

TEST REPORT

FCC/IC LTE Test for SM-R825U
Certification

APPLICANT
SAMSUNG Electronics Co., Ltd.

REPORT NO.
HCT-RF-1907-FI028

DATE OF ISSUE
July 29, 2019

HCT Co., Ltd.

74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA
Tel. +82 31 634 6300 F ax. +82 31 645 6401



HCT Co., Ltd.

74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA
Tel. +82 31 634 6300 Fax. +82 31 645 6401

TEST REPORT

FCC/IC LTE Test for
SM-R825U

REPORT NO.

HCT-RF-1907-FI028

DATE OF ISSUE

July 29, 2019

FCC ID/ IC

A3LSMR825/649E-SMR825

Applicant

SAMSUNG Electronics Co., Ltd.

129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea

Eut Type

Smart Watch

Model Name

SM-R825U

Additional Model(s)

SM-R825F

Date of Receipt

June 13, 2019

FCC Rule Part(s)

§ 27, § 2

IC Rule(s)

RSS-Gen Issue5, RSS-130 Issue2

FCC Classification

PCS Licensed Transmitter (PCB)

Manufacturer

SAMSUNG Electronics Co., Ltd.

Tested by

Kwon Jeong

Technical Manager

Jong Seok Lee

HCT CO., LTD.

Soo Chan Lee
SooChan Lee / CEO

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	July 29, 2019	Initial Release

The measurements shown in this report were made in accordance with the procedures specified in CFR47 section § 2.947. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998, 21 U.S. C.853(a)

CONTENTS

1. GENERAL INFORMATION	5
1.1. MAXIMUM OUTPUT POWER	6
2. INTRODUCTION	7
2.1. DESCRIPTION OF EUT	7
2.2. MEASURING INSTRUMENT CALIBRATION	7
2.3. TEST FACILITY	7
3. DESCRIPTION OF TESTS	8
3.1 TEST PROCEDURE	8
3.2 RADIATED POWER	9
3.3 RADIATED SPURIOUS EMISSIONS	11
3.4 OCCUPIED BANDWIDTH.	12
3.5 SPURIOUS AND HARMONIC EMISSIONS AT ANTENNA TERMINAL	14
3.6 BAND EDGE	15
3.7 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE	17
3.8 WORST CASE(RADIATED TEST)	19
3.9 WORST CASE(CONDUCTED TEST)	20
4. LIST OF TEST EQUIPMENT	21
5. MEASUREMENT UNCERTAINTY	22
6. SUMMARY OF TEST RESULTS	23
6.1 Test Condition : Conducted Test	23
6.2 Test Condition : Radiated Test	24
7. SAMPLE CALCULATION	25
7.1 ERP Sample Calculation	25
7.2 EIRP Sample Calculation	26
7.3. Emission Designator	27
8. TEST DATA	28
8.1 EFFECTIVE RADIATED POWER	28
8.2 RADIATED SPURIOUS EMISSIONS	29
8.3 OCCUPIED BANDWIDTH	32
8.4 CONDUCTED SPURIOUS EMISSIONS	33
8.5 BAND EDGE	33
8.6 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE	34
8.7 RECEIVER SPURIOUS EMISSIONS	38
9. TEST PLOTS	39
10. APPENDIX A_ TEST SETUP PHOTO	60

MEASUREMENT REPORT

1. GENERAL INFORMATION

Applicant Name:	SAMSUNG Electronics Co., Ltd.
Address:	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
FCC ID:	A3LSMR825
IC	649E-SMR825
Application Type:	Certification
FCC Classification:	PCS Licensed Transmitter (PCB)
FCC Rule Part(s):	§ 27, § 2
IC Rule(s):	RSS-Gen Issue5, RSS-130 Issue2
EUT Type:	Smart Watch
Model(s):	SM-R825U
Additional Model	SM-R825F
Tx Frequency:	779.5 MHz – 784.5 MHz (LTE – Band 13 (5MHz)) 782 MHz (LTE – Band 13 (10 MHz))
Date(s) of Tests:	June 13, 2019~ July 26, 2019

1.1. MAXIMUM OUTPUT POWER

Mode (MHz)	Tx Frequency (MHz)	Emission Designator	Modulation	ERP	
				Max. Power (W)	Max. Power (dBm)
LTE – Band13 (5)	779.5 – 784.5	4M50G7D	QPSK	0.015	11.71
		4M52W7D	16QAM	0.008	9.25
LTE – Band13 (10)	782.0	8M97G7D	QPSK	0.014	11.53
		8M97W7D	16QAM	0.008	9.03

2. INTRODUCTION

2.1. DESCRIPTION OF EUT

The EUT was a Smart Watch with UMTS and LTE.
It also supports IEEE 802.11 b/g/n (HT20), Bluetooth, BT LE.

2.2. MEASURING INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

2.3. TEST FACILITY

The Fully-anechoic chamber and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA.

3. DESCRIPTION OF TESTS

3.1 TEST PROCEDURE

Test Description	Test Procedure Used
Occupied Bandwidth	- KDB 971168 D01 v03r01 – Section 4.3 - ANSI C63.26-2015 – Section 5.4.4
Band Edge	- KDB 971168 D01 v03r01 – Section 6.0 - ANSI C63.26-2015 – Section 5.7
Spurious and Harmonic Emissions at Antenna Terminal	- KDB 971168 D01 v03r01 – Section 6.0 - ANSI C63.26-2015 – Section 5.7
Conducted Output Power	- N/A (See SAR Report)
Frequency stability	- ANSI C63.26-2015 – Section 5.6
Effective Radiated Power/ Effective Isotropic Radiated Power	- KDB 971168 D01 v03r01 – Section 5.2 & 5.8 - ANSI/TIA-603-E-2016 – Section 2.2.17
Radiated Spurious and Harmonic Emissions	- KDB 971168 D01 v03r01 – Section 6.2 - ANSI/TIA-603-E-2016 – Section 2.2.12

3.2 RADIATED POWER

Test Overview

Radiated tests are performed in the Fully-anechoic chamber.

The equipment under test is placed on a non-conductive table 3-meters away from the receive antenna in accordance with ANSI/TIA-603-E-2016 Clause 2.2.17.

Test Settings

1. Radiated power measurements are performed using the signal analyzer's "channel power" measurement capability for signals with continuous operation.
2. RBW = 1 – 5% of the expected OBW, not to exceed 1MHz
3. VBW $\geq 3 \times$ RBW
4. Span = 1.5 times the OBW
5. No. of sweep points $> 2 \times$ span / RBW
6. Detector = RMS
7. Trigger is set to "free run" for signals with continuous operation with the sweep times set to "auto".
8. The integration bandwidth was roughly set equal to the measured OBW of the signal for signals with continuous operation.
9. Trace mode = trace averaging (RMS) over 100 sweeps
10. The trace was allowed to stabilize

Test Note

1. The turntable is rotated through 360 degrees, and the receiving antenna scans in order to determine the level of the maximized emission.
2. 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 and the previously recorded signal was duplicated.

The power is calculated by the following formula;

$$P_{d(dBm)} = P_{g(dBm)} - \text{cable loss}_{(dB)} + \text{antenna gain}_{(dB)}$$

Where: P_d is the dipole equivalent power and P_g is the generator output power into the substitution antenna.

3. The maximum value is calculated by adding the forward power to the calibrated source plus its appropriate gain value.

These steps are repeated with the receiving antenna in both vertical and horizontal polarization. the difference between the gain of the horn and an isotropic antenna are taken into consideration

4. The EUT was tested in three orthogonal planes(X, Y, Z) and in all possible test configurations and positioning.
5. All measurements are performed as RMS average measurements while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies.

3.3 RADIATED SPURIOUS EMISSIONS

Test Overview

Radiated tests are performed in the Fully-anechoic chamber.

Radiated Spurious Emission Measurements at 3 meters by Substitution Method according to ANSI/TIA-603-E-2016.

Test Settings

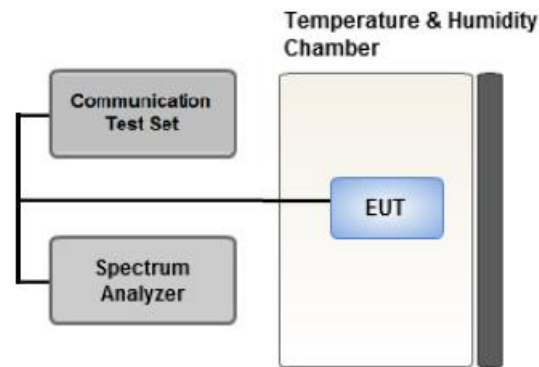
1. RBW = 100kHz for emissions below 1GHz and 1MHz for emissions above 1GHz
2. VBW $\geq 3 \times$ RBW
3. Span = 1.5 times the OBW
4. No. of sweep points $> 2 \times$ span / RBW
5. Detector = Peak
6. Trace mode = Max Hold
7. The trace was allowed to stabilize
8. Test channel : Low/ Middle/ High
9. Frequency range : We are performed all frequency to 10th harmonics from 9 kHz.

Test Note

1. Measurements value show only up to 3 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
2. The EUT was tested in three orthogonal planes(X, Y, Z) 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 test data

3.4 OCCUPIED BANDWIDTH.



Test setup

The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5 % of the total mean power of a given emission.

The EUT makes a call to the communication simulator.

The conducted occupied bandwidth used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.

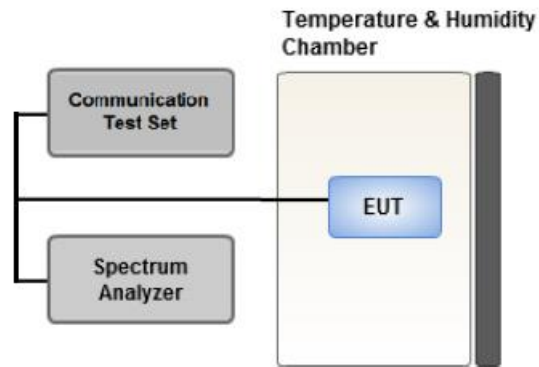
The communication simulator station system controlled a EUT to export maximum output power under transmission mode and specific channel frequency. Use OBW measurement function of Spectrum analyzer to measure 99 % occupied bandwidth

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 $\geq 3 \times$ 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

3.5 SPURIOUS AND HARMONIC EMISSIONS AT ANTENNA TERMINAL



Test setup

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.

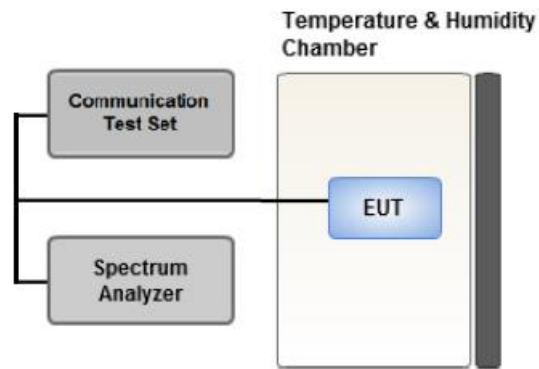
All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies.

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.

Test Settings

1. RBW = 1 MHz
2. VBW $\geq$ 3 MHz
3. Detector = RMS
4. Trace Mode = trace average
5. Sweep time = auto
6. Number of points in sweep $\geq 2 * \text{Span} / \text{RBW}$

3.6 BAND EDGE



Test setup

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.

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 $\geq 2 \times \text{Span/RBW}$
7. Trace mode = trace average
8. Sweep time = auto couple

9. The trace was allowed to stabilize

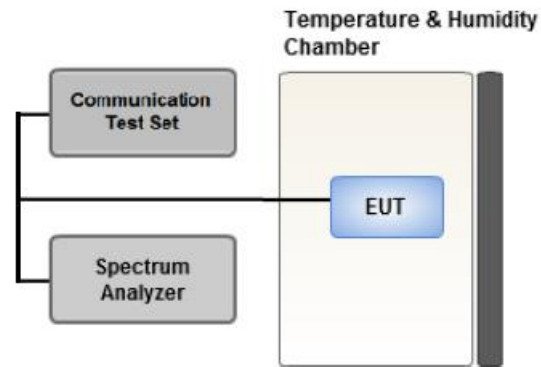
Test Notes

According to FCC 22.917, 24.238, 27.53 specified that power of any emission outside of The authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB. 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.

All measurements were done at 2 channels(low and high operational frequency range.)

The band edge measurement used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.

3.7 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE



Test setup

Test Overview

Frequency stability testing is performed in accordance with the guidelines of ANSI C63.26-2015.

The frequency stability of the transmitter is measured by:

1. Temperature:

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

2. Primary Supply Voltage:

.- Unless otherwise specified, vary primary supply voltage from 85% to 115% of the nominal value for other than hand carried battery equipment.

.- For hand carried, battery powered equipment, reduce the primary ac or dc supply voltage to the battery operating end point, which shall be specified by the manufacturer.

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.

3.8 WORST CASE(RADIATED TEST)

- The EUT was tested in three orthogonal planes(X, Y, Z) and in all possible test configurations and positioning.
- All modes of operation were investigated and the worst case configuration results are reported.
- The worst case is reported with the EUT positioning, modulations, RB sizes and offsets, and channel bandwidth configurations shown in the test data.
- SM-R825U & additional model were tested and the worst case results are reported.
(Worst case : SM-R825U)
- All modes of operation were tested and the worst case results are reported.
Mode : Stand alone, Stand alone+ wireless charging dock
Worst case : Stand alone+ wireless charging dock
- Please refer to the table below.

[Worst case]

Test Description	Modulation	RB size	RB offset	Axis
Effective Isotropic Radiated Power	QPSK, 16QAM	1	0	X
Radiated Spurious and Harmonic Emissions	QPSK	1	0	X

3.9 WORST CASE(CONDUCTED TEST)

- Worst case : Of all modulation, We have tested modulation of the high Conducted Output Power.

Conducted Output Power value can be confirmed on the SAR report.

- SM-R825U & additional model were tested and the worst case results are reported.

(Worst case : SM-R825U)

[Worst case]

Test Description	Modulation	Bandwidth (MHz)	Frequency	RB size	RB offset
Occupied Bandwidth	QPSK, 16QAM	5, 10	Mid	Full RB	0
Band Edge	* QPSK	5	Low	1	0
			High	1	24
		10	Low	1	0
			High	1	49
		5, 10	Low, High	Full RB	0
Spurious and Harmonic Emissions at Antenna Terminal	* QPSK	5, 10	Low, Mid, High	1	0

4. LIST OF TEST EQUIPMENT

Manufacture	Model/ Equipment	Serial Number	Calibration Date	Calibration Interval	Calibration Due
REOHDE & SCHWARZ	SCU 18 / AMPLIFIER	10094	04/16/2019	Annual	04/16/2020
Wainwright	WHK1.2/15G-10EF/H.P.F	4	04/02/2019	Annual	04/02/2020
Wainwright	WHK3.3/18G-10EF/H.P.F	2	04/02/2019	Annual	04/02/2020
Hewlett Packard	11667B / Power Splitter(DC~26.5 GHz)	11275	05/03/2019	Annual	05/03/2020
Agilent	E3632A/DC Power Supply	MY50360067	10/17/2018	Annual	10/17/2019
Schwarzbeck	UHAP/ Dipole Antenna	557	03/29/2019	Biennial	03/29/2021
Schwarzbeck	UHAP/ Dipole Antenna	558	03/29/2019	Biennial	03/29/2021
ESPEC	SU-642 / Chamber	93000718	08/07/2018	Annual	08/07/2019
Schwarzbeck	BBHA 9120D/ Horn Antenna(1~18GHz)	147	09/14/2018	Annual	09/14/2019
Schwarzbeck	BBHA 9120D/ Horn Antenna(1~18GHz)	9120D-1298	10/04/2018	Annual	10/04/2019
Schwarzbeck	BBHA 9170/ Horn Antenna(15~40GHz)	BBHA9170342	04/29/2019	Biennial	04/29/2021
Schwarzbeck	BBHA 9170/ Horn Antenna(15~40GHz)	BBHA9170124	01/28/2019	Biennial	01/28/2021
Agilent	N9020A/Signal Analyzer(10Hz~26.5GHz)	MY51110063	05/08/2019	Annual	05/08/2020
Hewlett Packard	8493C/ATTENUATOR(20dB)	17280	06/04/2019	Annual	06/04/2020
REOHDE & SCHWARZ	FSV40/Spectrum Analyzer(10Hz~40GHz)	100931	10/22/2018	Annual	10/22/2019
Agilent	8960 (E5515C)/ Base Station	MY48360800	09/27/2018	Annual	09/27/2019
Schwarzbeck	FMZB1513/ Loop Antenna(9kHz~30MHz)	1513-175	08/23/2018	Biennial	08/23/2020
Schwarzbeck	VULB9160/ Bilog Antenna	9160-3368	08/09/2018	Biennial	08/09/2020
Schwarzbeck	VULB9160/ Hybrid Antenna	760	03/22/2019	Biennial	03/22/2021
Anritsu Corp.	MT8821C/Wideband Radio Communication Tester	6201502997	08/13/2018	Annual	08/13/2019
Anritsu Corp.	MT8820C/Wideband Radio Communication Tester	6201026545	01/30/2019	Annual	01/30/2020
REOHDE & SCHWARZ	SMB100A/ SIGNAL GENERATOR (100kHz~40GHz)	114415	10/01/2018	Annual	10/01/2019
REOHDE & SCHWARZ	ESU40 / EMI TEST RECEIVER	100524	07/27/2018	Annual	07/27/2019
HCT CO., LTD.,	FCC LTE Mobile Conducted RF Automation Test Software	-	-	-	-

Note:

- Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

5. 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 data shown herein 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.

Parameter	Expanded Uncertainty ($\pm$ dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70
Radiated Disturbance (18 GHz ~ 40 GHz)	5.05

6. SUMMARY OF TEST RESULTS

6.1 Test Condition : Conducted Test

Test Description	FCC Part Section(s)	IC Section(s)	Test Limit	Test Result
Occupied Bandwidth	§ 2.1049	RSS Gen(6.7)	N/A	PASS
Band Edge / Spurious and Harmonic Emissions at Antenna Terminal.	§ 2.1051, § 27.53(c)	RSS 130(4.7)	$< 43 + 10\log_{10}$ (P[Watts]) at Band Edge and for all out-of-band emissions	PASS
On all frequencies between 763-775 MHz and 793-805 MHz.	§ 27.53(c)(4)	RSS 130(4.7)	$< 65 + 10\log_{10}$ (P[Watts])	PASS (See <u>Note3</u>)
Conducted Output Power	§ 2.1046	-	N/A	<u>See Note1</u>
Frequency stability / variation of ambient temperature	§ 2.1055, § 27.54	RSS 130(4.5)	Emission must remain in band	PASS

Note:

1. See SAR Report
2. The same samples were used for SAR and EMC
3. Since it was not possible to set the resolution bandwidth to 6.25 kHz with the available equipment, a bandwidth of 10 kHz was used instead to show compliance.

6.2 Test Condition : Radiated Test

Test Description	FCC Part Section(s)	IC Section(s)	Test Limit	Test Result
Effective Radiated Power	27.50(b)(10)	RSS 130(4.6)	< 3 Watts max. ERP	PASS
Radiated Spurious and Harmonic Emissions	§ 2.1053, § 27.53(g)	RSS 130(4.7)	< 43 + 10log10 (P[Watts]) for all out-of band emissions	PASS
Undesirable Emissions in the 1559 – 1610 MHz band	2.1053, 27.53(f)	RSS 130(4.7)	< -70dBW/MHz EIRP (wideband) < -80dBW EIRP (narrowband)	PASS
Receiver Spurious Emissions	N/A	RSS Gen(7)	Section 8.7	PASS

7. SAMPLE CALCULATION

7.1 ERP Sample Calculation

Ch./ Freq.		Measured Level(dBm)	Substitute Level(dBm)	Ant. Gain (dBd)	C.L	Pol.	ERP	
channel	Freq.(MHz)						W	dBm
128	824.20	-21.37	38.40	-10.61	0.95	H	0.483	26.84

$$\text{ERP} = \text{Substitute LEVEL(dBm)} + \text{Ant. Gain} - \text{CL(Cable Loss)}$$

- 1) The EUT mounted on a non-conductive turntable is 2.5 meter above test site ground level.
- 2) During the test , the turn table is rotated until the maximum signal is found.
- 3) Record the field strength meter's level.
- 4) Replace the EUT with dipole/Horn antenna that is connected to a calibrated signal generator.
- 5) Increase the signal generator output till the field strength meter's level is equal to the item (3).
- 6) The signal generator output level with Ant. Gain and cable loss are the rating of effective radiated power.

7.2 EIRP Sample Calculation

Ch./ Freq.		Measured Level(dBm)	Substitute Level(dBm)	Ant. Gain (dBi)	C.L	Pol.	EIRP	
channel	Freq.(MHz)						W	dBm
20175	1,732.50	-15.75	18.45	9.90	1.76	H	0.456	26.59

$$\text{EIRP} = \text{Substitute LEVEL(dBm)} + \text{Ant. Gain} - \text{CL(Cable Loss)}$$

- 1) The EUT mounted on a non-conductive turntable is 2.5 meter above test site ground level.
- 2) During the test , the turn table is rotated until the maximum signal is found.
- 3) Record the field strength meter's level.
- 4) Replace the EUT with dipole/Horn antenna that is connected to a calibrated signal generator.
- 5) Increase the signal generator output till the field strength meter's level is equal to the item (3).
- 6) The signal generator output level with Ant. Gain and cable loss are the rating of equivalent isotropic radiated power.

7.3. Emission Designator

GSM Emission Designator

Emission Designator = 249KGXW

GSM BW = 249 kHz

G = Phase Modulation

X = Cases not otherwise covered

W = Combination (Audio/Data)

EDGE Emission Designator

Emission Designator = 249KG7W

GSM BW = 249 kHz

G = Phase Modulation

7 = Quantized/Digital Info

W = Combination (Audio/Data)

WCDMA Emission Designator

Emission Designator = 4M17F9W

WCDMA BW = 4.17 MHz

F = Frequency Modulation

9 = Composite Digital Info

W = Combination (Audio/Data)

QPSK Modulation

Emission Designator = 4M48G7D

LTE BW = 4.48 MHz

G = Phase Modulation

7 = Quantized/Digital Info

D = Data transmission; telemetry; telecommand

16QAM Modulation

Emission Designator = 4M48W7D

LTE BW = 4.48 MHz

W = Amplitude/Angle Modulated

7 = Quantized/Digital Info

D = Data transmission; telemetry; telecommand

8. TEST DATA

8.1 EFFECTIVE RADIATED POWER

Freq (MHz)	Mod (Bandwidth)	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit	ERP	
								W	W	dBm
779.5	LTE B13 (5 MHz)	QPSK	-36.10	22.64	-10.32	0.83	H	< 3.00	0.014	11.49
		16-QAM	-38.58	20.16	-10.32	0.83	H		0.008	9.01
782.0		QPSK	-36.03	22.87	-10.33	0.83	H		0.015	11.71
		16-QAM	-38.49	20.41	-10.33	0.83	H		0.008	9.25
784.5		QPSK	-36.29	22.87	-10.34	0.83	H		0.015	11.71
		16-QAM	-38.85	20.31	-10.34	0.83	H		0.008	9.15

Freq (MHz)	Mod (Bandwidth)	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit	ERP	
								W	W	dBm
782.0	LTE B13 (10 MHz)	QPSK	-36.21	22.69	-10.33	0.83	H	< 3.00	0.014	11.53
		16-QAM	-38.71	20.19	-10.33	0.83	H		0.008	9.03

8.2 RADIATED SPURIOUS EMISSIONS

■ OPERATING FREQUENCY:	<u>782.0 MHz</u>
■ MEASURED OUTPUT POWER:	<u>11.71 dBm = 0.015 W</u>
■ MODE:	<u>LTE B13</u>
■ MODULATION SIGNAL:	<u>5 MHz QPSK</u>
■ DISTANCE:	<u>3 meters</u>
■ LIMIT: $43 + 10 \log_{10}(W) =$	<u>24.71 dBc</u>

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBd)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	dBc
23205 (779.5)	1,559.0	-52.02	6.73	-60.37	1.23	H	-57.02	68.73
	2,338.5	-56.96	7.87	-62.26	1.56	V	-58.10	69.81
	3,118.0	-56.45	9.21	-61.04	1.83	H	-55.81	67.52
23230 (782.0)	1,564.0	-49.42	6.76	-57.90	1.23	H	-54.53	66.23
	2,346.0	-57.88	7.92	-63.18	1.55	H	-58.96	70.67
	3,128.0	-57.88	9.21	-62.34	1.82	H	-57.10	68.81
23255 (784.5)	1,569.0	-48.88	6.78	-57.49	1.23	H	-54.09	65.80
	2,353.5	-57.88	7.97	-63.18	1.53	V	-58.89	70.60
	3,138.0	-57.68	9.20	-62.25	1.84	V	-57.04	68.75

- ▣ OPERATING FREQUENCY: 782.00 MHz
- ▣ MEASURED OUTPUT POWER: 11.53 dBm = 0.014 W
- ▣ MODE: LTE B13
- ▣ MODULATION SIGNAL: 10 MHz QPSK
- ▣ DISTANCE: 3 meters
- ▣ LIMIT: $43 + 10 \log_{10} (W) =$ 24.53 dBc

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBd)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	dBc
23230 (782.0)	1,564.0	-46.39	6.76	-59.17	1.23	H	-51.50	63.02
	2,346.0	-58.25	7.92	-67.85	1.55	H	-59.33	70.86
	3,128.0	-56.65	9.21	-65.41	1.82	H	-55.87	67.40

1559 MHz ~ 1610 MHz BAND

- OPERATING FREQUENCY: 779.5 MHz, 782.0 MHz, 784.5 MHz
- MEASURED OUTPUT POWER: 5 MHz QPSK
- DISTANCE: 3 meters
- WIDEBAND EMISSION LIMIT: -70 dBW/ MHz (= -40 dBm/ MHz)

Operating Frequency (MHz)	Measured Frequency (MHz)	EMISSION TYPE	Measured Level (dBm)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	Margin (dB)
779.5	1584.1	WIDEBAND	-54.87	6.96	-63.52	1.24	H	-59.95	19.95
782.0	1559.8		-45.05	6.73	-53.40	1.23	H	-50.05	10.05
784.5	1564.6		-46.06	6.76	-54.55	1.23	H	-51.17	11.17

- OPERATING FREQUENCY: 782.0 MHz
- MEASURED OUTPUT POWER: 10 MHz QPSK
- DISTANCE: 3 meters
- WIDEBAND EMISSION LIMIT: -70 dBW/ MHz (= -40 dBm/ MHz)

Operating Frequency (MHz)	Measured Frequency (MHz)	EMISSION TYPE	Measured Level (dBm)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	Margin (dB)
782.0	1576.1	WIDEBAND	-55.14	6.84	-63.68	1.24	V	-60.23	20.23

8.3 OCCUPIED BANDWIDTH

Band	Band Width	Frequency (MHz)	Modulation	Resource Block Size	Resource Block Offset	Data (MHz)
13	5 MHz	782.0	QPSK	25	0	4.4973
			16-QAM	25	0	4.5212
	10 MHz		QPSK	50	0	8.9646
			16-QAM	50	0	8.9735

Note:

1. Plots of the EUT's Occupied Bandwidth are shown Page 40 ~ 43.

8.4 CONDUCTED SPURIOUS EMISSIONS

Band	Band Width (MHz)	Frequency (MHz)	Frequency of Maximum Harmonic (GHz)	Factor (dB)	Measurement Maximum Data (dBm)	Result (dBm)	Limit (dBm)
13	5	779.5	3.7054	27.976	-67.143	-39.167	-13.00
		782.0	2.4263	27.976	-66.779	-38.803	
		784.5	3.6860	27.976	-67.044	-39.068	
	10	782.0	3.7024	27.976	-66.960	-38.984	

Note:

1. Plots of the EUT's Conducted Spurious Emissions are shown Page 56 ~ 59.
2. Conducted Spurious Emissions was Tested QPSK Modulation, Resource Block Size 1 and Resource Block Offset 0
3. Result (dBm) = Measurement Maximum Data (dBm) + Factor (dB)
4. Factor(dB) = Cable Loss + Attenuator + Power Splitter

Frequency Range (GHz)	Factor [dB]
0.03 – 1	25.270
1 – 5	27.976
5 – 10	28.591
10 – 15	29.116
15 – 20	29.489
Above 20	30.131

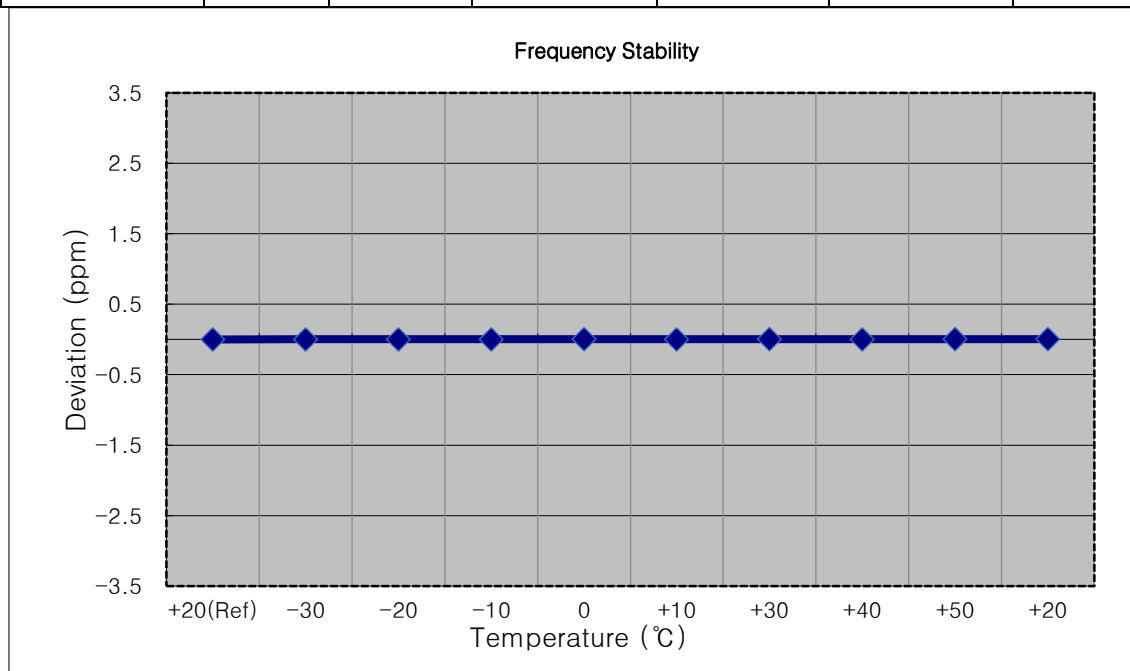
8.5 BAND EDGE

- Plots of the EUT's Band Edge are shown Page 44 ~ 55.

8.6 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE

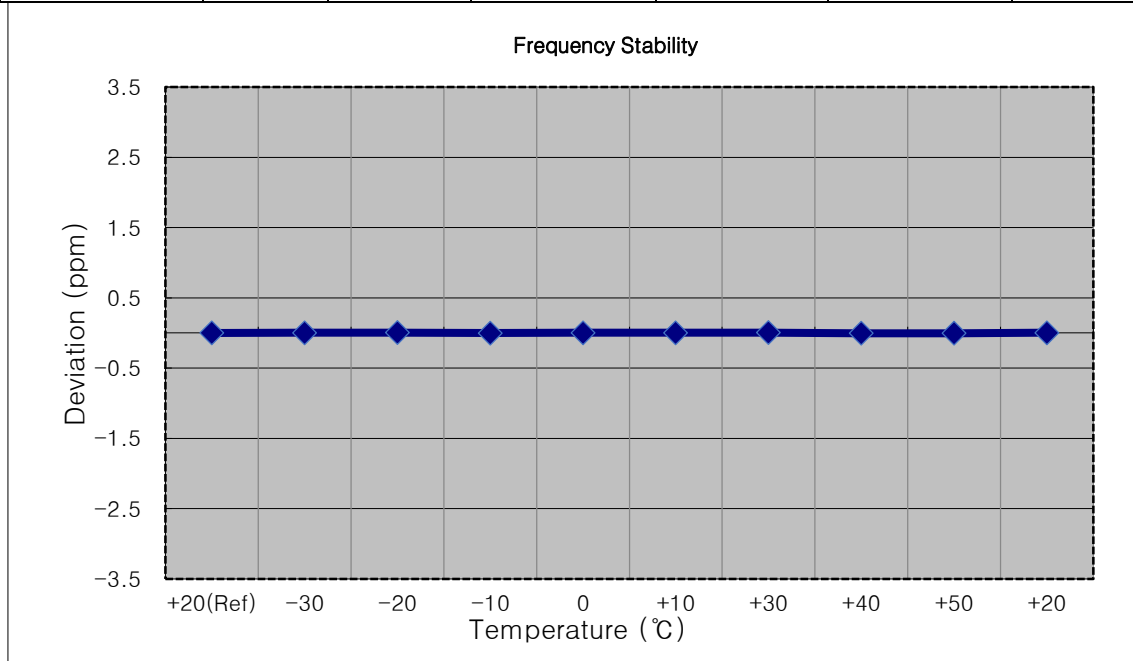
MODE:	<u>LTE 13</u>
OPERATING FREQUENCY:	<u>779,500,000 Hz</u>
CHANNEL:	<u>23205 (5 MHz)</u>
REFERENCE VOLTAGE:	<u>3.850 VDC</u>
DEVIATION LIMIT:	<u>Emission must remain in band</u>

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.850	+20(Ref)	779 499 997	0.00	0.000 000	0.0000
100%		-30	779 499 999	2.40	0.000 000	0.0031
100%		-20	779 499 999	2.30	0.000 000	0.0030
100%		-10	779 499 999	2.40	0.000 000	0.0031
100%		0	779 500 000	3.30	0.000 000	0.0042
100%		+10	779 499 999	1.90	0.000 000	0.0024
100%		+30	779 500 000	3.10	0.000 000	0.0040
100%		+40	779 499 999	2.70	0.000 000	0.0035
100%		+50	779 500 000	3.10	0.000 000	0.0040
Batt. Endpoint	3.500	+20	779 500 000	2.80	0.000 000	0.0036



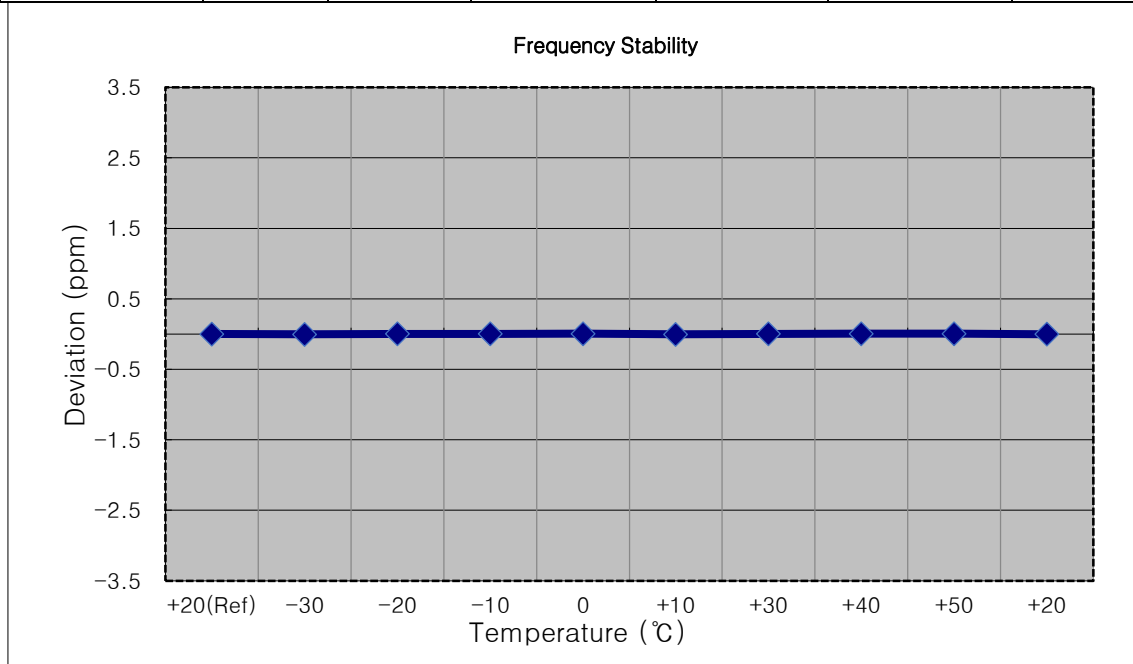
■ MODE: LTE 13
 ■ OPERATING FREQUENCY: 782,000,000 Hz
 ■ CHANNEL: 23230 (5 MHz)
 ■ REFERENCE VOLTAGE: 3.850 VDC
 ■ DEVIATION LIMIT: Emission must remain in band

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.850	+20(Ref)	782 000 003	0.00	0.000 000	0.0000
100%		-30	782 000 006	2.80	0.000 000	0.0036
100%		-20	782 000 007	3.90	0.000 000	0.0050
100%		-10	782 000 001	-1.80	0.000 000	-0.0023
100%		0	782 000 006	3.00	0.000 000	0.0038
100%		+10	782 000 005	2.20	0.000 000	0.0028
100%		+30	782 000 007	4.40	0.000 001	0.0056
100%		+40	782 000 001	-2.00	0.000 000	-0.0026
100%		+50	782 000 001	-2.20	0.000 000	-0.0028
Batt. Endpoint	3.500	+20	782 000 006	2.70	0.000 000	0.0035



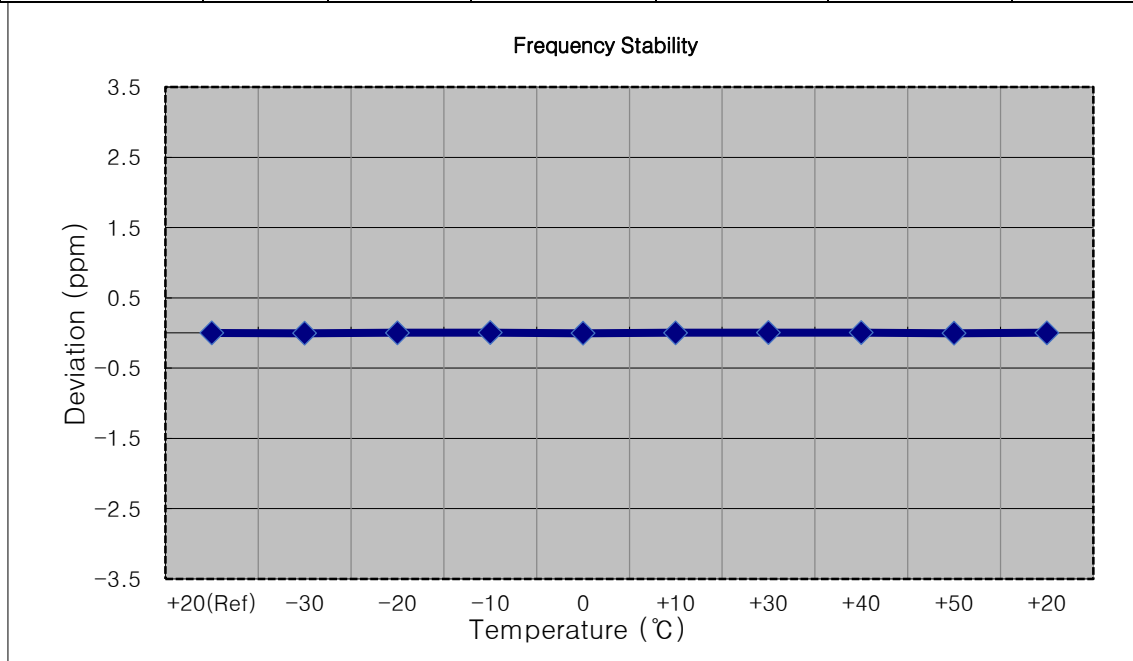
■ MODE: LTE 13
 ■ OPERATING FREQUENCY: 784,500,000 Hz
 ■ CHANNEL: 23255 (5 MHz)
 ■ REFERENCE VOLTAGE: 3.850 VDC
 ■ DEVIATION LIMIT: Emission must remain in band

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.850	+20(Ref)	784 500 004	0.00	0.000 000	0.0000
100%		-30	784 500 002	-2.40	0.000 000	-0.0031
100%		-20	784 500 007	2.30	0.000 000	0.0029
100%		-10	784 500 007	3.00	0.000 000	0.0038
100%		0	784 500 009	4.80	0.000 001	0.0061
100%		+10	784 500 002	-2.10	0.000 000	-0.0027
100%		+30	784 500 007	3.00	0.000 000	0.0038
100%		+40	784 500 009	5.00	0.000 001	0.0064
100%		+50	784 500 009	4.80	0.000 001	0.0061
Batt. Endpoint	3.500	+20	784 500 003	-1.50	0.000 000	-0.0019



- MODE: LTE 13
- OPERATING FREQUENCY: 782,000,000 Hz
- CHANNEL: 23230 (10 MHz)
- REFERENCE VOLTAGE: 3.850 VDC
- DEVIATION LIMIT: Emission must remain in band

Voltage (%)	Power (VDC)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
100%	3.850	+20(Ref)	782 000 003	0.00	0.000 000	0.0000
100%		-30	782 000 000	-3.50	0.000 000	-0.0045
100%		-20	782 000 006	2.40	0.000 000	0.0031
100%		-10	782 000 007	3.50	0.000 000	0.0045
100%		0	782 000 000	-3.20	0.000 000	-0.0041
100%		+10	782 000 005	2.30	0.000 000	0.0029
100%		+30	782 000 007	3.40	0.000 000	0.0043
100%		+40	782 000 008	4.40	0.000 001	0.0056
100%		+50	782 000 000	-3.00	0.000 000	-0.0038
Batt. Endpoint	3.500	+20	782 000 005	1.70	0.000 000	0.0022



8.7 RECEIVER SPURIOUS EMISSIONS

Frequency Range : 30 MHz ~ 1 GHz

Frequency	Reading	Ant. factor+Cable loss- Amp Gain	Ant. POL	Total	Limit	Margin
MHz	dB μ V	dB /m	(H/V)	dB μ V/m	dB μ V/m	dB
No Peak Found						

Frequency Range : Above 1 GHz

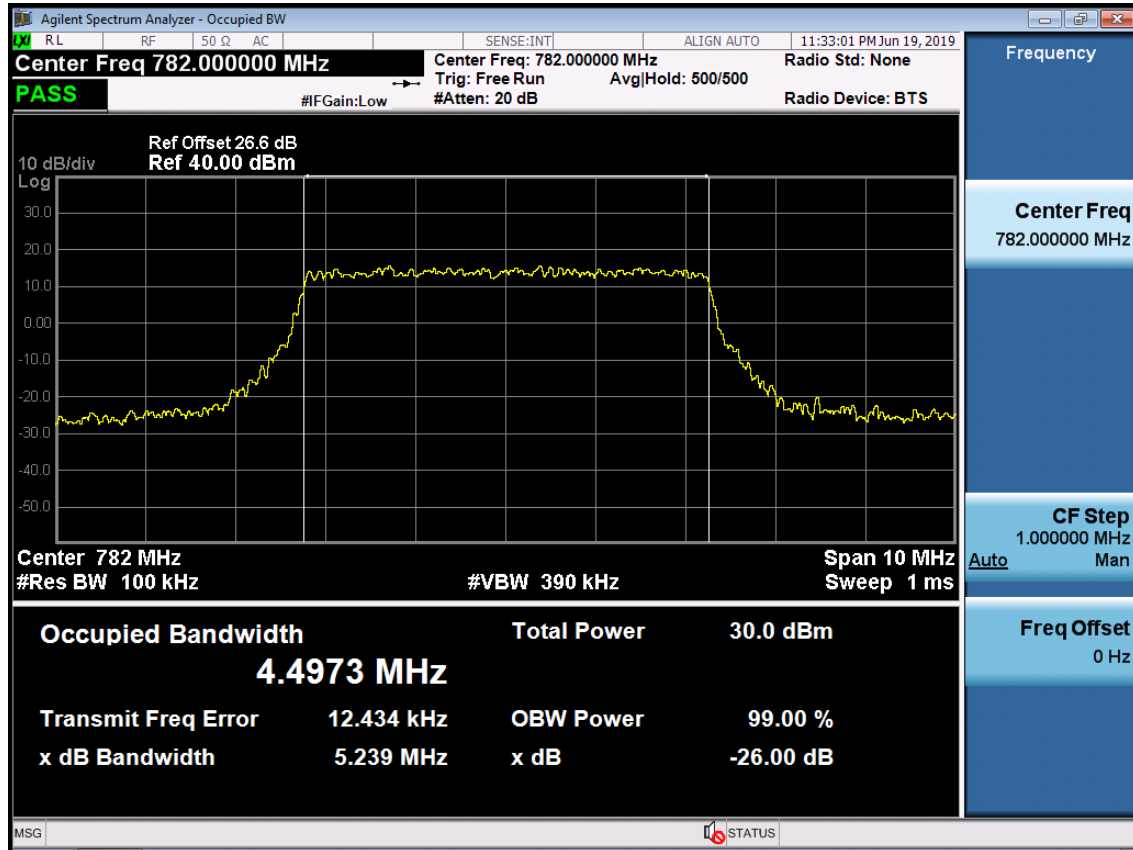
Frequency	Reading	Ant. factor+Cable loss- Amp Gain	Ant. POL	Total	Limit	Margin
MHz	dB μ V	dB /m	(H/V)	dB μ V/m	dB μ V/m	dB
No Peak Found						

Limit

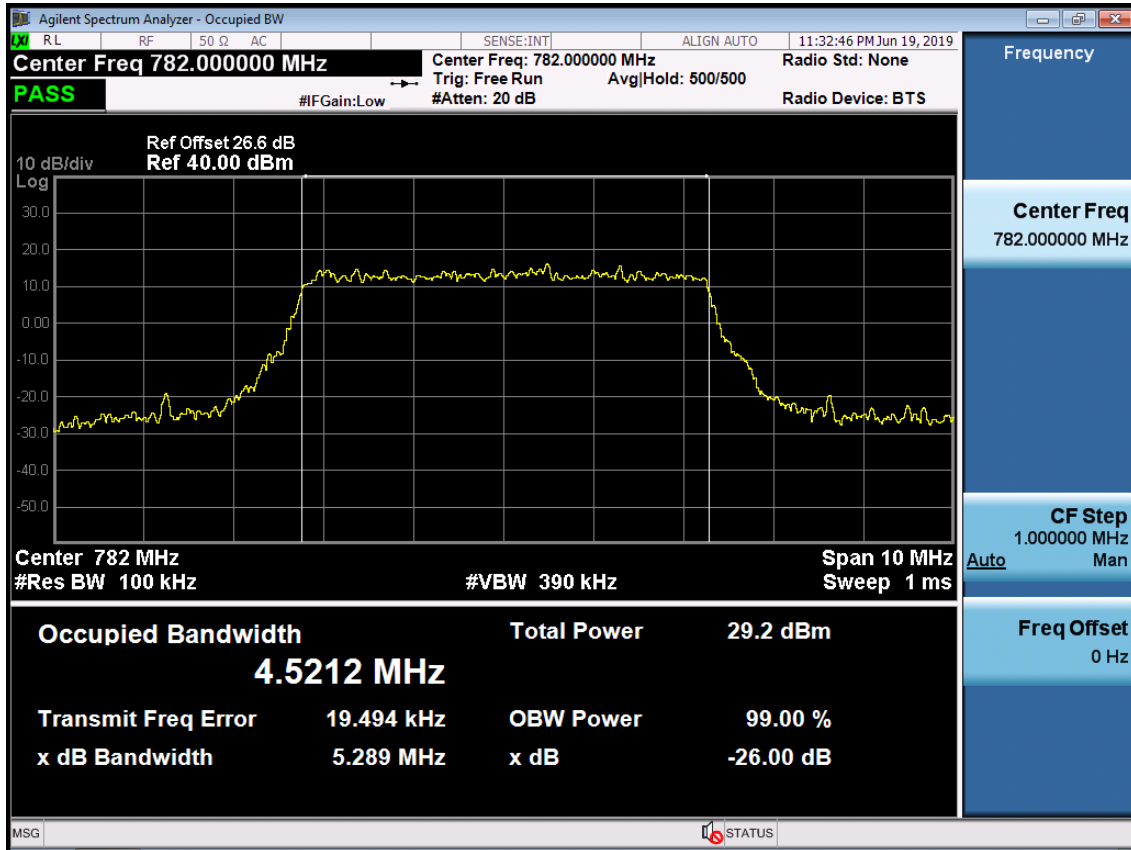
Frequency (MHz)	Field Strength (μ V/m at 3 meters)
30 – 88	100
88 - 216	150
216 – 960	200
Above 960	500

9. TEST PLOTS

BAND 13. Occupied Bandwidth Plot (Ch.23230 QPSK RB 25) 5 MHz



BAND 13. Occupied Bandwidth Plot (Ch.23230 16-QAM RB 25) 5 MHz



Agilent Spectrum Analyzer - Occupied BW

RL RF 50 Ω AC SENSE:INT ALIGN AUTO 11:37:53 PM Jun 19, 2019

Center Freq 782.000000 MHz Center Freq: 782.000000 MHz Radio Std: None
#IFGain:Low Trig: Free Run Avg/Hold: 500/500
PASS #Atten: 20 dB Radio Device: BTS

Ref Offset 26.6 dB
Ref 40.00 dBm

10 dB/div
Log

Center 782 MHz Span 20 MHz
#Res BW 200 kHz #VBW 820 kHz Sweep 1 ms

Occupied Bandwidth		Total Power	30.0 dBm
8.9646 MHz			
Transmit Freq Error	33.859 kHz	OBW Power	99.00 %
x dB Bandwidth	10.36 MHz	x dB	-26.00 dB

MSG STATUS

Frequency

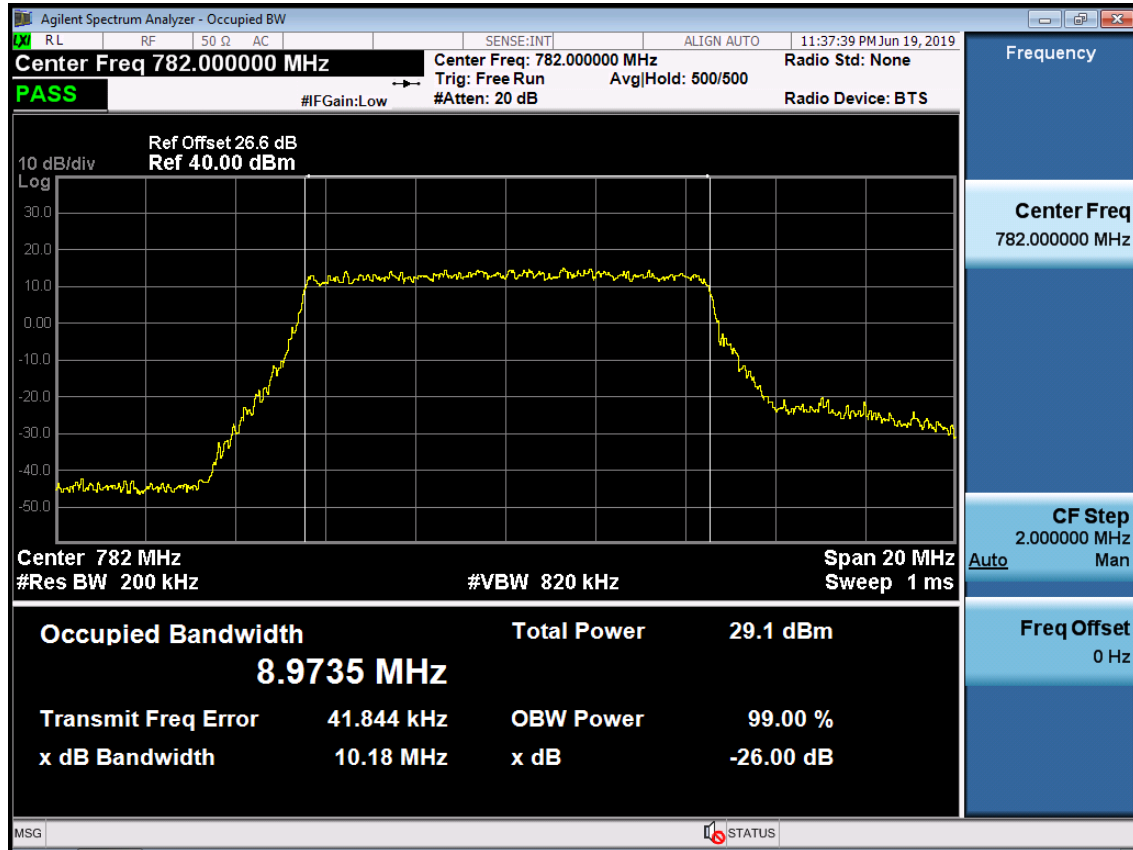
Center Freq
782.000000 MHz

CF Step
2.000000 MHz
Man

Auto

Freq Offset
0 Hz

BAND 13. Occupied Bandwidth Plot (Ch.23230 16-QAM RB 50) 10 MHz



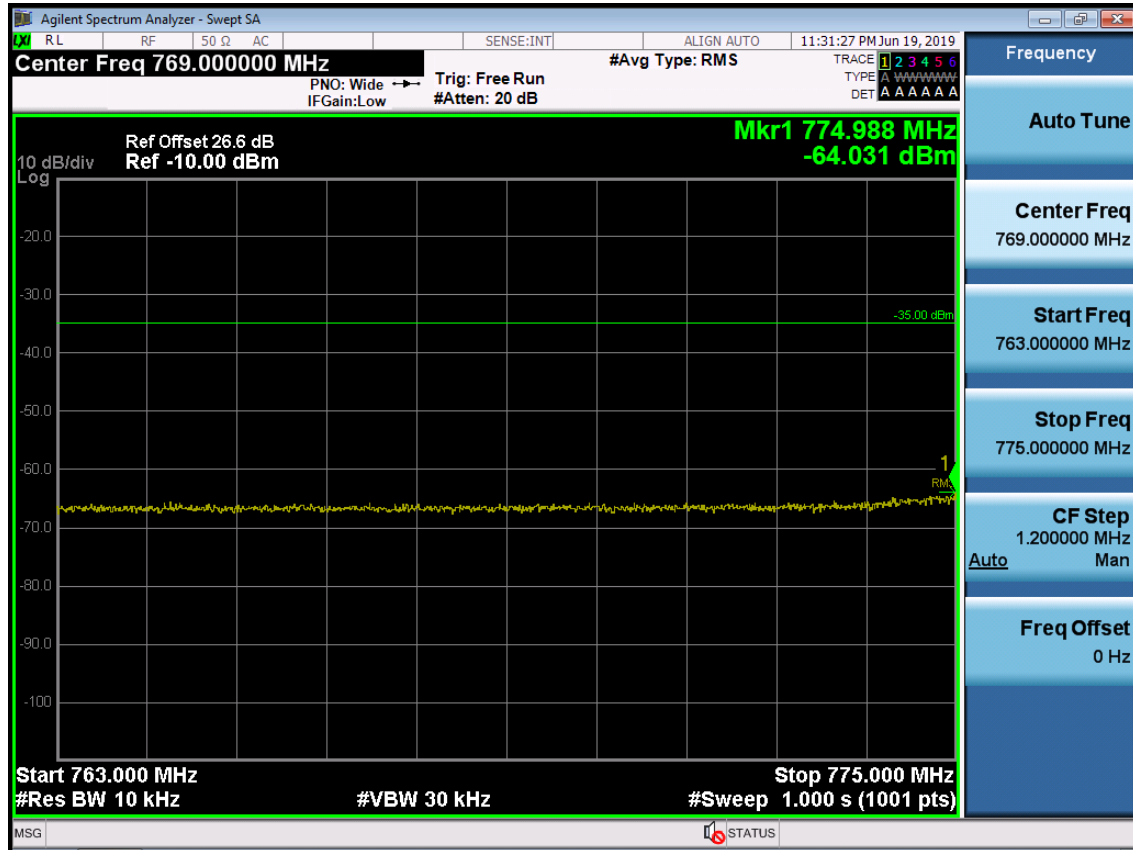
Band 13 Lower Band Edge Plot (5M BW Ch.23205 QPSK_RB1 OFFSET_0)



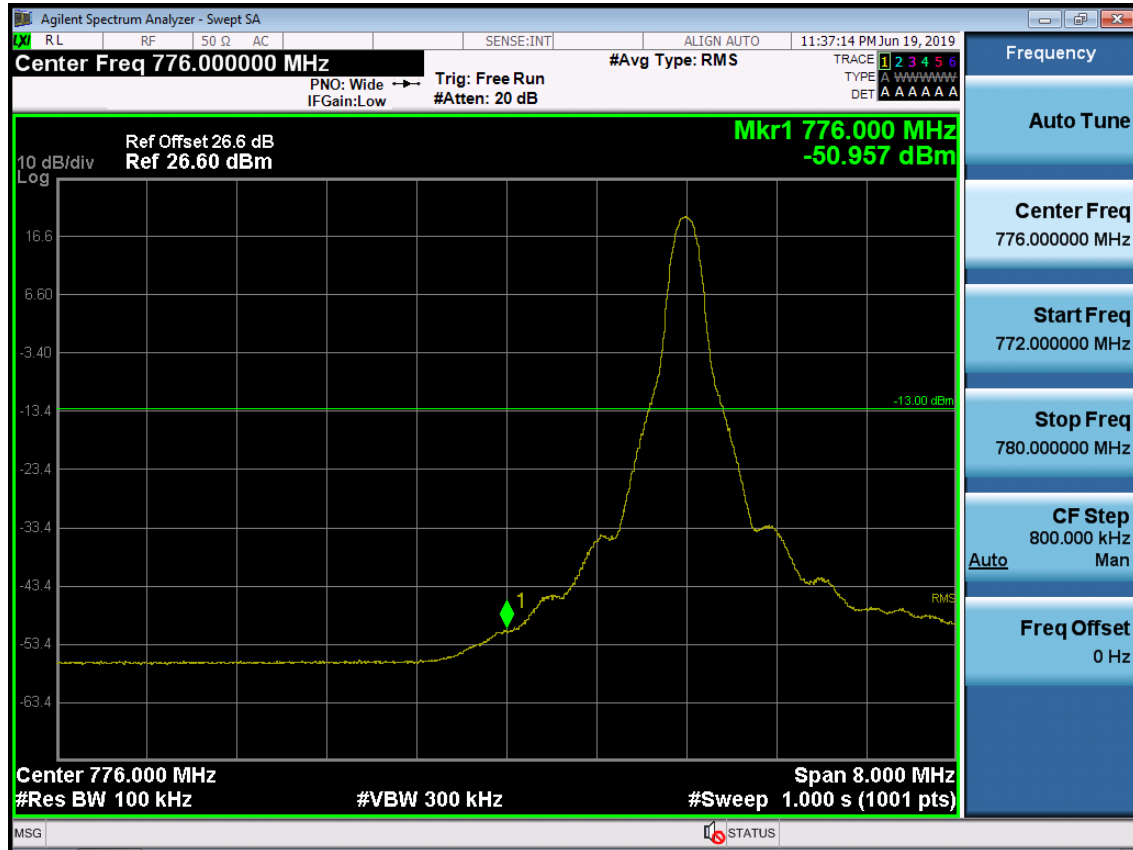
Band 13 Lower Band Edge Plot (5M BW Ch.23205 QPSK_RB_25)



Band 13 Lower Emission Mask (763 MHz ~ 775 MHz) Plot (5M BW Ch.23205 QPSK_RB25_0)



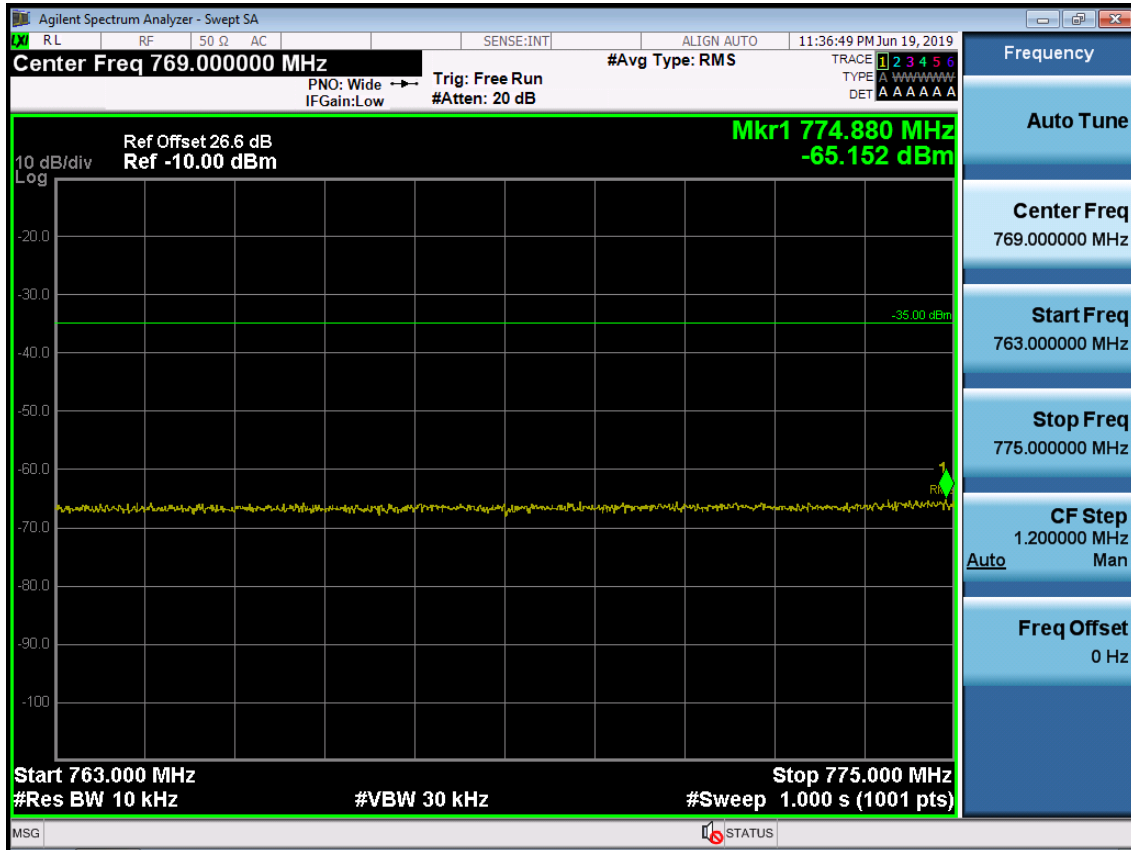
Band 13 Lower Band Edge Plot (10M BW Ch.23230 QPSK_RB1 OFFSET_0)



BAND 13. Lower & Upper Band Edge Plot (10M BW Ch.23230 QPSK RB_50)



Band 13 Lower Emission Mask (763 MHz ~ 775 MHz) Plot (10M BW Ch.23230 QPSK_RB50_0)



Band 13 Upper Band Edge Plot (5M BW Ch.23255 QPSK_RB1_Offset 24)



Band 13 Upper Band Edge Plot (5M BW Ch.23255 QPSK_RB_25)



Band 13 Upper Emission Mask (793 MHz ~805 MHz) Plot (5M BW Ch.23255 QPSK_RB25_0)



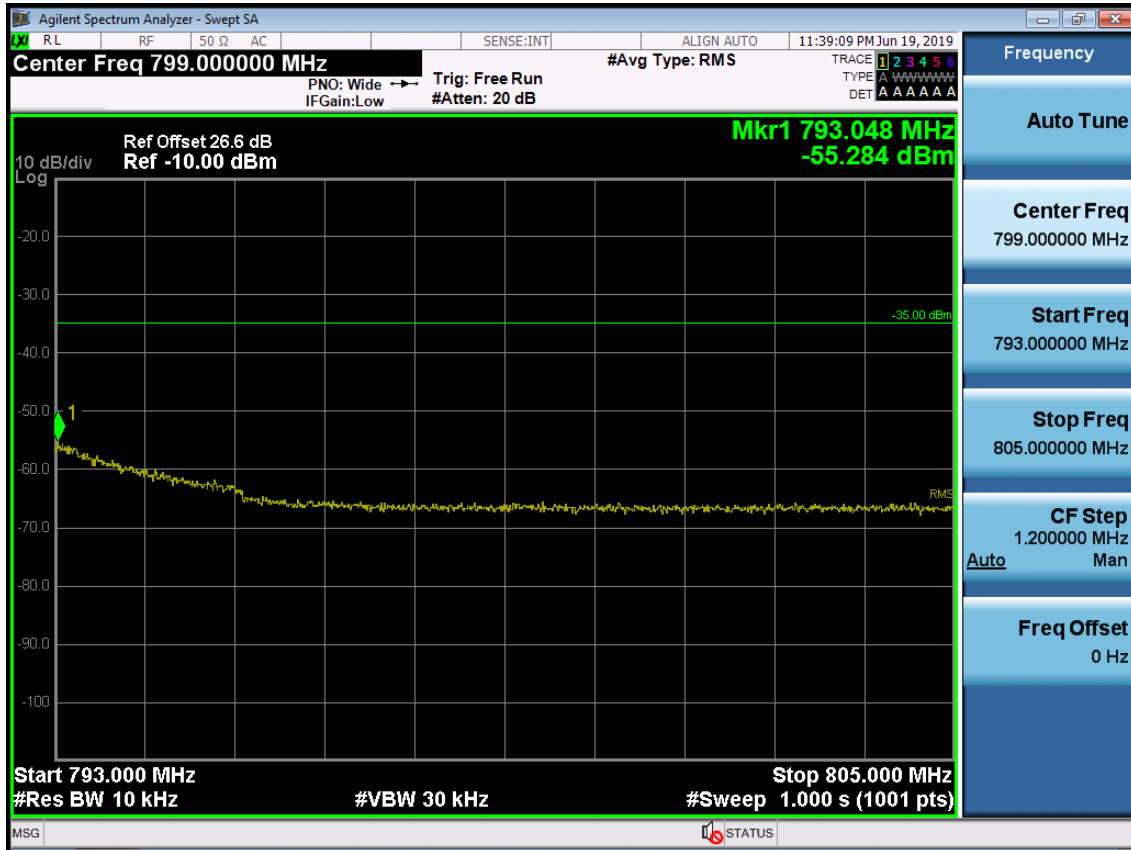
Band 13 Upper Band Edge Plot (10M BW Ch.23230 QPSK_RB1_Offset_49)



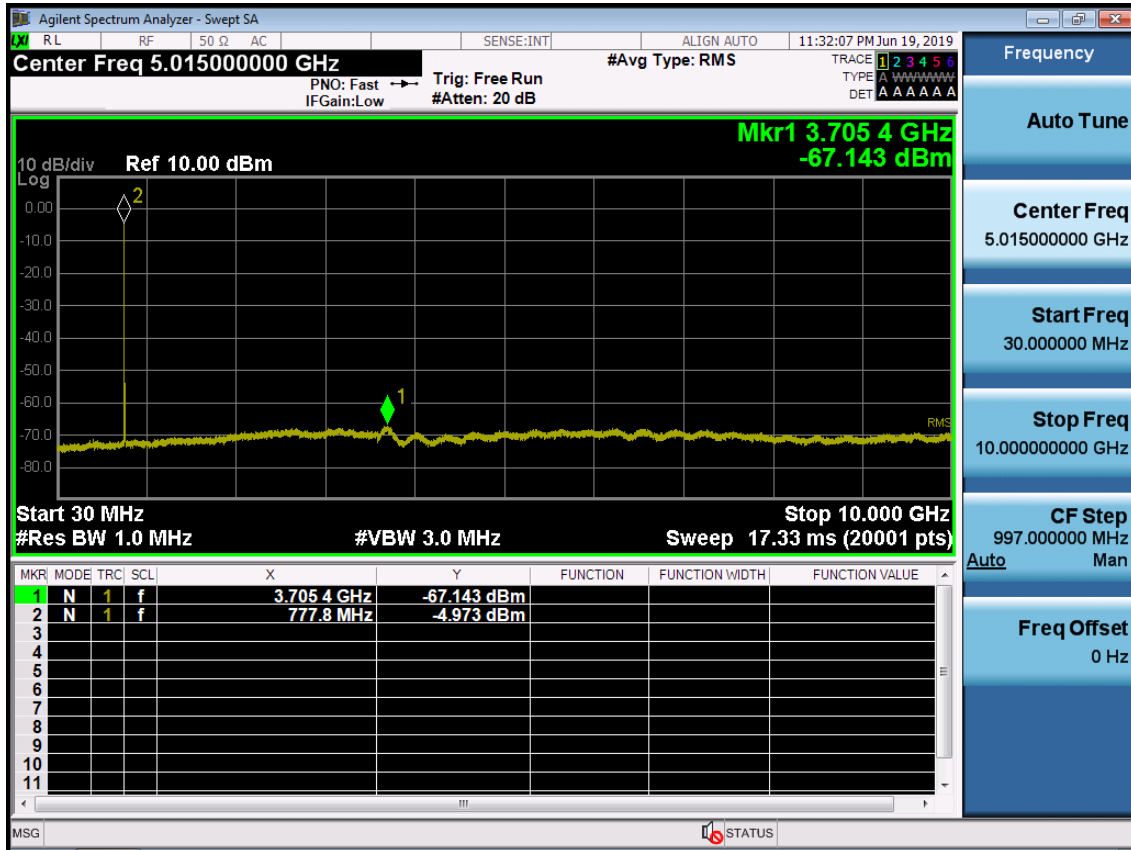
Band 13 Upper Band Edge Plot (10M BW Ch.23230 QPSK_ QPSK_RB_50)



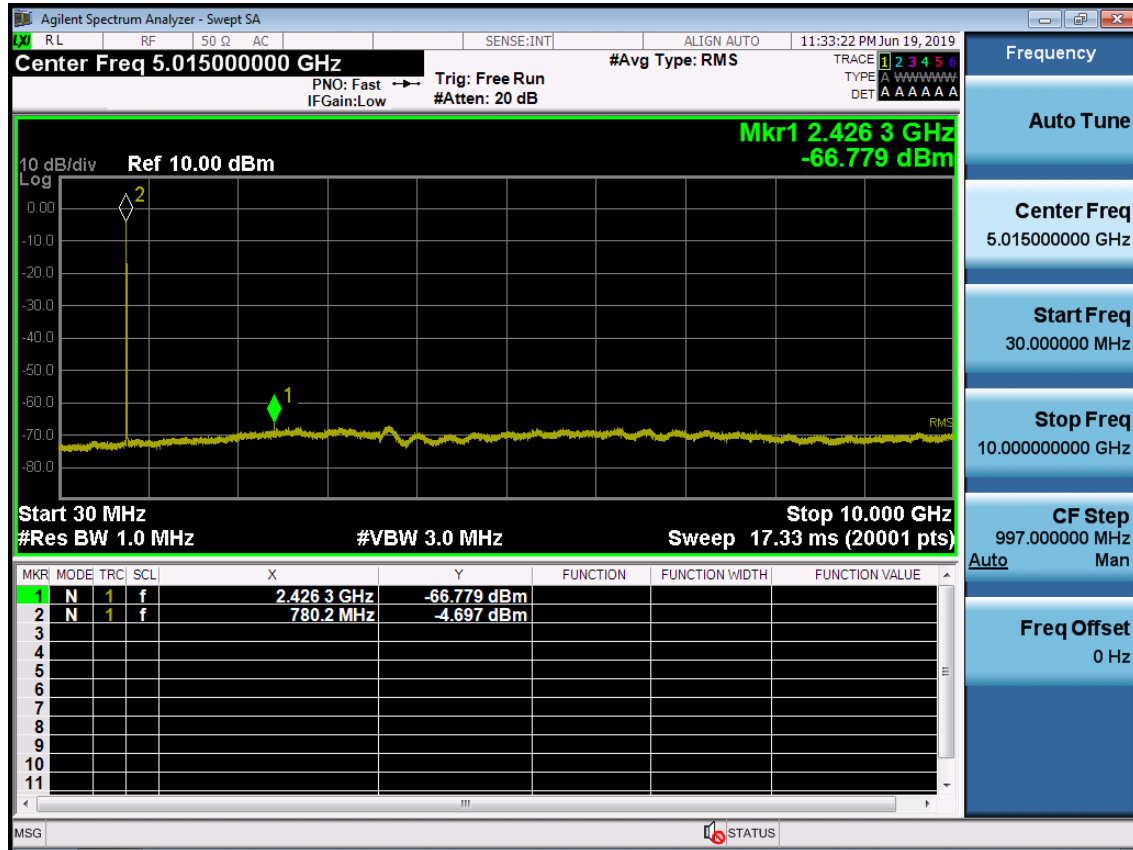
Band 13 Upper Emission Mask (793 MHz ~805 MHz) Plot (10M BW Ch.23230 QPSK_RB50_0)



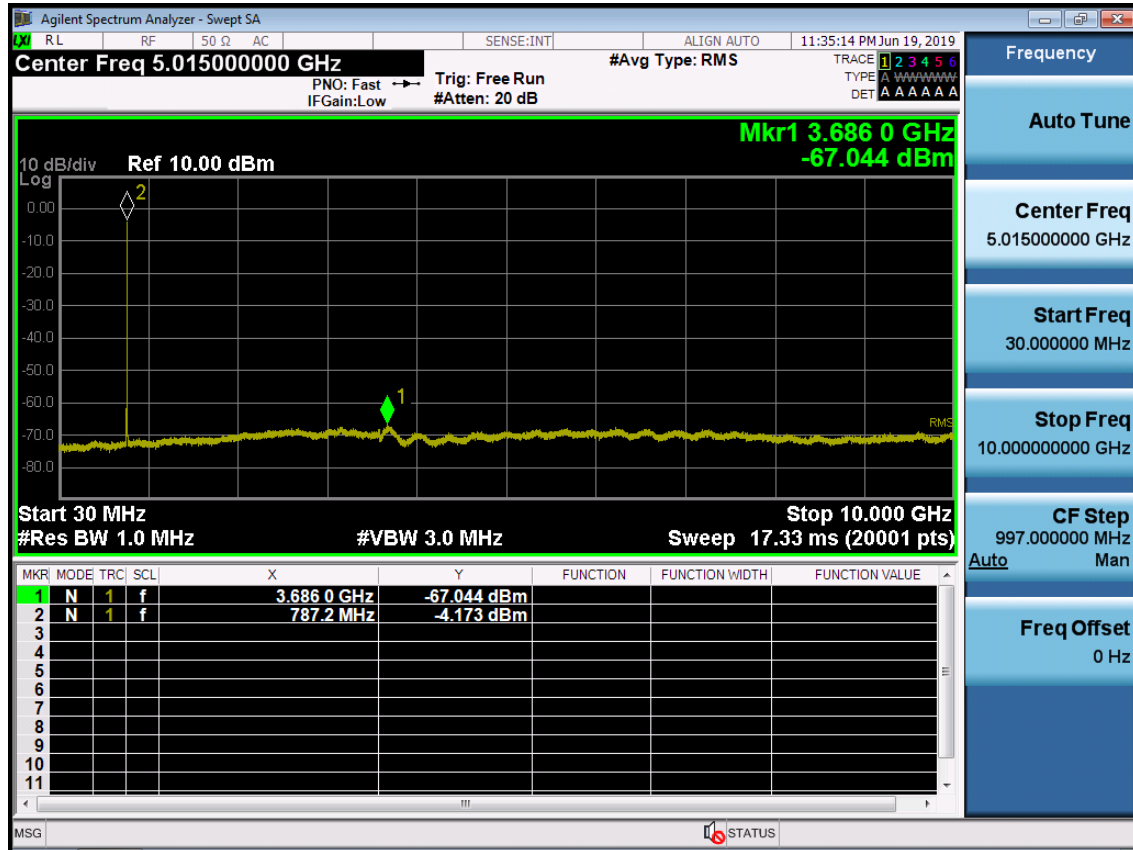
BAND 13. Conducted Spurious Plot (23205ch_5MHz_QPSK_RB 1_0)



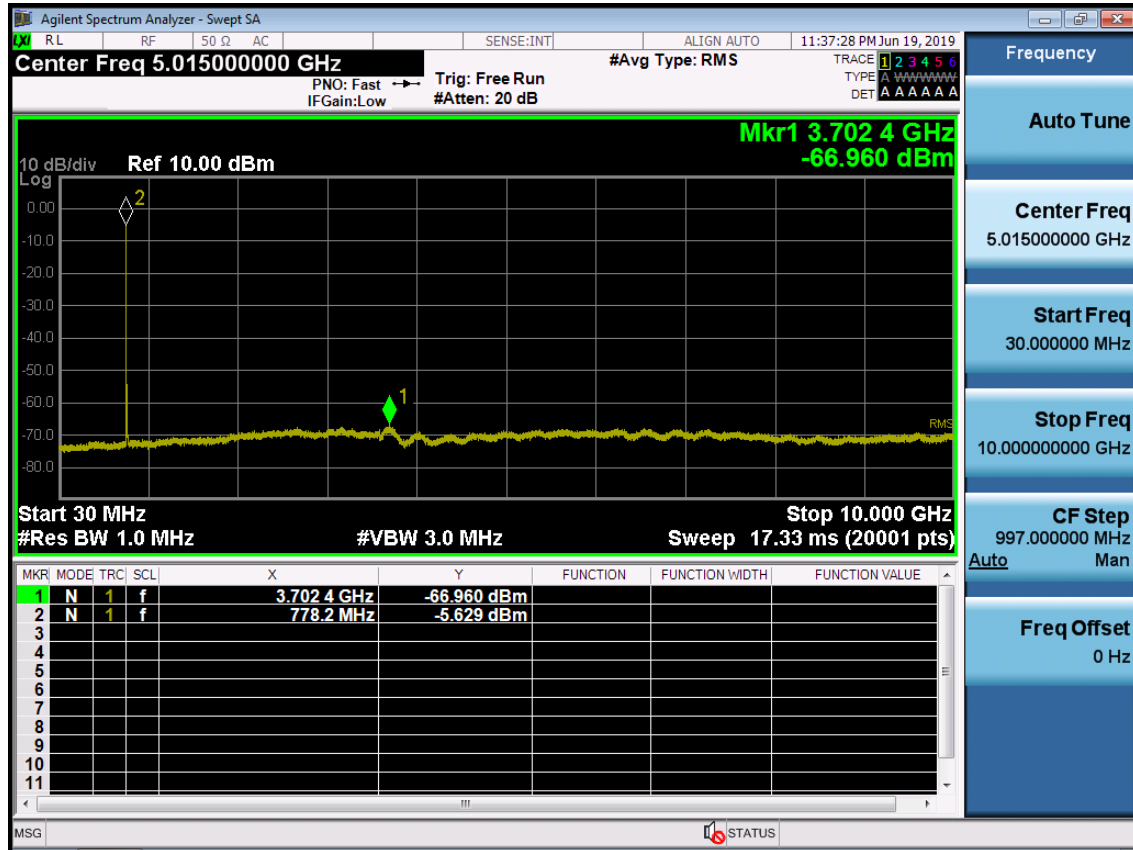
BAND 13. Conducted Spurious Plot (23230ch_5MHz_QPSK_RB 1_0)



BAND 13. Conducted Spurious Plot (23255ch_5MHz_QPSK_ RB 1_0)



BAND 13. Conducted Spurious Plot (Ch.23230 10 MHz QPSK RB 1, Offset 0)



10. APPENDIX A_ TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	HCT-RF-1907-FI028-P