Radio Test Report
Application for a Class II Permissive Change Equipment Authorization

FCC Part 27 Subpart C
729MHz – 745MHz
FCC Part 90 Subpart R
[758MHz – 768MHz]

CERTIFICATE #: 0214.19

FCC ID: VBNAHLBA-01

Product Name: Airscale Base Transceiver Station Remote Radio Head
Model: AHLBA

Applicant: Nokia Solutions and Networks
6000 Connection Drive
Irving, TX 75039

Test Sites: Nokia Solutions and Networks
6000 Connection Drive
Irving, TX 75039
and
National Technical Systems – Plano
1701 E Plano Pkwy #150
Plano, TX 75074
NTS Plano FCC Laboratory Designation No.: US1077
NTS Plano ISED Laboratory Assigned Code: 4319A

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Prepared By:

BreAnna Cheatham
Technical Writer

Approved By:

Kimberly Zavala
Quality Assurance

Reviewed By:

Alex Mathews
EMI Project Manager

REVISION HISTORY

Rev#	Date	Comments	Modified By
0	03/08/2019	Initial Draft	BreAnna Cheatham

TABLE OF CONTENTS

SCOPE

Tests have been performed on Nokia Solutions and Networks product Airscale Base Station Remote Radio Head (RRH) Model AHLBA, pursuant to the relevant requirements of the following standard(s) to obtain device certification against the regulatory requirements of the Federal Communications Commission (FCC).

- Code of Federal Regulations (CFR) Title 47 Part 2
- CFR Title 47 Part 27 Subpart C
- CFR Title 47 Part 90 Subpart R

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards:

ANSI C63.26-2015
ANSI C63.4-2014
ANSI TIA-603-E
FCC KDB 971168 D01 v03r01
FCC KDB 971168 D03 v01
FCC KDB 662911D01 v02r01
TIA-102.CAAA-D

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC requirements.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of Nokia Solutions and Networks product Airscale Base Station Remote Radio Head (RRH) Model AHLBA and therefore apply only to the tested sample. The sample was selected and prepared by Hobert Smith and John Rattanavong of Nokia Solutions and Networks.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, the device requires certification.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

Testing was performed only on Model AHLBA. No additional models were described or supplied for testing.

STATEMENT OF COMPLIANCE

The tested sample of Nokia Solutions and Networks product Airscale Base Transceiver Station Remote Radio Head (RRH) Model AHLBA complied with the requirements of the standards and frequency bands declared in the scope of this test report.

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

The following tables provide a summary of the test results:

FCC Part 27 Subpart C (Base Stations Operating in the 729 to 745MHz Band)

AHLBA operating in 729MHz to 745MHz Frequency Band- LTE plus single Narrow Band IoT Guard Band carrier				
FCC	Description	Measured	Limit	Results
Transmitter Modulation, output power and other characteristics				
§27.5	Frequency Ranges	LTE10: 734.0 – 740.0MHz	729.0MHz to 745.0MHz	Pass
§2.1033(c)(4)	Modulation Type	NB IoT Guard band (QPSK) with LTE10	Digital	Pass
§27.50	Output Power	Highest Conducted Power Output RMS: 49.05 dBm ERP depends on antenna gain which is unknown	1000W ERP	Pass
Informational	Peak to Average Power Ratio	Highest Measured PAPR: 6.93 dB	13dB	Pass
§2.1049	99% Emission Bandwidth	LTE10: 9.2443MHz	Remain in Block	Pass
	26dB down Emission Bandwidth	LTE10: 9.817MHz Emission Designator: 9M82F9W	Remain in Block	Pass
Transmitter Spurious Emissions[1]				
§27.53(g)	At the antenna terminals	< -19dBm	-19dBm per Transmit Chain	Pass[1]
	Field Strength	40.496dBuV/m at 3m Eq. to -54.704dBm EIRP	-13dBm EIRP	Pass[2]
Other Details				
§27.54	Frequency Stability	Stays within authorized frequency block 0.001ppm	Stays within block	Pass[2]
§1.1310	RF Exposure	N/A		Pass[3]

Note 1: Based on 100kHz RBW. In the 100kHz immediately outside and adjacent to the frequency block a RBW of 30kHz was used. The measurement bandwidth is 100kHz for measurements more than 100kHz from the band edge. See Section 27.53(g) for details.
Note 2: See the original FCC radio certification report for details (NTS Test Report Number PR078121 Revision 0 dated May 4, 2018).
Note 3: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

FCC Part 90 Subpart R (Base Stations Operating in the 758 to 768MHz Band)

AHLBA operating in the 758MHz to 768MHz Frequency Band- LTE plus single Narrow Band IoT Guard Band carrier				
FCC	Description	Measured	Limit	Results
Transmitter Modulation, output power and other characteristics				
90.531	Frequency Ranges	LTE10: 763.0MHz	758.0 – 768.0MHz	Pass
90.535	Modulation Type	NB IoT Guard band (QPSK) with LTE10	Digital	Pass
90.542	Output Power	Highest Conducted Power Output RMS: 49.08dBm ERP depends on antenna gain which is unknown	1000W ERP	Pass
	Peak to Average Power Ratio	Highest Measured PAPR: 7.43dB	13dB	Pass
2.1049	99% Emission Bandwidth	LTE10: 9.2358MHz	Remain in Block	Pass
	26dB down Emission Bandwidth	LTE10: 9.825MHz Emission Designator: 9M83F9W	Remain in Block	Pass
Transmitter Spurious Emissions				
90.543(e)	At the antenna terminals	< -19dBm	-19dBm per Transmit Chain	Pass[1]
	Field strength	43.53dBuV/m at 3m Eq. to -51.67dBm ERP	-13 dBm ERP	Pass[2]
90.543(e)(1)	At the Ant terminals: Maximum emissions in 769-775 MHz and 799- 805MHz bands	Conducted emissions were less than -58.959dBm for RBW of 6.25kHz	-52dBm per 6.25kHz bandwidth	Pass[3]
90.543(f)	At the Ant terminals: Maximum emissions in 1559-1610MHz band	Conducted emissions were not observed above measurement instrumentation noise floor or less than -109.568dBW/MHz	EIRP≤ Wideband: -76dBW/MHz Discrete: -86dBW/MHz	Pass[4]
Other Details				
90.539	Frequency Stability	Stays within authorized frequency block 0.001ppm	1ppm	Pass[2]
1.1310	RF Exposure	N/A		Pass[5]

Note 1: Based on 100kHz RBW. In the 100kHz immediately outside and adjacent to the frequency block a RBW of 30kHz was used. The measurement bandwidth is 100kHz for measurements more than 100kHz from the band edge. See Section 90.543(e) for details.
Note 2: See the original FCC radio certification report for details (NTS Test Report Number PR078121 Revision 0 dated May 4, 2018).
Note 3: Section 90.543(e)(1) requires an emission limit of -46dBm for any 6.25 kHz bandwidth between frequency bands 769-775 MHz and 799-805MHz. Adjusting for the four port MIMO requirement the emission limit in these frequency ranges is -52 dBm [i.e.: Limit = -46 dBm/6.25kHz (FCC Limit) – 6dB (4 port MIMO)].
Note 4: Section 90.543(f), the EIRP limit for the frequency range 1559-1610 MHz is -70dBW/MHz for wideband signals and -80dBW for discrete emissions of bandwidths less than 700Hz. Adjusting for the four port MIMO requirement, the limit is -76 dBW [-70 dBW -10 log (4)] for wideband signals and -86dBW [-80 dBW -10 log (4)] for discrete emissions.
Note 5: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

Extreme Conditions

Frequency stability is determined over extremes of temperature and voltage.

The extremes of voltage were 85 to 115 percent of the nominal value.

The extremes of temperature were -30°C to +50°C as specified in FCC §2.1055(a)(1).

Measurement Uncertainties

Measurement uncertainties of the test facility based on a 95% confidence level are as follows:

Test	Uncertainty
Radio frequency	± 0.2ppm
RF power conducted	±1.2 dB
RF power radiated	±3.3 dB
RF power density conducted	±1.2 dB
Spurious emissions conducted	±1.2 dB
Adjacent channel power	±0.4 dB
Spurious emissions radiated	±4 dB
Temperature	±1°C
Humidity	±1.6 %
Voltage (DC)	±0.2 %
Voltage (AC)	±0.3 %

EQUIPMENT UNDER TEST (EUT) DETAILS

General

A class II permissive change on the original filing is being pursued to add single Narrow Band IoT Guard Band (NB IoT GB here after) LTE carrier to the Airscale BTS RRH model AHLBA Federal Communication Commission certifications. The original FCC radio certification submittal was NTS Test Report Number PR078121 Revision 0 dated May 4, 2018. The original test effort includes testing for LTE technologies. Please refer to the test report on the original certification for details on all required testing.

All conducted RF testing performed for the original certification testing has been repeated using NB IoT GB for this class II permissive change per correspondence/guidance from Nemko TCB. The same test methodology used in the original certification testing was used in this class II permissive change test effort. NB IoT guard band offsets from the LTE 10 carrier center frequency was $\pm$ 4597.5kHz. Tests performed under the class II change effort include RF power, peak to average power ratio, emission bandwidth (99% and 26 dB down), band edge spurious emissions, and conducted spurious emissions. The LTE modulation type for this testing was setup according to 3GPP TS 36.141 E-UTRA Test Models and is “E-TM 1.1 (QPSK modulation type) with N-TM (narrow band IoT)”.

The testing was performed on the same hardware (AHLBA) as the original certification test. The same AHLBA RF port (Ant 1) determined in the original certification testing to be the highest power port was used for all testing in this effort. The base station and remote radio head software for this testing is an updated release that includes Narrow Band IoT Guard Band support.

The radiated emissions and frequency stability measurements performed in the original certification was not repeated under this effort per TCB guidance. The radiated emission and frequency stability/accuracy results from the original certification had enough margin to preclude requiring additional testing. The same frequency stability/accuracy radio design is the same for all radio technologies/modulation types.

The equipment under test (EUT) is a Nokia Solutions and Networks Airscale Base Transceiver Station (BTS) Remote Radio Head (RRH) module, model AHLBA. The AHLBA remote radio head is a multistandard multicarrier radio module designed to support LTE, and narrow band IoT (internet of things) operations (in-band, guard band, standalone). The scope of testing in this effort is for narrow band IoT guard band operations.

The AHLBA RRH has four transmit/four receive antenna ports (4TX/4RX for Band 12 and 4TX/4RX for Band 14). Each antenna port supports 3GPP frequency band 12 (BTS Rx: 699 to 715 MHz/BTS TX: 729 to 745 MHz) and 3GPP frequency band 14 (BTS Rx: 788 to 798 MHz/BTS TX: 758 to 768 MHz). The maximum RF output power of the RRH is 320 Watts (80 watts per antenna port and 80 watts per carrier). The RRH can be operated as a 4x4 MIMO, 2x2 MIMO or as non-MIMO. The TX and RX instantaneous bandwidth cover the full operational bandwidth. The RRH supports LTE bandwidths of 5 and 10 MHz for both frequency bands. The RRH supports four LTE downlink modulation types (QPSK, 16QAM, 64QAM and 256QAM). Multi-carrier operation is supported.

The RRH has external interfaces including DC power (DC In), ground, transmit/receive (ANT), external alarm (EAC), optical CPRI (OPT) and remote electrical tilt (RET). The RRH with applicable installation kit may be pole or wall mounted. The RRH may be configured with optional cooling fan.

The AHLBA LTE channel numbers and frequencies are as follows:

(1)	Downlink EARFCN	Downlink Frequency (MHz)	LTE Channel Bandwidth	
			5 MHz	10 MHz
Band 12 (Ant 1, 2, 3, 4)	5010	729.0	Band Edge	Band Edge
	……			
	5035	731.5	Bottom Ch	
	……			
	5060	734.0		Bottom Ch
	……			
	5090	737.0	Middle Ch	Middle Ch
	……			
	5120	740.0		Top Channel
	……			
	5145	742.5	Top Channel	
	……			
	5170	745	Band Edge	Band Edge

AHLBA Downlink Band Edge LTE Band 12 Frequency Channels

Notes:

(1) Single Narrow Band IoT Guard Band operations are supported on the LTE10 channel bandwidths only.
(2) Multicarrier operations using LTE10 channel bandwidths (in Band 12) are not available since the downlink frequency band is 16MHz.
(3) Multiband (Band 12 and Band 14) multicarrier testing was performed.

	Downlink EARFCN	Downlink Frequency (MHz)	LTE Channel Bandwidth	
			5 MHz	10 MHz
Band 14 (Ant 1, 2, 3, 4)	5280	758.0	Band Edge	Band Edge
	……			
	5305	760.5	Bottom Ch	
	……			
	5330	763.0	Middle Ch	Bottom Ch Middle Ch Top Channel
	……			
	5355	765.5	Top Channel	
	……			
	5380	768.0	Band Edge	Band Edge

AHLBA Downlink Band edge LTE Band 14 Frequency Channels

Notes:

(1) Single Narrow Band IoT Guard Band operations are supported on the LTE10 channel bandwidths only.
(2) Multicarrier operations (in Band 14) using LTE10 channel bandwidths are not available since the downlink frequency band is 10MHz.
(3) Multiband (Band 12 and Band 14) multicarrier testing was performed.

EUT Hardware

The EUT hardware used in testing on February 26, 2019.

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	AHLBA	AirScale BTS RRH	Part#: 474240A.101 Serial#: K9180844519	FCC ID: VBNAHLBA-01

Enclosure

The EUT enclosure is made of heavy duty aluminum.

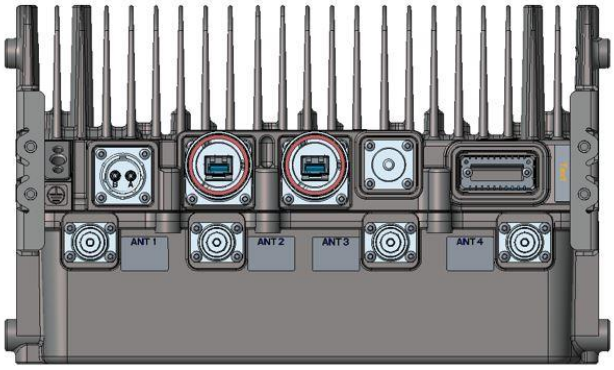
Support Equipment

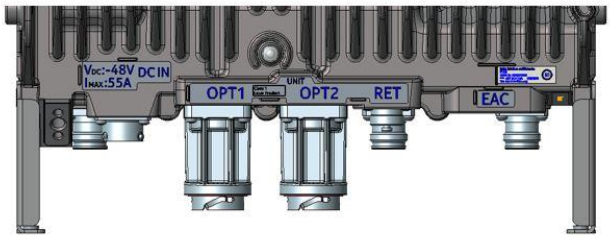
Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	AMIA	Airscale System Module	Part#: 473098A.101 Serial#: RK164201509	N/A
Dell	Studio XPS	Instrumentation PC	N/A	N/A

Auxillary Equipment

Company	Description	Part Number	Serial Number
Nokia	FOUC 10GHz SFP Module (Plugs into RRH Opt Ports)	473842A.101	KR16090020071
Microwave Circuits	1.1GHz High Pass Filter -100W[1]	H1G206G1	2454-01
Creowave Filters	Band 12 Carrier Blocking Filter[1]	CW-DPF-729-745-E1-M2	901001
Creowave Filters	Band 14 Carrier Blocking Filter[1]	CW-DPF-758-768-E5-M2	1001001
Weinschel	Attenuator 40dB-250 Watt[1]	58-40-43-LIM	TC909
Weinschel	Attenuator 10dB-250 Watt[1]	58-10-43-LIM	TD446
Weinschel	Termination-10 Watt[1]	M1418	BJ165-1
Weinschel	Termination-10 Watt[1]	M1418	BJ1657
Huber & Suhner	RF Cable – 0.5 meter[1]	Sucoflex 104	553624/4
Huber & Suhner	RF Cable – 1 meter[1]	Sucoflex 104	551123/4
Huber & Suhner	RF Cable - 1 meter[1]	Sucoflex 106	297370
Note 1: Used only in antenna port RF conducted emission testing.			

AHLBA Connector Layout:





EUT External Interfaces:

Name	Qty	Connector Type	Purpose (and Description)
DC In	1	Quick Disconnect	2-pole Power Circular Connector
GND	1	Screw lug (2xM5/1xM8)	Ground
ANT	4	4.3-10	RF signal for Transmitter/Receiver (50 Ohm)
Unit	1	LED	Unit Status LED
EAC	1	MDR26	External Alarm Interface (4 alarms)
OPT	2	SFP+ cage	Optical CPRI Interface up to 10 Gps.
RET	1	8-pin circular connector conforming to IEC 60130-9 – Ed.3.0	AISG 2.0 to external devices
Fan	1	Molex Microfit	Power for RRH Fan. Located on the side of RRH.

EUT Interface Ports

The I/O cabling configuration during testing was as follows:

Cable	Type	Shield	Length	Used in Test	Quantity	Termination
Power Input	Power	No	~ 3 m	Yes	1	Power Supply
Earth	Earth	No	~ 1 m	Yes	1	Lab earth ground
Antenna	RF	Yes	~ 3 m	Yes	4	50Ω Loads
External Alarm	Signal	Yes	~ 3 m	Yes	1	Un-terminated
Remote Electrical Tilt	Signal	Yes	~ 3 m	Yes	1	Un-terminated
Multimode Optical	Optical	No	>6 m	Yes	1	System Module

EUT Operation

During testing, the EUT was transmitting continuously with 100% duty-cycle at full power on all chains.

EUT Software

The laptop PC connects to the System Module over the LMP (Ethernet) port. The system module controls the RRH via the optical (CPRI) interface. The laptop is used for changing configuration settings, monitoring tests and controlling the BTS. The following software versions are used for the testing:

(1) RRH Unit Software: FRM58.11.R27I
(2) System Module Software: FL18A_ENB_0000_020112_000000
(3) BTS Site Manager: BTSSiteEM-FL18A_0000_000599_000000

Modifications

No modifications were made to the EUT during testing.

TESTING

General Information

Antenna port measurements were taken with NTS personnel (Alex Mathews) at Nokia premises located at 6000 Connection Drive; Irving, Texas 75309.

Radiated emissions and frequency accuracy/stability measurements were taken at NTS Plano branch located at 1701 E Plano Pkwy #150 Plano, TX 75074 during the original certification effort (NTS Test Report Number PR078121 Revision 0 dated May 4, 2018 for details).

Measurement Procedures

The RMS average output power, emission bandwidth, conducted spurious and conducted band edge measurements were performed with a spectrum analyzer. The carrier frequency accuracy/stability and complementary cumulative distribution function (CCDF) measurements were performed with an LTE signal analyzer. The EUT was operated at maximum RF output power for all tests. While measuring one transmit chain, the others were terminated with termination blocks. All measurements were corrected for the insertion loss of the RF network (attenuators, filters, and cables) inserted between the RF port of the EUT and the spectrum analyzer/signal analyzer. Block diagrams and photographs of the test setups are provided below.

The 26dB emission bandwidth was measured in accordance with Section 4.1 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.4. The 99% occupied bandwidth was measured in accordance with Section 6.7 of RSS-Gen Issue 5. For both measurements, an occupied bandwidth built-in function in the spectrum analyzer was used and Keysight Benchvue Software was used to capture the spectrum analyzer screenshots. Spectrum analyzer settings are shown on their corresponding plots in test results section.

The emissions at the band edges were captured with Keysight Benchvue Software with settings described in the corresponding sections of the FCC and IC regulatory requirements. Spectrum analyzer settings are shown on their corresponding plots in test results section.

Average output power measurements were performed in accordance with sections 5.4 of FCC KDB 971168 D01v03r01 and ANSI C63.26. Measurements were performed with the built-in channel power function found in the spectrum analyzer and the screenshots were captured using Keysight Benchvue Software. Peak to average power ratio (PAPR) was measured in accordance with Section 5.7.2 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.2.3.4. Signal Analyzer CCDF screenshots were captured using Keysight Benchvue Software. Analyzer settings are shown on their corresponding plots in test results section.

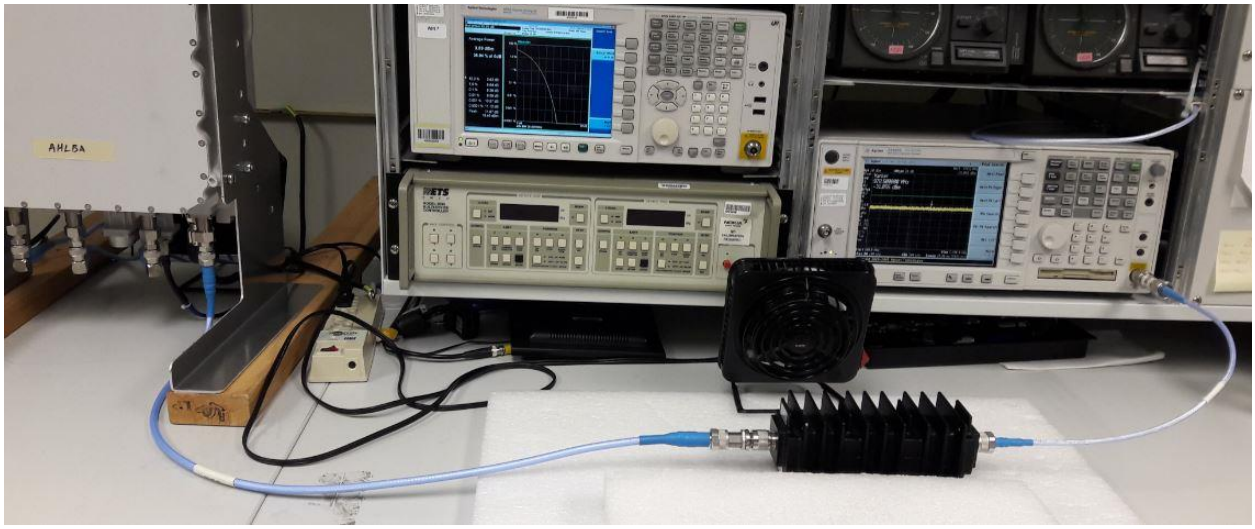
Conducted spurious emissions were captured with Keysight Benchvue Software across the 9kHz-8GHz frequency span. A high pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges above 1.1GHz. The total measurement RF path loss of the test setup (attenuators, high pass filter and test cables) were accounted for by the spectrum analyzer reference level offset. Spectrum analyzer settings are described in the corresponding test result section.

Measurement of conducted spurious emissions in the 769MHz to 775MHz and 799MHz to 805MHz frequency ranges required Band 12 and Band 14 carrier blocking filters to reduce the measurement instrumentation noise floor. The total measurement RF path loss of the test setup (attenuator, carrier blocking filters and test cables) were accounted for by an amplitude corrections table under the spectrum analyzer's amplitude softkey (not the reference level offset). Spectrum analyzer settings are described in the corresponding test result section.

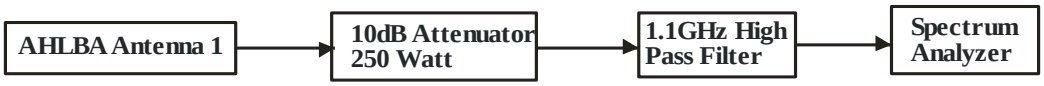
Antenna Port Conducted RF Measurement Test Setup Diagrams

The following setups were used in the RF conducted emissions testing. Photographs of the test setups are also provided.

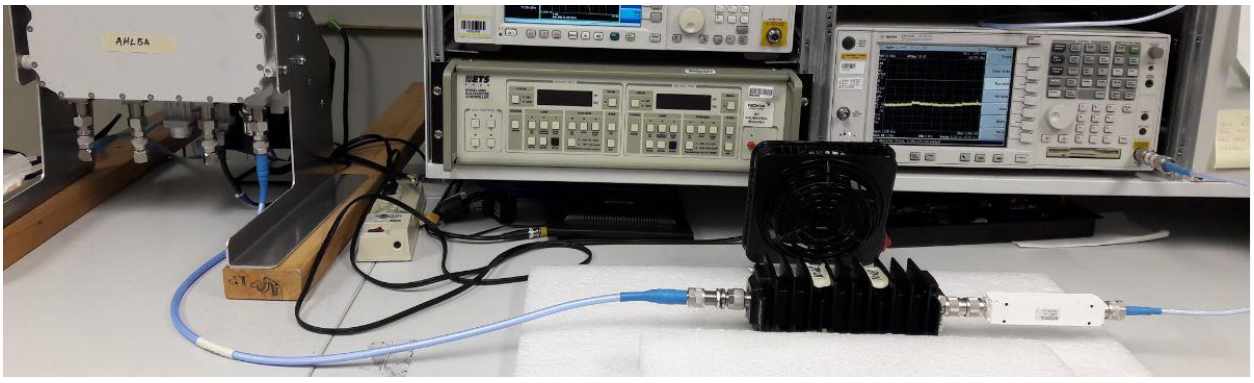
Setup for 9kHz to 150kHz, 150kHz to 20MHz, 20MHz to 700MHz, 700MHz to 800MHz, and 800MHz to 1.1GHz Measurements



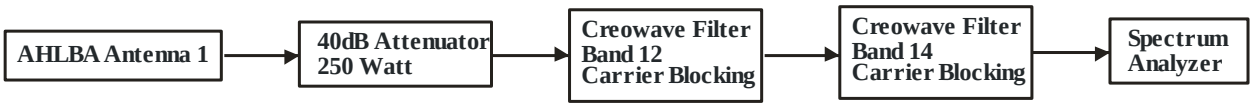
Photograph of 9kHz to 150kHz, 150kHz to 20MHz, 20MHz to 700MHz, 700MHz to 800MHz, and 800MHz to 1.1GHz Test Setup



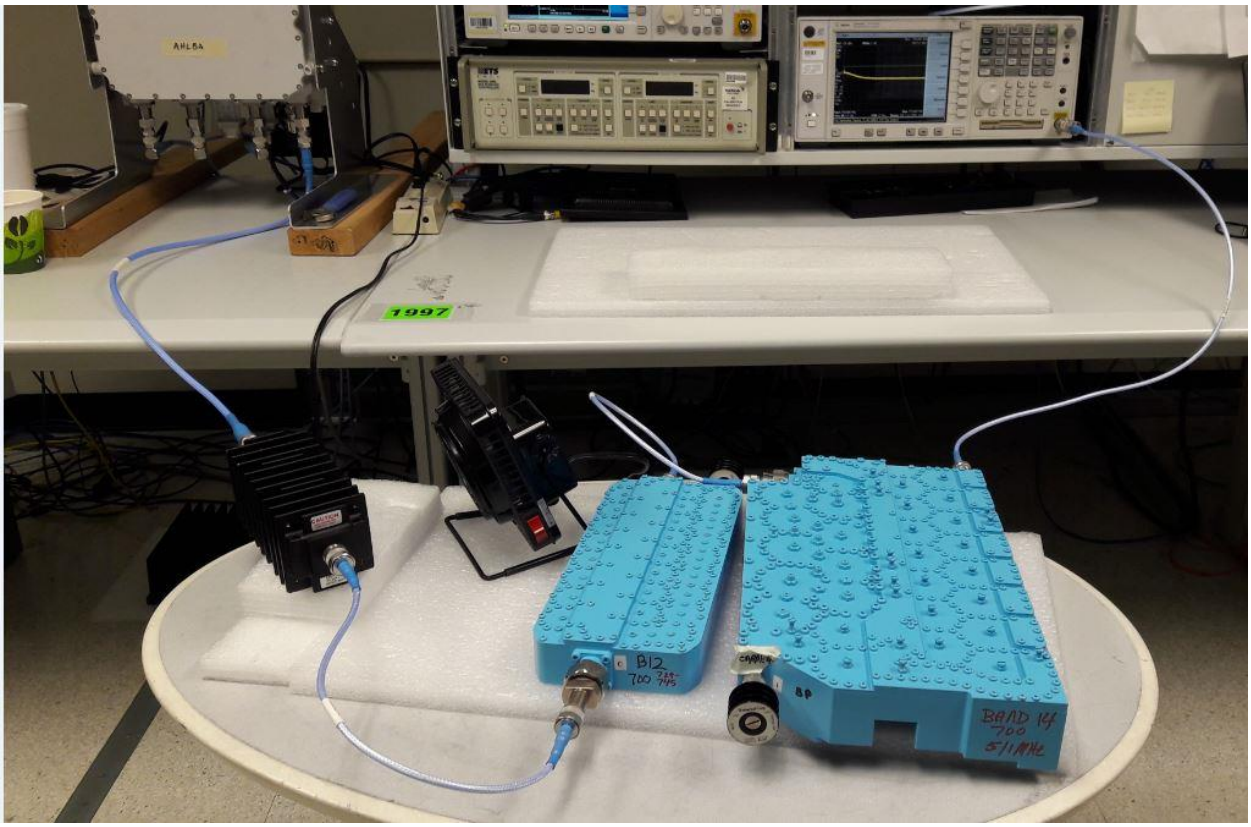
Setup for 1.1GHz to 8GHz and 1559MHz to 1610MHz Measurements



Photograph of 1.1GHz to 8GHz and 1559MHz to 1610MHz Test Setup



Setup for 769MHz to 775MHz and 799MHz to 805MHz Measurements



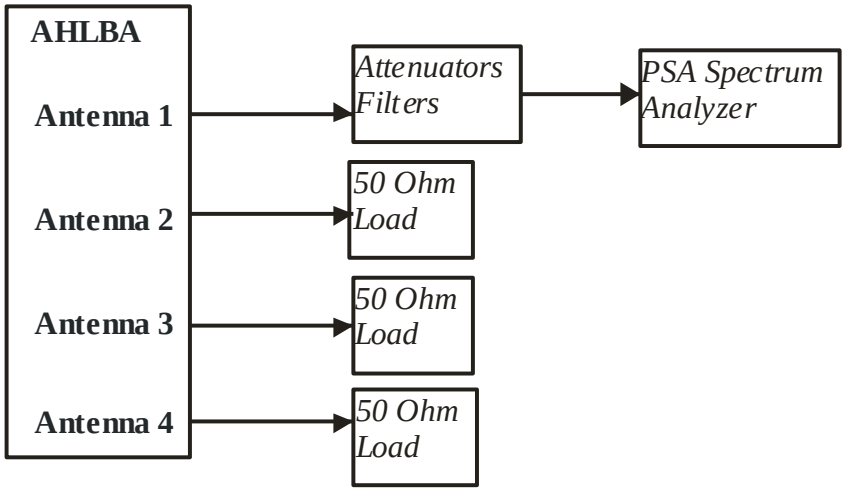
Photograph of 769MHz to 775MHz and 799MHz to 805MHz Test Setup

Test Measurement Equipment

Nokia Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
120194	PSA Spectrum Analyzer	Agilent	E4440A	12 Months	10/17/2019
NM04509	Network Analyzer	Rohde & Schwarz	ZVL 3	12 Months	02/12/2020
NM06345	Network Analyzer	Keysight	E5063A	12 Months	12/15/2019
NM04508	MXA Signal Analyzer	Agilent	N9020A	24 Months	05/02/2019

APPENDIX A: ANTENNA PORT TEST DATA FOR BAND 12 (729-745MHZ)

All conducted RF measurements in this section were made at AHLBA antenna port 1. The testing was performed on the same hardware (EUT) as the original certification test. The same EUT RF port (Ant 1) determined in the original certification testing to be the highest power port was used for all testing in this effort. All testing in this section was performed with the single Narrow Band IoT Guard Band LTE10 carrier. NB IoT guard band offsets from LTE carrier center frequencies were LTE10: ±4597.5 kHz. The LTE modulation type for this testing was setup according to 3GPP TS 36.141 E-UTRA Test Models and is "E-TM 1.1 (QPSK modulation type) with N-TM (narrow band IoT)". The test setup used is provided below.



Test Setup Used for Conducted RF Measurements on AHLBA

RF Output Power

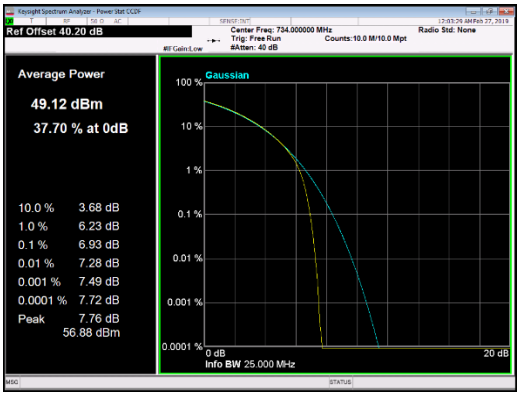
RF output power has been measured in RMS Average terms at the AHLBA Antenna Port 1 Band 12 (729 to 745MHz) transmit chain at the bottom, middle and top channels for the single Narrow Band IoT Guard Band LTE10 carrier as described in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.4.4. The AHLBA was operated at maximum RF output power. The peak to average power ratio (PAPR) has been measured using the signal analyzer complementary cumulative distribution function (CCDF) for a probability of 0.1% as described in section 5.7.2 of KDB971168 D01v03r01 and ANSI C63.26-2015 section 5.2.3.4. Measurements were performed for both the upper and lower narrow band IoT guard band carriers. All results are presented in tabular form below. The highest measured values are highlighted.

Ant Port 1 LTE Channel	LTE BW with IoT GB carrier	PAPR (dB)	Average (dBm)
Bottom Channel	**10MHz with lower IoT GB carrier**	**6.93**	48.96
Bottom Channel	**10MHz with upper IoT GB carrier**	6.87	48.98
Middle Channel	**10MHz with lower IoT GB carrier**	6.75	**49.05**
Middle Channel	**10MHz with upper IoT GB carrier**	6.74	49.00
Top Channel	**10MHz with lower IoT GB carrier**	6.70	**49.05**
Top Channel	**10MHz with upper IoT GB carrier**	6.69	48.99

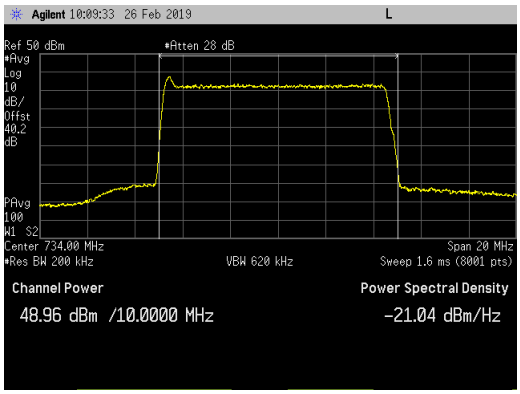
All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 40.2 dB and is accounted for by the spectrum analyzer reference level offset.

LTE10 Channel Power Plots for a Single Narrow Band IoT Lower Guard Band Carrier:

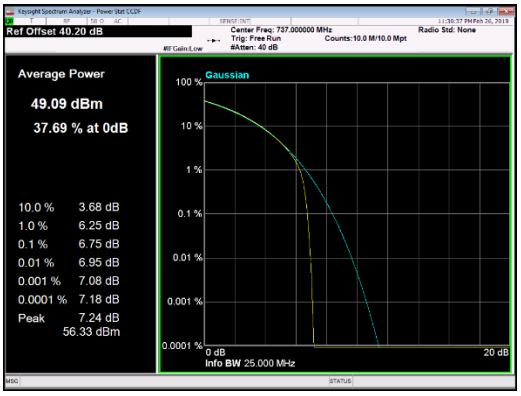
Port 1 – Bottom Channel_ CCDF



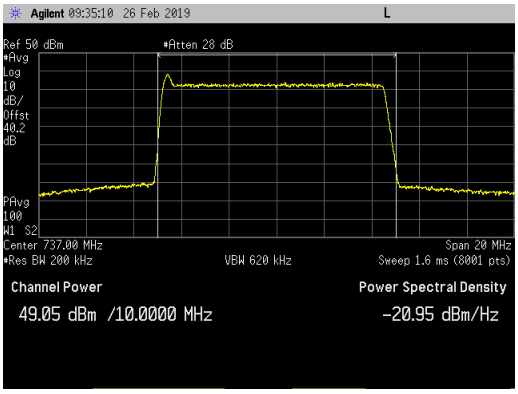
Port 1 – Bottom Channel_ Average



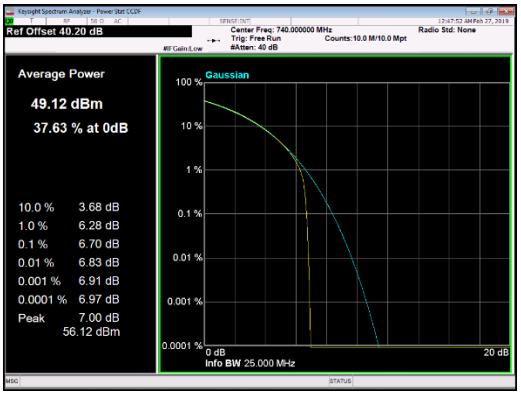
Port 1 – Middle Channel_ CCDF



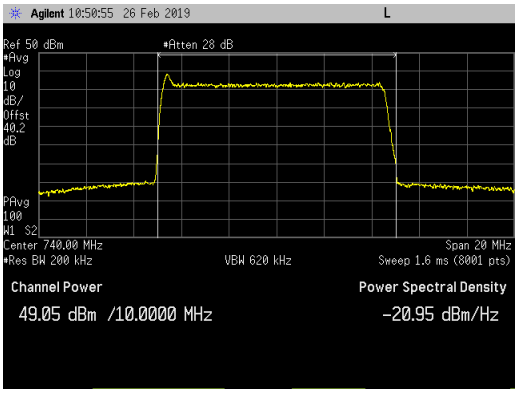
Port 1 – Middle Channel_ Average



Port 1 – Top Channel_ CCDF

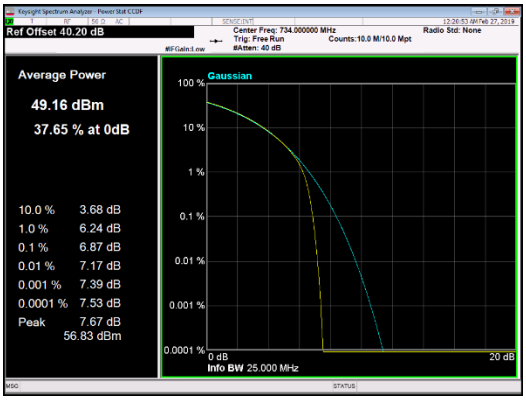


Port 1 – Top Channel_ Average

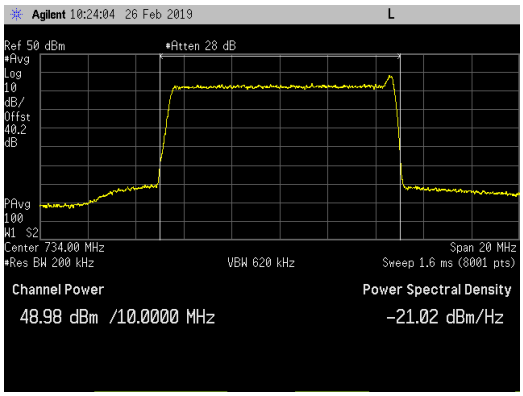


LTE10 Channel Power Plots for a Single Narrow Band IoT Upper Guard Band Carrier:

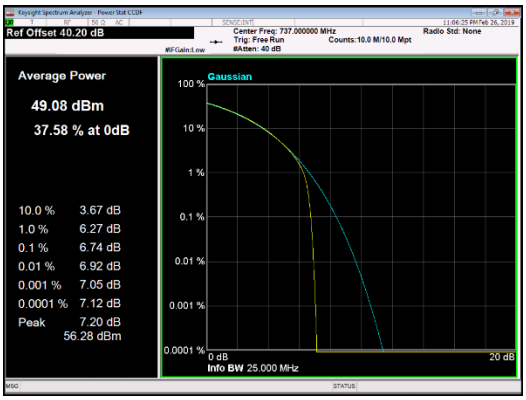
Port 1 – Bottom Channel_ CCDF



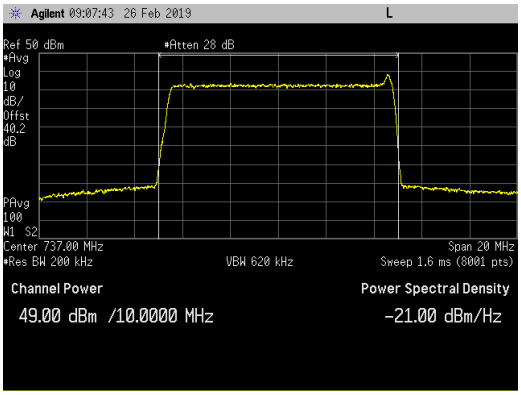
Port 1 – Bottom Channel_ Average



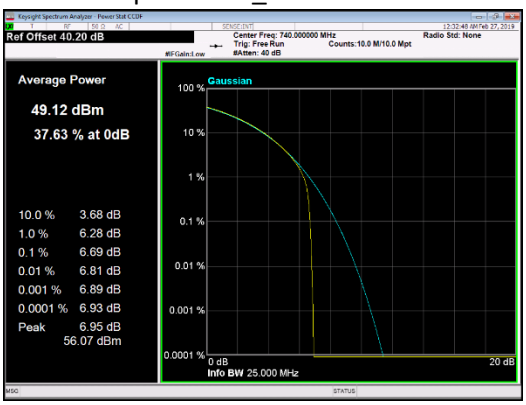
Port 1 – Middle Channel_ CCDF



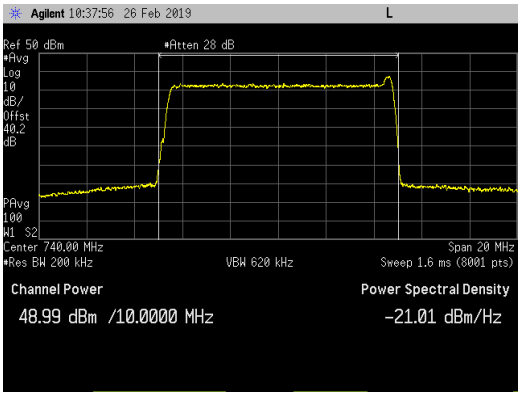
Port 1 – Middle Channel_ Average



Port 1 – Top Channel_ CCDF



Port 1 – Top Channel_ Average



Emission Bandwidth (26 dB down and 99%)

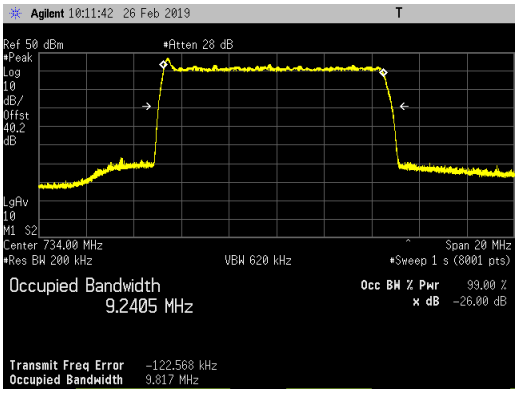
Emission bandwidth measurements were made at AHLBA antenna port 1 on the bottom, middle and top channels for single Narrow Band IoT Guard Band LTE10 carrier with maximum RF output power. Measurements were performed for both the upper and lower narrow band IoT guard band carriers. The 26dB emission bandwidth was measured in accordance with section 4 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.4. The 99% occupied bandwidth was measured in accordance with section 6.7 of RSS-Gen Issue 5. For both measurements, an occupied bandwidth built-in function in the spectrum analyzer was used. The results are provided in the following table. The largest emission bandwidths are highlighted.

Antenna Port 2 LTE Channel	LTE BW with IoT GB carrier	26dB Emission Bandwidth (MHz)	99% Emission Bandwidth (MHz)
Bottom Channel	**10MHz with lower IoT GB carrier**	**9.817**	9.2405
Bottom Channel	**10MHz with upper IoT GB carrier**	9.794	9.2403
Middle Channel	**10MHz with lower IoT GB carrier**	9.807	9.2423
Middle Channel	**10MHz with upper IoT GB carrier**	9.806	**9.2443**
Top Channel	**10MHz with lower IoT GB carrier**	9.789	9.2361
Top Channel	**10MHz with upper IoT GB carrier**	9.804	9.2417

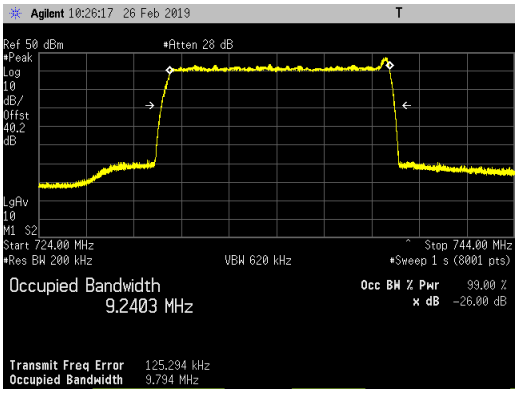
Emission bandwidth measurement data are provided in the following pages.

LTE10 Emission Bandwidth Plots for a Single Narrow Band IoT Guard Band Carrier on Ant Port 1:

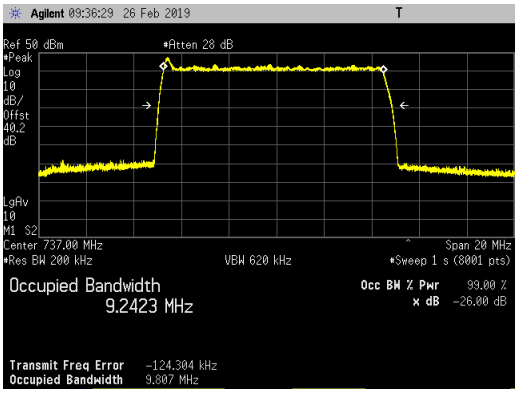
Bottom Channel_ Lower Guard Band



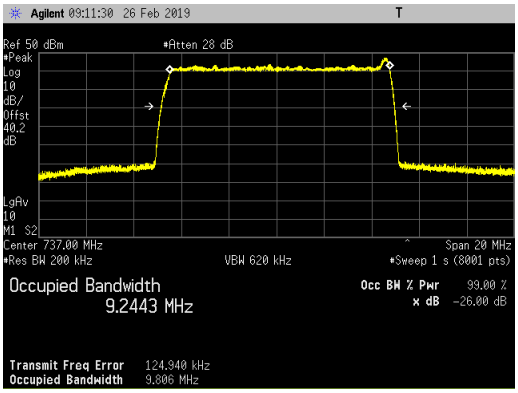
Bottom Channel_ Upper Guard Band



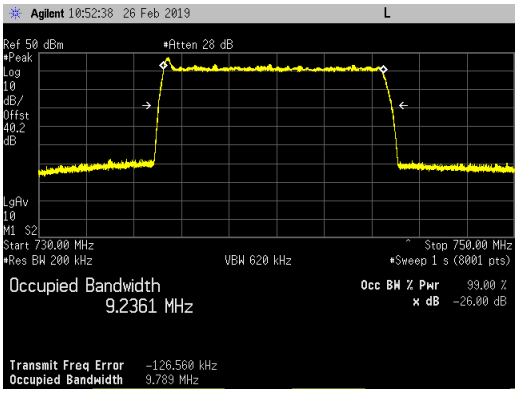
Middle Channel_ Lower Guard Band



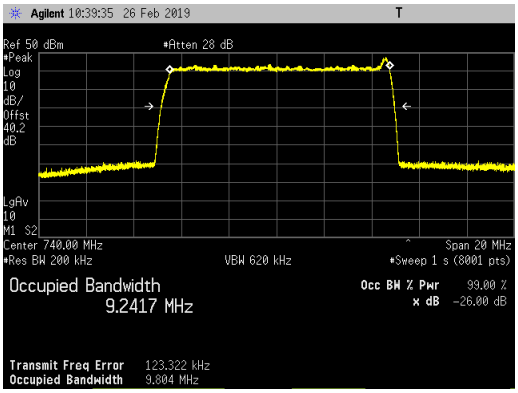
Middle Channel_ Upper Guard Band



Top Channel_ Lower Guard Band



Top Channel_ Upper Guard Band



Antenna Port Conducted Band Edge

Conducted band edge measurements were made at RRH antenna port 1. The AHLBA was operated at the Band 12 band edge frequencies with a single upper and lower NB IoT GB carrier for 10MHz LTE bandwidth at maximum power.

The same limit of -19dBm used in the original certification testing is used for this testing. The limit is adjusted to -19dBm [-13dBm -10 log (4)] per FCC KDB 662911D01 v02r01 because the BTS may operate as a 4 port MIMO transmitter.

Measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces. In the 100kHz bands outside and adjacent to the frequency block, a resolution bandwidth of 30kHz as allowed by FCC 27.53(g) was used. Outside the 100kHz band edge noted above, a 100kHz RBW and 300kHz VBW was used. Measurements were performed in the frequency range from the band edge to ~20 MHz outside the band edge (i.e.: 709 to 729MHz and 745 to 768MHz bands).

The results are summarized in the following table. The highest (worst case) emissions from the measurement data are provided.

Channel BW, Carrier Frequency, Carrier Power		**NB IoT Guard Band Placement**	**Lower Band Edge (dBm)**	**Upper Band Edge (dBm)**
Band 12	**Band 14**			
Single LTE 10 Carrier, 734MHz (BC), 80W	**Carrier Off**	**Lower**	-24.426	Not Applicable
Single LTE 10 Carrier, 734MHz (BC), 80W	**Carrier Off**	**Upper**	-25.118	Not Applicable
Single LTE 10 Carrier, 740MHz (TC), 80W	**Carrier Off**	**Lower**	Not Applicable	-24.786
Single Carrier LTE10, 740MHz (TC), 80W	**Carrier Off**	**Upper**	Not Applicable	-24.375
LTE10 Carrier, 734MHz (BC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Lower**	**-21.001**	Not Applicable
LTE10 Carrier, 734MHz (BC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Upper**	-23.727	Not Applicable
LTE10 Carrier, 740MHz (TC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Lower**	Not Applicable	-21.924
LTE10 Carrier, 740MHz (TC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Upper**	Not Applicable	-22.472

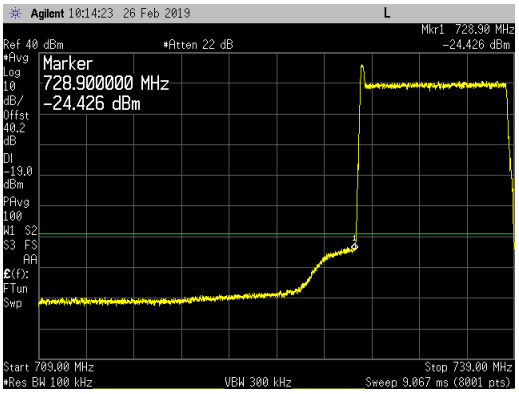
The total measurement RF path loss of the test setup (attenuator and test cables) was 40.2 dB and is accounted for by the spectrum analyzer reference level offset. The display line on the plots reflects the required limit.

Conducted band edge measurements are provided in the following pages.

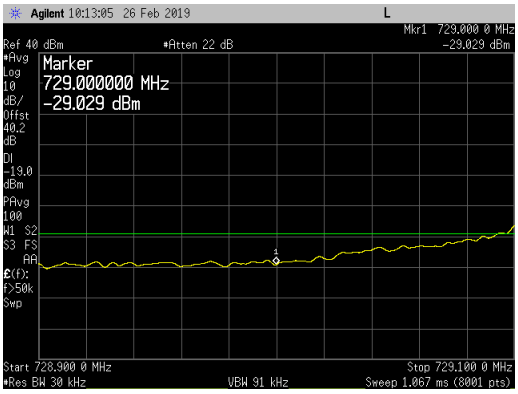
Band 12 LTE10 at Bot Ch (734MHz) 80W Single Narrow Band IoT Guard Band Carrier -Lower Band Edge Plots:

IoT Guard Band Carrier at Lower Placement

Ant Port 1_LBE_709 to 739MHz

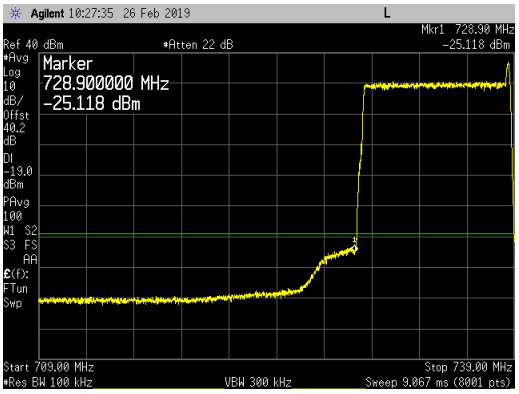


Ant Port 1_LBE_728.9 to 729.1MHz

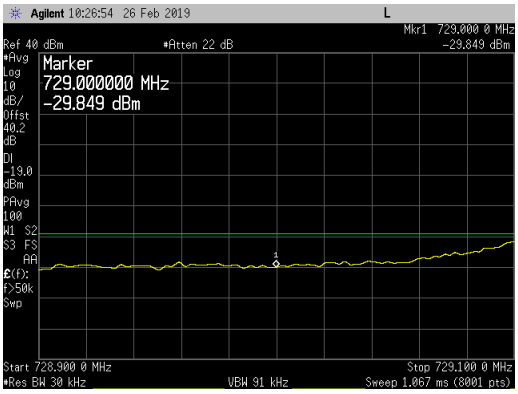


IoT Guard Band Carrier at Upper Placement

Ant Port 1_LBE_709 to 739MHz



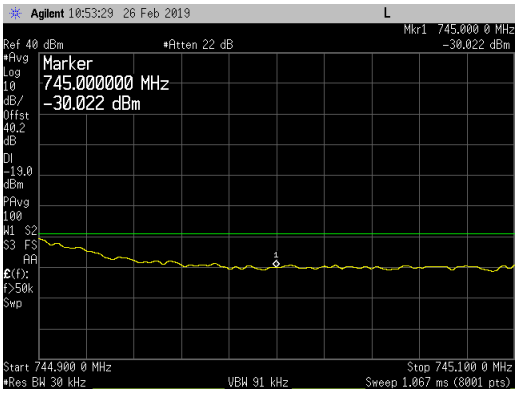
Ant Port 1_LBE_728.9 to 729.1MHz



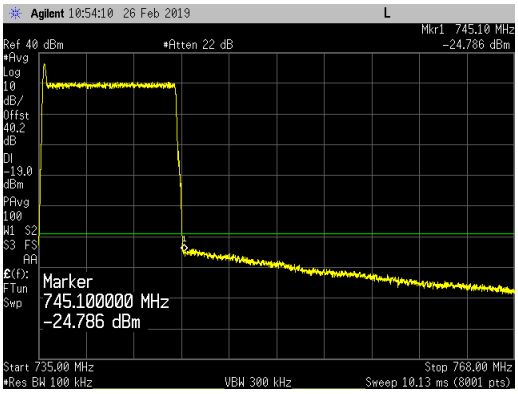
Band 12 LTE10 at Top Ch (740MHz) 80W Single Narrow Band IoT Guard Band Carrier -Upper Band Edge Plots:

IoT Guard Band Carrier at Lower Placement

Ant Port 1_UBE_744.9 to 745.1MHz

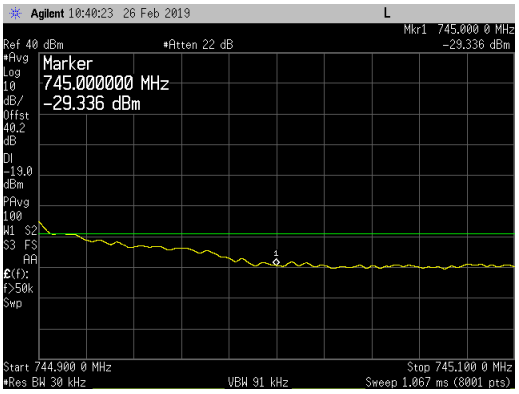


Ant Port 1_UBE_735 to 768MHz

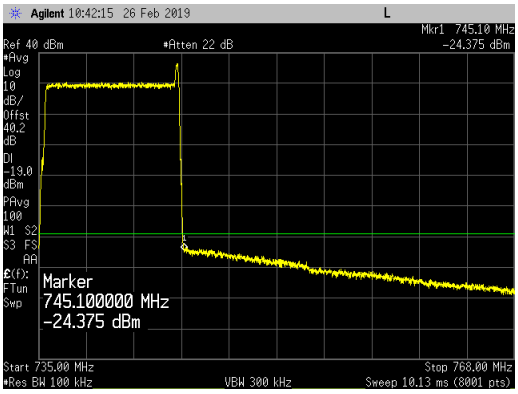


IoT Guard Band Carrier at Upper Placement

Ant Port 1_ UBE_744.9 to 745.1MHz



Ant Port 1_ UBE_735 to 768MHz

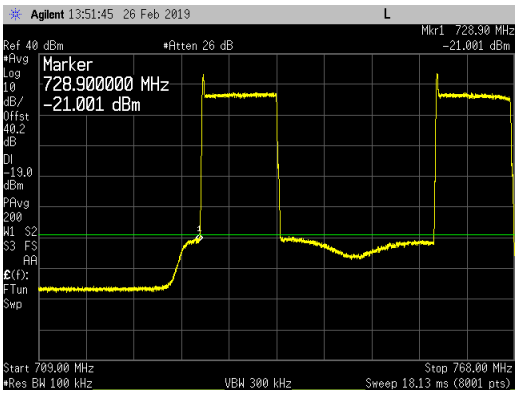


Band 12 Single Narrow Band IoT Guard Band Carrier -Lower Band Edge Plots:

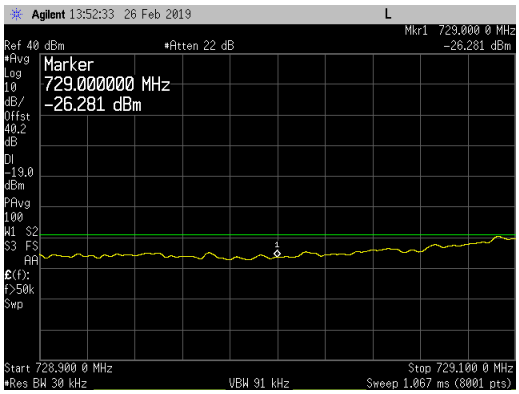
Dual Band [Band 12 at Bot Ch (734MHz) + Band 14 at Mid Ch (763MHz)] 40W + 40W LTE10 Carriers

IoT Guard Band Carrier at Lower Placement

Ant Port 1_LBE_709 to 768MHz

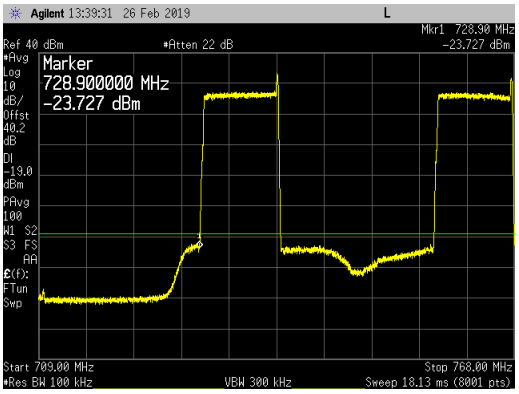


Ant Port 1_LBE_728.9 to 729.1MHz

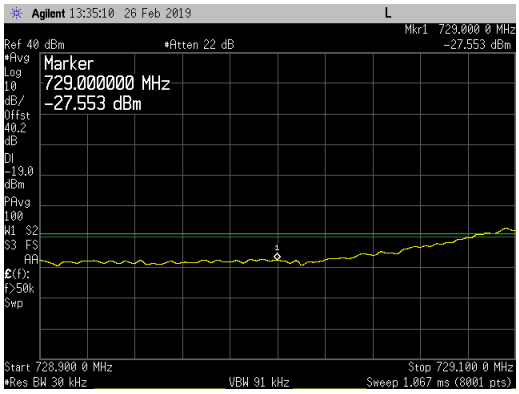


IoT Guard Band Carrier at Upper Placement

Ant Port 1_LBE_709 to 768MHz



Ant Port 1_LBE_728.9 to 729.1MHz

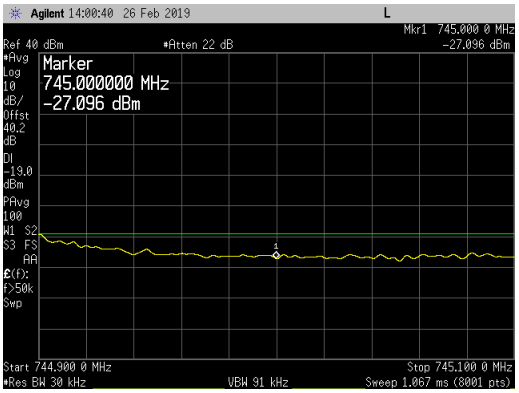


Band 12 Single Narrow Band IoT Guard Band Carrier -Upper Band Edge Plots:

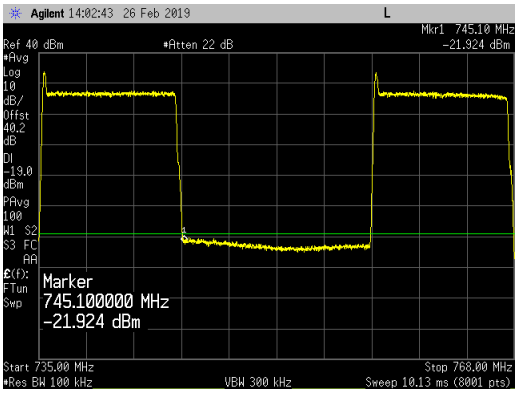
Dual Band [Band 12 at Top Ch (740MHz) + Band 14 at Mid Ch (763MHz)] 40W + 40W LTE10 Carriers

IoT Guard Band Carrier at Lower Placement

Ant 1_UBE_744.9 to 745.1MHz

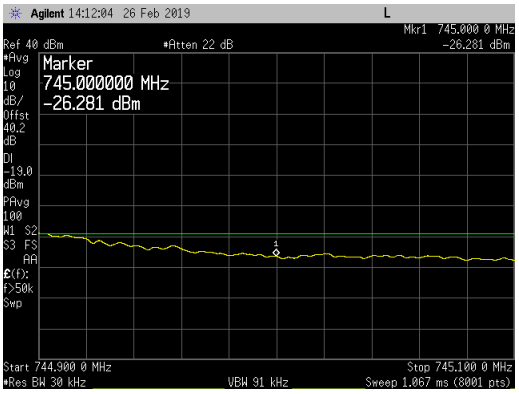


Ant 1_UBE_735 to 768MHz

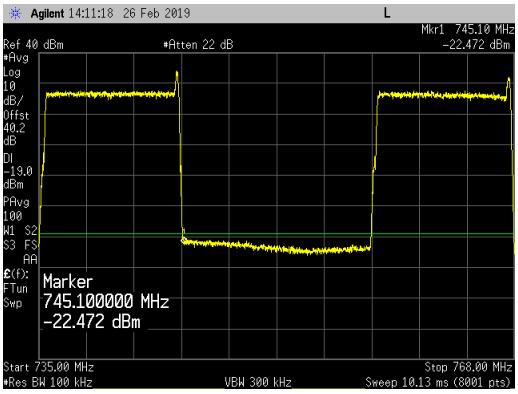


IoT Guard Band Carrier at Upper Placement

Ant 1_UBE_744.9 to 745.1MHz



Ant 1_UBE_735 to 768MHz



Transmitter Antenna Port Conducted Emissions

Transmitter conducted emission measurements were made at RRH antenna port 1. Measurements were performed over the 9kHz to 8GHz frequency range.

Two test configurations are needed for conducted spurious emission measurements to prove compliance for the 3GPP Band 12 transmitters. The first test will be with the 3GPP Band 12 transmitters enabled at 80 watts per carrier (the 3GPP Band 14 transmitters will not be enabled). The second test will be with the 3GPP Band 12 and the 3GPP Band 14 transmitters enabled simultaneously at 40 watts per carrier (or 80 watts/antenna port).

The RRH was operated on the Band 12 middle channel (737.0MHz) and Band 14 middle channel (763.0MHz) simultaneously with single upper and lower NB IoT GB carriers for 10MHz LTE bandwidth at maximum power (40W/carrier).

The parameters of the first test configuration are provided below:

3GPP Band 12 Transmission Parameters			3GPP Band 14 Transmission Parameters		
Carrier Frequency	Channel Bandwidth	Carrier Power	Carrier Frequency	Channel Bandwidth	Carrier Power
737.0MHz (Mid Ch)	LTE10	80 Watts	Carrier Idle/Off	N/A	0 Watts

The parameters of the second test configuration are provided below:

3GPP Band 12 Transmission Parameters			3GPP Band 14 Transmission Parameters		
Carrier Frequency	Channel Bandwidth	Carrier Power	Carrier Frequency	Channel Bandwidth	Carrier Power
737.0MHz (Mid Ch)	LTE10	40 Watts	763.0MHz (Mid Ch)	LTE10	40 Watts

The same limit of -19dBm used in the original certification testing is used for this testing. The limit is adjusted to -19dBm [-13dBm -10 log (4)] per FCC KDB 662911D01 v02r01 because the BTS may operate as a 4 port MIMO transmitter. The required measurement parameters include a 100kHz bandwidth with power measured in average value (since transmitter power was measured in average value).

Measurements were performed with a spectrum analyzer using a peak detector with max hold over 50 sweeps (except for the 700MHz to 800MHz frequency range). Measurements for the 700MHz to 800MHz frequency range were performed with the spectrum analyzer in the RMS average mode over 100 traces.

The limit for the 9kHz to 150kHz frequency range was adjusted to –39dBm to correct for a spectrum analyzer RBW of 1kHz versus required RBW of 100kHz [i.e.: -39dBm = -19dBm -10log(100kHz/1kHz)]. The limit for the 150kHz to 20MHz frequency range was adjusted to –29dBm to correct for a spectrum analyzer RBW of 10kHz versus required RBW of 100kHz [i.e.: -29dBm = -19dBm -10log(100kHz/10kHz)]. The required limit of -19dBm with a RBW of ≥100kHz was used for all other frequency ranges. The spectrum analyzer settings that were used for this test are summarized in the following table.

Frequency Range	RBW	VBW	Number of Data Points	Detector	Sweep Time	Max Hold over	Offset Note 1
9kHz to 150kHz	1kHz	3kHz	8001	Peak	Auto	50 Sweeps	40.1dB
150kHz to 20MHz	10kHz	30kHz	8001	Peak	Auto	50 Sweeps	40.1dB
20MHz to 700MHz	300kHz	910kHz	8001	Peak	Auto	50 Sweeps	40.1dB
700MHz to 800MHz	100kHz	300kHz	8001	Average	Auto	Note 2	40.2dB
800MHz to 1.1GHz	100kHz	300kHz	8192	Peak	Auto	50 Sweeps	40.2dB
1.1GHz to 8GHz	2MHz	6MHz	8192	Peak	Auto	50 Sweeps	17.3dB

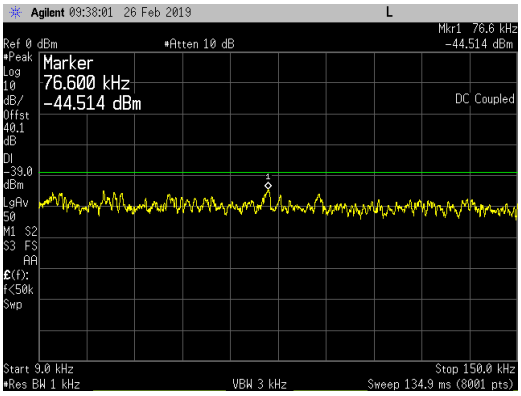
Note 1: The total measurement RF path loss of the test setup (attenuators, filters and test cables) is accounted for by the spectrum analyzer reference level offset.
Note 2: Max Hold not used and instead measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces.

A high pass filter was used to reduce measurement instrumentation noise floor for the frequency range above 1100MHz. The total measurement RF path loss of the test setup (attenuators, high pass filter and test cables) as shown in the table is accounted for by the spectrum analyzer reference level offset. The display line on the plots reflects the required limit.

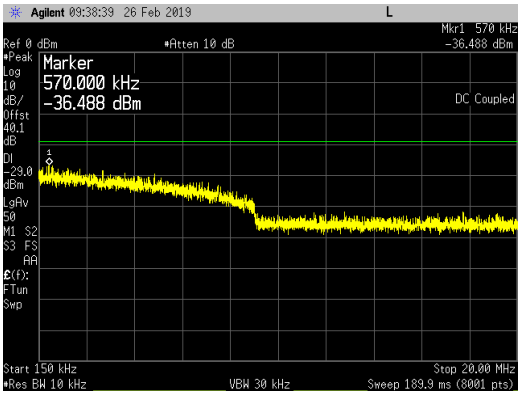
Conducted spurious emission plots/measurements are provided in the following pages.

Band 12 LTE10 Single Narrow Band IoT Lower Guard Band Carrier
-Single Carrier at Middle Channel (737MHz) at 80 watts/carrier and 80 watts/port:

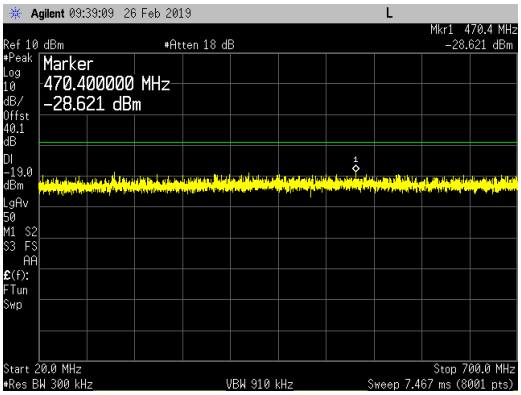
9kHz to 150kHz



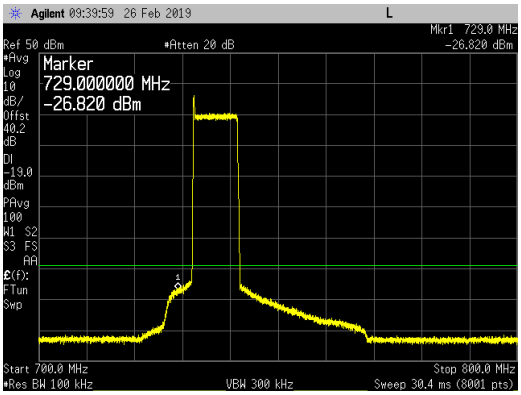
150kHz to 20MHz



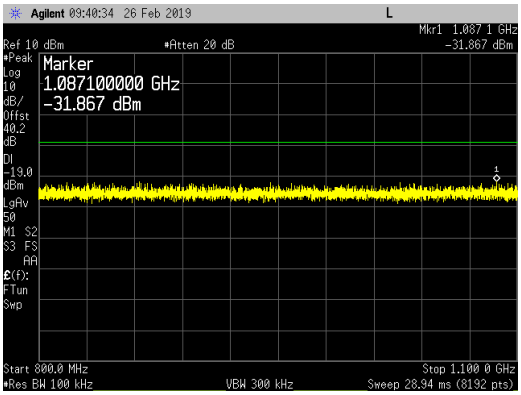
20MHz to 700MHz



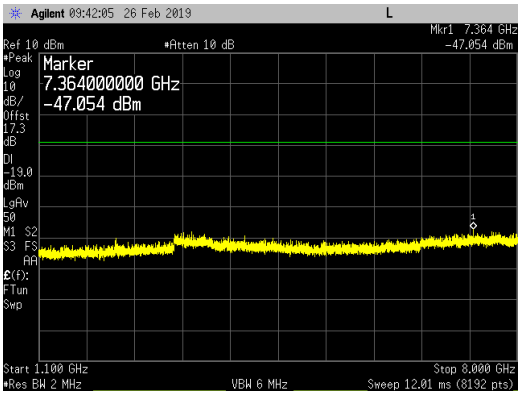
700MHz to 800MHz



800MHz to 1100MHz

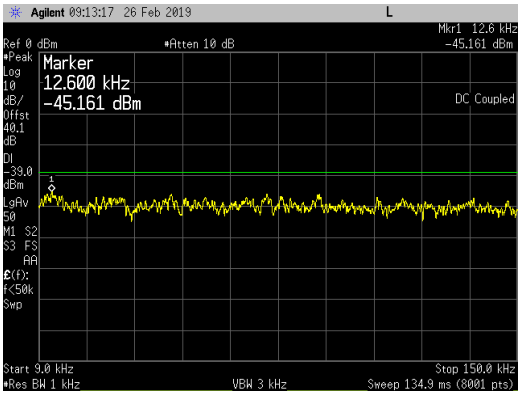


1.1GHz to 8GHz

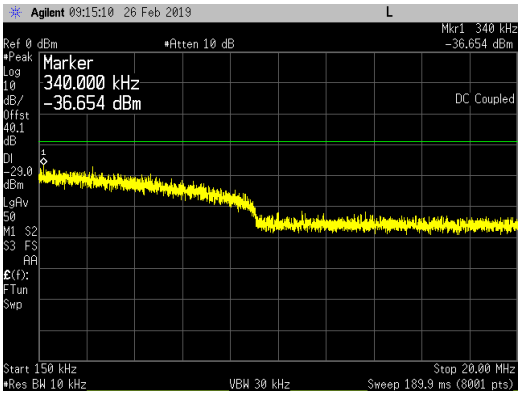


Band 12 LTE10 Single Narrow Band IoT Upper Guard Band Carrier
-Single Carrier at Middle Channel (737MHz) at 80 watts/carrier and 80 watts/port:

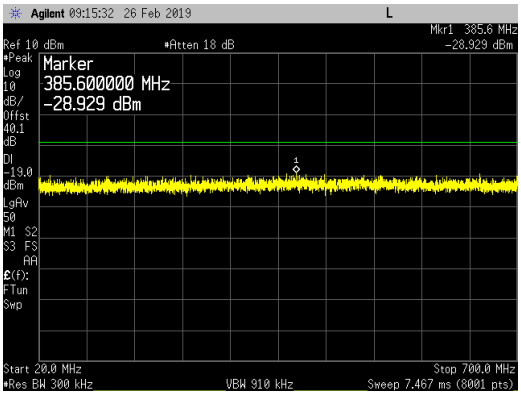
9kHz to 150kHz



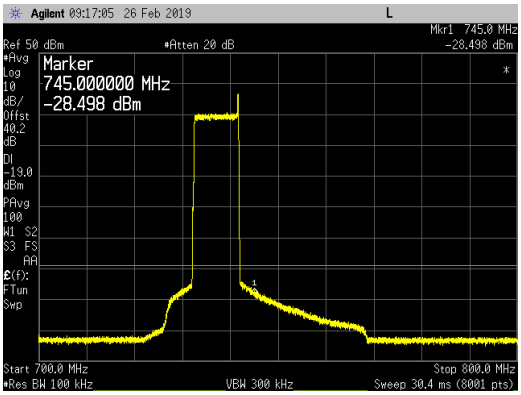
150kHz to 20MHz



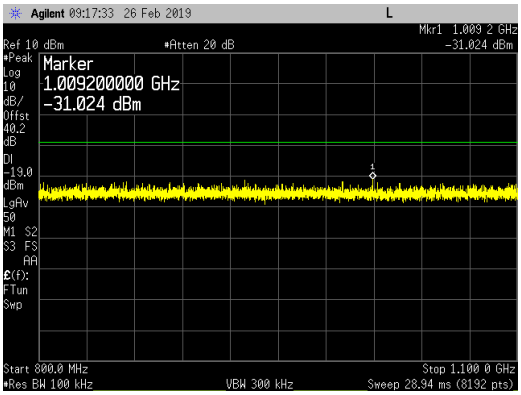
20MHz to 700MHz



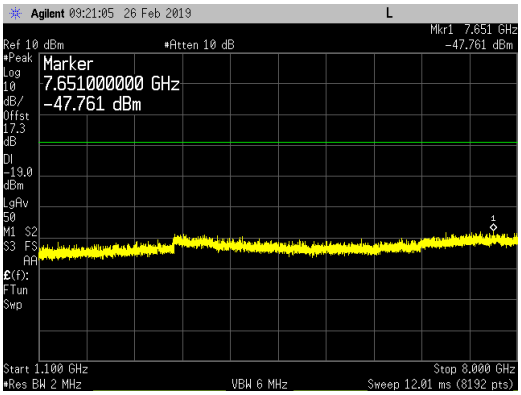
700MHz to 800MHz



800MHz to 1100MHz

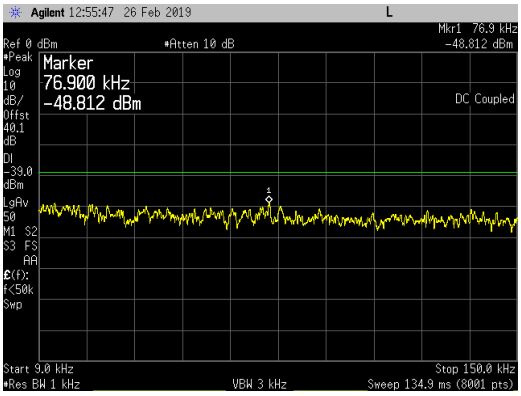


1.1GHz to 8GHz

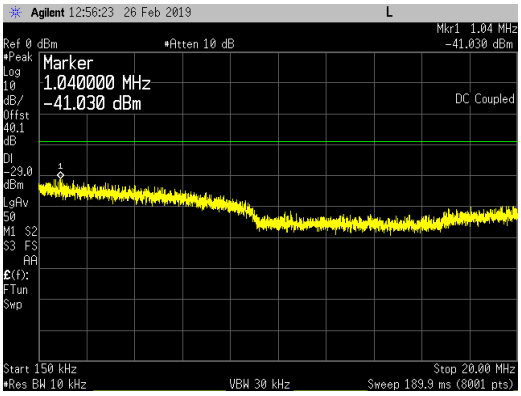


Band 12 and Band 14 LTE10 Single Narrow Band IoT Lower Guard Band Carriers (80W/Port)
- Dual Band [Band 12 at Mid Ch (737MHz) + Band 14 at Mid Ch (763MHz)] 40W + 40W LTE10 Carriers:

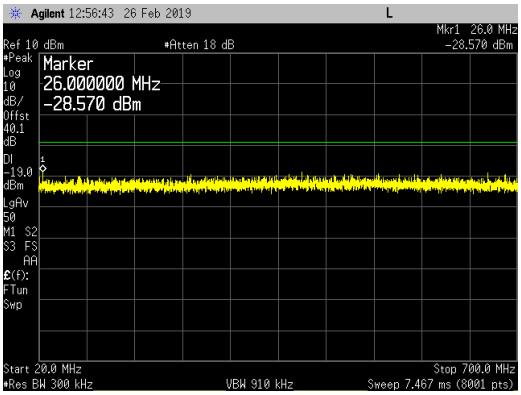
9kHz to 150kHz



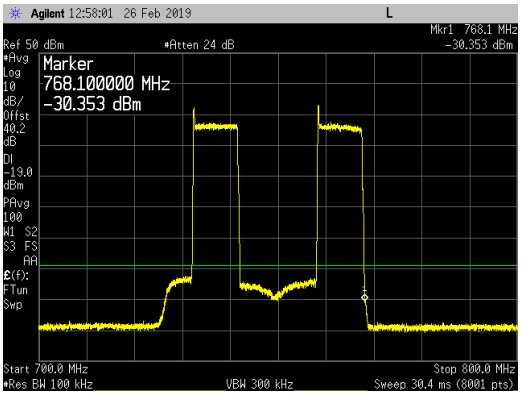
150kHz to 20MHz



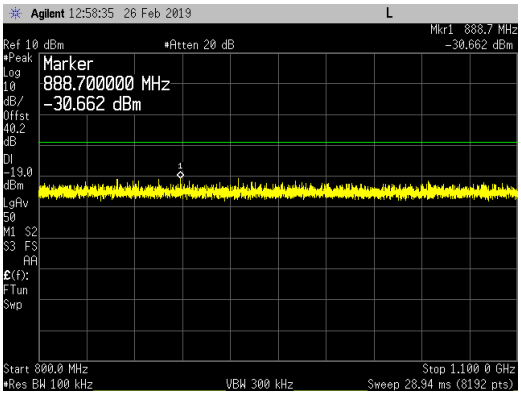
20MHz to 700MHz



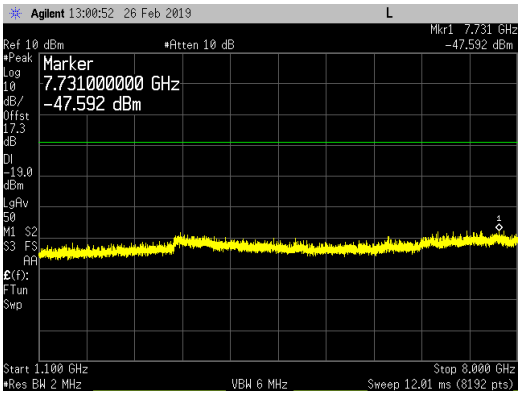
700MHz to 800MHz



800MHz to 1100MHz

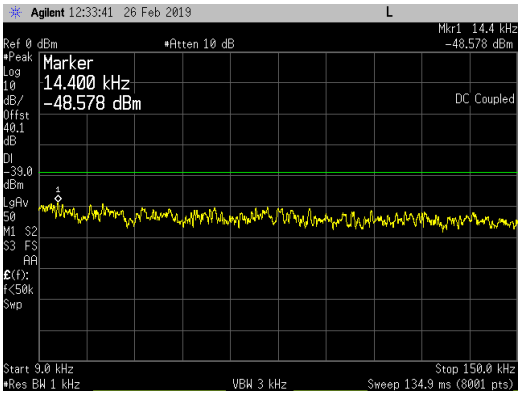


1.1GHz to 8GHz

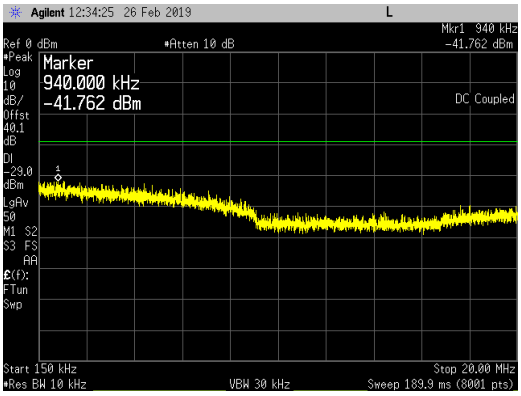


Band 12 and Band 14 LTE10 Single Narrow Band IoT Upper Guard Band Carriers (80W/Port)
- Dual Band [Band 12 at Mid Ch (737MHz) + Band 14 at Mid Ch (763MHz)] 40W + 40W LTE10 Carriers:

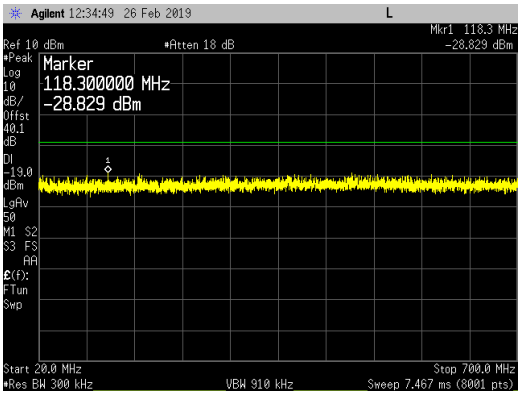
9kHz to 150kHz



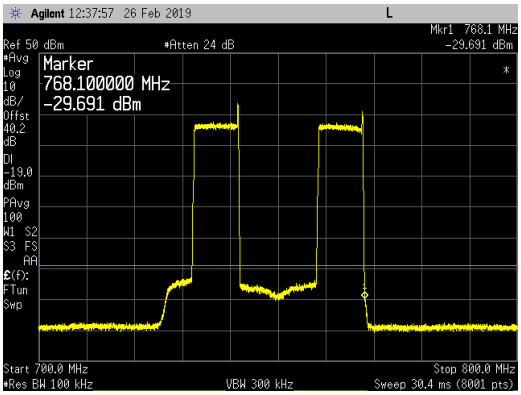
150kHz to 20MHz



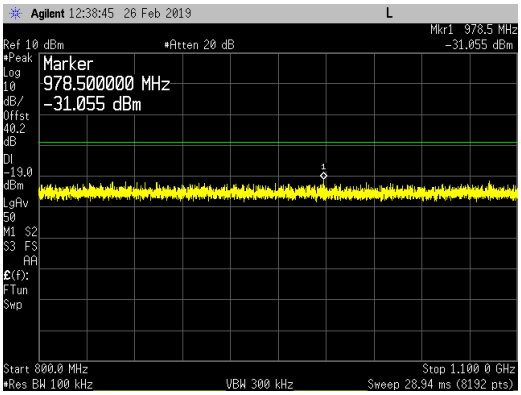
20MHz to 700MHz



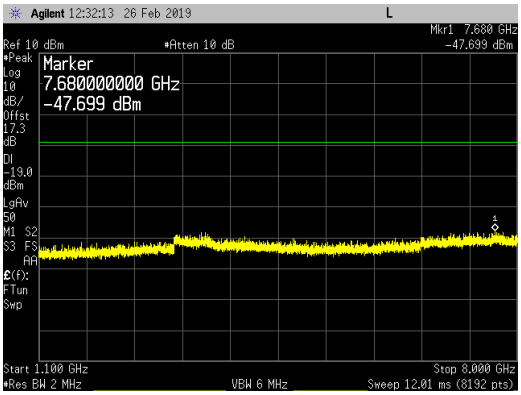
700MHz to 800MHz



800MHz to 1100MHz



1.1GHz to 8GHz



Transmitter Radiated Spurious Emissions

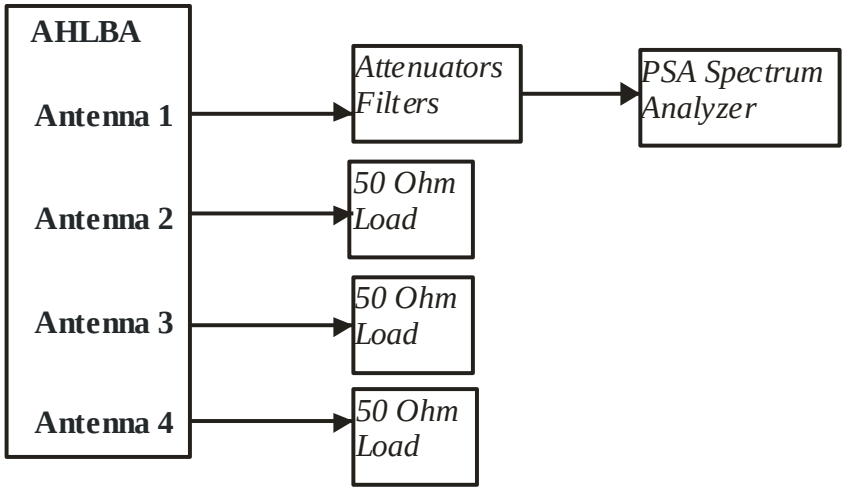
Radiated spurious emission plots/measurement results are in the original FCC and IC radio certification submittal (NTS Test Report Number PR078121 Revision 0 dated May 4, 2018).

Frequency Stability/Accuracy

Frequency Stability/Accuracy measurement results are in the original FCC and IC radio certification submittal (NTS Test Report Number PR078121 Revision 0 dated May 4, 2018).

APPENDIX B: ANTENNA PORT TEST DATA FOR BAND 14 (758-768MHZ)

All conducted RF measurements in this section were made at AHLBA antenna port 1. The testing was performed on the same hardware (EUT) as the original certification test. The same EUT RF port (Ant 1) determined in the original certification testing to be the highest power port was used for all testing in this effort. All testing in this section was performed with the single Narrow Band IoT Guard Band LTE10 carrier. NB IoT guard band offsets from LTE carrier center frequencies were LTE10: ±4597.5 kHz. The LTE modulation type for this testing was setup according to 3GPP TS 36.141 E-UTRA Test Models and is "E-TM 1.1 (QPSK modulation type) with N-TM (narrow band IoT)". The test setup used is provided below.



Test Setup Used for Conducted RF Measurements on AHLBA

RF Output Power

RF output power has been measured in RMS Average terms at the AHLBA Antenna Port 1 Band 14 (758 to 768MHz) transmit chain at the middle channel for the single Narrow Band IoT Guard Band LTE10 carrier as described in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.4.4. The AHLBA Band 14 configured for LTE10 may operate only on the middle channel since the operational bandwidth is 10MHz wide. The AHLBA was operated at maximum RF output power. The peak to average power ratio (PAPR) has been measured using the signal analyzer complementary cumulative distribution function (CCDF) for a probability of 0.1% as described in section 5.7.2 of KDB971168 D01v03r01 and ANSI C63.26-2015 section 5.2.3.4. Measurements were performed for both the upper and lower narrow band IoT guard band carriers. All results are presented in tabular form below. The highest measured values are highlighted.

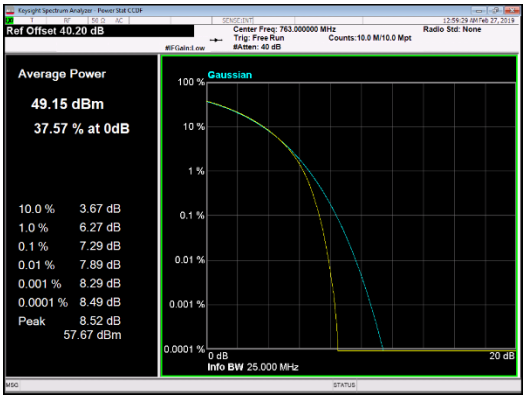
Ant Port 1 LTE Channel	LTE BW with IoT GB carrier	PAPR (dB)	Average (dBm)
Middle Channel	**10MHz with lower IoT GB carrier**	7.29	**49.08**
Middle Channel	**10MHz with upper IoT GB carrier**	**7.43**	48.90

All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 40.2 dB and is accounted for by the spectrum analyzer reference level offset.

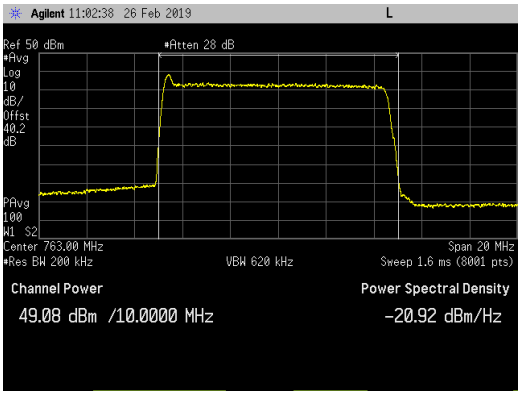
LTE10 Channel Power Plots:

Single Narrow Band IoT Lower Guard Band Carrier

Port 1 – Middle Channel_ CCDF

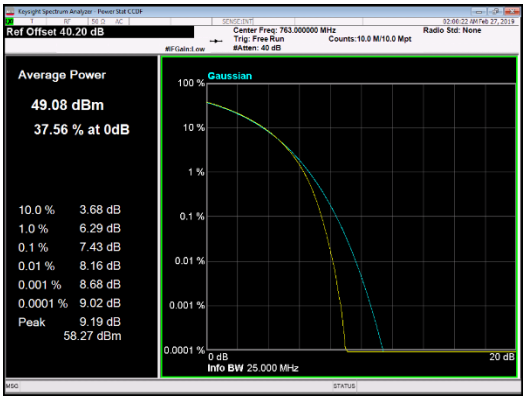


Port 1 – Middle Channel_ Average

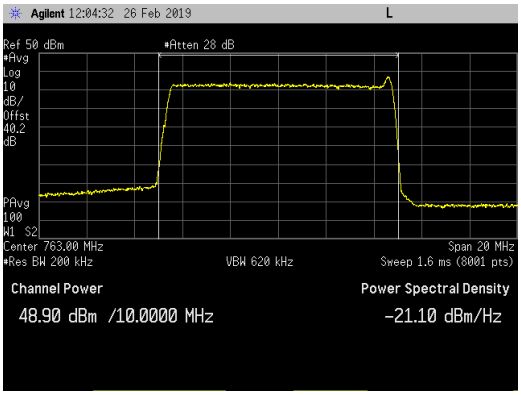


Single Narrow Band IoT Upper Guard Band Carrier:

Port 1 – Middle Channel_ CCDF



Port 1 – Middle Channel_ Average



Emission Bandwidth (26 dB down and 99%)

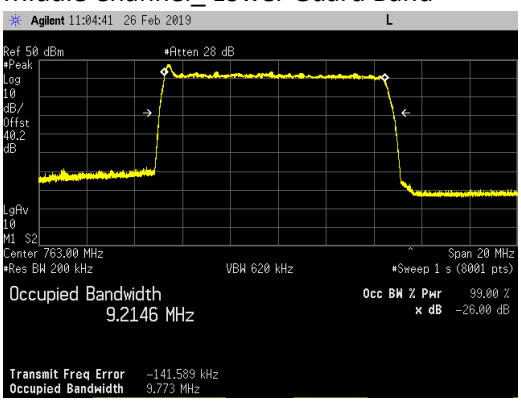
Emission bandwidth measurements were made at AHLBA antenna Port 1 Band 14 (758 to 768MHz) on the middle channel for single Narrow Band IoT Guard Band LTE10 carrier with maximum RF output power. The AHLBA Band 14 configured for LTE10 may operate only on the middle channel since the operational bandwidth is 10MHz wide. Measurements were performed for both the upper and lower narrow band IoT guard band carriers. The 26dB emission bandwidth was measured in accordance with section 4 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.4. The 99% occupied bandwidth was measured in accordance with section 6.7 of RSS-Gen Issue 5. For both measurements, an occupied bandwidth built-in function in the spectrum analyzer was used. The results are provided in the following table. The largest emission bandwidths are highlighted.

Antenna Port 2 LTE Channel	LTE BW with IoT GB carrier	26dB Emission Bandwidth (MHz)	99% Emission Bandwidth (MHz)
Middle Channel	**10MHz with lower IoT GB carrier**	9.773	9.2146
Middle Channel	**10MHz with upper IoT GB carrier**	**9.825**	**9.2358**

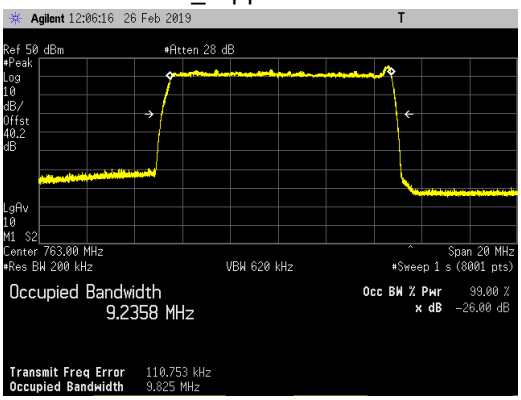
Emission bandwidth measurement data are provided in the following pages.

LTE10 Emission Bandwidth Plots for a Single Narrow Band IoT Guard Band Carrier on Ant Port 1:

Middle Channel_ Lower Guard Band



Middle Channel_ Upper Guard Band



Antenna Port Conducted Band Edge

Conducted band edge measurements were made at RRH antenna port 1. The AHLBA was operated at the Band 14 band edge frequencies with a single upper and lower NB IoT GB carrier for 10MHz LTE bandwidth at maximum power. The AHLBA Band 14 configured for LTE10 may operate only on the middle channel since the operational bandwidth is 10MHz wide.

In the frequency ranges below 758MHz, 768MHz to 769MHz, 775MHz to 788MHz and above 805MHz the limit of (-19dBm) is used for this testing as required by FCC 90.543(e). The same limit of -19dBm used in the original certification testing is used for this testing. The limit is adjusted to -19dBm [-13dBm -10 log (4)] per FCC KDB 662911D01 v02r01 because the BTS may operate as a 4 port MIMO transmitter.

Measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces. In the 100kHz bands outside and adjacent to the frequency block, a resolution bandwidth of 30kHz as allowed by FCC 90.543(e)(5) was used. Outside the 100kHz band edge noted above, a 100kHz RBW and 300kHz VBW was used. Measurements were performed in the frequency range from the band edge to 26 MHz outside the lower band edge and 42 MHz outside the upper band edge (i.e.: 732 to 758MHz and 768 to 810MHz bands).

The results are summarized in the following table. The highest (worst case) emissions from the measurement data are provided.

Frequency ranges below 758MHz, 768MHz to 769MHz, 775MHz to 788MHz and above 805MHz:

Frequency Ranges below 758MHz, 768MHz to 769MHz, 775MHz to 788MHz and above 805MHz				
Channel BW, Carrier Frequency, Carrier Power		**NB IoT Guard Band Placement**	**Lower Band Edge (dBm)**	**Upper Band Edge (dBm)**
Band 12	**Band 14**			
Carrier Off	**Single LTE 10 Carrier, 763MHz (MC), 80W**	**Lower**	-24.344	-30.981
Carrier Off	**Single LTE 10 Carrier, 763MHz (MC), 80W**	**Upper**	-25.724	-30.107
LTE10 Carrier, 737MHz (MC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Lower**	**-24.325**	-31.007
LTE10 Carrier, 737MHz (MC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Upper**	-25.413	-31.539

The total measurement RF path loss of the test setup (attenuator and test cables) was 40.2 dB and is accounted for by the spectrum analyzer reference level offset. The display line on the plots reflects the required limit.

Section 90.543(e)(1) requires an emission limit of -46dBm for any 6.25 kHz bandwidth between frequency bands 769-775 MHz and 799-805MHz. Adjusting for the four port MIMO requirement the emission limit in these frequency ranges is -52dBm [i.e.: Limit = -46 dBm/6.25kHz (FCC/IC Limit) – 6dB (4 port MIMO)]. The same limit of -52dBm used in the original certification testing is used for this testing. A RBW of 6.8kHz was used for these frequency ranges because a 6.25kHz bandwidth was not available on the spectrum analyzer (a RBW > 6.25kHz was selected). Measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces. The results are summarized in the following table.

The worst case (highest) measurement is -58.959 dBm.

Frequency ranges of 769MHz to 775MHz and 799MHz to 805MHz:

Frequency Ranges of 769MHz to 775MHz and 799MHz to 805MHz				
Channel BW, Carrier Frequency, Carrier Power		**NB IoT Guard Band Placement**	**769 to 775MHz (dBm)**	**799 to 805MHz (dBm)**
Band 12	**Band 14**			
Carrier Off	**Single LTE 10 Carrier, 763MHz (MC), 80W**	**Lower**	-60.146	-70.264
Carrier Off	**Single LTE 10 Carrier, 763MHz (MC), 80W**	**Upper**	**-58.959**	-70.237
LTE10 Carrier, 737MHz (MC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Lower**	-59.472	-70.351
LTE10 Carrier, 737MHz (MC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Upper**	-59.165	-70.396

The total measurement RF path loss of the test setup (attenuator, Band 12 carrier blocking filter, Band 14 carrier blocking filter and test cables) is accounted for by an amplitude corrections table programmed into spectrum analyzer as defined below.

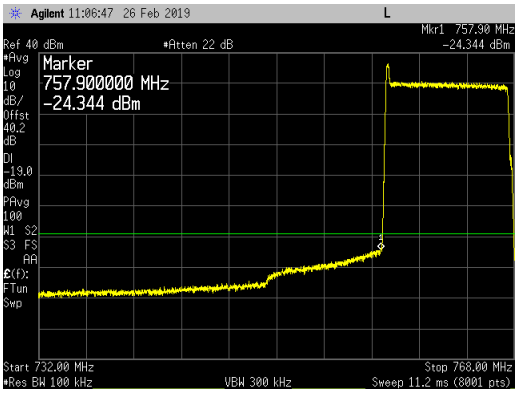
Amplitude Corrections Table for Frequency Ranges of 769MHz to 775MHz and 799MHz to 805MHz											
Frequency (MHz)	**769.00**	**769.05**	**769.10**	**769.15**	**769.20**	**769.25**	**769.30**	**769.40**	**769.50**	**769.60**	**769.70**
Correction (dB)	**47.0**	**46.6**	**46.2**	**45.9**	**45.6**	**45.4**	**45.2**	**44.8**	**44.5**	**44.2**	**44.0**
Frequency (MHz)	**769.80**	**769.90**	**770.00**	**770.20**	**770.50**	**771.00**	**771.50**	**775.00**	**799.00**	**805.00**	
Correction (dB)	**43.9**	**43.7**	**43.6**	**43.3**	**43.0**	**42.5**	**42.2**	**42.1**	**41.1**	**41.1**	

The display line on the plots reflects the required limit. Conducted band edge measurements are provided in the following pages.

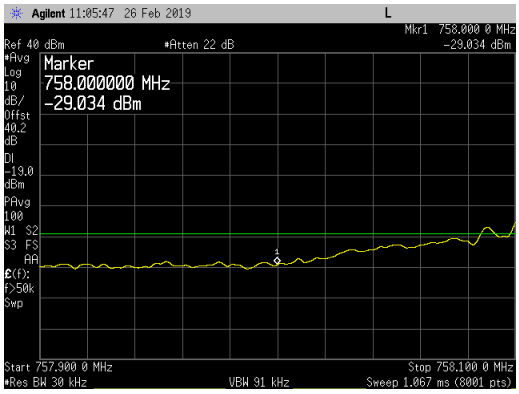
Band 14 LTE10 at Mid Ch (763MHz) 80W Single Narrow Band IoT Guard Band Carrier -Lower Band Edge Plots:

IoT Guard Band Carrier at Lower Placement

Ant 1_LBE_732MHz to 768MHz

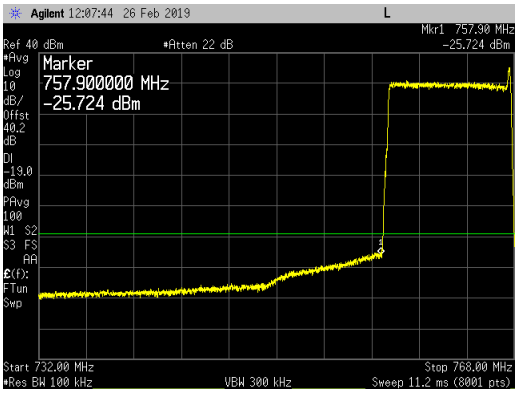


Ant 1_LBE_757.9Mz to 758.1MHz

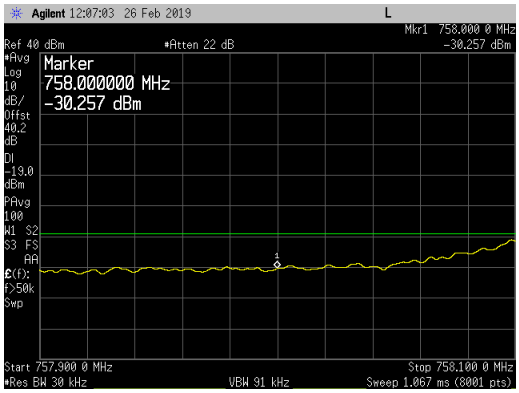


IoT Guard Band Carrier at Upper Placement

Ant 1_LBE_732MHz to 768MHz



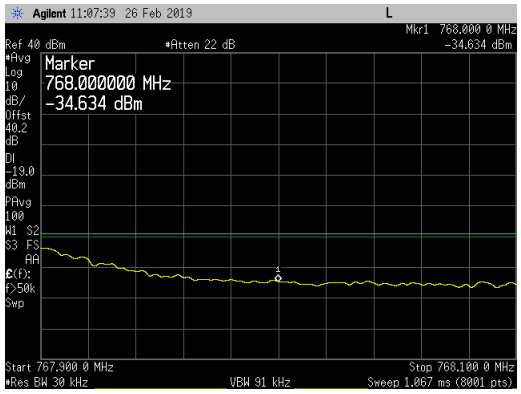
Ant 1_LBE_757.9Mz to 758.1MHz



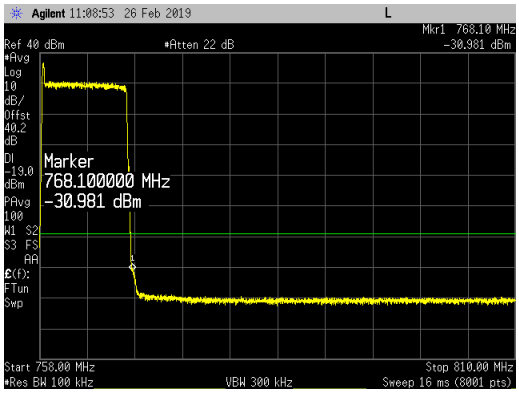
Band 14 LTE10 at Mid Ch (763MHz) 80W Single Narrow Band IoT Guard Band Carrier -Upper Band Edge Plots:

IoT Guard Band Carrier at Lower Placement

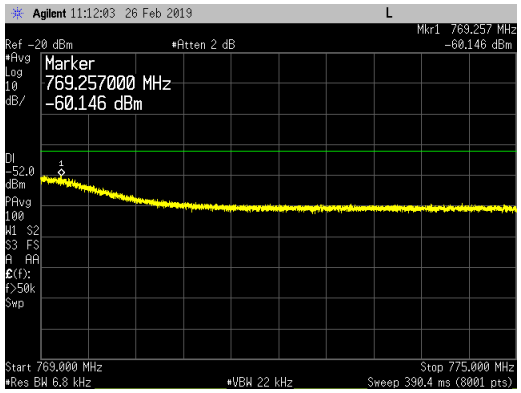
Ant 1_UBE_767.9Mz to 768.1MHz



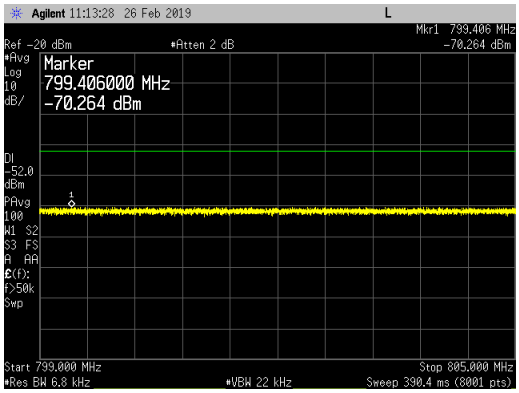
Ant 1_UBE_758Mz to 810MHz



Ant 1_UBE_769MHz to 775MHz



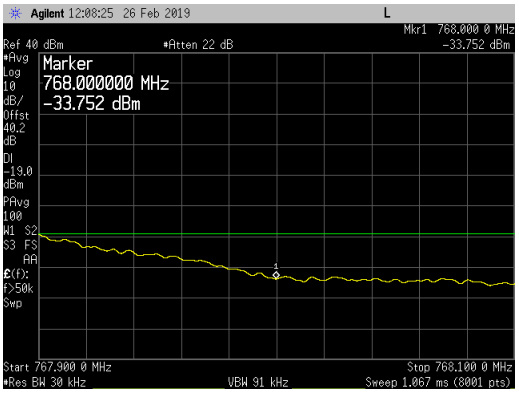
Ant 1_UBE_799MHz to 805MHz



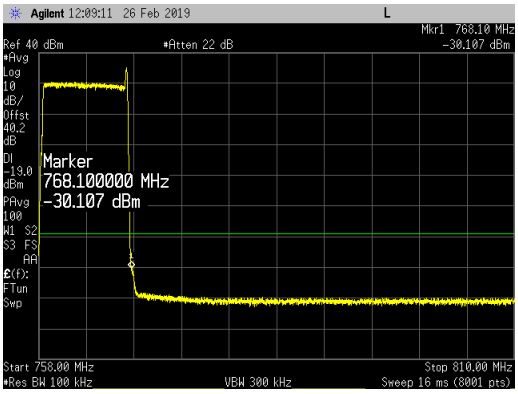
Band 14 LTE10 at Mid Ch (763MHz) 80W Single Narrow Band IoT Guard Band Carrier -Upper Band Edge Plots:

IoT Guard Band Carrier at Upper Placement

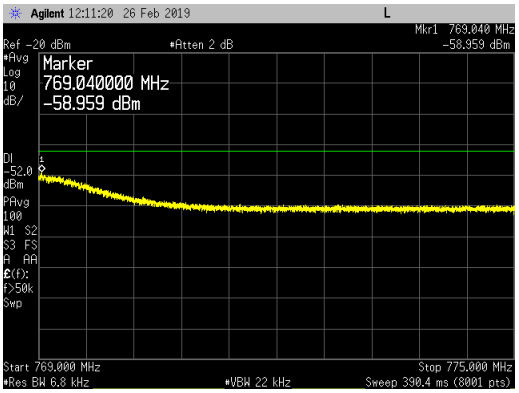
Ant 1_UBE_767.9Mz to 768.1MHz



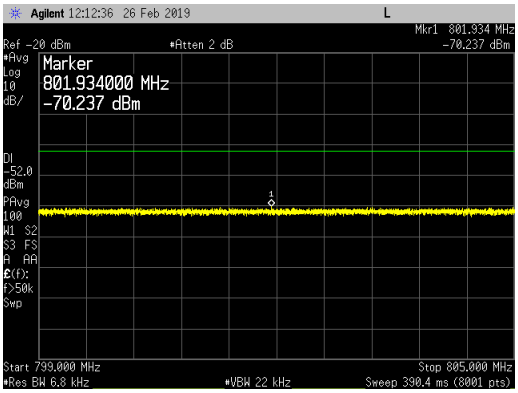
Ant 1_UBE_758Mz to 810MHz



Ant 1_UBE_769MHz to 775MHz



Ant 1_UBE_799MHz to 805MHz

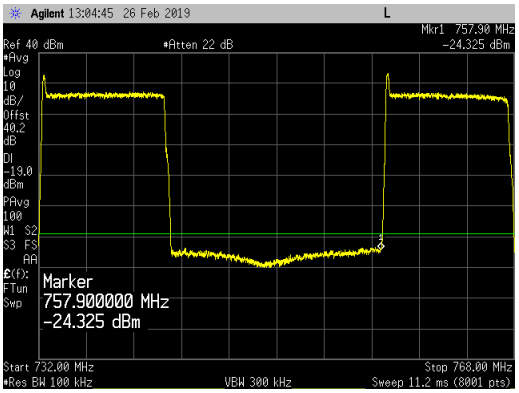


Band 14 Single Narrow Band IoT Guard Band Carrier -Lower Band Edge Plots:

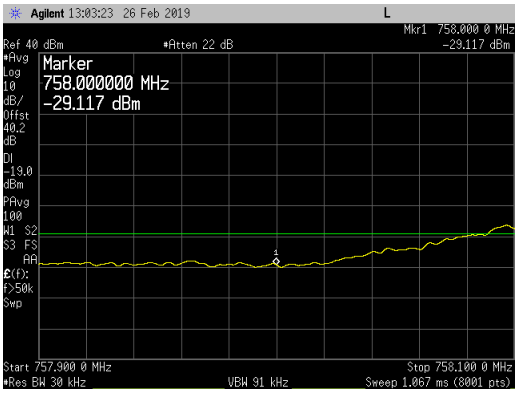
Dual Band [Band 12 at Mid Ch (737MHz) & Band 14 at Mid Ch (763MHz)] 40W + 40W LTE10 Carriers

IoT Guard Band Carrier at Lower Placement

Ant 1_LBE_732MHz to 768MHz

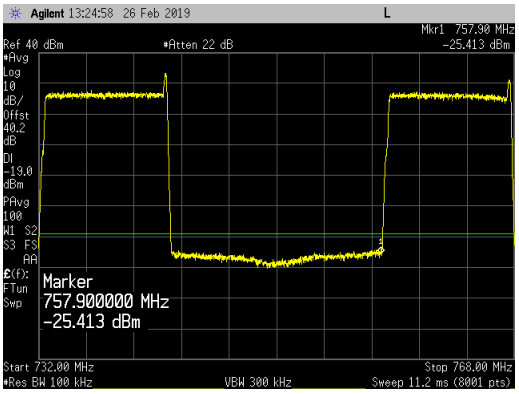


Ant 1_LBE_757.9Mz to 758.1MHz

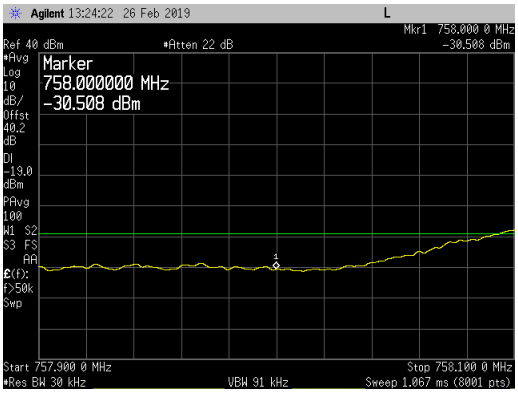


IoT Guard Band Carrier at Upper Placement

Ant 1_LBE_732MHz to 768MHz



Ant 1_LBE_757.9Mz to 758.1MHz

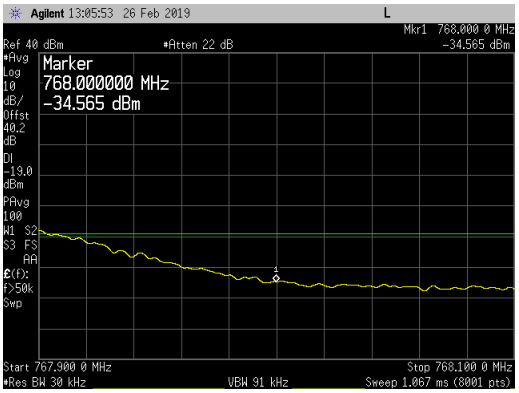


Band 14 Single Narrow Band IoT Guard Band Carrier -Upper Band Edge Plots:

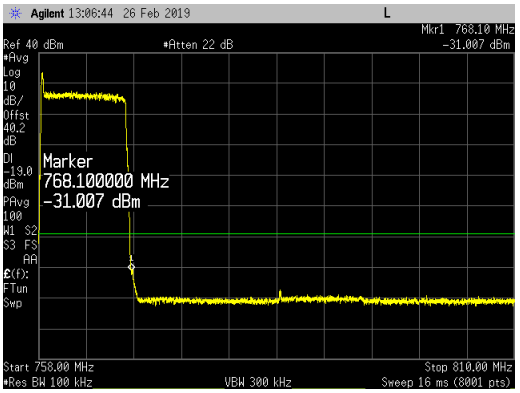
Dual Band [Band 12 at Mid Ch (737MHz) & Band 14 at Mid Ch (763MHz)] 40W + 40W LTE10 Carriers

IoT Guard Band Carrier at Lower Placement

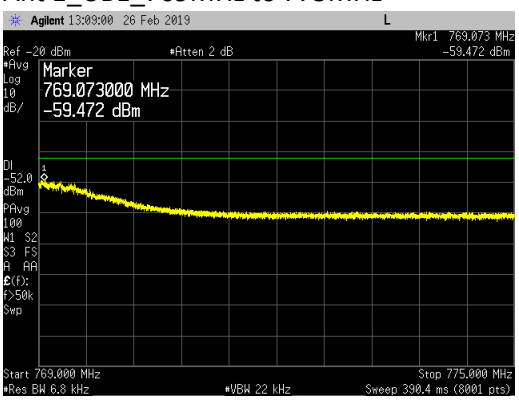
Ant 1_UBE_767.9Mz to 768.1MHz



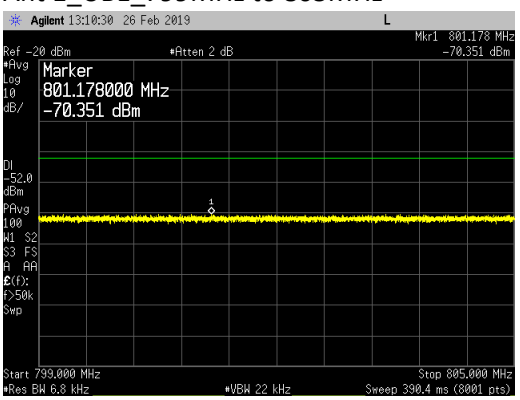
Ant 1_UBE_758Mz to 810MHz



Ant 1_UBE_769MHz to 775MHz



Ant 1_UBE_799MHz to 805MHz

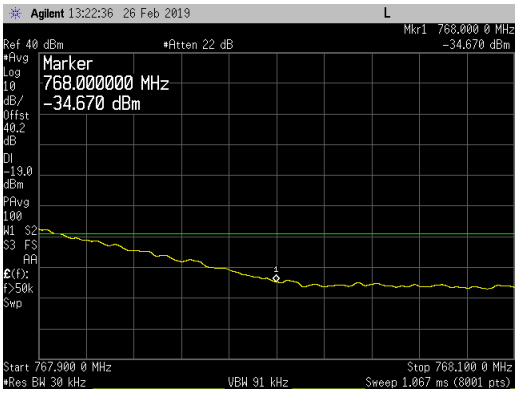


Band 14 Single Narrow Band IoT Guard Band Carrier -Upper Band Edge Plots:

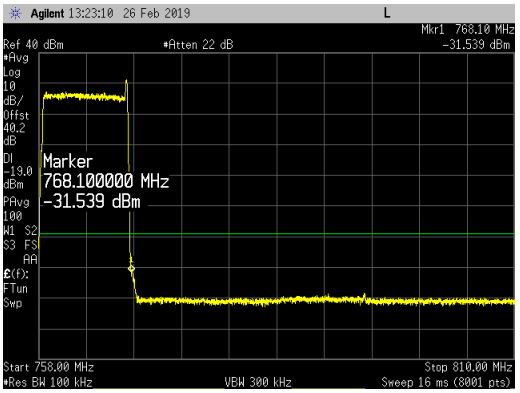
Dual Band [Band 12 at Mid Ch (737MHz) & Band 14 at Mid Ch (763MHz)] 40W + 40W LTE10 Carriers

IoT Guard Band Carrier at Upper Placement

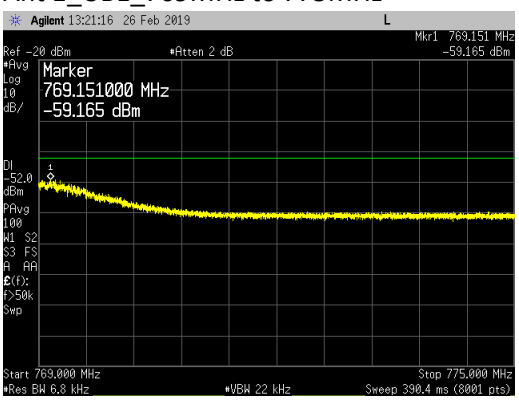
Ant 1_UBE_767.9Mz to 768.1MHz



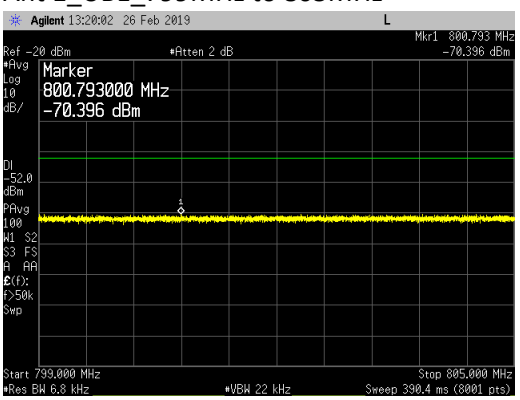
Ant 1_UBE_758Mz to 810MHz



Ant 1_UBE_769MHz to 775MHz



Ant 1_UBE_799MHz to 805MHz



Transmitter Antenna Port Conducted Emissions

Transmitter conducted emission measurements were made at RRH antenna port 1. Measurements were performed over the 9kHz to 8GHz frequency range.

Two test configurations are needed for conducted spurious emission measurements to prove compliance for the 3GPP Band 14 transmitters. The first test will be with the 3GPP Band 14 transmitters enabled at 80 watts per carrier (the 3GPP Band 12 transmitters will not be enabled). The second test will be with the 3GPP Band 12 and the 3GPP Band 14 transmitters enabled simultaneously at 40 watts per carrier (or 80 watts/antenna port).

The RRH was operated on the Band 12 middle channel (737.0MHz) and Band 14 middle channel (763.0MHz) simultaneously with single upper and lower NB IoT GB carriers for 10MHz LTE bandwidth at maximum power (40W/carrier).

The parameters of the first test configuration are provided below:

3GPP Band 12 Transmission Parameters			3GPP Band 14 Transmission Parameters		
Carrier Frequency	Channel Bandwidth	Carrier Power	Carrier Frequency	Channel Bandwidth	Carrier Power
Carrier Idle/Off	N/A	0 Watts	763.0MHz (Mid Ch)	LTE10	80 Watts

The parameters of the second test configuration are provided below:

3GPP Band 12 Transmission Parameters			3GPP Band 14 Transmission Parameters		
Carrier Frequency	Channel Bandwidth	Carrier Power	Carrier Frequency	Channel Bandwidth	Carrier Power
737.0MHz (Mid Ch)	LTE10	40 Watts	763.0MHz (Mid Ch)	LTE10	40 Watts

Note that the conducted spurious emission plots/measurement results for the second test with the 3GPP Band 12 and the 3GPP Band 14 transmitters enabled simultaneously at 40 watts per carrier (or 80 watts/antenna port) are in Appendix A.

The same limit of -19dBm used in the original certification testing is used for this testing. The limit is adjusted to -19dBm [-13dBm -10 log (4)] per FCC KDB 662911D01 v02r01 because the BTS may operate as a 4 port MIMO transmitter. The required measurement parameters include a 100kHz bandwidth with power measured in average value (since transmitter power was measured in average value).

Measurements were performed with a spectrum analyzer using a peak detector with max hold over 50 sweeps (except for the 700MHz to 800MHz frequency range). Measurements for the 700MHz to 800MHz frequency range were performed with the spectrum analyzer in the RMS average mode over 100 traces.

The limit for the 9kHz to 150kHz frequency range was adjusted to –39dBm to correct for a spectrum analyzer RBW of 1kHz versus required RBW of 100kHz [i.e.: -39dBm = -19dBm -10log(100kHz/1kHz)]. The limit for the 150kHz to 20MHz frequency range was adjusted to –29dBm to correct for a spectrum analyzer RBW of 10kHz versus required RBW of 100kHz [i.e.: -29dBm = -19dBm -10log(100kHz/10kHz)]. The required limit of -19dBm with a RBW of ≥100kHz was used for all other frequency ranges. The spectrum analyzer settings that were used for this test are summarized in the following table.

Frequency Range	RBW	VBW	Number of Data Points	Detector	Sweep Time	Max Hold over	Offset Note 1
9kHz to 150kHz	1kHz	3kHz	8001	Peak	Auto	50 Sweeps	40.1dB
150kHz to 20MHz	10kHz	30kHz	8001	Peak	Auto	50 Sweeps	40.1dB
20MHz to 700MHz	300kHz	910kHz	8001	Peak	Auto	50 Sweeps	40.1dB
700MHz to 800MHz	100kHz	300kHz	8001	Average	Auto	Note 2	40.2dB
800MHz to 1.1GHz	100kHz	300kHz	8192	Peak	Auto	50 Sweeps	40.2dB
1.1GHz to 8GHz	2MHz	6MHz	8192	Peak	Auto	50 Sweeps	17.3dB

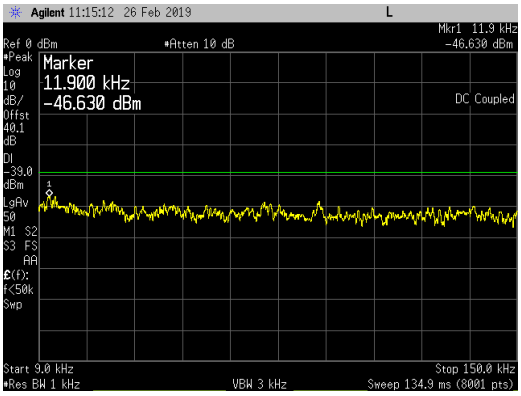
Note 1: The total measurement RF path loss of the test setup (attenuators, filters and test cables) is accounted for by the spectrum analyzer reference level offset.
Note 2: Max Hold not used and instead measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces.

A high pass filter was used to reduce measurement instrumentation noise floor for the frequency range above 1100MHz. The total measurement RF path loss of the test setup (attenuators, high pass filter and test cables) as shown in the table is accounted for by the spectrum analyzer reference level offset. The display line on the plots reflects the required limit.

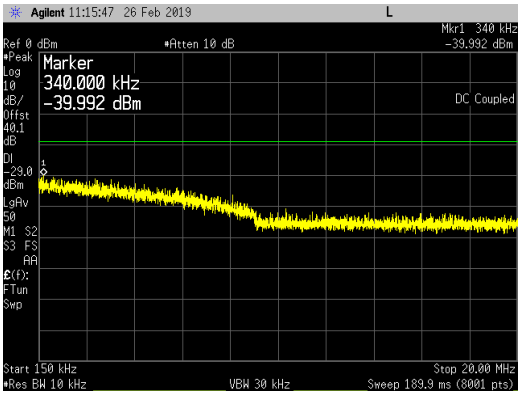
Conducted spurious emission plots/measurements are provided in the following pages.

Band 14 LTE10 Single Narrow Band IoT Lower Guard Band Carrier
-Single Carrier at Middle Channel (763MHz) at 80 watts/carrier and 80 watts/port:

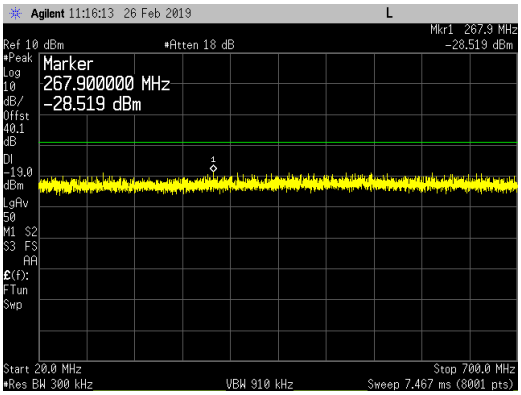
9kHz to 150kHz



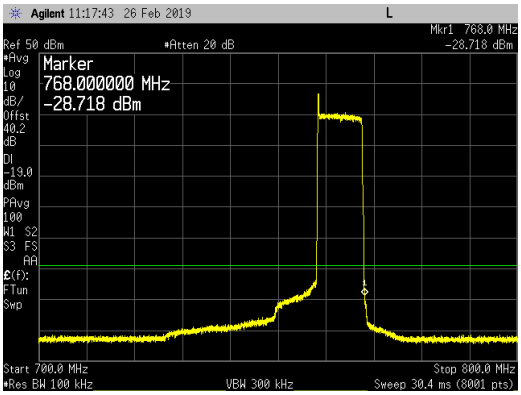
150kHz to 20MHz



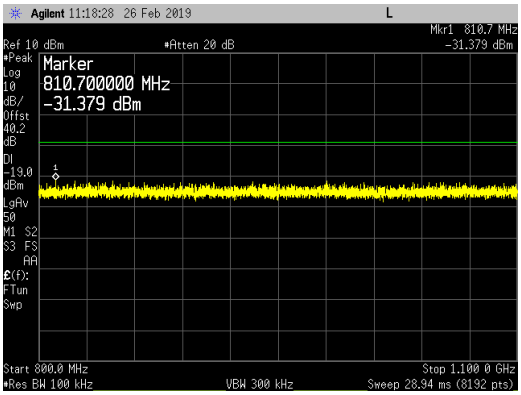
20MHz to 700MHz



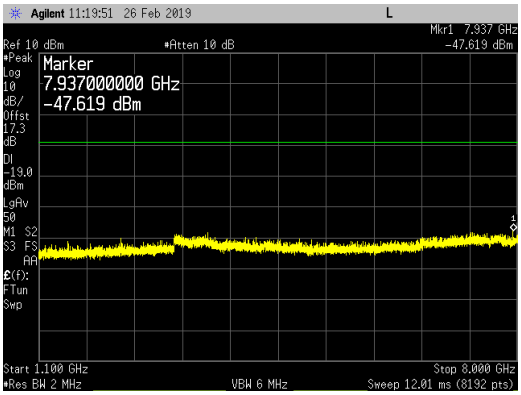
700MHz to 800MHz



800MHz to 1100MHz

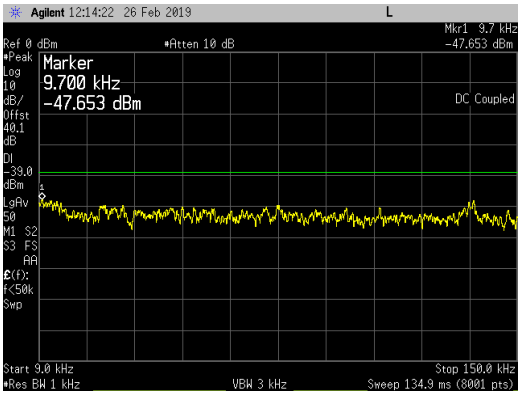


1.1GHz to 8GHz

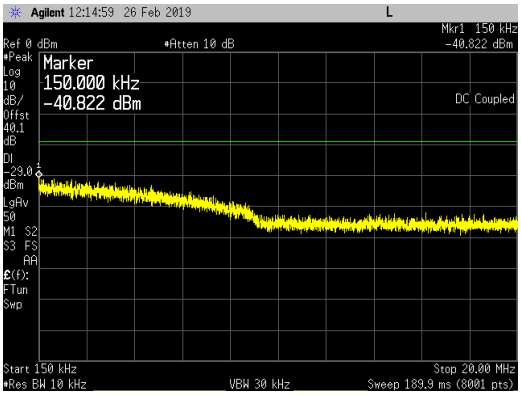


Band 14 LTE10 Single Narrow Band IoT Upper Guard Band Carrier
-Single Carrier at Middle Channel (763MHz) at 80 watts/carrier and 80 watts/port:

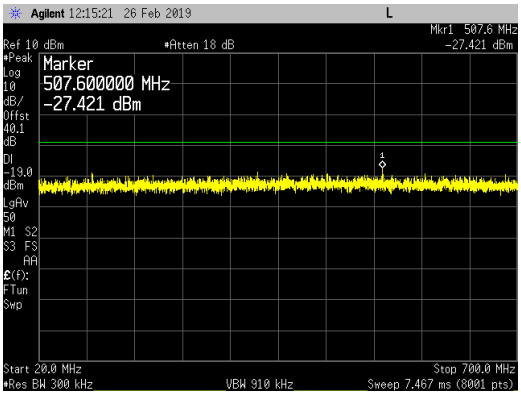
9kHz to 150kHz



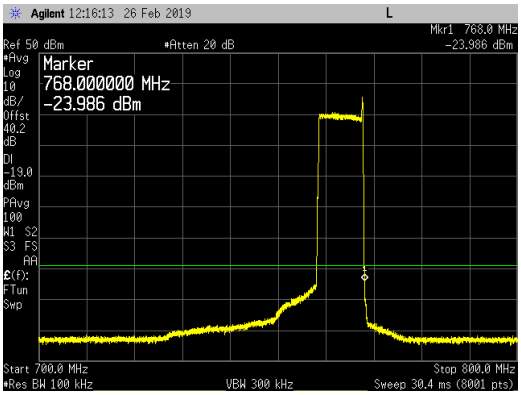
150kHz to 20MHz



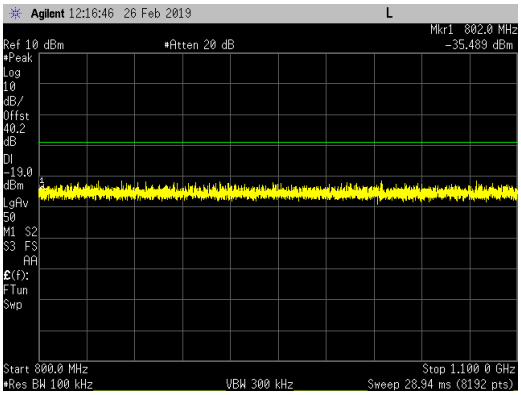
20MHz to 700MHz



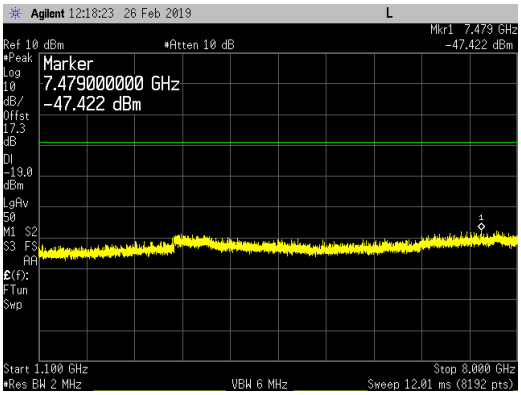
700MHz to 800MHz



800MHz to 1100MHz



1.1GHz to 8GHz



Note that the conducted spurious emission plots/measurement results for the second test with the 3GPP Band 12 and the 3GPP Band 14 transmitters enabled simultaneously at 40 watts per carrier (or 80 watts/antenna port) are in Appendix A.

Transmitter Antenna Port Conducted Emissions in 1559MHz to 1610MHz Frequency Range

Conducted emissions in the frequency range 1559MHz to 1610MHz were measured. The EIRP limit in this band is -70dBW/MHz for wideband signals and -80dBW for discrete emissions of bandwidths less than 700Hz as shown in FCC 90.543(f). This equates to an EIRP of -40dBm/MHz for wideband emissions and -50dBm/MHz for discrete emissions.

The limit is adjusted to -46 dBm [-40 dBm -10 log (4)] for wideband signals and -56dBm [-50 dBm -10 log (4)] for discrete emissions per FCC KDB 662911D01 v02r01 because the BTS may operate as a 4 port MIMO transmitter. The same limit and measurement method used in the original certification testing is used for this testing.

All measurements were made at AHLBA antenna port 1. Tests were conducted with carrier or carriers at maximum power (80W/port) with single and dual band operation. The AHLBA was operated with a single upper and lower NB IoT GB carrier for 10MHz LTE bandwidth. Test cases with Band 12 and Band 14 carriers at the middle channels were conducted. The AHLBA configured for Band 14 LTE10 may operate only on the middle channel since the operational bandwidth is 10MHz wide.

Measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces. A 1MHz RBW and 3MHz VBW was used for all measurements. A 1.1GHz high pass filter was used to block the carrier fundamental frequency to reduce the measurement instrumentation noise floor level. The total measurement RF path loss of the test setup (attenuator, filter and test cables) of 9.7dB is accounted for by the spectrum analyzer reference level offset.

All readings were at the measurement instrumentation noise floor. The highest (worst case) emission from the measurement data was -79.568dBm or -109.568dBW. The results are summarized in the following table.

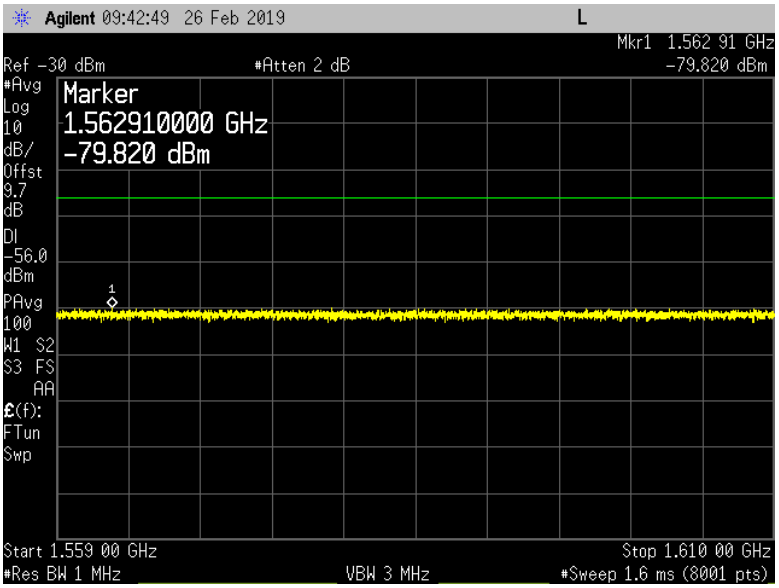
Channel BW, Carrier Frequency, Carrier Power		NB IoT Guard Band Placement	Conducted Emissions in 1559MHz to 1610MHz Frequency Range (dBm)
Band 12	Band 14		
Single LTE10 Carrier, 737MHz (MC), 80W	**Carrier Off**	**Lower**	-79.820
Single LTE10 Carrier, 737MHz (MC), 80W	**Carrier Off**	**Upper**	**-79.568**
Carrier Off	**Single LTE 10 Carrier, 763MHz (MC), 80W**	**Lower**	-79.588
Carrier Off	**Single LTE 10 Carrier, 763MHz (MC), 80W**	**Upper**	-81.493
LTE10 Carrier, 737MHz (MC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Lower**	-79.994
LTE10 Carrier, 737MHz (MC), 40W	**LTE10 Carrier, 763MHz (MC), 40W**	**Upper**	-79.866

Conducted emission plots/measurements for the 1559MHz to 1610MHz frequency range are provided in the following pages. The display line on the plots reflects the required worse case limit (-56dBm).

Band 12 LTE10 Single Narrow Band IoT Lower Guard Band Carrier (Band 14 Carrier Off)

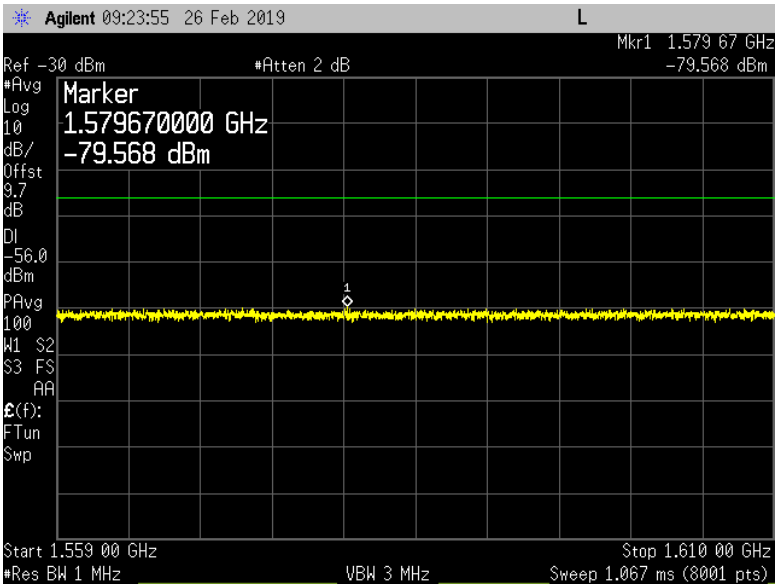
-Single Carrier at Middle Channel (737MHz) at 80 watts/carrier and 80 watts/port:

1559 to 1610 MHz



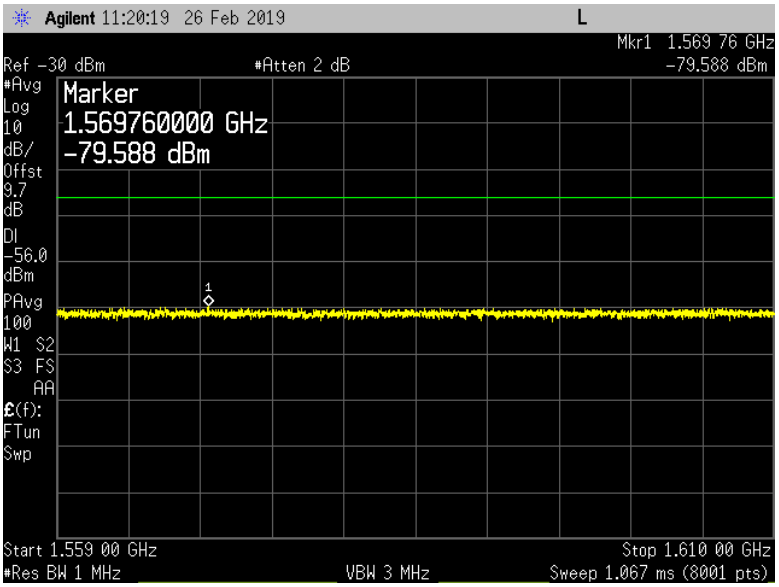
Band 12 LTE10 Single Narrow Band IoT Upper Guard Band Carrier (Band 14 Carrier Off)
-Single Carrier at Middle Channel (737MHz) at 80 watts/carrier and 80 watts/port:

1559 to 1610 MHz



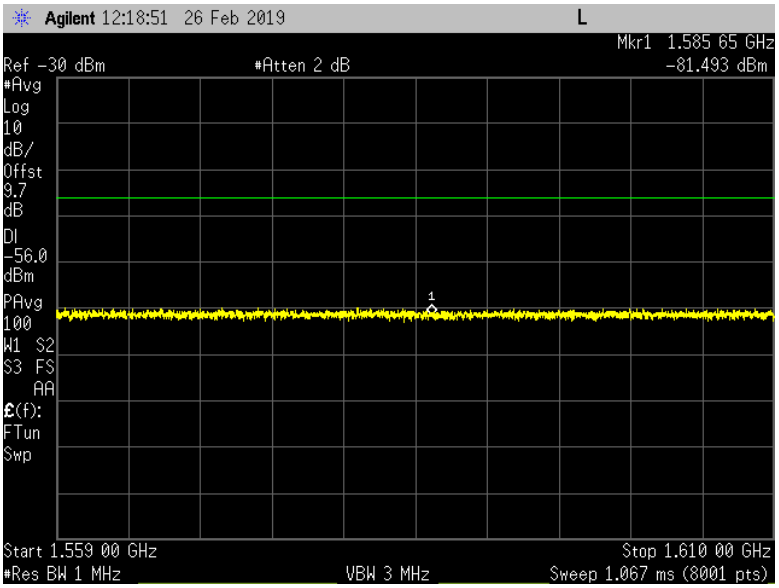
Band 14 LTE10 Single Narrow Band IoT Lower Guard Band Carrier (Band 12 Carrier Off) -Single Carrier at Middle Channel (763MHz) at 80 watts/carrier and 80 watts/port:

1559 to 1610 MHz



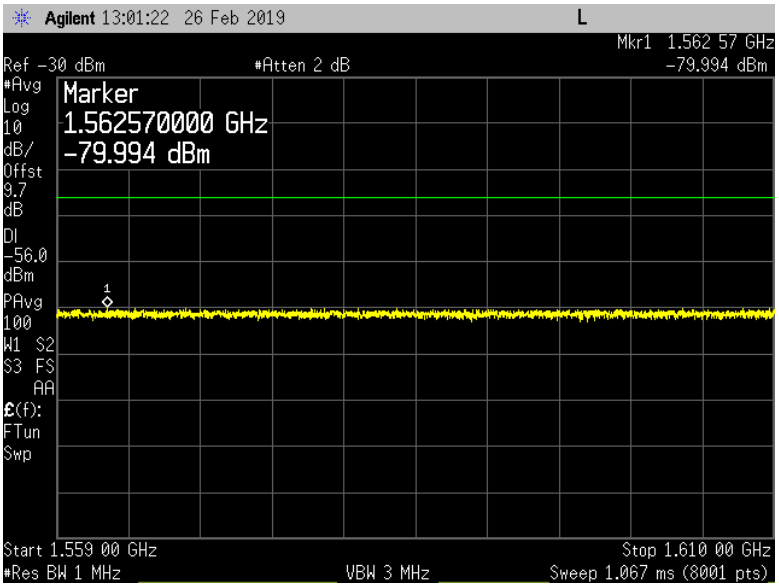
Band 14 LTE10 Single Narrow Band IoT Upper Guard Band Carrier (Band 12 Carrier Off) -Single Carrier at Middle Channel (763MHz) at 80 watts/carrier and 80 watts/port:

1559 to 1610 MHz



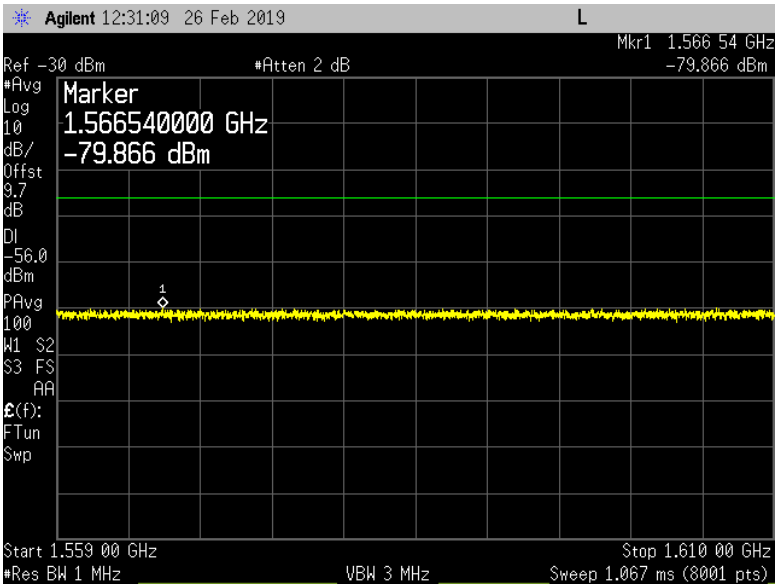
Band 12 and Band 14 LTE10 Single Narrow Band IoT Lower Guard Band Carriers (80W/Port)
- Dual Band [Band 12 at Mid Ch (737MHz) + Band 14 at Mid Ch (763MHz)] 40W + 40W LTE10 Carriers:

1559 to 1610 MHz



Band 12 and Band 14 LTE10 Single Narrow Band IoT Upper Guard Band Carriers (80W/Port)
- Dual Band [Band 12 at Mid Ch (737MHz) + Band 14 at Mid Ch (763MHz)] 40W + 40W LTE10 Carriers:

1559 to 1610 MHz



Transmitter Radiated Spurious Emissions

Radiated spurious emission plots/measurement results are in the original FCC and IC radio certification submittal (NTS Test Report Number PR078121 Revision 0 dated May 4, 2018).

Frequency Stability/Accuracy

Frequency Stability/Accuracy measurement results are in the original FCC and IC radio certification submittal (NTS Test Report Number PR078121 Revision 0 dated May 4, 2018).

END OF REPORT