

NTS Test Report No. PR089138 Rev. 1 Page 1 of 55

CREDIT

Radio Test Report

Application for Grant of Equipment Authorization

FCC Part 27 [2110MHz - 2200MHz]

CERTIFICATE #: 0214.19

FCC ID: VBNAHIB-01

Product Name: Airscale Base Transceiver Station Micro Remote Radio Head Model: AHIB

> **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** 

**Reviewed By:** 

**Alex Mathews EMI Project Manager** 

**Approved By:** 

Kimberly Zavala **Quality Assurance** 



# **REVISION HISTORY**

Rev#	Date	Comments	Modified By
0	04/23/2019	Initial Draft	BreAnna Cheatham
1	04/25/2019	Updated FCC Part 27 Subpart C&L Table	BreAnna Cheatham



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# SCOPE

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

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 Micro Remote Radio Head (RRH) Model AHIB 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 AHIB. 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 Micro Remote Radio Head (RRH) Model AHIB 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&L (Base Stations Operating in the 2110 - 2200MHz Band)

AHIB operating in the AWS Band						
FCC	Description	Measured	Limit	Results		
Transmitter Modulation, output power and other characteristics						
27.5(h)&(j)	Frequency Ranges	LTE10: 2115.0 - 2195.0MHz LTE15: 2117.5 - 2192.5MHz LTE20: 2120.0 - 2190.0MHz	2110.0 – 2200.0MHz	Pass		
2.1033(c)(4)	Modulation Type	NB loT Guard band (QPSK) with LTE10, LTE15 & LTE20	Digital	Pass		
27.50(d)(2)	Output Power	Highest Conducted Power Output RMS: 37.04dBm EIRP depends on antenna gain which is unknown	FCC: 1640W EIRP	Pass		
27.50(d)(5)	Peak to Average Power Ratio	Highest Measured PAPR: 7.26dB	13dB	Pass		
	99% Emission Bandwidth	LTE10: 9.2436MHz LTE15: 13.8374MHz LTE20: 18.3220MHz	Remain in Block	Pass		
27.53(h)(3)	26dB down Emission Bandwidth	LTE10: 9.819MHz Emission Designator: 9M82F9W LTE15: 14.766MHz Emission Designator: 14M8F9W LTE20: 19.721MHz Emission Designator: 19M7F9W	Remain in Block	Pass		
Transmitter	Spurious Emissions <sup>1</sup>					
27.53(h)	At the antenna terminals	< -19dBm	-19dBm per Transmit Chain	Pass		
27.00(1)	Field Strength	51.03dBuV/m at 3m Eq. to -46.35dBm EIRP	-13dBm EIRP	Pass <sup>2</sup>		
Other Details	6					
27.54	Frequency Stability	Stays within authorized frequency block	Stays within block	Pass <sup>2</sup>		
1.1310	1.1310         RF Exposure         N/A         Pass <sup>3</sup>					
Note 1: Based on 1MHz RBW. In the 1MHz immediately outside and adjacent to the frequency block a RBW of at least 1% of the emission bandwidth was used. The measurement bandwidth is 1MHz for measurements more than 1MHz from the band edge. Note 2: See the original FCC radio certification report for details (TUV Document 75938941 Report 01 Issue 1 dated 16 June 2017). 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 single Narrow Band IoT Guard Band (NB IoT GB here after) LTE carrier to the Airscale BTS Micro RRH model AHIB Federal Communication Commission certifications. The original FCC radio certification submittal is TUV Document 75938941 Report 01 Issue 1 dated 16 June 2017. The original test effort includes testing for LTE technologies. Please refer to the test report on the original certification for details.

Conducted RF tests performed under this 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 NB-IoT guard band 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)". NB IoT guard band offsets from LTE carrier center frequencies are as follows - LTE10: <u>+</u> 4597.5 kHz, LTE 15: <u>+</u> 6892.5kHz, and LTE20: <u>+</u> 9097.5kHz. The RRH NB-IoT GB operations are supported with LTE bandwidths of 10, 15 and 20MHz.

The radiated emissions and frequency stability measurements performed in the original certification were 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) Micro Remote Radio Head (RRH) module, model AHIB. The AHIB remote radio head is a 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 AHIB RRH has four Band 66 transmit/four receive antenna ports (4TX/4RX). Each antenna port supports 3GPP frequency band 66 operations (BTS Rx: 1710 to 1780 MHz/BTS TX: 2110 to 2200 MHz). The maximum RF output power of the RRH is 20 Watts (5 watts per carrier, 5 watts per antenna port). The RRH can be operated as a 4x4 MIMO or 2x2 MIMO. The RRH supports 5, 10, 15, and 20MHz LTE bandwidths. The RRH supports four LTE downlink modulation types (QPSK, 16QAM, 64QAM and 256QAM). Multi-carrier operation (up to four carriers) 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 AHIB LTE channel numbers and frequencies are as follows:



	Downlink	Downlink	LTE Channel Bandwidth			
	EARFCN	Frequency (MHz)	5 MHz	10 MHz	15 MHz	20 MHz
	66436	2110.0	Band Edge	Band Edge	Band Edge	Band Edge
	66461	2112.5	Bottom Ch			
	66486	2115.0		Bottom Ch		
	66511	2117.5			Bottom Ch	
3, 4)						
AHIB Band 66 (Ant 1, 2, 3, 4)	66536	2120.0				Bottom Ch
nt 1						
56 (A	66886	2155.0	Middle Ch	Middle Ch	Middle Ch	Middle Ch
9 pu						
B Ba	67236	2190.0				Top Channel
AHI						
	67261	2192.5			Top Channel	
	67286	2195.0		Top Channel		
	67311	2197.5	Top Channel			
	67336	2200.0	Band Edge	Band Edge	Band Edge	Band Edge

AHIB Downlink Band Edge LTE Band 66 Frequency Channels

Note:

- (1) Narrow Band IoT Guard Band operations are not supported for LTE5 channel bandwidth.
- (2) Two multicarrier test cases were performed based upon KDB 971168 D03v01. A multicarrier test case with three LTE10 carriers using two carriers (with minimum spacing between carrier frequencies) at the lower band edge (EARFCN 66486: 2115.0 & EARFCN 66586: 2125.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 67286: 2175.0MHz) was verified. A multicarrier test case with three LTE10 carriers using two carriers (with minimum spacing between carrier frequencies) at the upper band edge (EARFCN 67286: 2195.0 & EARFCN 67186: 2185.0MHz) and a third carrier with maximum spacing between carrier frequencies) at the upper band edge (EARFCN 67286: 2195.0 & EARFCN 67186: 2185.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 67286: 2195.0 & EARFCN 67186: 2185.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies.



# **EUT Hardware**

The EUT hardware used in testing on April 17-18, 2019.

Company	Model	Description	Part/Serial Number	FCC ID Number
Nokia Solutions and Networks	AHIB	AirScale BTS RRH	Part#: 474050A.101 Serial#: EA171912203	FCC ID: VBNAHIB-01

## Enclosure

The EUT enclosure is made of heavy-duty aluminum and has the following physical characteristics:

Configuration	Approximate Weight	Approximate Dimensions	Approximate Volume
AHIB	5.5 kg	295x245x55 mm	4 Liters

# Support Equipment

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	ASIA	Airscale System Module	Part#: 473095A.101 Serial#: L1164309322	N/A
Dell	Studio XPS	Instrumentation PC	N/A	N/A

# **Auxillary Equipment**

Company	Description Part Num		Serial Number	
Nokia	FOUC 10GHz SFP Module	473842A.101	KR16090020071	
NORIA	(Plugs into RRH Opt Ports)	4730420.101	KN10050020071	
RLC Electronics	2.4GHz High Pass Filter- 2 Watt F-100-3000-5-R		0028	
Microwave Circuits	Microwave Circuits 1.4GHz Low Pass Filter – 100 Watt		2454-01	
Narda	Attenuator 30dB-50 Watt	7768-30	-	
Huber & Suhner RF Cable – 1 meter		Sucoflex 104	551123/4	
Huber & Suhner	RF Cable - 1 meter	Sucoflex 106	297370	



# **EUT Operation**

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

# EUT Software

The PC connects to the System Module over the LMP (Ethernet) port. The system module controls the RRH via the optical (CPRI) interface. The PC 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.R32I
- (2) System Module Software: FL18A\_ENB\_0000\_020203\_000000
- (3) BTS Site Manager: BTSSiteEM-FL18A\_0000\_000604\_000000.exe

# 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 during the original certification effort (See TUV Document 75938941 Report 01 Issue 1 dated 16 June 2017 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 complementary cumulative distribution function (CCDF) measurements were performed with a 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.

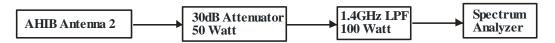
Average output power measurements were performed in accordance with sections 5.4 of FCC KDB 971168 D01v03r01 and ANSI C63.26. Measurements were performed with the channel power function found in the spectrum analyzer and the screenshots were captured using Keysight Benchvue Software. Peak to average 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-22GHz frequency span. A low pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges below 20MHz. A high pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges above 3GHz. The total measurement RF path loss of the test setup (attenuators, filters 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 are the setups used in the RF conducted emissions testing. Photographs of the test setups are also provided.



Setup for 9kHz to 150kHz and 150kHz to 20MHz Measurements

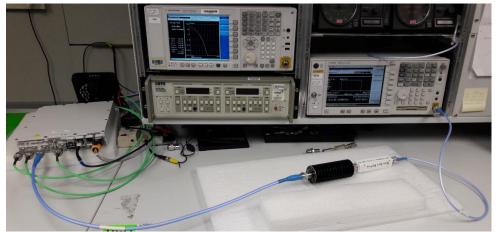


Photo of 9kHz to 150kHz and 150kHz to 20MHz Setup



Setup for 20MHz to 3GHz Measurement

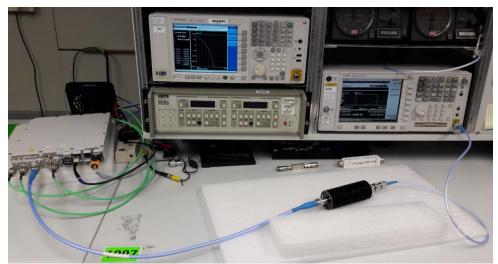
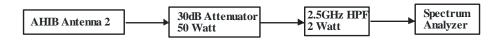
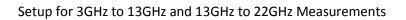


Photo of 20MHz to 3GHz Setup







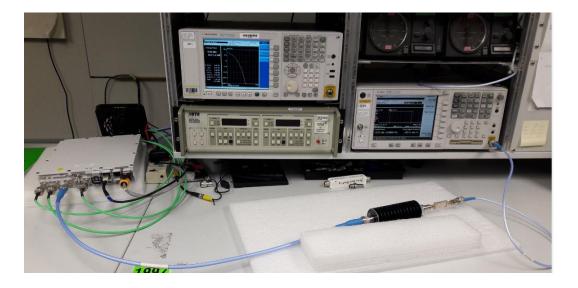


Photo of 3GHz to 13GHz and 13GHz to 22GHz Setup

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
NM06374	MXG Analog Signal Gen	Keysight	N5183B	36 Months	02/04/2021
NM04508	MXA Signal Analyzer	Agilent	N9020A	24 Months	05/02/2019

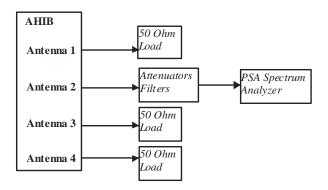
# **Test Measurement Equipment**



# APPENDIX A: ANTENNA PORT TEST DATA FOR THE AWS BAND

All conducted RF measurements in this section were made at AHIB antenna ports.

All testing in this section was performed with the single Narrow Band IoT Guard Band carriers at LTE10, LTE15 and LTE20 bandwidths. NB IoT guard band offsets from LTE carrier center frequencies were LTE10: <u>+</u> 4597.5 kHz, LTE 15: <u>+</u> 6892.5kHz, and LTE20: <u>+</u> 9097.5kHz. 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 AHIB



# **RF Output Power**

RF output power has been measured in RMS Average terms for each AWS transmit chain at the middle channels (2155MHz) for the Narrow Band IoT Guard Band LTE10 carriers as described in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.4.4. The AHIB 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 the upper band IoT guard band carriers. All results are presented in tabular form below. The highest measured values are highlighted.

Ant Port at LTE Channel	LTE BW with Lower & Upper NB-IoT GB carriers	PAPR (dB)	Average (dBm)
Port 1 at Middle Channel	10MHz with upper IoT GB carrier	7.21	36.87
Port 2 at Middle Channel	10MHz with upper IoT GB carrier	7.19	36.90
Port 3 at Middle Channel	10MHz with upper IoT GB carrier	7.20	36.89
Port 4 at Middle Channel	10MHz with upper IoT GB carrier	7.21	36.88

The highest power port was selected as the worst case. Based on the results above, Port 2 had the highest RMS average power (represents the worst case) and therefore it was selected for all the remaining antenna port tests.



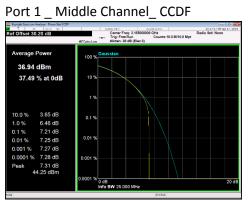
Subsequently output power levels on bottom, middle, and top channels in all 3 LTE channel bandwidths available (10, 15, & 20MHz) for the Narrow Band IoT Guard Band carrier were tested only at Port 2 and the results presented below. Measurements were performed for both the upper and lower narrow band IoT guard band carriers for each LTE channel bandwidth. The highest measured values are highlighted.

Ant Port 2 LTE Channel	LTE BW with Lower & Upper NB-IoT GB carriers	PAPR (dB)	Average (dBm)
Bottom Channel	10MHz with lower IoT GB carrier	7.20	36.93
Bottom Channel	10MHz with upper IoT GB carrier	7.20	36.98
Bottom Channel	15MHz with lower IoT GB carrier	7.22	36.86
Bottom Channel	15MHz with upper IoT GB carrier	7.22	36.86
Bottom Channel	20MHz with lower IoT GB carrier	7.22	36.75
Bottom Channel	20MHz with upper IoT GB carrier	7.22	36.94
Middle Channel	10MHz with lower IoT GB carrier	7.20	36.91
Middle Channel	10MHz with upper IoT GB carrier	7.19	36.90
Middle Channel	15MHz with lower IoT GB carrier	7.20	36.96
Middle Channel	15MHz with upper IoT GB carrier	7.21	36.88
Middle Channel	20MHz with lower IoT GB carrier	7.19	36.89
Middle Channel	20MHz with upper IoT GB carrier	7.19	36.88
Top Channel	10MHz with lower IoT GB carrier	7.22	36.93
Top Channel	10MHz with upper IoT GB carrier	7.22	36.85
Top Channel	15MHz with lower IoT GB carrier	7.23	36.99
Top Channel	15MHz with upper IoT GB carrier	7.25	37.01
Top Channel	20MHz with lower IoT GB carrier	7.24	37.04
Top Channel	20MHz with upper IoT GB carrier	7.26	36.98

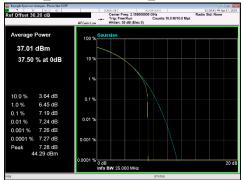
All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 30.2 dB and is accounted for by the spectrum analyzer reference level offset.



# LTE10 Channel Power Plots at Middle Channel (2155.0MHz) for Single NB-IoT Upper Guard Carriers:



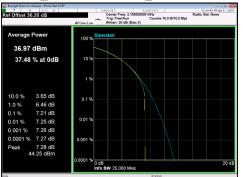
## Port 2 \_ Middle Channel\_ CCDF



# Port 3 \_ Middle Channel\_ CCDF

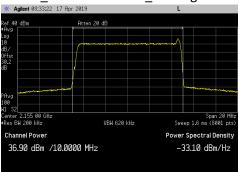


# Port 4 \_ Middle Channel\_ CCDF

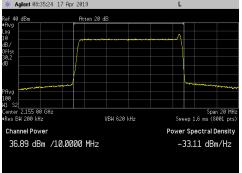


Port 1 \_ Middle Channel\_ Average

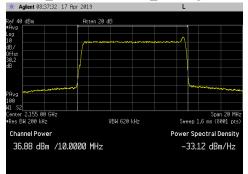




#### Port 3 \_\_\_\_\_ Middle Channel\_ Average \* Agilent 08:35:24 17 Apr 2019 L

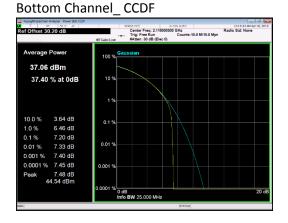


# Port 4 \_ Middle Channel\_ Average

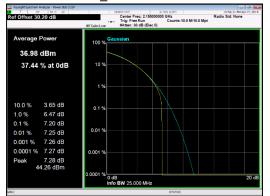




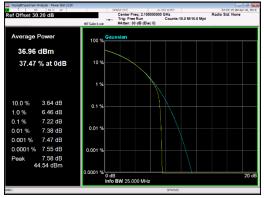
# LTE10 Channel Power Plots for Single NB-IoT Lower Guard Band Carriers at Antenna Port 2:

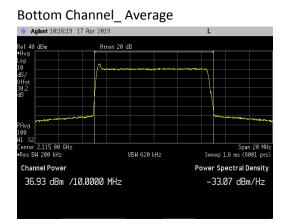


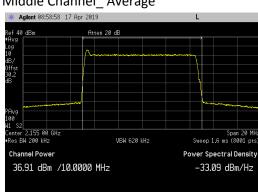
## Middle Channel CCDF





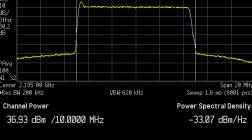






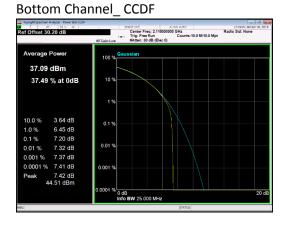
## Middle Channel Average



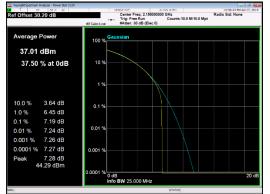




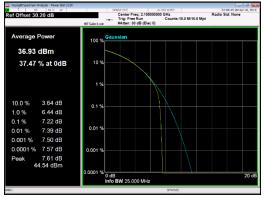
# LTE10 Channel Power Plots for Single NB-IoT Upper Guard Band Carriers at Antenna Port 2:

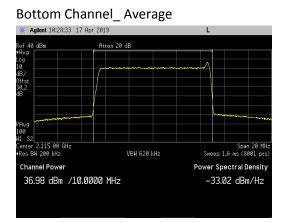


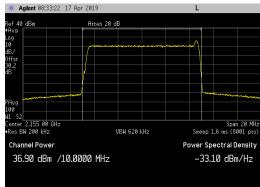
## Middle Channel\_ CCDF





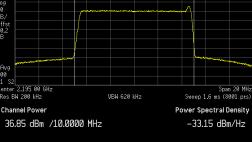






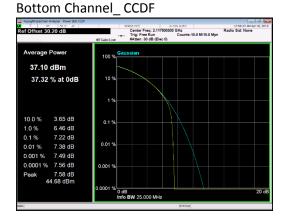
## Middle Channel\_ Average



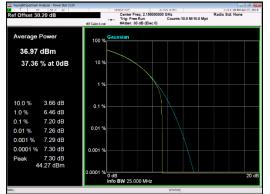




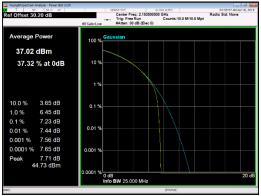
# LTE15 Channel Power Plots for Single NB-IoT Lower Guard Band Carriers at Antenna Port 2:

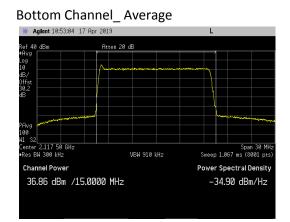


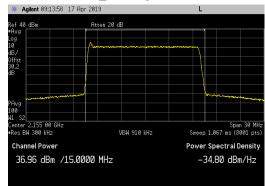
#### Middle Channel\_ CCDF



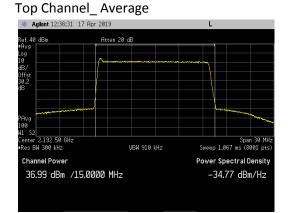






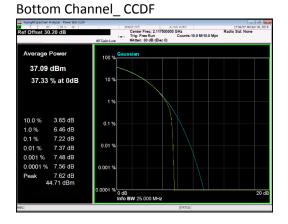


#### Middle Channel\_ Average

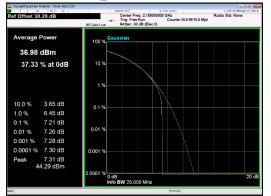




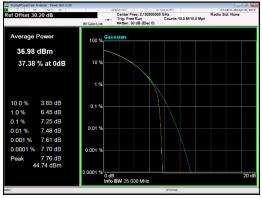
# LTE15 Channel Power Plots for Single NB-IoT Upper Guard Band Carriers at Antenna Port 2:

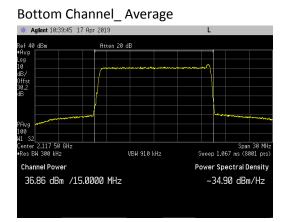


#### Middle Channel\_ CCDF

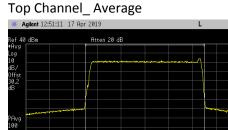








# Middle Channel\_ Average



 1.3 Cell
 Span 30 MHz

 Span 30 MHz
 Span 30 MHz

 Res BH 300 KHz
 VBH 910 KHz

 Sweep 1.067 ms (8001 pts)

 Channel Power

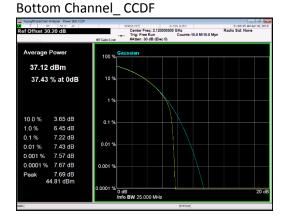
 Power Spectral Density

 37.01 dBm
 /15.0000 MHz

 -34.75 dBm/Hz



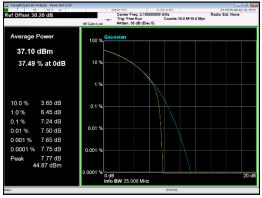
# LTE20 Channel Power Plots for Single NB-IoT Lower Guard Band Carriers at Antenna Port 2:

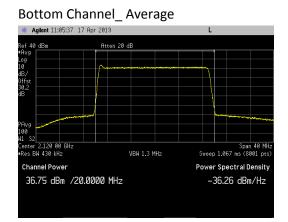


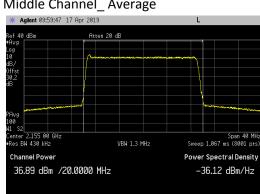
## Middle Channel CCDF

t at 56.0 AC	Instruction         ALDON AUTO         11:57:16 TM Ager 17, 261           Center Freq: 2:155000000 GHz         Radio Std: None         Radio Std: None           #T GeinLow         +
Average Power	100 % Gaussian
36.99 dBm	
37.44 % at 0dB	10 %
	1 %
10.0 % 3.65 dB 1.0 % 6.45 dB	0.1%
0.1 % 7.19 dB 0.01 % 7.28 dB	0.01 %
0.001 % 7.31 dB 0.0001 % 7.33 dB Peak 7.35 dB	0.001 %
44.34 dBm	0.0001 % 0 dB 20 dl

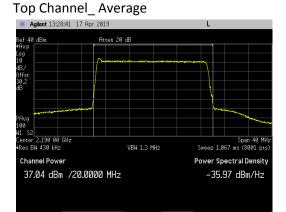








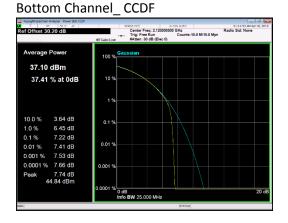




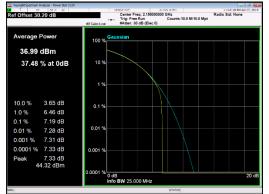
## Middle Channel Average



# LTE20 Channel Power Plots for Single NB-IoT Upper Guard Band Carriers at Antenna Port 2:

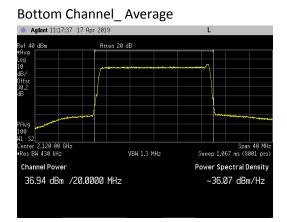


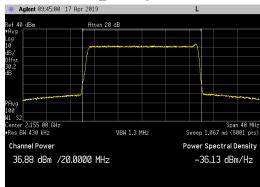
## Middle Channel\_ CCDF





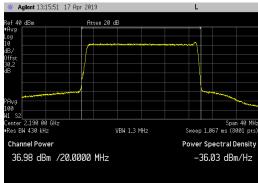






## Middle Channel\_ Average







# Emission Bandwidth (26 dB down and 99%)

Emission bandwidth measurements were made at AHIB antenna port 2 on the bottom, middle and top channels for a single NB-IoT Guard Band LTE10, LTE15 and LTE20 carriers 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 in each channel type are highlighted.

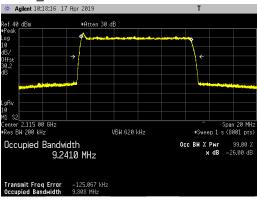
Ant Port 2 LTE Channel	LTE BW with Lower or Upper NB-IoT GB carriers	26dB Down Emission Bandwidth (MHz)	99% Emission Bandwidth (MHz)
<b>Bottom Channel</b>	10MHz with lower IoT GB carrier	9.808	9.2410
<b>Bottom Channel</b>	10MHz with upper IoT GB carrier	9.803	9.2400
<b>Bottom Channel</b>	15MHz with lower IoT GB carrier	14.766	13.8193
<b>Bottom Channel</b>	15MHz with upper IoT GB carrier	14.744	13.8304
<b>Bottom Channel</b>	20MHz with lower IoT GB carrier	19.721	18.3106
Bottom Channel	20MHz with upper IoT GB carrier	19.711	18.3215
Middle Channel	10MHz with lower IoT GB carrier	9.805	9.2436
Middle Channel	10MHz with upper IoT GB carrier	9.805	9.2424
Middle Channel	15MHz with lower IoT GB carrier	14.764	13.8176
Middle Channel	15MHz with upper IoT GB carrier	14.754	13.8374
Middle Channel	20MHz with lower IoT GB carrier	19.702	18.3133
Middle Channel	20MHz with upper IoT GB carrier	19.697	18.3220
Top Channel	10MHz with lower IoT GB carrier	9.805	9.2331
Top Channel	10MHz with upper IoT GB carrier	9.819	9.2422
Top Channel	15MHz with lower IoT GB carrier	14.759	13.8022
Top Channel	15MHz with upper IoT GB carrier	14.753	13.8272
Top Channel	20MHz with lower IoT GB carrier	19.682	18.2962
Top Channel	20MHz with upper IoT GB carrier	19.712	18.3123

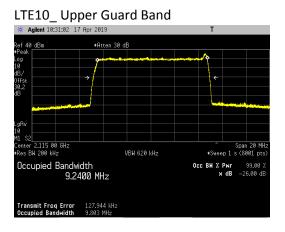
Emission bandwidth measurement data are provided in the following pages.



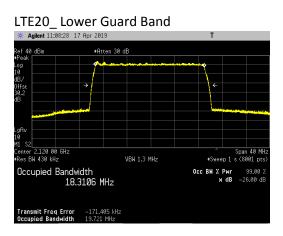
# Emission Bandwidth Plots on the Bottom Channel for NB-IoT Guard Band Carriers on Antenna Port 2:

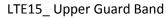


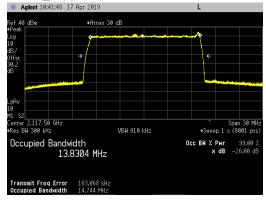


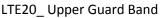


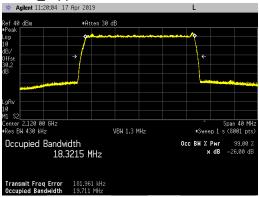
LTE15\_Lower Guard Band





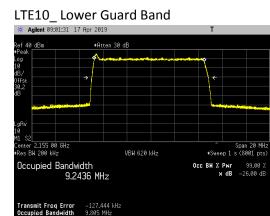


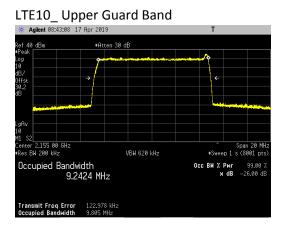




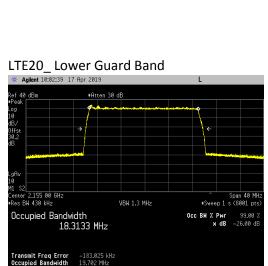


# Emission Bandwidth Plots on the Middle Channel for NB-IoT Guard Band Carriers on Antenna Port 2:

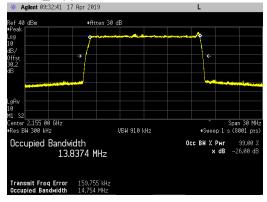




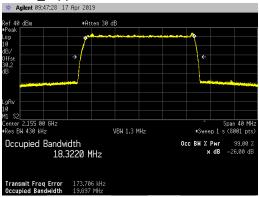
LTE15\_Lower Guard Band



# LTE15\_ Upper Guard Band

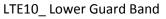


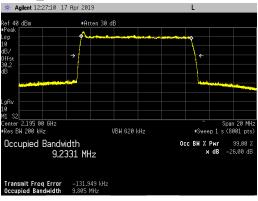


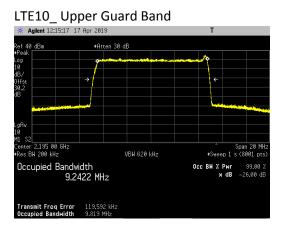




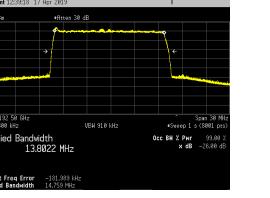
# Emission Bandwidth Plots on the Top Channel for NB-IoT Guard Band Carriers on Antenna Port 2:

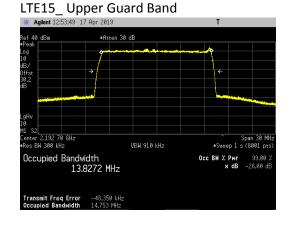


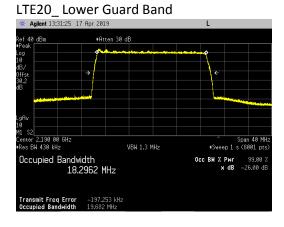


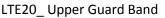


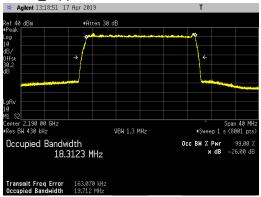
LTE15 Lower Guard Band \* Agilent 12:39:18 17 Apr 2019 #Atten 30 dB ef 40 dBn oz∣ nter 2.192 50 GHz ∞s BW 300 kHz Span 30 MH: \*Sweep 1 s (8001 pts) VBW 910 kHz Occupied Bandwidth 13.8022 MHz Осс ВИ X Рыг 99.00 X х dB -26.00 dB Transmit Freq Error -181.989 kHz Occupied Bandwidth 14.759 MHz













# Antenna Port Conducted Band Edge

Conducted band edge measurements were made at RRH antenna port 2. For the single carrier test cases, the RRH was operated at the band edge frequencies with a single upper and lower NB IoT GB carrier for 10MHz, 15MHz and 20MHz LTE channel bandwidth at maximum power (5 watts/port and 5 watts/carrier).

Two multicarrier test cases were performed based upon KDB 971168 D03v01. A multicarrier test case with three LTE10 carriers using two carriers (with minimum spacing between carrier frequencies) at the lower band edge (EARFCN 66486: 2115.0 & EARFCN 66586: 2125.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 67286: 2175.0MHz) was verified. A multicarrier test case with three LTE10 carriers using two carriers (with minimum spacing between carrier frequencies) at the upper band edge (EARFCN 67286: 2195.0 & EARFCN 67186: 2185.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 67186: 2185.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 67186: 2185.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 66686: 2135.0MHz) was verified.

The limit of -19dBm was used in the certification 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 1MHz bands outside and adjacent to the frequency block, a resolution bandwidth of 1% of the emission bandwidth was used. In the 1 to 2MHz frequency range outside the band edge (i.e.: 2108 to 2109MHz and 2201 to 2202MHz bands) the RBW was again reduced to 1% of the emission bandwidth and the power integrated over 1MHz. In the 2 to 22MHz frequency range outside the band edge (i.e.: 2088 to 2108MHz and 2202 to 2222MHz bands) a 1MHz RBW and 3MHz VBW was used. The band edge frequencies used for the multicarrier test cases were selected based upon the location of the top and bottom carriers of test configuration.



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

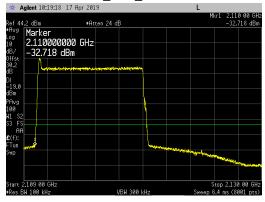
Channel BW, Carrier Frequency, Carrier Power	NB IoT Guard Band Placement	Lower Band Edge (dBm)	Upper Band Edge (dBm)
Single 10MHz Carrier,	Bana Hacchicht	(abili)	(abiii)
2115.0MHz (BC), 5W	Lower	-24.272	N/A
Single 10MHz Carrier,			
2115.0MHz (BC), 5W	Upper	-24.763	N/A
Single 15MHz Carrier,			
2117.5MHz (BC), 5W	Lower	-25.517	N/A
Single 15MHz Carrier,			
2117.5MHz (BC), 5W	Upper	-26.112	N/A
Single 20MHz Carrier,			
2120.0MHz (BC), 5W	Lower	-27.305	N/A
Single 20MHz Carrier,			
2120.0MHz (BC), 5W	Upper	-27.338	N/A
Single 10MHz Carrier,			
2195.0MHz (TC), 5W	Lower	N/A	-24.282
Single 10MHz Carrier,			
2195.0MHz (TC), 5W	Upper	N/A	-23.985
Single 15MHz Carrier,	1	N1/A	25.027
2192.5MHz (TC), 5W	Lower	N/A	-25.837
Single 15MHz Carrier,	Unnor	N/A	-25.400
2192.5MHz (TC), 5W	Upper	N/A	-25.400
Single 20MHz Carrier,	Lower	N/A	-26.775
2190.0MHz (TC), 5W	Lower	N/A	-20.775
Single 20MHz Carrier,	Upper	N/A	-26.367
2190.0MHz (TC), 5W	opper	IN/A	-20.307
Multi 10MHz Carriers,			
2115, 2125 & 2175MHz	Lower	-29.571	-28.473
at 1.6W/Carrier & 5W/port			
Multi 10MHz Carriers,			
2115, 2125 & 2175MHz	Upper	-29.336	-28.698
at 1.6W/Carrier & 5W/port			
Multi 10MHz Carriers,			
2135, 2185 & 2195MHz	Lower	-27.494	-29.476
at 1.6W/Carrier & 5W/port			
Multi 10MHz Carriers,			
2135, 2185 & 2195MHz	Upper	-27.745	-29.230
at 1.6W/Carrier & 5W/port			

The total measurement RF path loss of the test setup (attenuator and test cables) was 30.2 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.



# LTE10 Single 5W Carrier Lower Band Edge Plots for Antenna Port 2:

IoT Guard Band Carrier at Lower Placement Bottom Channel\_ LBE\_2109 to 2130MHz



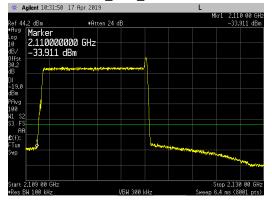
# Bottom Channel\_LBE\_2108 to 2109MHz

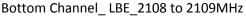
🔆 Agilent 10:20:22 17 Ap	r 2019		L			
Ref 10 dBm	#Atten 20 dB					
≢Avg K						
Log 10						
10						
dB/						
Offst						
30.2	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		······		
PAvg						
100						
и́1 s2						
Start 2.108 000 GHz			S	top 2.109 000 GHz		
*Res BW 100 kHz	VBW 3	00 kHz		167 ms (8001 pts)		
Channel Power			Power Sp	ectral Density		
-25.31 dBm /1.000	10 MU-		OF	21 JD., /U.,		
-23.31 UDM /1.000	ע וח∠		-85.31 dBm/Hz			

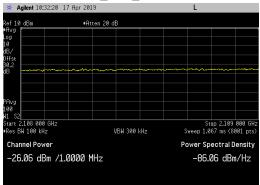
🔆 Agilent 10:20:51 17 Ap	1 2013				L	cr1 2.10	7 96 GI
f 10 dBm	#Atten 22	dB					272 dBr
Marker 2.107960000 ( 2.107960000 (	GHz						
fst 1.2							
19.0						Harrister and	وتججونها
3m Ivg				and the second second			
10 	all the state of the second		for the state				
FS AA							
iun in							
art 2.088 00 GHz es BW 1 MHz		VBW 3 M				top 2.10	8 00 GH 001 pts

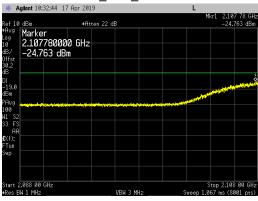
## Bottom Channel\_ LBE\_2088 to 2108MHz

IoT Guard Band Carrier at Upper Placement Bottom Channel\_LBE\_2109 to 2130MHz







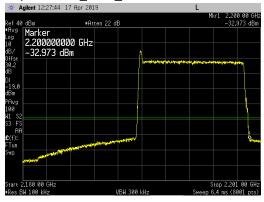


# Bottom Channel\_ LBE\_2088 to 2108MHz



# LTE10 Single 5W Carrier Upper Band Edge Plots for Antenna Port 2:

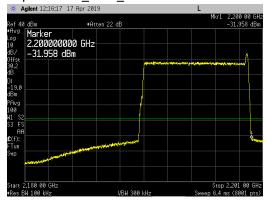
IoT Guard Band Carrier at Lower Placement Top Channel\_ UBE\_2180 to 2201MHz

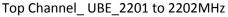


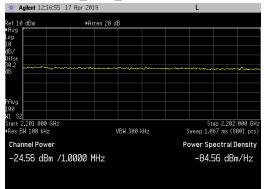
Top Channel\_UBE\_2201 to 2202MHz

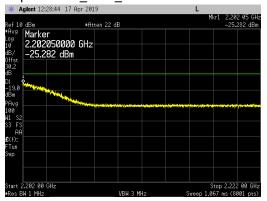
*	Agilent 12:	28:20 1	7 Apr 201	9				L		
	10 dBm		#Ât	ten 20 d	В					
ŧAv	g									
Log 10										
dB/										
Offs	t									
30.2 dB		~~~~	~~~~~	~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
ΡΑν 100	g									
Ŵ1	\$2									
	t 2.201 000								op 2.202	
*Re:	s BW 100 kH				VBW 300 I	<hz< td=""><td>S</td><td>жеер 1.0</td><td>67 ms (8</td><td>301 pts)</td></hz<>	S	жеер 1.0	67 ms (8	301 pts)
Cł	nannel Pow	/er					Po	ower Sp	ectral D	ensity
H	-25.42 dBm /1.0000 MHz							-85.4	42 dBn	ı/Hz

IoT Guard Band Carrier at Upper Placement Top Channel\_ UBE\_2180 to 2201MHz

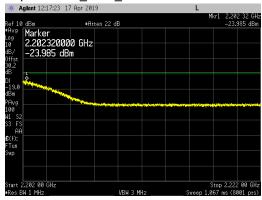








## Top Channel\_ UBE\_2202 to 2222MHz

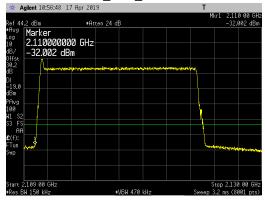


# Top Channel\_ UBE\_2202 to 2222MHz



# LTE15 Single 5W Carrier Lower Band Edge Plots for Antenna Port 2:

IoT Guard Band Carrier at Lower Placement Bottom Channel\_ LBE\_2109 to 2130MHz



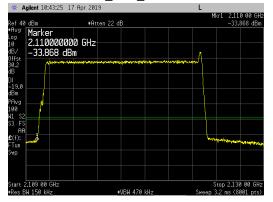
# Bottom Channel\_LBE\_2108 to 2109MHz

🔆 Agilent 10:57:26 17 Ap	r 2019		L	
Ref 10 dBm	#Atten 20 dB			
≢Avg K				
Log 10				
dB/				
Offst				
30.2 dB		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
PAvg				
100 W1 S2				
Start 2.108 000 GHz			St	op 2.109 000 GHz
•Res BW 150 kHz	∗VBW 4	70 kHz		167 ms (8001 pts)
Channel Power			Power Sp	ectral Density
-26.71 dBm /1.000	10 MHz		-86.	71 dBm/Hz

🔆 Agilent 1	0:57:49 17	Apr 201	9				L		
Ref 10 dBm		#Ĥt	ten 22 di	3			М		7 78 GHz 517 dBm
	er 778000 517 dBi								
30.2 dB									1
DI -19.0 dBm PAvg								and the second second	udoasen Å
100 H1 S2				******					
S3 FS AA €(f):									
FTun Swp									
Start 2.088 00 #Res BW 1 MH;				VBW 3 MI	lz	s		top 2.101 67 ms (81	

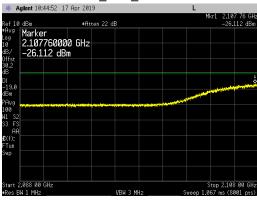
## Bottom Channel\_ LBE\_2088 to 2108MHz

IoT Guard Band Carrier at Upper Placement Bottom Channel\_LBE\_2109 to 2130MHz



## Bottom Channel\_ LBE\_2108 to 2109MHz



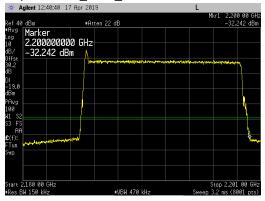


# Bottom Channel\_ LBE\_2088 to 2108MHz



# LTE15 Single 5W Carrier Upper Band Edge Plots for Antenna Port 2:

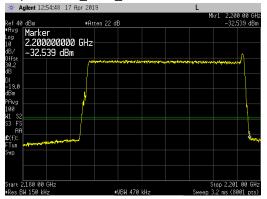
IoT Guard Band Carrier at Lower Placement Top Channel\_ UBE\_2180 to 2201MHz



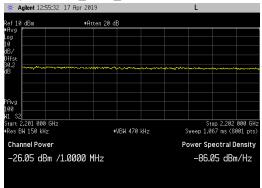
Top Channel\_ UBE\_2201 to 2202MHz

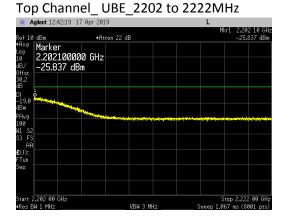
*	Agilent 12	:41:35 1	7 Apr 201	9				L		
	10_dBm		<b>#</b> Ĥt	ten 20 d	В					
ŧΑvs	3									
Log 10										
dB/										
Offs	t									
30.2 dB		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	and the second s				~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			~~~~~
PAve	~									
100	9									
W1										
	t 2.201 00								op 2.202	
*Res	s BW 150 kH	IZ		•	VBW 470	kHz		weep 1.0	67 ms (8	001 pts)
Ch	nannel Pos	//er					Po	ower Sp	ectral D	ensity
-2	-26.47 dBm /1.0000 MHz						-86.47 dBm/Hz			

IoT Guard Band Carrier at Upper Placement Top Channel\_ UBE\_2180 to 2201MHz

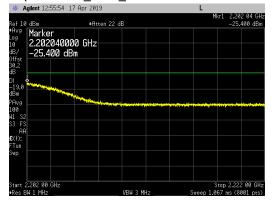








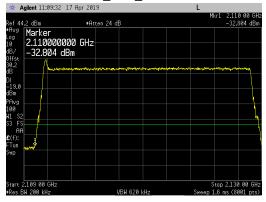
## Top Channel\_ UBE\_2202 to 2222MHz





# LTE20 Single 5W Carrier Lower Band Edge Plots for Antenna Port 2:

IoT Guard Band Carrier at Lower Placement Bottom Channel\_ LBE\_2109 to 2130MHz



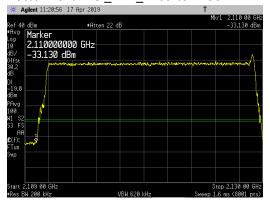
Bottom Channel\_LBE\_2108 to 2109MHz

🔆 Agilent 11:10:07 1	7 Apr 2019				L		
Ref 10 dBm	#Atten 20	dB					
≢Avg K							
Log 10							
dB/							
Offst							
30.2 dB		m	-		warman and an	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
PAvg							
100 W1 S2							
Start 2.108 000 GHz					St	op 2.109	000 GHz
≢Res BW 200 kHz		VBW 620 M	<hz< td=""><td>S۳</td><td>eep 1.0</td><td>67 ms (8</td><td>001 pts)</td></hz<>	S۳	eep 1.0	67 ms (8	001 pts)
Channel Power				Po	wer Sp	ectral D	ensity
-28.00 dBm /1.	0000 MU-				00 0	00 dBn	· /凵_
-20.00 00m /1.	uuuu n⊓∠				-00.6	וםט שנ	ii/ ⊓∠

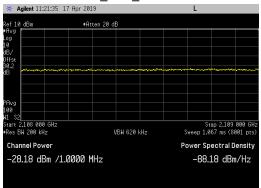
🔆 А	gilent 11:	10:27 17	Apr 201	9			L		
	10		- ^				М	kr1 2.10	
Ref 10 #Avg			#HC	ten 22 d	D			-27.	305 dBm
*HVg Log	Marke	r 44000	ด เม-						
dB/		44000 05 dBr							
Offst 30.2 dB									
DI									
-19.0 dBm PAvg							 and the second	and for the first state	
100 W1 S2	***				an sa	iya da y <b>a</b> da wa di ki			
S3 FS AA									
£(f): FTun									
Swp									
Start 2	.088 00	GHz					S	top 2.108	3 00 GHz
≢Res B	W 1 MHz				VBW 3 M	z	\$	67 ms (80	

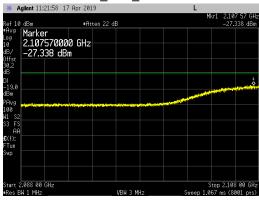
Bottom Channel\_ LBE\_2088 to 2108MHz

IoT Guard Band Carrier at Upper Placement Bottom Channel\_LBE\_2109 to 2130MHz



## Bottom Channel\_ LBE\_2108 to 2109MHz



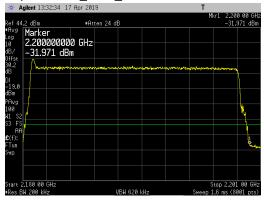


# Bottom Channel\_ LBE\_2088 to 2108MHz



# LTE20 Single 5W Carrier Upper Band Edge Plots for Antenna Port 2:

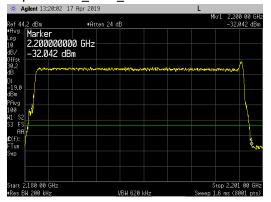
IoT Guard Band Carrier at Lower Placement Top Channel\_ UBE\_2180 to 2201MHz

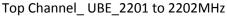


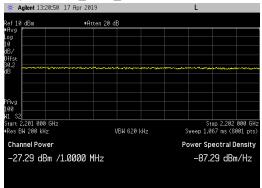
Top Channel\_ UBE\_2201 to 2202MHz

*	Agilent 13:	33:12 1	7 Apr 201	9				L		
	10_dBm		<b>#</b> Ĥt	ten 20 d	В					
≢Av Log	9									
109 10										
dB/										
Offs	t									
30.2 dB	~~~~~	-	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~				·····	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
ΡΑν 100	9									
W1										
	t 2.201 000								op 2.202	
*Re:	s BW 200 kH	z		ļ	/BW 620 I	кНz		жеер 1.0	67 ms (8	001 pts)
Cł	nannel Pov	ver					Po	ower Sp	ectral D	ensity
-	27.67 dł	3m /1.0	2000 M	Hz				-87.6	57 dBn	ı/Hz

IoT Guard Band Carrier at Upper Placement Top Channel\_ UBE\_2180 to 2201MHz

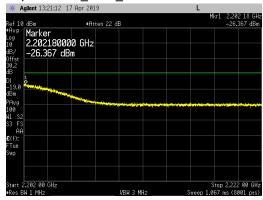






₩ Ag	<b>jilent</b> 13:3	3:44 17	Apr 201	.9	_			L		
Ref 10	dBm		+At	ten 22 d	в			M	<r1 2.20<br="">-26.</r1>	2 24 GHz 775 dBm
10 10 dB/ Offst	Marker 2.2022 -26.77	24000								
10.2 IB II - 19.0 IBm		-								
PAvg 100 11 S2 53 FS			and the second second	ngand yn yf erfans synger	an a				encemperation.	ana tanàng ka
AA C(f): Tun Swp										
Start 2. ⊧Res Bk	.202 00 0 √1 MHz	iHz			VBW 3 M	Hz	s	S weep 1.0	top 2.222 67 ms (80	

#### Top Channel\_UBE\_2202 to 2222MHz

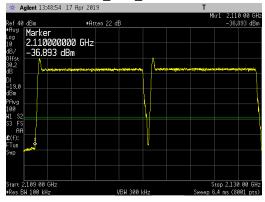


# Top Channel\_ UBE\_2202 to 2222MHz



# Multi LTE10 Carriers at 2115, 2125 & 2175MHz at 5W/Port\_ Lower Band Edge Plots for Antenna Port 2:

IoT Guard Band Carrier at Lower Placement Bottom Channel\_ LBE\_2109 to 2130MHz



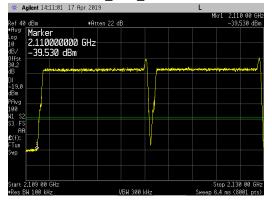
# Bottom Channel\_LBE\_2108 to 2109MHz

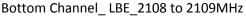
🔆 Agilent 13:50:04 17 Apr	2019				L			
Ref 10 dBm	#Atten 20 dB							
≢Avg K								
Log 10								
dB/								
Offst								
30.2 dB	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		~~~~~			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
PAvg								
100								
W1 S2								
Start 2.108 000 GHz #Res BW 100 kHz	VE	W 300 kł	łz	SH		op 2.109 67 ms (80		
Channel Power				Po	wer Sp	ectral D	ensity	
-30.43 dBm /1.000	0 MHz				-90.43 dBm/Hz			

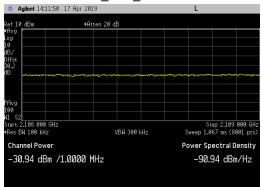
🔆 Agilent 13:50:27 17 Ag	pr 2019				L		
Ref 10 dBm	#Atten 22 d	В			M	r1 2.10 -29.5	7 56 GHz 571 dBm
*Avg Log 10 2.107560000 dB/ Offst -29.571 dBm	GHz						
30.2 dB							
DI -19.0							
dBm PAvg					موجع الماري	and an a state of the second	
100 W1 S2							
S3 FS AA							
£(f): FTun							
Swp							
Start 2.088 00 GHz					S	top 2.108	00 GHz
•Res BW 1 MHz		VBW 3 M	z	S	кеер 1.0	67 ms (80	001 pts)_

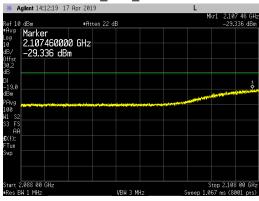
Bottom Channel\_LBE\_2088 to 2108MHz

IoT Guard Band Carrier at Upper Placement Bottom Channel\_LBE\_2109 to 2130MHz







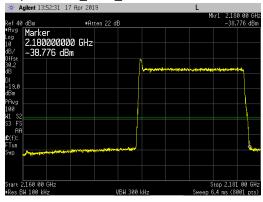


### Bottom Channel\_ LBE\_2088 to 2108MHz



# Multi LTE10 Carriers at 2115, 2125 & 2175MHz at 5W/Port\_ Upper Band Edge Plots for Antenna Port 2:

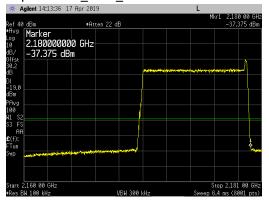
IoT Guard Band Carrier at Lower Placement Top Channel\_ UBE\_2160 to 2181MHz

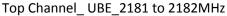


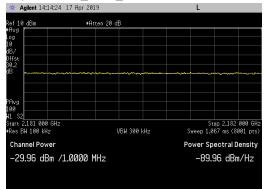
Top Channel\_UBE\_2181 to 2182MHz

🔆 Agilent 13:54:01 17 F	Apr 2019				L		
Ref 10_dBm	#Atten 20 dE	3					
≢Avg K							
Log 10							
dB/							
Offst							
30.2 dB							
ab warmana		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
PAvg							
100 W1 S2							
Start 2.181 000 GHz					St	op 2.182	000 GHz
≢Res BW 100 kHz	ί	IBW 300 H	(Hz			67 ms (80	
Channel Power		Power Spectral Densit					
-30.24 dBm /1.00	100 MHz	-90.24 dBm/Hz					ı/Hz

IoT Guard Band Carrier at Upper Placement Top Channel\_ UBE\_2160 to 2181MHz



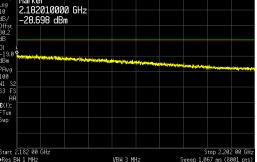




# ★ Agilent 13:55:01 17 Apr 2019 L Ref 10 dBm •Atten 22 dB -28.473 dBm \*Hvg Agilent 13:55:01 17 Apr 2019 L #Hvg Marker -28.473 dBm 19 2.182:480000 GHz -28.473 dBm 02:2 -28.473 dBm -28.473 dBm 01:30:2 -28.473 dBm -28.473 dBm 02:4 -28.473 dBm -28.473 dBm 01:30:2 -28.473 dBm -28.473 dBm 02:4 -28.473 dBm -28.473 dBm 01:30:2 -28.473 dBm -28.473 dBm 02:4 -28.473 dBm -28.473 dBm 01:30:2 -28.473 dBm -28.473 dBm 02:4 -28.473 dBm -28.473 dBm 02:4 -28.473 dBm -28.473 dBm 02:4 -28.473 dBm -28.473 dBm 03:2 -28.473 dBm -28.473 dBm 04:3 -28.473 dBm -28.473 dBm 10:40 -29.473 dBm -29.473 dBm 10:40 -29.473 dBm -29.473 dBm 10:40 -29.47

Top Channel\_ UBE\_2182 to 2202MHz

# 



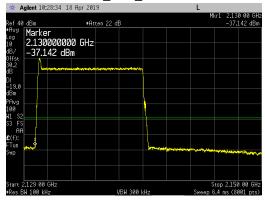
2.182 01 GH -28.698 dBm

#### Top Channel\_UBE\_2182 to 2202MHz \* Agilent 14:15:13 17 Hor 2019



# Multi LTE10 Carriers at 2135, 2185 & 2195MHz at 5W/Port\_ Lower Band Edge Plots for Antenna Port 2:

IoT Guard Band Carrier at Lower Placement Bottom Channel\_ LBE\_2129 to 2150MHz



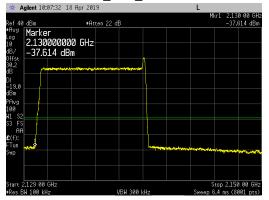
# Bottom Channel\_LBE\_2128 to 2129MHz

🗰 Agilent 10:29:32 18 Ap	2019				L		
Ref 10 dBm	≢Atten 20 dE						
⊧Avg K							
Log							
10							
dB/							
Offst							
30.2 dB							
ap		~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~				· ·····
PAvg							
100 N1 S2							
W1 S2 Start 2.128 000 GHz					· · ·	op 2.129	000 CII-
		DU 200 I					
*Res BW 100 kHz	v	BM 300 k	(HZ	21	weeb 1.0	67 ms (8	001 pts)
Channel Power				Po	wer Sp	ectral D	lensity
-29.23 dBm /1.000	N MH-7	-89.23 dBm					
23.23 dDm / 1.000					00.	-5 001	17 112

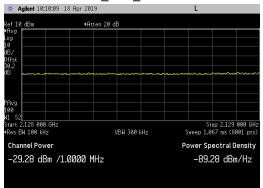
🔆 Agilent 10:30:35	18 Apr 2019		L	
( 10 10				127 06 GH
ef 10 dBm Avg Morkor	#Atten 22	dD		27.494 dBm
2.1270600	100 GHz			
<sup>B/</sup>   -27,494 d	Rm			
ffst				
0.2 B				
1				1
19.0				
Bm		an and the second state of the	and the state of the second	and the second
Avg	فاسترده معلقه فالمسترج والمعاقد والمعاج			
00				
1 \$2				
3 FS				
AA				
:(f): Tun				
wp				
- P				
tart 2.108 00 GHz			Stop 2.	128 00 GH:
Res BW 1 MHz		VBW 3 MHz	Sweep 1.067 ms	

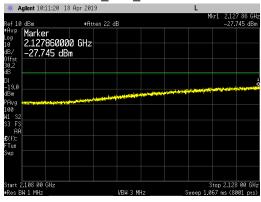
Bottom Channel\_ LBE\_2108 to 2128MHz

IoT Guard Band Carrier at Upper Placement Bottom Channel\_LBE\_2129 to 2150MHz



#### Bottom Channel\_ LBE\_2128 to 2129MHz



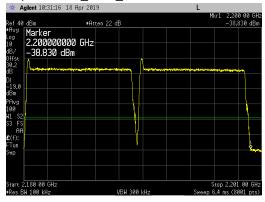


#### Bottom Channel\_ LBE\_2108 to 2128MHz



# Multi LTE10 Carriers at 2135, 2185 & 2195MHz at 5W/Port\_ Upper Band Edge Plots for Antenna Port 2:

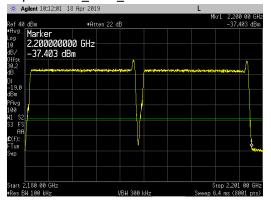
IoT Guard Band Carrier at Lower Placement Top Channel\_ UBE\_2180 to 2201MHz



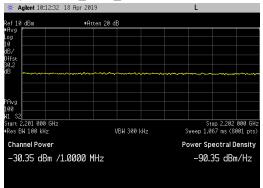
Top Channel\_ UBE\_2201 to 2202MHz

🔆 Agilent 10:31:43 18	Apr 2019				L		
Ref 10_dBm	#Atten 20 d	IB					
#Avg K							
Log 10							
dB/							
Offst D00 D							
30.2 dB							
		·····					~~~~~
no.							
PAvg 100							
M1 S2							
Start 2.201 000 GHz						op 2.202	
*Res BW 100 kHz		VBW 300 H	(Hz	S	жеер 1.0	67 ms (8	001 pts)
Channel Power				Po	wer Sp	ectral D	ensity
-31.17 dBm /1.0	000 MHz	-91.17 dBm/					ı/Hz

IoT Guard Band Carrier at Upper Placement Top Channel\_ UBE\_2180 to 2201MHz

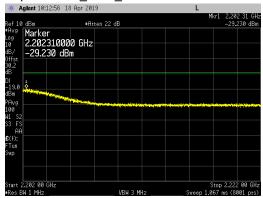






Agilent 10:32:05 18	3 Apr 2019		L	2.202 27 G	
f 10 dBm	#Atten 22	dB	Mkr1	-29.476 dE	
<ul> <li>Marker</li> <li>2.20227000</li> <li>–29.476 dB</li> </ul>					
fst .2					
9.0 3 m vg	With printing in the second second	والمعاجمة والملح والمرا			
9 \$2					
FS AA D:					
r): un o					
art 2.202 00 GHz			Stor	2.222 00 GI	
es BW 1 MHz		VBW 3 MHz	_ Sweep 1.067		

#### Top Channel\_ UBE\_2202 to 2222MHz Top C



# Top Channel\_ UBE\_2202 to 2222MHz



# **Transmitter Antenna Port Conducted Emissions**

Transmitter conducted emission measurements were made at RRH antenna port 2. Measurements were performed over the 9kHz to 22GHz frequency range. The AHIB was operated with a single upper and lower NB IoT GB carrier for all test cases.

The RRH was operated using NB-IoT GB carriers for 10MHz, 15MHz and 20MHz LTE channel bandwidth at maximum power (5 watts/port and 5 watts/carrier) on the AWS middle channel (2155.0MHz) for the single carrier test cases.

Two multicarrier test cases were performed based upon KDB 971168 D03v01. A multicarrier test case with three LTE10 carriers using two carriers (with minimum spacing between carrier frequencies) at the lower band edge (EARFCN 66486: 2115.0 & EARFCN 66586: 2125.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 67286: 2175.0MHz) was verified. A multicarrier test case with three LTE10 carriers using two carriers (with minimum spacing between carrier frequencies) at the upper band edge (EARFCN 67286: 2195.0 & EARFCN 67186: 2185.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 67186: 2185.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 67286: 2195.0 & EARFCN 67186: 2185.0MHz) and a third carrier with maximum spacing between the other two carrier frequencies (EARFCN 66686: 2135.0MHz) was verified.

The limit of -19dBm was used in the certification 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 1MHz 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 20MHz to 3GHz frequency range). Measurements for the 20MHz to 3GHz 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 -49dBm to correct for a spectrum analyzer RBW of 1kHz versus required RBW of 1MHz [i.e.: -49dBm = -19dBm -10log(1MHz/1kHz)]. The limit for the 150kHz to 20MHz frequency range was adjusted to -39dBm to correct for a spectrum analyzer RBW of 10kHz versus required RBW of 1MHz [i.e.: -39dBm = -19dBm -10log(1MHz/10kHz)]. The required limit of -19dBm with a RBW of  $\geq$ 1MHz was used for all other frequency ranges.



The spectrum analyzer settings that were used for this test are summarized in the following table	e.
---	----

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 Sweep		29.4dB			
150kHz to 20MHz	10kHz	30kHz	8001	Peak	Auto	50 Sweeps	29.4dB			
20MHz to 3GHz	1MHz	3MHz	8001	Peak	Auto	50 Sweeps	30.4dB			
3GHz to 13GHz	2MHz	6MHz	8192	Peak	Auto	50 Sweeps	32.0dB			
13GHz to 20GHz	2MHz	6MHz	8192	Peak	Auto	50 Sweeps	37.3dB			
2105 to 2205MHz	1MHz	3MHz	8001	Average	Auto	Note (2)	30.2dB			
Note 1: The total measurement RF path loss of the test setup (attenuators, test cables and filters) is										
accounted for by the spectrum analyzer reference level offset.										
Note 2: Max Hold no	t used an	d instaad	massuraments	wara parfor	mod with	the spectrum	analyzor			

Note 2: Max Hold not used and instead measurements were performed with the spectrum analyzer in the RMS average mode over 100 traces.

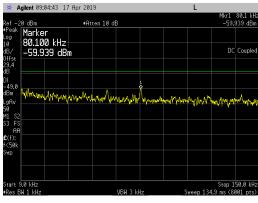
A low pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges less than 20MHz. A high pass filter was used to reduce measurement instrumentation noise floor for the frequency ranges above 3GHz. The total measurement RF path loss of the test setup (attenuators, low pass filter, 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.

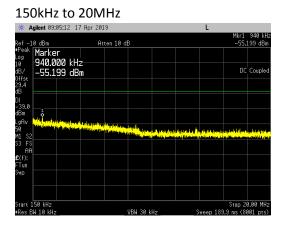
Conducted spurious emission plots/measurements are provided in the following pages.



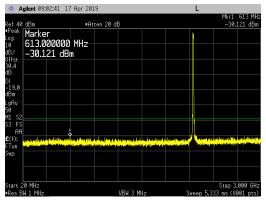
# LTE10 Single 5W Carrier \_ Middle Channel (2155.0MHz) for Antenna Port 2\_ NB-IoT Lower GB:

9kHz to 150kHz

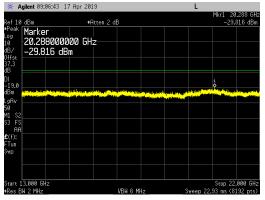




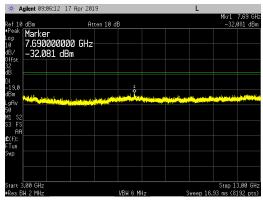
#### 20MHz to 3GHz

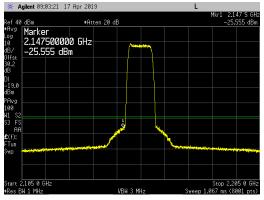


#### 13GHz to 22GHz



# 3GHz to 13GHz

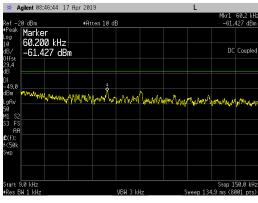


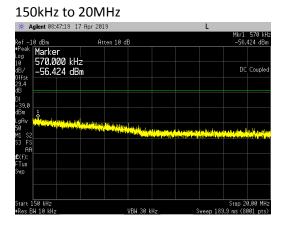




# LTE10 Single 5W Carrier \_ Middle Channel (2155.0MHz) for Antenna Port 2\_ NB-IoT Upper GB:

9kHz to 150kHz

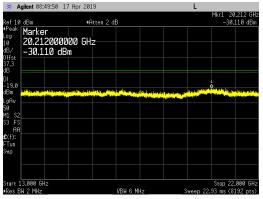




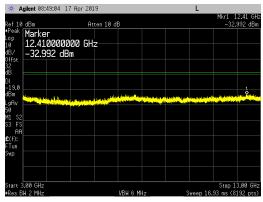
#### 20MHz to 3GHz

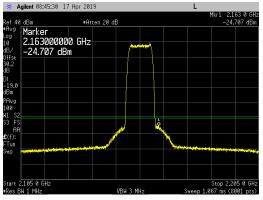
ж А	gilent 08:	44:30 17	Apr 201	9				L		
Ref 40	dBm		#Ât	ten 20 di	В					.654 GHz 318 dBm
10 dB/		r 00000 18 dBi								
Offst 30.4 dB										
DI -19.0 dBm L=0::										
LgAv 50 M1 S2 S3 FS										
53 F3 AA €(f): FTun	a a la dite a di di	ili tatili.	udlat kad	ada adalah s	Interiore de	1 descarates				in an transfer (1941) San an transfer (1944)
Swp										
Start 2										.000 GHz
≢Res B	W 1 MHz				VBW 3 MF	Z	- Si	reep 5.3	33 ms (8	001 pts)_

#### 13GHz to 22GHz



# 3GHz to 13GHz

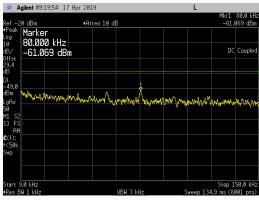


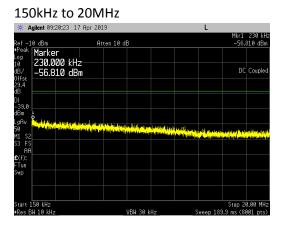




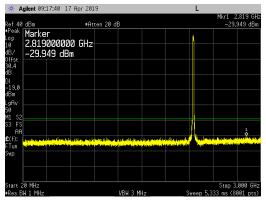
# LTE15 Single 5W Carrier \_ Middle Channel (2155.0MHz) for Antenna Port 2\_ NB-IoT Lower GB:

#### 9kHz to 150kHz

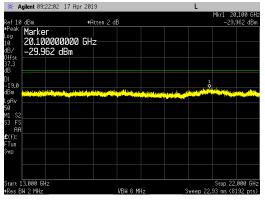




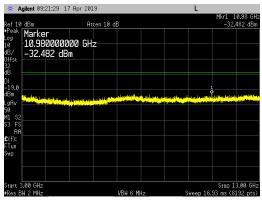
#### 20MHz to 3GHz

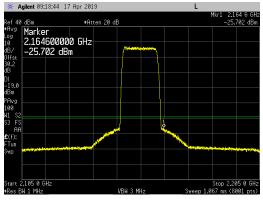


#### 13GHz to 22GHz



# 3GHz to 13GHz

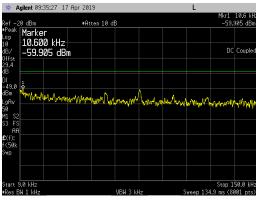


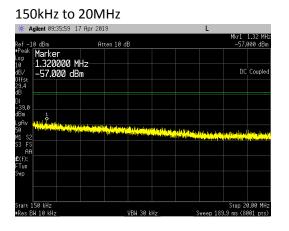




# LTE15 Single 5W Carrier \_ Middle Channel (2155.0MHz) for Antenna Port 2\_ NB-IoT Upper GB:



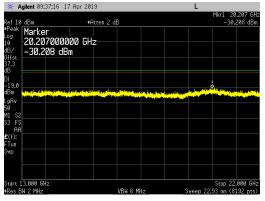




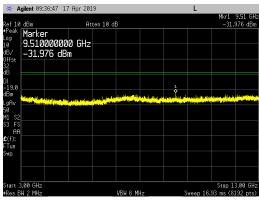
#### 20MHz to 3GHz

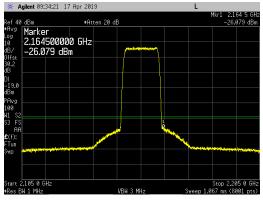
🔆 Agilent 09:33:28 17 Ap	L						
Ref 40 dBm	≢Atten 20 dE	3					.397 GHz 360 dBm
*Peak Log 10 2.397000000 dB/ -30.360 dBm	GHz						
Offst 30.4 dB							
DI -19.0 dBm							
LgAv 50 M1 S2							
S3 FS AA £(f): <u>a data said waa addaad aa</u> a	stanstationika militika sebi	National Ba	. 16-116-11 - 11-11	- lo lu obr	1	and the latest	and a first
FTun Swp	en al participa de compañía de la c		les per la se de	to a star with	Lughon.e	Literie de la composition de la composi	يانيە يەراللىلى بە
Start 20 MHz #Res BW 1 MHz		VBW 3 MH;	2	St	reep 5.3	Stop 3. 33 ms (80	.000 GHz 301 pts)

#### 13GHz to 22GHz



# 3GHz to 13GHz

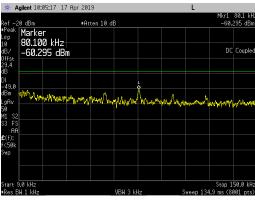


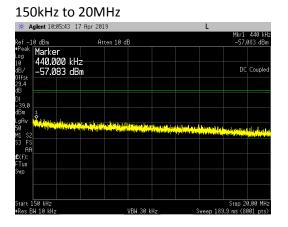




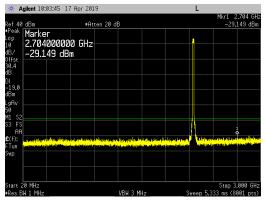
# LTE20 Single 5W Carrier \_ Middle Channel (2155.0MHz) for Antenna Port 2\_ NB-IoT Lower GB:



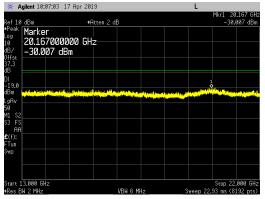




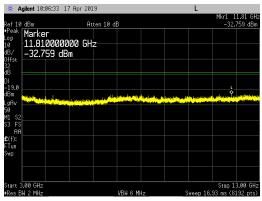
#### 20MHz to 3GHz

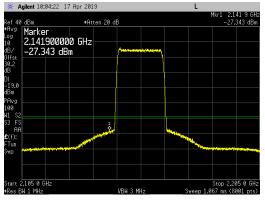


#### 13GHz to 22GHz



# 3GHz to 13GHz

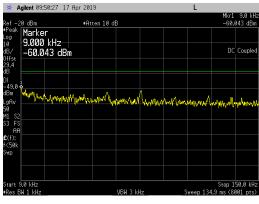


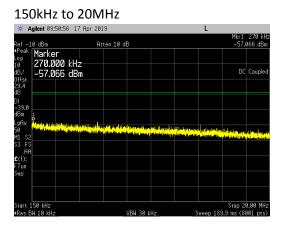




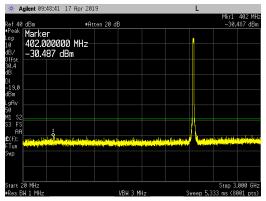
# LTE20 Single 5W Carrier \_ Middle Channel (2155.0MHz) for Antenna Port 2\_ NB-IoT Upper GB:

#### 9kHz to 150kHz

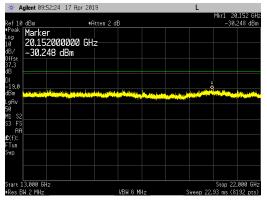




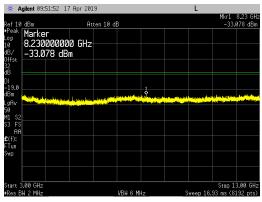
#### 20MHz to 3GHz

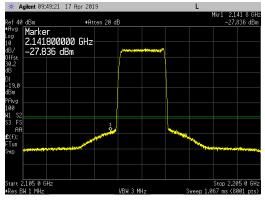


#### 13GHz to 22GHz



# 3GHz to 13GHz



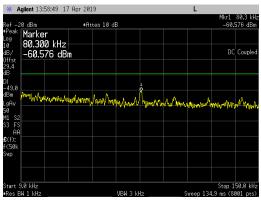


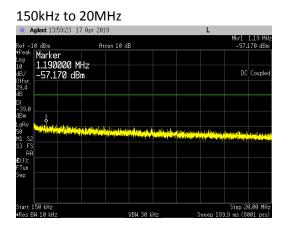


# LTE 10 Multicarrier for Antenna Port 2\_ NB-IoT Lower GB\_LTE10 Carriers at 2115, 2125 & 2175MHz

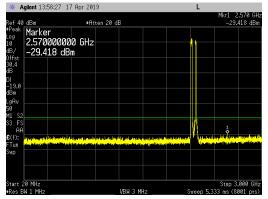
(1.6W/carrier & 5W/port):

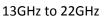
9kHz to 150kHz

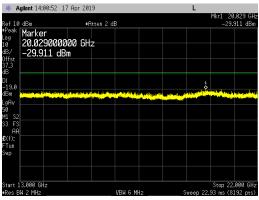




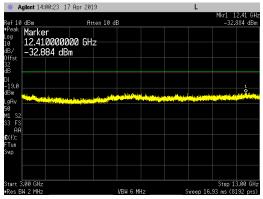
20MHz to 3GHz

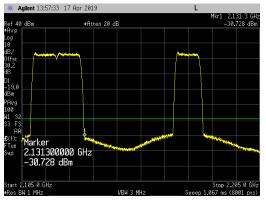










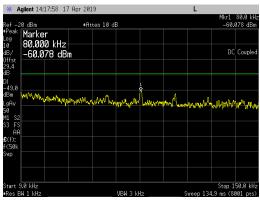


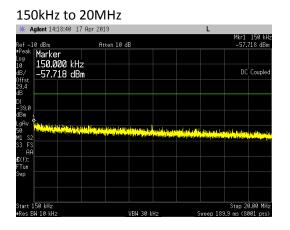


# LTE 10 Multicarrier for Antenna Port 2\_ NB-IoT Upper GB\_LTE10 Carriers at 2115, 2125 & 2175MHz

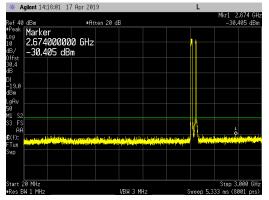
# (1.6W/carrier & 5W/port):

9kHz to 150kHz

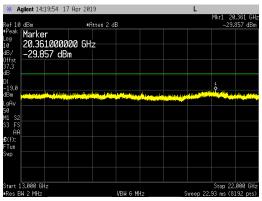




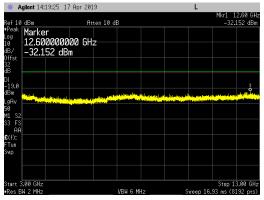
#### 20MHz to 3GHz

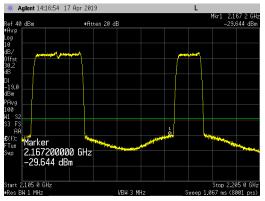


# 13GHz to 22GHz



#### 3GHz to 13GHz



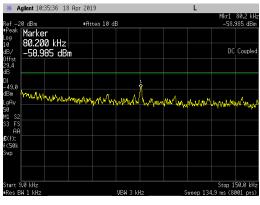




# LTE 10 Multicarrier for Antenna Port 2\_ NB-IoT Lower GB\_LTE10 Carriers at 2135, 2185 & 2195MHz

(1.6W/carrier & 5W/port):

9kHz to 150kHz



 150kHz to 20MHz

 Aglent 10:36:16
 18 Apr 2019
 L

 Ref -10 dBm
 Atten 10 dB
 -58.325 dBm

 Peak
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 190,000 kHz
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 0

 964
 190,000 kHz
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 0

 9764
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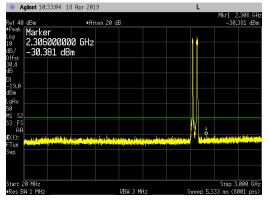
 9764
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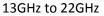
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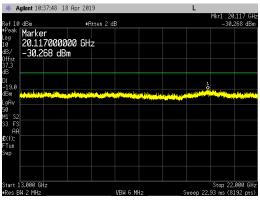
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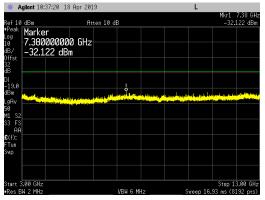
20MHz to 3GHz

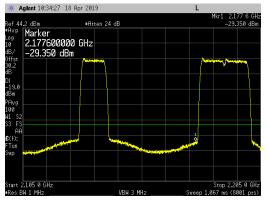










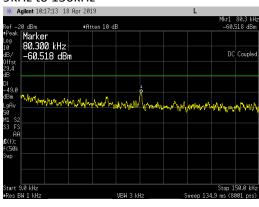


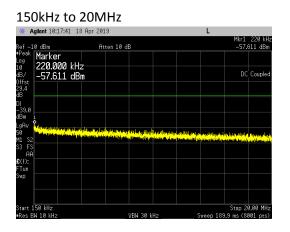


# LTE 10 Multicarrier for Antenna Port 2\_ NB-IoT Upper GB\_LTE10 Carriers at 2135, 2185 & 2195MHz

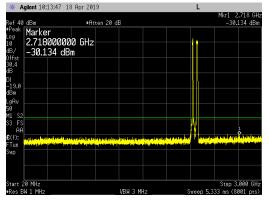
# (1.6W/carrier & 5W/port):

9kHz to 150kHz

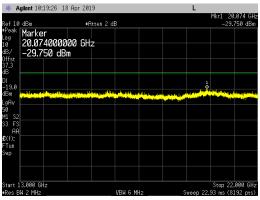




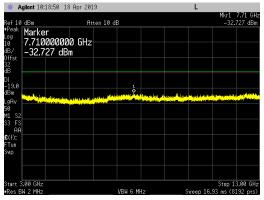
#### 20MHz to 3GHz

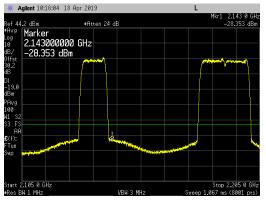


#### 13GHz to 22GHz



#### 3GHz to 13GHz







# **Transmitter Radiated Spurious Emissions**

Radiated spurious emission plots/measurement results are in the original FCC radio certification submittal (TUV Document 75938941 Report 01 Issue 1 dated 16 June 2017).

# **Frequency Stability/Accuracy**

Frequency Stability/Accuracy measurement results are in the original FCC radio certification submittal (TUV Document 75938941 Report 01 Issue 1 dated 16 June 2017).



**End of Report**