ENGINEERING TEST REPORT

QT-AD10C Module
Model: QT-AD10C
FCC ID: Q5N-QTAD10C
IC: 4614A-QTAD10C

Applicant:

Quantum5x Systems Inc.
30 Adelaide Street North Suite 12
London, Ontario
Canada N6B 3N5

In Accordance With

Federal Communications Commission (FCC)
47 CFR, Parts 2 and 74,
RSS-123- Issue 4- Licensed Wireless Microphones

UltraTech's File No.: 20Q5X077_F74HRSS123

This Test report is Issued under the Authority of Tri M. Luu Vice President of Engineering UltraTech Group of Labs Date: May 16, 2020	
Report Prepared by: Santhosh Fernandez Issued Date: May 16, 2020	Tested by: Nimisha Desai Test Dates: March 3-10, 2020

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.236
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15 – Radio Frequency Devices
Purpose of Test:	Equipment Certification for Section 15.236 Operation of Wireless Microphones
Test Procedures:	▪ ANSI C63.4 ▪ ANSI C63.26
Environmental Classification:	[x] Commercial, industrial or business environment [x] Residential environment

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2020	Code of Federal Regulations (CFR), Title 47 – Telecommunication
ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz
ANSI C63.26	2015	American National Standard for Compliance Testing of Transmitters used in Licensed Radio Services
FCC KDB Publication No. 206256 D01 Wireless Microphone Certification v02	2017	Basic certification requirements for wireless microphones
ETSI EN 300 422-1 V1.4.2	2011-08	Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement
RSS-Gen, Issue 5	2019	General Requirements for Compliance of Radio Apparatus
RSS-123, Issue 4	2019	Licensed Wireless Microphones
ICES-003, Issue 6	2016	Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

Applicant	
Name:	Quantum5x Systems Inc.
Address:	30 Adelaide Street North Suite 12 London, Ontario Canada N6B 3N5
Contact Person:	Mr. Paul Johnson Phone #: 519-675-6999 Fax #: 519-667-2162 Email Address: paul@q5x.com

Manufacturer	
Name:	Quantum5x Systems Inc.
Address:	30 Adelaide Street North Suite 12 London, Ontario Canada N6B 3N5
Contact Person:	Mr. Paul Johnson Phone #: 519-675-6999 Fax #: 519-667-2162 Email Address: paul@q5x.com

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Quantum5x Systems Inc.
Product Name:	QT-AD10 Module
Model Name or Number:	QT-AD10C
Serial Number:	Test Sample #122
Type of Equipment:	Licensed Wireless Microphones
Input Power Supply Type:	Lithium-Ion Battery / External DC Power
Primary User Functions of EUT:	The Primary use is to broadcast audio from the user.

2.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Portable and Mobile
Intended Operating Environment:	Commercial, industrial or business environment
Power Supply Requirement:	3.7 V Lithium-Ion battery/ 5 VDC via AC adapter
RF Output Power Rating:	2 to15.3 mW
Operating Frequency Range:	941.625-959.725 MHz (FCC) 941.625-951.525 MHz, 953.525-959.725 MHz (ISED Canada)
RF Output Impedance:	50 Ω
Duty Cycle:	100%
Modulation Type:	16MR Digital Modulation
Emission Type	G2E
Antenna Connector Types:	Integral(MH-4L internal) / SSMA connector

2.4. ASSOCIATED ANTENNA DESCRIPTIONS

Antenna Type	Maximum Gain (dBi)
¼ Wave wire UHF	0

2.5. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Audio Connector	1	Single Pin Lemo	4" min length, Shielded
2	UHF Antenna	1	Hardwired	129mm
3	802.15.4 Antenna	1	Hardwired	30mm
4	Battery Charger	1	Micro USB	<3 feet - Shielded

2.6. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment # 1	
Description:	AC/DC Adapter 5 V, 500 mA
Brand name:	Emerson Network Power
Model Name or Number:	DCH3-050US-0002
Serial#	010138
Connected to EUT's Port:	Micro USB

Ancillary Equipment # 2	
Description:	Remote Gateway
Brand name:	Q5X
Model Name or Number:	QG-H1
Connected to EUT's Port:	Wirelessly

Ancillary Equipment # 3	
Description:	Laptop
Brand name:	Acer
Model Name or Number:	D270-1998
Serial#	NUSGAAA 0012281 DF327614
Connected to EUT's Port:	N/A

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21 to 23 °C
Humidity:	45 to 58%
Pressure:	102 kPa
Power Input Source:	3.7 V Lithium-Ion battery / 5 VDC via AC adapter

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	Test software provided by the Applicant to operate the EUT at each channel frequency continuously and in the range of typical modes of operation.
Special Hardware Used:	N/A
Transmitter Test Antenna:	The EUT is tested with the antenna port terminated to a 50 Ohm RF Load.

Transmitter Test Signals	
Frequency Band(s):	941.625-959.725 MHz (FCC) 941.625-951.525 MHz, 953.525-959.725 MHz (ISED Canada)
Frequency(ies) Tested:	941.625 MHz, 5951.525 MHz, 953.525MHz 959.725MHz
RF Power Output: (measured maximum output power at antenna terminals)	14.52 mW Average
Normal Test Modulation:	Digital16MR
Modulating Signal Source:	Internal

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).

Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with ANAB File No.: AT-1945.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
74.861(d) (1) and RSS-123 8.2	RF Power Output	Yes
2.1047(b) and 74.861(e)(3)	Modulation characteristics, Modulation Limiting	N/A (not FM)
Rule part: 2.1049, 74.861(d)(4)i and RSS-123 8.3	Occupied bandwidth	Yes
74.861(d) (4) i and RSS-123 8.3	Emission Masks	Yes
74.861(d)(4)i and RSS-123 8.3	Spurious Emissions at Antenna Terminal	Yes
74.861(d)(4)i and RSS-123 8.3	Field Strength of Spurious Radiation	Yes
2.1055 and 74.861(e)(4) and RSS-123 8.2	Frequency Stability	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.207(a), RSS Gen-8.8	AC Power Line Conducted Emissions	Yes
ICES-003, Issue 6	Information Technology Equipment (Including Digital Apparatus) - Limits and Methods of Measurement	Yes

4.3. DEVIATION OF STANDARD TEST PROCEDURES

None

4.4. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

EXHIBIT 5. TEST DATA

5.1. MAXIMUM RADIATED POWER [§ 74.861(d) (1) and RSS-123 8.2]

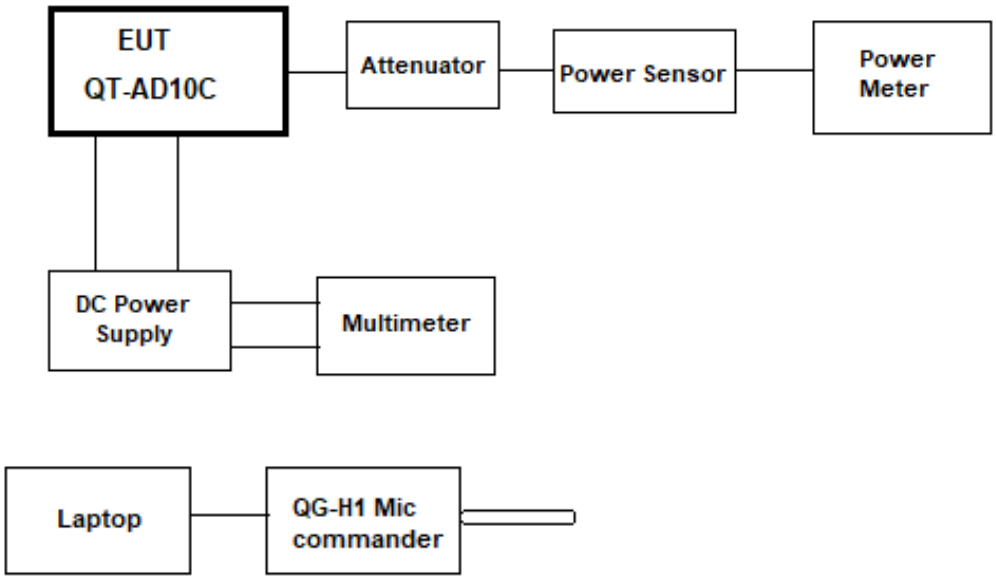
5.1.1. Limit(s)

For all bands except the 1435-1525 MHz band, the maximum transmitter power, which will be authorized, is 1 watt.

5.1.2. Method of Measurements & Test Arrangement

ANSI 63.26

5.1.3. Test Arrangement



5.1.4. Test Equipment

Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Power Analyzer	HP	8991A	3342A00657	sensor dependant	12 Sep 2021
Power Sensor	HP	84814A	3205A00175	0.5-40GHz	12 Sep 2021
Attenuator (10dB)	Pasternack	PE7001-10	--	DC-3GHz	Cal on use
Power Supply	Tenma	72-7295	490300271	1-40V, DC 5A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

5.1.5. Test Data

QT-AD10, Average Conducted Output Power, Wire antenna 0dBi, 16MR Modulation

Frequencies MHz	Power Rating mW	Power Rating dBm	Measured dBm	Actual Power mW	Limit mW
941.625	15.300	11.85	11.62	14.52	1000.00
951.525	15.300	11.85	11.19	13.15	1000.00
953.525	15.300	11.85	11.17	13.09	1000.00
959.725	15.300	11.85	10.95	12.45	1000.00
941.625	2.000	3.01	2.35	1.72	1000.00
951.525	2.000	3.01	1.98	1.58	1000.00
953.525	2.000	3.01	1.90	1.55	1000.00
959.725	2.000	3.01	1.68	1.47	1000.00

Note: EUT Modulation cannot be disabled while operating.

5.2. OCCUPIED BANDWIDTH [§2.1049, 74.861(d) (4) i and RSS-123 8.3

5.2.1. Limit(s)

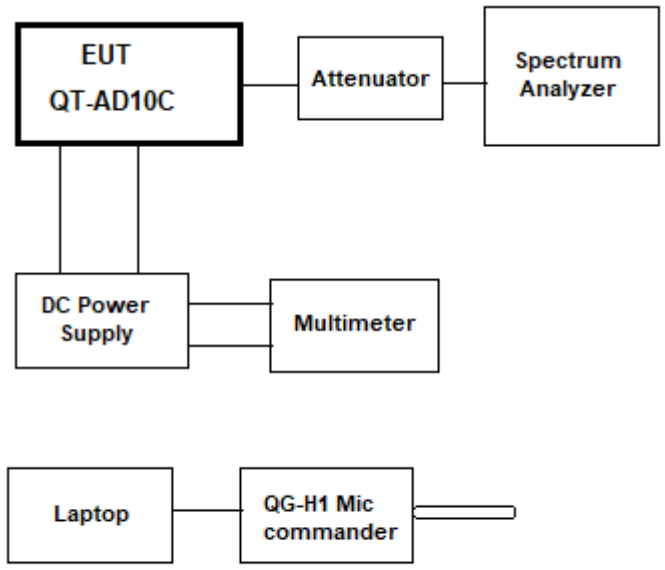
Table 1: Frequency bands, transmit power/e.r.p., authorized bandwidths and frequency stability limits

Frequency band (MHz)	Transmit power (W)	e.r.p. (W)	Authorized bandwidth (kHz)	Frequency stability (± ppm)
26.10-26.48	--	1	200	50
88-107.5	--	1	200	50
150-174	0.05	--	54	50
450-451	--	1	200	50
455-456	--	1	200	50
941.5-952	1	--	200	20
953-959.85	1	--	200	20
6930-6955	1	--	600	10
7100-7125	1	--	600	10

5.2.2. Method of Measurements

ANSI 63.26 Section 5.4

5.2.3. Test Arrangement



5.2.4. Test Equipment

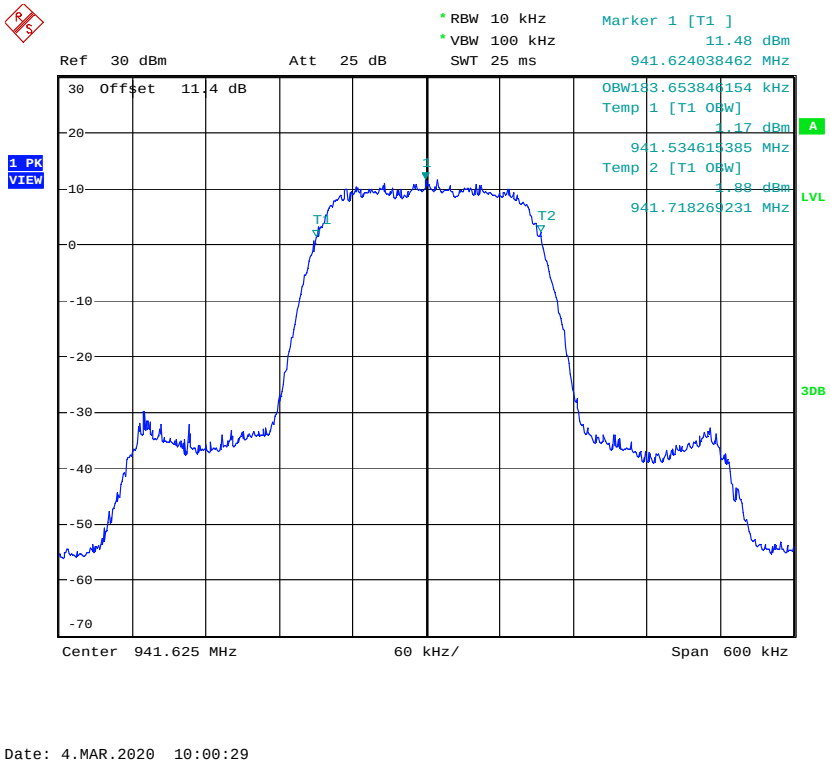
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	23 Oct 2021
Attenuator (10dB)	Pasternack	PE7001-10	--	DC-3GHz	Cal on use
Power Supply	Tenma	72-7295	490300271	1-40V, DC 5A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

5.2.5. Test Data

Frequency (MHz)	Digital Modulation	Power Setting	99% OBW (kHz)	Limit (kHz)
941.625	16MR	High	183.65	200
951.525	16MR	High	183.65	200
953.525	16MR	High	182.69	200
959.725	16MR	High	183.65	200

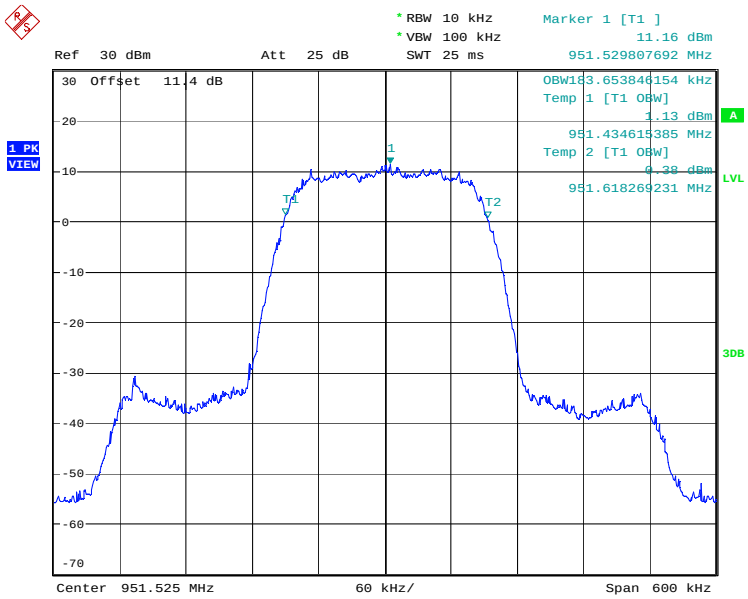
5.2.5.1. 99% OBW @ 941.625 MHz, High power

OBW: 183.65 KHz



5.2.5.2. 99% OBW @ 951.525 MHz, High power

OBW: 183.65 KHz



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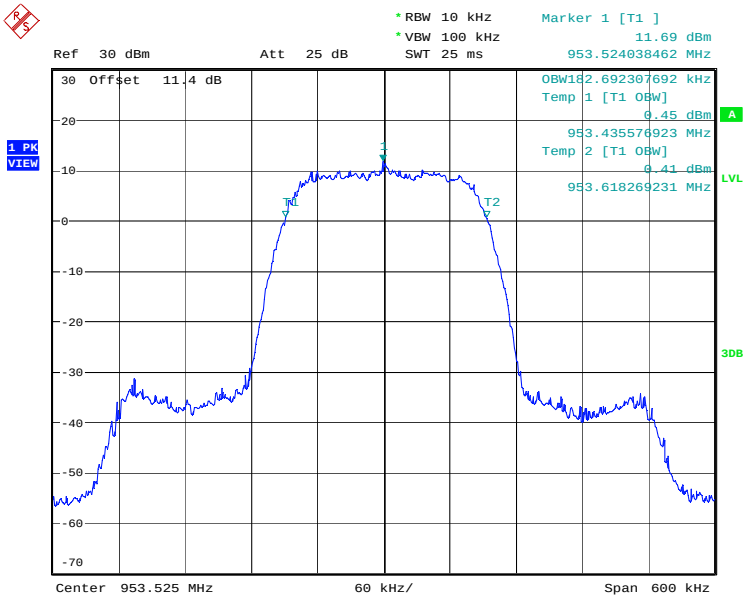
5.2.5.3. 99% OBW @953.525 MHz, High power

OBW: 182.69 KHz



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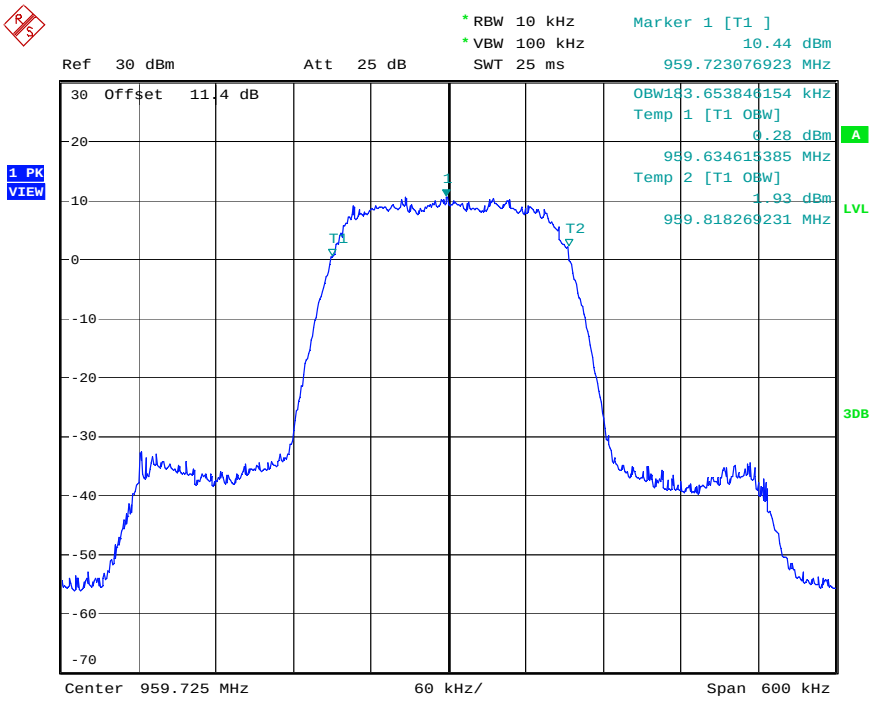
5.2.5.4. 99% OBW @ 959.725 MHz, High power

OBW: 183.65 KHz



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5.3. FREQUENCY TOLERANCE [§2.1055 and 74.861(e)(4), RSS 123 8.2]

5.3.1. Limit(s)

RSS123

Table 1: Frequency bands, transmit power/e.r.p., authorized bandwidths and frequency stability limits

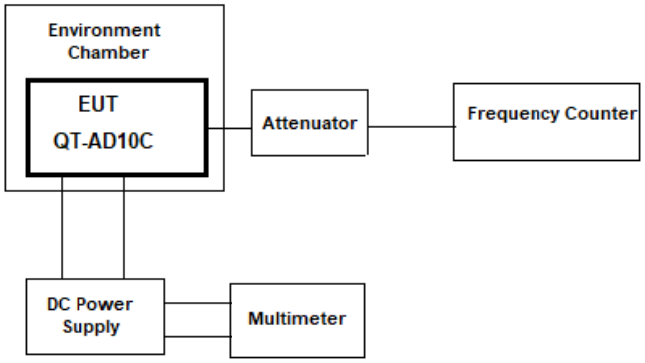
Frequency band (MHz)	Transmit power (W)	e.r.p. (W)	Authorized bandwidth (kHz)	Frequency stability (± ppm)
26.10-26.48	--	1	200	50
88-107.5	--	1	200	50
150-174	0.05	--	54	50
450-451	--	1	200	50
455-456	--	1	200	50
941.5-952	1	--	200	20
953-959.85	1	--	200	20
6930-6955	1	--	600	10
7100-7125	1	--	600	10

§74.861(e)(4) The frequency tolerance of the transmitter shall be 0.005 percent (50ppm).

5.3.2. Method of Measurements & Test Arrangement

FCC 2.1055 and RSS Gen 6.11

5.3.3. Test Arrangement



5.3.4. Test Equipment

Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Environmental Chamber	Envirotronics	SSH32C	11994847-S-11059	-60 to 177° C	10 Jun 2021
Frequency Counter	EIP	545A	2683	10MHz-1GHz	07 Aug 2020
Attenuator	Radiall	R411.820.121	--	DC-18GHz	Cal on use
Power Supply	Tenma	72-7295	490300271	1-40V, DC 5A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

5.3.5. Test Data

Carrier Frequency:	951.525	MHz	
Full Power Level:	12.13	mW	
Frequency Tolerance Limit:	20	ppm	(19030.5 Hz)
Max. Frequency Tolerance Measured:	1.55	ppm	(1477 Hz)
Nominal Voltage:	3.7	Vdc	

	Frequency Drift (Hz)		
Temp (Cel.)	**Normal Voltage (3.7 Vdc)**	**Battery End Point (3.0V dc)**	**+15% (4.255 Vdc)**
-30	-1280	--	--
-20	-731	--	--
-10	564	--	--
0	1073	--	--
10	1321	--	--
20	1374	1374	1377
30	1477	--	--
40	1349	--	--
50	1194	--	--

5.4. EMISSION MASK [§ 74.861(d)(4)i , RSS 123 8.3)]

5.4.1. Limit(s)

For the 653-657 MHz, 941.5-944 MHz, 944-952 MHz, 952.850-956.250 MHz, 956.45-959.85 MHz, 1435-1525 MHz, 6875-6900 MHz and 7100-7125 MHz bands, analog emissions within the band from one megahertz below to one megahertz above the carrier frequency shall comply with the emission mask in section 8.3.1.2 of the European Telecommunications Institute Standard ETSI EN 300 422-1 v1.4.2 (2011-08), Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement. Beyond one megahertz below and above the carrier frequency, emissions shall comply with the limits specified in section 8.4 of ETSI EN 300 422-1 v1.4.2 (2011-08).

ETSI EN 300 422-1 V1.4.2 Clause 8.3.2.2 Limits for Digital Systems

The transmitter output spectrum shall be within the mask defined in figure 4. This mask may also be used for analogue.

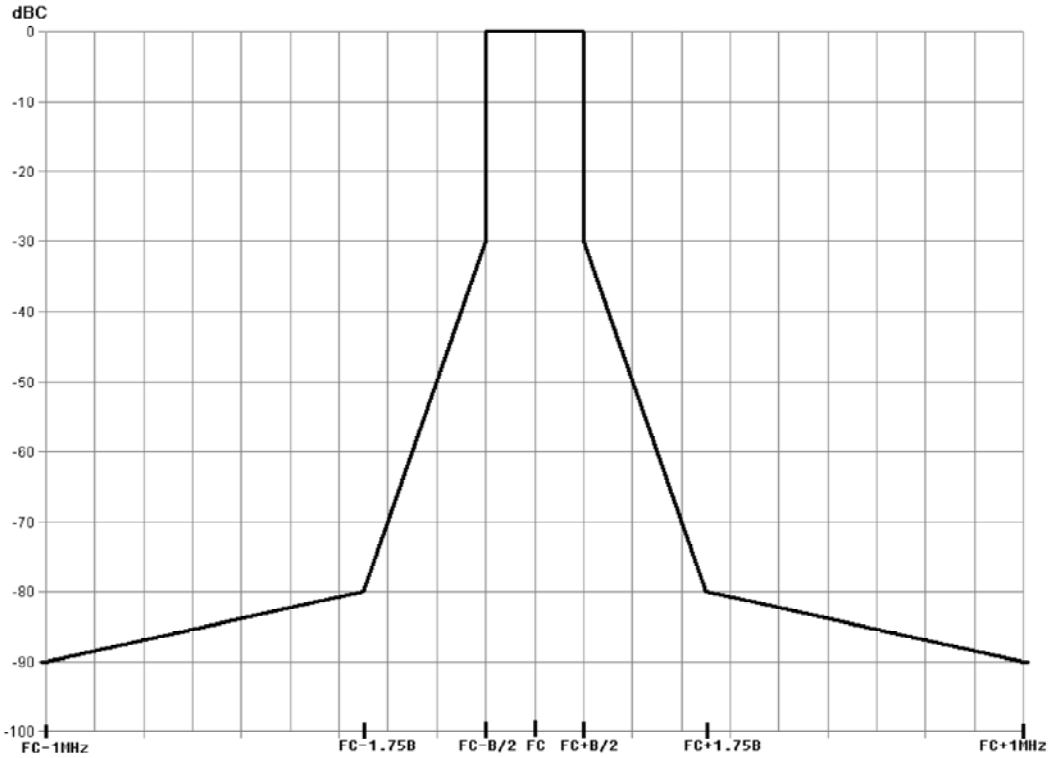
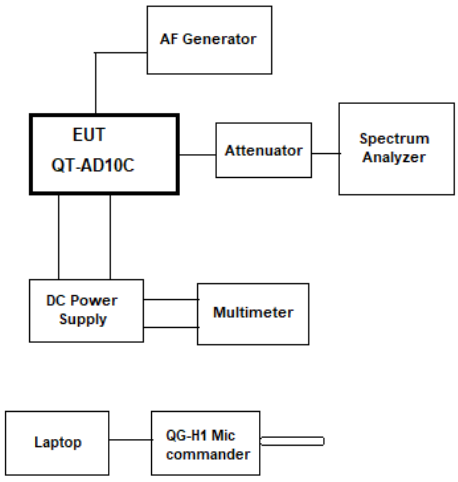


Figure 4: Spectrum mask for digital systems below 1 GHz

5.4.2. Method of Measurements

ETSI EN 300 422-1 V1.4.2 Clause 8.3.2

5.4.3. Test Arrangement



5.4.4. Test Equipment

Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	23 Oct 2021
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	20 Mar 2020
Attenuator (10dB)	Pasternack	PE7001-10	--	DC-3GHz	Cal on use
Power Supply	Tenma	72-7295	490300271	1-40V, DC 5A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

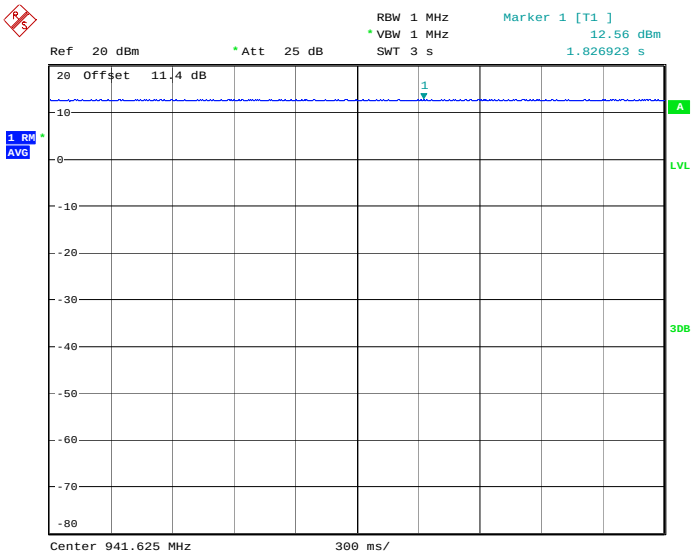
Test Date: March 4, 2020

5.4.5. Test Data

Emission Mask – High Power

5.4.5.1. Test Frequency: 941.625 MHz, High power

Step1: Carrier Power



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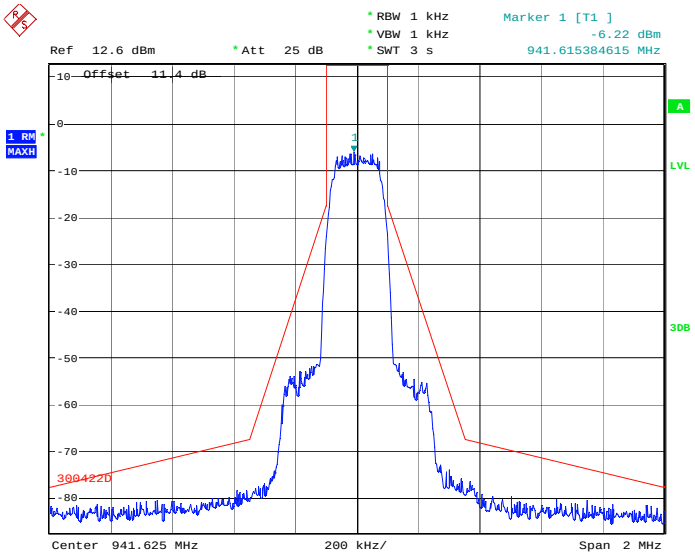
Step 2: Maximum Relative Level



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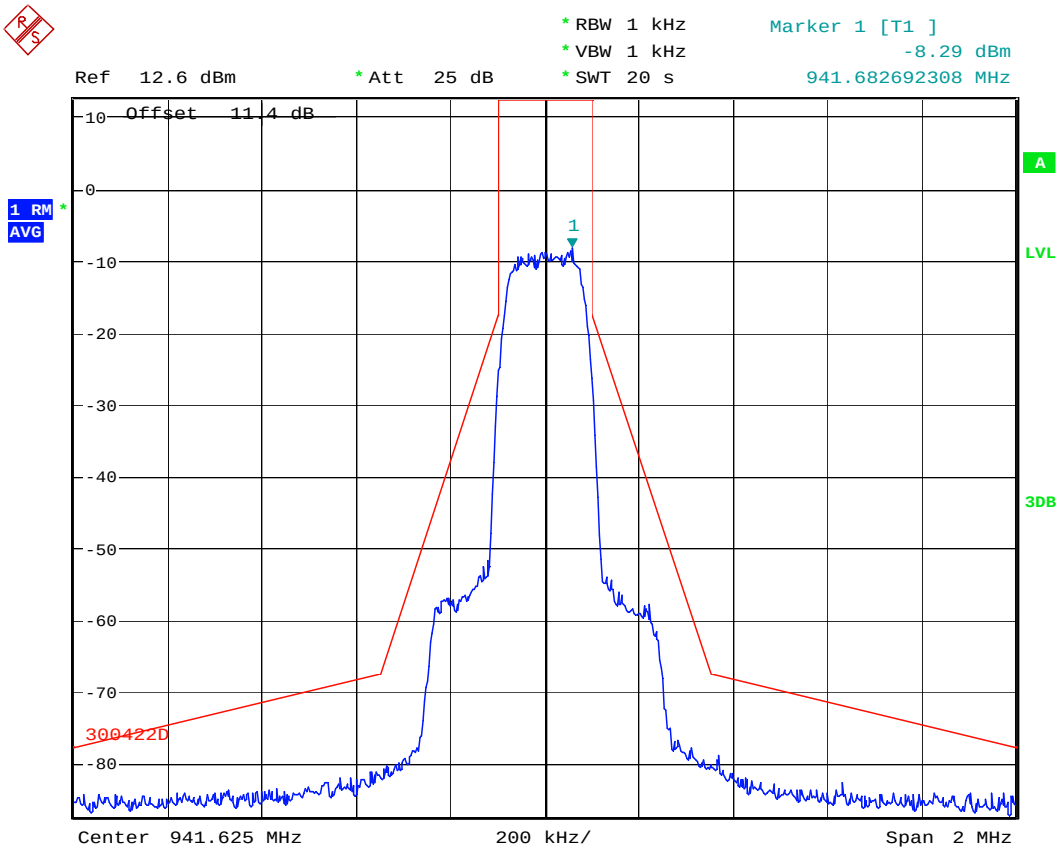
Step 3: Lower and Upper frequency transmitter



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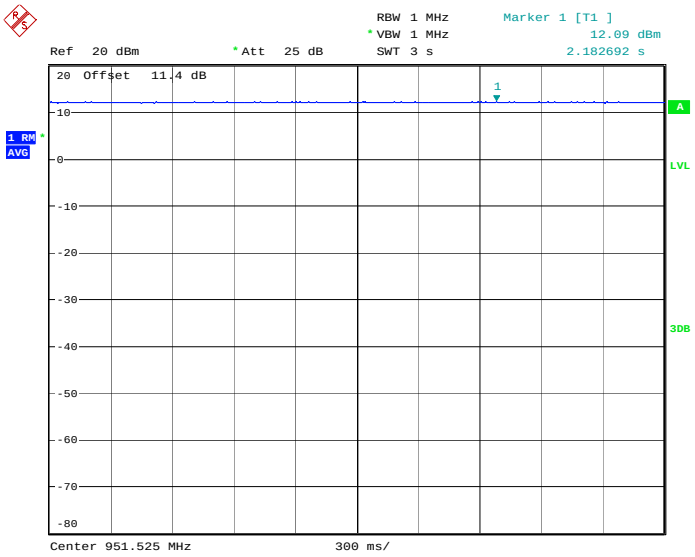
5.4.5.2. Test Frequency: 951.525 MHz, High power

Step1: Carrier Power



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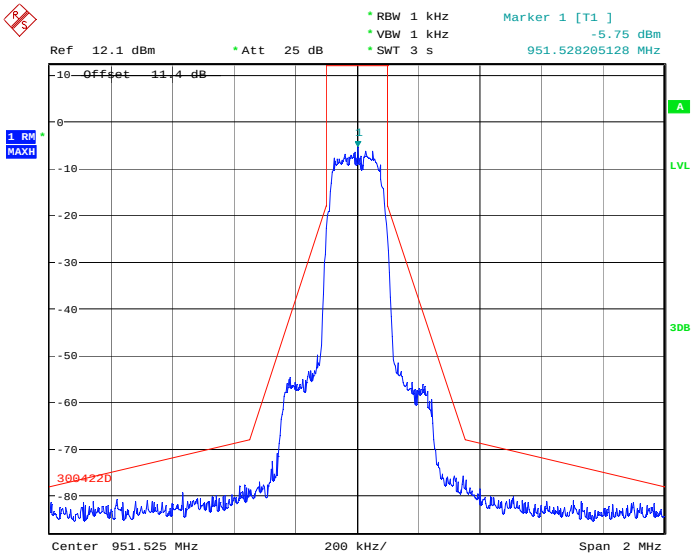
Step 2: Maximum Relative Level



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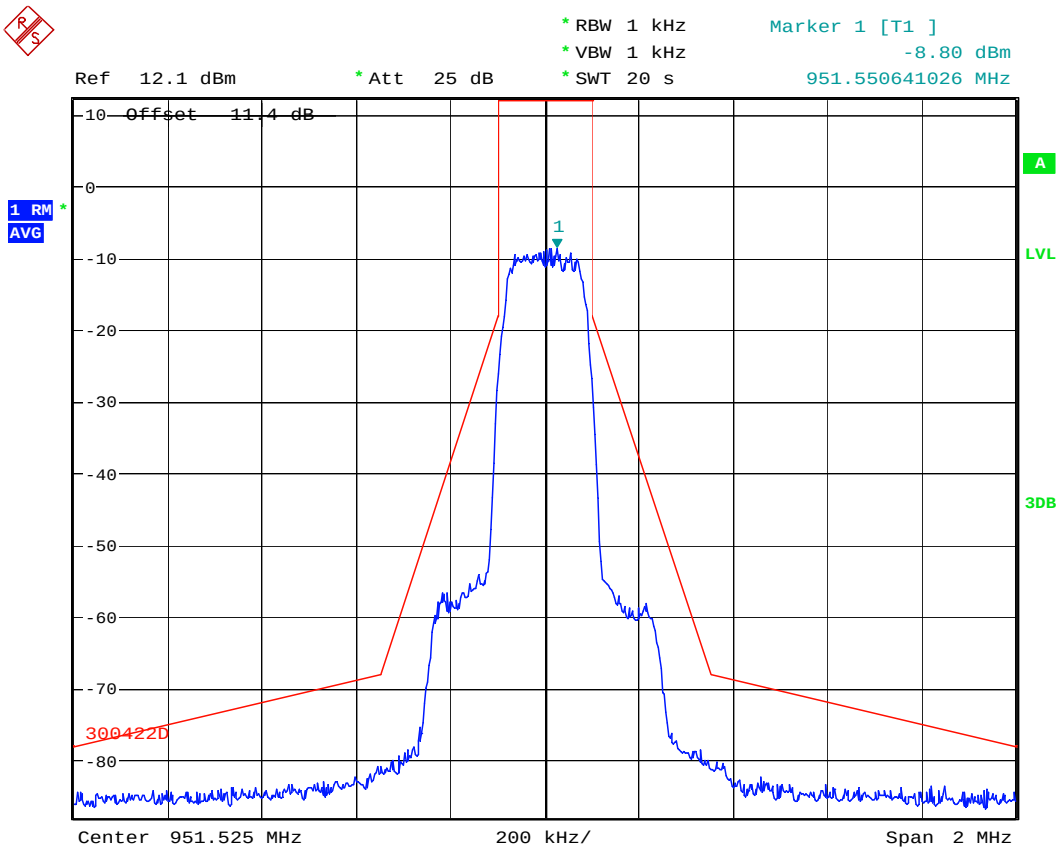
Step 3: Lower and Upper frequency transmitter



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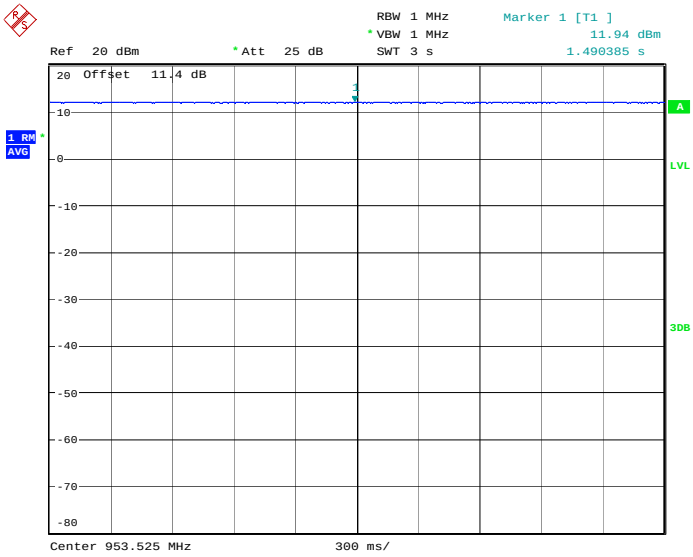
5.4.5.3. Test Frequency: 953.525 MHz, High power

Step1: Carrier Power



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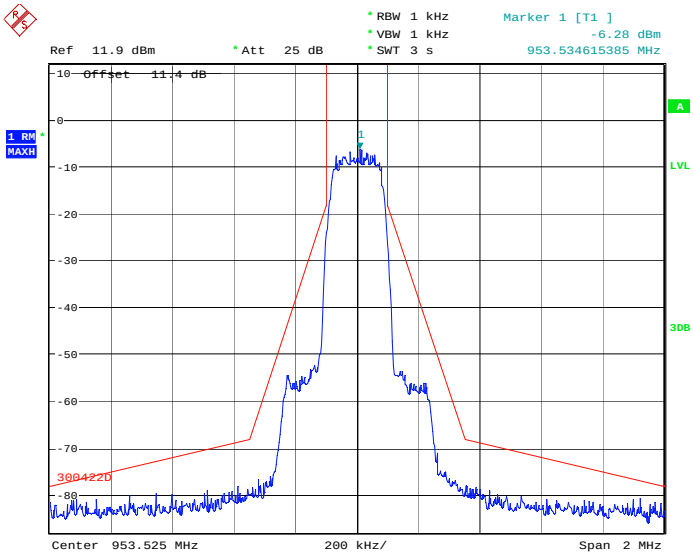
Step 2: Maximum Relative Level



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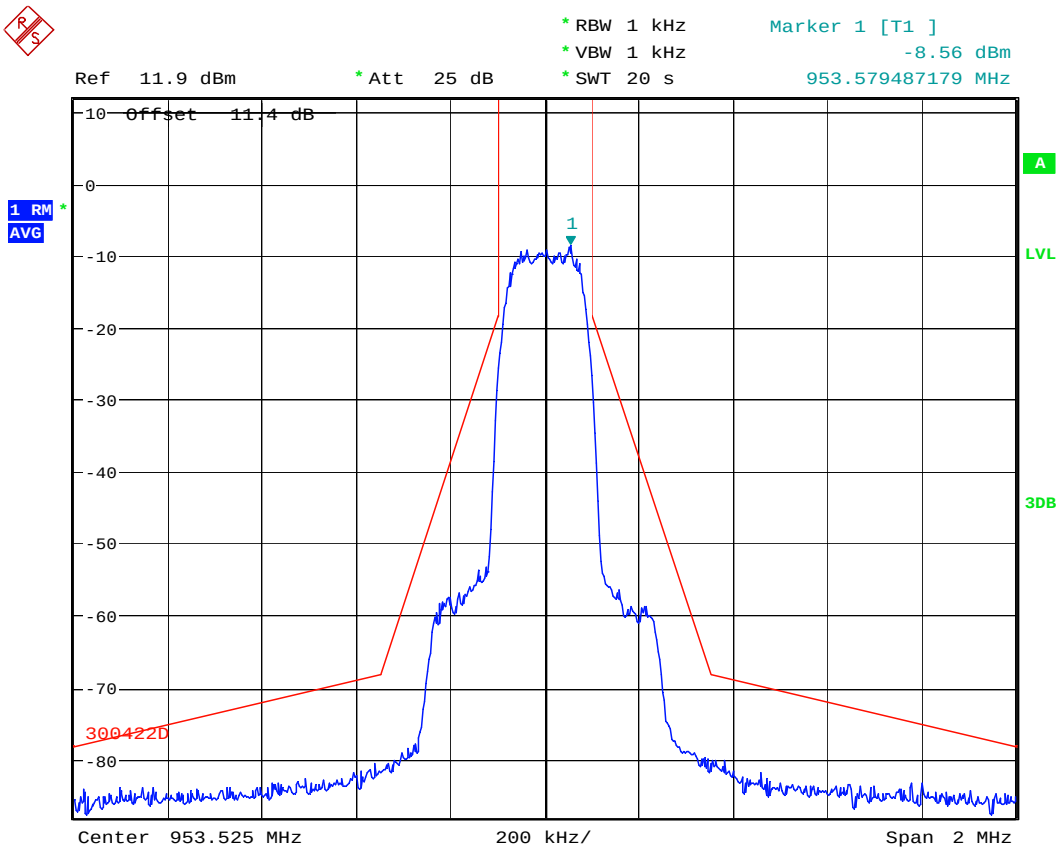
Step 3: Lower and Upper frequency transmitter



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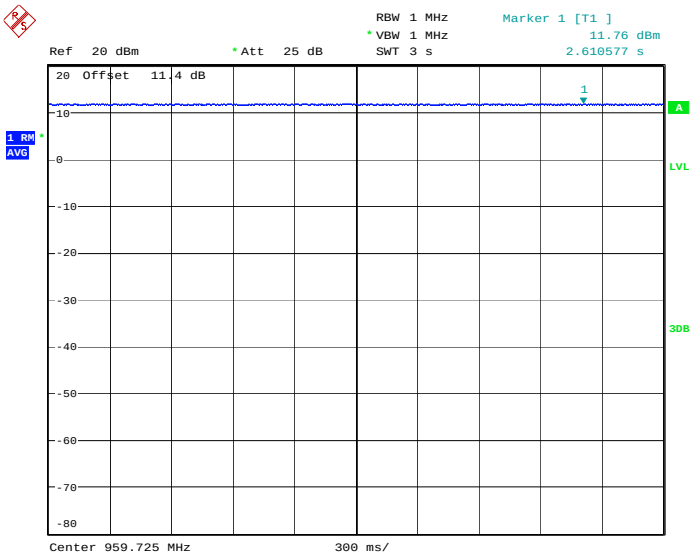
5.4.5.4. Test Frequency: 959.725 MHz, High power

Step1: Carrier Power



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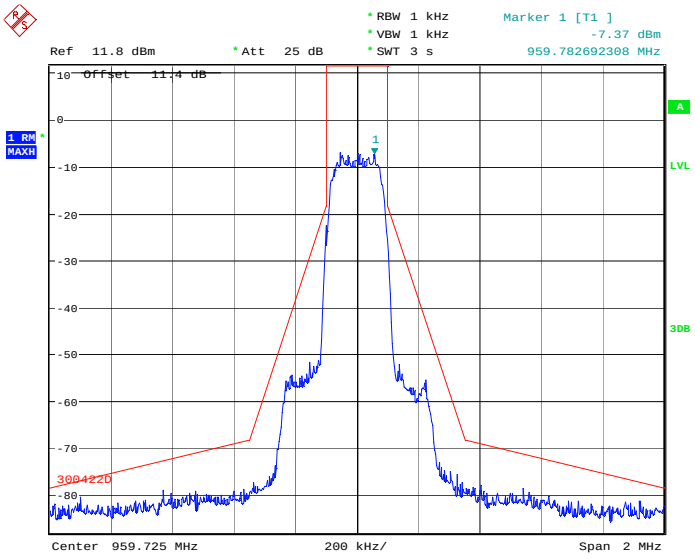
Step 2: Maximum Relative Level



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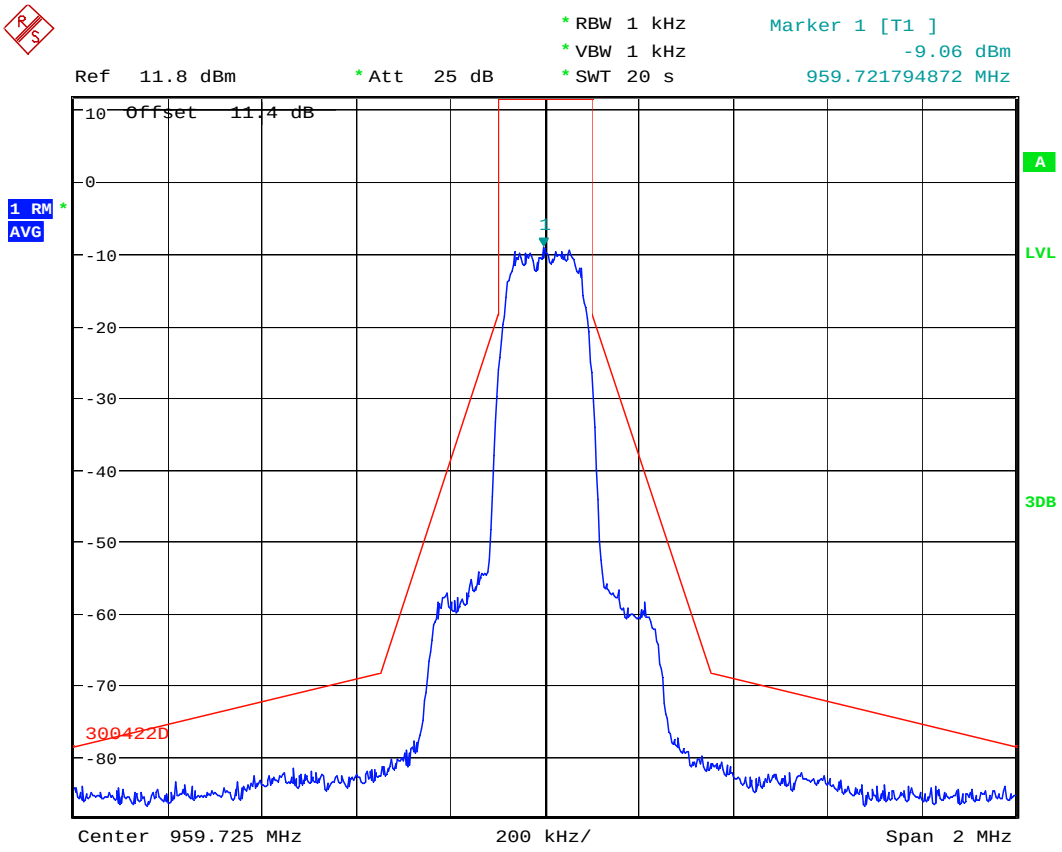
Step 3: Lower and Upper frequency transmitter



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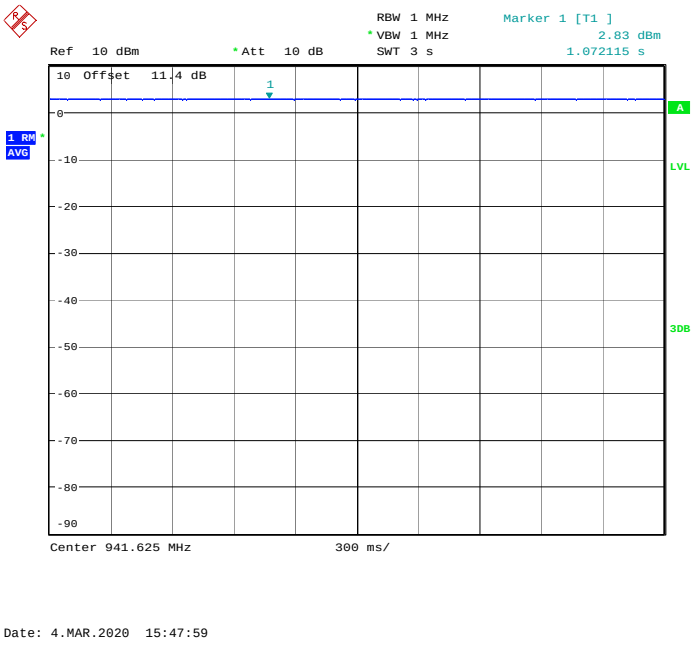
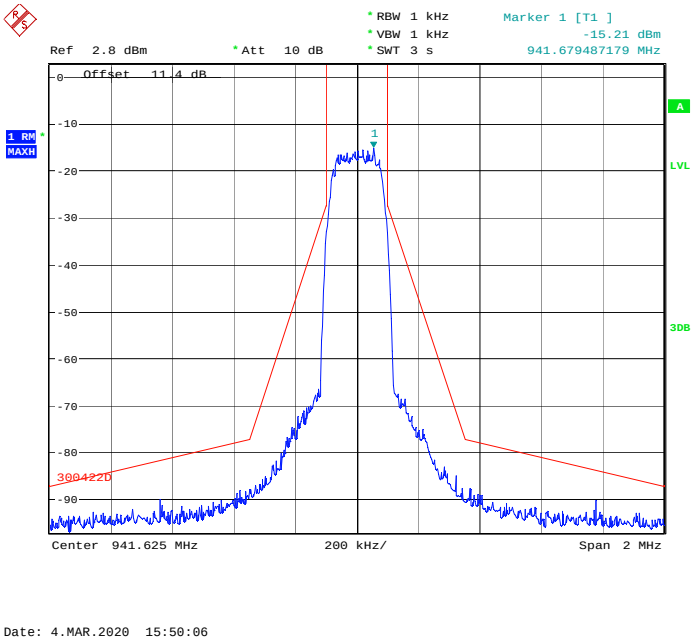
5.4.5.5. Test Frequency: 941.625 MHz, Low power

Step1: Carrier Power



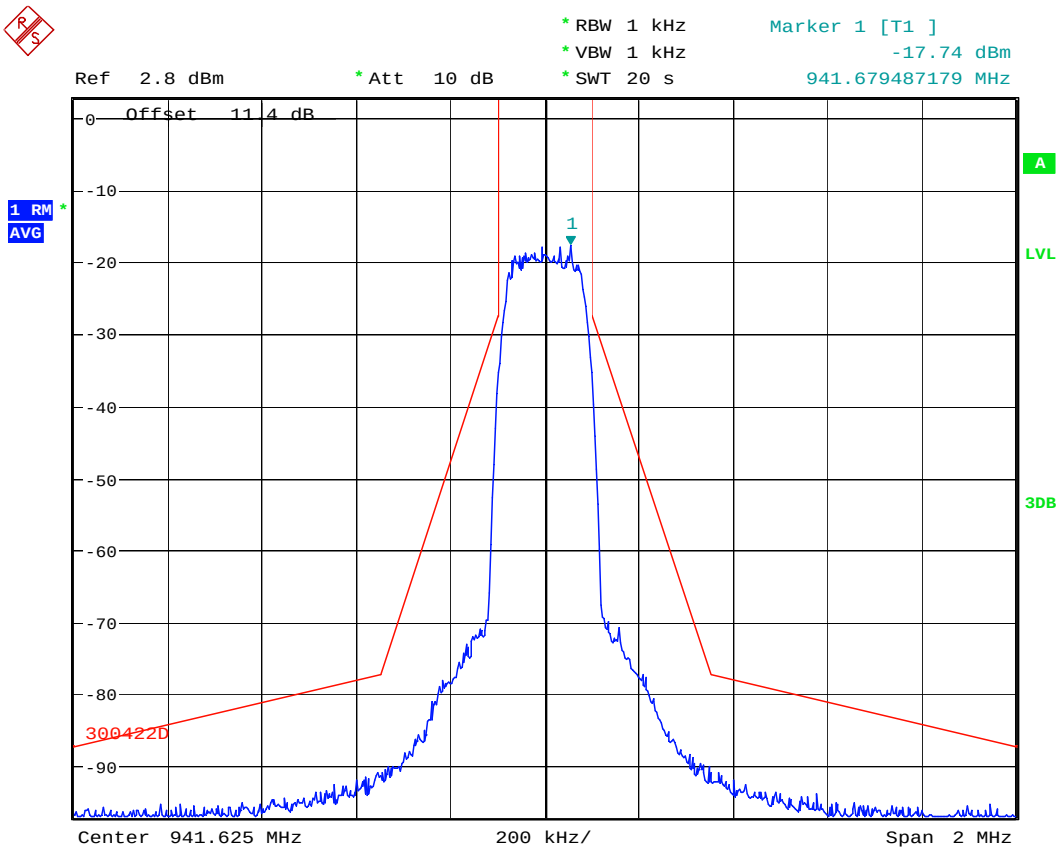
Date: 4.MAR.2020 15:47:59

Step 2: Maximum Relative Level



Date: 4.MAR.2020 15:50:06

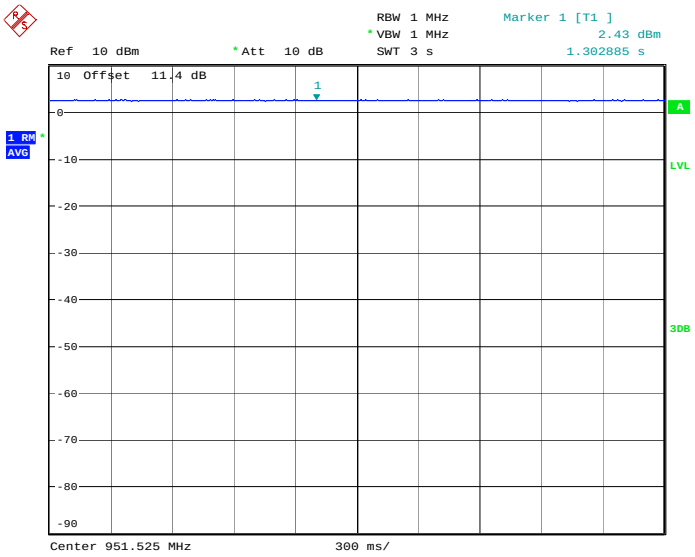
Step 3: Lower and Upper frequency transmitter



Date: 4.MAR.2020 15:50:53

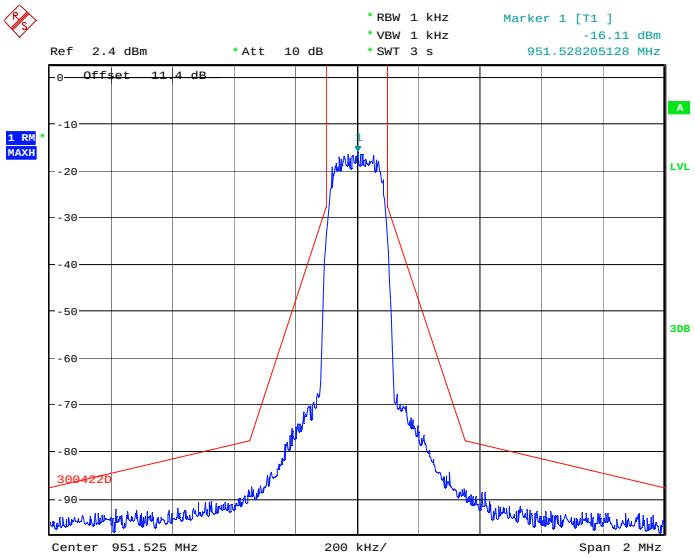
5.4.5.6. Test Frequency: 951.525 MHz, Low power

Step1: Carrier Power



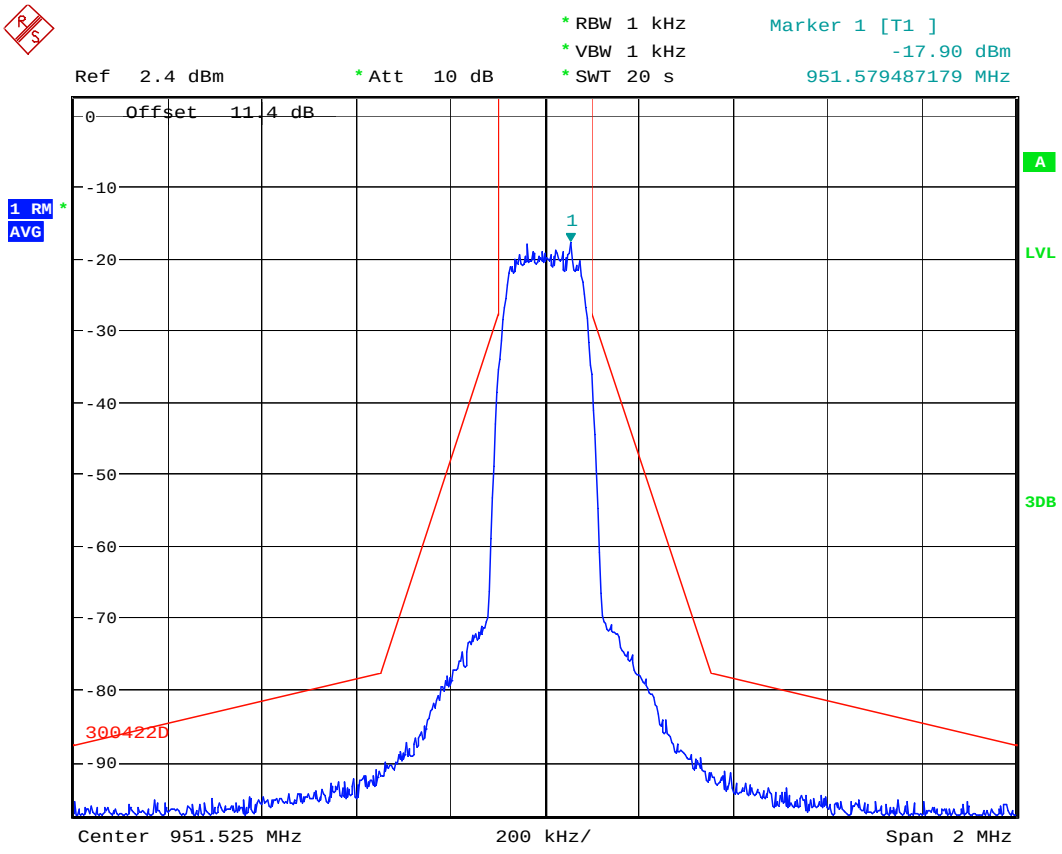
Date: 4.MAR.2020 15:52:43

Step 2: Maximum Relative Level



Date: 4.MAR.2020 15:54:27

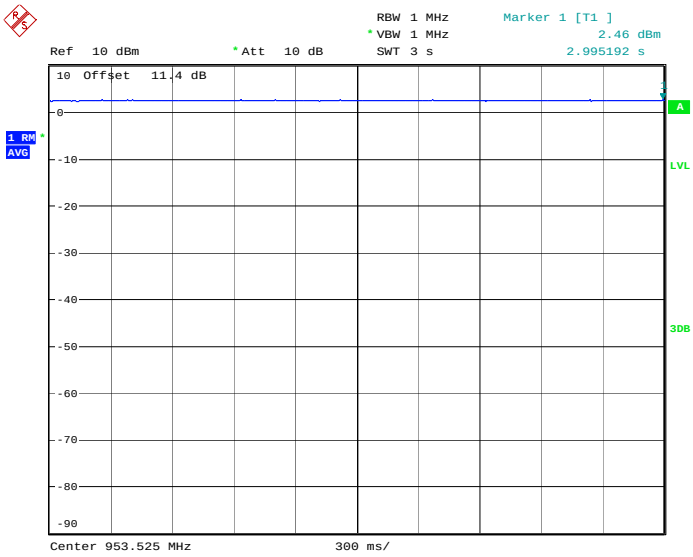
Step 3: Lower and Upper frequency transmitter



Date: 4.MAR.2020 15:55:17

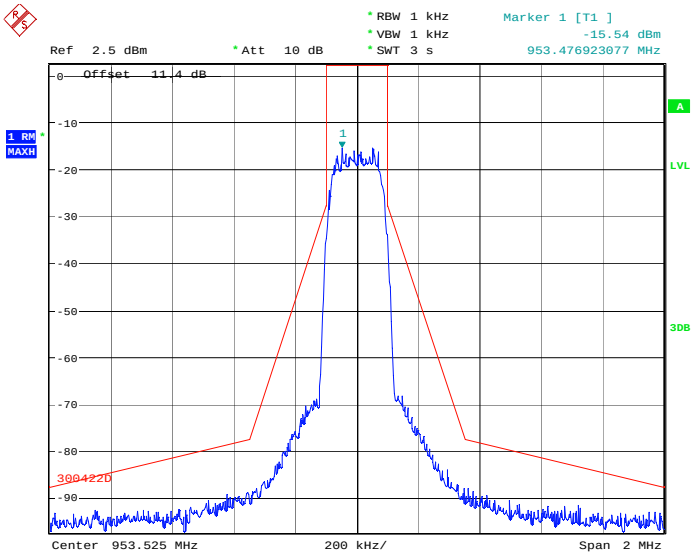
5.4.5.7. Test Frequency: 953.525 MHz, Low power

Step1: Carrier Power



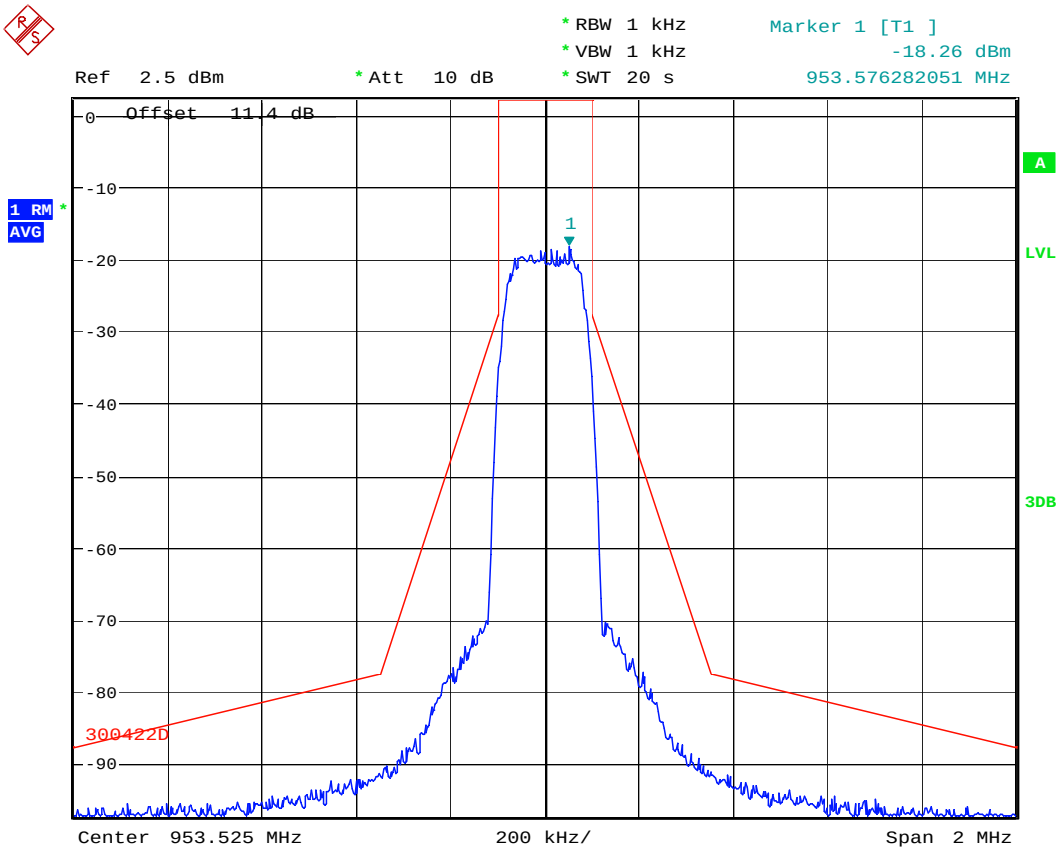
Date: 4.MAR.2020 15:56:37

Step 2: Maximum Relative Level



Date: 4.MAR.2020 15:59:27

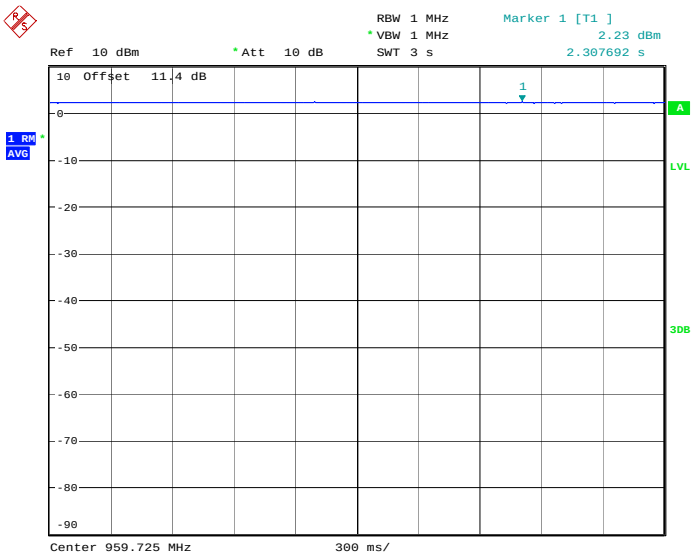
Step 3: Lower and Upper frequency transmitter



Date: 4.MAR.2020 16:00:19

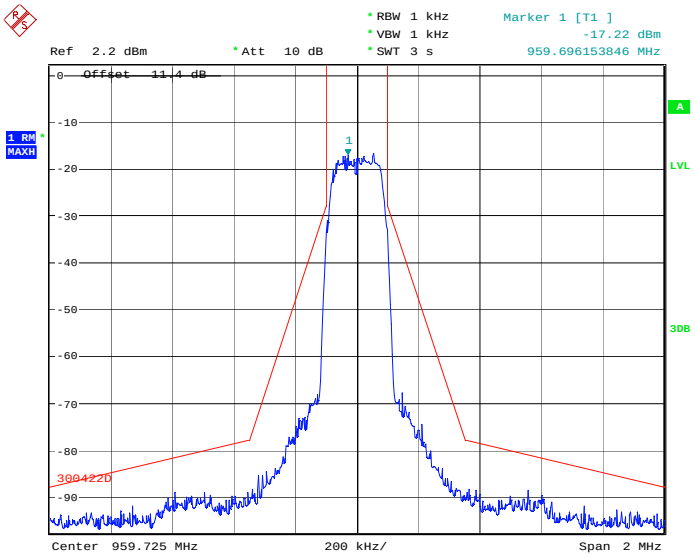
5.4.5.8. Test Frequency: 959.725 MHz, Low power

Step1: Carrier Power



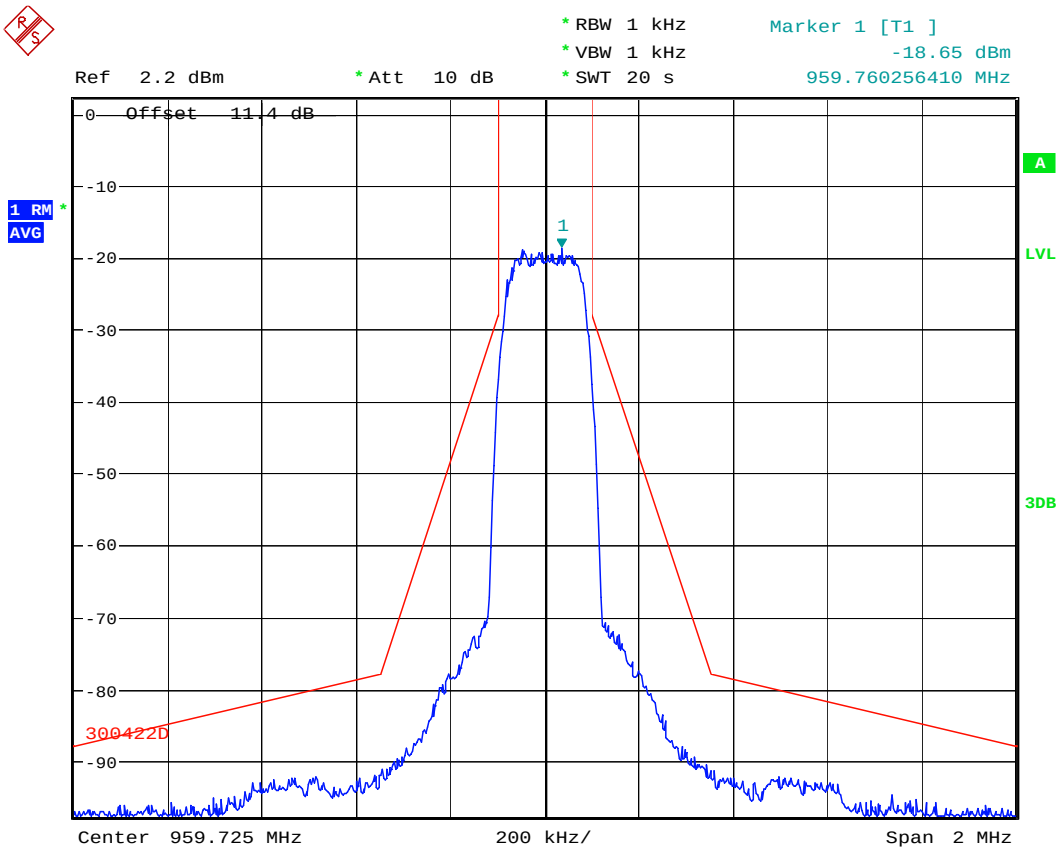
Date: 4.MAR.2020 16:02:33

Step 2: Maximum Relative Level



Date: 4.MAR.2020 16:04:08

Step 3: Lower and Upper frequency transmitter



Date: 4.MAR.2020 16:05:31

5.5. SPURIOUS EMISSIONS AT ANTENNA TERMINAL METERS [§ 74.861(d)(4)i , RSS 123 8.3)]

5.5.1. Limit(s)

Emissions within the band from one megahertz below to one megahertz above the carrier frequency shall comply with the emission mask in § 8.3 of ETSI EN 300 422-1 V1.4.2 (2011-08), Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement. Emissions outside of this band shall comply with the limits specified in section 8.4 of ETSI EN 300 422-1 V1.4.2 (2011-08).

EN 300 422-1 V2.1.2 (2017-01) Table 3: Limit for spurious emissions

Frequency / State	47 MHz to 74 MHz 87.5 MHz to 137 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
TX mode	4 nW	250 nW	1 µW
RX and all other modes	2 nW	2 nW	20 nW

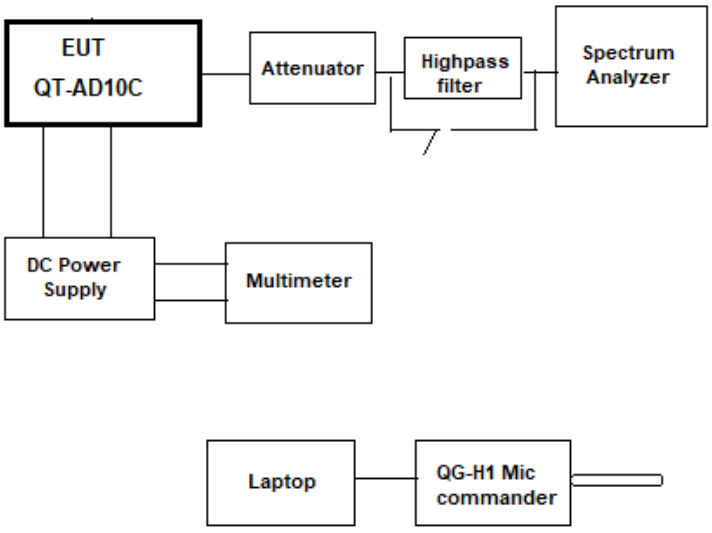
In dBm

Frequency / State	47 MHz to 74 MHz 87.5 MHz to 137 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
TX mode	-54 dBm	-36 dBm	-30 dBm
RX and all other modes	-57 dBm	-57 dBm	-47 dBm

5.6. Method of Measurements

ETSI EN 300 422-1 V1.4.2

5.6.1. Test Arrangement



5.6.2. Test Equipment

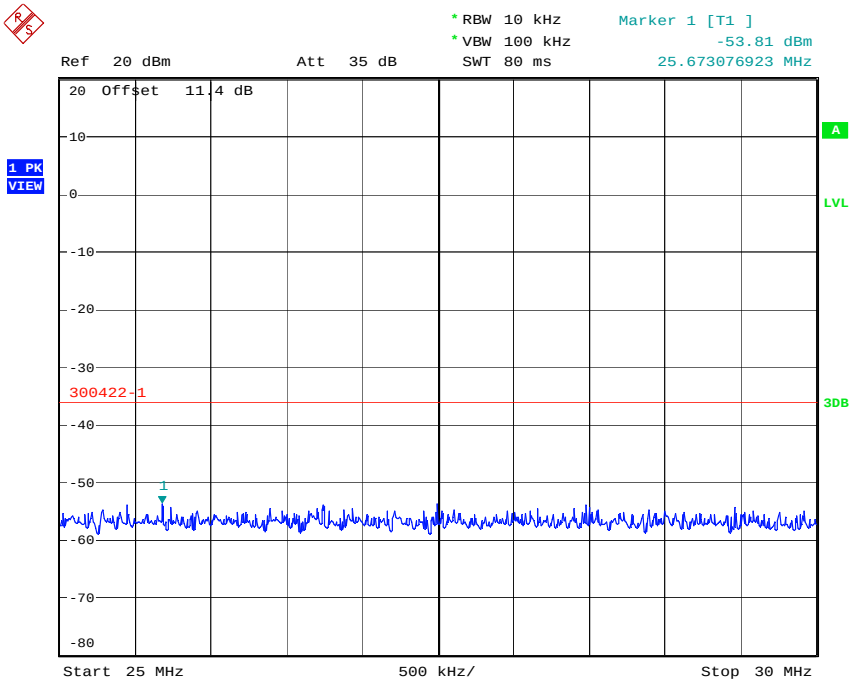
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Spectrum Analyzer	Rohde & Schwarz	FSU	100398	20Hz-26.5GHz	23 Oct 2021
AF Signal Generator	HP	HP-8920B	US39064699	30MHz-1GHz	20 Mar 2020
Attenuator (10dB)	Pasternack	PE7001-10	--	DC-3GHz	Cal on use
Hi-pass filter	K&L	11SH10-1500	2	Cut off 1500MHz	Cal on use
Power Supply	Tenma	72-7295	490300271	1-40V, DC 5A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

March 5, 2020

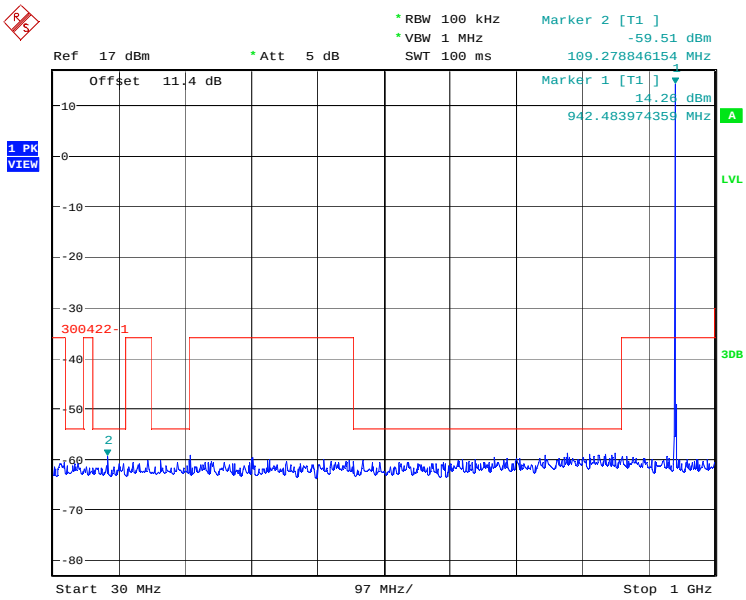
5.6.3. Test Data

HIGH POWER

5.6.3.1. Test Frequency: 941.625 MHz, High power



Date: 5.MAR.2020 09:32:30



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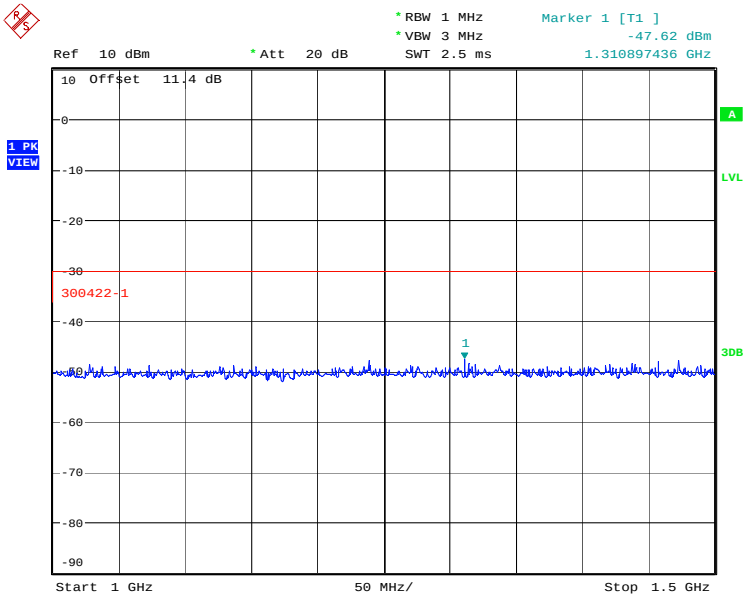
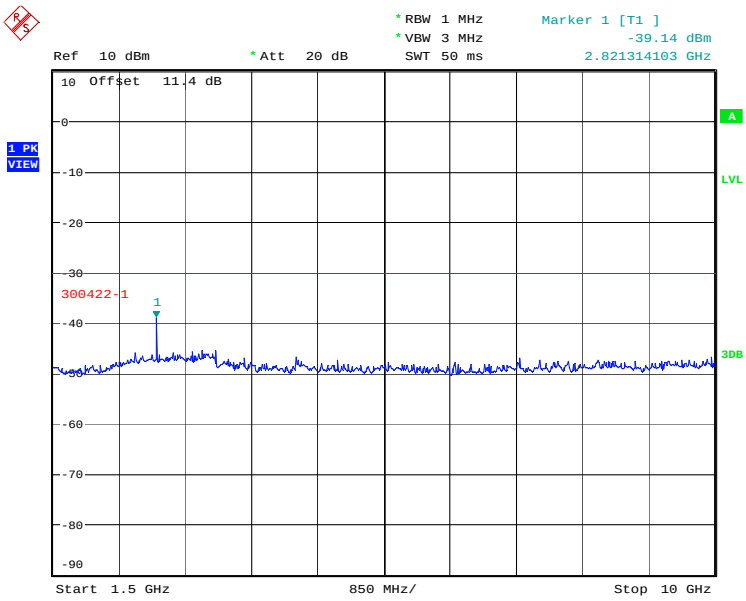
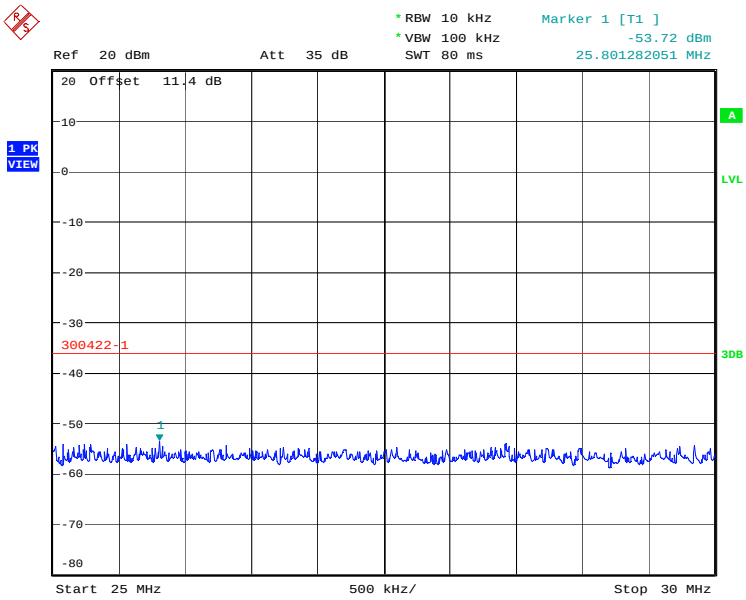


Date: 5.MAR.2020 09:56:33



Date: 5.MAR.2020 10:01:50

5.6.3.2. Test Frequency: 951.525 MHz, High power



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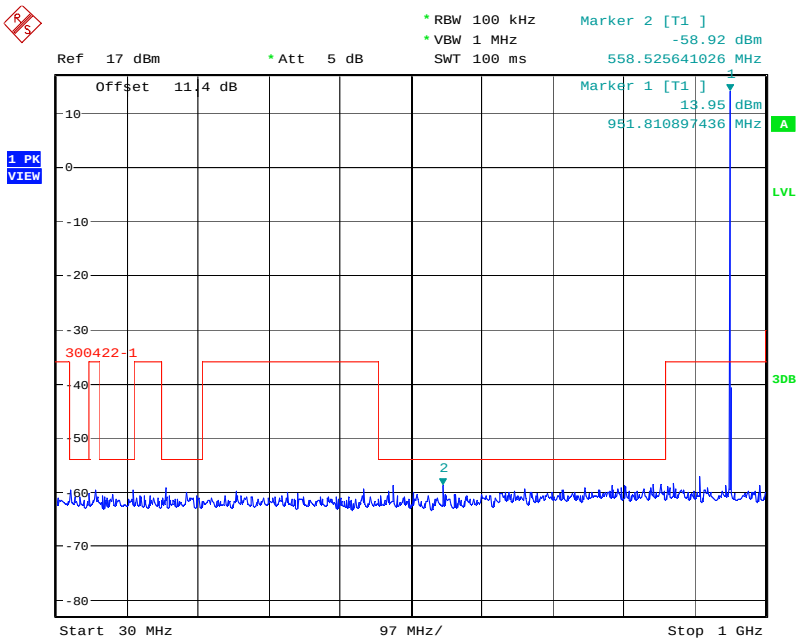

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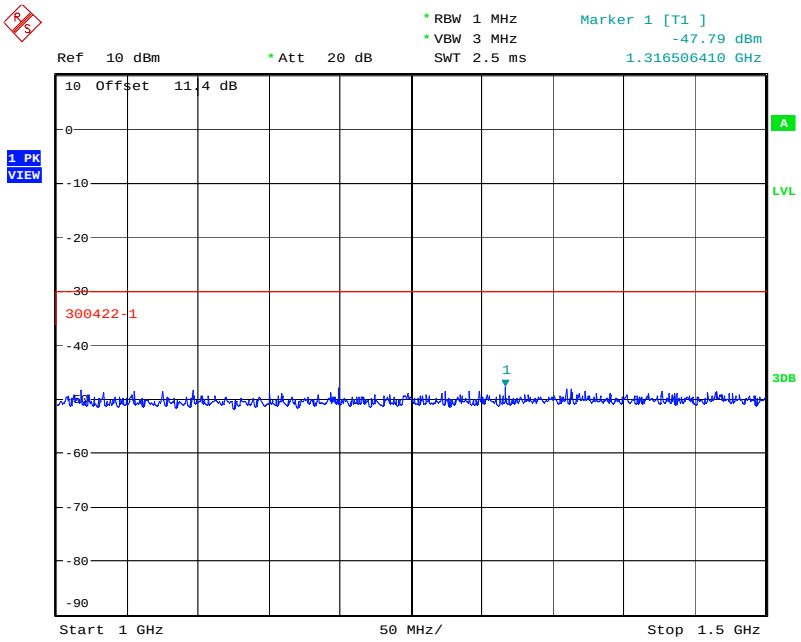

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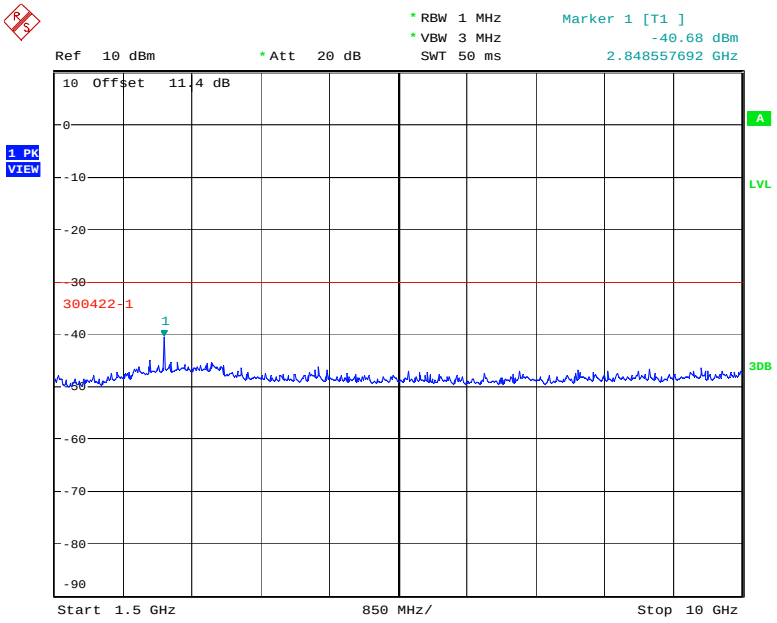
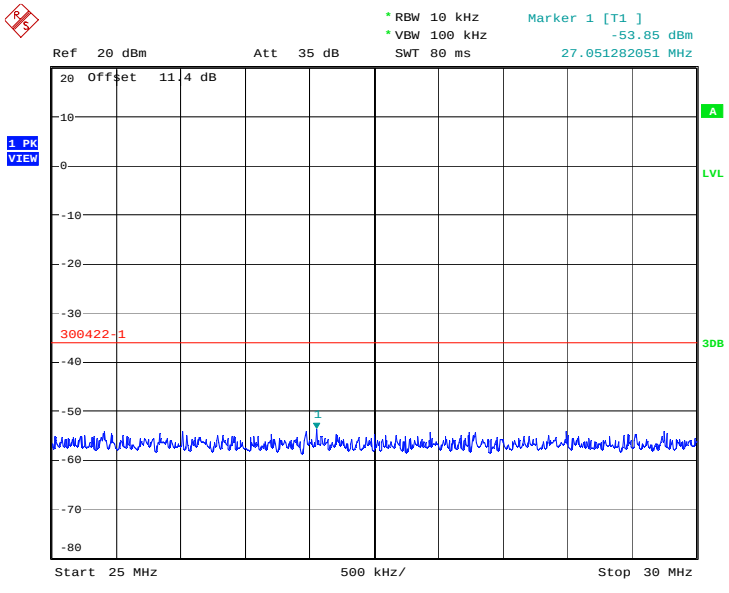
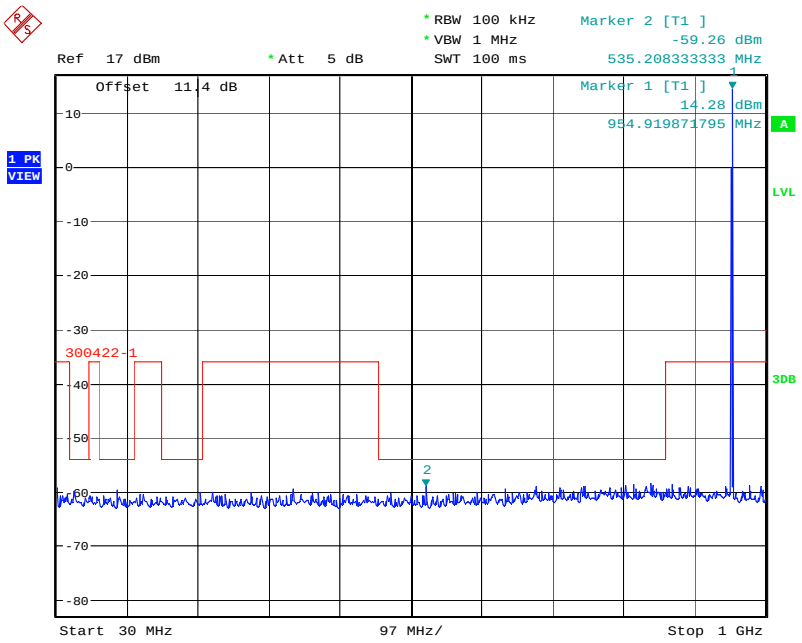


5.6.3.3. Test Frequency: 953.525 MHz, High power





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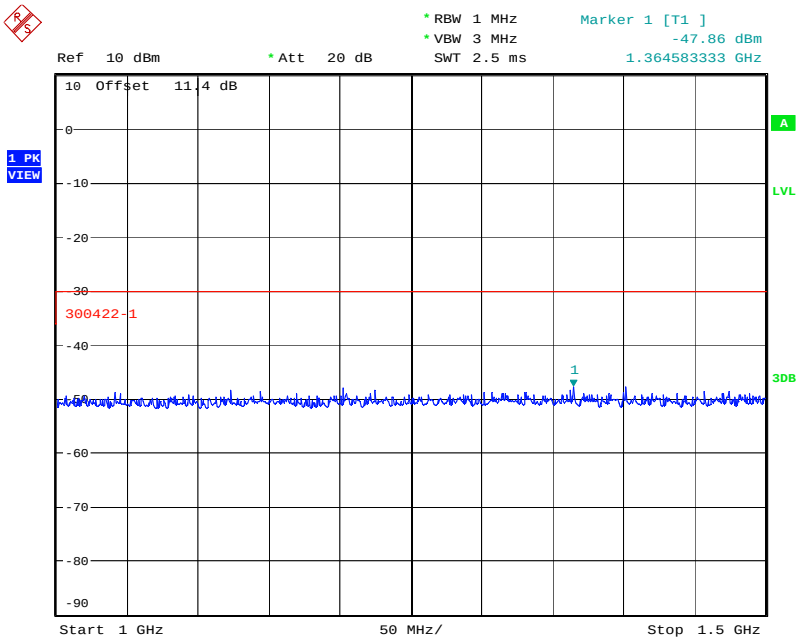
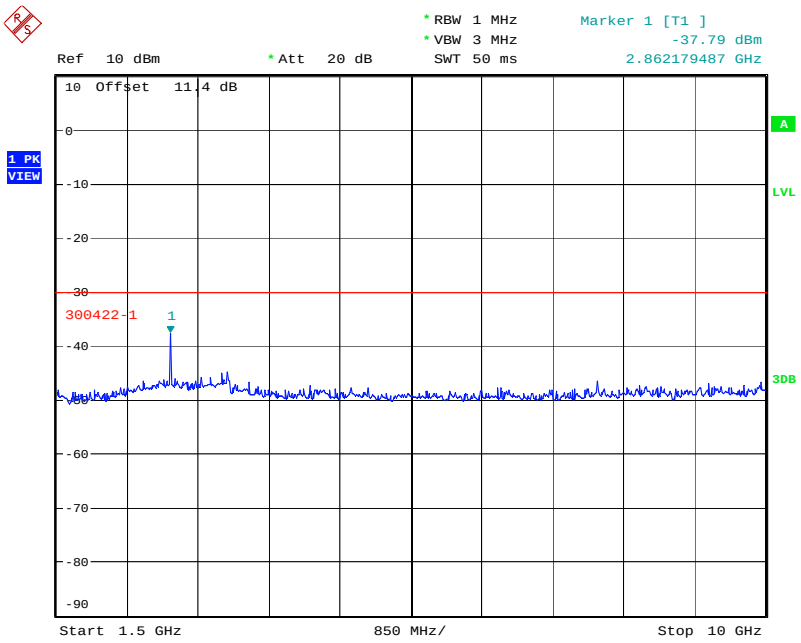
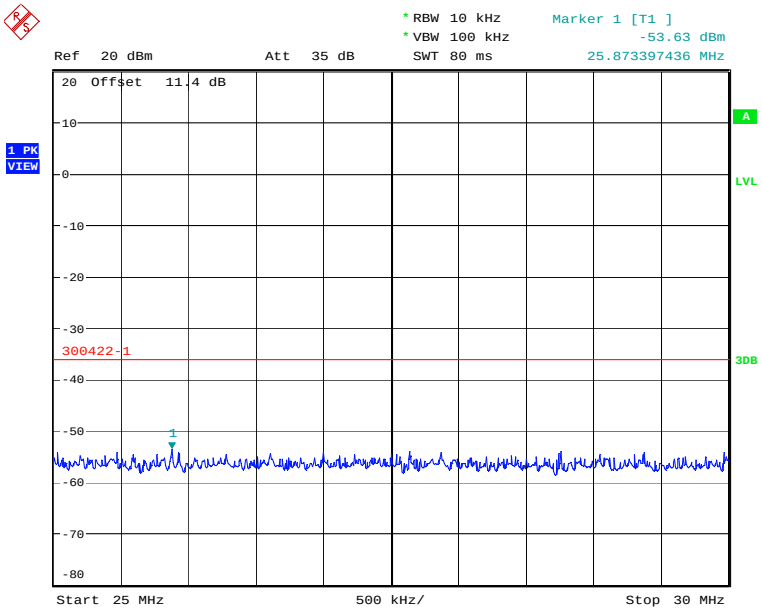
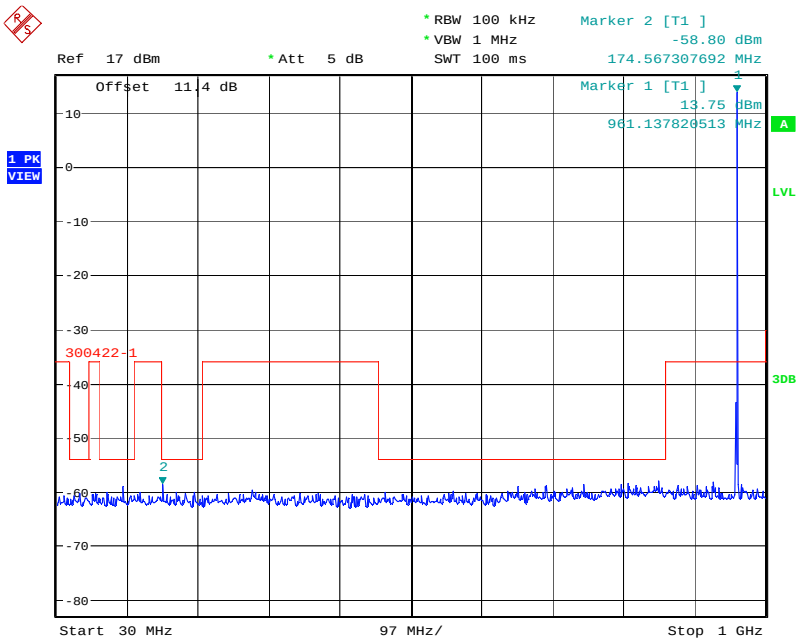


Date: 5.MAR.2020 09:58:16

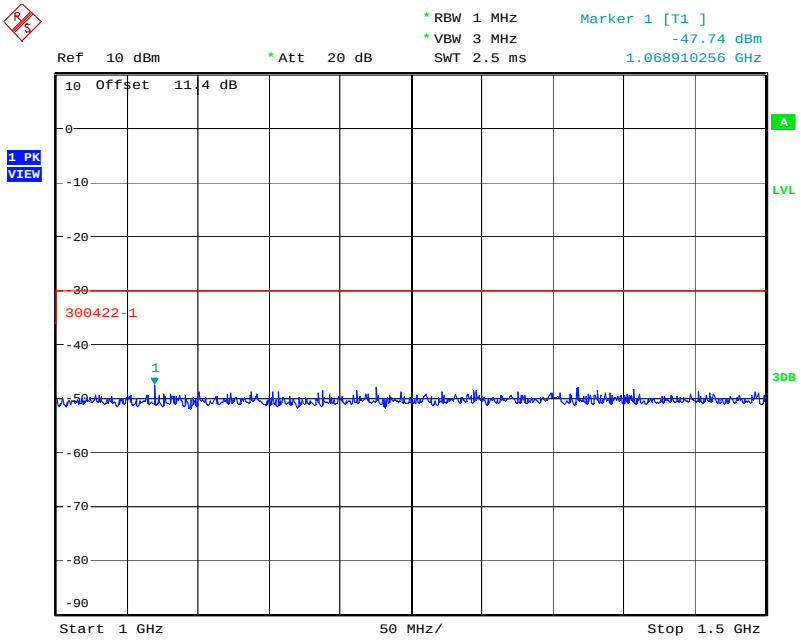


5.6.3.4. Test Frequency: 959.725 MHz, High power





Date: 5.MAR.2020 09:52:33



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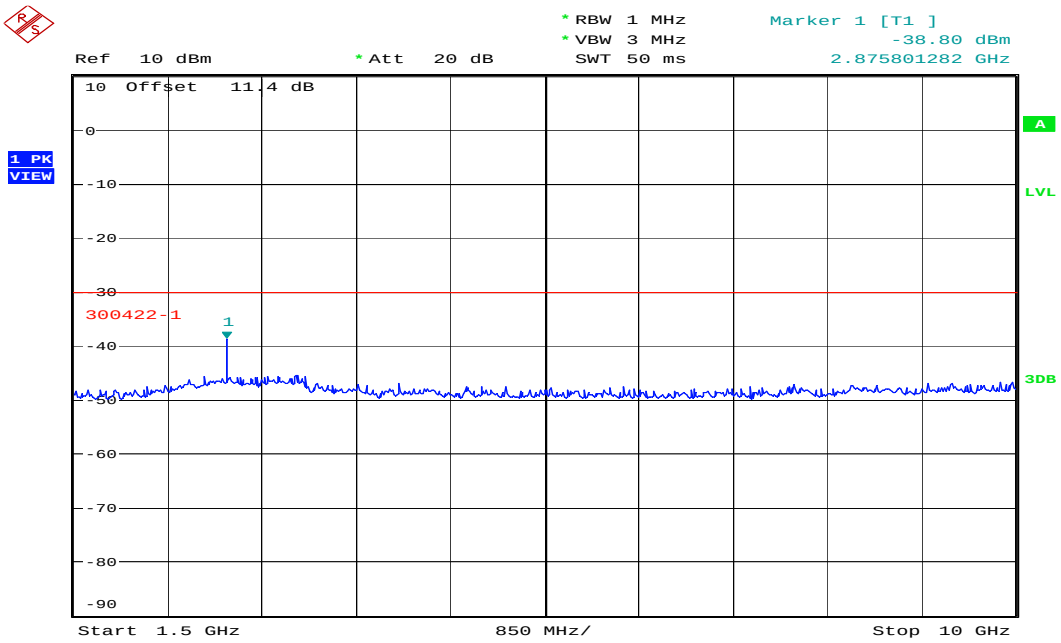
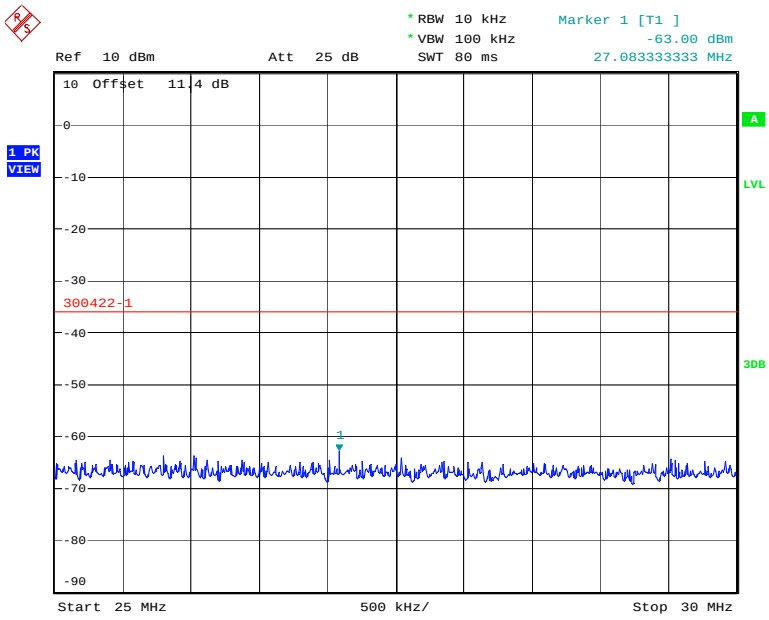


Date: 5.MAR.2020 10:06:47

LOW POWER

5.6.3.5. Test Frequency: 941.625 MHz, Low power



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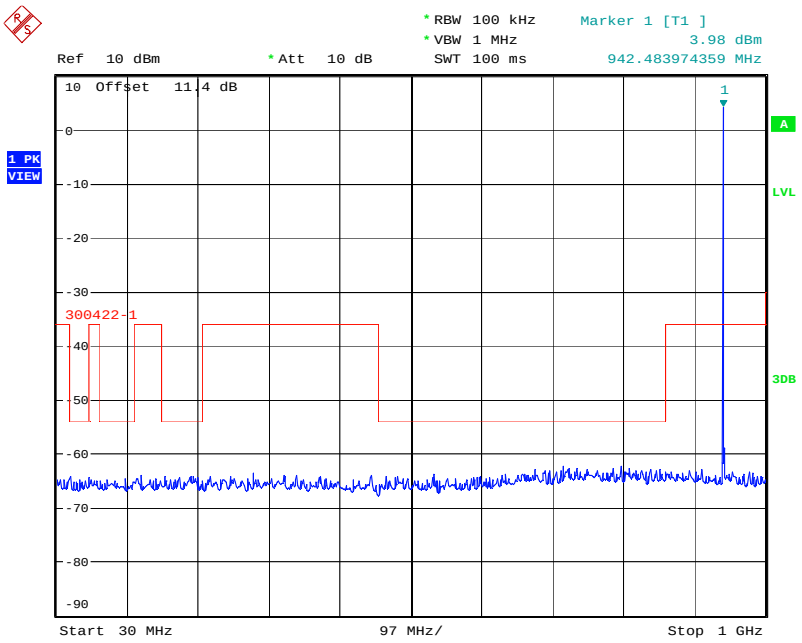

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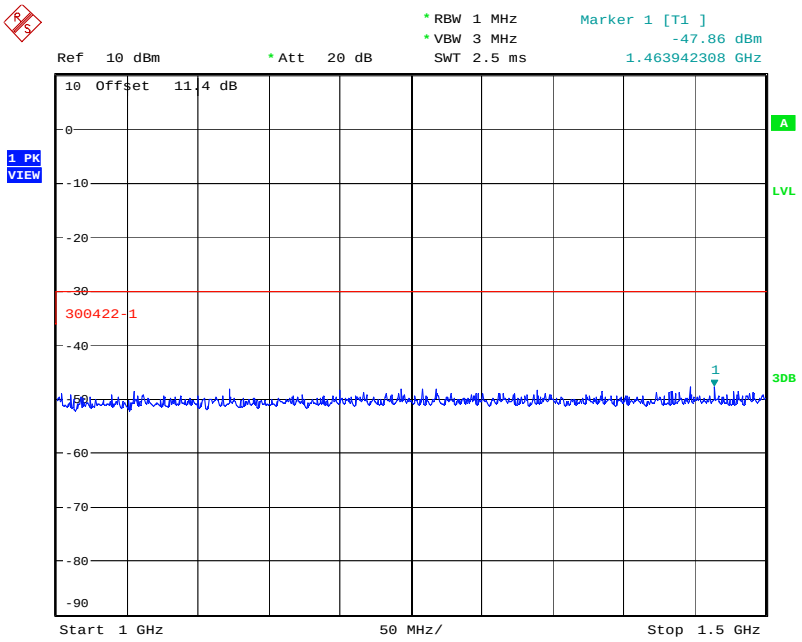

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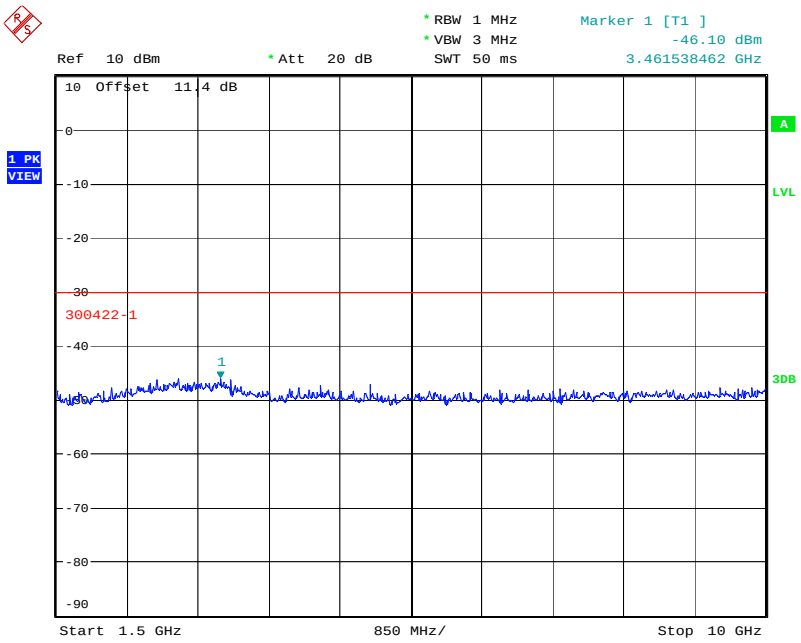

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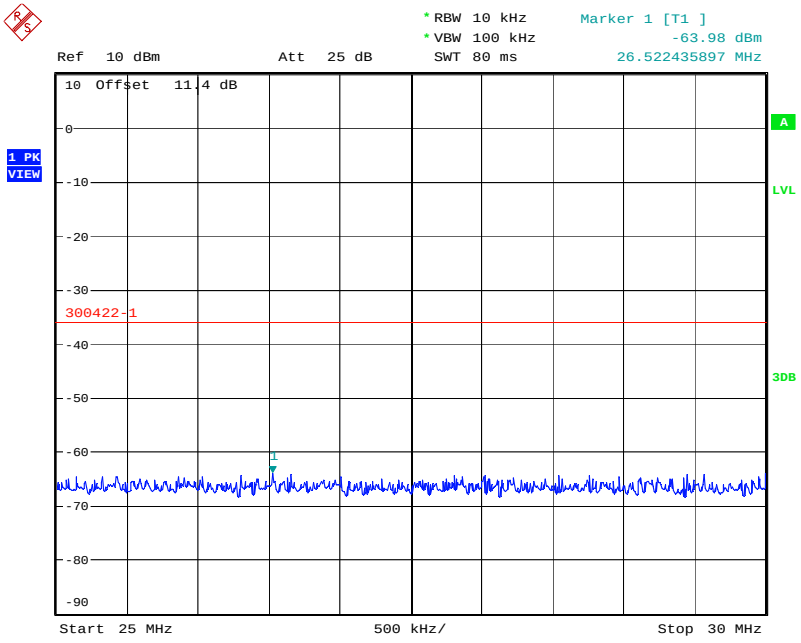
5.6.3.6. Test Frequency: 951.525 MHz, Low power



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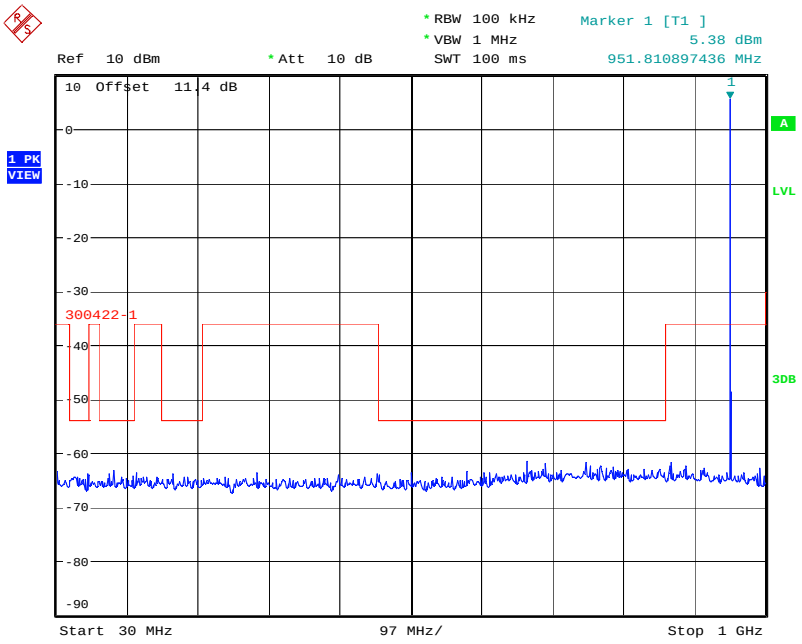

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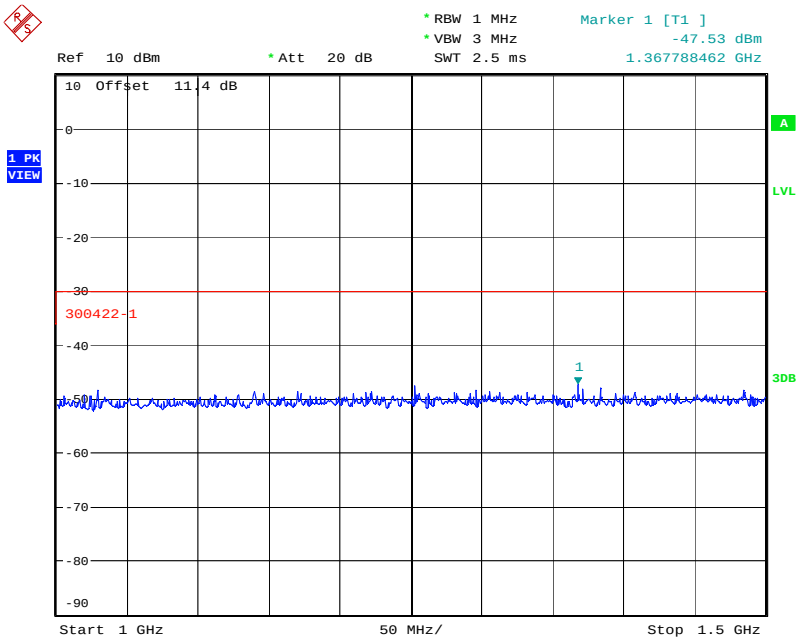

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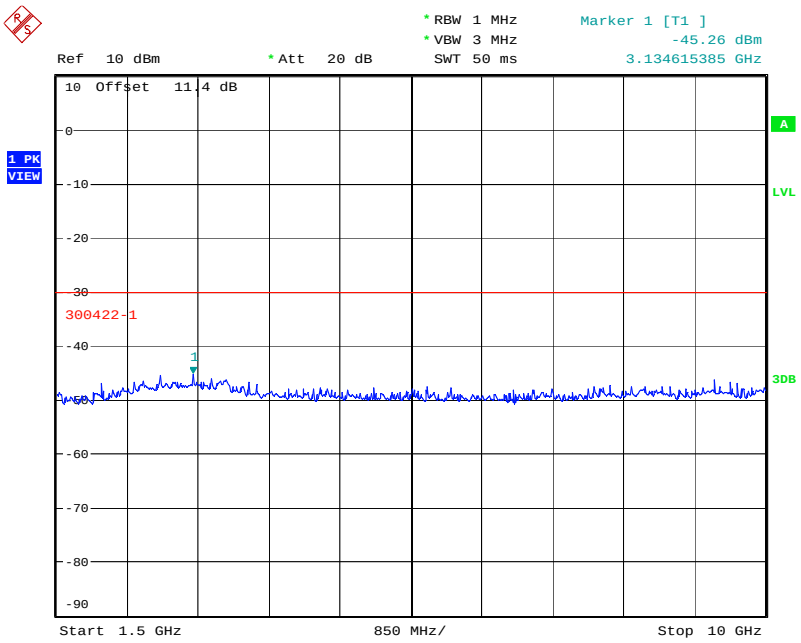

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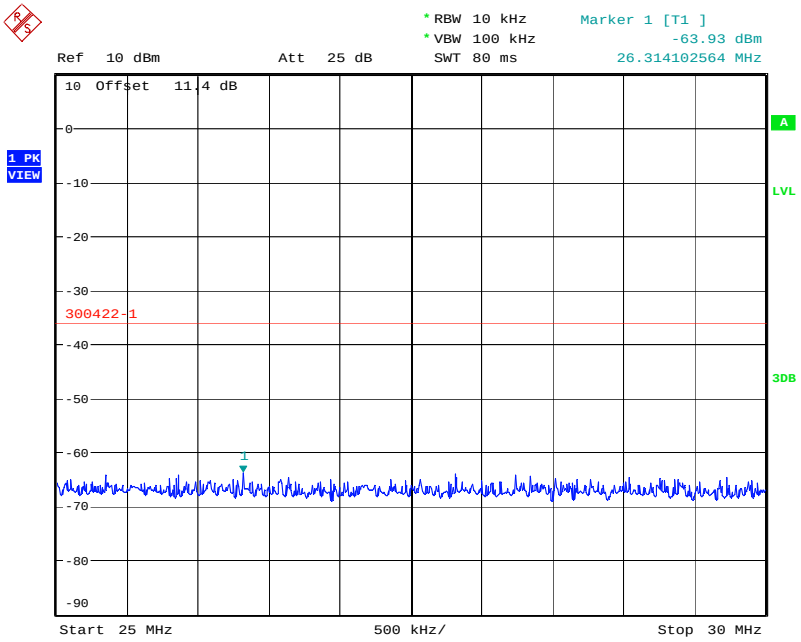
5.6.3.7. Test Frequency: 953.525 MHz, Low power



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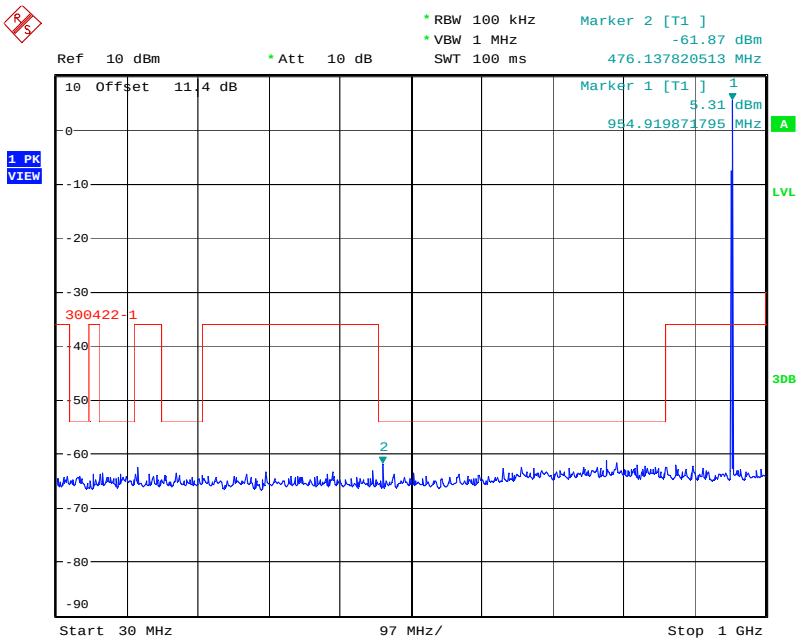

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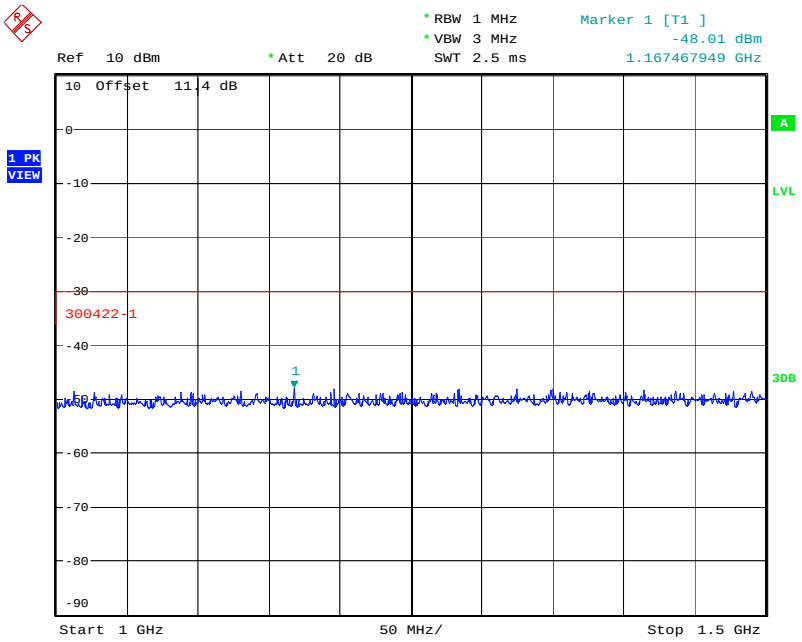

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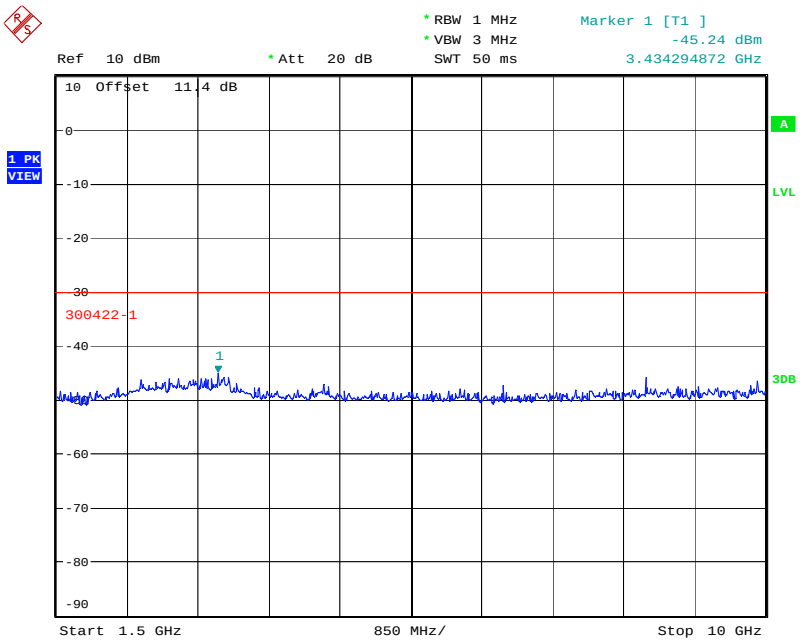

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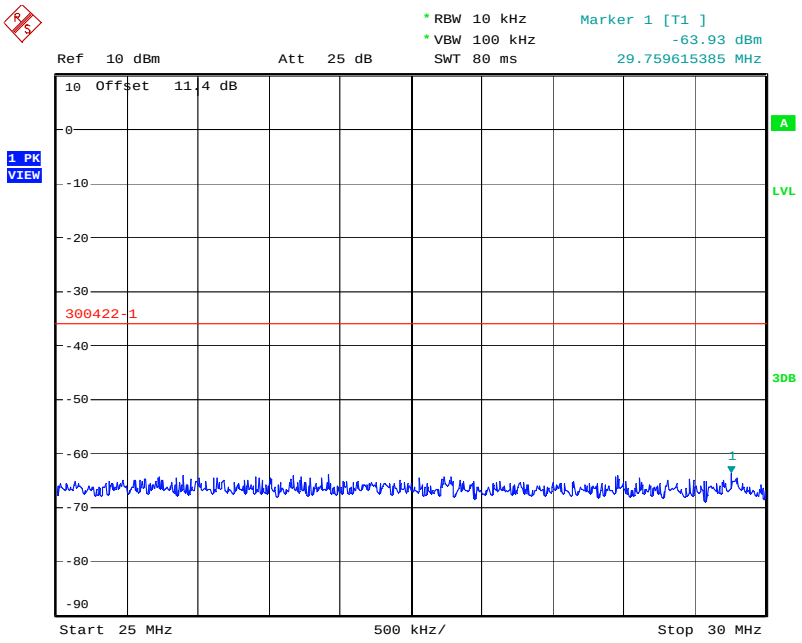
5.6.3.8. Test Frequency: 959.725 MHz, Low power



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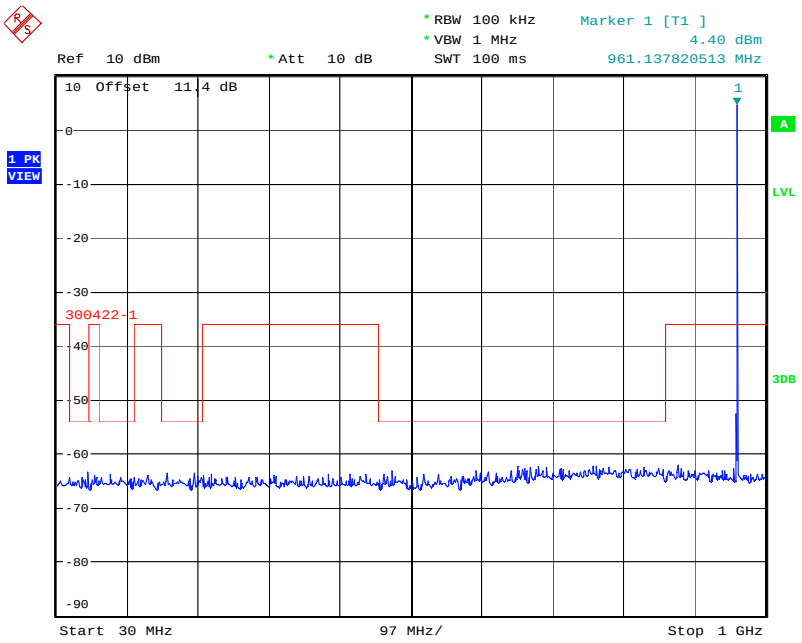
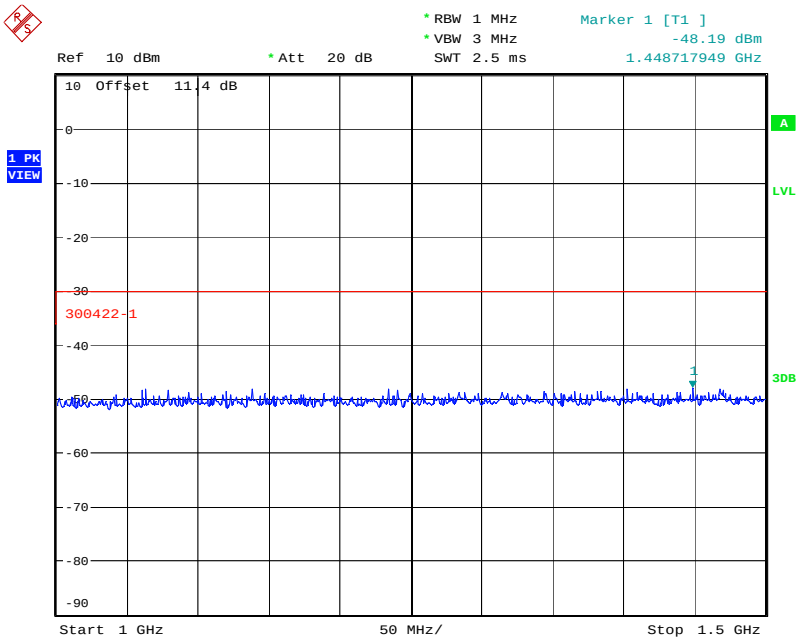
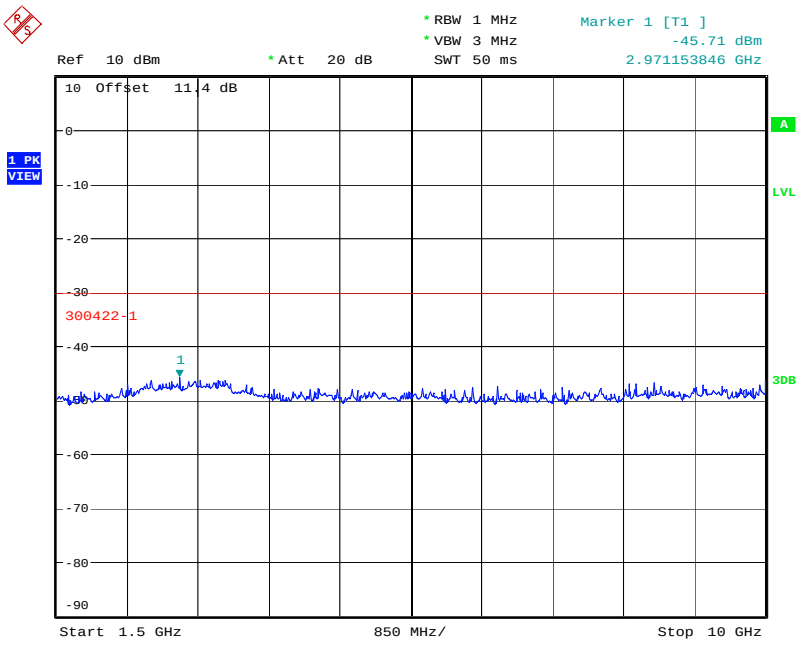


Date: 5.MAR.2020 10:21:19

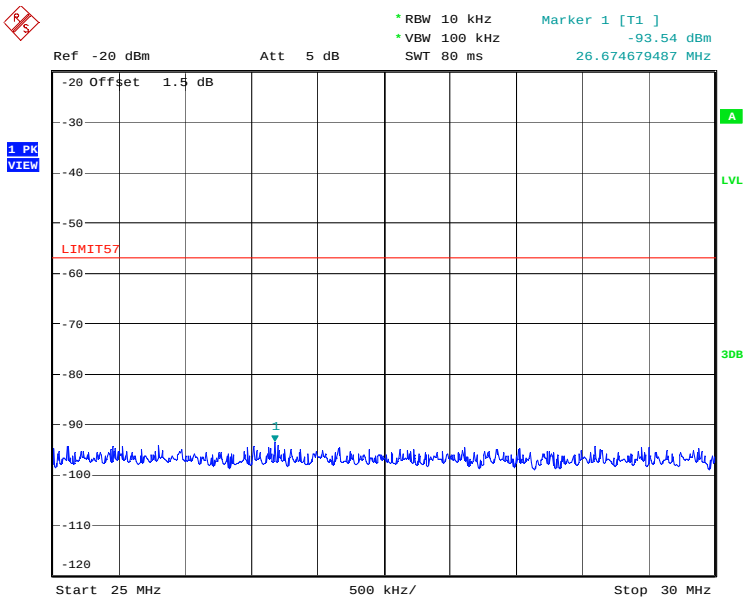


Date: 5.MAR.2020 10:24:47



Date: 5.MAR.2020 10:30:26

5.6.3.9. Standby Conducted



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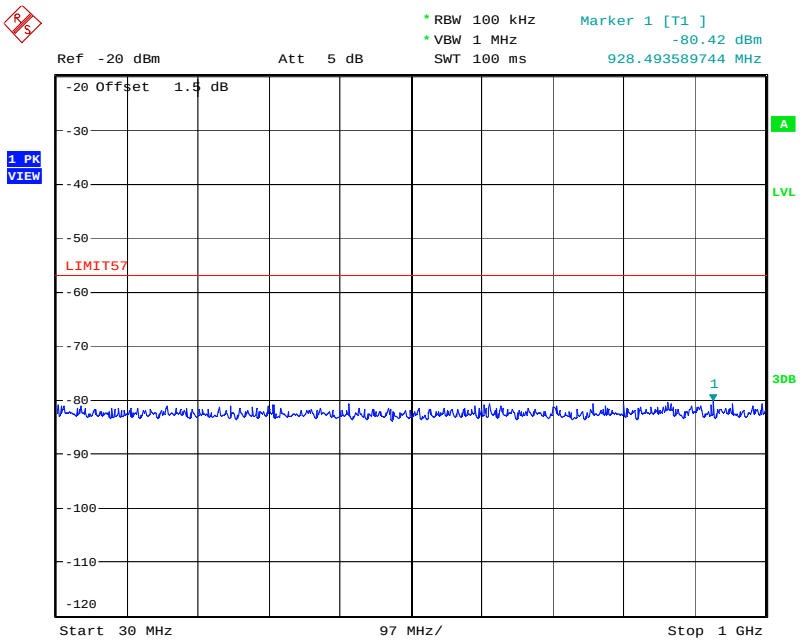

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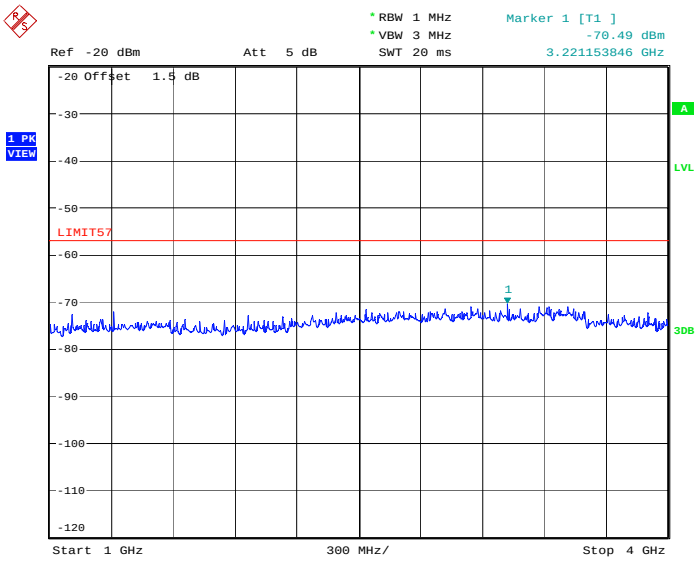


Date: 5.MAR.2020 10:49:31

5.7. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 74.861(d)(4)I, RSS 123- 8.1]

5.7.1. Limit(s)

Emissions within the band from one megahertz below to one megahertz above the carrier frequency shall comply with the emission mask in § 8.3 of ETSI EN 300 422-1 V1.4.2 (2011-08), Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement. Emissions outside of this band shall comply with the limits specified in section 8.4 of ETSI EN 300 422-1 V1.4.2 (2011-08).

EN 300 422-1 V2.1.2 (2017-01) Table 3: Limit for spurious emissions

Frequency / State	47 MHz to 74 MHz 87.5 MHz to 137 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
TX mode	4 nW	250 nW	1 µW
RX and all other modes	2 nW	2 nW	20 nW

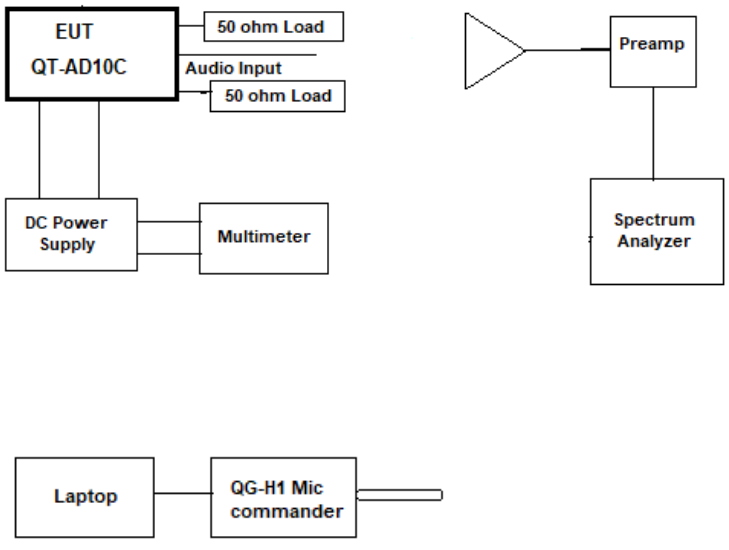
In dBµV/m@ 3m

Frequency / State	47 MHz to 74 MHz 87.5 MHz to 137 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
TX mode	41.2 dBµV/m	59.2 dBµV/m	65.2 dBµV/m
RX and all other modes	38.2 dBµV/m	38.2 dBµV/m	48.2 dBµV/m

5.7.2. Method of Measurements

ETSI EN 300 422-1 V1.4.2

5.7.3. Test Arrangement



5.7.4. Test Data

Remark(s):

- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT shall be tested in three orthogonal positions.
- The following test results at high power setting to represent the worst-case.

Fundamental Frequency:	941.625 MHz
Frequency Test Range:	30 MHz – 10 GHz
All spurious emissions and harmonics are more than 20 dB below the applicable limit.	

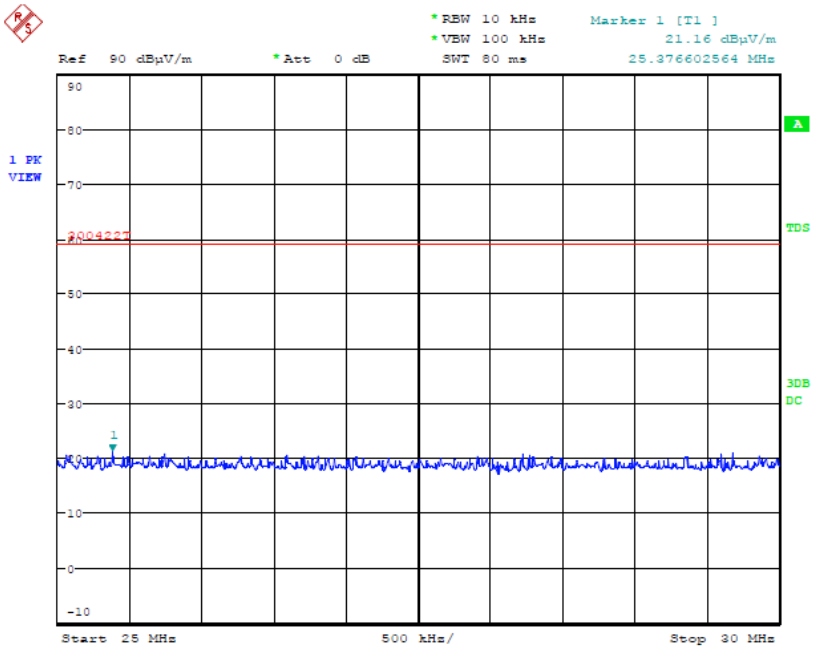
Fundamental Frequency:	951.525 MHz
Frequency Test Range:	30 MHz – 10 GHz
All spurious emissions and harmonics are more than 20 dB below the applicable limit.	

Fundamental Frequency:	953.525 MHz
Frequency Test Range:	30 MHz – 10 GHz
All spurious emissions and harmonics are more than 20 dB below the applicable limit.	

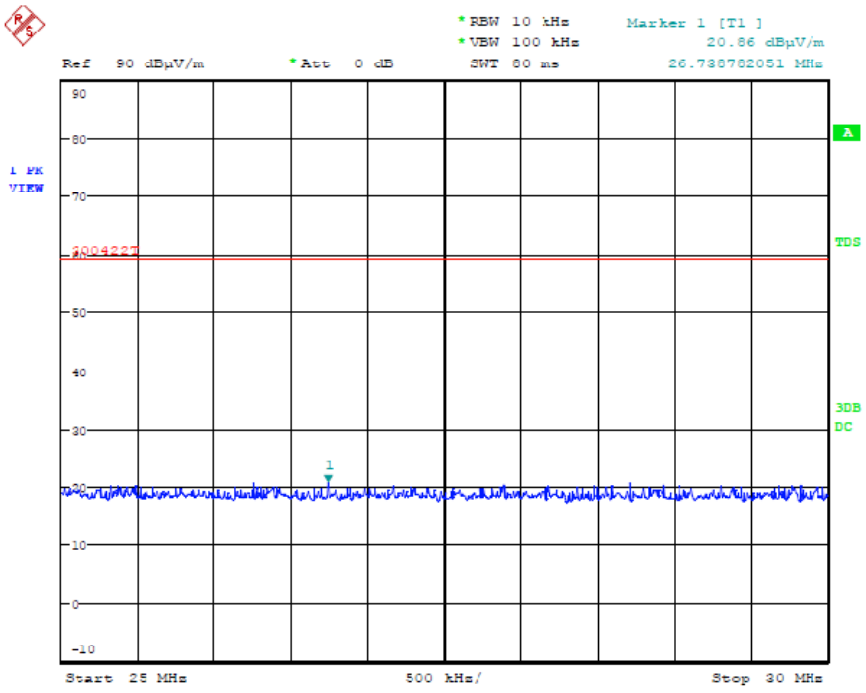
Fundamental Frequency:	959.725 MHz
Frequency Test Range:	30 MHz – 10 GHz
All spurious emissions and harmonics are more than 20 dB below the applicable limit.	

Note: The module has a 2.4GHz DTS radio next to the UHF microphone radio being tested and this intentional signal will be displayed in the plots below

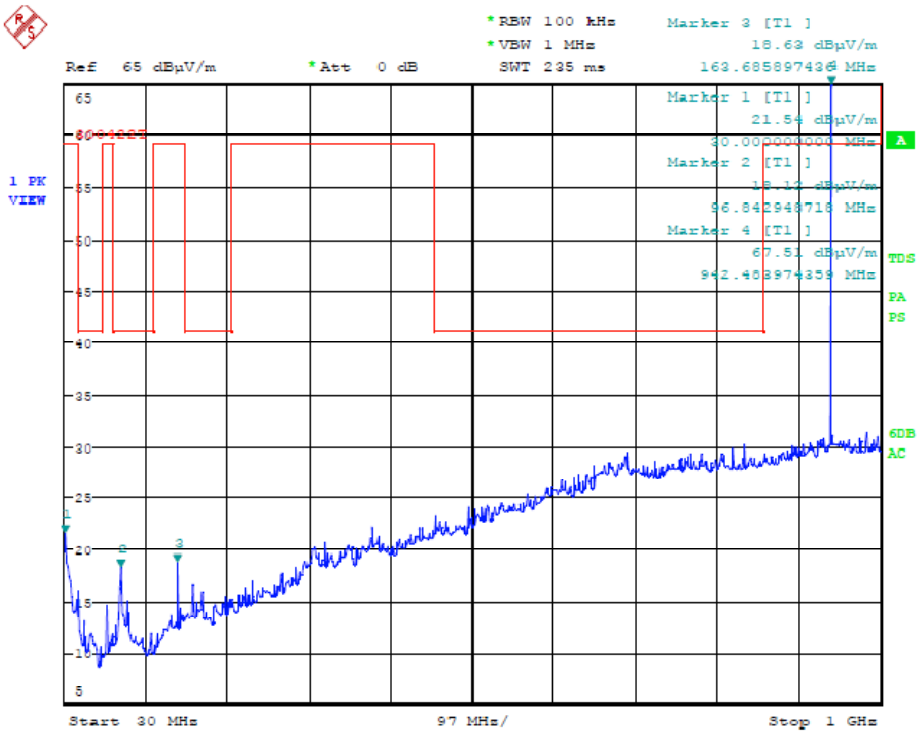
5.7.4.1. 941.625 MHz Tx Radiated 25-30 MHz @ 3m-Vertical



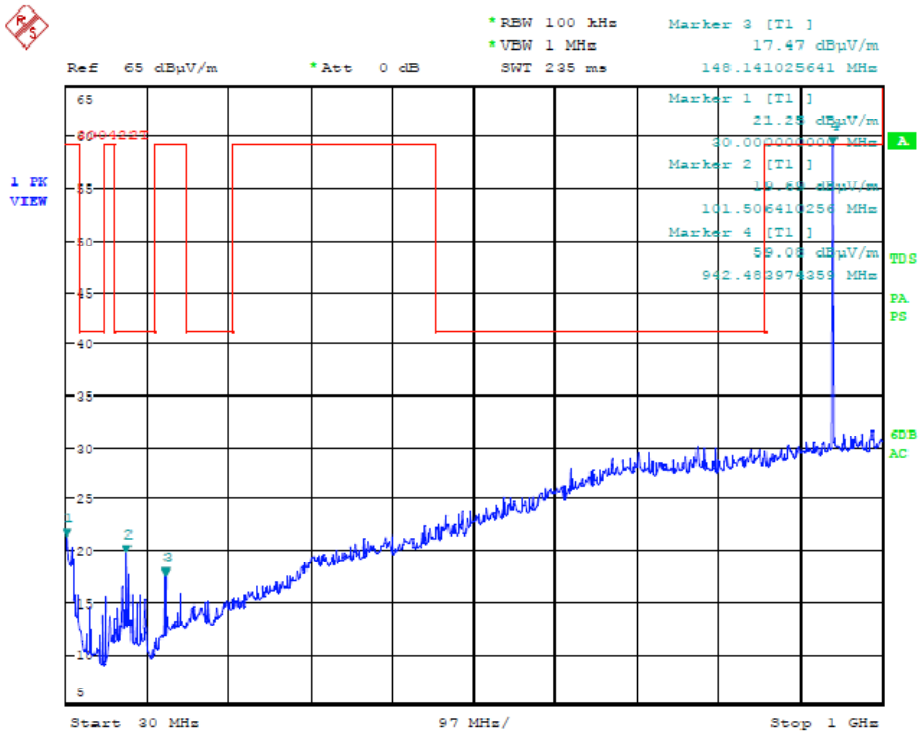
5.7.4.2. 941.625 MHz Tx Radiated 25-30 MHz @ 3m-Horizontal



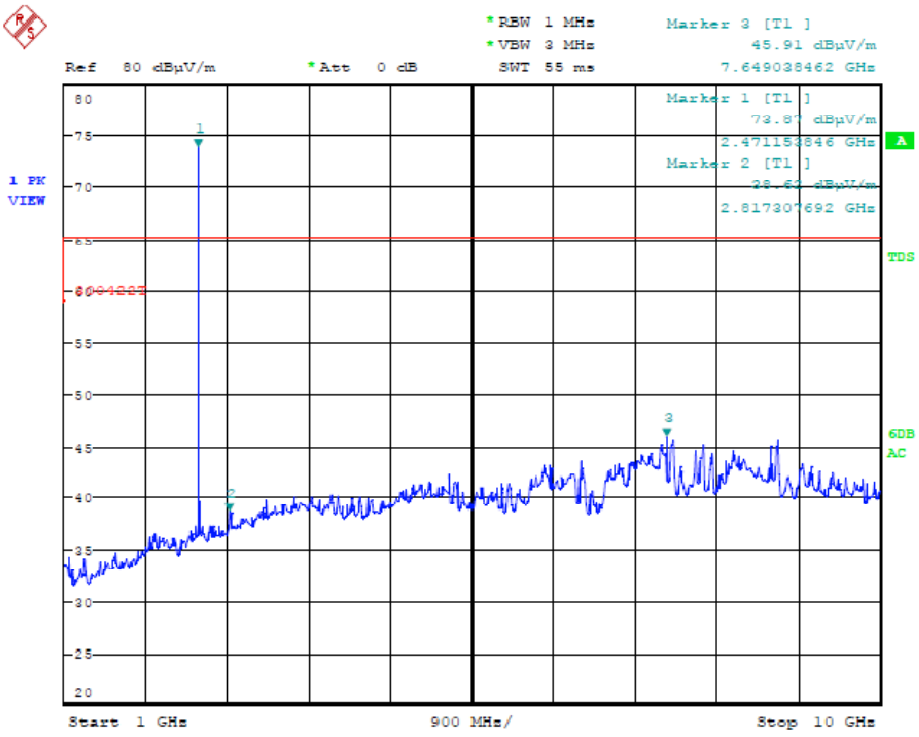
5.7.4.3. 941.625 MHz Tx Radiated 30-1000 MHz @ 3m-Vertical



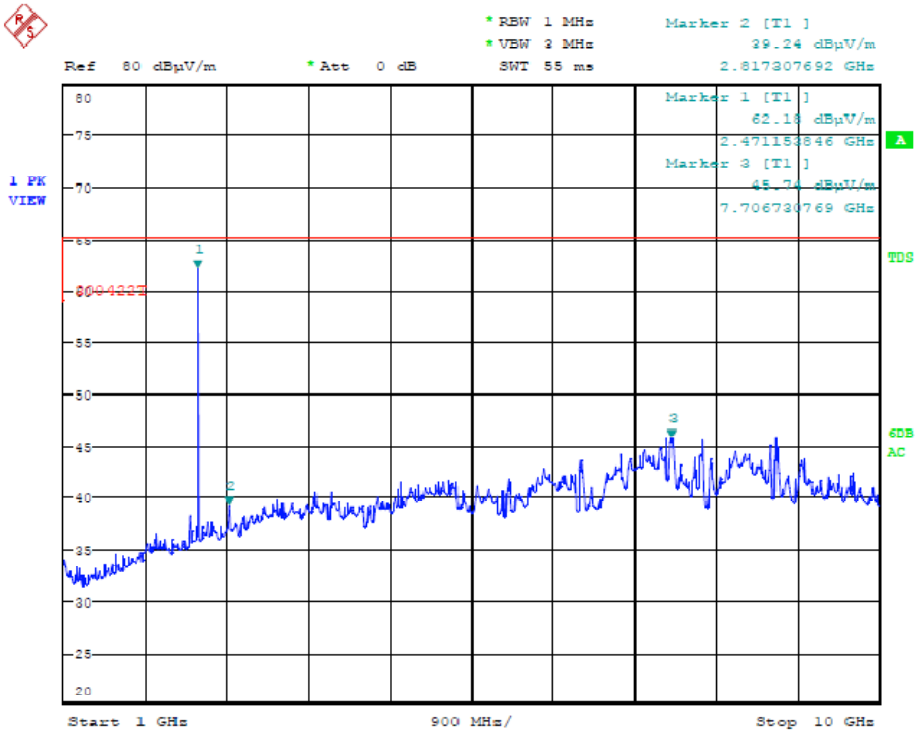
5.7.4.4. 941.625 MHz Tx Radiated 30-1000 MHz @ 3m-Horizontal



5.7.4.5. 941.625 MHz Tx Radiated 1-10 GHz @ 3m-Vertical



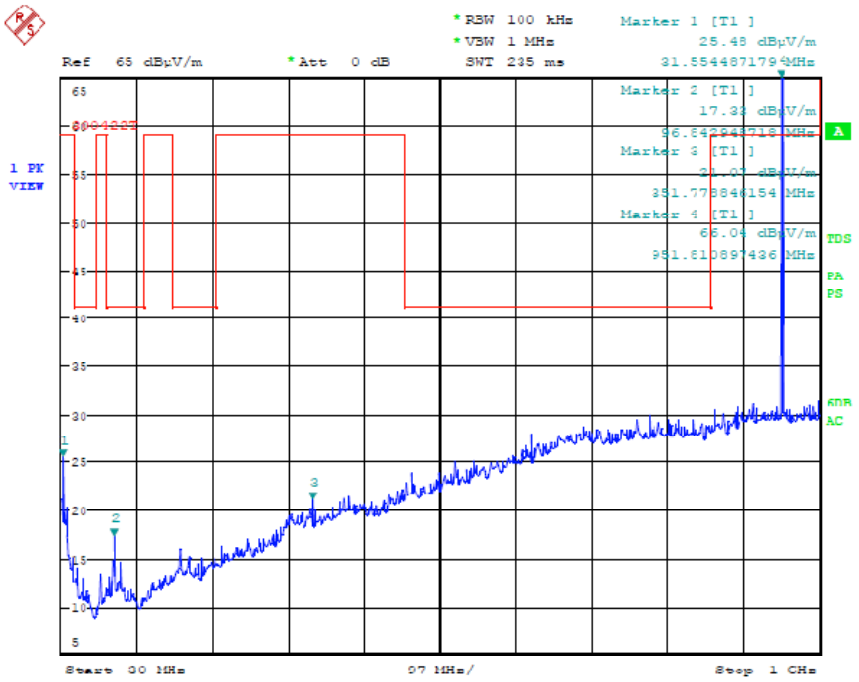
5.7.4.6. 941.625 MHz Tx Radiated 1-10 GHz @ 3m- Horizontal



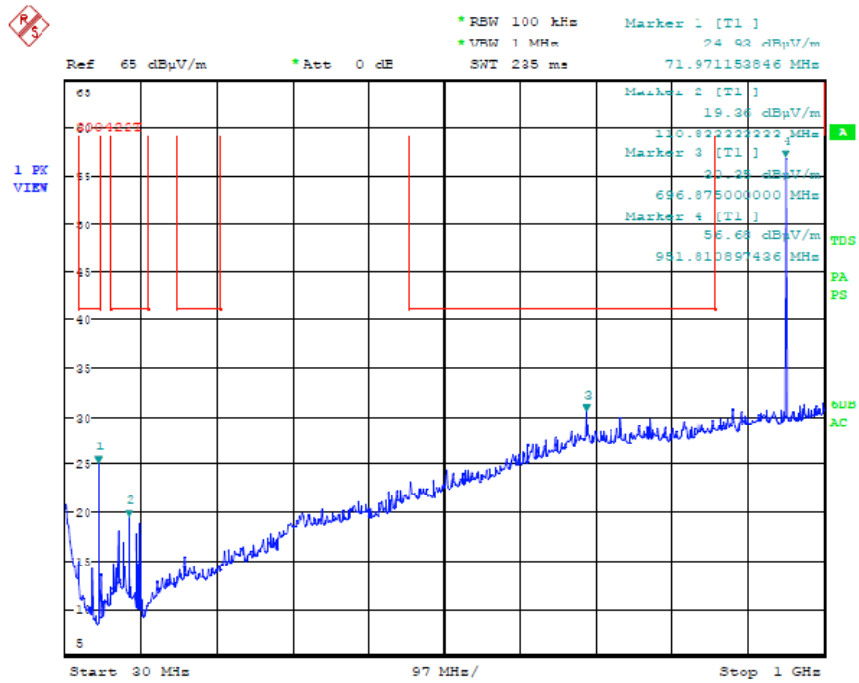
5.7.4.7. 951.525 MHz Tx Radiated 25-30 MHz @ 3m

No Significant emissions

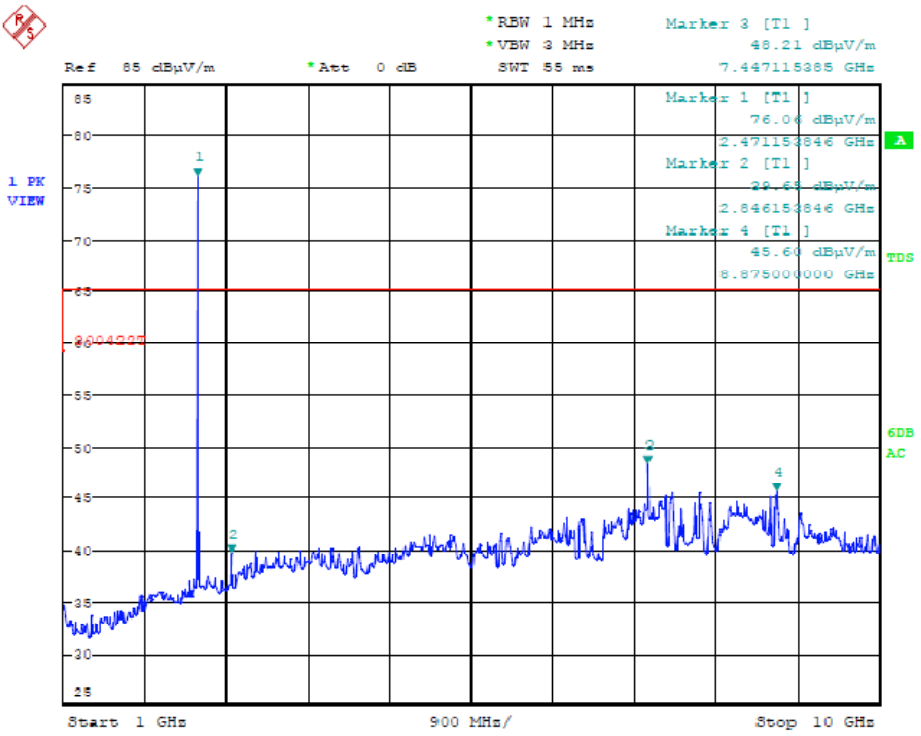
5.7.4.8. 951.525 MHz Tx Radiated 30-1000 MHz @ 3m-Vertical



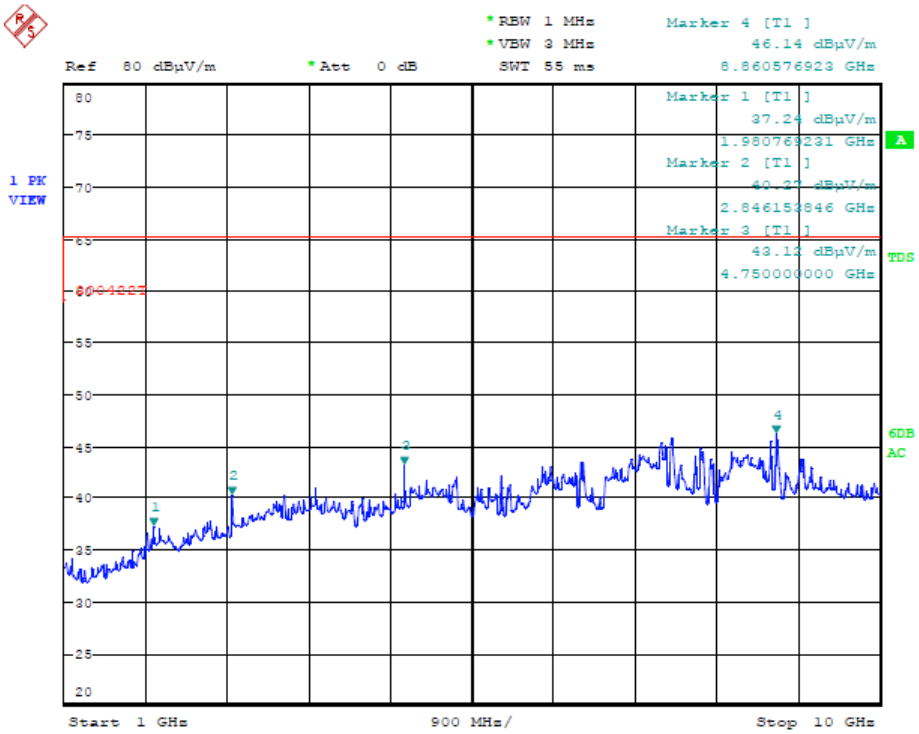
5.7.4.9. 951.525 MHz Tx Radiated 30-1000 MHz @ 3m-Horizontal



5.7.4.10. 951.525 MHz Tx Radiated 1-10 GHz @ 3m-Vertical



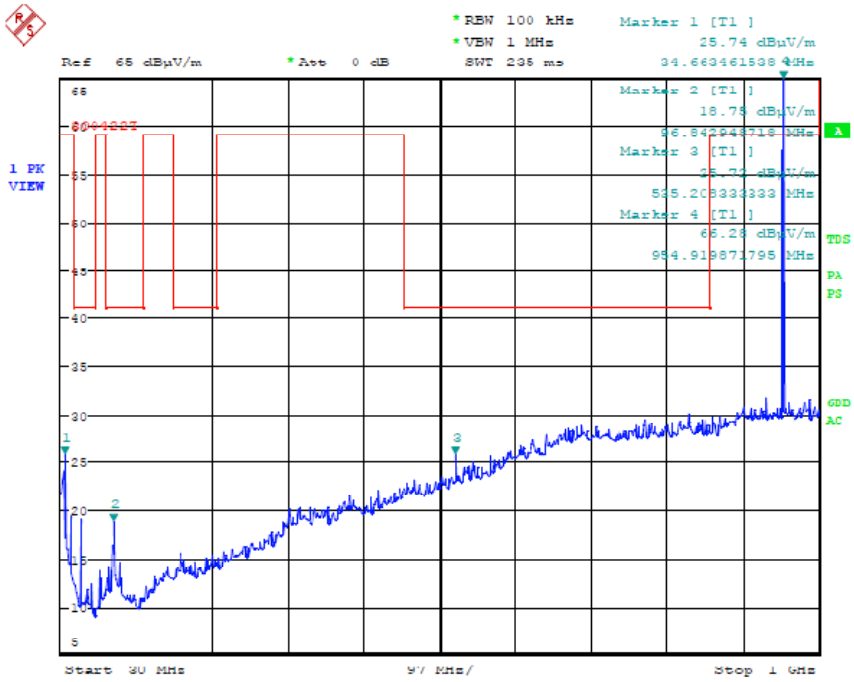
5.7.4.11. 951.525 MHz Tx Radiated 1-10 GHz @ 3m- Horizontal



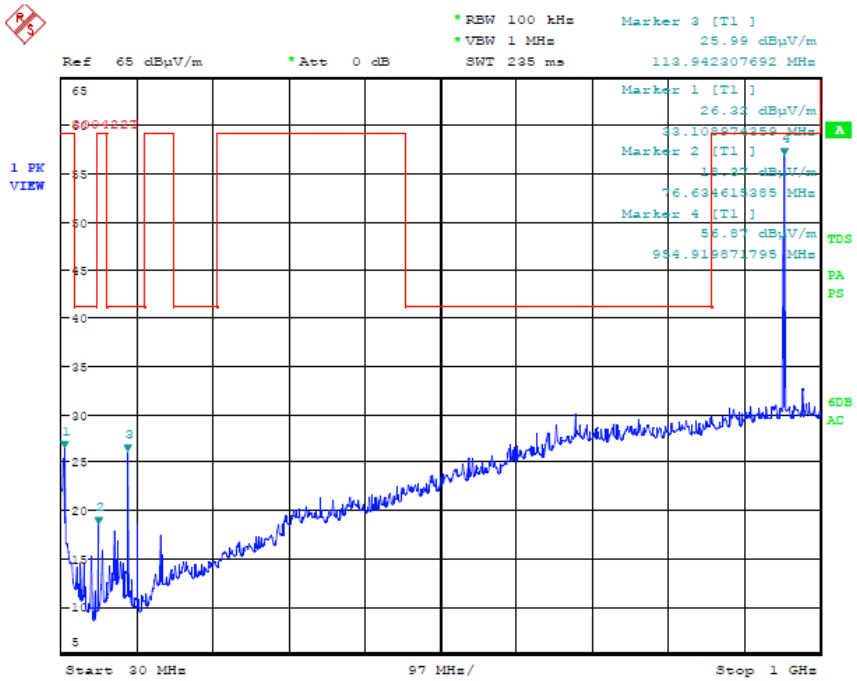
5.7.4.12. 953.525MHz Tx Radiated 25-30 MHz @ 3m

No Significant emissions

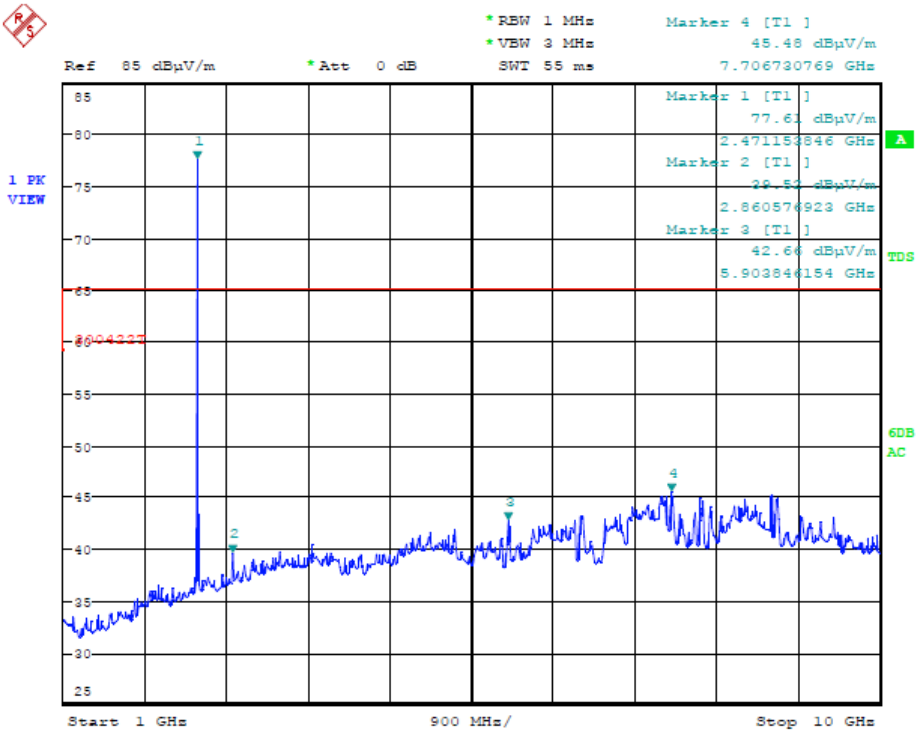
5.7.4.13. 953.525MHz Tx Radiated 30-1000 MHz @ 3m-Vertical



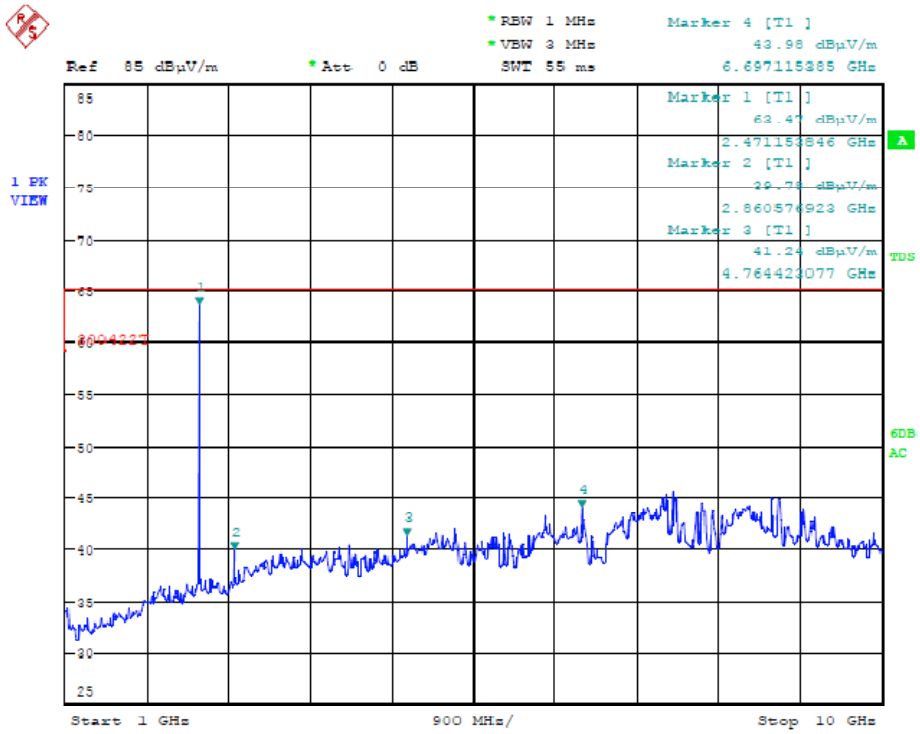
5.7.4.14. 953.525MHz Tx Radiated 30-1000 MHz @ 3m-Horizontal



5.7.4.15. 953.525MHz Tx Radiated 1-10 GHz @ 3m-Vertical



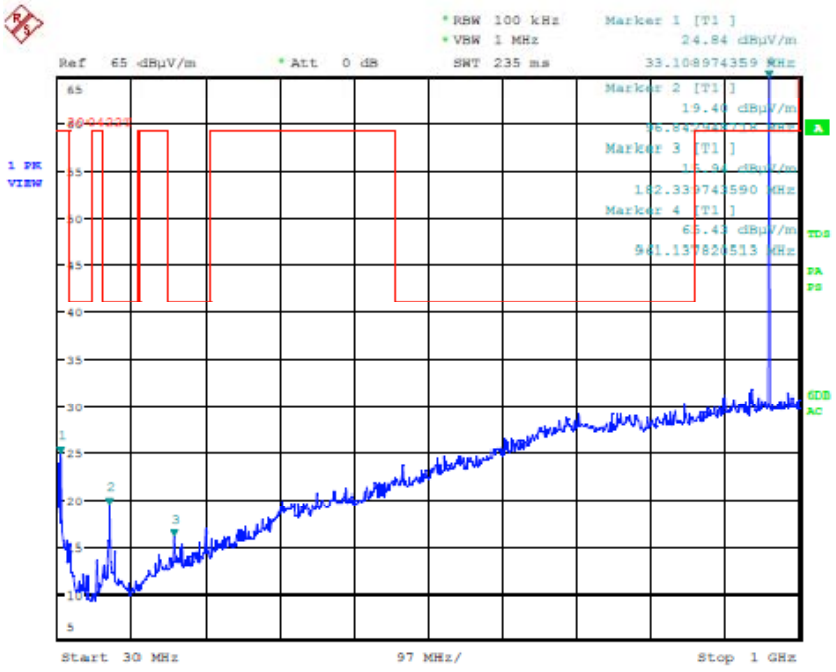
5.7.4.16. 953.525MHz Tx Radiated 1-10 GHz @ 3m- Horizontal



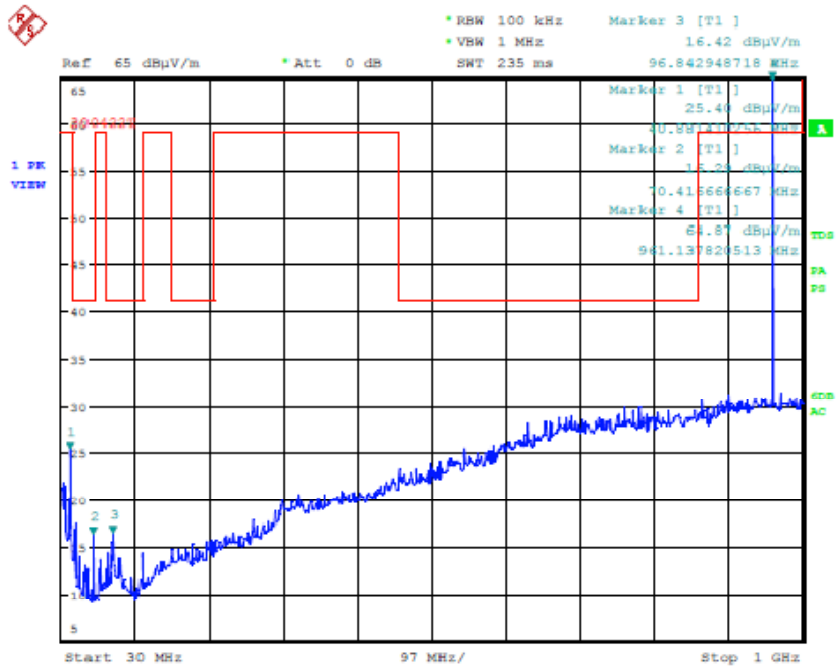
5.7.4.17. 959.725MHz Tx Radiated 25-30 MHz @ 3m

No Significant emissions

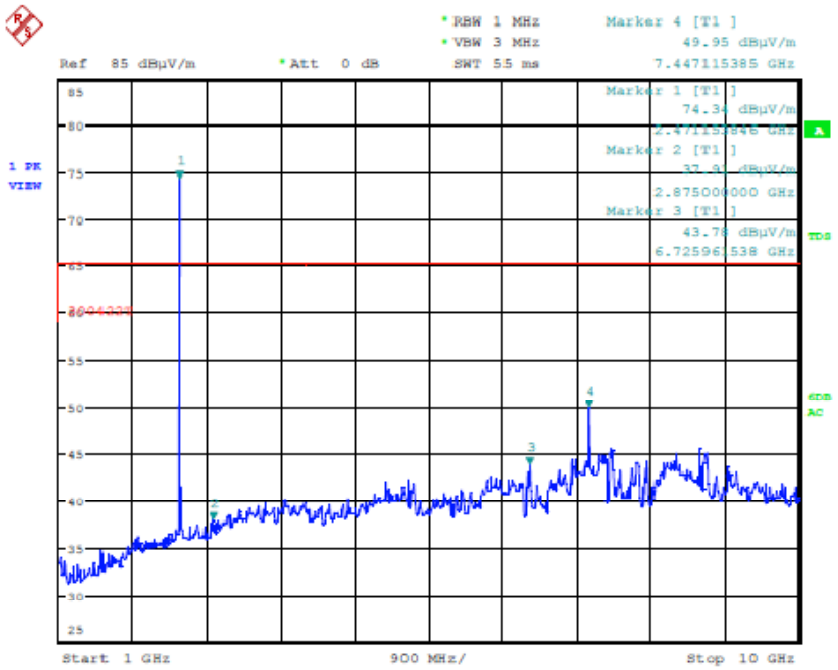
5.7.4.18. 959.725MHz Tx Radiated 30-1000 MHz @ 3m-Vertical



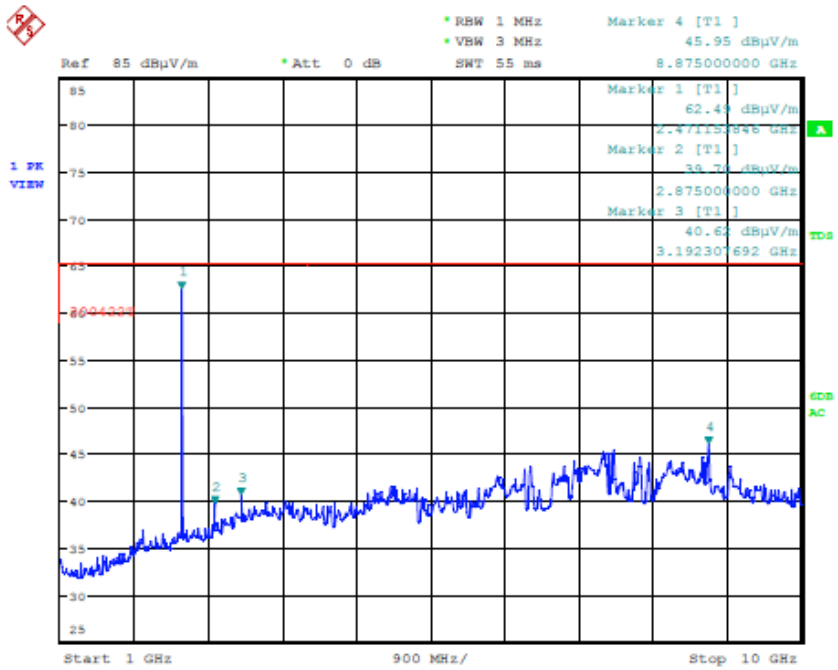
5.7.4.19. 959.725MHz Tx Radiated 30-1000 MHz @ 3m-Horizontal



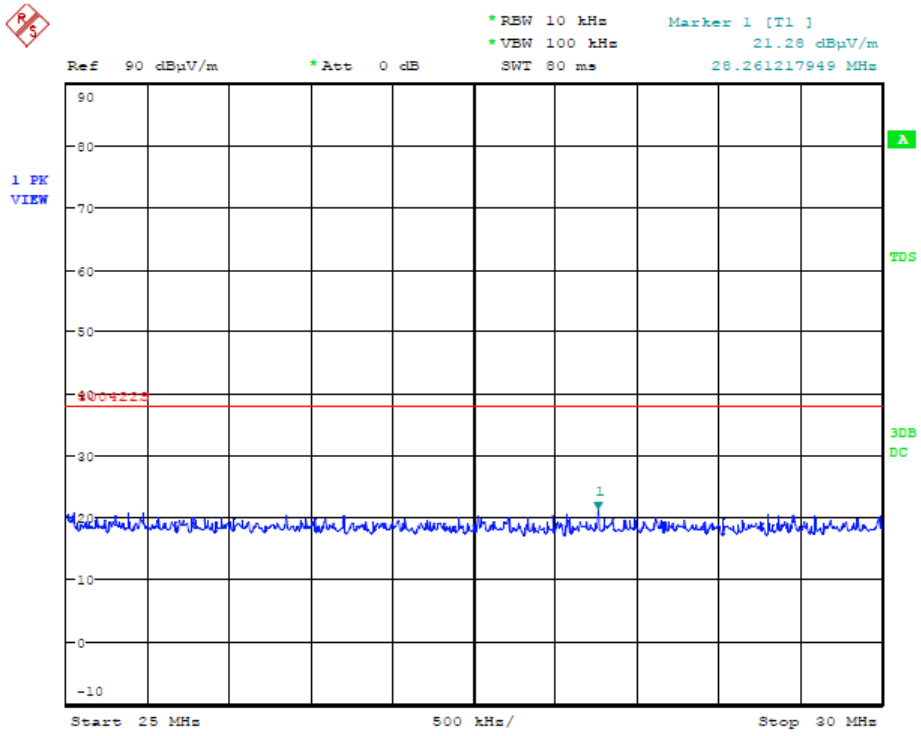
5.7.4.20. 959.725MHz Tx Radiated 1-10 GHz @ 3m-Vertical



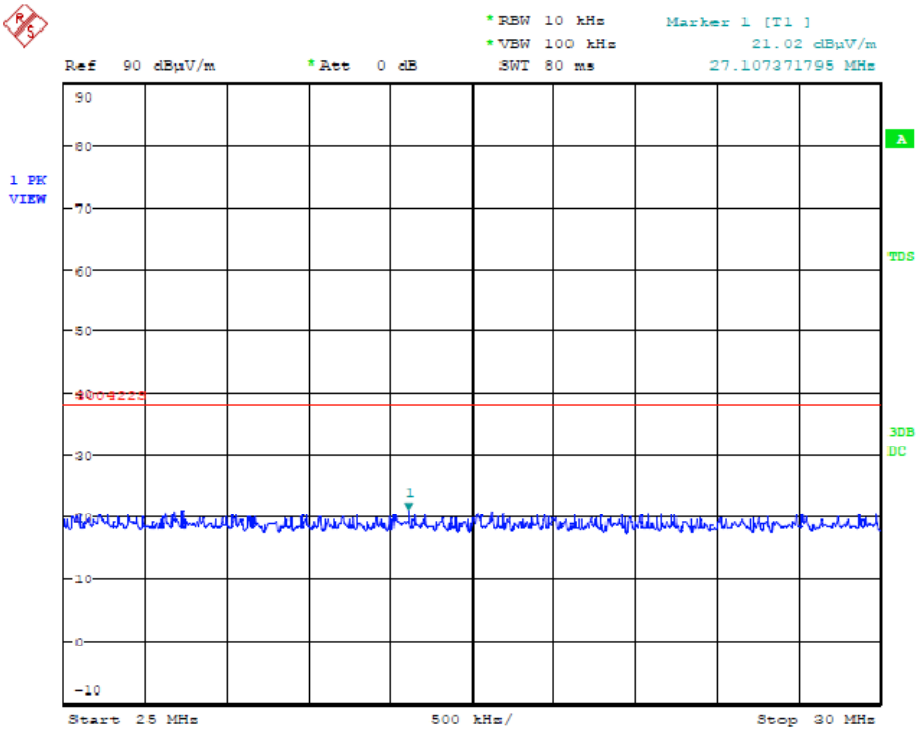
5.7.4.21. 959.725MHz Tx Radiated 1-10 GHz @ 3m- Horizontal



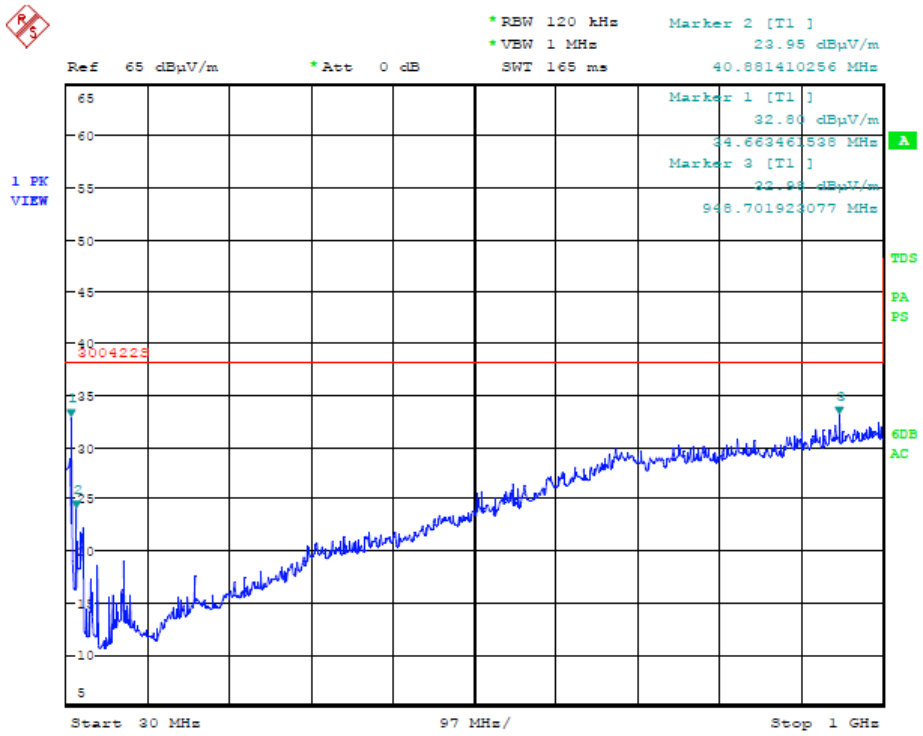
5.7.4.22. Standby mode Radiated 25-30 MHz @ 3m-Vertical



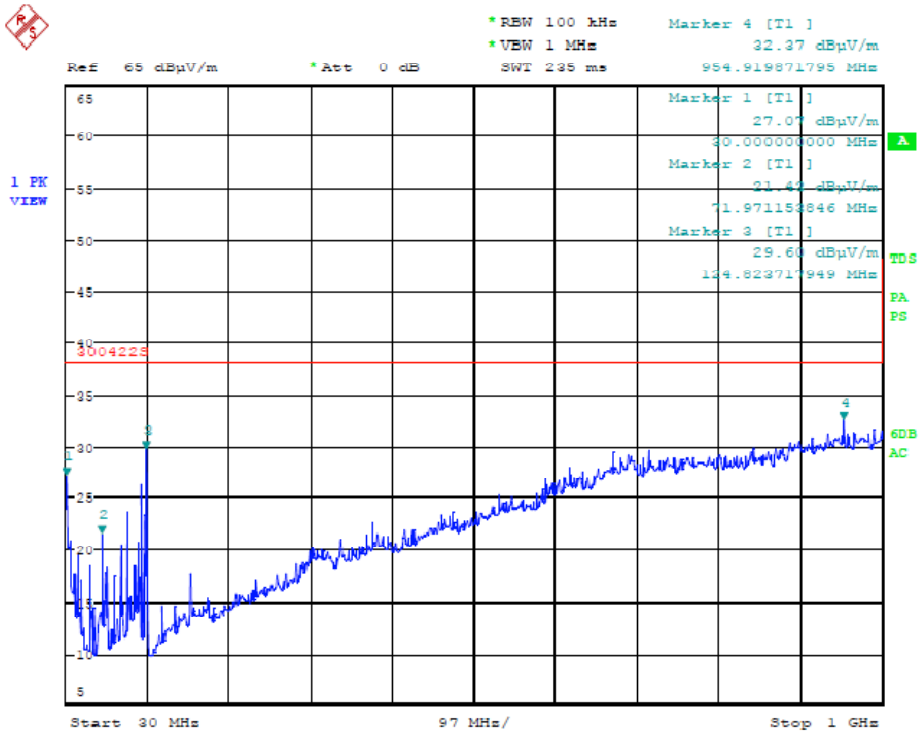
5.7.4.23. Standby mode Radiated 25-30 MHz @ 3m-Horizontal



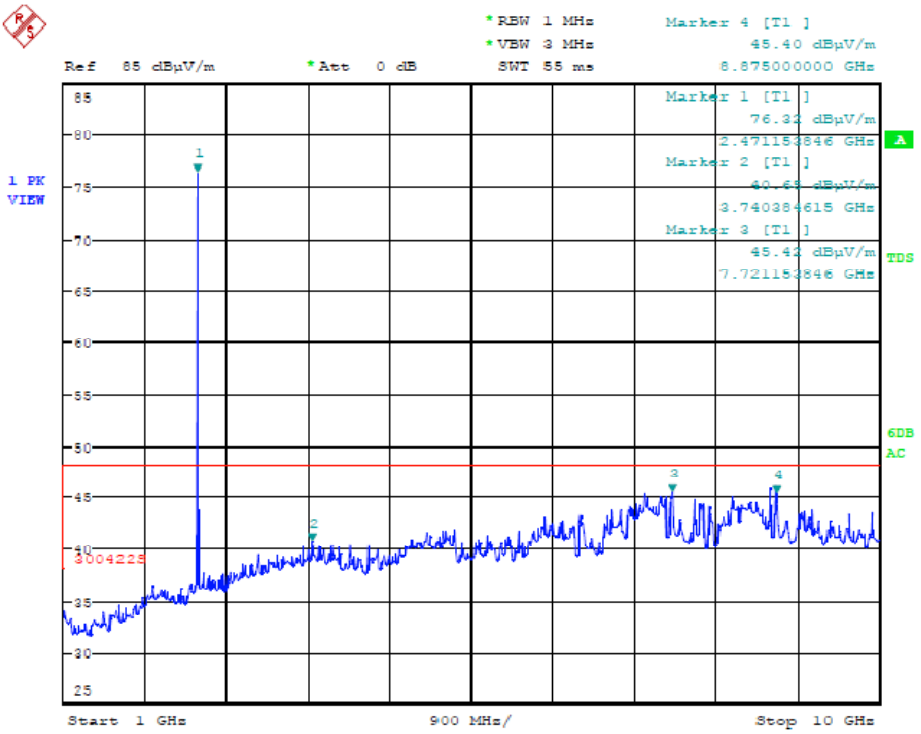
5.7.4.24. Standby mode Radiated 30-1000 MHz @ 3m-Vertical



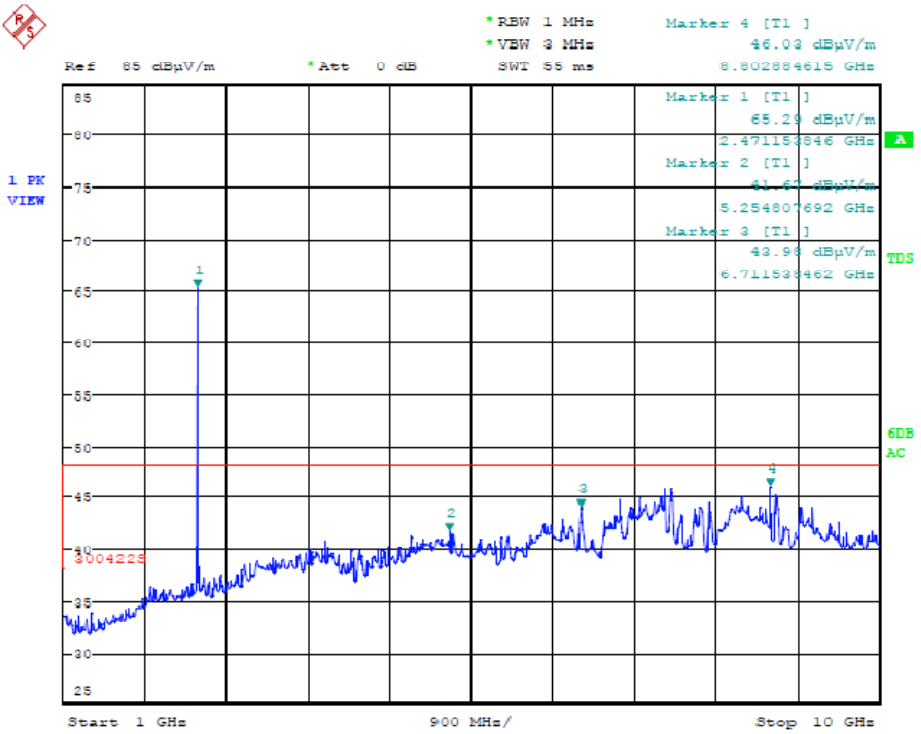
5.7.4.25. Standby mode Radiated 30-1000 MHz @ 3m-Horizontal



5.7.4.26. Standby mode Radiated 1-10 GHz @ 3m-Vertical



5.7.4.27. Standby mode Radiated 1-10 GHz @ 3m- Horizontal



5.8. RF EXPOSURE REQUIRMENTS [§§ 15.247(i), 1.1310 & 2.1091] RSS Gen 3.4, RSS 102

5.8.1. Limits

FCC has specified the general guidance for meeting RF Exposure requirements in KDB 447498 D01 General RF Exposure Guidance v06, the following are the applicable sections for this module summarized from this guidance.

1) The RF exposure requirements for devices operating in mobile and portable exposure conditions are different. When both exposure conditions apply to a device, compliance is determined according to the rules and policies established for both exposure conditions. Equipment authorization for devices that are categorically excluded from routine RF exposure evaluation according to §2.1091(c) and §2.1093(c).
2) Standalone and simultaneous transmission use conditions for mobile and portable exposure conditions must be determined according to the host platform and product operating configuration requirements
3) Transmitter modules must be approved according to one of the following host platform exposure conditions, with respect to the product configurations tested or evaluated for equipment approval for incorporation in qualified host products. The approved host platform exposure condition(s) must be identified on the grant of equipment certification. When transmitter modules are incorporated in host devices that qualify for RF exposure test exclusion and no other testing or equipment approval is required, the standalone and simultaneous transmission configurations and test exclusion conditions must be fully documented in the grantee's records.

4) The 1-g body and 10-g extremity SAR Test Exclusion Thresholds in 4.3 should be applied to determine SAR test requirements.

RSS 102 Limits:

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance[4,5]

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

5.8.1.1. Standalone SAR test exclusion threshold condition for radio is verified as per below.

Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition(s), listed below, is (are) satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The minimum test separation distance defined in 4.1 f) is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander. To qualify for SAR test exclusion, the test separation distances applied must be fully explained and justified, typically in the SAR measurement or SAR analysis report, by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting are required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for SAR test exclusion. When required, the device specific conditions described in the other published RF exposure KDB procedures must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops and tablets, etc.

4.3.1 (a) For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR, where

- f(GHz) is the RF channel transmit frequency in GHz.
- Power and distance are rounded to the nearest mW and mm before calculation31
- The result is rounded to one decimal place for comparison
- Thevalues 3.0 and 7.5 are referred to as numeric thresholds

Radio#1 UHF Mic Radio:

Max frequency: 960 MHz
Max power 15.3 mW,
Antenna gain 0 dBi and @ 5 mm separation distance.
Power= 15.3 mW

Relative to Numeric Threshold
= [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)]

= (15.3)/5 x (√0.96) **= 2.998 < 3**, satisfies the exclusion threshold for STAND ALONE

Radio#2 WIFI Radio:

Max frequency: 2.48 GHz
Max power 16.62 dbm,
Antenna gain 2 dBi and duty Cycle of 3.458% @ 5 mm separation distance.
Power= 16.62+2=18.62 dBm=72.77mW at 100%
Power after duty cycle=0.03458*72.77=2.52 mW

Relative to Numeric Threshold
= [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)]

= (2.52)/5 x (√2.48) < 3 **= 0.793 < 3**, satisfies the exclusion threshold for STAND ALONE

5.8.1.2. Simultaneous transmission SAR test exclusion considerations

4.32 (b) When an antenna qualifies for the standalone SAR test exclusion of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:

1) [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance,mm)]·[√f(GHz)/x] W/kg, for test separation distances ≤ 50 mm;
where x = 7.5 for 1-g SAR and x = 18.75 for 10-g SAR.

This SAR estimation formula has been considered in conjunction with the SAR Test Exclusion Thresholds to result in substantially conservative SAR values of ≤ 0.4 W/kg. When SAR is estimated, the peak SAR location is assumed to be at the feed-point or geometric center of the antenna, whichever provides a smaller antenna separation distance, and this location must be clearly identified in test reports. The estimated SAR is used only to determine simultaneous transmission SAR test exclusion; it should not be reported as the standalone SAR. When SAR is estimated, it must be applied to determine the sum of 1-g SAR test exclusion. When SAR to peak location separation ratio test exclusion is applied, the highest reported SAR for simultaneous transmission can be an estimated standalone SAR if the estimated SAR is the highest among the simultaneously transmitting antennas (see also KDB Publication 690783 D01). For situations where the estimated SAR is overly conservative for certain conditions, the test lab may choose to perform standalone SAR measurements, then use the measured SAR to determine simultaneous transmission SAR test exclusion. Estimated SAR values at selected frequencies, distances, and power levels are illustrated in Appendix D

1. **WIFI Radio:**
   Max frequency: 2.48 GHz
   Max power 16.62 dbm,
   Antenna gain 2 dBi and duty Cycle of 3.458%
   @ 5 mm separation distance.
   Power= 16.62+2=18.62 dBm=72.77mW at 100%
   Power after duty cycle=0.03458*72.77=2.52
   Estimated SAR_1 [2.52/5].[√2.48/7.5]=[0.504*0.2099]=0.106 W/kg

2. **UHF Mic Radio:**
   Max frequency: 960 MHz
   Max power 15.3 mW,
   Antenna gain 0 dBi and duty Cycle of 100% @ 5 mm separation distance.

   Power =15.3 mW
   Estimated SAR_2 [15.3/5].[√0.96/7.5]=[3.2820*0.1046]=0.4W/kg

4.32 c) When the sum of SAR is larger than the limit, SAR test exclusion is determined by the SAR to peak location separation ratio. The simultaneously transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SAR to peak location separation ratio to qualify for test exclusion. The ratio is determined by $(SAR_1 + SAR_2)^{1.5}/R_i$, rounded to two decimal digits, and must be ≤ 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion. When 10-g SAR applies, the ratio must be ≤ 0.10. SAR1 and SAR2 are the highest reported or estimated SAR values for each antenna in the pair, and Ri is the separation distance in mm between the peak SAR locations for the antenna pair. The antennas in all antenna pairs that do not qualify for simultaneous transmission SAR test exclusion must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Publication 865664 D01.

Peak SAR location distance measured at feed points of antenna pairs: r1 = 25.02mm r2 = 44.59mm

SAR to peak location separation ratio (SPLSR) = (Estimated SAR_1 + Estimated SAR_2)^1.5/R_i

SPLSR = (0.106 + 0.4)^1.5/25.02 = 0.014 must be ≤ 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion

5.9. POWER LINE CONDUCTED EMISSIONS [§15.207(a)] [RSS Gen-8.8]

5.9.1. Limit(s)

The equipment shall meet the limits of the following table:

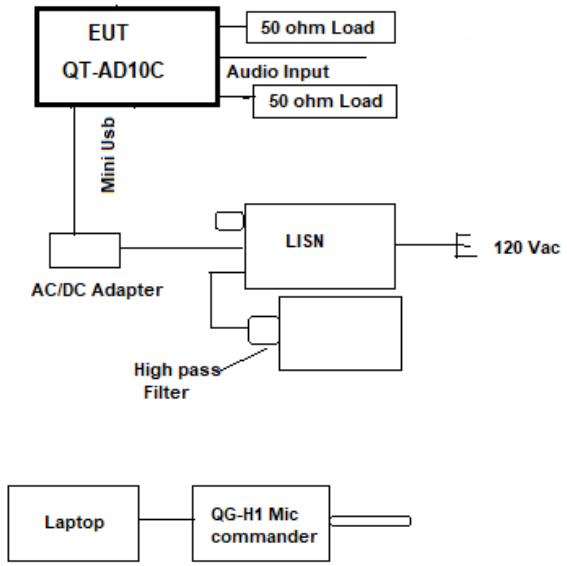
Frequency of emission (MHz)	Conducted Limits (dBμV)	
	Quasi-peak	Average
0.15–0.5 .....……..	66 to 56*	56 to 46*
0.5–5 .....……..	56	46
5-30 ……..	60 ..……..	50

*Decreases linearly with the logarithm of the frequency

5.9.2. Method of Measurements

ANSI C63.4

5.9.3. Test Arrangement

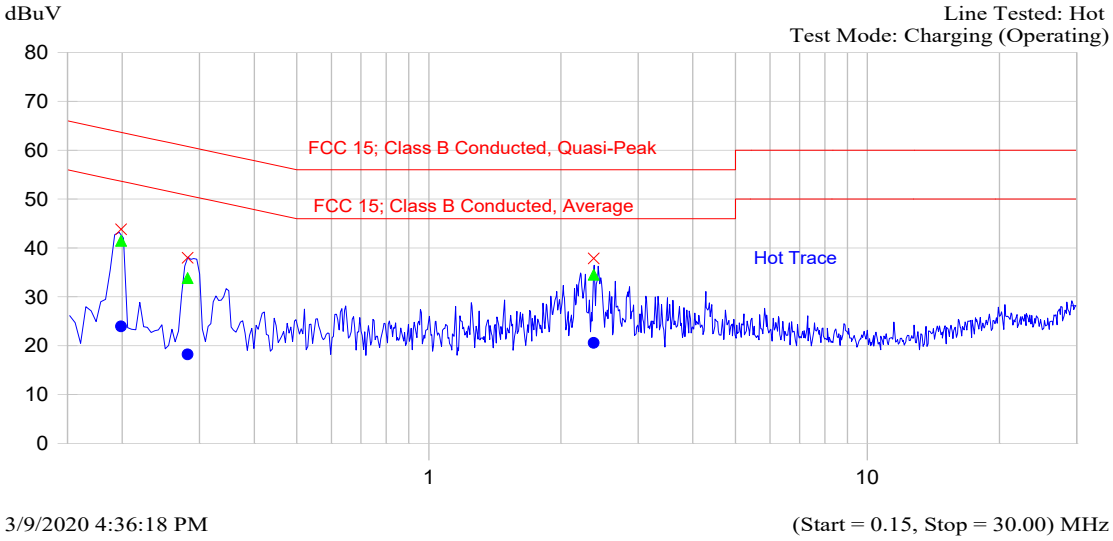


5.9.4. Test Equipment

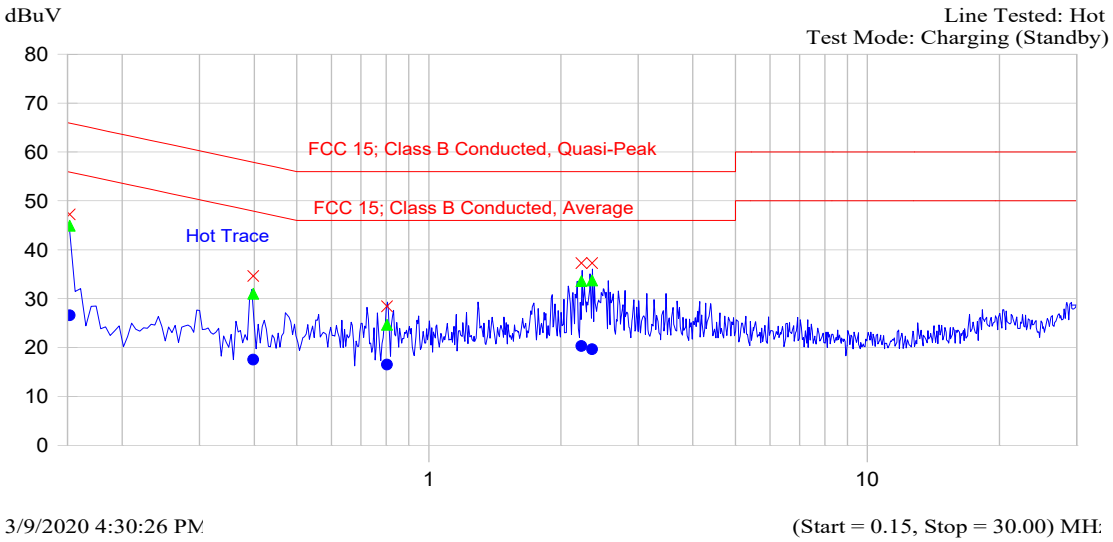
Test Instrument	Manufacturer	Model No	Serial No	Frequency Range	Cal Due date
Analyzer	HP	8593EM	3710A00223	9KHz-2GHz	13 May 2020
High pass filter	Rhode Schwarz	EZ-25	830164/006	150KHz-30MHz	07 Jun 2020
LISN	EMCO	3825-2	8907-1531	150KHz-30MHz	16 Jan 2021

5.9.5. Test Data

5.9.5.1. Hot Line

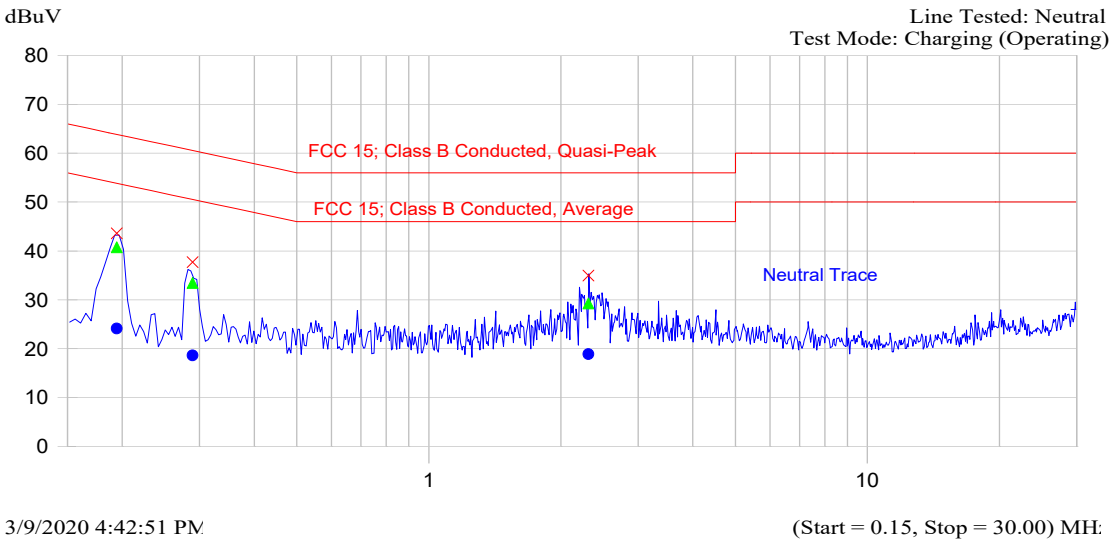


Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.199	43.8	41.5	-22.2	24.0	-29.7	Hot Trace
0.282	38.0	33.8	-26.9	18.2	-32.5	Hot Trace

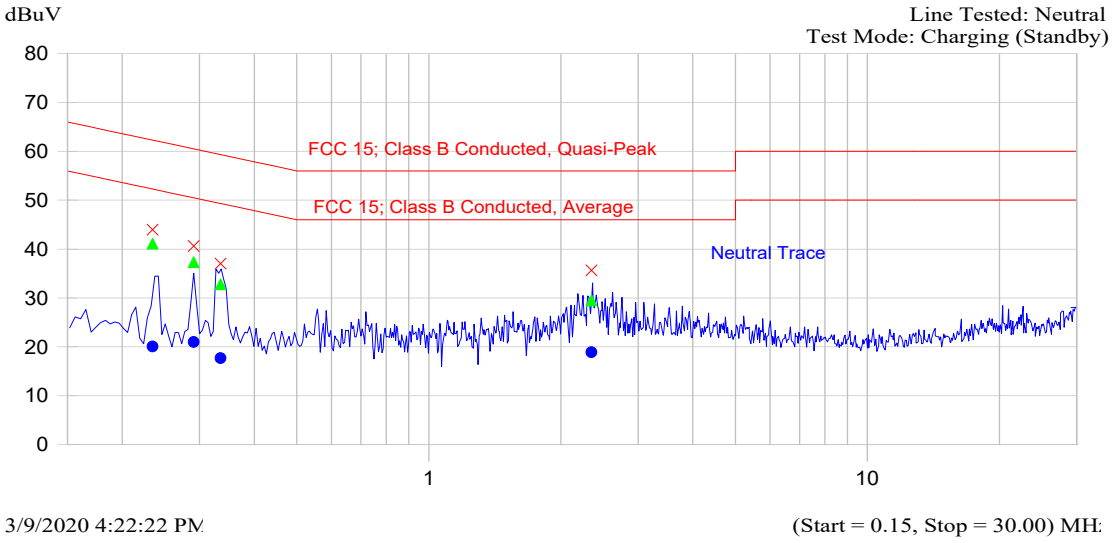


Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.152	47.2	44.9	-21.0	26.6	-29.3	Hot Trace
0.802	28.4	24.7	-31.3	16.5	-29.5	Hot Trace

5.9.5.2. Neutral Line



Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.194	43.6	40.8	-23.1	24.2	-29.7	Neutral Trace



Frequency MHz	Peak dBuV	QP dBuV	QP-QP Limit dB	Avg dBuV	Avg-Avg Limit dB	Trace Name
0.234	43.9	41.1	-21.2	20.1	-32.2	Neutral Trace
2.348	35.7	29.5	-26.5	18.9	-27.1	Neutral Trace

5.10. Radiated Emissions –Unintentional @ ICES-003

5.10.1. Limits

The equipment shall meet the limits of the following table:

Test Frequency Range (MHz)	Class B Limits (dBµV/m)	EMI Detector Used	Measurement Distance (meters)
30 – 88	40.0	Quasi-Peak	3
88 – 216	43.5	Quasi-Peak	3
216 – 960	46.0	Quasi-Peak	3
960 -1000	54.0	Quasi-Peak	3
Above 1000	54.0 74.0	Average Peak	3

5.10.2. Method of Measurements

Refer to Ultratech Test Procedures ULTR-P001-2004 & ANSI C63.4 for method of measurements.

The spectrum shall be investigated from the lowest radio frequency signal generated or used in the device, without going below the lowest frequency for which a radiated emission limit is specified, up to the frequency 5th harmonic of the highest frequency or 40 GHz, whichever is lower

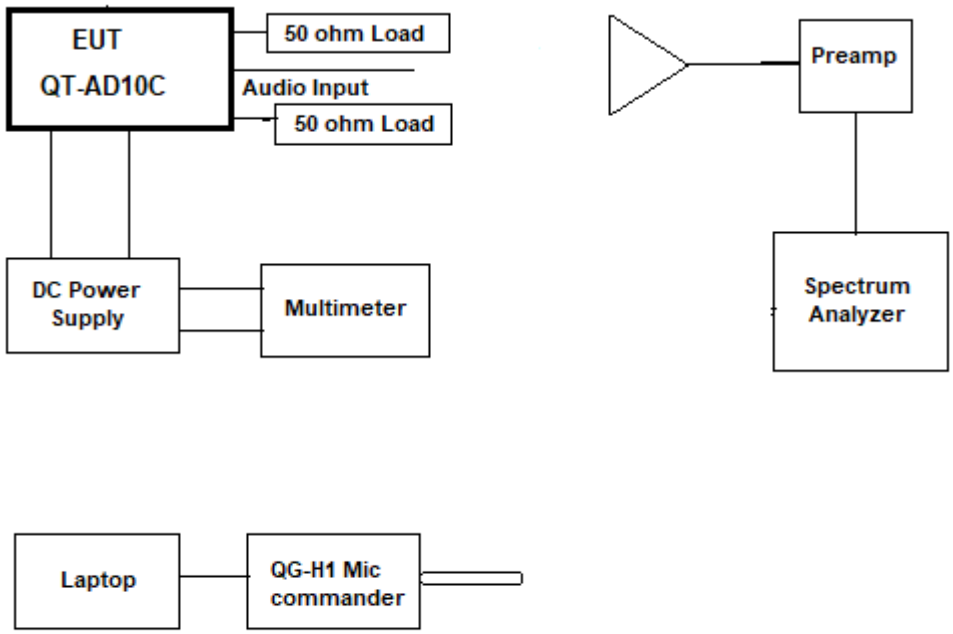
Calculation of Field Strength:

The field strength is calculated by adding the calibrated antenna factor and cable factor, and subtracting the Amplifier gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength
RA = Receiver/Analyzer Reading
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain

5.10.3. Test Arrangement



5.10.4. Test Equipment

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Due Date
EMI Receiver	Rohde & Schwarz	ESU40	100037	20Hz–40 GHz	15 Mar 2020
Biconilog Antenna	EMCO	3142B	1575	26-2000MHz	10 May 2020
Horn Antenna	ETS	3115	5061	1-18GHz	30 Apr 2020
Preamplifier	Com-Power	PAM-118A	551016	500MHz-18GHz	18 Mar 2020
50 ohm Load	Pasternack	PE6081	--	DC-18GHz	Cal on use
50 ohm Load	Pasternack	PE6036	--	DC-18GHz	Cal on use
Power Supply	Tenma	72-7295	490300271	1-40V, DC 5A	----
Multimeter	Fluke	8842A	4142058	---	05 Sep 2020

Test Dates: Mar. 6 & 9, 2020

5.10.5. Test Data

The emissions were scanned from 30 MHz to 10 GHz at 3 meters distance and all emissions in excess of 20 dB below the limits were recorded.

FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP/AVG)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
45.54	36.20	PEAK	V	40.0	**-3.8**	PASS
45.54	21.70	PEAK	H	40.0	-18.3	PASS
101.50	27.25	PEAK	V	43.5	-16.3	PASS
101.50	19.55	PEAK	H	43.5	-24.0	PASS
152.80	32.20	PEAK	V	43.5	-11.3	PASS
152.80	25.84	PEAK	H	43.5	-17.7	PASS
200.99	31.90	PEAK	V	43.5	-11.6	PASS
200.99	33.55	PEAK	H	43.5	-10.0	PASS
413.95	28.18	PEAK	V	46.0	-17.8	PASS
413.95	33.80	PEAK	H	46.0	-12.2	PASS

No further significant signals.

EXHIBIT 6. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

6.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

	Line Conducted Emission Measurement Uncertainty (9 kHz – 30 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)}$	± 1.44	± 1.8
U	Expanded uncertainty U: $U = 2u_c(y)$	± 2.89	± 3.6

6.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	Measured (dB)	Limit (dB)
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)}$	± 2.15	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.30	± 5.2

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	Measured (dB)	Limit (dB)
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)}$	± 2.14	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.29	± 5.2

	Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):	Measured (dB)	Limit (dB)
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)}$	± 1.52	Under consideration
U	Expanded uncertainty U: $U = 2u_c(y)$	± 3.04	Under consideration