

FCC Sub6 REPORT

Certification

Applicant Name:
SAMSUNG Electronics Co., Ltd.

Date of Issue:
May 19, 2022

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

Location:
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Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA

Report No.: HCT-RF-2205-FC033-R1

FCC ID: A3LSMG990U2

APPLICANT: SAMSUNG Electronics Co., Ltd.

Model(s): SM-G990U2
 Additional Model(s): SM-G990U3/DS
 EUT Type: Mobile Phone
 FCC Classification: PCS Licensed Transmitter Held to Ear (PCE)
 FCC Rule Part(s): §27, §2

Mode (MHz)	Tx Frequency (MHz)	Emission Designator	Modulation	ERP	
				Max. Power (W)	Max. Power (dBm)
Sub6 n12 (5)	701.5 – 713.5	4M50G7D	PI/2 BPSK	0.081	19.07
		4M51G7D	QPSK	0.078	18.92
		4M49W7D	16QAM	0.061	17.86
		4M49W7D	64QAM	0.046	16.64
		4M49W7D	256QAM	0.025	14.05
Sub6 n12 (10)	704.0 – 711.0	8M95G7D	PI/2 BPSK	0.078	18.93
		8M93G7D	QPSK	0.077	18.87
		8M93W7D	16QAM	0.065	18.13
		8M96W7D	64QAM	0.049	16.90
		8M95W7D	256QAM	0.024	13.88
Sub6 n12 (15)	706.5 – 708.5	13M4G7D	PI/2 BPSK	0.078	18.90
		13M4G7D	QPSK	0.079	18.96
		13M4W7D	16QAM	0.060	17.81
		13M4W7D	64QAM	0.049	16.89
		13M4W7D	256QAM	0.025	13.91

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)

Report No.: HCT-RF-2205-FC033-R1

REVIEWED BY



Report prepared by : Jung Ki Lim
Engineer of Telecommunication Testing Center

Report approved by : Jong Seok Lee
Manager of Telecommunication Testing Center

This test results were applied only to the test methods required by the standard.

This laboratory is not accredited for the test results marked *.

The above Test Report is the accredited test result by (KS Q) ISO/IEC 17025 and KOLAS(Korea Laboratory Accreditation Scheme), which signed the ILAC-MRA. (HCT Accreditation No.: KT197)

* The report shall not be reproduced except in full(only partly) without approval of the laboratory.

Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-RF-2205-FC033	May 13, 2022	- First Approval Report
HCT-RF-2205-FC033-R1	May 19, 2022	- Revised the Section 3.9. (Page 16.) - Added the Title for EN-DC 2A-n12A data. (Page 26.)

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.

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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:	A3LSMG990U2
Application Type:	Certification
FCC Classification:	PCS Licensed Transmitter Held to Ear (PCE)
FCC Rule Part(s):	§27, §2
EUT Type:	Mobile Phone
Model(s):	SM-G990U2
Additional Model(s):	SM-G990U3/DS
SCS(kHz):	15
Bandwidth(MHz):	5, 10, 15
Waveform:	CP-OFDM, DFT-S-OFDM
Modulation:	DFT-S-OFDM: PI/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM CP-OFDM: QPSK, 16QAM, 64QAM, 256QAM
Tx Frequency:	701.5 MHz – 713.5 MHz (Sub6 n12 (5 MHz)) 704.0 MHz – 711.0 MHz (Sub6 n12 (10 MHz)) 706.5 MHz – 708.5 MHz (Sub6 n12 (15 MHz))
Date(s) of Tests:	April 08, 2022 ~ May 04, 2022
Serial number:	Radiated: R3CT30Q0QVR Conducted: R3CT30Q0RQT

2. INTRODUCTION

2.1. DESCRIPTION OF EUT

The EUT was a Mobile Phone with GSM/GPRS/EGPRS/UMTS, CDMA(BC0, 1, 10) and LTE, Sub6.

It also supports IEEE 802.11 a/b/g/n/ac/ax (20/40/80), Bluetooth, BT LE, NFC, AIT, WPT, mmWave(n260/261).

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)
Peak- to- Average Ratio	- KDB 971168 D01 v03r01 – Section 5.7 - ANSI C63.26-2015 – Section 5.2.3.4
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 1 MHz
3. VBW \geq 3 x RBW
4. Span = 1.5 times the OBW
5. No. of sweep points $>$ 2 x 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 1 GHz, 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;

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

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 = 100 kHz for emissions below 1 GHz and 1 MHz for emissions above 1 GHz
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. For spurious emissions above 1 GHz, 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 spurious emissions is calculated by the following formula;

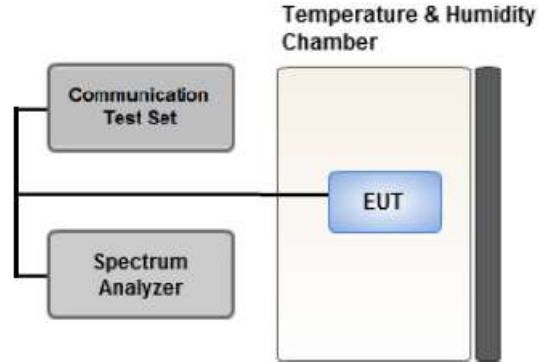
$$\text{Result}_{(\text{dBm})} = P_{g(\text{dBm})} - \text{cable loss}_{(\text{dB})} + \text{antenna gain}_{(\text{dBi})}$$

Where: P_g is the generator output power into the substitution antenna.

If the fundamental frequency is below 1 GHz, RF output power has been converted to EIRP.

$$\text{EIRP}_{(\text{dBm})} = \text{ERP}_{(\text{dBm})} + 2.15$$

3.4 PEAK- TO- AVERAGE RATIO



Test setup

① CCDF Procedure for PAPR

Test Settings

1. Set resolution/measurement bandwidth \geq signal's occupied bandwidth;
2. Set the number of counts to a value that stabilizes the measured CCDF curve;
3. Set the measurement interval as follows:
 - .- for continuous transmissions, set to 1 ms,
 - .- or burst transmissions, employ an external trigger that is synchronized with the EUT burst timing sequence, or use the internal burst trigger with a trigger level that allows the burst to stabilize and set the measurement interval to a time that is less than or equal to the burst duration.
4. Record the maximum PAPR level associated with a probability of 0.1 %.

② Alternate Procedure for PAPR

Use one of the procedures presented in 5.2(ANSI C63.26-2015) to measure the total peak power and record as P_{Pk} .

Use one of the applicable procedures presented 5.2(ANSI C63.26-2015) to measure the total average power and record as P_{Avg} . Determine the P.A.R. from:

$$P.A.R_{(dB)} = P_{Pk (dBm)} - P_{Avg (dBm)} \quad (P_{Avg} = \text{Average Power} + \text{Duty cycle Factor})$$

Test Settings(Peak Power)

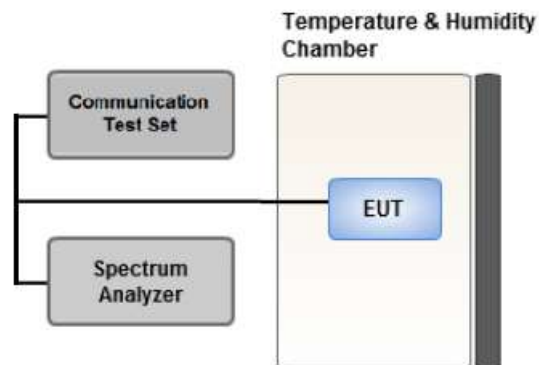
The measurement instrument must have a RBW that is greater than or equal to the OBW of the signal to be measured and a VBW $\geq 3 \times$ RBW.

1. Set the RBW \geq OBW.
2. Set VBW $\geq 3 \times$ RBW.
3. Set span $\geq 2 \times$ OBW.
4. Sweep time $\geq 10 \times$ (number of points in sweep) \times (transmission symbol period).
5. Detector = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the peak amplitude level.

Test Settings(Average Power)

1. Set span to $2 \times$ to $3 \times$ the OBW.
2. Set RBW \geq OBW.
3. Set VBW $\geq 3 \times$ RBW.
4. Set number of measurement points in sweep $\geq 2 \times$ span / RBW.
5. Sweep time:
Set $\geq [10 \times (\text{number of points in sweep}) \times (\text{transmission period})]$ for single sweep (automation-compatible) measurement. The transmission period is the (on + off) time.
6. Detector = power averaging (rms).
7. Set sweep trigger to "free run."
8. Trace average at least 100 traces in power averaging (rms) mode if sweep is set to auto-couple. (To accurately determine the average power over the on and off period of the transmitter, it can be necessary to increase the number of traces to be averaged above 100 or, if using a manually configured sweep time, increase the sweep time.)
9. Use the peak marker function to determine the maximum amplitude level.
10. Add $[10 \log (1/\text{duty cycle})]$ to the measured maximum power level to compute the average power during continuous transmission. For example, add $[10 \log (1/0.25)] = 6$ dB if the duty cycle is a constant 25 %.

3.5 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.

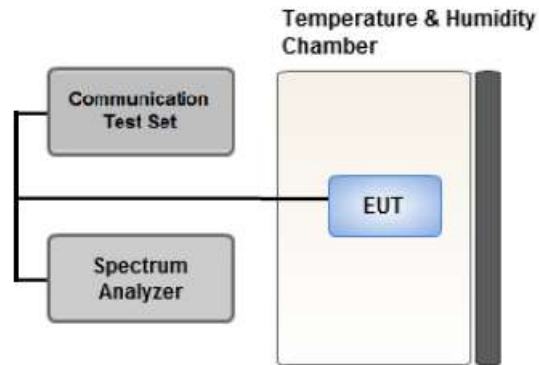
The conducted occupied bandwidth used the power splitter via EUT RF power connector between simulation base station and spectrum analyzer.

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 26 dB 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

3.6 SPURIOUS AND HARMONIC EMISSIONS AT ANTENNA TERMINAL



Test setup

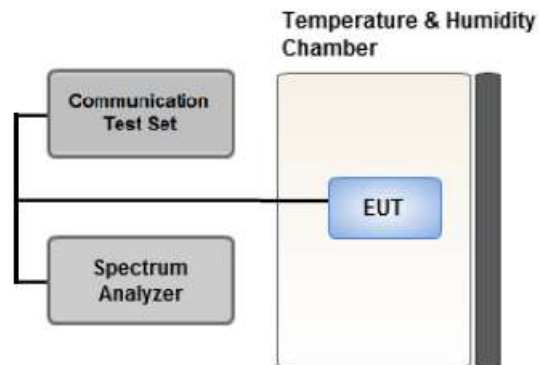
Test Overview

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 * Span / RBW

3.7 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

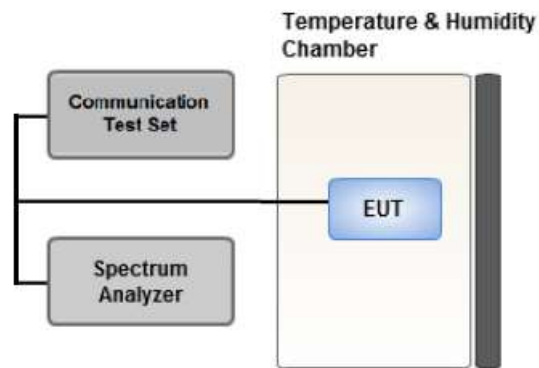
Test Notes

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.

3.8 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.

3.9 WORST CASE(RADIATED TEST)

- Waveform : All Waveform of operation were investigated and the worst case configuration results are reported.
(Worst case: DFT-S-OFDM)
- 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.
Mode: SA, NSA
Worst case: NSA (2A-n12A)
Mode : Stand alone, Stand alone + External accessories (Earphone, AC adapter, etc)
Worst case : Stand alone
- We were performed the RSE test in condition of co-location.
Mode : Stand alone, Simultaneous transmission scenarios
Worst case : Stand alone
- Radiated Spurious emissions are measured while operating in EN-DC mode with Sub 6 NR carrier as well as an LTE carrier (anchor).
All EN-DC mode of operation were investigated and the worst case configuration results are reported.
(Worst case: 2A-n12A (10 MHz))
- All RB sizes, offsets of operation were investigated and the worst case configuration results are reported.
Please refer to the table below.
- In the case of radiated spurious emissions, all bandwidth of operation were investigated and the worst case bandwidth results are reported.
(Worst case : 5 MHz)
- SM-G990U2 & additional models were tested and the worst case results are reported.
(Worst case : SM-G990U2)

[Worst case]

Test Description	Modulation	RB size	RB offset	Axis
Effective Radiated Power	PI/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM	1	1	X
	Radiated Spurious and Harmonic Emissions	QPSK	1	1

3.10 WORST CASE(CONDUCTED TEST)

- Waveform : All Waveform of operation were investigated and the worst case configuration results are reported.

(Worst case: DFT-S-OFDM)

- Modulation : All Modulation of operation were investigated and the worst case configuration results are reported.

(Worst case: PI/2 BPSK)

- All modes of operation were investigated and the worst case configuration results are reported.

Mode: SA, NSA

Worst case: NSA (2A-n12A)

- All RB sizes, offsets of operation were investigated and the worst case configuration results are reported.

Please refer to the table below.

- SM-G990U2 & additional models were tested and the worst case results are reported.

(Worst case : SM-G990U2)

[Worst case]

Test Description	Modulation	Bandwidth (MHz)	Frequency	RB size	RB offset
Occupied Bandwidth Peak- to- Average Ratio	PI/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM	5, 10, 15	Mid	Full RB	0
Band Edge	PI/2 BPSK	5	Low	1	0
			High	1	24
		10	Low	1	0
			High	1	51
		15	Low	1	0
			High	1	78
5, 10, 15	Low, High	Full RB	0		
Spurious and Harmonic Emissions at Antenna Terminal	PI/2 BPSK	5, 10, 15	Low, Mid, High	1	1

4. LIST OF TEST EQUIPMENT

Equipment	Model	Manufacture	Serial No.	Due to Calibration	Calibration Interval
Precision Dipole Antenna	UHAP	Schwarzbeck	01273	03/27/2024	Biennial
Precision Dipole Antenna	UHAP	Schwarzbeck	01274	03/27/2024	Biennial
Horn Antenna(1~18GHz)	BBHA 9120D	Schwarzbeck	02289	03/21/2024	Biennial
Horn Antenna(1~18GHz)	BBHA 9120D	Schwarzbeck	9120D-1299	05/04/2023	Biennial
Horn Antenna(15~40GHz)	BBHA 9170	Schwarzbeck	BBHA9170342	10/13/2022	Biennial
Horn Antenna(15~40GHz)	BBHA 9170	Schwarzbeck	BBHA9170124	04/12/2023	Biennial
Loop Antenna(9kHz~30 MHz)	FMZB1513	Rohde & Schwarz	1513-175	06/04/2023	Biennial
Bilog Antenna	VULB9160	Schwarzbeck	3150	03/03/2023	Biennial
Hybrid Antenna	VULB9160	Schwarzbeck	760	02/22/2023	Biennial
High Pass Filter	WHKX10-900-1000-15000-40SS	Wainwright Instruments	15	06/15/2022	Annual
High Pass Filter	WHKX10-2700-3000-18000-40SS	Wainwright Instruments	145	06/15/2022	Annual
High Pass Filter	WHNX6-4740-6000-26500-40CC	Wainwright Instruments	11	06/15/2022	Annual
LOW NOISE AMP (100 MHz ~ 18GHz)	CBLU1183540B-01	CERNEC	26822	06/15/2022	Annual
Power Amplifier	CBL18265035	CERNEC	22966	12/02/2022	Annual
Power Amplifier	CBL26405040	CERNEC	25956	03/11/2023	Annual
DC Power Supply	E3632A	Hewlett Packard	MY40004427	09/15/2022	Annual
Power Splitter(DC~26.5 GHz)	11667B	Hewlett Packard	11275	03/11/2023	Annual
Chamber	SU-642	ESPEC	93008124	03/04/2023	Annual
Signal Analyzer(10Hz~26.5GHz)	N9020A	Agilent	MY51110063	04/19/2023	Annual
ATTENUATOR(20dB)	8493C	Hewlett Packard	17280	06/01/2022	Annual
Spectrum Analyzer(10Hz~40GHz)	FSV40	REOHDE & SCHWARZ	101436	02/25/2023	Annual
Base Station	8960 (E5515C)	Agilent	MY48360800	08/18/2022	Annual
Wideband Radio Communication Tester	MT8821C	Anritsu Corp.	6262287700	05/25/2022	Annual
Wideband Radio Communication Tester	MT8000A	Anritsu Corp.	6262302511	05/26/2022	Annual
SIGNAL GENERATOR (100kHz~40GHz)	SMB100A	REOHDE & SCHWARZ	177633	07/05/2022	Annual
Signal Analyzer(5Hz~40.0GHz)	N9030B	KEYSIGHT	MY55480167	06/02/2022	Annual
4-Way Divider	ZC4PD-K1844+	Mini-Circuits	942907	09/27/2022	Annual
FCC LTE Mobile Conducted RF Automation Test Software	-	HCT CO., LTD.,	-	-	-

Note:

1. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.
2. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

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)	2.00 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (9 kHz ~ 30 MHz)	4.40 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (30 MHz ~ 1 GHz)	5.74 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (1 GHz ~ 18 GHz)	5.51 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (18 GHz ~ 40 GHz)	5.92 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (Above 40 GHz)	5.48 (Confidence level about 95 %, $k=2$)

6. SUMMARY OF TEST RESULTS

6.1 Test Condition : Conducted Test

Test Description	FCC Part Section(s)	Test Limit	Test Result
Occupied Bandwidth	§2.1049	N/A	PASS
Band Edge / Spurious and Harmonic Emissions at Antenna Terminal.	§2.1051, §27.53(g)	< 43 + 10log10 (P[Watts]) at Band Edge and for all out-of-band emissions	PASS
Conducted Output Power	§2.1046	N/A	<u>See Note1</u>
Frequency stability / variation of ambient temperature	§2.1055, §27.54	Emission must remain in band	PASS

Note:

1. See SAR Report
2. Conducted test were tested using 5G Wireless Tester.

6.2 Test Condition : Radiated Test

Test Description	FCC Part Section(s)	Test Limit	Test Result
Effective Radiated Power	§27.50(c)(10)	< 3 Watts max. ERP	PASS
Radiated Spurious and Harmonic Emissions	§2.1053, §27.53(g)	< 43 + 10log10 (P[Watts]) for all out-of band emissions	PASS

Note:

1. Radiated tests were tested using 5G Wireless Tester.

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

QAM 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 [SCS (kHz)]	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit	ERP	
								W	W	dBm
701.5	Sub6 n12/ 5 MHz [15 kHz]	PI/2 BPSK	-29.68	29.85	-9.75	1.29	H	< 3.00	0.076	18.82
		QPSK	-29.81	29.72	-9.75	1.29	H		0.074	18.69
		16-QAM	-30.84	28.69	-9.75	1.29	H		0.058	17.66
		64-QAM	-32.05	27.48	-9.75	1.29	H		0.044	16.45
		256-QAM	-34.63	24.90	-9.75	1.29	H		0.024	13.87
707.5		PI/2 BPSK	-29.44	30.13	-9.77	1.29	H		0.081	19.07
		QPSK	-29.59	29.98	-9.77	1.29	H		0.078	18.92
		16-QAM	-30.65	28.92	-9.77	1.29	H		0.061	17.86
		64-QAM	-31.87	27.70	-9.77	1.29	H		0.046	16.64
		256-QAM	-34.46	25.11	-9.77	1.29	H		0.025	14.05
713.5		PI/2 BPSK	-29.75	29.64	-9.80	1.29	H		0.072	18.56
		QPSK	-29.86	29.53	-9.80	1.29	H		0.070	18.45
		16-QAM	-30.87	28.52	-9.80	1.29	H		0.055	17.44
		64-QAM	-32.14	27.25	-9.80	1.29	H		0.041	16.17
		256-QAM	-34.81	24.58	-9.80	1.29	H		0.022	13.50

Freq (MHz)	Mod/ Bandwidth [SCS (kHz)]	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit		ERP	
								W	W	dBm	dBm
704.0	Sub6 n12/ 10 MHz [15 kHz]	PI/2 BPSK	-29.75	29.88	-9.76	1.29	H	< 3.00	0.076	18.83	
		QPSK	-29.87	29.76	-9.76	1.29	H		0.074	18.71	
		16-QAM	-30.91	28.72	-9.76	1.29	H		0.058	17.67	
		64-QAM	-32.08	27.55	-9.76	1.29	H		0.045	16.50	
		256-QAM	-34.72	24.91	-9.76	1.29	H		0.024	13.86	
707.5		PI/2 BPSK	-29.65	29.92	-9.77	1.29	H		0.077	18.86	
		QPSK	-29.78	29.79	-9.77	1.29	H		0.075	18.73	
		16-QAM	-30.82	28.75	-9.77	1.29	H		0.059	17.69	
		64-QAM	-31.61	27.96	-9.77	1.29	H		0.049	16.90	
		256-QAM	-34.79	24.78	-9.77	1.29	H		0.024	13.72	
711.0	PI/2 BPSK	-29.56	30.00	-9.78	1.29	H	0.078	18.93			
	QPSK	-29.62	29.94	-9.78	1.29	H	0.077	18.87			
	16-QAM	-30.36	29.20	-9.78	1.29	H	0.065	18.13			
	64-QAM	-32.44	27.12	-9.78	1.29	H	0.040	16.05			
	256-QAM	-34.61	24.95	-9.78	1.29	H	0.024	13.88			

Freq (MHz)	Mod/ Bandwidth [SCS (kHz)]	Modulation	Measured Level (dBm)	Substitute Level (dBm)	Ant. Gain(dBd)	C.L	Pol	Limit		ERP	
								W	W	dBm	dBm
706.5	Sub6 n12/ 15 MHz [15 kHz]	PI/2 BPSK	-29.76	29.83	-9.77	1.29	H	< 3.00	0.076	18.78	
		QPSK	-29.94	29.65	-9.77	1.29	H		0.072	18.60	
		16-QAM	-30.82	28.77	-9.77	1.29	H		0.059	17.72	
		64-QAM	-31.65	27.94	-9.77	1.29	H		0.049	16.89	
		256-QAM	-34.68	24.91	-9.77	1.29	H		0.024	13.86	
707.5		PI/2 BPSK	-29.63	29.94	-9.77	1.29	H		0.077	18.88	
		QPSK	-29.65	29.92	-9.77	1.29	H		0.077	18.86	
		16-QAM	-30.73	28.84	-9.77	1.29	H		0.060	17.78	
		64-QAM	-32.02	27.55	-9.77	1.29	H		0.045	16.49	
		256-QAM	-34.66	24.91	-9.77	1.29	H		0.024	13.85	
708.5	PI/2 BPSK	-29.58	29.97	-9.78	1.29	H	0.078	18.90			
	QPSK	-29.52	30.03	-9.78	1.29	H	0.079	18.96			
	16-QAM	-30.67	28.88	-9.78	1.29	H	0.060	17.81			
	64-QAM	-31.85	27.70	-9.78	1.29	H	0.046	16.63			
	256-QAM	-34.57	24.98	-9.78	1.29	H	0.025	13.91			

8.2 RADIATED SPURIOUS EMISSIONS

- NR Band: N12
- LTE Band(Anchor): B2
- Bandwidth: 5 MHz
- Modulation: PI/2 BPSK
- Distance: 3 meters
- SCS: 15 kHz

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	Limit (dBm)
140300 (701.5)	1 403.00	-57.42	7.60	-62.89	1.86	V	-57.15	-13.00
	2 104.50	-58.03	8.77	-63.95	2.30	H	-57.48	-13.00
	2 806.00	-58.78	10.67	-62.83	2.72	V	-54.88	-13.00
141500 (707.5)	1 415.00	-57.40	7.61	-64.03	1.87	V	-58.28	-13.00
	2 122.50	-58.33	8.98	-64.15	2.31	H	-57.48	-13.00
	2 830.00	-58.51	10.52	-62.52	2.73	V	-54.73	-13.00
142700 (713.5)	1 427.00	-55.62	7.66	-62.42	1.84	V	-56.60	-13.00
	2 140.50	-56.85	9.26	-61.68	2.32	H	-54.74	-13.00
	2 854.00	-59.06	10.42	-63.03	2.76	H	-55.37	-13.00

■ ENDC-Mode : 2A(10 MHz)-n12A(5 MHz)

Ch	Freq (MHz)	Measured Level (dBm)	Ant. Gain (dBi)	Substitute Level (dBm)	C.L	Pol	Result (dBm)	Limit (dBm)
18900 (1880.0)	3760.00	-61.44	11.64	-61.67	3.16	V	-53.19	-13.00
	5640.00	-61.39	12.00	-55.21	3.93	H	-47.14	-13.00
	7520.00	-62.08	11.54	-47.63	4.51	H	-40.60	-13.00

8.3 PEAK-TO-AVERAGE RATIO

Band	Band Width	Frequency (MHz)	Modulation	Resource Block Size	Resource Block Offset	Data (dB)
Sub6 n12	5 MHz	707.5	BPSK	25	0	3.61
			QPSK			4.16
			16-QAM			5.23
			64-QAM			5.62
			256-QAM			6.27
	10 MHz		BPSK	50		3.72
			QPSK			4.55
			16-QAM			5.11
			64-QAM			5.69
			256-QAM			6.20
	15 MHz		BPSK	75		3.75
			QPSK			4.52
			16-QAM			5.47
			64-QAM			5.60
			256-QAM			6.29

Note:

1. Plots of the EUT's Peak- to- Average Ratio are shown Page 49 ~ 63.
2. Peak- to- Average Ratio is not required. These values are reported for information only.

8.4 OCCUPIED BANDWIDTH

Band	Band Width	Frequency (MHz)	Modulation	Resource Block Size	Resource Block Offset	Data (MHz)
Sub6 n12	5 MHz	707.5	BPSK	25	0	4.4969
			QPSK			4.5057
			16-QAM			4.4878
			64-QAM			4.4906
			256-QAM			4.4856
	10 MHz		BPSK	50		8.9475
			QPSK			8.9340
			16-QAM			8.9229
			64-QAM			8.9599
			256-QAM			8.9487
	15 MHz		BPSK	75		13.389
			QPSK			13.435
			16-QAM			13.431
			64-QAM			13.440
			256-QAM			13.408

Note:

1. Plots of the EUT's Occupied Bandwidth are shown Page 34 ~ 48.

8.5 CONDUCTED SPURIOUS EMISSIONS

Band	Band Width (MHz)	Frequency (MHz)	Frequency of Maximum Harmonic (GHz)	Factor (dB)	Measurement Maximum Data (dBm)	Result (dBm)	Limit (dBm)
Sub6 n12	5	701.5	8.3285	30.815	-70.253	-39.438	-13.00
		707.5	5.1935	30.815	-70.226	-39.411	
		713.5	9.7393	30.815	-70.753	-39.938	
	10	704.0	8.8699	30.815	-70.131	-39.316	
		707.5	8.5952	30.815	-70.102	-39.287	
		711.0	8.8450	30.815	-70.633	-39.818	
	15	706.5	9.7039	30.815	-70.360	-39.545	
		707.5	9.1521	30.815	-69.960	-39.145	
		708.5	3.8026	30.200	-70.382	-40.182	

Note:

1. Plots of the EUT's Conducted Spurious Emissions are shown Page 85 ~ 93.
2. Result (dBm) = Measurement Maximum Data (dBm) + Factor (dB)
3. Factor(dB) = Cable Loss + Attenuator + Splitter

Frequency Range (GHz)	Factor [dB]
0.03 – 1	27.494
1 – 5	30.200
5 – 10	30.815
10 – 15	31.340
15 – 20	31.713
Above 20	32.355

8.6 BAND EDGE

- Plots of the EUT's Band Edge are shown Page 64 ~ 84.

8.7 FREQUENCY STABILITY / VARIATION OF AMBIENT TEMPERATURE

- ▣ BandWidth: 5 MHz
- ▣ Voltage(100 %): 3.880 VDC
- ▣ Batt. Endpoint: 3.650 VDC
- ▣ Deviation Limit: Emission must remain in band

Test. Frequency (MHz)	Voltage (%)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
707.5	100 %	+20(Ref)	707 500 009	0.0	0.000 000	0.000
	100 %	-30	707 500 019	10.5	0.000 001	0.015
	100 %	-20	707 500 019	10.0	0.000 001	0.014
	100 %	-10	707 500 022	13.0	0.000 002	0.018
	100 %	0	707 500 016	6.7	0.000 001	0.010
	100 %	+10	707 500 012	3.4	0.000 000	0.005
	100 %	+30	707 500 012	3.4	0.000 000	0.005
	100 %	+40	707 500 013	4.0	0.000 001	0.006
	100 %	+50	707 500 021	12.2	0.000 002	0.017
	Batt. Endpoint	+20	707 500 021	12.4	0.000 002	0.018

- ▣ BandWidth: 10 MHz
- ▣ Voltage(100 %): 3.880 VDC
- ▣ Batt. Endpoint: 3.650 VDC
- ▣ Deviation Limit: Emission must remain in band

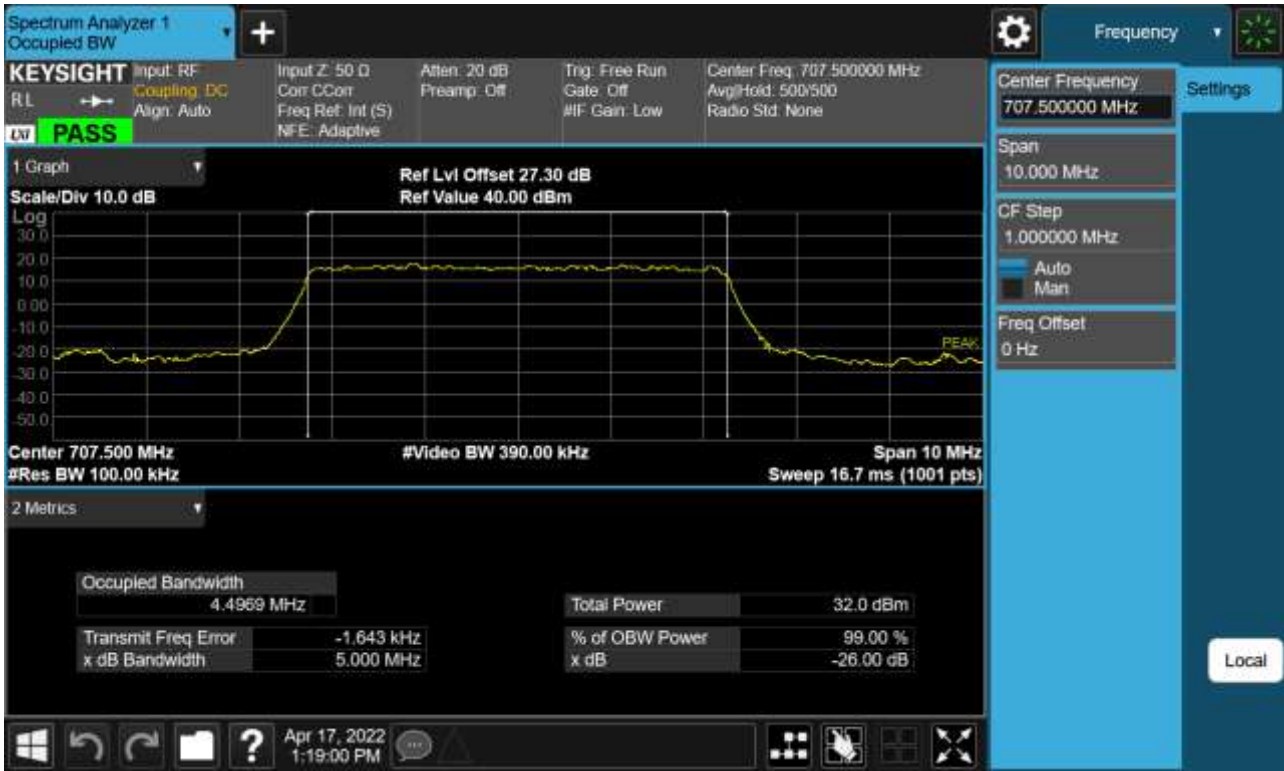
Test. Frequency (MHz)	Voltage (%)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
707.5	100 %	+20(Ref)	707 500 003	0.0	0.000 000	0.000
	100 %	-30	707 500 010	7.0	0.000 001	0.010
	100 %	-20	707 500 019	16.3	0.000 002	0.023
	100 %	-10	707 500 019	15.6	0.000 002	0.022
	100 %	0	707 500 009	6.4	0.000 001	0.009
	100 %	+10	707 500 008	5.0	0.000 001	0.007
	100 %	+30	707 500 014	10.8	0.000 002	0.015
	100 %	+40	707 500 016	12.8	0.000 002	0.018
	100 %	+50	707 500 013	10.2	0.000 001	0.014
	Batt. Endpoint	+20	707 500 014	11.2	0.000 002	0.016

- ▣ BandWidth: 15 MHz
- ▣ Voltage(100 %): 3.880 VDC
- ▣ Batt. Endpoint: 3.650 VDC
- ▣ Deviation Limit: Emission must remain in band

Test. Frequency (MHz)	Voltage (%)	Temp. (°C)	Frequency (Hz)	Frequency Error (Hz)	Deviation (%)	ppm
707.5	100 %	+20(Ref)	707 500 010	0.0	0.000 000	0.000
	100 %	-30	707 500 026	16.1	0.000 002	0.023
	100 %	-20	707 500 014	4.3	0.000 001	0.006
	100 %	-10	707 500 024	14.5	0.000 002	0.020
	100 %	0	707 500 020	10.5	0.000 001	0.015
	100 %	+10	707 500 023	12.7	0.000 002	0.018
	100 %	+30	707 500 026	16.1	0.000 002	0.023
	100 %	+40	707 500 023	13.4	0.000 002	0.019
	100 %	+50	707 500 016	5.8	0.000 001	0.008
	Batt. Endpoint	+20	707 500 016	6.3	0.000 001	0.009

9. TEST PLOTS

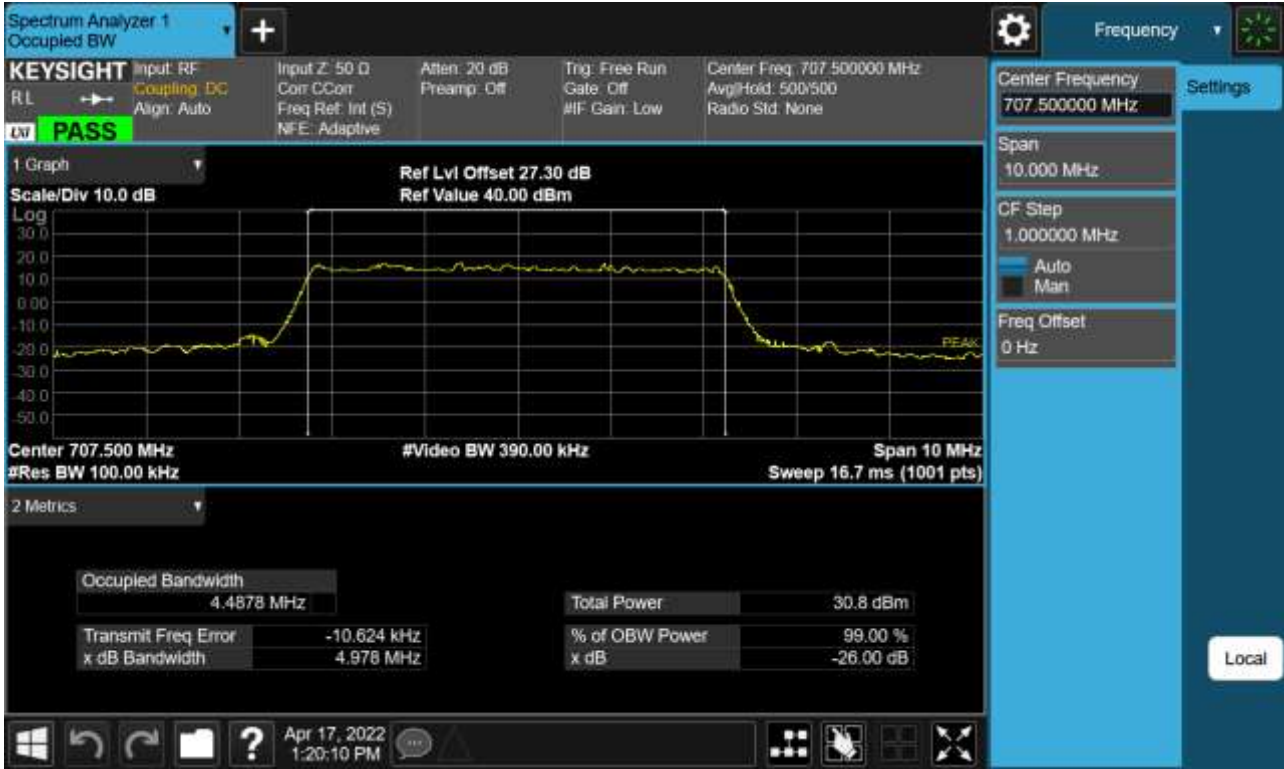
Sub6 n12. Occupied Bandwidth Plot (5M BW Ch.141500 BPSK_RB25_0)



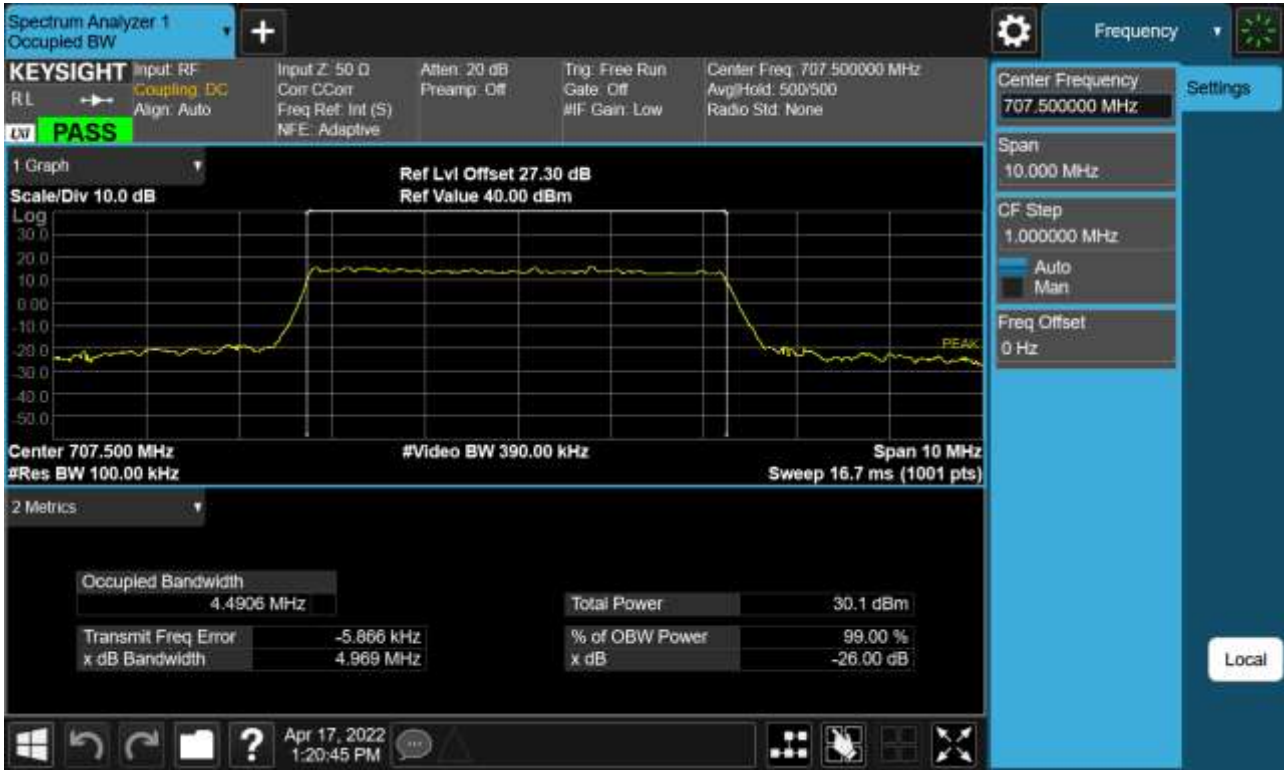
Sub6 n12. Occupied Bandwidth Plot (5M BW Ch.141500 QPSK_RB25_0)



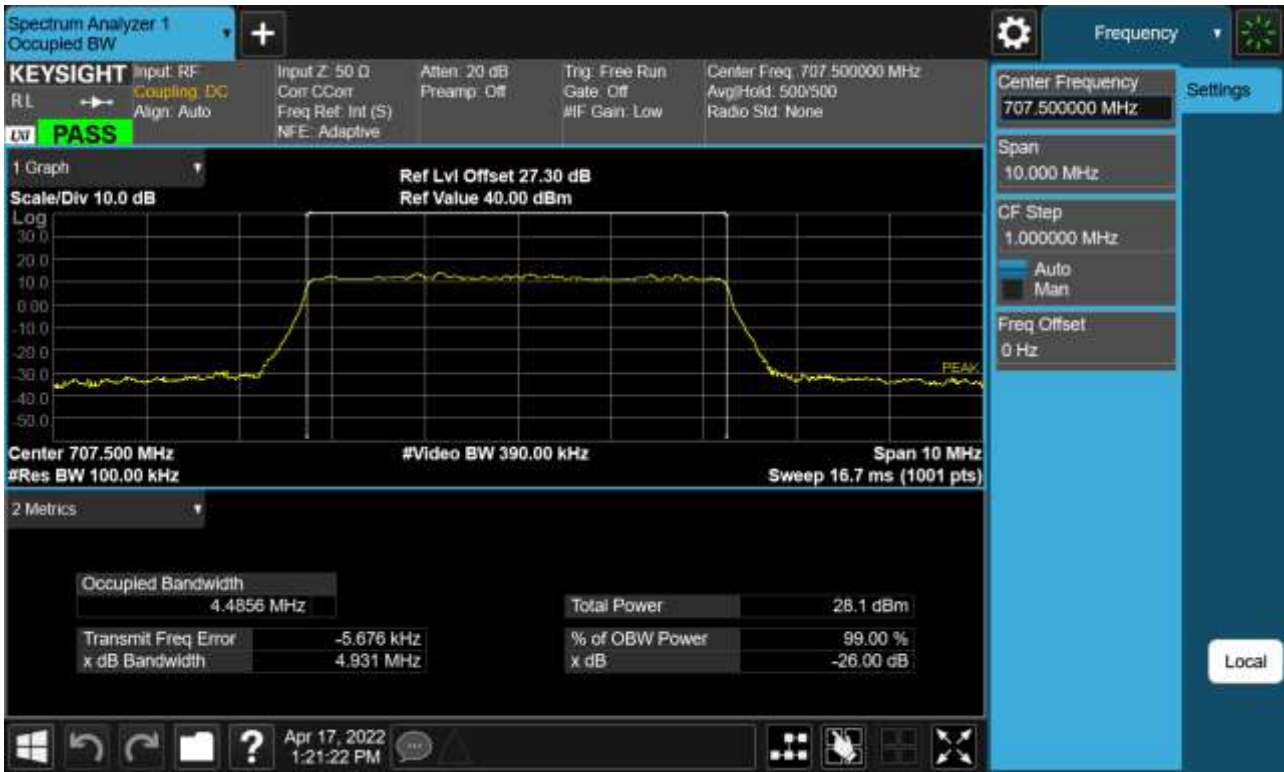
Sub6 n12. Occupied Bandwidth Plot (5M BW Ch.141500 16QAM_RB25_0)



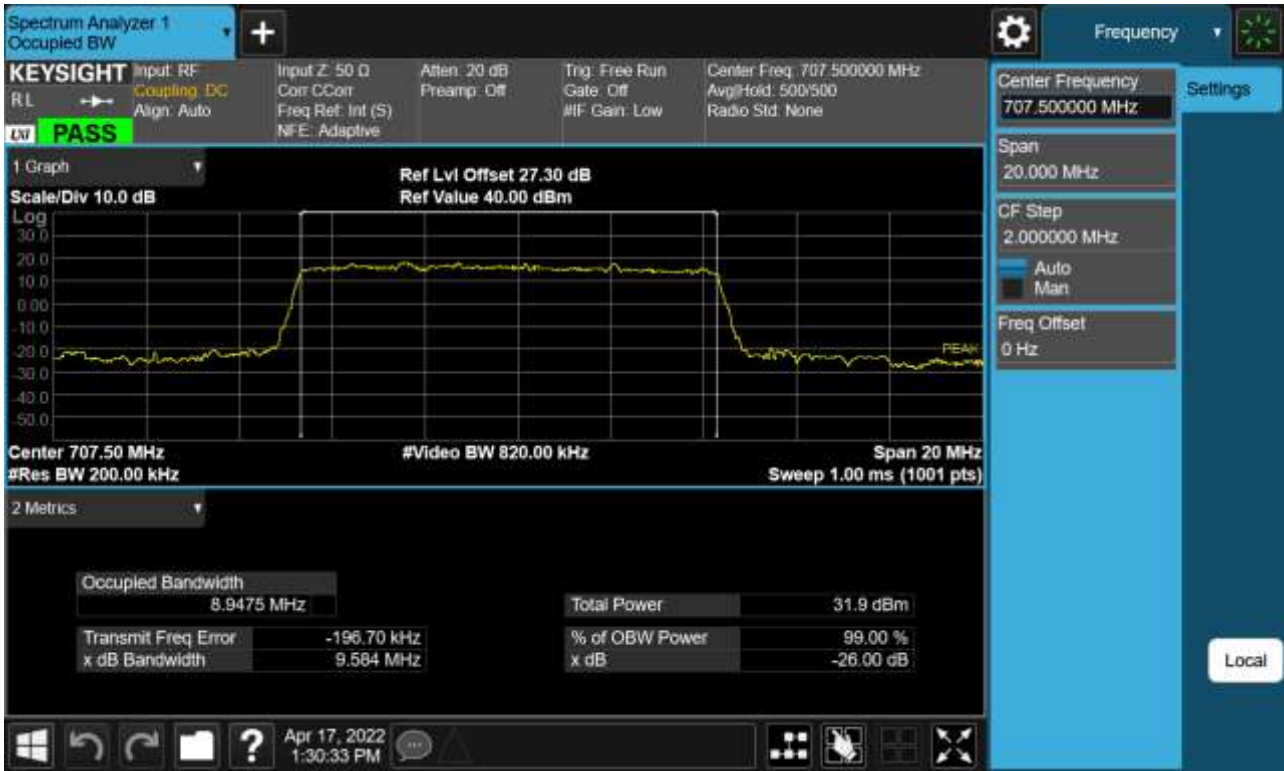
Sub6 n12. Occupied Bandwidth Plot (5M BW Ch.141500 64QAM_RB25_0)



Sub6 n12. Occupied Bandwidth Plot (5M BW Ch.141500 256QAM_RB25_0)



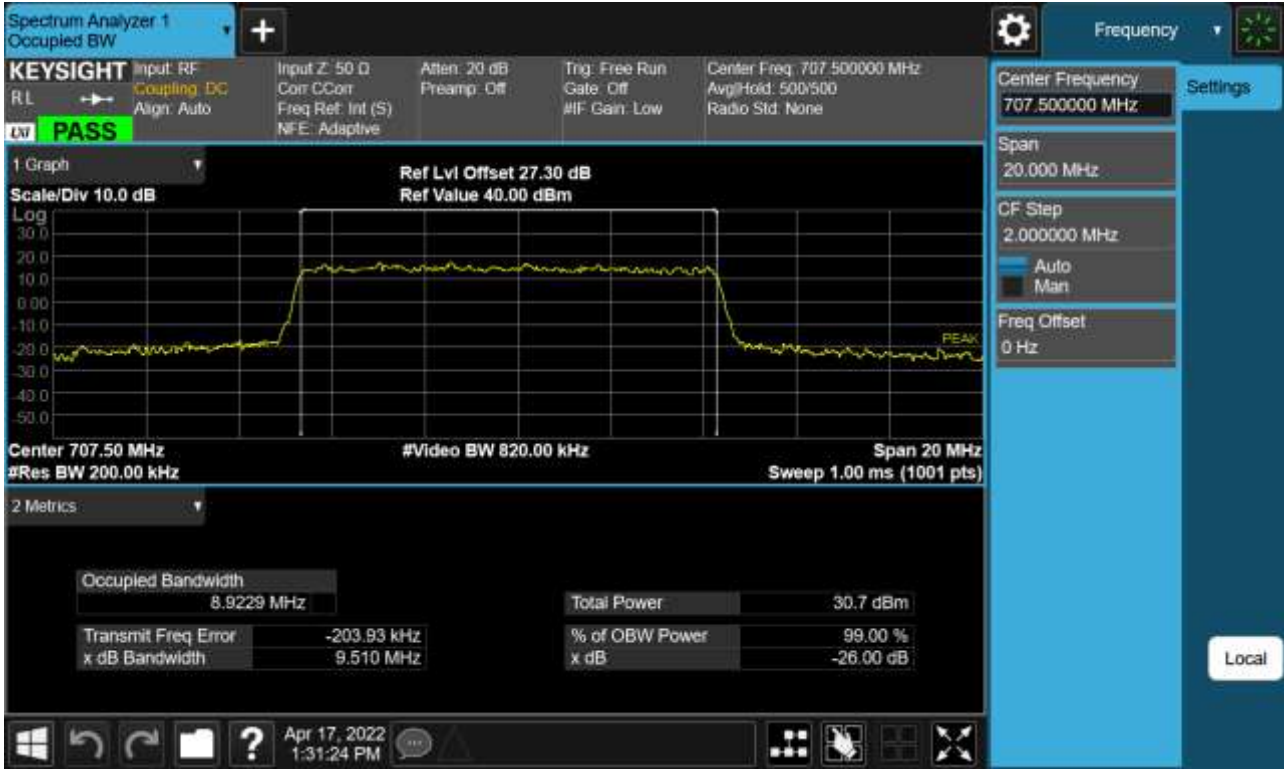
Sub6 n12. Occupied Bandwidth Plot (10M BW Ch.141500 BPSK_RB50_0)



Sub6 n12. Occupied Bandwidth Plot (10M BW Ch.141500 QPSK_RB50_0)



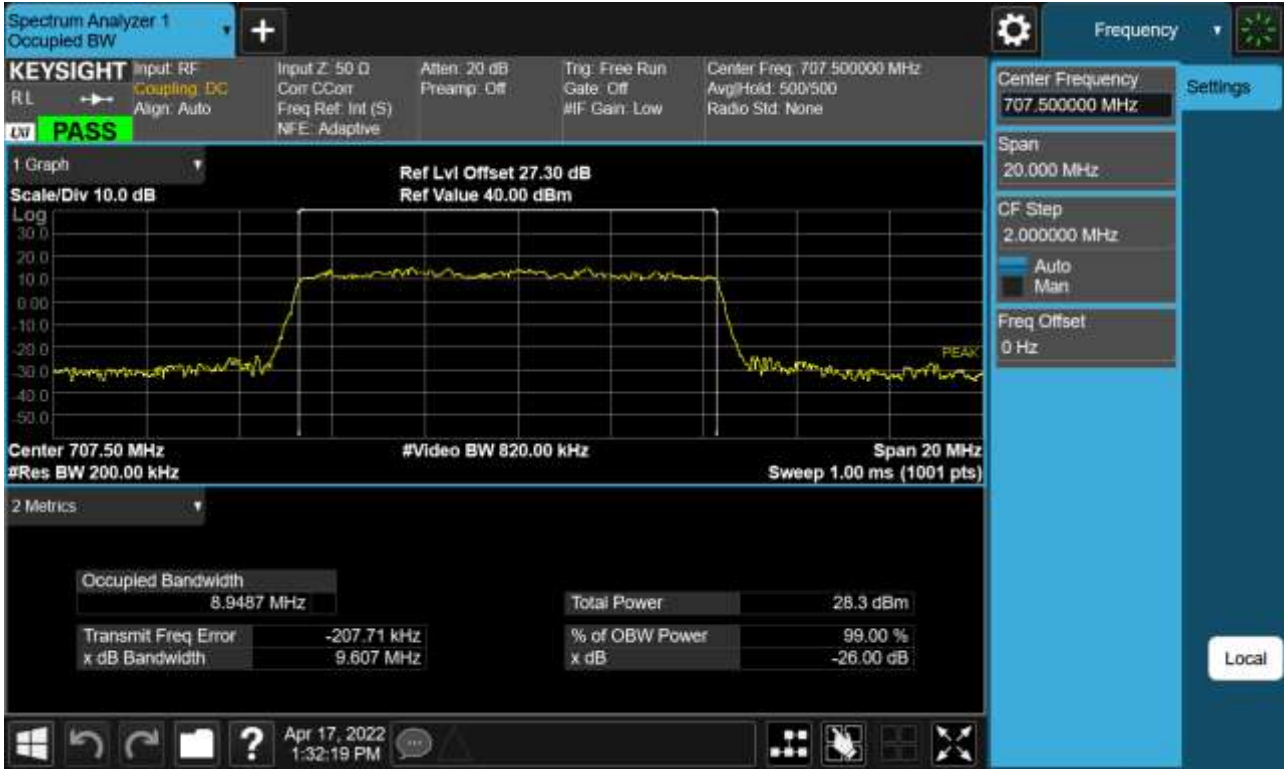
Sub6 n12. Occupied Bandwidth Plot (10M BW Ch.141500 16QAM_RB50_0)



Sub6 n12. Occupied Bandwidth Plot (10M BW Ch.141500 64QAM_RB50_0)



Sub6 n12. Occupied Bandwidth Plot (10M BW Ch.141500 256QAM_RB50_0)



Sub6 n12. Occupied Bandwidth Plot (15M BW Ch.141500 BPSK_RB75_0)



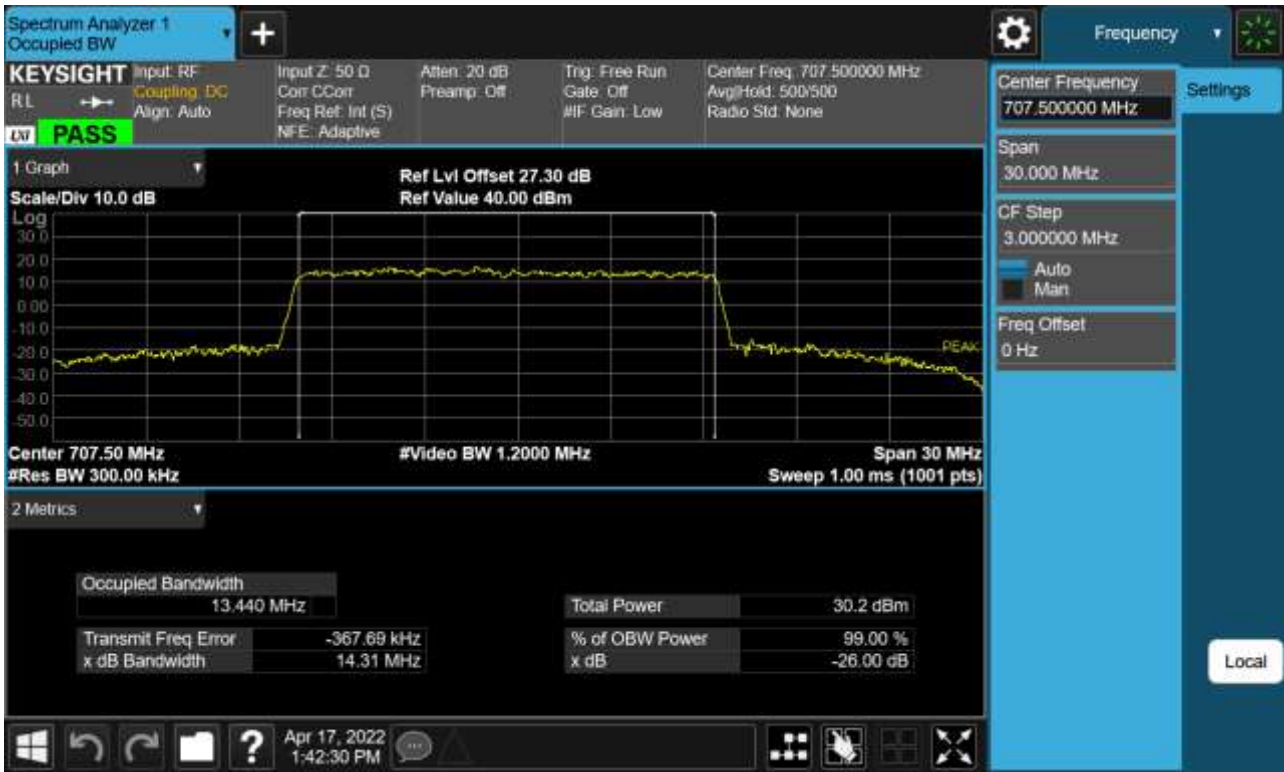
Sub6 n12. Occupied Bandwidth Plot (15M BW Ch.141500 QPSK_RB75_0)



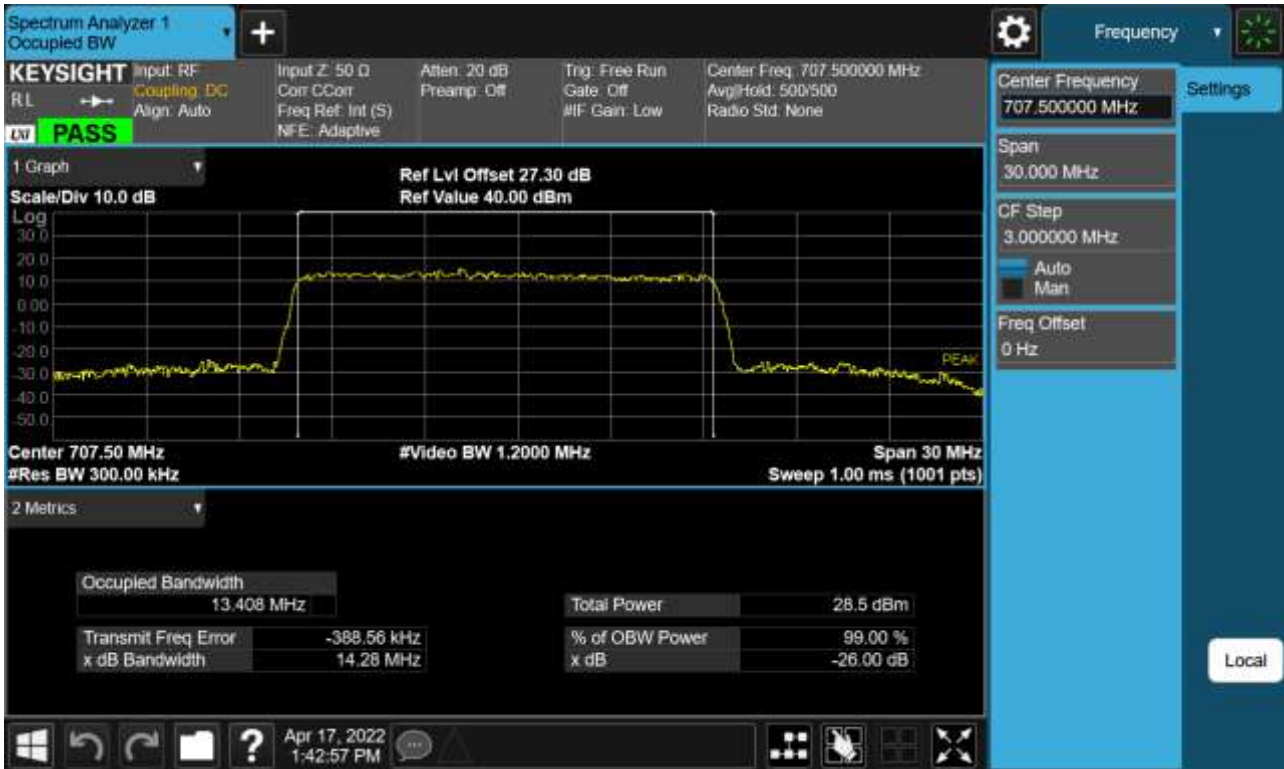
Sub6 n12. Occupied Bandwidth Plot (15M BW Ch.141500 16QAM_RB75_0)



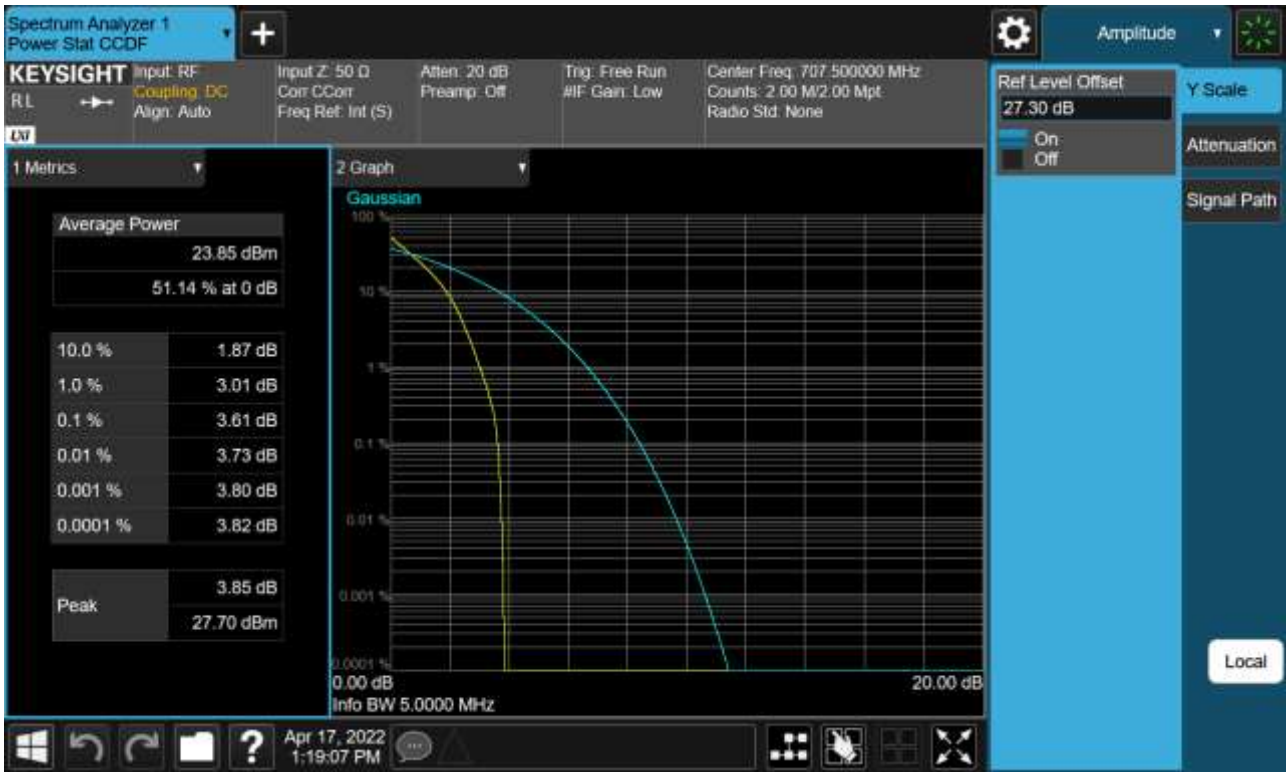
Sub6 n12. Occupied Bandwidth Plot (15M BW Ch.141500 64QAM_RB75_0)



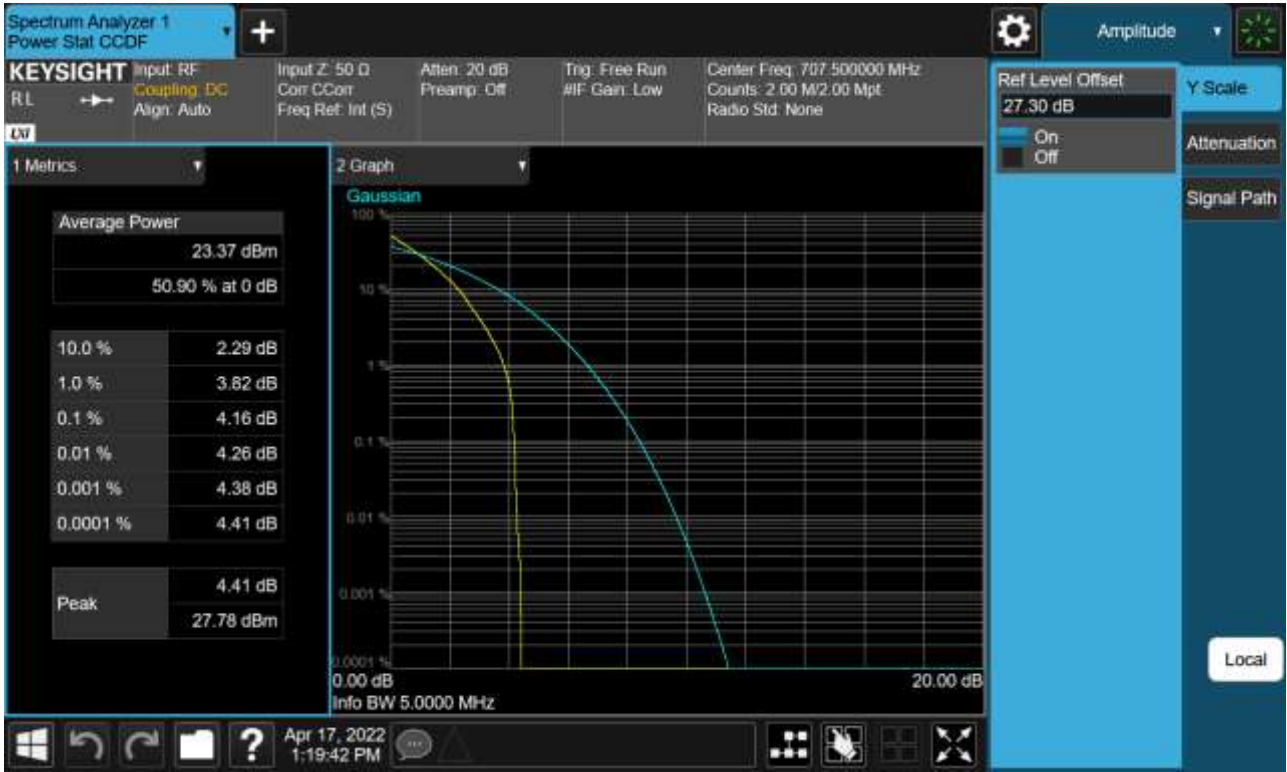
Sub6 n12. Occupied Bandwidth Plot (15M BW Ch.141500 256QAM_RB75_0)



Sub6 n12. PAR Plot (5M BW Ch.141500 BPSK_RB25_0)



Sub6 n12. PAR Plot (5M BW Ch.141500 QPSK_RB25_0)



Sub6 n12. PAR Plot (5M BW Ch.141500 16QAM_RB25_0)



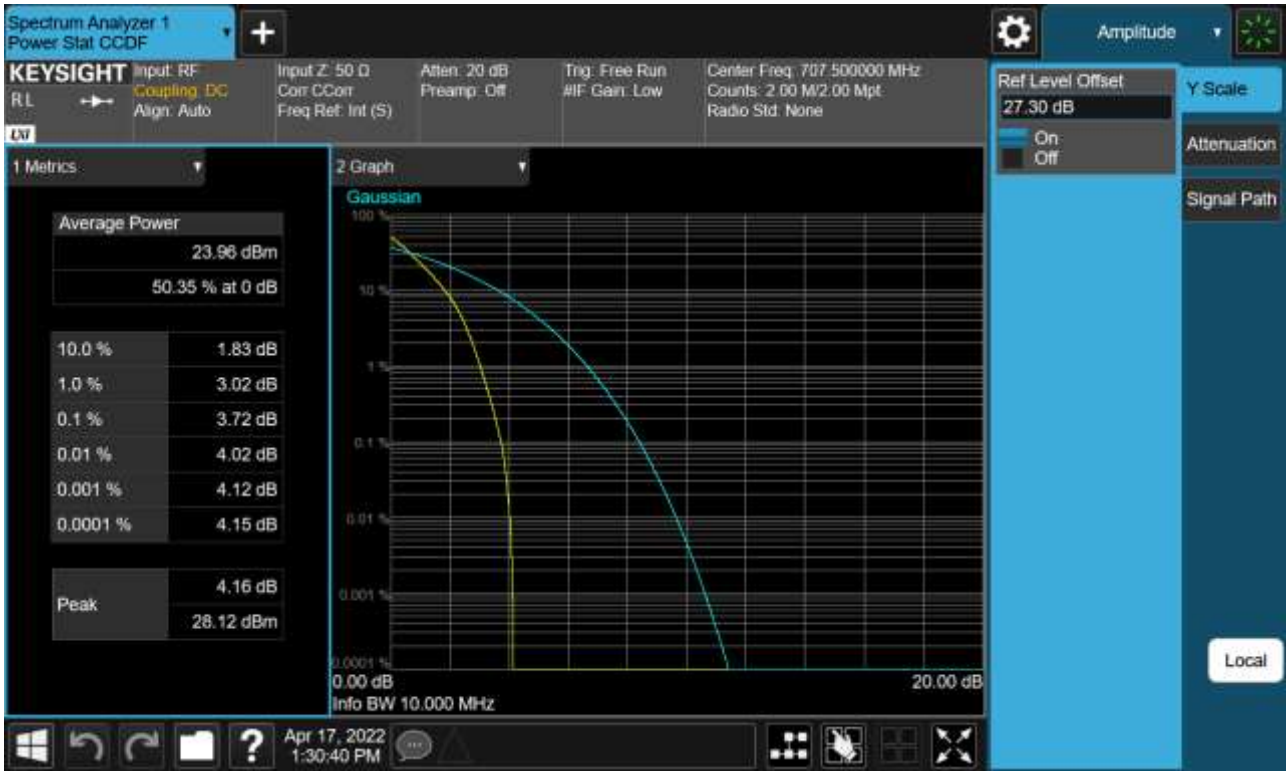
Sub6 n12. PAR Plot (5M BW Ch.141500 64QAM_RB25_0)



Sub6 n12. PAR Plot (5M BW Ch.141500 256QAM_RB25_0)



Sub6 n12. PAR Plot (10M BW Ch.141500 BPSK_RB50_0)



Sub6 n12. PAR Plot (10M BW Ch.141500 QPSK_RB50_0)



Sub6 n12. PAR Plot (10M BW Ch.141500 16QAM_RB50_0)



Sub6 n12. PAR Plot (10M BW Ch.141500 64QAM_RB50_0)



Sub6 n12. PAR Plot (10M BW Ch.141500 256QAM_RB50_0)



Sub6 n12. PAR Plot (15M BW Ch.141500 BPSK_RB75_0)



Sub6 n12. PAR Plot (15M BW Ch.141500 QPSK_RB75_0)



Sub6 n12. PAR Plot (15M BW Ch.141500 16QAM_RB75_0)



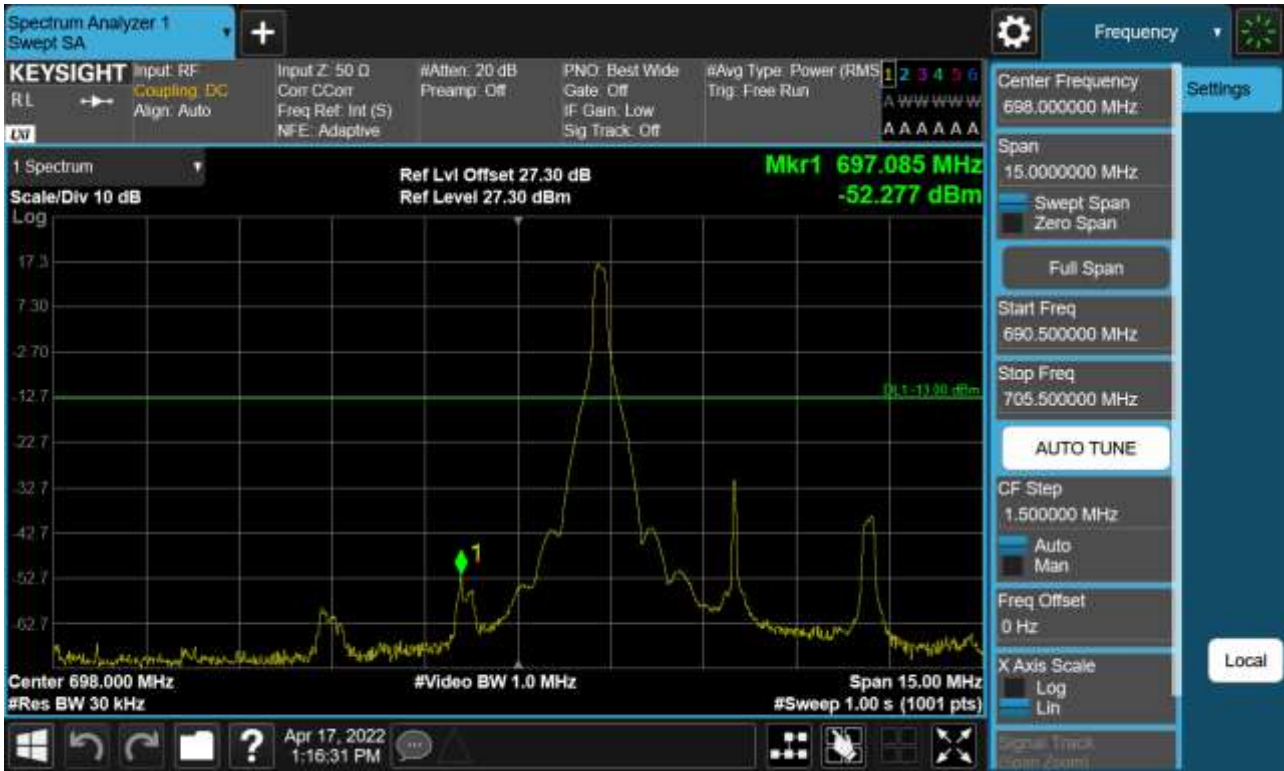
Sub6 n12. PAR Plot (15M BW Ch.141500 64QAM_RB75_0)



Sub6 n12. PAR Plot (15M BW Ch.141500 256QAM_RB75_0)



Sub6 n12. Lower Band Edge Plot (5M BW Ch.140300 BPSK_RB1_Offset 0)



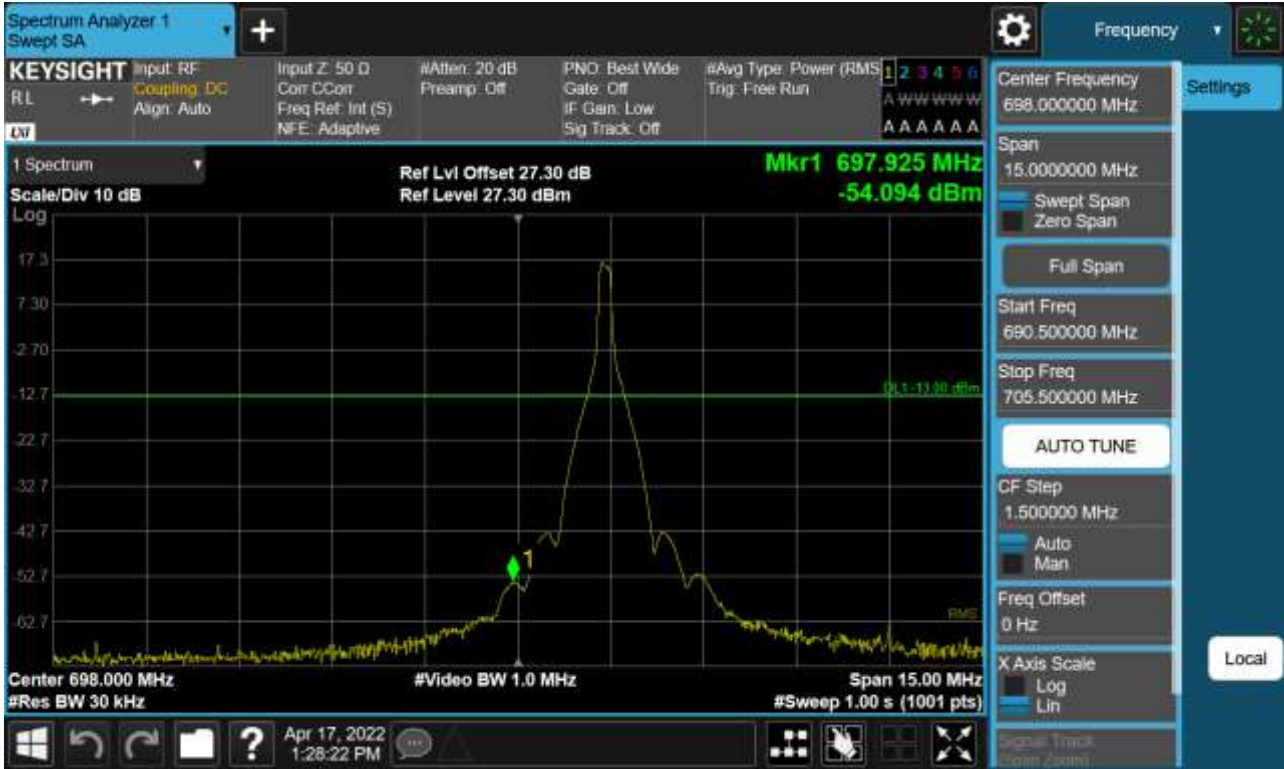
Sub6 n12. Lower Band Edge Plot (5M BW Ch.140300 BPSK_RB25_Offset 0)



Sub6 n12. Lower Extended Band Edge Plot (5M BW Ch.140300 BPSK_RB25_0)



Sub6 n12. Lower Band Edge Plot (10M BW Ch.140800 BPSK_RB1_Offset 0)



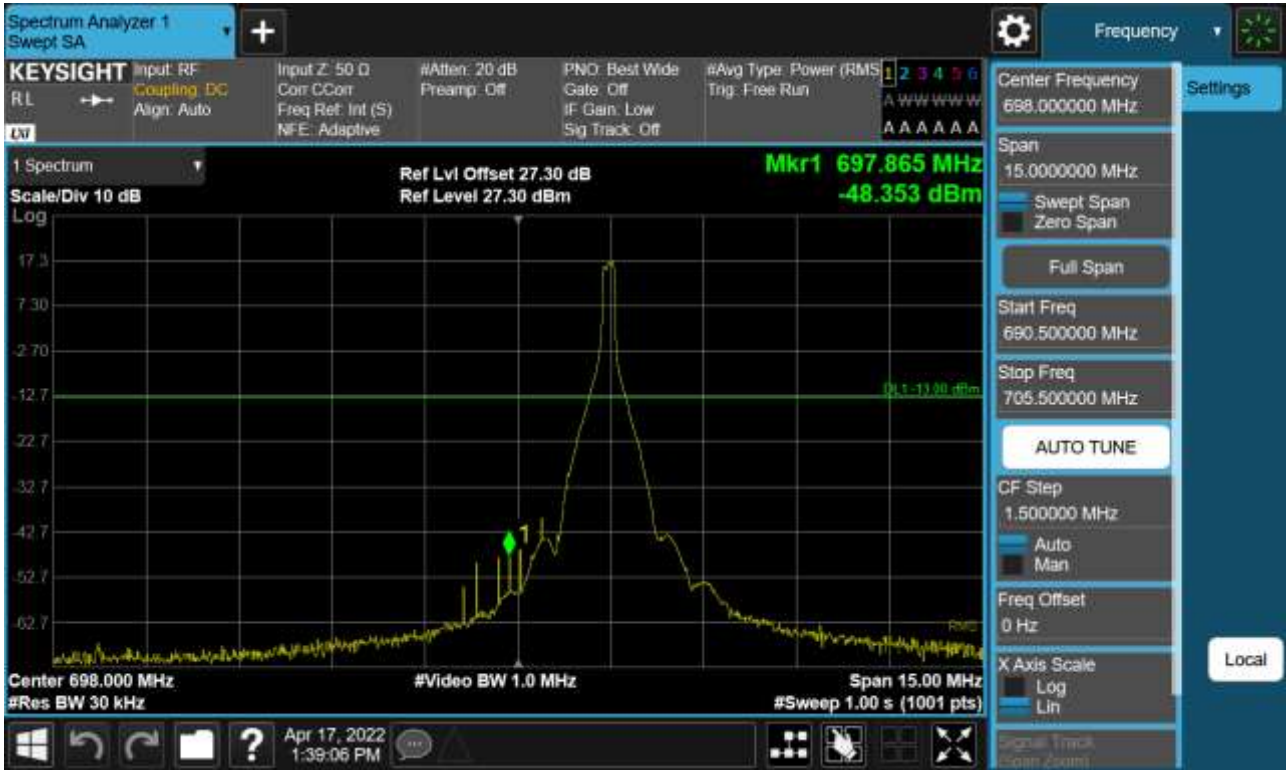
Sub6 n12. Lower Band Edge Plot (10M BW Ch.140800 BPSK_RB50_Offset 0)



Sub6 n12. Lower Extended Band Edge Plot (10M BW Ch.140800 BPSK_RB50_0)



Sub6 n12. Lower Band Edge Plot (15M BW Ch.141300 BPSK_RB1_Offset 0)



Sub6 n12. Lower Band Edge Plot (15M BW Ch.141300 BPSK_RB75_Offset 0)



Sub6 n12. Lower Extended Band Edge Plot (15M BW Ch.141300 BPSK_RB75_0)



Sub6 n12. Upper Band Edge Plot (5M BW Ch.142700 BPSK_RB1_Offset 24)_1



Sub6 n12. Upper Band Edge Plot (5M BW Ch.142700 BPSK_RB1_Offset 24)_2



Sub6 n12. Upper Band Edge Plot (5M BW Ch.142700 BPSK_RB25_Offset 0)



Sub6 n12. Upper Extended Band Edge Plot (5M BW Ch.142700 BPSK_RB25_0)



Sub6 n12. Upper Band Edge Plot (10M BW Ch.142200 BPSK_RB1_Offset 51)_1



Sub6 n12. Upper Band Edge Plot (10M BW Ch.142200 BPSK_RB1_Offset 51)_2



Sub6 n12. Upper Band Edge Plot (10M BW Ch.142200 BPSK_RB50_Offset 0)



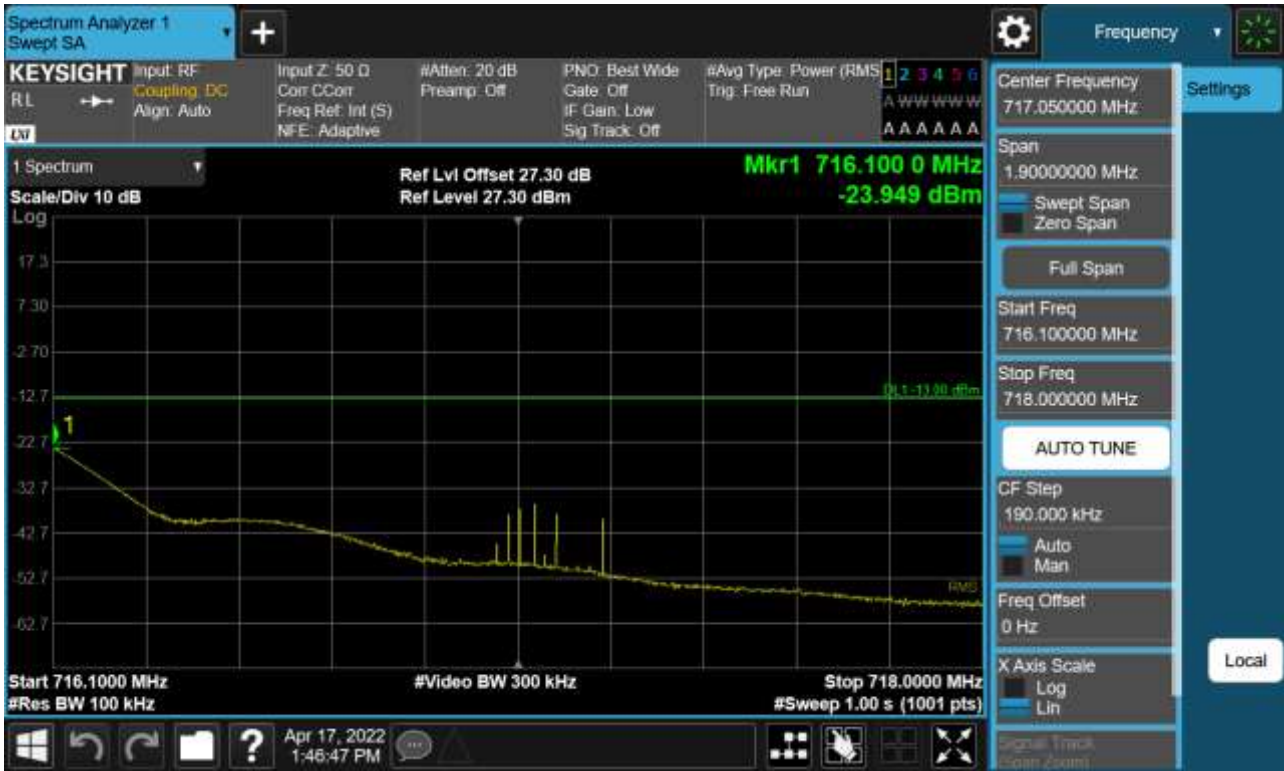
Sub6 n12. Upper Extended Band Edge Plot (10M BW Ch.142200 BPSK_RB50_0)



Sub6 n12. Upper Band Edge Plot (15M BW Ch.141700 BPSK_RB1_Offset 78)_1



Sub6 n12. Upper Band Edge Plot (15M BW Ch.141700 BPSK_RB1_Offset 78)_2



Sub6 n12. Upper Band Edge Plot (15M BW Ch.141700 BPSK_RB75_Offset 0)



Sub6 n12. Upper Extended Band Edge Plot (15M BW Ch.141700 BPSK_RB75_0)



Sub6 n12. Conducted Spurious Plot _ (140300ch_5MHz_BPSK_RB 1_1)



Sub6 n12. Conducted Spurious Plot _ (141500ch_5MHz_BPSK_RB 1_1)



Sub6 n12. Conducted Spurious Plot _ (142700ch_5MHz_BPSK_RB 1_1)



Sub6 n12. Conducted Spurious Plot _ (140800ch_10MHz_BPSK_RB 1_1)



Sub6 n12. Conducted Spurious Plot _ (141500ch_10MHz_BPSK_RB 1_1)



Sub6 n12. Conducted Spurious Plot _ (142200ch_10MHz_BPSK_RB 1_1)



Sub6 n12. Conducted Spurious Plot _ (141300ch_15MHz_BPSK_RB 1_1)



Sub6 n12. Conducted Spurious Plot _ (141500ch_15MHz_BPSK_RB 1_1)



Sub6 n12. Conducted Spurious Plot _ (141700ch_15MHz_BPSK_RB 1_1)



10. ANNEX A_ TEST SETUP PHOTO

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

No.	Description
1	HCT-RF-2205-FC033-P