Radio Test Report

Application for a Class II Permissive Change of Equipment Authorization

CERTIFICATE #: 0214.19

FCC Part 24 and IC RSS-133
[1930MHz – 1990MHz]

FCC ID: VBNFHFB-01
IC: 661W-FHFB

Product Name: Flexi MultiRadio Base Transceiver Station Remote Radio Head
Model: FHFB

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

Test Dates: October 31 -November 01, 2018
Total Number of Pages: 44

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REVISION HISTORY

Rev#	Date	Comments	Modified By
0	11/08/2018	Initial Draft	BreAnna Cheatham

TABLE OF CONTENTS

SCOPE

Tests have been performed on the Nokia Solutions and Networks product Flexi MultiRadio Base Station Remote Radio Head (RRH) Model FHFB, pursuant to the relevant requirements of the following standard(s) to obtain device certification against the regulatory requirements of the Federal Communications Commission (FCC) and Innovation, Science and Economic Development Canada (ISED).

- Code of Federal Regulations (CFR) Title 47 Part 2
- (Radio Standards Specification) RSS-Gen Issue 5, April 2018
- CFR Title 47 Part 24 Subpart E – Broadband PCS
- RSS-133 Issue 6, Amendment 1 - January 18, 2018 (2GHz Personal Communications Services)

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 the Nokia Solutions and Networks product Flexi MultiRadio Base Station Remote Radio Head (RRH) Model FHFB and therefore apply only to the tested sample. The sample was selected and prepared by Hobert Smith and John Rattanavong of Nokia Solutions and Networks.

OBJECTIVE

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

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

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

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

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

STATEMENT OF COMPLIANCE

The tested sample of the Nokia Solutions and Networks product Flexi MultiRadio Base Transceiver Station Remote Radio Head (RRH) Model FHFB 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 24 and IC RSS-133 (Base Stations Operating in the 1930MHz to 1990MHz Band)

FHFB operating in the PCS Band					
FCC	IC	Description	Measured	Limit	Results
Transmitter Modulation, output power and other characteristics					
24.229	RSS-133 Section 6.1	Frequency Ranges	GSM/EDGE:1930.2 – 1989.8MHz	1930.0 – 1990.0MHz	Pass
2.1047	RSS-133 Section 6.2	Modulation Type	GMSK and 8PSK	Digital	Pass
24.232	RSS-133 Section 6.4	Output Power	Highest Conducted Port Power Output RMS: 46.5dBm Highest Conducted Carrier Power Output RMS: 43.4dBm EIRP depends on antenna gain which is unknown	1640W/MHz EIRP/MHz	Pass
24.232	RSS-133 Section 6.4	Peak to Average Power Ratio	Highest Measured PAPR: 3.5dB	13dB	Pass
	RSS-133 Section 2.3	99% Emission Bandwidth	GMSK: 246.8393kHz 8PSK: 243.5877kHz	Remain in Block	Pass
24.238		26dB down Emission Bandwidth	GMSK: 324.879kHz 8PSK: 313.941kHz	Remain in Block	Pass
Transmitter Spurious Emissions[1]					
24.238	RSS-133 Section 6.5.1	At the antenna terminals	< -13dBm	-13dBm per Transmit Chain	Pass
		Field Strength	< -13dBm	-13dBm EIRP	Pass[2]
Other Details					
24.235	RSS-133	Frequency Stability	Stays within authorized frequency block	Stays within block	Pass[2]
1.1310	RSS-102	RF Exposure	N/A		Pass[3]

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 and IC radio certification report for details (NTS Test Report Number PR033297 Revision 1 dated February 10, 2016).
Note 3: Applicant's declaration on a separate exhibit based on hypothetical antenna gains.

Emission Designators			
GSM -GMSK		**EDGE -8PSK**	
FCC	**IC**	**FCC**	**IC**
325KGXW	247KGXW	314KG7W	244KG7W
Note: FCC based on 26dB emission bandwidth; IC based on 99% emission bandwidth.			

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

The equipment under test (EUT) is a Nokia Solutions and Networks Flexi Multiradio Base Transceiver Station (BTS) Remote Radio Head (RRH) module, model FHFB which covers 3GPP frequency band 25 (Downlink: 1930 to 1995 MHz). The FHFB has 4 co-located transmitters with each transmit port supporting 40 watts maximum rated RF output power. The FHFB hardware is multi-standard capable including GSM, EDGE, WCDMA and LTE radio technologies. Multi-carrier operation is supported.

The FHFB has external interfaces including DC power, ground, antennas (TX/RX), RX monitor, EAC (external alarm), optical (OBSAI) and remote electrical tilt (RET). The RRH with applicable installation kits may be pole or wall mounted.

A class II permissive change on the original filing is being pursued to add GSM and EDGE technologies to the Flexi Multiradio BTS FHFB RRH Federal Communication Commission and Industry Canada certifications. The original FCC and IC radio certification submittal was NTS Test Report Number PR033297 Revision 1 dated February 10, 2016. The original test effort includes testing for LTE and WCDMA technologies. Please refer to the test report on the original certification for details on all required testing.

All conducted RF testing performed for the original certification testing has been repeated using GSM and EDGE modulation types for this class II permissive change per correspondence/guidance from Nemko TCB. The same test methodology used in the original certification testing was used in this class II permissive change test effort. Tests performed under the class II change effort include RF power, peak to average power ratio, emission bandwidth (99% and 26 dB down), band edge spurious emissions (± 1MHz), and conducted spurious emissions.

The testing was performed on the same hardware (EUT) as the original certification test. The same EUT RF port (Ant 4) determined in the original certification testing to be the highest power port was used for all testing in this effort. The base station and remote radio head software for this testing is an updated release that includes the GSM and EDGE modulation types.

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 sufficient margin to preclude requiring additional testing. The same frequency stability/accuracy radio design is the same for all radio technologies/modulation types.

The FHFB channel numbers and frequencies for GSM and EDGE modes are as follows:

The GSM/EDGE channel bandwidth is 200kHz. The minimum spacing between adjacent carriers is 400kHz. The maximum RF bandwidth is 35MHz for GSM carriers on the same antenna port. The spacing is 200 kHz between channel numbers.

	Downlink ARFCN	Downlink Frequency (MHz)	GSM/EDGE Channels
Band 2_FHFB Antennas 1, 2, 3, 4		1930.0	Band Edge
	512	1930.2	Bottom Channel
	513	1930.4	Bottom Channel + 1
	……		
	636	1955.0	Max spacing from upper band edge: UBE-35MHz
	……		
	661	1960.0	Middle Channel
	……		
	686	1965.0	Max spacing from lower band edge: LBE+35MHz
	……		
	809	1989.6	Top Channel - 1
	810	1989.8	Top Channel
	……	1990.0	Band Edge

FHFB Downlink Band Edge Band 2 GSM/EDGE Frequency Channels

Multicarrier Multiradio Test Cases: The test cases were performed with three carriers (KDB 971168 D03v01 was used as a guide). The test cases were performed with two GSM/EDGE carriers at maximum spacing (35MHz) between the carriers and an LTE5 carrier with 256QAM modulation with minimum spacing to the GSM/EDGE carrier nearest to the band edge. The LTE channel numbers are noted in the original test report.

(1) Two GSM/EDGE carriers at the lower band edge (i.e.: 1930.2 & 1965.0MHz) and a third carrier (LTE5) with minimum spacing to the band edge carrier (1933.3MHz).
(2) Two GSM/EDGE carriers at the upper band edge (i.e.: 1955.0 & 1989.8MHz) and a third carrier (LTE5) with minimum spacing to the band edge carrier (1986.7MHz).

EUT Hardware

The EUT hardware used in testing on October 31 - November 01, 2018.

Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	FHFB	Flexi MultiRadio BTS RRH	Part#: 473042A.101 Serial#: L9144000909	FCC ID: VBNFHFB-01 IC: 661W-FHFB

Enclosure

The EUT enclosure is made of heavy duty aluminum.

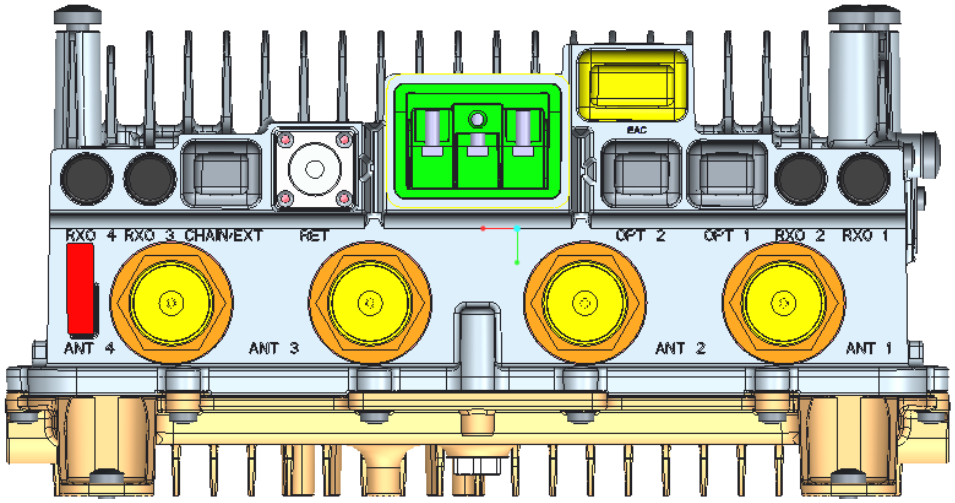
Support Equipment

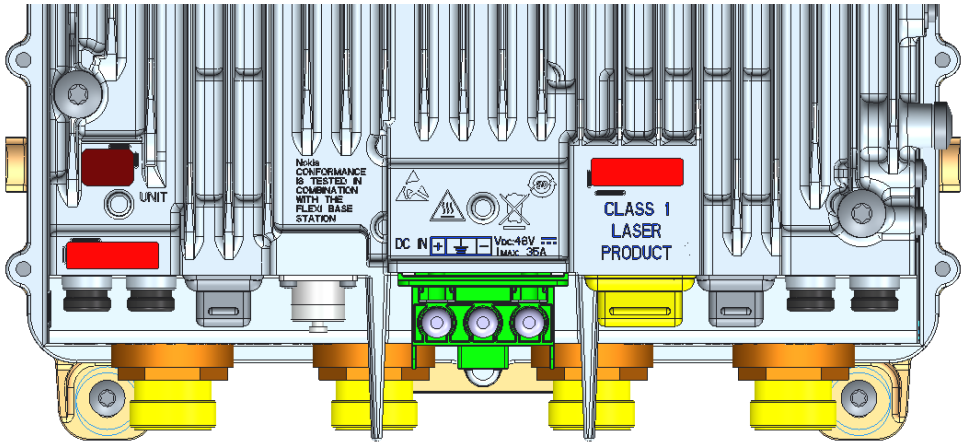
Company	Model	Description	Part/Serial Number	FCC ID/IC Number
Nokia Solutions and Networks	AMIA	Airscale System Module	Part#: 473098A.101 Serial#: RK164201509	N/A
HP	Pro Book 6470b	Laptop PC	N/A	N/A
Dell	Studio XPS	Instrumentation PC	N/A	N/A

Auxillary Equipment

Company	Description	Part Number	Serial Number
Nokia	FOSH 6GHz SFP Module (Plugs into RRH Opt Ports)	472579A.101	CF1MC47T
RLC Electronics	2.4GHz High Pass Filter -2 Watt	F-100-3000-5-R	0028
Microwave Circuits	1.4GHz Low Pass Filter -100 Watt	L13502G1	2454-01
Weinschel	Attenuator 20dB -150 Watt	66-20-33-LIM	BZ2075
Weinschel	Attenuator 40dB -250 Watt	58-40-43-LIM	TC909
Weinschel	Attenuator 10dB -250 Watt	58-10-43-LIM	TD446
Huber & Suhner	RF Cable -0.5 meter	Sucoflex 104	553624/4
Huber & Suhner	RF Cable -1 meter	Sucoflex 106	297370

FHFB Connector Layout:





EUT External Interfaces

Name	Qty	Connector Type	Purpose (and Description)
DC In	1	Screw Terminal	3-pole Power Input Terminal
GND	1	Screw lug (2xM5/1xM8)	Ground
ANT	4	7/16	RF signal for Transmitter/Receiver (50 Ohm)
RXO	4	QMA	RX output for monitoring
Unit	1	LED	Unit Status LED
EAC	1	MDR14	External Alarm Interface (4 alarms)
OPT	2	SFP+ cage	Optical Interface
RET	1	8-pin circular connector conforming to IEC 60130-9 – Ed.3.0	AISG 2.0 to external devices

EUT Interface Ports

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

Cable	Type	Shield	Length	Used in Test	Quantity	Termination
RRH Power Input	Power	No	~ 2 m	Yes	1	DC Power Supply
Earth	Earth	No	~ 1.5 m	Yes	1	Lab earth ground
Antenna	RF	Yes	~ 2 m	Yes	4	50Ω Loads
External Alarm	Signal	Yes	~ 3 m	Yes	1	Un-terminated
Remote Electrical Tilt	Signal	Yes	~ 3 m	Yes	1	Un-terminated
Multimode Optical	Optical	No	>6 m	Yes	1	System Module

EUT Operation

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

EUT Software

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

(1) RRH Unit Software: FRM38.06.R03
(2) System Module Software: SBTS00_FSM4_9999_180604_008438

Modifications

No modifications were made to the EUT during testing.

TESTING

General Information

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

Radiated emissions and frequency accuracy/stability measurements were taken at NTS Plano branch located at 1701 E Plano Pkwy #150 Plano, TX 75074 during the original certification effort (See NTS Test Report Number PR033297 Revision 1 dated February 10, 2016 for details).

Measurement Procedures

The RMS average output power, peak power output, emission bandwidth, conducted spurious and conducted band edge measurements were performed with a spectrum analyzer. The EUT was operated at maximum RF output power for all tests unless otherwise noted. While measuring one transmit chain, the other one was 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. Block diagrams and photographs of the test setups are provided below.

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 and Keysight Benchvue Software was used to capture the spectrum analyzer screenshots. Spectrum analyzer settings are shown on their corresponding plots in test results section.

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

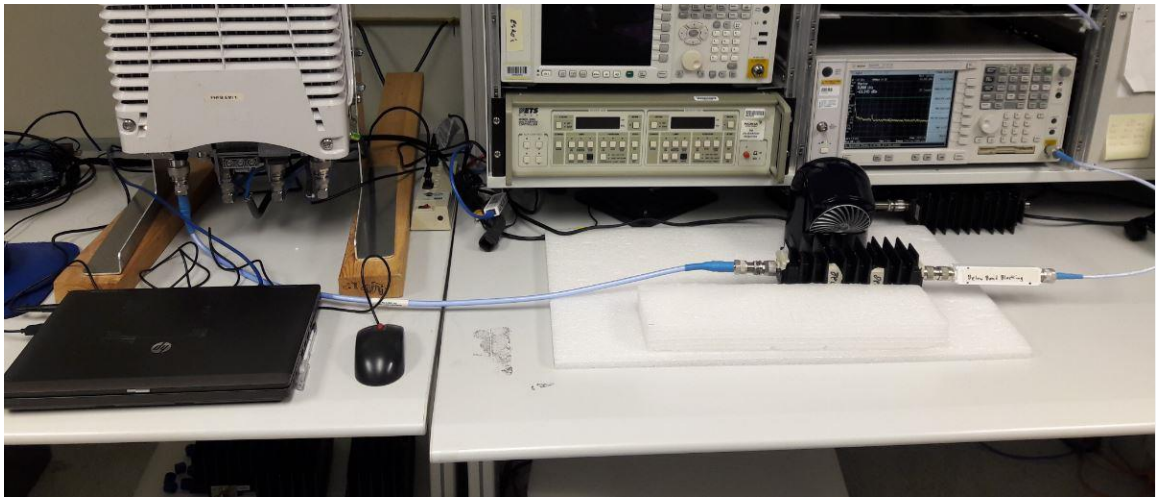
Average output power measurements were performed in accordance with sections 5.2 of FCC KDB 971168 D01v03r01 and ANSI C63.26 and the screenshots were captured using Keysight Benchvue Software. Peak power measurements were performed as described in section 5.1 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.3.3 and the screenshots were captured using Keysight Benchvue Software. The peak to average power ratio (PAPR) has been calculated as described in section 5.7 of KDB971168 D01v03r01 and ANSI C63.26-2015 section 5.2.6. Analyzer settings are shown on their corresponding plots in test results section.

Conducted spurious emissions were captured with Keysight Benchvue Software across the 9kHz-20GHz 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 6GHz. 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

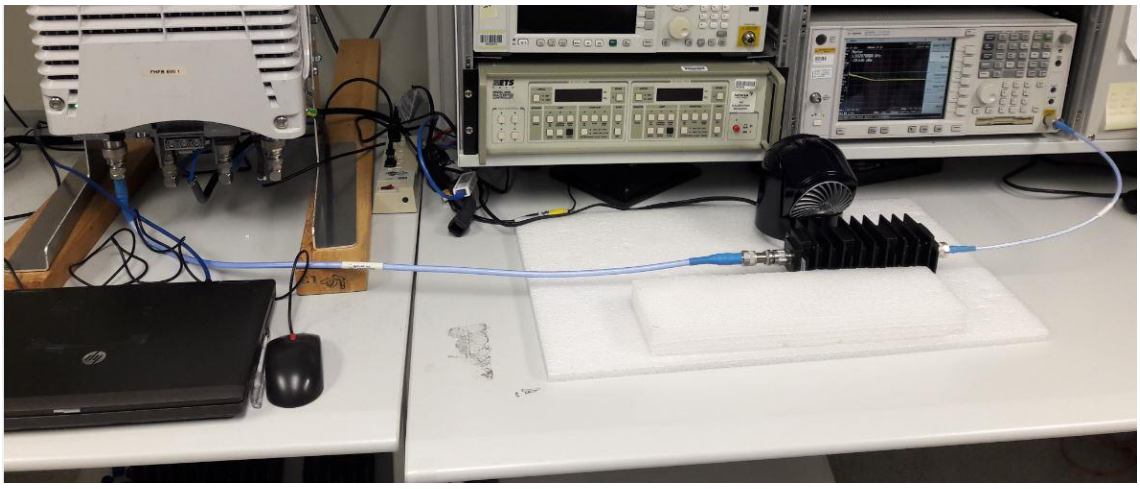
The following setups were used in the FHFB RF conducted emissions testing. The photographs of the test setups are also provided.

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

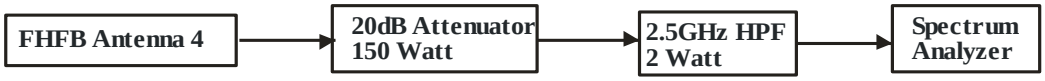


Photograph of 9kHz to 150kHz and 150kHz to 20MHz Test Setup

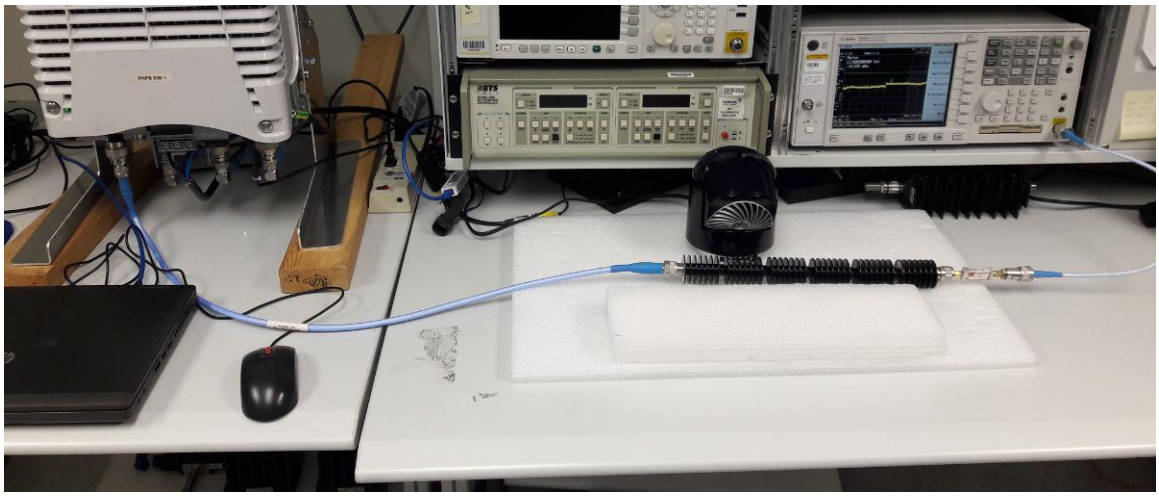
Setup for 20MHz to 3GHz and 3GHz to 6GHz Measurements



Photograph of 20MHz to 3GHz and 3GHz to 6GHz Test Setup



Setup for 6GHz to 20GHz Measurements



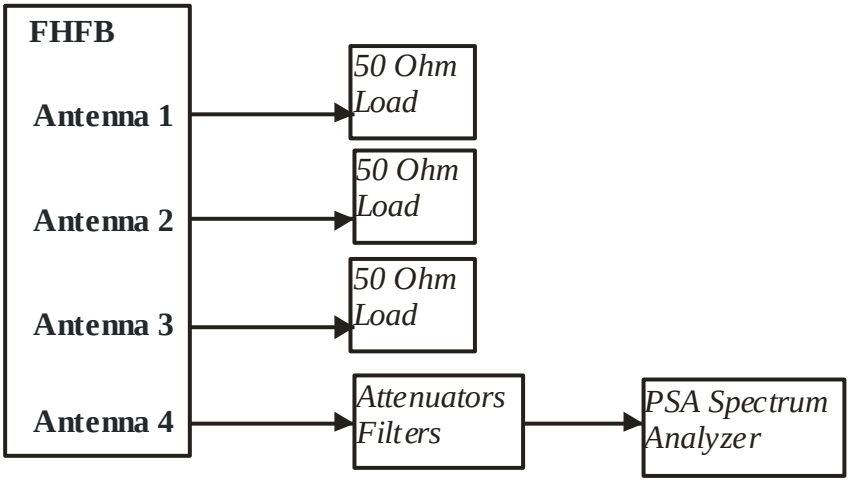
Photograph of for 6GHz to 20GHz Test Setup

Test Measurement Equipment

Nokia Equipment #	Description	Manufacturer	Model	Calibration Duration	Calibration Due Date
120194[1]	PSA Spectrum Analyzer	Agilent	E4440A	12 Months	10/17/2019
NM06345[1]	ENA Network Analyzer	Keysight	E5063A	12 Months	11/20/2018
NM04509[1]	Network Analyzer	Rohde & Schwarz	ZVL 3	12 Months	02/03/2019
NM06374[1]	MXG Analog Signal Gen	Keysight	N5183B	36 Months	02/04/2021
Note 1: Customer equipment					

APPENDIX A: ANTENNA PORT GSM/EDGE TEST DATA FOR THE PCS BAND

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



Test Setup Used for FHFB Conducted RF Measurements

RF Output Power

RF output power has been measured in both Peak and RMS Average terms at FHFB Antenna Port 4 at the bottom, middle and top frequency channels using a single carrier for GSM/EDGE modulations. RMS Average power was measured as described in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 sections 5.2.4.3 and 5.2.4.4. Peak power was measured as described in section 5.1 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.3.3. The peak to average power ratio (PAPR) has been calculated as described in section 5.7 of KDB971168 D01v03r01 and ANSI C63.26-2015 section 5.2.6.

The RMS Average power output on Antenna Ports 4 was also measured using two carriers per antenna port on the bottom, middle and top channels (with minimum spacing between carrier frequencies). The port power measurements are required to be performed with multiple GSM/EDGE carriers to produce maximum power output on the port. The maximum single GSM/EDGE carrier power output is 20 watts while the maximum port power output is 40 watts. All results are presented in tabular form below. Measurements were rounded off to the nearest tenth.

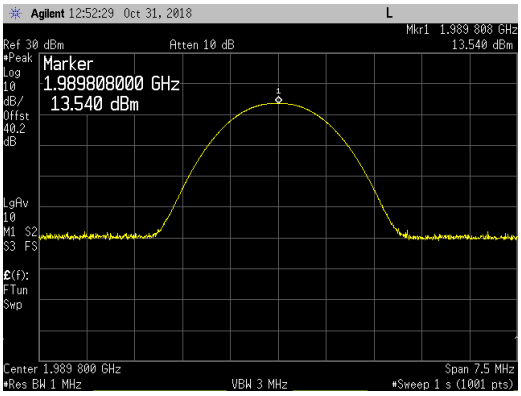
Modulation	Carrier Frequency _ Channel	Measurement	Peak (dBm)	Average (dBm)	PAPR (dB)
GMSK	**1930.2MHz _ Bottom Channel**	**Carrier Power***	13.5	13.1	0.4
	1930.4MHz _ BC+1	**Carrier Power**	43.0	42.6	0.4
	1960.0MHz _ Middle Channel	**Carrier Power**	**43.7**	**43.4**	0.3
	1989.6MHz _ TC-1	**Carrier Power**	43.4	42.9	**0.5**
	1989.8MHz _ Top Channel	**Carrier Power***	13.5	13.1	0.4
	1930.2MHz and 1930.6MHz	**Port Power**	N/A	45.6	N/A
	1959.8MHz and 1960.2MHz	**Port Power**	N/A	**46.5**	N/A
	1989.4MHz and 1989.8MHz	**Port Power**	N/A	46.1	N/A
8PSK	**1930.2MHz _ Bottom Channel**	**Carrier Power***	16.1	12.6	**3.5**
	1930.4MHz _ BC+1	**Carrier Power**	46.0	42.9	3.1
	1960.0MHz _ Middle Channel	**Carrier Power**	**46.8**	**43.4**	3.4
	1989.6MHz _ TC-1	**Carrier Power**	46.4	43.0	3.4
	1989.8MHz _ Top Channel	**Carrier Power***	16.6	13.2	3.4
	1930.2MHz and 1930.6MHz	**Port Power**	N/A	45.6	N/A
	1959.8MHz and 1960.2MHz	**Port Power**	N/A	**46.5**	N/A
	1989.4MHz and 1989.8MHz	**Port Power**	N/A	46.0	N/A

*The carrier power levels at the bottom and top channels had to be reduced (~30dB) to meet the band edge emission requirements. The next channel from the band edge (i.e.: BC+1 and TC-1) met the band edge emission requirements with the RRH operating at maximum carrier output power.

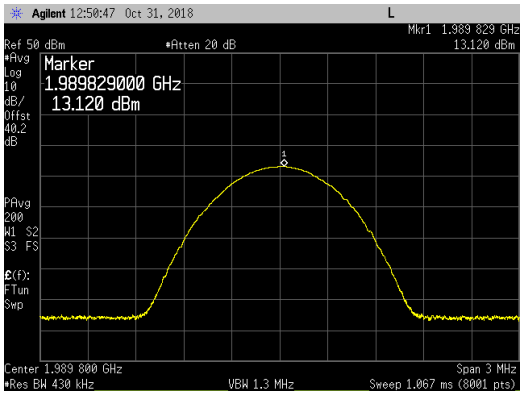
All measurement results are provided in the following pages. The total measurement RF path loss of the test setup (attenuator and test cables) was 40.2 dB and is accounted for by the spectrum analyzer reference level offset.

Carrier Power Plots at FHFB Antenna Port 4 for GMSK Modulation:

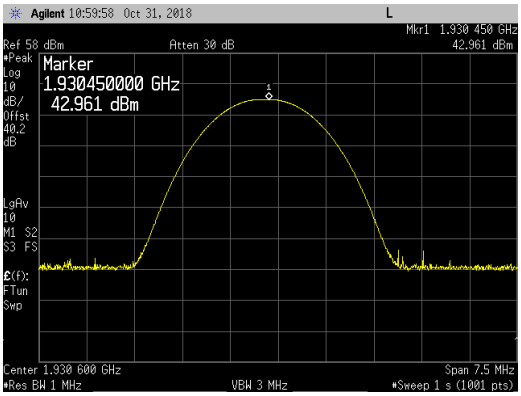
Bottom Channel_1930.2MHz_Peak



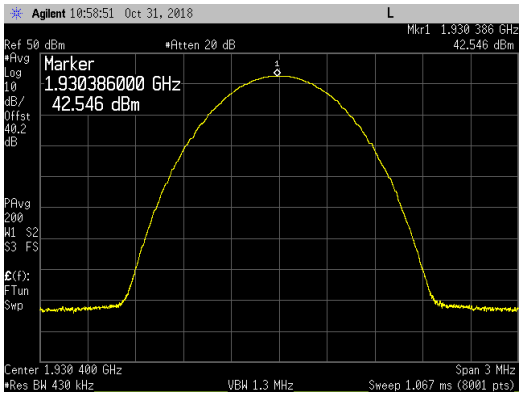
Bottom Channel_1930.2MHz_Average



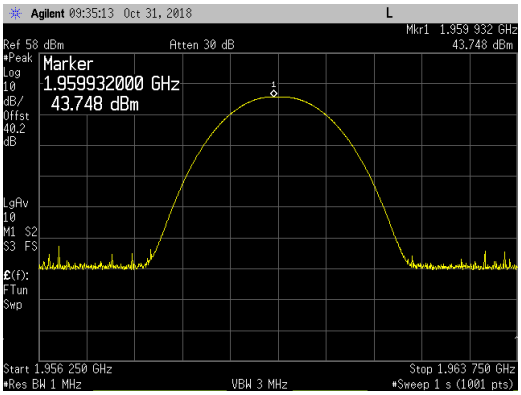
Bottom Channel +1_1930.4MHz__Peak



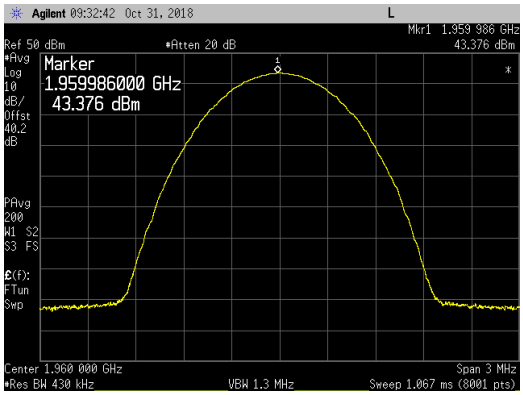
Bottom Channel +1_1930.4MHz_Average



Middle Channel_1960.0MHz_Peak

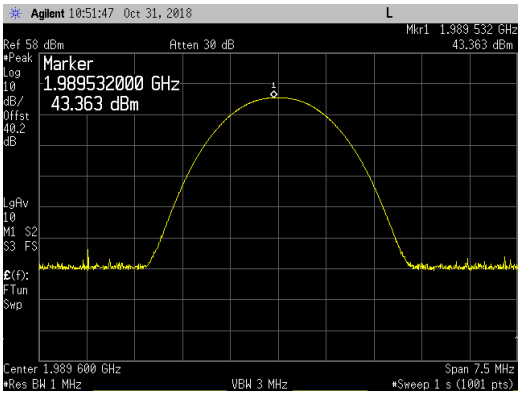


Middle Channel_1960.0MHz_Ave

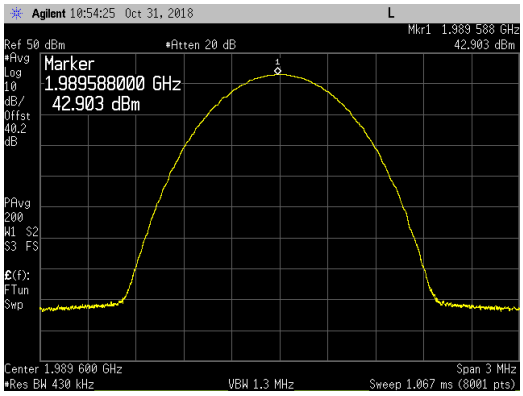


Carrier Power Plots at FHFB Antenna Port 4 for GMSK Modulation continued:

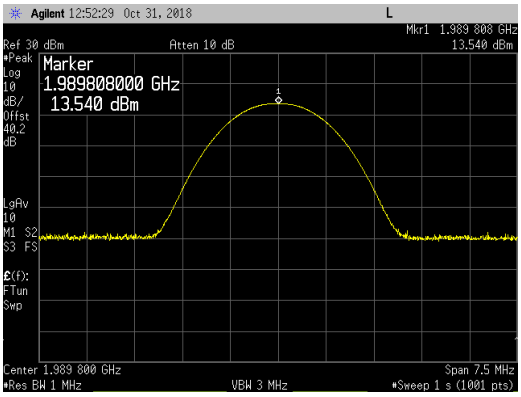
Top Channel -1_1989.6MHz_Peak



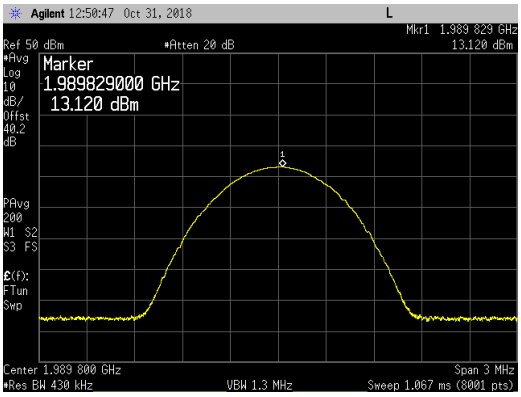
Top Channel -1_1989.6MHz_Average



Top Channel_1989.8MHz_Peak

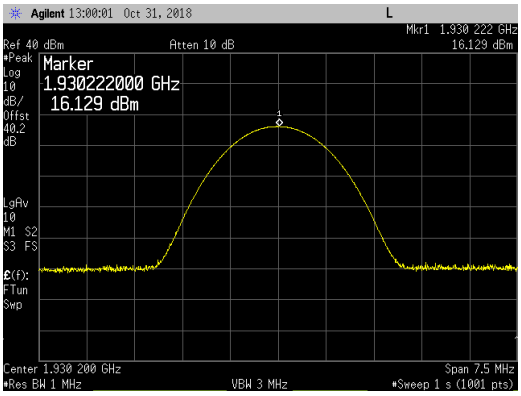


Top Channel_1989.8MHz_Average

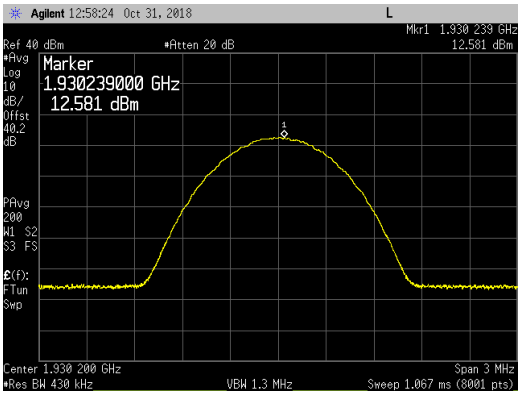


Carrier Power Plots at FHFB Antenna Port 4 for 8PSK Modulation:

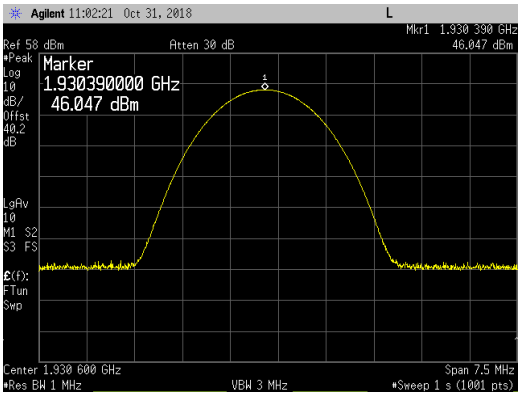
Bottom Channel_1930.2MHz_Peak



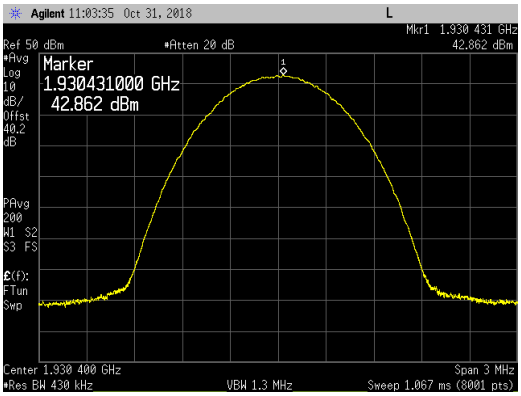
Bottom Channel_1930.2MHz_Average



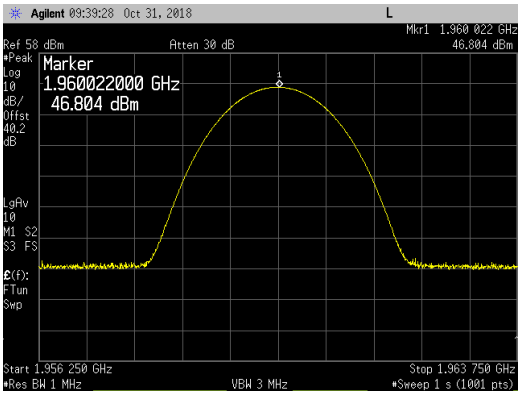
Bottom Channel +1_1930.4MHz__Peak



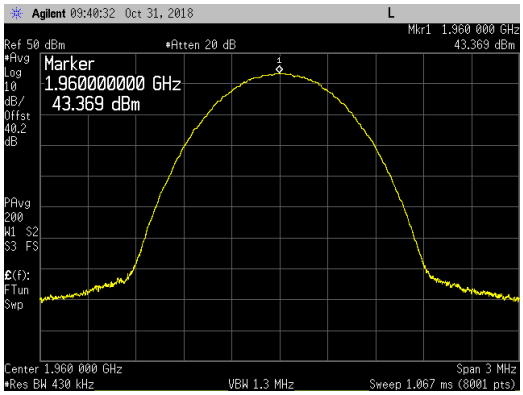
Bottom Channel +1_1930.4MHz_Average



Middle Channel_1960.0MHz_Peak

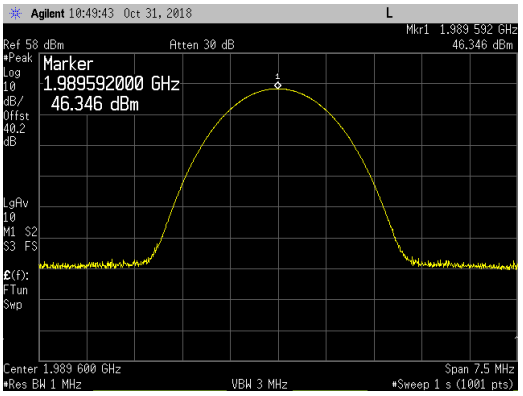


Middle Channel_1960.0MHz_Ave

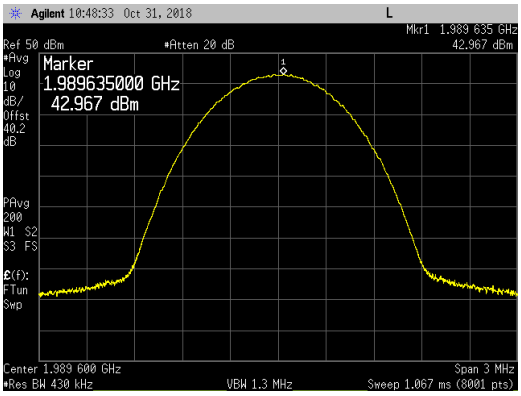


Carrier Power Plots at FHFB Antenna Port 4 for 8PSK Modulation continued:

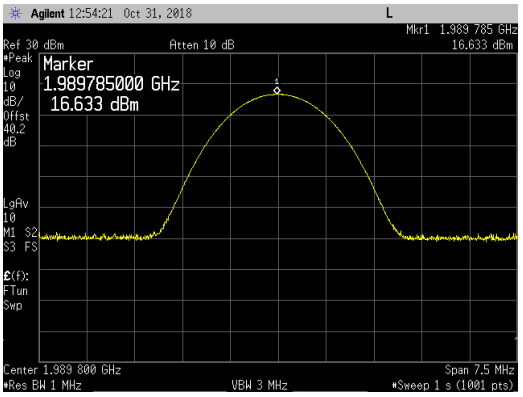
Top Channel -1_1989.6MHz_Peak



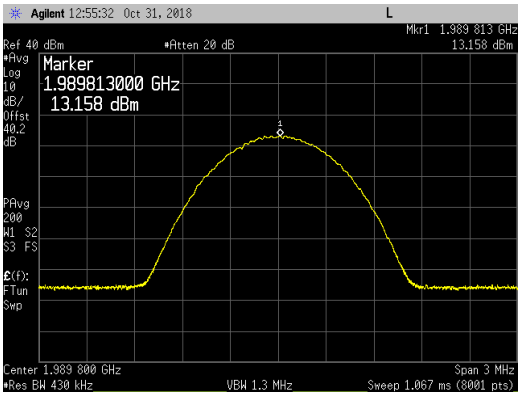
Top Channel -1_1989.6MHz_Average



Top Channel_1989.8MHz_Peak

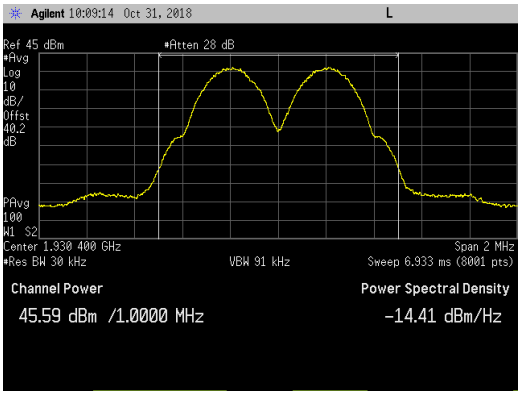


Top Channel_1989.8MHz_Average

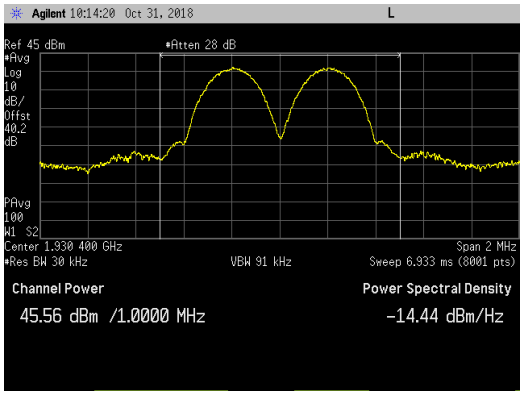


Port Power Plots at FHFB Antenna Port 4 for GMSK and 8PSK Modulations:

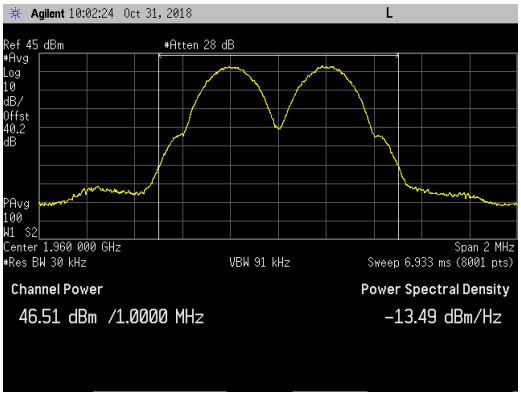
GMSK-BCs_1930.2 & 1930.6MHz_Average



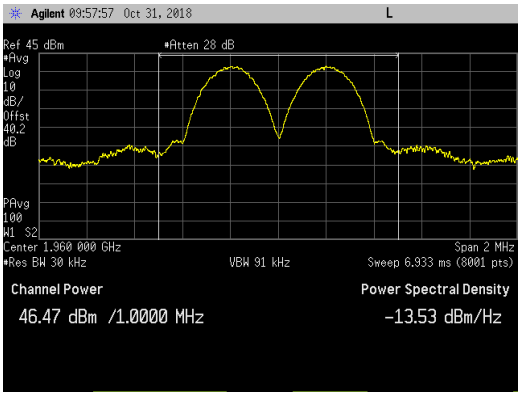
8PSK-BCs_1930.2 & 1930.6MHz_Average



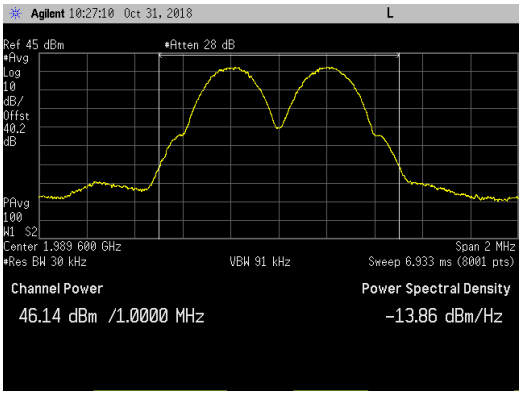
GMSK-MCs_1959.8 & 1960.2MHz_Average



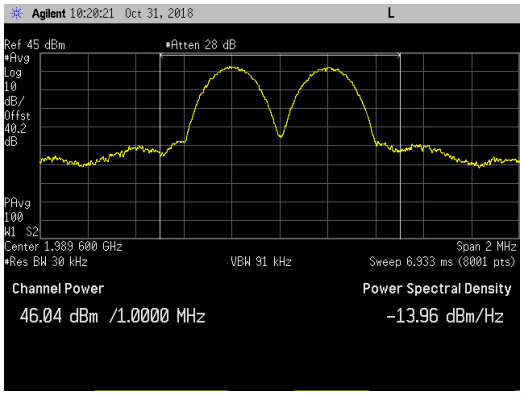
8PSK-MCs_1959.8 & 1960.2MHz_Average



GMSK-TCs_1989.4 & 1989.8MHz_Average



8PSK-TCs_1989.4 & 1989.8MHz_Average



Emission Bandwidth (26 dB down and 99%)

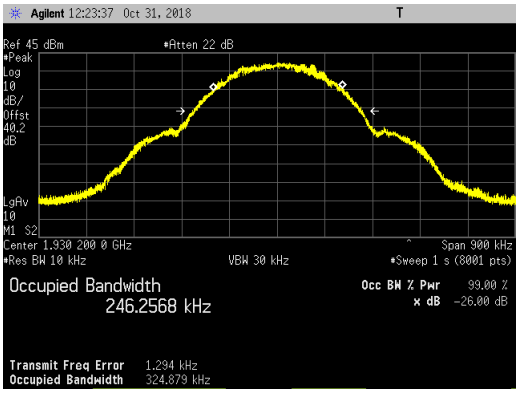
Emission bandwidth measurements were made at antenna port 4 on the bottom, middle and top channels. The FHFB was operated at maximum RF output power for GSM/EDGE modulations. The 26dB emission bandwidth was measured in accordance with section 4 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.4. 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 bandwidth is highlighted.

Modulation	Frequency _ Channel	Emission Bandwidth (kHz)	
		26dB	99%
GMSK	**1930.2MHz_Bottom Channel**	**324.879**	246.2568
	1960.0MHz_Middle Channel	320.032	**246.8393**
	1989.8MHz_Top Channel	319.848	246.6332
8PSK	**1930.2MHz_Bottom Channel**	**313.941**	242.7462
	1960.0MHz_Middle Channel	309.511	**243.5877**
	1989.8MHz_Top Channel	308.307	243.3473

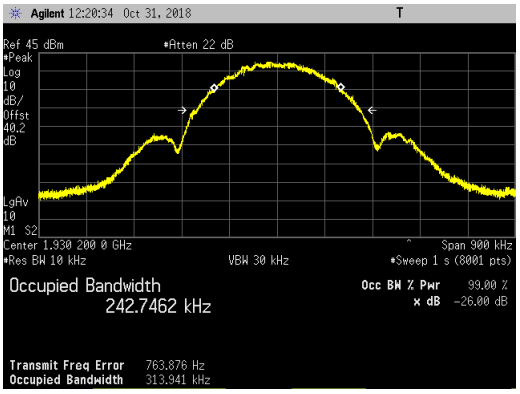
Emission bandwidth measurement data are provided in the following pages.

Emission Bandwidth Plots at FHFB Antenna Port 4:

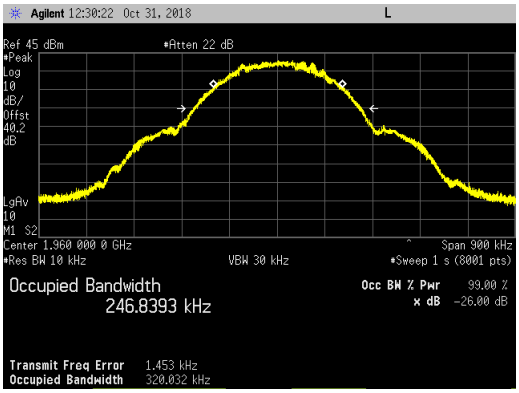
Bottom Channel_1930.2MHz_GMSK Modulation



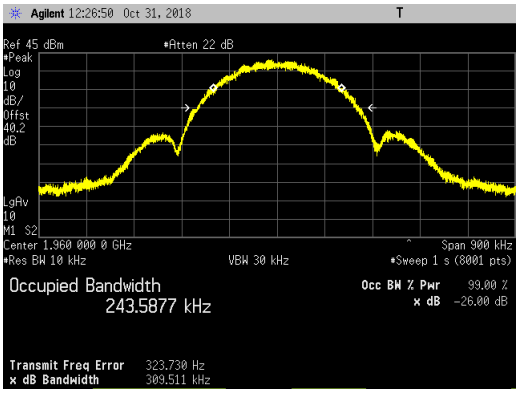
Bottom Channel_1930.2MHz_8PSK Modulation



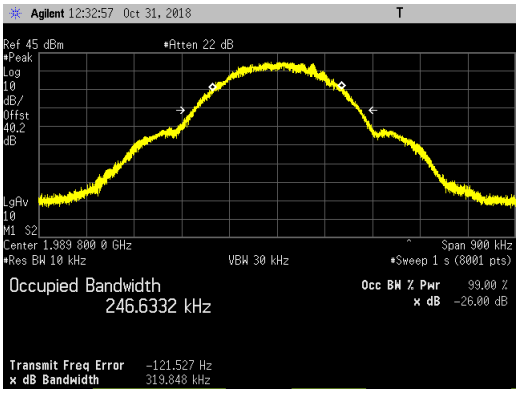
Middle Channel_1960.0MHz_GMSK Modulation



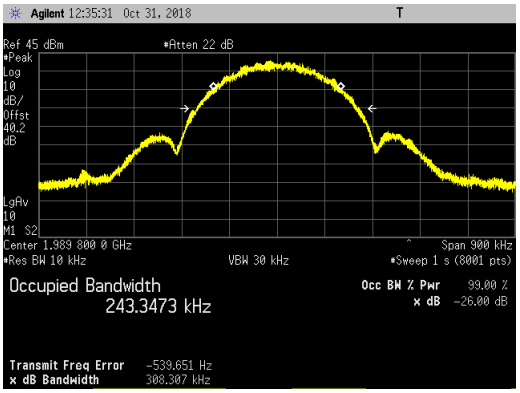
Middle Channel_1960.0MHz_8PSK Modulation



Top Channel_1989.8MHz_GMSK Modulation



Top Channel_1989.8MHz_8PSK Modulation



Antenna Port Conducted Band Edge

Conducted band edge measurements were made at FHFB antenna port 4 at the upper and lower band edges. The FHFB was operated at the band edge frequencies with GSM/EDGE modulation types.

The FHFB single carrier output power was reduced at the bottom (1930.2MHz) and top (1989.8MHz) RF channels to pass the band edge emission requirements. The FHFB single carrier at maximum output power passed band edge emissions requirements at one RF channel inside the bottom and top RF channels (i.e.: BC+1_1930.4MHz and TC-1_1989.6MHz).

In addition to the single carrier test cases, multicarrier multiradio test cases based upon KDB 971168 D03v01 were performed using three carriers per antenna port. The multicarrier multiradio test cases were selected with worst case parameters including smallest available LTE channel bandwidth (LTE1.4 and LTE 3 channel bandwidths are not available for FHFB multiradio operations). The carrier with the highest spectral density (GSM/EDGE) was nearest to the band edge. The test cases were performed with two GSM/EDGE carriers at maximum spacing (35MHz) between the carriers and an LTE5 carrier with 256QAM modulation with minimal spacing to the GSM/EDGE carrier nearest to the band edge. The first multicarrier multiradio test case is with two GSM/EDGE carriers at the lower band edge (i.e.: 1930.2 & 1965.0MHz) and a third carrier (LTE5) with minimum spacing to the band edge carrier (1933.3MHz). The second multicarrier multiradio test case is with two GSM/EDGE carriers at the upper band edge (i.e.: 1955.0 & 1989.8MHz) and a third carrier (LTE5) with minimum spacing to the band edge carrier (1986.7MHz). The multicarrier multiradio cases at maximum output port power passed band edge emissions requirements at one RF channel inside the bottom and top RF channels (i.e.: BC+1_1930.4MHz and TC-1_1989.6MHz). The power was reduced to pass the band edge requirements at the bottom and top channels.

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 $\geq$1% of the measured emission bandwidth (3.3kHz for GSM/EDGE or 50kHz for LTE5) per 24.238(b) and RSS 133 6.5(i) is required. In the 1 to 2MHz frequency range outside the band edge (i.e.: 1928 to 1929MHz and 1996 to 1997MHz bands) the RBW was set to $\geq$1% of the measured emission bandwidth and the power integrated over 1MHz. In the 2MHz to 22MHz frequency range outside the band edge (i.e.: 1908 to 1928MHz and 1997 to 2017MHz 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.

The power of any emission outside of the authorized operating frequency range cannot exceed -13 dBm as specified in section 24.238(a) and RSS 133 6.5(i). The limit is adjusted to -19dBm [-13dBm -10 log (4)] per FCC KDB 662911 D01v02r01 because the BTS may operate as a 4 port MIMO transmitter (required for the multiradio test cases only). The -19dBm limit was used for both MIMO (multiradio) test cases and GSM/EDGE only (single carrier) test cases (even though the -13dBm limit is required for the GSM/EDGE only test cases). The $\geq$1% resolution bandwidth value of 51kHz was used for all test cases even though a smaller value (~3.3kHz) could have been selected for the GSM/EDGE single carrier cases.

Band 2 Carrier Frequency Modulation Type and Carrier Power Level	Port 4 (dBm)	
	Lower	Upper
Single Carrier at Bottom Channel (1930.2MHz)/Top Channel (1989.8MHz) GMSK and Reduced Carrier Power	-23.705	-21.961
Single Carrier at Bottom Channel (1930.2MHz)/Top Channel (1989.8MHz) 8PSK and Reduced Carrier Power	-26.760	-23.555
Single Carrier at BC+1 (1930.4MHz)/TC-1 (1989.6MHz) GMSK and Maximum Carrier Power (20 Watts)	-29.911	-30.64
Single Carrier at BC+1 (1930.4MHz)/TC-1 (1989.6MHz) 8PSK and Maximum Carrier Power (20 Watts)	-27.146	-24.236
Three Carriers at LBE: GMSK at 1930.2MHz & 1965.0MHz, LTE5 at 1933.3MHz/ Three Carriers at UBE: GMSK at 1955.0MHz & 1989.8MHz, LTE5 at 1986.7MHz Reduced Port Power	-22.334	-20.401
Three Carriers at LBE: 8PSK at 1930.2MHz & 1965.0MHz, LTE5 at 1933.3MHz/ Three Carriers at UBE: 8PSK at 1955.0MHz & 1989.8MHz, LTE5 at 1986.7MHz Reduced Port Power	-23.835	-20.586
Three Carriers at LBE: GMSK at 1930.4MHz & 1965.0MHz, LTE5 at 1933.3MHz/ Three Carriers at UBE: GMSK at 1955.0MHz & 1989.6MHz, LTE5 at 1986.7MHz Maximum Port Power (40 Watts)	-23.935	-22.026
Three Carriers at LBE: 8PSK at 1930.4MHz & 1965.0MHz, LTE5 at 1933.3MHz/ Three Carriers at UBE: 8PSK at 1955.0MHz & 1989.6MHz, LTE5 at 1986.7MHz Maximum Port Power (40 Watts)	-21.760	-20.65

The reduced power level was 30dB down from maximum power level (~13dBm for the single carrier as shown in the RF output power section of this report).

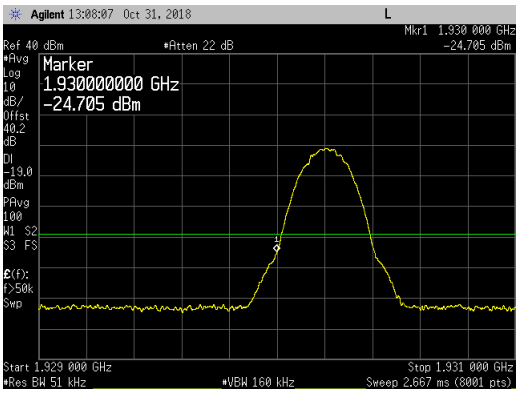
The total measurement RF path loss of the test setup (attenuator and test cables) was 40.2 dB and is accounted for by the spectrum analyzer reference level offset. The display line on the plots reflects the required limit.

Conducted band edge measurements are provided in the following pages.

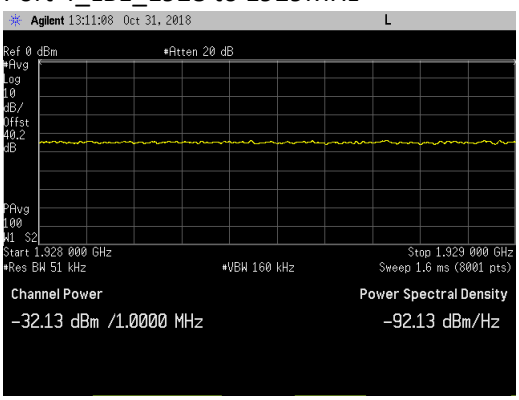
Band 2 Single Carrier at Reduced Power -Lower and Upper Band Edge Plots:

GSMK Carrier at Bottom Channel (1930.2MHz)

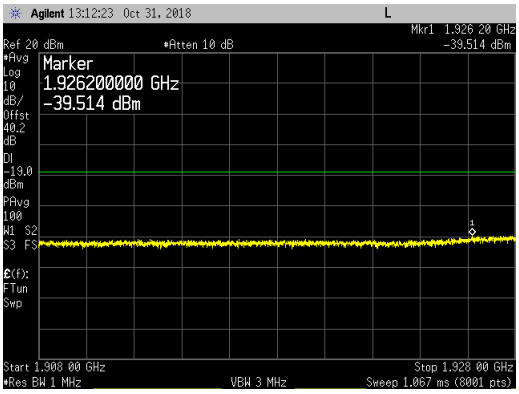
Port 4_LBE_1929 to 1931MHz



Port 4_LBE_1928 to 1929MHz

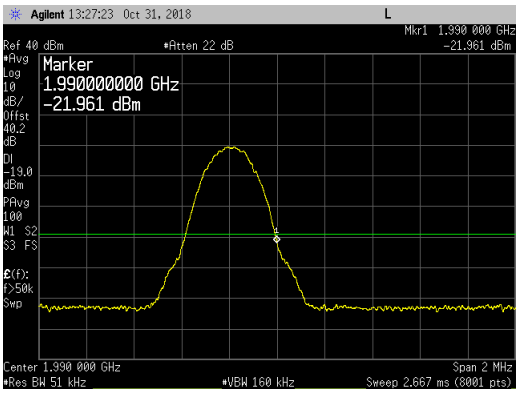


Port 4_LBE_1908 to 1928MHz

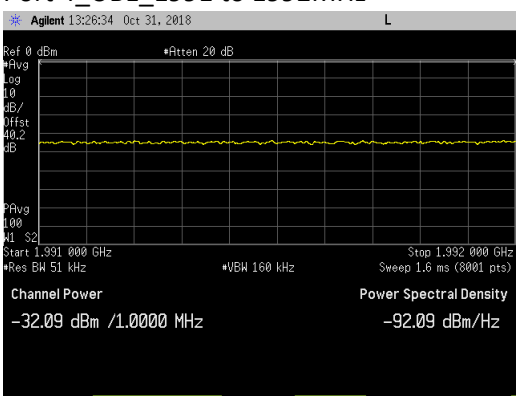


GMSK Carrier at Top Channel (1989.8MHz)

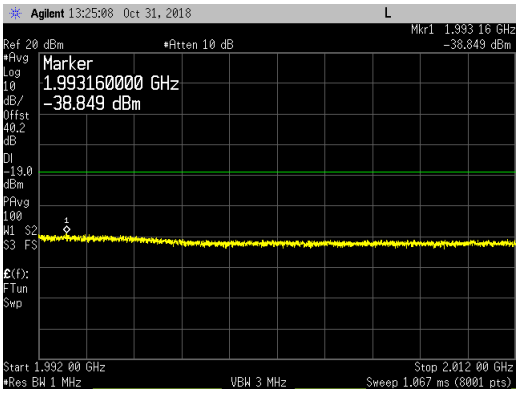
Port 4_UBE_1989 to 1991MHz



Port 4_UBE_1991 to 1992MHz



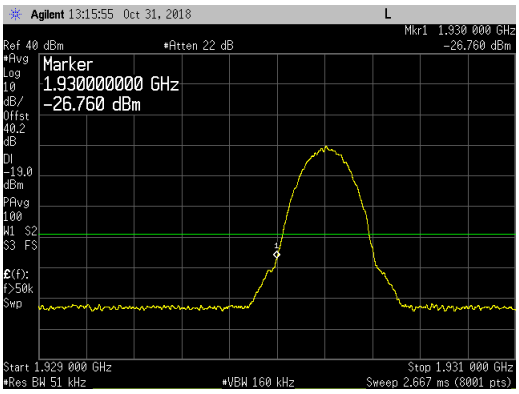
Port 4_UBE_1992 to 2012MHz



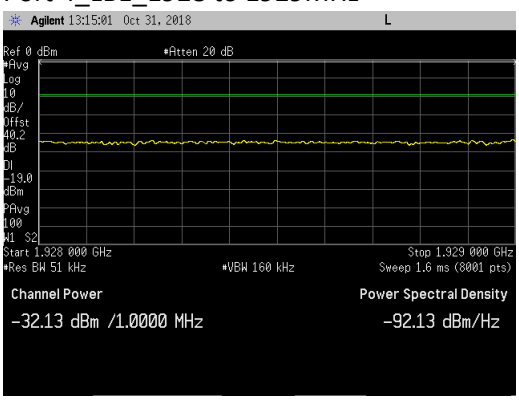
Band 2 Single Carrier at Reduced Power -Lower and Upper Band Edge Plots:

8PSK Carrier at Bottom Channel (1930.2MHz)

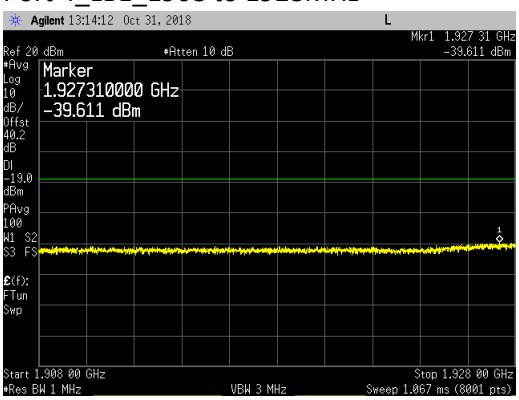
Port 4_LBE_1929 to 1931MHz



Port 4_LBE_1928 to 1929MHz

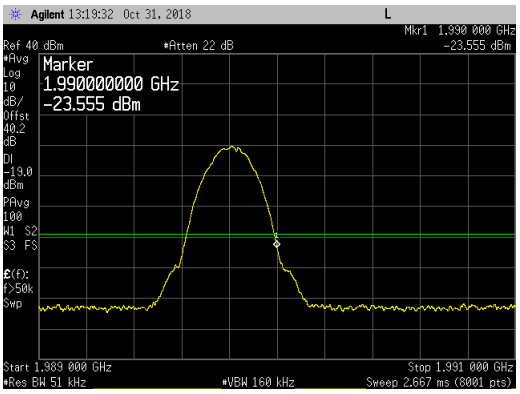


Port 4_LBE_1908 to 1928MHz

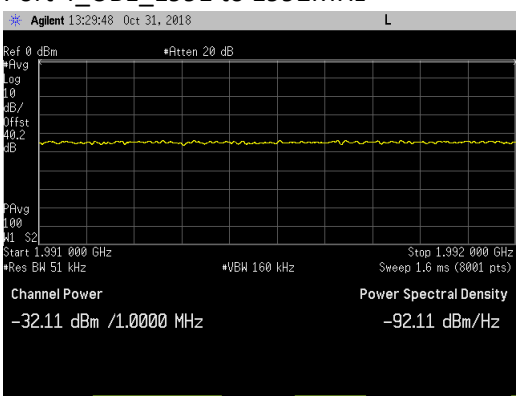


8PSK Carrier at Top Channel (1989.8MHz)

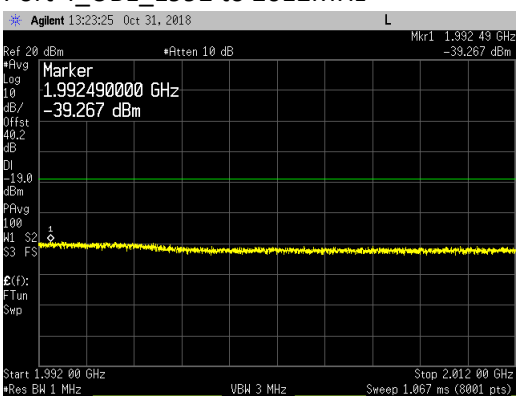
Port 4_UBE_1989 to 1991MHz



Port 4_UBE_1991 to 1992MHz



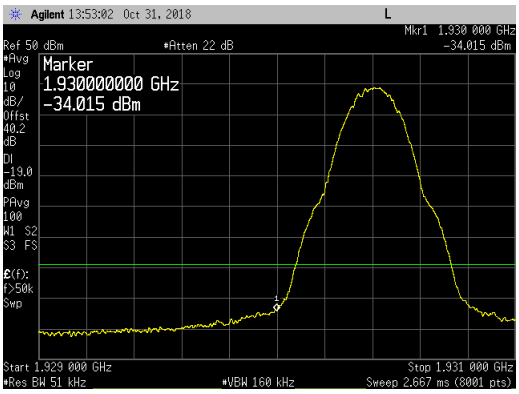
Port 4_UBE_1992 to 2012MHz



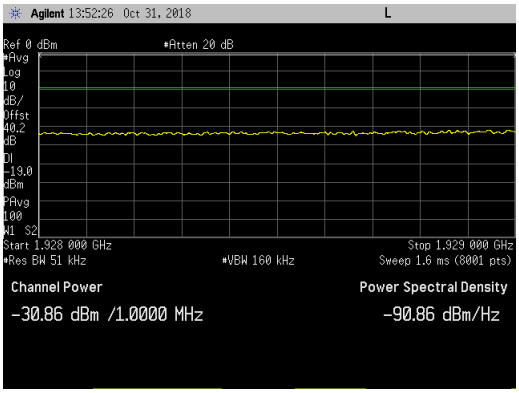
Band 2 Single Carrier at Maximum Power -Lower and Upper Band Edge Plots:

GMSK Carrier at BC+1 (1930.4MHz)

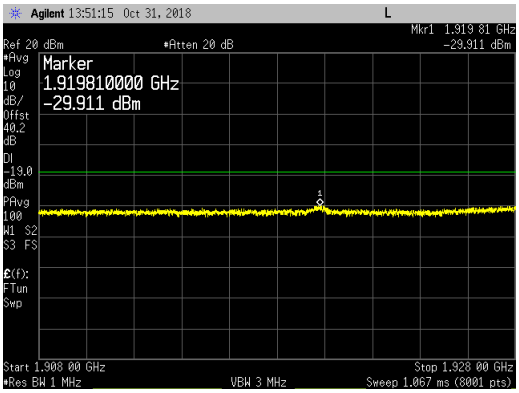
Port 4_LBE_1929 to 1931MHz



Port 4_LBE_1928 to 1929MHz

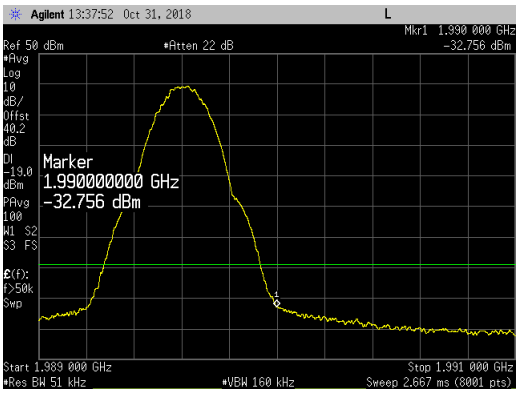


Port 4_LBE_1908 to 1928MHz

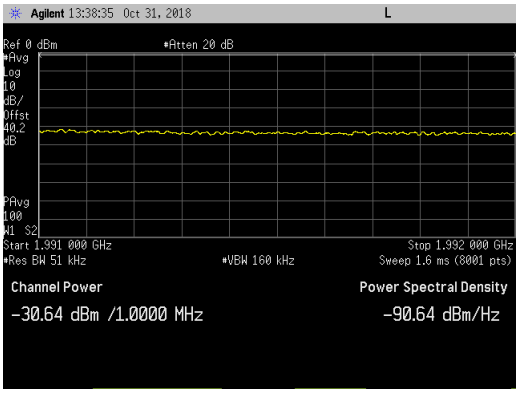


GMSK Carrier at TC-1 (1989.6MHz)

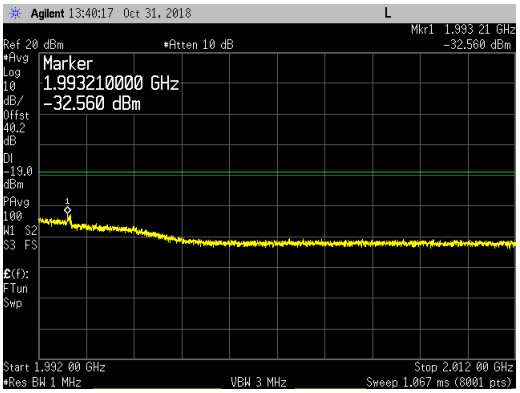
Port 4_UBE_1989 to 1991MHz



Port 4_UBE_1991 to 1992MHz



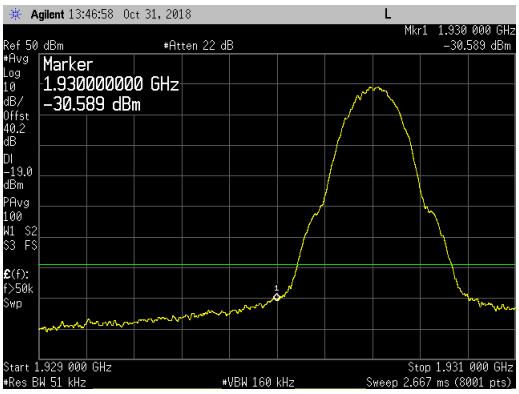
Port 4_UBE_1992 to 2012MHz



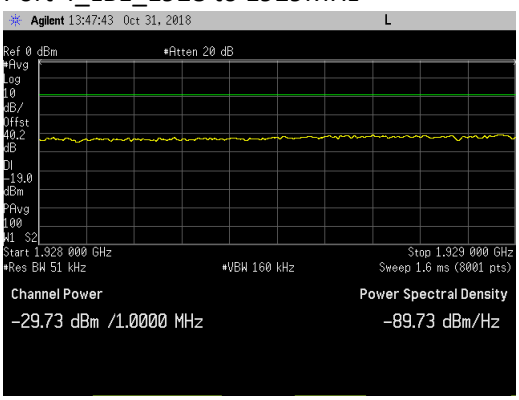
Band 2 Single Carrier at Maximum Power -Lower and Upper Band Edge Plots:

8PSK Carrier at BC+1 (1930.4MHz)

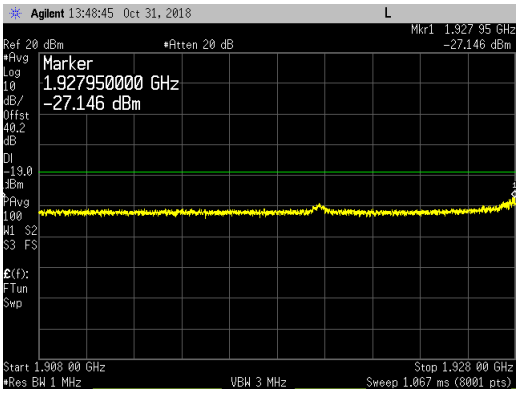
Port 4_LBE_1929 to 1931MHz



Port 4_LBE_1928 to 1929MHz

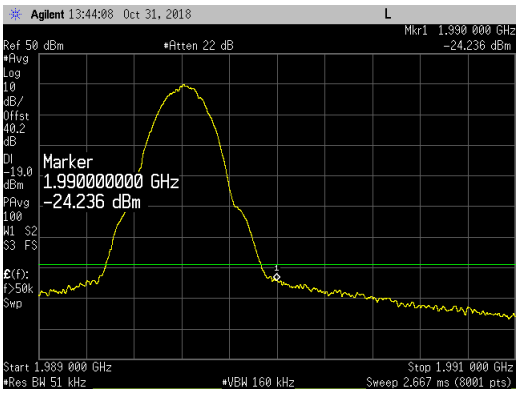


Port 4_LBE_1908 to 1928MHz

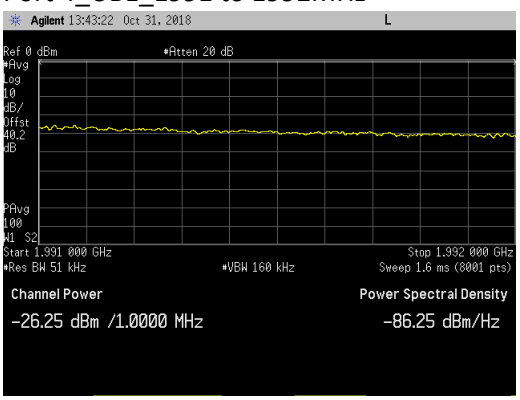


8PSK Carrier at TC-1 (1989.6MHz)

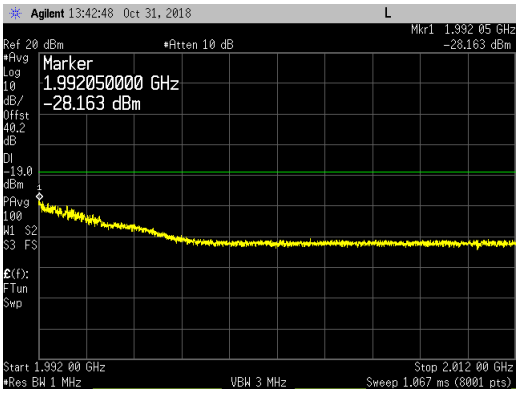
Port 4_UBE_1989 to 1991MHz



Port 4_UBE_1991 to 1992MHz



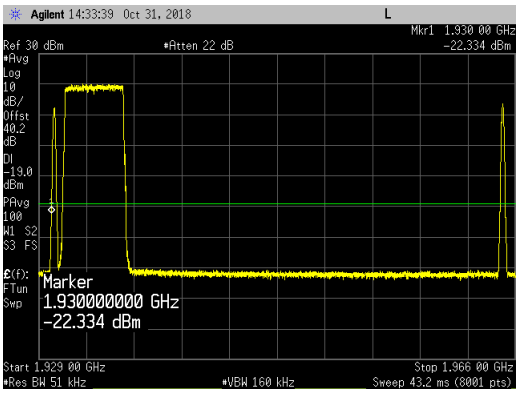
Port 4_UBE_1992 to 2012MHz



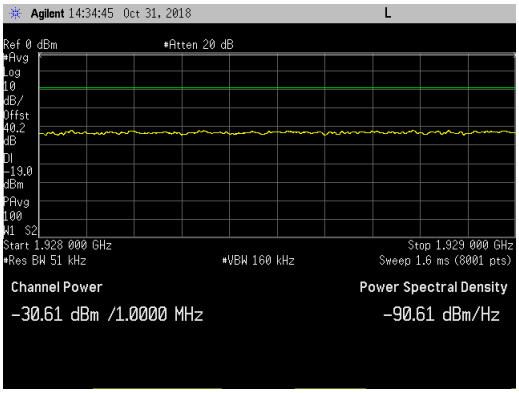
Band 2 Three Multiradio Carriers at Reduced Power -Lower and Upper Band Edge Plots:

GMSK at 1930.2 & 1965.0MHz, LTE5 at 1933.3MHz

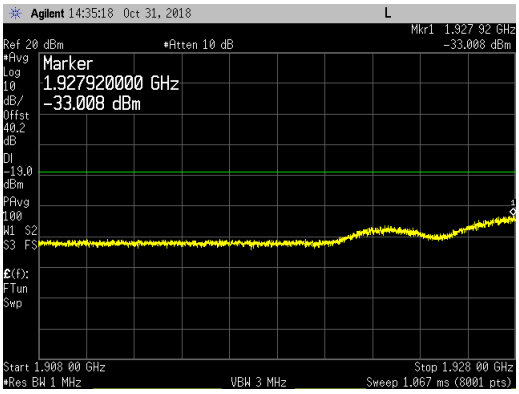
Port 4_LBE_1929 to 1966MHz



Port 4_LBE_1928 to 1929MHz

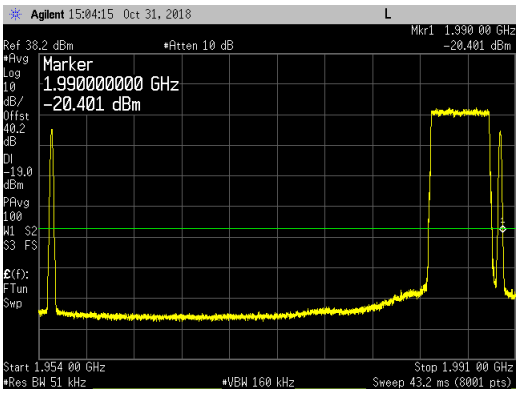


Port 4_LBE_1908 to 1928MHz

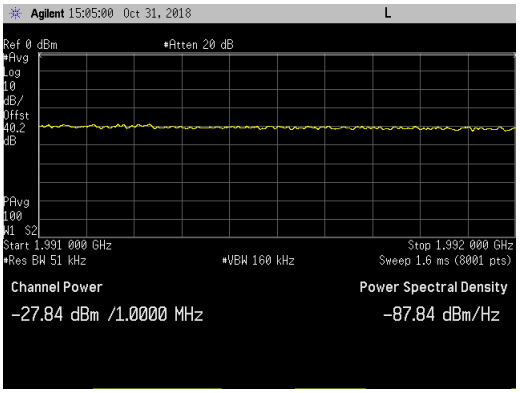


GMSK at 1955.0 & 1989.8MHz, LTE5 at 1986.7MHz

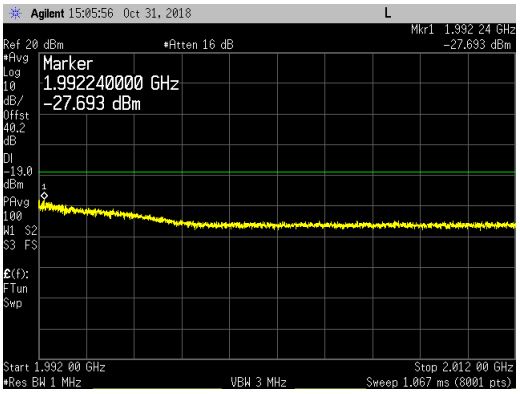
Port 4_UBE_1954 to 1991MHz



Port 4_UBE_1991 to 1992MHz



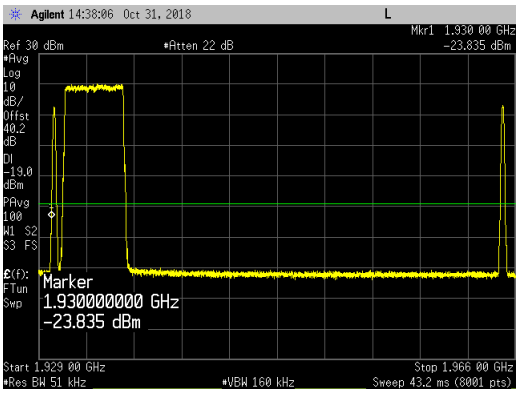
Port 4_UBE_1992 to 2012MHz



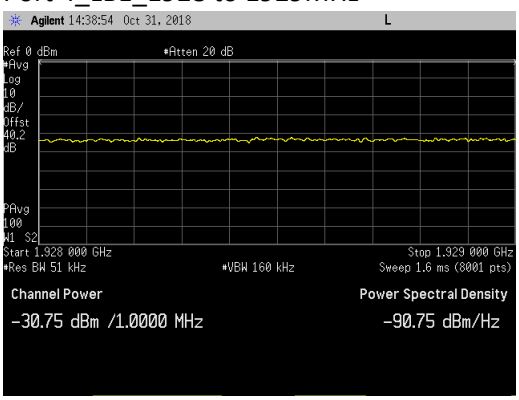
Band 2 Three Multiradio Carriers at Reduced Power -Lower and Upper Band Edge Plots:

8PSK at 1930.2 & 1965.0MHz, LTE5 at 1933.3MHz

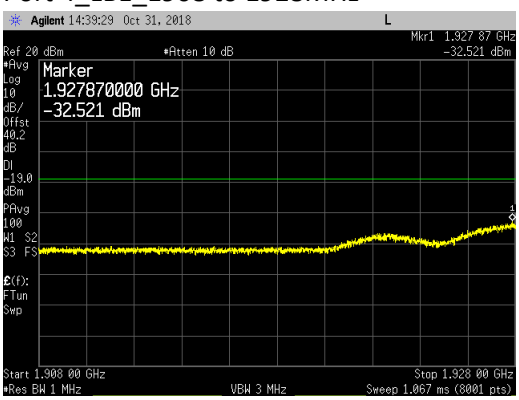
Port 4_LBE_1929 to 1966MHz



Port 4_LBE_1928 to 1929MHz

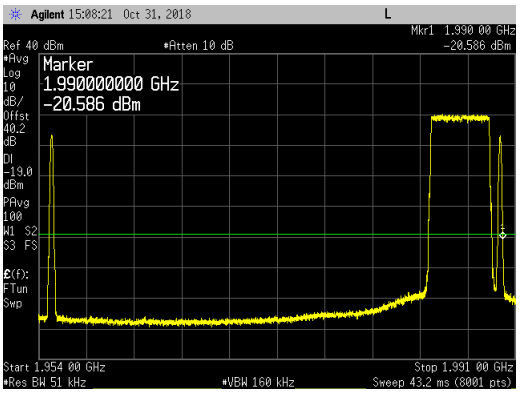


Port 4_LBE_1908 to 1928MHz

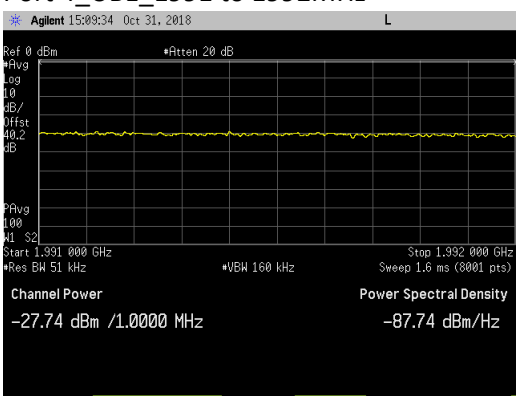


8PSK at 1955.0 & 1989.8MHz, LTE5 at 1986.7MHz

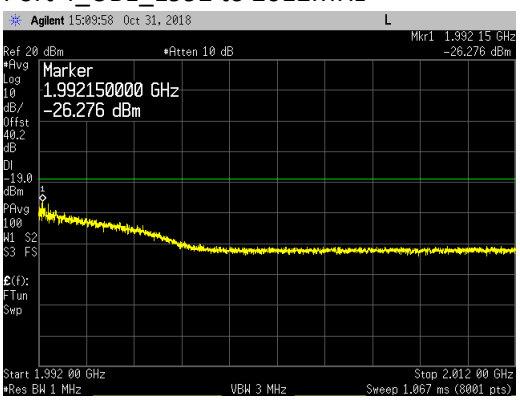
Port 4_UBE_1954 to 1991MHz



Port 4_UBE_1991 to 1992MHz



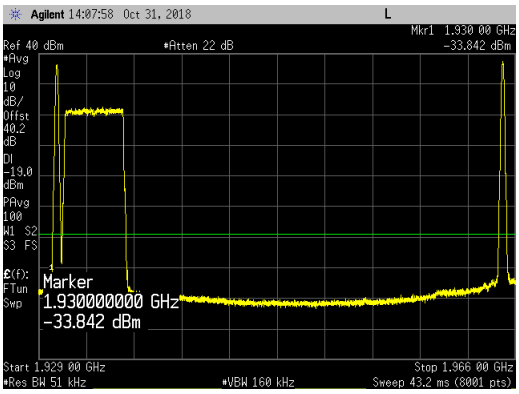
Port 4_UBE_1992 to 2012MHz



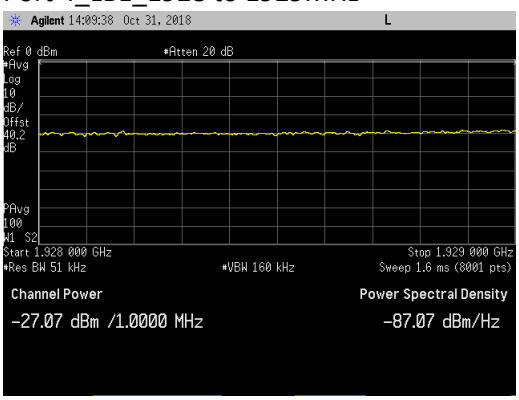
Band 2 Three Multiradio Carriers at Maximum Power -Lower and Upper Band Edge Plots:

GMSK at 1930.4 & 1965.0MHz, LTE5 at 1933.3MHz

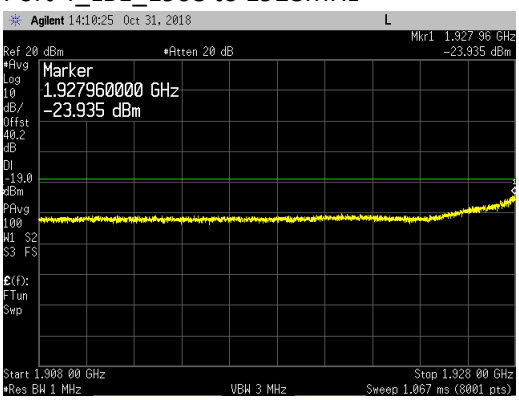
Port 4_LBE_1929 to 1966MHz



Port 4_LBE_1928 to 1929MHz

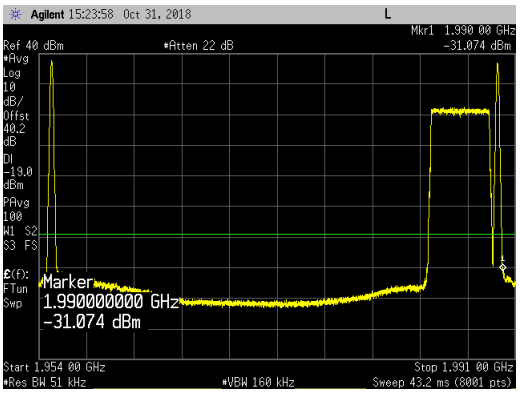


Port 4_LBE_1908 to 1928MHz

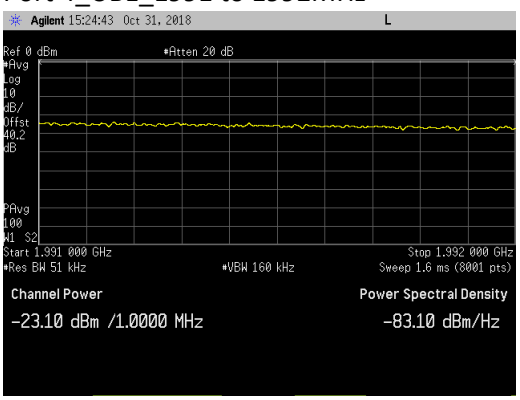


GMSK at 1955.0 & 1989.6MHz, LTE5 at 1986.7MHz

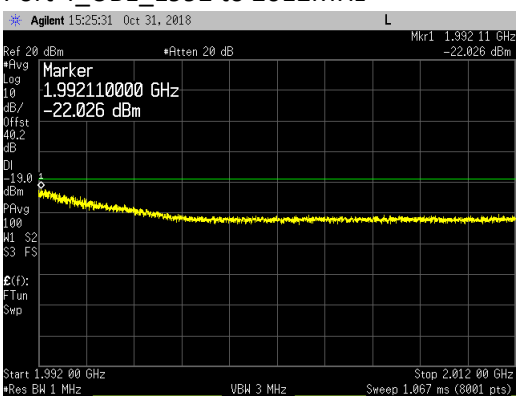
Port 4_UBE_1954 to 1991MHz



Port 4_UBE_1991 to 1992MHz



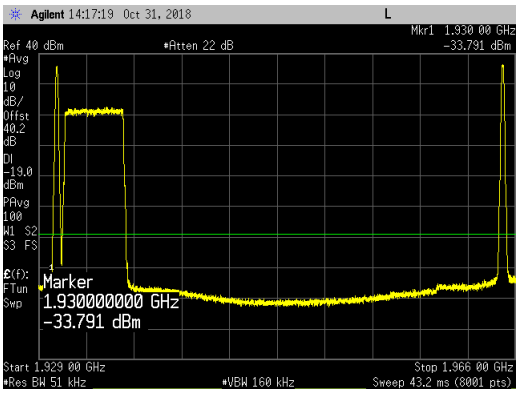
Port 4_UBE_1992 to 2012MHz



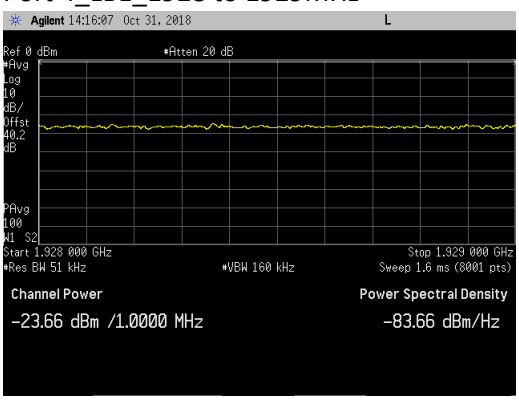
Band 2 Three Multiradio Carriers at Maximum Power -Lower and Upper Band Edge Plots:

8PSK at 1930.4 & 1965.0MHz, LTE5 at 1933.3MHz

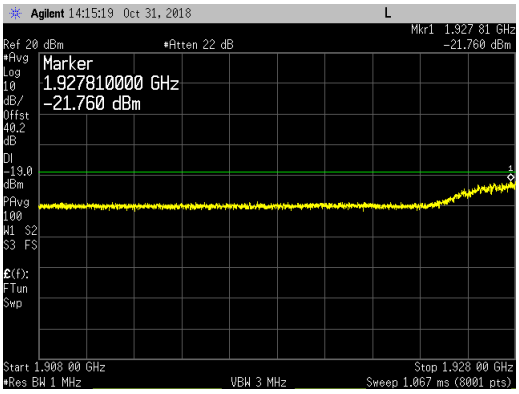
Port 4_LBE_1929 to 1966MHz



Port 4_LBE_1928 to 1929MHz

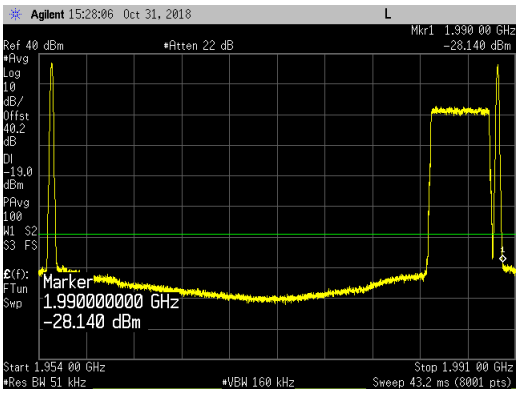


Port 4_LBE_1908 to 1928MHz

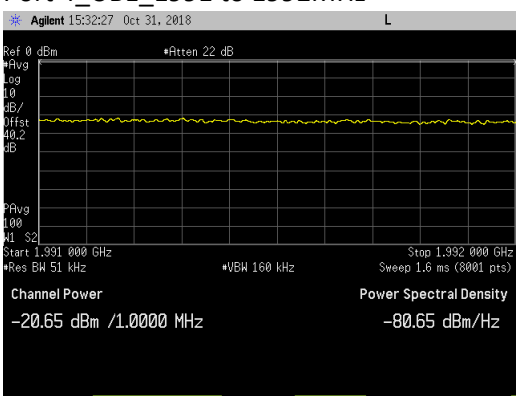


8PSK at 1955.0 & 1989.6MHz, LTE5 at 1986.7MHz

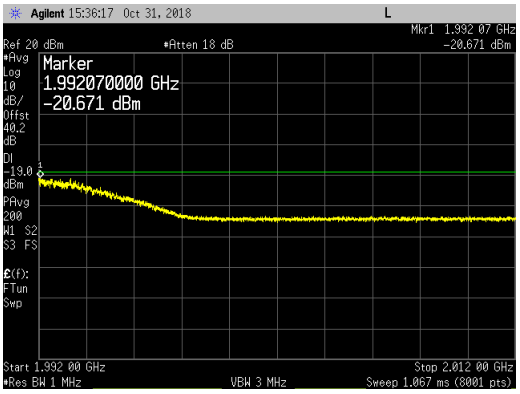
Port 4_UBE_1954 to 1991MHz



Port 4_UBE_1991 to 1992MHz



Port 4_UBE_1992 to 2012MHz



Transmitter Antenna Port Conducted Emissions

Transmitter conducted emission measurements were made at RRH antenna port 4 with GSM/EDGE modulation types. Measurements were performed over the 9kHz to 20GHz frequency range. The RRH was operated at maximum power with a single carrier on the Band 2 middle channel (1960.0MHz).

In addition to the single carrier test cases, multicarrier multiradio test cases based upon KDB 971168 D03v01 were performed using three carriers per antenna port operating at maximum power. The multicarrier multiradio test cases were selected with worst case parameters including smallest available LTE channel bandwidth (LTE1.4 and LTE 3 channel bandwidths are not available for FHFB multiradio operations). The test cases were performed with two GSM/EDGE carriers at maximum spacing (35MHz) between the carriers and an LTE5 carrier with 256QAM modulation with minimum spacing to the GSM/EDGE carrier nearest to the band edge. The first multicarrier multi-radio test case is with two GSM/EDGE carriers at the lower band edge (i.e.: 1930.4 & 1965.0MHz) and a third carrier (LTE5) with minimum spacing to the band edge carrier (1933.3MHz). The second multicarrier multiradio test case is with two GSM/EDGE carriers at the upper band edge (i.e.: 1955.0 & 1989.6MHz) and a third carrier (LTE5) with minimum spacing to the band edge carrier (1986.7MHz).

The power of any emission outside of the authorized operating frequency range cannot exceed -13 dBm as specified in section 24.238(a) and RSS 133 6.5(i). The limit is adjusted to -19dBm [-13dBm -10 log (4)] per FCC KDB 662911 D01v02r01 because the BTS may operate as a 4 port MIMO transmitter (required for the multiradio test cases). The -19dBm limit was used for both MIMO (multiradio) test cases and GSM/EDGE only (single carrier) test cases (even though the -13dBm limit is required for the GSM/EDGE only test cases). 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(1000kHz/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(1000kHz/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.

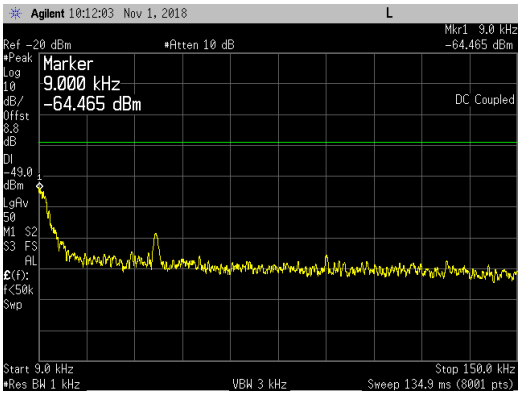
Frequency Range	RBW	VBW	Number of Data Points	Detector	Sweep Time	Max Hold over	Offset Note 1
9kHz to 150kHz	1kHz	3kHz	8001	Peak	Auto	50 Sweeps	8.8dB
150kHz to 20MHz	10kHz	30kHz	8001	Peak	Auto	50 Sweeps	8.9dB
20MHz to 3000MHz	1MHz	3MHz	8001	Average	Auto	Note 2	40.2dB
3GHz to 6GHz	1MHz	3MHz	8001	Peak	Auto	50 Sweeps	40.1dB
6GHz to 20GHz	2MHz	6MHz	8192	Peak	Auto	50 Sweeps	25.0dB

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

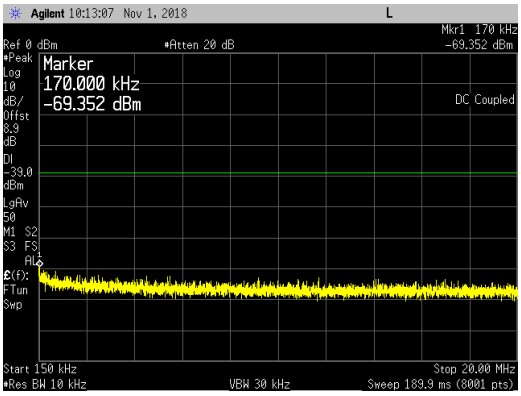
A low pass filter was used to reduce the measurement instrumentation noise floor for the frequency ranges below 20MHz. A high pass filter was used to reduce the measurement instrumentation noise floor for the frequency range above 6GHz. The total measurement RF path loss of the test setup (attenuators, 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.

Single Carrier at Max Carrier Power (20 Watts) with GMSK Modulation at Middle Channel (1960.0MHz):

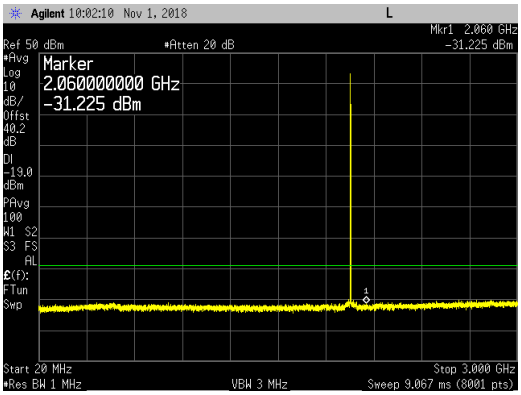
9kHz to 150kHz



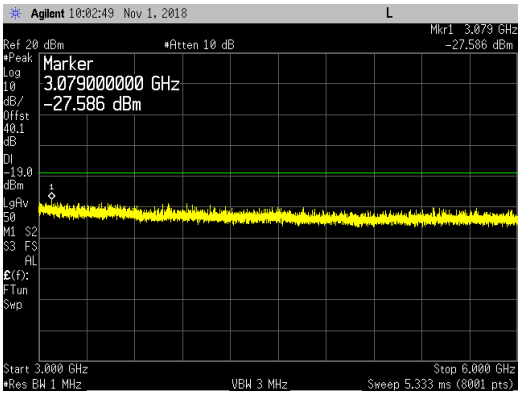
150kHz to 20MHz



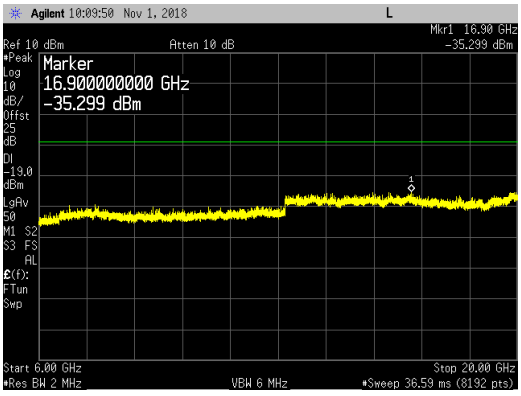
20MHz to 3000MHz



3GHz to 6GHz

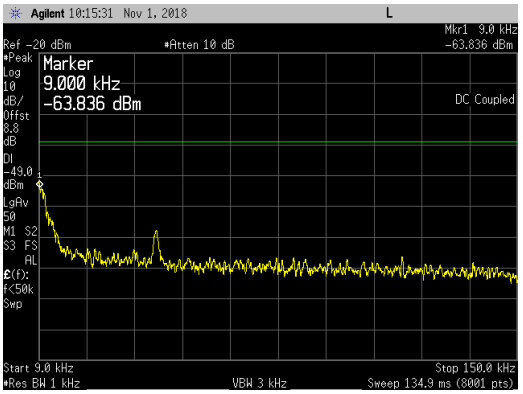


6GHz to 20GHz

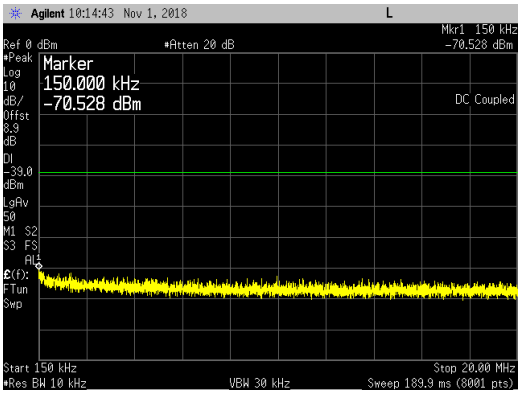


Single Carrier at Max Carrier Power (20Watts) with 8PSK Modulation at Middle Channel (1960.0MHz):

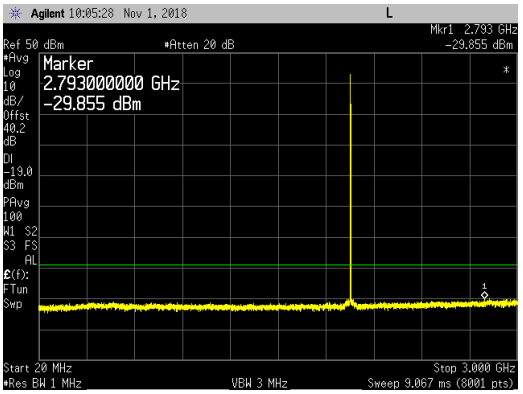
9kHz to 150kHz



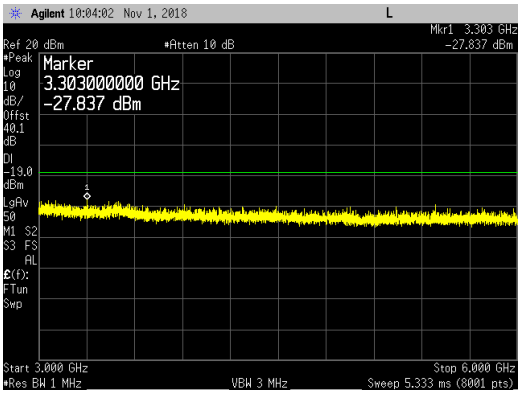
150kHz to 20MHz



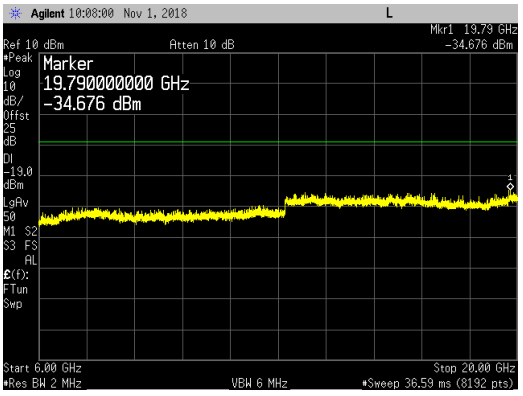
20MHz to 3000MHz



3GHz to 6GHz

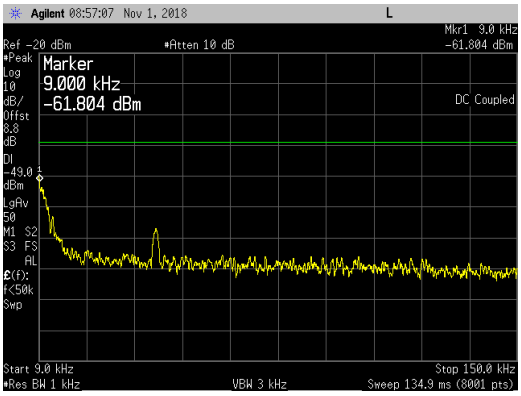


6GHz to 20GHz

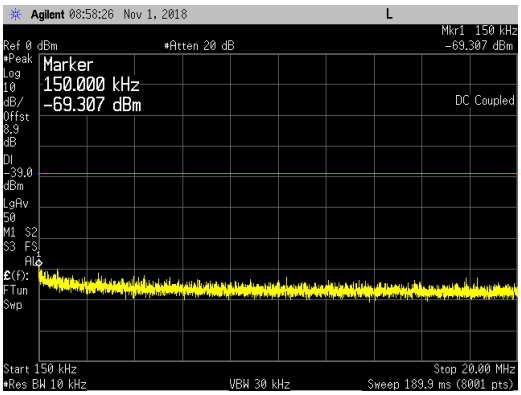


Three Multiradio Carriers at Max Port Power (40W) _GMSK at 1930.4 & 1965.0MHz, LTE5 at 1933.3MHz:

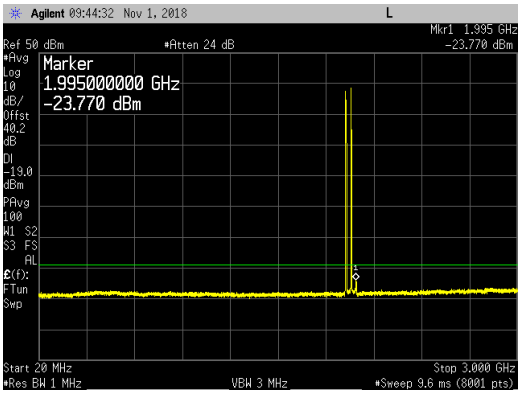
9kHz to 150kHz



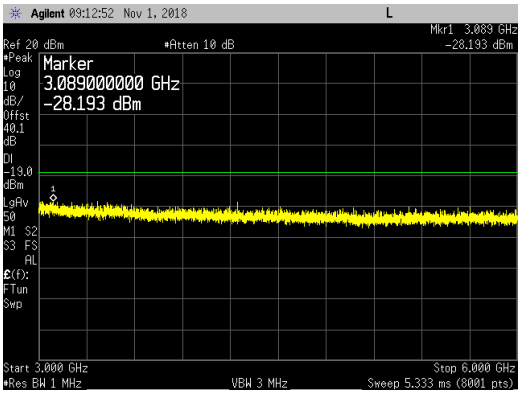
150kHz to 20MHz



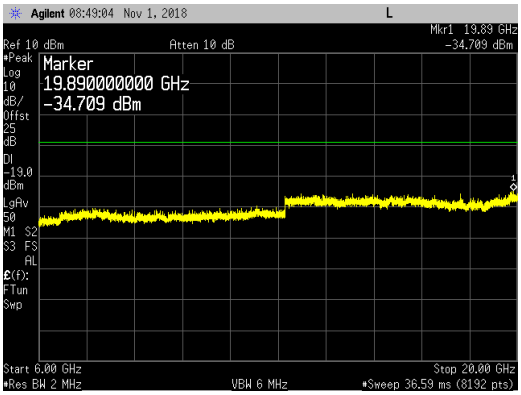
20MHz to 3000MHz



3GHz to 6GHz

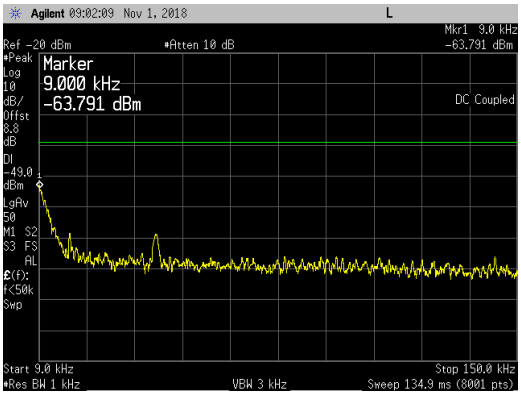


6GHz to 20GHz

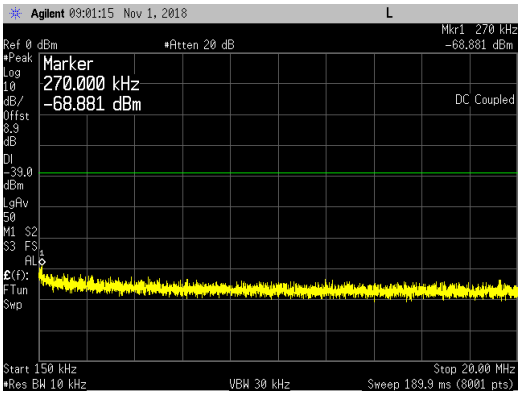


Three Multiradio Carriers at Max Port Power (40W) _8PSK at 1930.4 & 1965.0MHz, LTE5 at 1933.3MHz:

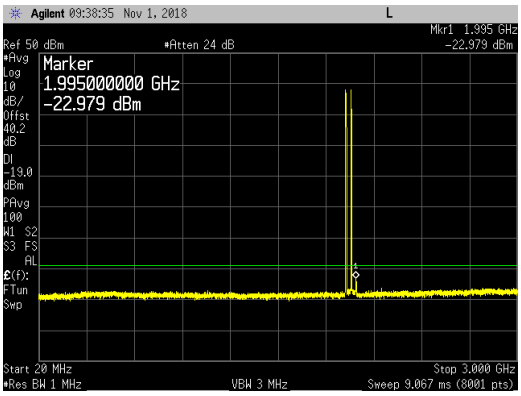
9kHz to 150kHz



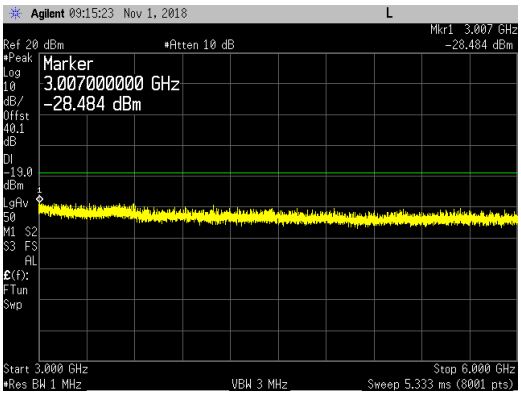
150kHz to 20MHz



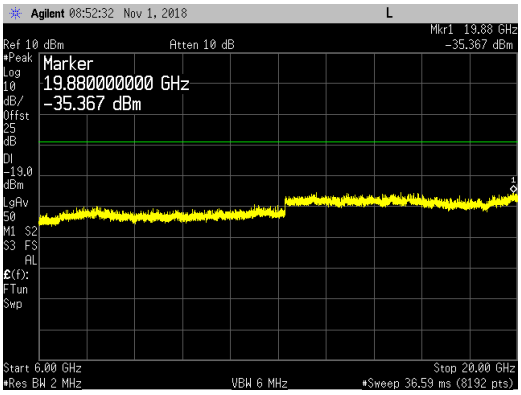
20MHz to 3000MHz



3GHz to 6GHz

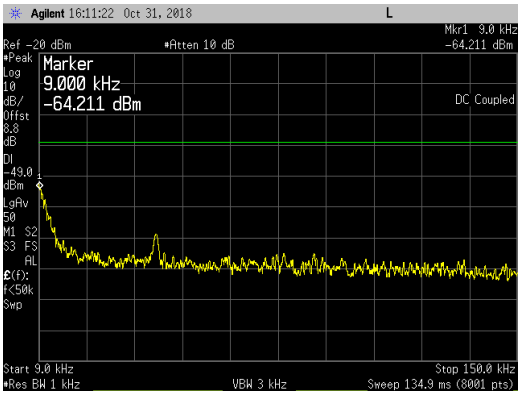


6GHz to 20GHz

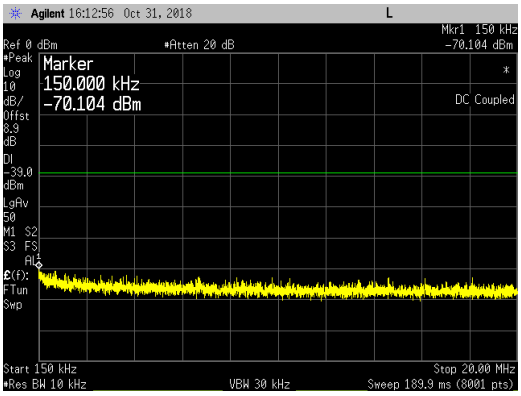


Three Multiradio Carriers at Max Port Power (40W) _GMSK at 1955.0 & 1989.6MHz, LTE5 at 1986.7MHz

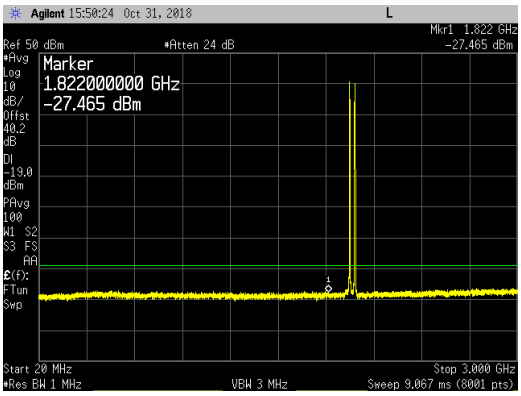
9kHz to 150kHz



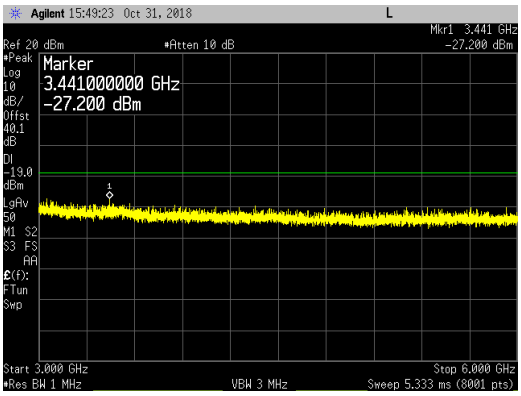
150kHz to 20MHz



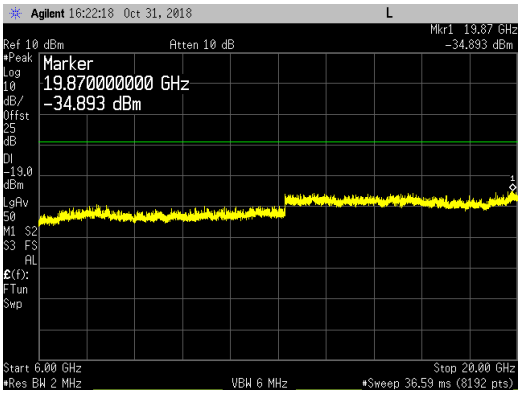
20MHz to 3000MHz



3GHz to 6GHz

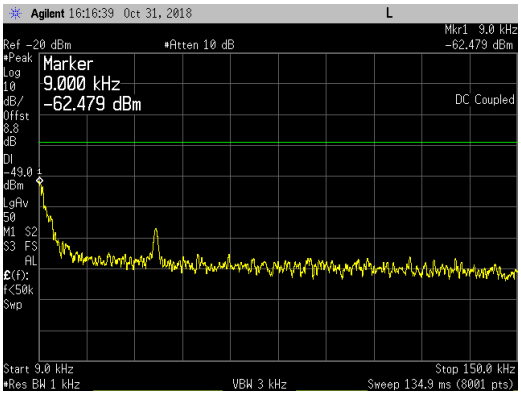


6GHz to 20GHz

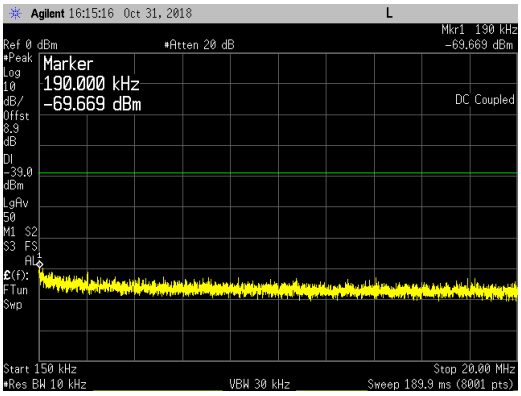


Three Multiradio Carriers at Max Port Power (40W) _8PSK at 1955.0 & 1989.6MHz, LTE5 at 1986.7MHz:

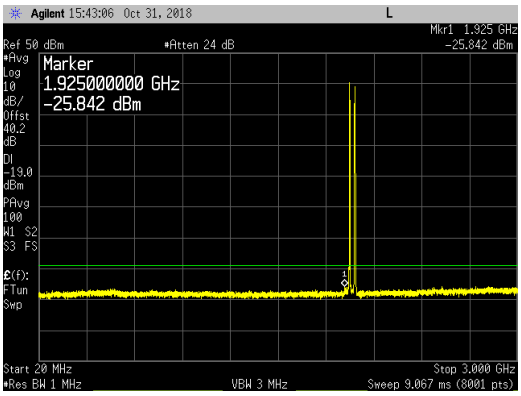
9kHz to 150kHz



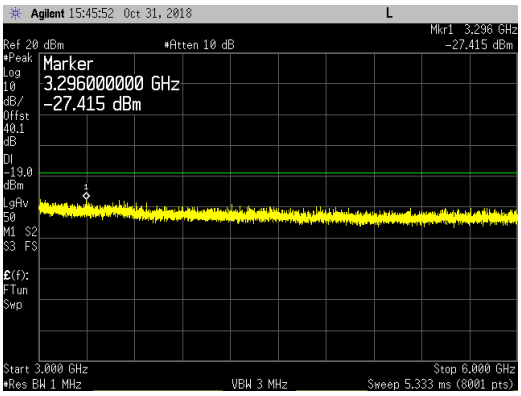
150kHz to 20MHz



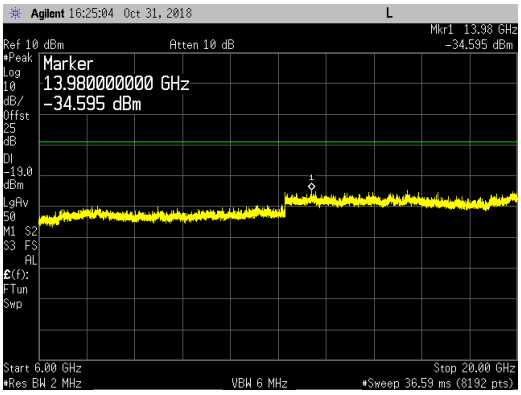
20MHz to 3000MHz



3GHz to 6GHz



6GHz to 20GHz



Transmitter Radiated Spurious Emissions

Radiated spurious emission plots/measurement results are in the original FCC and IC radio certification submittal (NTS Test Report Number PR033297 Revision 1 dated February 10, 2016).

Frequency Stability/Accuracy

Frequency Stability/Accuracy measurement results are in the original FCC and IC radio certification submittal (NTS Test Report Number PR033297 Revision 1 dated February 10, 2016).

End of Report