Test Report

EUT Name: HARMAN Spark

Model Name: HSA-15UA-BR

FCC CFR47 Part 2 (2017)/ FCC CFR47 Part 90R (2017)

Prepared for:

Harman International Industries Incorporated
636 Ellis St
Mountain View CA 94043 U.S.A.
Tel: +91-9873387741

Prepared by:

TUV Rheinland of North America, Inc.
5015 Brandin Ct.
Fremont, CA 94538, U.S.A.
Tel: (925) 249-9123
Fax: (925) 249-9124
http://www.tuv.com/

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Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
0	05/13/2020	Original Document	RK
1	05/26/2020	Updated EUT Information	RK

Note: Latest revision report will replace all previous reports.

Statement of Compliance

Manufacturer:	Harman International Industries Incorporated 636 Ellis St Mountain View CA 94043, U.S.A.
Name of Equipment:	HARMAN Spark
Model No.	HSA-15UA-BR
Type of Equipment:	OBD II Telematics Device
Test Dates:	April 23, 2020 to May 8, 2020

Guidance Documents:

FCC CFR 47 Part 2
FCC CFR 47 Part90 R (2017)

Test Methods:

FCC KDB 971168 D01 Power Meas License Digital Systems v03r01
ANSI/TIA/EIA-603-E 2016
ANSI C63.26-2015

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TUV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the Executive Summary of this report.

This report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government. This report shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.

Rachana Khanduri	May 26, 2020	Osvaldo Casorla	May 26, 2020
Test Engineer	Date	Laboratory Signatory	Date

Testing Cert #3331.02 **US1131** **2932D**

1 Executive Summary

1.1 *Scope*

This report is intended to document the status of conformance with the requirements of the FCC based on the results of testing performed on April 23, 2020 through May 8, 2020 on the HSA-15UA-BR manufactured by Harman International Industries Incorporated. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 *Purpose*

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 *Summary of Test Results*

Table 1: Summary of Test Results

Test	FCC Rule	Result	Remarks
RF Power Output	2.1046	Complied	Meet the requirement of limit.
Effective Radiated Power	90.542(a) 7	Complied	Meet the requirement of limit.
Occupied Bandwidth	2.1049 90.209	Complied	Meet the requirement of limit.
Emission Mask	90.210(b)	Complied	Meet the requirement of limit.
Band Edge	2.1051 90.543	Complied	Meet the requirement of limit.
Peak-to-Average Power Ratio	KDB 971168 D01 (5.7)	Complied	Meet the requirement of limit.
Frequency Stability	2.1055 90.539 (c)	Complied	Meet the requirement of limit.
Spurious Emissions at Antenna Terminals	2.1051 90.543 (e)	Complied	Meet the requirement of limit.
Radiated Spurious Emissions	2.1053 90.543 (e)	Complied	Meet the requirement of limit.
Notes:			

1.4 *Special Accessories*

No special accessories were necessary in order to achieve compliance.

1.5 *Equipment Modifications*

None

2 Laboratory Information

2.1 *Accreditations & Endorsements*

2.1.1 US Federal Communications Commission

TUV Rheinland of North America EMC test facilities located at 1279 Quarry Lane, Ste. A, Pleasanton, CA, 94566, and 5015 Brandin Ct, Fremont, CA. 94538, are recognized by the Commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Pleasanton Registration No. US1131, Fremont Registration No. US1131). The laboratory Scopes of Accreditation include Title 47 CFR Parts 15, 18 and 90. The accreditations are updated every three years.

2.1.2 A2LA

TUV Rheinland of North America EMC test facilities are accredited by the American Association for Laboratory Accreditation (A2LA). The laboratories have been assessed and accredited by A2LA in accordance with ISO Standard 17025:2017 (Testing Certificate #3331.02). The Scope of Laboratory Accreditation includes emission and immunity testing. The accreditations are updated annually.

2.1.3 Industry Canada

The Pleasanton 5-meter Semi-Anechoic Chamber, Registration No. 2932M-1, has been accepted by Industry Canada to perform testing to 3 and 5 meters based on the test procedures described in ANSI C63.4-2014. The Fremont 10-meter Semi-Anechoic Chamber, Registration No. 2932D-1, has been accepted by Industry Canada to perform testing to 3 and 10 meters based on the test procedures described in ANSI C63.4-2014.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America EMC test facilities located at 1279 Quarry Lane, Ste. A, Pleasanton, CA, 94566, and 5015 Brandin Ct, Fremont, CA. 94538, have been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0326

VCCI Registration No. for Fremont: A-0327

2.1.5 **Acceptance by Mutual Recognition Arrangement**

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 1279 Quarry Ln, Pleasanton, CA 94566 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 *Test Facilities*

Test facilities are located at 5015 Brandin Ct, Fremont, California, 94538, USA and 1279 Quarry Lane, Pleasanton, California 94566, USA (Fremont is the Pleasanton Annex).

2.2.1 **Emission Test Facility**

The Semi-Anechoic Chambers and AC Line Conducted measurement facilities used to collect radiated and conducted emissions data have been constructed in accordance with ANSI C63.7:1992. The Fremont 10 meter semi-anechoic chamber has been measured in accordance with and verified to comply with the theoretical volumetric normalized site attenuation of ANSI C63.4:2014 and SVSWR requirements of CISPR 16-1-4 Consol. Ed. 3.0 (2010-04), at test distances of 3 and 10 meters. This site has been described in reports dated November 1st, 2006, submitted to the FCC, and accepted by letter dated November 28, 2006. The site is listed with the FCC and accredited by A2LA (Testing Certificate #3331.02). The Pleasanton 5 meter semi-anechoic chamber has been verified to comply with the theoretical volumetric normalized site attenuation of ANSI C63.4:2009 and SVSWR requirements of CISPR 16-1-4 Consol. Ed. 3.0 (2010-04) at a test distance of 3 meters. This site has been described in reports dated November 1st, 2006, submitted to the FCC, and accepted by letter dated November 28, 2006. The site is listed with the FCC and accredited by A2LA (Testing Certificate #3331.02).

2.3 *Measurement Uncertainty*

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities; it is equal to the positive square root of the sum of the variances or co-variances of these other quantities, weighted according to how the measurement result varies with changes in these quantities. The term *standard uncertainty* is the result of a measurement expressed as a standard deviation.

The Expanded Uncertainty defines an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurement and the fraction may be viewed as the coverage probability or level of confidence of the interval.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.2 Measurement Uncertainty Emissions

Per CISPR 16-4-2	U_{lab}	U_{cispr}
Radiated Disturbance @ 10 meters		
30 – 1,000 MHz	2.25 dB	4.51 dB
Radiated Disturbance @ 3 meters		
30 – 1,000 MHz	2.26 dB	4.52 dB
1 – 6 GHz	2.12 dB	4.25 dB
6 – 18 GHz	2.47 dB	4.93 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	1.09 dB	2.18 dB
Disturbance Power		
30 MHz – 300 MHz	3.92 dB	4.3 dB

Voltech PM6000A

The estimated combined standard uncertainty for harmonic current and flicker measurements is ± 5.0%.	Per CISPR 16-4-2 Methods

2.3.3 Measurement Uncertainty Immunity

The estimated combined standard uncertainty for ESD immunity measurements is ± 8.2%.	Per IEC 61000-4-2
The estimated combined standard uncertainty for radiated immunity measurements is ± 4.10 dB.	Per IEC 61000-4-3
The estimated expanded uncertainty for EFT fast transient immunity measurements is ± 5.84%.	Per IEC 61000-4-4
The estimated expanded uncertainty for surge immunity measurements is ± 5.84 %.	Per IEC 61000-4-4
The estimated combined standard uncertainty for conducted immunity measurements with CDN is ± 3.66 dB	Per IEC 61000-4-6
The estimated combined standard uncertainty for power frequency magnetic field immunity is ± 2.9%.	Per IEC 61000-4-8
The estimated expanded uncertainty for voltage variation and interruption measurements is ± 3.48%.	Per IEC 61000-4-11

Thermo KeyTek EMC Pro

The estimated combined standard uncertainty for EFT fast transient immunity measurements is ± 2.6%.
The estimated combined standard uncertainty for surge immunity measurements is ± 2.6%.
The estimated combined standard uncertainty for voltage variation and interruption measurements is ± 1.74%.

The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2017. Equipment calibration records are kept on file at the test facility.

3 Product Information

3.1 *Introduction*

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

3.2 *Customer*

Table 2: Customer Information

Company Name	Harman International Industries Incorporated
Address	636 Ellis St
City, State, Zip	Mountain View CA 94043
Country	U.S.A.
Phone	+91-9873387741

3.3 *Product Description*

OBD II Telematics Device, is a car OBD sensor for use in a motor vehicle. The device has the capability of operating in the LTE Band 14.

3.4 *Equipment Under Test (EUT)*

Table 3: EUT Specifications

EUT Specification	
Power Input	12VDC from Car Battery
Number of Antenna Feeds:	3 Antenna Feeds
Hardware Version	V2.0
Software Version	HSA-15UA_81_LA301_V49_R04B
IMEI TAC	35623311
Cellular Transmit Frequency Band	LTE Band 14
Operating Frequency Range	TX (MHz) : 788-798
	Rx (MHz): 758 -768
Cellular Max. Rated Power Output	23 dBm
Cellular Antenna Type	PCB Trace
Cellular Antenna Gain (Peak)	1.84 dBi
Cellular Modulation Type	QPSK/16-QAM
Extreme Voltage	Minimum: 11.6V Maximum:24V
Extreme Temperature	Lowest: -20°C Highest: +60°C
Type of Equipment	☐ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☒ Other:

Table 4: Description of Sample used for Testing

Device	IMEI Number	Configuration	Used For
Harman OBD II	356233110001275	Conducted	Conducted Cellular test
Harman OBD II	356233110001317	Conducted	Conducted Cellular test
Harman OBD II	356233110000350	Radiated	Radiated Tests
Harman OBD II	356233110000301	Radiated	Radiated Tests

3.5 *Test Equipment Configuration*

The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was connected to the declared rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of a EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation.

The final configuration was selected to produce the worst case radiation for emissions testing.

3.6 *Operating Mode*

In the case of a EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

The final operating mode was selected to produce the worst case radiation for emissions testing.

4 Test Data

Testing was performed in accordance with FCC rule. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in ANSI C63.26-2015 and FCC KDB 971168 D01 V03 were used. Worst case configuration was determined to be QPSK and was the modulation chosen for testing throughout this report.

All mode, data rates and positions were investigated.

The following testing in LTE is set based on the maximum RF output Power.

Test Modes are chosen as the worst case configuration below for LTE Band 14.

Test items	Bandwidth (MHz)		Modulation		RB			Test Channels		
	5	10	QPSK	16QAM	1%	50%	100%	Low	Mid	High
RF Output Power	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Effective Isotropic Radiated Power	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Occupied Bandwidth	☒	☒	☒	☒	☐	☐	☒	☒	☒	☒
Emission Mask	☒	☒	☒	☒	☐	☐	☒	☒	☒	☒
Band Edge	☒	☒	☒	☐	☐	☐	☒	☒	☐	☒
Peak-to-Average Power Ratio	☒	☒	☒	☒	☐	☐	☒	☒	☒	☒
Frequency Stability	☒	☒	☒	☐	☐	☐	☒	☒	☒	☒
Spurious Emissions at Antenna Terminals	☒	☒	☒	☐	☒	☐	☐	☒	☒	☒
Radiated Spurious Emission	☒	☒	☒	☐	☒	☐	☐	☒	☒	☒
Note	1. The mark "☒" means that this configuration is chosen for testing. 2. The mark "☐" means that this configuration is not chosen for testing.									

4.1 *Conducted RF Output Power/ERP/EIRP*

§2.1046(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in §2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

Part 90.542 (a) (6) Control stations and mobile stations transmitting in the 758-768 MHz band and the 788-798 MHz band are limited to 30 watts ERP.

Part 90.542 (a) (7) portable stations (hand-held devices) transmitting in the 758-768 MHz band and the 788-798 band are limited to 3 watts ERP.

4.1.1.1 Spectrum Analyzer Method

KDB 971168 D01 V03 section 5 and ANSI C63.26-2015 Section 5.2.4.4 General procedure for measuring average power of a broadband signal with a spectrum analyzer or EMI receiver measurement procedure was used. The EUT was configured with the CMW 500 to the measured center frequency transmitting at a 100% duty cycle with the correct bandwidth, modulation, and Resource Block configuration in the case of LTE. In all cases the EUT was set to transmit at maximum power by the CMW500. The EUT was directly connected to the spectrum analyzer with the following settings:

1. Center frequency set to the EUT's channel center frequency
2. Span = 2-3 x the OBW
3. RBW = 1% to 5% OBW
4. VBW ≥ 3 x RBW
5. Sweep Points ≥ 2 x Span/RBW
6. Sweep time: Auto-couple
7. Detector = power averaging (rms)

The power measurement is made by averaging 100 or more traces. The final conducted power is calculated by integrating over the spectrum using the instruments channel power measurement function. The EIRP values are calculated using equation from section 5.6 of KDB 971168 D01 V03.

$$EIRP = P_{measured} + G_T - L_c$$

ERP values are calculated using the EIRP by the following:

$$ERP = EIRP - 2.15\ dB$$

Where:

$P_{measured}$ ≡ maximum conducted power
G_T ≡ gain of transmitting antenna in dBi
L_c ≡ signal attenuation between transmitter and antenna in EUT

4.1.1.2 Average Power Meter Method

KDB 971168 D01 section 5 and ANSI C63.26-2015 Section 5.2.4.2 – General procedure for measuring average power with an average power meter was used. The EUT was setup to transmit at 100% duty cycle and the center frequency, output power and resource block configuration (LTE) were all set using a CMW 500 call box. The EUT was directly connected to the power sensor. The power sensors VBW is greater than the OBW of the transmitting signal and the sensors rise time is faster than the rise time of the RF signal to ensure measurement integrity.

The EIRP values are calculated using equation from section 5.6 of KDB 971168 D01 V03.

$$EIRP = P_{measured} + G_T - L_c$$

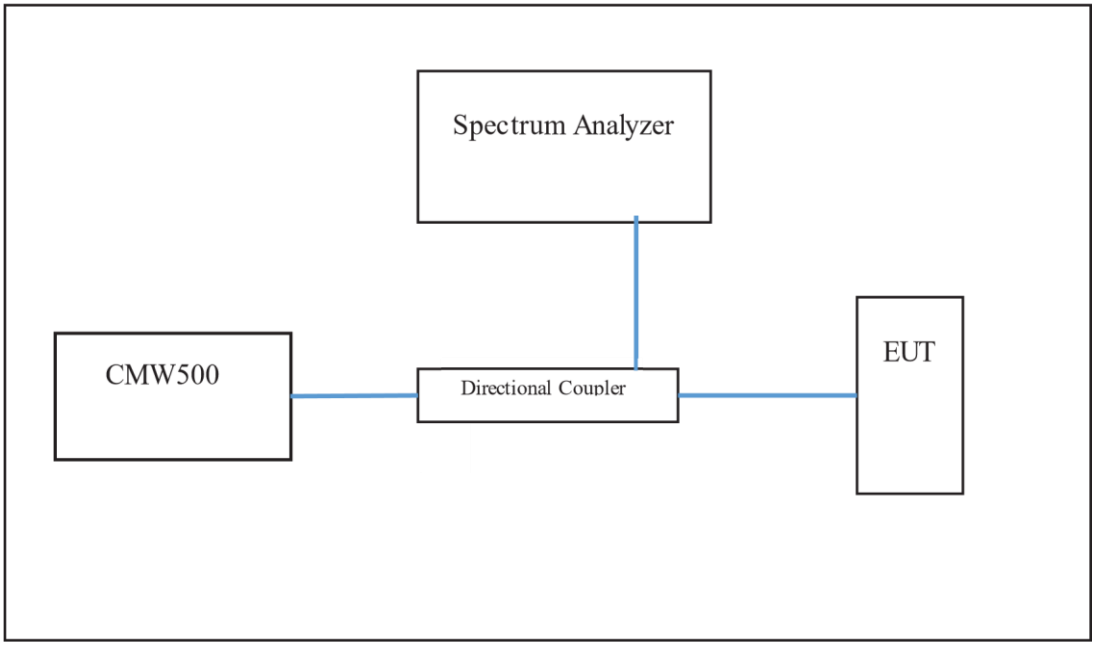
ERP values are calculated using the EIRP by the following:

$$ERP = EIRP - 2.15\ dB$$

Where:

$P_{measured}$ ≡ maximum conducted power
G_T ≡ gain of transmitting antenna in dBi
L_c ≡ signal attenuation between transmitter and antenna in EUT

4.1.2 Test Setup



4.1.3 Deviations

N/A

4.1.4 Test Results

LTE Band 14 -QPSK

Bandwidth (MHz)	Channel Number	Frequency (MHz)	Resource Blocks (RB)	RB Position	Conducted Power (dBm)	Gain (dBi)	E.I.R.P (dBm)	E.R.P (dBm)	Limit E.R.P (dBm)	Margin (dB)
5 MHz	23305	790.5	1	0	21.76	1.84	23.60	21.45	34.77	13.32
				13	21.84	1.84	23.68	21.53	34.77	13.24
				24	21.70	1.84	23.54	21.39	34.77	13.38
			12	0	20.63	1.84	22.47	20.32	34.77	14.45
				13	20.62	1.84	22.46	20.31	34.77	14.46
			25	0	20.68	1.84	22.52	20.37	34.77	14.40
	23330	793	1	0	21.04	1.84	22.88	20.73	34.77	14.04
				13	21.82	1.84	23.66	21.51	34.77	13.26
				24	21.45	1.84	23.29	21.14	34.77	13.63
			12	0	20.88	1.84	22.72	20.57	34.77	14.20
				13	20.66	1.84	22.50	20.35	34.77	14.42
			25	0	20.66	1.84	22.50	20.35	34.77	14.42
	23355	795.5	1	0	21.99	1.84	23.83	21.68	34.77	13.09
				13	21.84	1.84	23.68	21.53	34.77	13.24
				24	22.00	1.84	23.84	21.69	34.77	13.08
			12	0	20.51	1.84	22.35	20.20	34.77	14.57
				13	20.47	1.84	22.31	20.16	34.77	14.61
			25	0	20.59	1.84	22.43	20.28	34.77	14.49

LTE Band 14 -16QAM

Bandwidth (MHz)	Channel Number	Frequency (MHz)	Resource Blocks (RB)	RB Position	Conducted Power (dBm)	Gain (dBi)	E.I.R.P (dBm)	E.R.P (dBm)	Limit E.R.P (dBm)	Margin (dB)
5 MHz	23305	790.5	1	0	21.23	1.84	23.07	20.92	34.77	13.85
				13	20.72	1.84	22.56	20.41	34.77	14.36
				24	20.62	1.84	22.46	20.31	34.77	14.46
			12	0	19.55	1.84	21.39	19.24	34.77	15.53
				13	19.57	1.84	21.41	19.26	34.77	15.51
			25	0	19.67	1.84	21.51	19.36	34.77	15.41
	23330	793	1	0	20.59	1.84	22.43	20.28	34.77	14.49
				13	20.56	1.84	22.40	20.25	34.77	14.52
				24	20.72	1.84	22.56	20.41	34.77	14.36
			12	0	19.63	1.84	21.47	19.32	34.77	15.45
				13	19.67	1.84	21.51	19.36	34.77	15.41
			25	0	19.77	1.84	21.61	19.46	34.77	15.31
	23355	795.5	1	0	20.89	1.84	22.73	20.58	34.77	14.19
				13	20.66	1.84	22.50	20.35	34.77	14.42
				24	20.91	1.84	22.75	20.60	34.77	14.17
			12	0	19.64	1.84	21.48	19.33	34.77	15.44
				13	19.64	1.84	21.48	19.33	34.77	15.44
			25	0	19.63	1.84	21.47	19.32	34.77	15.45

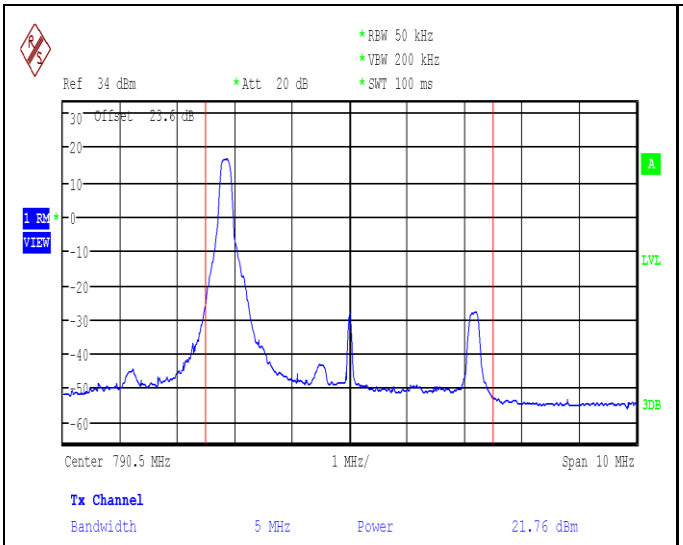
LTE Band 14 -QPSK

Bandwidth (MHz)	Channel Number	Frequency (MHz)	Resource Blocks (RB)	RB Position	Conducted Power (dBm)	Gain (dBi)	E.I.R.P (dBm)	E.R.P (dBm)	Limit E.R.P (dBm)	Margin (dB)
10MHz	23330	793	1	0	22.22	1.84	24.06	21.91	34.77	12.86
				25	21.92	1.84	23.76	21.61	34.77	13.16
				49	22.21	1.84	24.05	21.90	34.77	12.87
			25	0	20.71	1.84	22.55	20.40	34.77	14.37
				25	20.72	1.84	22.56	20.41	34.77	14.36
			50	0	20.61	1.84	22.45	20.30	34.77	14.47

LTE Band 14 -16QAM

Bandwidth (MHz)	Channel Number	Frequency (MHz)	Resource Blocks (RB)	RB Position	Conducted Power (dBm)	Gain (dBi)	E.I.R.P (dBm)	E.R.P (dBm)	Limit E.R.P (dBm)	Margin (dB)
10MHz	23330	793	1	0	20.97	1.84	22.81	20.66	34.77	14.11
				25	20.92	1.84	22.76	20.61	34.77	14.16
				49	20.90	1.84	22.74	20.59	34.77	14.18
			25	0	19.70	1.84	21.54	19.39	34.77	15.38
				25	19.83	1.84	21.67	19.52	34.77	15.25
			50	0	19.76	1.84	21.60	19.45	34.77	15.32

4.1.5 Test Plots



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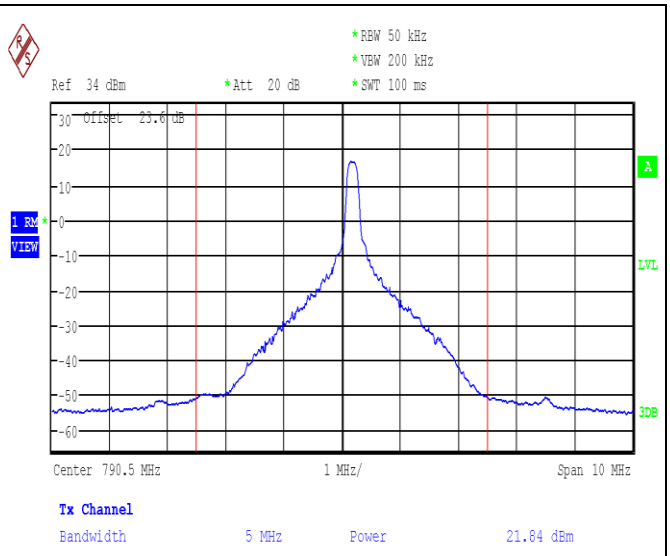
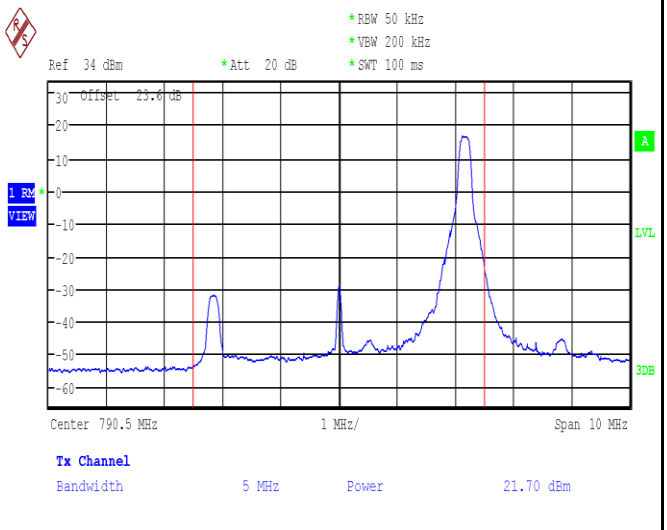


5 MHz-QPSK-790.5MHz-RB# 1 RB Pos: 13



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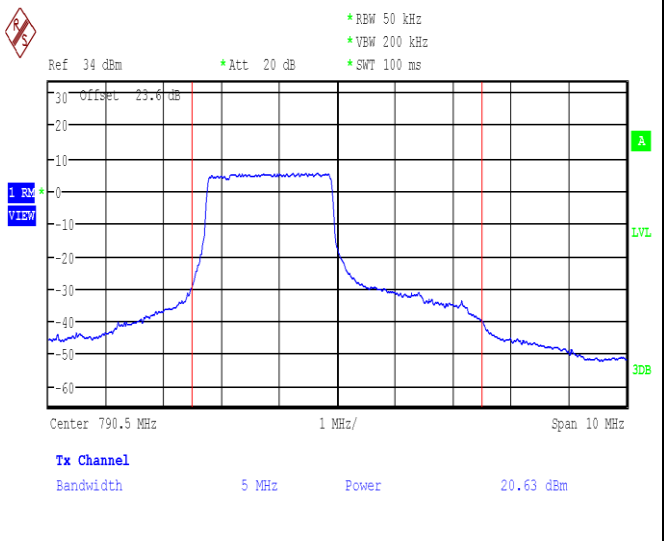

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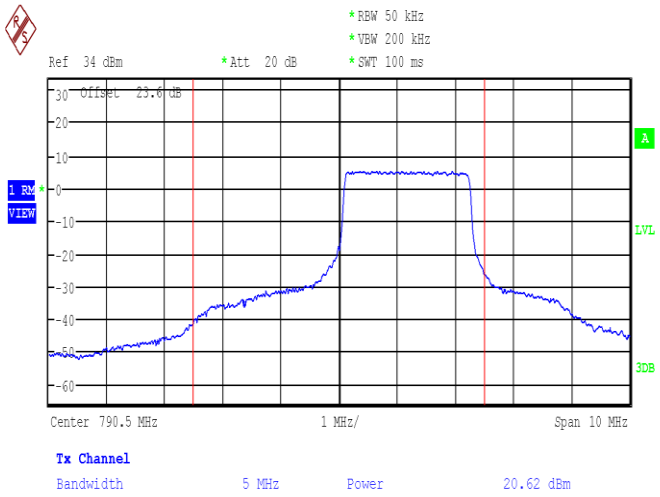
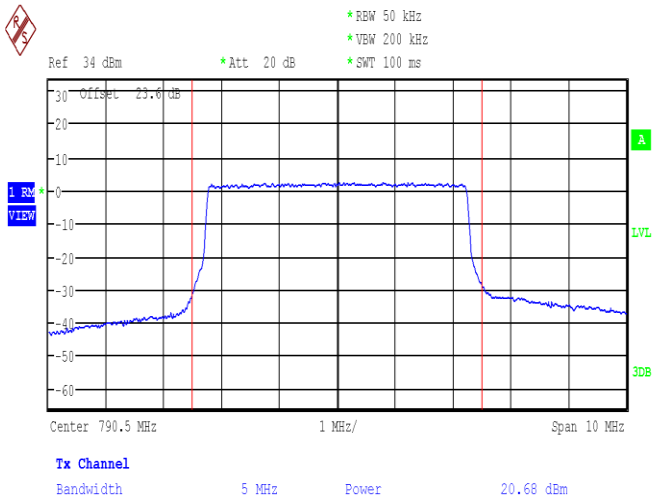


5 MHz-QPSK-790.5MHz-RB# 12 RB Pos: 13



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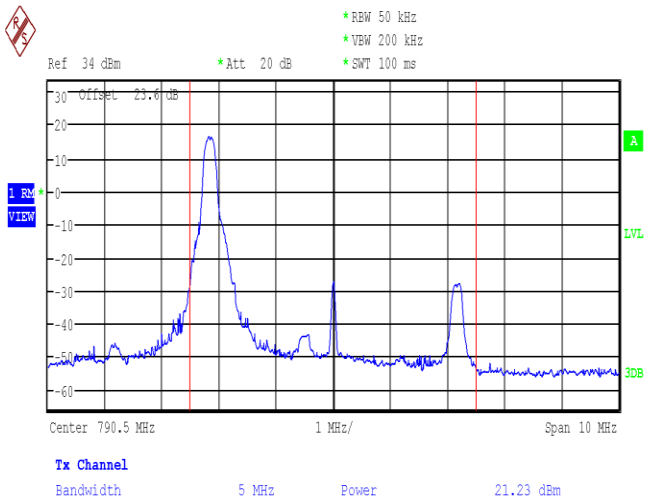

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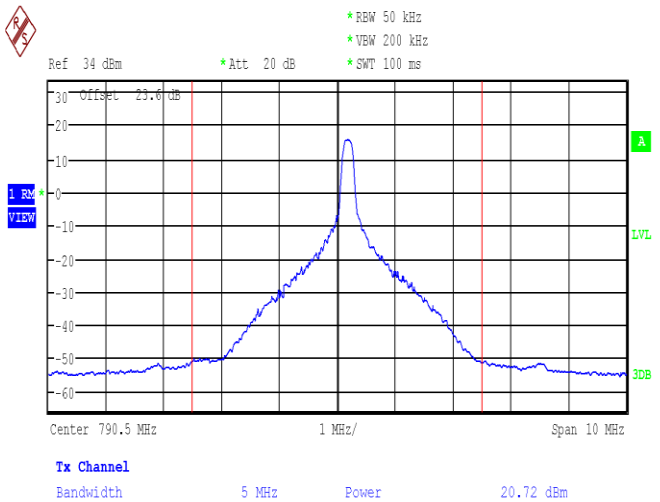

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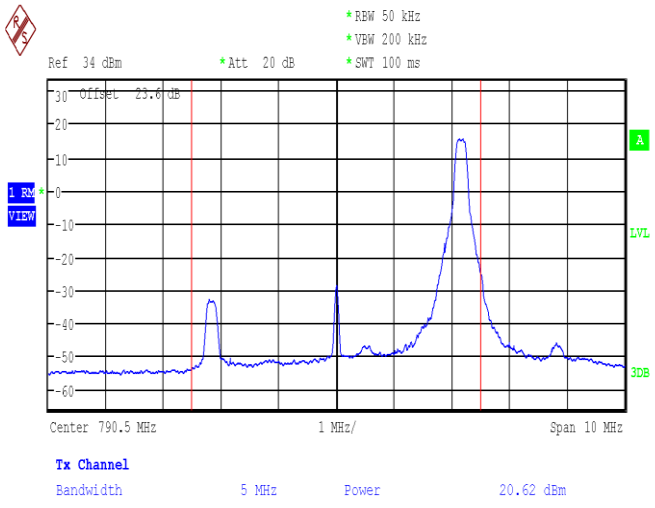

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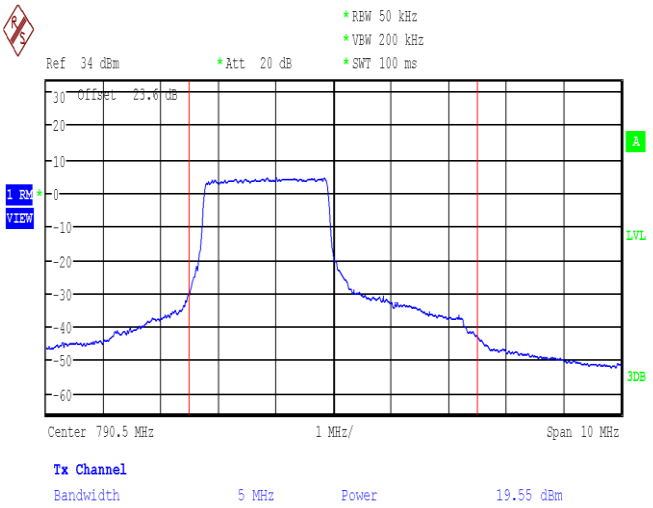

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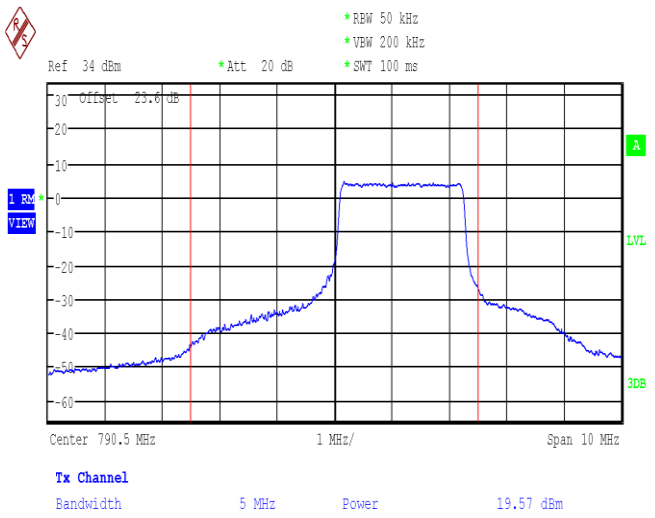

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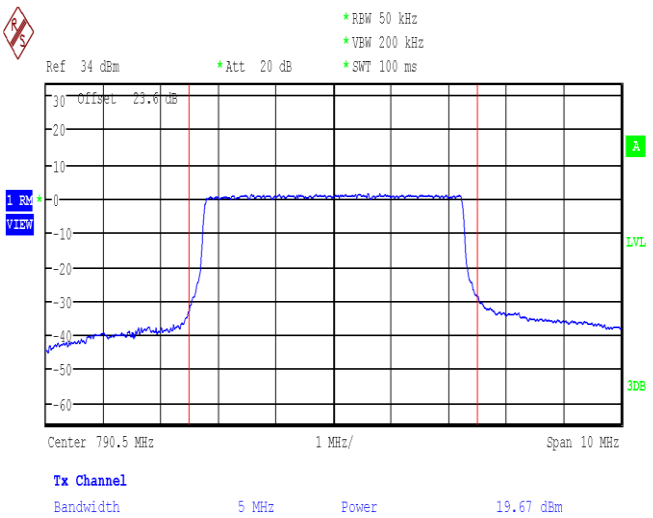
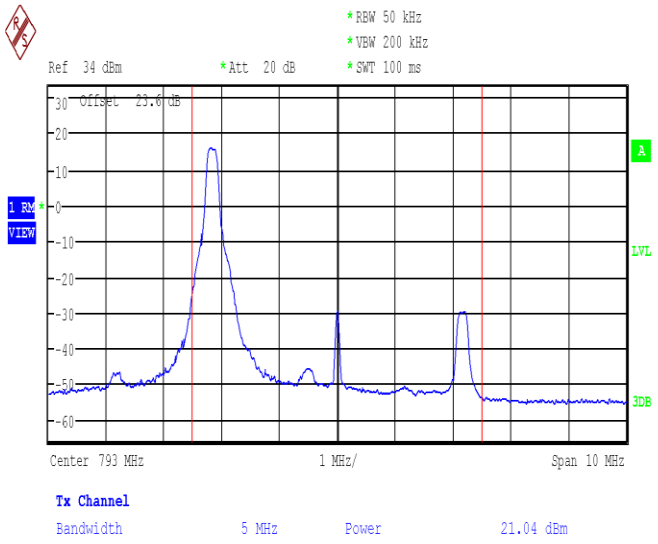


5 MHz-16QAM-790.5MHz-RB# 25 RB Pos: 0



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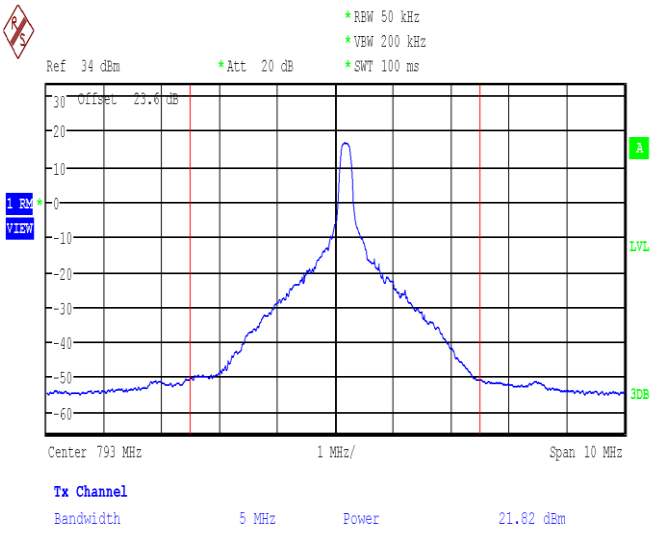

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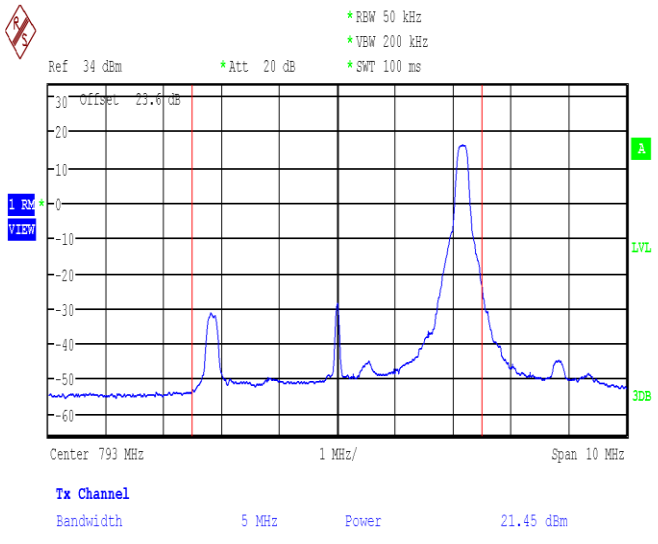
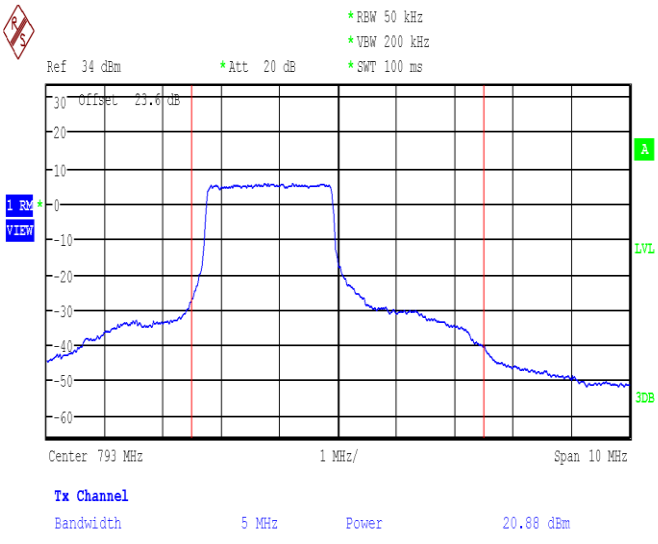
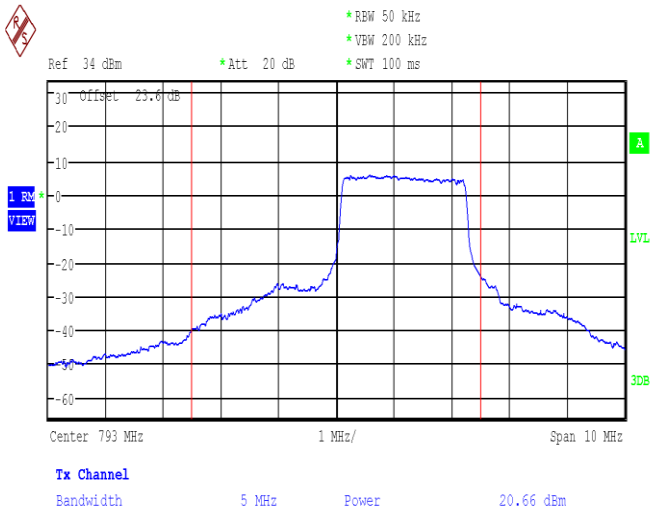


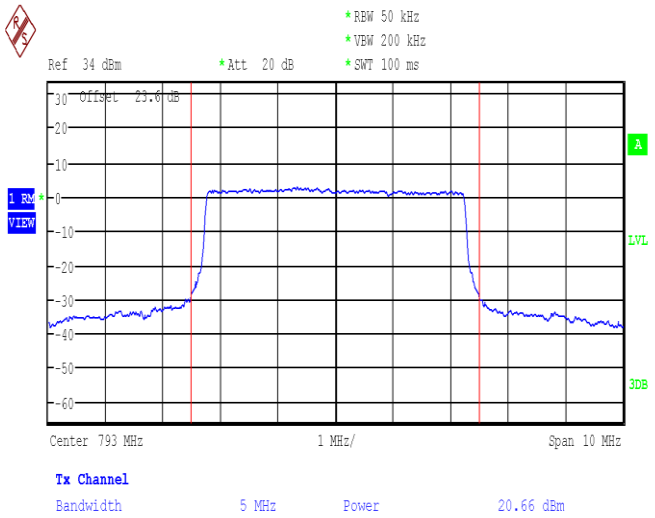
5 MHz-QPSK-793MHz-RB# 1 RB Pos: 24



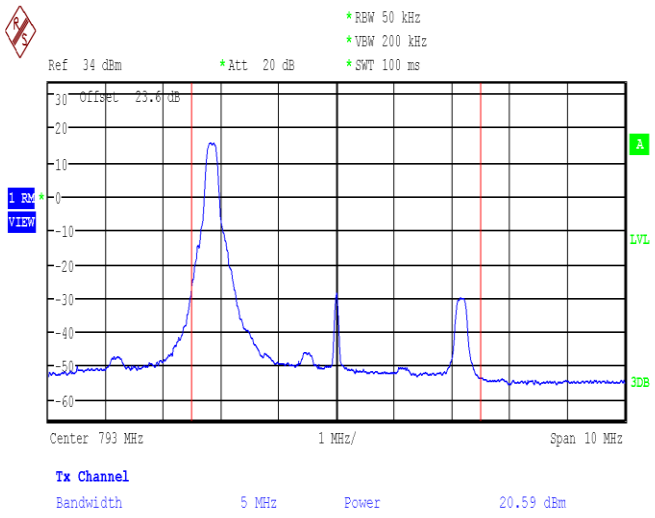
5 MHz-QPSK-793MHz-RB# 12 RB Pos: 0



5 MHz-QPSK-793MHz-RB# 12 RB Pos: 13



5 MHz-QPSK-793MHz-RB# 25 RB Pos: 0



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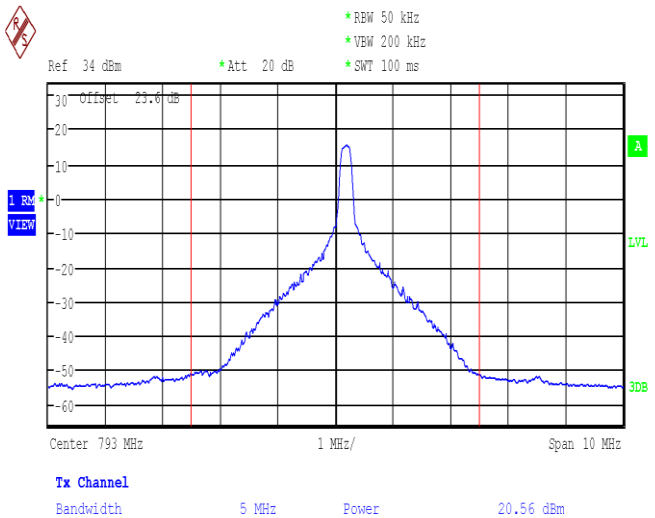
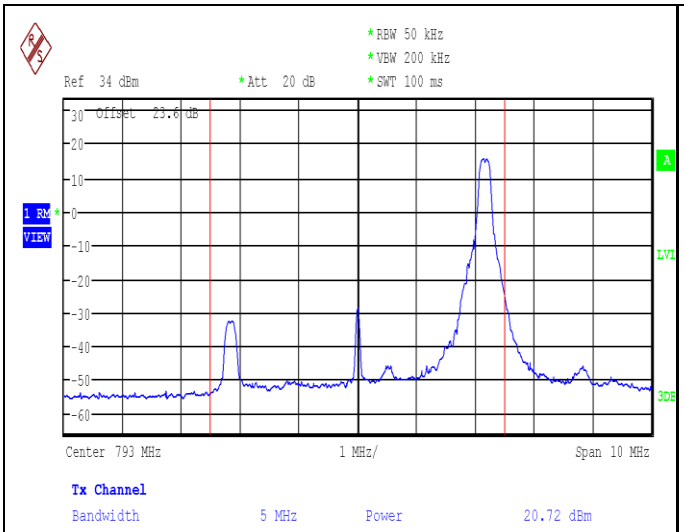
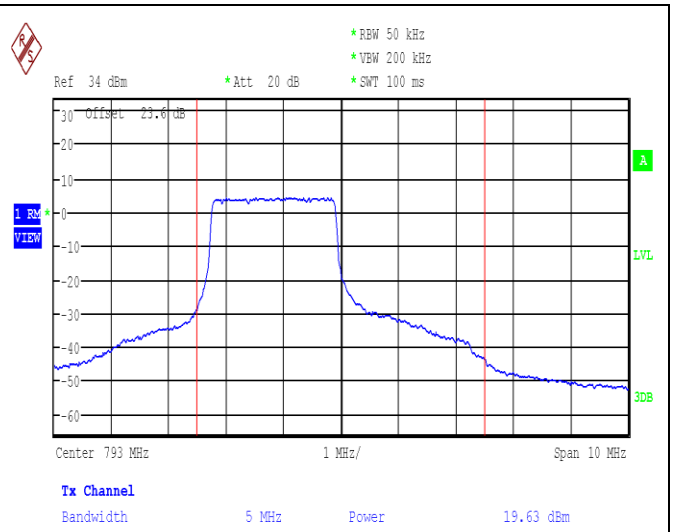


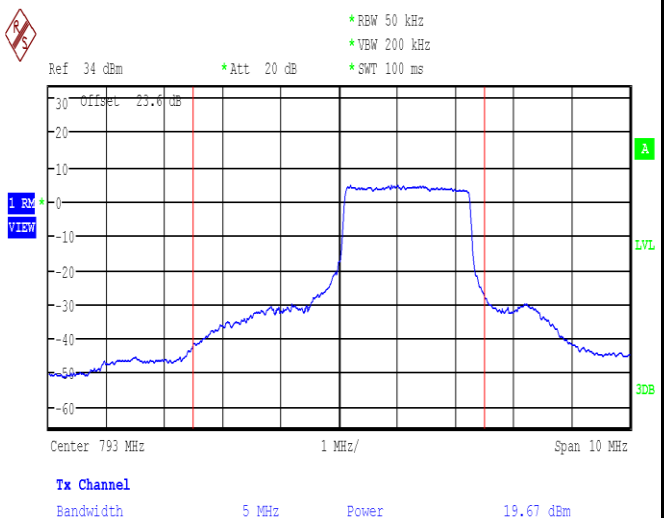
5 MHz-16QAM-793MHz-RB# 1 RB Pos: 13



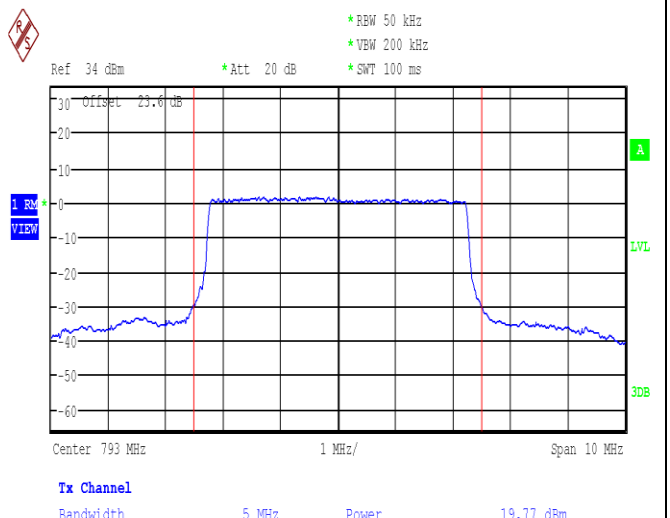
5 MHz-16QAM-793MHz-RB# 1 RB Pos: 24



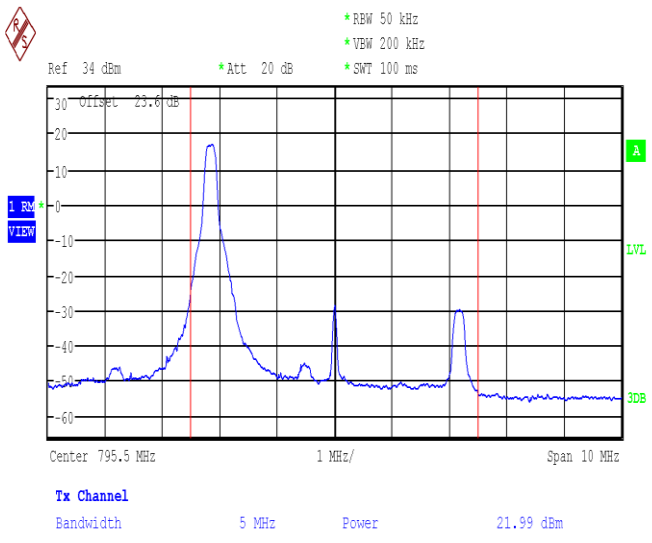
5 MHz-16QAM-793MHz-RB# 12 RB Pos: 0



5 MHz-16QAM-793MHz-RB# 12 RB Pos: 13



5 MHz-16QAM-793MHz-RB# 25 RB Pos: 0



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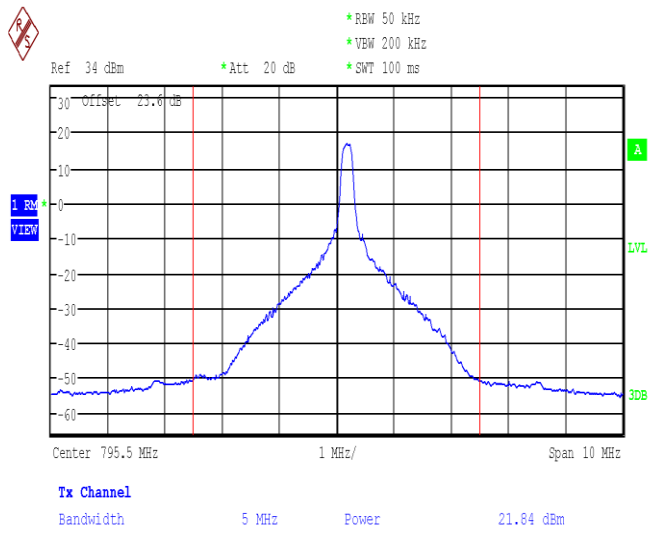

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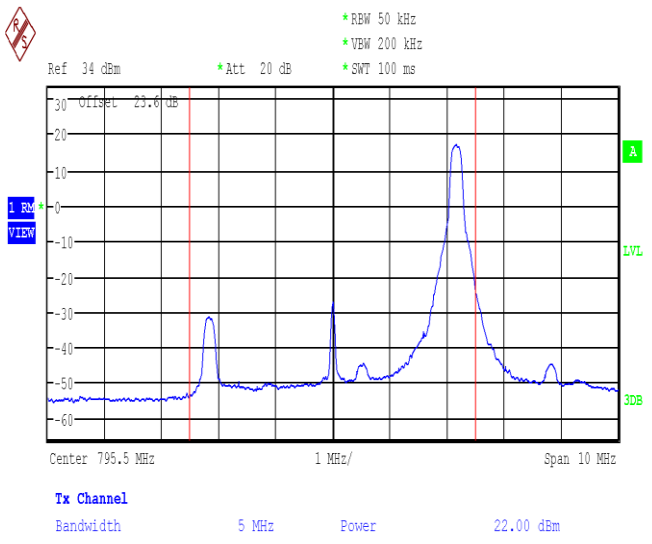

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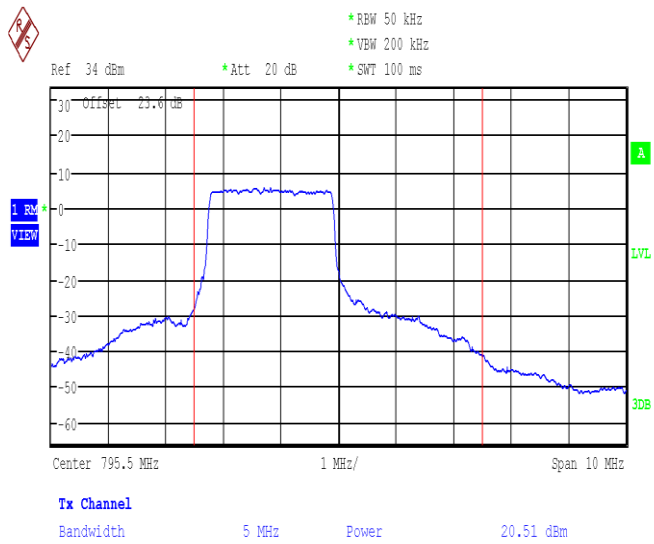

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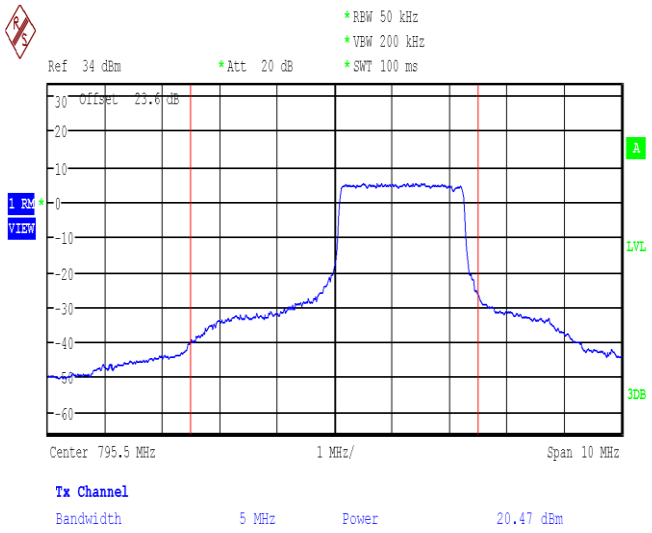

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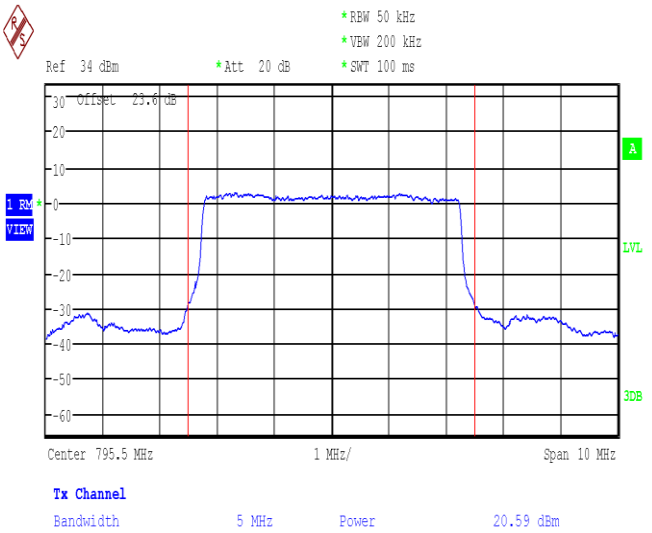
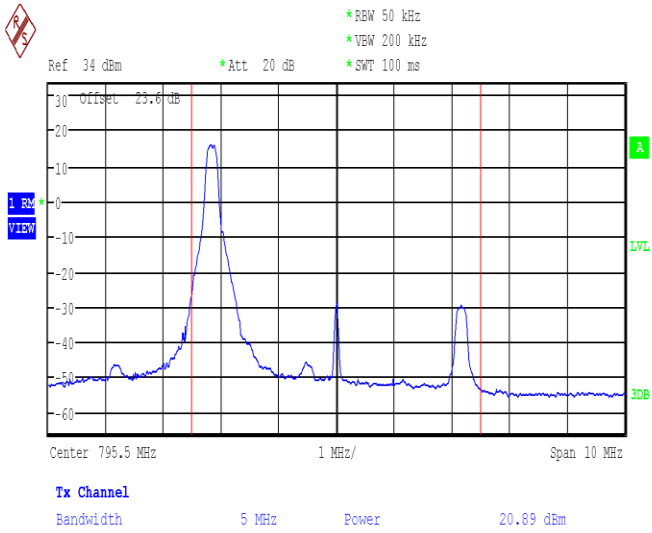


5 MHz-QPSK-795.5MHz-RB# 25 RB Pos: 0



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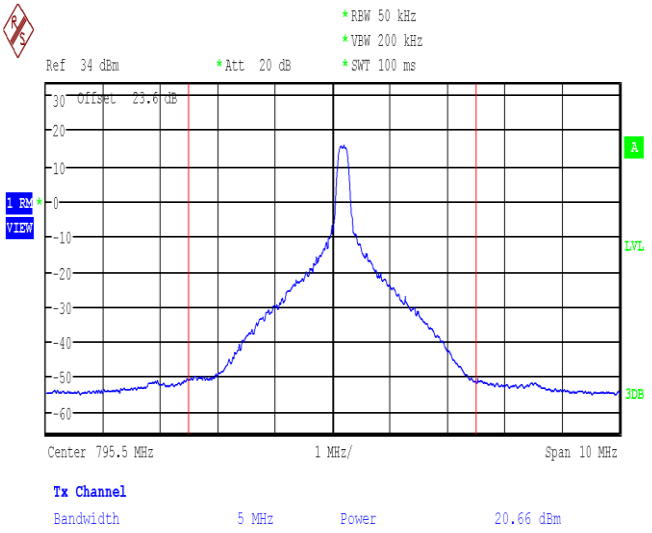

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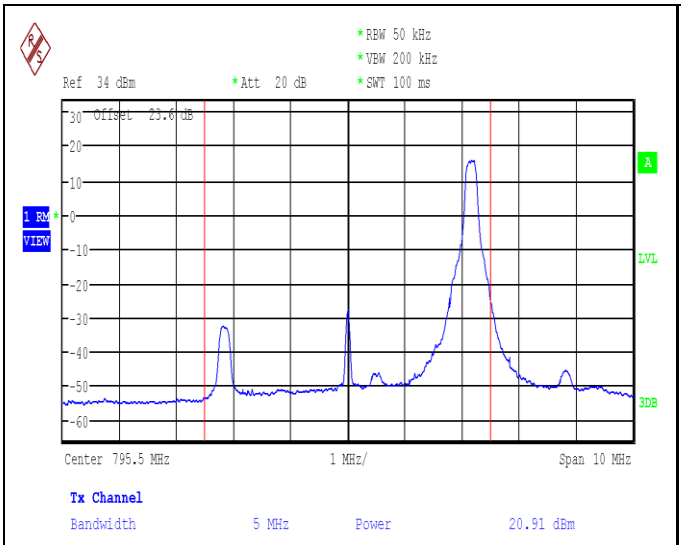
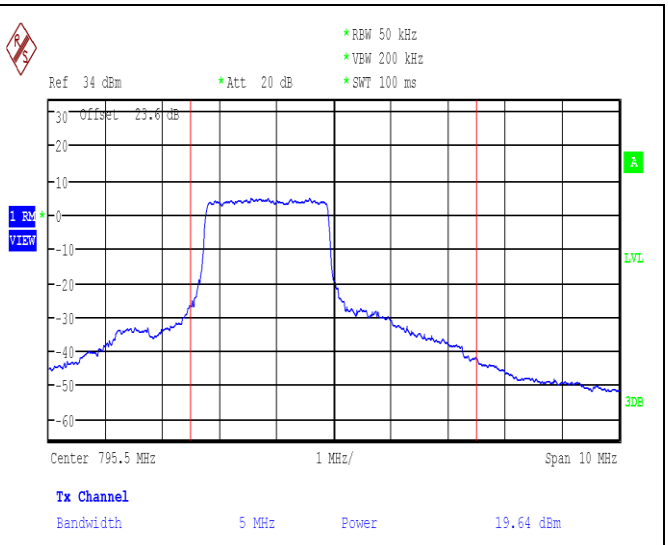


5 MHz-16QAM-795.5MHz-RB# 1 RB Pos: 24



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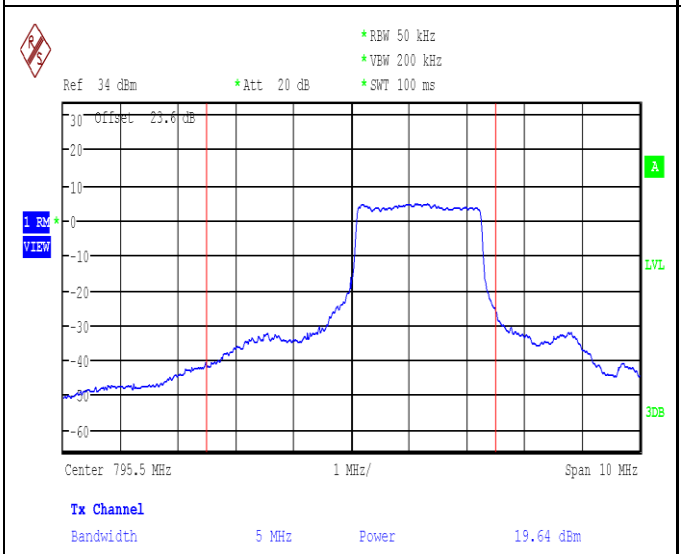
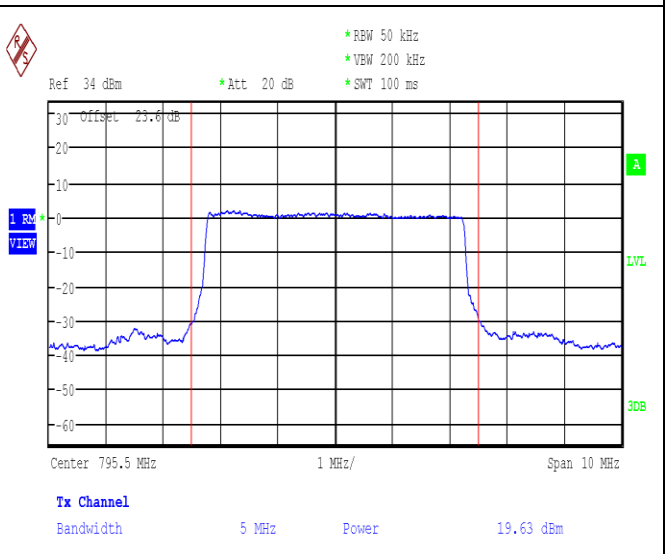
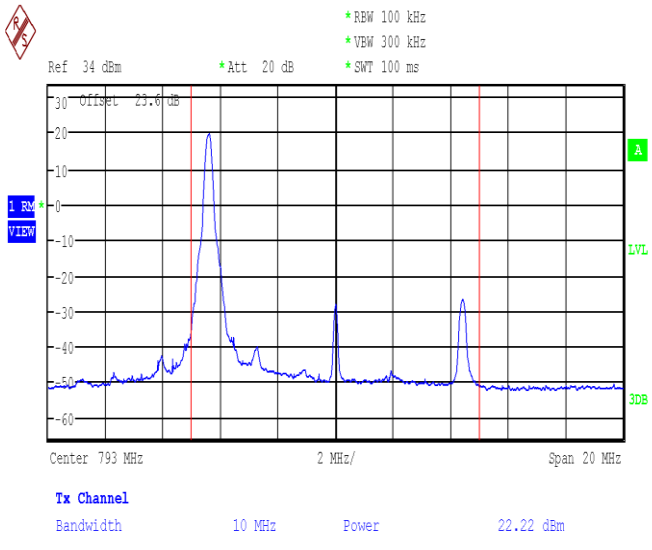


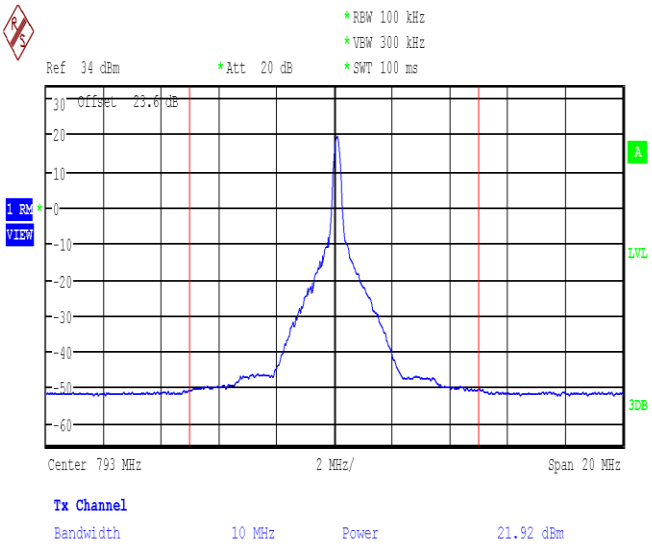
5 MHz-16QAM-795.5MHz-RB# 12 RB Pos: 13



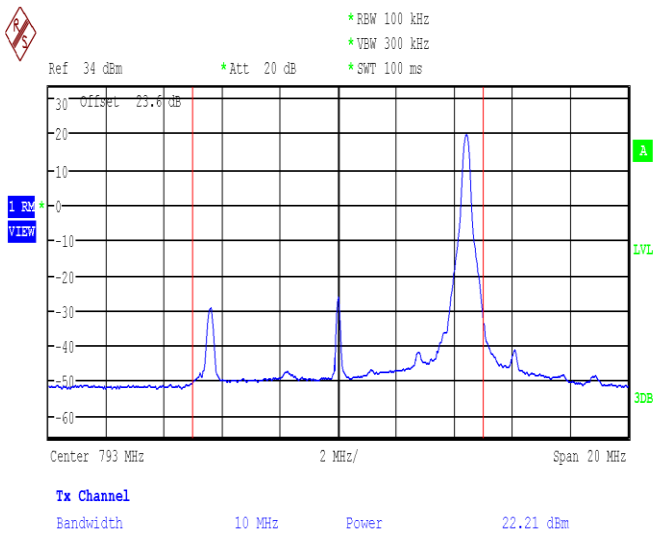
5 MHz-16QAM-795.5MHz-RB# 25 RB Pos: 0



10 MHz-QPSK-793MHz-RB# 1 RB Pos: 0



10 MHz-QPSK-793MHz-RB# 1 RB Pos: 25



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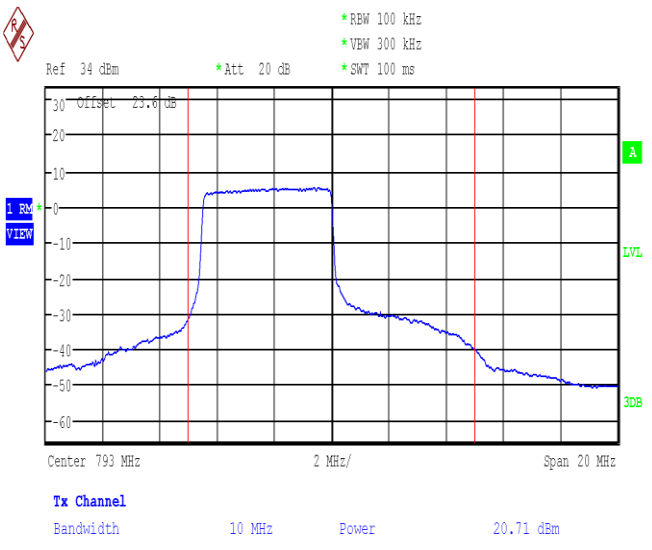
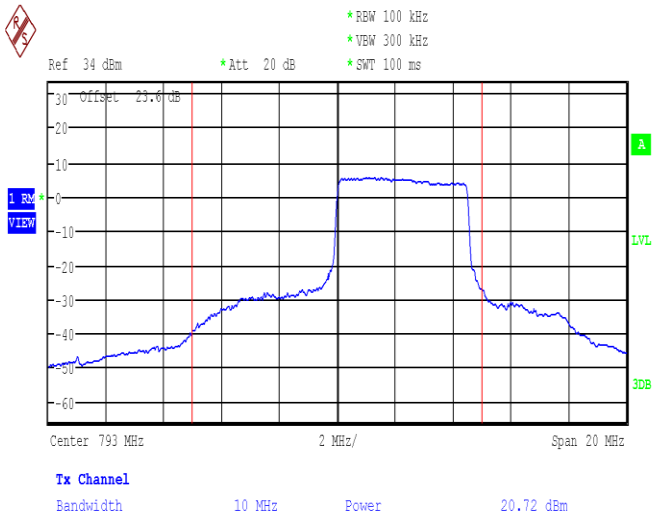
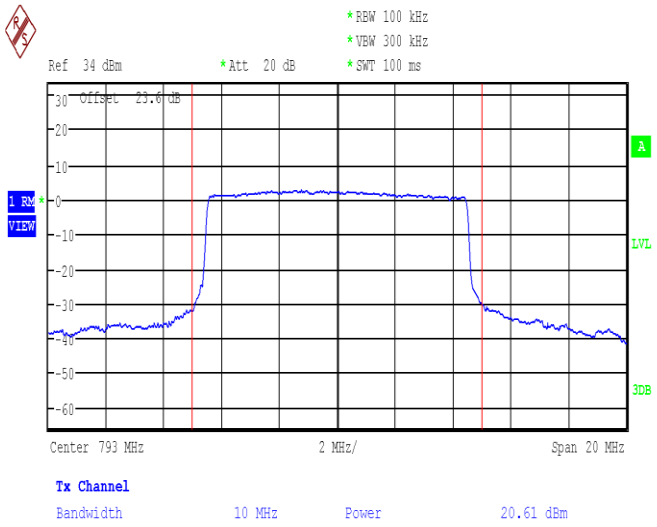


10 MHz-QPSK-793MHz-RB# 25 RB Pos: 0



10 MHz-QPSK-793MHz-RB# 25 RB Pos: 25



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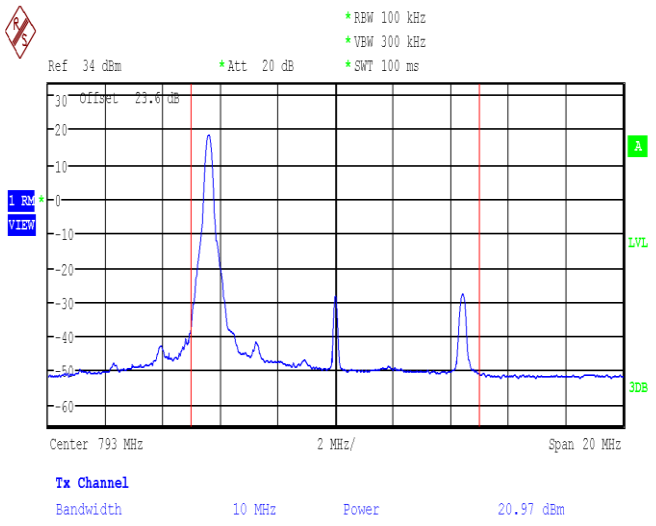
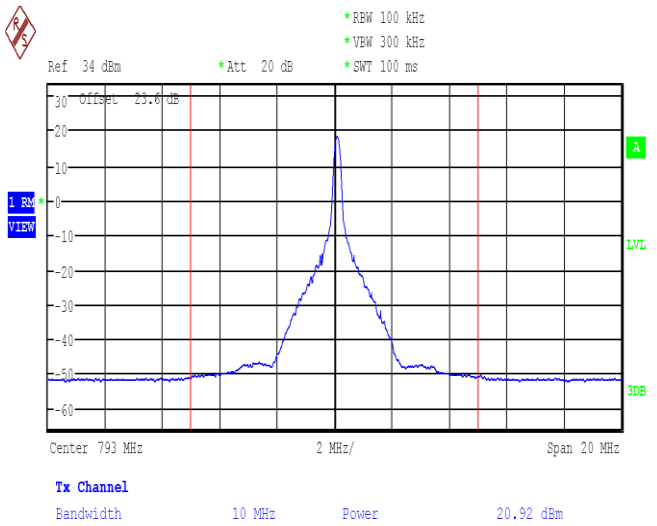
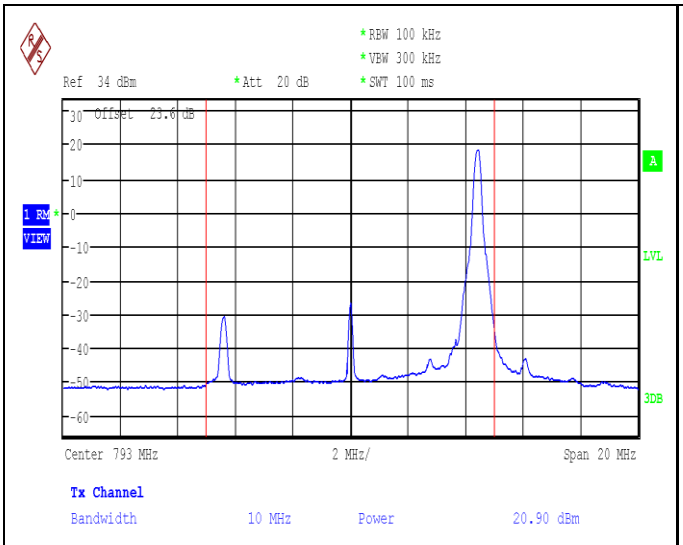


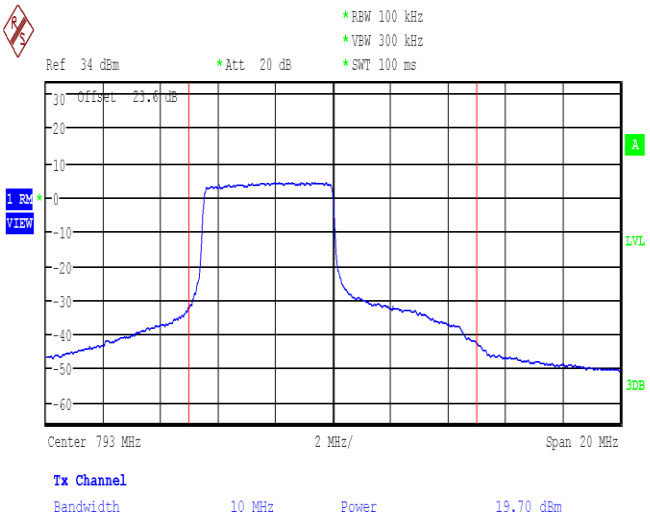
10 MHz-16QAM-793MHz-RB# 1 RB Pos: 0



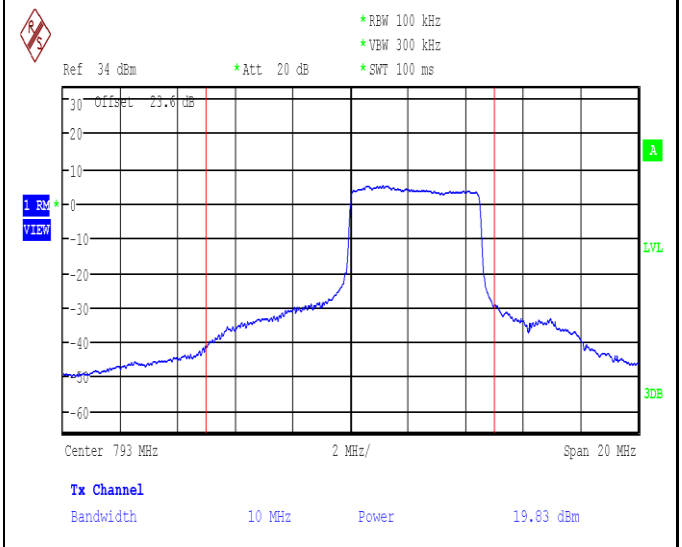
10 MHz-16QAM-793MHz-RB# 1 RB Pos: 25



10 MHz-16QAM-793MHz-RB# 1 RB Pos:49



10 MHz-16QAM-793MHz-RB# 25 RB Pos: 0



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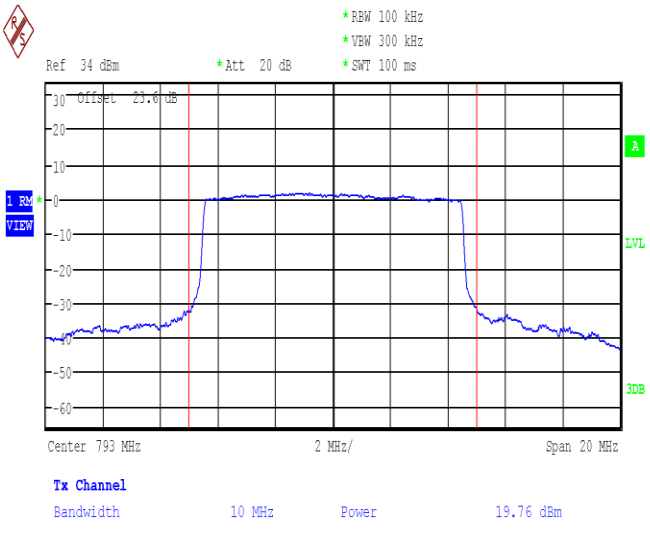


10 MHz-16QAM-793MHz-RB# 50 RB Pos: 0

4.2 *Occupied Bandwidth*

§90.209 (a) Each authorization issued to a station licensed under this part will show an emission designator representing the class of emission authorized. The designator will be prefixed by a specified necessary bandwidth. This number does not necessarily indicate the bandwidth occupied by the emission at any instant. In those cases where part 2.202 of this chapter does not provide a formula for the computation of necessary bandwidth, the occupied bandwidth, as defined in part 2 of this chapter, may be used in lieu of the necessary bandwidth.

4.2.1 **Test Methodology**

4.2.1.1 26dB Bandwidth

KDB 971168 D01 V03 section 4.2 and ANSI C63.26-2015 Section 5.4.3 Occupied bandwidth – Relative Measurement procedure were used. The EUT was setup with the CMW500 to transmit at 100% duty cycle and the corresponding bandwidths, modulations, and Recourse Block configurations. In all cases the EUT was setup to transmit at maximum power via the CMW500. The device's antenna port was directly connected to the spectrum analyzer with the following setting:

1. Center frequency set to the EUT's channel center frequency
2. Span = 1.5 to 2 times the anticipated OBW
3. RBW = 1% to 5% of the anticipated OBW
4. VBW ≥ 3 x RBW
5. Reference level set not to exceed analyzer's input mixer level for linear operation
6. Detector = Peak
7. Trace = Max Hold

Measured the maximum power of the signal (reference value). Used reference value to find 26 dBc above and below the reference value. Used the delta marker function to determine the 26 OBW.

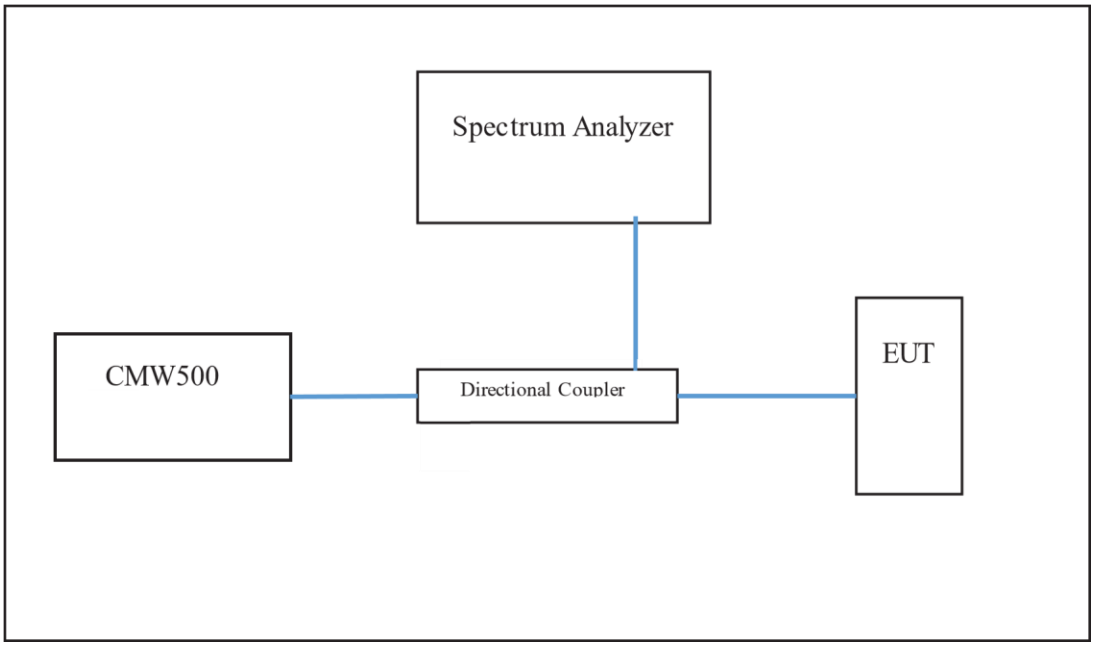
4.2.1.2 99% Bandwidth

KDB 971168 D01 V03 section 4.3 and ANSI C63.26-2015 Section 5.4.4 Occupied Bandwidth – Power Bandwidth (99%) measurement procedure was used. The EUT was setup with the CMW500 to transmit at 100% duty cycle and the corresponding bandwidths, modulations, and Recourse Block configurations. In all cases the EUT was setup to transmit at maximum power via the CMW500. The device antenna port was directly connected to the spectrum analyzer with the following settings:

1. Center frequency set to the EUT channel center frequency
2. Span = 1.5 x OBW
3. RBW = 1% to 5% of the anticipated OBW
4. Reference level set not to exceed the analyzer's input mixer level for linear operation
5. Detector = Peak
6. Trace = Max Hold

Measured the device's OBW using the analyzer's 99% OBW function.

4.2.2 Test Setup



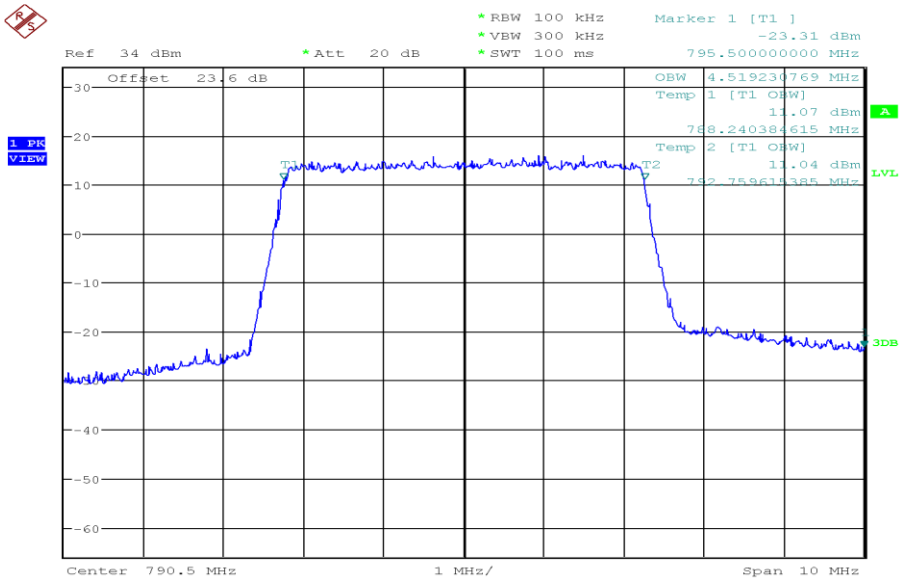
4.2.3 Deviations

N/A

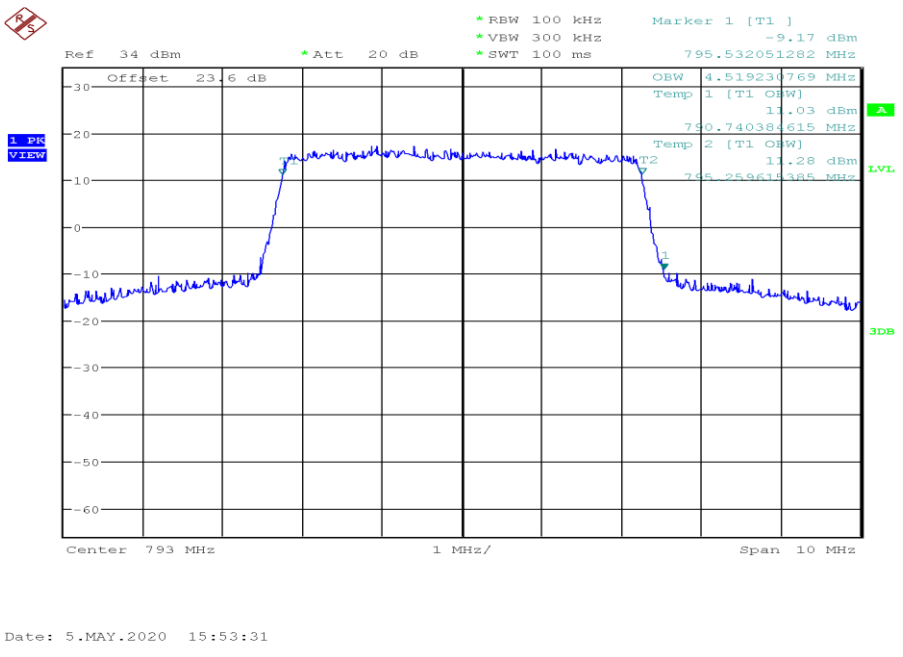
4.2.4 Test Results

LTE Band 14						
RB	Bandwidth (MHz)	Bandwidth (MHz)	Channel	Frequency (MHz)	99% Power Bandwidh (MHz)	-26dBc Bandwidth (MHz)
100%	QPSK	5	23305	790.5	4.519	5.032
			23330	793.0	4.519	5.240
			23355	795.5	4.535	5.048
		10	23330	793.0	9.103	10.321
	16 QAM	5	23305	790.5	4.535	5.048
			23330	793.0	4.519	5.208
			23355	795.5	4.535	5.096
		10	23330	793.0	9.103	10.384

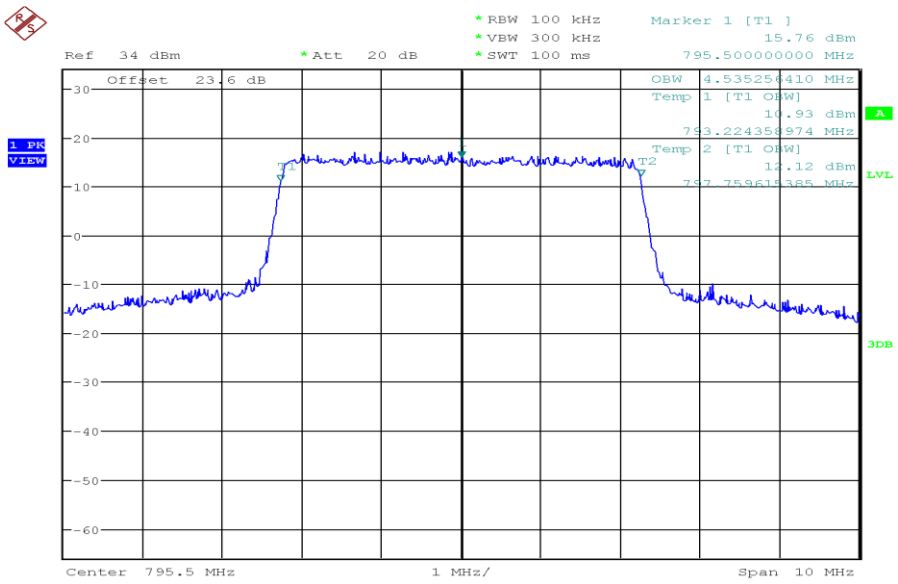
4.2.5 **Test Plots**



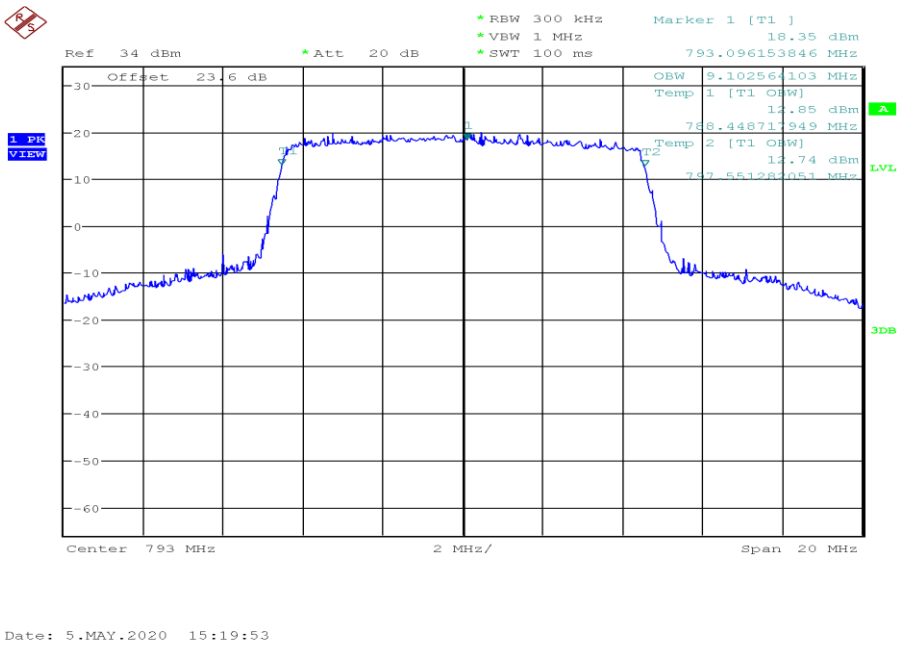
99% OBW-5 MHz-QPSK– Ch: 23305–790.5MHz



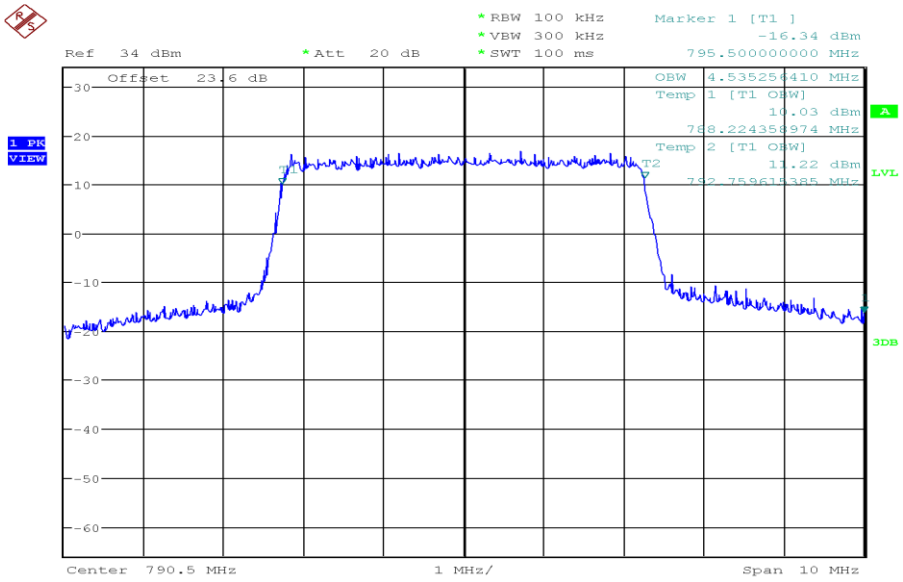
99% OBW-5 MHz-QPSK– Ch: 23330–793MHz



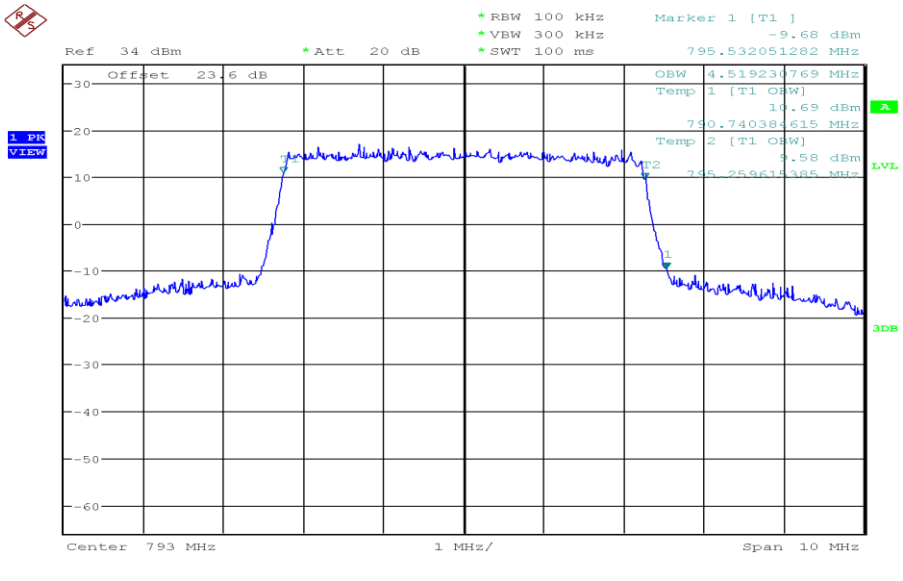
99% OBW-5 MHz-QPSK– Ch: 23355–795.5MHz



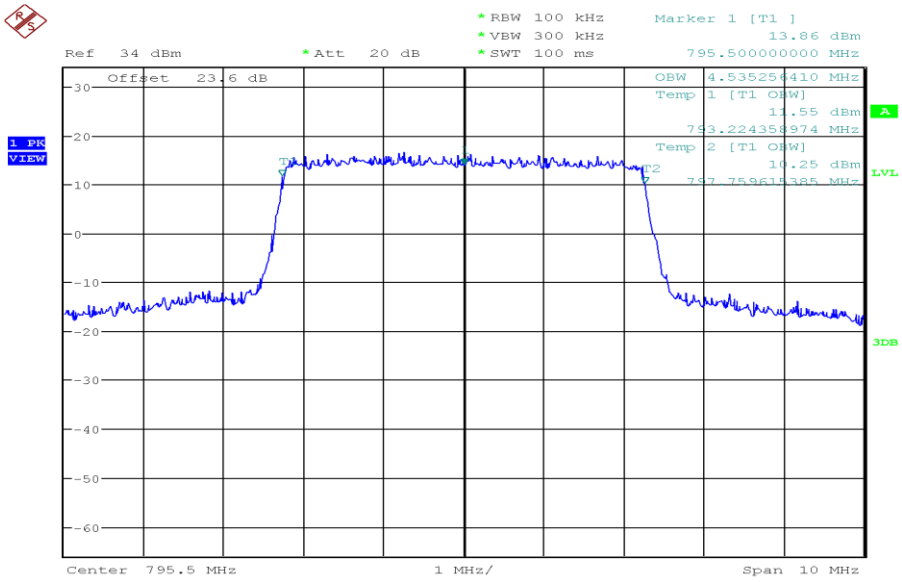
99% OBW-10 MHz-QPSK– Ch: 23330–793MHz



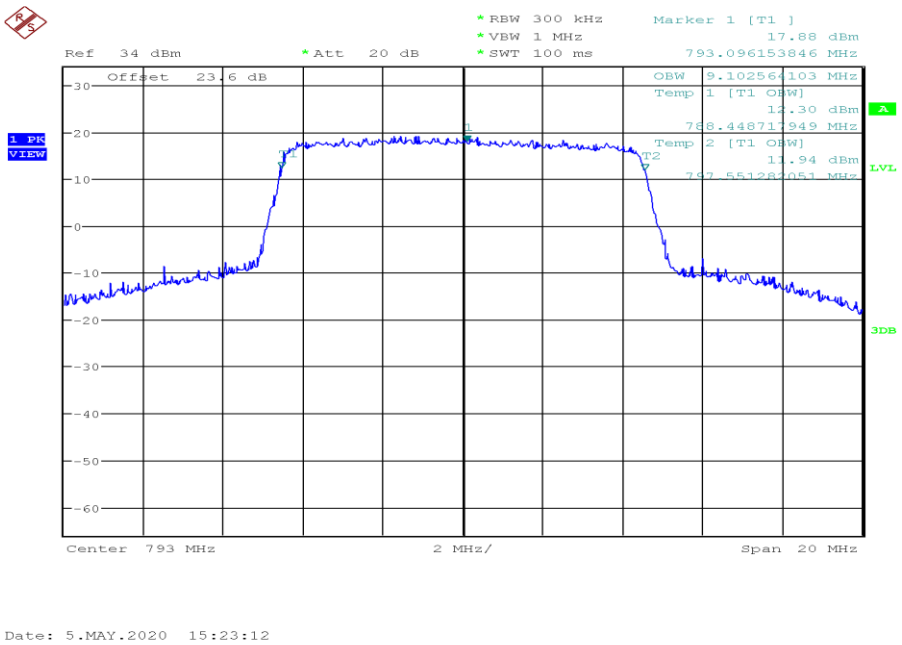
99% OBW-5 MHz-16QAM– Ch: 23305–790.5MHz



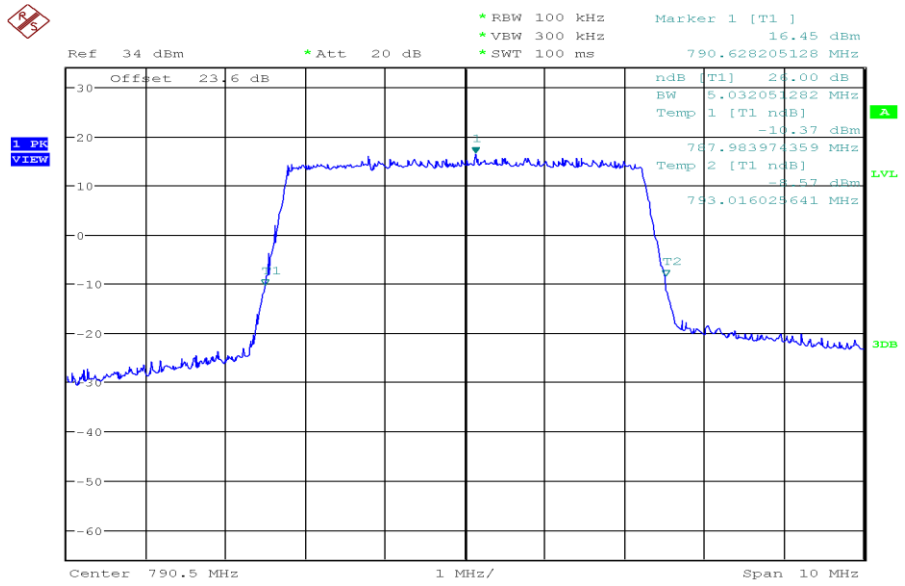
99% OBW-5 MHz-16QAM– Ch: 23330–793MHz



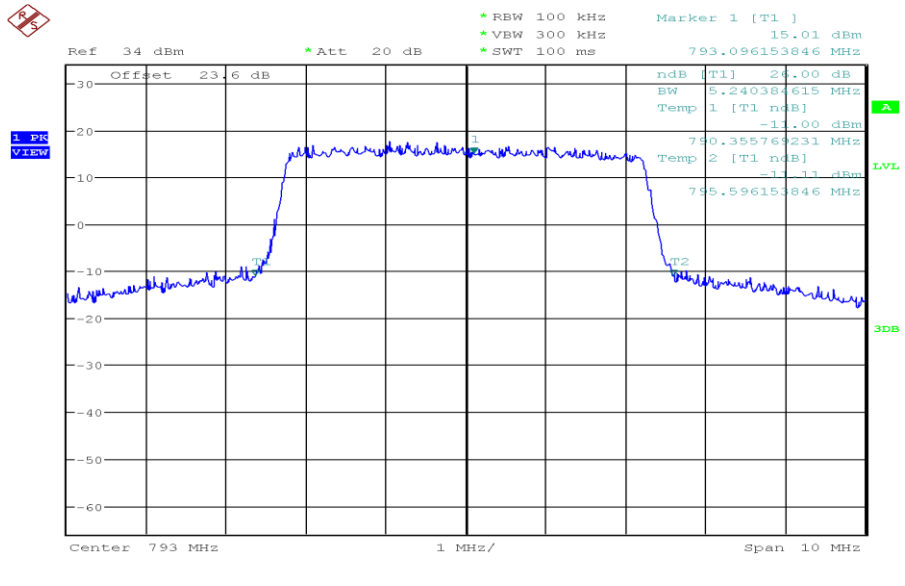
99% OBW-5 MHz-16QAM– Ch: 23355–795.5MHz



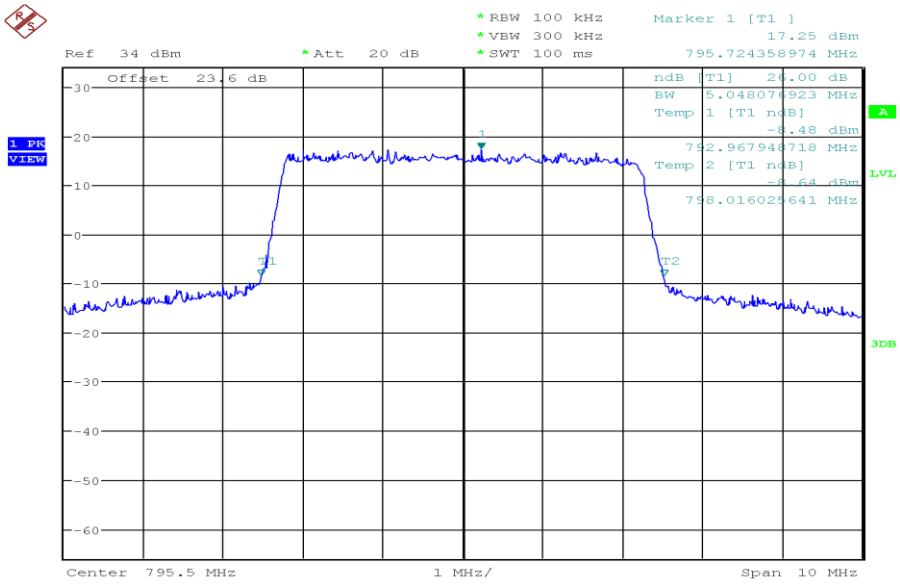
99% OBW-10 MHz-16QAM– Ch: 23330–793MHz



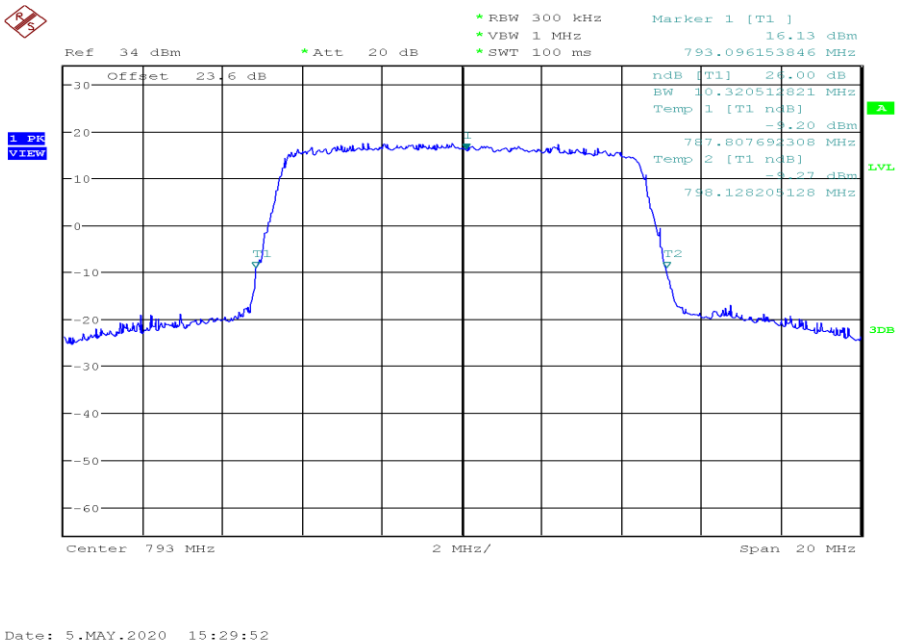
26dB Bandwidth-5 MHz-QPSK– Ch: 23305–790.5MHz



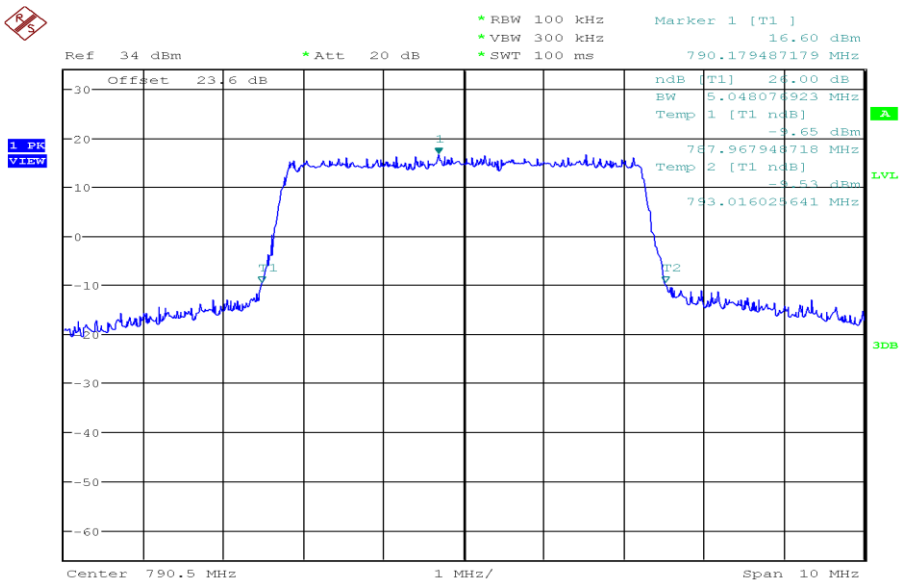
26dB Bandwidth-5 MHz-QPSK– Ch: 23330–793MHz



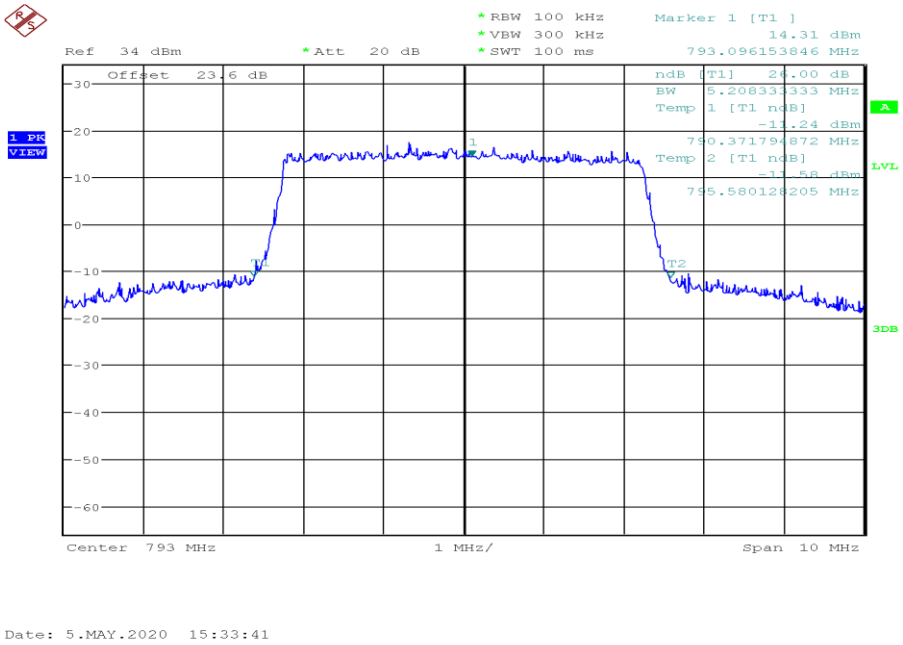
26dB Bandwidth-5 MHz-QPSK– Ch: 23355–795.5MHz



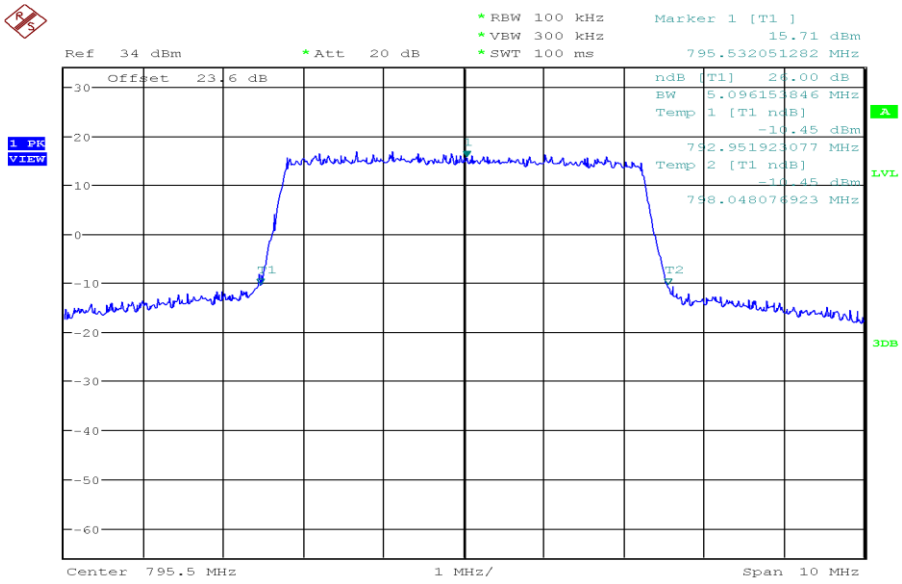
26dB Bandwidth-10 MHz-QPSK– Ch: 23330–793MHz



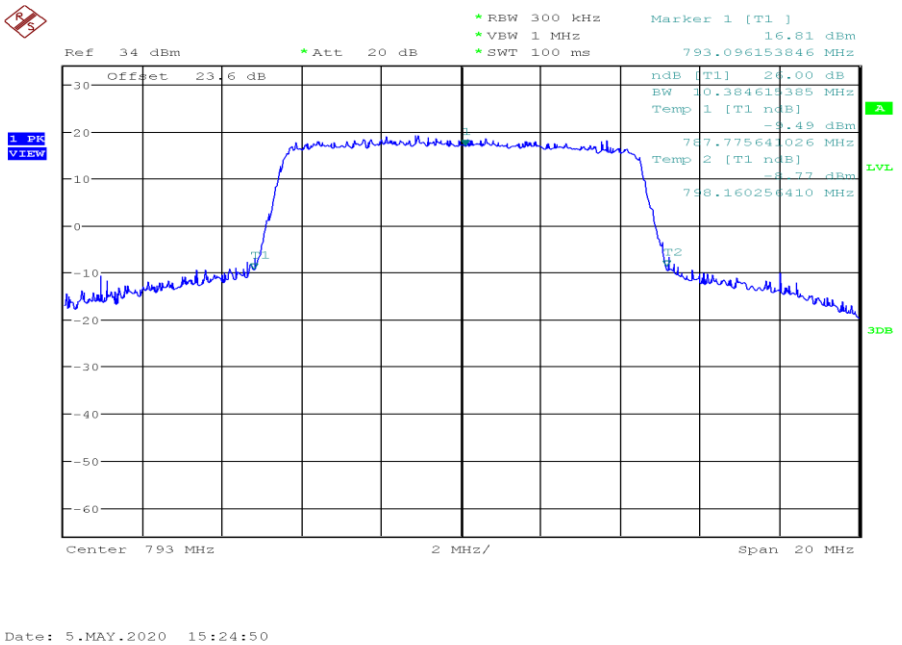
26dB Bandwidth-5 MHz-16QAM– Ch: 23305–790.5MHz



26dB Bandwidth-5 MHz-16QAM– Ch: 23330–793MHz



26dB Bandwidth-5 MHz-16QAM– Ch: 23355–795.5MHz



26dB Bandwidth-10 MHz-16QAM– Ch: 23330–793MHz

4.3 *Emission Mask Measurement*

Per 90.210(n), Emission mask shall comply with 90.210(b)

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than100 percent of the authorized bandwidth: At least 25 dB.

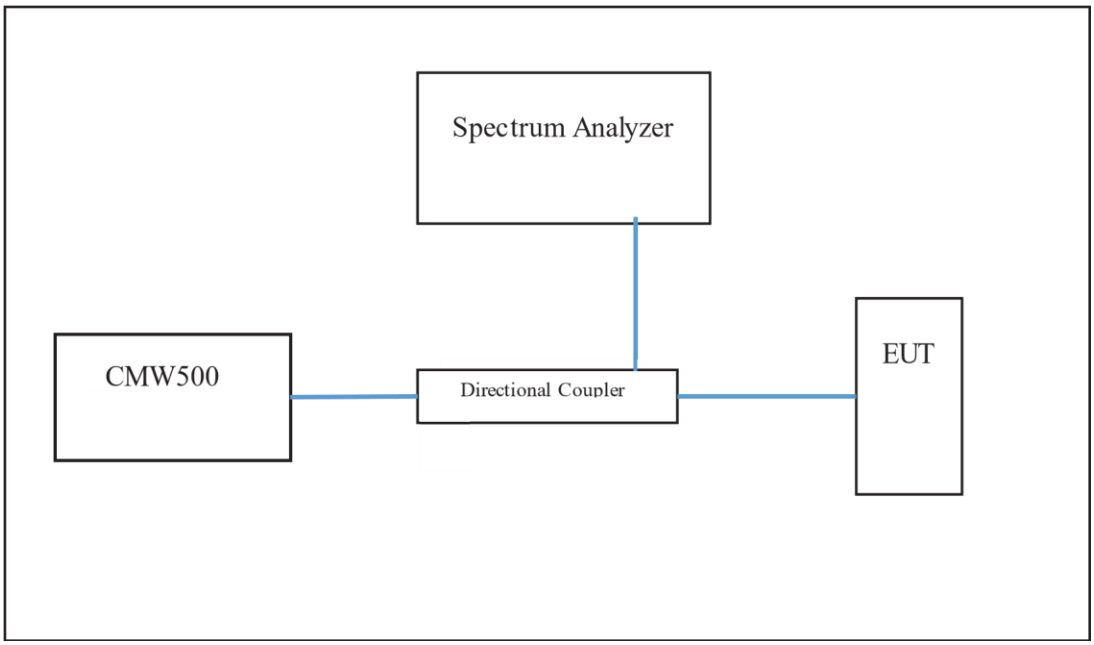
(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB

4.3.1 **Test Methodology**

The EUT was connected to Spectrum Analyzer and Base Station Simulator via directional coupler. The band edge of the lowest and highest channels were measured. The average detector is used.

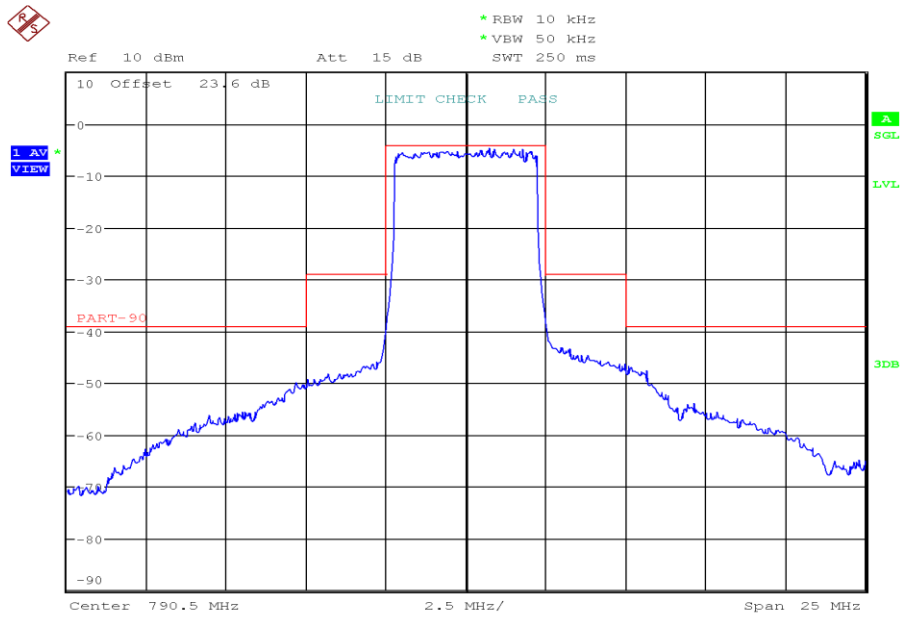
4.3.2 **Test Setup**



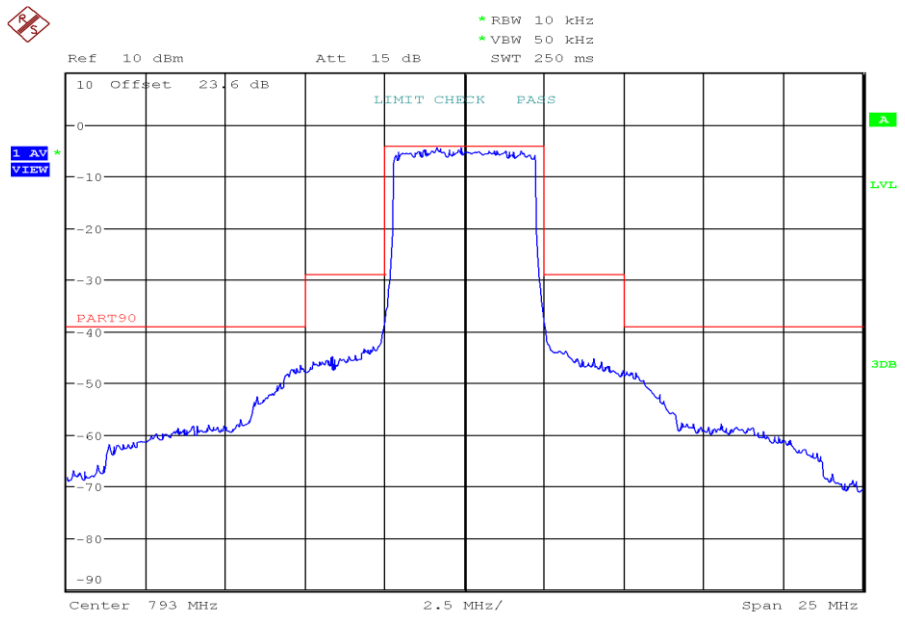
4.3.3 **Deviations**

N/A

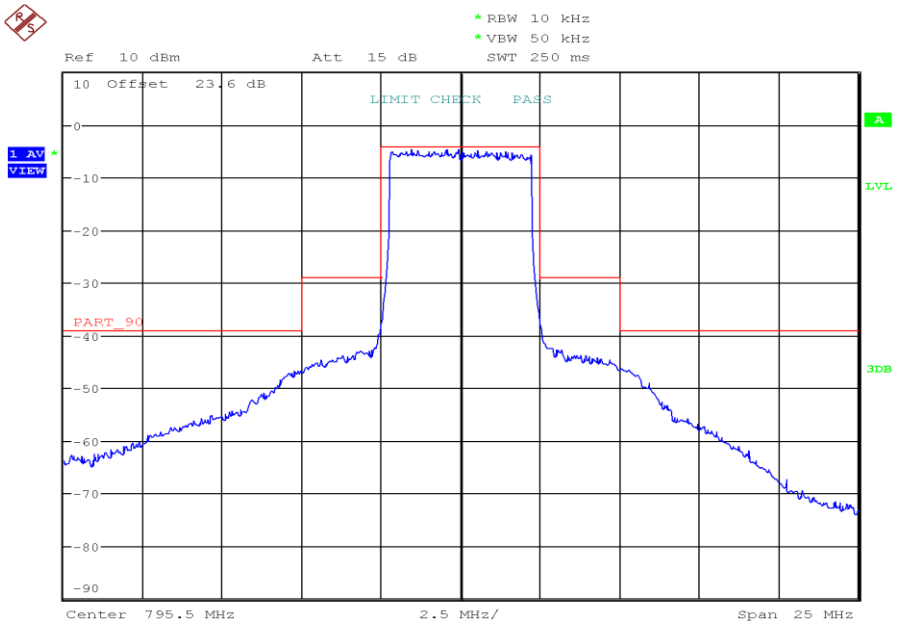
4.3.4 Test Results:



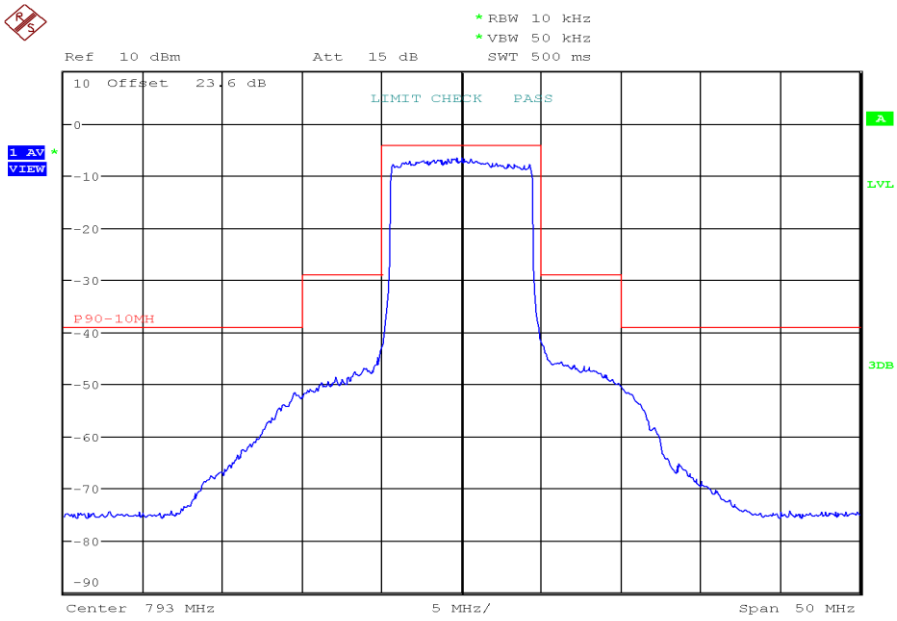
Emission Mask-5 MHz-QPSK– Ch: 23305–790.5MHz



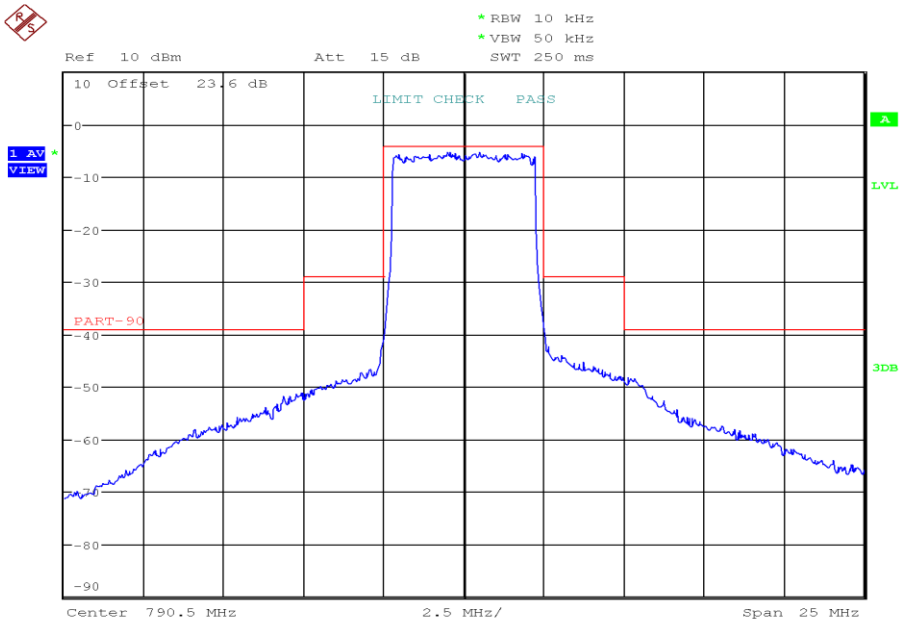
Emission Mask-5 MHz-QPSK– Ch: 23330–793MHz



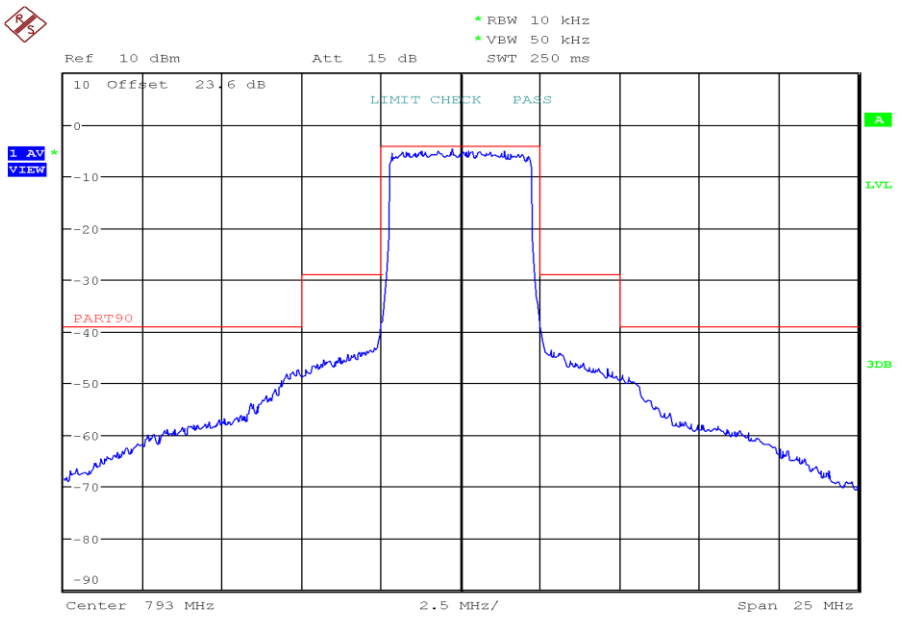
Emission Mask-5 MHz-QPSK– Ch: 23355–795.5MHz



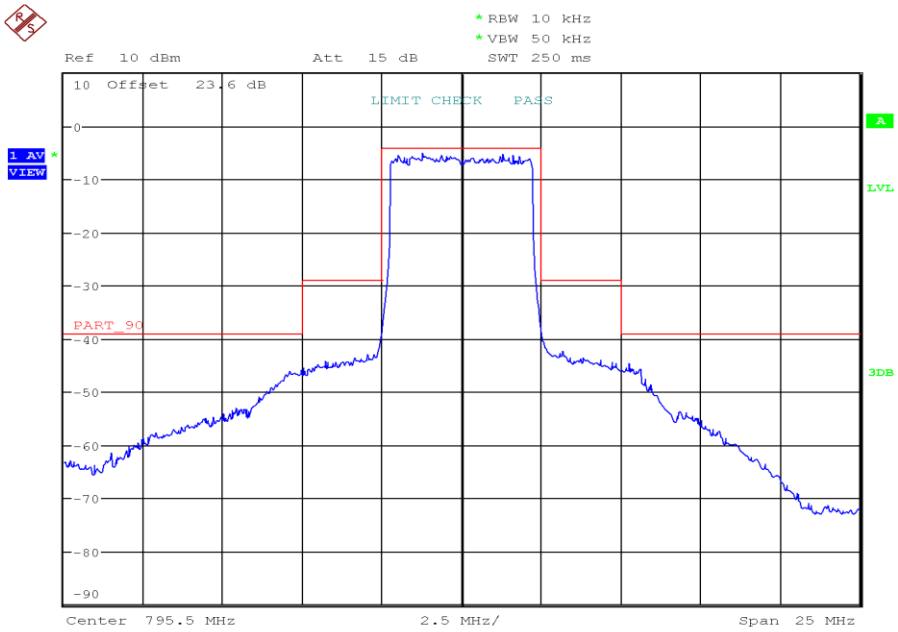
Emission Mask-10 MHz-QPSK– Ch: 23330–793MHz



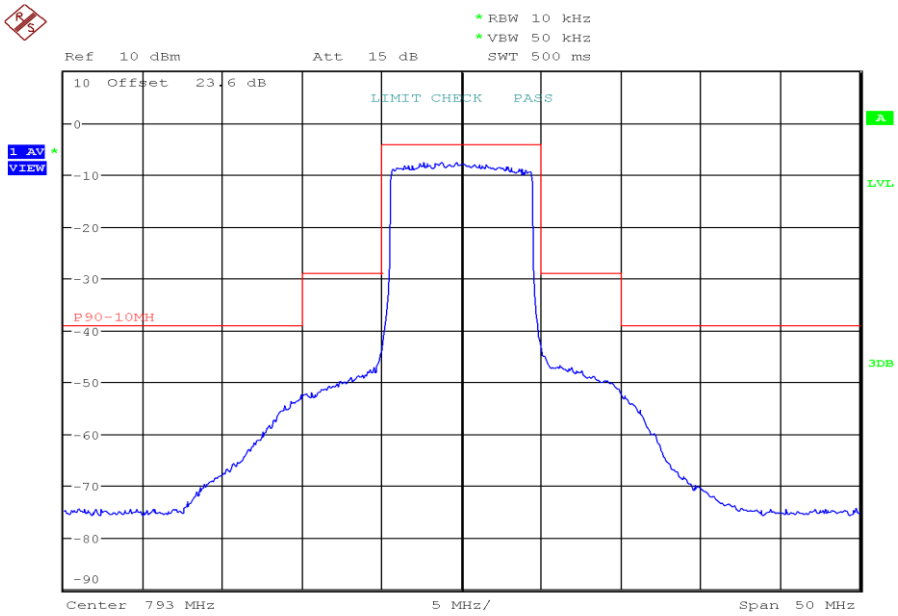
Emission Mask-5 MHz-16QAM– Ch: 23305–790.5MHz



Emission Mask-5 MHz-16QAM– Ch: 23330–793MHz



Emission Mask-5 MHz-16QAM– Ch: 23355–795.5MHz



Emission Mask-10 MHz-16QAM– Ch: 23330–793MHz

4.4 Band Edge

Part 90.543 Emission limitations (e) For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations.

(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.

(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least 43 + 10 log (P) dB.

(4) Compliance with the provisions of paragraphs (e)(1) and (2) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

(5) Compliance with the provisions of paragraph (e)(3) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.

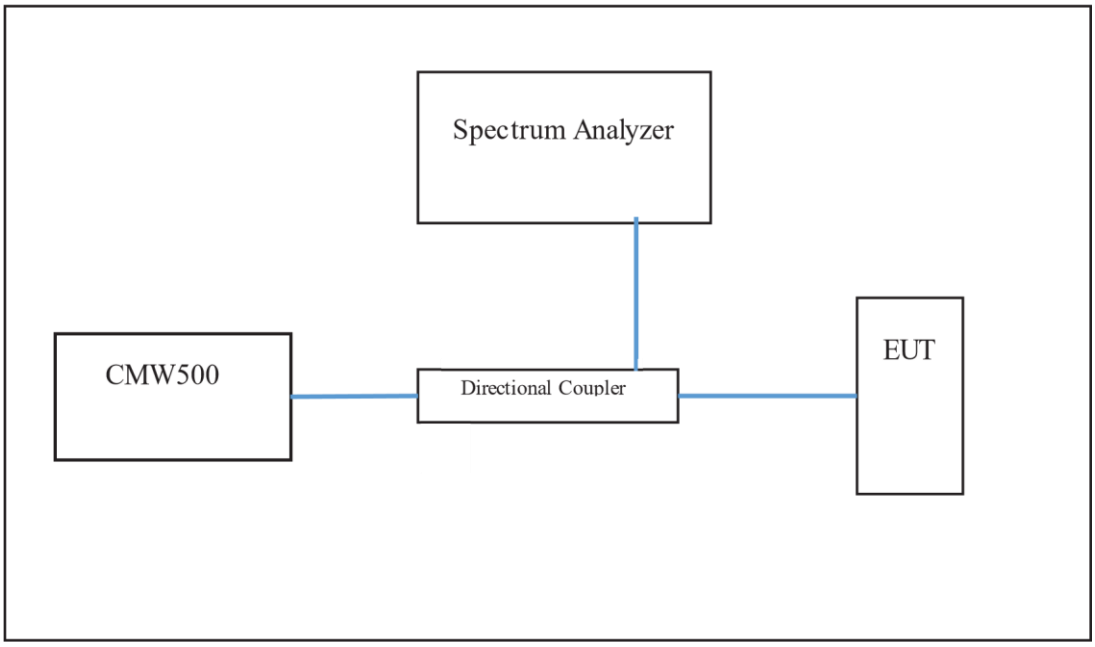
(f) For operations in the 758-775 MHz and 788-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

4.4.1 Test Methodology

KDB 971168 D01 v03 section 6 Spurious Emissions at Antenna Port and ANSI C63.26-2015 section 5.7 – Unwanted (out-of-band and spurious emissions) conducted emissions measurement procedures (conducted test at antenna port) were used. The EUT was configured with the CMW 500 to the measured center frequency transmitting at a 100% duty cycle with the correct bandwidth, modulation, and Resource Block configuration in the case of LTE. In all cases the EUT was given the command to transmit at maximum power by the CMW500. The EUT was directly connected to a spectrum analyzer with the following settings:
RBW is set to 10 KHz, VBW is set to 30 KHz for LTE Band 14 (769MHz-775MHz).
RBW is set to 100 KHz, VBW is set to 300 KHz for LTE Band 14 (775MHz-788MHz).
RBW is set to 10 KHz, VBW is set to 30 KHz for LTE Band 14 (799MHz-805MHz).
Set spectrum analyzer with RMS detector.
Span was set large enough so as to capture all out of band emissions near the band edge.
The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

Immediately outside the band when a narrower bandwidth is employed the power is integrated over the one MHz span outside the authorized band.

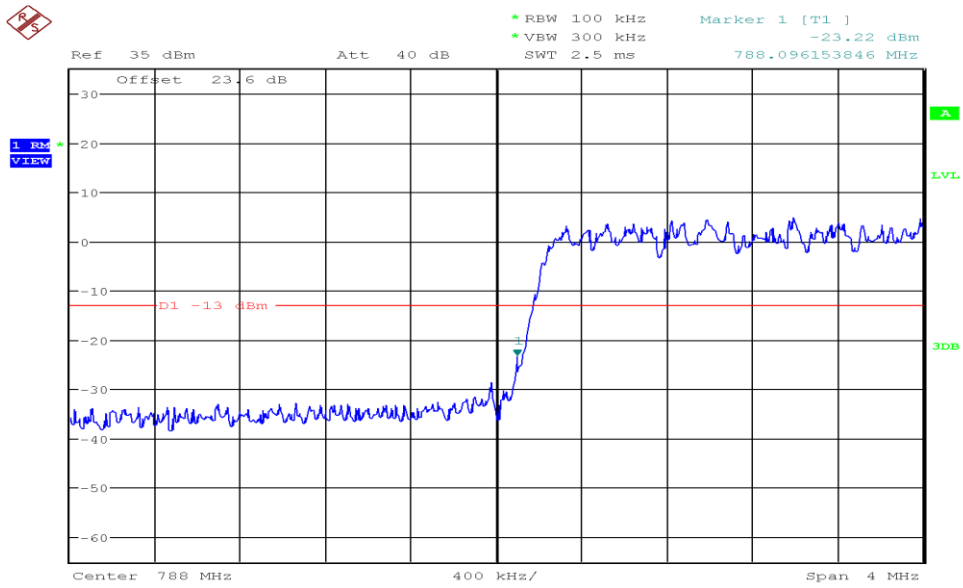
4.4.2 **Test Setup**



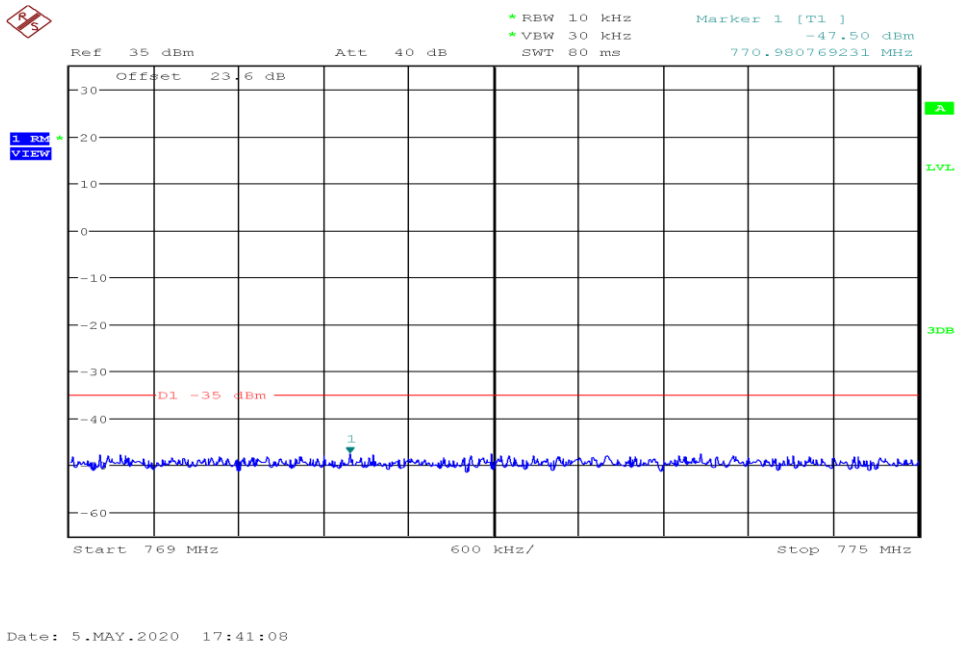
4.4.3 **Deviations**

N/A

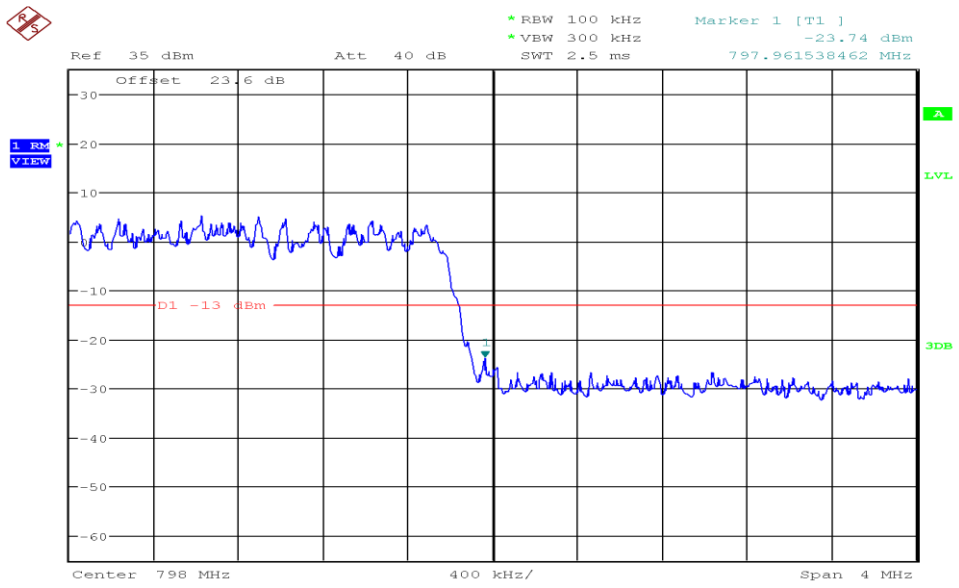
4.4.4 Test Results



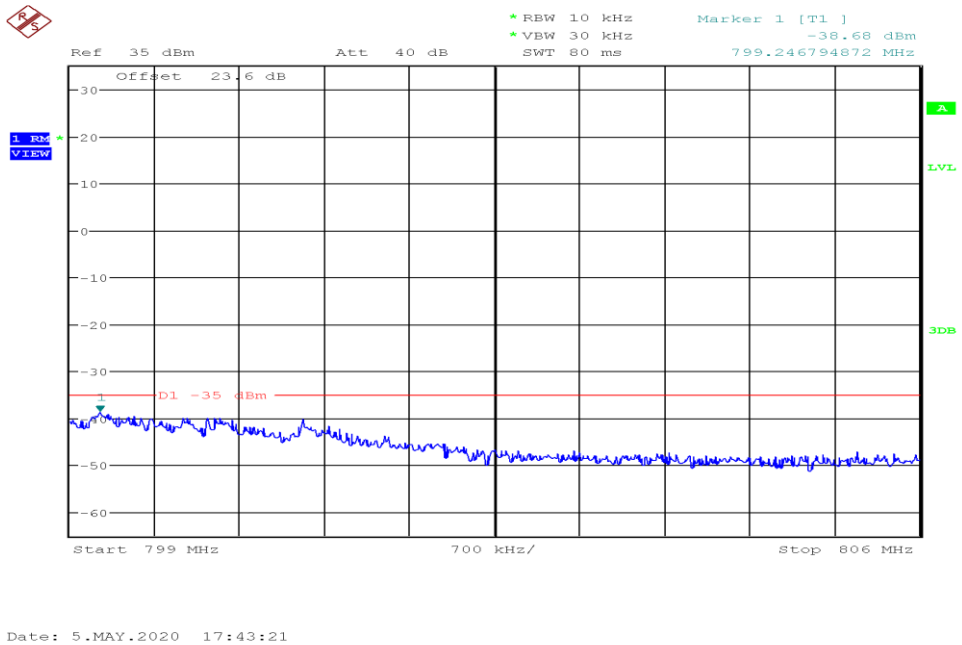
Lower Band Edge Plot (Band 14 - 5 MHz QPSK – Full RB Configuration)



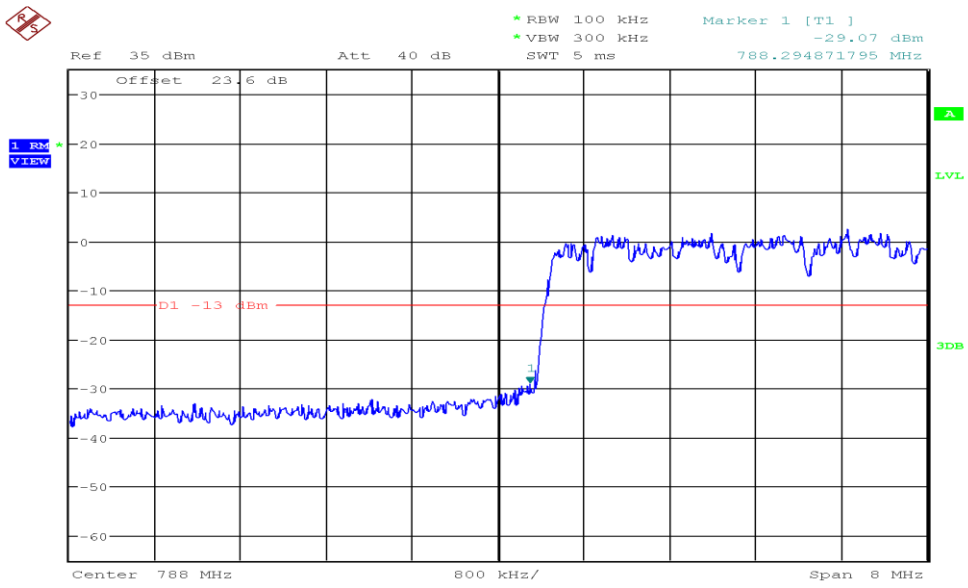
Lower Extended Band Edge Plot (Band 14 - 5 MHz QPSK – Full RB Configuration)



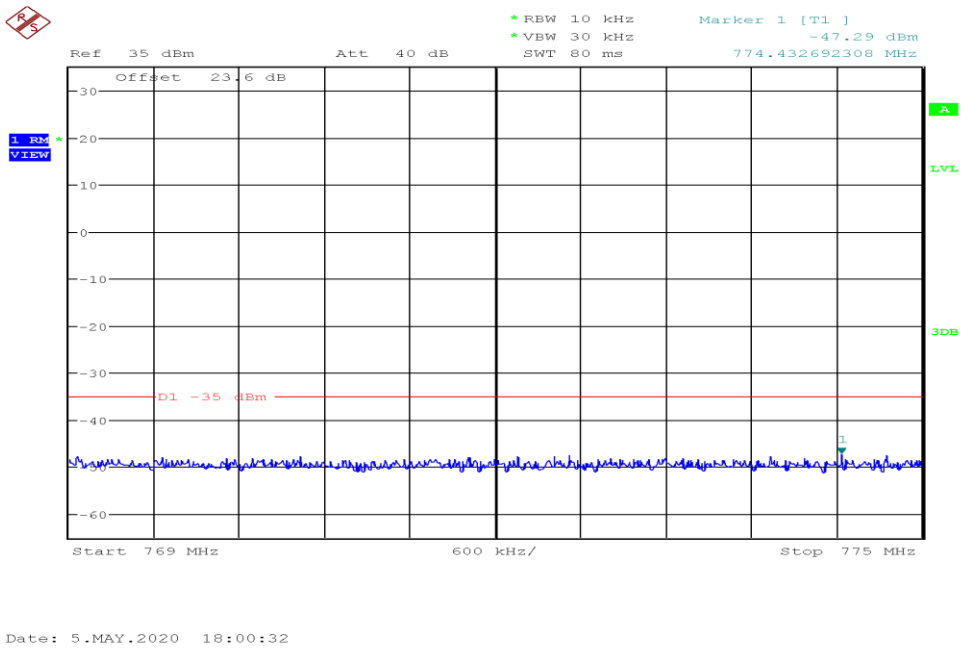
Upper Band Edge Plot (Band 14 - 5 MHz QPSK – Full RB Configuration)



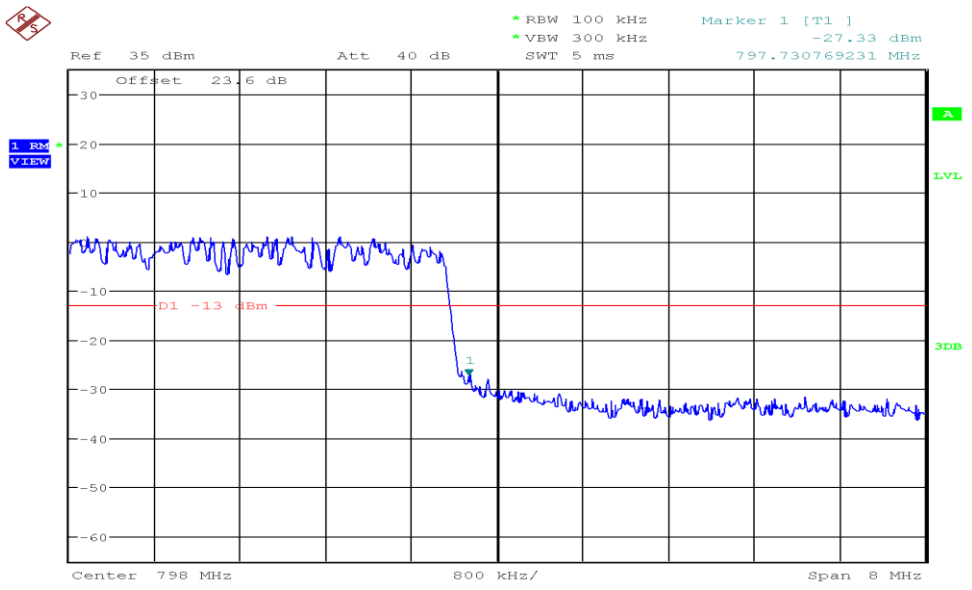
Upper Extended Band Edge Plot (Band 14 - 5 MHz QPSK – Full RB Configuration)



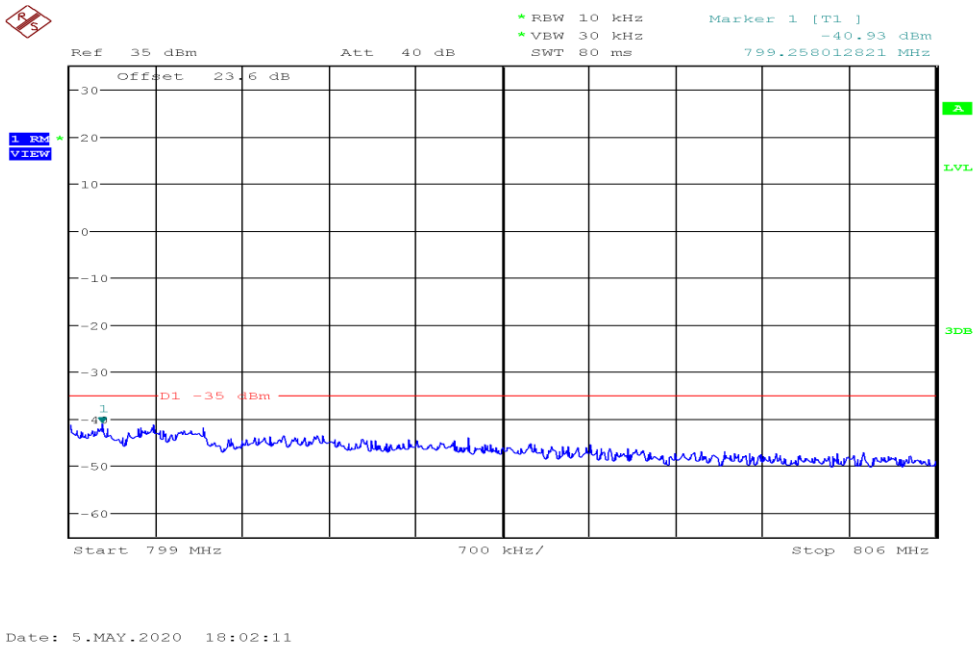
Lower Band Edge Plot (Band 14 - 10 MHz QPSK – Full RB Configuration)



Lower Extended Band Edge Plot (Band 14 - 10 MHz QPSK – Full RB Configuration)



Upper Band Edge Plot (Band 14 - 10 MHz QPSK – Full RB Configuration)



Upper Extended Band Edge Plot (Band 14 - 10 MHz QPSK – Full RB Configuration)

4.5 *Peak to Average Power Ratio (PAPR)*

In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

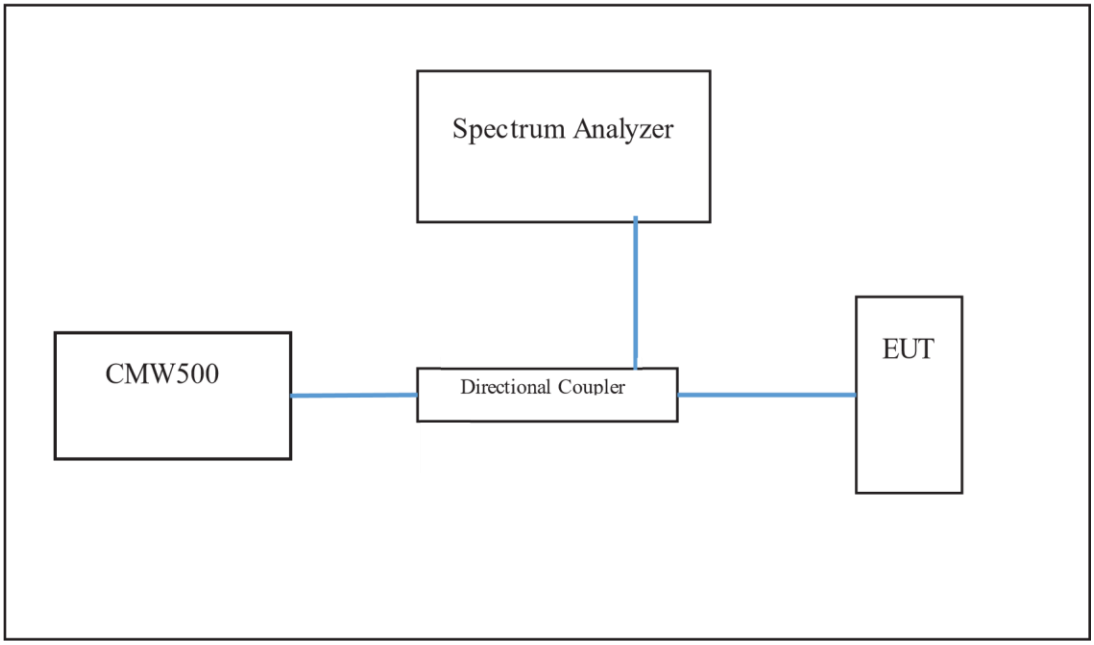
4.5.1 Test Methodology

KDB 971168 D01 V03 and ANSI C63.26-2015 section 5.2.3.4 - Measurement of peak power meter in a broadband noise-like signal using CCDF was used. A CMW500 was used to set the device transmitter with bandwidth, power level, modulation, center frequency and Resource Block configuration (LTE) of interest. In all cases the EUT was set to transmit at maximum power by the CMW500. The EUT was directly connected to a spectrum analyzer with the filling settings:

1. Center frequency set to the EUT's channel center frequency
2. RBW ≥ OBW
3. VBW ≥ RBW

The CCDF's count is set to a value large enough to stabilize the CCDF curve. The measurement interval is set to 1 ms. The final value reported is the Peak-To-Average ratio at 0.1%.

4.5.2 Test Setup



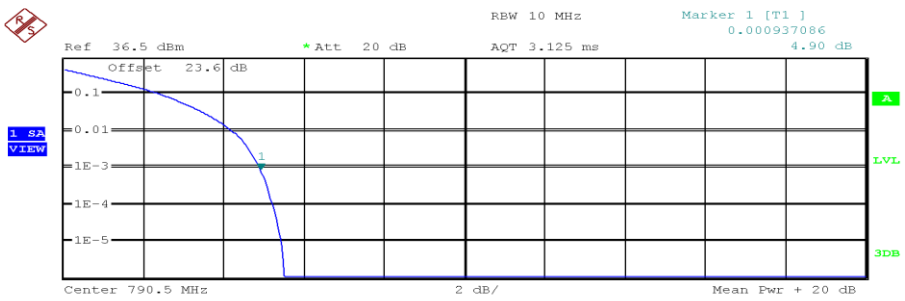
4.5.3 Deviations

N/A

4.5.4 **Test Results**

LTE Band 14							
RB	Bandwidth (MHz)	Channel	Frequency (MHz)	Resource Blocks (RB)	Peak to Average Ratio (dB)	Limit (dB)	Results
QPSK	5	23305	790.5	25	4.90	≤ 13	Pass
		23330	793	25	4.65	≤ 13	Pass
		23355	795.5	25	4.71	≤ 13	Pass
	10	23330	793	50	6.09	≤ 13	Pass
16QAM	5	23305	790.5	25	5.83	≤ 13	Pass
		23330	793	25	5.54	≤ 13	Pass
		23355	795.5	25	6.73	≤ 13	Pass
	10	23330	793	50	5.13	≤ 13	Pass

4.5.5 Test Plots

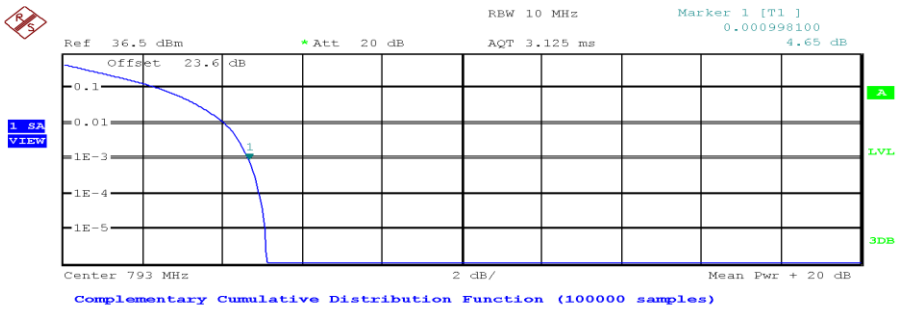


Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	20.49 dBm
Peak	25.99 dBm
Crest	5.50 dB
10 %	2.40 dB
1 %	4.20 dB
.1 %	4.90 dB
.01 %	5.22 dB

Date: 5.MAY.2020 16:28:05

PAPR-5 MHz-QPSK– Ch: 23305–790.5MHz

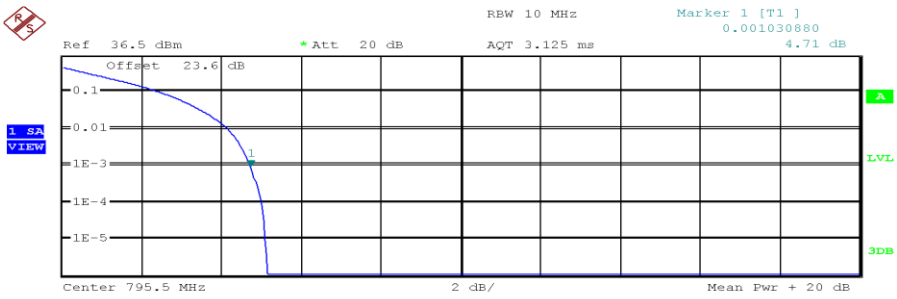


Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	20.54 dBm
Peak	25.63 dBm
Crest	5.10 dB
10 %	2.40 dB
1 %	4.04 dB
.1 %	4.65 dB
.01 %	4.90 dB

Date: 5.MAY.2020 16:23:14

PAPR-5 MHz-QPSK– Ch: 23330–793MHz

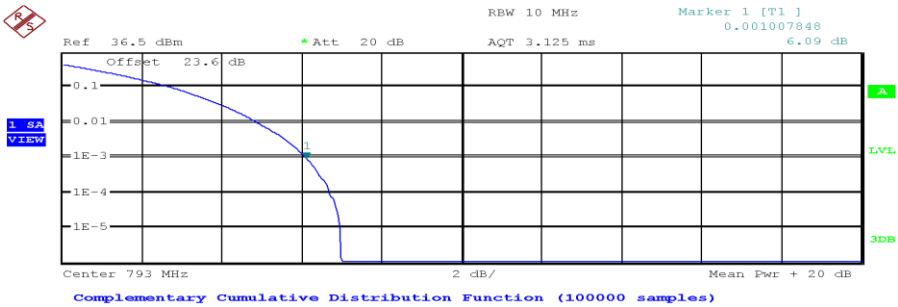


Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	20.13 dBm
Peak	25.28 dBm
Crest	5.15 dB
10 %	2.47 dB
1 %	4.13 dB
.1 %	4.71 dB
.01 %	5.00 dB

Date: 5.MAY.2020 16:39:02

PAPR-5 MHz-QPSK– Ch: 23355–795.5MHz

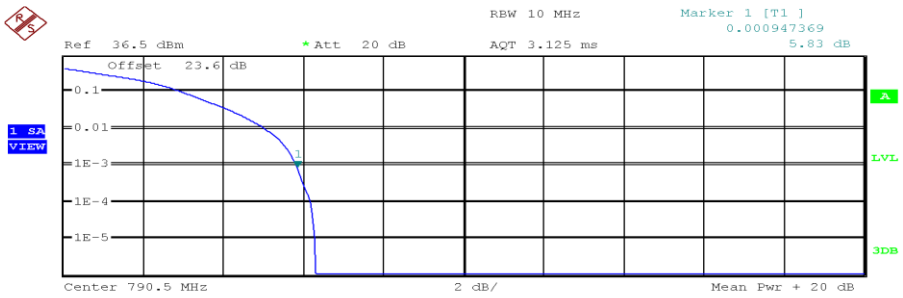


Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	20.56 dBm
Peak	27.54 dBm
Crest	6.98 dB
10 %	2.72 dB
1 %	4.87 dB
.1 %	6.09 dB
.01 %	6.70 dB

Date: 5.MAY.2020 16:41:11

PAPR-10 MHz-QPSK– Ch: 23330–793MHz

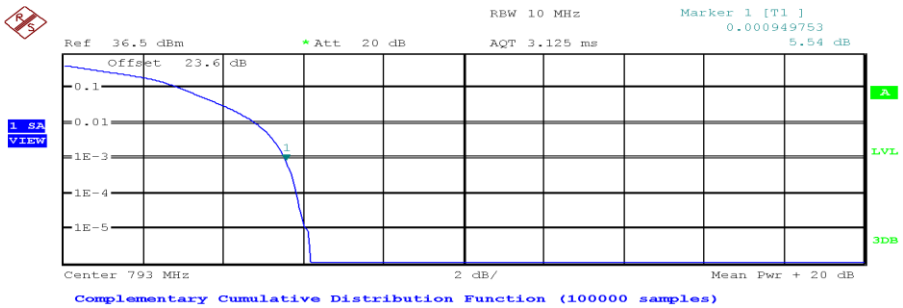


Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	19.62 dBm
Peak	25.92 dBm
Crest	6.30 dB
10 %	2.95 dB
1 %	5.03 dB
.1 %	5.83 dB
.01 %	6.19 dB

Date: 5.MAY.2020 16:33:17

PAPR-5 MHz-16QAM– Ch: 23305–790.5MHz

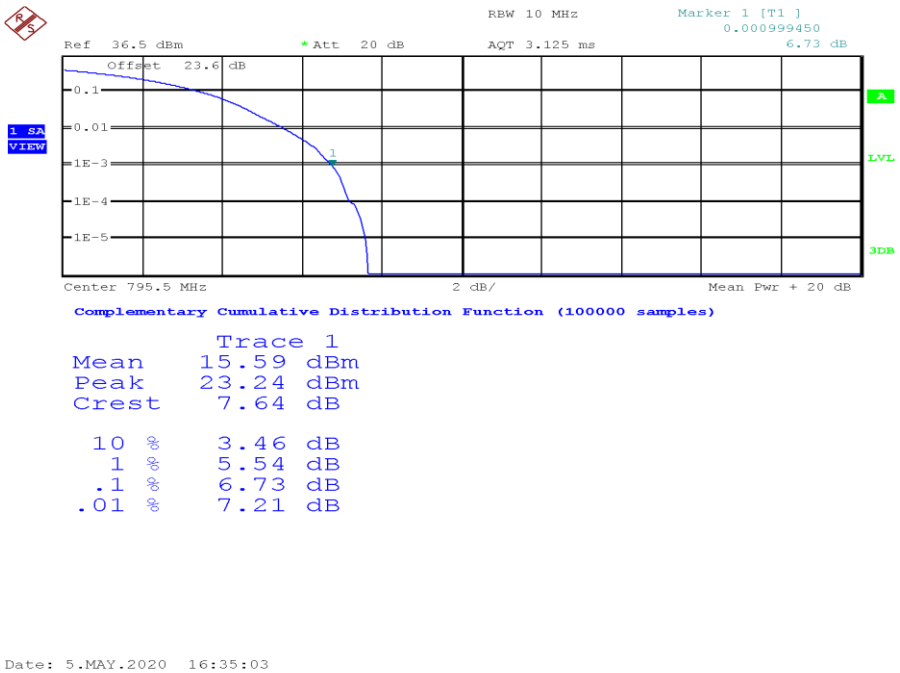


Complementary Cumulative Distribution Function (100000 samples)

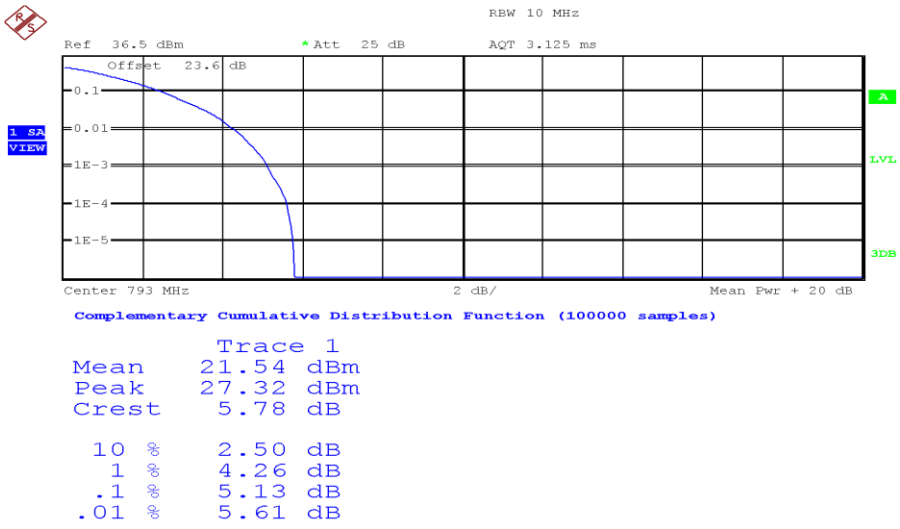
	Trace 1
Mean	19.39 dBm
Peak	25.56 dBm
Crest	6.17 dB
10 %	2.92 dB
1 %	4.81 dB
.1 %	5.54 dB
.01 %	5.83 dB

Date: 5.MAY.2020 16:25:19

PAPR-5 MHz-16QAM– Ch: 23330–793MHz



PAPR-5 MHz-16QAM– Ch: 23355–795.5MHz



PAPR-10 MHz-16QAM– Ch: 23330–793MHz

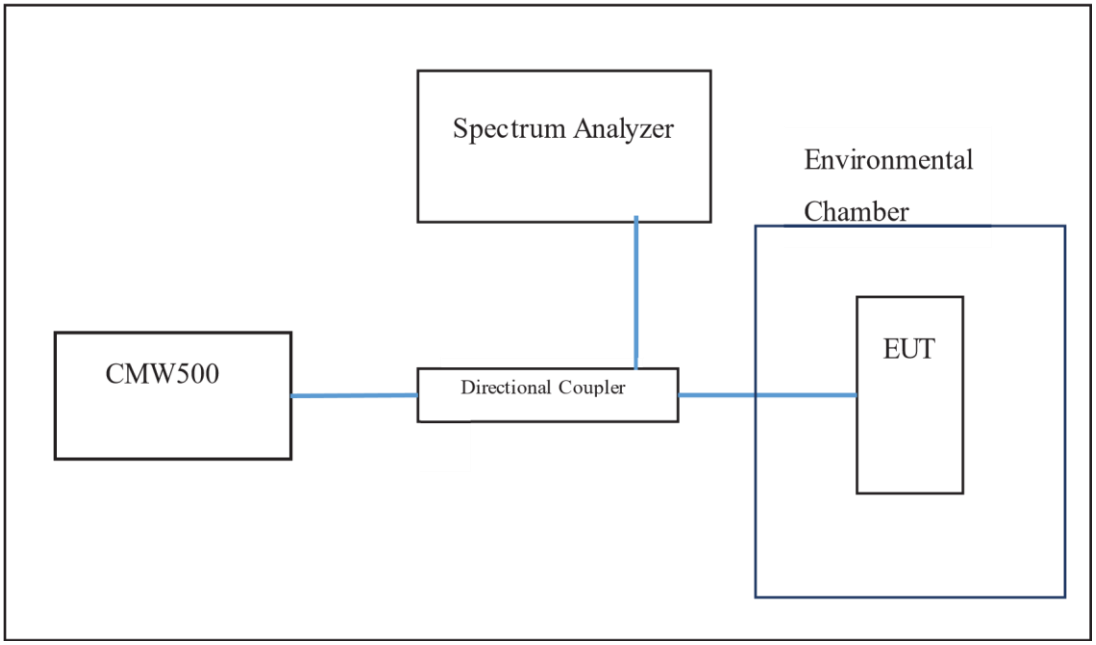
4.6 Frequency Stability

Part 90.539 (e) The frequency stability of mobile, portable and control transmitters operating in the wideband segment must be 1.25 parts per million or better when AFC is locked to a base station, and 5 parts per million or better when AFC is not locked.

4.6.1 Test Methodology

KDB 971168 D01 v03r01 section 9 and ANSI C63.26-2015 section 5.6.3 – Procedure for stability testing were used. The EUT was configured with the CMW 500 to the measured center frequency transmitting at a 100% duty cycle with the correct bandwidth, modulation, and Resource Block configuration in the case of LTE. In all cases the EUT was given the command to transmit at maximum power by the CMW500. The temperature frequency stability was measured -20° to 60° degrees Celsius by 10° degree steps. The device was allowed to cold soak at each temperature for 30 mints (minimum) before the transmitter was turned on, connected and measurement made. The voltage frequency stability was measured from ±15% of the operating voltage

4.6.2 Test Setup



4.6.1 Deviations

N/A

4.6.2 **Test Results**

LTE Band 14 (QPSK, 5MHz Bandwidth)					
Condition		Low Channel (790.5MHz)		High Channel (795.5MHz)	
Temperature	Voltage	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
Normal (25^0C)	Normal	790.499995	-0.00695	795.500003	0.00402
Extreme (60^0C)		790.499992	-0.00974	795.499997	-0.00427
Extreme (50^0C)		790.500005	0.00658	795.499999	-0.00176
Extreme (40^0C)		790.499996	-0.00481	795.499994	-0.00779
Extreme (30^0C)		790.500003	0.00495	795.499993	-0.00918
Extreme (20^0C)		790.499997	-0.00367	795.500003	0.00402
Extreme (10^0C)		790.499994	-0.00721	795.500002	0.00277
Extreme (0^0C)		790.500002	0.00190	795.499998	-0.00277
Extreme (-10^0C)		790.500001	0.00063	795.499996	-0.00553
Extreme (-20^0C)		790.500001	0.00063	795.500005	0.00679
Normal (25^0C)	LV	790.499999	-0.00152	795.500006	0.00805
	HV	790.499998	-0.00240	795.500004	0.00553

LTE Band 14 (QPSK, 10 MHz Bandwidth)			
Condition		Mid Channel (793MHz)	
Temp°C	Voltage	Frequency (MHz)	Frequency Error (ppm)
Normal (25°C)	Normal	792.999998	-0.00315
Extreme (60°C)		792.999992	-0.00971
Extreme (50°C)		792.999993	-0.00921
Extreme (40°C)		792.999998	-0.00265
Extreme (30°C)		793.000003	0.00353
Extreme (20°C)		792.999997	-0.00391
Extreme (10°C)		793.000003	0.00353
Extreme (0°C)		793.000005	0.00643
Extreme (-10°C)		793.000006	0.00783
Extreme (-20°C)		793.000006	0.00783
Normal (25°C)	LV	793.000004	0.00441
	HV	793.000004	0.00441

4.7 Spurious Emissions at the Antenna Terminals

Part 90.543 Emission limitations (e) *For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:*

(1) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations.

(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.

(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least 43 + 10 log (P) dB.

(4) Compliance with the provisions of paragraphs (e)(1) and (2) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

(5) Compliance with the provisions of paragraph (e)(3) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.

(f) For operations in the 758-775 MHz and 788-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

4.7.1.1 *Spurious Unwanted Emissions measurement*

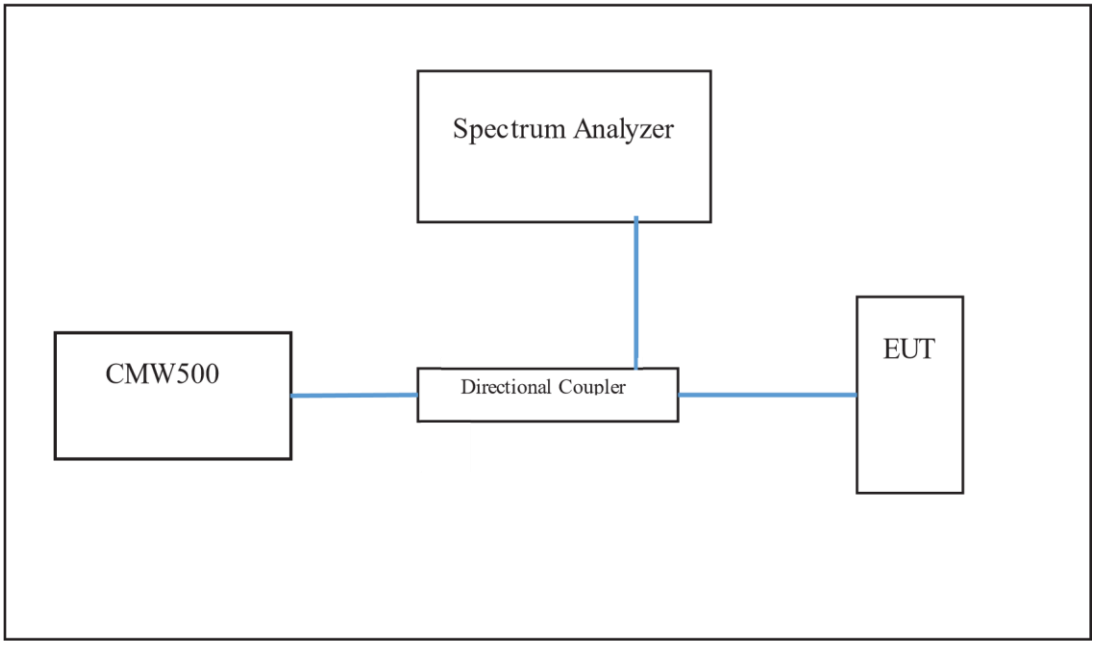
KDB 971168 D01 v03 section 6 Spurious Emissions at Antenna Port and ANSI C63.26-2015 section 5.7 – Unwanted (out-of-band and spurious emissions) conducted emissions measurement procedures (conducted test at antenna port) were used. The EUT was configured with the CMW 500 to the measured center frequency transmitting at a 100% duty cycle with the correct bandwidth, modulation, and Resource Block configuration in the case of LTE. In all cases the EUT was given the command to transmit at maximum power by the CMW500. The EUT was directly connected to a spectrum analyzer with the following settings:

1. Below 1 GHz:
    a. RBW = 100 kHz
    b. VBW = 300 KHz
    c. Span = 970MHz
    d. Sweep point ≥ 2 x (Span/RBW)
    e. Sweep time > sweep points x (symbol period)
    f. Detector = power averaging (rms)

2. Above 1 GHz
    a. RBW = 1 MHz
    b. VBW = 3 MHz
    c. Span = 6GHz to 20 GHz
    d. Sweep Points = 2 x (Span/RBW)
    e. Sweep Time > sweep points x (symbol period)
    f. Detector = power averaging (rms)

Worst case configuration is tested and was determined by power measurement performed in section 4.2 of this report. The modulation, frequency, resource block configuration, in the case of LTE, are chosen based on this power.

4.7.2 **Test Setup**

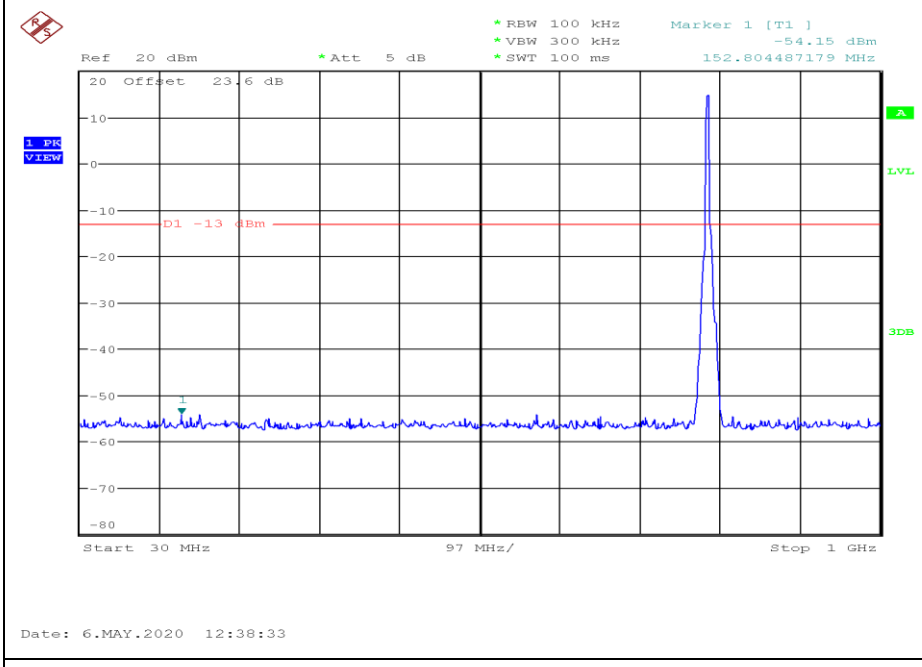


4.7.3 **Deviations**

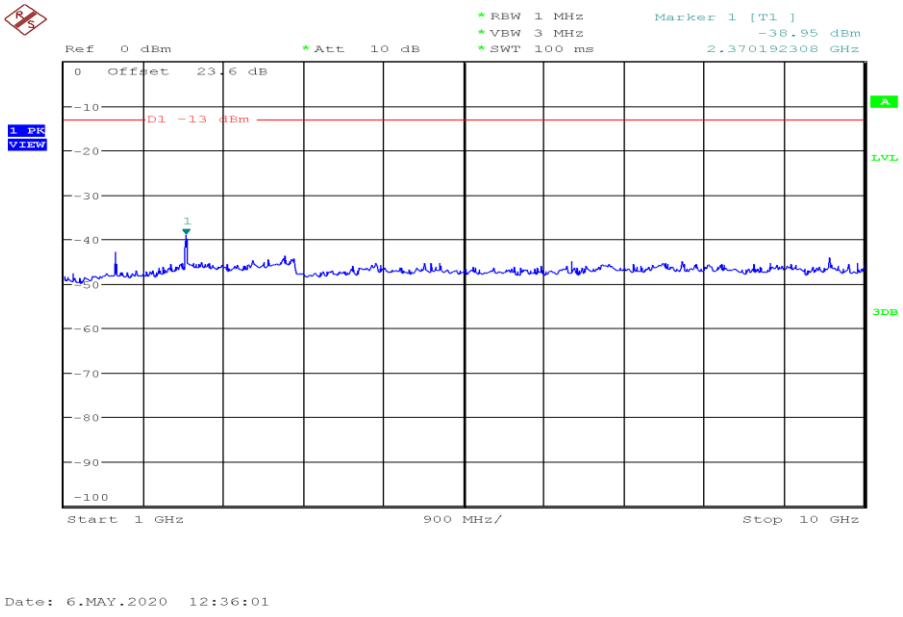
N/A

4.7.4 Test Results

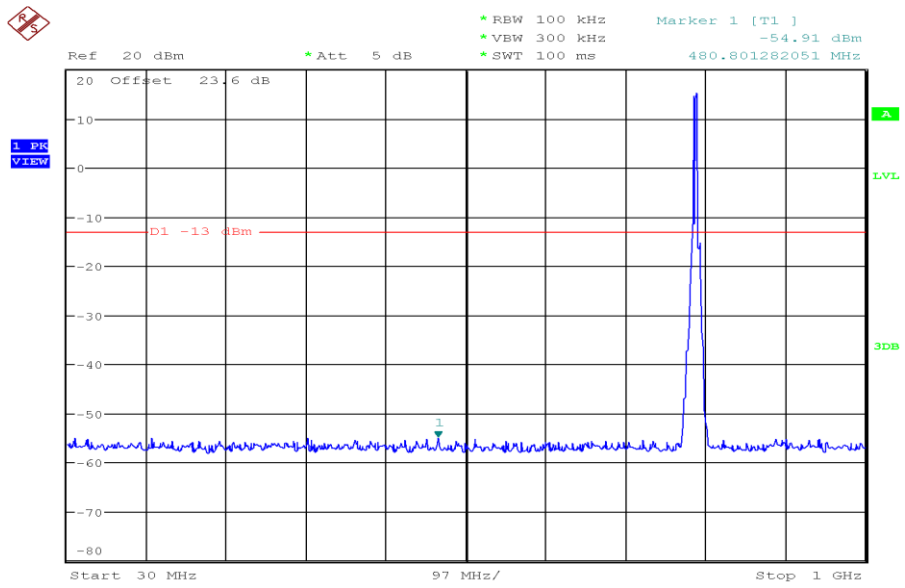
The signal beyond the limit is carrier.



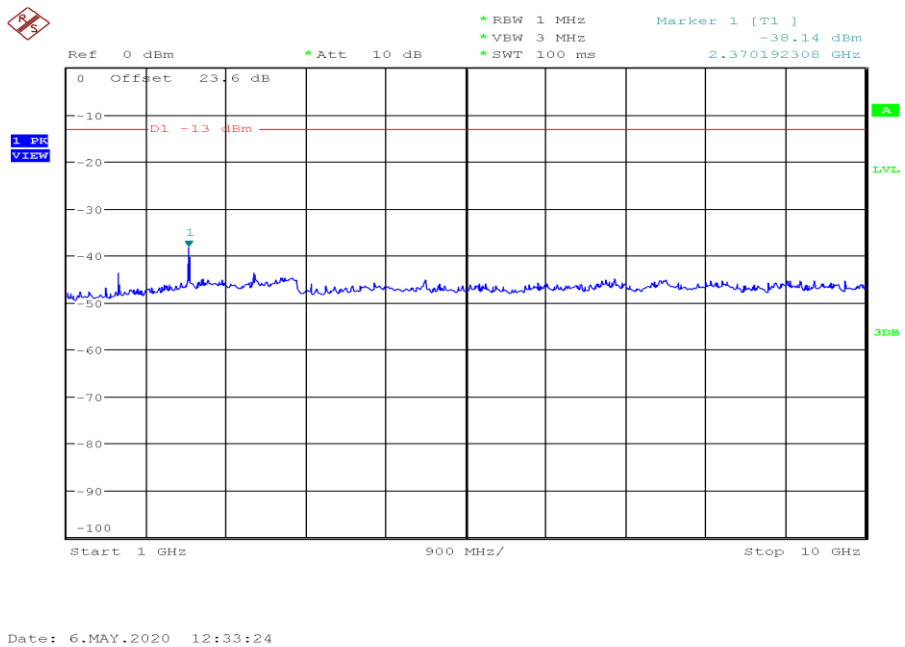
LTE Band 14 - 5 MHz QPSK CH-Low 790.5MHz- 30MHz-1GHz



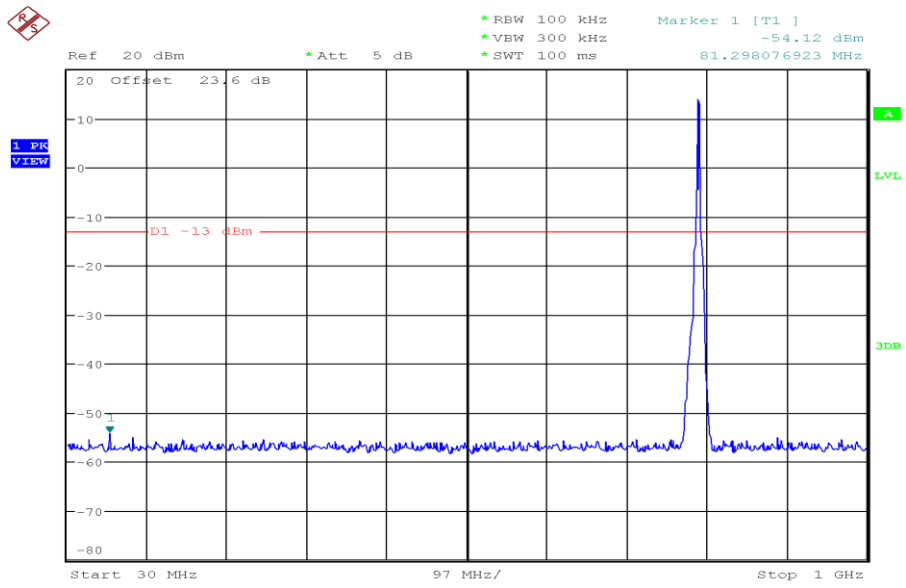
LTE Band 14 - 5 MHz QPSK CH-Low 790.5MHz- 1GHz – 9 GHz



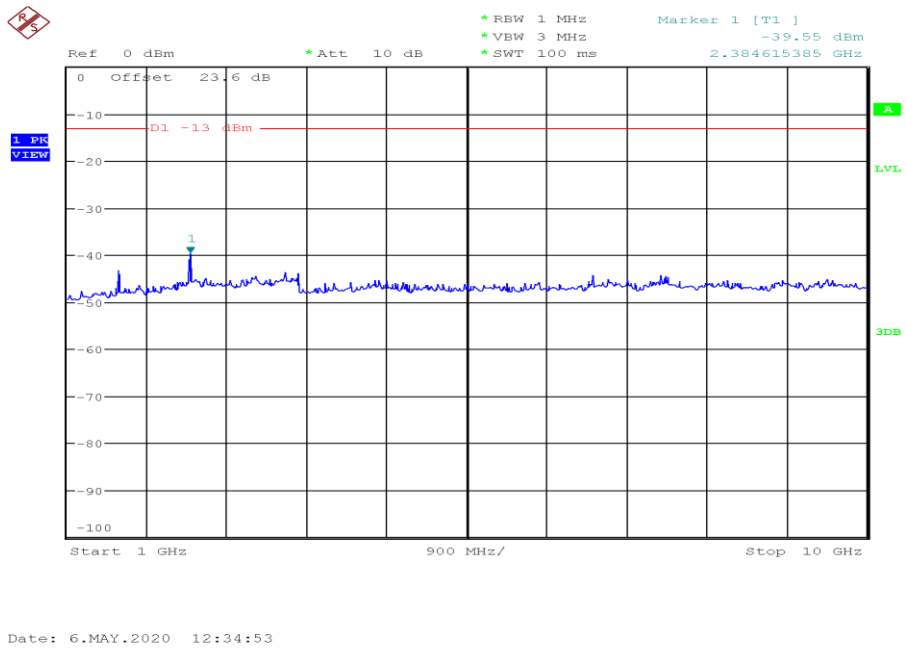
LTE Band 14 - 5 MHz QPSK CH-Mid 793MHz- 30MHz-1GHz



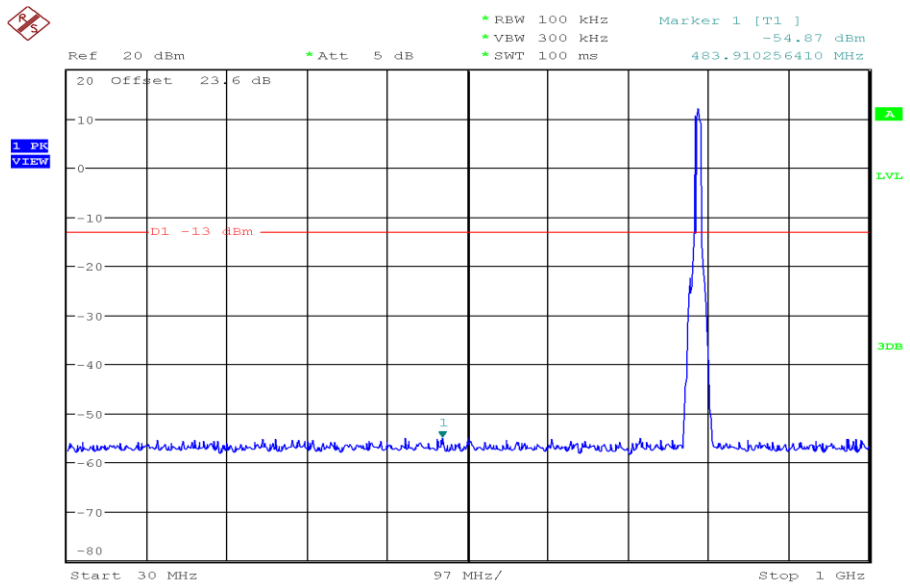
LTE Band 14 - 5 MHz QPSK CH-Mid 793MHz- 1GHz – 10GHz



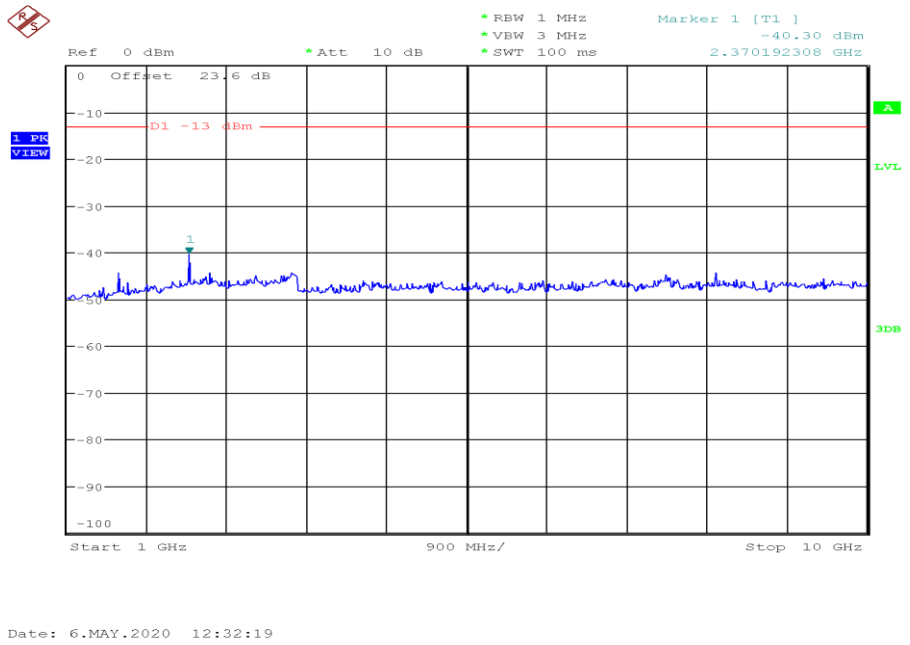
LTE Band 14 - 5 MHz QPSK CH-High 795.5MHz- 30MHz-1GHz



LTE Band 14 - 5 MHz QPSK CH-High 795.5MHz- 1GHz – 10GHz



LTE Band 14 - 10 MHz QPSK CH-Mid 793MHz- 30MHz-1GHz



LTE Band 14 - 10 MHz QPSK CH-Mid 793MHz- 1GHz - 10GHz

4.8 Radiated Spurious Emissions

Part 90.543 Emission limitations (e) *For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:*

The power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) by at least 43 + 10 log10(P) dB. The limit of emission is equal to -13 dBm (82.23dBuV/m).

For operations in the 758-775 MHz and 788-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

4.8.1 Test Methodology

4.8.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emissions test procedure. The frequency range of interest was divided into sub-ranges. For each sub-range peak emission data was recorded and plotted while the turntable was rotated 360° in 90° steps and the measurement antenna was rotated in horizontal and vertical antenna polarization.

Preliminary emission profile testing was performed inside a semi-anechoic chamber. The EUT was placed on a non-conductive table 80 cm above the floor for emissions less than 1 GHz and 150cm above the floor for emissions greater than 1 GHz. The EUT was positioned as shown in the setup photographs. The measurement antenna was placed at a distance of 3m.

4.8.1.2 Final Test

Final testing was performed on an NSA compliant test site.

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. Emissions within 20 dB of the limit were measured.

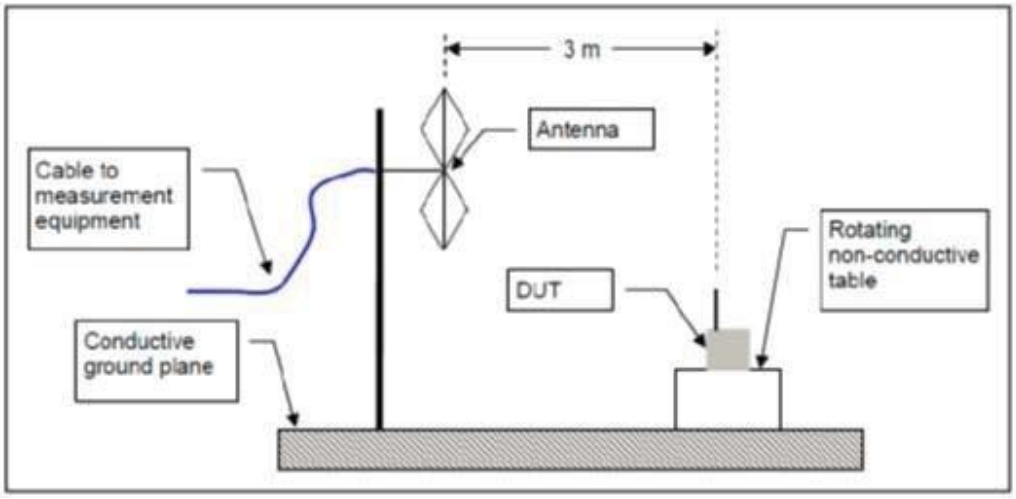
Substitution measurements are done for emissions within 10 dB of the limit.

The final scans were performed on the worst EUT axis for three operating channels in the operating mode with the highest power.

Resolution bandwidth (RBW) = 120 KHz and Video bandwidth (VBW) = 300 KHz for Spurious emission below 1GHz.

Resolution bandwidth (RBW) = 1 MHz and Video bandwidth (VBW) = 3 MHz for Spurious emission above 1GHz.

4.8.1.3 Test Setup



4.8.2 Deviations

N/A

4.8.3 Test Results

The final measurement data was taken under the worst case operating modes, configurations, and cable positions. It also reflects the results including any modifications and/or special accessories listed in section 1

Note: Below 30 MHz was investigated and no emissions was found above noise floor. No Emissions within 6dB of the limit were found above 18 GHz.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

4.8.3.1 30MHz – 1GHz

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
62.059840	42.34	82.23	39.89	1000.0	120.000	103.0	V	104.0	-17.2	
128.122280	32.58	82.23	49.65	1000.0	120.000	103.0	V	-179.0	-11.7	
296.691440	25.45	82.23	56.78	1000.0	120.000	103.0	H	53.0	-13.0	
509.850120	20.04	82.23	62.19	1000.0	120.000	103.0	V	-46.0	-7.5	
790.137920	34.99	82.23	47.24	1000.0	120.000	103.0	H	83.0	-3.5	
892.142600	22.99	82.23	59.24	1000.0	120.000	301.0	H	158.0	-1.5	

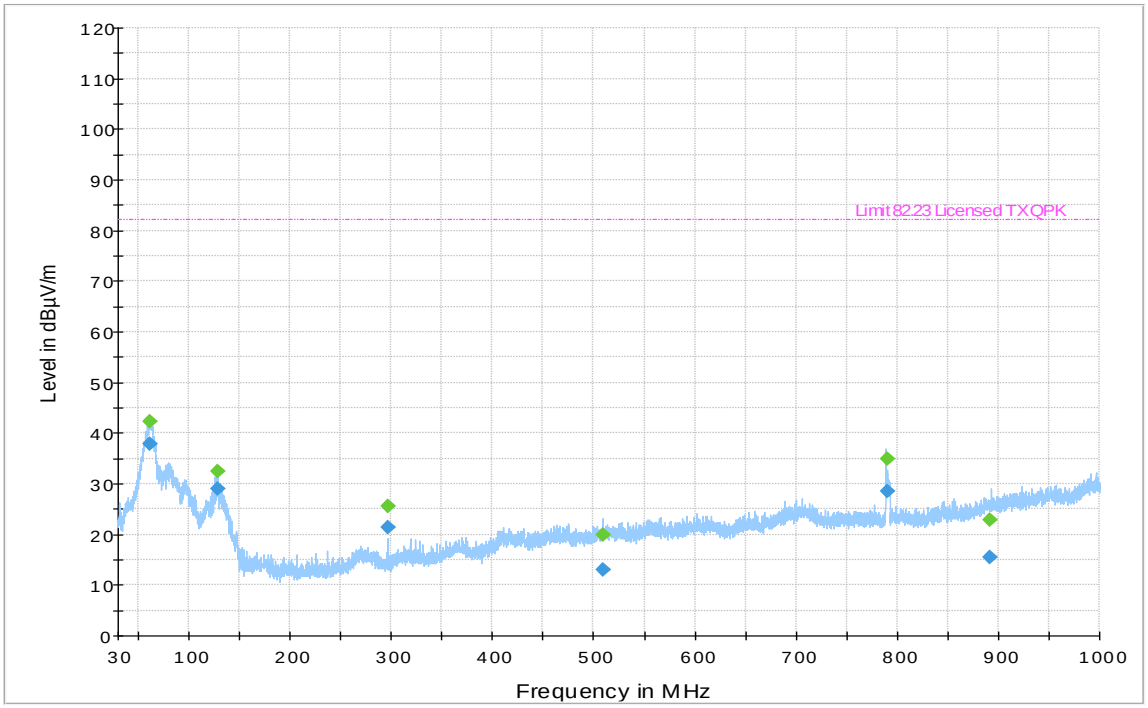


Figure 1: Radiated Spurious Emission 30MHz-1GHz –LTE Band 14-QPSK- 5MHz-Low CH- 790.5MHz

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
61.811520	43.11	82.23	39.12	1000.0	120.000	103.0	V	98.0	-17.2	
127.006360	30.54	82.23	51.69	1000.0	120.000	301.0	H	-81.0	-11.5	
296.701240	24.67	82.23	57.56	1000.0	120.000	103.0	H	-73.0	-13.0	
675.834240	22.44	82.23	59.79	1000.0	120.000	301.0	V	145.0	-5.8	
793.285840	34.17	82.23	48.06	1000.0	120.000	103.0	H	162.0	-3.3	
901.478360	22.53	82.23	59.70	1000.0	120.000	301.0	V	2.0	-1.3	

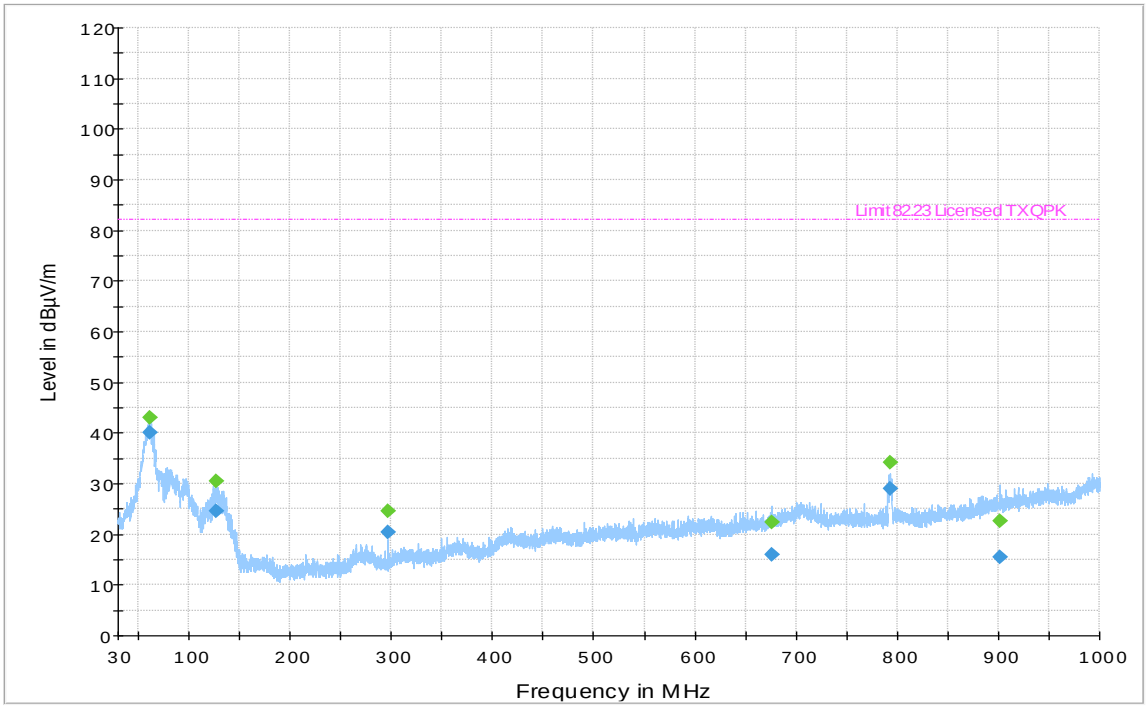


Figure 2: Radiated Spurious Emission 30MHz-1GHz –LTE Band 14-QPSK-10MHz-Mid CH- 793MHz

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
61.912600	43.29	82.23	38.94	1000.0	120.000	103.0	V	140.0	-17.2	
127.260080	30.63	82.23	51.60	1000.0	120.000	301.0	H	-92.0	-11.5	
199.350520	13.53	82.23	68.70	1000.0	120.000	103.0	V	143.0	-14.4	
658.071800	20.36	82.23	61.87	1000.0	120.000	301.0	H	-134.0	-5.4	
795.830120	19.79	82.23	62.44	1000.0	120.000	301.0	H	-110.0	-3.1	
935.117800	23.61	82.23	58.62	1000.0	120.000	301.0	V	84.0	-0.5	

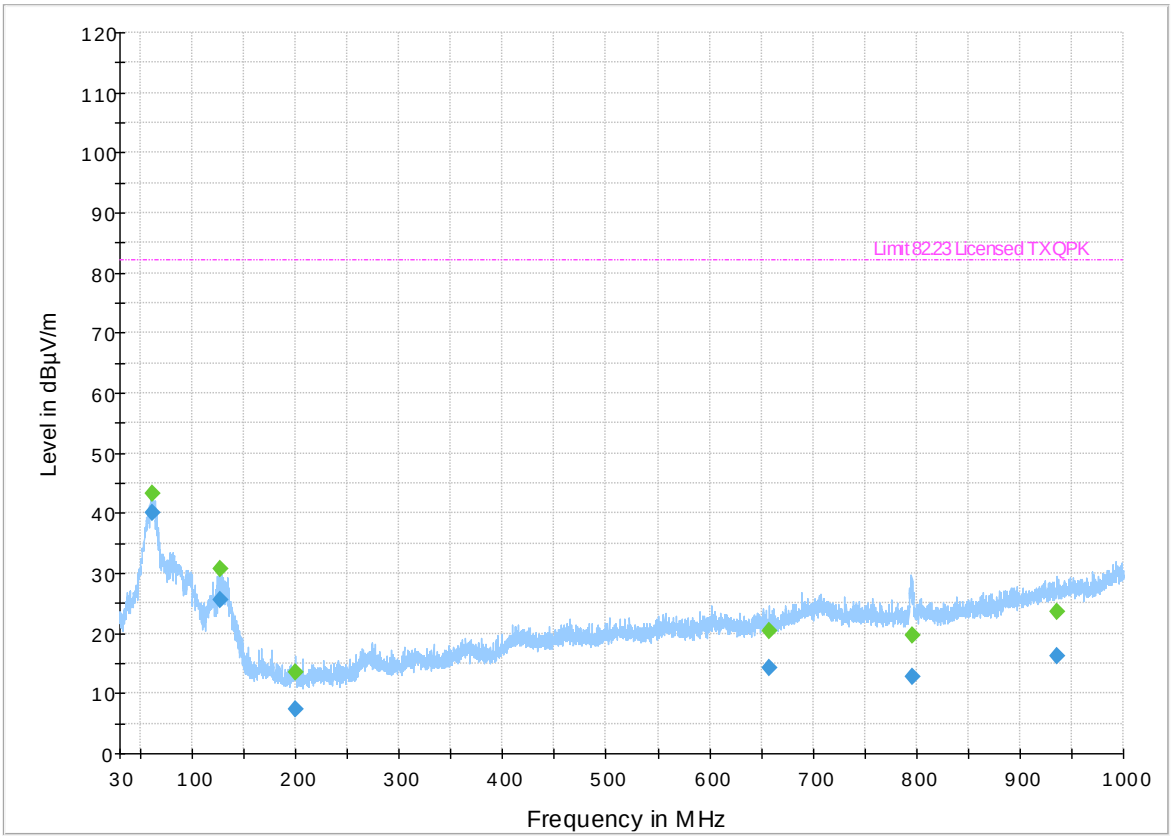


Figure 3: Radiated Spurious Emission 30MHz-1GHz –LTE Band 14-QPSK-5MHz-High CH- 795.5MHz

4.8.3.2 1GHz-18GHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
4511.914500	38.37	---	82.23	43.86	1000.0	1000.000	104.0	H	166.0	-25.1	
4511.914500	---	25.95	82.23	56.28	1000.0	1000.000	104.0	H	166.0	-25.1	
6696.850000	---	28.60	82.23	53.63	1000.0	1000.000	103.0	H	-44.0	-21.4	
6696.850000	41.52	---	82.23	40.71	1000.0	1000.000	103.0	H	-44.0	-21.4	
9509.099500	44.76	---	82.23	37.47	1000.0	1000.000	104.0	V	-175.0	-16.4	
9509.099500	---	31.46	82.23	50.77	1000.0	1000.000	104.0	V	-175.0	-16.4	
14093.555500	49.53	---	82.23	32.70	1000.0	1000.000	103.0	H	-180.0	-11.2	
14093.555500	---	36.38	82.23	45.85	1000.0	1000.000	103.0	H	-180.0	-11.2	
17926.661000	52.68	---	82.23	29.55	1000.0	1000.000	104.0	V	-180.0	-6.2	
17926.661000	---	39.88	82.23	42.35	1000.0	1000.000	104.0	V	-180.0	-6.2	

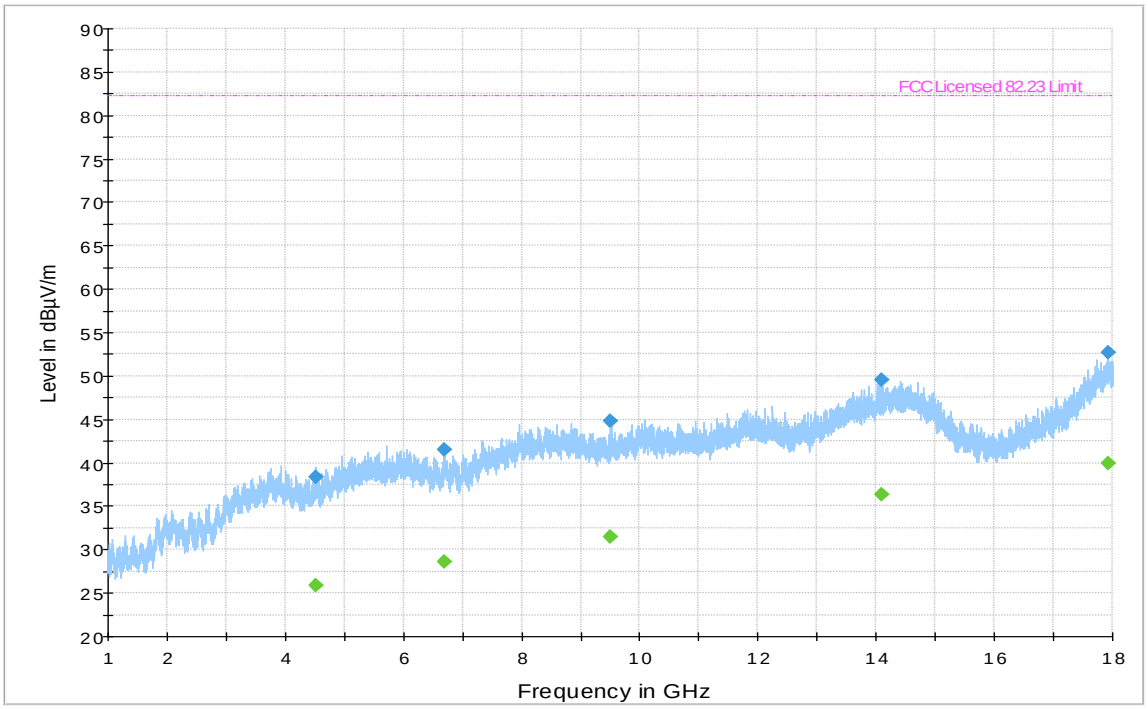


Figure 4: Radiated Spurious Emission 1GHz-18GHz –LTE Band 14-QPSK- 5MHz-Low CH- 790.5MHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
1000.618250	---	18.15	82.23	64.08	1000.0	1000.000	151.0	H	180.0	-36.0	
1000.618250	31.50	---	82.23	50.73	1000.0	1000.000	151.0	H	180.0	-36.0	
7941.680000	44.25	---	82.23	37.98	1000.0	1000.000	104.0	V	180.0	-18.0	
7941.680000	---	31.54	82.23	50.69	1000.0	1000.000	104.0	V	180.0	-18.0	
12307.780500	44.80	---	82.23	37.43	1000.0	1000.000	104.0	V	98.0	-13.8	
12307.780500	---	32.21	82.23	50.02	1000.0	1000.000	104.0	V	98.0	-13.8	
14611.126000	---	36.38	82.23	45.85	1000.0	1000.000	104.0	V	180.0	-11.6	
14611.126000	49.22	---	82.23	33.01	1000.0	1000.000	104.0	V	180.0	-11.6	
17966.234000	---	39.39	82.23	42.84	1000.0	1000.000	104.0	V	180.0	-5.9	
17966.234000	52.86	---	82.23	29.37	1000.0	1000.000	104.0	V	180.0	-5.9	

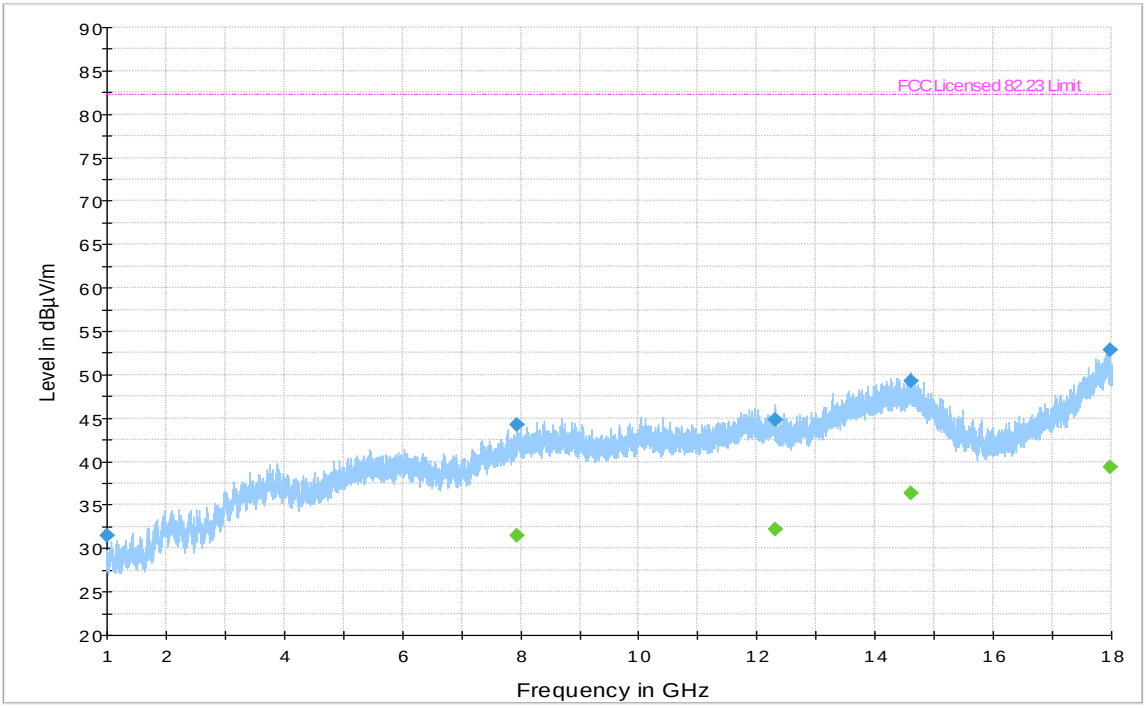


Figure 5: Radiated Spurious Emission 1MHz-18GHz –LTE Band 14-QPSK-10MHz-Mid CH- 793MHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
1001.225750	---	18.12	82.23	64.11	1000.0	1000.000	103.0	H	-145.0	-36.0	
1001.225750	30.78	---	82.23	51.45	1000.0	1000.000	103.0	H	-145.0	-36.0	
1839.087000	---	21.54	82.23	60.69	1000.0	1000.000	104.0	H	-53.0	-32.5	
1839.087000	34.02	---	82.23	48.21	1000.0	1000.000	104.0	H	-53.0	-32.5	
5198.900000	40.89	---	82.23	41.34	1000.0	1000.000	105.0	V	180.0	-23.2	
5198.900000	---	28.06	82.23	54.17	1000.0	1000.000	105.0	V	180.0	-23.2	
7361.455000	---	30.01	82.23	52.22	1000.0	1000.000	105.0	H	180.0	-19.5	
7361.455000	42.65	---	82.23	39.58	1000.0	1000.000	105.0	H	180.0	-19.5	
14567.848500	49.15	---	82.23	33.08	1000.0	1000.000	105.0	V	-180.0	-11.6	
14567.848500	---	36.52	82.23	45.71	1000.0	1000.000	105.0	V	-180.0	-11.6	
17920.070500	---	40.14	82.23	42.09	1000.0	1000.000	105.0	V	180.0	-6.2	
17920.070500	52.99	---	82.23	29.24	1000.0	1000.000	105.0	V	180.0	-6.2	

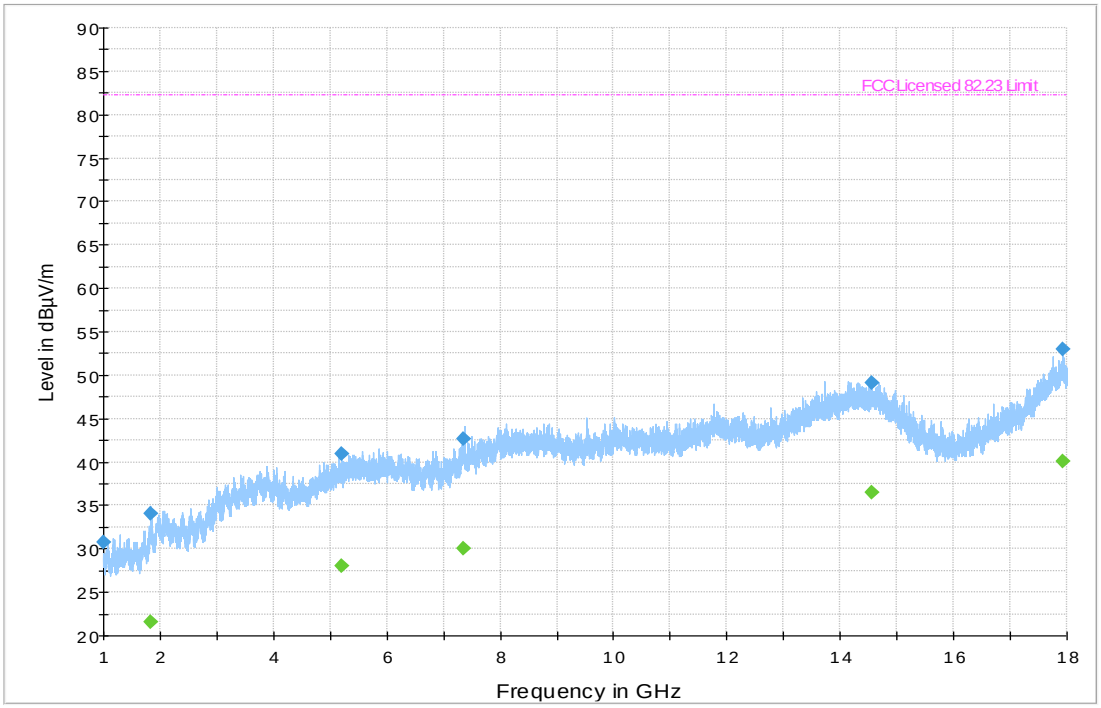


Figure 6: Radiated Spurious Emission 1GHz-18GHz –LTE Band 14-QPSK-5MHz-High CH- 795.5MHz

5 Test Equipment List

5.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
EMI Receiver	Rohde & Schwarz	ESW44	101663-dv	07/06/2018	07/06/2020
Spectrum Analyzer	Rohde & Schwarz	FSU26.5	200050	02/23/2020	02/23/2021
Preamplifier, 9 kHz – 1 GHz	Sonoma	310N	213221	01/16/2019	01/16/2021
Bilog Antenna	Sunol Sciences	JB3	A061907	12/19/2018	12/19/2020
Amplifier	Miteq	TTA1800-30-HG	1842452	01/15/2019	01/15/2021
Base station simulator	Rohde & Schwarz	CNW500	164957	02/22/2020	02/22/2021
Horn Antenna	Sunol Sciences	DRH-118	A040806	03/05/2019	03/05/2021
Amplifier	HP	8449B	3008A01013	01/15/2019	01/15/2021
Amplifier	Sonoma	310N	185516	N/A (See Note)	
1GHz High Pass Filter	MICRO-TRONICS	HPM50115-02	G006	N/A (See Note)	
RF Notch Filter 900MHz	MICRO-TRONICS	BRM50706	001	N/A (See Note)	
Environmental Chamber	Votsch Industrietechnik	VT 4002	58566126240010	N/A (See Note)	
Note: Equipment is characterized before use.					