Radio Test Report

Application for a Class II Permissive Change Equipment Authorization

FCC Part 27 Subpart C
617MHz – 652MHz
and
728MHz – 746MHz

CERTIFICATE #: 0214.19

FCC ID: VBNAHLOA-01

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

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

Test Sites: National Technical Systems – Plano
1701 E Plano Pkwy #150
Plano, TX 75074

NTS Plano FCC Laboratory Designation No.: US1077

Test Dates: August 27-28, 2019
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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	09/04/2019	Initial Draft	BreAnna Cheatham

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SCOPE

Tests have been performed on Nokia Solutions and Networks product Airscale Base Station Remote Radio Head (RRH) Model AHLOA, 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

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 AHLOA 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 and Canada, 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 AHLOA. 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 AHLOA 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 617 to 652MHz Band)

AHLOA operating in 617MHz to 652MHz Frequency Band				
FCC	Description	Measured	Limit	Results
Transmitter Modulation, output power and other characteristics				
§27.5	Frequency Ranges	NB IoT Stand-alone: 617.2 – 651.8MHz	617.0MHz to 652.0MHz	Pass
§2.1033(c)(4)	Modulation Type	NB IoT Stand-alone	Digital	Pass
§27.50	Output Power	Highest Conducted Port Power Output RMS: 47.9dBm Highest Conducted Carrier Power Output RMS: 43.3dBm ERP depends on antenna gain which is unknown	1000W ERP	Pass
Informational	Peak to Average Power Ratio	Highest Measured PAPR: 8.6dB	13dB	Pass
§2.1049	99% Emission Bandwidth	NB IoT Stand-Alone: 196.1kHz	Remain in Block	Pass
	26dB down Emission Bandwidth	NB IoT Stand-Alone: 277.6kHz Emission Designator: 278KG7D	Remain in Block	Pass
Transmitter Spurious Emissions[1]				
§27.53(g)	At the antenna terminals	< -13dBm	-13dBm per Transmit Chain	Pass[1]
	Field Strength	41.942dBuV/m at 3m Eq. to -53.231dBm EIRP	-13dBm EIRP	Pass[2]
Other Details				
§27.54	Frequency Stability	Stays within authorized frequency block 0.0015ppm	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 April 25, 2018).
Note 3: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

FCC Part 27 Subpart C (Base Stations Operating in the 728 to 746MHz Band)

AHLOA operating in 728MHz to 746MHz Frequency Band				
FCC	Description	Measured	Limit	Results
Transmitter Modulation, output power and other characteristics				
§27.5	Frequency Ranges	NB IoT Stand-alone: 728.2 – 745.8MHz	728.0MHz to 746.0MHz	Pass
§2.1033(c)(4)	Modulation Type	NB IoT Stand-alone	Digital	Pass
§27.50	Output Power	Highest Conducted Port Power Output RMS: 47.7dBm Highest Conducted Carrier Power Output RMS: 43.3dBm ERP depends on antenna gain which is unknown	1000W ERP	Pass
Informational	Peak to Average Power Ratio	Highest Measured PAPR: 8.9dB	13dB	Pass
§2.1049	99% Emission Bandwidth	NB IoT Stand-alone: 196.2kHz	Remain in Block	Pass
	26dB down Emission Bandwidth	NB IoT Stand-alone: 276.9kHz Emission Designator: 277KG7D	Remain in Block	Pass
Transmitter Spurious Emissions[1]				
§27.53(g)	At the antenna terminals	NB IoT Stand-alone: < -13dBm	-13dBm per Transmit Chain	Pass[1]
	Field Strength	41.523dBuV/m at 3m Eq. to -53.677dBm EIRP	-13dBm EIRP	Pass[2]
Other Details				
§27.54	Frequency Stability	Stays within authorized frequency block 0.0013ppm	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 April 25, 2018).
Note 3: 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 narrow band IoT (internet of things) standalone operations to the Airscale BTS RRH model AHLOA Federal Communication Commission certifications. The original FCC radio certification submittal was NTS Test Report Number PR078121 Revision 0 dated April 25, 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 standalone carriers 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. 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 NB-IoT standalone testing was setup according to the 3GPP TS 36.141 E-UTRA Test Model “N-TM (narrow band IoT)”.

The testing was performed on the same hardware (AHLOA) as the original certification test. The same AHLOA RF port (Ant 4) 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 standalone carrier 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 AHLOA. The AHLOA 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 NB-IoT standalone operations.

The AHLOA RRH has four transmit/four receive antenna ports (4TX/4RX for Band 71 and 4TX/4RX for Band 85). Each antenna port supports 3GPP frequency band 71 (BTS Rx: 663 to 698 MHz/BTS TX: 617 to 652 MHz) and 3GPP frequency band 85 (BTS Rx: 698 to 716 MHz/BTS TX: 728 to 746 MHz). The maximum RF output power of the RRH is 240 Watts (60 watts per antenna port, 60 watts per LTE carrier, 20 watts per NB-IoT standalone 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 NB-IoT standalone carrier operations with a 200kHz bandwidth channel and QPSK modulation over 3GPP bands 71 and 85. The NB-IoT standalone carrier are for non-MIMO RRH operations.

The AHLOA channel numbers and frequencies are provided below for NB-IoT standalone operations. The NB-IoT standalone carrier channel bandwidth is 200kHz. The minimum spacing between adjacent NB-IoT standalone carriers is 300kHz. The frequency spacing is 100 kHz between channel numbers. The maximum power per NB-IoT standalone carrier is 20 watts. Three standalone carriers operating simultaneously are required for maximum port power (60W).

	Downlink EARFCN	Downlink Frequency (MHz)	NB-IoT Standalone Channels
Band 71 (Ant 1, 2, 3, 4)	68586	617.0	Band Edge
	68587	617.1	
	68588	617.2	Bottom Channel
	68589	617.3	Bottom Channel + 1
	……		
	68761	634.5	Middle Channel
	……		
	68933	651.7	Top Channel - 1
	68934	651.8	Top Channel
	68935	651.9	
	68936	652.0	Band Edge

AHLOA Downlink Band Edge Band 71 NB-IoT Standalone Frequency Channels

Multicarrier test cases:

(1) Three band 71 carriers with minimum spacing between carriers at the lower band edge are EARFCN 68588: 617.2MHz, EARFCN 68591: 617.5MHz and EARFCN 68594: 617.8MHz.
(2) Three band 71 carriers with minimum spacing between carriers at the center frequency are EARFCN 68758: 634.2MHz, EARFCN 68761: 634.5MHz and EARFCN 68764: 634.8MHz.
(3) Three band 71 carriers with minimum spacing between carriers at the upper band edge are EARFCN 68928: 651.2MHz, EARFCN 68931: 651.5MHz and EARFCN 68934: 651.8MHz.
(4) Three band 71 carriers based upon KDB 971168 D03v01 using two carriers at the lower band edge with minimum spacing between carriers and one carrier at the upper band edge with maximum spacing between the other two carriers are EARFCN 68588: 617.2MHz, EARFCN 68591: 617.5MHz and EARFCN 68934: 651.8MHz.
(5) Three multiband carriers based upon KDB 971168 D03v01 using two band 71 carriers at the lower band edge with minimum spacing between carriers and one band 85 carrier at the upper band edge with maximum spacing between the other two carriers are EARFCN 68588: 617.2MHz, EARFCN 68591: 617.5MHz and EARFCN 5178: 745.8MHz.

	Downlink EARFCN	Downlink Frequency (MHz)	NB-IoT Standalone Channels
Band 85 (Ant 1, 2, 3, 4)	70366	728.0	Band Edge
	70367	728.1	
	70368	728.2	Bottom Channel
	70369	728.3	Bottom Channel + 1
	……		
	70456	737.0	Middle Channel
	……		
	70543	745.7	Top Channel - 1
	70544	745.8	Top Channel
	70545	745.9	
	70546	746.0	Band Edge

AHLOA Downlink Band Edge Band 85 NB-IoT Standalone Frequency Channels

Multicarrier test cases:

(1) Three band 85 carriers with minimum spacing between carriers at the lower band edge are EARFCN 70368: 728.2MHz, EARFCN 70371: 728.5MHz and EARFCN 70374: 728.8MHz.
(2) Three band 85 carriers with minimum spacing between carriers at the center frequency are EARFCN 70453: 736.7MHz, EARFCN 70456: 737.0MHz and EARFCN 70459: 737.3MHz.
(3) Three band 85 carriers with minimum spacing between carriers at the upper band edge are EARFCN 70538: 745.2MHz, EARFCN 70541: 745.5MHz and EARFCN 70544: 745.8MHz.
(4) Three band 85 carriers based upon KDB 971168 D03v01 using two carriers at the lower band edge with minimum spacing between carriers and one carrier at the upper band edge with maximum spacing between the other two carriers are EARFCN 70368: 728.2MHz, EARFCN 70371: 728.5MHz and EARFCN 70544: 745.8MHz.
(5) Three multiband carriers based upon KDB 971168 D03v01 using two band 71 carriers at the lower band edge with minimum spacing between carriers and one band 85 carrier at the upper band edge with maximum spacing between the other two carriers are EARFCN 68588: 617.2MHz, EARFCN 68591: 617.5MHz and EARFCN 70544: 745.8MHz.

EUT Hardware

The EUT hardware used in testing on August 27-28, 2019.

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	AHLOA	AirScale BTS RRH	Part#: 474331A.101 Serial#: K9180540675	FCC ID: VBNAHLOA-01

Enclosure

The EUT enclosure is made of heavy-duty aluminum.

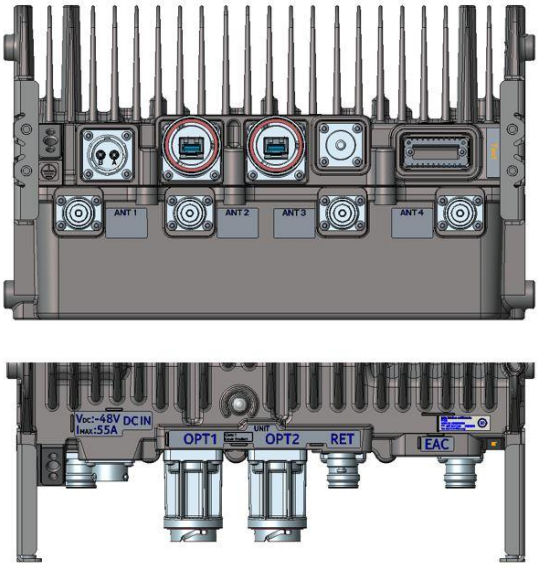
Support Equipment

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
HP	Elite Book 6930p	Laptop 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	MA17331610190
RLC Electronics	1.2GHz High Pass Filter[1]	F-14699	0050
Weinschel	Attenuator 20dB -150 Watt[1]	66-20-33-LIM	BZ2075
Weinschel	Attenuator 20dB -150 Watt[1]	66-20-33-LIM	BZ1165
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.			

AHLOA 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: FRM59.06.R14K
(2) System Module Software: SBTS19A_ENB_0000_000229_000135

Modifications

No modifications were made to the EUT during testing.

TESTING

General Information

Antenna port measurements were taken at NTS Plano branch (by Christian Booker) located at 1701 E Plano Pkwy #150 Plano, TX 75074.

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 April 25, 2018 for details).

Measurement Procedures

The RMS average output power, peak power, emission bandwidth, conducted spurious and conducted band edge measurements were performed with a spectrum 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 5.2 of FCC KDB 971168 D01v03r01 and ANSI C63.26 and the screenshots were captured using Keysight Benchvue Software. Peak power measurements were performed as described in section 5.1 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.3 and the screenshots were captured using Keysight Benchvue Software. The peak to average power ratio (PAPR) was calculated as described in section 5.7 of KDB971168 D01v03r01 and ANSI C63.26-2015 section 5.2.6. 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 1.2GHz. 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.

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 600MHz, 600 to 800MHz and 800MHz to 1.2GHz Measurements

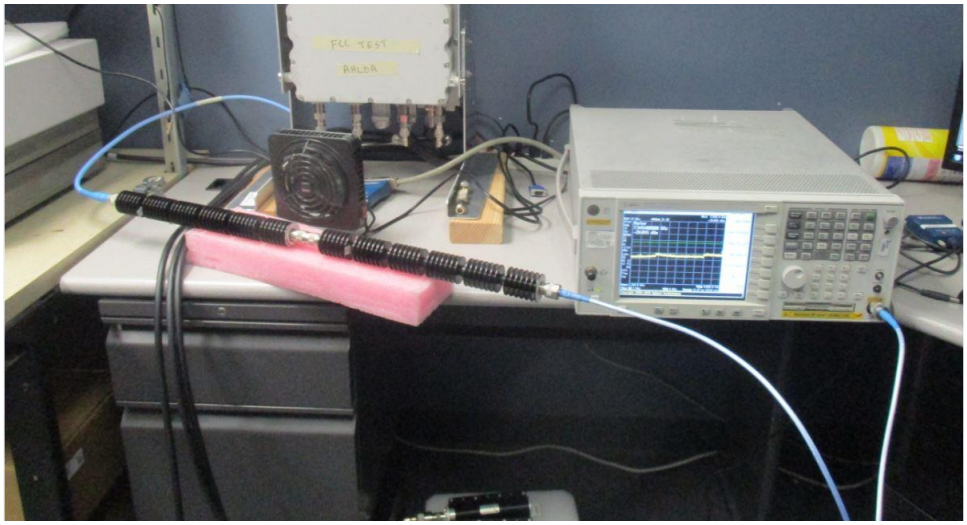
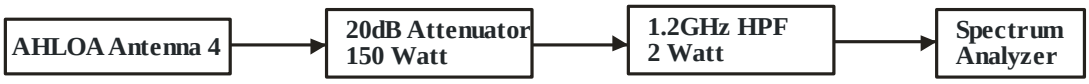
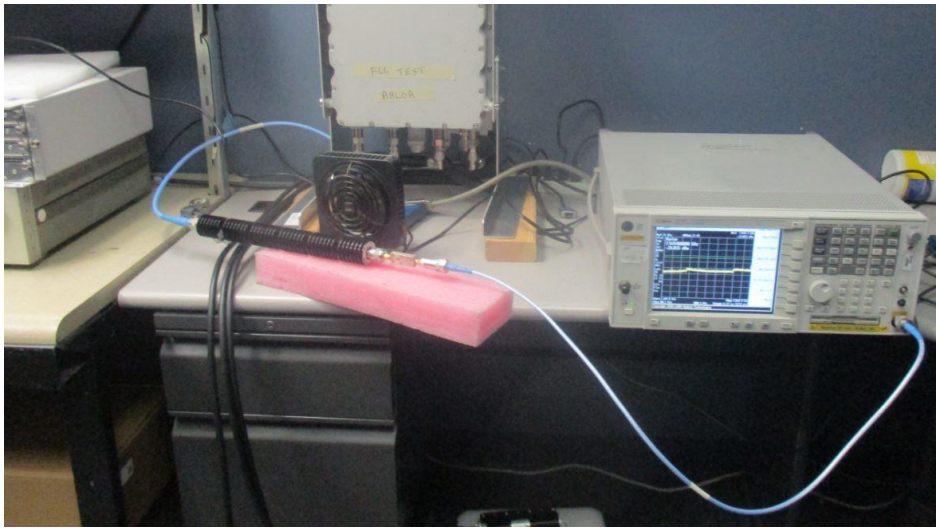


Photo of 9kHz to 150kHz, 150kHz to 20MHz, 20MHz to 600MHz, 600 to 800MHz and 800MHz to 1.2GHz Setup



Setup for 1.2GHz to 8GHz Measurements



Photograph of 1.2GHz to 8GHz Test Setup

Test Measurement Equipment

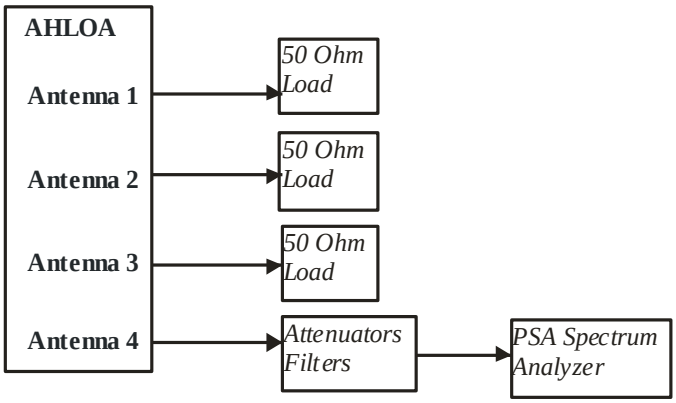
NTS Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
WC021617	PSA Spectrum Analyzer	Agilent	E4440A	12 Months	06/04/2020
WC025239	Analog Signal Generator	Agilent	E8257D	12 Months	09/06/2019

APPENDIX A: ANTENNA PORT TEST DATA FOR NB-IOT STANDALONE BAND 71 (617-652MHz)

All conducted RF measurements in this section were made at AHLOA antenna port 4. The testing was performed on the same hardware (EUT) as the original certification test. The same EUT RF port (Ant 4) determined in the original certification testing to be the highest power port was used for all testing in this effort.

All testing in this appendix was performed with standalone carriers for Band 71. The NB-IoT standalone testing was setup according to the 3GPP TS 36.141 E-UTRA Test Model "N-TM (narrow band IoT)".

The test setup used is provided below.



Test Setup Used for AHLOA Conducted RF Measurements

RF Output Power

RF output power has been measured in both Peak and RMS Average terms at the AHLOA Antenna Port 4 transmit chain [LTE Band 71 (617 to 652MHz)] at the bottom, middle and top frequency channels for a NB-IoT stand-alone single carrier (QPSK). RMS Average power was measured as described in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 sections 5.2.4.3 & 5.2.4.4. Peak power was measured as described in section 5.1 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.3.3. The peak to average power ratio (PAPR) has been calculated as described in section 5.7 of KDB971168 D01v03r01 and ANSI C63.26-2015 section 5.2.6.

The RMS Average power output on Antenna Port 4 (3GPP frequency band 71) was also measured using three carriers per antenna port on the bottom, middle and top channels (with minimum spacing between carrier frequencies). The port power measurements are required to be performed with multiple carriers to produce maximum power output on the port. The maximum single carrier power output is 20 watts while the maximum port power output is 60 watts. All results are presented in tabular form below. The highest measured values for carrier peak power, carrier average power, carrier PAPR and port average power are highlighted. Measurements were rounded off to the nearest tenth.

Antenna Port RF Channel	Stand-alone Carrier Frequencies	Measurement	Peak (dBm)	Average (dBm)	PAPR (dB)
Port 4 Bottom Channel	**617.2 MHz**	**Carrier Power**	51.3	**43.3**	8.0
	617.2, 617.5 and 617.8 MHz	**Port Power**	N/A	47.1	N/A
Port 4 Middle Channel	**634.5 MHz**	**Carrier Power**	**51.7**	43.2	8.5
	634.2, 634.5 and 634.8 MHz	**Port Power**	N/A	**47.9**	N/A
Port 4 Top Channel	**651.8 MHz**	**Carrier Power**	51.2	42.6	**8.6**
	651.2, 651.5 and 651.8 MHz	**Port Power**	N/A	47.0	N/A

RF output power in RMS Average terms for the KDB 971168 Band 71 multicarrier test case to verify/document the power levels. All results are presented in tabular form below.

Measured RMS Average Power Level for the Multicarrier Configuration at Antenna Port 4	
Band 71 KDB 971168 Multicarrier Test Case	
Bottom Carriers: **617.2 & 617.5MHz**	**Top Carrier:** **651.8MHz**
45.1 dBm (32.4 Watts)	42.9 dBm (19.5 Watts)
Total Port Power (Band 71 carriers) is 51.9 Watts or 47.2 dBm	

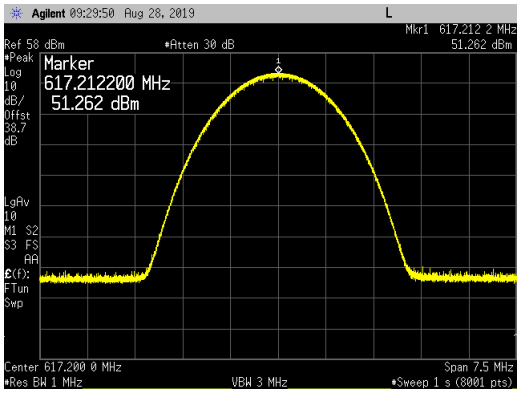
RF output power in RMS Average terms for KDB 971168 Band 71/Band 85 multiband multicarrier test case to verify/document the power levels. All results are presented in tabular form below.

Measured RMS Average Power Level for the Multiband Multicarrier Configuration at Ant Port 4	
Band 71/Band 85 KDB 971168 Multicarrier Test Case	
Bottom Carriers: **617.2 & 617.5MHz**	**Top Carrier:** **745.8MHz**
45.1 dBm (32.4 Watts)	42.4 dBm (17.4 Watts)
Total Port Power (Band 71 & Band 85 carriers) is 49.8 Watts or 47.0 dBm	

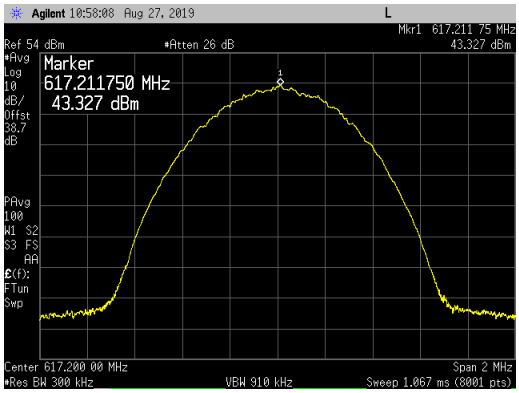
All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 38.7 dB and is accounted for by the spectrum analyzer reference level offset.

Band 71 Single Standalone Carrier Power Plots at Antenna Port 4:

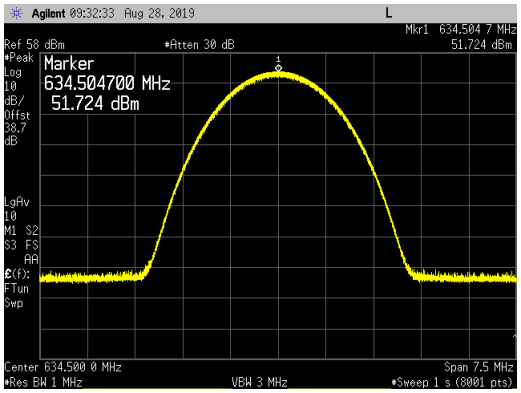
Bot Ch_ 617.2MHz_ Carrier Pwr_ Peak



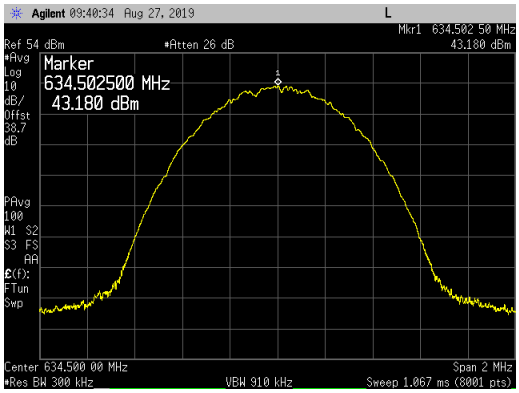
Bot Ch_ 617.2MHz_ Carrier Pwr_ Average



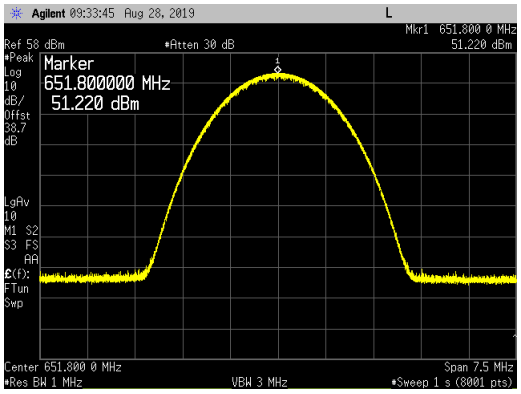
Mid Ch_ 634.5MHz_ Carrier Pwr_ Peak



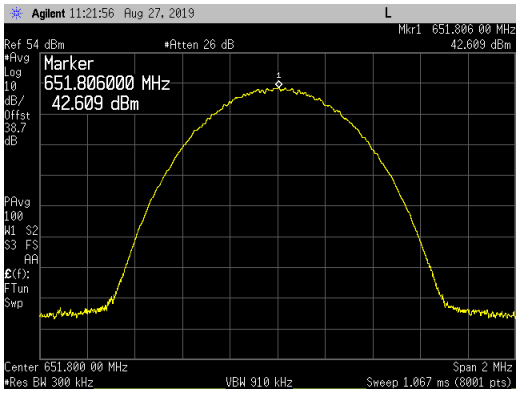
Mid Ch_ 634.5MHz_ Carrier Pwr_ Average



Top Ch_ 651.8MHz_ Carrier Pwr_ Peak

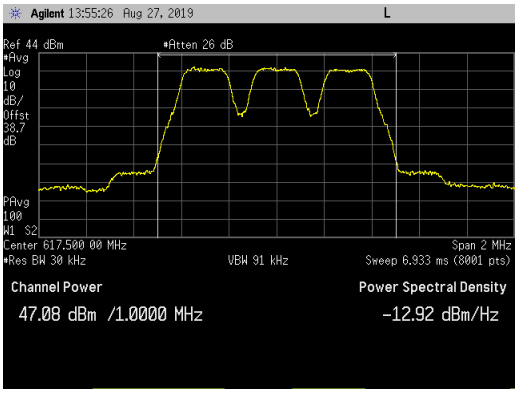


Top Ch_ 651.8MHz_ Carrier Pwr_ Average

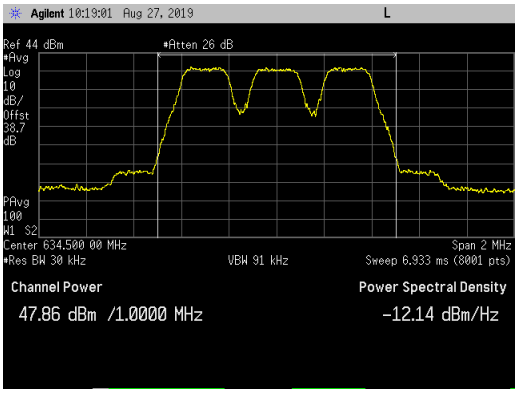


Band 71 Three Standalone Multicarrier Power Plots at Antenna Port 4:

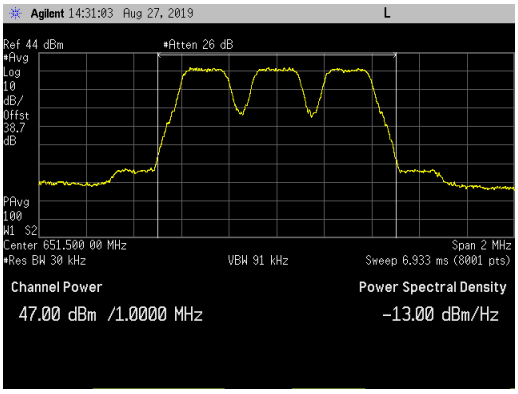
Bot Chs_ 617.2, 617.5, 617.8MHz_ Port Pwr_ Average



Mid Chs_ 634.2, 634.5, 634.8MHz_ Port Pwr_ Average

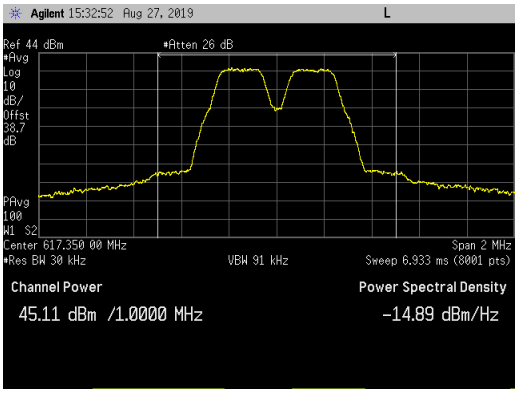


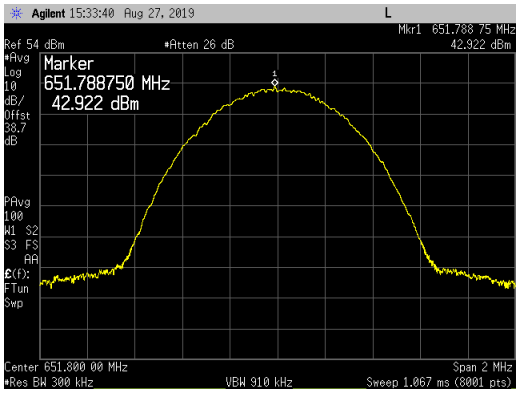
Top Chs_ 651.2, 651.5, 651.8MHz_ Port Pwr_ Average



Band 71 Three Standalone KDB 971168 Multicarrier Power Plots at Antenna Port 4:

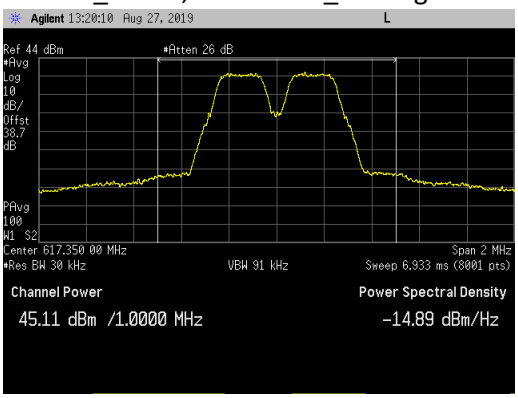
Bot Chs_ 617.2, 617.5MHz _ Average and Top Ch_ 651.8MHz _ Average

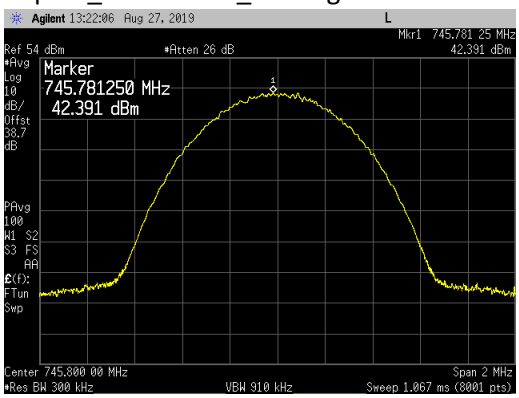




Band 71/Band 85 Three Standalone KDB 971168 Multicarrier Power Plots at Antenna Port 4:

Bot Chs_ 617.2, 617.5MHz _ Average and Top Ch_ 745.8MHz _ Average





Emission Bandwidth (26 dB down and 99%)

Emission bandwidth measurements were made at AHLOA antenna port 4 on the bottom, middle and top channels for frequency band 71. The AHLOA was operated at maximum RF carrier output power (20W/Carrier) for NB-IoT standalone single carrier (QPSK).

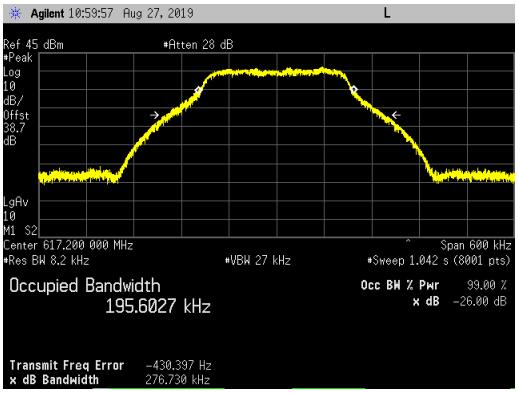
The 26dB emission bandwidth was measured in accordance with section 4 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.4. The 99% occupied bandwidth was measured in accordance with section 6.7 of RSS-Gen Issue 5. For both measurements, an occupied bandwidth built-in function in the spectrum analyzer was used. The results are provided in the following table. The largest emission bandwidths are highlighted. Measurements were rounded off to the nearest tenth.

Antenna Port 4 LTE NB-IoT Standalone Carrier	26dB Emission Bandwidth (kHz)	99% Emission Bandwidth (kHz)
Bottom Channel	276.7	195.6
Middle Channel	**277.6**	**196.1**
Top Channel	275.9	194.1

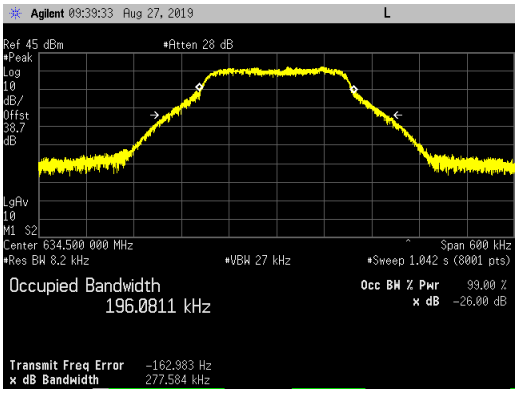
Emission bandwidth measurement data are provided in the following pages.

Emission Bandwidth Plots for NB-IoT Standalone Carriers on Port 4:

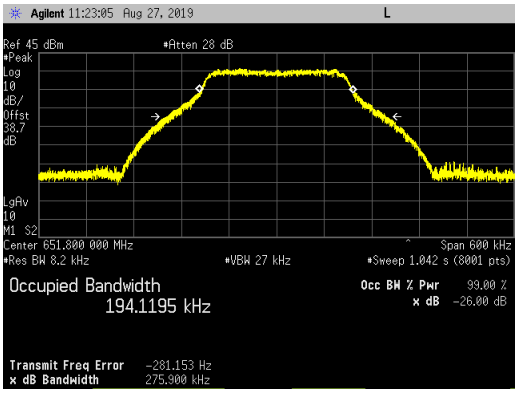
Bottom Channel



Middle Channel



Top Channel



Antenna Port Conducted Band Edge

Conducted band edge measurements were made at RRH antenna port 4 using NB-IoT standalone carrier (QPSK).

Single Carrier Test Case
The RRH was operated at maximum power with a single Band 71 carrier at the band edge frequencies.

Multicarrier Test Cases
Measurements were also performed with three Band 71 carriers (with minimum spacing between carrier frequencies) on the bottom and top channels. Three carriers are required to produce maximum port power output. The maximum single carrier power output is 20 watts while the maximum port power output is 60 watts

Another multicarrier test case based upon KDB 971168 D03v01 using three Band 71 carriers (60 watts/port and 20 watts/carrier) was performed with two carriers (with minimum spacing between carrier frequencies) at the lower band edge (i.e.: 617.2MHz and 617.5MHz) and a third carrier (with maximum spacing between the other two carrier frequencies) at the upper band edge (651.8MHz).

Multiband Multicarrier Test Case
A multiband (Band 71 and Band 85) multicarrier test case based upon KDB 971168 D03v01 using three carriers per antenna port was performed at maximum power (60 watts/port and 20 watts/carrier). Two Band 71 carriers (with minimum spacing between carrier frequencies) at the lower band edge (i.e.: 617.2MHz and 617.5MHz) and a third carrier with maximum spacing between the other two carrier frequencies at Band 85 top channel (i.e.: 745.8MHz). This test case is documented in Appendix B for the Band 85 carrier.

The power of any emission outside of the authorized operating frequency range cannot exceed -13 dBm as specified in FCC 27.53(g). The NB-IoT standalone carrier are for non-MIMO RRH operations.

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. In the 100 to 200kHz frequency range outside the band edge (i.e.: 616.8 to 616.9MHz and 652.1 to 652.2MHz bands) the RBW was set to 30kHz and the power integrated over 100kHz. In the 200kHz to 22.2MHz frequency range outside the band edge (i.e.: 596.8 to 616.8MHz and 652.2 to 672.2MHz bands) a 100kHz RBW and 300kHz VBW was used.

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

NB IoT Standalone Carrier Frequency Carrier Power and Port Power	Band 71 (dBm)	
	Lower	Upper
Band 71 Single Carrier at the Bot Ch (617.2MHz) 20W per Carrier and 20W per Port	-19.73	N/A
Band 71 Single Carrier at the Top Ch (651.8MHz) 20W per Carrier and 20W per Port	N/A	-17.96
Band 71 Three Carriers at the Bot Chs (617.2, 617.5, & 617.8MHz) 20W per Carrier and 60W per Port	-17.00	N/A
Band 71 Three Carriers at the Top Chs (651.2, 651.5, & 651.8MHz) 20W per Carrier and 60W per Port	N/A	-16.32
Band 71 Three Carriers at Bot Chs (617.2 & 617.5MHz) & Top Ch (651.8MHz) 20W per Carrier and 60W per Port	-17.06	-15.79
Band 71/85 Three Cars at Bot Chs (617.2 & 617.5MHz) & Top Ch (745.8MHz) 20W per Carrier and 60W per Port (Note 2)	**-15.37**	N/A

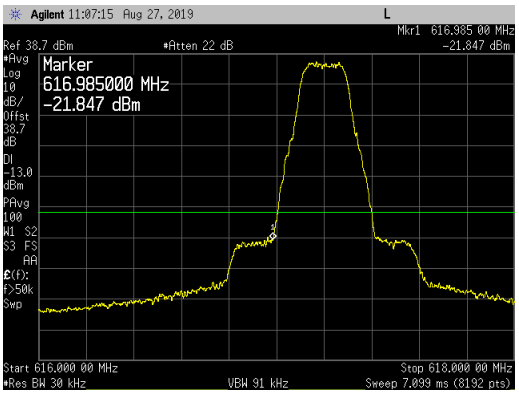
Note 1: Measurements were performed at RBW/2 (or 15kHz) off the lower/upper band edge frequencies as allowed by ANSI C63.26-2015 paragraph 5.7.2.

Note 2: The band 71/85 test case is documented in Appendix B for the Band 85 carrier.

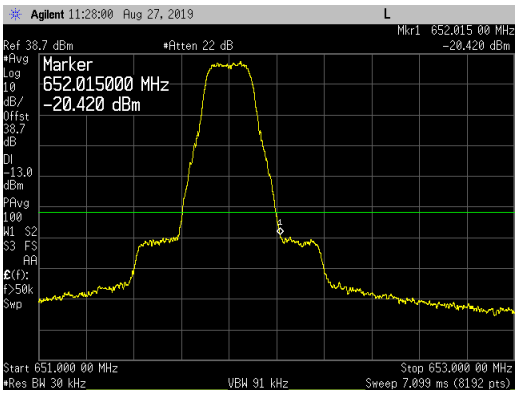
The total measurement RF path loss of the test setup (attenuator and test cables) was 38.7 dB and is accounted for by the spectrum analyzer reference level offset. The display line on the plots reflects the required limit. Conducted band edge measurements are provided in the following pages.

Band 71 Single NB-IoT Standalone Carrier (20W/Carrier & 20W/Port) on Ant Port 4 - Band Edge Plots:

Carrier at Bottom Channel (617.2MHz)
Lower Band Edge_616 to 618MHz



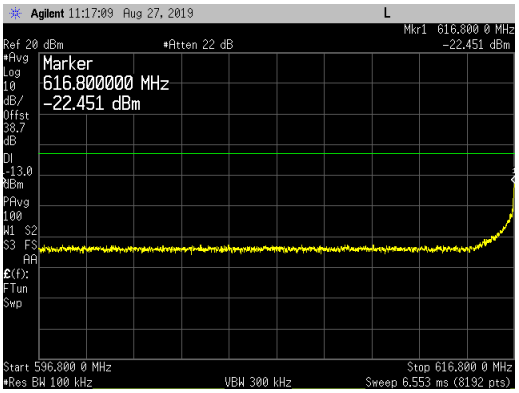
Carrier at Top Channel (651.8MHz)
Upper Band Edge_651 to 653MHz



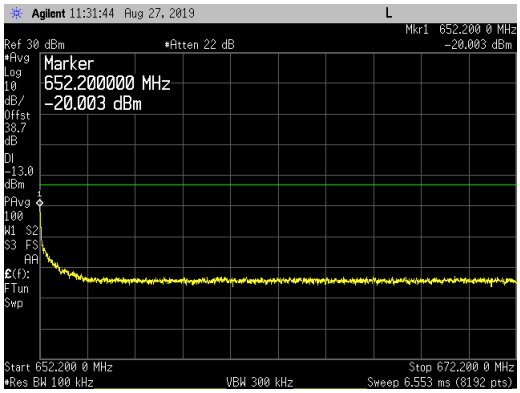
Lower Band Edge_616.8 to 616.9MHz

Upper Band Edge_652.1 to 652.2MHz

Lower Band Edge_596.8 to 616.8MHz

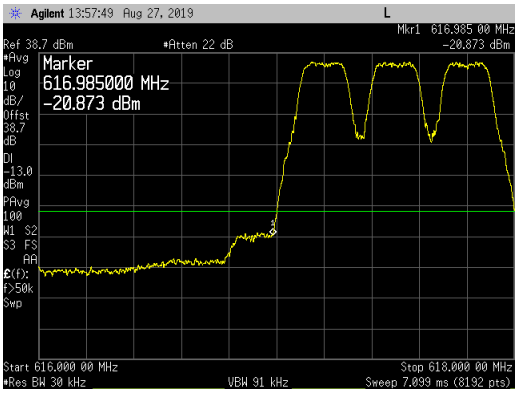


Upper Band Edge_652.2 to 672.2MHz

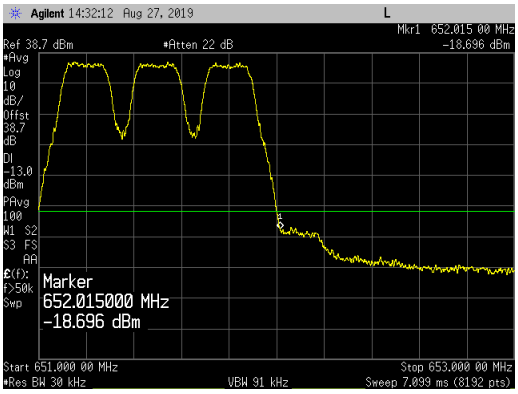


Band 71 Three NB-IoT Standalone Carriers (20W/Carrier & 60W/Port) on Ant Port 4 - Band Edge Plots:

Carriers at 617.2, 617.5 & 617.8MHz
Lower Band Edge_616 to 618MHz

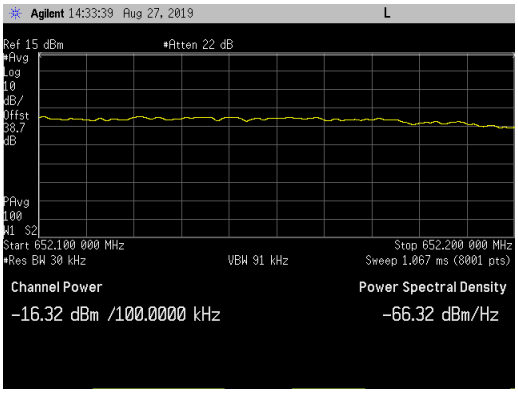


Carriers at 651.2, 651.5 & 651.8MHz
Upper Band Edge_651 to 653MHz

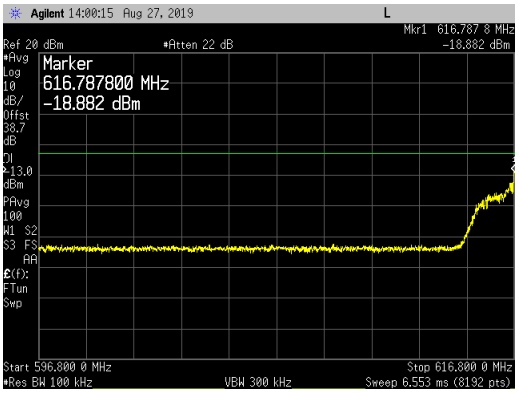


Lower Band Edge_616.8 to 616.9MHz

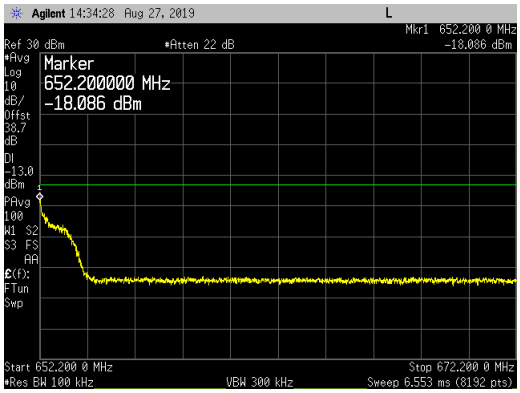
Upper Band Edge_652.1 to 652.2MHz



Lower Band Edge_596.8 to 616.8MHz

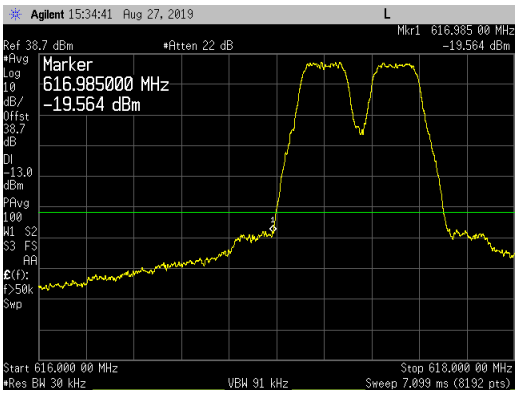


Upper Band Edge_652.2 to 672.2MHz

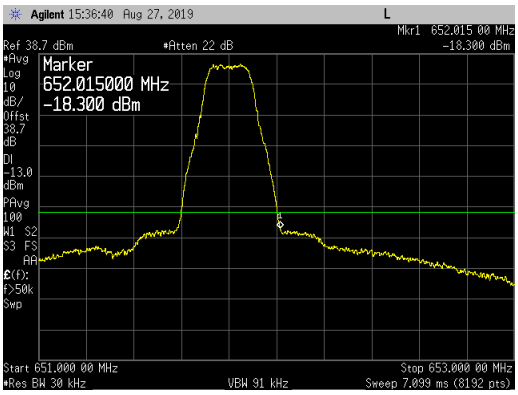


Band 71 Three NB-IoT Standalone Carriers per KDB 971168 (20W/Car & 60W/Port) on Ant Port 4 - BE Plots:

Carriers at 617.2, 617.5 & 651.8MHz
Lower Band Edge_616 to 618MHz



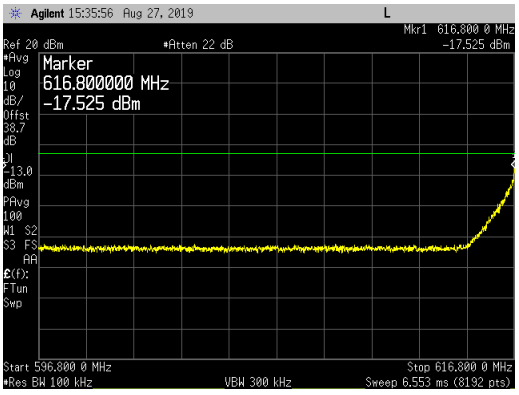
Carriers at 617.2, 617.5 & 651.8MHz
Upper Band Edge_651 to 653MHz



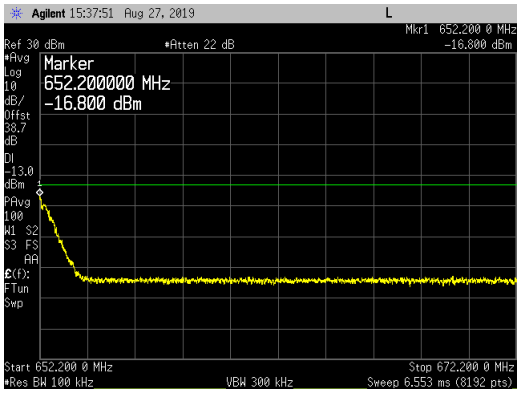
Lower Band Edge_616.8 to 616.9MHz

Upper Band Edge_652.1 to 652.2MHz

Lower Band Edge_596.8 to 616.8MHz



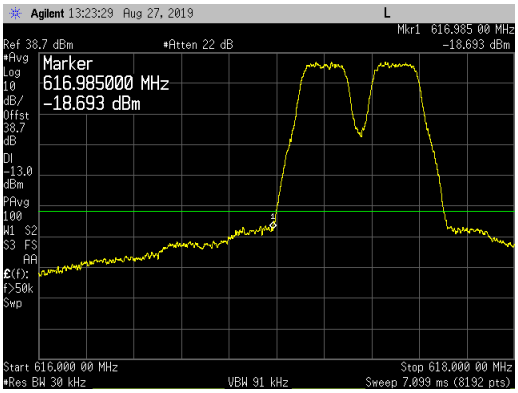
Upper Band Edge_652.2 to 672.2MHz



Band 71/85 Three NB-IoT Standalone Carriers per KDB 971168 (20W/Car & 60W/Port) on Ant Port 4 - BE Plots:

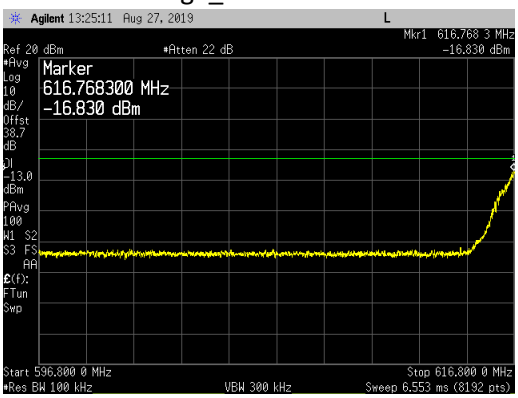
Carriers at 617.2, 617.5 & 745.8MHz

Lower Band Edge_616 to 618MHz



Lower Band Edge_616.8 to 616.9MHz

Lower Band Edge_596.8 to 616.8MHz



Transmitter Antenna Port Conducted Emissions

Transmitter conducted emission measurements were made at AHLOA antenna port 4 using NB-IoT standalone carrier (QPSK). Measurements were performed over the 9kHz to 8GHz frequency range.

Single Carrier Test Case

The RRH was operated at maximum carrier power (20W/carrier and 40W/port) with a single NB-IoT stand-alone carriers (QPSK) at the Band 71 middle channel (634.5MHz) and at Band 85 middle channel (737.0MHz) operating simultaneously.

Multicarrier Test Cases

Measurements were performed with three carriers (with minimum spacing between carrier frequencies) on the Band 71 middle channels (634.2, 634.5 and 634.8MHz). Three carriers are required to produce maximum port power output. The maximum single carrier power output is 20 watts while the maximum port power output is 60 watts.

Another multicarrier test case based upon KDB 971168 D03v01 using three Band 71 carriers (60 watts/port and 20 watts/carrier) was performed with two carriers (with minimum spacing between carrier frequencies) at the lower band edge (i.e.: 617.2MHz and 617.5MHz) and a third carrier (with maximum spacing between the other two carrier frequencies) at the upper band edge (651.8MHz).

Multiband Multicarrier Test Case

A multiband (Band 71 and Band 85) multicarrier test case based upon KDB 971168 D03v01 using three carriers per antenna port was performed at maximum power (60 watts/port and 20 watts/carrier). Two Band 71 carriers (with minimum spacing between carrier frequencies) at the lower band edge (i.e.: 622.0MHz and 632.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies at Band 85 top channel (i.e.: 745.8MHz).

The parameters of the test configurations are provided below:

NB IoT Standalone Carrier Frequency Carrier Power and Port Power
Band 71 / Band 85 Single Carriers at Middle Channels (634.5 & 737.0MHz) 20W per Carrier and 40W per Port
Band 71 Three Carriers at Middle Channels (634.3, 634.5 & 634.8MHz) 20W per Carrier and 60W per Port
Band 71 Three Carriers per KDB971168 (617.2, 617.5, & 651.8MHz) 20W per Carrier and 60W per Port
Band 71 / Band 85 Three Carriers per KDB971168 (617.2, 617.5, & 745.8MHz) 20W per Carrier and 60W per Port

The power of any emission outside of the authorized operating frequency range cannot exceed -13 dBm as specified in FCC 27.53(g). The NB-IoT standalone carrier are for non-MIMO RRH operations. 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 9kHz to 150kHz and 600MHz to 800MHz frequency ranges). Measurements for the 9kHz to 150kHz and 600MHz to 800MHz frequency ranges 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 –33dBm to correct for a spectrum analyzer RBW of 1kHz versus required RBW of 100kHz [i.e.: -33dBm = -13dBm -10log(100kHz/1kHz)]. The required limit of -13dBm 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	Average	Auto	Note 2	37.7dB
150kHz to 20MHz	100kHz	300kHz	8001	Peak	Auto	50 Sweeps	37.7dB
20MHz to 600MHz	200kHz	620kHz	8001	Peak	Auto	50 Sweeps	38.7dB
600MHz to 800MHz	100kHz	300kHz	8001	Average	Auto	Note 2	38.8dB
800MHz to 1.2GHz	100kHz	300kHz	8001	Peak	Auto	50 Sweeps	39.0dB
1.2GHz to 8GHz	2MHz	6MHz	8192	Peak	Auto	50 Sweeps	21.0dB

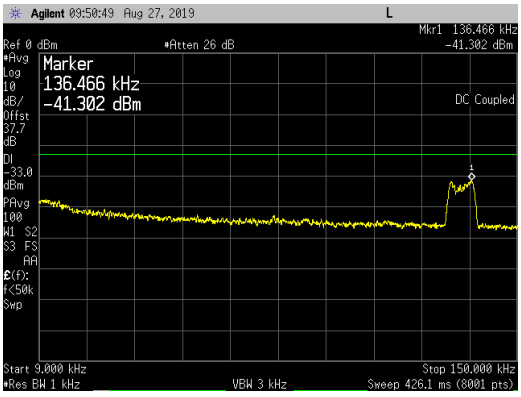
Note 1: The total measurement RF path loss of the test setup (attenuators, filters and test cables) is accounted for by the spectrum analyzer reference level offset.
Note 2: Max Hold not used and instead measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces.

A high pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges above 1200MHz. 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.

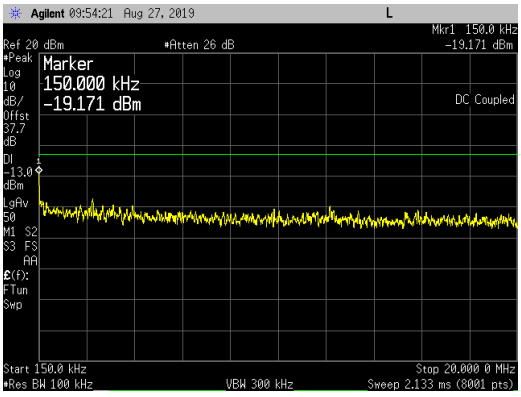
Conducted spurious emission plots/measurements are provided in the following pages.

Band 71 and Band 85 Single NB-IoT Standalone Carriers (20W/Carrier & 40W/Port) on Ant Port 4 Middle Channels (634.5MHz and 737.0MHz):

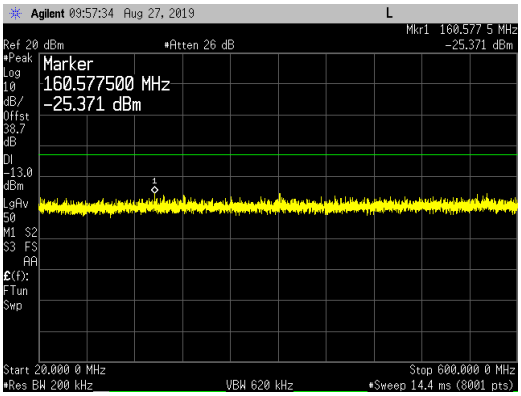
9kHz to 150kHz



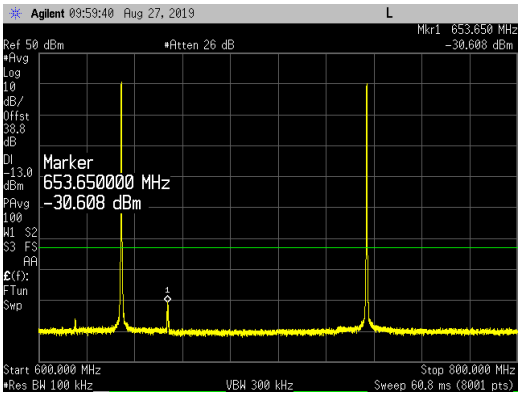
150kHz to 20MHz



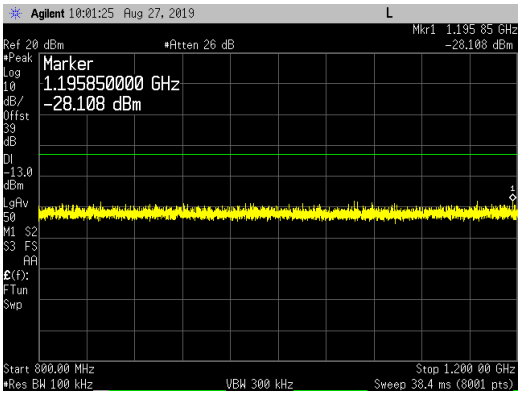
20MHz to 600MHz



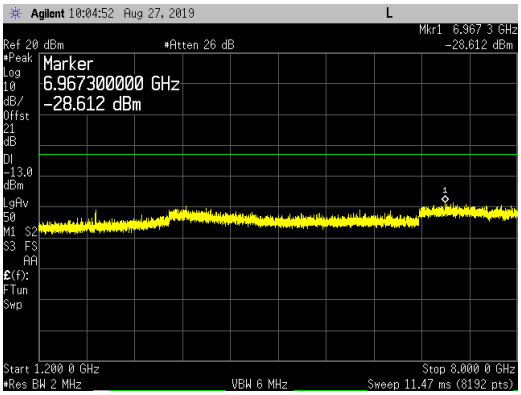
600MHz to 800MHz



800MHz to 1.2GHz

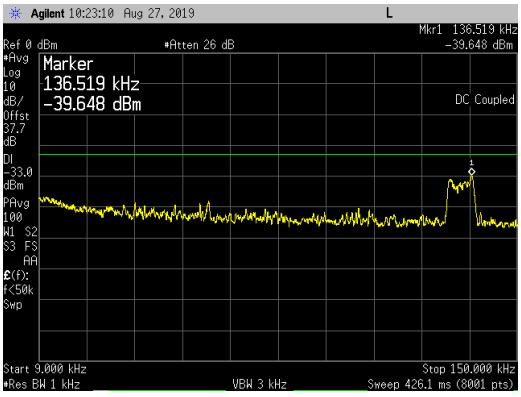


1.2GHz to 8GHz

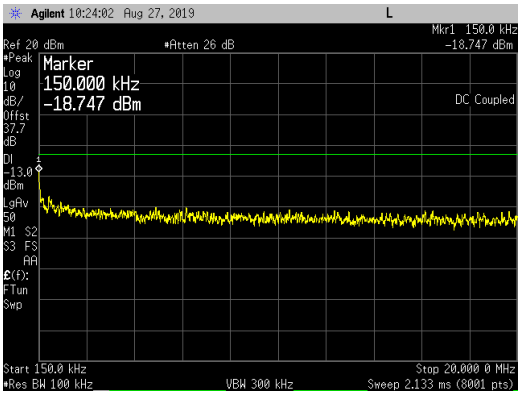


Band 71 Three NB-IoT Standalone Carriers (20W/Carrier & 60W/Port) on Ant Port 4
Middle Channels (634.2, 634.5, & 634.8MHz):

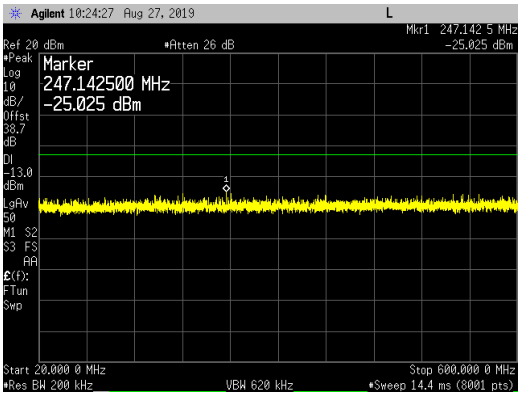
9kHz to 150kHz



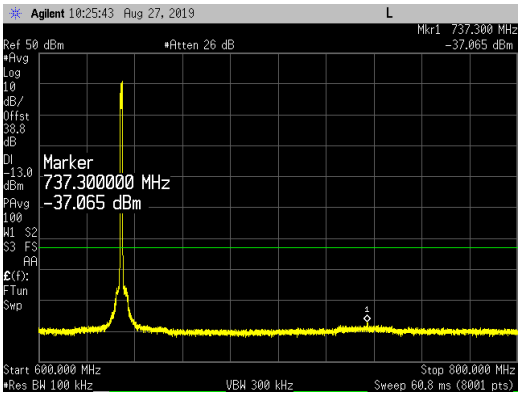
150kHz to 20MHz



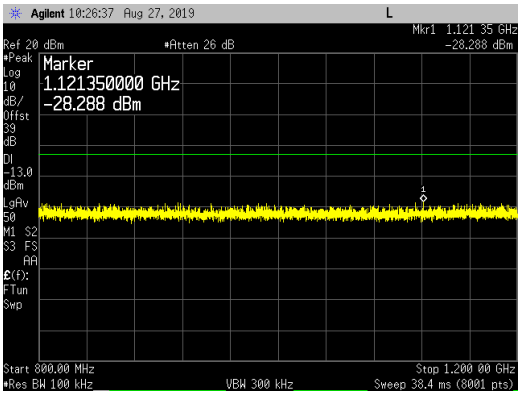
20MHz to 600MHz



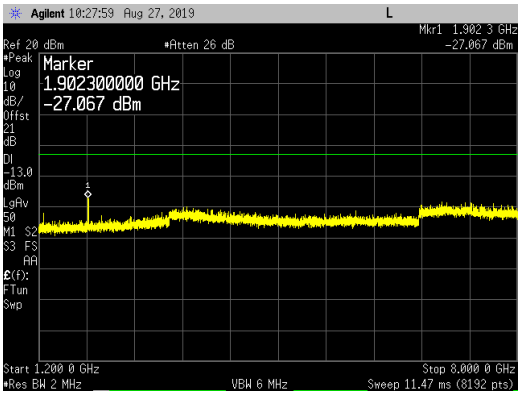
600MHz to 800MHz



800MHz to 1.2GHz

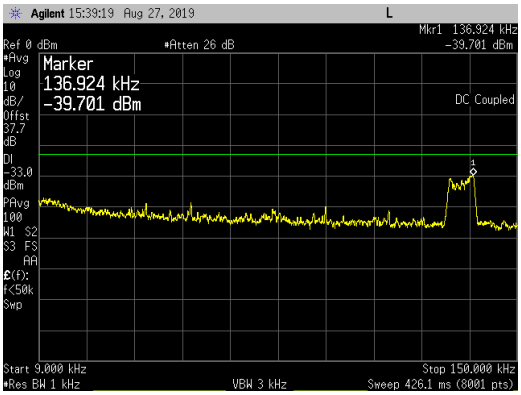


1.2GHz to 8GHz

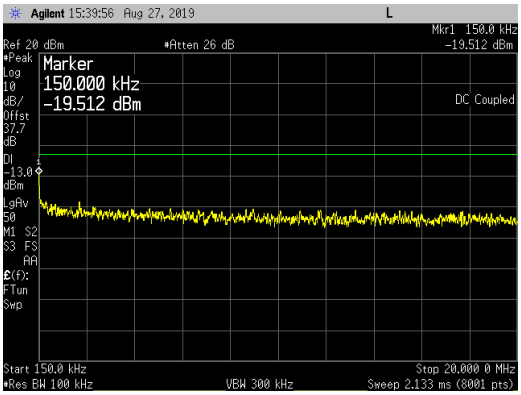


Band 71 Three NB-IoT Standalone Carriers (20W/Carrier & 60W/Port) on Ant Port 4 Per KDB971168 (617.2, 617.5, & 651.8MHz):

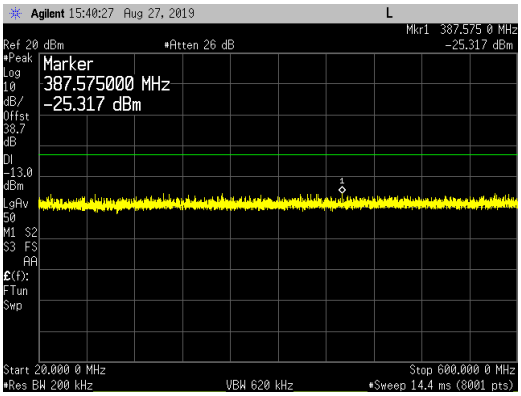
9kHz to 150kHz



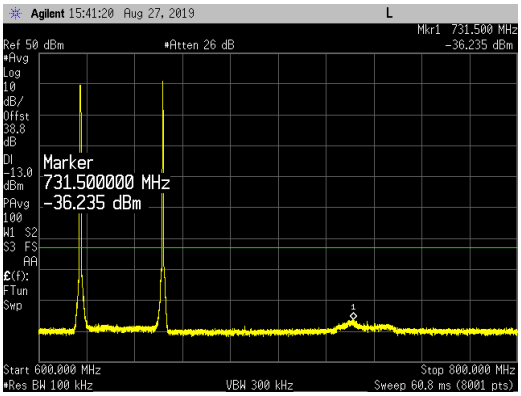
150kHz to 20MHz



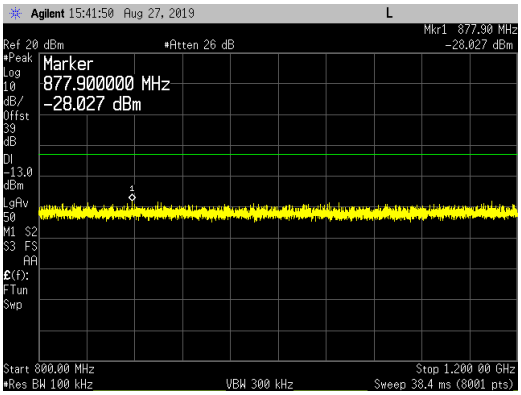
20MHz to 600MHz



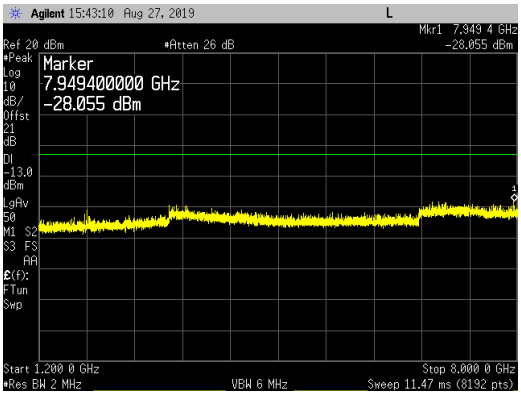
600MHz to 800MHz



800MHz to 1.2GHz

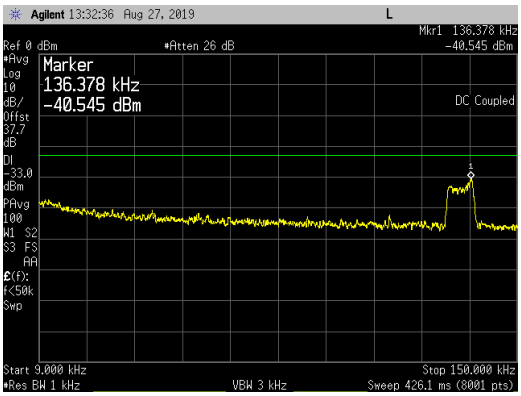


1.2GHz to 8GHz

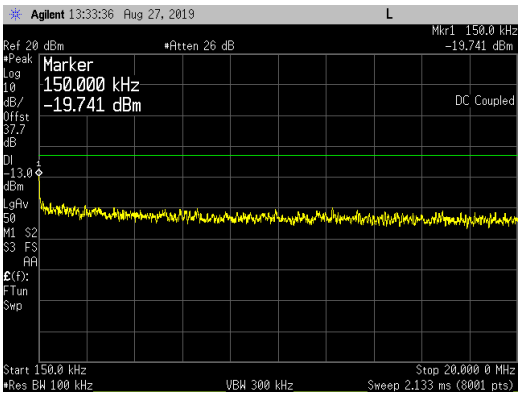


Band 71 and Band 85 Three NB-IoT Standalone Carriers (20W/Carrier & 60W/Port) on Ant Port 4 Per KDB971168 (617.2, 617.5, & 745.8MHz):

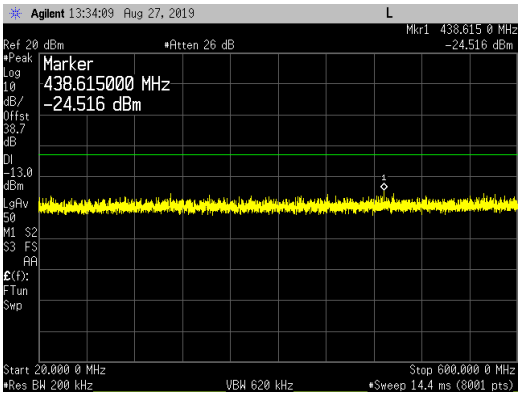
9kHz to 150kHz



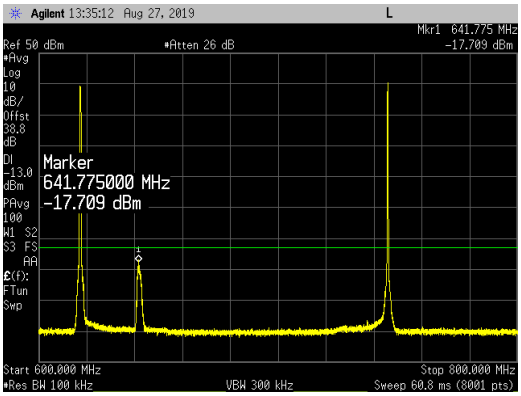
150kHz to 20MHz



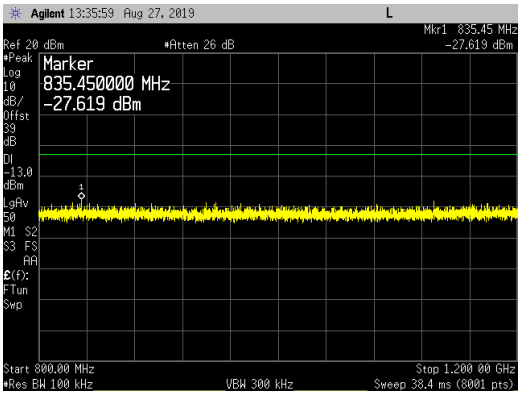
20MHz to 600MHz



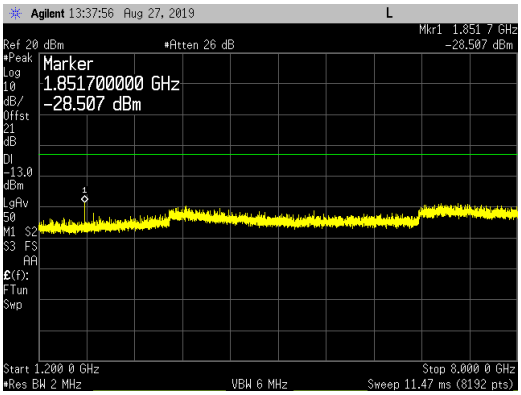
600MHz to 800MHz



800MHz to 1.2GHz



1.2GHz to 8GHz



Transmitter Radiated Spurious Emissions

Radiated spurious emission plots/measurement results are in the original FCC radio certification submittal (NTS Test Report Number PR078121 Revision 0 dated April 25, 2018).

Frequency Stability/Accuracy

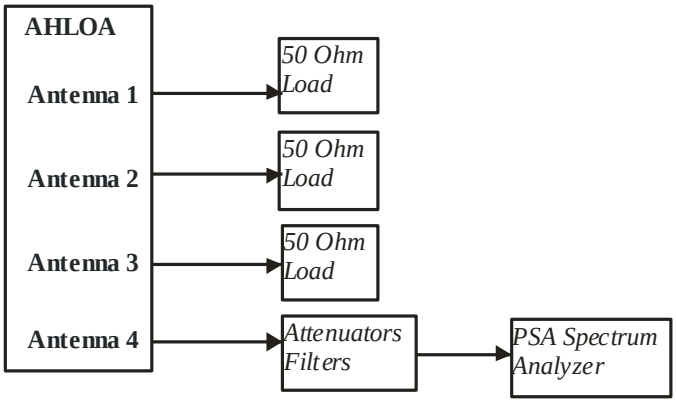
Frequency Stability/Accuracy measurement results are in the original FCC radio certification submittal (NTS Test Report Number PR078121 Revision 0 dated April 25, 2018).

APPENDIX B: ANTENNA PORT TEST DATA FOR NB-IOT STANDALONE BAND 85 (728-746MHZ)

All conducted RF measurements in this section were made at AHLOA antenna port 4. The testing was performed on the same hardware (EUT) as the original certification test. The same EUT RF port (Ant 4) determined in the original certification testing to be the highest power port was used for all testing in this effort.

All testing in this appendix was performed with standalone carriers for Band 85. The NB-IoT standalone testing was setup according to the 3GPP TS 36.141 E-UTRA Test Model "N-TM (narrow band IoT)".

The test setup used is provided below.



Test Setup Used for Conducted RF Measurements on AHLOA

RF Output Power

RF output power has been measured in both Peak and RMS Average terms at the AHLOA Antenna Port 4 transmit chain [LTE Band 85 (728 to 746MHz)] at the bottom, middle and top frequency channels for a NB-IoT stand-alone single carrier (QPSK). RMS Average power was measured as described in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 sections 5.2.4.3 & 5.2.4.4. Peak power was measured as described in section 5.1 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.3.3. The peak to average power ratio (PAPR) has been calculated as described in section 5.7 of KDB971168 D01v03r01 and ANSI C63.26-2015 section 5.2.6.

The RMS Average power output on Antenna Port 4 (3GPP frequency band 85) was also measured using three carriers per antenna port on the bottom, middle and top channels (with minimum spacing between carrier frequencies). The port power measurements are required to be performed with multiple carriers to produce maximum power output on the port. The maximum single carrier power output is 20 watts while the maximum port power output is 60 watts. All results are presented in tabular form below. The highest measured values for carrier peak power, carrier average power, carrier PAPR and port average power are highlighted. Measurements were rounded off to the nearest tenth.

Antenna Port RF Channel	Stand-alone Carrier Frequencies	Measurement	Peak (dBm)	Average (dBm)	PAPR (dB)
Port 4 Bottom Channel	**728.2 MHz**	**Carrier Power**	**51.8**	42.9	**8.9**
	728.2, 728.5 and 728.8 MHz	**Port Power**	N/A	47.4	N/A
Port 4 Middle Channel	**737.0 MHz**	**Carrier Power**	51.7	**43.3**	8.4
	736.7, 737.0 and 737.3 MHz	**Port Power**	N/A	**47.7**	N/A
Port 4 Top Channel	**745.8 MHz**	**Carrier Power**	51.5	42.9	8.6
	745.2, 745.5 and 745.8 MHz	**Port Power**	N/A	47.3	N/A

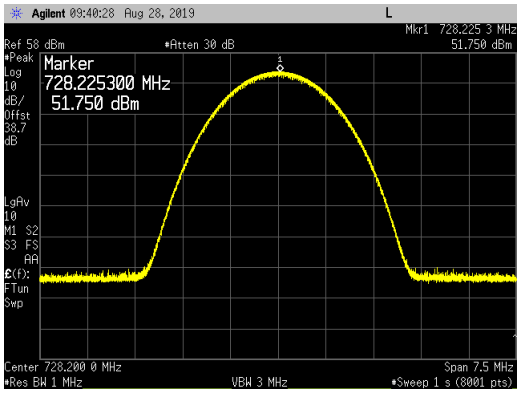
RF output power has been measured in RMS Average terms for KDB 971168 multicarrier test case to verify/document the power levels. All results are presented in tabular form below.

Measured RMS Average Carrier Power Level for the Multicarrier Configurations at Antenna Port 4	
Band 85 KDB 971168 Multicarrier Test Case	
Bottom Carriers 728.2 & 728.5MHz	**Top Carrier 745.8MHz**
45.3 dBm (33.9 Watts)	43.0 dBm (20.0 Watts)
Total Port Power in Band 85 is 53.9 Watts or 47.3 dBm	

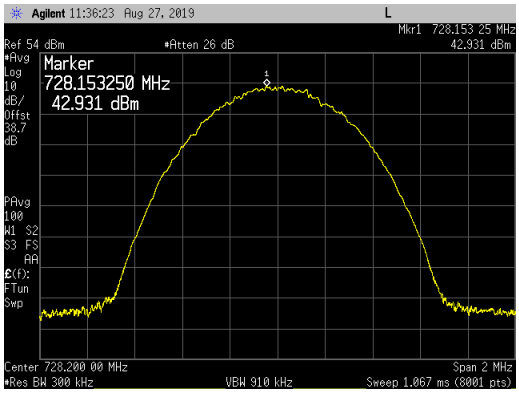
All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 38.7 dB and is accounted for by the spectrum analyzer reference level offset.

Band 85 Single Standalone Carrier Power Plots at Antenna Port 4:

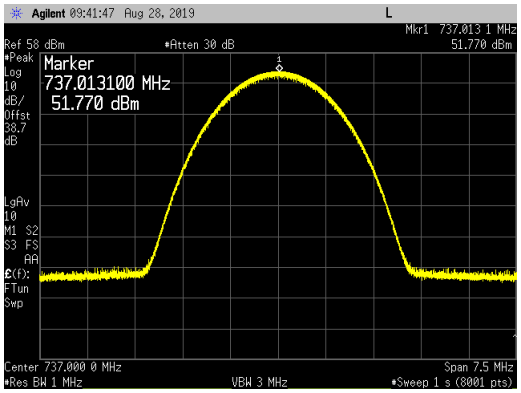
Bot Ch_ 728.2MHz_ Carrier Pwr_ Peak



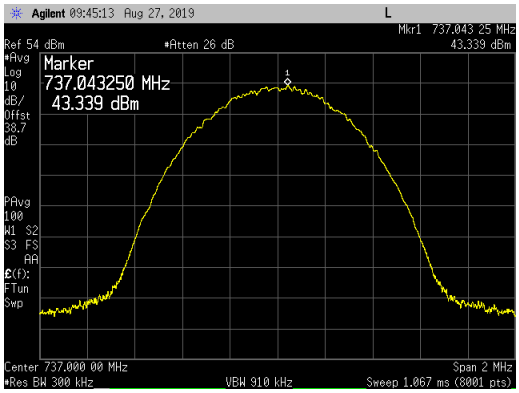
Bot Ch_ 728.2MHz_ Carrier Pwr_ Average



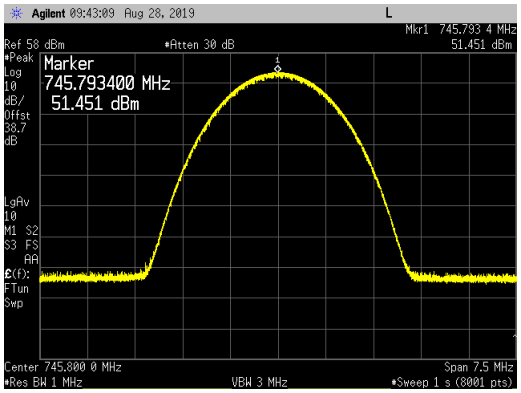
Mid Ch_ 737.0MHz_ Carrier Pwr_ Peak



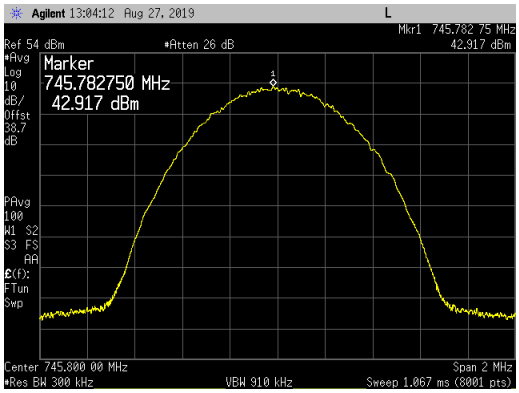
Mid Ch_ 737.0MHz_ Carrier Pwr_ Average



Top Ch_ 745.8MHz_ Carrier Pwr_ Peak

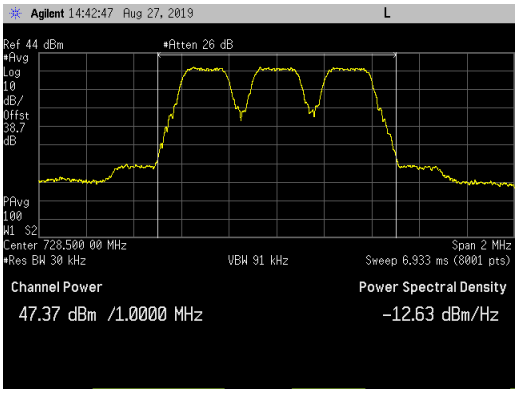


Top Ch_ 745.8MHz_ Carrier Pwr_ Average

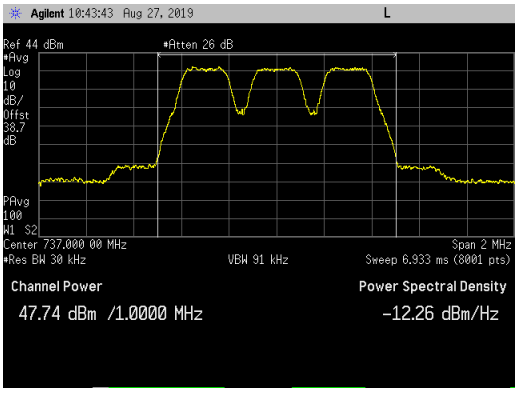


Band 85 Three Standalone Multicarrier Power Plots at Antenna Port 4:

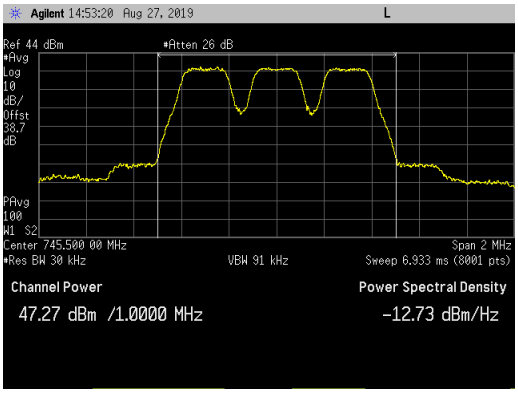
Bot Chs_ 728.2, 728.5, 728.8MHz_ Port Pwr_ Average



Mid Chs_ 736.7, 737.0, 737.3MHz_ Port Pwr_ Average

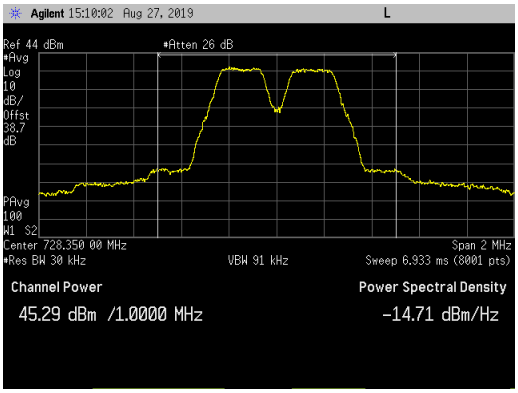


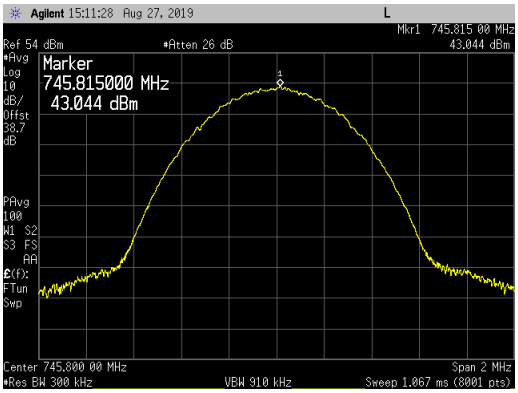
Top Chs_ 745.2, 745.5, 745.8MHz_ Port Pwr_ Average



Band 85 Three Standalone KDB 971168 Multicarrier Power Plots at Antenna Port 4:

Bot Chs_ 728.2, 728.5MHz _ Average and Top Ch_ 745.8MHz _ Average





Emission Bandwidth (26 dB down and 99%)

Emission bandwidth measurements were made at AHLOA antenna port 4 on the bottom, middle and top channels for frequency band 85. The AHLOA was operated at maximum RF carrier output power (20W/Carrier) for NB-IoT standalone single carrier (QPSK).

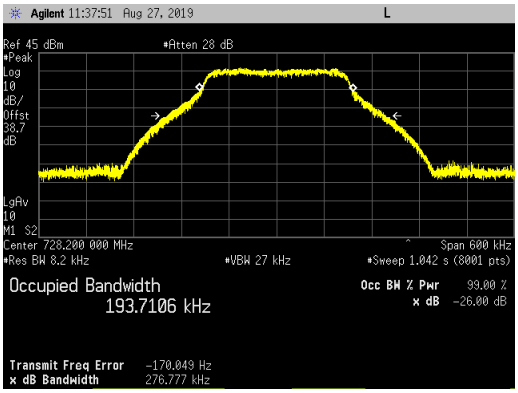
The 26dB emission bandwidth was measured in accordance with section 4 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.4. The 99% occupied bandwidth was measured in accordance with section 6.7 of RSS-Gen Issue 5. For both measurements, an occupied bandwidth built-in function in the spectrum analyzer was used. The results are provided in the following table. The largest emission bandwidths are highlighted. Measurements were rounded off to the nearest tenth.

Antenna Port 4 LTE NB-IoT Standalone Carrier	26dB Emission Bandwidth (kHz)	99% Emission Bandwidth (kHz)
Bottom Channel	276.8	193.7
Middle Channel	276.2	194.2
Top Channel	**276.9**	**196.2**

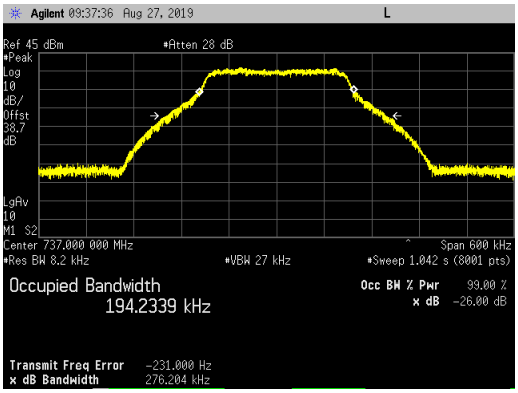
Emission bandwidth measurement data are provided in the following pages.

Emission Bandwidth Plots for NB-IoT Standalone Carriers on Port 4:

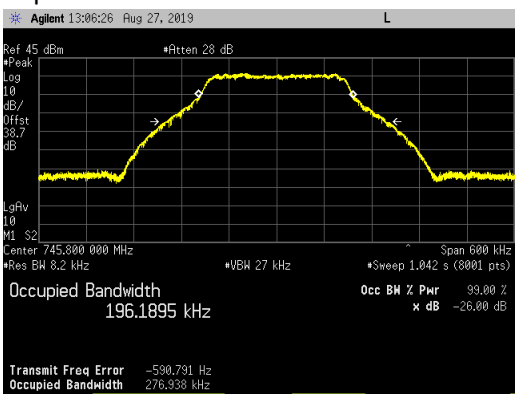
Bottom Channel



Middle Channel



Top Channel



Antenna Port Conducted Band Edge

Conducted band edge measurements were made at RRH antenna port 4 using NB-IoT standalone carrier (QPSK).

Single Carrier Test Case

The RRH was operated at maximum power with a single Band 85 carrier at the band edge frequencies.

Multicarrier Test Cases

Measurements were also performed with three Band 85 carriers (with minimum spacing between carrier frequencies) on the bottom and top channels. Three carriers are required to produce maximum port power output. The maximum single carrier power output is 20 watts while the maximum port power output is 60 watts

Another multicarrier test case based upon KDB 971168 D03v01 using three Band 85 carriers (60 watts/port and 20 watts/carrier) was performed with two carriers (with minimum spacing between carrier frequencies) at the lower band edge (i.e.: 728.2 & 728.5MHz) and a third carrier (with maximum spacing between the other two carrier frequencies) at the upper band edge (i.e.: 745.8MHz).

Multiband Multicarrier Test Case

A multiband (Band 71 and Band 85) multicarrier test case based upon KDB 971168 D03v01 using three carriers per antenna port was performed at maximum power (60 watts/port and 20 watts/carrier). Two Band 71 carriers (with minimum spacing between carrier frequencies) at the lower band edge (i.e.: 622.0MHz and 632.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies at Band 85 top channel (i.e.: 745.8MHz). This test case is documented in Appendix A for the Band 71 carriers.

The power of any emission outside of the authorized operating frequency range cannot exceed -13 dBm as specified in FCC 27.53(g). The NB-IoT standalone carrier are for non-MIMO RRH operations.

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. In the 100 to 200kHz frequency range outside the band edge (i.e.: 727.8 to 727.9MHz and 746.1 to 746.2MHz bands) the RBW was set to 30kHz and the power integrated over 100kHz. In the 200kHz to 22.2MHz frequency range outside the band edge (i.e.: 707.8 to 727.8MHz and 746.2 to 766.2MHz bands) a 100kHz RBW and 300kHz VBW was used.

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

NB IoT Standalone Carrier Frequency Carrier Power and Port Power	Band 85 (dBm)	
	Lower	Upper
Band 85 Single Carrier at the Bot Ch (728.2MHz) 20W per Carrier and 20W per Port	-16.91	N/A
Band 85 Single Carrier at the Top Ch (745.8MHz) 20W per Carrier and 20W per Port	N/A	-16.92
Band 85 Three Carriers at the Bot Chs (728.2, 728.5, & 728.8MHz) 20W per Carrier and 60W per Port	-13.73	N/A
Band 85 Three Carriers at the Top Chs (745.2, 745.5, & 745.8MHz) 20W per Carrier and 60W per Port	N/A	**-13.35**
Band 85 Three Carriers at Bot Chs (728.2 & 728.5MHz) & Top Ch (745.8MHz) 20W per Carrier and 60W per Port	-15.78	-14.74
Band 71/85 Three Cars at Bot Chs (617.2 & 617.5MHz) & Top Ch (745.8MHz) 20W per Carrier and 60W per Port (Note 2)	N/A	-14.95

Note 1: Measurements were performed at RBW/2 (or 15kHz) off the lower/upper band edge frequencies as allowed by ANSI C63.26-2015 paragraph 5.7.2.

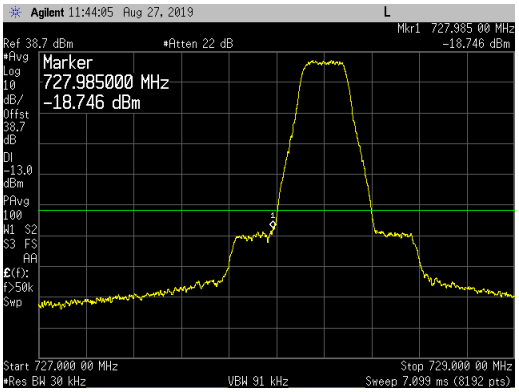
Note 2: The band 71/85 test case is documented in Appendix A for the Band 71 carriers.

The total measurement RF path loss of the test setup (attenuator and test cables) was 38.7 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

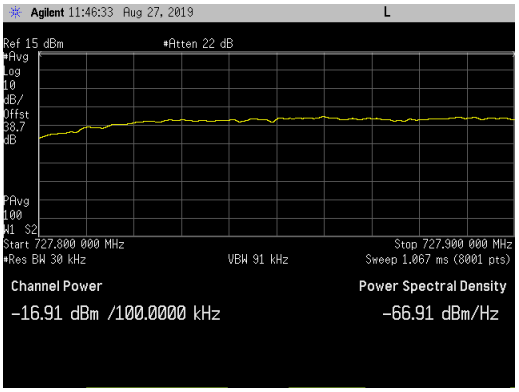
Band 85 Single NB-IoT Standalone Carrier (20W/Carrier & 20W/Port) on Ant Port 4 - Band Edge Plots:

Carrier at Bottom Channel (728.2MHz)

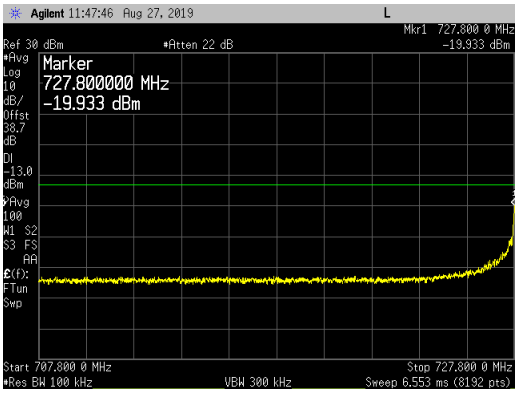
Lower Band Edge_727 to 729MHz



Lower Band Edge_727.8 to 727.9MHz

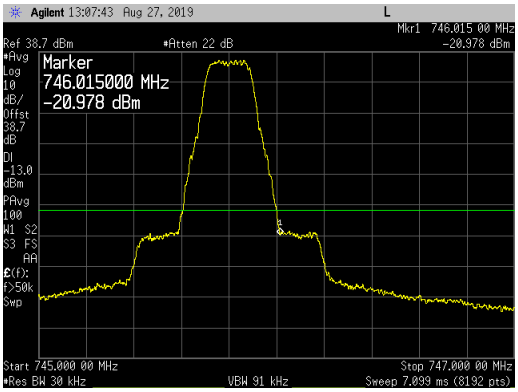


Lower Band Edge_707.8 to 727.8MHz



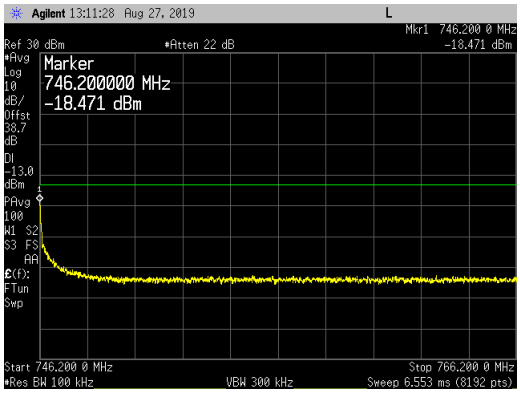
Carrier at Top Channel (745.8MHz)

Upper Band Edge_745 to 747MHz



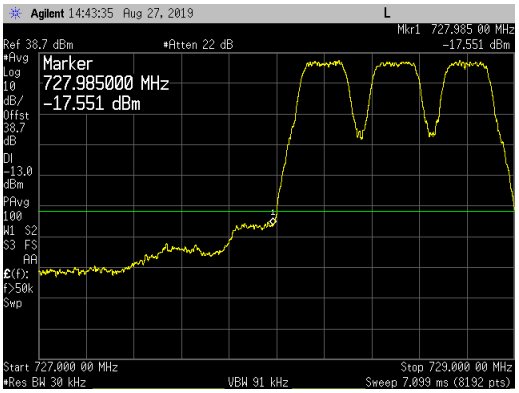
Upper Band Edge_746.1 to 746.2MHz

Upper Band Edge_746.2 to 766.2MHz

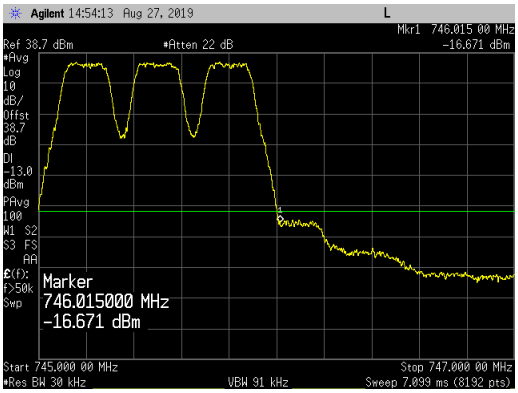


Band 85 Three NB-IoT Standalone Carriers (20W/Carrier & 60W/Port) on Ant Port 4 - Band Edge Plots:

Carriers at 728.2, 728.5 & 728.8MHz
Lower Band Edge_727 to 729MHz

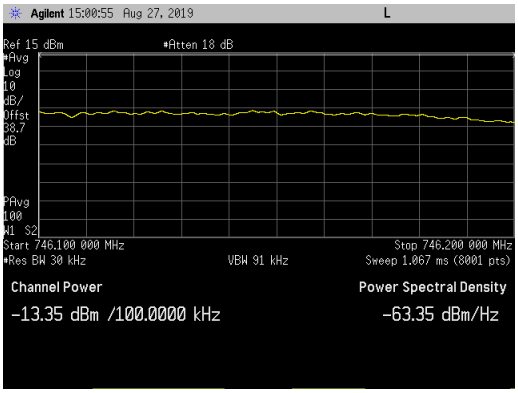


Carriers at 745.2, 745.5 & 745.8MHz
Upper Band Edge_745 to 747MHz

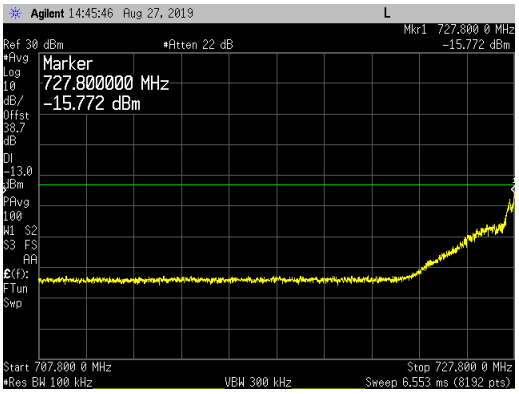


Lower Band Edge_727.8 to 727.9MHz

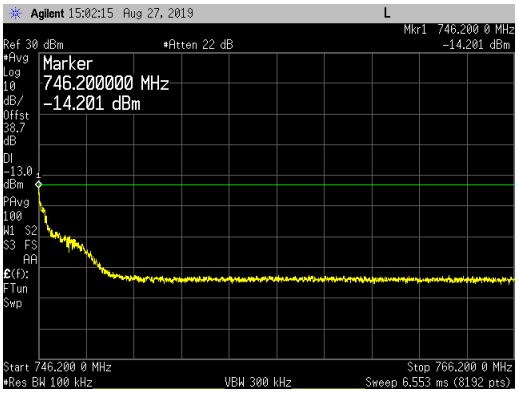
Upper Band Edge_746.1 to 746.2MHz



Lower Band Edge_707.8 to 727.8MHz

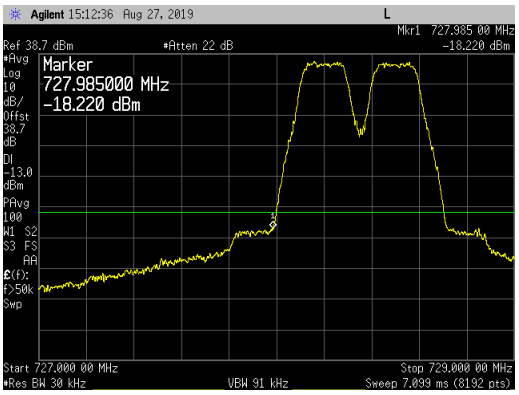


Upper Band Edge_746.2 to 766.2MHz

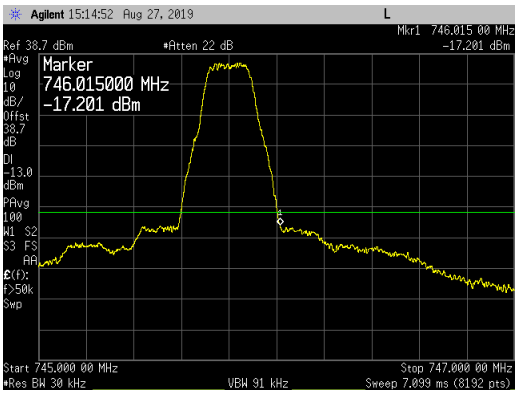


Band 85 Three NB-IoT Standalone Carriers per KDB 971168 (20W/Car & 60W/Port) on Ant Port 4 - BE Plots:

Carriers at 728.2, 728.5 & 745.8MHz
Lower Band Edge_727 to 729MHz

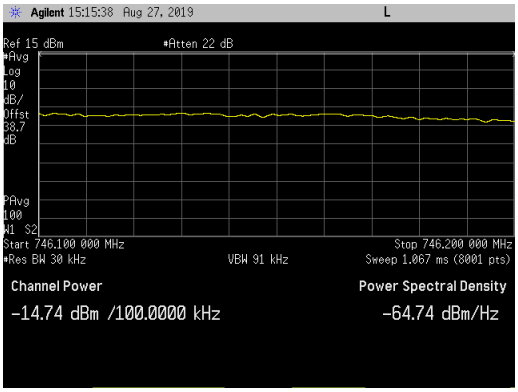


Carriers at 728.2, 728.5 & 745.8MHz
Upper Band Edge_745 to 747MHz

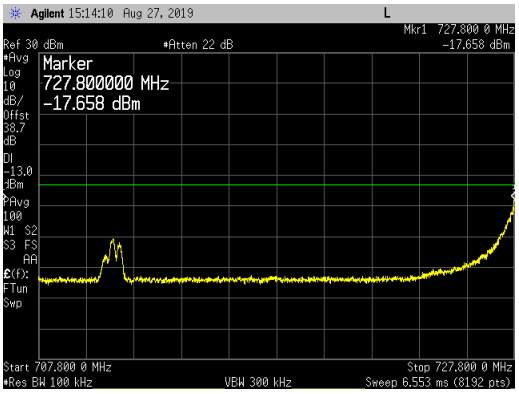


Lower Band Edge_727.8 to 727.9MHz

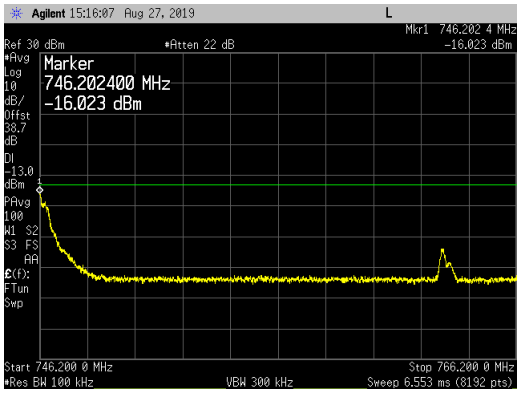
Upper Band Edge_746.1 to 746.2MHz



Lower Band Edge_707.8 to 727.8MHz



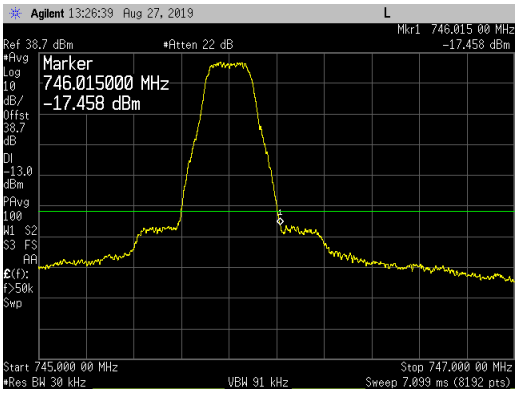
Upper Band Edge_746.2 to 766.2MHz



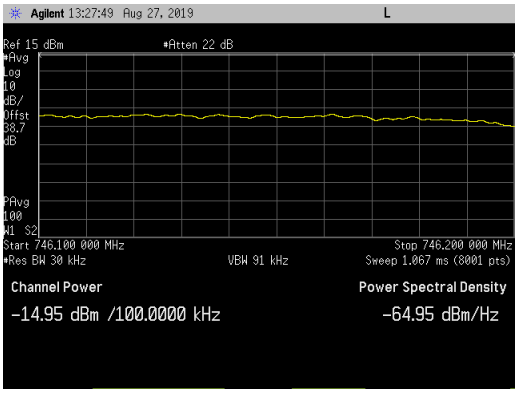
Band 71/85 Three NB-IoT Standalone Carriers per KDB 971168 (20W/Car & 60W/Port) on Ant Port 4 - BE Plots:

Carriers at 617.2, 617.5 & 745.8MHz

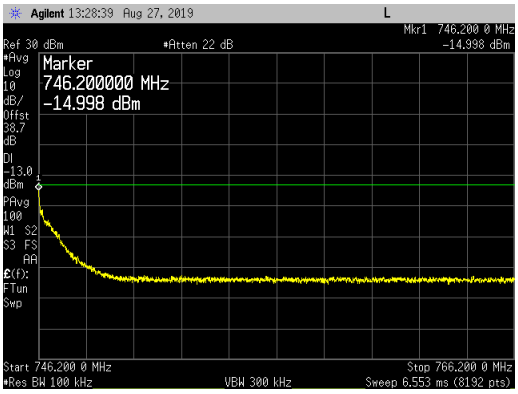
Upper Band Edge_745 to 747MHz



Upper Band Edge_746.1 to 746.2MHz



Upper Band Edge_746.2 to 766.2MHz



Transmitter Antenna Port Conducted Emissions

Transmitter conducted emission measurements were made at RRH antenna port 4 using NB-IoT standalone carrier (QPSK). Measurements were performed over the 9kHz to 8GHz frequency range.

Single Carrier Test Case

The RRH was operated at maximum carrier power (20W/carrier and 40W/port) with a single NB-IoT stand-alone carriers (QPSK) at the Band 71 middle channel (634.5MHz) and at Band 85 middle channel (737.0MHz) operating simultaneously. This test case is documented in Appendix A.

Multicarrier Test Cases

Measurements were also performed with three Band 85 carriers (with minimum spacing between carrier frequencies) on the middle channels (736.7, 737.0, 737.3MHz). Three carriers are required to produce maximum port power output. The maximum single carrier power output is 20 watts while the maximum port power output is 60 watts.

Another multicarrier test case based upon KDB 971168 D03v01 using three Band 85 carriers was performed with two carriers (with minimum spacing between carrier frequencies) at the lower band edge and a third carrier (with maximum spacing between the other two carrier frequencies) at the upper band edge. The carrier frequencies are 728.2, 728.5 and 745.8MHz.

Multiband Multicarrier Test Case

A multiband (Band 71 and Band 85) multicarrier test case based upon KDB 971168 D03v01 using three carriers per antenna port was performed at maximum power (60 watts/port and 20 watts/carrier). Two Band 71 carriers (with minimum spacing between carrier frequencies) at the lower band edge (i.e.: 622.0MHz and 632.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies at Band 85 top channel (i.e.: 745.8MHz). This test case is documented in Appendix A.

The parameters of the test configurations are provided below:

NB IoT Standalone Carrier Frequency Carrier Power and Port Power
Band 71 / Band 85 Single Carriers at Middle Channels (634.5 & 737.0MHz) 20W per Carrier and 40W per Port (Note)
Band 85 Three Carriers at Middle Channels (736.7, 737.0 & 737.3MHz) 20W per Carrier and 60W per Port
Band 85 Three Carriers per KDB971168 (728.2, 728.5 & 745.8MHz) 20W per Carrier and 60W per Port
Band 71 / Band 85 Three Carriers per KDB971168 (617.2, 617.5, & 745.8MHz) 20W per Carrier and 60W per Port (Note)

Note: The band 71/85 test case is documented in Appendix A.

The power of any emission outside of the authorized operating frequency range cannot exceed -13 dBm as specified in FCC 27.53(g). The NB-IoT standalone carrier are for non-MIMO RRH operations. 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 9kHz to 150kHz and 600MHz to 800MHz frequency ranges). Measurements for the 9kHz to 150kHz and 600MHz to 800MHz frequency ranges 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 –33dBm to correct for a spectrum analyzer RBW of 1kHz versus required RBW of 100kHz [i.e.: -33dBm = -13dBm -10log(100kHz/1kHz)]. The required limit of -13dBm 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	Average	Auto	Note 2	37.7dB
150kHz to 20MHz	100kHz	300kHz	8001	Peak	Auto	50 Sweeps	37.7dB
20MHz to 600MHz	200kHz	620kHz	8001	Peak	Auto	50 Sweeps	38.7dB
600MHz to 800MHz	100kHz	300kHz	8001	Average	Auto	Note 2	38.8dB
800MHz to 1.2GHz	100kHz	300kHz	8001	Peak	Auto	50 Sweeps	39.0dB
1.2GHz to 8GHz	2MHz	6MHz	8192	Peak	Auto	50 Sweeps	21.0dB

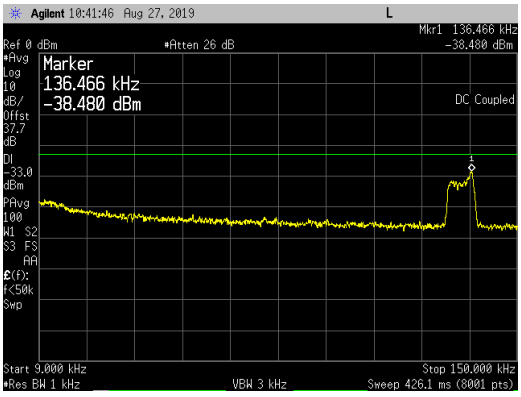
Note 1: The total measurement RF path loss of the test setup (attenuators, filters and test cables) is accounted for by the spectrum analyzer reference level offset.
Note 2: Max Hold not used and instead measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces.

A high pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges above 1200MHz. 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.

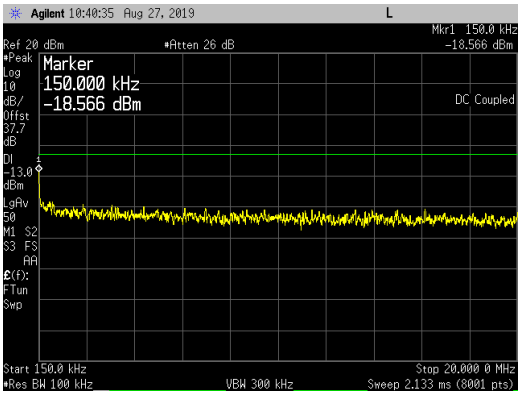
Conducted spurious emission plots/measurements are provided in the following pages.

Band 85 Three NB-IoT Standalone Carriers (20W/Carrier & 60W/Port) on Ant Port 4
Middle Channels (736.7, 737.0, & 737.3MHz):

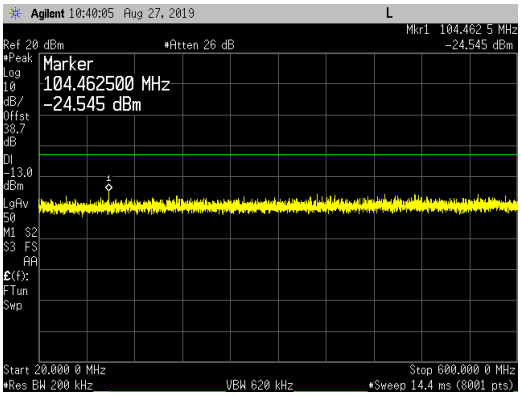
9kHz to 150kHz



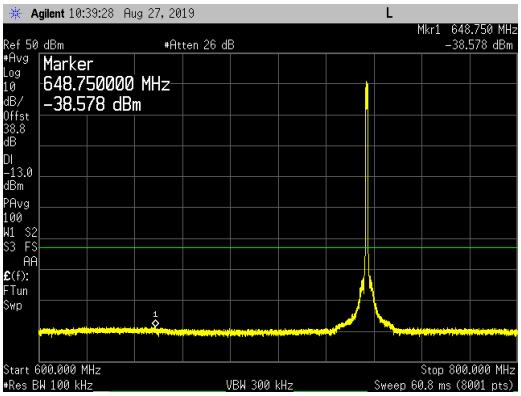
150kHz to 20MHz



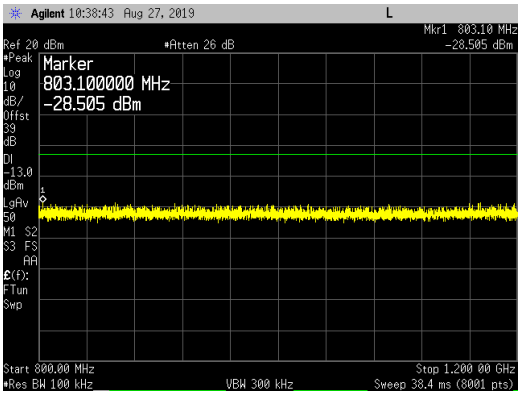
20MHz to 600MHz



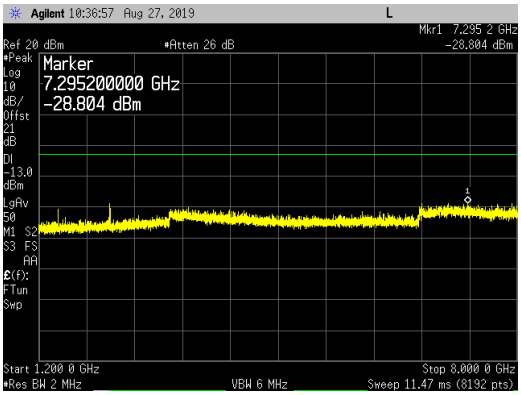
600MHz to 800MHz



800MHz to 1.1GHz

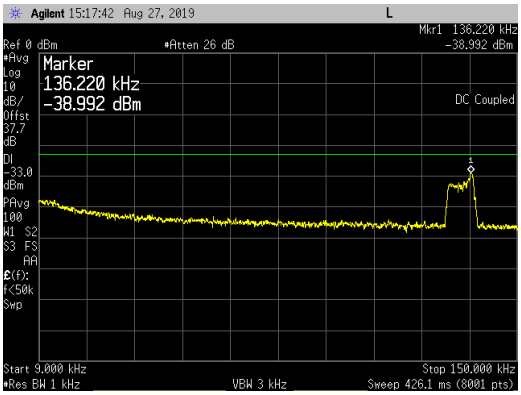


1.1GHz to 8GHz

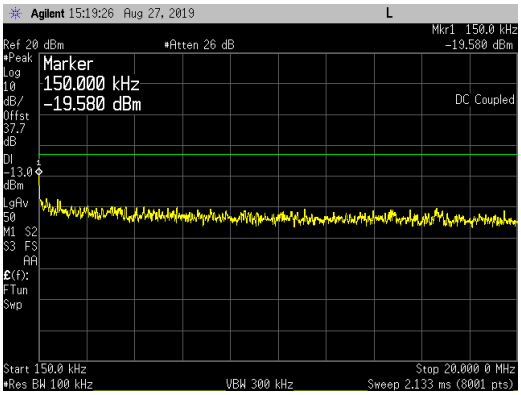


Band 85 Three NB-IoT Standalone Carriers (20W/Carrier & 60W/Port) on Ant Port 4
Per KDB971168 (728.2, 728.5, 745.8MHz):

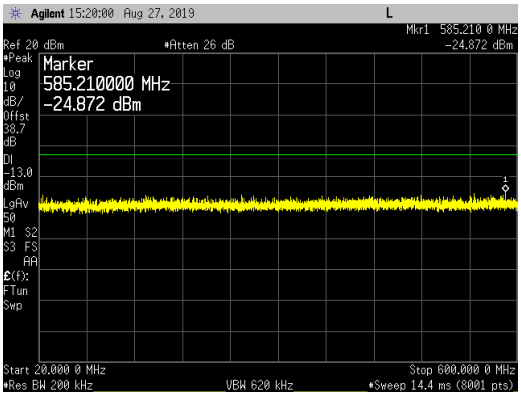
9kHz to 150kHz



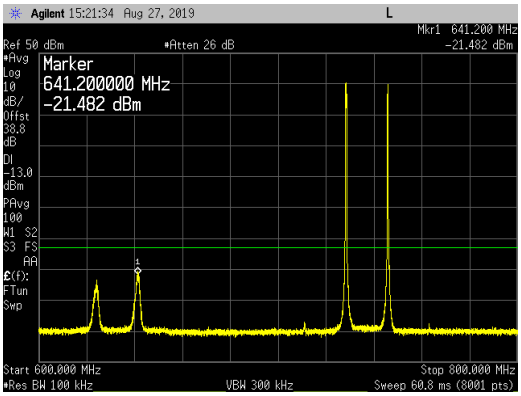
150kHz to 20MHz



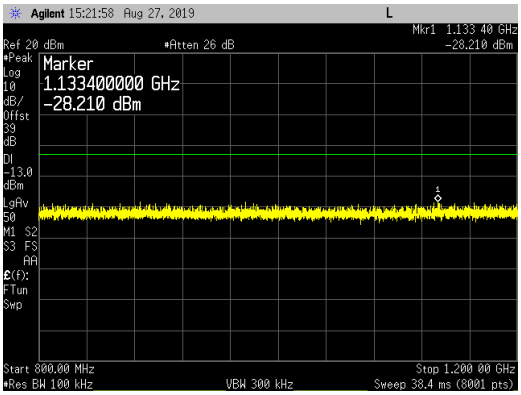
20MHz to 600MHz



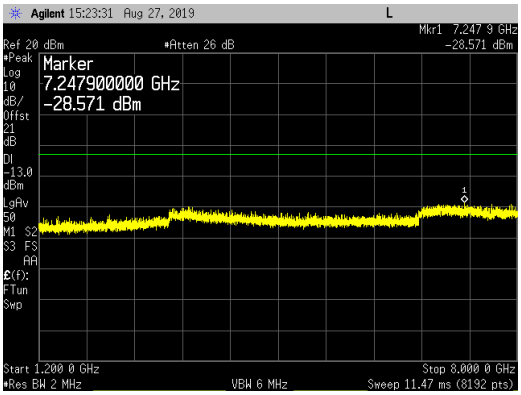
600MHz to 800MHz



800MHz to 1.1GHz



1.1GHz to 8GHz



Transmitter Radiated Spurious Emissions

Radiated spurious emission plots/measurement results are in the original FCC radio certification submittal (NTS Test Report Number PR078121 Revision 0 dated April 25, 2018).

Frequency Stability/Accuracy

Frequency Stability/Accuracy measurement results are in the original FCC radio certification submittal (NTS Test Report Number PR078121 Revision 0 dated April 25, 2018).

END OF REPORT