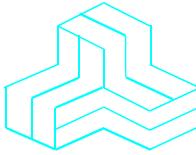


ENGINEERING TEST REPORT



**MOBEXCOM DVR Vehicular Repeater
Model: MOBEXCOM DVRS VHF**

FCC ID: LO6-DVRSVHF

Applicant:

Futurecom Systems Group, ULC
3277 Langstaff Road
Concord, Ontario
Canada, L4K 5P8

Tested in Accordance With

**Federal Communications Commission (FCC)
47 CFR, Parts 2, 22, 74, 80 and 90 (Subpart I)**

UltraTech's File No.: 18FSG173_FCC90

*This Test report is Issued under the Authority of
Tri M. Luu
Vice President of Engineering
UltraTech Group of Labs*

Date: December 4, 2018

Report Prepared by: Santhosh Fernandez

Tested by: Nimisha Desai

Issued Date: December 4, 2018

Test Dates: September 6- October 2, 2018

- The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.
- This report must not be used by the client to claim product endorsement by any agency of the US Government.
- This test report shall not be reproduced, except in full, without a written approval from UltraTech

UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel.: (905) 829-1570 Fax.: (905) 829-8050
Website: www.ultratech-labs.com, Email: vic@ultratech-labs.com, Email: tri@ultratech-labs.com



1309



CA 0001/2049



AT-1945



SL2-IN-E-1119R



CA2049

TABLE OF CONTENTS

| | |
|--|-----------|
| EXHIBIT 1. INTRODUCTION | 1 |
| 1.1. SCOPE..... | 1 |
| 1.2. RELATED SUBMITTAL(S)/GRANT(S)..... | 1 |
| 1.3. NORMATIVE REFERENCES | 1 |
| EXHIBIT 2. PERFORMANCE ASSESSMENT | 2 |
| 2.1. CLIENT INFORMATION | 2 |
| 2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION..... | 2 |
| 2.3. EUT'S TECHNICAL SPECIFICATIONS | 3 |
| 2.4. LIST OF EUT'S PORTS | 4 |
| 2.5. ANCILLARY EQUIPMENT | 4 |
| EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS | 5 |
| 3.1. CLIMATE TEST CONDITIONS | 5 |
| 3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS | 5 |
| EXHIBIT 4. SUMMARY OF TEST RESULTS | 6 |
| 4.1. LOCATION OF TESTS | 6 |
| 4.2. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS..... | 6 |
| 4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES..... | 6 |
| 4.4. DEVIATION OF STANDARD TEST PROCEDURES | 6 |
| EXHIBIT 5. TEST DATA..... | 7 |
| 5.1. RF POWER OUTPUT [§§ 2.1046, 22.565, 74.461, 80.215 & 90.205] | 7 |
| 5.1.1. <i>Limits</i> | 7 |
| 5.1.2. <i>Method of Measurements</i> | 7 |
| 5.1.3. <i>Test Arrangement</i> | 7 |
| 5.1.4. <i>Test Data</i> | 7 |
| 5.2. EMISSION MASK [§§ 2.1049, 74.462, 80.211(F), 90.209 & 90.210]..... | 8 |
| 5.2.1. <i>Limits</i> | 8 |
| 5.2.2. <i>Method of Measurements</i> | 8 |
| 5.2.3. <i>Test Data</i> | 9 |
| 5.4. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§ 2.1051, 2.1057, 22.359, 80.211(F)(3) & 90.210] | 33 |
| 5.4.1. <i>Limits</i> | 33 |
| 5.4.2. <i>Method of Measurements</i> | 33 |
| 5.4.3. <i>Test Data</i> | 34 |
| 5.5. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1053, 2.1057, 22.359, 80.211(F)(3) & 90.210]..... | 50 |
| 5.5.1. <i>Limits</i> | 50 |
| 5.5.2. <i>Method of Measurements</i> | 50 |
| 5.5.3. <i>Test Data</i> | 50 |
| 5.6. FREQUENCY STABILITY [§§ 2.1055, 22.355, 74.464, 80.209 & 90.213]..... | 52 |
| 5.6.1. <i>Limits</i> | 52 |
| 5.6.2. <i>Method of Measurements</i> | 53 |
| 5.6.3. <i>Test Data</i> | 53 |
| EXHIBIT 6. BLOCK DIAGRAM AND TEST EQUIPMENT..... | 54 |

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90

December 4, 2018

| | |
|---|-----------|
| 6.1. CONDUCTED POWER | 54 |
| 6.2. MASK | 55 |
| 6.3. TX CONDUCTED EMISSION | 56 |
| 6.4. TX RADIATED..... | 57 |
| 6.5. FREQUENCY STABILITY | 58 |
| EXHIBIT 7. MEASUREMENT UNCERTAINTY..... | 59 |
| 7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY | 59 |
| EXHIBIT 8. MEASUREMENT METHODS | 60 |
| 8.1. CONDUCTED POWER MEASUREMENTS..... | 60 |
| 8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD | 61 |
| 8.2.1. <i>MAXIMIZING RF EMISSION LEVEL (E-FIELD)</i> | 61 |
| 8.2.2. <i>Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method</i> | 62 |
| 8.3. FREQUENCY STABILITY | 64 |
| 8.4. EMISSION MASK..... | 65 |
| 8.5. SPURIOUS EMISSIONS (CONDUCTED) | 65 |

EXHIBIT 1. INTRODUCTION

1.1. SCOPE

| | |
|------------------|--|
| Reference: | FCC Parts 2, 22, 74, 80 and 90 (Subpart I) |
| Title: | Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2, 22, 74, 80 and 90 (Subpart I) |
| Purpose of Test: | To gain FCC C2PC Equipment Authorization for Radio operating in Parts 2, 22, 74, 80 and 90 (Subpart I) |
| Test Procedures: | ANSI/TIA-603-E, ANSI C63.26 |

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

None.

1.3. NORMATIVE REFERENCES

| Publication | Year | Title |
|----------------------------|------|---|
| FCC CFR Parts 0-19, 80-End | 2018 | Code of Federal Regulations, 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 |
| ANSI/TIA-603-E | 2016 | Land Mobile FM or PM Communications Equipment Measurement and Performance Standards |

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

| Applicant | |
|------------------------|---|
| Name: | Futurecom Systems Group, ULC |
| Address: | 3277 Langstaff Road Concord, ON Canada L4K 5P8 |
| Contact Person: | Mr. Tony Bombera Phone #: 905 532 1114 Fax #: 905 660 6858 Email Address: tony.bombera@futurecom.com |

| Manufacturer | |
|------------------------|---|
| Name: | Futurecom Systems Group, ULC |
| Address: | 3277 Langstaff Road Concord, ON Canada L4K 5P8 |
| Contact Person: | Mr. Tony Bombera Phone #: 905 532 1114 Fax #: 905 660 6858 Email Address: tony.bombera@futurecom.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: | Futurecom Systems Group, ULC |
| Product Name: | MOBEXCOM DVR Vehicular Repeater |
| Model Name or Number: | MOBEXCOM DVRS VHF |
| Serial Number: | Preproduction |
| Type of Equipment: | Licensed Non-Broadcast Station Transmitter |
| Power Supply Requirement: | 13.8 VDC |
| Transmitting/Receiving Antenna Type: | Non-integral |
| Operational Description: | The Futurecom MOBEXCOM DVR Vehicular Repeater is designed to interface to a range of mobile radios. It permits expanded operation of portable radios. The MOBEXCOM DVR Vehicular Repeater communicates with the mobile radio using a serial data protocol. |

2.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER | |
|--|--|
| Equipment Type: | Mobile |
| Intended Operating Environment: | Commercial, industrial or business environment |
| Power Supply Requirement: | 13.8 Vdc |
| RF Input Power Rating: | 0 dBm |
| RF Output Power Rating: | <ul style="list-style-type: none">• 20 watts max.• 1 watt min. |
| Operating Frequency Range: | 136-174 MHz |
| RF Output Impedance: | 50 Ohms |
| Channel Spacing | 12.5 kHz and 25 kHz |
| Occupied Bandwidth (99%): | <ul style="list-style-type: none">• 9.8 kHz (analog), 6.7 kHz (digital) (12.5 kHz Channel Spacing)• 14.8 kHz (25 kHz Channel Spacing) |
| Emission Designation: | <ul style="list-style-type: none">• 11K0F3E, 8K10F1D and 8K10F1E (12.5 kHz Channel Spacing)• 16K0F3E (25 kHz Channel Spacing) |
| Antenna Connector Type: | TNC Female |
| Antenna Description: | Omnidirectional antenna : The Antenna Gain Limit is 2.15 dBi |

* For an average case of commercial telephony, the Necessary Bandwidth is calculated as follows:

For FM Voice Modulation:

Channel Spacing = 12.5 KHz, D = 2.5 KHz max., K = 1, M = 3 KHz

$B_n = 2M + 2DK = 2(3) + 2(2.5)(1) = \underline{11 \text{ KHz}}$

Emission designation: 11K0F3E

Channel Spacing = 25 KHz, D = 5 KHz max., K = 1, M = 3 KHz

$B_n = 2M + 2DK = 2(3) + 2(5)(1) = \underline{16 \text{ KHz}}$

Emission designation: 16K0F3E

2.4. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|-------------|------------------------|---------------------------|-----------------|------------------------------------|
| 1 | Transmitter | 1 | TNC Female | Terminated with 50 Ohm load |
| 2 | Receiver | 1 | TNC Female | Terminated with 50 Ohm load |
| 3 | DC Input | 1 | 6-pin Circular | Non-shielded |
| 4 | USB | 1 | 4-pin Circular | Shielded |
| 5 | Mobile Radio | 1 | 20-pin Circular | Shielded |
| 6 | AUX | 1 | 9-pin Circular | Shielded |

2.5. ANCILLARY EQUIPMENT

None.

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°C |
| Humidity: | 51% |
| Pressure: | 102 kPa |
| Power input source: | 13.8 Vdc |

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

| | |
|----------------------------------|--|
| Operating Modes: | The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data. |
| Special Test Software: | Testing software provided by the manufacturer to configure different test configurations. |
| Special Hardware Used: | N/A |
| Transmitter Test Antenna: | The EUT is tested with the transmitter antenna port terminated to a 50 Ohms RF Load. |

| Transmitter Test Signals | |
|--|---|
| Frequency Band(s): | 136-174 MHz |
| Frequency(ies) Tested: (Near lowest and near highest frequencies in the frequency range of operation.) | 138.1 MHz; 151.1 MHz, 161.8 MHz & 174 MHz |
| RF Power Output (Rated maximum output power): | 20 Watts High & 1 Watt Low |
| Normal Test Modulation: | Unmodulated, FM Voice (analog & digital) |
| Modulating signal source: | External |

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.

- 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 EMISSION TEST RESULTS

| FCC Section(s) | Test Requirements | Applicability (Yes/No) |
|--|--|------------------------|
| 1.1307, 1.1310, 2.1091 & 2.1093 | RF Exposure Limit | N/A |
| 2.1046, 22.565, 74.461, 80.215 & 90.205 | RF Power Output | Yes |
| 2.1047(a), 80.213(e) & 90.242(b)(8) | Audio Frequency Response | N/A |
| 2.1047(b), 74.463, 80.213 & 90.210 | Modulation Limiting | N/A |
| 2.1049, 74.462, 80.211(f), 90.209 & 90.210 | Emission Mask | Yes |
| 2.1051, 2.1057, 80.211(f)(3), & 90.210 | Emission Limits - Spurious Emissions at Antenna Terminal | Yes |
| 2.1053, 2.1057, 22.359, 80.211(f)(3), & 90.210 | Emission Limits - Field Strength of Spurious Emissions | Yes |
| 2.1055, 22.355, 74.464 80.209 & 90.213 | Frequency Stability | Yes |
| 74.462(c) & 90.214 | Transient Frequency Behavior | N/A |

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

4.4. DEVIATION OF STANDARD TEST PROCEDURES

None.

EXHIBIT 5. TEST DATA

5.1. RF POWER OUTPUT [§§ 2.1046, 22.565, 74.461, 80.215 & 90.205]

5.1.1. Limits

Please refer to FCC 47 CFR 90.205, 74.461, 80.215 & 22.565 for specification details.

5.1.2. Method of Measurements

Refer to Section 8.1 (Conducted) and 8.2 (Radiated) of this report for measurement details

5.1.3. Test Arrangement

5.1.4. Test Data

High Power

| Frequencies MHz | 12.5KHz/ 25KHz | Power dBm | Power Rating dBm | Actual Power Watts | Power Rating Watts |
|--------------------|-------------------|--------------|---------------------|-----------------------|-----------------------|
| 138.100 | 12.5 | 42.99 | 43.01 | 19.91 | 20.0 |
| 151.100 | 12.5 | 43.01 | 43.01 | 20.00 | 20.0 |
| 161.800 | 12.5 | 43.02 | 43.01 | 20.04 | 20.0 |
| 173.300 | 12.5 | 42.96 | 43.01 | 19.77 | 20.0 |
| 138.100 | 25 | 42.98 | 43.01 | 19.86 | 20.0 |
| 151.100 | 25 | 43.00 | 43.01 | 19.95 | 20.0 |
| 161.800 | 25 | 43.02 | 43.01 | 20.04 | 20.0 |
| 173.300 | 25 | 42.94 | 43.01 | 19.68 | 20.0 |

Low Power

| Frequencies MHz | 12.5KHz/ 25KHz | Power dBm | Power Rating dBm | Actual Power Watts | Power Rating Watts |
|--------------------|-------------------|--------------|---------------------|-----------------------|-----------------------|
| 138.100 | 12.5 | 30.06 | 30.00 | 1.01 | 1.0 |
| 151.100 | 12.5 | 30.06 | 30.00 | 1.01 | 1.0 |
| 161.800 | 12.5 | 30.04 | 30.00 | 1.01 | 1.0 |
| 173.300 | 12.5 | 29.99 | 30.00 | 1.00 | 1.0 |
| 138.100 | 25 | 30.04 | 30.00 | 1.01 | 1.0 |
| 151.100 | 25 | 30.05 | 30.00 | 1.01 | 1.0 |
| 161.800 | 25 | 30.04 | 30.00 | 1.01 | 1.0 |
| 173.300 | 25 | 29.98 | 30.00 | 1.00 | 1.0 |

5.2. EMISSION MASK [§§ 2.1049, 74.462, 80.211(f), 90.209 & 90.210]

5.2.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

| Frequency Range (MHz) | Maximum Authorized BW (KHz) | Channel Spacing (KHz) | Recommended Frequency Deviation (KHz) | FCC Applicable Mask |
|-----------------------|-----------------------------|-----------------------|---------------------------------------|-----------------------|
| 156-174, 421-512 | 11.25 | 12.5 | 2.5 | Mask D – Voice & Data |
| 156-174, 421-512 | 20 | 25 | 5.0 | Mask B – Voice & Data |
| 150-174, 421-512 | 6 | 6.25 | 1.25 | Mask E – Voice & Data |

§80.211(f) Emission limitations

Emissions shall be attenuated below the mean output power of the transmitter as follows:

- (1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;
- (2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and
- (3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log_{10}$ (mean power in watts) dB.

5.2.2. Method of Measurements

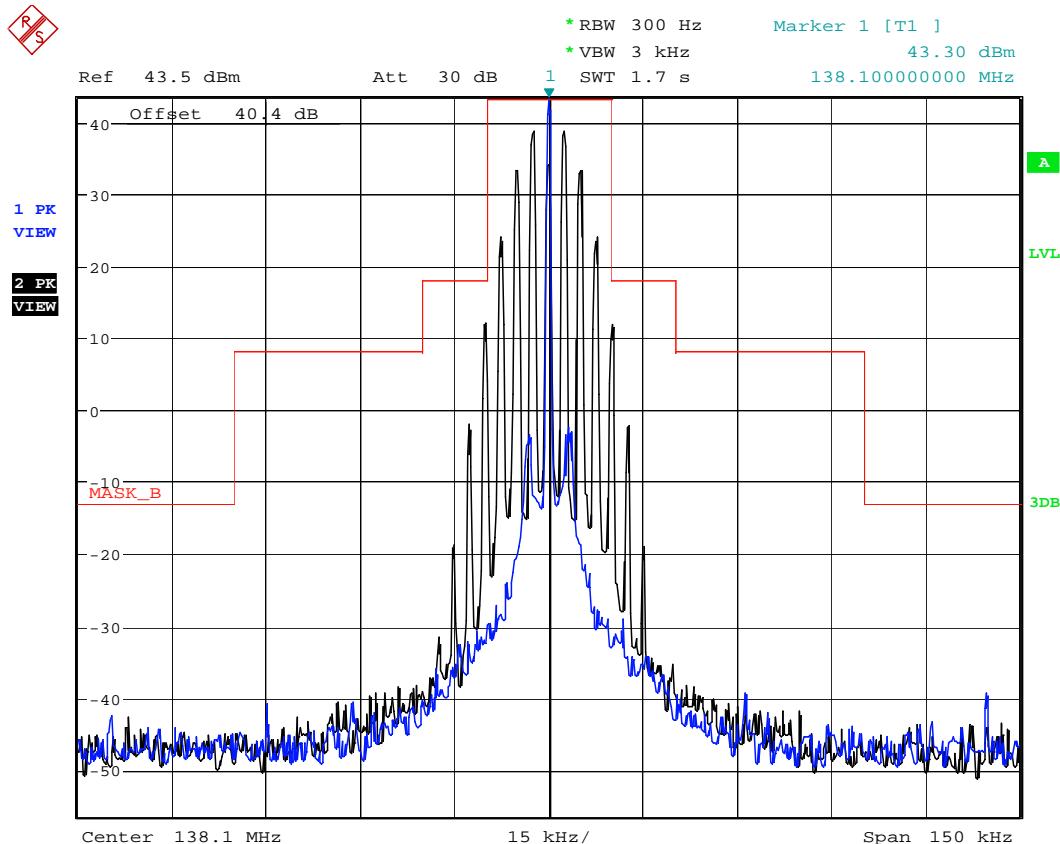
Refer to Section 8.4 of this report for measurement details.

5.2.3. Test Data

MASK B

High Power (Transmitter Mode)

5.2.3.1. Configuration: Mask B, 138.1MHz, 25 KHz, Analog, High power



Date: 6.SEP.2018 14:04:02

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

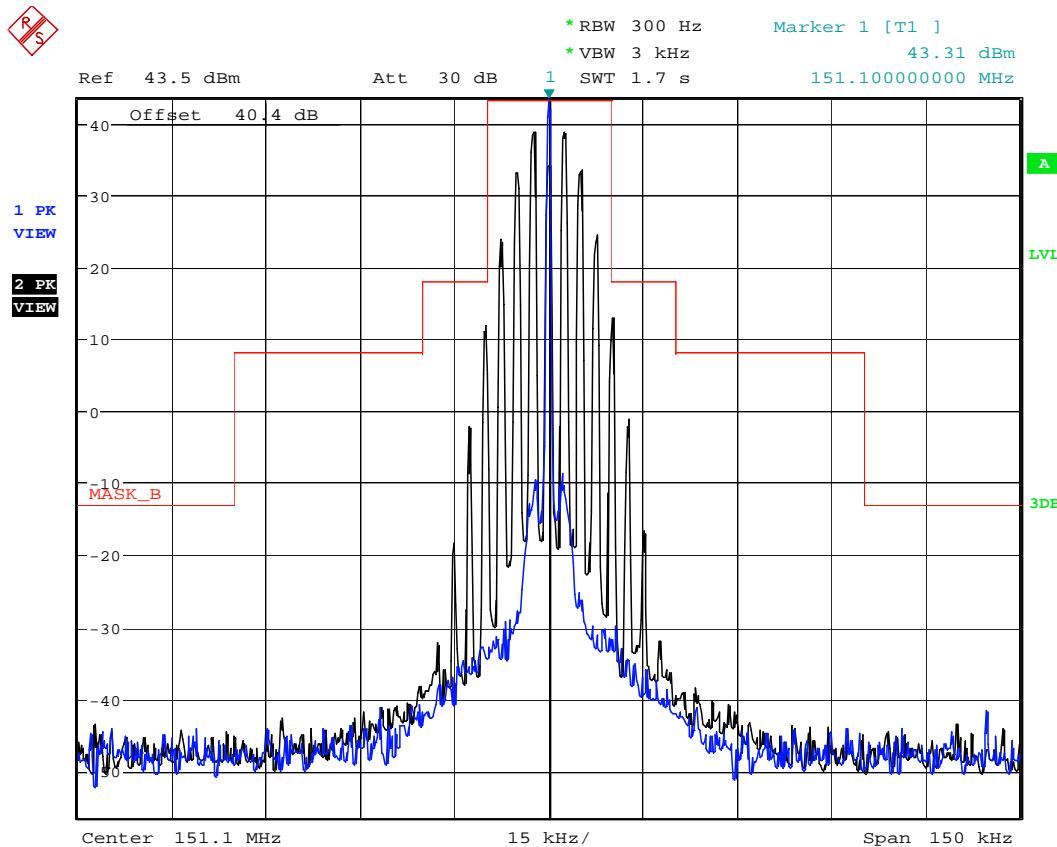
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90

December 4, 2018

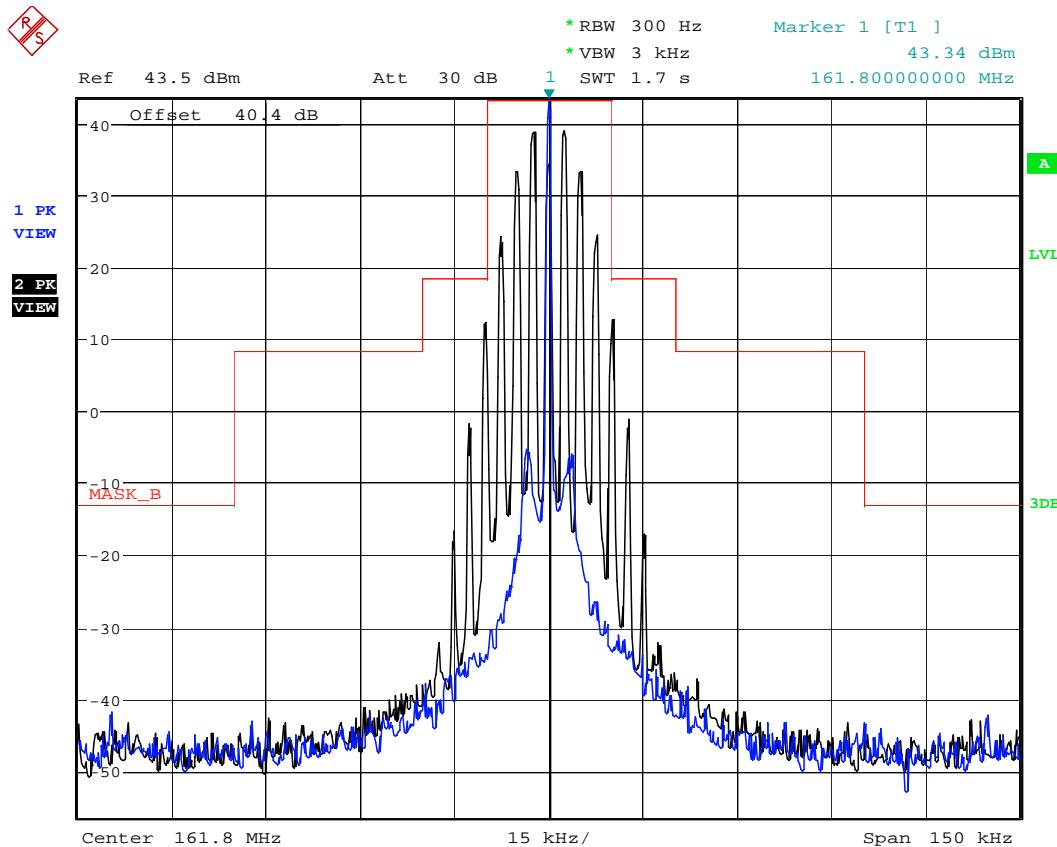
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.2.3.2. Configuration: Mask B, 151.1MHz, 25 KHz, Analog, High power



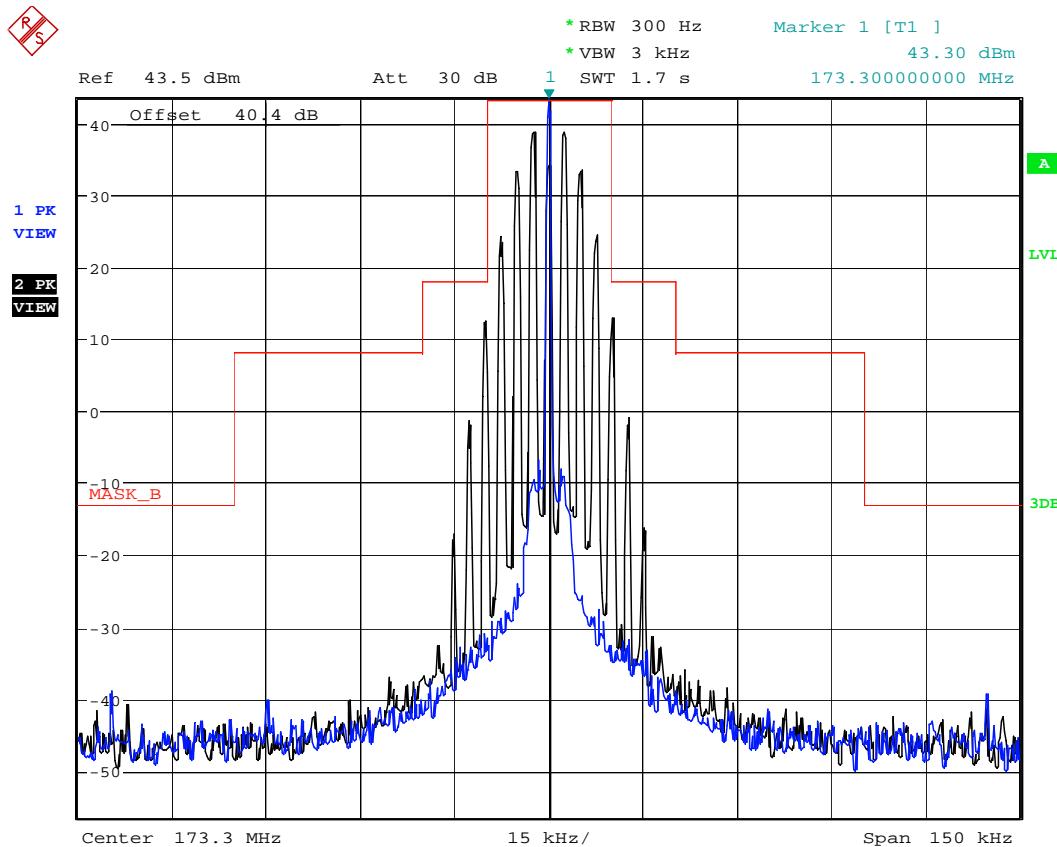
Date: 6.SEP.2018 14:06:48

5.2.3.3. Configuration: Mask B, 161.8MHz, 25 KHz, Analog, High power



Date: 6.SEP.2018 14:09:37

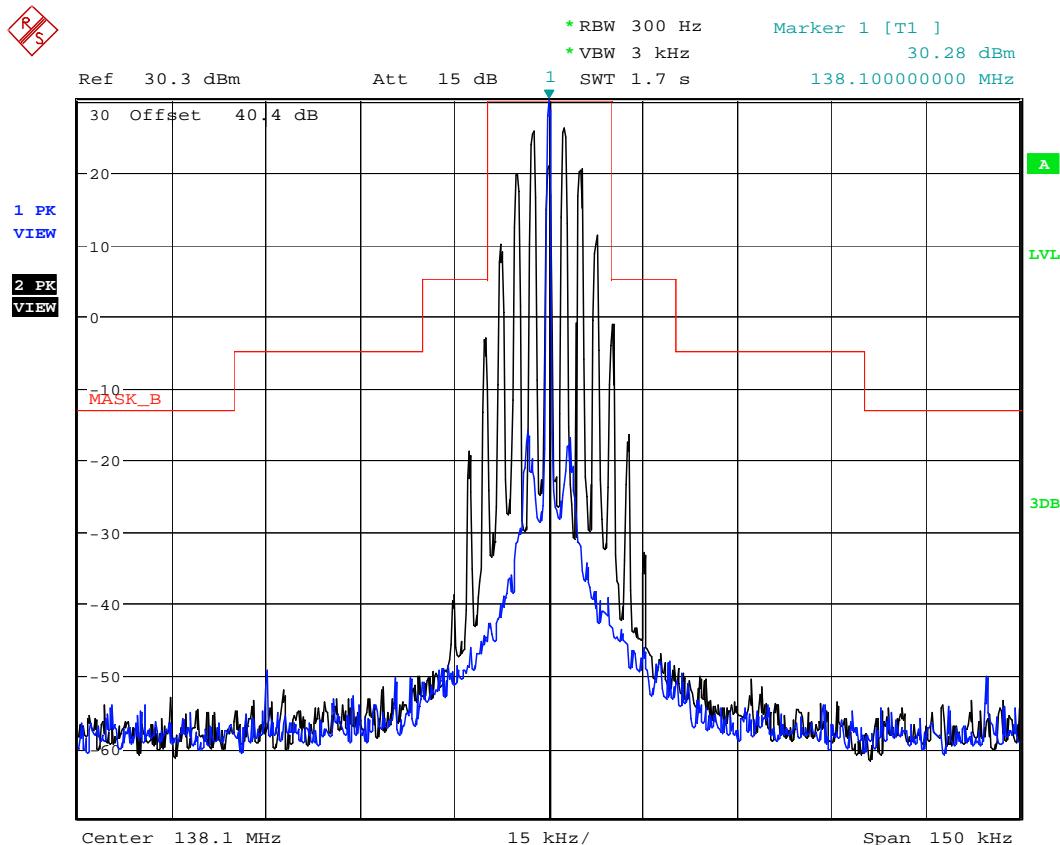
5.2.3.4. Configuration: Mask B, 173.3MHz, 25 KHz, Analog, High power



Date: 6.SEP.2018 14:12:13

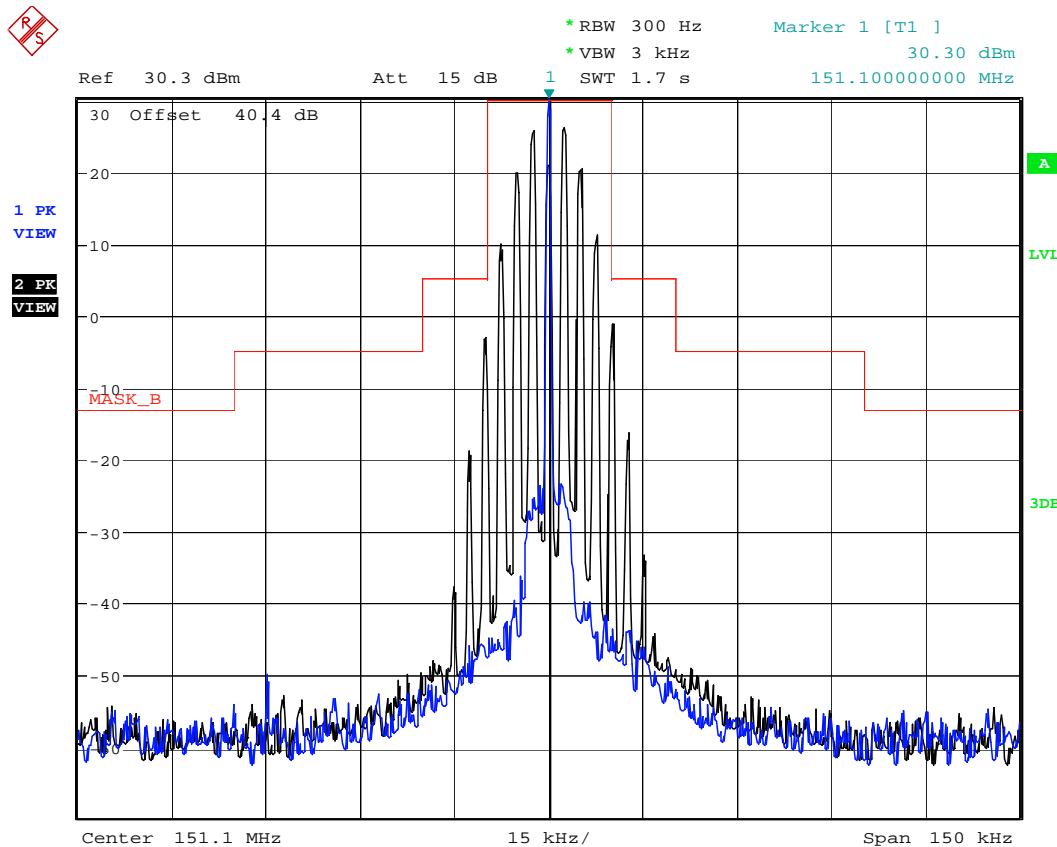
Low Power (Transmitter Mode)

5.2.3.5. Configuration: Mask B, 138.1MHz, 25 KHz, Analog, Low power



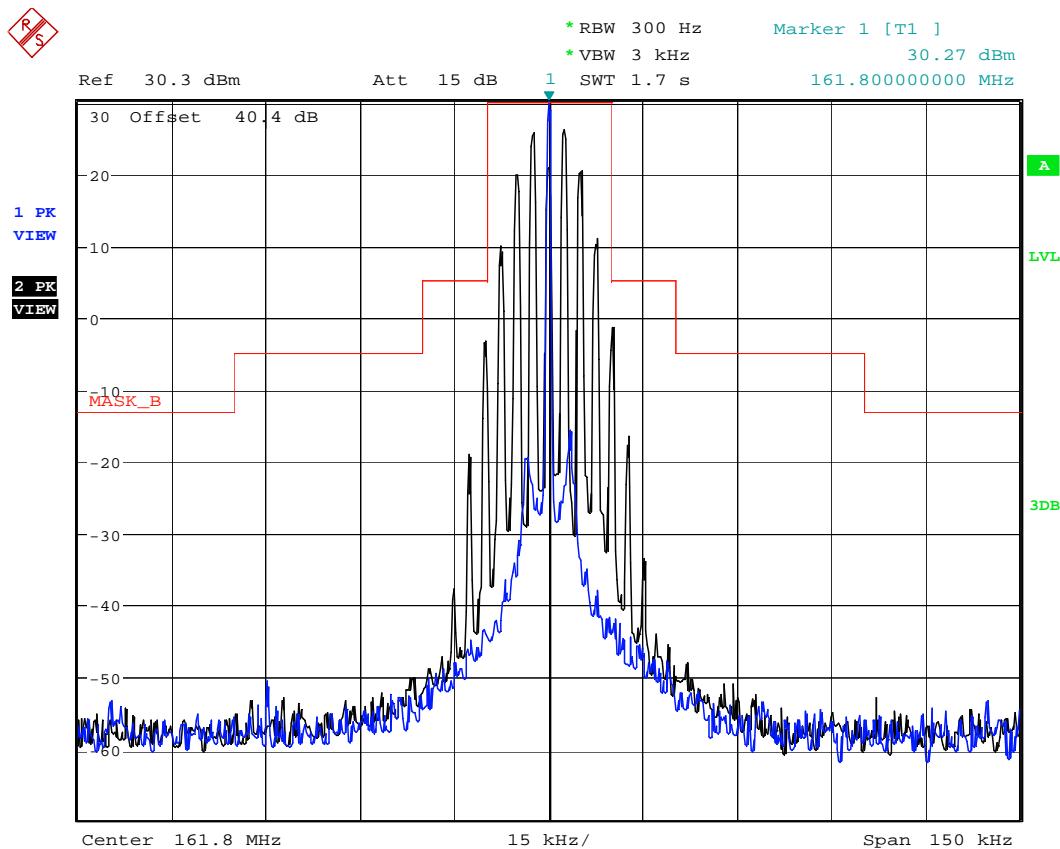
Date: 6.SEP.2018 14:23:59

5.2.3.6. Configuration: Mask B, 151.1MHz, 25 KHz, Analog, Low power



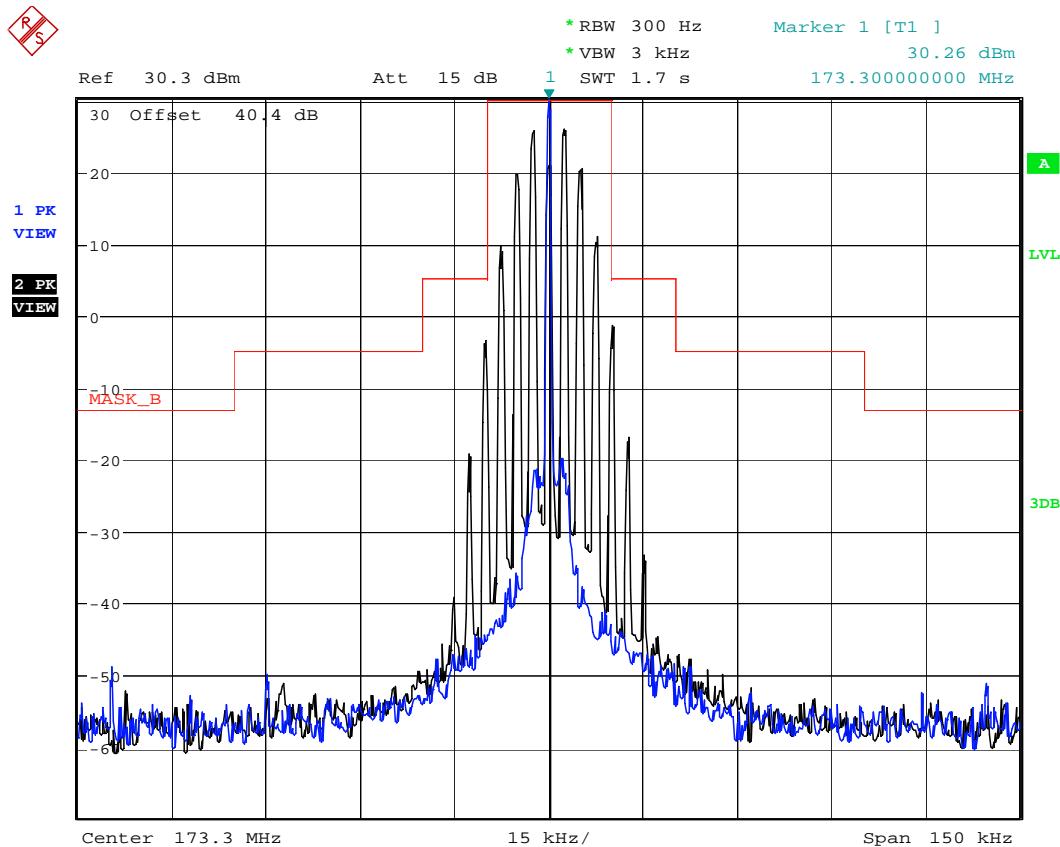
Date: 6.SEP.2018 14:26:18

5.2.3.7. Configuration: Mask B, 161.8MHz, 25 KHz, Analog, Low power



Date: 6.SEP.2018 14:28:25

5.2.3.8. Configuration: Mask B, 173.3MHz, 25 KHz, Analog, Low power

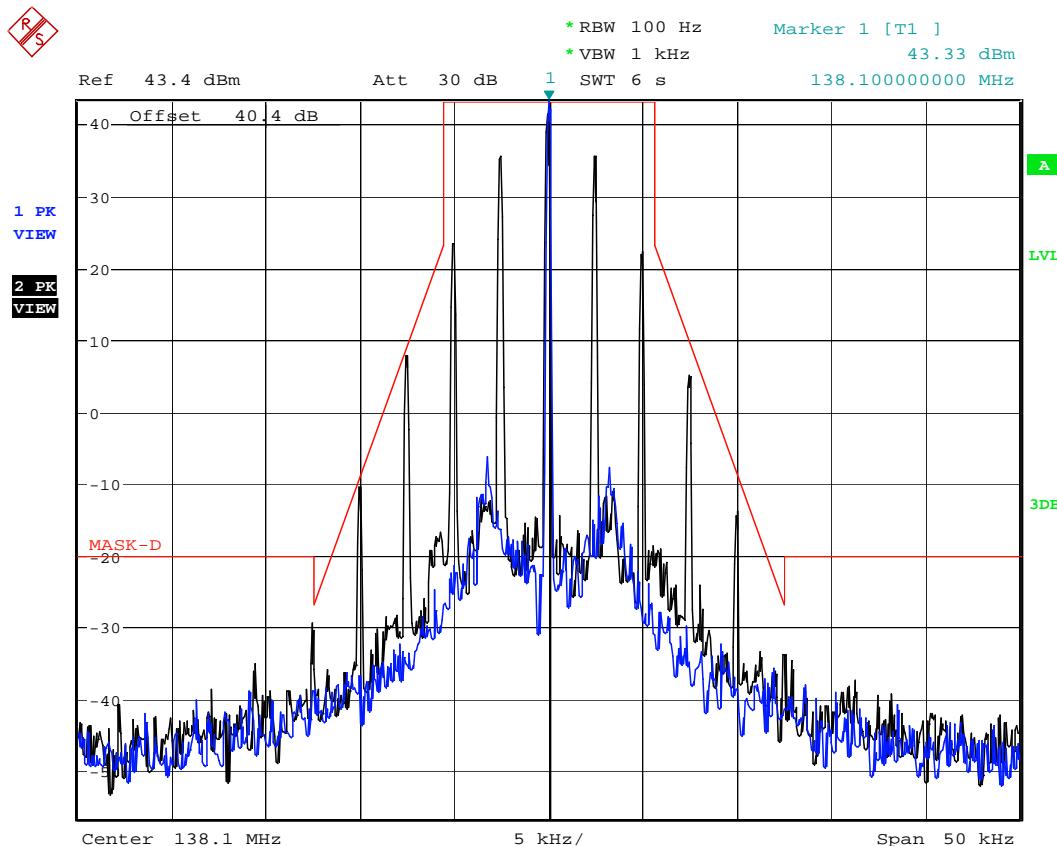


Date: 6.SEP.2018 14:30:32

MASK D

High Power (Transmitter Mode)

5.2.3.9. Configuration: Mask D, 138.1MHz, 12.5 KHz, Analog, High power



Date: 6.SEP.2018 15:25:33

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

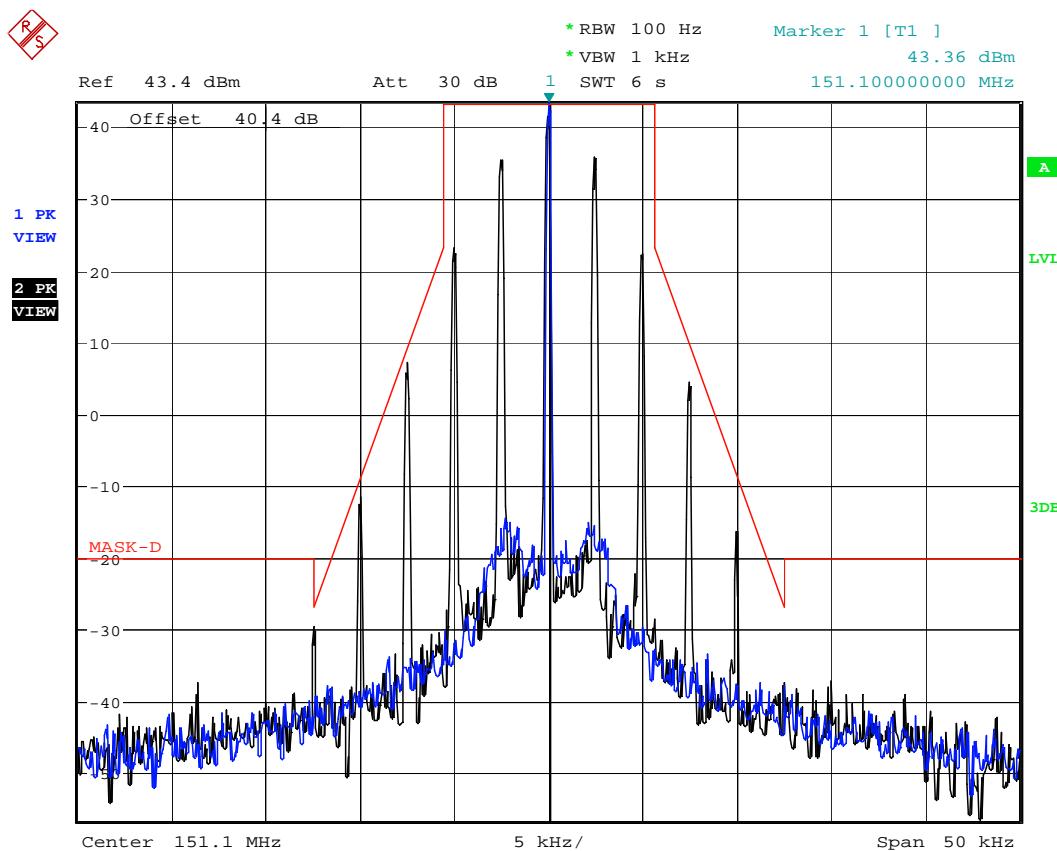
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90

December 4, 2018

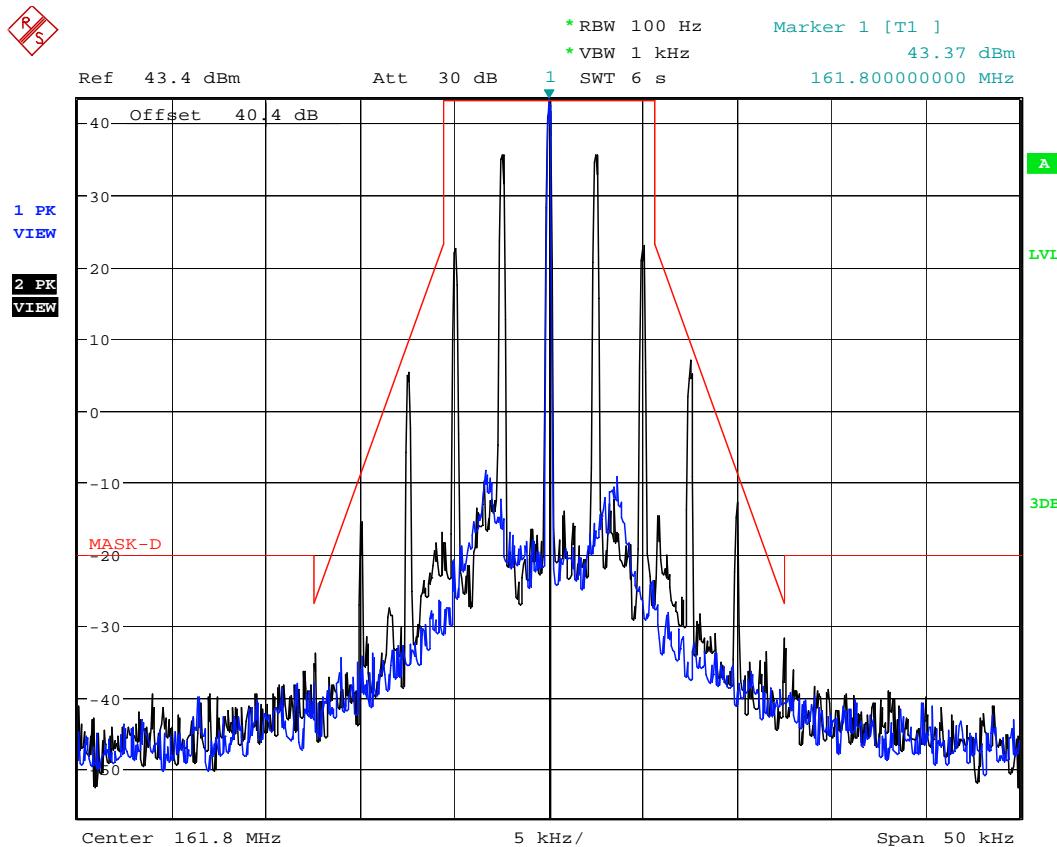
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.2.3.10. Configuration: Mask D, 151.1MHz, 12.5 KHz, Analog, High power



Date: 6.SEP.2018 15:36:47

5.2.3.11. Configuration: Mask D, 161.8MHz, 12.5 KHz, Analog, High power



Date: 6.SEP.2018 15:41:32

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

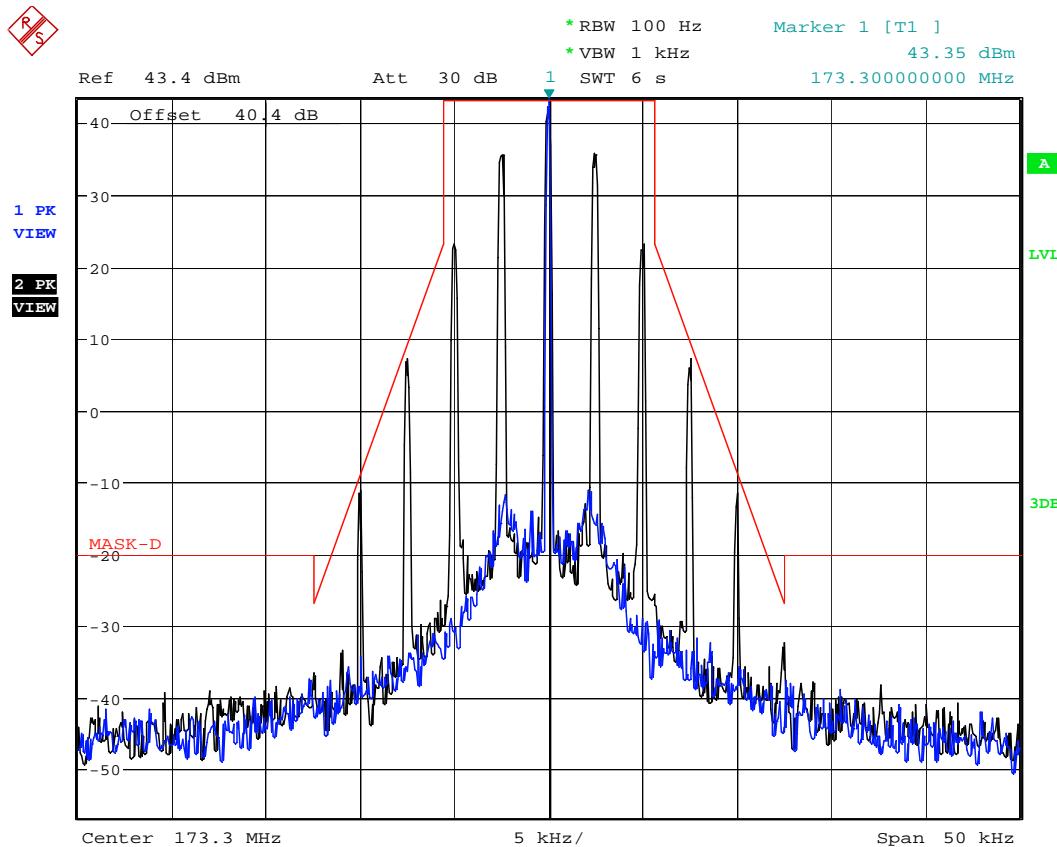
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90

December 4, 2018

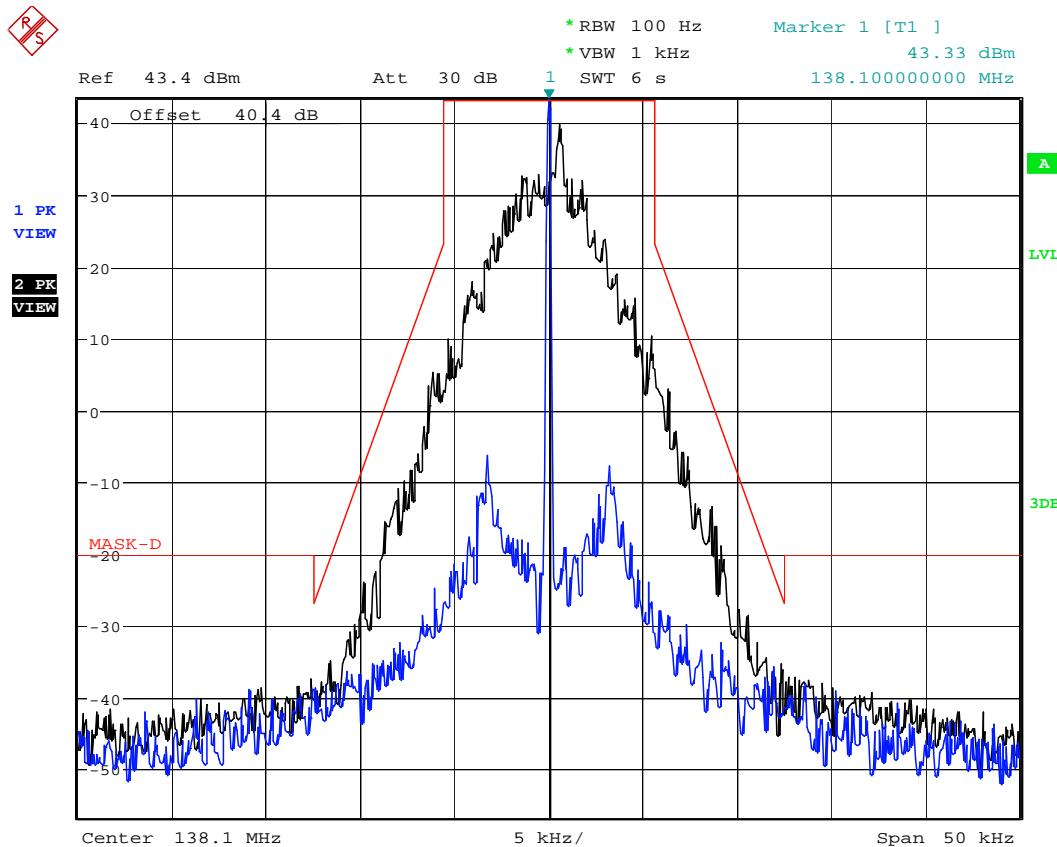
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.2.3.12. Configuration: Mask D, 173.3MHz, 12.5 KHz, Analog, High power



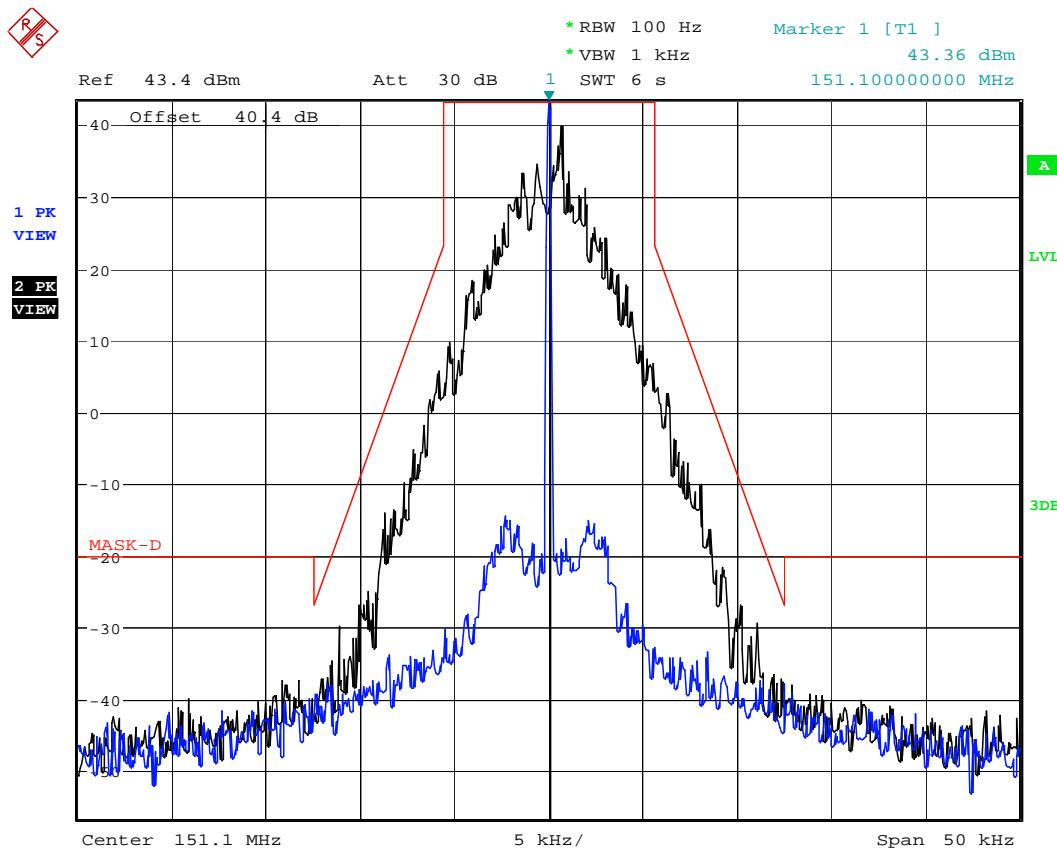
Date: 7.SEP.2018 08:15:54

5.2.3.13. Configuration: Mask D, 138.1MHz, 12.5 KHz, Digital, High power



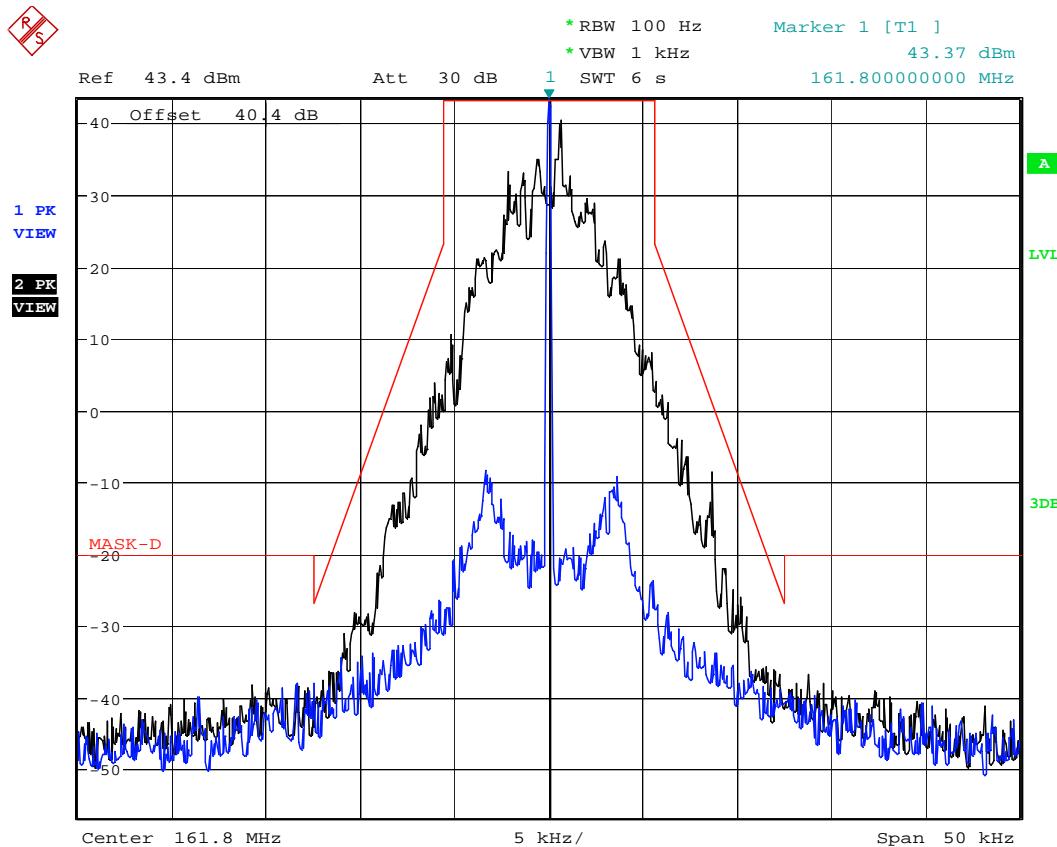
Date: 6.SEP.2018 15:27:11

5.2.3.14. Configuration: Mask D, 151.1MHz, 12.5 KHz, Digital, High power



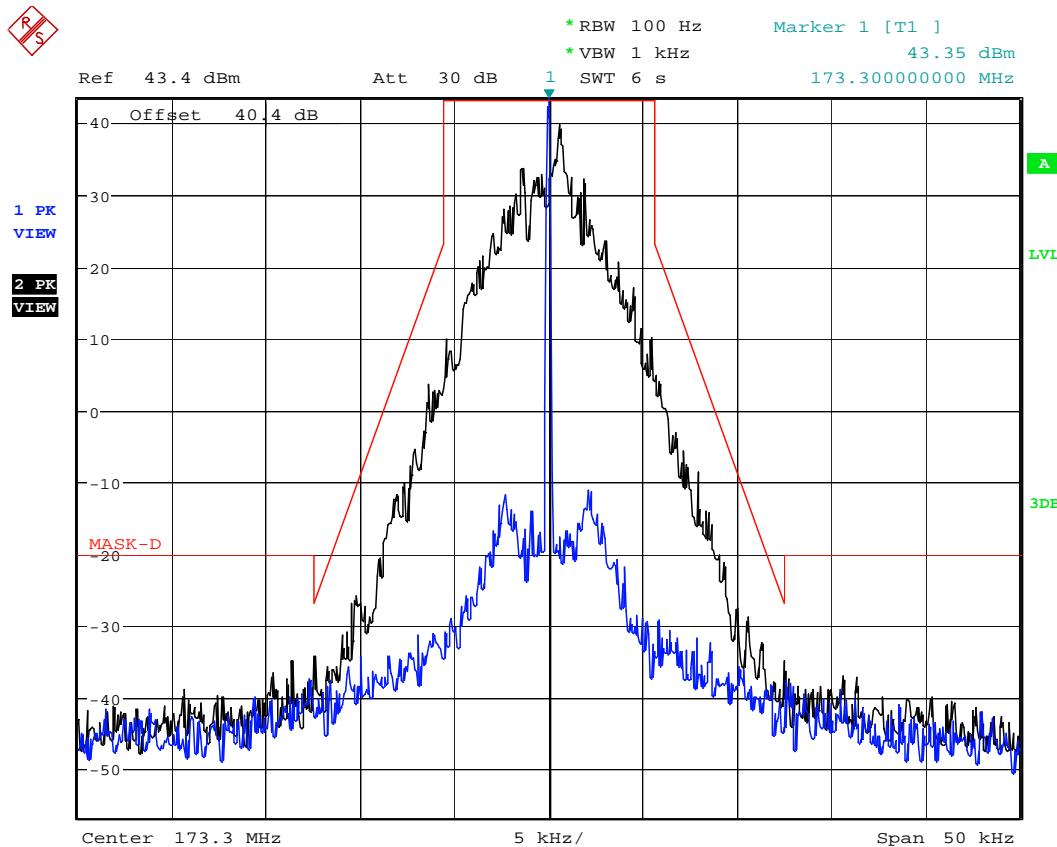
Date: 6.SEP.2018 15:37:56

5.2.3.15. Configuration: Mask D, 161.8MHz, 12.5 KHz, Digital, High power



Date: 6.SEP.2018 15:48:16

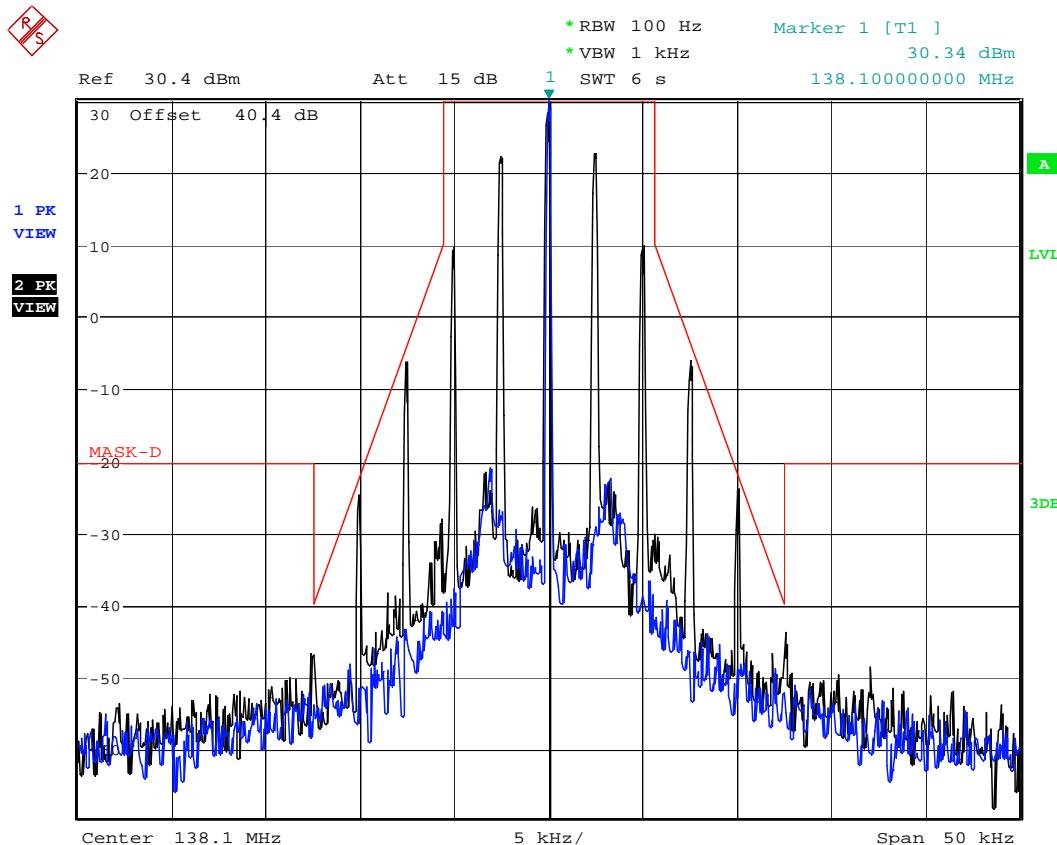
5.2.3.16. Configuration: Mask D, 173.3MHz, 12.5 KHz, Digital, High power



Date: 7.SEP.2018 08:17:51

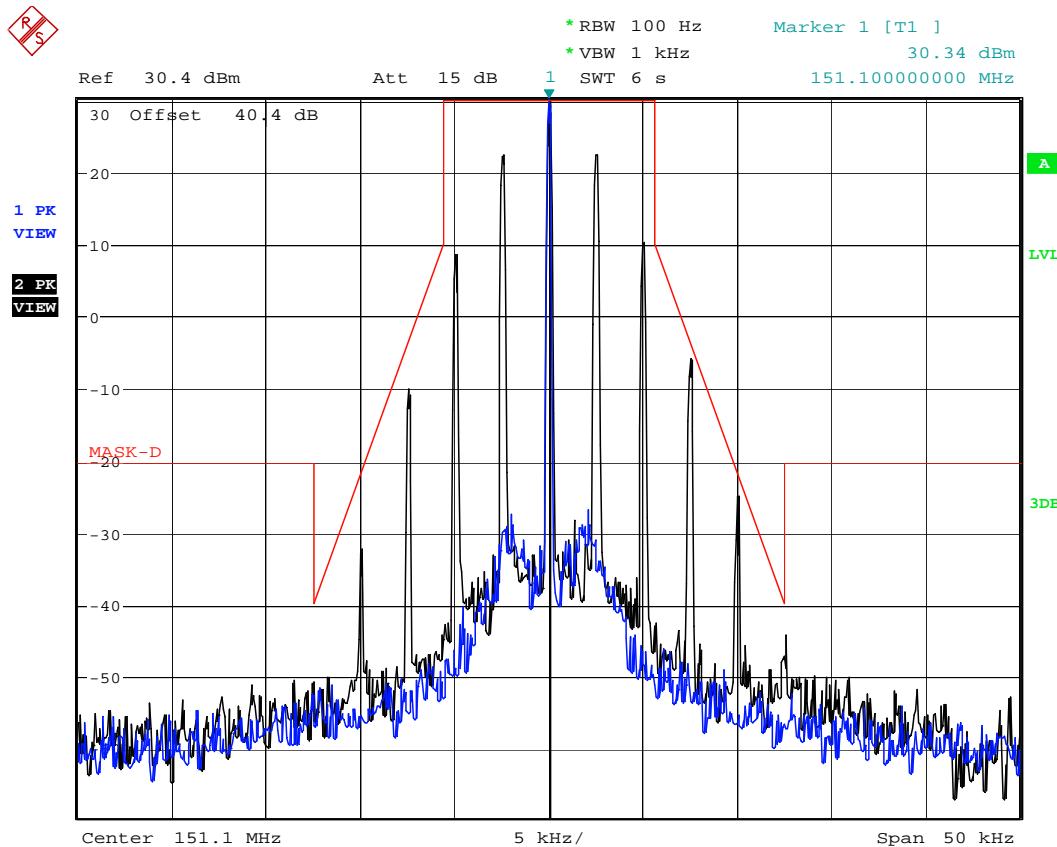
Low Power (Transmitter Mode)

5.2.3.17. Configuration: Mask D, 138.1MHz, 12.5 KHz, Analog, Low power



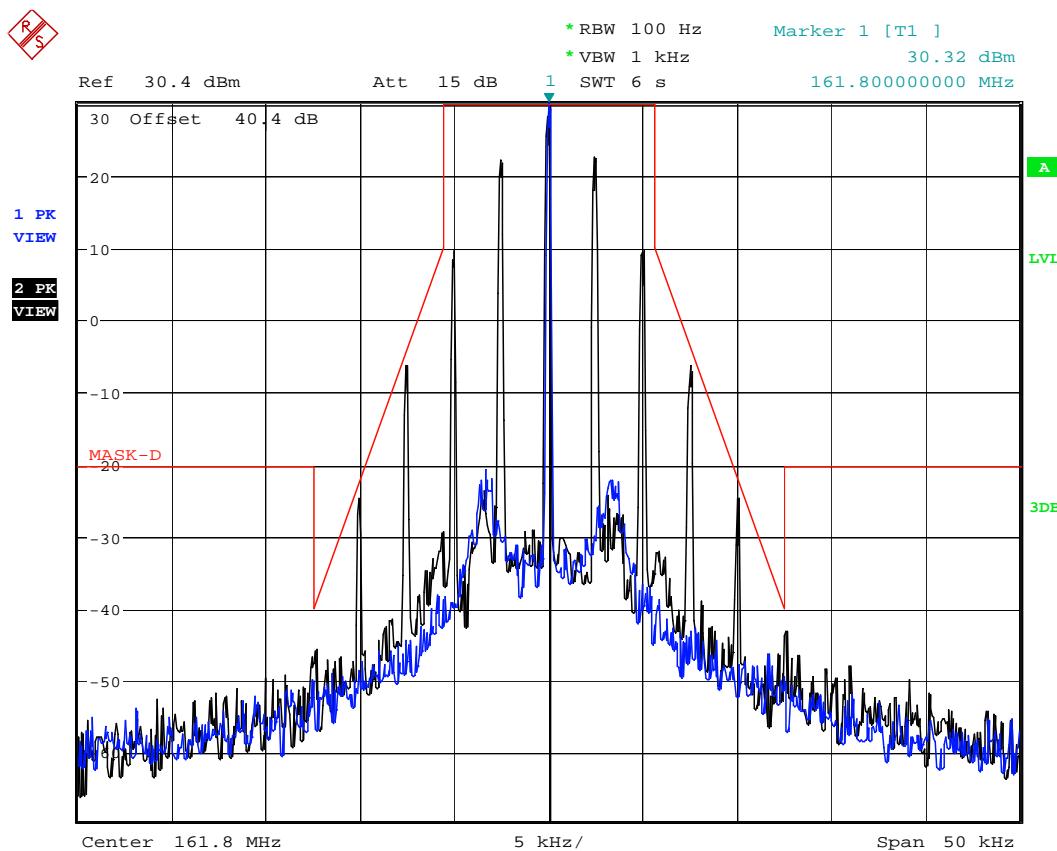
Date: 6.SEP.2018 14:41:27

5.2.3.18. Configuration: Mask D, 151.1MHz, 12.5 KHz, Analog, Low power



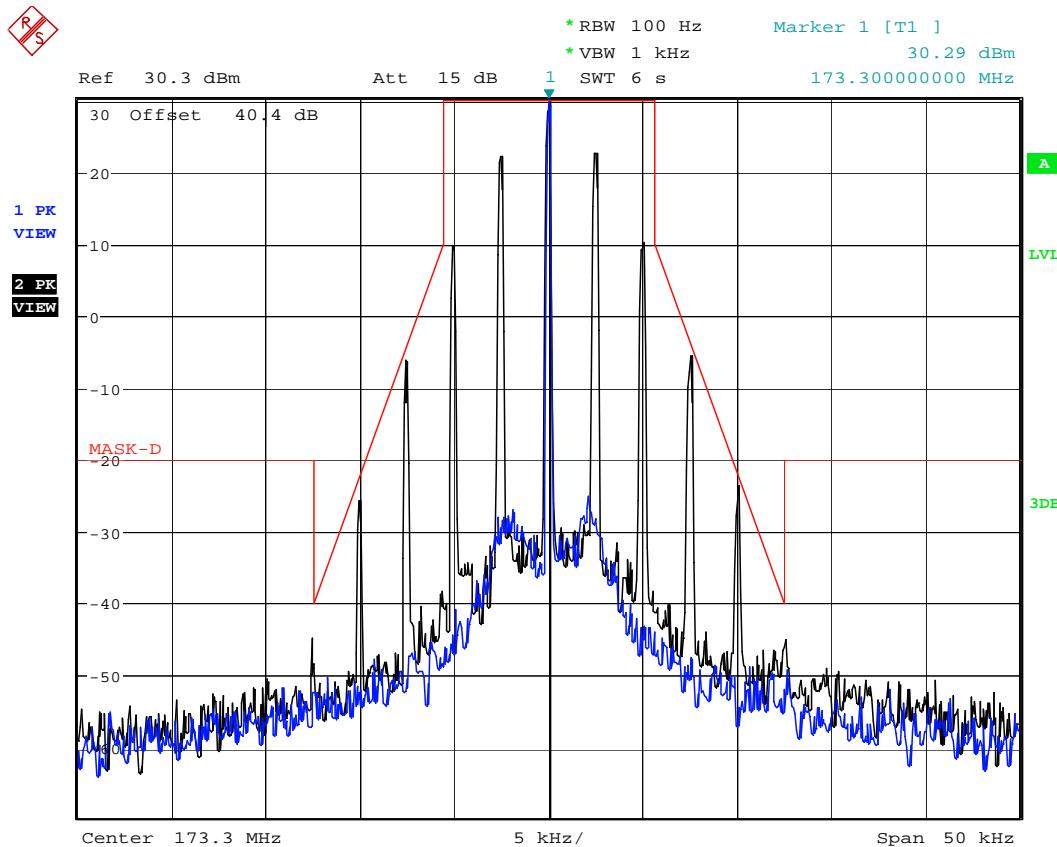
Date: 6.SEP.2018 14:48:51

5.2.3.19. Configuration: Mask D, 161.8MHz, 12.5 KHz, Analog, Low power



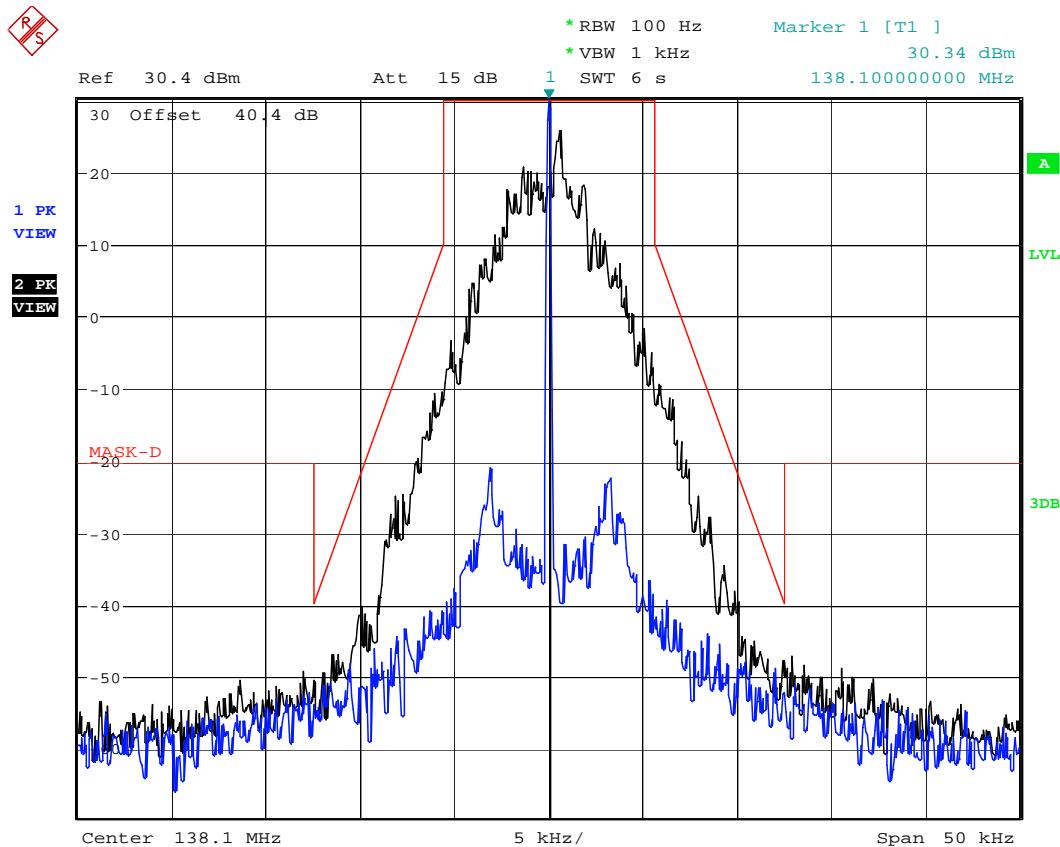
Date: 6.SEP.2018 14:52:08

5.2.3.20. Configuration: Mask D, 173.3MHz, 12.5 KHz, Analog, Low power



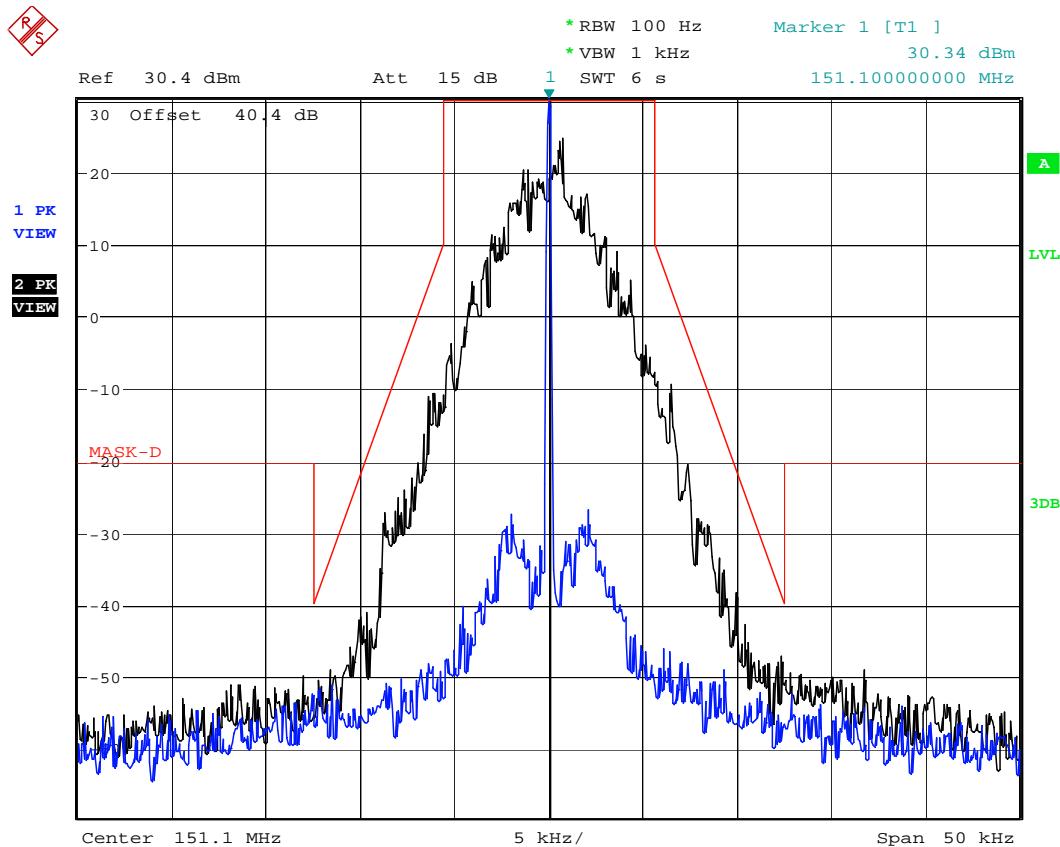
Date: 6.SEP.2018 15:19:12

5.2.3.21. Configuration: Mask D, 138.1MHz, 12.5 KHz, Digital, Low power



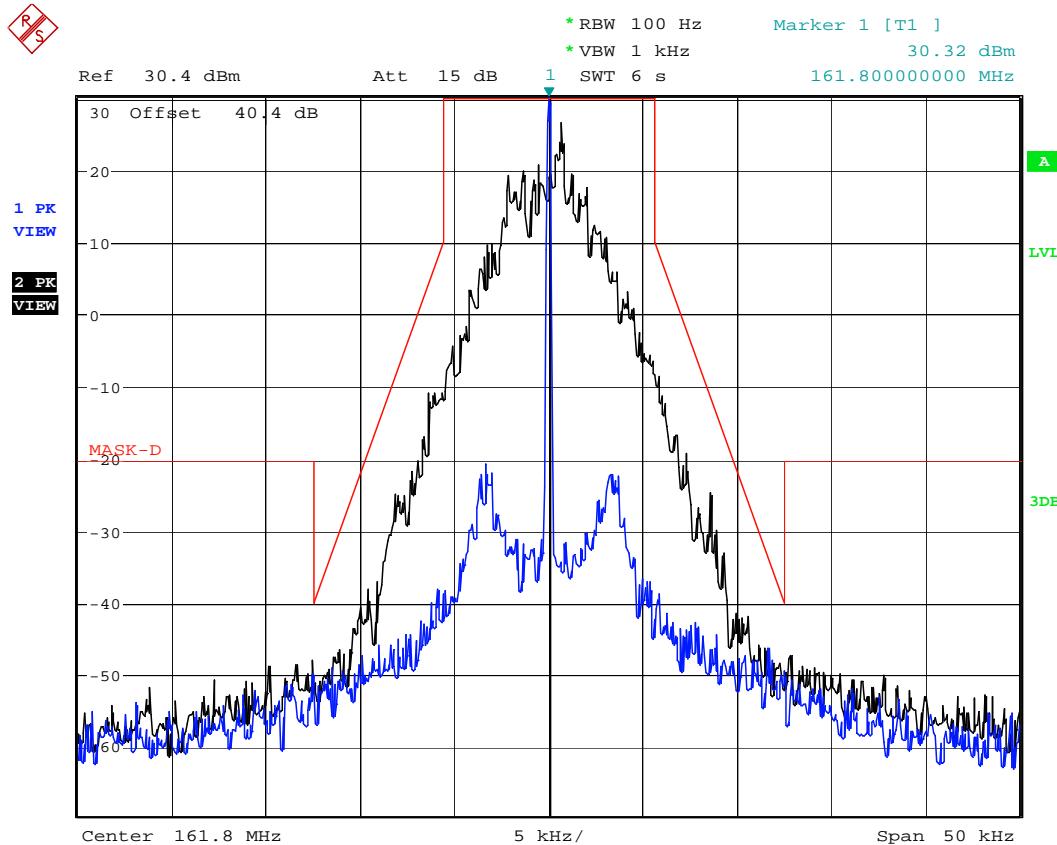
Date: 6.SEP.2018 14:43:21

5.2.3.22. Configuration: Mask D, 151.1MHz, 12.5 KHz, Digital, Low power



Date: 6.SEP.2018 14:46:03

5.2.3.23. Configuration: Mask D, 161.8MHz, 12.5 KHz, Digital, Low power



Date: 6.SEP.2018 14:53:39

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

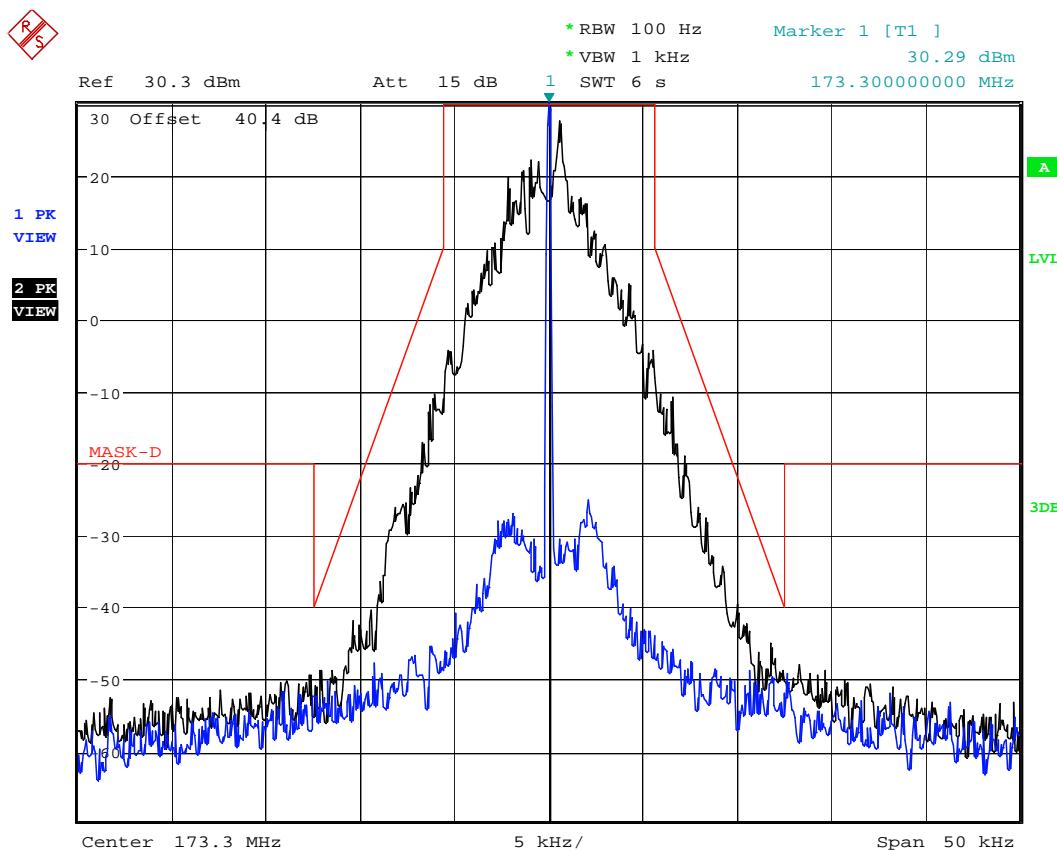
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90

December 4, 2018

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST).

5.2.3.24. Configuration: Mask D, 173.3MHz, 12.5 KHz, Digital, Low power



Date: 6.SEP.2018 15:17:43

5.4. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§ 2.1051, 2.1057, 22.359, 80.211(f)(3) & 90.210]

5.4.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

| FCC Rules | Attenuation Limit (dBc) |
|-----------------|---|
| § 22.359 | At least $43 + 10 \log (P)$ dB. |
| § 80.211(f)(3), | At least $43 + 10 \log_{10}$ (mean power in watts) dB |
| § 90.210(b) | At least $43 + 10 \log (P)$ dB |
| § 90.210(d) | At least $50 + 10 \log (P)$ dB or 70 dB, whichever is the lesser attenuation. |
| § 90.210(e) | At least $55 + 10 \log (P)$ or 65 dB, whichever is the lesser attenuation. |

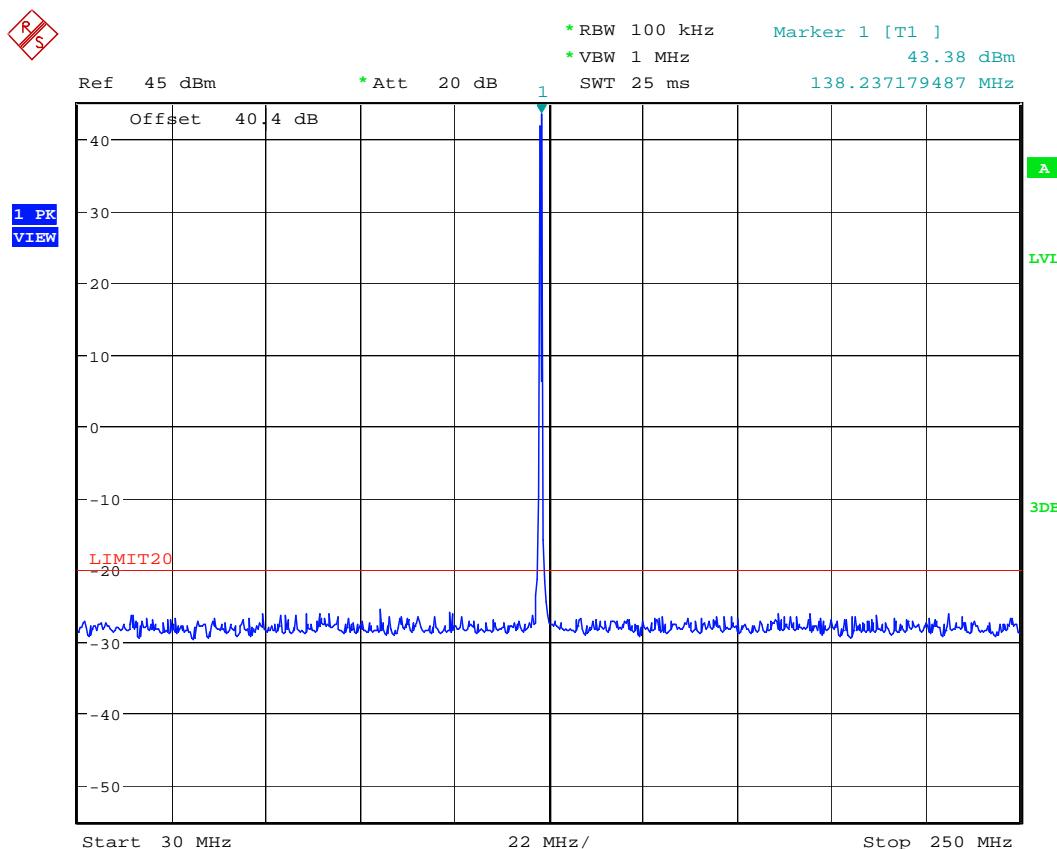
5.4.2. Method of Measurements

Refer to Section 8.5 of this report for measurement details

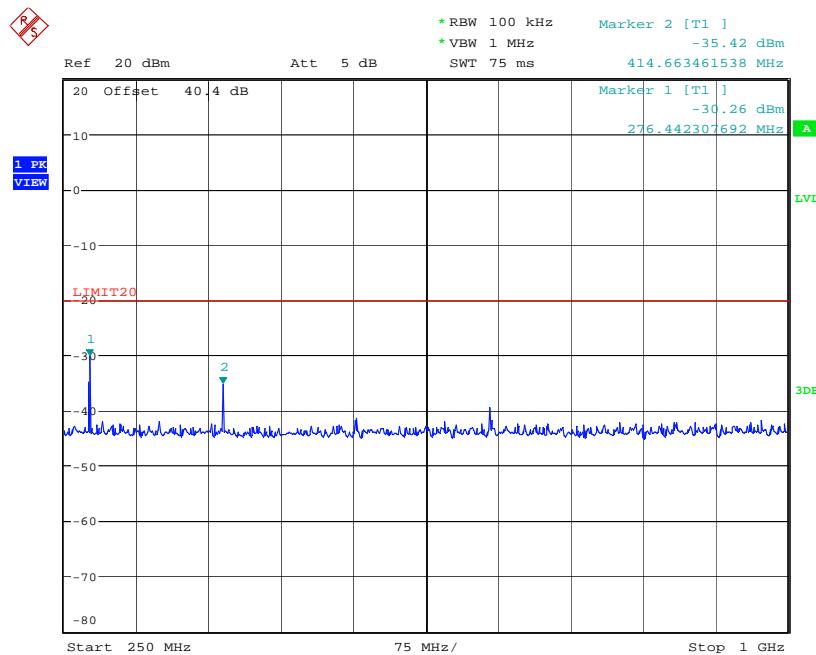
5.4.3. Test Data

High Power (Transmitter Mode)

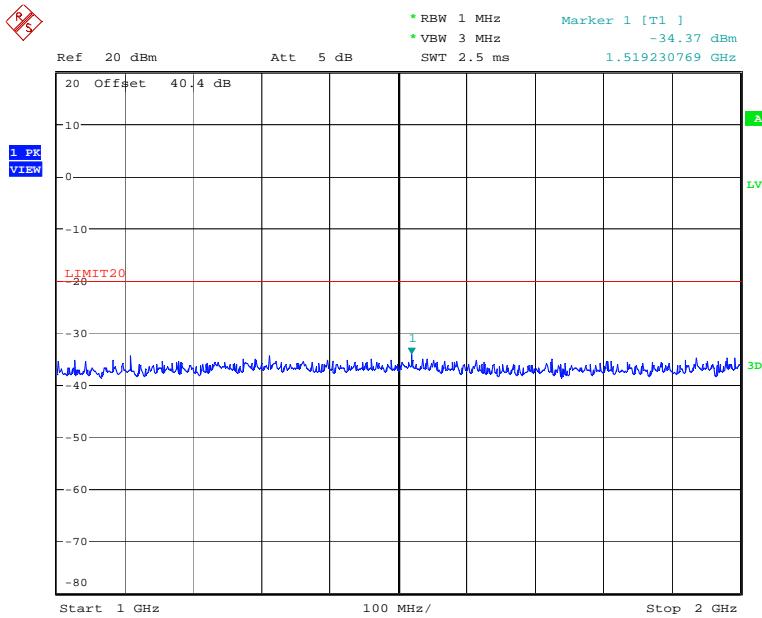
5.4.3.1. Configuration: Tx Conducted, 138.1MHz, 12.5 KHz, Digital, High power



Date: 7.SEP.2018 08:29:57



Date: 7.SEP.2018 08:47:39



Date: 7.SEP.2018 09:36:33

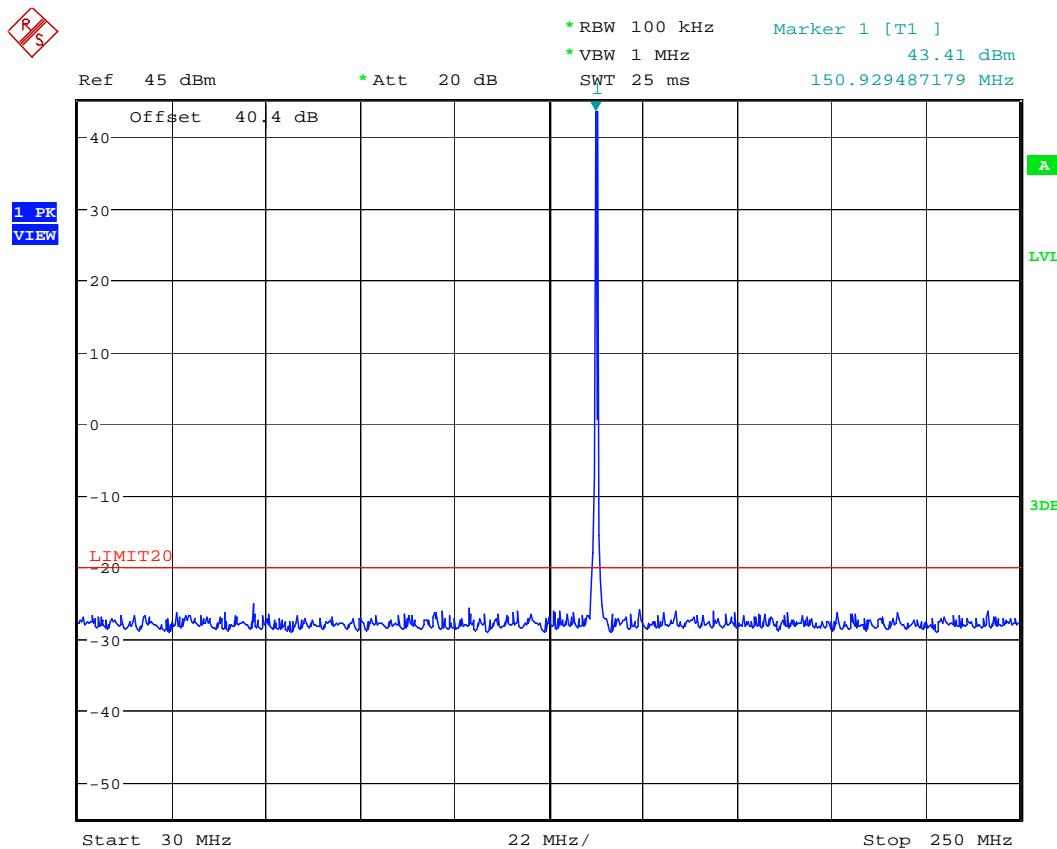
ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

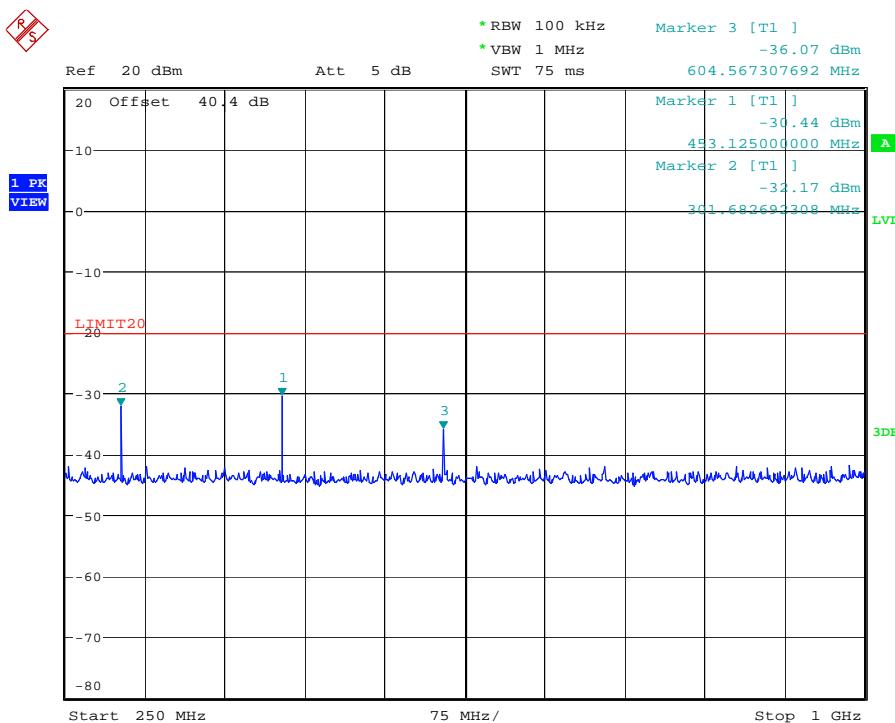
Tel #: 905-829-1570, Fax #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90
 December 4, 2018

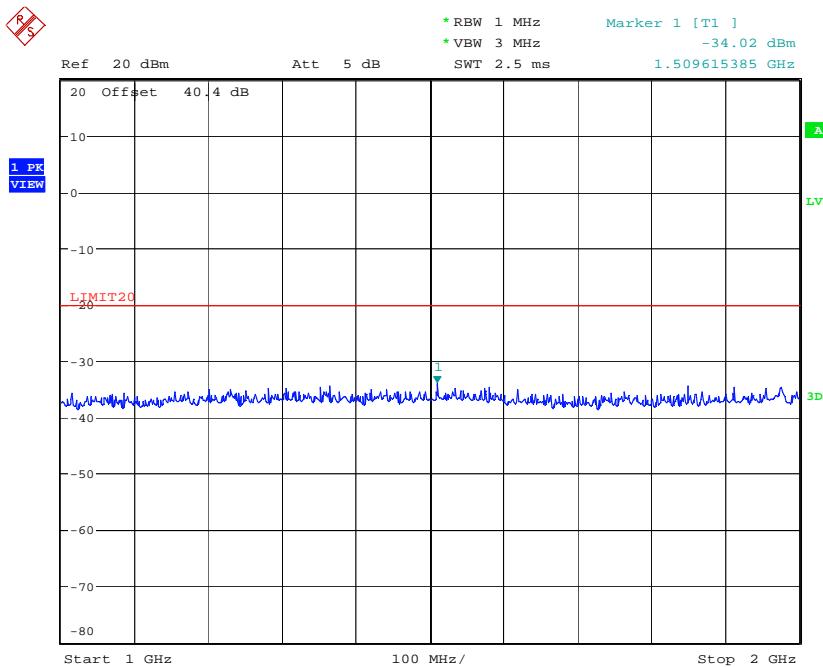
5.4.3.2. Configuration: Tx Conducted, 151.1MHz, 12.5 KHz, Digital, High power



Date: 7.SEP.2018 08:32:41



Date: 7.SEP.2018 08:49:14



Date: 7.SEP.2018 09:37:44

ULTRATECH GROUP OF LABS

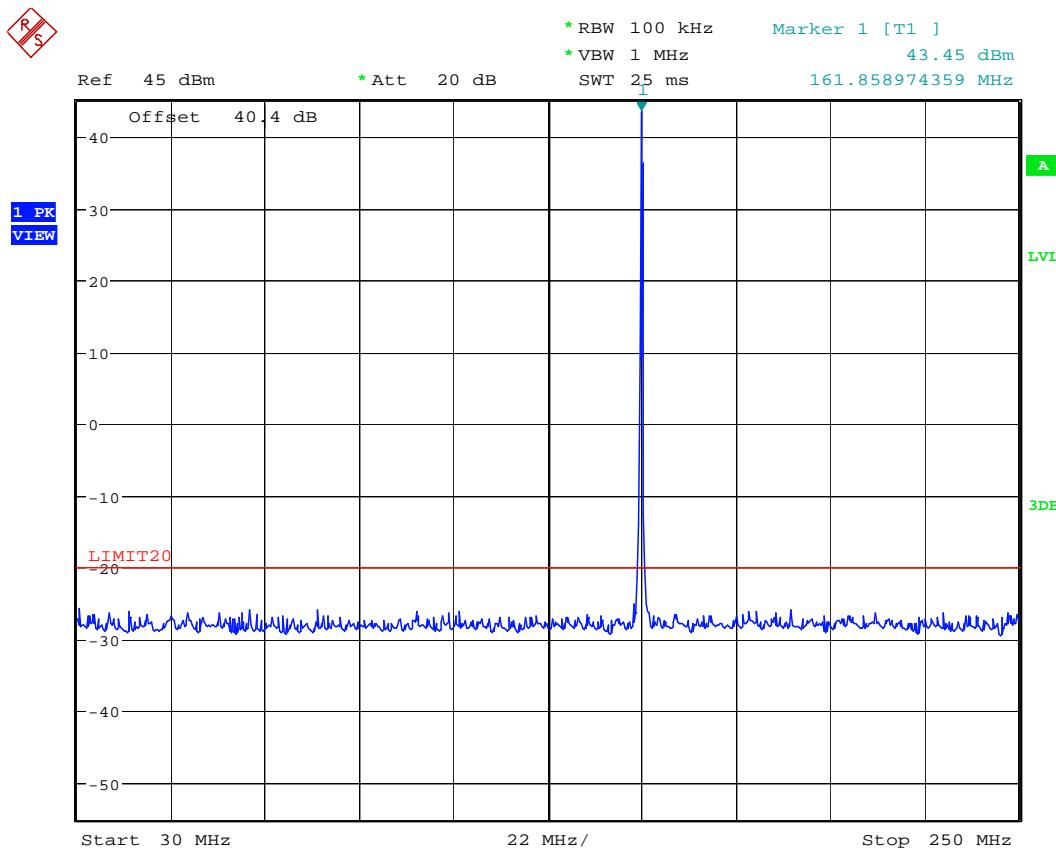
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel #: 905-829-1570, Fax #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

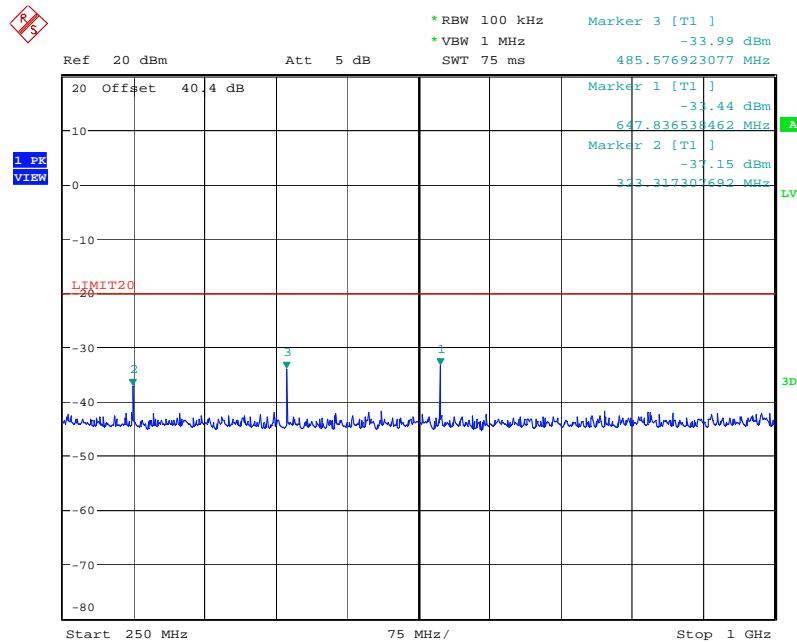
File #: 18FSG173_FCC90

December 4, 2018

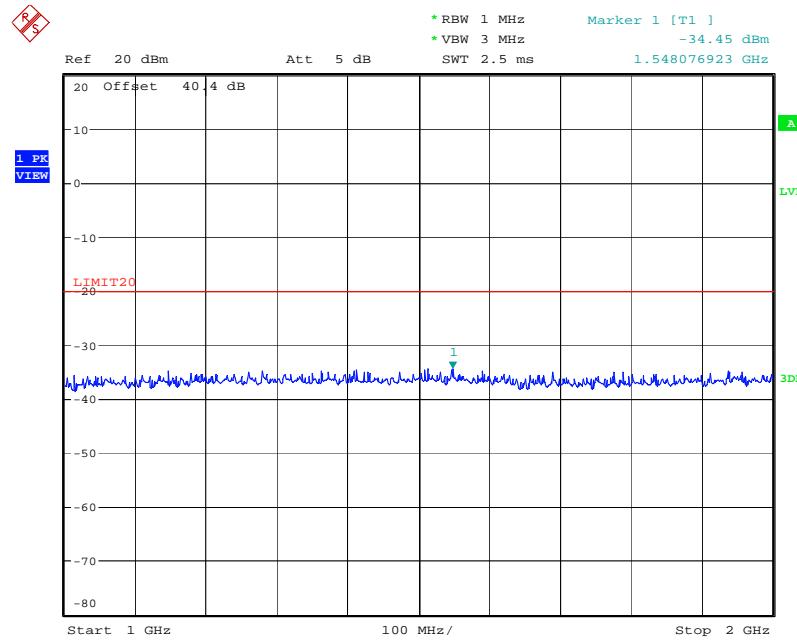
5.4.3.3. Configuration: Tx Conducted, 161.8MHz, 12.5 KHz, Digital, High power



Date: 7.SEP.2018 08:33:50



Date: 7.SEP.2018 08:51:01



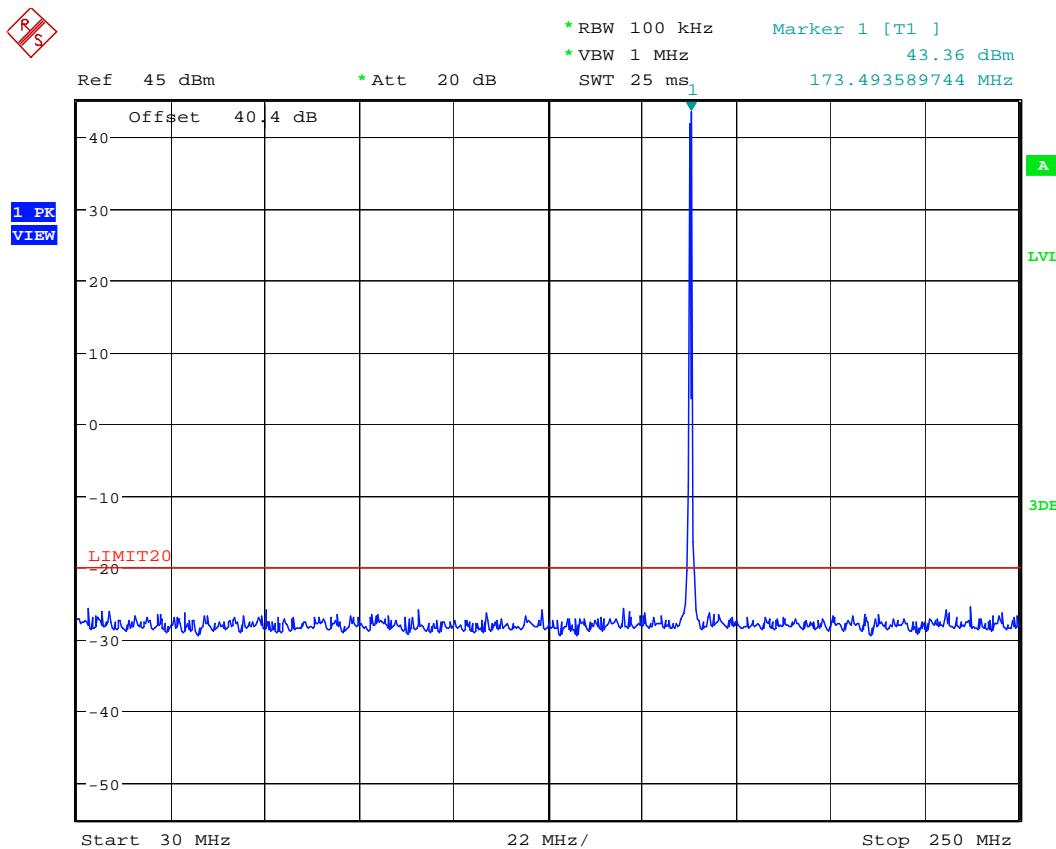
Date: 7.SEP.2018 09:38:49

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90
 December 4, 2018

5.4.3.4. Configuration: Tx Conducted, 173.3MHz, 12.5 KHz, Digital, High power



Date: 7.SEP.2018 08:35:13

ULTRATECH GROUP OF LABS

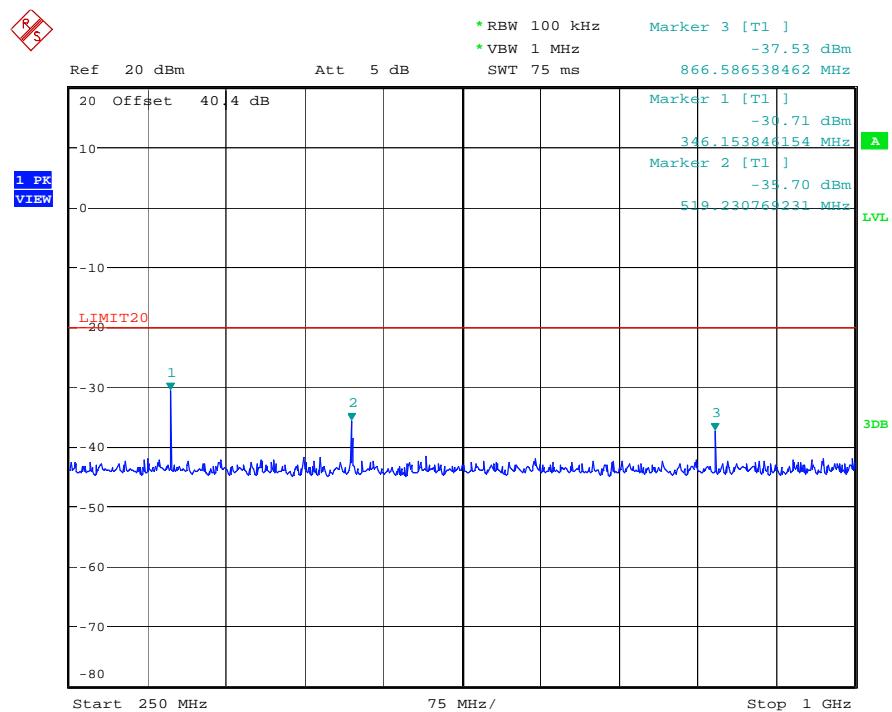
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

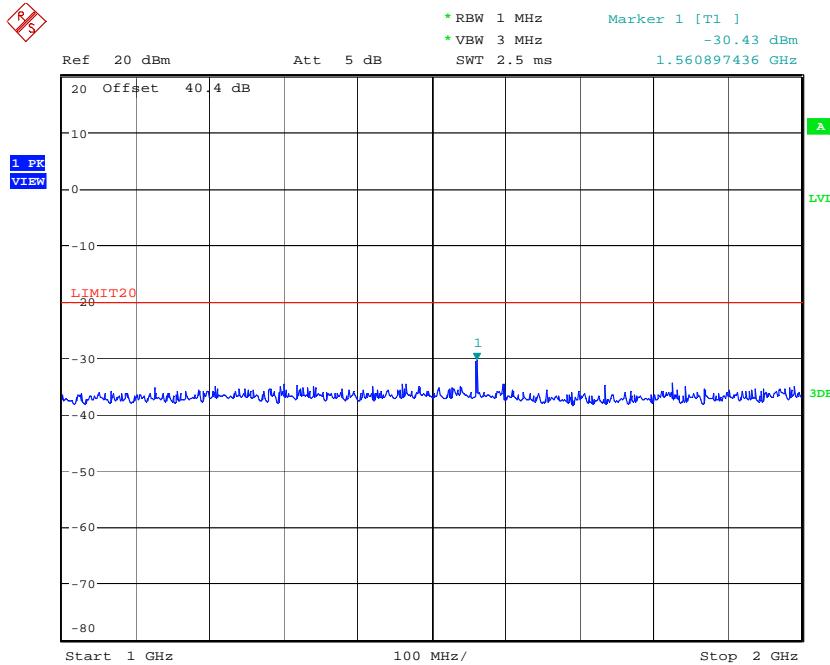
File #: 18FSG173_FCC90

December 4, 2018

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)



Date: 7.SEP.2018 09:21:27



Date: 7.SEP.2018 09:39:50

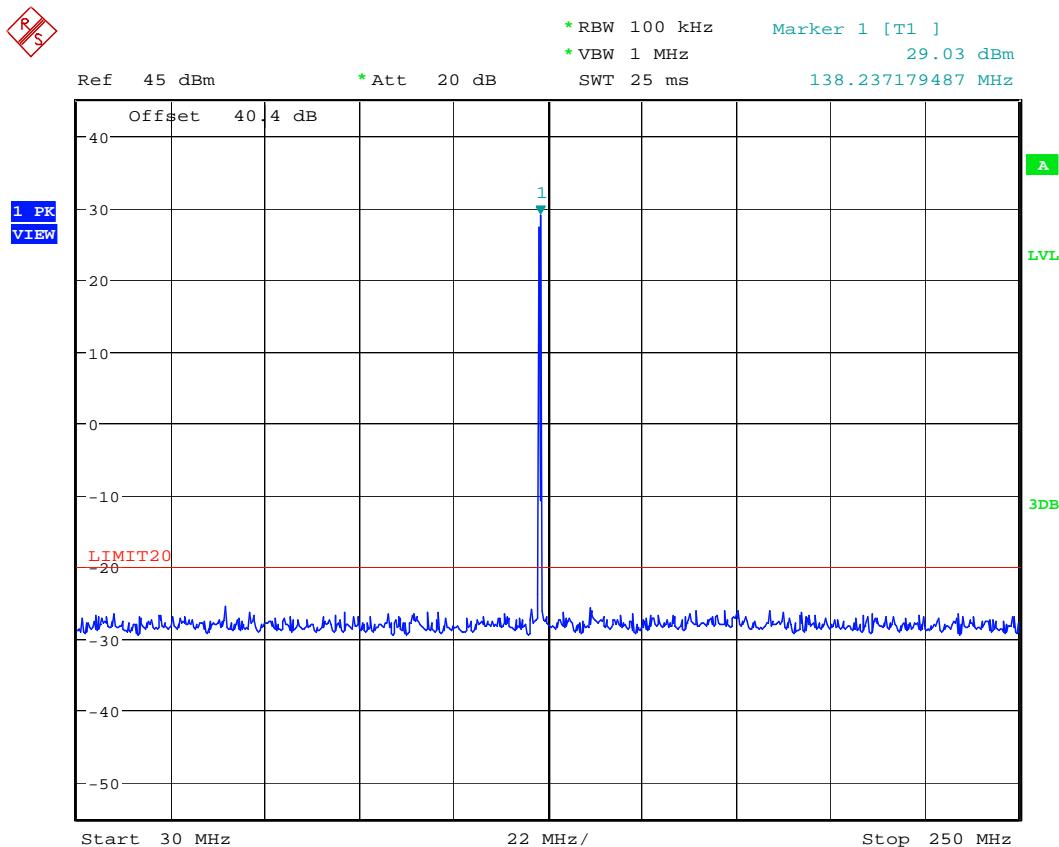
ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

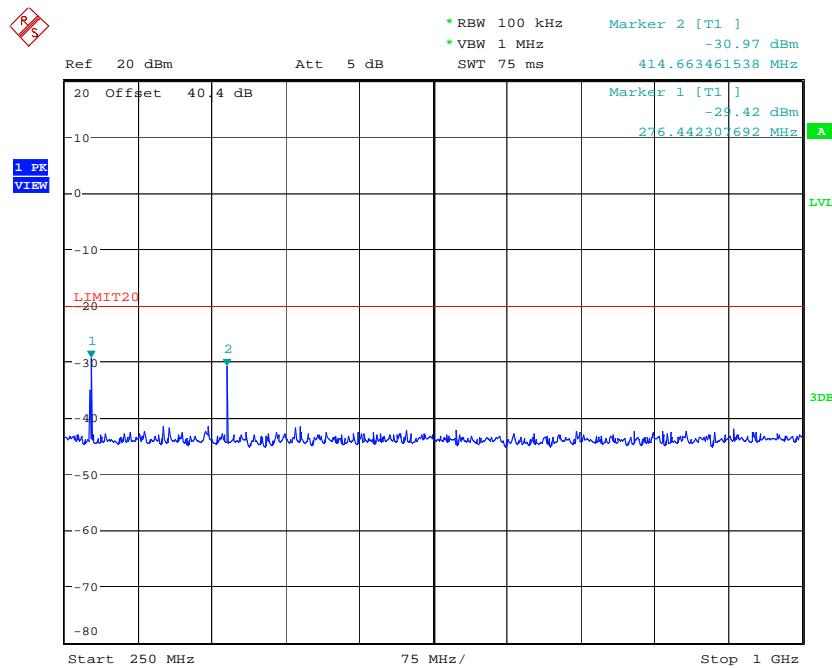
File #: 18FSG173_FCC90
 December 4, 2018

Low Power

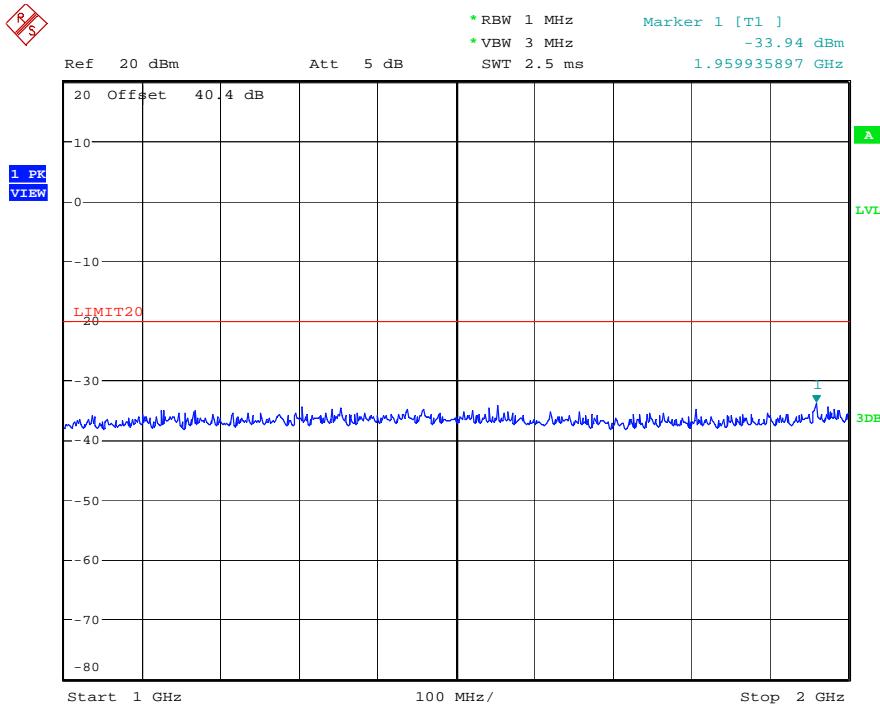
5.4.3.5. Configuration: Tx Conducted, 138.1MHz, 12.5 KHz, Digital, Low power



Date: 7.SEP.2018 08:40:10



Date: 7.SEP.2018 09:24:08



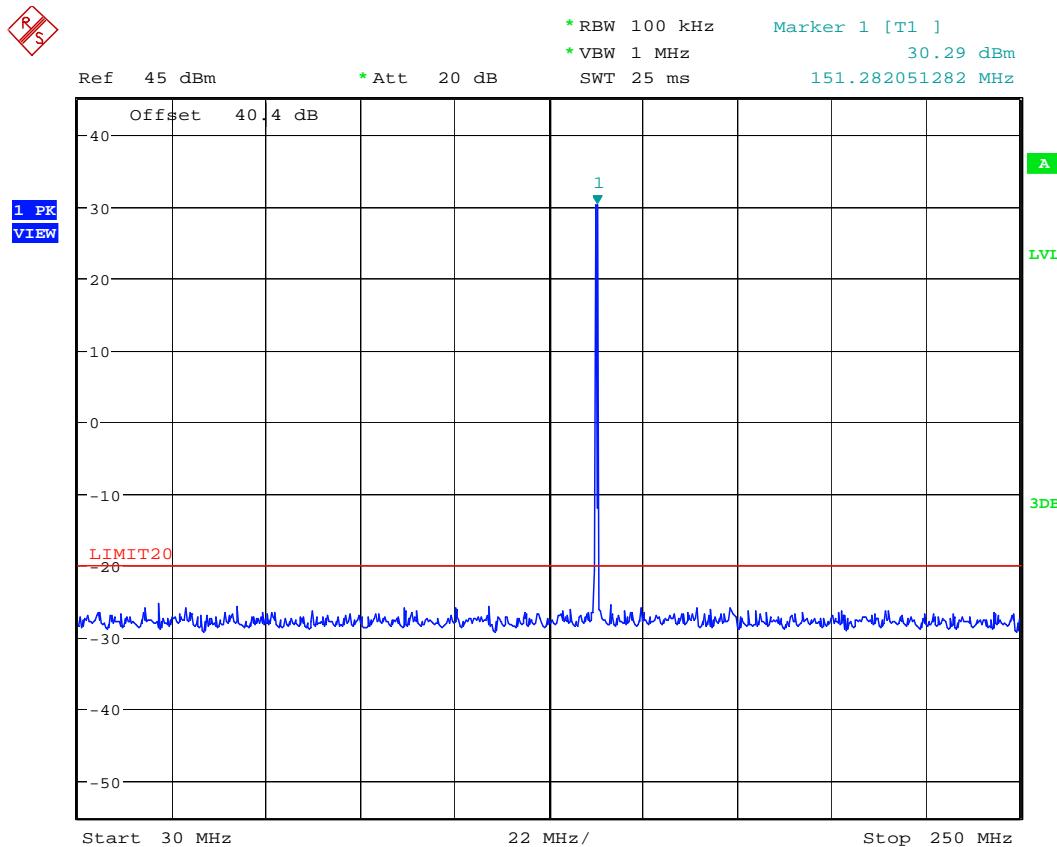
Date: 7.SEP.2018 09:41:39

ULTRATECH GROUP OF LABS

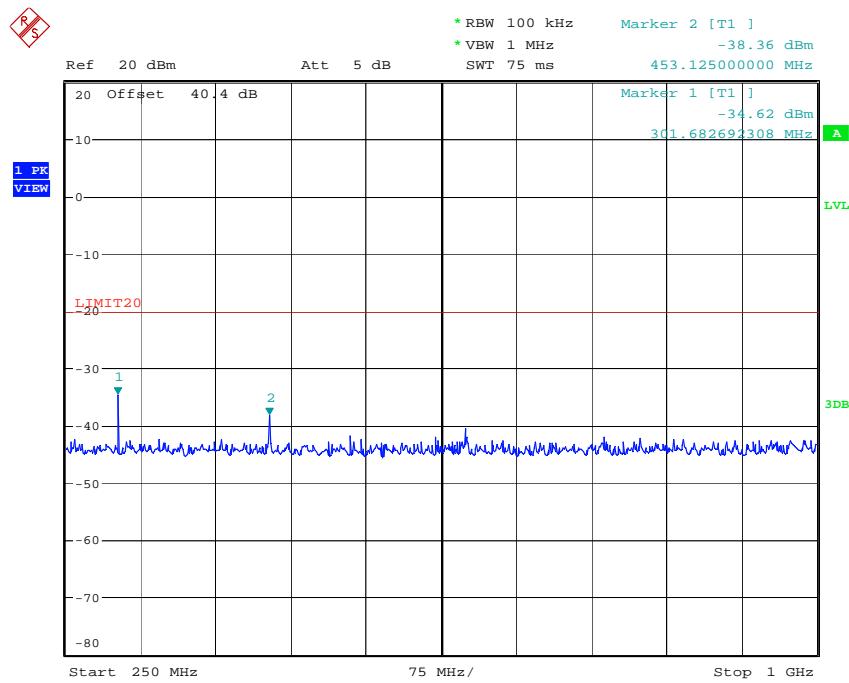
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90
 December 4, 2018

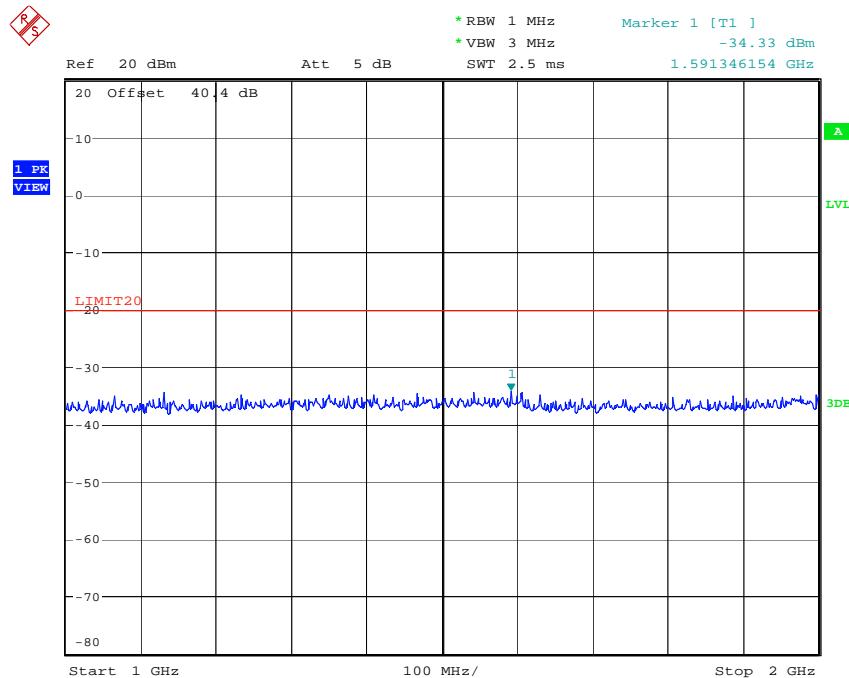
5.4.3.6. Configuration: Tx Conducted, 151.1MHz, 12.5 KHz, Digital, Low power



Date: 7.SEP.2018 08:41:24



Date: 7.SEP.2018 09:26:46



Date: 7.SEP.2018 09:42:42

ULTRATECH GROUP OF LABS

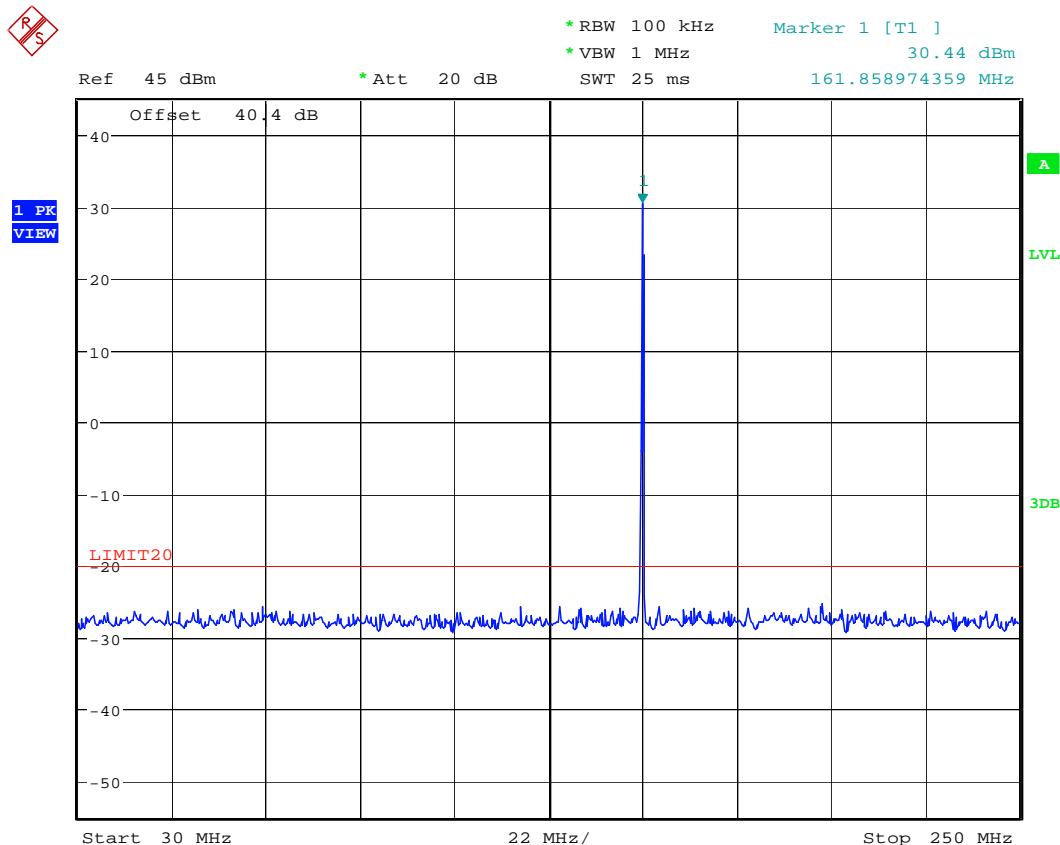
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90

December 4, 2018

5.4.3.7. Configuration: Tx Conducted, 161.8MHz, 12.5 KHz, Digital, Low power



Date: 7.SEP.2018 08:42:14

ULTRATECH GROUP OF LABS

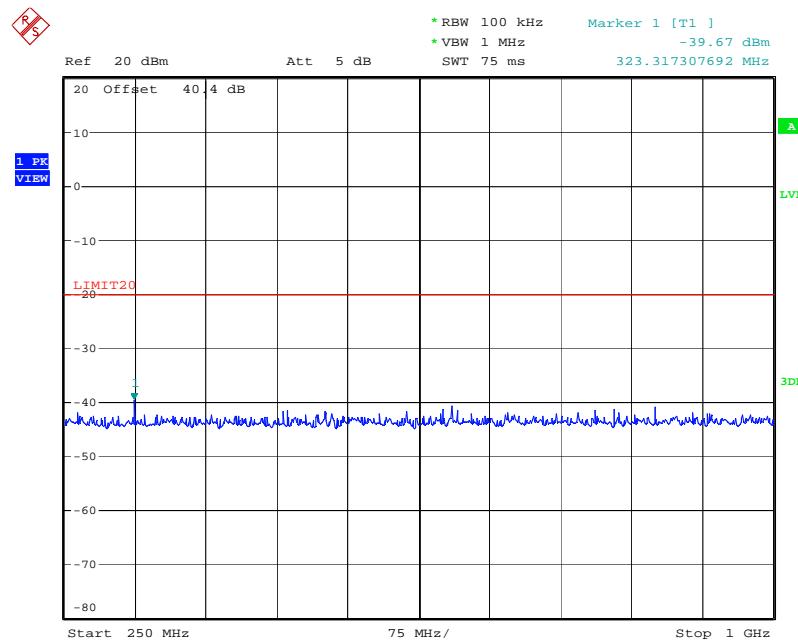
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

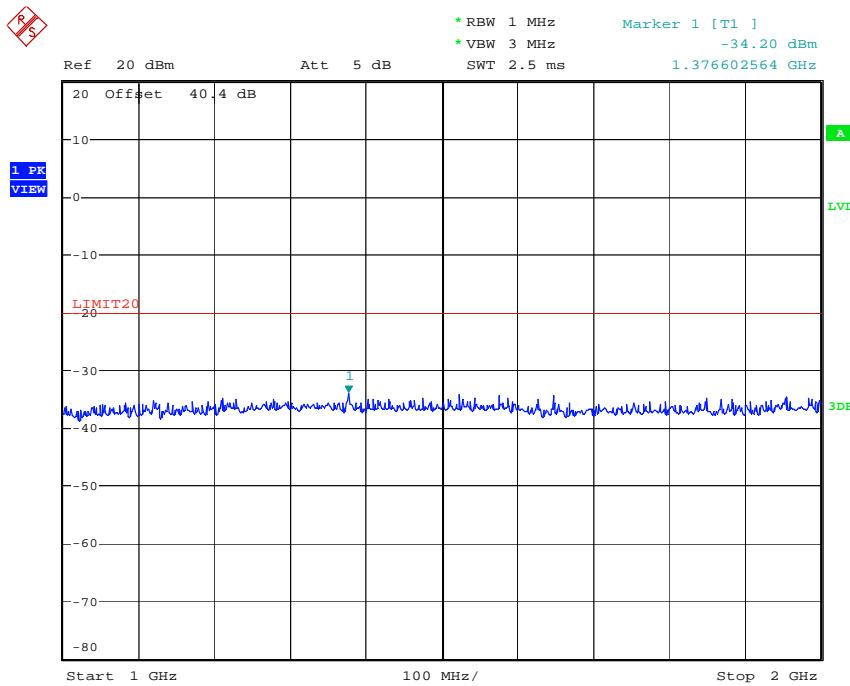
File #: 18FSG173_FCC90

December 4, 2018

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)



Date: 7.SEP.2018 09:27:57



Date: 7.SEP.2018 09:43:34

ULTRATECH GROUP OF LABS

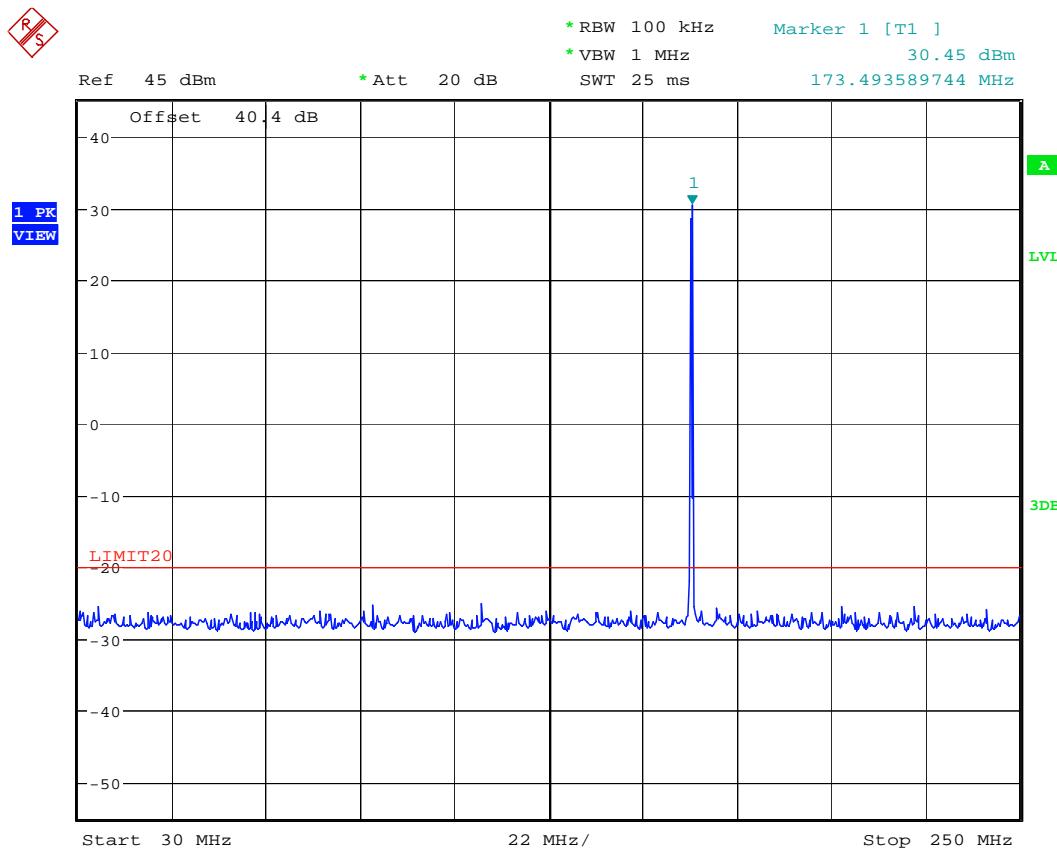
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

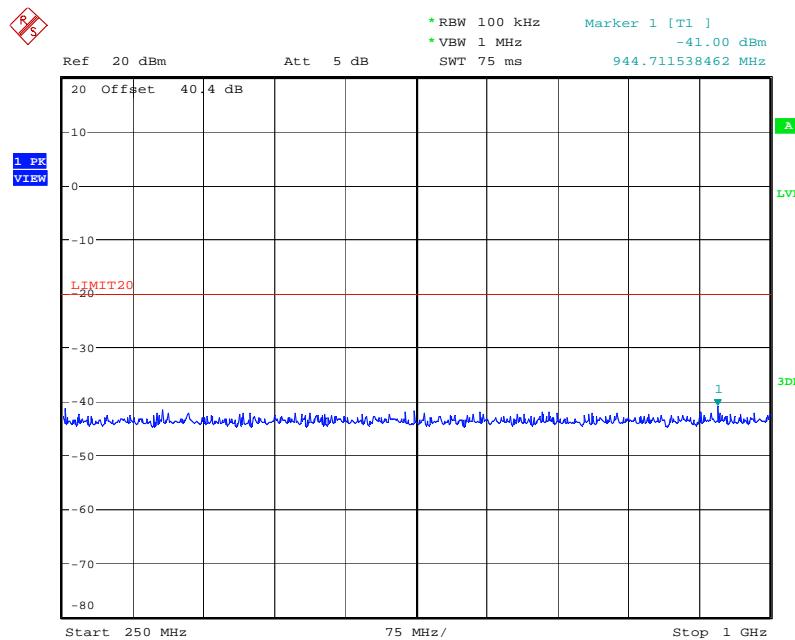
File #: 18FSG173_FCC90

December 4, 2018

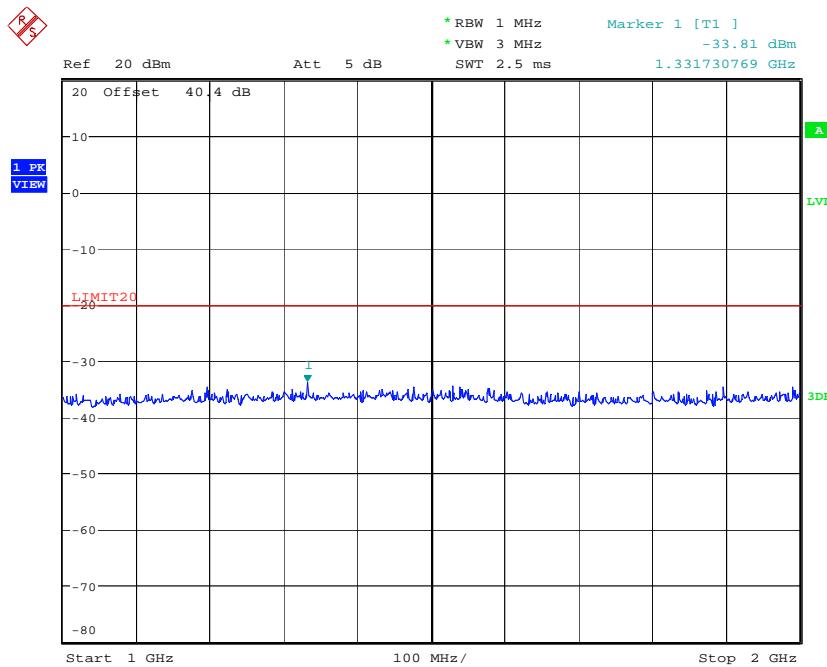
5.4.3.8. Configuration: Tx Conducted, 173.3MHz, 12.5 KHz, Digital, Low power



Date: 7.SEP.2018 08:43:16



Date: 7.SEP.2018 09:30:41



Date: 7.SEP.2018 09:44:34

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90
 December 4, 2018

5.5. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1053, 2.1057, 22.359, 80.211(f)(3) & 90.210]

5.5.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

| FCC Rules | Attenuation Limit (dBc) |
|-----------------|--|
| § 22.359 | At least $43 + 10 \log(P)$ dB. |
| § 80.211(f)(3), | At least $43 + 10 \log_{10}$ (mean power in watts) dB |
| § 90.210(b) | At least $43 + 10 \log(P)$ dB |
| § 90.210(d) | At least $50 + 10 \log(P)$ dB or 70 dB, whichever is the lesser attenuation. |
| § 90.210(e) | At least $55 + 10 \log(P)$ or 65 dB, whichever is the lesser attenuation. |

5.5.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Section 8.2 of this report.

5.5.3. Test Data

Remarks:

- The RF spurious/harmonic emission characteristics for different channel spacing are indistinguishable. Therefore, the following radiated emissions were performed at digital 12.5 kHz channel spacing operation, and the results were compared with the for the worst-case.
- The radiated emissions were performed with high power setting at 3 m distance to represents the worst-case test configuration.
- The emissions were scanned from 30 MHz to 10th harmonics ; all spurious emissions that are in excess of 20dB below the specified limit shall be recorded.

5.5.3.1. Near Lowest Frequency (138.1 MHz)

| Test Frequency (MHz): | | 138.1 | | | | |
|--|------------------------|------------------------|----------------------------|--------------------|-------------|-------------|
| Power | | High | | | | |
| Limit (dBm): | | -20 | | | | |
| Frequency (MHz) | E-Field (dB μ V/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP Measured (dBm) | Limit (dBm) | Margin (dB) |
| All emissions found are more than 20 dB below the limit. | | | | | | |

5.5.3.2. Near Middle Frequency (151.1 MHz)

| Test Frequency (MHz): | | 151.1 | | | | |
|--|------------------------|------------------------|----------------------------|--------------------|-------------|-------------|
| Power | | High | | | | |
| Limit (dBm): | | -20 | | | | |
| Frequency (MHz) | E-Field (dB μ V/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP Measured (dBm) | Limit (dBm) | Margin (dB) |
| All emissions found are more than 20 dB below the limit. | | | | | | |

5.5.3.3. Near Middle Frequency (161.8 MHz)

| Test Frequency (MHz): | | 161.8 | | | | |
|--|------------------------|------------------------|----------------------------|--------------------|-------------|-------------|
| Power | | High | | | | |
| Limit (dBm): | | -20 | | | | |
| Frequency (MHz) | E-Field (dB μ V/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP Measured (dBm) | Limit (dBm) | Margin (dB) |
| All emissions found are more than 20 dB below the limit. | | | | | | |

5.5.3.4. Near Highest Frequency (173.3 MHz)

| Test Frequency (MHz): | | 173.3 | | | | |
|--|------------------------|------------------------|----------------------------|--------------------|-------------|-------------|
| Power conducted (dBm): | | 46.8 | | | | |
| Limit (dBm): | | -20 | | | | |
| Frequency (MHz) | E-Field (dB μ V/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP Measured (dBm) | Limit (dBm) | Margin (dB) |
| All emissions found are more than 20 dB below the limit. | | | | | | |

5.6. FREQUENCY STABILITY [§§ 2.1055, 22.355, 74.464, 80.209 & 90.213]

5.6.1. Limits

§ 90.213 Transmitters used must have minimum frequency stability as specified in the following table.

| Frequency Range (MHz) | Channel Bandwidth (KHz) | Frequency Tolerance (ppm) | | |
|-----------------------|-------------------------|---------------------------|-------|-------|
| | | Mobile Stations | | |
| | | > 2 W | ≤ 2 W | |
| 150-174 MHz | 6.25 | 1.0 | 2.0 | 2.0 |
| | 12.5 | 2.5 | 5.0 | 5.0 |
| | 25 | 5.0 | 5.0 | 50.0* |
| 421-512 MHz | 6.25 | 0.5 | 1.0 | 1.0 |
| | 12.5 | 1.5 | 2.5 | 2.5 |
| | 25 | 2.5 | 5.0 | 5.0 |

- Stations operating in the 154.45 to 154.49 MHz or the 173.2 to 173.4 MHz bands must have a frequency stability of 5 ppm.
- Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150-174 MHz band and 2.5 ppm in the 421-512 MHz band.

§ 22.355 Transmitters used must have minimum frequency stability as specified in the following table.

TABLE C-1—FREQUENCY TOLERANCE FOR
 TRANSMITTERS IN THE PUBLIC MOBILE SERVICES

| Frequency range (MHz) | Base, fixed (ppm) | Mobile ≤3 watts (ppm) | Mobile ≤3 watts (ppm) |
|-----------------------|-------------------|-----------------------|-----------------------|
| 25 to 50 | 20.0 | 20.0 | 50.0 |
| 50 to 450 | 5.0 | 5.0 | 50.0 |
| 450 to 512 | 2.5 | 5.0 | 5.0 |
| 821 to 896 | 1.5 | 2.5 | 2.5 |
| 928 to 929 | 5.0 | n/a | n/a |
| 929 to 960 | 1.5 | n/a | n/a |
| 2110 to 2220 | 10.0 | n/a | n/a |

§ 74.464 - For operations on frequencies above 25 MHz using authorized bandwidths up to 30 kHz, the licensee of a remote pickup broadcast station or system shall maintain the operating frequency of each station in compliance with the frequency tolerance requirements of §90.213 of this chapter. For all other operations, the licensee of a remote pickup broadcast station or system shall maintain the operating frequency of each station in accordance with the following:

| Frequency range | Tolerance (percent) | |
|----------------------------------|---------------------|----------------|
| | Base station | Mobile station |
| 25 to 30 MHz: | | |
| 3 W or less | .002 | .005 |
| Over 3 W | .002 | .002 |
| 30 to 300 MHz: | | |
| 3 W or less | .0005 | .005 |
| Over 3 W | .0005 | .0005 |
| 300 to 500 MHz, all powers | .00025 | .0005 |

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4

Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18FSG173_FCC90

December 4, 2018

5.6.2. Method of Measurements

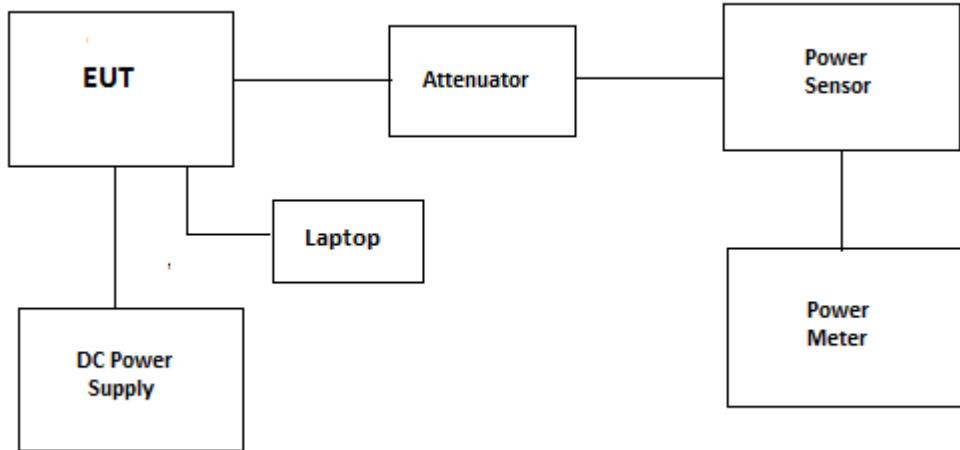
Refer to Section 8.3 of this report for measurement details

5.6.3. Test Data

| Test Frequency: | 138.1 MHz | | |
|---|--|---|--|
| Full Power Level: | 19.91 W | | |
| Frequency Tolerance Limit: | \pm 1.5 ppm or \pm 207 Hz | | |
| Max. Frequency Tolerance Measured: | -79 Hz or -0.57 ppm | | |
| Input Voltage Rating: | 13.8 VDC | | |
| Ambient Temperature (°C) | Frequency Drift (Hz) | | |
| | Supply Voltage (Nominal) 13.8 VDC | Supply Voltage (-15%) 11.73VDC | Supply Voltage (+15%) 15.87 VDC |
| -30 | -79 | -- | -- |
| -20 | -69 | -- | -- |
| -10 | -54 | -- | -- |
| 0 | -40 | -- | -- |
| 10 | -35 | -- | -- |
| 20 | -19 | -18 | -19 |
| 30 | -10 | -- | -- |
| 40 | 16 | -- | -- |
| 50 | 24 | -- | -- |
| 60 | 24 | -- | -- |

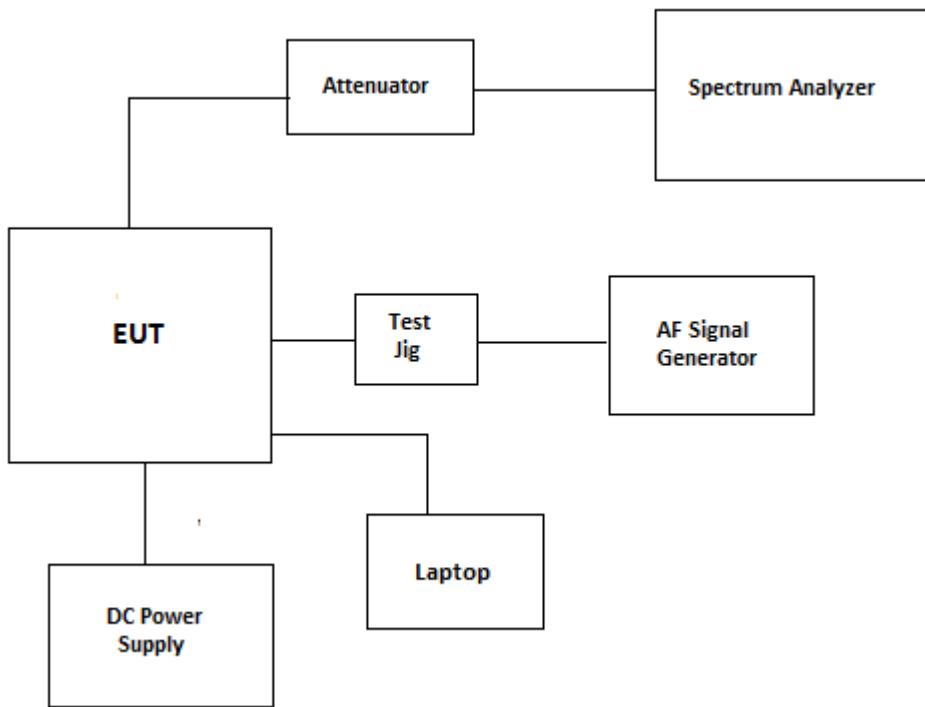
EXHIBIT 6. Block Diagram and Test Equipment

6.1. Conducted Power



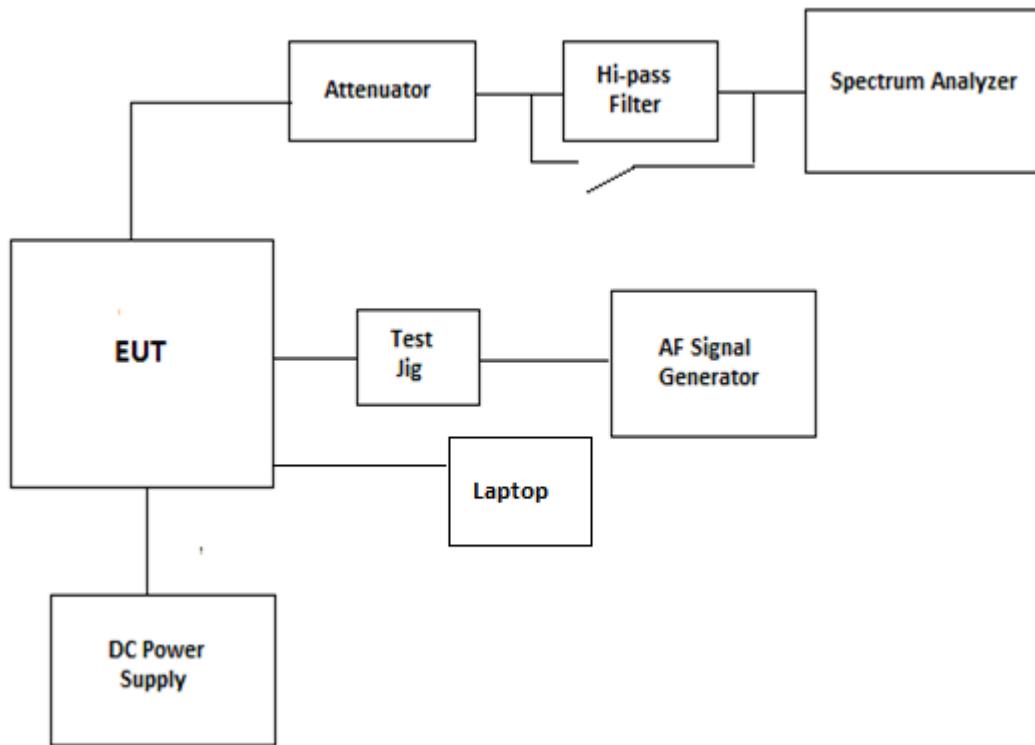
| Test Instrument | Manufacturer | Model No | Serial No | Frequency Range | Cal Due date |
|------------------|--------------------|----------|------------|-------------------------|--------------|
| Power Meter | HP | 436A | 2709A27515 | 100KHz-sensor dependant | 04 May 2019 |
| Power Sensor | HP | 8482A | MY41172054 | 10MHz-18GHz | 26 Oct 2019 |
| Attenuator(20dB) | Narda | 26298 | A577 | DC-1GHz | Cal on use |
| Attenuator(20dB) | Aeroflex\Weinschel | 23-20-34 | BH7876 | DC-18GHz | Cal on use |
| Power Supply | Dr. meter | HY5020E | 013141252 | 1-40V, DC 20A | ---- |
| Multimeter | Tenma | 72-6202 | 02080027 | --- | 14 Dec 2019 |

6.2. Mask



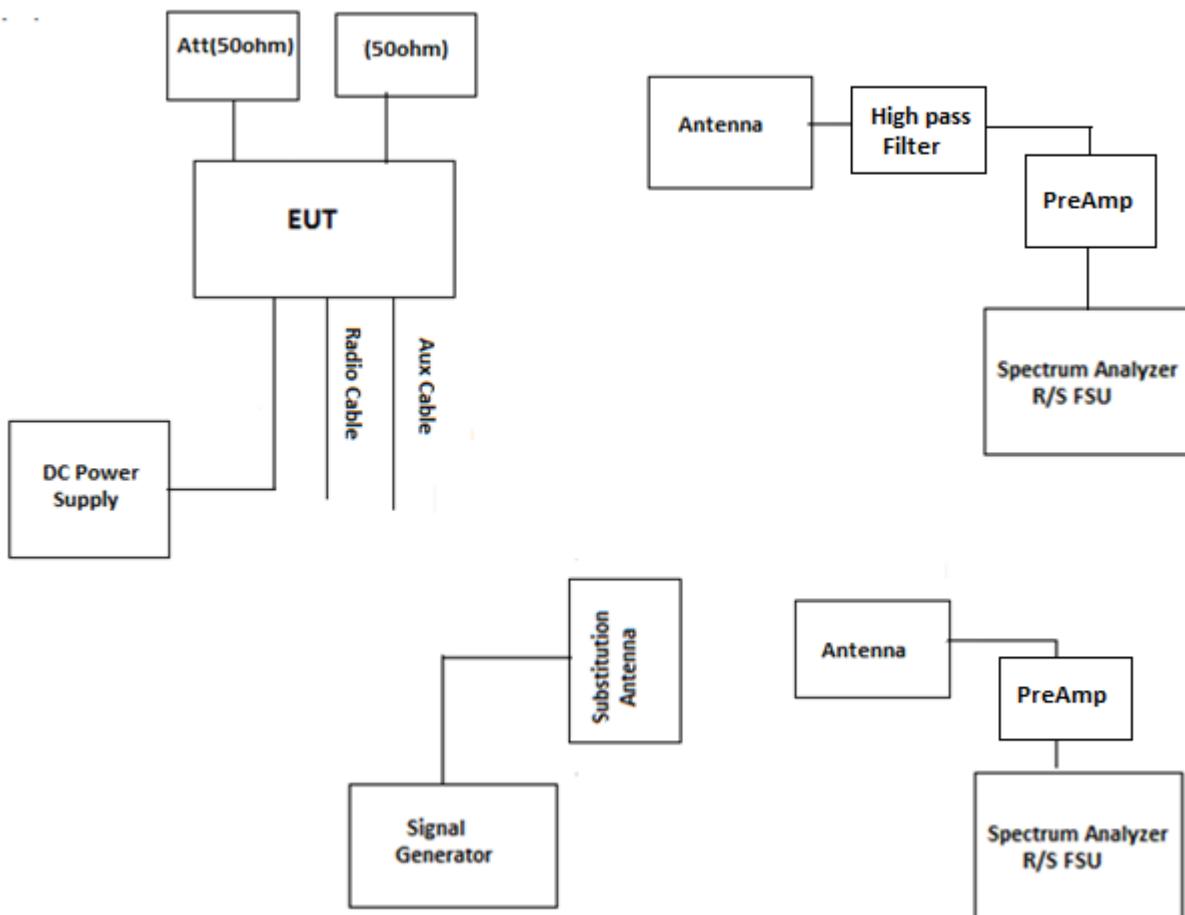
| Test Instrument | Manufacturer | Model No | Serial No | Frequency Range | Cal Due date |
|---------------------|---------------------|----------|------------|-----------------|--------------|
| Spectrum Analyzer | Rohde & Schwarz | FSU | 100398 | 20Hz-26.5GHz | 06 Oct 2019 |
| AF Signal Generator | HP | HP-8920B | US39064699 | 30MHz-1GHz | 20 Mar 2020 |
| Attenuator(20dB) | Narda | 26298 | A577 | DC-1GHz | Cal on use |
| Attenuator(20dB) | Aeroflex\Weins chel | 23-20-34 | BH7876 | DC-18GHz | Cal on use |
| Power Supply | Dr. meter | HY5020E | 013141252 | 1-40V, DC 20A | ---- |
| Multimeter | Tenma | 72-6202 | 02080027 | --- | 14 Dec 2019 |

6.3. Tx Conducted Emission



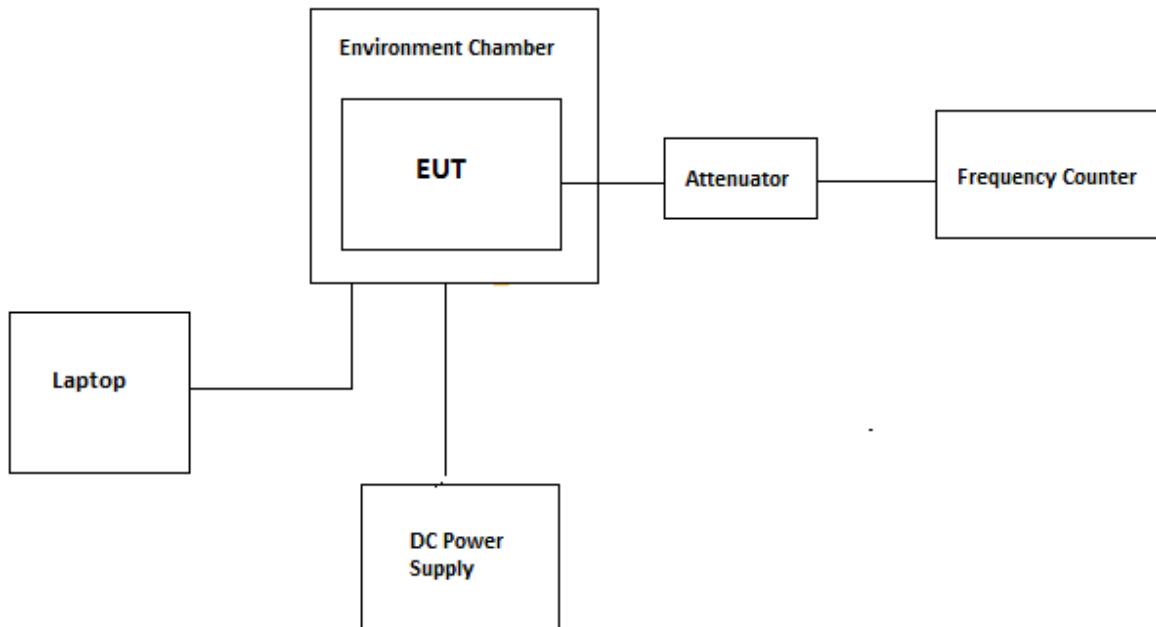
| Test Instrument | Manufacturer | Model No | Serial No | Frequency Range | Cal Due date |
|---------------------|---------------------|----------|------------|-----------------|--------------|
| Spectrum Analyzer | Rohde & Schwarz | FSU | 100398 | 20Hz-26.5GHz | 06 Oct 2019 |
| AF Signal Generator | HP | HP-8920B | US39064699 | 30MHz-1GHz | 20 Mar 2020 |
| Hi-pass filter | Mini-Circuit | SHP-250 | -- | Cut off 250MHz | Cal on use |
| Attenuator(20dB) | Narda | 26298 | A577 | DC-1GHz | Cal on use |
| Attenuator(20dB) | Aeroflex\Weins chel | 23-20-34 | BH7876 | DC-18GHz | Cal on use |
| Power Supply | Dr. meter | HY5020E | 013141252 | 1-40V, DC 20A | ---- |
| Multimeter | Tenma | 72-6202 | 02080027 | -- | 14 Dec 2019 |

6.4. Tx Radiated



| Test Instrument | Manufacturer | Model No | Serial No | Frequency Range | Cal Due date |
|----------------------|---------------------|----------|-----------|-----------------|--------------|
| Spectrum Analyzer | Rohde & Schwarz | FSU | 100398 | 20Hz-26.5GHz | 06 Oct 2019 |
| Log Periodic Antenna | ETS | 3148 | 00023845 | 200-2000MHz | 02 Aug 2020 |
| Preamplifier | Com-Power | PAM-118A | 551016 | 500MHz-18GHz | 09 Mar 2019 |
| Preamplifier | Com-Power | PA-103 | 161040 | 1-1000MHz | 16 May 2019 |
| Bicon Antenna | ETS | 3110B | 3379 | 30-200MHz | 06 Feb 2020 |
| Horn Antenna | ETS | 3117 | 00119425 | 1-18GHz | 29 Jun 2019 |
| Hi-pass filter | Mini-Circuit | SHP-250 | -- | Cut off 250MHz | Cal on use |
| Attenuator(20dB) | Narda | 26298 | A577 | DC-1GHz | Cal on use |
| Attenuator(20dB) | Aeroflex\Weins chel | 23-20-34 | BH7876 | DC-18GHz | Cal on use |

6.5. Frequency Stability



| Test Instrument | Manufacturer | Model No | Serial No | Frequency Range | Cal Due date |
|-------------------|--------------------|-------------|-----------|-----------------|--------------|
| Frequency Counter | EIP | 545A | 2683 | 10MHz-1GHz | 07 Aug 2020 |
| Attenuator(20dB) | Weinschel | WA 35-20-33 | A164 | DC-8.5GHz | Cal on use |
| Attenuator(20dB) | Aeroflex\Weinschel | 34-20-34 | BP6023 | DC-18GHz | Cal on use |
| Power Supply | Tenma | 72-6153 | - | 1-18Vdc, 0-10A | ---- |
| Multimeter | Fluke | 8842A | 5021295 | --- | 23 Oct 2019 |

EXHIBIT 7. 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.

7.1. 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 |

EXHIBIT 8. MEASUREMENT METHODS

8.1. CONDUCTED POWER MEASUREMENTS

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- If the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

Step 1: Duty Cycle measurements if the transmitter's transmission is transient

- Using a EMI Receiver with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, $x = \text{Tx on} / (\text{Tx on} + \text{Tx off})$ with $0 < x < 1$, is measured and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

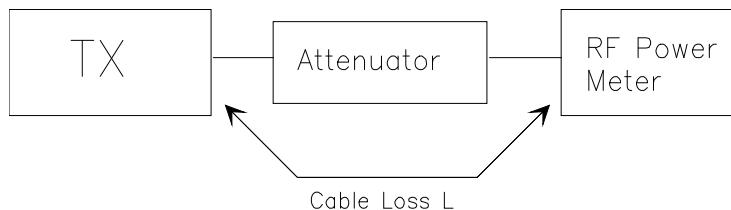
Step 2: Calculation of Average EIRP. See Figure 1

- The average output power of the transmitter shall be determined using a wideband, calibrated RF average power meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "A" (in dBm);
- The e.i.r.p. shall be calculated from the above measured power output "A", the observed duty cycle x, and the applicable antenna assembly gain "G" in dBi, according to the formula:

$$\text{EIRP} = A + G + 10\log(1/x)$$

{ $X = 1$ for continuous transmission $\Rightarrow 10\log(1/x) = 0 \text{ dB}$ }

Figure 1.



8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD

8.2.1. MAXIMIZING RF EMISSION LEVEL (E-FIELD)

- (a) The measurements were performed with full rf output power and modulation.
- (b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
- (c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
- (d) The BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
- (e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dB μ V/m) = Reading (dB μ V) + Total Correction Factor (dB/m)

- (f) Set the EMI Receiver and #2 as follows:

Center Frequency: test frequency
Resolution BW: 100 KHz
Video BW: same
Detector Mode: positive
Average: off
Span: 3 x the signal bandwidth

- (g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
- (h) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
- (i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
- (j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
- (k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
- (l) Repeat for all different test signal frequencies.

8.2.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

(a) Set the EMI Receiver (for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

Center Frequency: equal to the signal source
Resolution BW: 100 KHz
Video BW: VBW > RBW
Detector Mode: positive
Average: off
Span: 3 x the signal bandwidth

(b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
 $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$

(c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.
(d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
◆ DIPOLE antenna for frequency from 30-1000 MHz or
◆ HORN antenna for frequency above 1 GHz }.
(e) Mount the transmitting antenna at 1.5 meter high from the ground plane.
(f) Use one of the following antenna as a receiving antenna:
◆ DIPOLE antenna for frequency from 30-1000 MHz or
◆ HORN antenna for frequency above 1 GHz }.
(g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.
(h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.
(i) Tune the EMI Receivers to the test frequency.
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(k) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
(l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(m) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.
(n) Record the power level read from the Average Power Meter and calculate the ERP/EIRP as follows:

$$P = P1 - L1 = (P2 + L2) - L1 = P3 + A + L2 - L1$$

$$\text{EIRP} = P + G1 = P3 + L2 - L1 + A + G1$$

$$\text{ERP} = \text{EIRP} - 2.15 \text{ dB}$$

Total Correction factor in EMI Receiver # 2 = $L2 - L1 + G1$

Where: P: Actual RF Power fed into the substitution antenna port after corrected.
P1: Power output from the signal generator
P2: Power measured at attenuator A input
P3: Power reading on the Average Power Meter
EIRP: EIRP after correction
ERP: ERP after correction

(o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)
(p) Repeat step (d) to (o) for different test frequency
(q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
(r) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

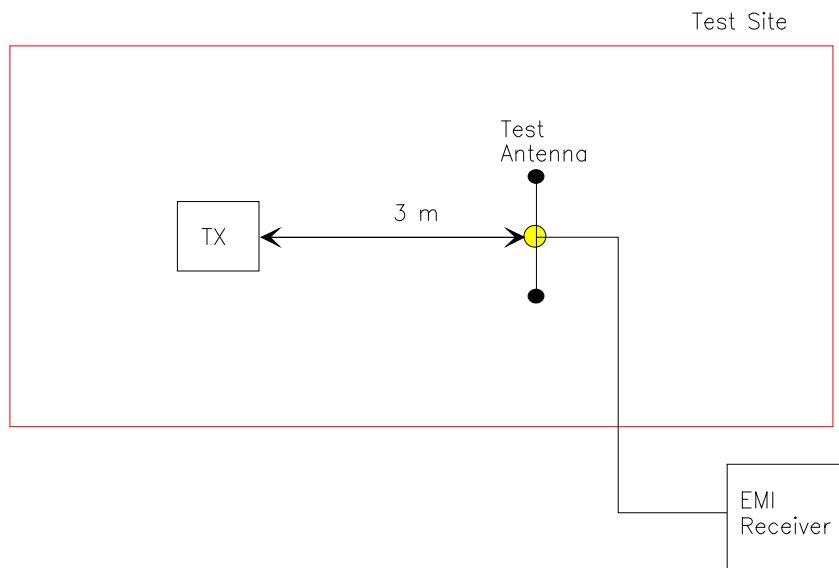
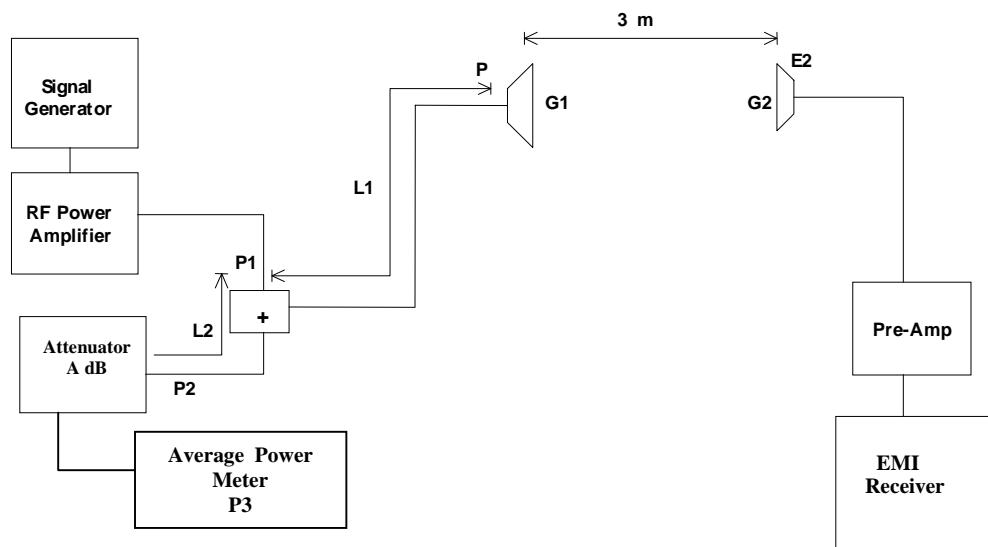


Figure 3



8.3. FREQUENCY STABILITY

Refer to FCC @ 2.1055.

- (a) The frequency stability shall be measured with variation of ambient temperature as follows: From -30 to +50 centigrade except that specified in subparagraph (2) & (3) of this paragraph.
- (b) Frequency measurements shall be made at extremes of the specified temperature range and at intervals of not more than 10 centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short-term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stability circuitry need be subjected to the temperature variation test.
- (d) The frequency stability supply shall be measured with variation of primary supply voltage as follows:
 - (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
 - (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
 - (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.
- (e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c) and (d) of this section. (For example, measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment).

8.4. EMISSION MASK

Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(i): The transmitter was modulated by a 2.5 KHz tone signal at an input level 16 dB greater than that required to produce 50% modulation (e.g.: ± 2.5 KHz peak deviation at 1 KHz modulating frequency). The input level was established at the frequency of maximum response of the audio modulating circuit.

Digital Modulation Through a Data Input Port @ 2.1049(h): Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the Emission Masks shall be shown for operation with any devices used for modifying the spectrum when such devices are operational at the discretion of the user.

The following EMI Receiver bandwidth shall be used for measurement of Emission Mask/Out-of-Band Emission Measurements:

- (1) For 25 KHz Channel Spacing: RBW = 300 Hz
- (2) For 12.5 KHz or 6.25 KHz Channel Spacings: RBW = 100 Hz

In all cases the Video Bandwidth shall be equal or greater than the measuring bandwidth.

8.5. SPURIOUS EMISSIONS (CONDUCTED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the EMI Receiver controls set as RBW = 30 KHz minimum , VBW \geq RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC 47 CFR 2.1057 - Frequency spectrum to be investigated: The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10th harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC 47 CFR 2.1051 - Spurious Emissions at Antenna Terminal: The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions, which are attenuated more than 20 dB below the permissible value, need not be specified.