-PCTEST ENGINEERING LABORATORY, INC.
7185 Oakland Mills Road, Columbia, MD 21046 USA
Tel. 410.290.6652 / Fax 410.290.6654
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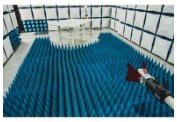

MEASUREMENT REPORT
LTE NB Device

Applicant Name:
Tecore Networks
7030 Hi Tech Drive
Hanover, MD 21076
USA

Date of Testing:
5/13 - 5/21/2019
Test Site/Location:
PCTEST Lab. Columbia, MD, USA
Test Report Serial No.:
1M1905200075.QLJ.

FCC ID:	**QLJ4GNBIOT-086**
APPLICANT:	**Tecore Networks**

Application Type:	Certification
Model:	NB-IoT
EUT Type:	Remote Radio Head
FCC Classification:	Licensed Non-Broadcast Station Transmitter (TNB)
FCC Rule Part(s):	§27; §2
Test Procedure(s):	ANSI C63.26-2015, ANSI/TIA-603-E-2016, KDB 971168 D01 v03r01

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in §2.947. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Randy Ortanez
President

ACCREDITED
TESTING CERT#2041.01

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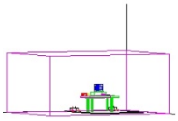
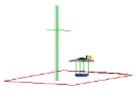


MEASUREMENT REPORT
FCC Part 27



FCC Rule Part	TX Frequency (MHz)	ANT1		ANT2		MIMO		ANT1 Emission Designator	ANT2 Emission Designator	Modulation
		Max. Power (W)	Max. Power (dBm)	Max. Power (W)	Max. Power (dBm)	Max. Power (W)	Max. Power (dBm)			
27	757.0 - 758.0	21.23	43.27	18.58	42.69	37.07	45.69	180KG7D	180KG7D	QPSK

EUT Overview

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 PCTEST Test Location

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility located at 7185 Oakland Mills Road, Columbia, MD 21046. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014.

1.3 Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Columbia, MD 21046, U.S.A.

- PCTEST is an ISO 17025-2005 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.01 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- PCTEST facility is a registered (2451B) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Tecore Networks Remote Radio Head FCC ID: QLJ4GNBIOT-086**. The test data contained in this report pertains only to the emissions due to the EUT's LTE function. The Remote Radio Head functions as a NarrowBand LTE device operating in the Guard Band A Block per FCC Part 27 Subpart G. The signal output level is set to 20 Watts from each antenna port and it is fed via a low loss cable to the input of a spectrum analyzer or a 50Ω load, depending on the type of testing performed. EUT was set up to operate as shown below with a -48VDC power supply. Server equipment was used to control the RF functions of the EUT.

The Device is capable of operating through either a single port with 16 Watts (1 x 16) or two ports with 8 Watts repectivley (2 x 8).

Test Device Serial No.: 19060002

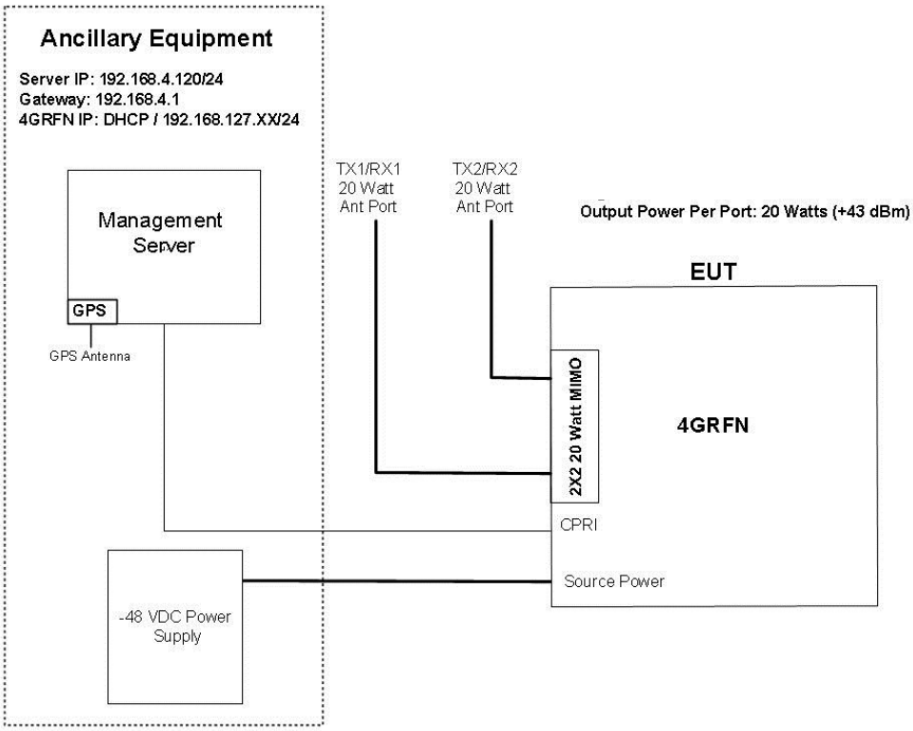


Figure 2-1. Test Setup

2.2 Device Capabilities

This device contains the following capabilities: LTE 2x2 MIMO

2.3 Test Configuration

The EUT was tested per the guidance of ANSI/TIA-603-E-2016 and KDB 971168 D01 v03r01. See Section 7.0 of this test report for a description of the radiated and antenna port conducted emissions tests.

2.4 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and no modifications were made during testing.

3.0 DESCRIPTION OF TESTS

3.1 Measurement Procedure

The measurement procedures described in the document titled "Land Mobile FM or PM – Communications Equipment – Measurements and Performance Standards" (ANSI/TIA-603-E-2016) and "Procedures for Compliance Measurement of the Fundamental Emission Power of Licensed Wideband (> 1 MHz) Digital Transmission Systems" (KDB 971168 D01 v03r01) were used in the measurement of the EUT.

3.2 Radiated Power and Radiated Spurious Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. For measurements below 1GHz, the absorbers are removed. A raised turntable is used for radiated measurement. The turn table is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm tall test table made of Styrodur is placed on top of the turn table. A Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

The equipment under test was transmitting while connected to its integral antenna and is placed on a turntable 3 meters from the receive antenna. The receive antenna height is adjusted between 1 and 4 meter height, the turntable is rotated through 360 degrees, and the EUT is manipulated through all orthogonal planes representative of its typical use to achieve the highest reading on the receive spectrum analyzer. Radiated power levels are also investigated with the receive antenna horizontally and vertically polarized. The maximized power level is recorded using the spectrum analyzer "Channel Power" function with the integration band set to the emissions' occupied bandwidth, a RMS detector, RBW = 100kHz, VBW = 300kHz, and a 1 second sweep time over a minimum of 10 sweeps, per the guidelines of KDB 971168 D01 v03r01.

Per the guidance of ANSI/TIA-603-E-2016, a half-wave dipole is then substituted in place of the EUT. For emissions above 1GHz, a horn antenna is substituted in place of the EUT. The substitute antenna is driven by a signal generator with the level of the signal generator being adjusted to obtain the same receive spectrum analyzer level previously recorded from the spurious emission from the EUT. The power of the emission is calculated using the following formula:

$$P_{d\ [dBm]} = P_{g\ [dBm]} - \text{cable loss}_{\ [dB]} + \text{antenna gain}_{\ [dBd/dBi]}$$

Where, P_d is the dipole equivalent power, P_g is the generator output into the substitution antenna, and the antenna gain is the gain of the substitute antenna used relative to either a half-wave dipole (dBd) or an isotropic source (dBi). The substitute level is equal to $P_{g\ [dBm]}$ – cable loss $_{[dB]}$.

The calculated P_d levels are then compared to the absolute spurious emission limit of -13dBm which is equivalent to the required minimum attenuation of 43 + 10 $\log_{10}$(Power $_{[Watts]}$).

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 474788 D01.

4.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4-2014. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
Conducted Bench Top Measurements	1.13
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

5.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	N9020A	MXA Signal Analyzer	4/20/2019	Annual	4/20/2020	US46470561
Emco	3115	Horn Antenna (1-18GHz)	3/28/2018	Biennial	3/28/2020	9704-5182
EMCO	3160-09	Small Horn (18 - 26.5GHz)	8/9/2018	Biennial	8/9/2020	135427
ETS Lindgren	3117	1-18 GHz DRG Horn (Medium)	2/14/2019	Biennial	2/14/2021	125518
ETS Lindgren	3164-08	Quad Ridge Horn Antenna	2/22/2019	Biennial	2/22/2021	128338
ETS-Lindgren	3115	Double Ridged Guide Horn 750MHz - 18GHz	3/28/2018	Biennial	3/28/2020	150693
Rohde & Schwarz	TS-PR26	18-26.5 GHz Pre-Amplifier	9/19/2018	Annual	9/19/2019	100040
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	6/18/2018	Annual	6/18/2019	102134
Sunol	DRH-118	Horn Antenna (1-18GHz)	8/11/2017	Biennial	8/11/2019	A050307
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	4/19/2018	Biennial	4/19/2020	A051107

Table 5-1. Test Equipment

Notes:

1. For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

2. Equipment with a calibration date of “N/A” shown in this list was not used to make direct calibrated measurements.

6.0 SAMPLE CALCULATIONS

Emission Designator

QPSK Modulation

Emission Designator = 8M62G7D

LTE BW = 8.62 MHz
G = Phase Modulation
7 = Quantized/Digital Info
D = Data transmission, telemetry, telecommand

QAM Modulation

Emission Designator = 8M45W7D

LTE BW = 8.45 MHz
W = Amplitude/Angle Modulated
7 = Quantized/Digital Info
D = Data transmission, telemetry, telecommand

Spurious Radiated Emission – LTE Band

Example: Middle Channel LTE Mode 2nd Harmonic (1564 MHz)

The average spectrum analyzer reading at 3 meters with the EUT on the turntable was –81.0 dBm. The gain of the substituted antenna is 8.1 dBi. The signal generator connected to the substituted antenna terminals is adjusted to produce a reading of –81.0 dBm on the spectrum analzyer. The loss of the cable between the signal generator and the terminals of the substituted antenna is 2.0 dB at 1564 MHz. So 6.1 dB is added to the signal generator reading of –30.9 dBm yielding –24.80 dBm. The fundamental EIRP was 25.501 dBm so this harmonic was 25.501 dBm – (-24.80).

7.0 TEST RESULTS

7.1 Summary

Company Name: Tecore Networks

FCC ID: QLJ4GNBIOT-086

FCC Classification: Licensed Non-Broadcast Station Transmitter (TNB)

Mode(s): LTE

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
2.1046	Transmitter Conducted Output Power	N/A	CONDUCTED	PASS	Section 7.2
2.1049	Occupied Bandwidth	N/A			Section 7.3
2.1051; 27.53	Out of Band Emissions	> 43 + 10 $\log_{10}$ (P[Watts]) at Band Edge and for all out-of-band emissions			Section 7.4, 7.5
27.54	Frequency Stability	Emission must remain in band (Part 27)			Section 7.7
1053	Undesirable Emissions	> 43 + 10 $\log_{10}$ (P[Watts]) for all out-of-band emissions	RADIATED	PASS	Section 7.6
27.50	Radiated Power	1000W at 305m		At Licensing	N/A

Table 7-1. Summary of Radiated Test Results

Notes:

1) All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2) The analyzer plots (Sections 7.2, 7.4, 7.5) were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables, directional couplers, and attenuators used as part of the system to maintain a link between the call box and the EUT at all frequencies of interest.
3) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables, attenuators, and couplers.
4) For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "LTE Automation," Version 4.8.
5) For the Radiated Emissions test, the EUT was tested for case radiated spurious emissions with both antenna ports terminated in 50ohms while the EUT was set to transmit from either both antenna ports (2 x 8W) or one antenna port (1 x 16W) at maximum power.

7.2 Conducted Power

§2.1046

Test Overview

The EUT was set to transmit in all four available modulations of LTE mode at 43.01 dBm or as applicable for the channe through a management server. An output power level of 43.01dBm was used to ensure that the amplifier would operate in its linear region. The output terminal of the EUT was connected through a calibrated cable and 30dB of external attenuation to a signal analyzer. The signal analyzers' "Channel Power" function was used to measure the conducted output powers in accordance to the guidance of KDB 971168 D01 v03r01.

Test Procedures Used

KDB 971168 D01 v03r01 – Section 5.2.1

ANSI C63.26-2015 Section 6.4.3.1

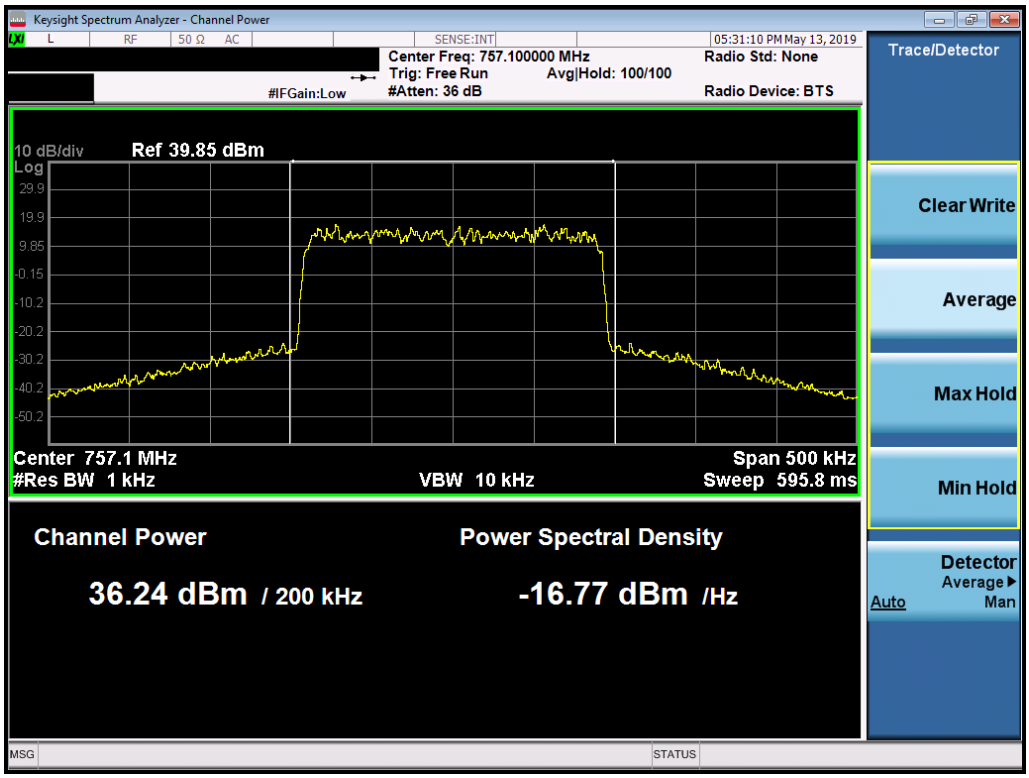
Test Settings

1. Power measurements are performed using the signal analyzer's "channel power" measurement capability for signals with continuous operation.
2. Span = 2 - 3 times the OBW
3. RBW = 1 – 5% of the expected OBW
4. VBW ≥ 3 x RBW
5. No. of sweep points ≥ 2 x span / RBW
6. Sweep time = auto-couple
7. Detector = RMS
8. Trigger is set to "free run" for signals with continuous operation.
9. The integration bandwidth was roughly set equal to the measured OBW of the signal for signals with continuous operation.
10. Trace mode = trace averaging (RMS) over 100 sweeps
11. The trace was allowed to stabilize

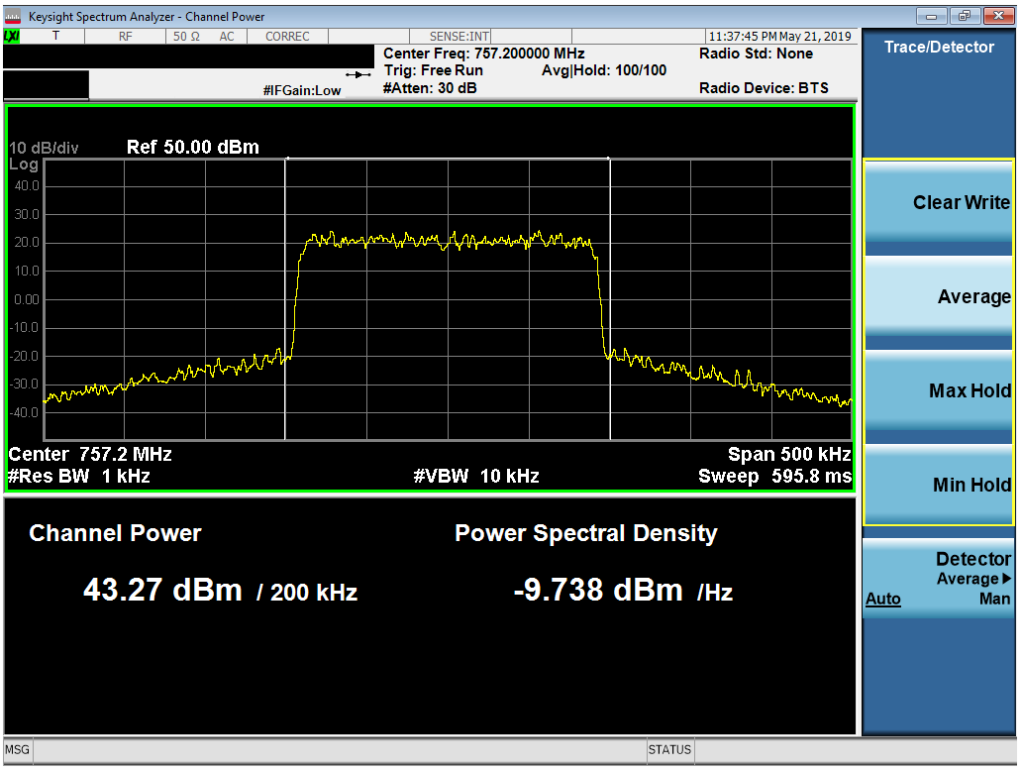
Antenna 1 Conducted Power Measurements

Frequency [MHz]	Channel Bandwidth [kHz]	Mod.	ANT 1 Conducted Power [dBm]	ANT 2 Conducted Power [dBm]	Total Conducted Power [dBm]	Total Conducted Power [Watts]	Test Mode
757.10	200	QPSK	36.24		36.24	4.21	Ant 1 SISO [1 x 16]
757.20	200	QPSK	43.27		43.27	21.23	Ant 1 SISO [1 x 16]
757.50	200	QPSK	42.72		42.72	18.71	Ant 1 SISO [1 x 16]
757.80	200	QPSK	42.68		42.68	18.54	Ant 1 SISO [1 x 16]
757.90	200	QPSK	35.83		35.83	3.83	Ant 1 SISO [1 x 16]

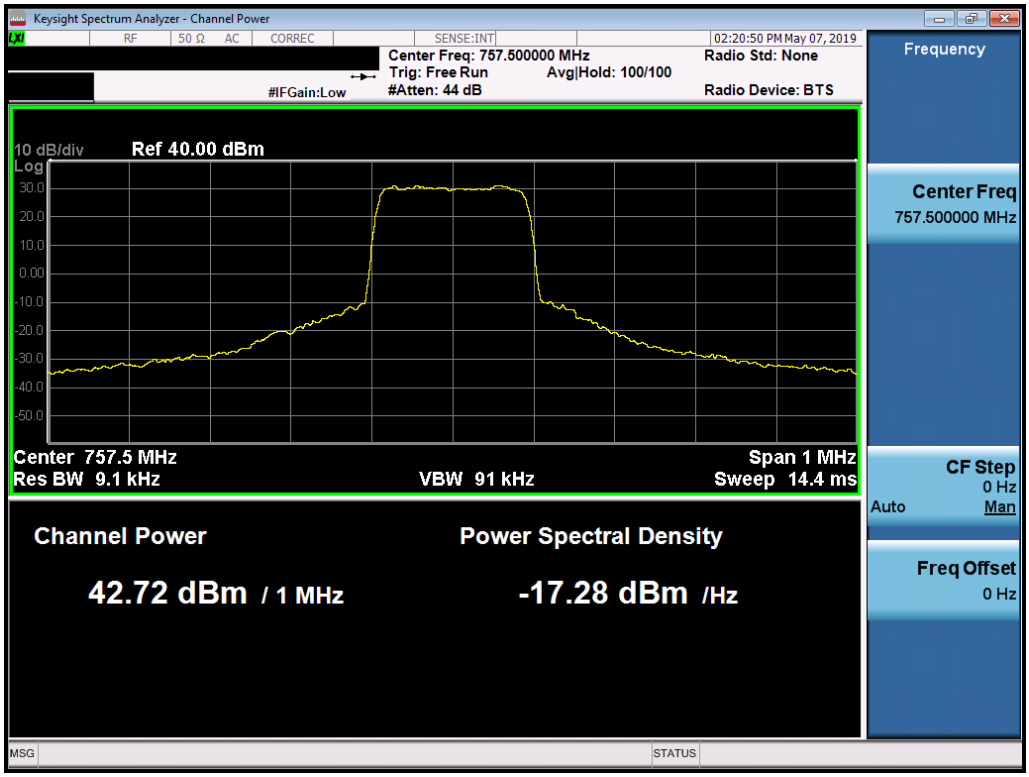
Table 7-2. Maximum Average Conducted Power ANT 1



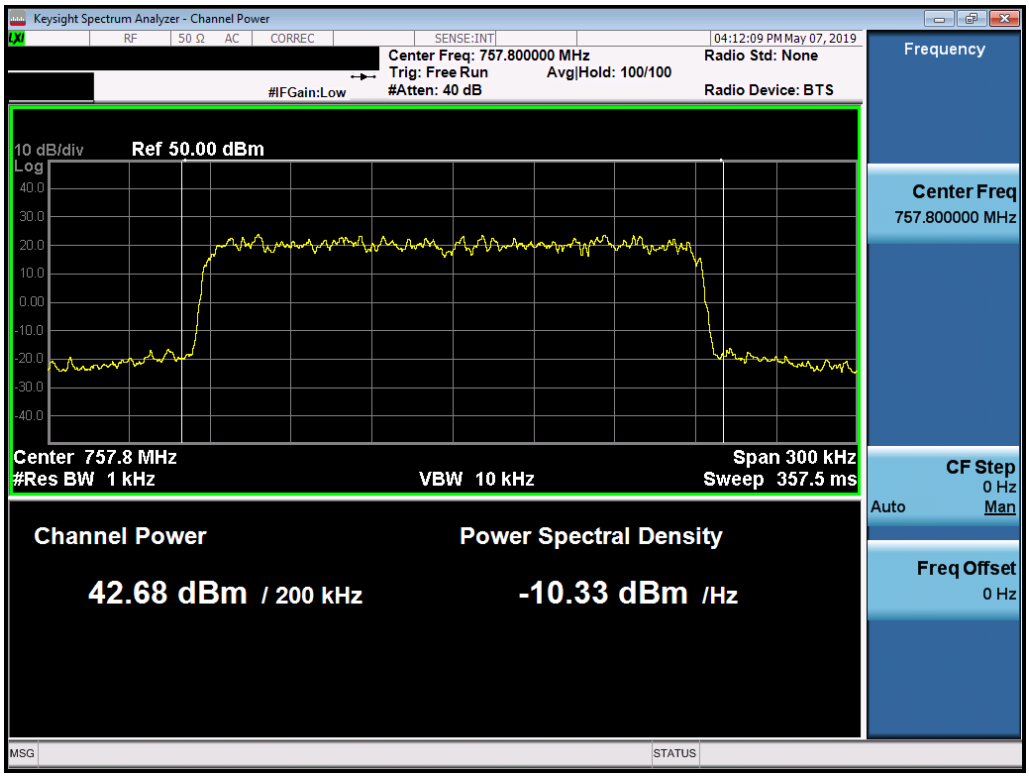
Plot 7-1. Max Conducted Power Plot (757.1 - 200 kHz - QPSK - ANT1 SISO)



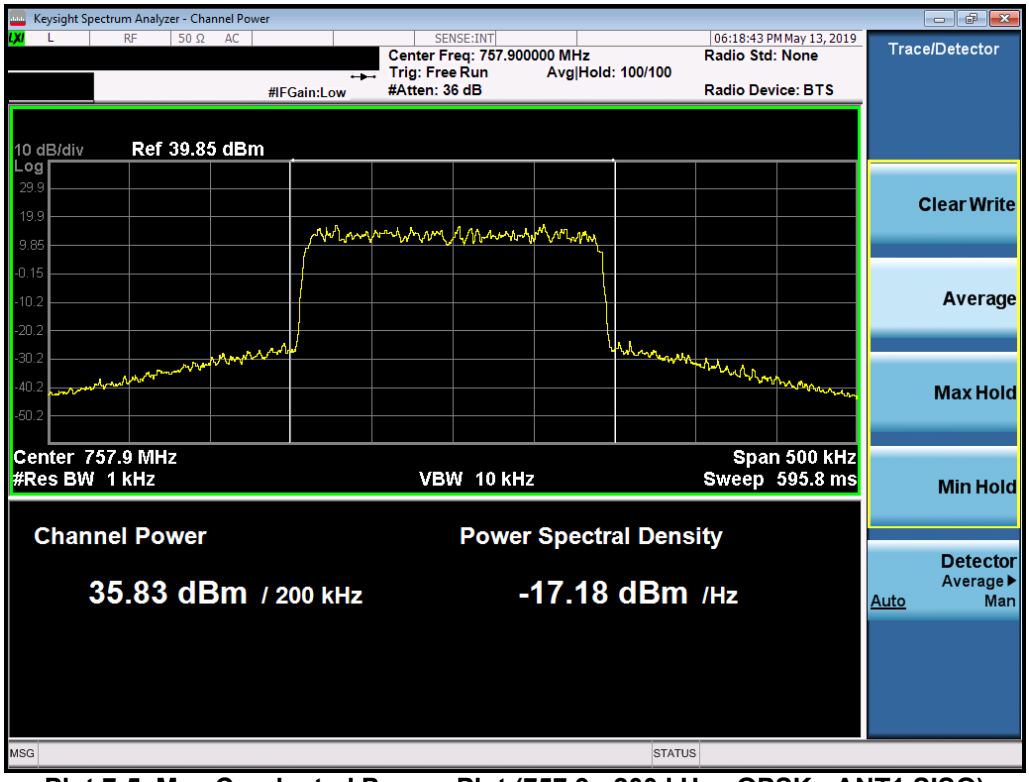
Plot 7-2. Max Conducted Power Plot (757.2 - 200 kHz - QPSK - ANT1 SISO)



Plot 7-3. Max Conducted Power Plot (757.5 - 200 kHz - QPSK - ANT1 SISO)



Plot 7-4. Max Conducted Power Plot (757.8 - 200 kHz - QPSK - ANT1 SISO)

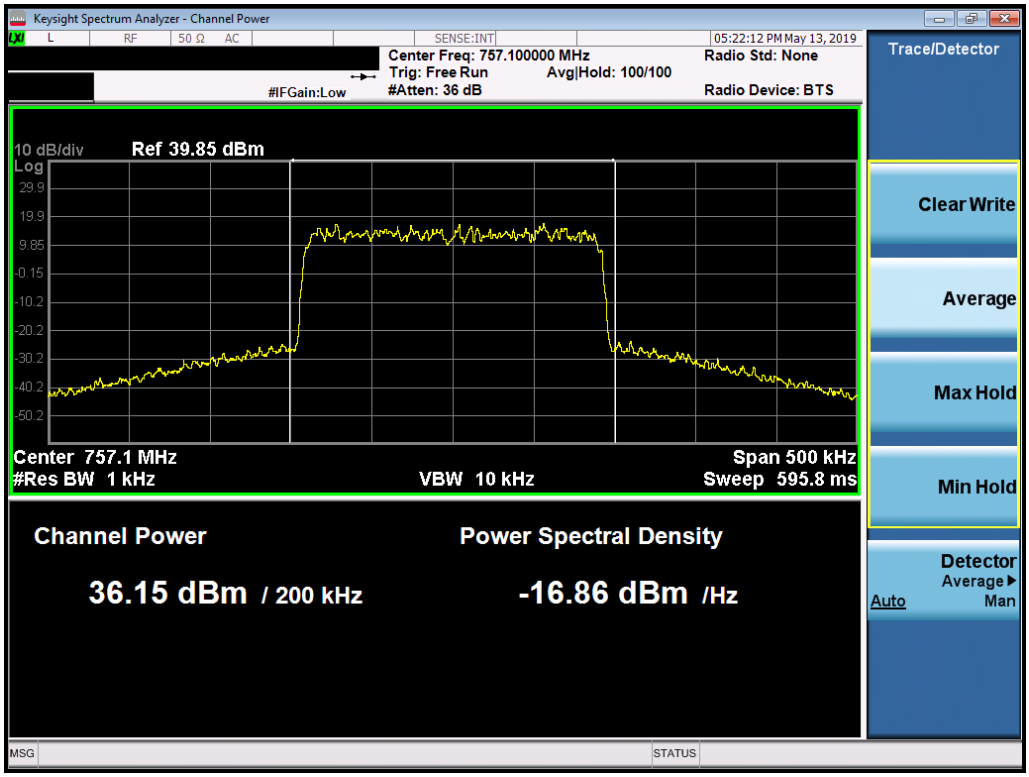


Plot 7-5. Max Conducted Power Plot (757.9 - 200 kHz - QPSK - ANT1 SISO)

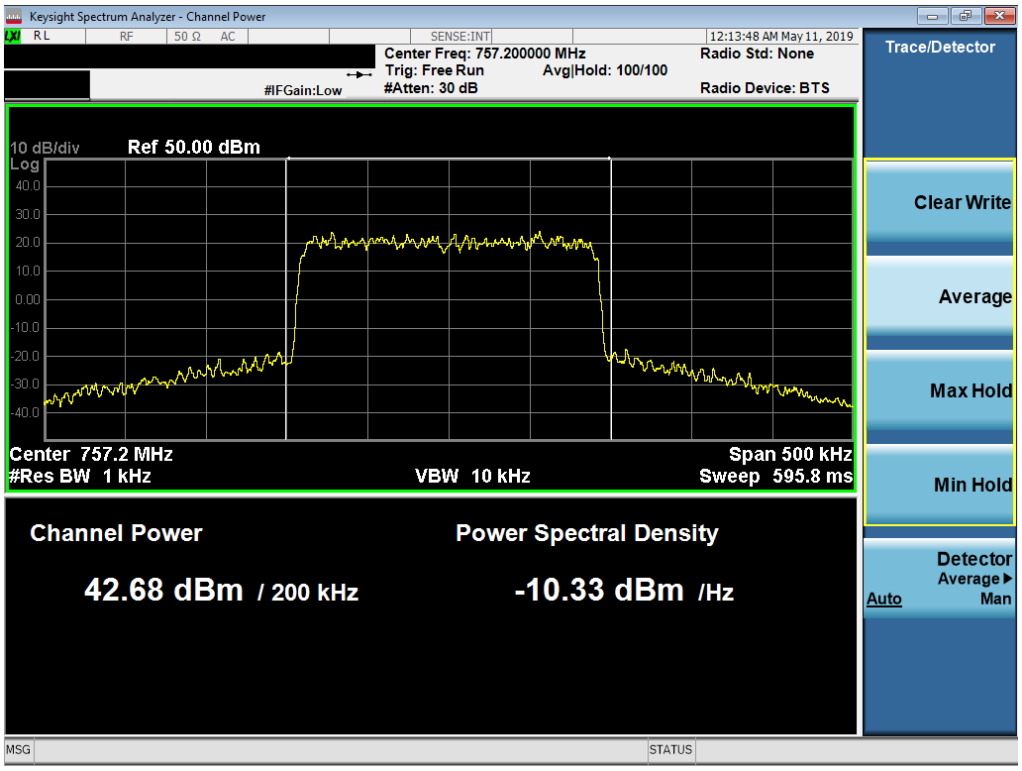
Antenna 2 Conducted Power Measurements

Frequency [MHz]	Channel Bandwidth [kHz]	Mod.	ANT 1 Conducted Power [dBm]	ANT 2 Conducted Power [dBm]	Total Conducted Power [dBm]	Total Conducted Power [Watts]	Test Mode
757.10	200	QPSK		36.15	36.15	4.12	Ant 2 SISO [1 x 16]
757.20	200	QPSK		42.68	42.68	18.54	Ant 2 SISO [1 x 16]
757.50	200	QPSK		42.69	42.69	18.58	Ant 2 SISO [1 x 16]
757.80	200	QPSK		42.66	42.66	18.45	Ant 2 SISO [1 x 16]
757.90	200	QPSK		35.74	35.74	3.75	Ant 2 SISO [1 x 16]

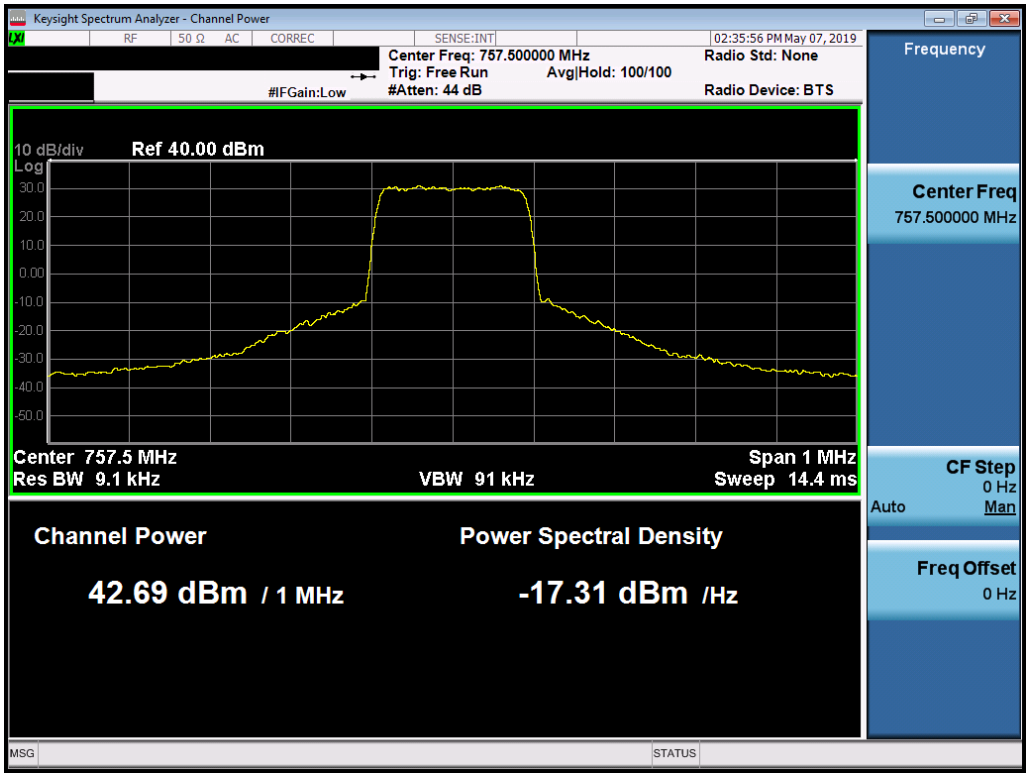
Table 7-3. Maximum Average Conducted Power ANT 2



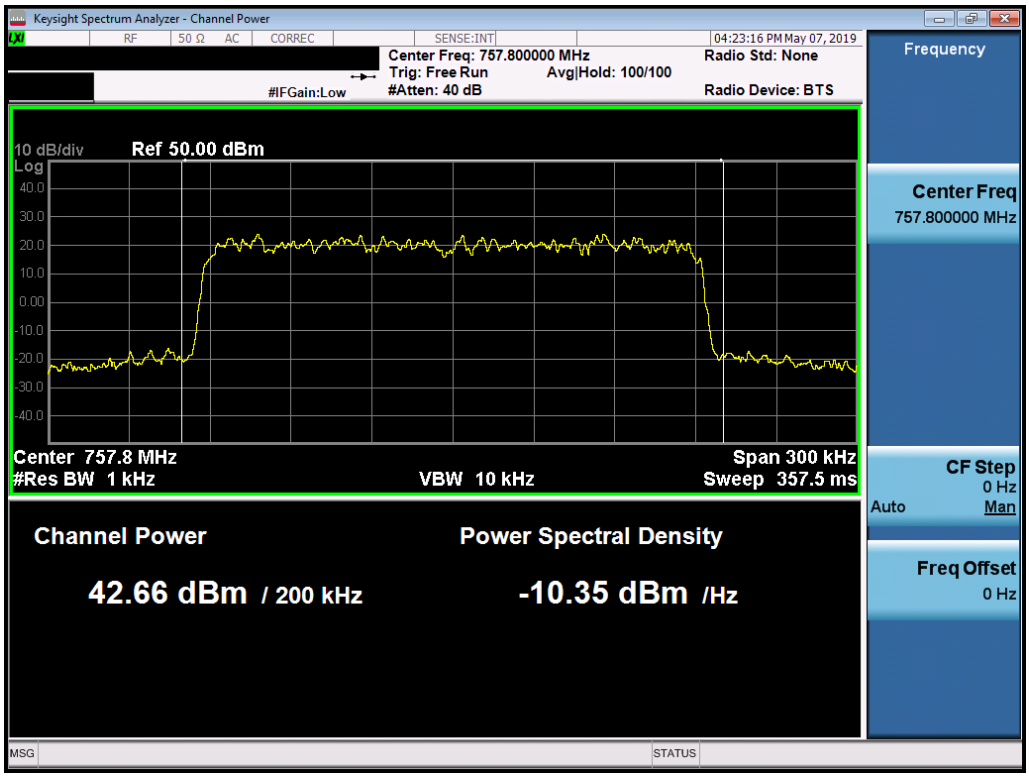
Plot 7-6. Max Conducted Power Plot (757.1 - 200 kHz - QPSK – ANT2 SISO)



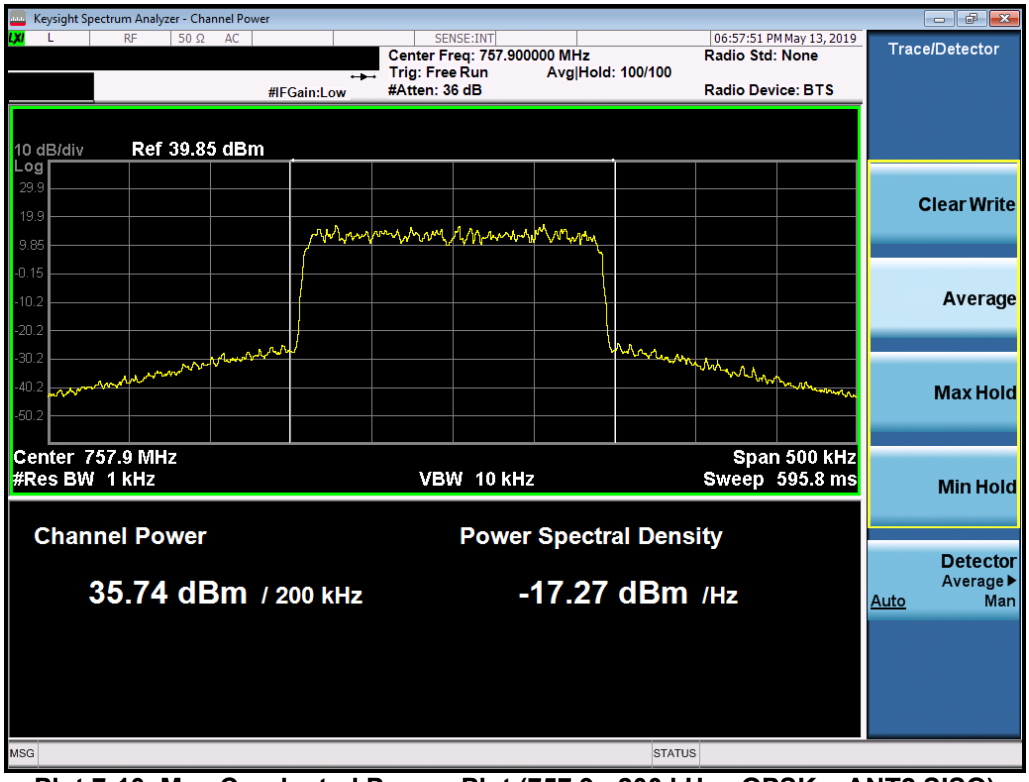
Plot 7-7. Max Conducted Power Plot (757.2 - 200 kHz - QPSK – ANT2 SISO)



Plot 7-8. Max Conducted Power Plot (757.5 - 200 kHz - QPSK – ANT2 SISO)



Plot 7-9. Max Conducted Power Plot (757.8 - 200 kHz - QPSK – ANT2 SISO)

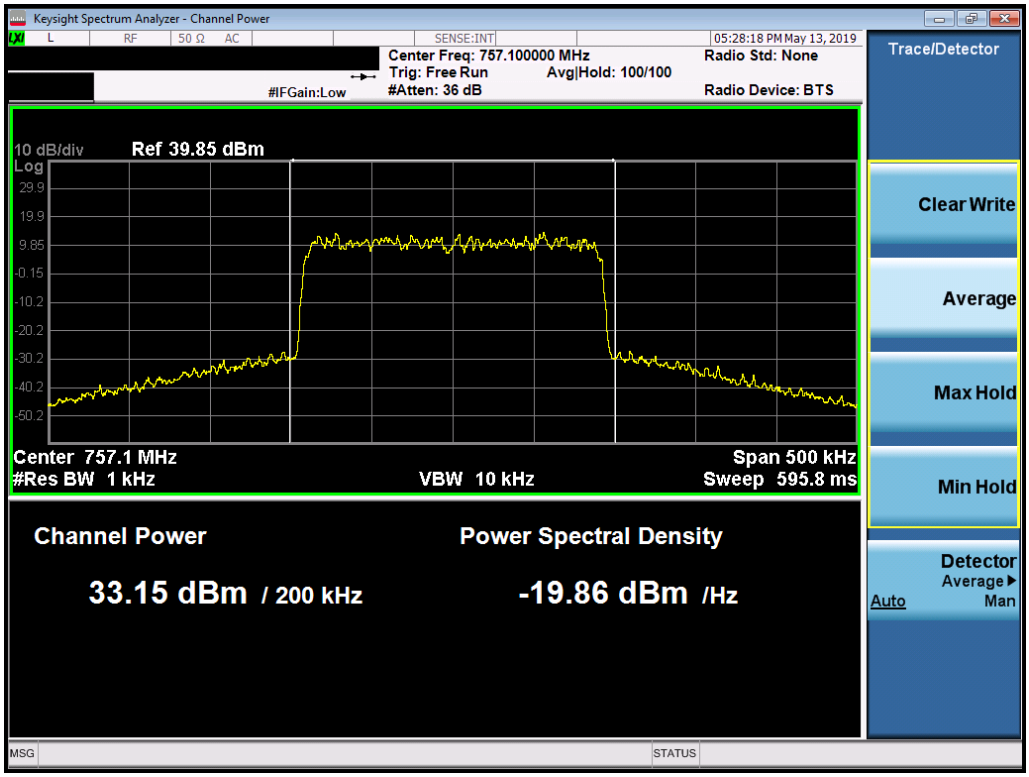


Plot 7-10. Max Conducted Power Plot (757.9 - 200 kHz - QPSK – ANT2 SISO)

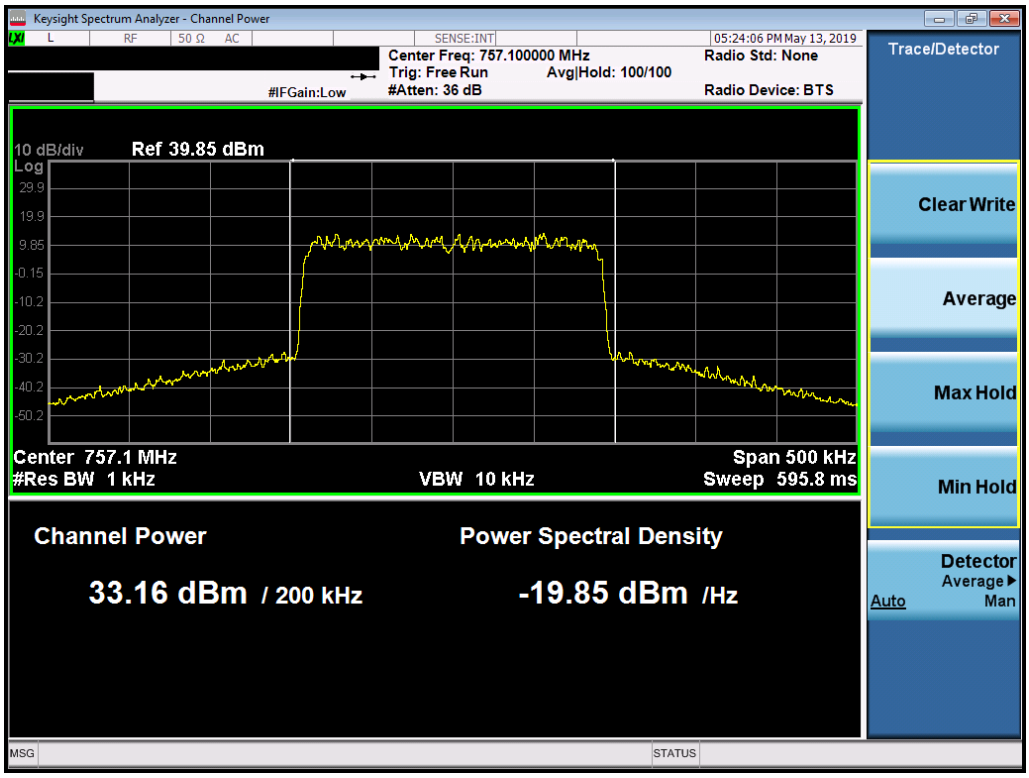
MIMO Conducted Power Measurements

Frequency [MHz]	Channel Bandwidth [kHz]	Mod.	ANT 1 Conducted Power [dBm]	ANT 2 Conducted Power [dBm]	Total Conducted Power [dBm]	Total Conducted Power [Watts]	Test Mode
757.10	200	QPSK	33.40	33.16	36.29	4.26	MIMO [2 x 8]
757.20	200	QPSK	42.67	42.67	45.68	36.99	MIMO [2 x 8]
757.50	200	QPSK	42.66	42.70	45.69	37.07	MIMO [2 x 8]
757.80	200	QPSK	42.66	42.62	45.65	36.73	MIMO [2 x 8]
757.90	200	QPSK	33.07	33.04	36.07	4.04	MIMO [2 x 8]

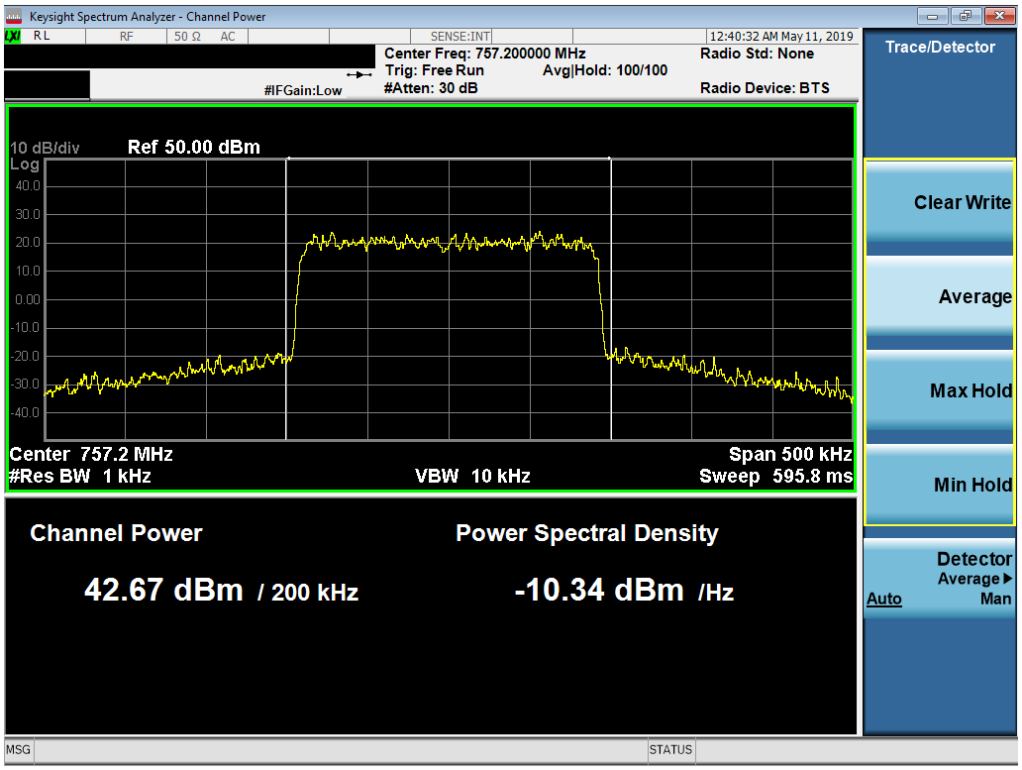
Table 7-4. Maximum Average Conducted Power MIMO



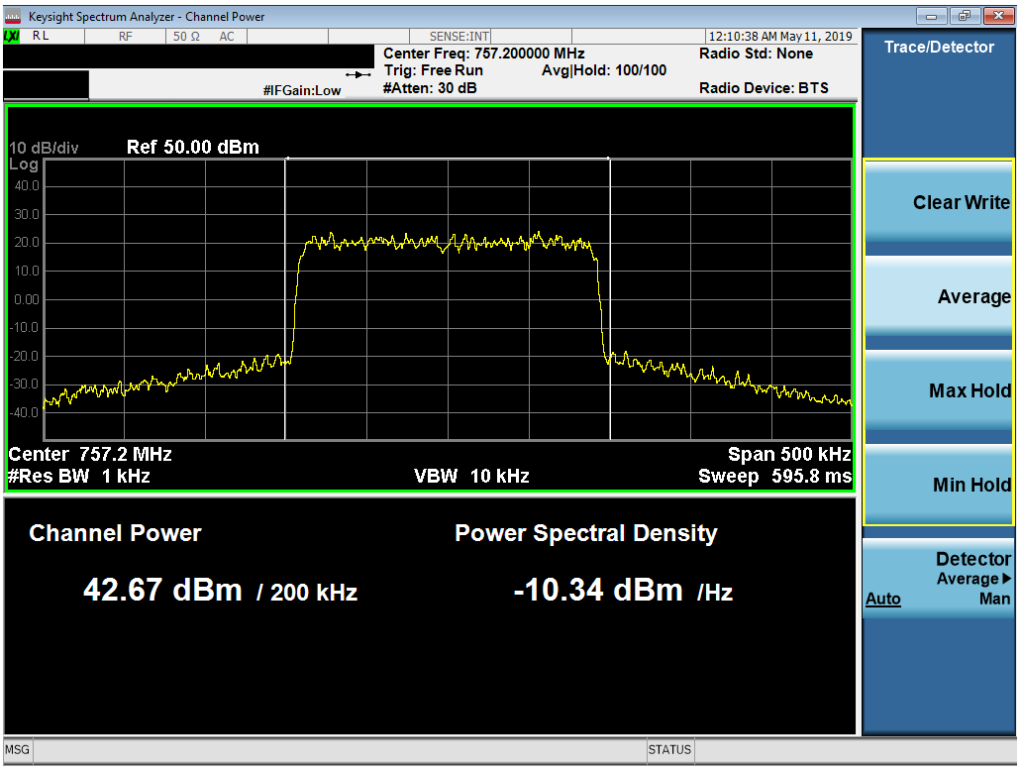
Plot 7-11. Max Conducted Power Plot (757.1 - 200 kHz - QPSK – ANT1 MIMO)



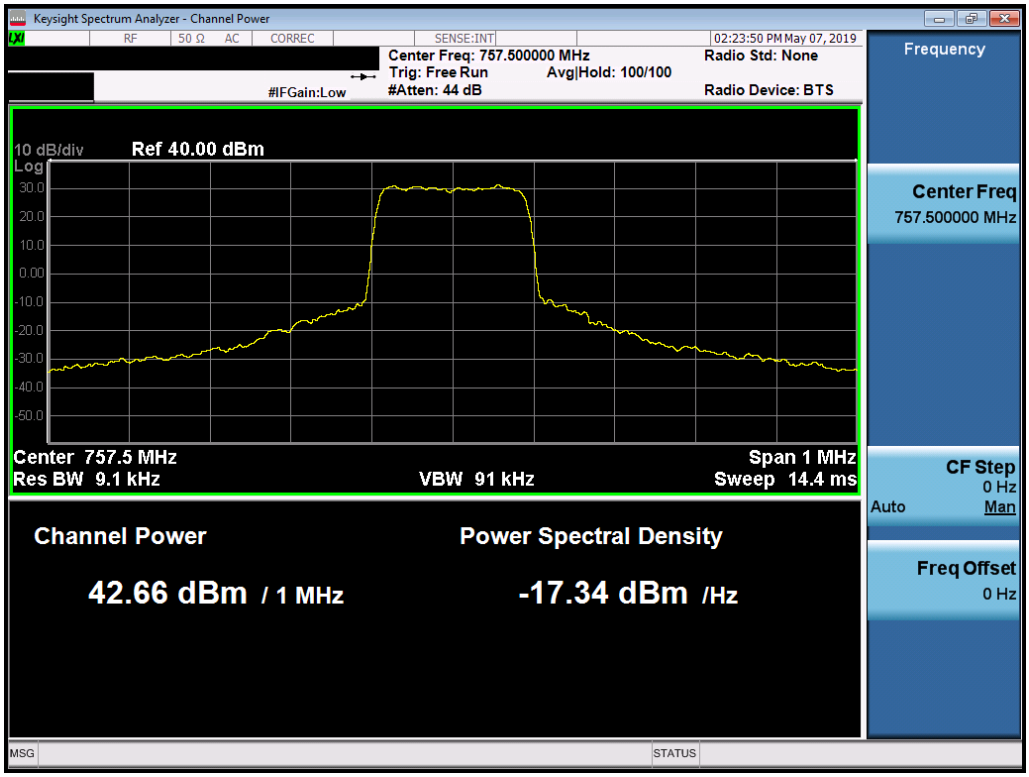
Plot 7-12. Max Conducted Power Plot (757.1 - 200 kHz - QPSK – ANT2 MIMO)



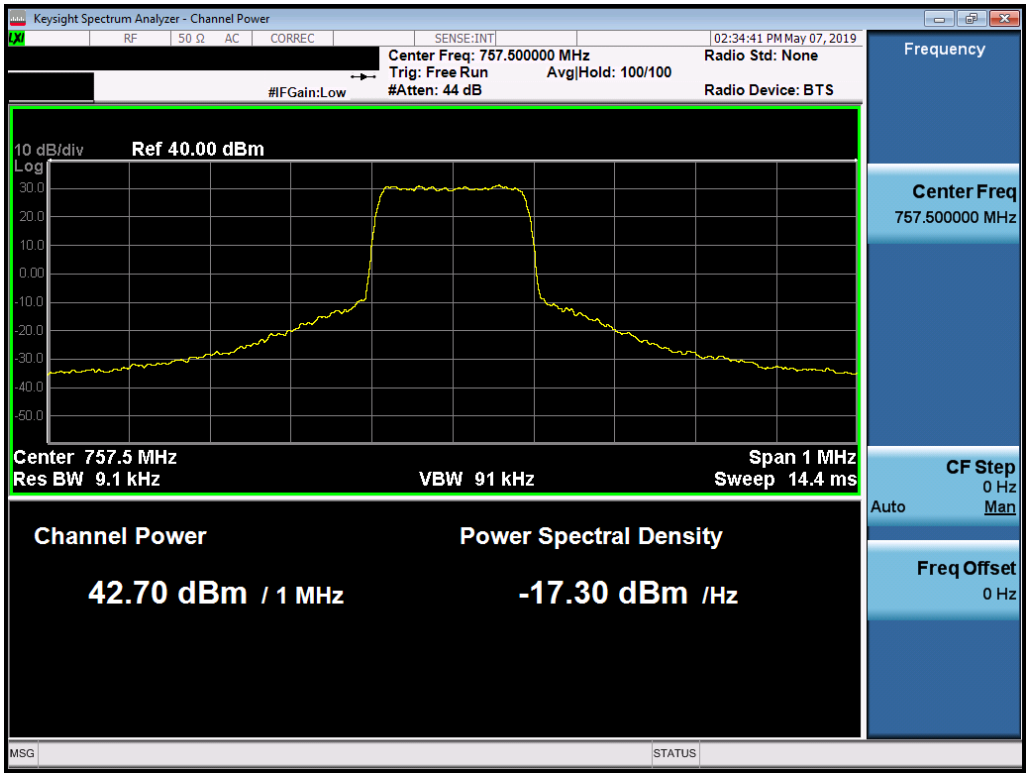
Plot 7-13. Max Conducted Power Plot (757.2 - 200 kHz - QPSK – ANT1 MIMO)



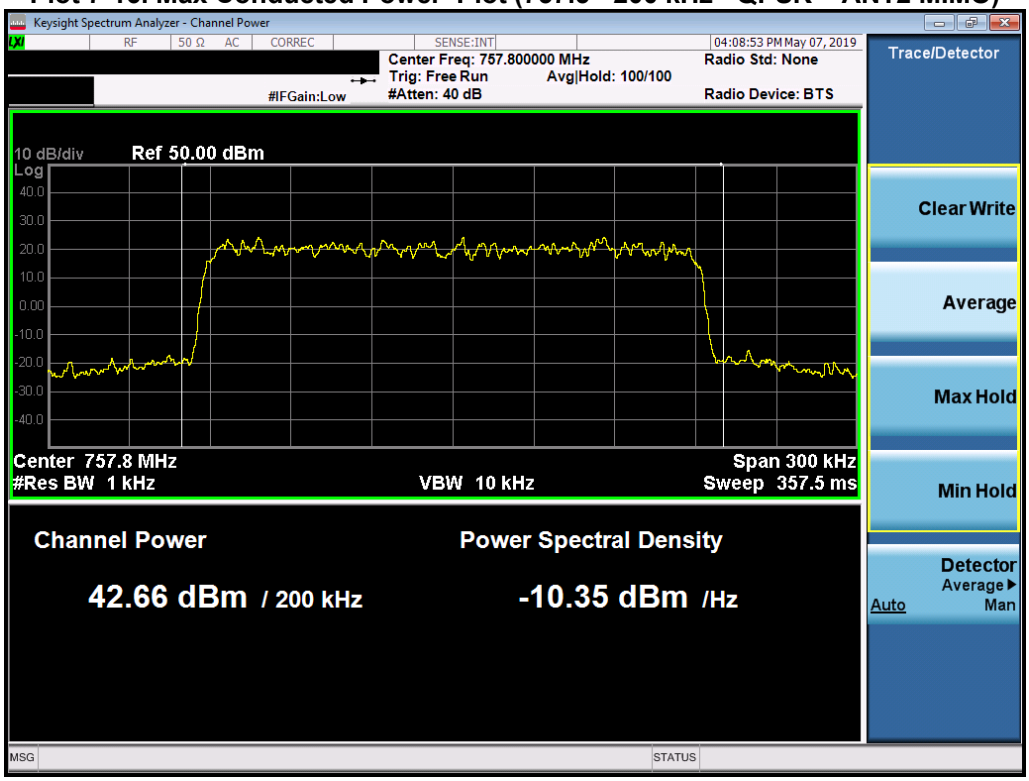
Plot 7-14. Max Conducted Power Plot (757.2 - 200 kHz - QPSK – ANT2 MIMO)



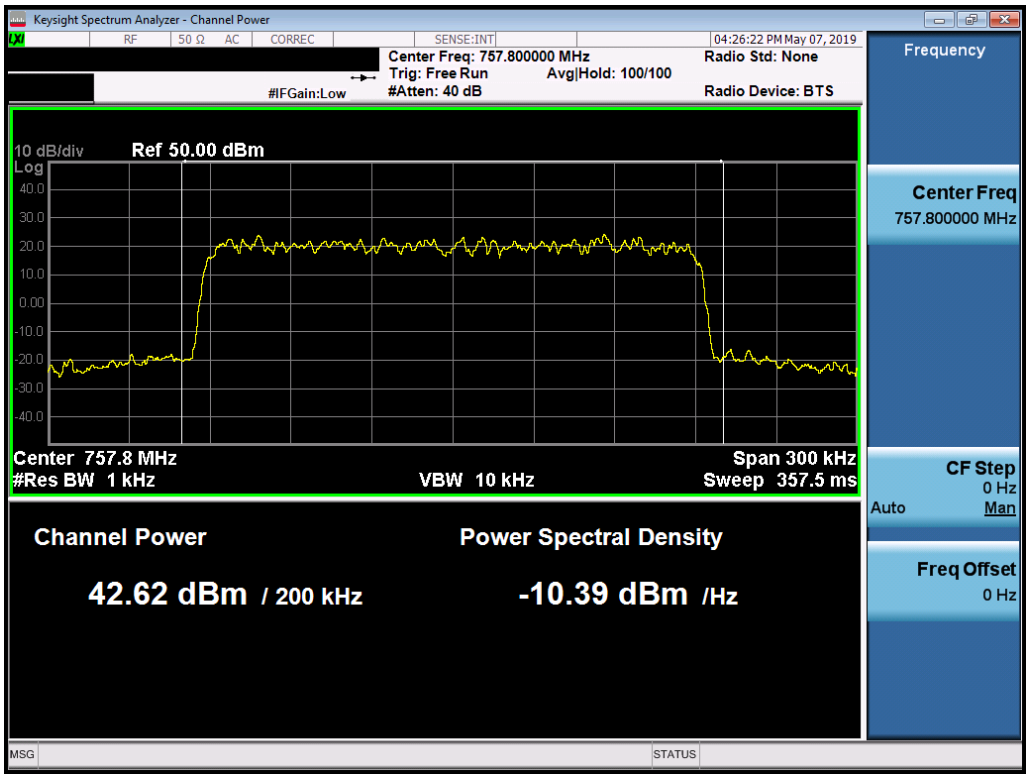
Plot 7-15. Max Conducted Power Plot (757.5 - 200 kHz - QPSK – ANT1 MIMO)



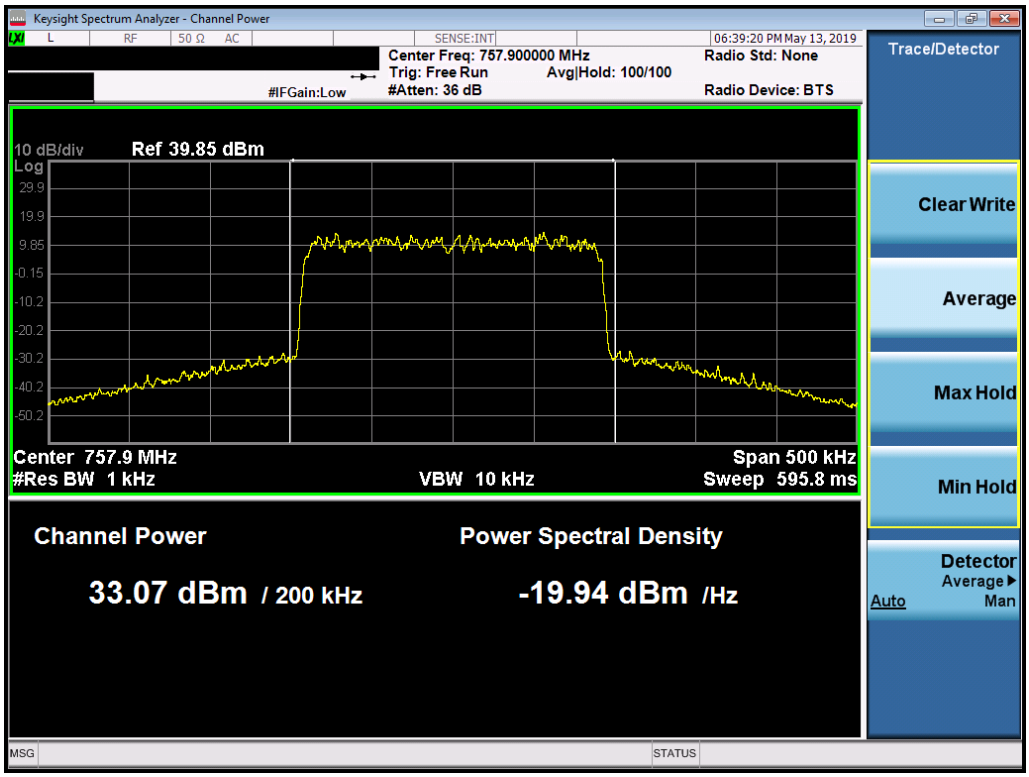
Plot 7-16. Max Conducted Power Plot (757.5 - 200 kHz - QPSK – ANT2 MIMO)



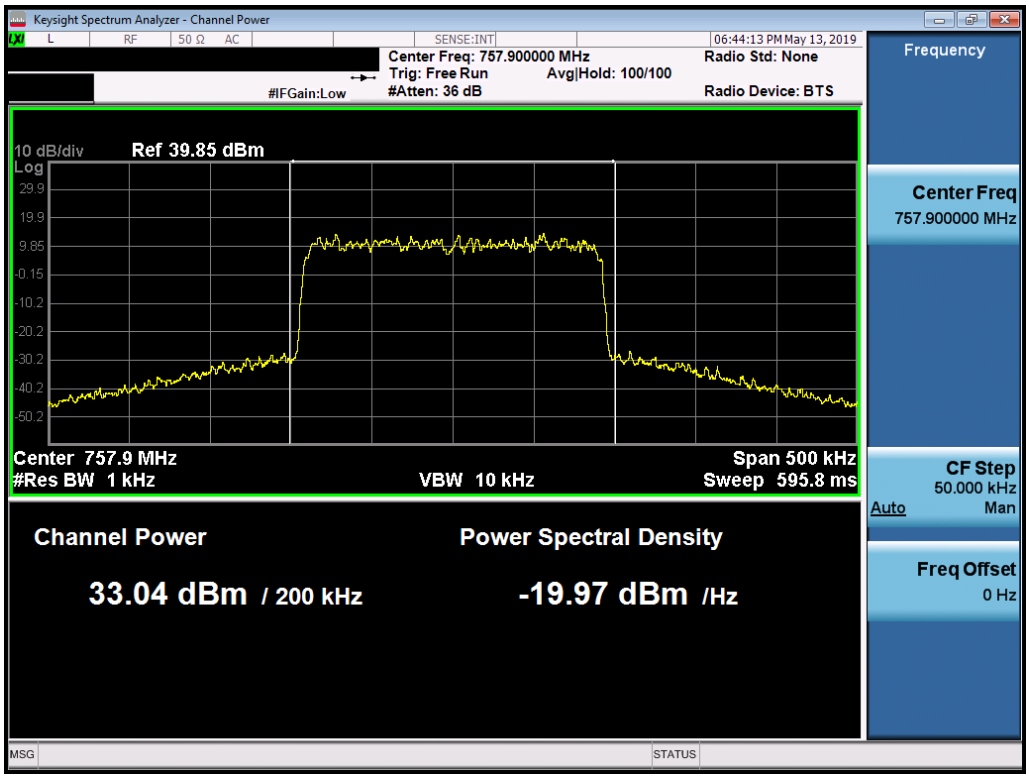
Plot 7-17. Max Conducted Power Plot (757.8 - 200 kHz - QPSK – ANT1 MIMO)



Plot 7-18. Max Conducted Power Plot (757.8 - 200 kHz - QPSK – ANT2 MIMO)



Plot 7-19. Max Conducted Power Plot (757.9 - 200 kHz - QPSK – ANT1 MIMO)



Plot 7-20. Max Conducted Power Plot (757.9 - 200 kHz - QPSK – ANT2 MIMO)

7.3 Occupied Bandwidth

Test Overview

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. All modes of operation were investigated and the worst case configuration results are reported in this section.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 4.2

Test Settings

1. The signal analyzer's automatic bandwidth measurement capability was used to perform the 99% occupied bandwidth and the 26dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 1 – 5% of the expected OBW
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize
8. If necessary, steps 2 – 7 were repeated after changing the RBW such that it would be within 1 – 5% of the 99% occupied bandwidth observed in Step 7

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

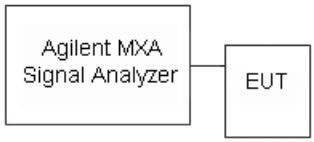


Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None.

Occupied Bandwidth Results

Plot 7-21. Occupied Bandwidth Plot (200kHz QPSK) - ANT1 SISO

Plot 7-22. Occupied Bandwidth Plot (200kHz QPSK) – ANT2 SISO

7.4 Spurious and Harmonic Emissions at Antenna Terminal

Test Overview

The level of the carrier and the various conducted spurious and harmonic frequencies is measured by means of a calibrated spectrum analyzer. The spectrum is scanned from the lowest frequency generated in the equipment up to a frequency including its 10th harmonic. All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.

The minimum permissible attenuation level of any spurious emission is 43 + 10 $log_{10}(P_{[Watts]})$, where P is the transmitter power in Watts.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to at least 10 * the fundamental frequency (separated into at least two plots per channel)
2. Detector = RMS
3. Trace mode = trace average
4. Sweep time = auto couple
5. The trace was allowed to stabilize
6. Please see test notes below for RBW and VBW settings

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

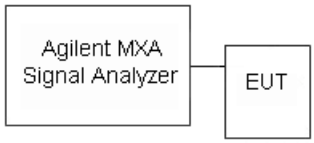


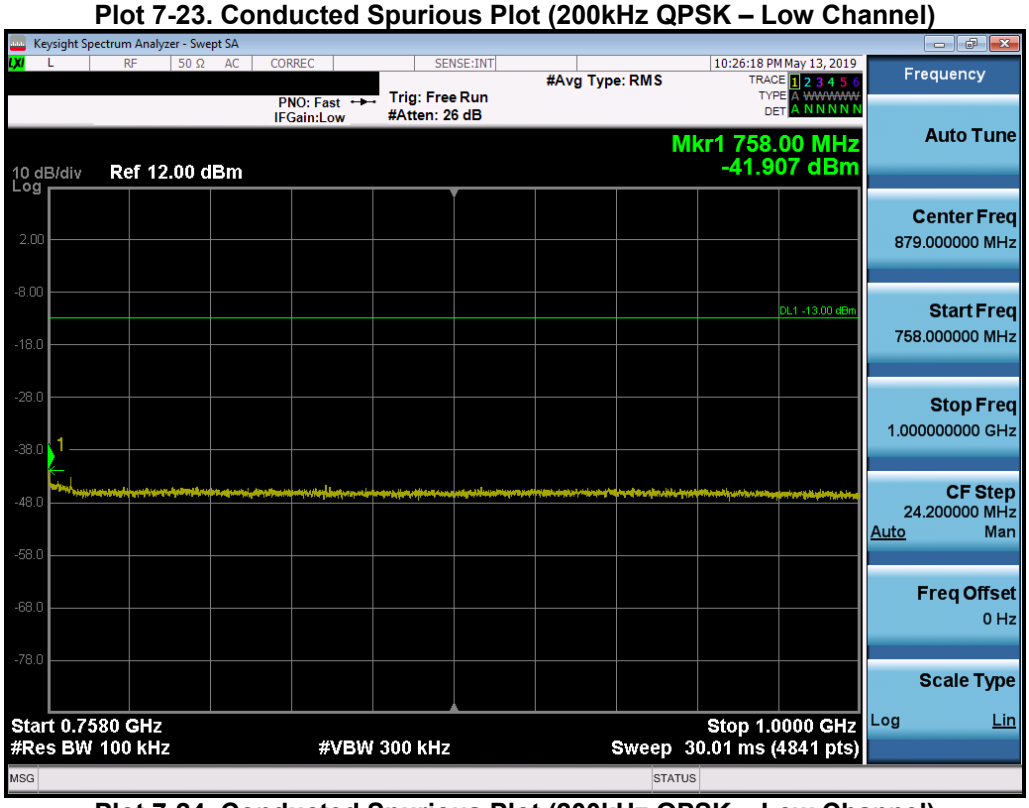
Figure 7-2. Test Instrument & Measurement Setup

Test Notes

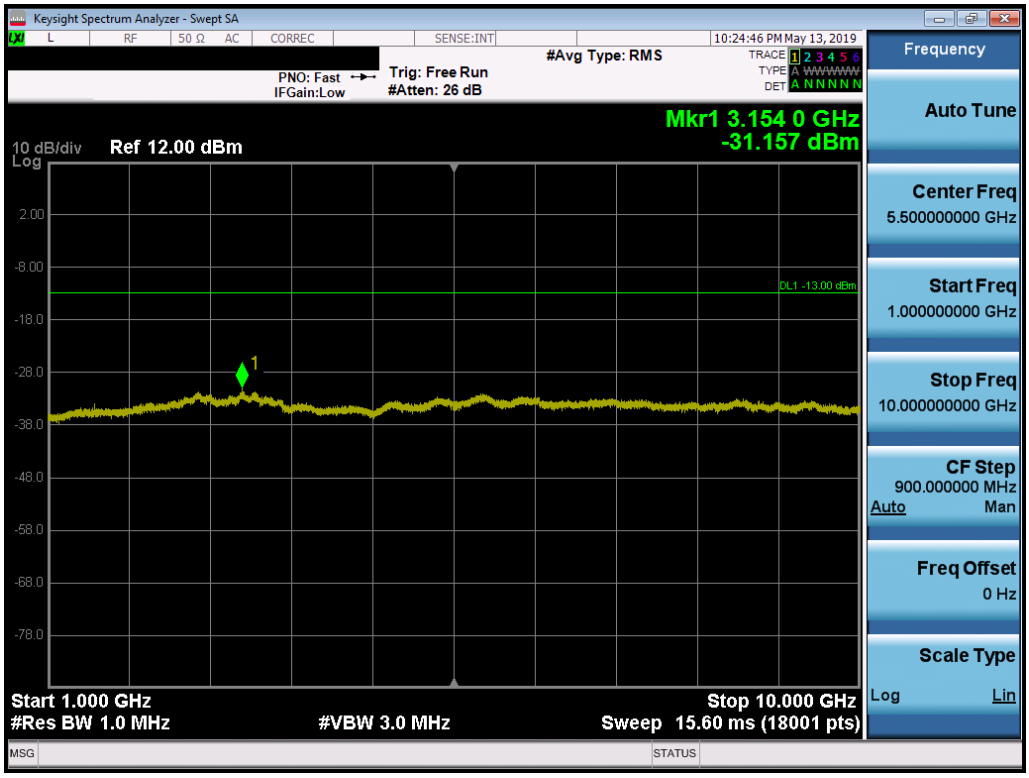
Compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater for frequencies less than 1 GHz. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emission are attenuated at least 26 dB below the transmitter power.

Antenna 1 SISO

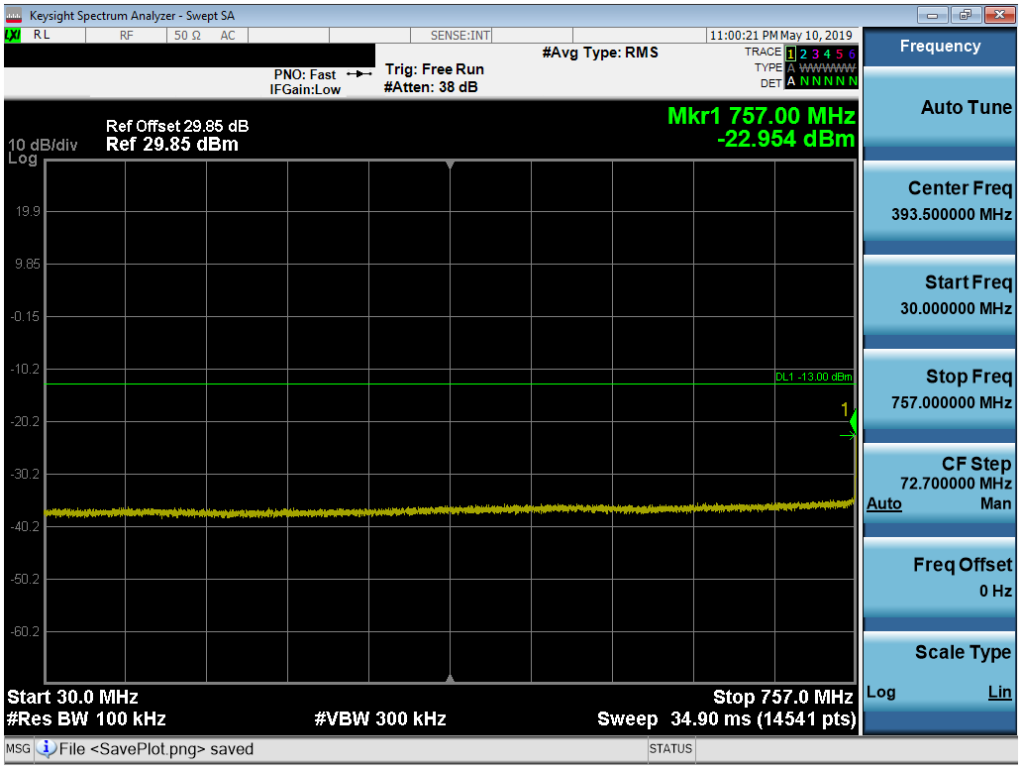
Plot 7-23. Conducted Spurious Plot (200kHz QPSK – Low Channel)



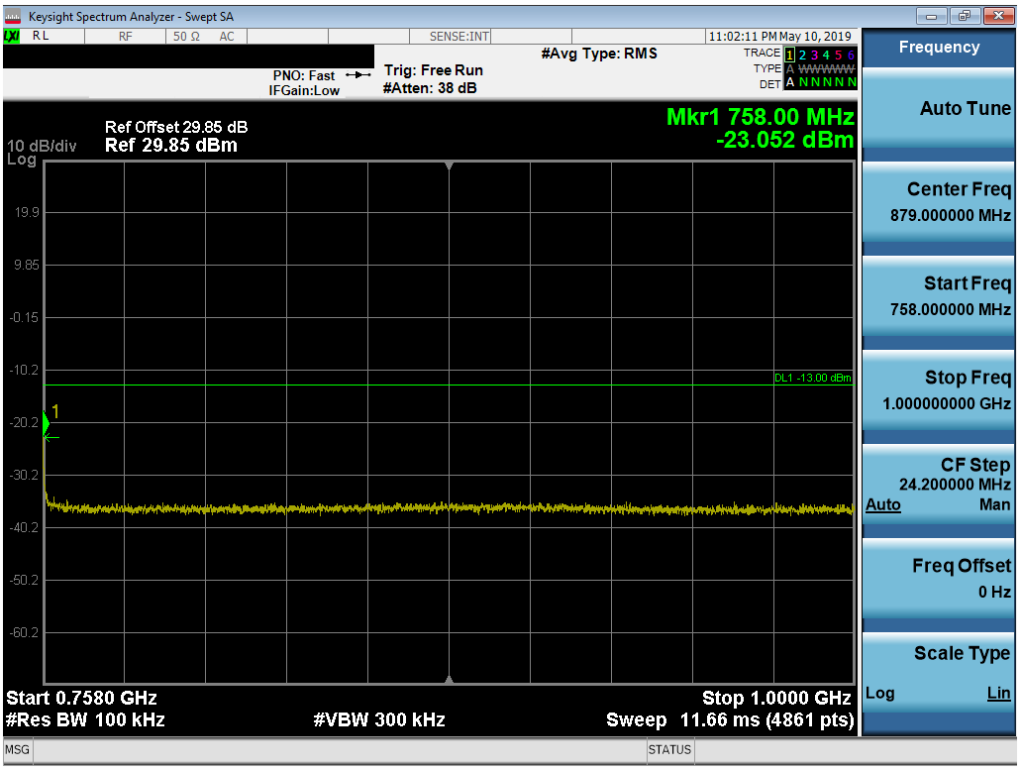
Plot 7-24. Conducted Spurious Plot (200kHz QPSK – Low Channel)



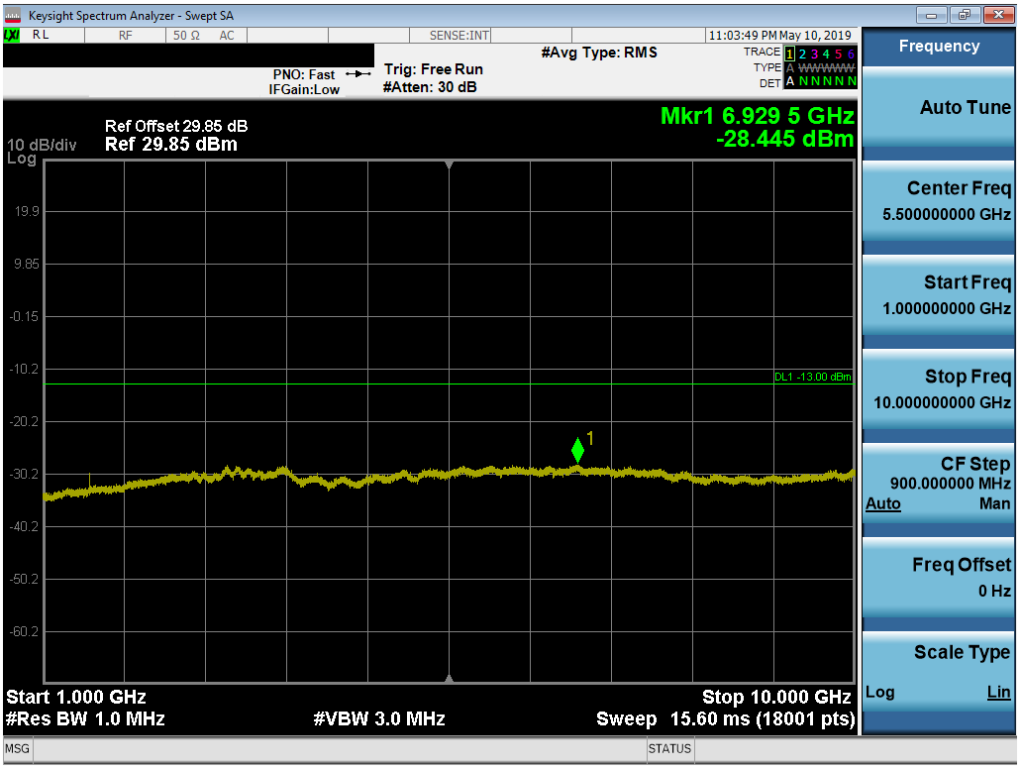
Plot 7-25. Conducted Spurious Plot (200kHz QPSK – Low Channel)



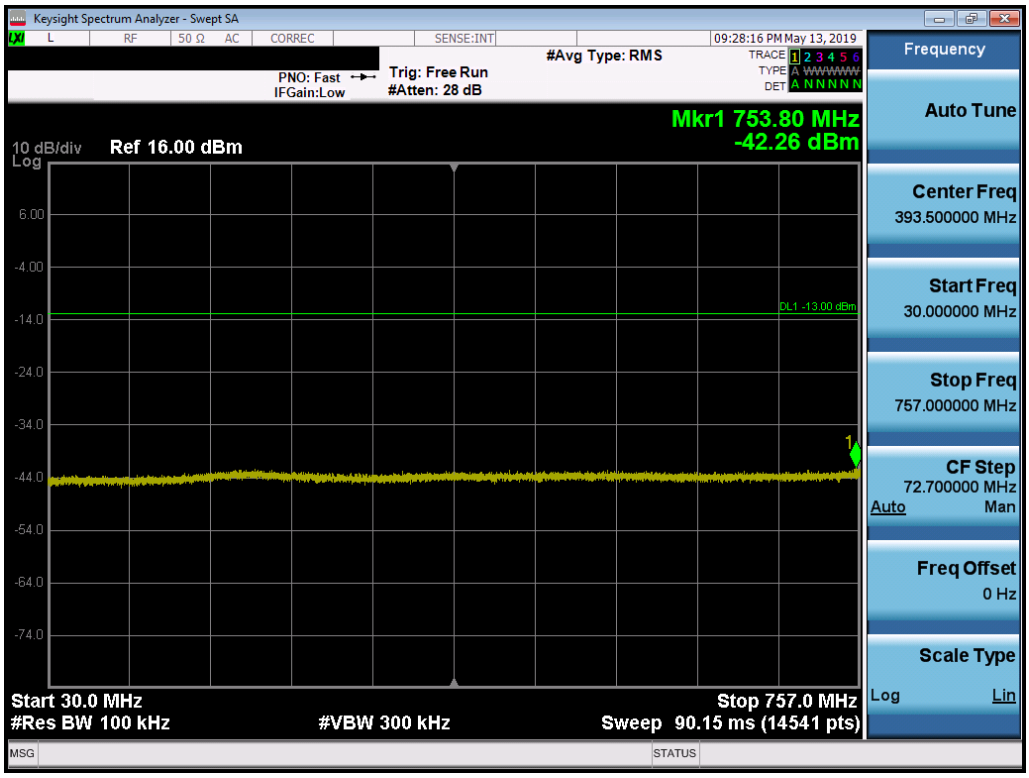
Plot 7-26. Conducted Spurious Plot (200kHz QPSK – Mid Channel)



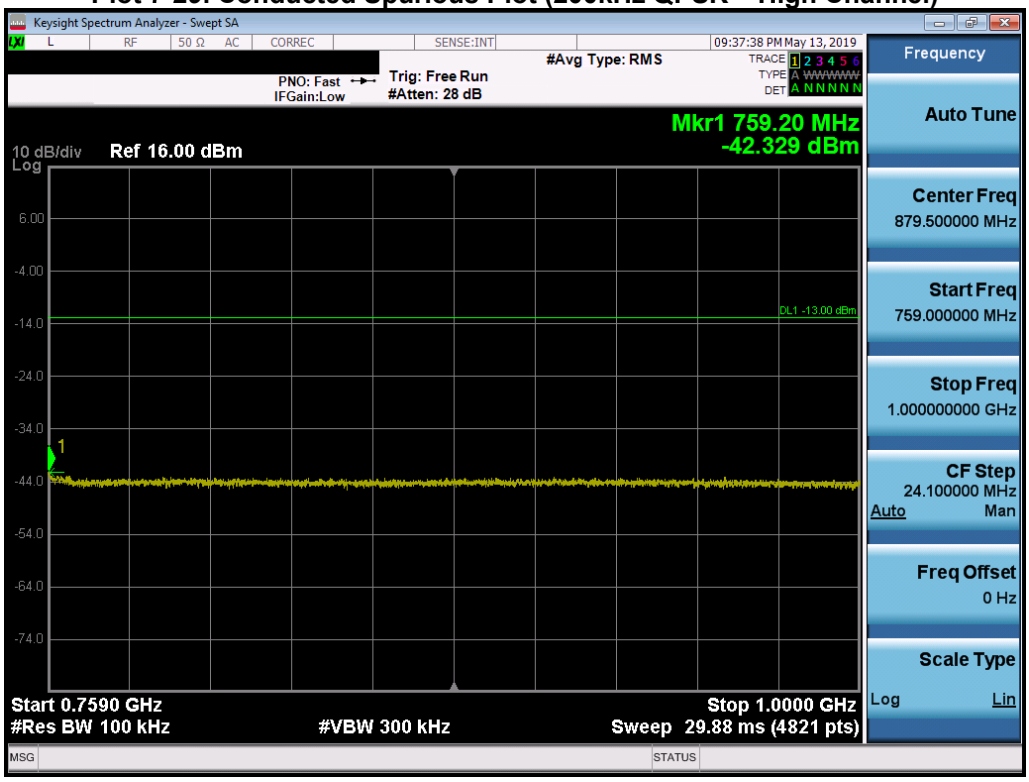
Plot 7-27. Conducted Spurious Plot (200kHz QPSK – Mid Channel)



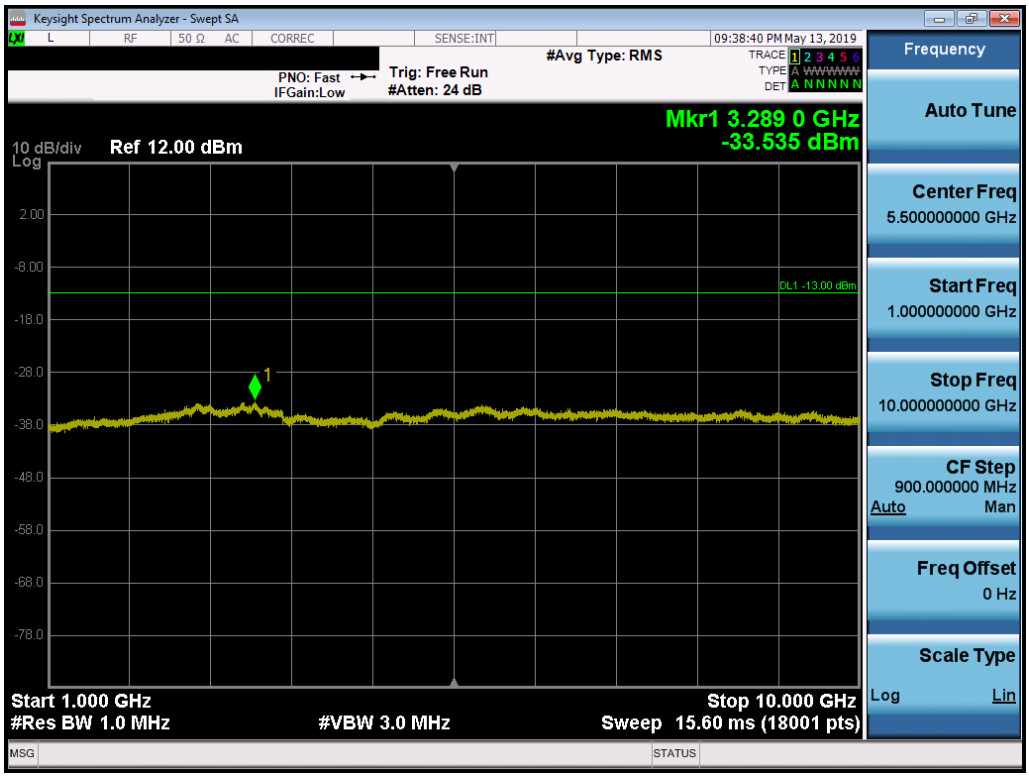
Plot 7-28. Conducted Spurious Plot (200kHz QPSK – Mid Channel)



Plot 7-29. Conducted Spurious Plot (200kHz QPSK – High Channel)

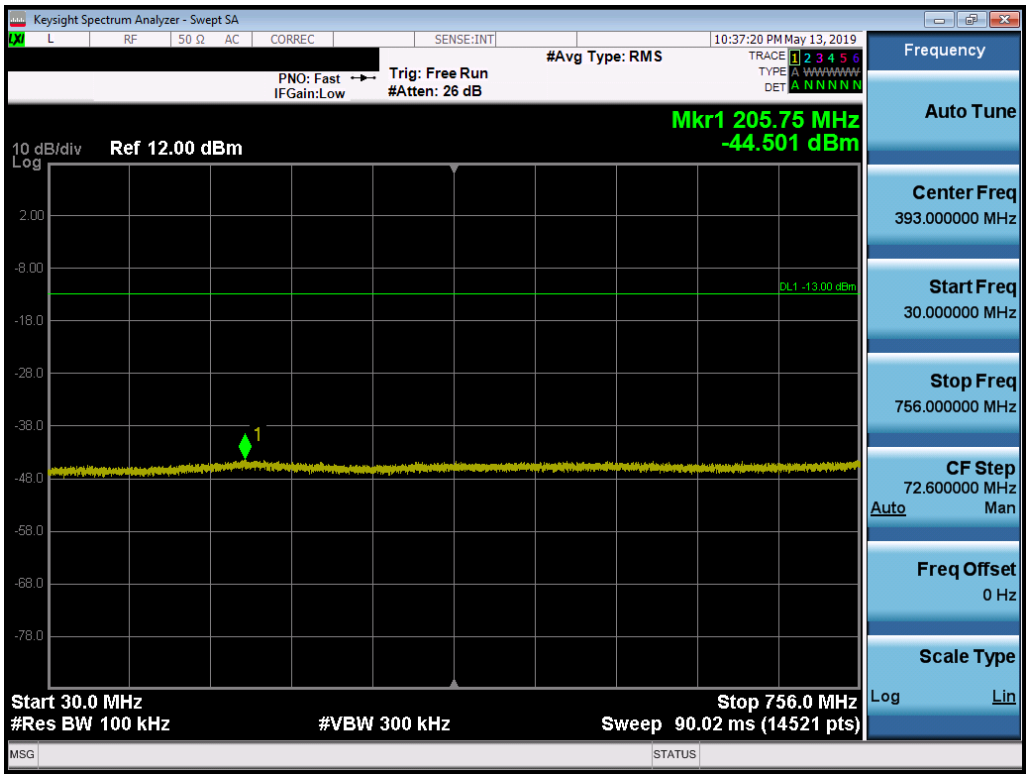


Plot 7-30. Conducted Spurious Plot (200kHz QPSK – High Channel)

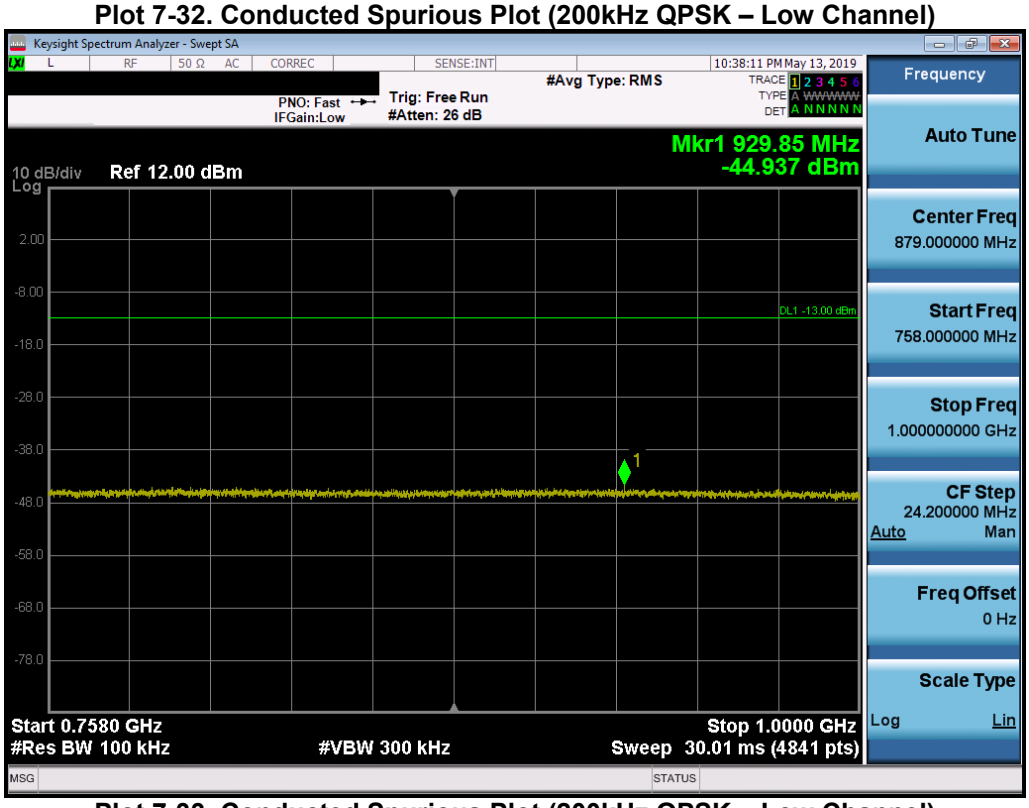


Plot 7-31. Conducted Spurious Plot (200kHz QPSK – High Channel)

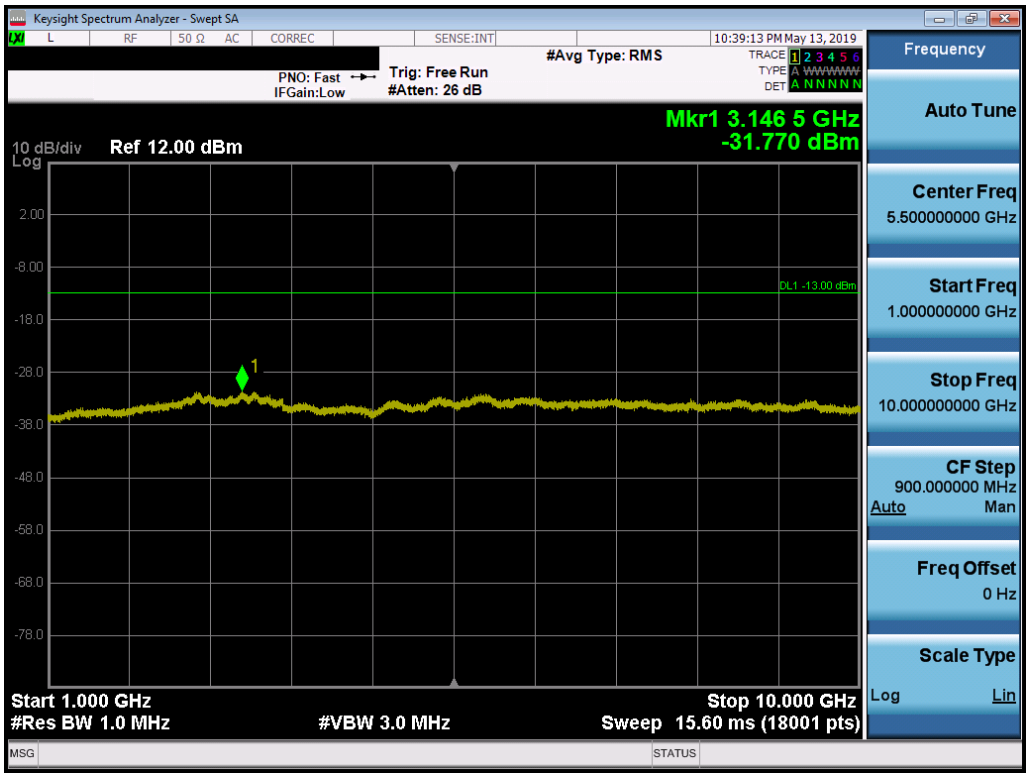
Antenna 2 SISO



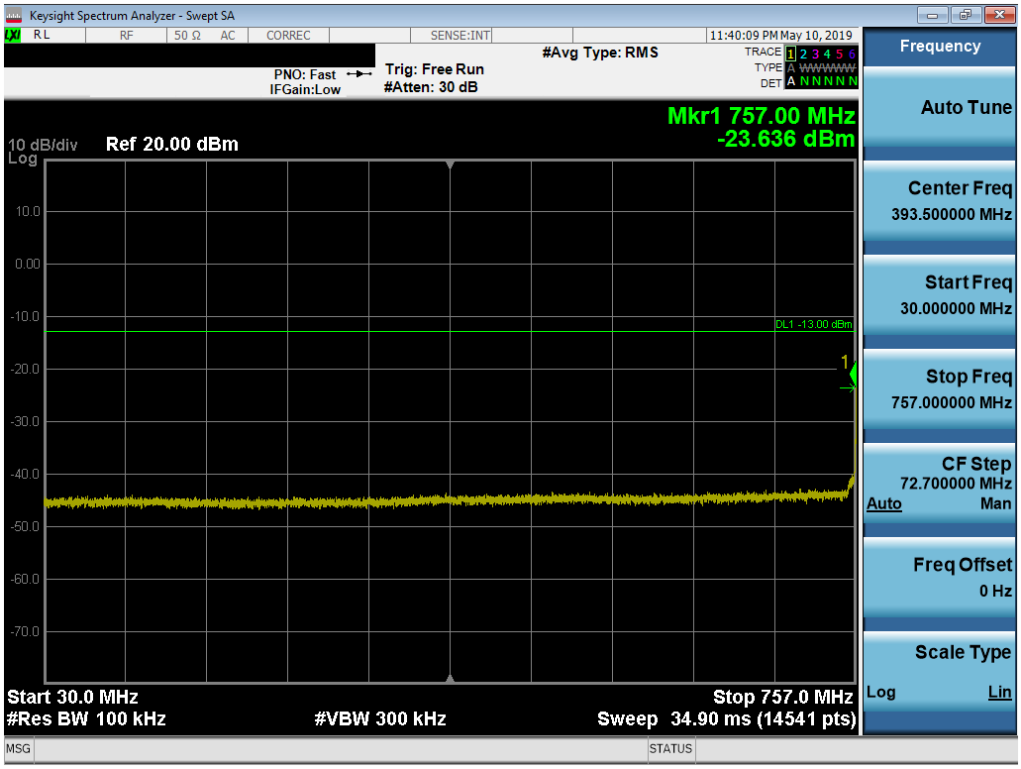
Plot 7-32. Conducted Spurious Plot (200kHz QPSK – Low Channel)



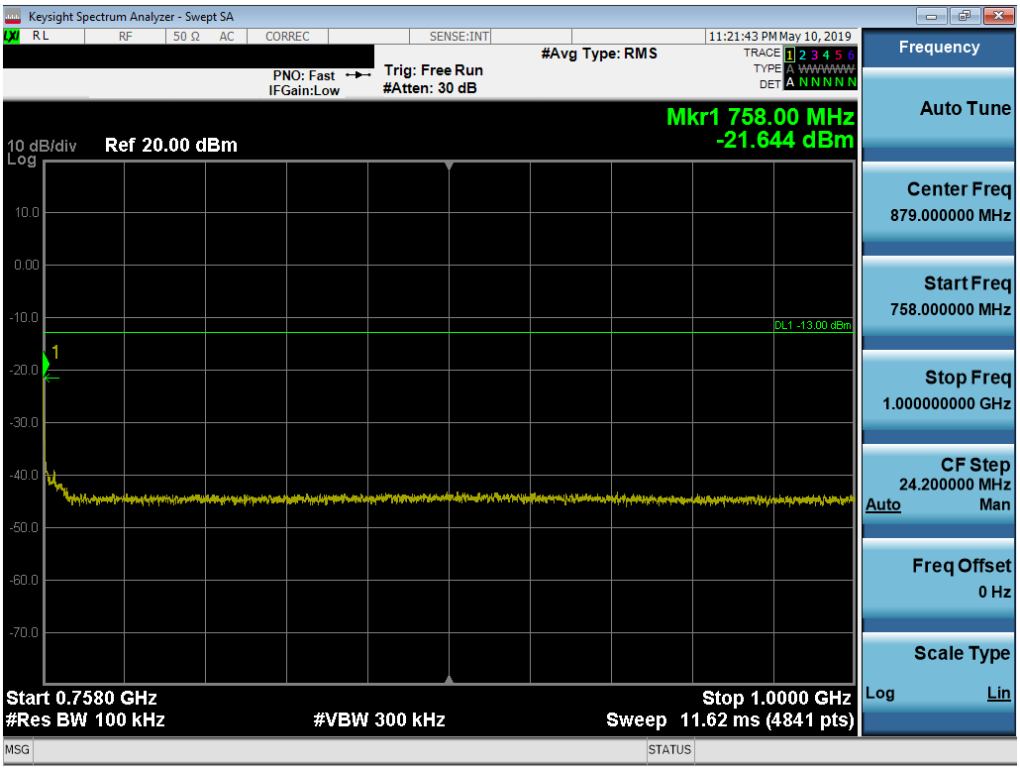
Plot 7-33. Conducted Spurious Plot (200kHz QPSK – Low Channel)



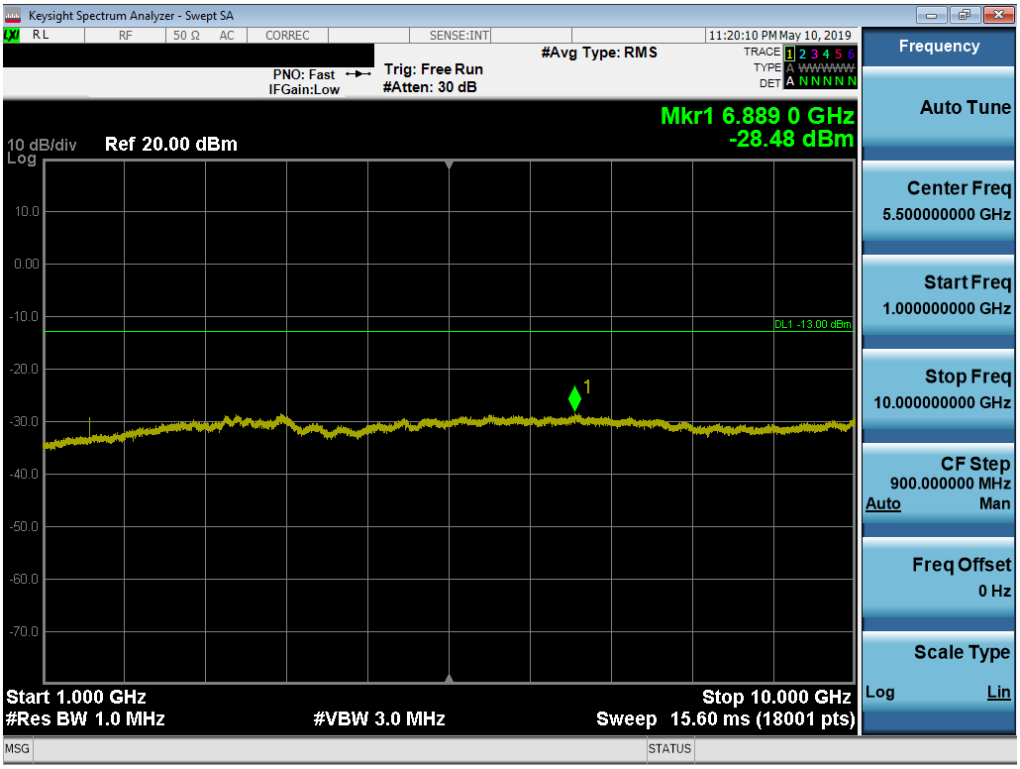
Plot 7-34. Conducted Spurious Plot (200kHz QPSK – Low Channel)



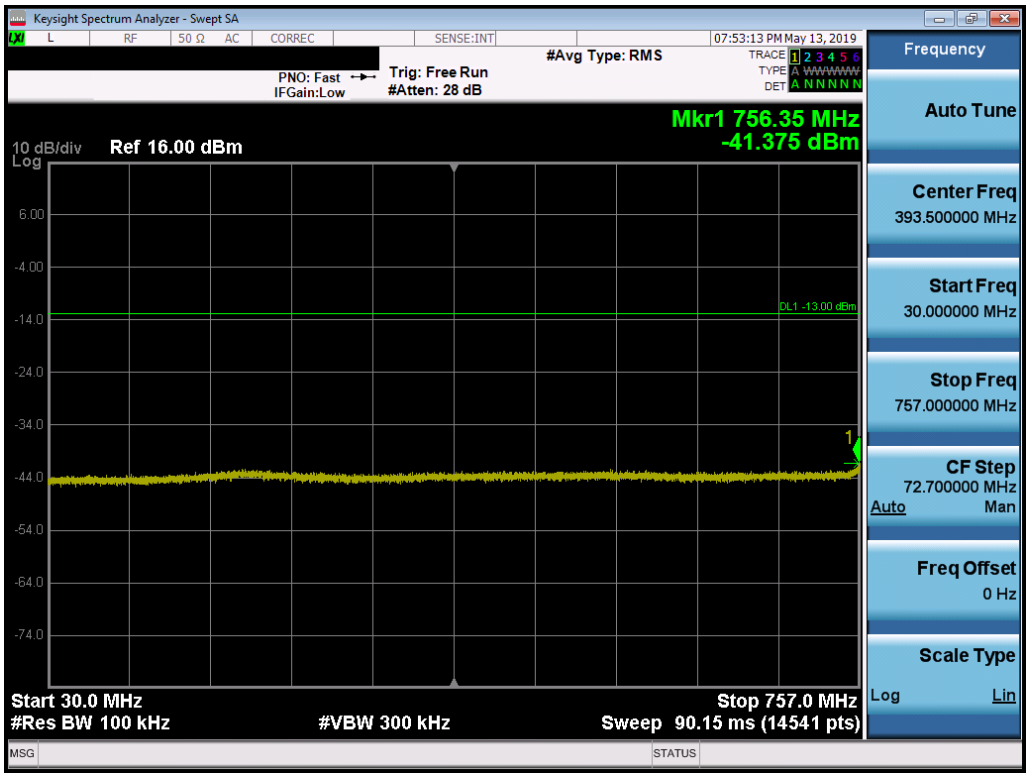
Plot 7-35. Conducted Spurious Plot (200kHz QPSK – Mid Channel)



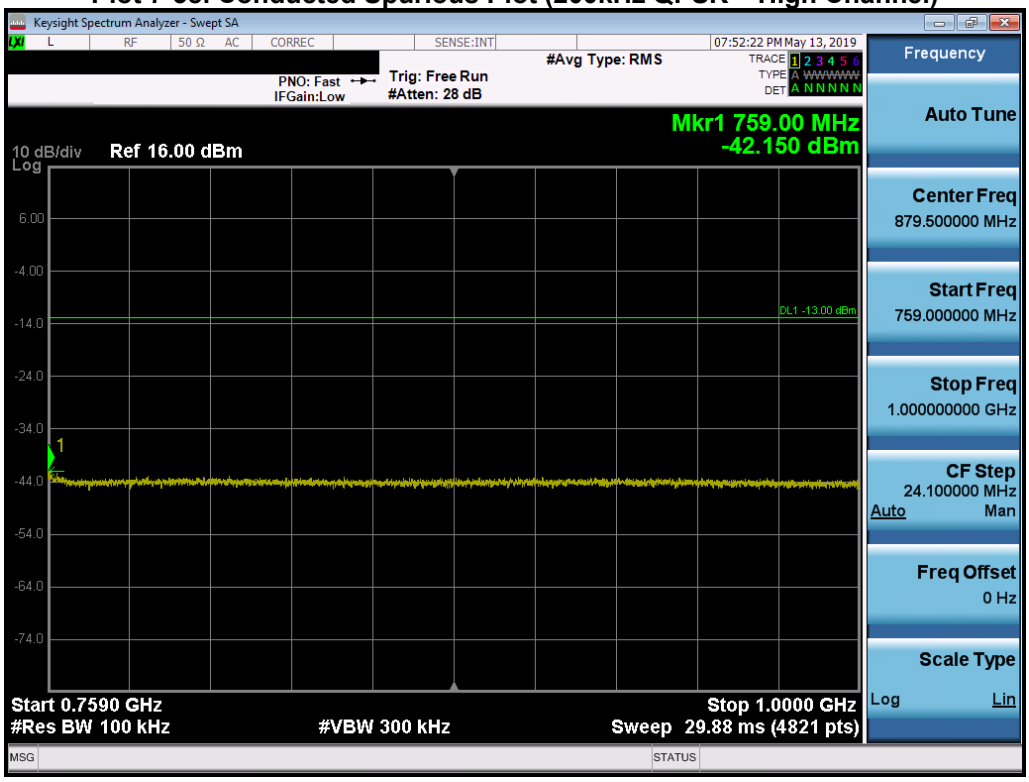
Plot 7-36. Conducted Spurious Plot (200kHz QPSK – Mid Channel)



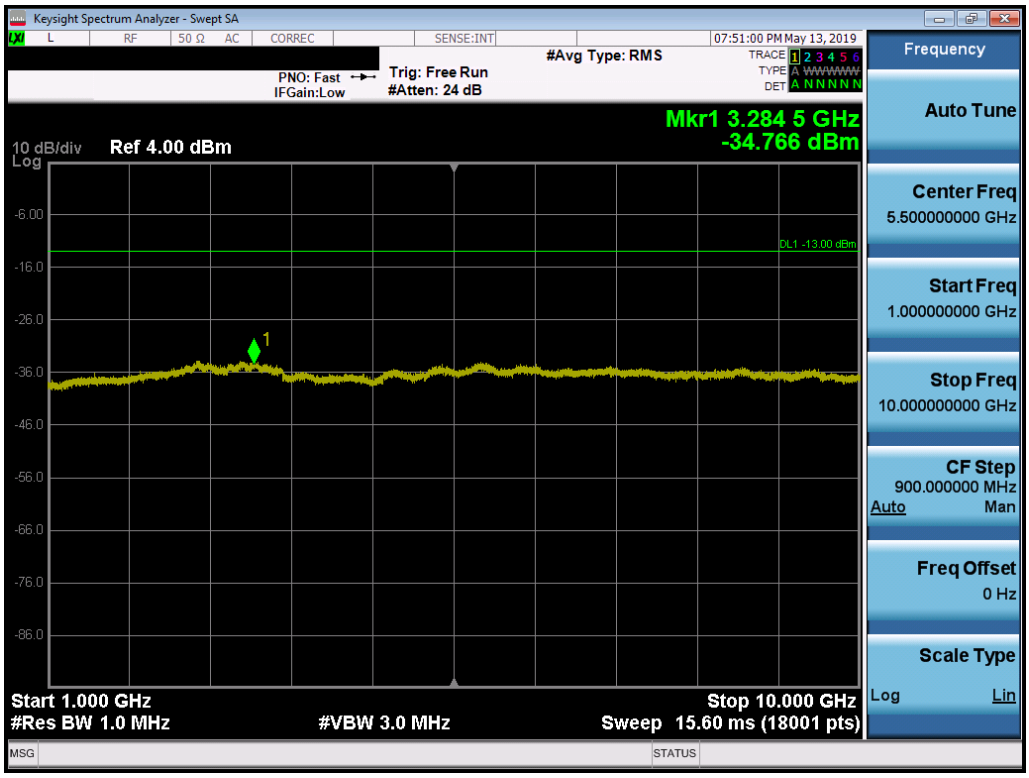
Plot 7-37. Conducted Spurious Plot (200kHz QPSK – Mid Channel)



Plot 7-38. Conducted Spurious Plot (200kHz QPSK – High Channel)



Plot 7-39. Conducted Spurious Plot (200kHz QPSK – High Channel)



Plot 7-40. Conducted Spurious Plot (200kHz QPSK – High Channel)

7.5 Band Edge Emissions at Antenna Terminal

Test Overview

All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.

The minimum permissible attenuation level of any spurious emission is 43 + 10 log$_{10}$(P$_{[Watts]}$), where P is the transmitter power in Watts.

Test Procedure Used

KDB 971168 D01 v03r01 – Section 6.0

Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW ≥ 1% of the emission bandwidth
4. VBW ≥ 3 x RBW
5. Detector = RMS
6. Number of sweep points ≥ 2 x Span/RBW
7. Trace mode = trace average
8. Sweep time = auto couple
9. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

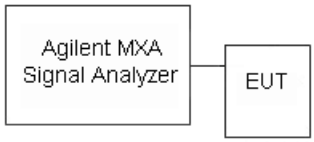


Figure 7-3. Test Instrument & Measurement Setup

Test Notes

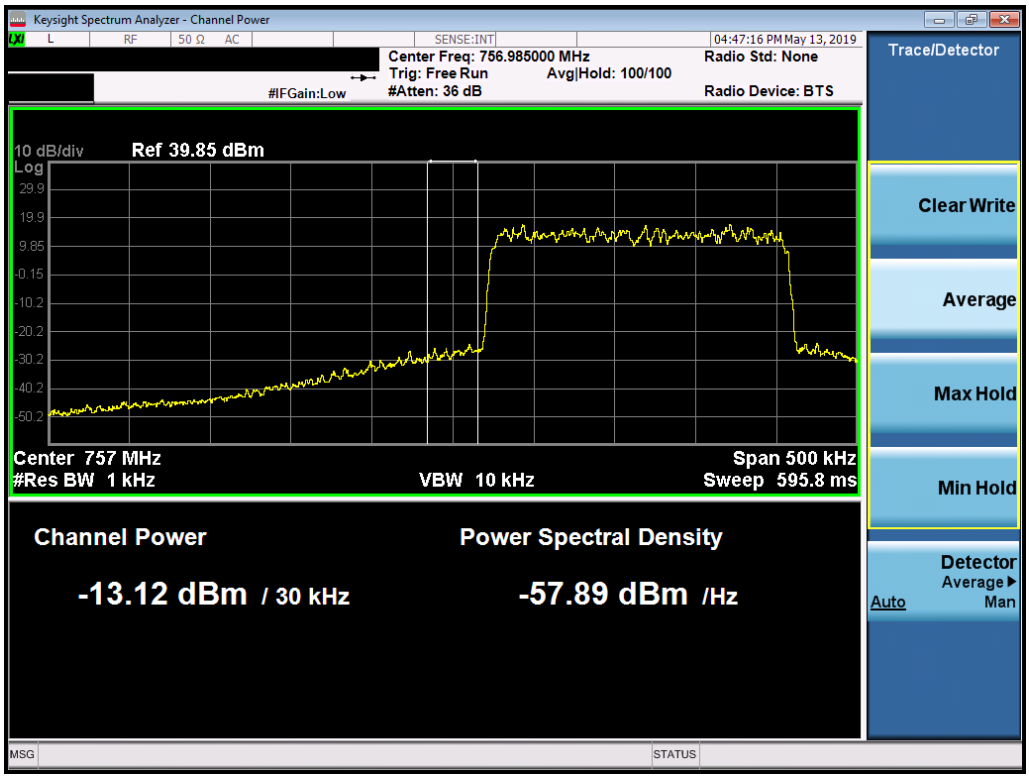
Per 27.917(b)(1) in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed to demonstrate compliance with the out-of-band emissions limit. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emission are attenuated at least 26 dB below the transmitter power.

Per 27.53 (c)(5) in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed.

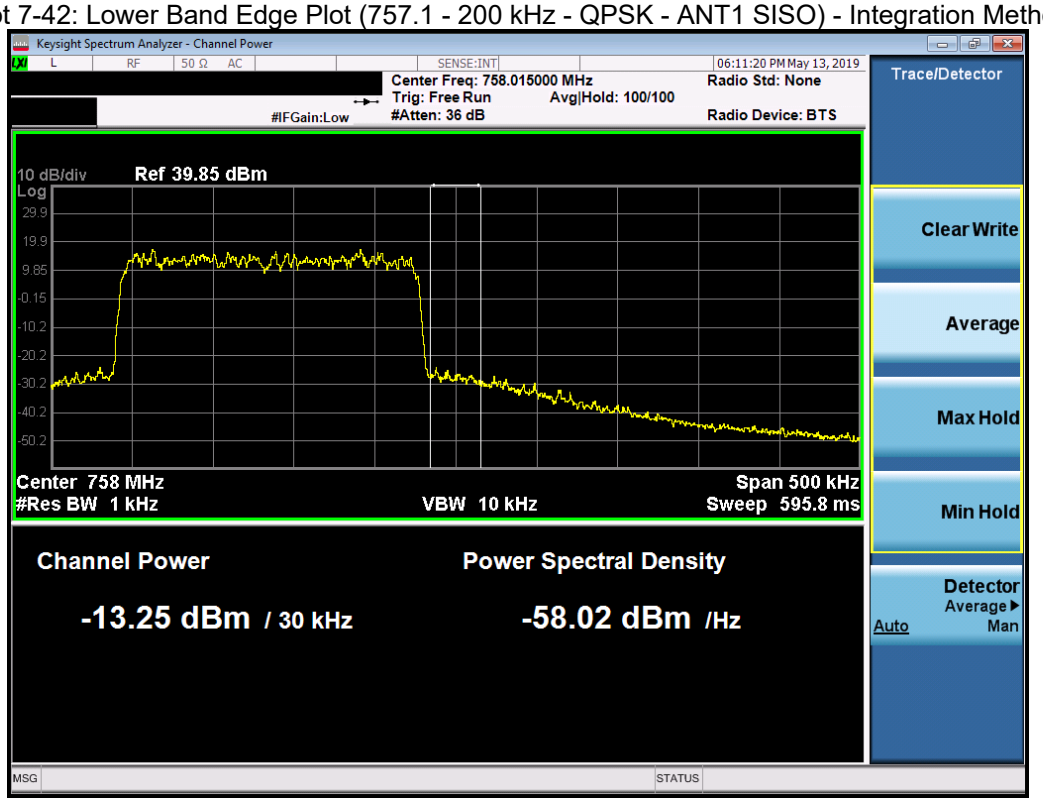
Channel Frequency [MHz]	Channel Bandwidth [kHz]	Mod.	Band Edge	Ant 1 Cond. Band Edge [dBm]	Ant 2 Cond. Band Edge [dBm]	MIMO Cond. Band Edge [dBm]	MIMO Cond. Band Edge Limit [dBm]	Cond. Band Edge Margin [dB]
757.10	200	QPSK	Low	-13.12		**-13.12**	-13	-0.12
757.10	200	QPSK	Low		-13.03	-13.03	-13	-0.03
757.10	200	QPSK	Low	-16.15	-16.16	**-13.14**	-13	-0.14
757.90	200	QPSK	High	-13.25		**-13.25**	-13	-0.25
757.90	200	QPSK	High		-13.12	-13.12	-13	-0.12
757.90	200	QPSK	High	-16.15	-16.07	-13.10	-13	-0.10

Plot 7-41. Conducted Band Edge Measurements

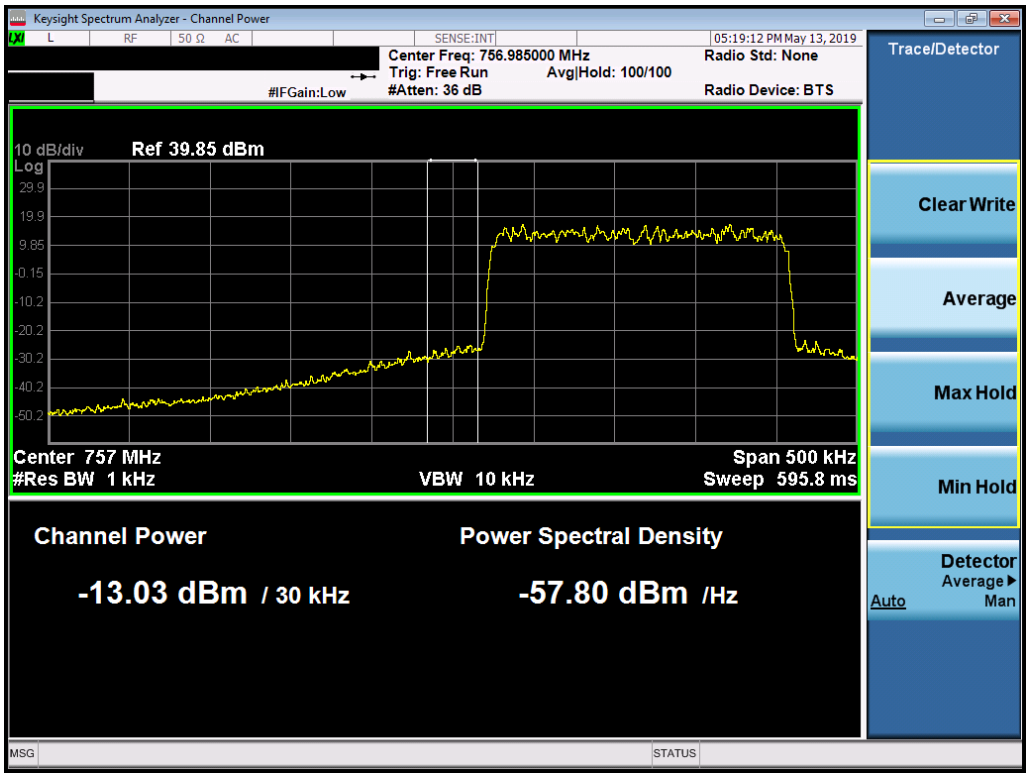
Band Edge Test Results



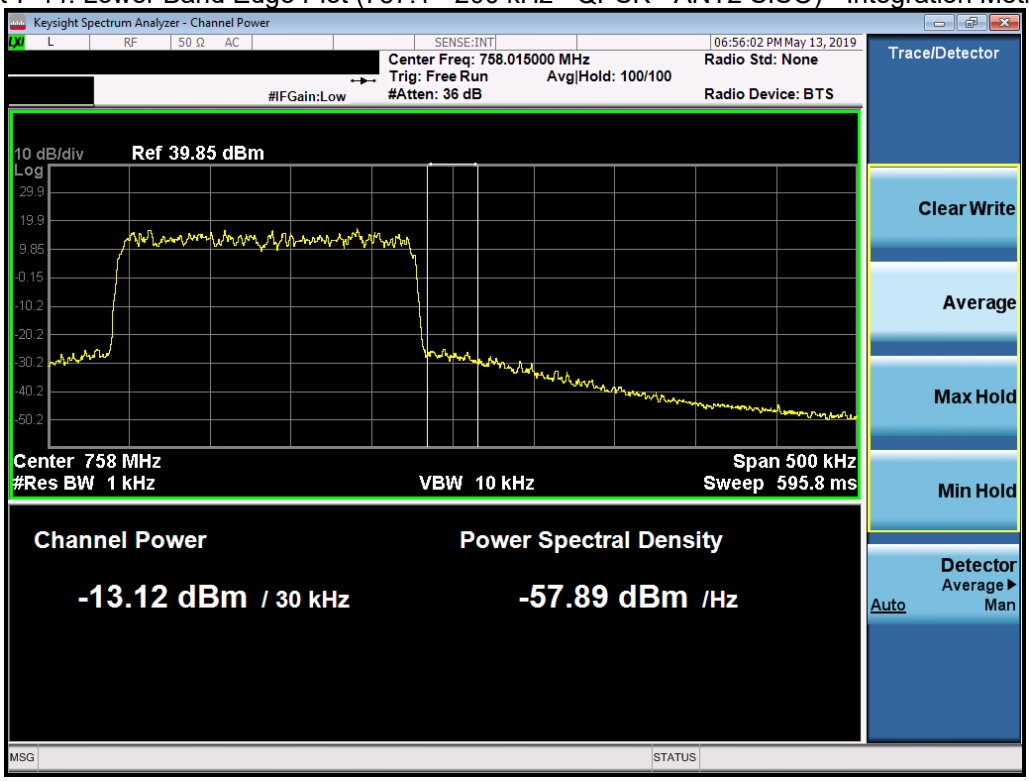
Plot 7-42: Lower Band Edge Plot (757.1 - 200 kHz - QPSK - ANT1 SISO) - Integration Method



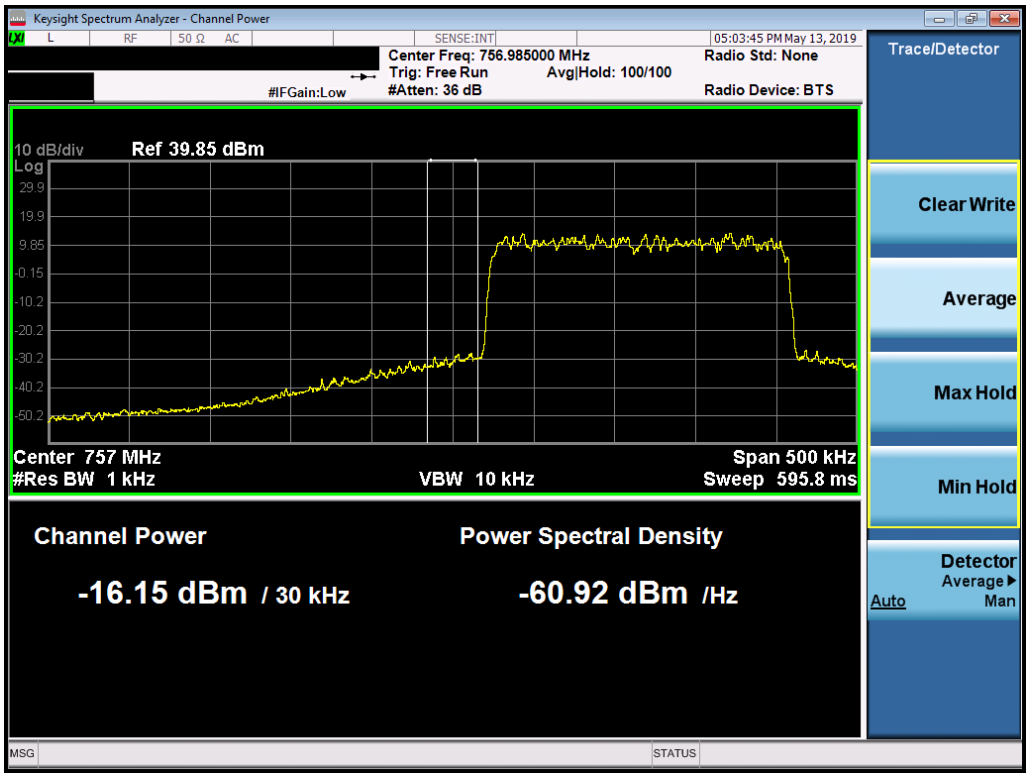
Plot 7-43: Upper Band Edge Plot (757.9 - 200 kHz - QPSK - ANT1 SISO) - Integration Method



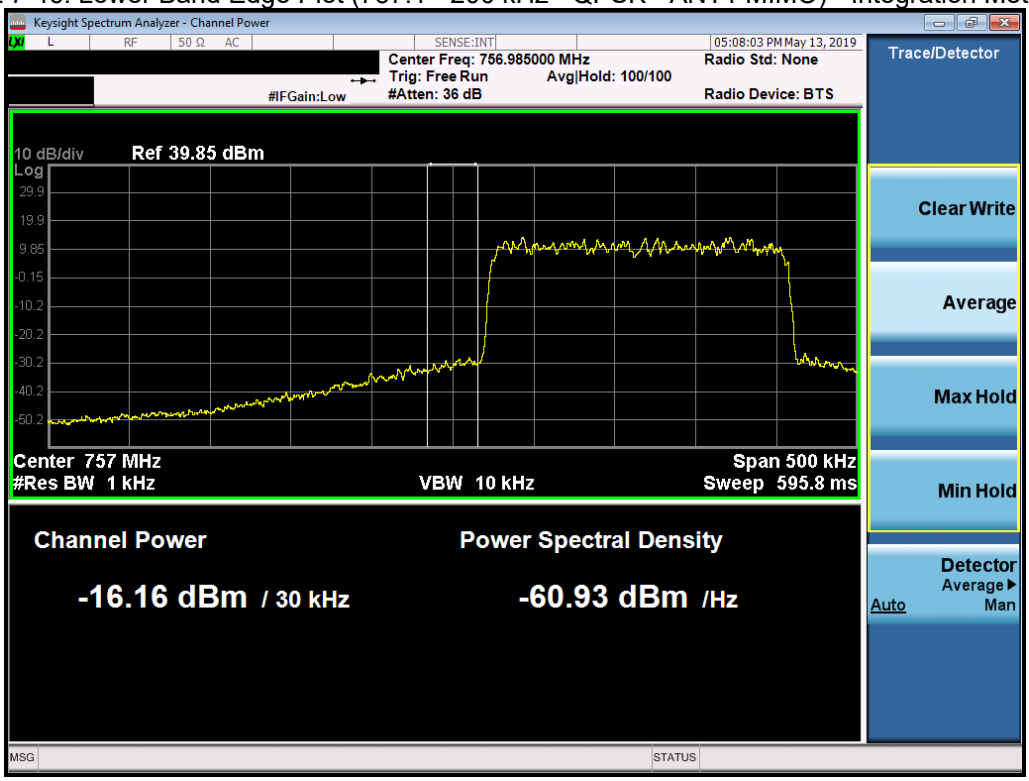
Plot 7-44: Lower Band Edge Plot (757.1 - 200 kHz - QPSK - ANT2 SISO) - Integration Method



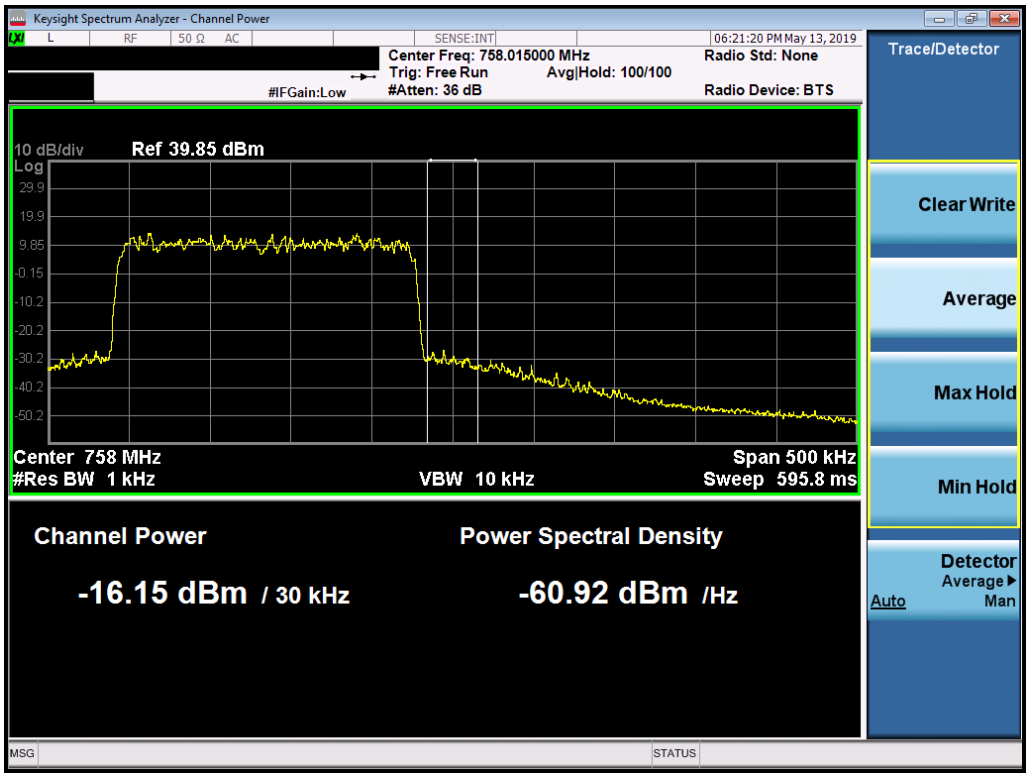
Plot 7-45: Upper Band Edge Plot (757.9 - 200 kHz - QPSK - ANT2 SISO) - Integration Method



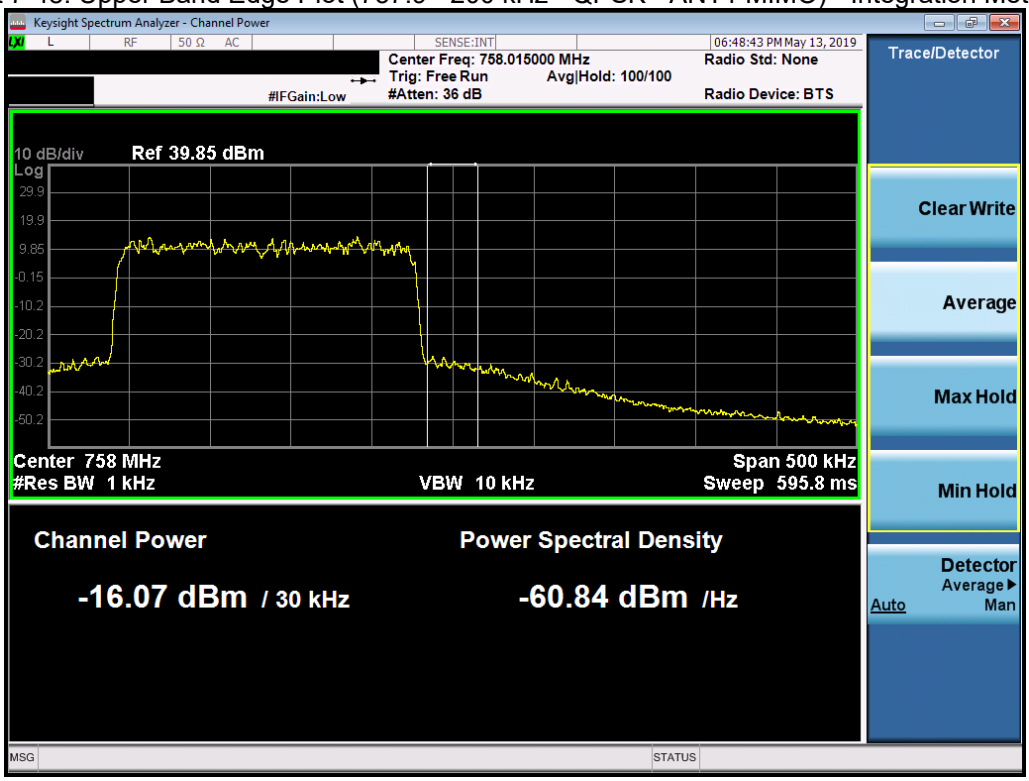
Plot 7-46: Lower Band Edge Plot (757.1 - 200 kHz - QPSK - ANT1 MIMO) - Integration Method



Plot 7-47: Lower Band Edge Plot (757.1 - 200 kHz - QPSK - ANT2 MIMO) - Integration Method



Plot 7-48: Upper Band Edge Plot (757.9 - 200 kHz - QPSK - ANT1 MIMO) - Integration Method



Plot 7-49: Upper Band Edge Plot (757.9 - 200 kHz - QPSK - ANT2 MIMO) - Integration Method

7.6 Radiated Spurious Emissions Measurements

Test Overview

Radiated spurious emissions measurements are performed using the substitution method described in ANSI/TIA-603-E-2016 with the EUT transmitting into an integral antenna. Measurements on signals operating below 1GHz are performed using vertically and horizontally polarized tuned dipole antennas. Measurements on signals operating above 1GHz are performed using vertically and horizontally polarized broadband horn antennas.

Test Procedures Used

KDB 971168 D01 v03r01 – Section 5.8

ANSI/TIA-603-E-2016 – Section 2.2.12

Test Settings

1. RBW = 100kHz for emissions below 1GHz and 1MHz for emissions above 1GHz
2. VBW ≥ 3 x RBW
3. Span = 1.5 times the OBW
4. No. of sweep points ≥ 2 x span / RBW
5. Detector = RMS
6. Trace mode = Average (Max Hold for pulsed emissions)
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

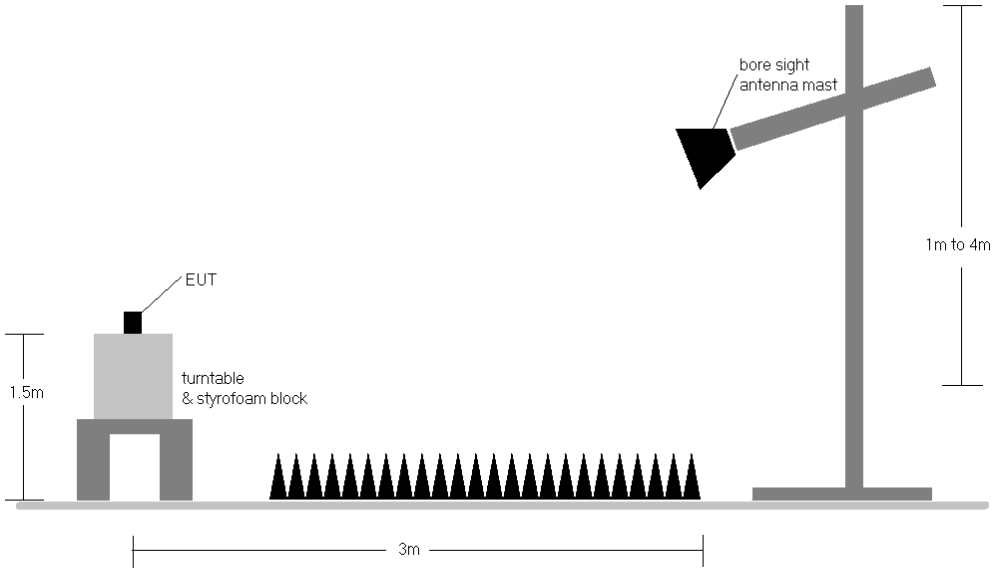


Figure 7-4. Test Instrument & Measurement Setup

Test Notes

1) The EUT was tested in three orthogonal planes and in all possible test configurations and positioning. The worst case emissions are reported with the EUT positioning, modulations, RB sizes and offsets, and channel bandwidth configurations shown in the tables below.

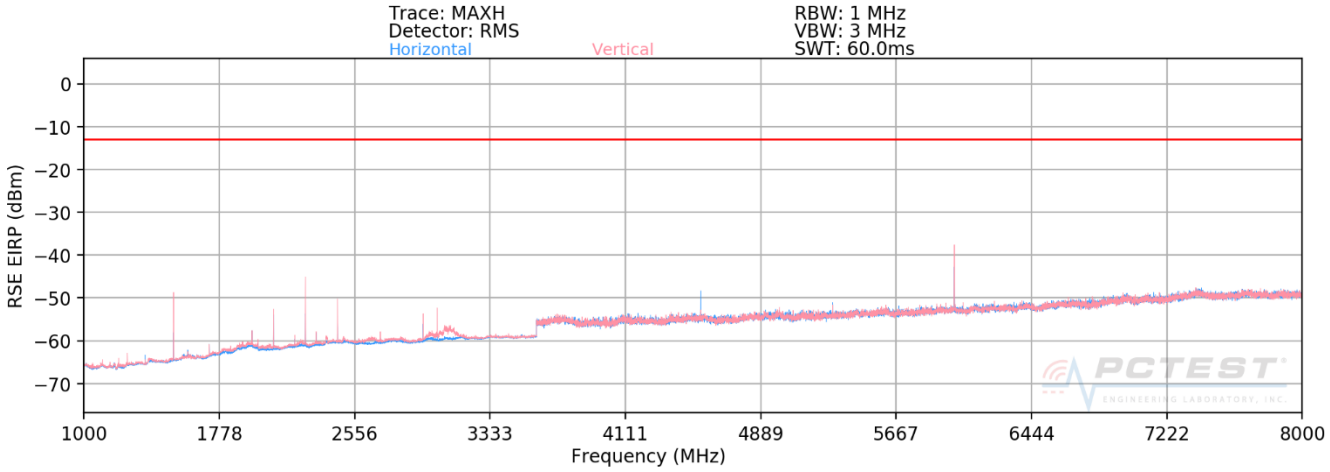
2) This unit was tested while powered by an DC power source.

3) The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter. The worst-case emissions are reported.

4) Emissions below 18GHz were measured at a 3 meter test distance while emissions above 18GHz were measured at a 1 meter test distance with the application of a distance correction factor.

5) The "-" shown in the following RSE tables are used to denote a noise floor measurement.

Radiated Spurious Test Results



Plot 7-50. Radiated Spurious Plot 1-8GHz (Mid Channel – 200kHz QPSK)

OPERATING FREQUENCY:	757.10	MHz
MODULATION SIGNAL:	QPSK	
BANDWIDTH:	0.2	MHz
DISTANCE:	3	meters
LIMIT:	-13	dBm

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Level at Antenna Terminals [dBm]	Substitute Antenna Gain [dBi]	Spurious Emission Level [dBm]	Margin [dB]
1514.20	V	183	270	-54.53	3.62	-50.91	-37.9
2271.30	V	192	262	-55.92	3.84	-52.08	-39.1
3028.40	V	129	153	-57.04	5.22	-51.82	-38.8
3785.50	V	-	-	-61.94	6.80	-55.14	-42.1
4542.60	V	215	137	-62.43	8.18	-54.25	-41.3
5299.70	V	100	144	-57.74	8.75	-48.99	-36.0
6056.80	V	341	316	-61.92	8.88	-53.04	-40.0

Table 7-5. Radiated Spurious Data (Low Channel)

OPERATING FREQUENCY:	757.50	MHz
MODULATION SIGNAL:	QPSK	
BANDWIDTH:	0.2	MHz
DISTANCE:	3	meters
LIMIT:	-13	dBm

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Level at Antenna Terminals [dBm]	Substitute Antenna Gain [dBi]	Spurious Emission Level [dBm]	Margin [dB]
1515.00	V	154	222	-49.97	0.00	-49.97	-10.0
2272.50	V	218	244	-46.29	3.84	-42.45	-29.4
3030.00	V	294	303	-46.92	5.22	-41.70	-28.7
3787.50	V	100	149	-61.17	6.81	-54.36	-41.4
4545.00	V	120	165	-48.36	8.18	-40.18	-27.2
5302.50	V	-	-	-65.75	8.74	-57.01	-44.0
6060.00	V	333	31	-43.76	8.88	-34.88	-21.9

Table 7-6. Radiated Spurious Data (Mid Channel)

OPERATING FREQUENCY:	757.90	MHz
MODULATION SIGNAL:	QPSK	
BANDWIDTH:	0.2	MHz
DISTANCE:	3	meters
LIMIT:	-13	dBm

Frequency [MHz]	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Level at Antenna Terminals [dBm]	Substitute Antenna Gain [dBi]	Spurious Emission Level [dBm]	Margin [dB]
1515.80	V	189	263	-51.58	0.00	-51.58	-11.6
2273.70	V	266	278	-56.53	3.85	-52.68	-39.7
3031.60	V	132	151	-56.30	5.22	-51.07	-38.1
3789.50	V	-	-	-61.85	6.82	-55.03	-42.0
4547.40	V	-	-	-62.38	8.18	-54.20	-41.2
5305.30	V	100	142	-56.59	8.74	-47.85	-34.9
6063.20	V	209	165	-61.69	8.88	-52.81	-39.8

Table 7-7. Radiated Spurious Data (High Channel)

7.7 Frequency Stability / Temperature Variation

Test Overview and Limit

Frequency stability testing is performed in accordance with the guidelines of ANSI/TIA-603-E-2016. The frequency stability of the transmitter is measured by:

a.) **Temperature:** The temperature is varied from -30°C to +50°C in 10°C increments using an environmental chamber.

b.) **Primary Supply Voltage:** The primary supply voltage is varied from 85% to 115% of the nominal value for non hand-carried battery and AC powered equipment. For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

Test Procedure Used

ANSI/TIA-603-E-2016

Test Settings

1. The carrier frequency of the transmitter is measured at room temperature (20°C to provide a reference).
2. The equipment is turned on in a "standby" condition for fifteen minutes before applying power to the transmitter. Measurement of the carrier frequency of the transmitter is made within one minute after applying power to the transmitter.
3. Frequency measurements are made at 10°C intervals ranging from -30°C to +50°C. A period of at least one half-hour is provided to allow stabilization of the equipment at each temperature level.

Test Setup

The EUT was connected via an RF cable to a spectrum analyzer with the EUT placed inside an environmental chamber.

Test Notes

None

Band 7 Frequency Stability Measurements

§2.1055 §27.54

OPERATING FREQUENCY:	757,500,000	Hz
CHANNEL:	23230	
REFERENCE VOLTAGE:	48.00	VDC

VOLTAGE (%)	POWER (VDC)	TEMP (°C)	FREQUENCY (Hz)	Freq. Dev. (Hz)	Deviation (%)
100 %	-48.00	+ 20 (Ref)	757,500,251	251	0.0000331
100 %		- 30	757,499,937	-63	-0.0000083
100 %		- 20	757,500,062	62	0.0000082
100 %		- 10	757,500,662	662	0.0000874
100 %		0	757,500,035	35	0.0000046
100 %		+ 10	757,500,255	255	0.0000337
100 %		+ 20	757,500,330	330	0.0000436
100 %		+ 30	757,500,285	285	0.0000376
100 %		+ 40	757,500,385	385	0.0000508
100 %		+ 50	757,500,412	412	0.0000544
85 %	-40.80	+ 20	757,500,068	68	0.0000090
115 %	-55.20	+ 20	757,500,244	244	0.0000322

Table 7-8. Frequency Stability Data

Note:

Based on the results of the frequency stability test at the center channel the frequency deviation results measured are very small. As such it is determined that the channels at the band edge would remain in-band when the maximum measured frequency deviation noted during the frequency stability tests is applied. Therefore the device is determined to remain operating in band over the temperature and voltage range as tested.

Band 7 Frequency Stability Measurements

§2.1055 §27.54

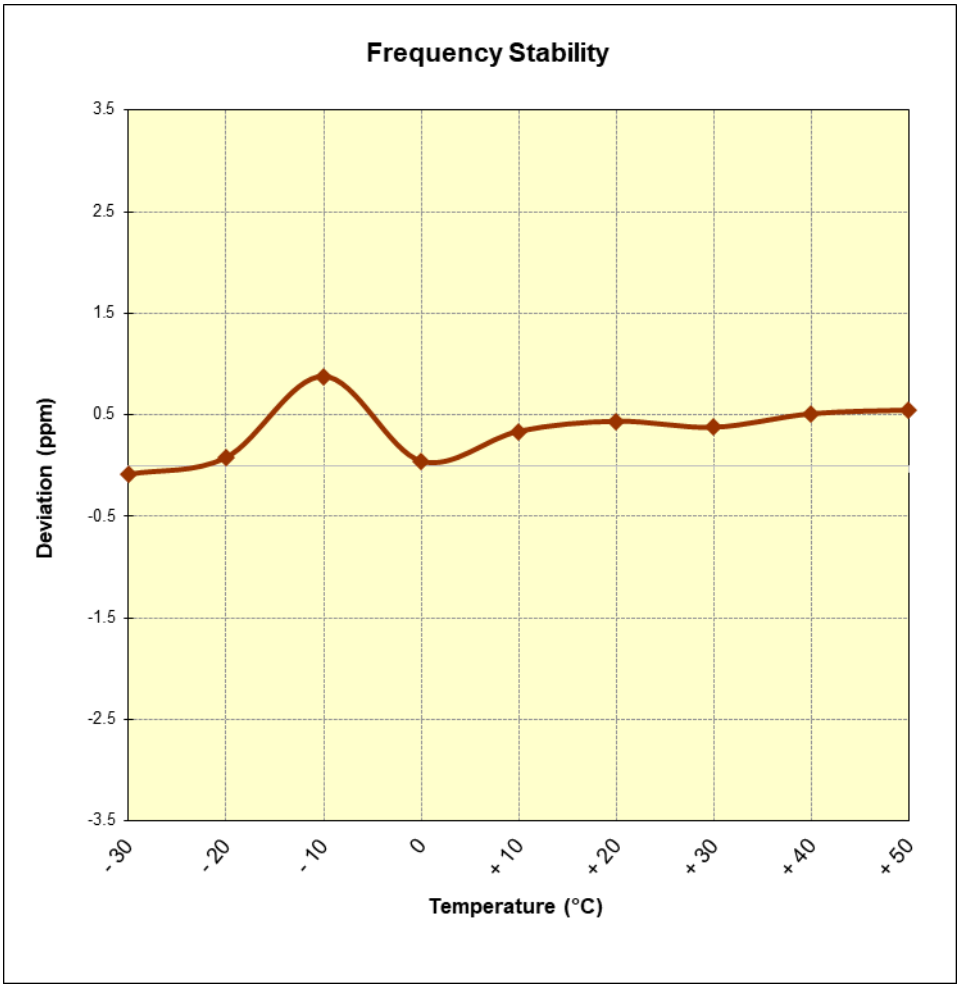


Figure 7-5. Frequency Stability Graph

8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Tecore Networks Remote Radio Head FCC ID: QLJ4GNBIOT-086** complies with all the requirements of Part 27 of the FCC Rules for LTE operation only.