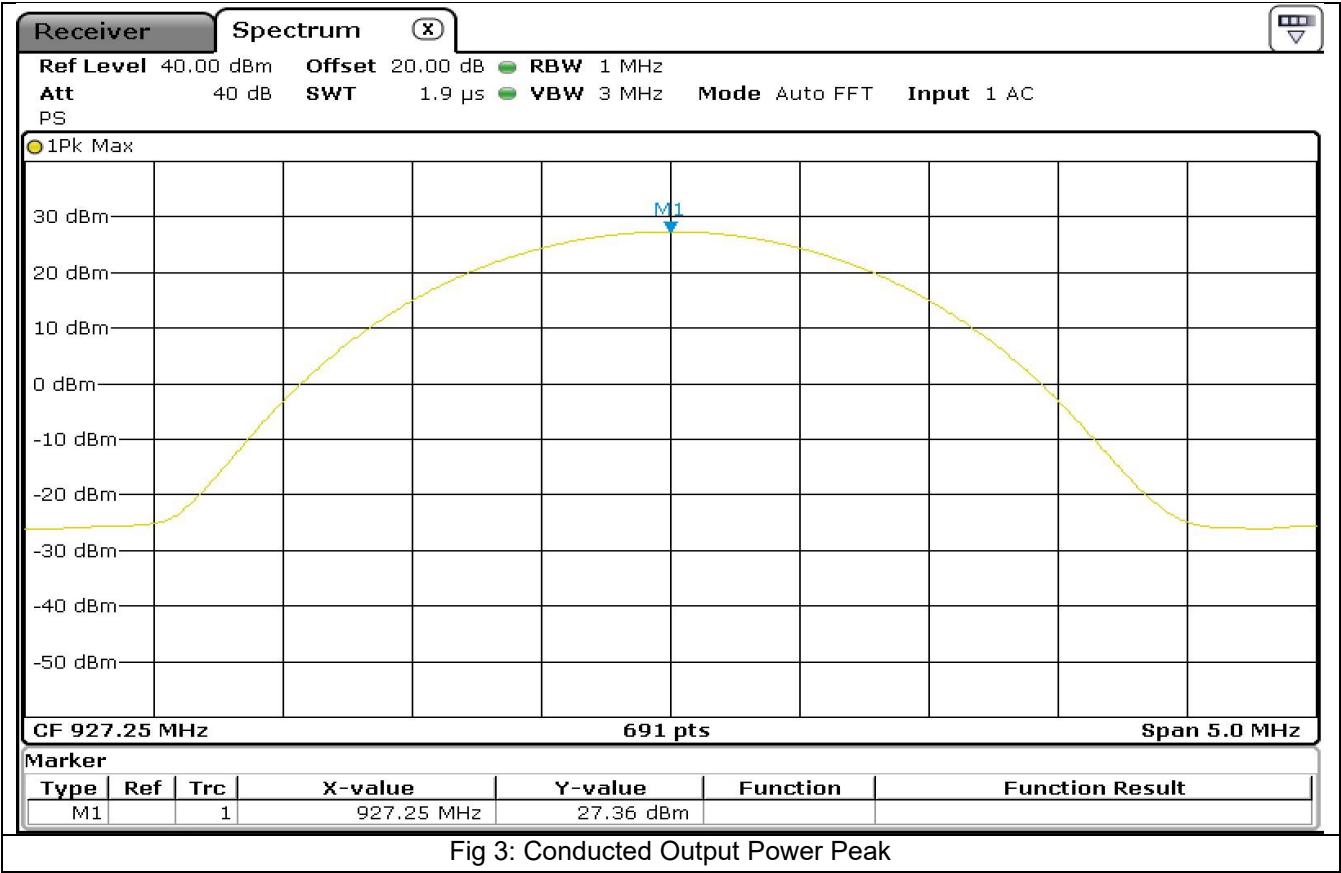


Bandwidth Result

Channel	Frequency	99% Bandwidth
	MHz	KHz
Low	902.75	75.253
Mid	914.75	75.253
High	927.25	75.253

Test Result: Pass

3.2 Output power Conducted



Frequency	Measurement Peak	Limit	Margin
MHz	dBm	dBm	dB
902.75	27.5	30	2.5
914.75	27.54	30	2.46
927.25	27.36	30	2.64

Limit

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels

Test Result: Pass

3.3 Spurious Emissions EUT

3.3.1 Conducted Spurious Emissions (100KHz bandwidth)

Frequency	Peak 100KHz RBW	Measured	Limit Min	Margin
GHz	dBm	dBc	dBc	dB
1.8055	-59.36	59.36	20	39.36
2.70825	-57.36	57.36	20	37.36
3.611	-63.7	63.7	20	43.7
4.51375	-68.91	68.91	20	48.91
5.4165	-73.64	73.64	20	53.64
6.31925	-68.21	68.21	20	48.21
7.222	-62.88	62.88	20	42.88
8.12475	-71.99	71.99	20	51.99
9.0275	-77.25	77.25	20	57.25

Results for Conducted Emission for Low Channel (902.75MHz)

Frequency	Peak 100KHz RBW	Measured	Limit Min	Margin
GHz	dBm	dBc	dBc	dB
1.8295	-66.42	66.42	20	46.42
2.74425	-56.24	56.24	20	36.24
3.659	-61.7	61.7	20	41.7
4.57375	-70.84	70.84	20	50.84
5.4885	-72.06	72.06	20	52.06
6.40325	-70.29	70.29	20	50.29
7.318	-73.92	73.92	20	53.92
8.23275	-68.22	68.22	20	48.22
9.1475	-81.63	81.63	20	61.63

Results for Conducted Emission for Middle Channel (914.75MHz)

Frequency	Peak 100KHz RBW	Measured	Limit Min	Margin
GHz	dBm	dBc	dBc	dB
1.8545	-66.22	66.22	20	46.22
2.78175	-56.9	56.9	20	36.9
3.709	-64.85	64.85	20	44.85
4.63625	-72.32	72.32	20	52.32
5.5635	-72.77	72.77	20	52.77
6.49075	-72.21	72.21	20	52.21
7.418	-78.9	78.9	20	58.9
8.34525	-70.07	70.07	20	50.07
9.2725	-71.22	71.22	20	51.22

Results for Conducted Emission for Middle Channel (927.25MHz)

Refer to Appendix A for Scans

Test Result: Pass

3.3.2 Conducted Emissions Band Edge

Refer to Appendix B for Scans

Test Result: Pass

4 Radiated Emissions

4.1 Radiated Spurious Emissions with HH8X Antenna

4.1.1 Radiated Spurious Emission for 902.75MHz with Antenna HH8X

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
2.708	13.8	O1	Vertical	29.1	0	5.1	48.0	54.0	26.0	Pass
3.611	43.5	O1	Vertical	31.7	38.2	5.8	42.8	54.0	31.2	Pass
4.514	45.2	O1	Vertical	32.6	39.1	7.5	46.2	54.0	27.8	Pass
5.417	45.0	O1	Vertical	34.3	39.2	8.2	48.3	54.0	25.7	Pass
8.125	45.8	O1	Vertical	36.7	41.1	10.9	52.3	54.0	21.7	Pass
9.028	43.0	O1	Vertical	37.8	38.9	10.2	52.1	54.0	21.9	Pass
2.708	13.9	O1	Horizontal	29.1	0	5.1	48.1	54.0	25.9	Pass
3.611	42.9	O1	Horizontal	31.7	38.2	5.8	42.2	54.0	31.8	Pass
4.514	44.3	O1	Horizontal	32.6	39.1	7.5	45.3	54.0	28.7	Pass
5.417	44.4	O1	Horizontal	34.3	39.2	8.2	47.7	54.0	26.3	Pass
8.125	45.5	O1	Horizontal	36.7	41.1	10.9	52.0	54.0	22.0	Pass
9.028	43.0	O1	Horizontal	37.8	38.9	10.2	52.1	54.0	21.9	Pass

Final Field Strength Peak (dBuV/m) = Reading Peak (dBuV/m) + Antenna Factor (dB) - Pre-amp Gain (dB) + Cable Loss (dB)
Calculation Example 48 = 13.8 + 29.1 - 0 + 5.1

Note in cases for frequencies where the peak reading meets the average limit the average is not reported

Test Result: Pass

4.1.2 Radiated Spurious Emission for 914.75MHz with Antenna HH8X

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
2.744	13.6	O1	Vertical	29.1	0	5.1	47.8	54.0	26.2	Pass
3.659	43.9	O1	Vertical	31.8	38.3	6	43.4	54.0	30.6	Pass
4.574	43.4	O1	Vertical	32.7	39.7	8.1	44.5	54.0	29.5	Pass
7.318	44.6	O1	Vertical	36.4	40.6	10.1	50.5	54.0	23.5	Pass
8.233	44.7	O1	Vertical	36.8	40.9	11	51.6	54.0	22.4	Pass
9.148	43.8	O1	Vertical	37.8	38.8	10.1	52.9	54.0	21.1	Pass
2.744	14.1	O1	Horizontal	29.1	0	5.1	48.3	54.0	25.7	Pass
3.659	44.2	O1	Horizontal	31.8	38.3	6	43.7	54.0	30.3	Pass
4.574	43.5	O1	Horizontal	32.7	39.7	8.1	44.6	54.0	29.4	Pass
7.318	43.8	O1	Horizontal	36.4	40.6	10.1	49.7	54.0	24.3	Pass
8.233	44.5	O1	Horizontal	36.8	40.9	11	51.4	54.0	22.6	Pass
9.148	43.4	O1	Horizontal	37.8	38.8	10.1	52.5	54.0	21.5	Pass

Final Field Strength Peak (dBuV/m) = Reading Peak (dBuV/m) + Antenna Factor (dB) - Pre-amp Gain (dB) + Cable Loss (dB)
 Calculation Example $47.8 = 13.6 + 29.1 - 0 + 5.1$

Note in cases for frequencies where the peak reading meets the average limit the average is not reported

Test Result: Pass

4.1.3 Radiated Spurious Emission for 927.25MHz with Antenna HH8X

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamplifier Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
2.782	13.6	O1	Vertical	29.3	0	5.3	48.2	54.0	25.8	Pass
3.709	45.5	O1	Vertical	32.1	38.3	6	45.3	54.0	28.7	Pass
4.636	43.7	O1	Vertical	32.6	39.7	8.1	44.7	54.0	29.3	Pass
7.418	45.1	O1	Vertical	36.6	40.8	10.4	51.3	54.0	22.7	Pass
8.345	45.4	O1	Vertical	37.2	40.7	10.9	52.8	54.0	21.2	Pass
2.782	14.0	O1	Vertical	29.3	0	5.3	48.6	54.0	25.4	Pass
3.709	45.1	O1	Vertical	32.1	38.3	6	44.9	54.0	29.1	Pass
4.636	43.8	O1	Vertical	32.6	39.7	8.1	44.8	54.0	29.2	Pass
7.418	45.3	O1	Vertical	36.6	40.8	10.4	51.5	54.0	22.5	Pass
8.345	43.0	O1	Vertical	37.2	40.7	10.9	50.4	54.0	23.6	Pass

Final Field Strength Peak (dBuV/m) = Reading Peak (dBuV/m) + Antenna Factor (dB) - Pre-amp Gain (dB) + Cable Loss (dB)
 Calculation Example **48.2 = 13.6 + 29.3 - 0 + 5.3**

Note in cases for frequencies where the peak reading meets the average limit the average is not reported

Refer to Appendix C for Scans

Test Result: Pass

4.2 Output Power Radiated with external Antenna

4.2.1 Results for Radiated Power on Antenna HH8X

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Transmitted Power	Limit	Margin	Result
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBm	dBm	dB	P/F
902.750	99.3	O1	Vertical	23.5	0	5.3	128.1	32.9	36.0	3.1	Pass
902.750	92.6	O1	Horizontal	23.5	0	5.3	121.4	26.2	36.0	9.8	Pass
914.750	98.7	O1	Vertical	23.5	0	5.4	127.6	32.4	36.0	3.60	Pass
914.750	94.0	O1	Horizontal	23.5	0	5.4	122.9	27.7	36.0	8.30	Pass
927.250	96.4	O1	Vertical	23.7	0	5.5	125.6	30.4	36.0	5.60	Pass
927.250	90.6	O1	Horizontal	23.7	0	5.5	119.8	24.6	36.0	11.40	Pass

Final Field Strength Peak (dBuV/m) = Reading Peak (dBuV/m) + Antenna Factor (dB) - Pre-amp Gain (dB) + Cable Loss (dB)
Calculation Example $128.1 = 99.3 + 23.5 - 0 + 5.3$

Transmitted power (dBm) = Final Field Strength Peak (dBuV/m) - 95.2 dB
Calculation Example $32.9 = 128.1 - 95.2$

Test Result: Pass

5 List of Test Equipment

Instrument	Manufacturer	Model	Serial Num	CEI Ref	Cal Date	Cal Interval Months
Microwave Preamplifier	Hewlett Packard	83017A	3123A00175	805	30-Sep-23	12
Spectrum Analyser 30Hz-40GHz	Rohde & Schwarz	FSP40	100053	850	11-Dec-21	36
Test Receiver 3.6GHz	Rohde & Schwarz	ESR	1316.3003k03-101625-s	869	24-May-23	36
Receiver N9038A EMI 3Hz - 8.4 GHz	Keysight	MXE N9038A	MX60320104	1204	28-Feb-23	36
Antenna Horn	EMCO	3115	2363	1100	22-Feb-23	36
Fully Anechoic Chamber	CEI	FAR 3M	906	906	24-Jul-22	36
Anechoic Chamber	CEI	SAR 10M	845	845	22-Nov-22	36
Antenna Biconical	Schwarzbeck	VHBB 9124	9124 667	871	07-Oct-21	36
Antenna Log Periodic	Chase	UPA6108	1072	609	10-Sep-21	36
Antenna Horn Standard Gain 18-26.5GHz	A-Info	LB-42-25-C-KF	J2021091103028	877	30-Jul-23	12
Cable 20m				1213	16-May-23	12
Cable purple Ktype 1.8m				917	30-Jul-23	12
Cable HF Ktype 1.5m				705	30-Jul-23	12

6 Measurement Uncertainties

Measurement	Uncertainty
Radio Frequency	+/- 5×10^{-7}
Maximum Frequency Deviation	+/- 1.7 %
Conducted Emissions	+/- 1 dB
Radiated Emission 30MHz-100MHz	+/- 5.3 dB
Radiated Emission 100MHz-300MHz	+/- 4.7 dB
Radiated Emission 300MHz-1GHz	+/- 3.9 dB
Radiated Emission 1GHz-40GHz	+/- 3.8 dB
Modulation bandwidth	+/- 5×10^{-7}
Duty Cycle	+/- 5 %
Power supply	± 0.1 VDC
Temperature	± 0.2 °C
Frequency	± 0.01 ppm

The measurement uncertainties stated were calculated with a k=2 for a confidence level of over 95% as per ETS TR100 028.

The test data can be compared directly to the specification limit to determine compliance, as the calculated measurement uncertainty meets the requirements of the applicable specification.

Appendix A: Conducted Measurements Spurious Emissions

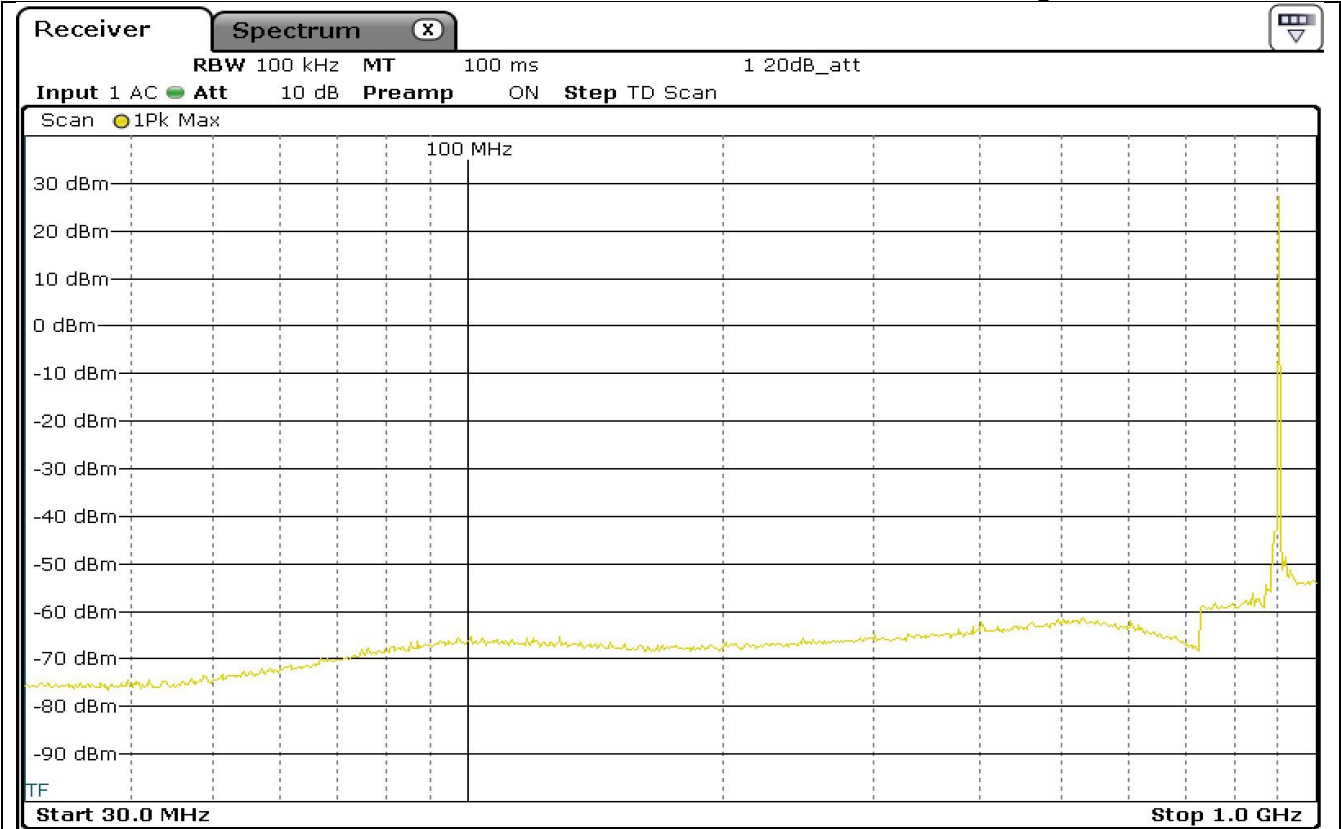


Fig A1: Low Channel Conducted Spurious Emissions 30MHz - 1GHz

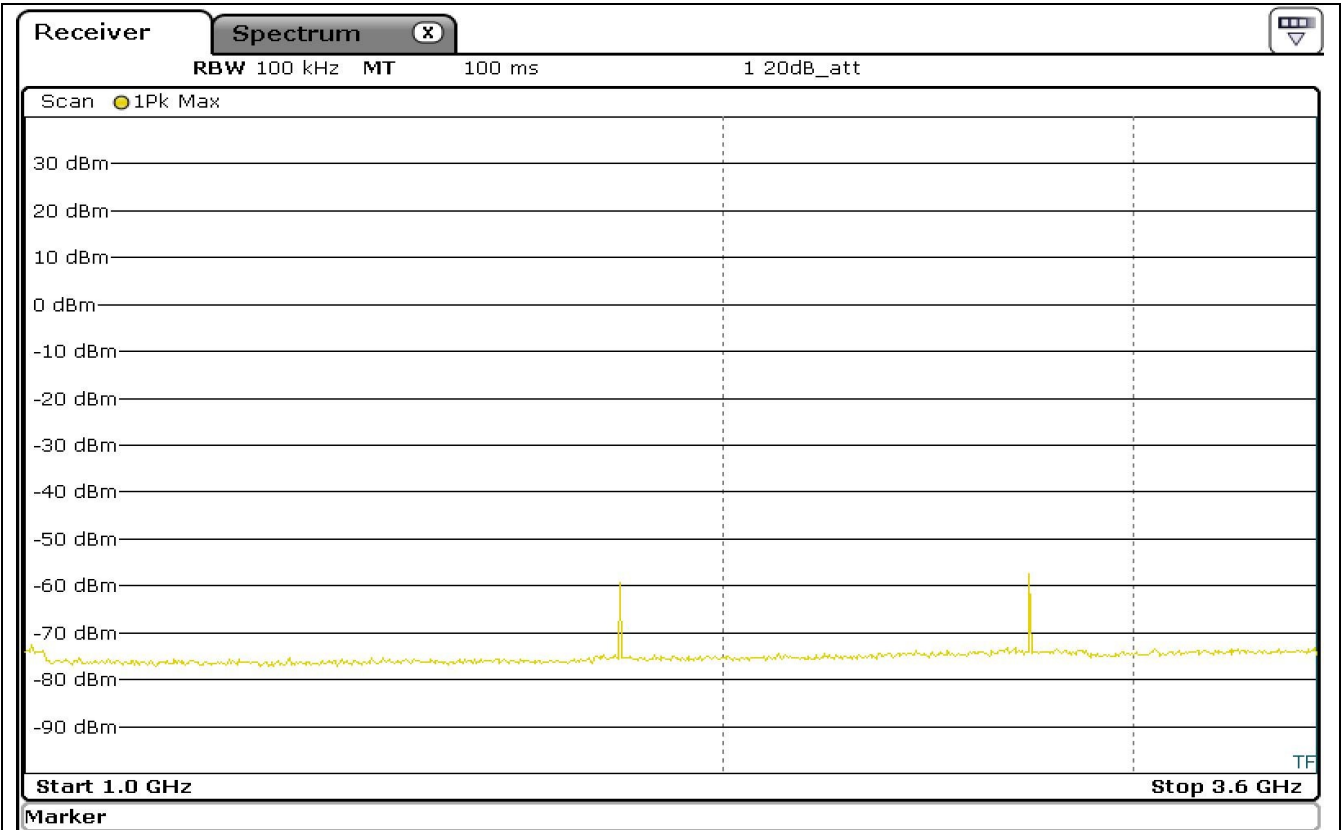


Fig A2: Low Channel Conducted Spurious Emissions 1GHz - 3.6GHz



Fig A3: Low Channel Conducted Spurious Emissions 3.6GHz - 8.8GHz



Fig A3: Low Channel Conducted Spurious Emissions 8.8GHz - 10GHz

Appendix B: Conducted Tests for Band Edges

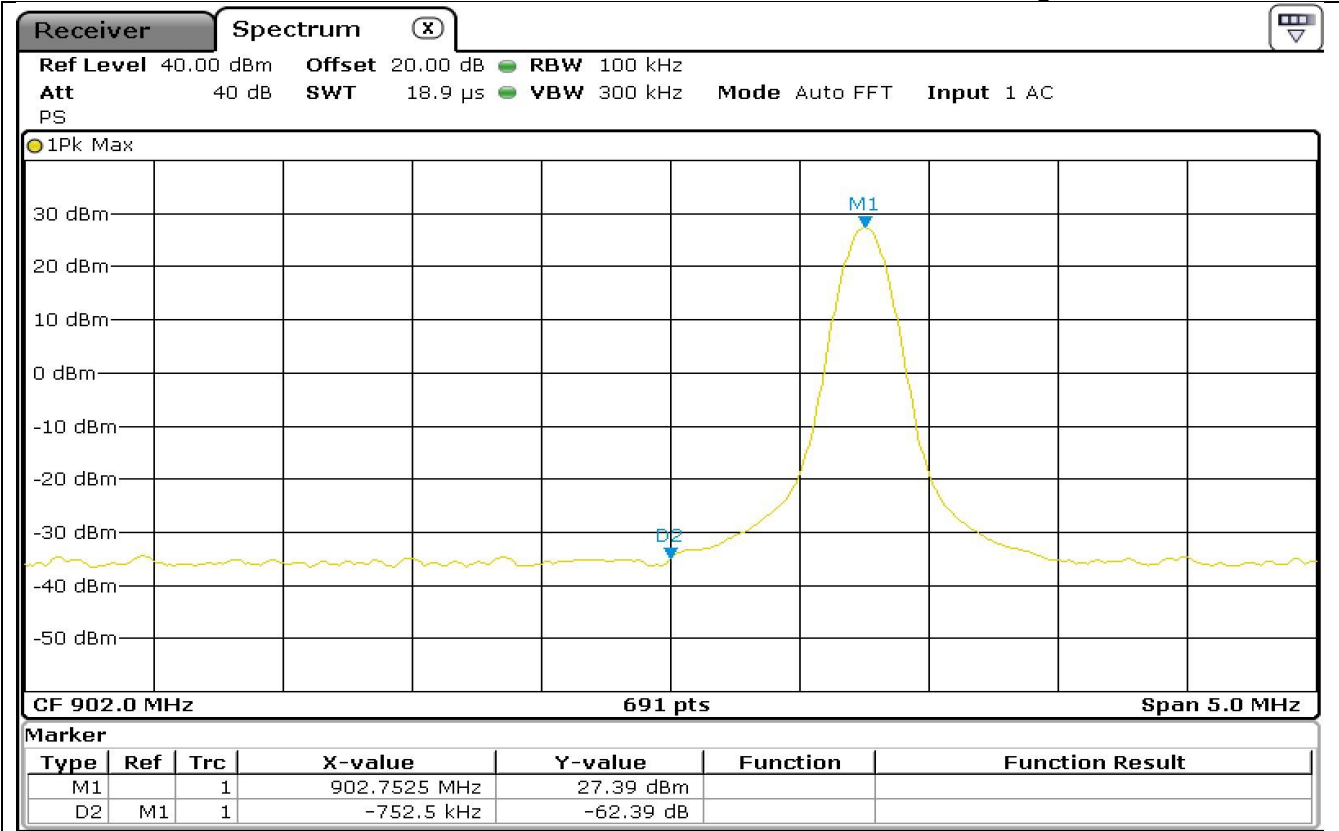


Fig B1: Low Channel Band Edge Conducted Non-Hopping

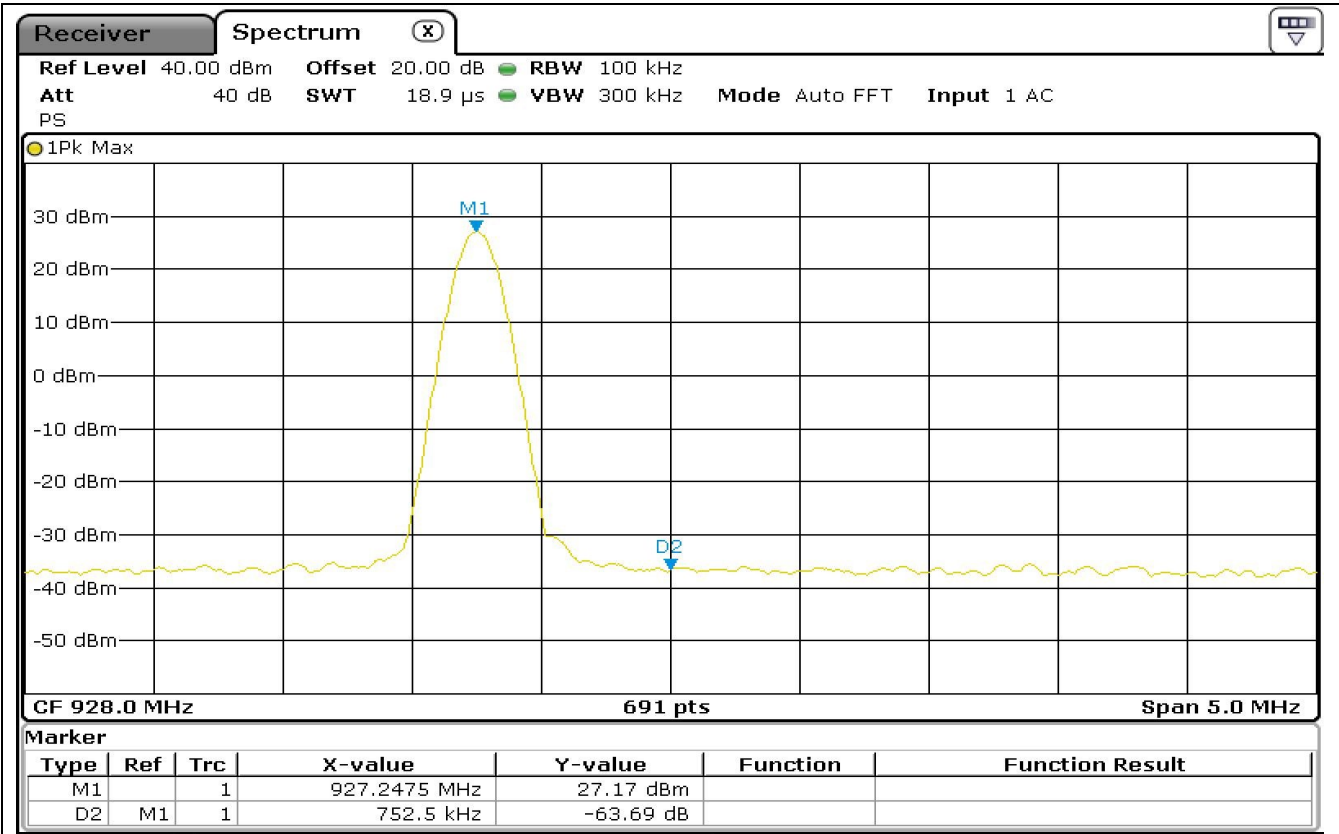


Fig B2: High Channel Band Edge Conducted Non-Hopping

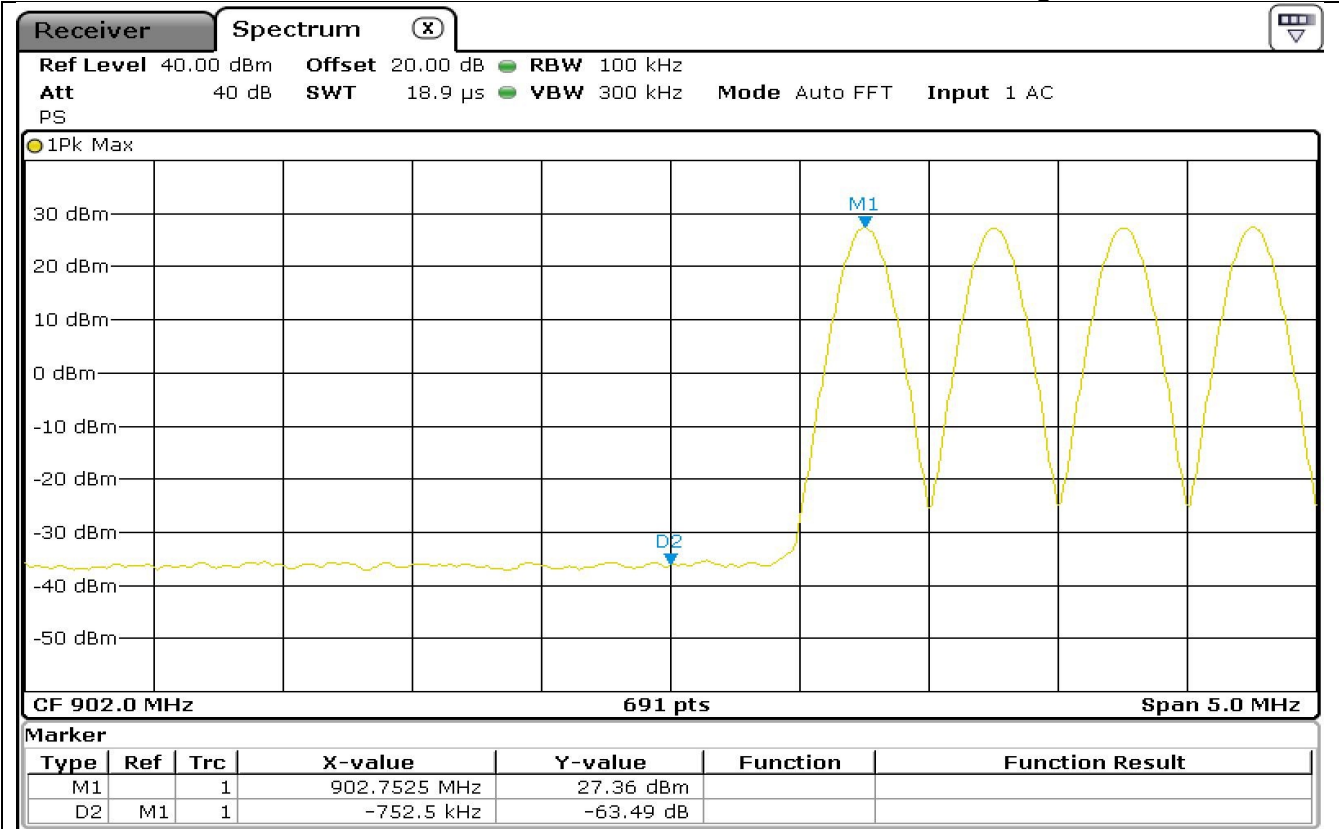


Fig B3: Low Channel Band Edge Conducted Hopping

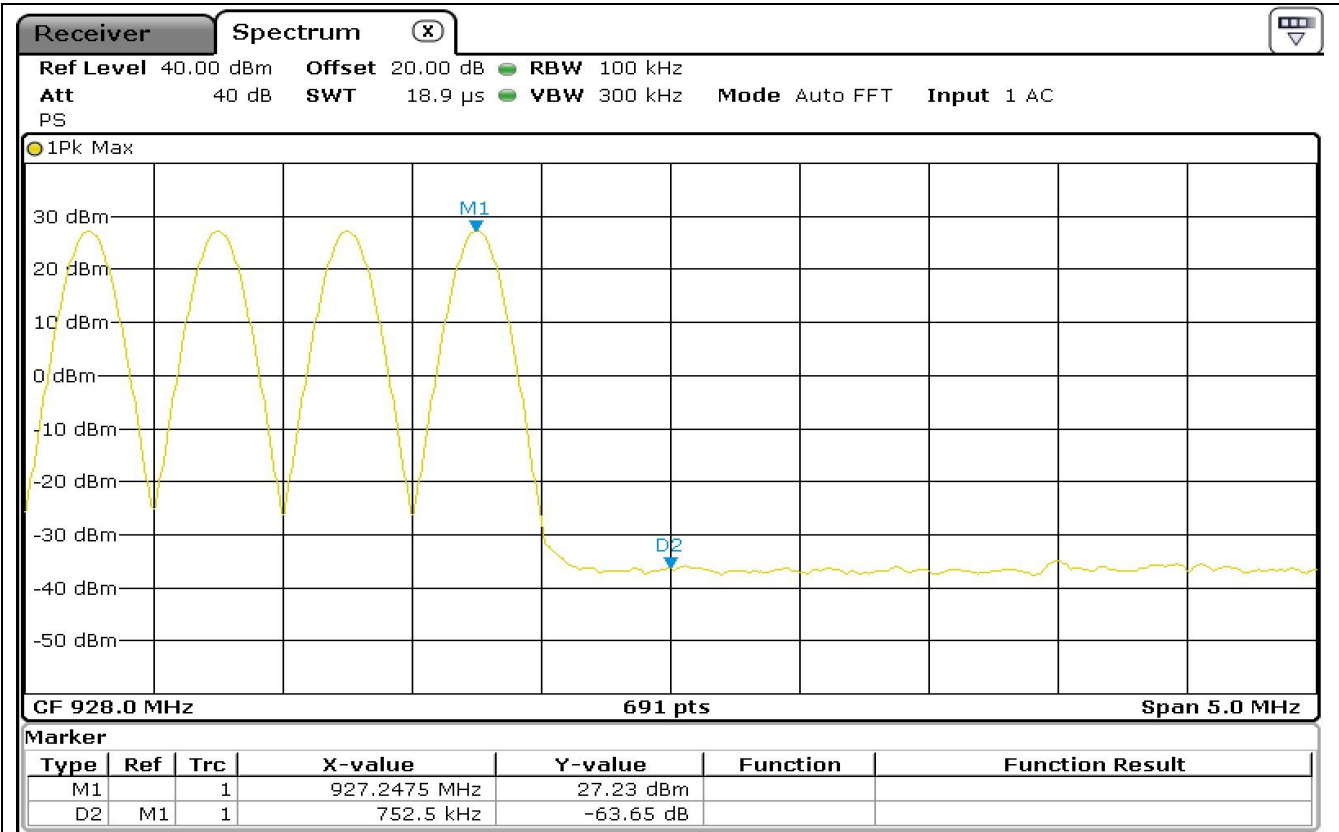


Fig B4: High Channel Band Edge Conducted Hopping

Appendix C: Radiated Spurious Emissions with HH8X Antenna

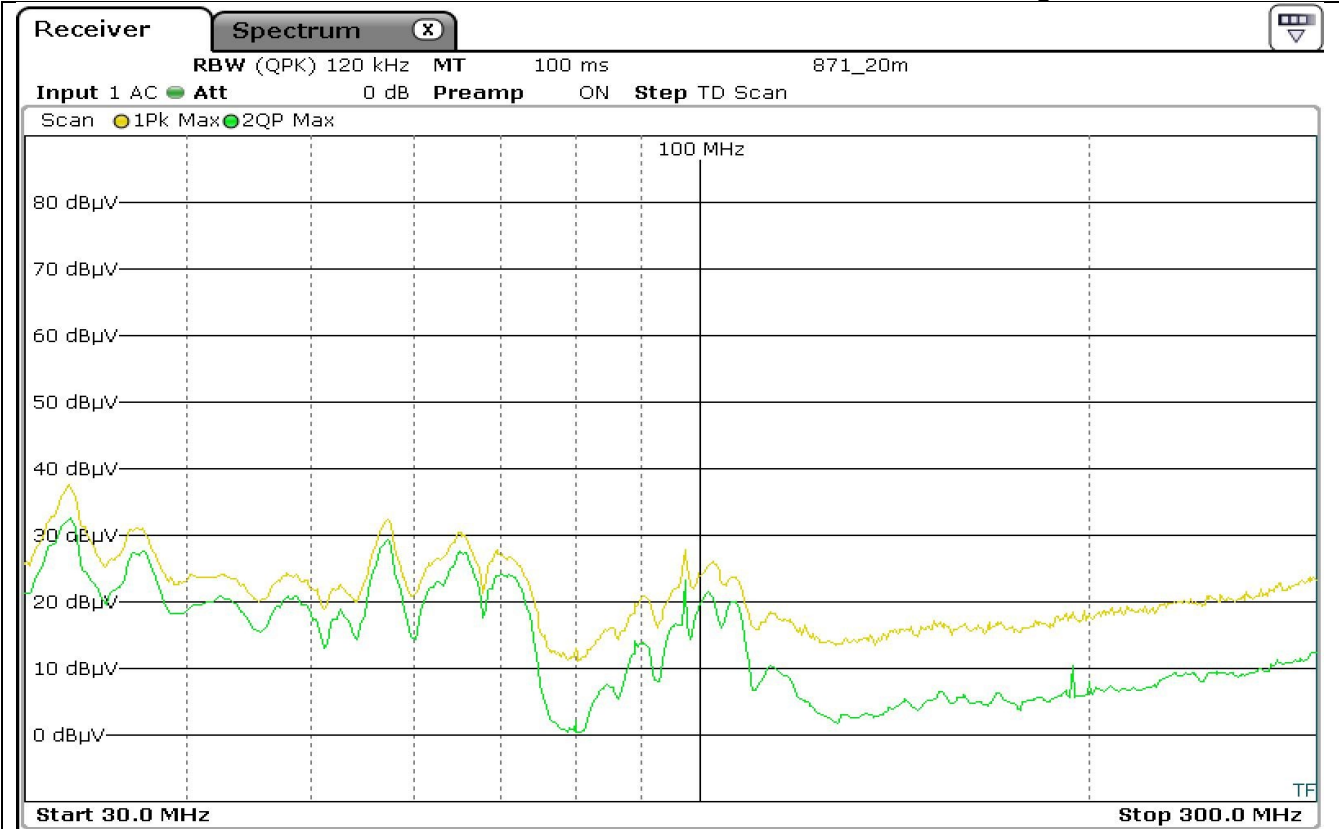


Fig C1: High Channel Radiated Emissions 30MHz - 300MHz, Vertical, 3metres

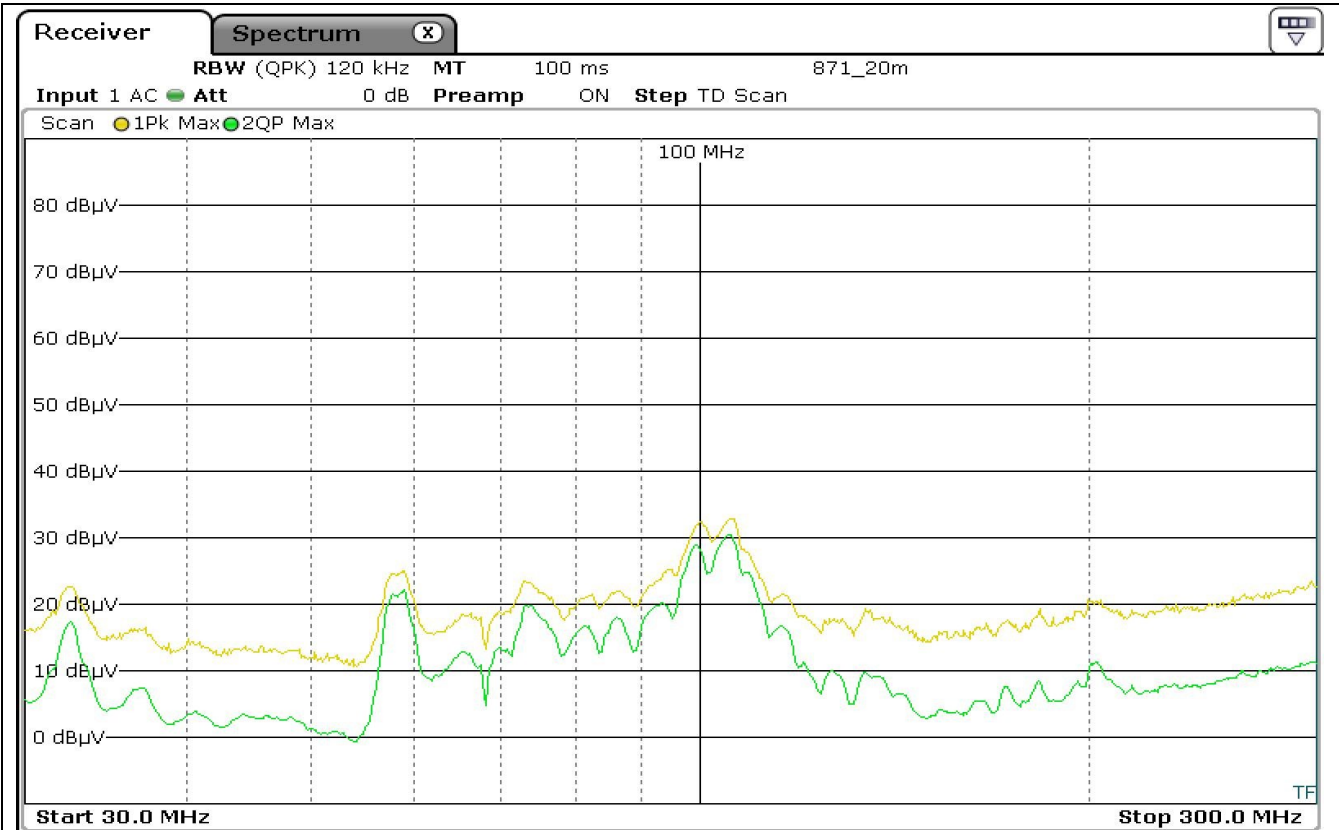


Fig C2: High Channel Radiated Emissions 30MHz - 300MHz, Horizontal, 3metres

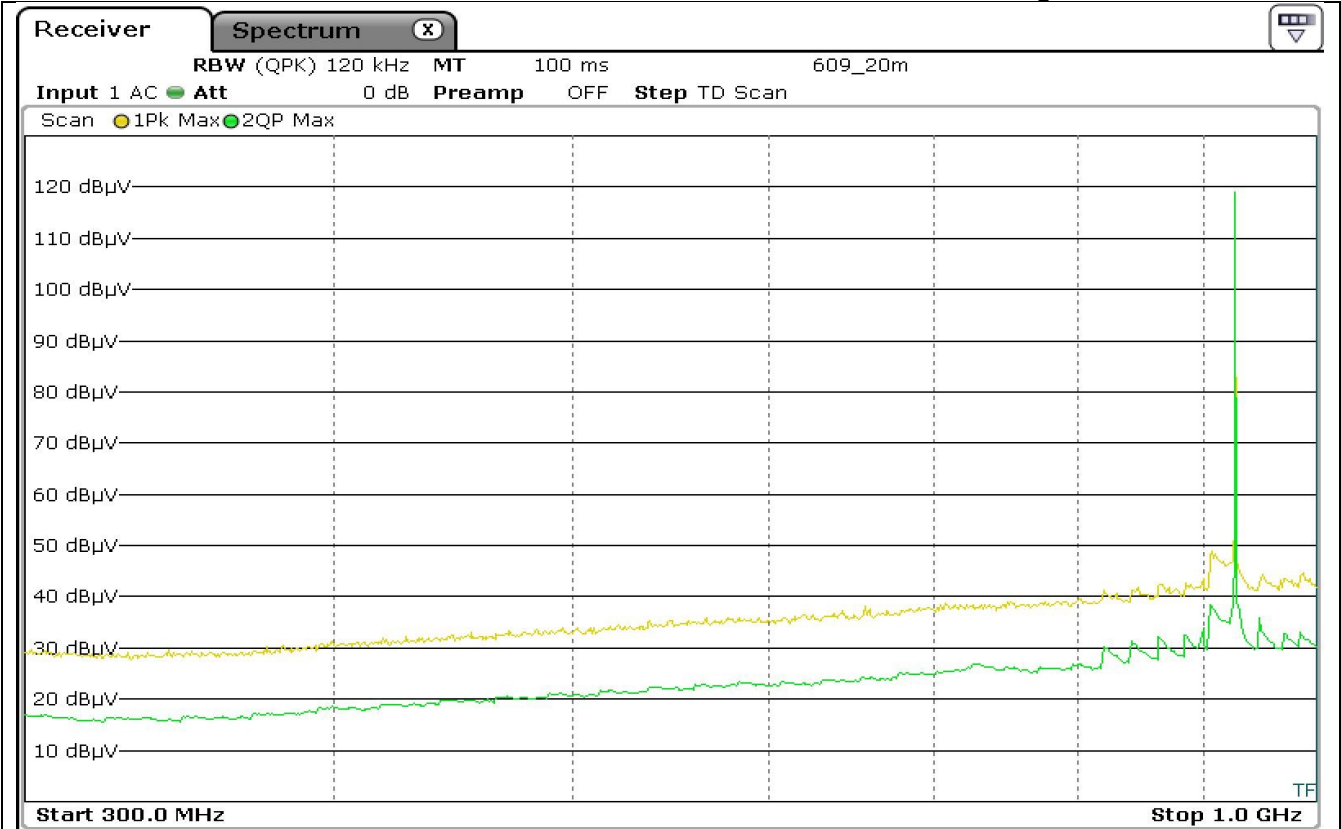


Fig C3: High Channel Radiated Emissions 300MHz - 1GHz, Vertical, 3metres

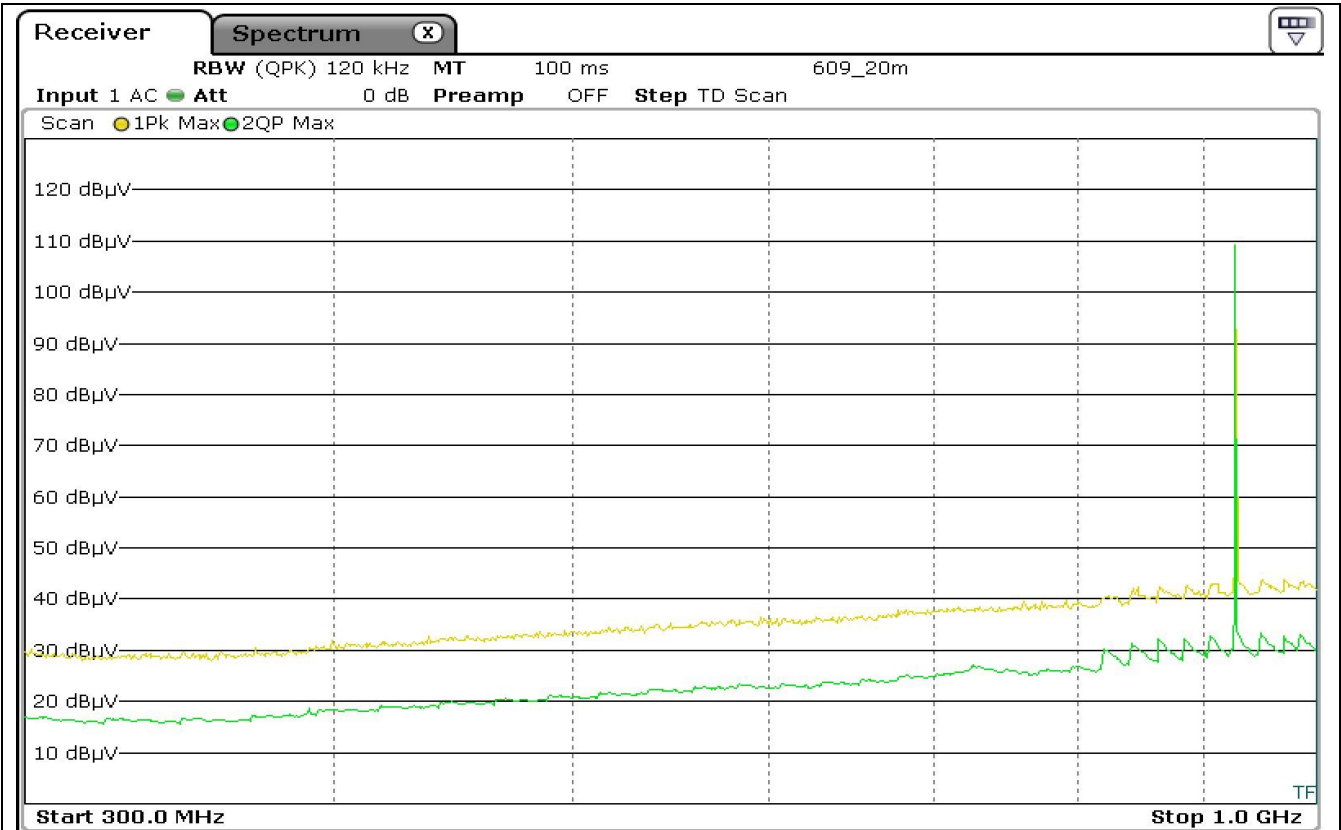
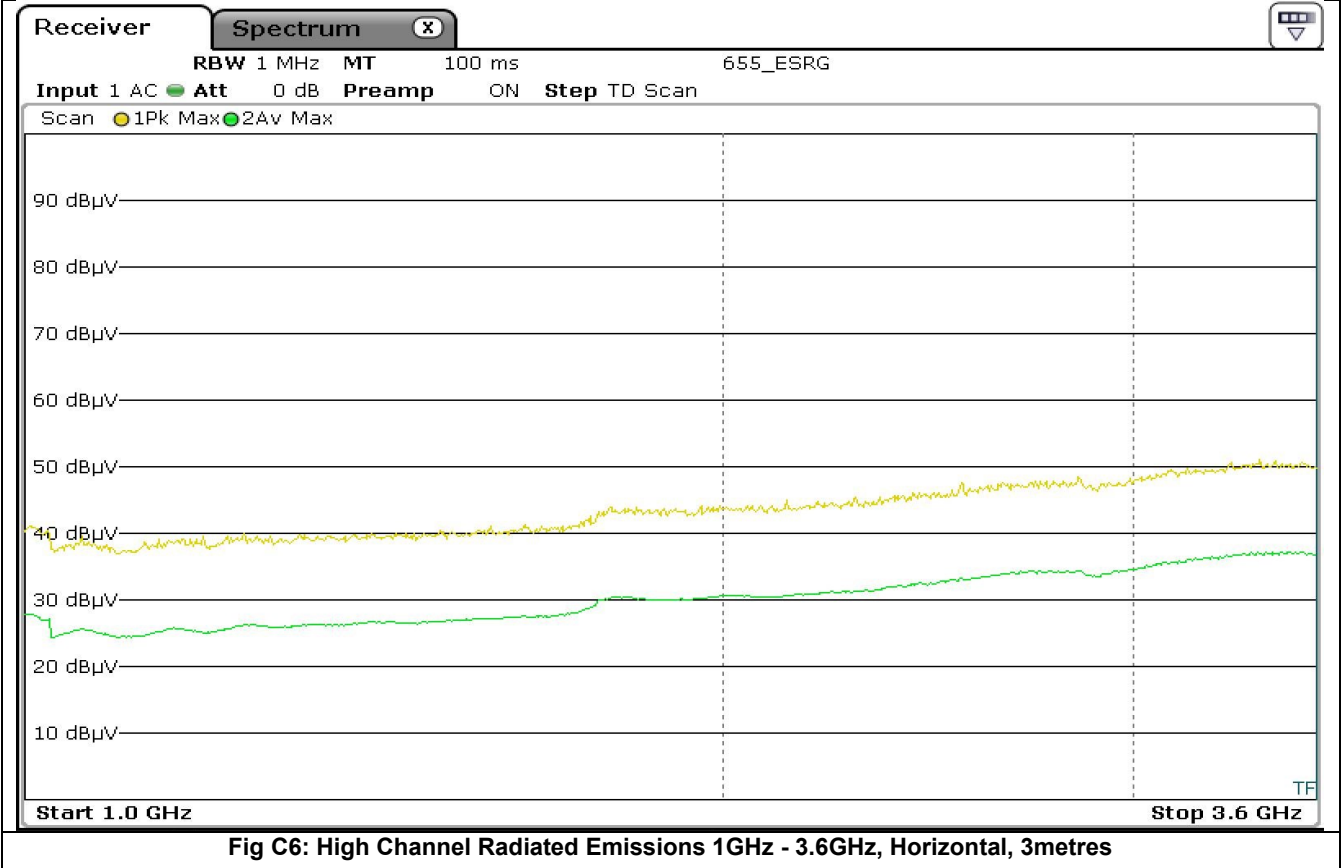
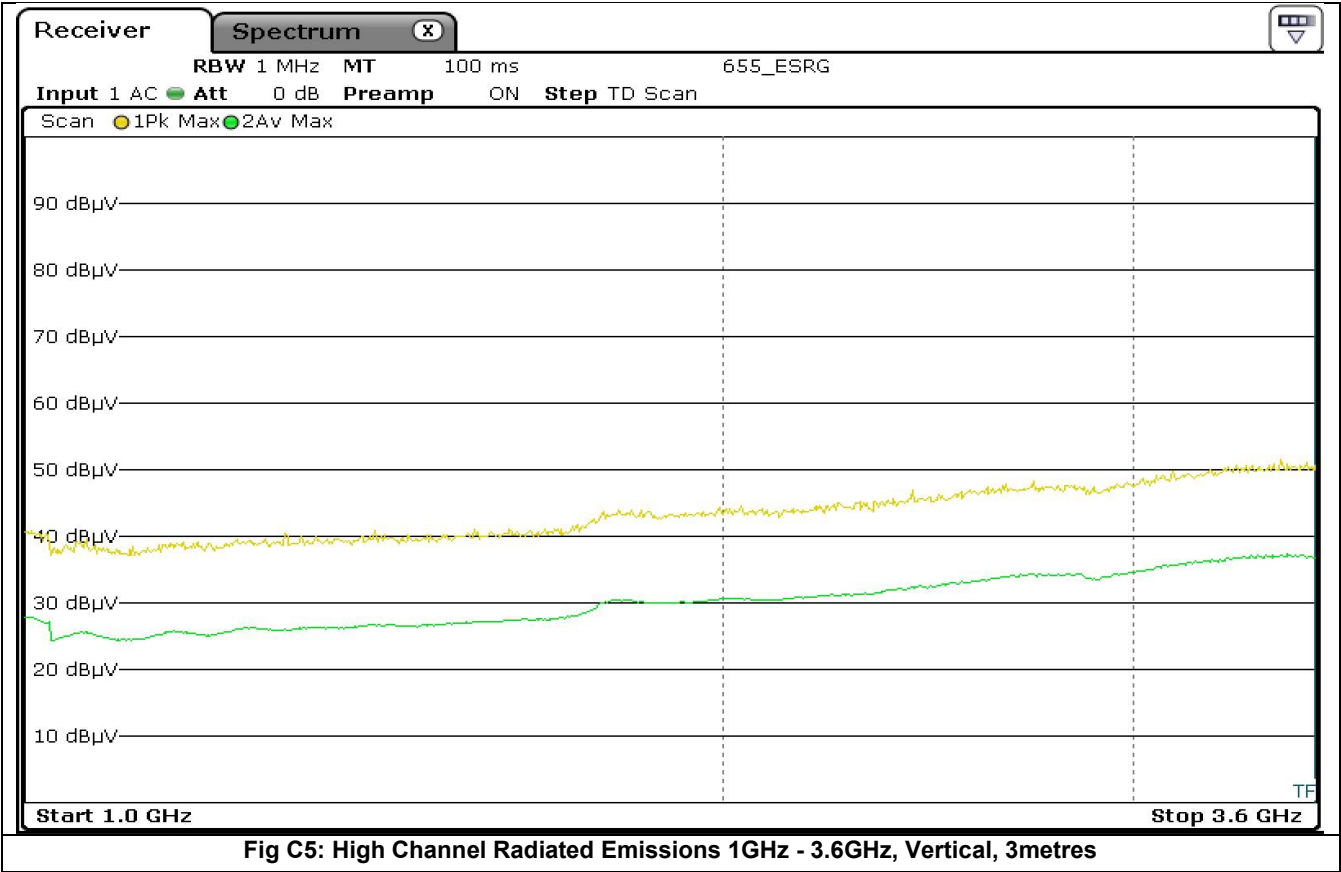
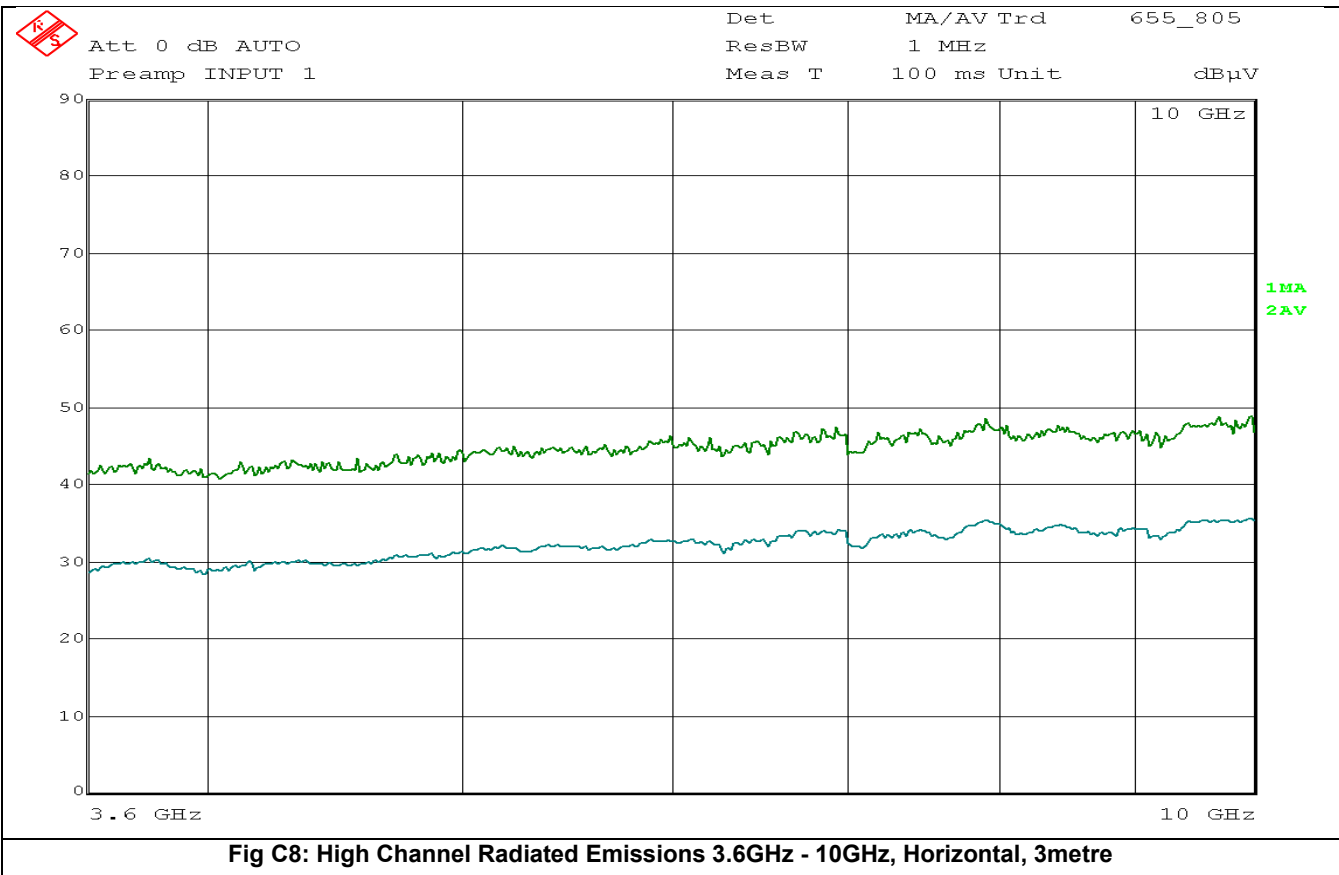
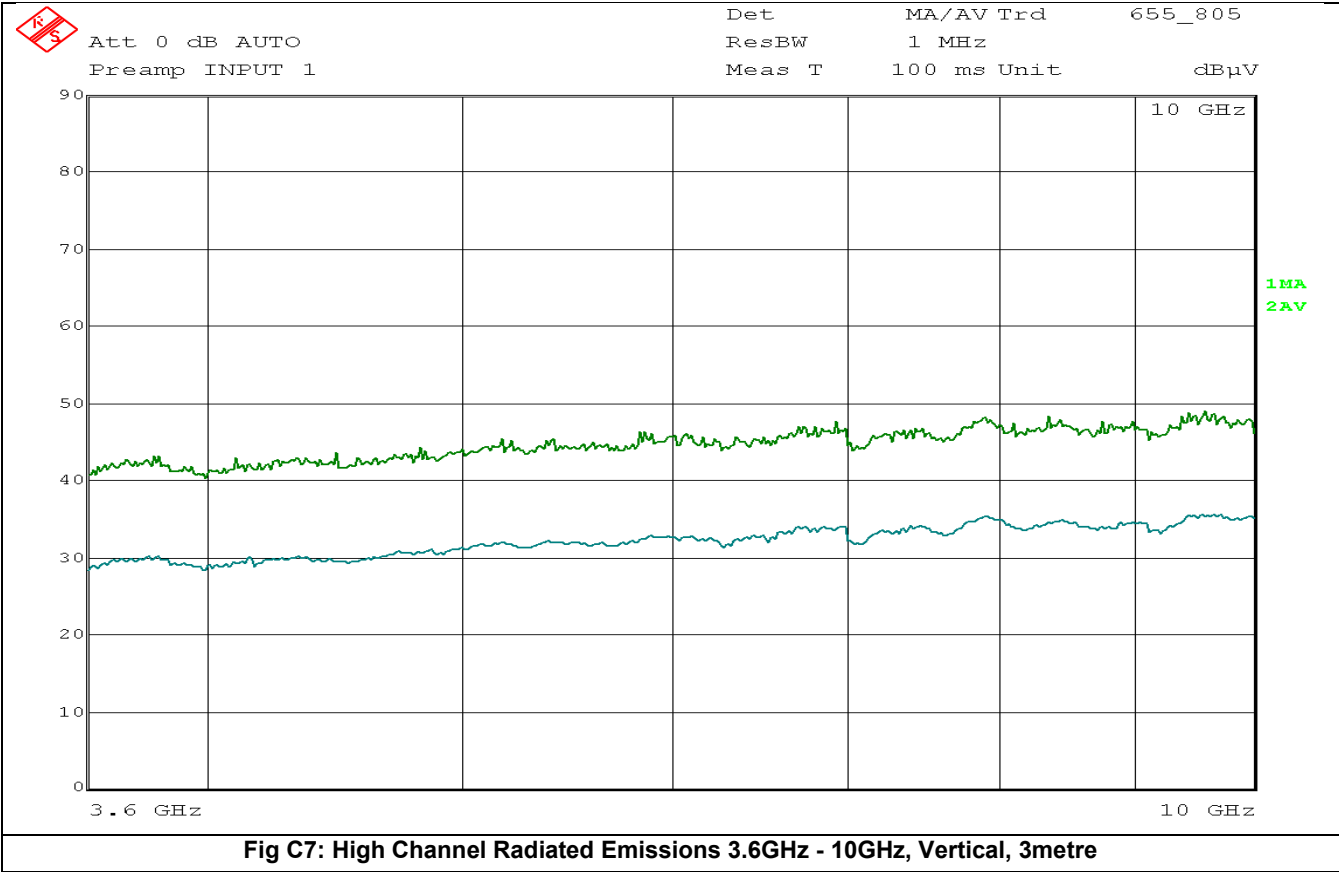


Fig C4: High Channel Radiated Emissions 300MHz - 1GHz, Horizontal, 3metres





Appendix D: Test Setup

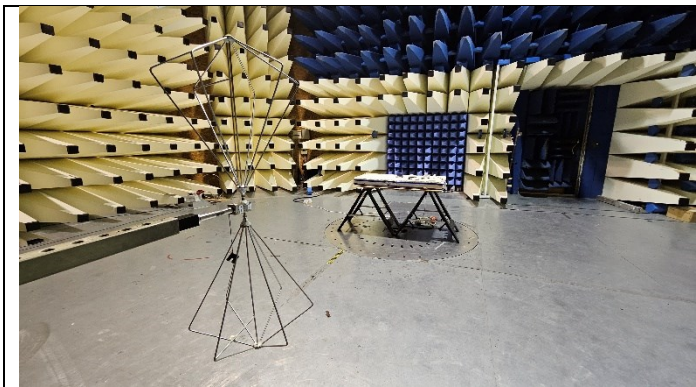


Fig D1: Radiated Emissions Below 1GHz



Fig D2: Radiated Emissions Below 1GHz



Fig D3: Radiated Emissions Below 1GHz

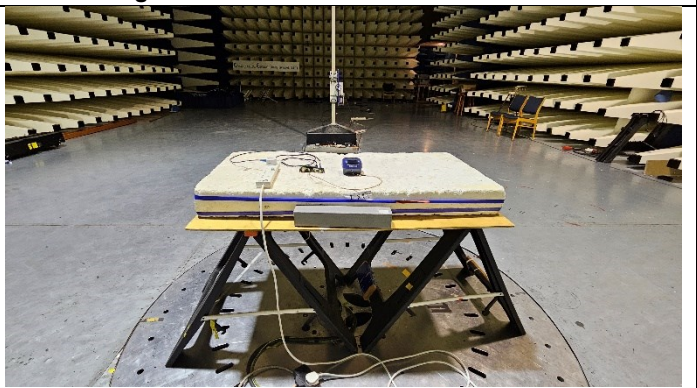


Fig D4: Radiated Emissions Below 1GHz

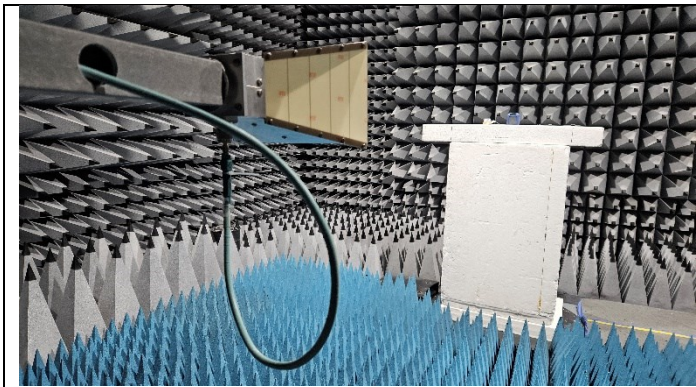


Fig D5: Radiated Emissions Above 1GHz

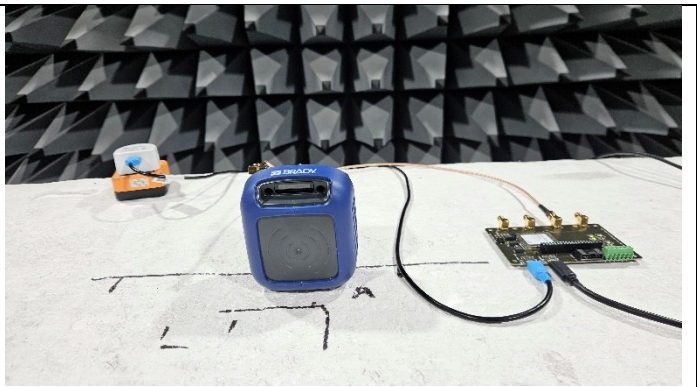


Fig D6: Close up (Orientation O1)

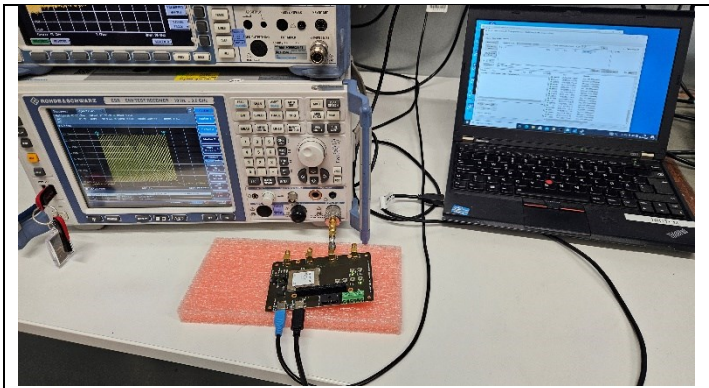
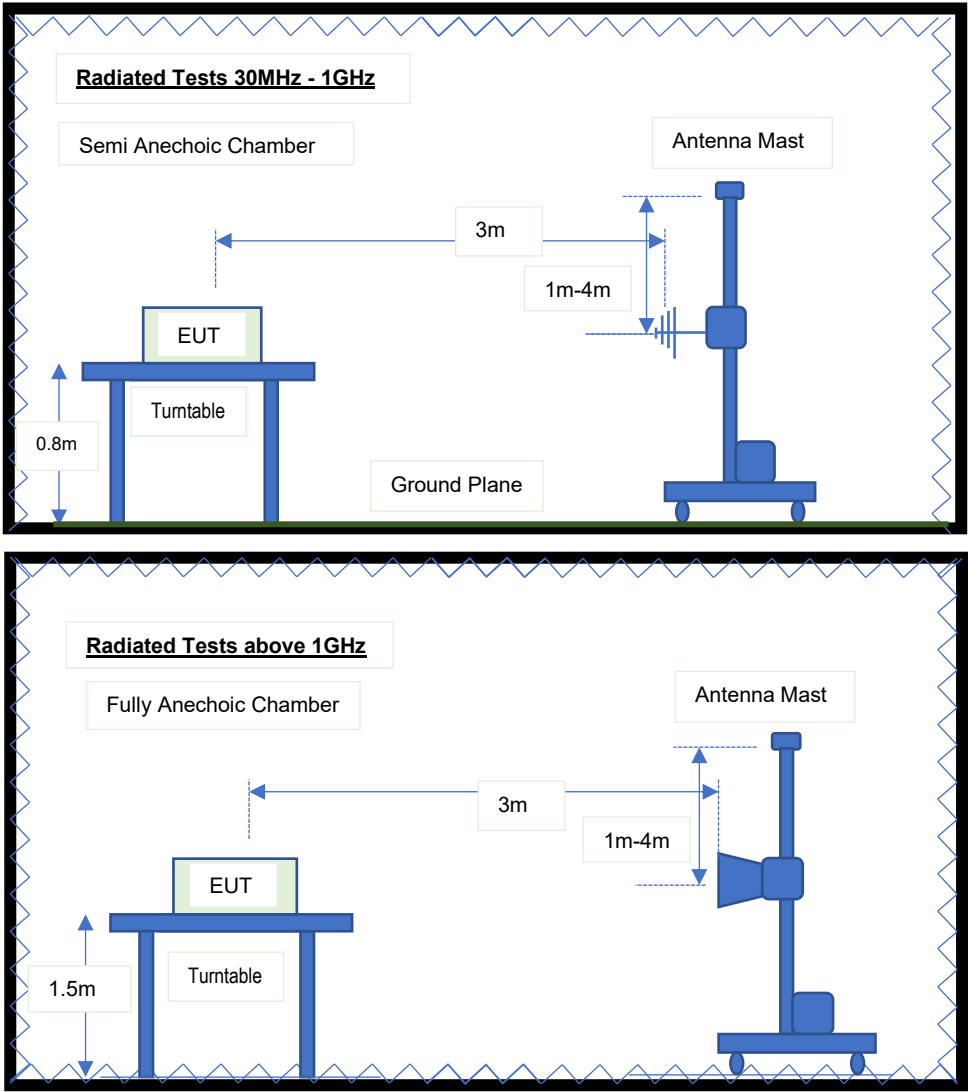


Fig D7: Conducted Emissions

Appendix E: Block Diagrams of Test Setup



End of Report