CERTIFICATE #: 0214.19

Class II Change Application for
Grant of Equipment Authorization

Nokia Solutions and Networks
Multiradio Base Transceiver Station
FRIG Remote Radio Head

FCC ID: VBNFRIG-01
IC: 661AI-FRIG

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

NTS Plano FCC Laboratory Designation No.: US1077
NTS Plano ISED Laboratory Assigned Code: 4319A

Test Dates: September 12-14, 2018
Total Number of pages: 127

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General Manager

Revision History

Rev#	Date	Comments	Modified By
0	10/01/2018	Initial Draft	Christian Booker
1	10/03/2018	Updated Per Customer Request	BreAnna Cheatham
2	10/08/2018	Updated Per TCB Redlines	Chelsie Morrow

CONTENTS

1. SCOPE/OBJECTIVE

A class II permissive change on the original filing is being pursued to add a single Narrow band Internet of Things Guard Band (NB IoT GB here after) carrier to the FRIG AirScale Base Station Remote Radio Head Federal Communication Commission and Industry Canada certifications. Please refer to the test report on the original certification for details on all required testing.

All conducted RF testing performed for the original certification testing has been repeated using NB IoT GB for this class II permissive change per correspondence/guidance from Nemko TCB. NB IoT offsets from LTE carrier center frequencies were: LTE10: +/-4597.5kHz: LTE15: +/-6892.5kHz; and, LTE20: +/-9097.5kHz. Tests performed under the class II change effort include RF power, peak to average power ratio, emission bandwidth (99% and 26 dB down), band edge spurious emissions (± 1MHz), and conducted spurious emissions.

Antenna port conducted RF measurements were taken with NTS personnel **(Jose Mendez)** at Nokia located at 6000 Connection Drive, Irving, Texas, on **September 12-24, 2018**. The base station and remote radio head software for this testing is an updated release that includes the single carrier NB IoT GB support. The LTE and guard band modulation type was QPSK for all testing herein. The test sample was selected and prepared by John LoPresti of Nokia Solutions and Networks.

Conducted 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

FCC KDB 971168 DO1 v03r01

FCC KDB 662911 DO1 v02r01

STATEMENT OF COMPLIANCE

The tested sample of Nokia Solutions and Networks product FRIG AirScale Base Station Remote Radio Head 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.

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 %

2. RESULT SUMMARY FOR THE CLASS II TESTING

The following tables provide a summary (Class II testing only) of the test results:

FRIG with 2x60W configuration LTE plus single NB IoT Guard Band carrier					
FCC	IC	Description	Measured	Limit	Results
27.5(h)&(j)	RSS-139 Sec 6.1	Frequency Ranges	LTE10: 2115.0 - 2150.0MHz LTE15: 2117.5 - 2147.5MHz LTE20: 2120.0 - 2145.0MHz	2110.0 – 2155.0MHz	Pass
2.1033(c)(4)	RSS-139 Sec 6.2	Modulation Type	NB IoT Guard band (QPSK) with LTE10, LTE15 & LTE20	Digital	Pass
27.50(d)(2)	RSS-139 Sec 6.5	Output Power	Highest Conducted Power Output RMS: 47.67dBm EIRP depends on antenna gain which is unknown. Highest Conducted RMS Power Output for Ant1+Ant3 is 47.67+3 dB = 50.67 (or 116.68 W)	1640W EIRP	Pass
27.50(d)(5)	RSS-139 Sec 6.5	Peak to Average Ratio	Highest Measured PAPR: 8.17dB	13dB	Pass
	RSS-Gen Sec 6.6	99% Emission Bandwidth	LTE10: 9.24 MHz LTE15: 13.82 MHz LTE20: 18.31MHz	Remain in Block	Pass
27.53(h)(3)		26dB down Emission Bandwidth	LTE10: 9.68 MHz LTE15: 14.48 MHz LTE20: 19.27 MHz	Remain in Block	Pass
27.53(h)	RSS-139 Sec 6.6	Transmitter Spurious Emissions at the Antenna Terminal (See Note 1)	< -16dBm	-16dBm per Transmit Chain	Pass
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.					
Note 2: In addition to the above, refer to the original certification report (SGS report number F1Y10001) for the complete list of test results.					

FRIG with 4x30W configuration LTE plus single NB IoT Guard Band carrier					
FCC	IC	Description	Measured	Limit	Results
27.5(h)&(j)	RSS-139 Sec 6.1	Frequency Ranges	LTE10: 2115.0 - 2150.0MHz LTE15: 2117.5 - 2147.5MHz LTE20: 2120.0 - 2145.0MHz	2110.0 – 2155.0MHz	Pass
2.1033(c)(4)	RSS-139 Sec 6.2	Modulation Type	NB IoT Guard band (QPSK) with LTE10, LTE15 & LTE20	Digital	Pass
27.50(d)(2)	RSS-139 Sec 6.5	Output Power	Highest Conducted Power Output RMS: 44.47 dBm EIRP depends on antenna gain which is unknown	1640W EIRP	Pass
27.50(d)(5)	RSS-139 Sec 6.5	Peak to Average Ratio	Highest Measured PAPR: 8.06dB	13dB	Pass
	RSS-Gen Sec 6.6	99% Emission Bandwidth	LTE10: 9.25 MHz LTE15: 13.83 MHz LTE20: 18.30 MHz	Remain in Block	Pass
27.53(h)(3)		26dB down Emission Bandwidth	LTE10: 9.67 MHz LTE15: 14.48 MHz LTE20: 19.23 MHz	Remain in Block	Pass
27.53(h)	RSS-139 Sec 6.6	Transmitter Spurious Emissions at the Antenna Terminal (See Note 1)	< -19dBm	-19dBm per Transmit Chain	Pass
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.					
Note 2: In addition to the above, refer to the original certification report (SGS report number F1Y10001) for the complete list of test results.					

3. EUT HARDWARE

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	FRIG	AirScale BTS RRH	Part#: 472704A.103 Serial#: RY142309120	FCC ID: VBNFRIG-01 IC ID: 661AI-FRIG

4. TEST MEASUREMENT EQUIPMENT

Company	Type	Model	Serial Number	Last Cal	Cal Due
Keysight	Spectrum Analyzer	MXA N2090A	US46220313	02/16/17	02/16/19
Keysight	Spectrum Analyzer	PSA E4440A	MY44303970	10/18/17	10/18/19
R&S	Network Analyzer	ZVL	102098	02/11/18	02/11/19
R&S	Network Analyzer	ZVA50	100241	05/04/2018	05/04/2019

5. AUXILLARY EQUIPMENT

Company	Description	Part Number	Serial Number
Aeroflex/Weinschel	Attenuator, 10 dB, 100 W	68-10-43	QV695
Aeroflex/Weinschel	Attenuator, 20 dB, 100 W	48-20-33	BT3184
Aeroflex/Weinschel	Attenuator, 20 dB, 50 W	24-20-34	BH6436
Microlab	Attenuator, 6 dB	FZ-06FN	24786
Microlab	Attenuator, 30 dB	FZ-30FN	29216
Weinschel	Attenuator, 20 dB, 150 W	57-20-33-LM	MC060
Microwave Circuits	Low Pass Filter, DC-1350 MHz	L13502G1	2050-02 DC0229

6. SUPPORT EQUIPMENT

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia	FSMF	Flexi System Module	Part#: 084792A.102 Serial#: L1132000045	N/A
Nokia	6GHz SFP Module	FOSH 6G SFP+ 300m 850nm	PN: 472579A.101 SN: FR162521945	
Nokia	6GHz SFP Module	FOSH 6G SFP+ 300m 850nm	PN: 472579A.101 SN: FR1625704824	
HP	Z240	Tower Workstation (PC)	N/A	N/A

7. EUT SOFTWARE

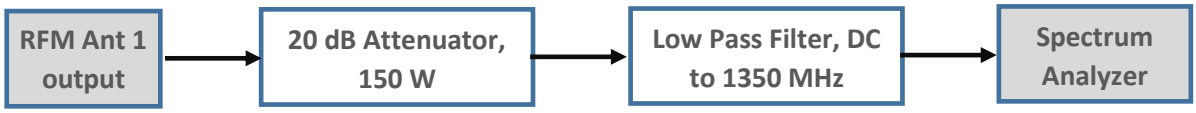
The base station and RF module software for this testing is an updated release that includes the NB IoT GB type as defined below.

(1) RFM Unit Software: FRM
(2) System Module Software: FL18SP_ENB_0000_000623_0000
(3) RRH Unit Software: VEG28.02.R23A

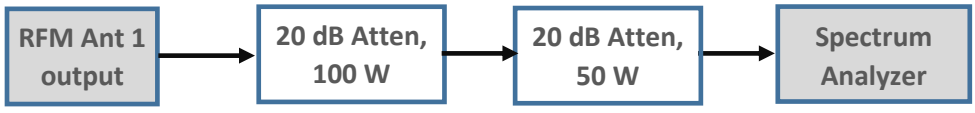
FL18SP only supports NBIOT guardband signals for LTE10, LTE15 and LTE20 bandwidths. Therefore, these were the only ones tested for this feature. As required in 3GPP TS 36.141 §6.1.4, the IOT carrier configured was given Cell ID 103.

8. RF TEST SETUP DIAGRAMS

The following are the setups used in the RF conducted emissions testing.

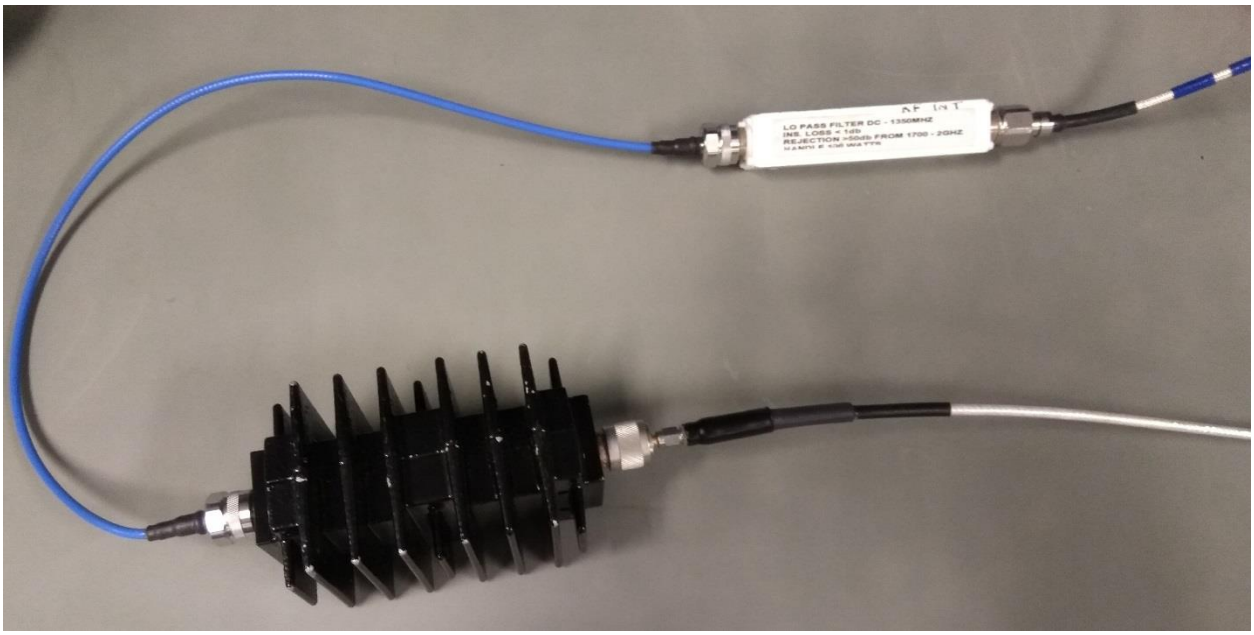


Setup for 9kHz to 10MHz Measurements



Setup for 10MHz to 22GHz Measurements

9. TEST SETUP PHOTOGRAPHS



9KHz to 10MHz Setup Photo

10 MHz to 22GHz Setup Photo

10. FRIG LTE DOWNLINK BAND EDGE EARFCNS

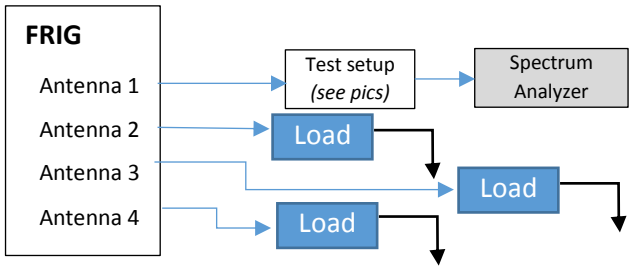
Band 4 (BTS Rx: 1710 to 1755 MHz/BTS Tx: 2110 to 2155 MHz) band edge downlink (BTS Transmit) EARFCNs for LTE channel bandwidths (5, 10, 15 and 20 MHz) are provided in following table. The EARFCN is defined as E-UTRA Absolute Radio Frequency Channel Number. The channel spacing is 100 kHz between channel numbers.

Downlink EARFCN E-UTRA Band 66	Downlink Frequency (MHz)	Channel Bandwidth			
		5 MHz	10 MHz	15 MHz	20 MHz
1950	2110.0	Band edge	Band edge	Band edge	Band edge
……					
1975	2112.5	Bottom Channel			
1976	2112.6	BC +1			
……					
2000	2115.0		Bottom Channel		
2001	2115.1		BC + 1		
……					
2025	2117.5			Bottom Channel	
2026	2117.6			BC +1	
……					
2050	2120.0				Bottom Channel
2051	2120.1				BC + 1
……					
2175	2132.5	Middle Channel	Middle Channel	Middle Channel	Middle Channel
……					
2299	2144.9				TC - 1
2300	2145.0				Top Channel
……					
2324	2147.4			TC - 1	
2325	2147.5			Top Channel	
……					
2349	2149.9		TC - 1		
2350	2150.0		Top Channel		
……					
2374	2152.4	TC - 1			
2375	2152.5	Top Channel			
……					
2399	2154.9	Band edge	Band edge	Band edge	Band edge

FRIG Downlink Band Edge LTE Frequency Channels

11. TEST DATA FOR FRIG 2X60W CONFIGURATION

All conducted RF measurements for this test effort in this section were made at FRIG antenna port 1 (the highest power 60W port). The general test setup used is provided below.



General Test Setup Used for Conducted RF Measurements on FRIG for 2x60W Configuration

11.1. RF Output Power

Peak and RMS Average RF output power was measured at the FRIG RRH antenna port. Measurements were made on the bottom, middle and top channels placing the NB IoT Guard Band carrier at the lower end of the carrier and then the upper end of the carrier for the LTE bandwidths of 10MHz, 15MHz, and 20MHz. Peak to average power ratio (PAPR) has been calculated as described in section 5.7.2 of KDB971168 D01 v03r01. The results of the power measurements and PAPR calculations are provided in the table below.

NB IoT Guard Band Carrier in Lower Guard Band

FRIG Ant 1 Port	LTE Bandwidth	LTE - Aggregate w/NB IoT GB		
		Peak (dBm)	Average (dBm)	PAPR (dB)
Bottom Channel	10M	55.17	47.44	7.73
	15M	55.23	47.43	7.8
	20M	55.21	47.20	8.01
Middle Channel	10M	55.49	47.67	7.82
	15M	55.35	47.45	7.9
	20M	55.62	47.60	8.02
Top channel	10M	55.18	47.09	8.09
	15M	55.33	47.33	8
	20M	55.52	47.56	7.96

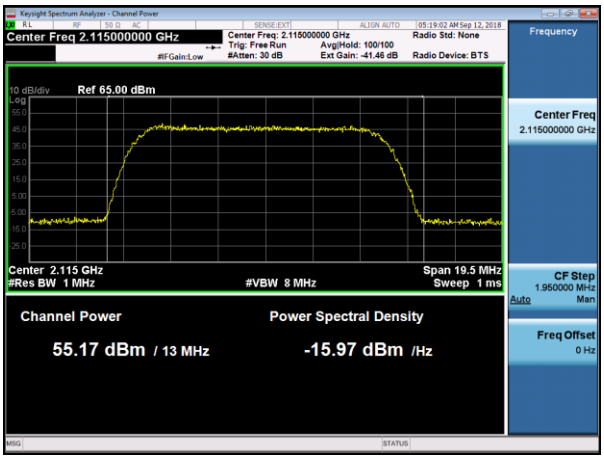
NB IoT Guard Band Carrier in Upper Guard Band

FRIG Ant 1 Port	LTE Bandwidth	LTE - Aggregate w/NB IoT GB		
		Peak (dBm)	Average (dBm)	PAPR (dB)
Bottom Channel	10M	54.67	46.87	7.80
	15M	55.26	47.40	7.86
	20M	55.26	47.25	8.01
Middle Channel	10M	54.87	47.12	7.75
	15M	55.53	47.56	7.97
	20M	55.42	47.41	8.01
Top channel	10M	55.34	47.43	7.91
	15M	55.29	47.33	7.96
	20M	55.47	47.30	8.17

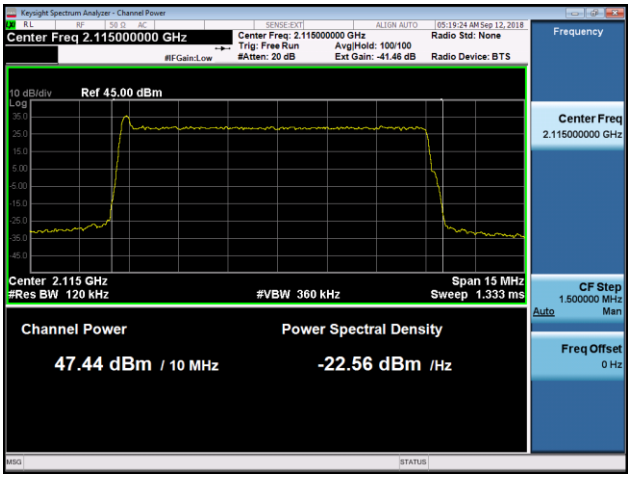
All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 41.46 dB and is accounted for by the spectrum analyzer external gain offset.

Channel Power Plots, NB IoT Guard Band Carrier in Lower Guard Band (10MHz):

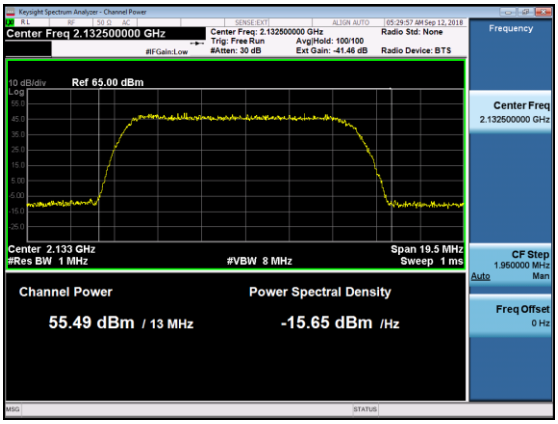
LTE10_Bottom Channel Peak



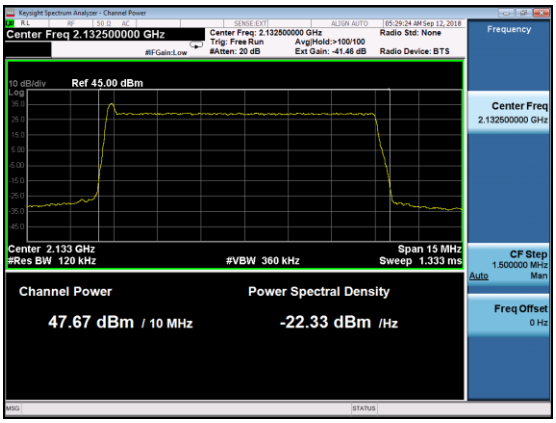
LTE10_Bottom Channel Average



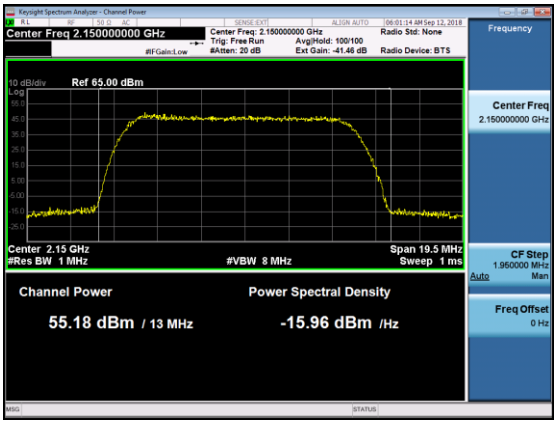
LTE10_Middle Channel Peak



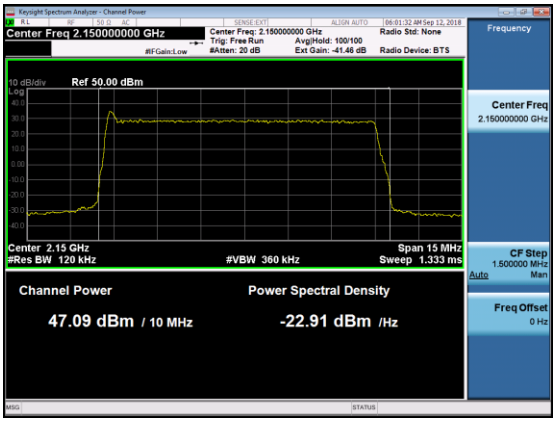
LTE10_Middle Channel Average



LTE10_Top Channel Peak

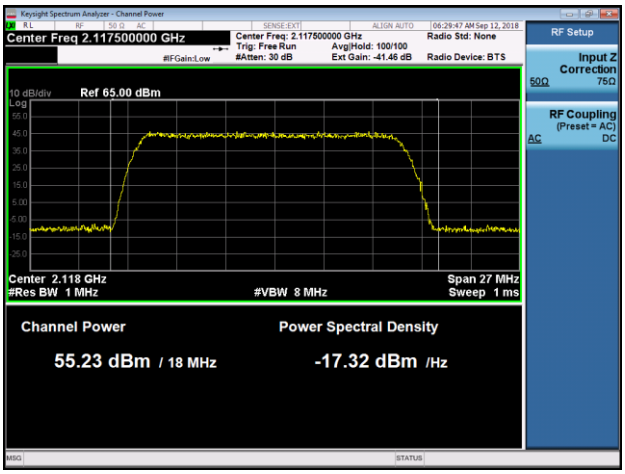


LTE10_Top Channel Average

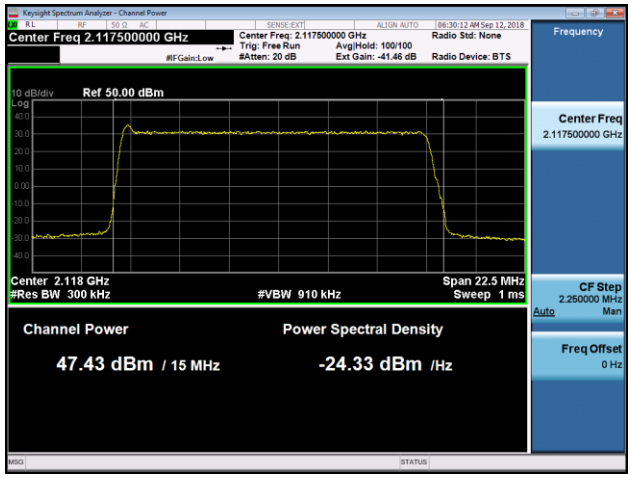


Channel Power Plots, NB IoT Guard Band Carrier in Lower Guard Band (15MHz):

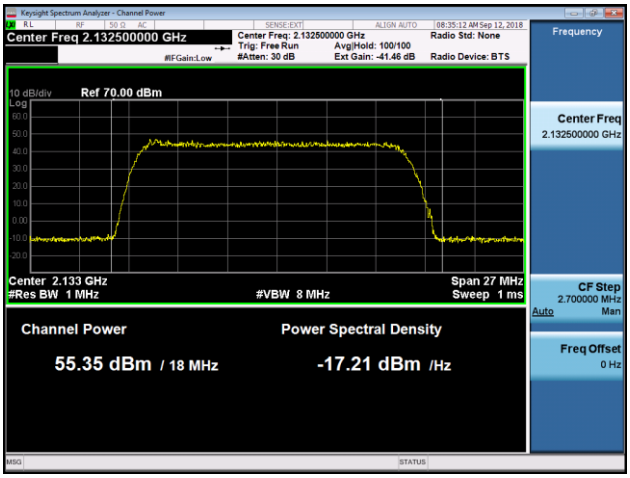
LTE15_Bottom Channel Peak



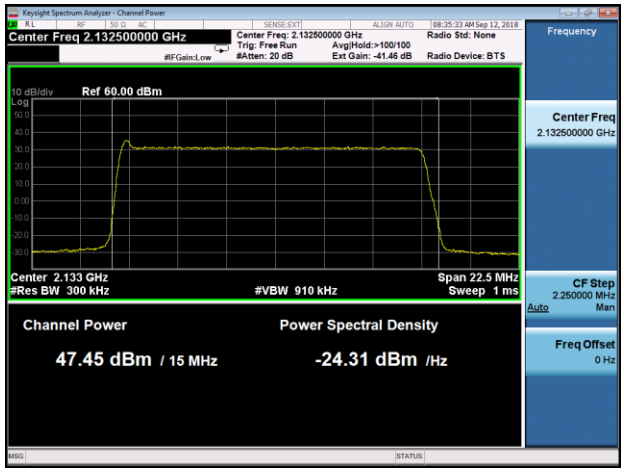
LTE15_Bottom Channel Average



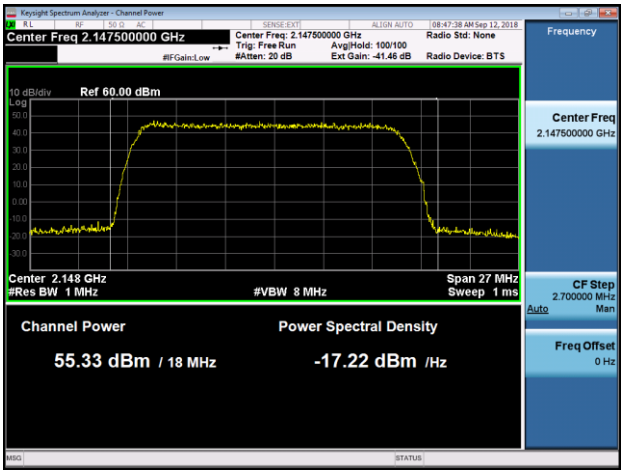
LTE15_Middle Channel Peak



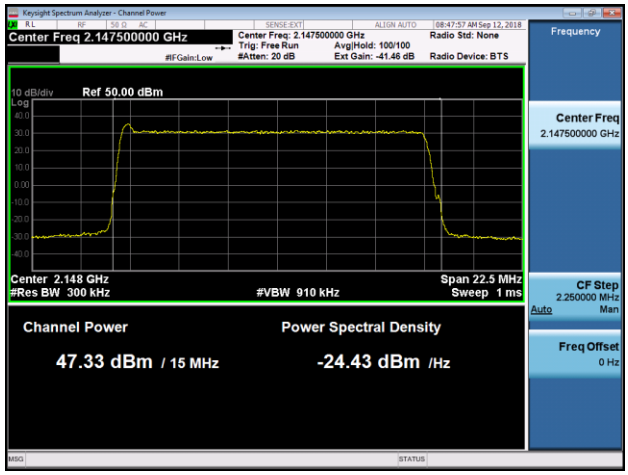
LTE15_Middle Channel Average



LTE15_Top Channel Peak

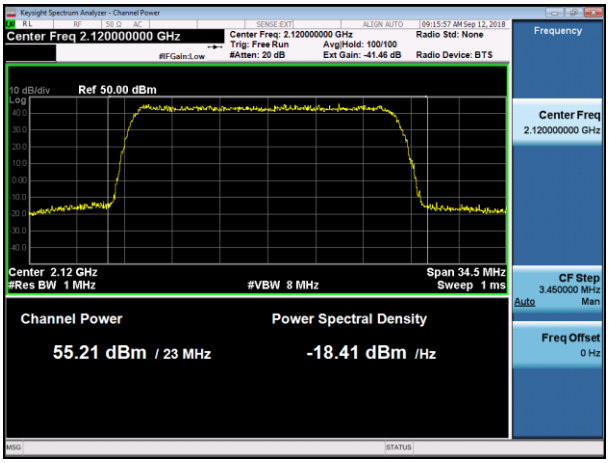


LTE15_Top Channel Average

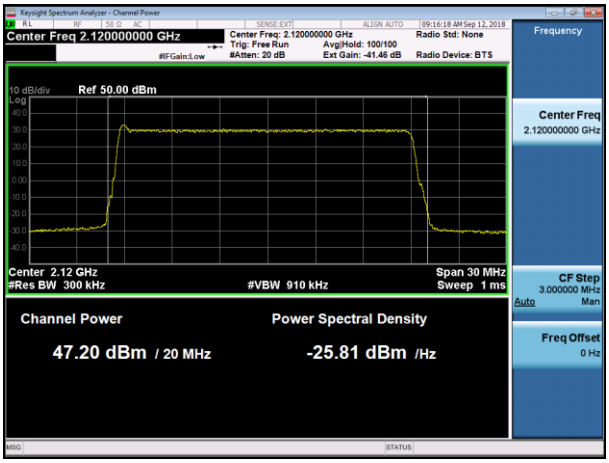


Channel Power Plots, NB IoT Guard Band Carrier in Lower Guard Band (20MHz):

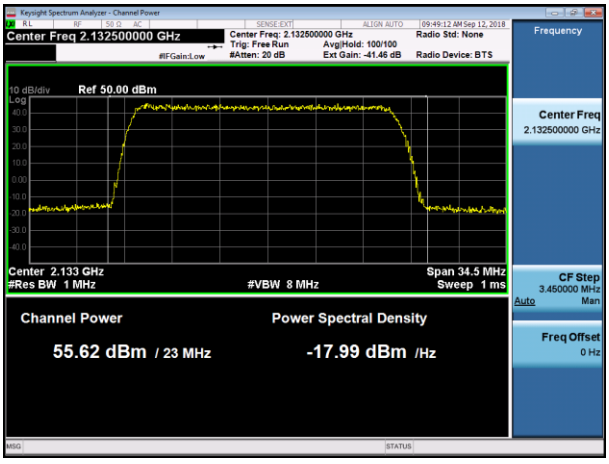
LTE20_Bottom Channel Peak



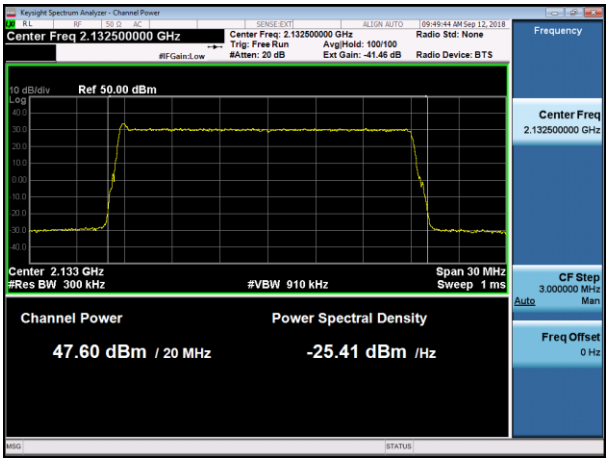
LTE20_Bottom Channel Average



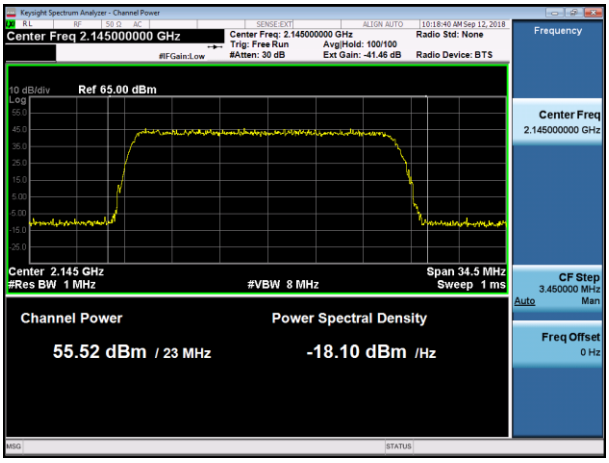
LTE20_Middle Channel Peak



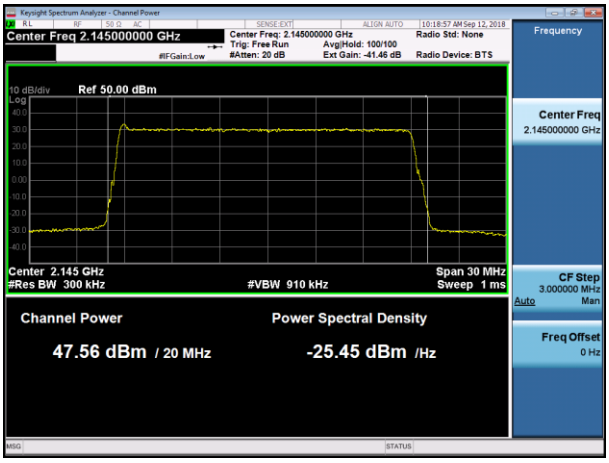
LTE20_Middle Channel Average



LTE20_Top Channel Peak

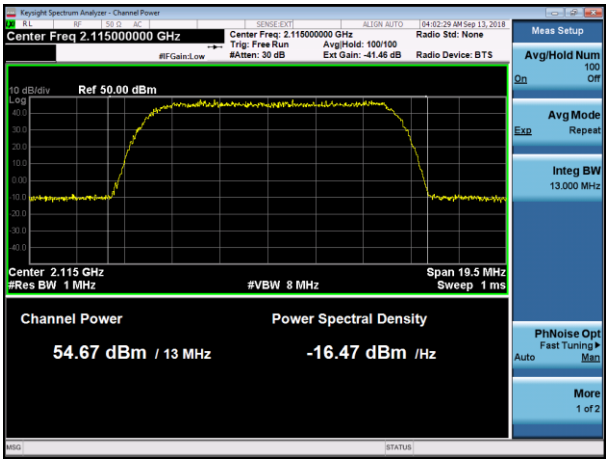


LTE20_Top Channel Average

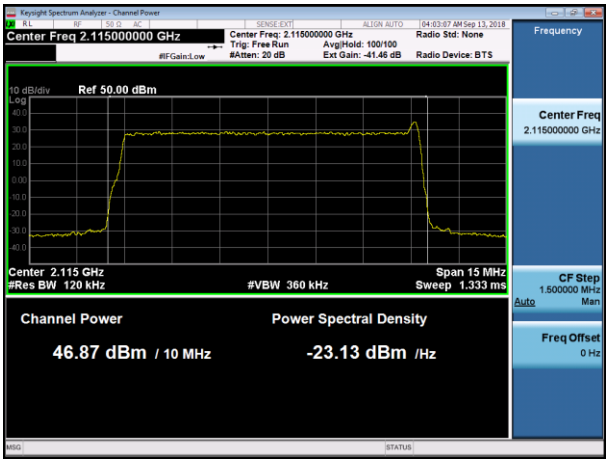


Channel Power Plots, NB IoT Guard Band Carrier in Upper Guard Band (10MHz):

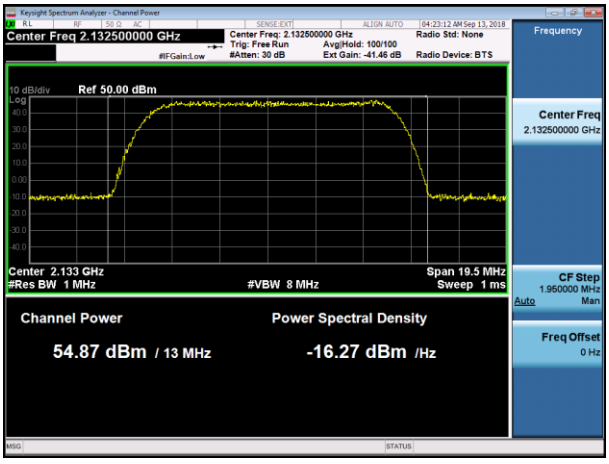
LTE10_Bottom Channel Peak



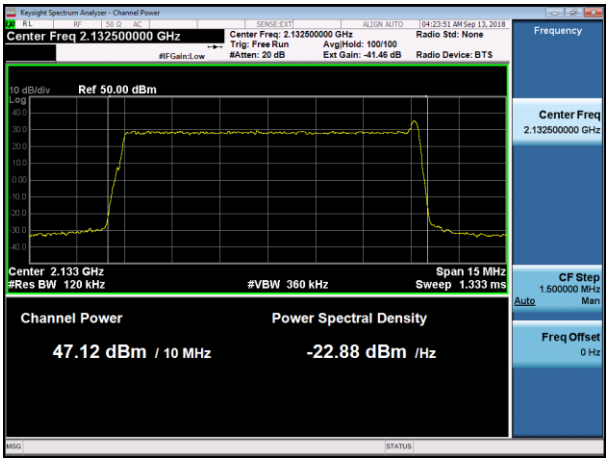
LTE10_Bottom Channel Average



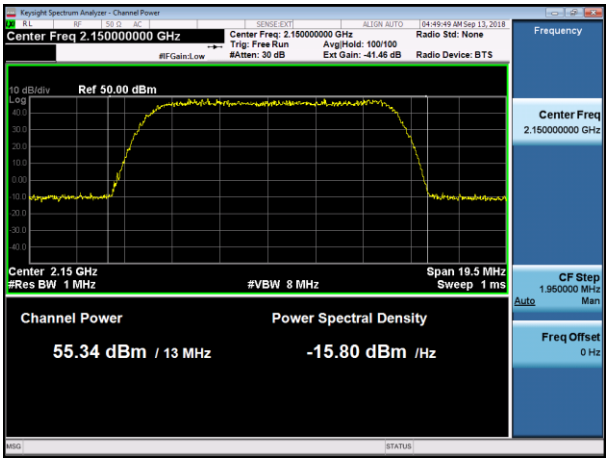
LTE10_Middle Channel Peak



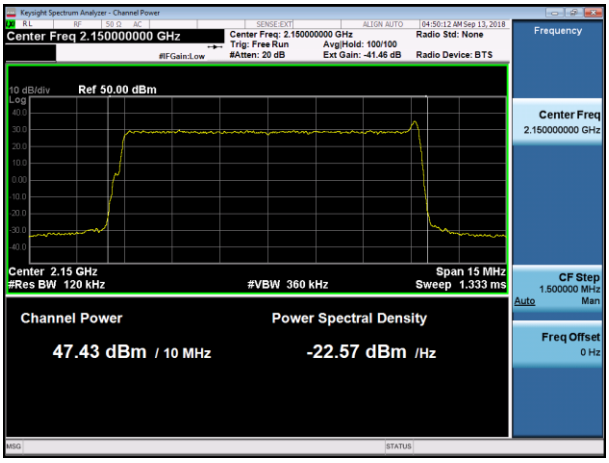
LTE10_Middle Channel Average



LTE10_Top Channel Peak

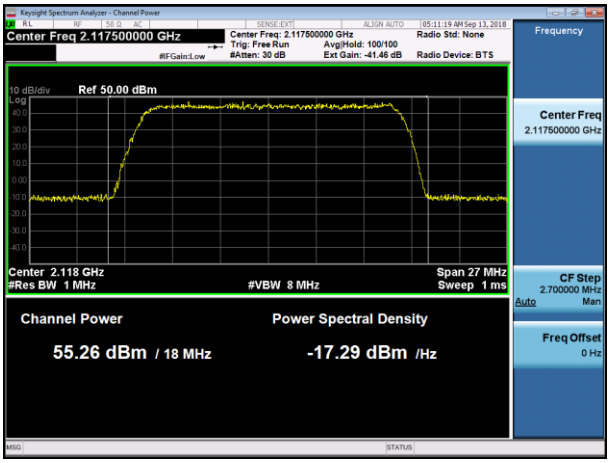


LTE10_Top Channel Average

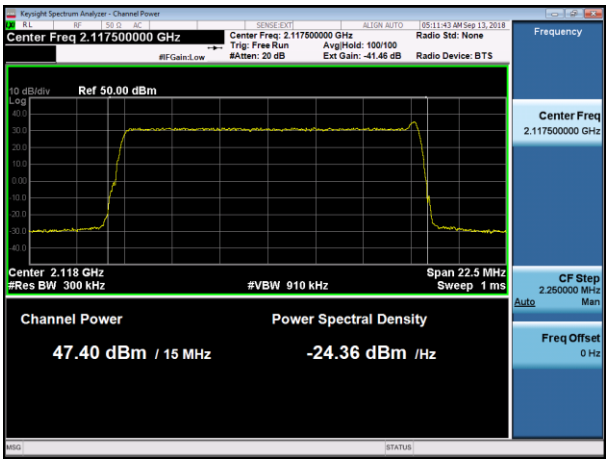


Channel Power Plots, NB IoT Guard Band Carrier in Upper Guard Band (15MHz):

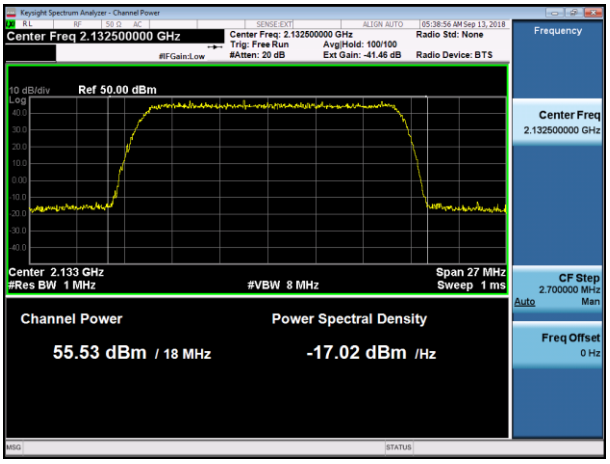
LTE15_Bottom Channel Peak



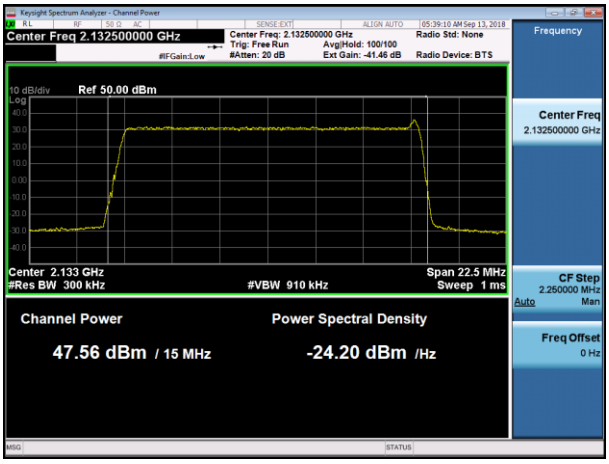
LTE15_Bottom Channel Average



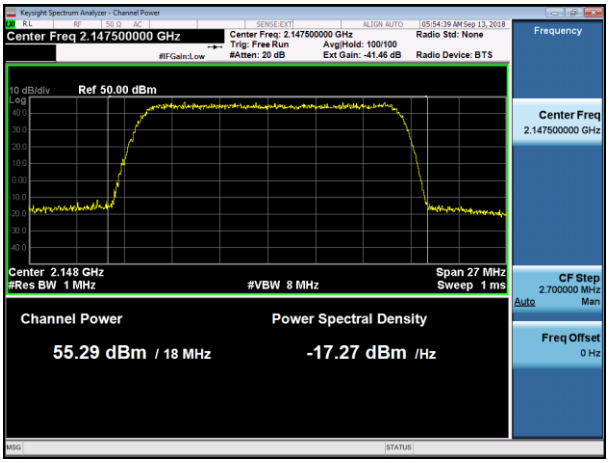
LTE15_Middle Channel Peak



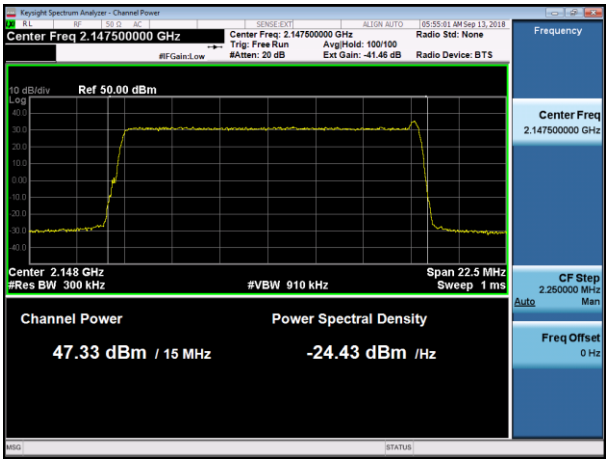
LTE15_Middle Channel Average



LTE15_Top Channel Peak

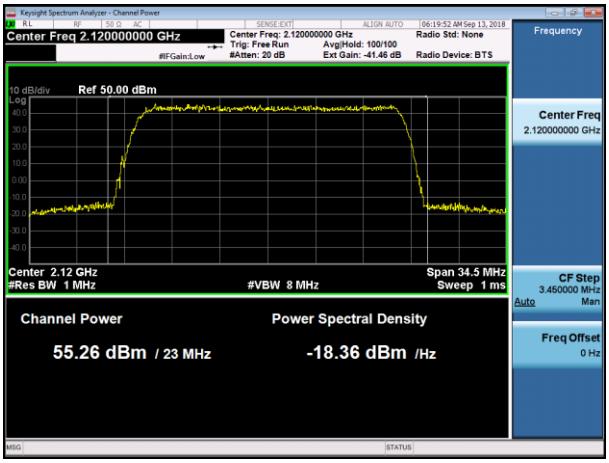


LTE15_Top Channel Average

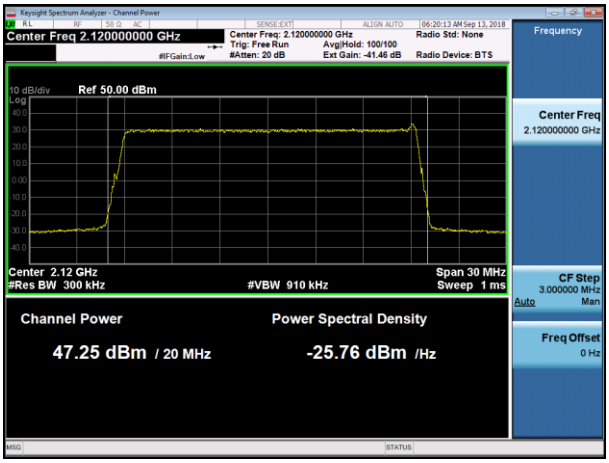


Channel Power Plots, NB IoT Guard Band Carrier in Upper Guard Band (20MHz):

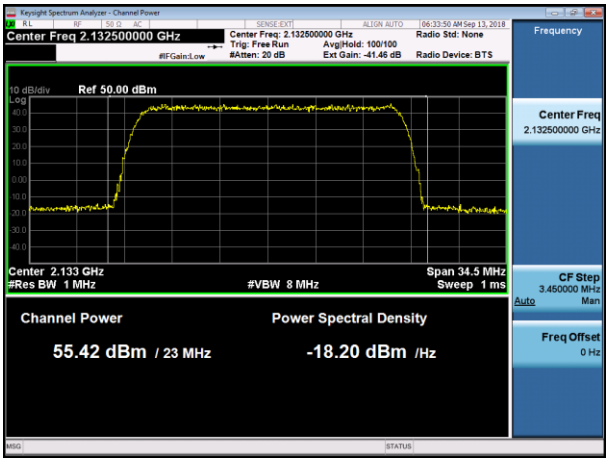
LTE20_Bottom Channel Peak



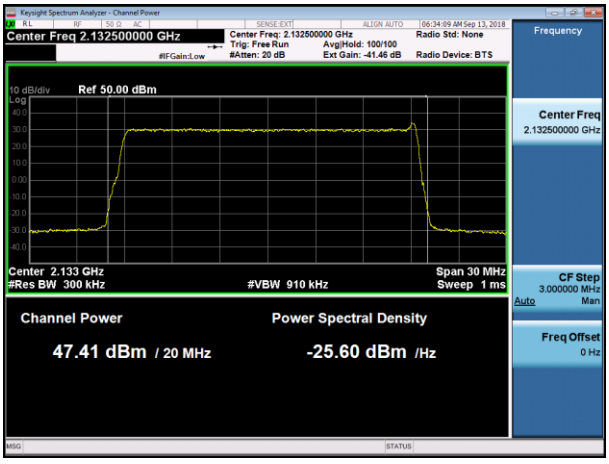
LTE20_Bottom Channel Average



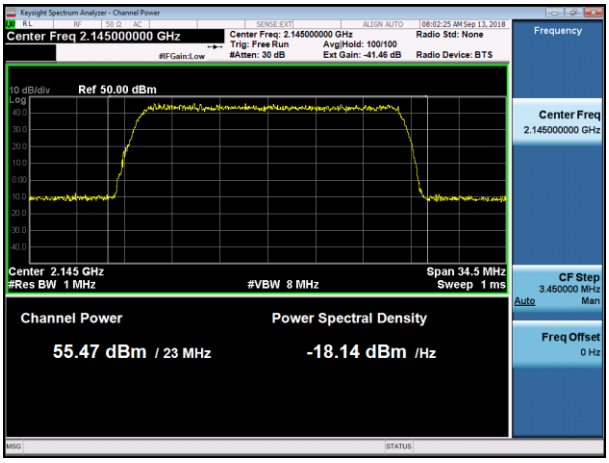
LTE20_Middle Channel Peak



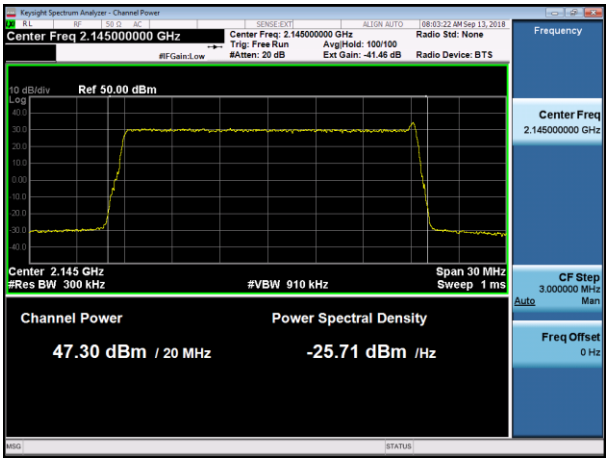
LTE20_Middle Channel Average



LTE20_Top Channel Peak



LTE20_Top Channel Average



11.2. Emission Bandwidth (26 dB down and 99%)

Emission bandwidth measurements were made at FRIG antenna port 1 for NB IoT GB. Measurements were made on the bottom, middle and top channels for LTE bandwidths of 10MHz, 15MHz, and 20MHz. The results are provided in the following table.

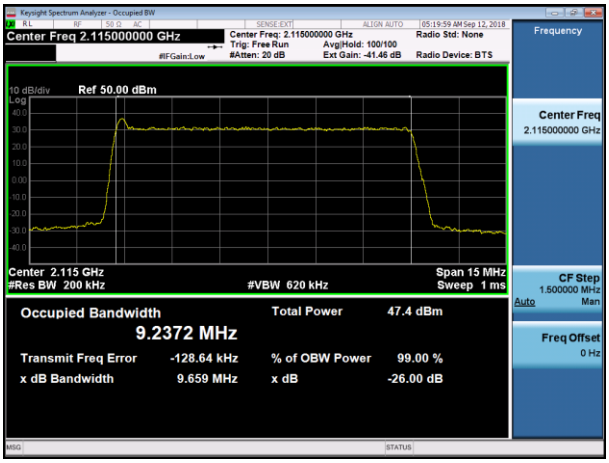
LTE Bandwidth	NB IoT Guard band (Lower)					
	Bottom Channel		Middle Channel		Top Channel	
	26dB(MHz)	99% (MHz)	26dB(MHz)	99% (MHz)	26dB(MHz)	99% (MHz)
10M	9.66	9.24	9.67	9.24	9.66	9.22
15M	14.43	13.82	14.48	13.79	14.44	13.82
20M	19.24	18.31	19.20	18.30	19.20	18.27

LTE Bandwidth	NB IoT Guard band (upper)					
	Bottom Channel		Middle Channel		Top Channel	
	26dB(MHz)	99% (MHz)	26dB(MHz)	99% (MHz)	26dB(MHz)	99% (MHz)
10M	9.67	9.25	9.64	9.25	9.68	9.24
15M	14.42	13.81	14.47	13.82	14.45	13.82
20M	19.21	18.29	19.22	18.30	19.27	18.30

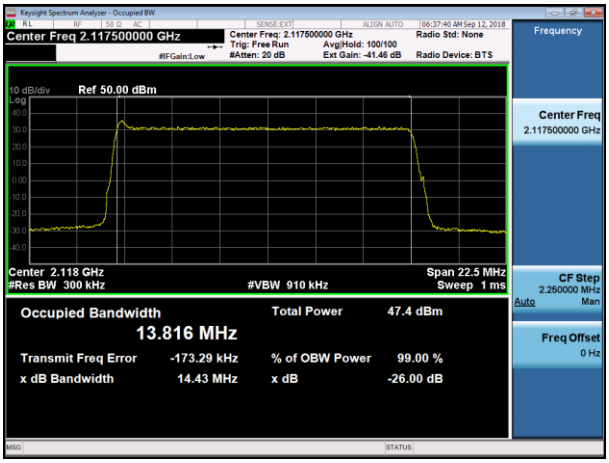
Emission bandwidth measurement data are provided in the following pages.

LTE10 and LTE20 plus NB IoT Guard Band Carrier in lower Guard Band (Lower) Bandwidth Plots:

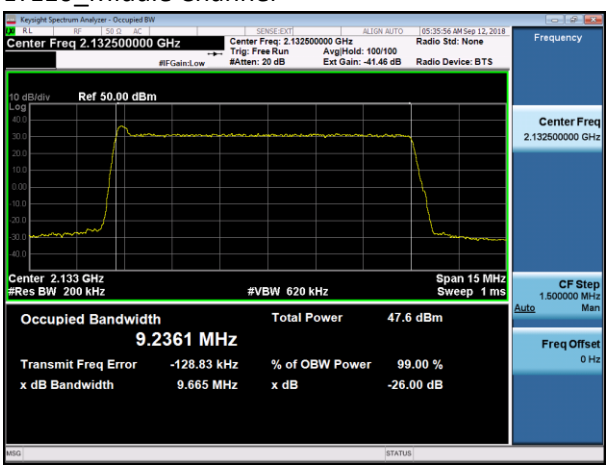
LTE10_Bottom Channel



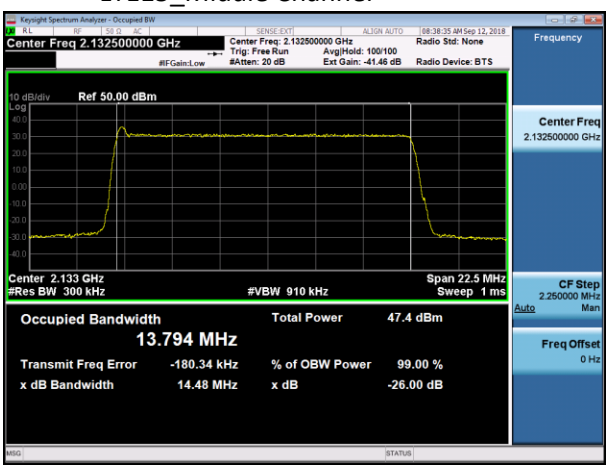
LTE15_Bottom Channel



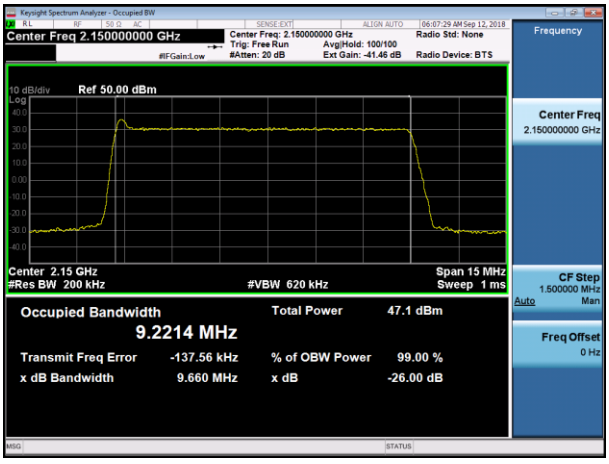
LTE10_Middle Channel



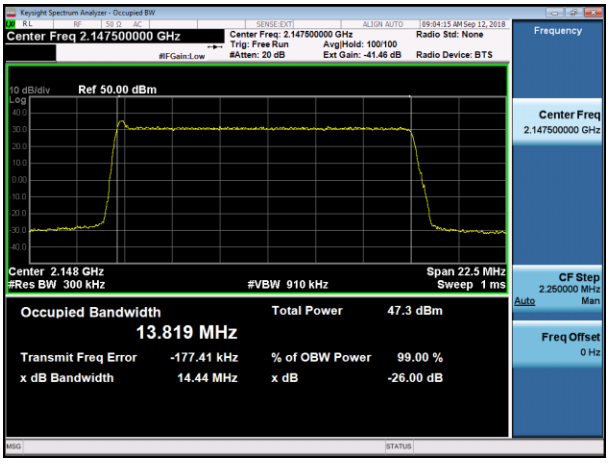
LTE15_Middle Channel



LTE10_Top Channel

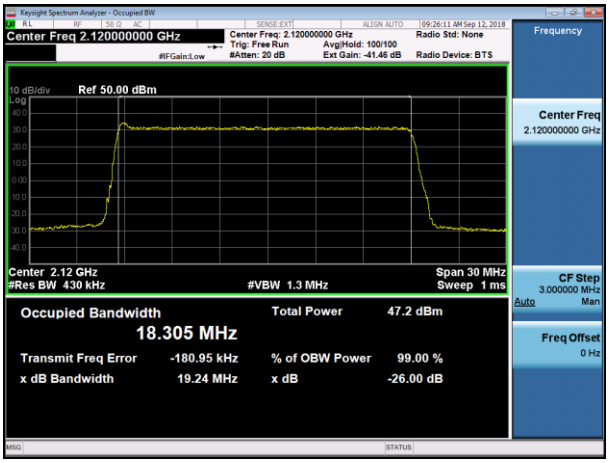


LTE15_Top Channel

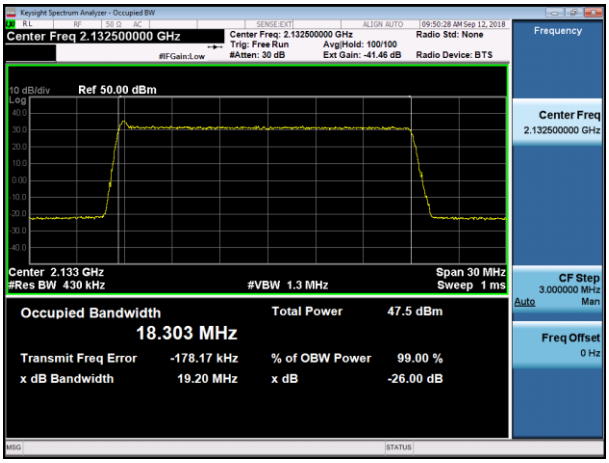


LTE20 plus NB IoT Guard Band Carrier in lower Guard Band (Lower) Bandwidth Plots:

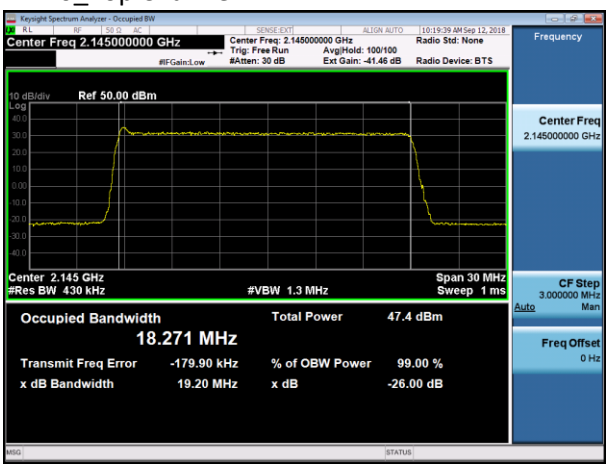
LTE20_Bottom Channel



LTE20_Middle Channel

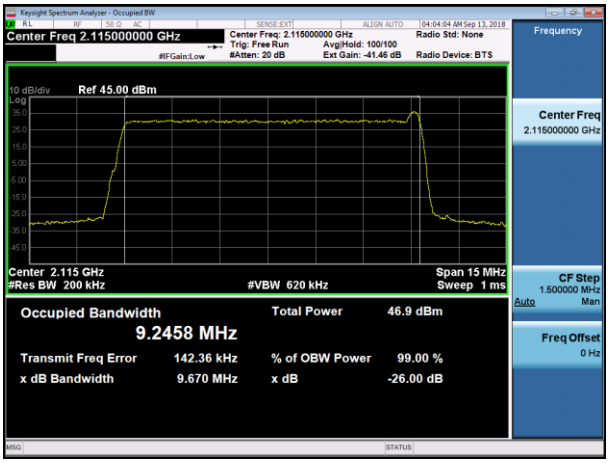


LTE20_Top Channel

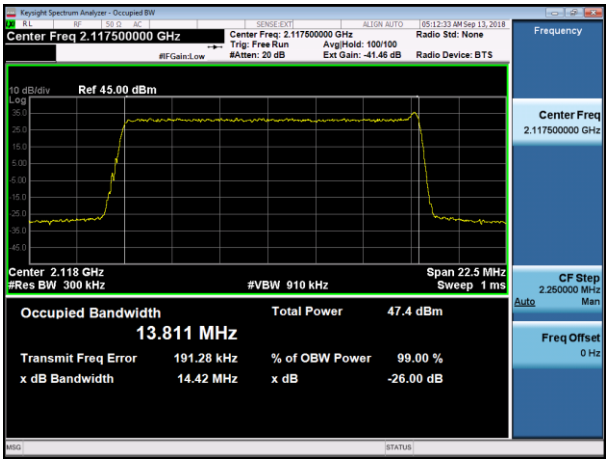


LTE10 and LTE20 plus NB IoT Guard Band Carrier in lower Guard Band (Upper) Bandwidth Plots:

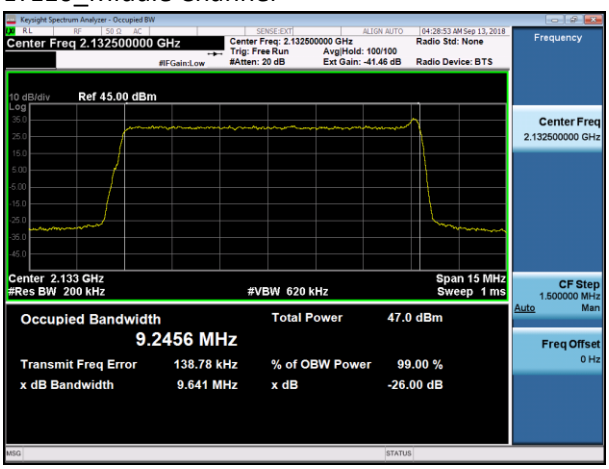
LTE10_Bottom Channel



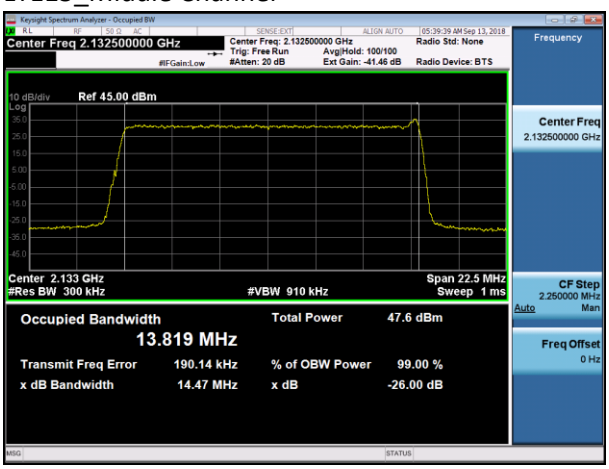
LTE15_Bottom Channel



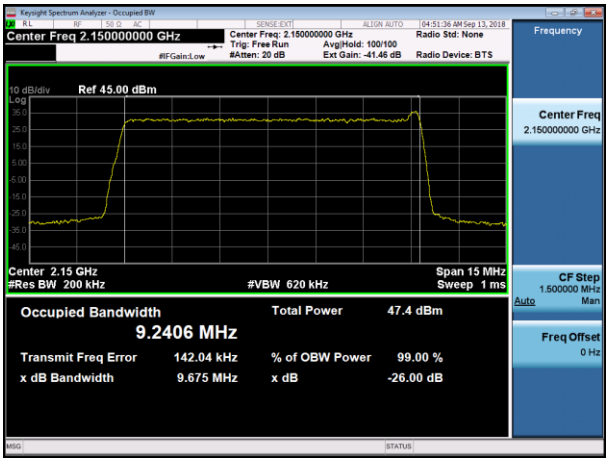
LTE10_Middle Channel



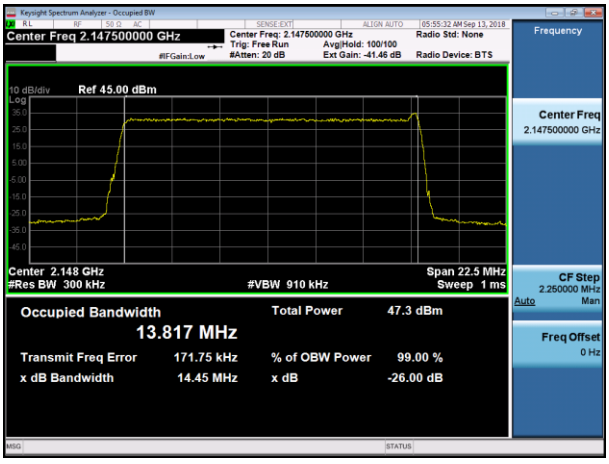
LTE15_Middle Channel



LTE10_Top Channel

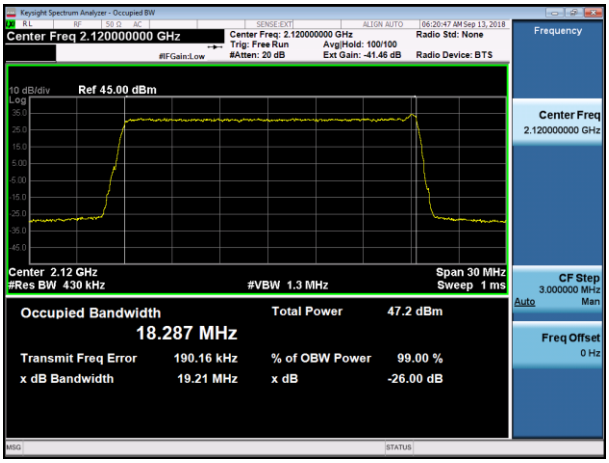


LTE15_Top Channel

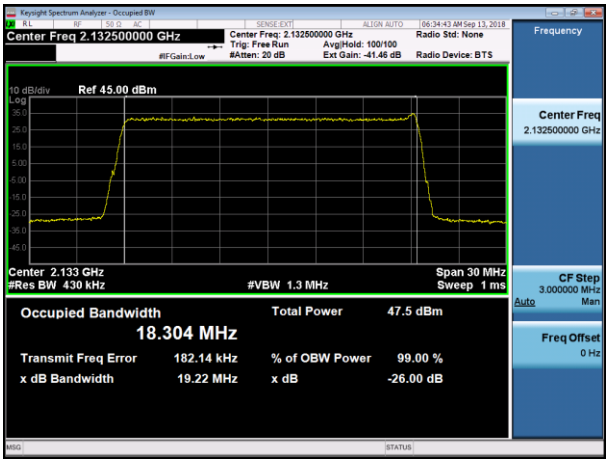


LTE20 plus NB IoT Guard Band Carrier in lower Guard Band (Lower) Bandwidth Plots:

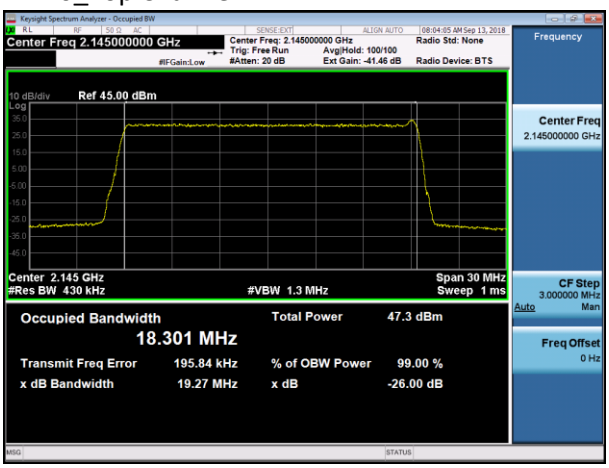
LTE20_Bottom Channel



LTE20_Middle Channel



LTE20_Top Channel



11.3. Antenna Port Conducted Band Edge

Conducted band edge measurements were made at FRIG RRH antenna port 1. The FRIG was operated at the band edge frequencies with a single NB IoT Guard band carrier for 10MHz, 15MHz and 20MHz LTE bandwidths.

The same limit of -16dBm used in the original certification testing is used for this testing. The limit is adjusted to -16dBm [-13dBm -10 log (2)] per FCC KDB 662911D01 v02r01 because the BTS may operate as a 2 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 2156 to 2157MHz bands) the RBW was again reduced to 1% of the emission bandwidth and the power integrated over 1MHz. In the 2 to 5MHz frequency range outside the band edge (i.e.: 2105 to 2108MHz and 2154 to 2156MHz bands) a 1MHz RBW and 3MHz VBW was used.

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

LTE Bandwidth	Lower Guard Band Carrier		Limit
	Bottom Channel	Top Channel	
10M	-16.248	-22.163	-16dBm
15M	-21.351	-24.892	-16dBm
20M	-19.947	-23.203	-16dBm

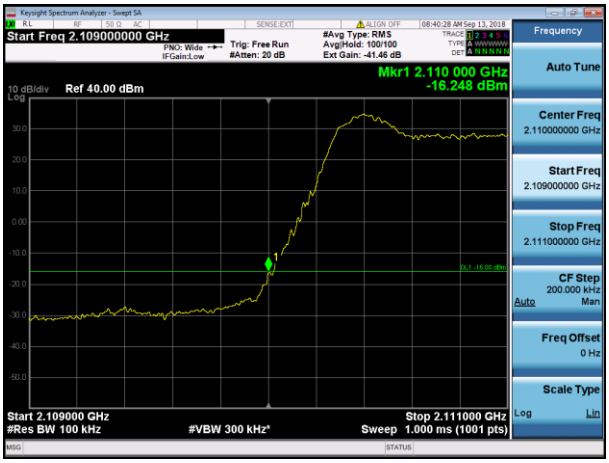
LTE Bandwidth	Upper Guard Band Carrier		Limit
	Bottom Channel	Top Channel	
10M	-22.980	-18.717	-16dBm
15M	-24.697	-20.249	-16dBm
20M	-23.954	-21.865	-16dBm

The total measurement RF path loss of the test setup (attenuator and test cables) was 41.46 dB and is accounted for by the spectrum analyzer external gain offset.

Conducted band edge measurements are provided in the following pages.

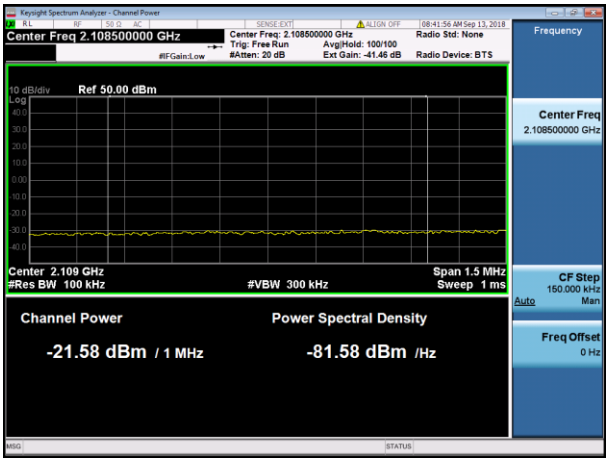
LTE10 + Lower NB IoT GB Carrier Band Edge Plots:

LTE10_Bottom Channel_LBE_2109 to 2111MHz

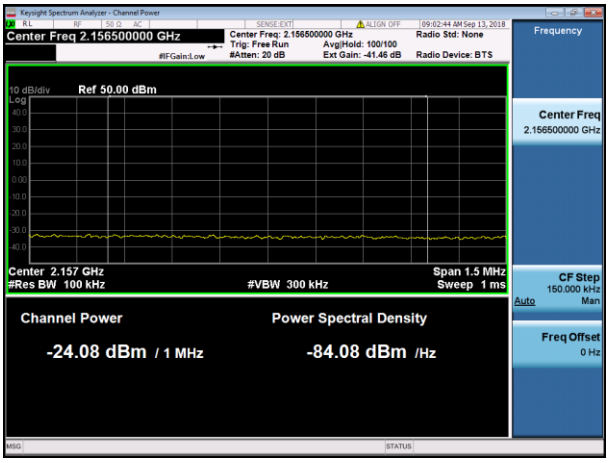


LTE10_Top Channel_UBE_2154 to 2156MHz

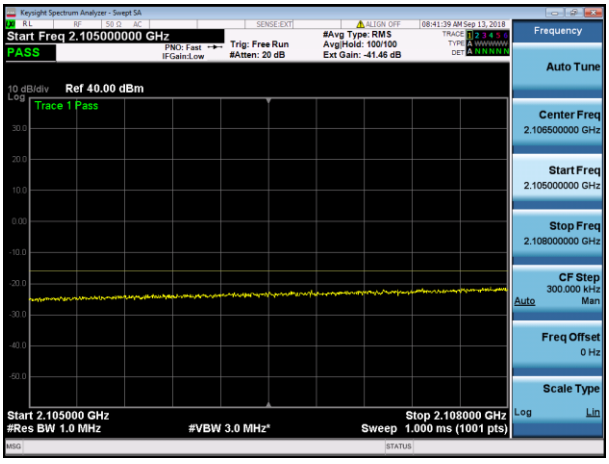
LTE10_Bottom Channel_LBE_2108 to 2109MHz



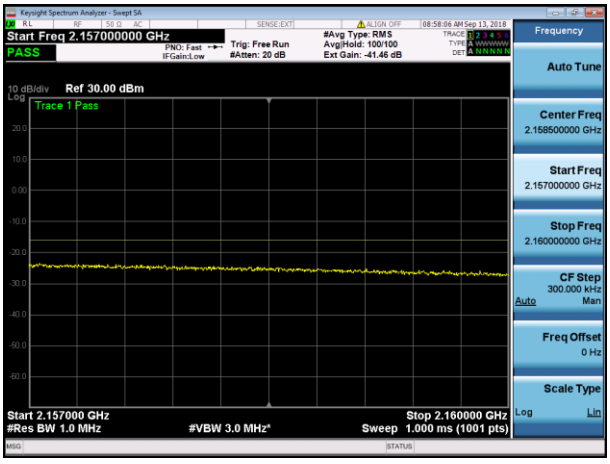
LTE10_Top Channel_UBE_2156 to 2157MHz



LTE10_Bottom Channel_LBE_2105 to 2108MHz

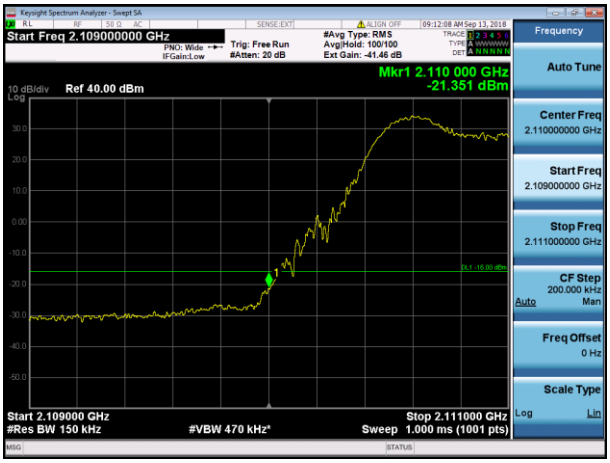


LTE10_Top Channel_UBE_2157 to 2160MHz



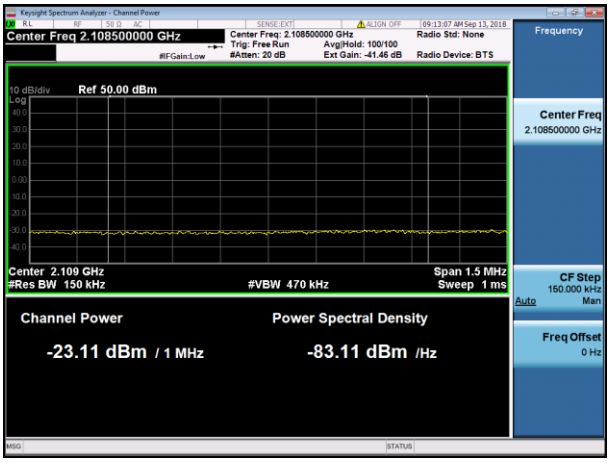
LTE15 + Lower NB IoT GB Carrier Band Edge Plots for Antenna Port 1:

LTE15_Bottom Channel_LBE_2109 to 2111MHz

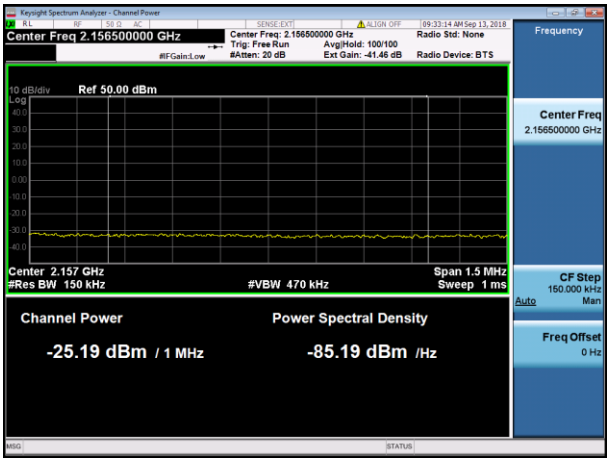


LTE15_Top Channel_UBE_2154 to 2156MHz

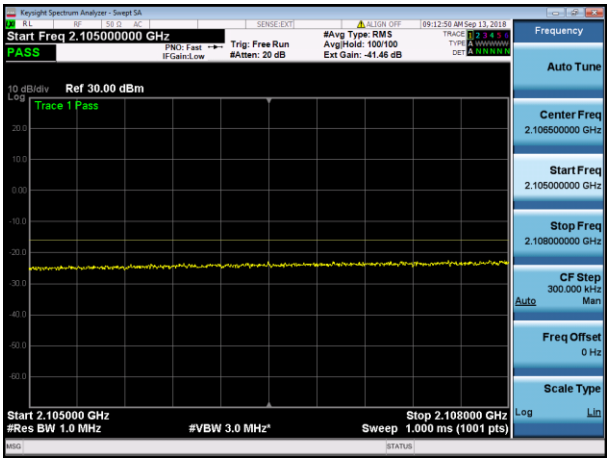
LTE15_Bottom Channel_LBE_2108 to 2109MHz



LTE15_Top Channel_UBE_2156 to 2157MHz



LTE15_Bottom Channel_LBE_2105 to 2108MHz



LTE15_Top Channel_UBE_2157 to 2160MHz