TEST REPORT

Report Number. : R13490622-E3

Applicant	:	QUECTEL WIRELESS SOLUTIONS CO., LTD BUILDING 5, SHANGHAI BUSINESS PARK PHASE III (AREA B), NO.1016 TIANLIN ROAD, MINHANG DISTRICT SHANGHAI, 200233 CHINA
Model	:	BG95-M3
FCC ID	:	XMR202010BG95M3
EUT Description	:	LTE CAT M1 & CAT NB2 & EGPRS MODULE
Test Standard(s)	:	FCC CFR47 PART 27

Date Of Issue:
2021-01-14

Prepared by:
UL LLC
12 Laboratory Dr.
Research Triangle Park, NC 27709 U.S.A.
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NVLAP TESTING

NVLAP Lab code: 200246-0
NVLAP Lab code: 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	2021-01-14	Initial Issue	Niklas Haydon

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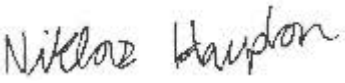
1. ATTESTATION OF TEST RESULTS

Applicant Name and Address	QUECTEL WIRELESS SOLUTIONS CO., LTD BUILDING 5, SHANGHAI BUSINESS PARK PHASE III (AREA B), NO.1016 TIANLIN ROAD, MINHANG DISTRICT SHANGHAI, 200233 CHINA
Model	BG95-M3
FCC ID	XMR202010BG95M3
EUT Description	LTE CAT M1 & CAT NB2 & EGPRS MODULE
Serial Number	P1C20GR25000016, P1C20GL0A000070, P1C20GR25000041
Date Tested	2020-09-15 to 2021-01-13
Applicable Standards	FCC CFR47 PART 27
Test Results	COMPLIES

UL LLC and UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL LLC. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. government.

Approved & Released By:	Prepared By:
	
Thu Chan Staff Engineer UL Verification Services Inc.	Niklas Haydon Operations Leader UL LLC

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with the following:

- ANSI C63.26:2015
- FCC CFR 47 Part 2, Part 27
- FCC KDB 971168 D01 v03r01: Power Meas License Digital Systems
- FCC KDB 971168 D02 v02r01: Misc Rev Approv License Devices
- FCC KDB 412172 D01 v01r01. Determining ERP and EIRP

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 12 Laboratory Drive, Research Triangle Park, North Carolina, USA, 2800 Perimeter Park Dr., Suite B, Morrisville, North Carolina, USA, and 47173 Benicia Street, Fremont, California, USA. The following tables identify which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

12 Laboratory Dr.	2800 Perimeter Park Dr.
Site Code: 2180C	
☒ Chamber A RTP	☒ North Chamber
☐ Chamber C RTP	☐ South Chamber

UL LLC (RTP) is accredited by NVLAP, Laboratory Code 200246-0

UL LLC (RTP) test sites and facilities are covered under FCC Test Firm Registration # 703469. Chambers above are covered under Industry Canada company address and respective code: 2180C.

47173 Benicia Street	47266 Benicia Street	47658 Kato Road
☐ Chamber A	☐ Chamber D	☐ Chamber I
☐ Chamber B	☐ Chamber E	☐ Chamber J
☐ Chamber C	☐ Chamber F	☐ Chamber K
	☐ Chamber G	☐ Chamber L
	☐ Chamber H	☐ Chamber M

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0

UL Verification Services Inc test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code: 2324A.

4. DECISION RULES AND MEASUREMENT UNCERTAINTY

4.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

4.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	2.00%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
Unwanted Emissions, conducted	1.94 dB
All emissions, radiated	4.88 dB
Temperature	2.26°C
Humidity	6.79%
DC Supply voltages	1.70%
Time	3.39%

Uncertainty figures are valid to a confidence level of 95%.

4.4. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:
Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:
Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.
36.5 dBuV + 0 dB +10.1 dB+ 0 dB = 46.6 dBuV

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5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a LTE Cat M1 & Cat NB2 & EGPRS Module.

5.2. MAXIMUM OUTPUT POWER

ERP TEST PROCEDURE

ANSI C63.26:2015
KDB 971168 D01 Section 5.6

ERP = PMeas + GT − LC
where: ERP/EIRP = effective or equivalent radiated power, respectively (expressed in the same units as PMeas, typically dBW or dBm);
PMeas = measured transmitter output power or PSD, in dBm or dBW;
GT = gain of the transmitting antenna, in dBd (ERP);
LC = signal attenuation in the connecting cable between the transmitter and antenna, in dB.

The transmitter has a maximum average conducted and ERP output powers as follows:

Part 27						
ERP Limit (W)		30.00				
Antenna Gain (dBi)		4.45				
Frequency Range	Carrier Spacing (kHz)	Low Frequency (MHz)	Upper Frequency (MHz)	Conducted Average (dBm)	ERP Average (dBm)	ERP Average (W)
787.2-787.8	3.75	787.2	787.8	20.54	22.84	0.192
	15			20.56	22.86	0.193

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5.3. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was version BG95M3LAR02A03.

5.4. MAXIMUM ANTENNA GAIN

Please see table below:

LTE Bands	Antenna Gain (dBi)
NB-IoT LTE Frequency Band 787.2-787.8 MHz	4.45

5.5. WORST-CASE CONFIGURATION AND MODE

The worst-case scenario for all measurements is based on the average conducted output power measurement investigation results. Output power measurements were measured on 3.75kHz and 15 kHz carrier spacing at each support MCS index. It was found that MCS0 for both 3.75kHz and 15kHz carrier spacing resulted in the highest output power. All testing was performed using MCS0 to represent the worst case. Each test was performed on the mode with the worst case conducted output power and is specified in each test section.

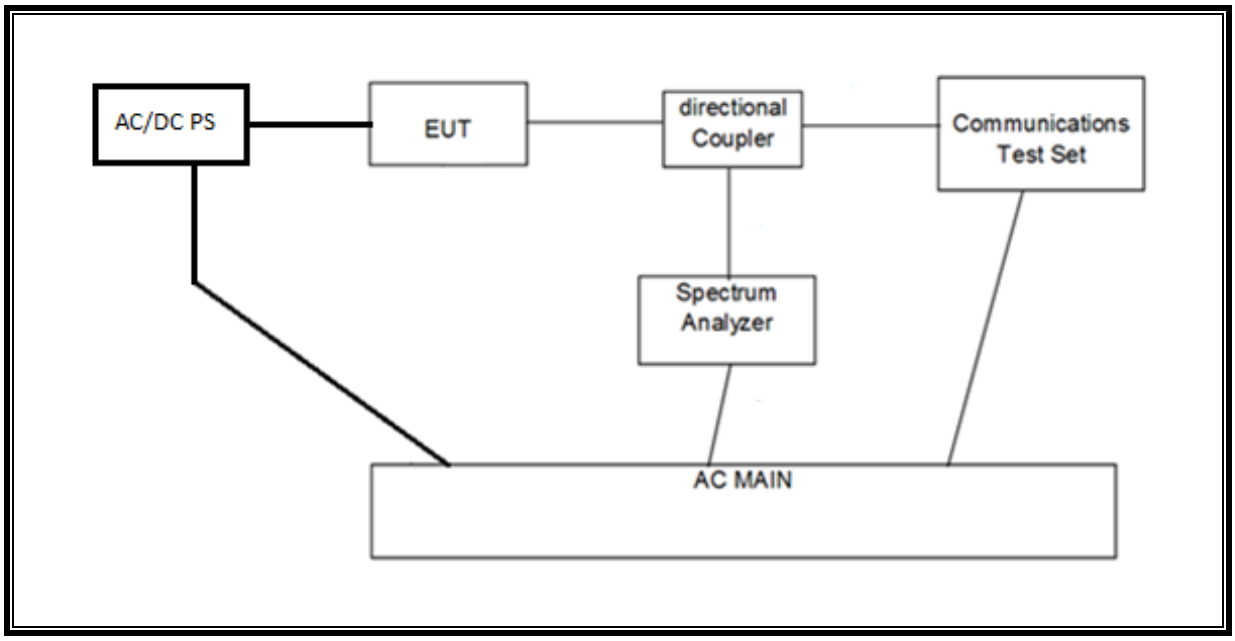
The EUT was investigated in three orthogonal orientations X/Y/Z on both the antenna and board. For both the antenna and the board, it was determined that X orientation was worst-case orientation, therefore all radiated emissions tests were performed in X orientation.

5.6. DESCRIPTION OF TEST SETUP

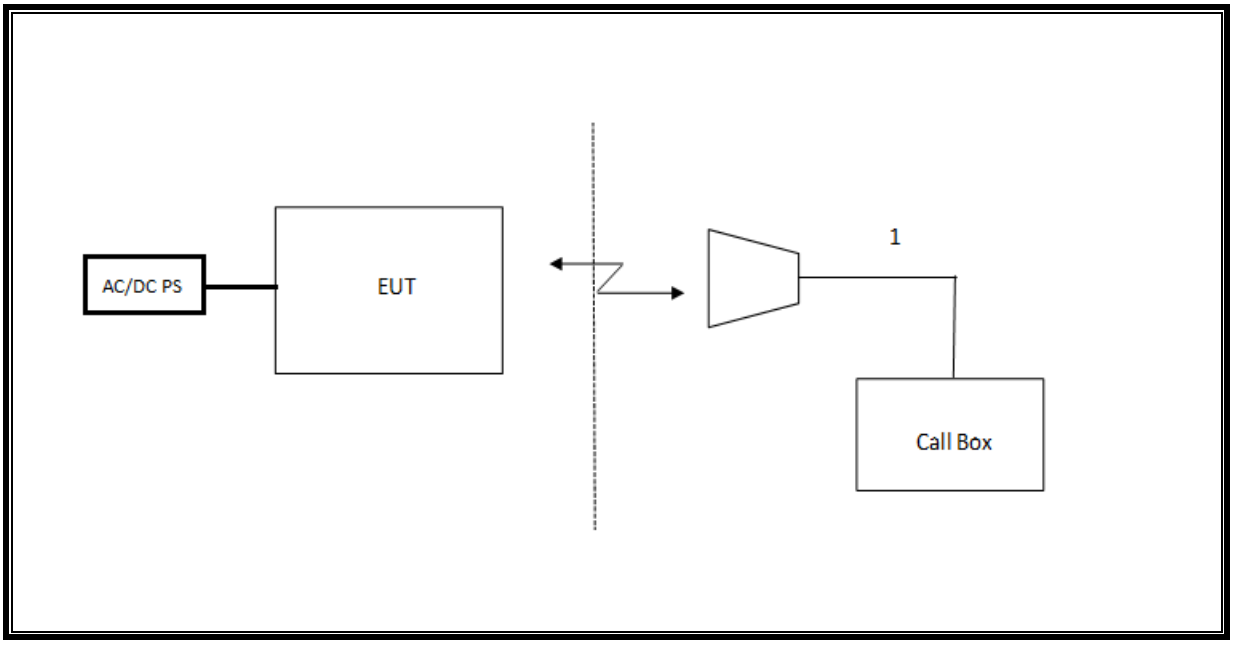
SUPPORT TEST EQUIPMENT				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID/ DoC**
AC/DC adapter	Shanghai Jingsai Electronic Technology Co.	CLS-050200	Non-serialized	N/A
Evaluation board	Quectel Wireless Solutions Co, LTD	Q1-A2329	MP820HL1F000037	N/A
Evaluation board	Quectel Wireless Solutions Co, LTD	Q1-A2329	MP820HL1F000063	N/A
Evaluation board	Quectel Wireless Solutions Co, LTD	Q1-A2329	MP820HL1F000064	N/A

I/O CABLES						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	DC	1	Detachable	Un-shielded	1.1	N/A

CONDUCTED SETUP



RADIATED SETUP



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6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - North Chamber)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	30-1000 MHz				
AT0074	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2020-07-27	2021-07-27
	1-18 GHz				
AT0072	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-04-27	2021-04-27
	Gain-Loss Chains				
N-SAC02	Gain-loss string: 25-1000MHz	Various	Various	2020-07-29	2021-07-29
N-SAC03	Gain-loss string: 1-18GHz	Various	Various	2020-07-28	2021-07-28
	Receiver & Software				
SA0026	Spectrum Analyzer	Agilent	N9030A	2020-07-16	2021-07-16
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Additional Equipment used				
s/n 200037610	Environmental Meter	Fisher Scientific	06-662-4	2020-01-22	2022-01-22
PRE0209821	Radio Communication Analyzer	Anritsu	MT8821C	2020-08-27	2021-08-27
HPF012	1GHz high-pass filter, 2W, F_{high} =18GHz	Micro-Tronics	HPM18129	2020-02-19	2021-02-19
198934	20dB, DC-12GHz, 2W	Pasternack	PE7047-20	2020-05-13	2021-05-13

Test Equipment Used - Wireless Conducted Measurement Equipment (Morrisville)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	Conducted Room 2				
SA0027	Spectrum Analyzer	Keysight Technologies	N9030A	2020-06-10	2021-06-10
72822	Spectrum Analyzer	Agilent Technologies	E4446A	2020-01-02	2021-01-02
PWM001	RF Power Meter	Keysight Technologies	N1921A	2020-05-27	2021-05-27
PWS001	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1912A	2020-07-17	2021-07-17
HI0090	Environmental Meter	Fisher Scientific	15-077-963	2020-06-26	2021-06-26
SOFTEMI	EMC Software	UL	Version 2020.9.1, 2020.10.22 2020.12.3	NA	NA
PRE0209821	Radio Communication Analyzer	Anritsu	MT8821C	2020-08-27	2021-08-27

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (RTP - A Chamber)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0059	Active Loop Antenna	EMCO	6502	2020-08-06	2021-08-06
CBL089	Cable, coax, RG142, 20-ft, N-male @ both ends	Pasternack	PE3455-240	2020-05-13	2021-05-13
CBL090	Cable, coax, RG223, 8-ft, N-male @ both ends	Pasternack	PE3447-96	2020-05-13	2021-05-13
SA0016	Spectrum Analyzer	Agilent	N9030A	2019-11-21	2020-11-21
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
HI0085	Environmental Meter	Extech	SD700	2020-04-20	2021-04-30

Test Equipment Used - Wireless Conducted Measurement Equipment (Fremont)

Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
Spectrum Analyzer, PSA, 3Hz to 26.5GHz	Keysight Technologies Inc	E4440A	T434	01/23/2021	01/23/2020
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies Inc	N9030A	T906	07/20/2021	07/20/2020
Wideband Communication Test Set, Call Box	Rohde & Schwarz (Koeln) GmbH & Co. KG	CMW500	T919	02/22/2021	02/22/2020
Thermometer – Digital	Thermometer – Digital	14-650-118	PRE0186412	02/18/2021	02/18/2020
SOFTEMI	EMC Software	UL	Version 2020.10.22 2020.12.3	NA	NA

NOTES:

1. * Testing is completed before equipment expiration date.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

7. RF OUTPUT POWER VERIFICATION

CONDUCTED OUTPUT POWER MEASUREMENT PROCEDURE

All conducted average power is obtained from the Anritsu MT8821c telecommunication test set.

LIMITS

FCC: §27.50(b)
(9) Control stations and mobile stations transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands and fixed stations transmitting in the 787-788 MHz and 805-806 MHz bands are limited to 30 watts ERP.

RESULTS

Test Engineer ID:	40882	Test Date:	2020-11-30, 2021-01-05

Carrier Spacing	Subcarrier	Carrier Location	MCS Index	Conducted Average (dBm)		
				CH 134184	CH 134187	CH 134190
				787.2 MHz	787.5 MHz	787.8 MHz
3.75kHz	1	0	0	20.44	20.48	20.54
3.75kHz	1	23	0	20.23	20.25	20.31
3.75kHz	1	47	0	20.26	20.24	20.29
Carrier Spacing	Subcarrier	Carrier Location	MCS Index	Conducted Average (dBm)		
				CH 134184	CH 134187	CH 134190
				787.2 MHz	787.5 MHz	787.8 MHz
15kHz	1	0	0	20.26	20.29	20.36
15kHz	1	5	0	20.51	20.30	20.47
15kHz	1	11	0	20.19	20.13	20.32
Carrier Spacing	Subcarrier	Carrier Location	MCS Index	Conducted Average (dBm)		
				CH 134184	CH 134187	CH 134190
				787.2 MHz	787.5 MHz	787.8 MHz
15kHz	3	0	0	20.30	20.45	20.38
15kHz	3	3	0	20.33	20.27	20.44
15kHz	3	6	0	20.21	20.05	20.17
15kHz	3	9	0	20.00	19.95	20.03
Carrier Spacing	Subcarrier	Carrier Location	MCS Index	Conducted Average (dBm)		
				CH 134184	CH 134187	CH 134190
				787.2 MHz	787.5 MHz	787.8 MHz
15kHz	6	0	0	20.11	20.10	20.23
15kHz	6	6	0	20.27	20.08	20.34
Carrier Spacing	Subcarrier	Carrier Location	MCS Index	Conducted Average (dBm)		
				CH 134184	CH 134187	CH 134190
				787.2 MHz	787.5 MHz	787.8 MHz
15kHz	12	0	0	20.38	20.40	20.56

8. CONDUCTED TEST RESULTS

8.1. 26dB BANDWIDTH

RULE PART(S)

FCC: §2.1049

LIMITS

For reporting purposes only.

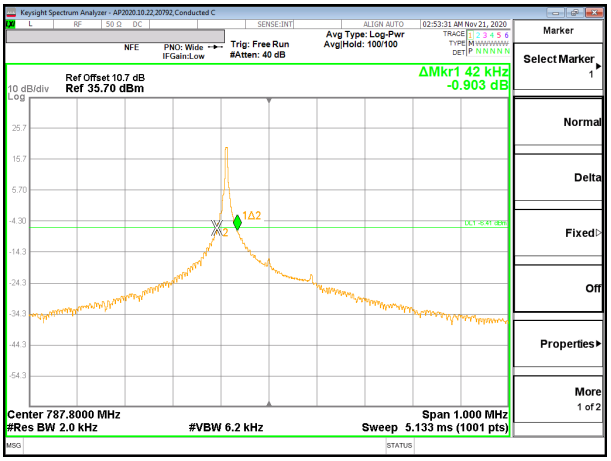
TEST PROCEDURE

The transmitter output was connected to a calibrated coaxial cable and coupler, the other end of which was connected to a spectrum analyzer. -26dB bandwidth was measured with the spectrum analyzer at the high channel in each band. Only the high channel and a single carrier location plots are shown below.

RESULTS

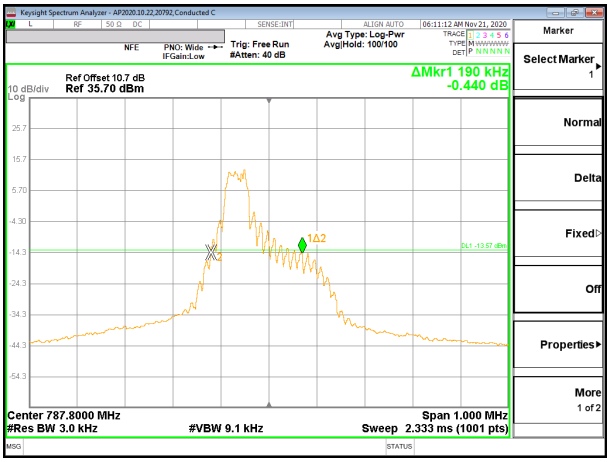
Test Engineer ID:	20792	Test Date:	2020-11-21

Carrier Spacing	Subcarrier	Carrier Location	MCS Index	26dB bandwidth (kHz) CH 134190 787.8 MHz
3.75kHz	1	0	0	42.0
3.75kHz	1	23	0	43.0
3.75kHz	1	47	0	43.0
Carrier Spacing	**Subcarrier**	**Carrier Location**	**MCS Index**	**26dB bandwidth (kHz) CH 134190 787.8 MHz**
15kHz	1	0	0	108.0
15kHz	1	5	0	131.0
15kHz	1	11	0	103.0
Carrier Spacing	**Subcarrier**	**Carrier Location**	**MCS Index**	**26dB bandwidth (kHz) CH 134190 787.8 MHz**
15kHz	3	0	0	190.0
15kHz	3	3	0	188.0
15kHz	3	6	0	191.0
15kHz	3	9	0	160.0
Carrier Spacing	**Subcarrier**	**Carrier Location**	**MCS Index**	**26dB bandwidth (kHz) CH 134190 787.8 MHz**
15kHz	6	0	0	242.0
15kHz	6	6	0	226.0
Carrier Spacing	**Subcarrier**	**Carrier Location**	**MCS Index**	**26dB bandwidth (kHz) CH 134190 787.8 MHz**
15kHz	12	0	0	251.0

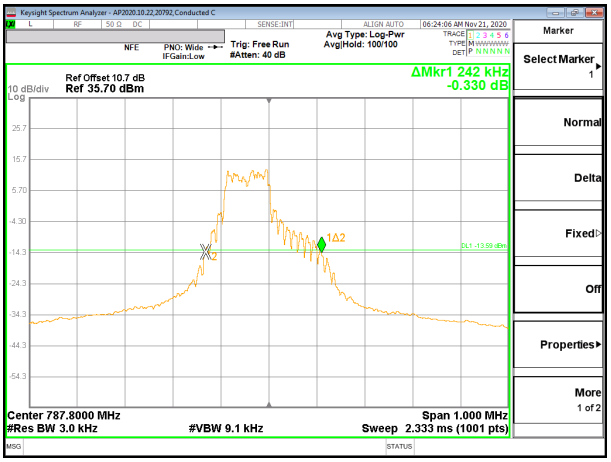


NB-IoT 3.75kHz High Channel subcarrier 1, carrier location 0

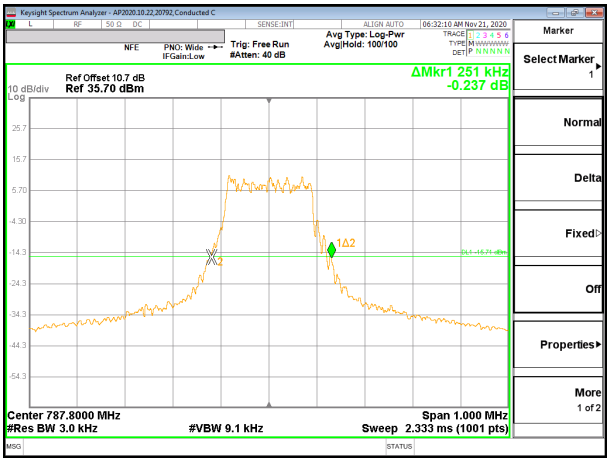
NB-IoT 15kHz High Channel subcarrier 1, carrier location 0



NB-IoT 15kHz High Channel subcarrier 3, carrier location 0



NB-IoT 15kHz High Channel subcarrier 6, carrier location 0



NB-IoT 15kHz High Channel subcarrier 12, carrier location 0

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8.2. 99% BANDWIDTH

RULE PART(S)

FCC: §2.1049

LIMITS

For reporting purposes only.

TEST PROCEDURE

The transmitter output was connected to a calibrated coaxial cable and coupler, the other end of which was connected to a spectrum analyzer. 99% bandwidth was measured with the spectrum analyzer at the high channel in each band. Only the high channel and a single carrier location plots are shown below.

RESULTS

Test Engineer ID:	20792	Test Date:	2020-11-21

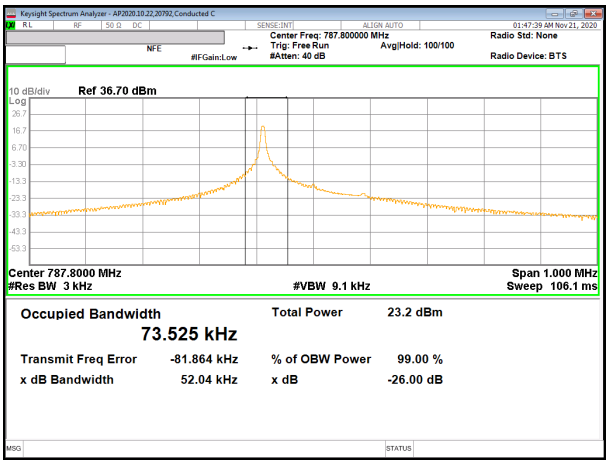
Carrier Spacing	Subcarrier	Carrier Location	MCS Index	99% bandwidth (kHz) CH 134190 787.8 MHz
3.75kHz	1	0	0	73.5250
3.75kHz	1	23	0	77.9270
3.75kHz	1	47	0	74.6350

Carrier Spacing	Subcarrier	Carrier Location	MCS Index	99% bandwidth (kHz) CH 134190 787.8 MHz
15kHz	1	0	0	126.480
15kHz	1	5	0	132.900
15kHz	1	11	0	128.840

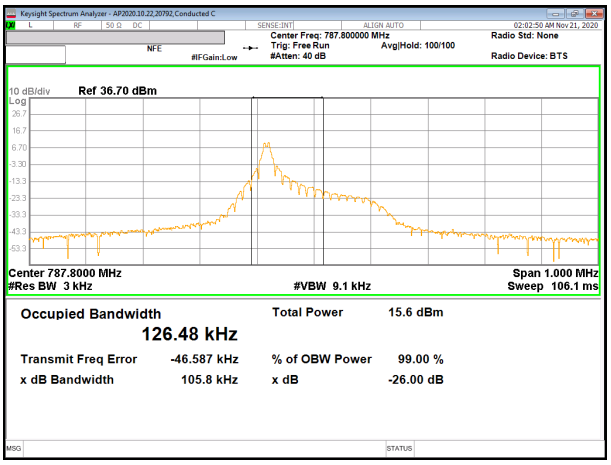
Carrier Spacing	Subcarrier	Carrier Location	MCS Index	99% bandwidth (kHz) CH 134190 787.8 MHz
15kHz	3	0	0	113.700
15kHz	3	3	0	120.370
15kHz	3	6	0	127.410
15kHz	3	9	0	120.030

Carrier Spacing	Subcarrier	Carrier Location	MCS Index	99% bandwidth (kHz) CH 134190 787.8 MHz
15kHz	6	0	0	157.730
15kHz	6	6	0	153.030

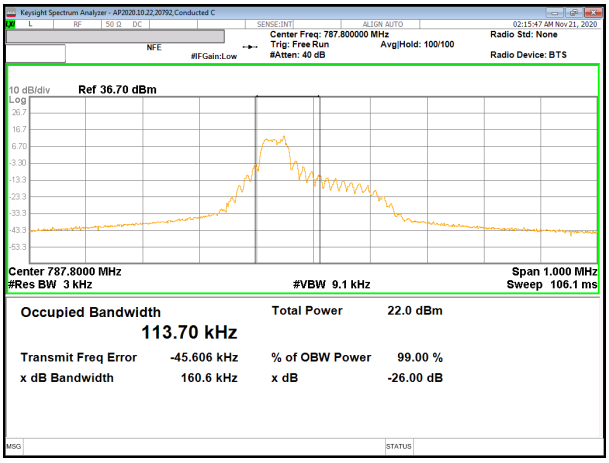
Carrier Spacing	Subcarrier	Carrier Location	MCS Index	99% bandwidth (kHz) CH 134190 787.8 MHz
15kHz	12	0	0	185.400



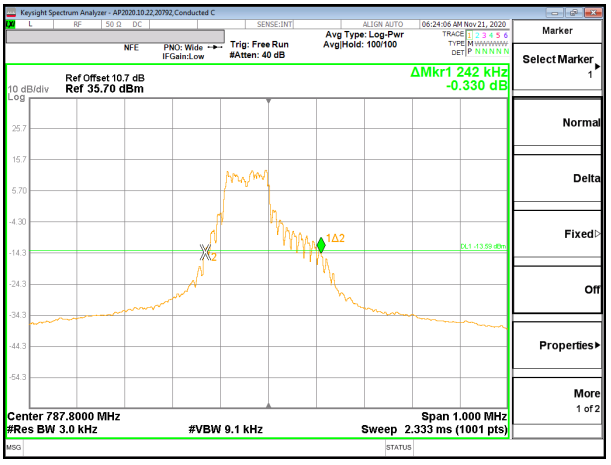
NB-IoT 3.75kHz High Channel subcarrier 1, carrier location 0



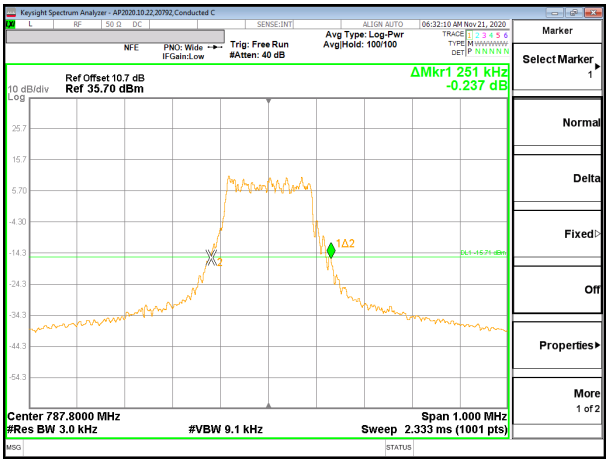
NB-IoT 15kHz High Channel subcarrier 1, carrier location 0



NB-IoT 15kHz High Channel subcarrier 3, carrier location 0



NB-IoT 15kHz High Channel subcarrier 6, carrier location 0



NB-IoT 15kHz High Channel subcarrier 12, carrier location 0

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8.3. BAND EDGE AND EMISSION MASK

TEST PROCEDURE

The transmitter output was connected to a Anritsu MT8821c Test Set and configured to operate at maximum power. The band edge emissions were measured at the required operating frequencies in each band on the Spectrum Analyzer.

RESULTS

3.75kHz and 15kHz carrier spacing, each subcarrier, lowest and highest carrier location modes are tested and reported.

LIMITS

FCC: §27.53(c)

(c) For operations in the 746-758 MHz band and the 776-788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On any frequency outside the 746-758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;

(2) On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;

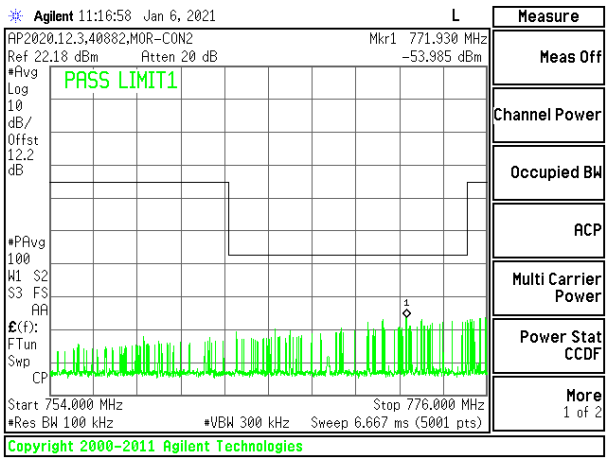
(3) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations;

(4) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations;

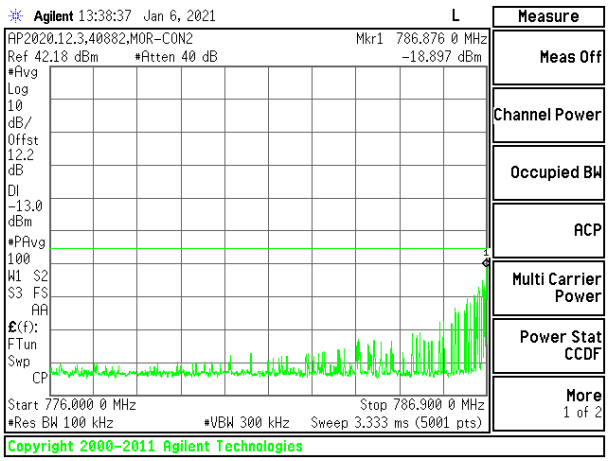
(5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;

(6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

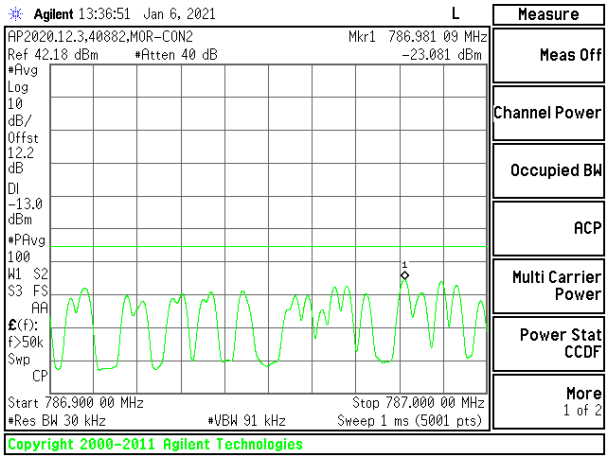
TESTED BY: 40882 (marked on plots), 20792 (all plots not marked)



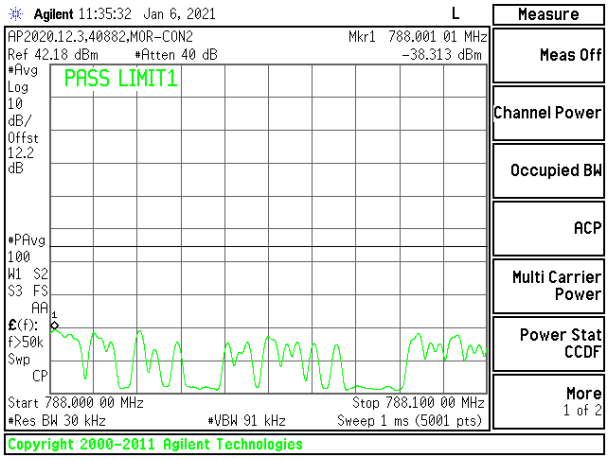
NB-IoT 3.75kHz Low Channel subcarrier 1, carrier location 0 - 754-776 MHz



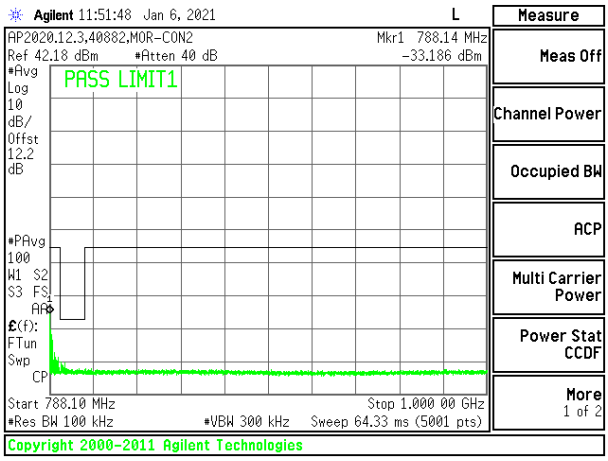
NB-IoT 3.75kHz Low Channel subcarrier 1, carrier location 0 - 776-786.9 MHz



NB-IoT 3.75kHz Low Channel subcarrier 1, carrier location 47 - 786.9-787 MHz



NB-IoT 3.75kHz Low Channel subcarrier 1, carrier location 0 - 788-788.1 MHz



NB-IoT 3.75kHz Low Channel subcarrier 1, carrier location 0 – 788.1-1000 MHz

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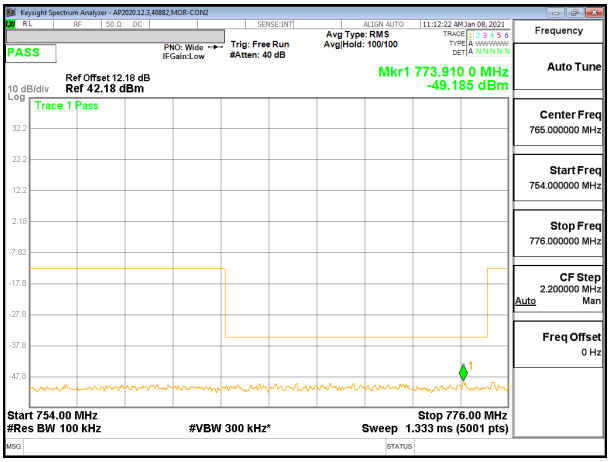
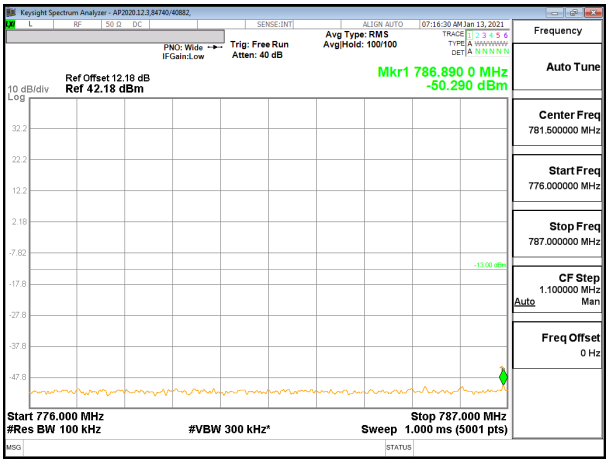
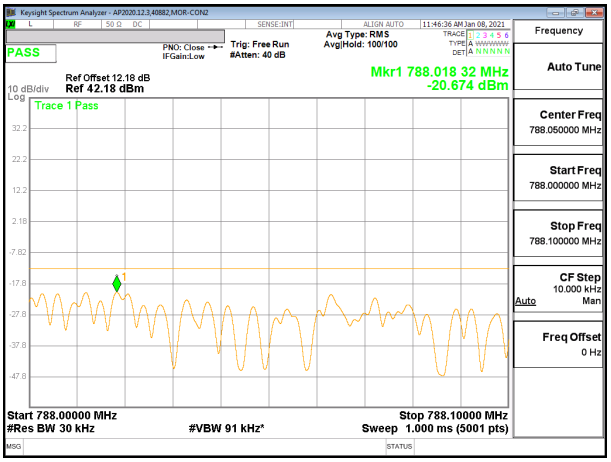


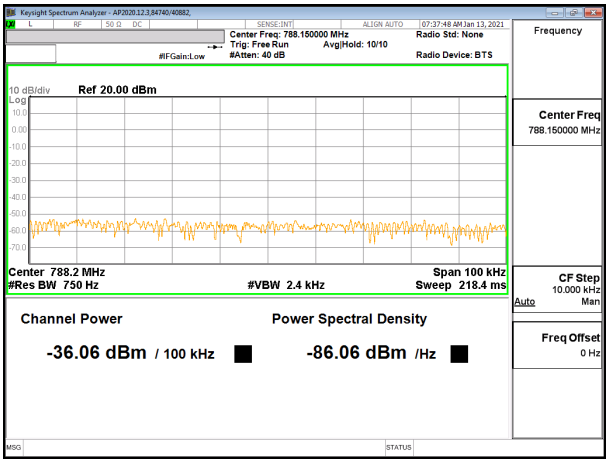
NB-IoT 3.75kHz High Channel subcarrier 1, carrier location 47 - 754-776 MHz



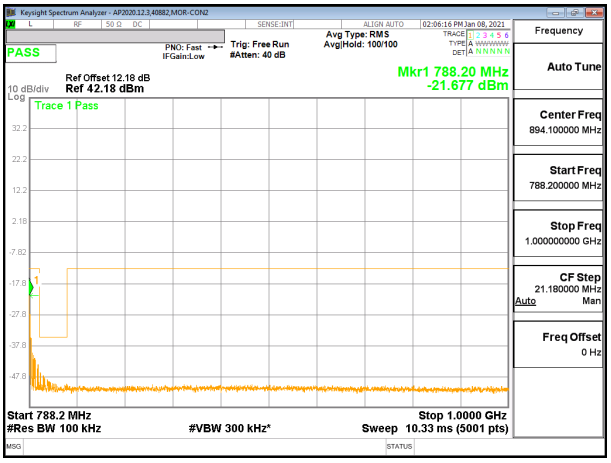
NB-IoT 3.75kHz High Channel subcarrier 1, carrier location 47 - 776-787 MHz



NB-IoT 3.75kHz High Channel subcarrier 1, carrier location 47 - 778-788.1 MHz



NB-IoT 3.75kHz High Channel subcarrier 1, carrier location 47 – 788.1-788.2 MHz



NB-IoT 3.75kHz High Channel subcarrier 1, carrier location 47 – 788.2-1000 MHz

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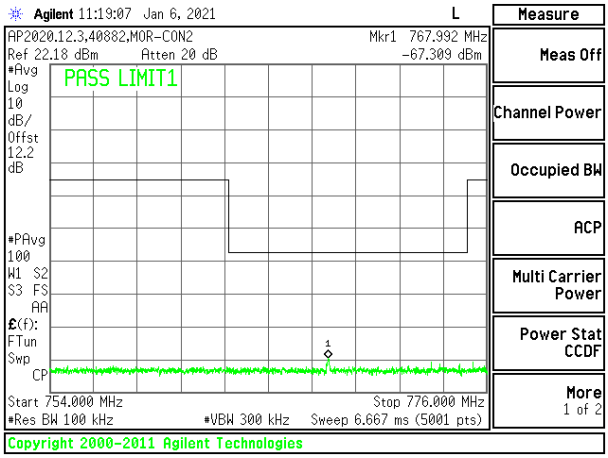
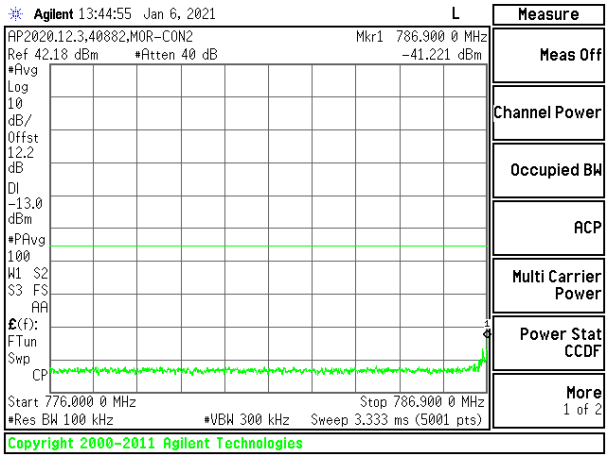
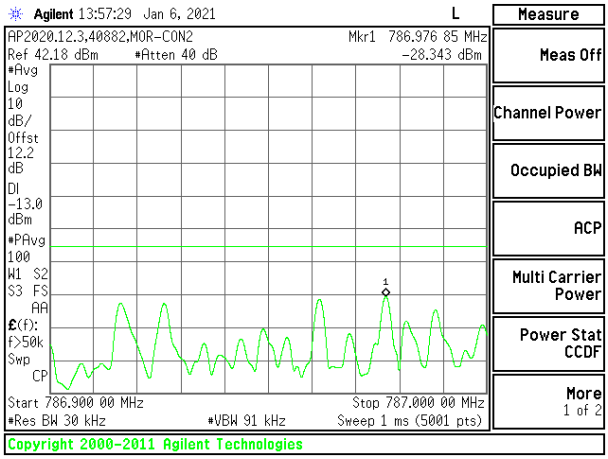


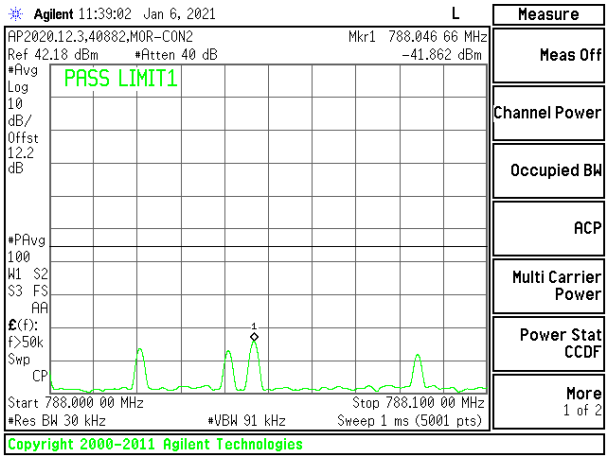
NB-IoT 15kHz Low Channel subcarrier 1, carrier location 0 - 754-776 MHz



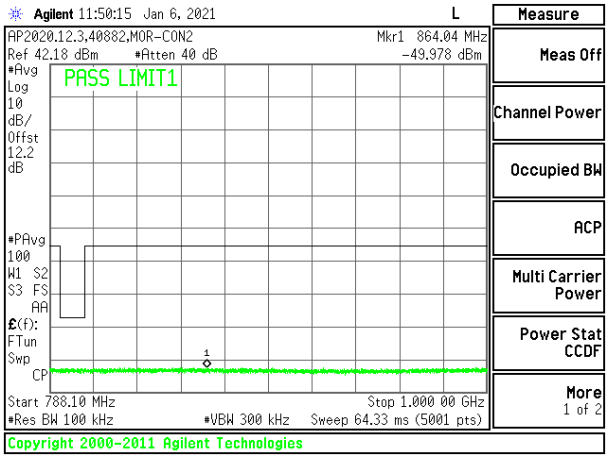
NB-IoT 15kHz Low Channel subcarrier 1, carrier location 0 - 776-786.9 MHz



NB-IoT 15kHz Low Channel subcarrier 1, carrier location 0 - 786.9-787 MHz



NB-IoT 15kHz Low Channel subcarrier 1, carrier location 0 - 788-788.1 MHz



NB-IoT 15kHz Low Channel subcarrier 1, carrier location 0 – 788.1-1000 MHz

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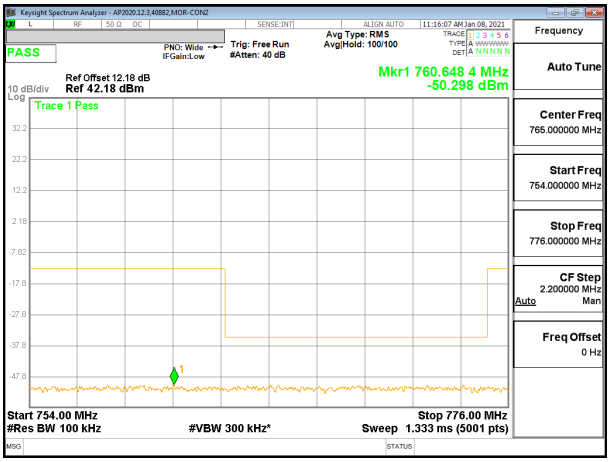
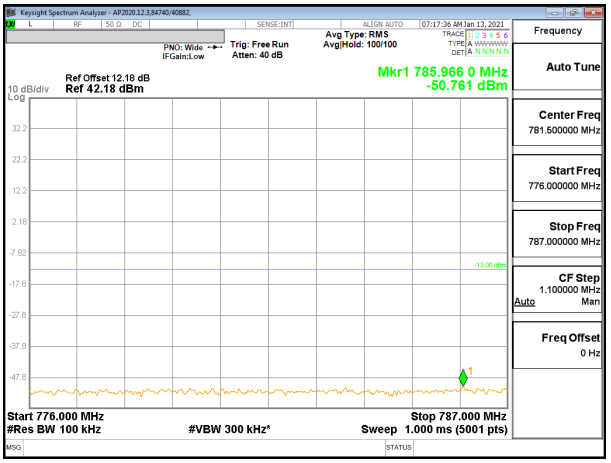
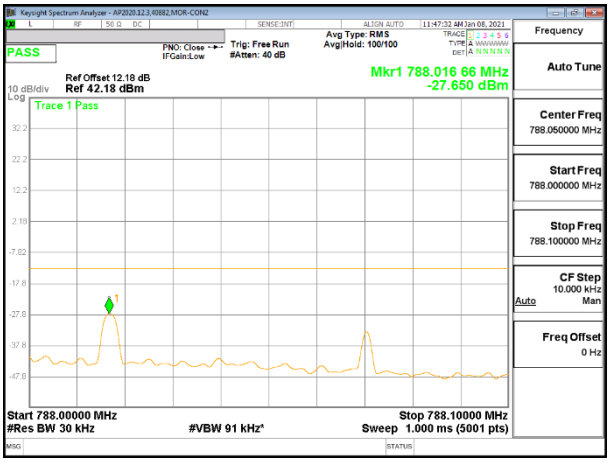


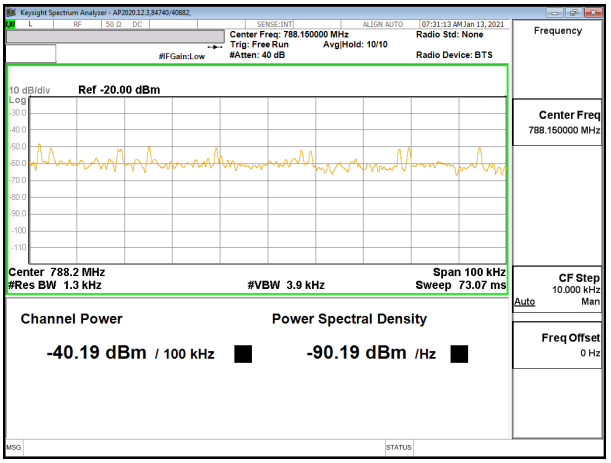
NB-IoT 15kHz High Channel subcarrier 1, carrier location 11 - 754-776 MHz



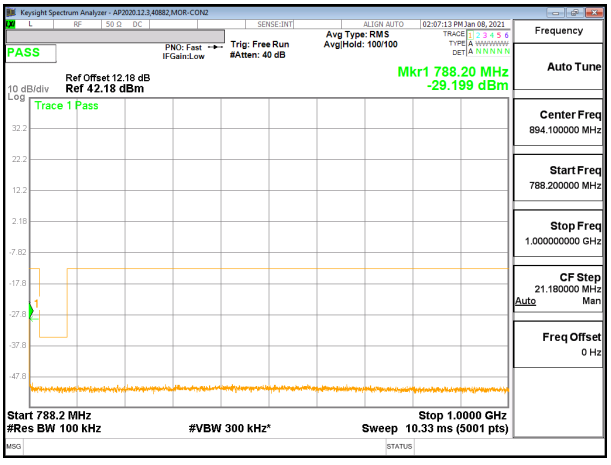
NB-IoT 15kHz High Channel subcarrier 1, carrier location 11 - 776-787 MHz



NB-IoT 15kHz High Channel subcarrier 1, carrier location 11 - 788-788.1 MHz



NB-IoT 15kHz High Channel subcarrier 1, carrier location 11 – 788.1-788.2 MHz



NB-IoT 15kHz High Channel subcarrier 1, carrier location 11 – 788.2-1000 MHz

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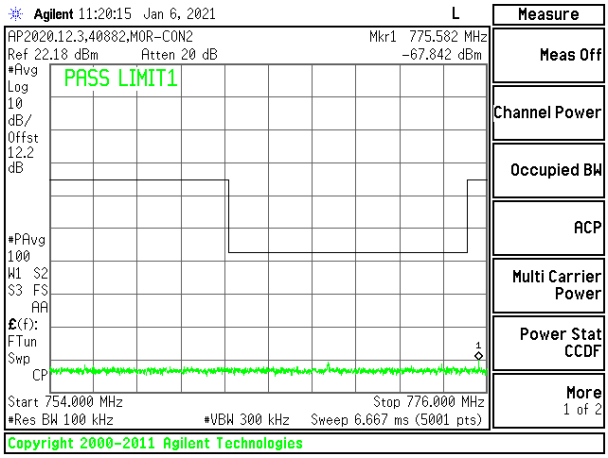
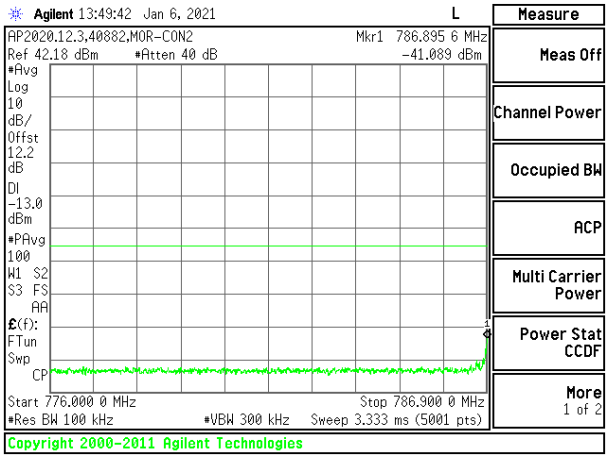
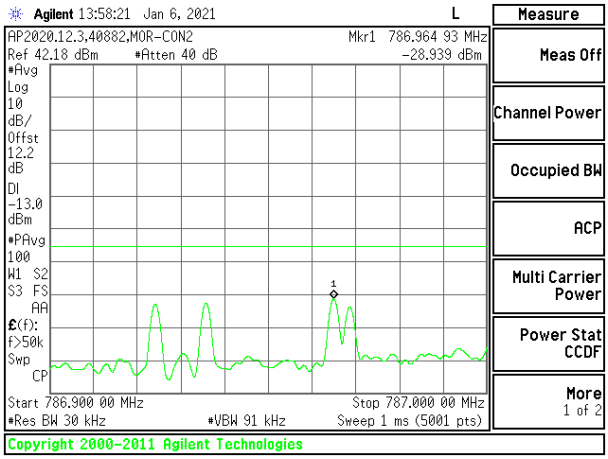
12 Laboratory Dr., RTP, NC 27709, USA TEL:(919) 549-1400



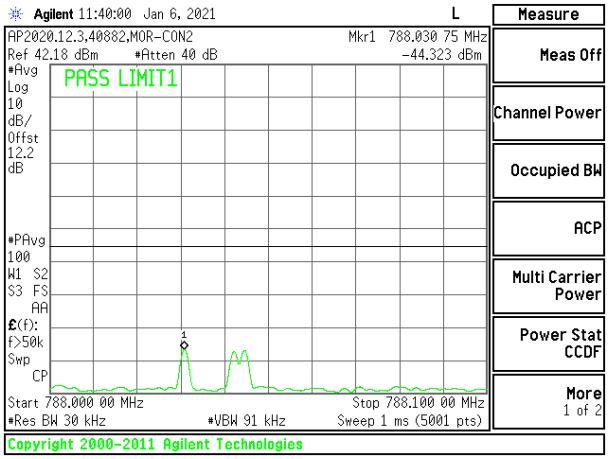
NB-IoT 15kHz Low Channel subcarrier 3, carrier location 0 - 754-776 MHz



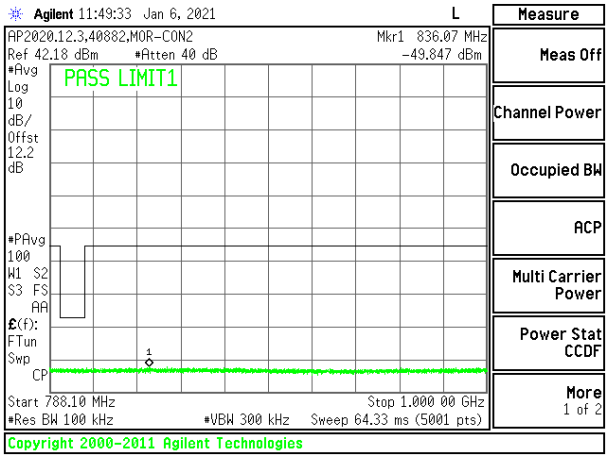
NB-IoT 15kHz Low Channel subcarrier 3, carrier location 0 - 776-786.9 MHz



NB-IoT 15kHz High Channel subcarrier 3, carrier location 0 - 786.9-787 MHz



NB-IoT 15kHz High Channel subcarrier 3, carrier location 0 - 788-788.1 MHz



NB-IoT 15kHz High Channel subcarrier 3, carrier location 0 – 788.1-1000 MHz

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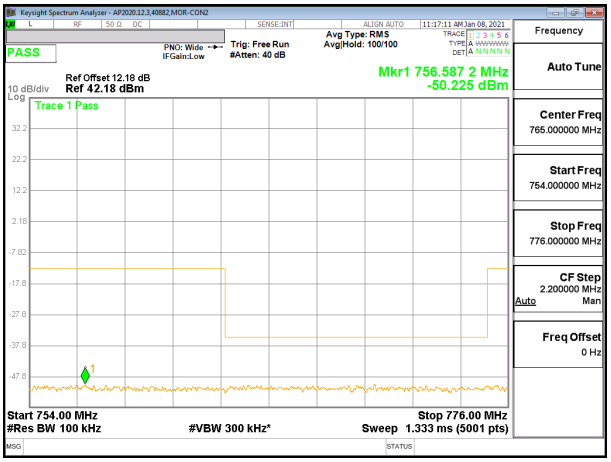
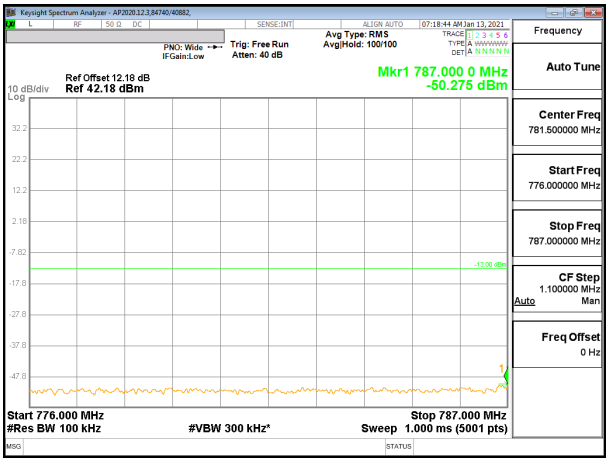
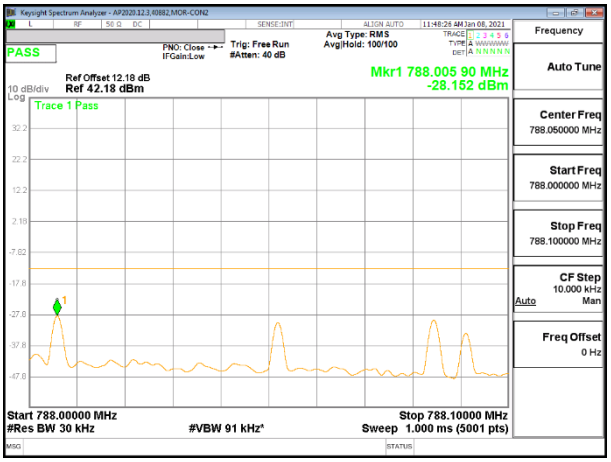


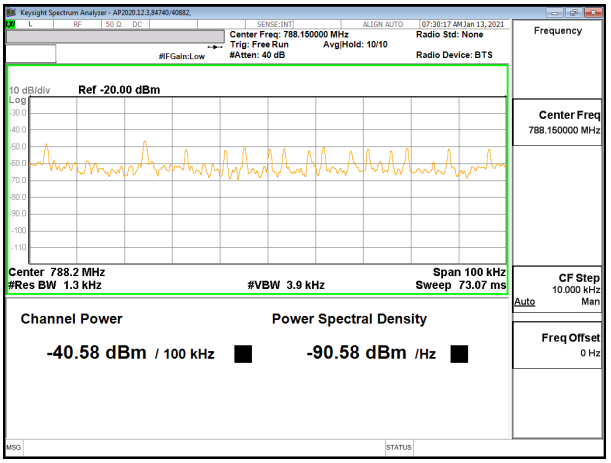
NB-IoT 15kHz High Channel subcarrier 3, carrier location 9 - 754-776 MHz



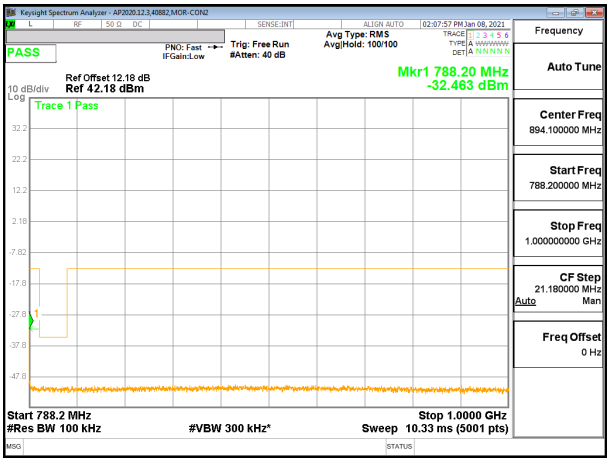
NB-IoT 15kHz High Channel subcarrier 3, carrier location 9 - 776-787 MHz



NB-IoT 15kHz High Channel subcarrier 3, carrier location 9 - 788-788.1 MHz



NB-IoT 15kHz High Channel subcarrier 3, carrier location 9 – 788.1-788.2 MHz



NB-IoT 15kHz High Channel subcarrier 3, carrier location 9 – 788.2-1000 MHz

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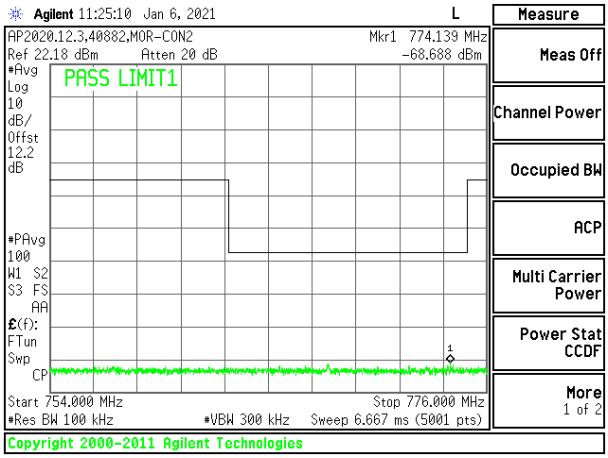
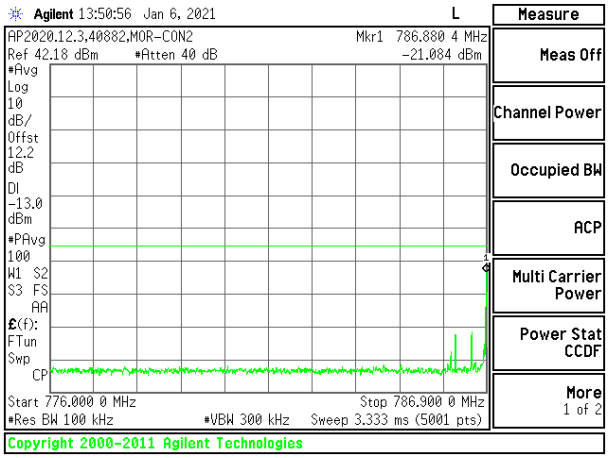
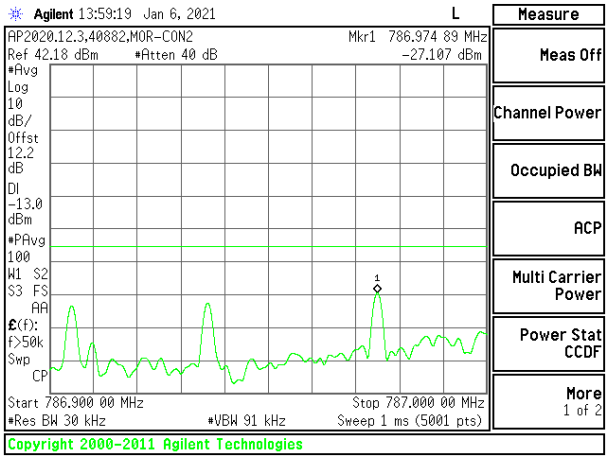


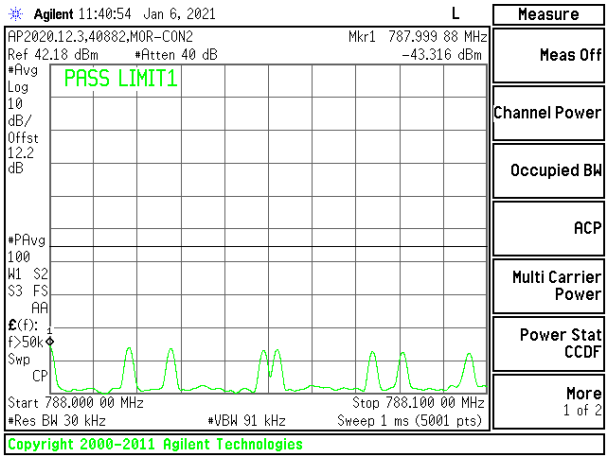
NB-IoT 15kHz Low Channel subcarrier 6, carrier location 0 - 754-776 MHz



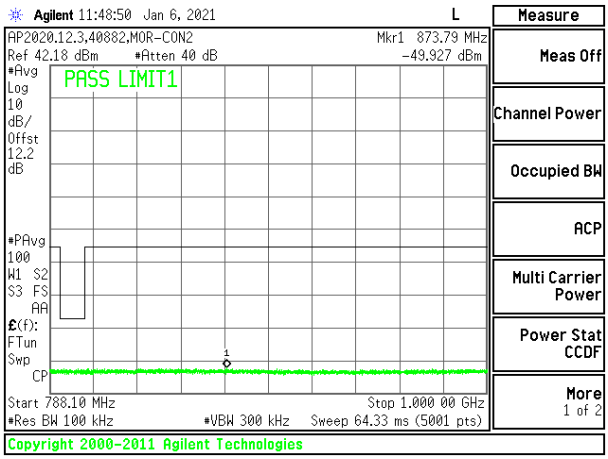
NB-IoT 15kHz Low Channel subcarrier 6, carrier location 0 - 776-786.9 MHz



NB-IoT 15kHz Low Channel subcarrier 6, carrier location 0 - 786.9-787 MHz



NB-IoT 15kHz Low Channel subcarrier 6, carrier location 0 - 788-788.1 MHz



NB-IoT 15kHz Low Channel subcarrier 6, carrier location 0 – 788.1-1000 MHz

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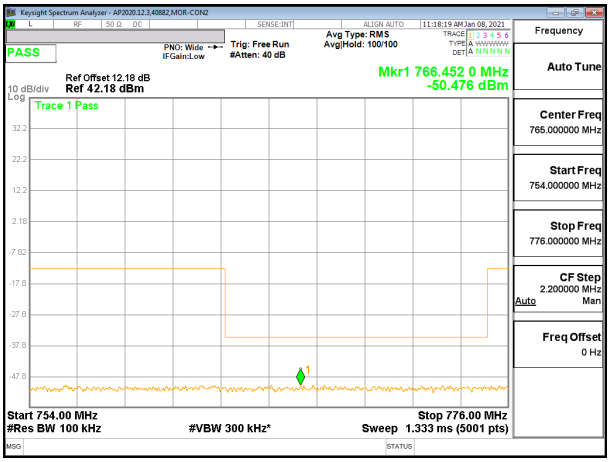
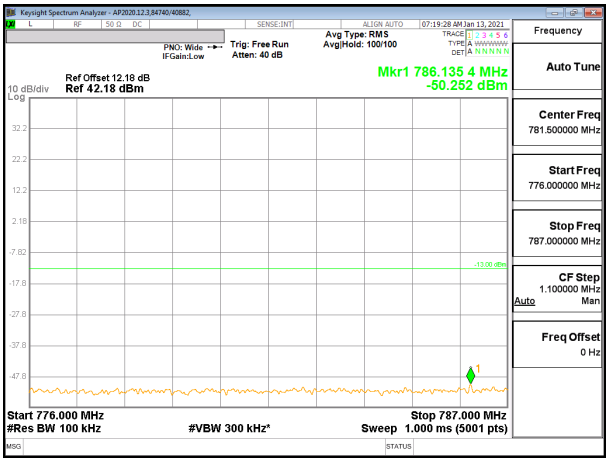
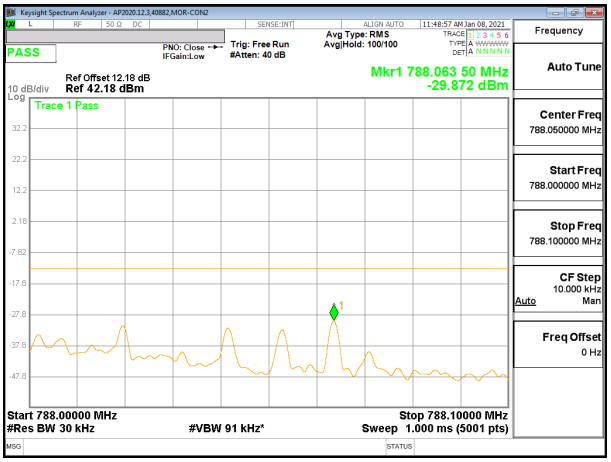


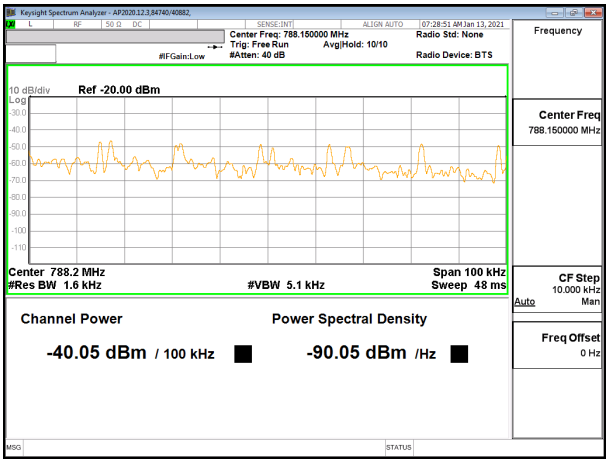
NB-IoT 15kHz High Channel subcarrier 6, carrier location 6 - 754-776 MHz



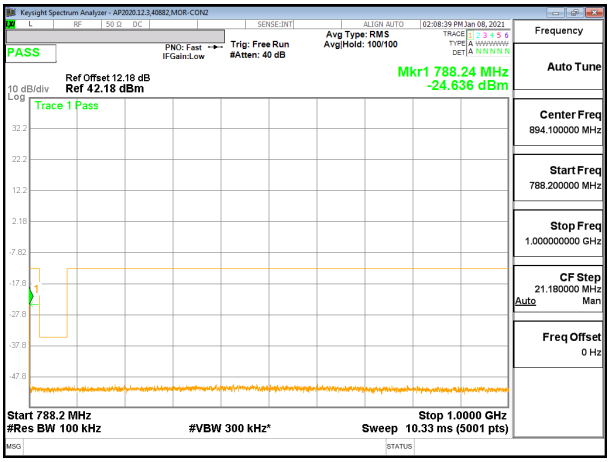
NB-IoT 15kHz High Channel subcarrier 6, carrier location 6 - 776-787 MHz



NB-IoT 15kHz High Channel subcarrier 6, carrier location 6 - 788-788.1 MHz



NB-IoT 15kHz High Channel subcarrier 6, carrier location 6 – 788.1-788.2 MHz



NB-IoT 15kHz High Channel subcarrier 6, carrier location 6 – 788.2-1000 MHz

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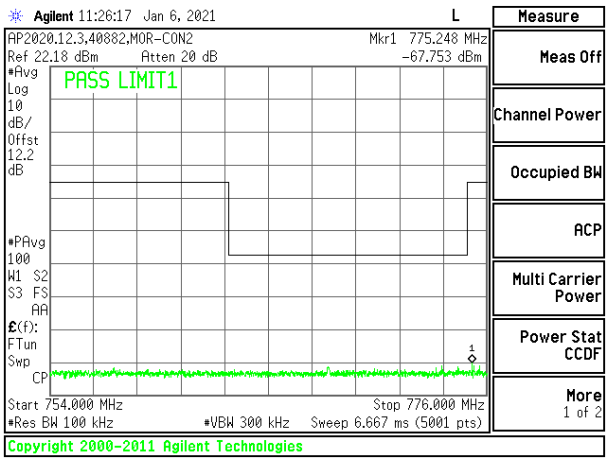
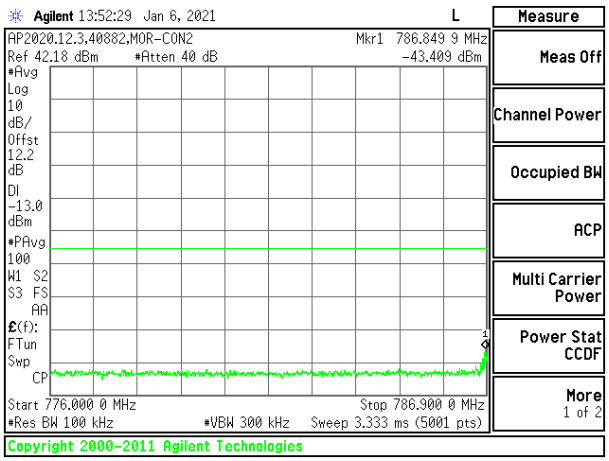
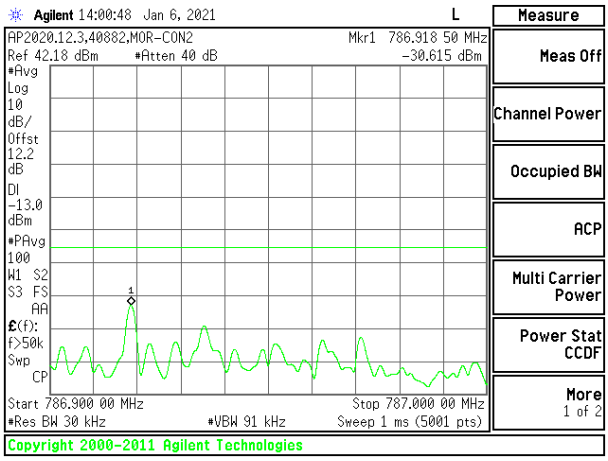


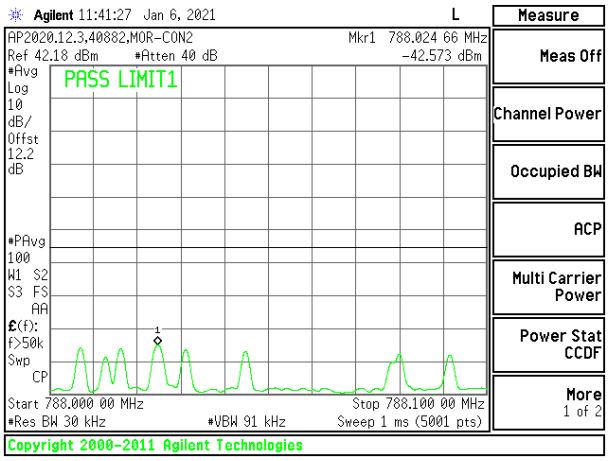
NB-IoT 15kHz Low Channel subcarrier 12, carrier location 0 - 754-776 MHz



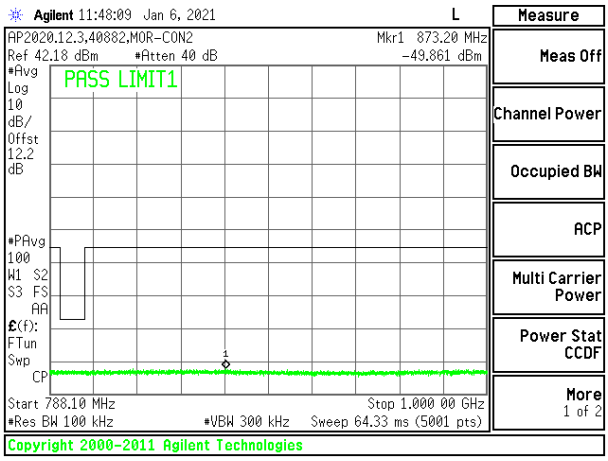
NB-IoT 15kHz Low Channel subcarrier 12, carrier location 0 - 776-786.9 MHz



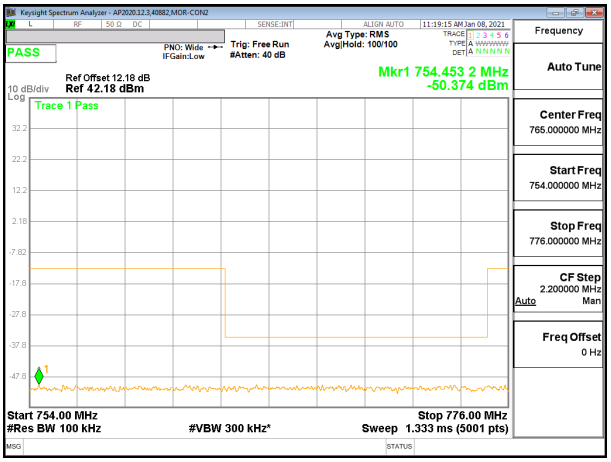
NB-IoT 15kHz Low Channel subcarrier 12, carrier location 0 - 786.9-787 MHz



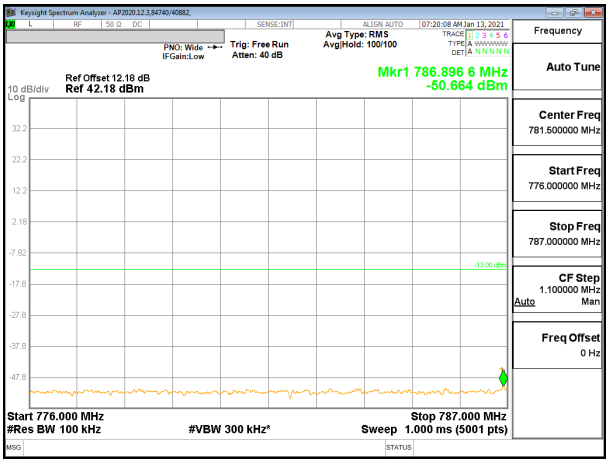
NB-IoT 15kHz Low Channel subcarrier 12, carrier location 0 - 788-788.1 MHz



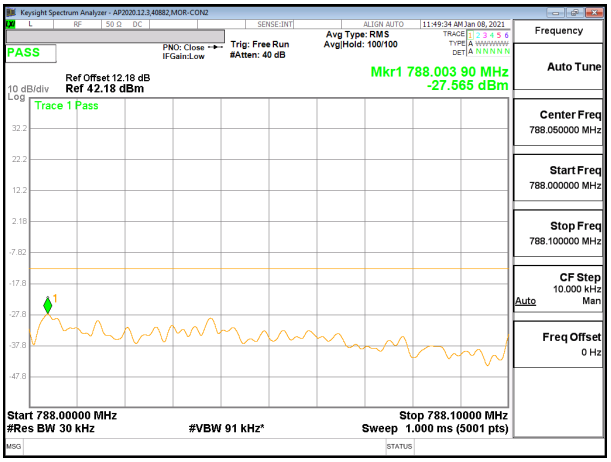
NB-IoT 15kHz Low Channel subcarrier 12, carrier location 0 – 788.1-1000 MHz



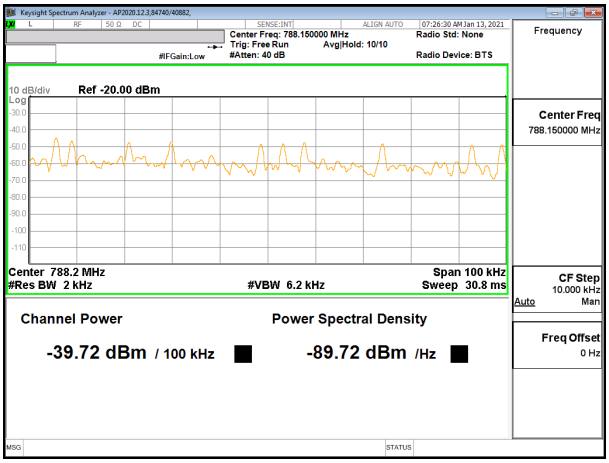
NB-IoT 15kHz High Channel subcarrier 12, carrier location 0 - 754-776 MHz



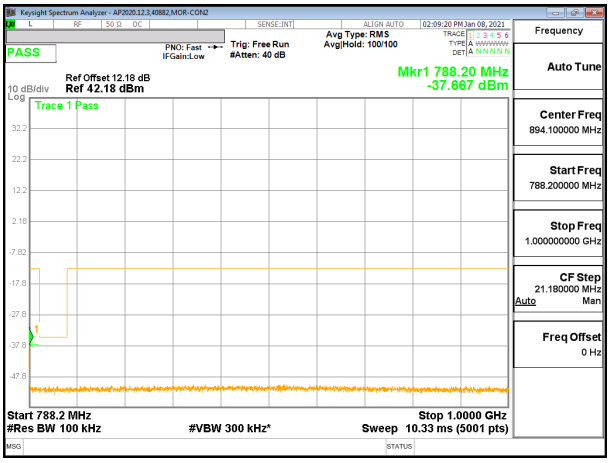
NB-IoT 15kHz High Channel subcarrier 12, carrier location 0 - 776-787 MHz



NB-IoT 15kHz High Channel subcarrier 12, carrier location 0 - 788-788.1 MHz



NB-IoT 15kHz High Channel subcarrier 12, carrier location 0 – 788.1-788.2 MHz



NB-IoT 15kHz High Channel subcarrier 12, carrier location 0 – 788.2-1000 MHz

8.4. OUT OF BAND EMISSIONS

TEST PROCEDURE

The RF output of the transmitter was connected to a spectrum analyzer through a calibrated coaxial cable. Sufficient scans were taken to show the out-of-band Emissions, if any, up to 10th harmonic. Multiple sweeps were recorded in maximum hold mode using a peak detector to ensure that the worst-case emissions were caught.

For each out of band emissions measurement 30MHz-10GHz:

- Set limit at -13 dBm
- Set RBW & VBW to 100 kHz for the measurement below 1 GHz, and 1 MHz for the measurement above 1 GHz. (NOTE: Worst case set RBW/VBW to 1MHz/3MHz)

For each out of band emissions measurement 1559-1610MHz

- Set limit at -40 dBm
- Set RBW/VBW to 1MHz/3MHz

RESULTS

3.75kHz and 15kHz carrier spacing with 1 subcarrier modes are tested and reported below.

LIMITS

FCC: §27.53 (f)
For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

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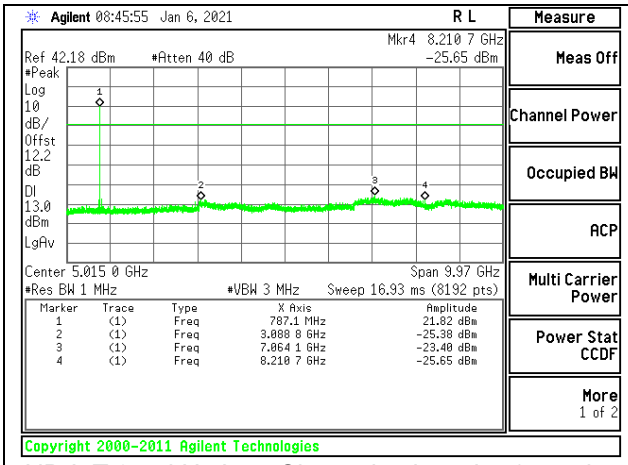
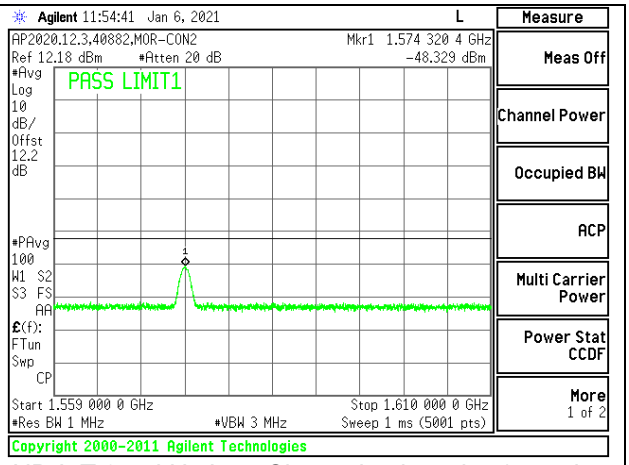
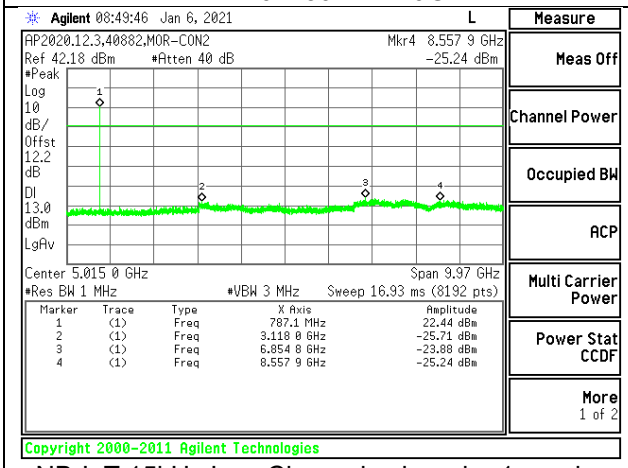


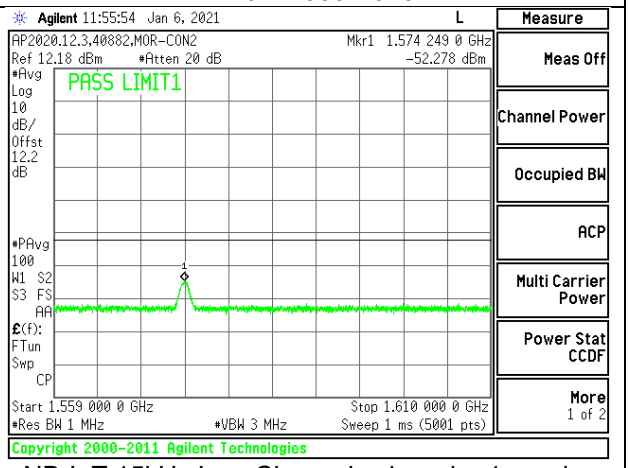
NB-IoT 3.75kHz Low Channel subcarrier 1, carrier location 0 – 30MHz-10GHz



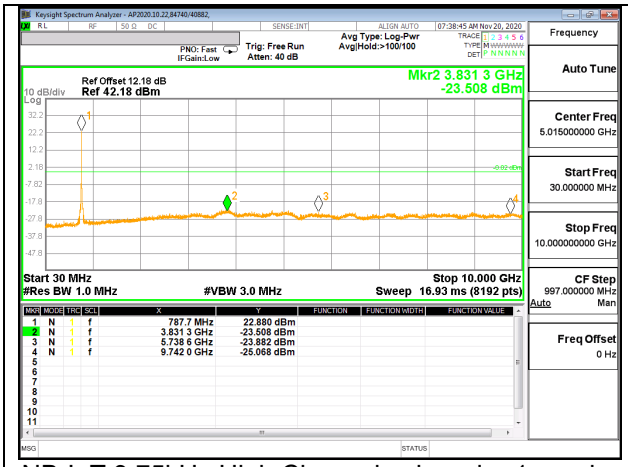
NB-IoT 3.75kHz Low Channel subcarrier 1, carrier location 0 – 1559-1610MHz



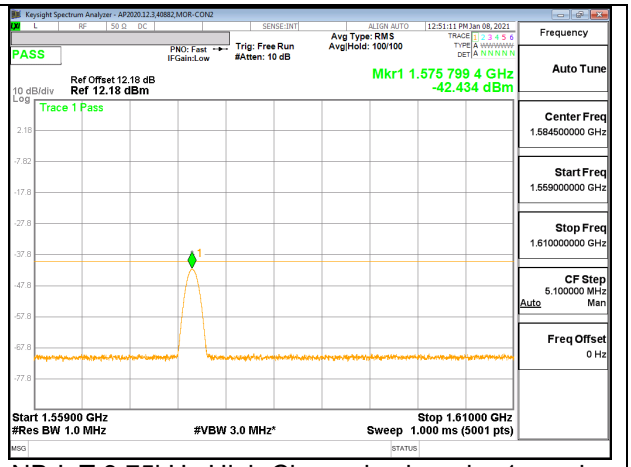
NB-IoT 15kHz Low Channel subcarrier 1, carrier location 5 – 30MHz-10GHz



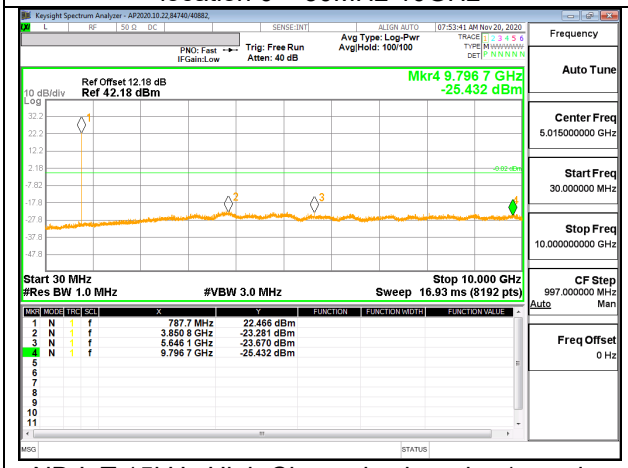
NB-IoT 15kHz Low Channel subcarrier 1, carrier location 5 – 1559-1610MHz



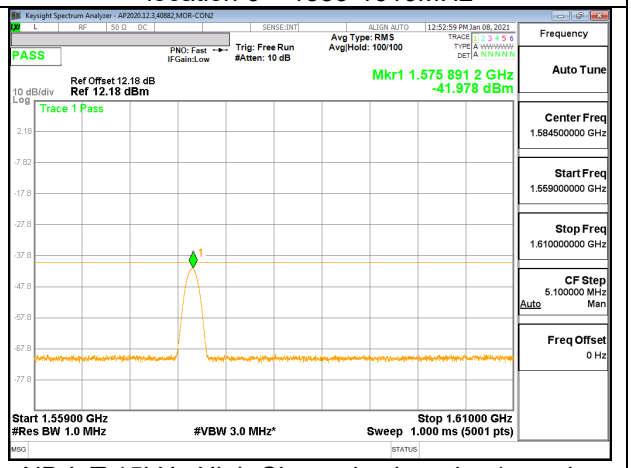
NB-IoT 3.75kHz High Channel subcarrier 1, carrier location 0 – 30MHz-10GHz



NB-IoT 3.75kHz High Channel subcarrier 1, carrier location 0 – 1559-1610MHz



NB-IoT 15kHz High Channel subcarrier 1, carrier location 5 – 30MHz-10GHz



NB-IoT 15kHz High Channel subcarrier 1, carrier location 5 – 1559-1610MHz

8.5. FREQUENCY STABILITY

TEST PROCEDURE

Use Anritsu MT8821c with Frequency Error measurement capability.

- Temp. = −30°C to +50°C
- Voltage = (85% - 115%)

  Low voltage, 3.23VDC, Normal, 3.8VDC and High voltage, 4.37VDC.

Frequency Stability vs Temperature:
The EUT is place inside a temperature chamber. The temperature is set to 20ºC and allowed to stabilize. After sufficient soak time, the transmitting frequency error is measured. The temperature is increased by 10 degrees, allowed to stabilize and soak, and then the measurement is repeated. This is repeated until +50ºC is reached.

Frequency Stability vs Voltage:
The peak frequency error is recorded (worst-case).

RESULTS

See the following pages.

LIMITS

FCC: §27.54
The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

Test Engineer ID:	40882	**Test Date:**	2020-11-20, 2021-01-08

Limit		**787.2**	**787.8**	**Delta (Hz) LOW**	**Delta (Hz) HIGH**	**Frequency Stability (ppm) LOW**	**Frequency Stability (ppm) HIGH**
Condition		**F low @ -13dBm (MHz)**	**F high @ -13dBm (MHz)**				
Temperature	**Voltage**						
Normal (20C)	Normal	787.199994	787.799997				
Extreme (50C)		787.199991	787.799994	3.00	2.76	0.002	0.001
Extreme (40C)		787.199993	787.800003	1.00	-6.09	0.001	-0.003
Extreme (30C)		787.199996	787.800005	-2.00	-7.64	-0.001	-0.004
Extreme (10C)		787.200004	787.800006	-10.00	-9.21	-0.005	-0.005
Extreme (0C)		787.200007	787.800004	-13.00	-6.76	-0.007	-0.004
Extreme (-10C)		787.200004	787.800003	-10.00	-6.55	-0.005	-0.003
Extreme (-20C)		787.200004	787.799995	-10.00	1.53	-0.005	0.001
Extreme (-30C)		787.199996	787.800008	-2.00	-10.79	-0.001	-0.006
20C	15%	787.199995	787.800005	-1.00	-8.26	-0.001	-0.004
	-15%	787.199994	787.800002	-0.30	-5.23	0.000	-0.003

9. RADIATED TEST RESULTS

9.1. FIELD STRENGTH OF SPURIOUS RADIATION, ABOVE 1GHz

TEST PROCEDURE

KDB 971168 D01 v03r01/D02 v02/r01 Field strength method

All tests above 1GHz were done with a Resolution Bandwidth of 1MHz, and a Video Bandwidth of 3MHz.

EIRP = E - 104.77dB + 20log(d)
At 3m EIRP = E - 95.2
Know
E = V + AF + G/L
Therefore,
EIRP = V + AF + G/L - 95.2 (@3m)
Know
V = W + 107
Therefore,
EIRP = ((W + 107) + AF + G/L) - 95.2 (@3m)
EIRP = W + AF + G/L + 11.8 (@3m)
Know
ERP = EIRP - 2.15 (@3m)
Therefore,
ERP = (W + AF + G/L + 11.8) - 2.15 (@3m)
ERP = W + AF + G/L - 9.65 (@3m)

Where
E = E-field strength in dB(uV/m).
EIRP = equivalent (or effective) isotropically radiated power in dBm. (= P + Gi. P in terms of dBm, Gi in terms of dBi.)
ERP = effective radiated power in dBm. (= P + Gd. P in terms of dBm, Gd in terms of dBd.)
V = voltage in dBuV measured by the spectrum analyzer.
W = power in dBm measured by the spectrum analyzer.
AF = antenna factor of measurement antenna in dB(/m).
G/L = Insertion-loss of cables, filters, and preamps between the measurement antenna and spectrum analyzer

RESULTS

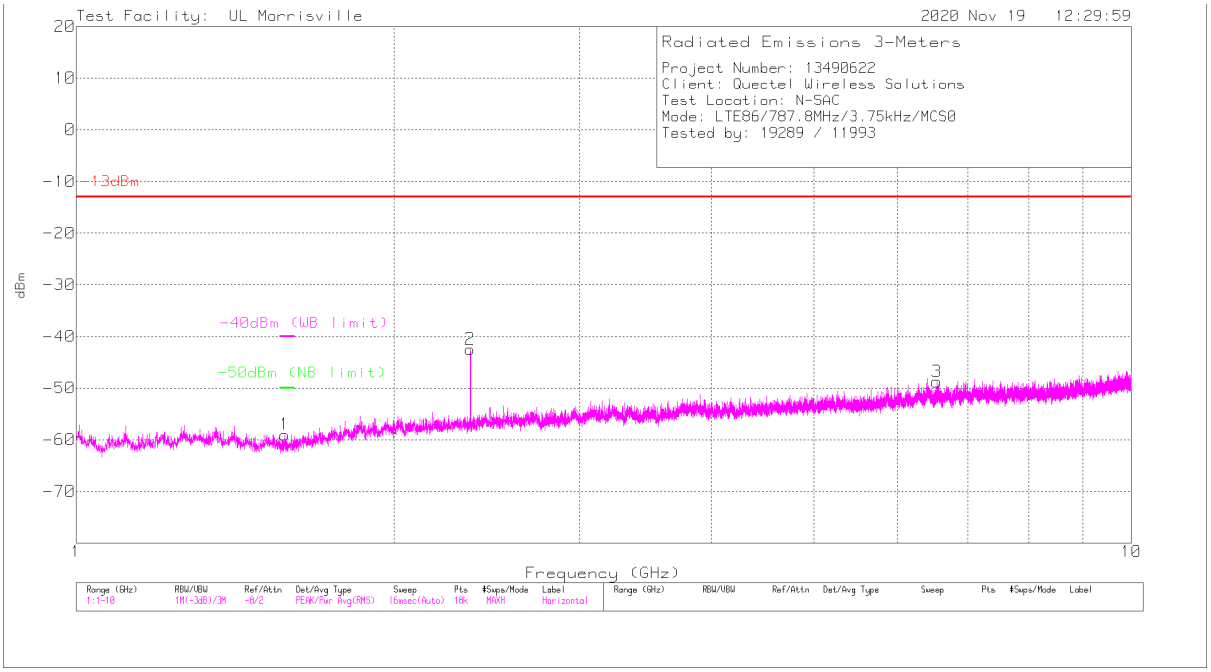
3.75kHz carrier spacing with 1 subcarrier high channel were tested and reported below.

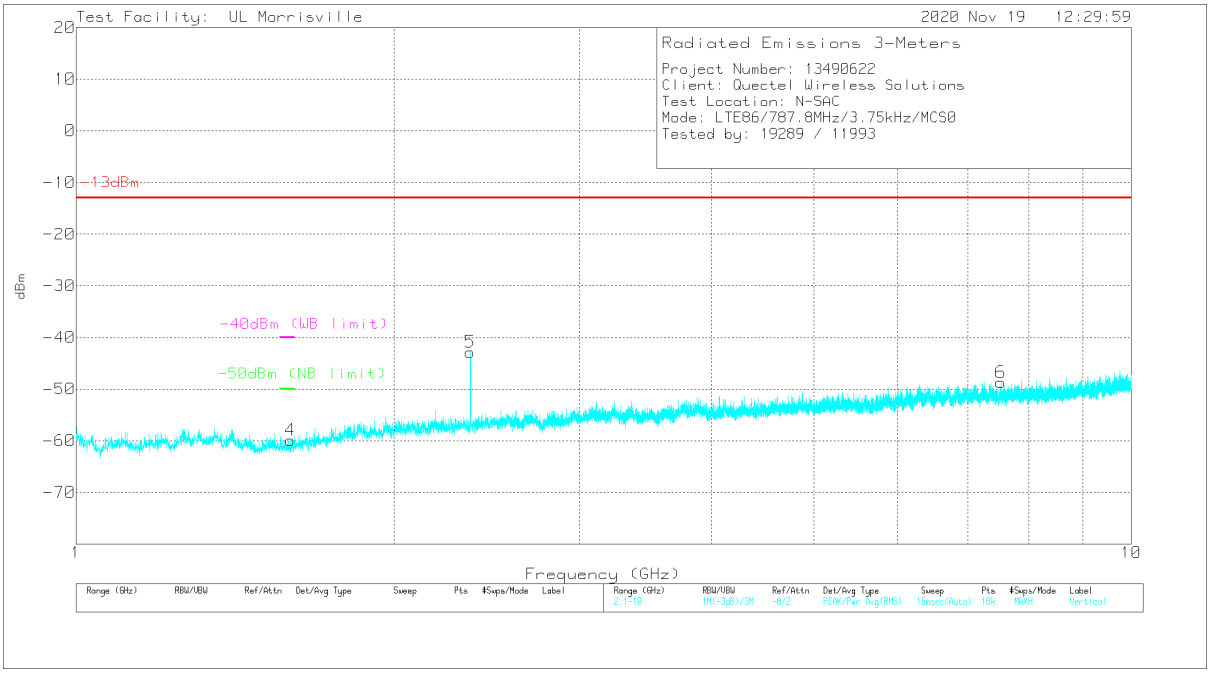
LIMITS

FCC: §27.53 (h)
The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

FCC: §27.53 (f)
For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

Project #:	13490622
Date:	2020-11-19
Test Engineer:	19289/11993
Configuration:	RF module (on evaluation board) with 1 external Tx antenna
Mode	787.8MHz/3.75kHz/MCS0/subcarrier 1/carrier location 0
Chamber #:	N-SAC





Marker	Frequency (GHz)	Meter Reading (dBm)	Det	AT0072 dB(/m)	Amp/Cbl/Fltr/Pad (dB)	Filter (dB)	CF (dB)	Corrected Reading (dBm)	Limit (dBm)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1 (*)	1.57597	-63.01	Pk	27.8	-36.2	.6	11.8	-59.01	-40	-19.01	0-360	200	H
2	2.36292	-51.76	Pk	31.7	-34.6	.4	11.8	-42.46	-13	-29.46	0-360	101	H
3	6.54069	-65.56	Pk	35.7	-31.3	.6	11.8	-48.76	-13	-35.76	0-360	200	H
4 (*)	1.59547	-64.1	Pk	27.8	-36	.6	11.8	-59.9	-40	-19.9	0-360	200	V
5	2.36292	-52.13	Pk	31.7	-34.6	.4	11.8	-42.83	-13	-29.83	0-360	300	V
6	7.52363	-67.1	Pk	35.7	-29.7	.6	11.8	-48.7	-13	-35.7	0-360	300	V

Pk - Peak detector
(*) = Wideband noise

9.2. FIELD STRENGTH OF SPURIOUS RADIATION, BELOW 1GHz

TEST PROCEDURE

KDB 971168 D01 v03r01/D02 v02/r01 Field strength method

All tests below 1GHz were done with a Resolution Bandwidth of 100kHz, and a Video Bandwidth of 300kHz.

EIRP = E - 104.77dB + 20log(d)
At 3m EIRP = E - 95.2
Know
E = V + AF + G/L
Therefore,
EIRP = V + AF + G/L - 95.2 (@3m)
Know
V = W + 107
Therefore,
EIRP = ((W + 107) + AF + G/L) - 95.2 (@3m)
EIRP = W + AF + G/L + 11.8 (@3m)
Know
ERP = EIRP - 2.15 (@3m)
Therefore,
ERP = (W + AF + G/L + 11.8) - 2.15 (@3m)
ERP = W + AF + G/L - 9.65 (@3m)

Where
E = E-field strength in dB(uV/m).
EIRP = equivalent (or effective) isotropically radiated power in dBm. (= P + Gi. P in terms of dBm, Gi in terms of dBi.)
ERP = effective radiated power in dBm. (= P + Gd. P in terms of dBm, Gd in terms of dBd.)
V = voltage in dBuV measured by the spectrum analyzer.
W = power in dBm measured by the spectrum analyzer.
AF = antenna factor of measurement antenna in dB(/m).
G/L = Insertion-loss of cables, filters, and preamps between the measurement antenna and spectrum analyzer

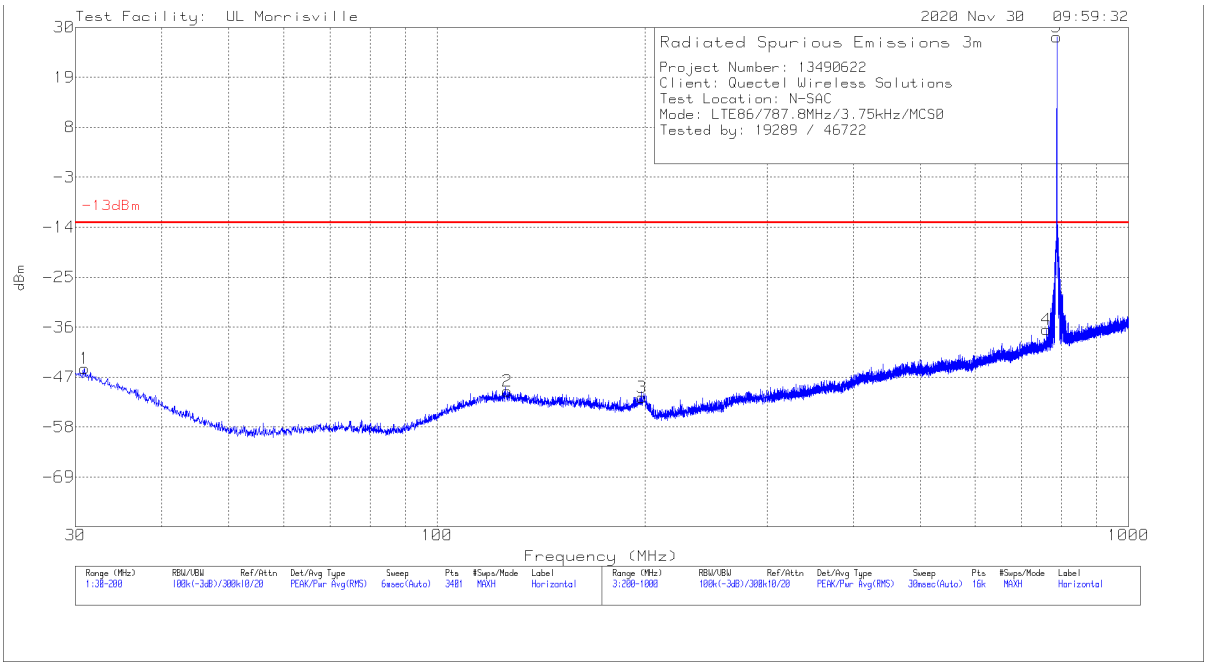
RESULTS

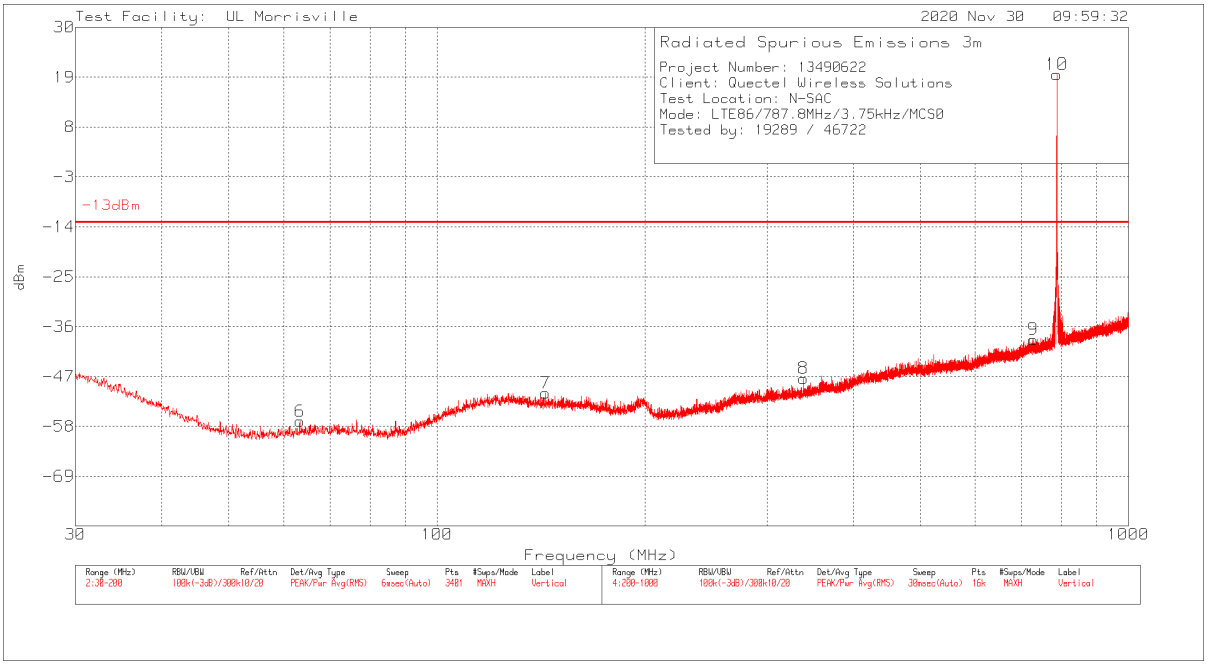
3.75kHz carrier spacing with 1 subcarrier high channel were tested and reported below.

LIMITS

FCC: §27.53 (h)
The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

Project #:	13490622
Date:	2020-11-30
Test Engineer:	19289/46722
Configuration:	RF module (on evaluation board) with 1 external Tx antenna
Mode	787.8MHz/3.75kHz/MCS0/subcarrier 1/carrier location 0
Chamber #:	N-SAC





Marker	Frequency (MHz)	Meter Reading (dBm)	Det	AT0074 (dB/m)	Amp/Cbl (dB)	Pad (dB)	Conversion Factor (dB)	Corrected Reading dBm	-13dBm	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	30.95	-71.96	Pk	26.3	-31.4	20.1	11.8	-45.16	-13	-32.16	0-360	300	H
2	126.45	-72.02	Pk	20	-30	20.1	11.8	-50.12	-13	-37.12	0-360	99	H
3	197.9	-72.97	Pk	18.9	-29.3	20.1	11.8	-51.47	-13	-38.47	0-360	200	H
4	723.85	-70.53	Pk	26.6	-25.8	20.1	11.8	-37.83	-13	-24.83	0-360	300	H
5 (UL)	787.7	-5.81	Pk	27.2	-25.4	20.1	11.8	27.89	-	-	0-360	99	H
6	63.35	-71.78	Pk	13.8	-30.8	20.1	11.8	-56.88	-13	-43.88	0-360	100	V
7	143.6	-71.51	Pk	18.8	-29.8	20.1	11.8	-50.61	-13	-37.61	0-360	100	V
8	339.1	-71.41	Pk	20.1	-28	20.1	11.8	-47.41	-13	-34.41	0-360	300	V
9	727.875	-71.84	Pk	26.7	-25.6	20.1	11.8	-38.84	-13	-25.84	0-360	99	V
10 (UL)	787.7	-14.09	Pk	27.2	-25.4	20.1	11.8	19.61	-	-	0-360	99	V

Pk - Peak detector

9.3. FIELD STRENGTH OF SPURIOUS RADIATION, BELOW 30MHz

TEST PROCEDURE

KDB 971168 D01 v03r01/D02 v02/r01 Field strength method

EIRP = E - 104.77dB + 20log(d)
At 3m EIRP = E - 95.2
Know
E = V + AF + G/L
Therefore,
EIRP = V + AF + G/L - 95.2 (@3m)
Know
V = W + 107
Therefore,
EIRP = ((W + 107) + AF + G/L) - 95.2 (@3m)
EIRP = W + AF + G/L + 11.8 (@3m)
Know
ERP = EIRP - 2.15 (@3m)
Therefore,
ERP = (W + AF + G/L + 11.8) - 2.15 (@3m)
ERP = W + AF + G/L - 9.65 (@3m)

Where
E = E-field strength in dB(uV/m).
EIRP = equivalent (or effective) isotropically radiated power in dBm. (= P + Gi. P in terms of dBm, Gi in terms of dBi.)
ERP = effective radiated power in dBm. (= P + Gd. P in terms of dBm, Gd in terms of dBd.)
V = voltage in dBuV measured by the spectrum analyzer.
W = power in dBm measured by the spectrum analyzer.
AF = antenna factor of measurement antenna in dB(/m).
G/L = Insertion-loss of cables, filters, and preamps between the measurement antenna and spectrum analyzer

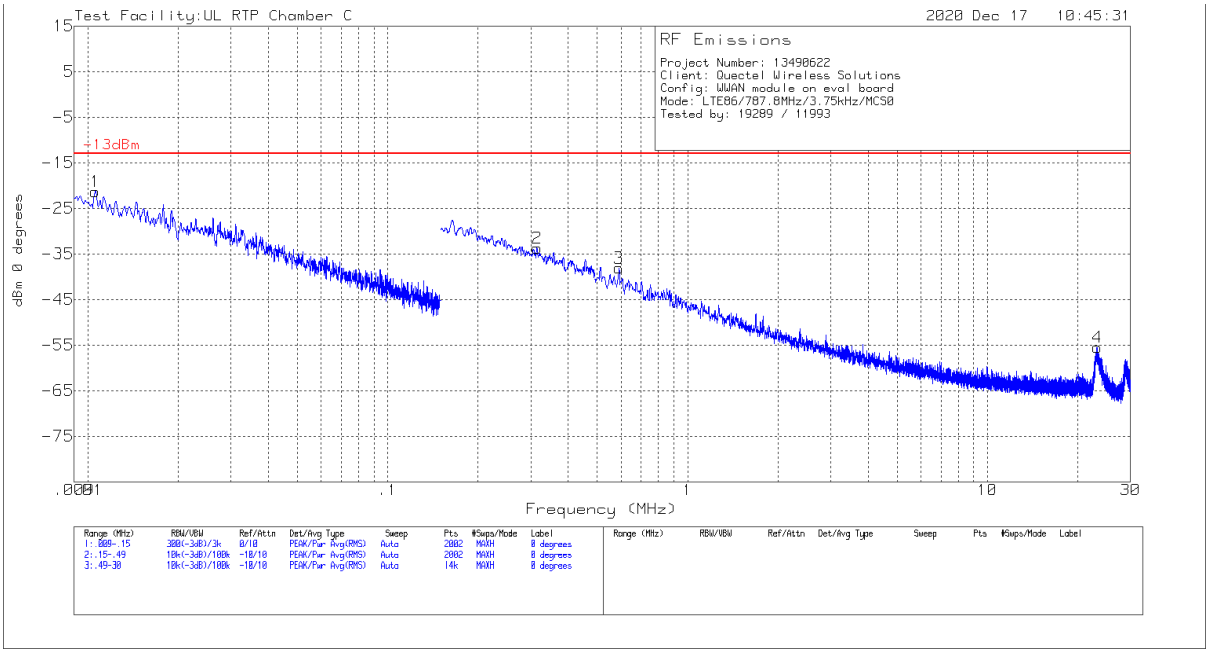
RESULTS

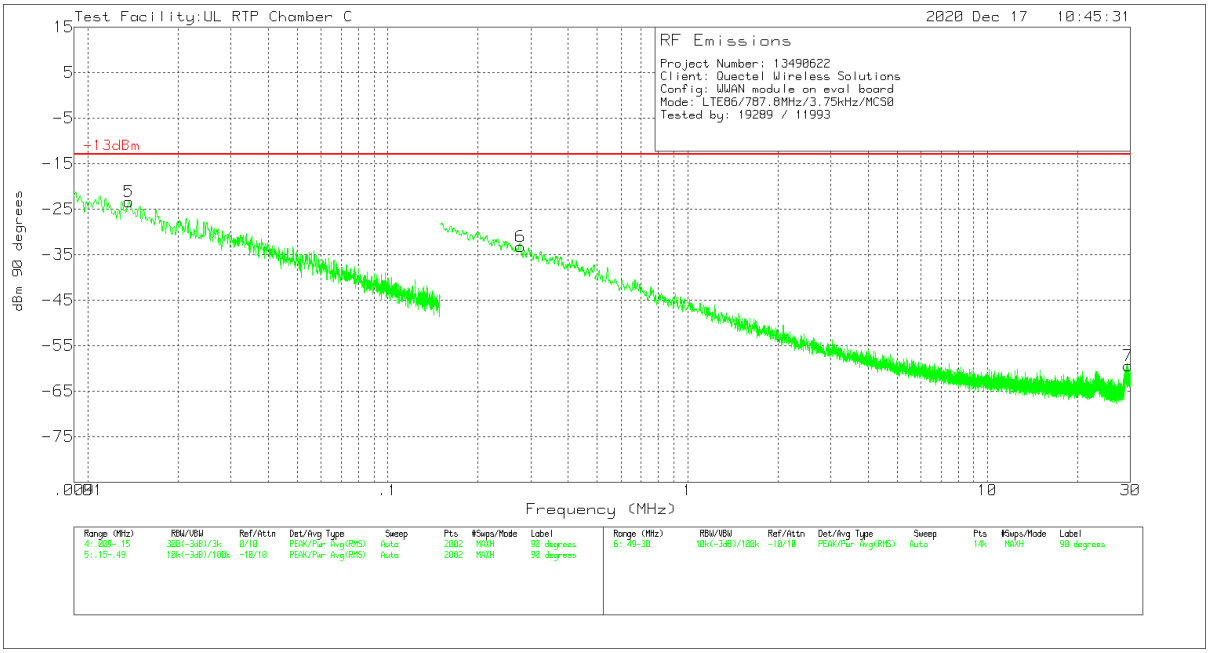
3.75kHz carrier spacing with 1 subcarrier high channel was tested and reported below.

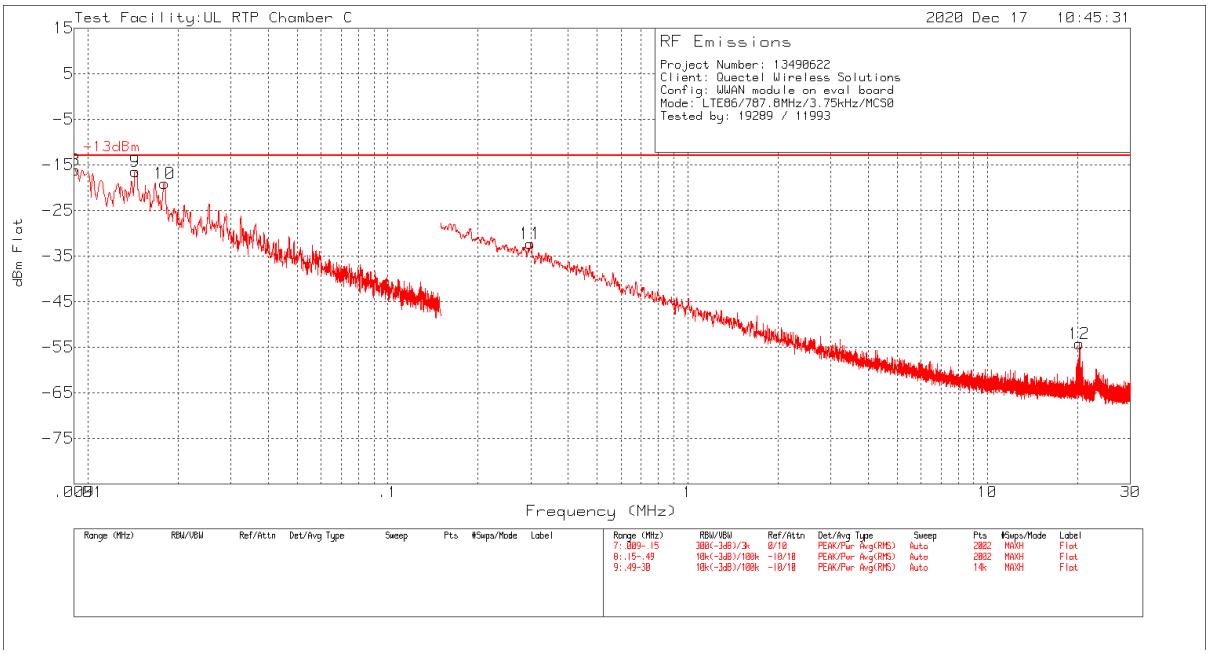
LIMITS

FCC: §27.53 (h)
The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

Project #:	13490622
Date:	2020-12-17
Test Engineer:	19289/11993
Configuration:	RF module (on evaluation board) with 1 external Tx antenna
Mode	787.8MHz/3.75kHz/MCS0/subcarrier 1/carrier location 0
Chamber #:	A







Marker	Frequency (MHz)	Meter Reading (dBm)	Det	AT0079 (dB/m)	cbl (dB)	Conversion Factor (dB)	Corrected Reading dBm	-13dBm	PK Margin (dB)	Azimuth (Degs)
0 degrees										
1	.01058	-59.2	Pk	17.7	.1	20.1	-21.3	-13	-8.3	0-360
2	.31431	-64.62	Pk	10.7	.1	20.1	-33.72	-13	-20.72	0-360
3	.59118	-69.24	Pk	10.8	.2	20.1	-38.14	-13	-25.14	0-360
4	23.27221	-86.04	Pk	9.4	1	20.1	-55.54	-13	-42.54	0-360
90 degrees										
5	.01369	-59.96	Pk	16.4	.1	20.1	-23.36	-13	-10.36	0-360
6	.27767	-64.18	Pk	10.7	.1	20.1	-33.28	-13	-20.28	0-360
7	29.48976	-88.68	Pk	8	1.1	20.1	-59.48	-13	-46.48	0-360
Flat										
8	.00907	-55.17	Pk	18.8	.1	20.1	-16.17	-13	-3.17	0-360
9	.01439	-52.81	Pk	16.1	.1	20.1	-16.51	-13	-3.51	0-360
10	.01803	-53.84	Pk	14.5	.1	20.1	-19.14	-13	-6.14	0-360
11	.29926	-63.21	Pk	10.7	.1	20.1	-32.31	-13	-19.31	0-360
12	20.26726	-85.17	Pk	9.9	.9	20.1	-54.27	-13	-41.27	0-360

Pk - Peak detector

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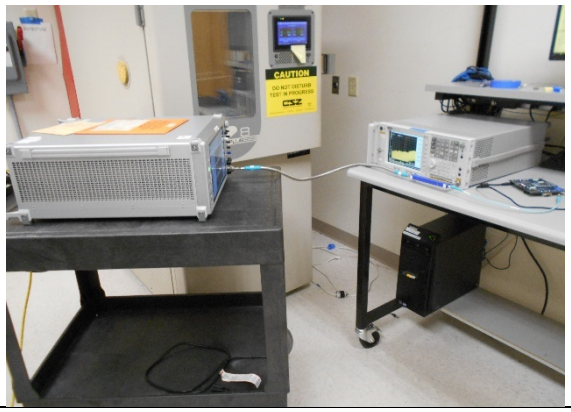
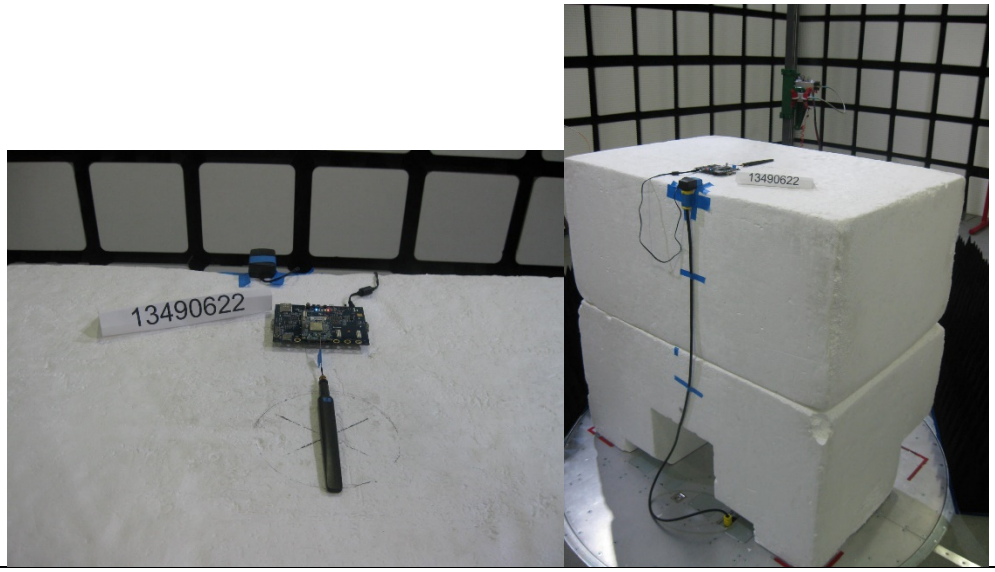
10. SETUP PHOTOS

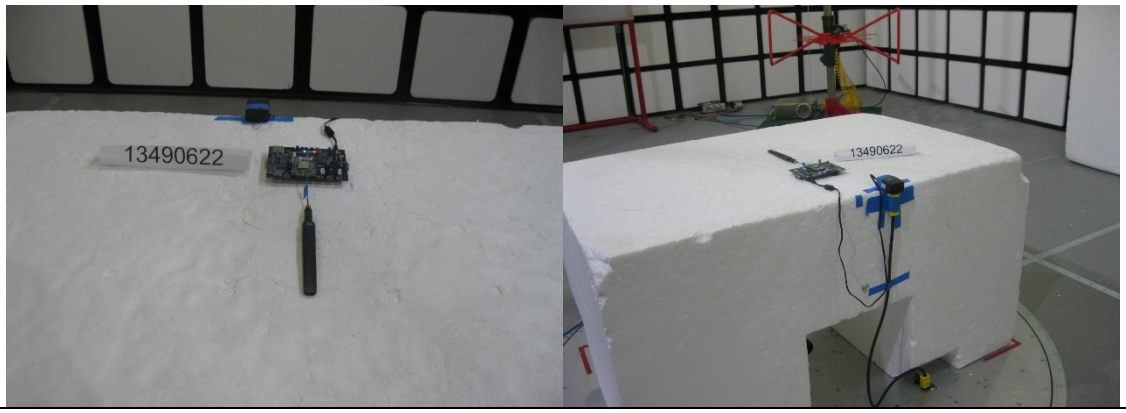
ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP

FRONT PHOTO
FREQUENCY TOLERANCE OVER EXTREME CONDITIONS
 
FRONT PHOTO

RADIATED RF MEASUREMENT SETUP FOR ABOVE 1GHZ



FRONT AND BACK PHOTO

RADIATED RF MEASUREMENT SETUP FOR BELOW 1GHZ



FRONT AND BACK PHOTO

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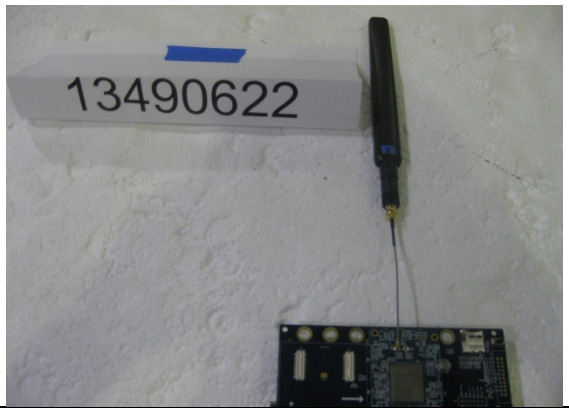
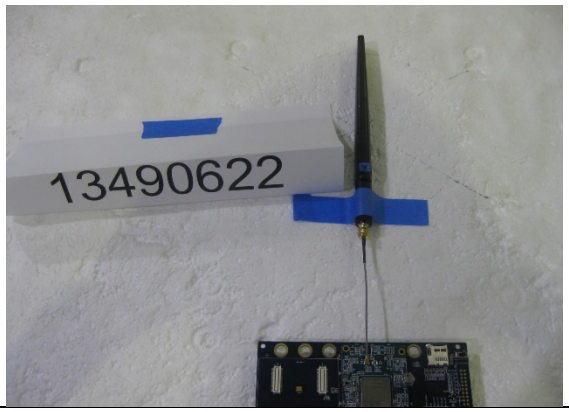
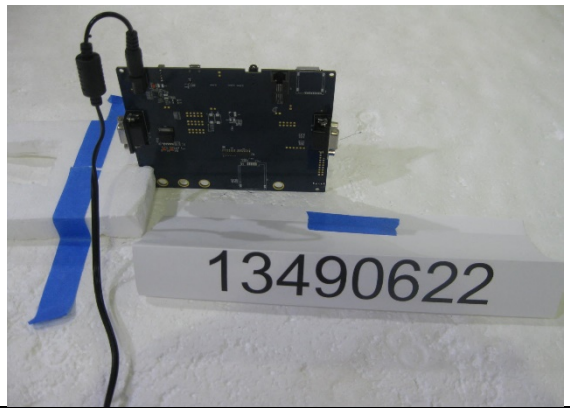
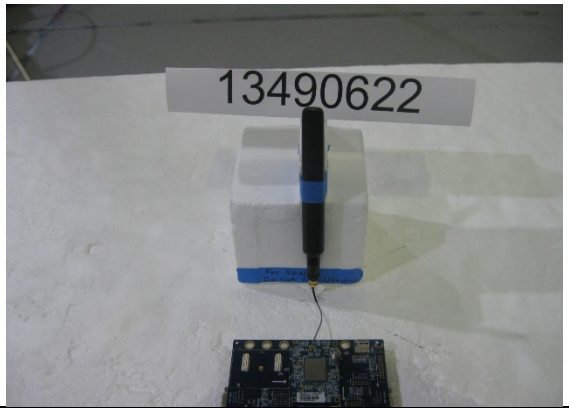
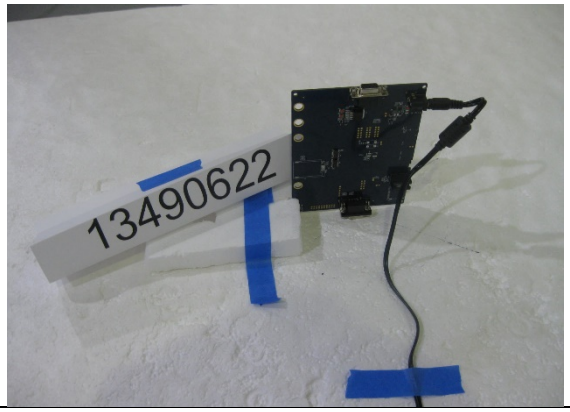
RADIATED RF MEASUREMENT SETUP FOR PORTABLE CONFIGURATION	
	
X-AXIS ANTENNA PHOTO	X-AXIS BOARD PHOTO
	
Y-AXIS ANTENNA PHOTO	Y-AXIS BOARD PHOTO
	
Z-AXIS ANTENNA PHOTO	Z-AXIS BOARD PHOTO

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END OF REPORT

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