

FCC Test Report (Part 96 – LTE B48)

Report No.: RFBCLD-WTW-P21060790-1

FCC ID: QI3BEC-MX241NP

Test Model: BEC MX-241NP

Received Date: Jun. 24, 2021

Test Date: Jul. 07 ~ Jul. 09, 2021

Issued Date: Sep. 11, 2021

Applicant: BILLION ELECTRIC CO., LTD.

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Designation Number:



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Release Control Record

Issue No.	Description	Date Issued
RFBCLD-WTW-P21060790-1	Original release	Sep. 11, 2021

1 Certificate of Conformity

Product: 4G LTE CBRS Wi-Fi Router

Brand: BEC, BILLION

Test Model: BEC MX-241NP

Sample Status: Engineering sample

Applicant: BILLION ELECTRIC CO., LTD.

Test Date: Jul. 07 ~ Jul. 09, 2021

Standards: 47 CFR FCC Part 96

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

Prepared by : Celine Chou , **Date:** Sep. 11, 2021
Celine Chou / Senior Specialist

Approved by : Bruce Chen , **Date:** Sep. 11, 2021
Bruce Chen / Senior Engineer

2 Summary of Test Results

47 CFR FCC Part 96			
FCC Clause	Test Item	Result	Remarks
2.1046 96.41(b)	Maximum Peak Output Power	Pass	Meet the requirement of limit.
2.1046 96.41(b)	Maximum Power Spectral Density	Pass	Meet the requirement of limit.
96.41(a) 2.1047	Modulation Characteristics	Pass	Meet the requirement
96.41(g)	Peak to Average Ration	Pass	Meet the requirement of limit.
2.1049	Emission Bandwidth	Pass	Meet the requirement of limit.
2.1055	Frequency Stability	Pass	Meet the requirement of limit.
2.1051 96.41(e)	Conducted Spurious Emissions	Pass	Meet the requirement of limit.
2.1053 96.41(e)	Radiated Spurious Emissions	Pass	Meet the requirement of limit. Minimum passing margin is -0.33dB at 7395.00MHz.

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) ($\pm$)
Radiated Emissions up to 1 GHz	9kHz ~ 30MHz	3.04 dB
	30MHz ~ 200MHz	3.59 dB
	200MHz ~ 1000MHz	3.60 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	2.29 dB
	18GHz ~ 40GHz	2.29 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	4G LTE CBRS Wi-Fi Router		
Brand	BEC, BILLION		
Test Model	BEC MX-241NP		
Sample Status	Engineering sample		
Power Supply Rating	12Vdc from adapter 56Vdc from POE		
Modulation Type	QPSK, 16QAM		
Operating Frequency	LTE Band 48 (Channel Bandwidth 5MHz)	3552.5MHz ~ 3697.5MHz	
	LTE Band 48 (Channel Bandwidth 10MHz)	3555.0MHz ~ 3695.0MHz	
	LTE Band 48 (Channel Bandwidth 15MHz)	3557.5MHz ~ 3692.5MHz	
	LTE Band 48 (Channel Bandwidth 20MHz)	3560.0MHz ~ 3690.0MHz	
Max. EIRP Power		QPSK	16QAM
	LTE Band 48 (Channel Bandwidth 5MHz)	179.887mW (22.55dBm/10MHz)	190.985mW (22.81dBm/10MHz)
	LTE Band 48 (Channel Bandwidth 10MHz)	163.682mW (22.14dBm/10MHz)	172.584mW (22.37dBm/10MHz)
	LTE Band 48 (Channel Bandwidth 15MHz)	136.773mW (21.36dBm/10MHz)	141.579mW (21.51dBm/10MHz)
	LTE Band 48 (Channel Bandwidth 20MHz)	153.815mW (21.87dBm/10MHz)	160.694mW (22.06dBm/10MHz)
Max. EIRP Power (Full power)		QPSK	16QAM
	LTE Band 48 (Channel Bandwidth 5MHz)	179.887mW (22.55dBm/10MHz)	190.985mW (22.81dBm/10MHz)
	LTE Band 48 (Channel Bandwidth 10MHz)	163.682mW (22.14dBm/10MHz)	172.584mW (22.37dBm/10MHz)
	LTE Band 48 (Channel Bandwidth 15MHz)	142.561mW (21.54dBm/15MHz)	147.571mW (21.69dBm/15MHz)
	LTE Band 48 (Channel Bandwidth 20MHz)	155.597mW (21.92dBm/20MHz)	163.682mW (22.14dBm/20MHz)
Emission Designator		QPSK	16QAM
	LTE Band 48 (Channel Bandwidth 5MHz)	4M49G7D	4M48D7W
	LTE Band 48 (Channel Bandwidth 10MHz)	8M96G7D	8M97D7W
	LTE Band 48 (Channel Bandwidth 15MHz)	13M4G7D	13M4D7W
	LTE Band 48 (Channel Bandwidth 20MHz)	18M0G7D	18M0D7W
Antenna Type	Refer to note		
Antenna Connector	Refer to note		
Accessory Device	Adapter		
Cable Supplied	NA		

Note:

1. The EUT consumes power from the following Adapters & POE. (POE for support unit only)

Adapter 1	
Brand	BILLION
Model	BA018-120120AXU
Input Power	100-240Vac, 50/60Hz, 0.5A
Output Power	12Vdc, 1.2A
Power Line	1.55m non-shielded without core

Adapter 2	
Brand	BILLION
Model	PA1015-120HUB120
Input Power	100-240Vac, 50/60Hz, 0.4A
Output Power	12Vdc, 1.2A
Power Line	1.5m non-shielded without core

* After pre-test, adapter 1 was chosen for final test and presented in the test report.

POE	
Brand	BILLION
Model	BP035-560063PAX
Input Power	100-240Vac, 50/60Hz, 0.8A
Output Power	56Vdc, 0.625A
Power Line	1.83m non-shielded without core

2. The following antennas were provided to the EUT.

No.	Type	Connector	Gain (dBi)
1	Dipole	SMA Plug	5.9

* The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.

3. WLAN 2.4GHz & WWAN technology can transmit at same time.

4. Spurious emission of the simultaneous operation (WLAN 2.4GHz & WWAN) has been evaluated and no non-compliance was found.

3.2 Test Mode Applicability and Tested Channel Detail

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports. The worst case was found when positioned as the table below. Following channel(s) was (were) selected for the final test as listed below:

Band	Radiated Emission
LTE Band 48	X-plane

LTE Band 48

Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation
Maximum Output Power	55265 to 56715	55265 (3552.5MHz), 55990 (3625.0MHz), 56715 (3697.5MHz)	5MHz	QPSK / 16QAM
	55290 to 56690	55290 (3555.0MHz), 55990 (3625.0MHz), 56690 (3695.0MHz)	10MHz	QPSK / 16QAM
	55315 to 56665	55315 (3557.5MHz), 55990 (3625.0MHz), 56665 (3692.5MHz)	15MHz	QPSK / 16QAM
	55340 to 56640	55340 (3560.0MHz), 55990 (3625.0MHz), 56640 (3690.0MHz)	20MHz	QPSK / 16QAM
Modulation characteristics	55340 to 56640	55990 (3625.0MHz)	20MHz	QPSK / 16QAM
Frequency Stability	55265 to 56715	55265 (3552.5MHz), 56715 (3697.5MHz)	5MHz	16QAM
	55290 to 56690	55290 (3555.0MHz), 56690 (3695.0MHz)	10MHz	16QAM
	55315 to 56665	55315 (3557.5MHz), 56665 (3692.5MHz)	15MHz	16QAM
	55340 to 56640	55340 (3560.0MHz), 56640 (3690.0MHz)	20MHz	16QAM
Occupied Bandwidth	55265 to 56715	55265 (3552.5MHz), 55990 (3625.0MHz), 56715 (3697.5MHz)	5MHz	QPSK / 16QAM
	55290 to 56690	55290 (3555.0MHz), 55990 (3625.0MHz), 56690 (3695.0MHz)	10MHz	QPSK / 16QAM
	55315 to 56665	55315 (3557.5MHz), 55990 (3625.0MHz), 56665 (3692.5MHz)	15MHz	QPSK / 16QAM
	55340 to 56640	55340 (3560.0MHz), 55990 (3625.0MHz), 56640 (3690.0MHz)	20MHz	QPSK / 16QAM

Test Item	Available Channel	Tested Channel	Channel Bandwidth	Modulation
Peak to Average Ratio	55265 to 56715	55265 (3552.5MHz), 55990 (3625.0MHz), 56715 (3697.5MHz)	5MHz	QPSK / 16QAM
	55290 to 56690	55290 (3555.0MHz), 55990 (3625.0MHz), 56690 (3695.0MHz)	10MHz	QPSK / 16QAM
	55315 to 56665	55315 (3557.5MHz), 55990 (3625.0MHz), 56665 (3692.5MHz)	15MHz	QPSK / 16QAM
	55340 to 56640	55340 (3560.0MHz), 55990 (3625.0MHz), 56640 (3690.0MHz)	20MHz	QPSK / 16QAM
Conducted Emission	55265 to 56715	55265 (3552.5MHz), 55990 (3625.0MHz), 56715 (3697.5MHz)	5MHz	16QAM
	55290 to 56690	55290 (3555.0MHz), 55990 (3625.0MHz), 56690 (3695.0MHz)	10MHz	16QAM
	55315 to 56665	55315 (3557.5MHz), 55990 (3625.0MHz), 56665 (3692.5MHz)	15MHz	16QAM
	55340 to 56640	55340 (3560.0MHz), 55990 (3625.0MHz), 56640 (3690.0MHz)	20MHz	16QAM
Radiated Emission Below 1GHz	55340 to 56640	55990 (3625.0MHz)	20MHz	16QAM
Radiated Emission Above 1GHz	55265 to 56715	55265 (3552.5MHz), 55990 (3625.0MHz), 56715 (3697.5MHz)	5MHz	16QAM
	55340 to 56640	55340 (3560.0MHz), 55990 (3625.0MHz), 56640 (3690.0MHz)	20MHz	16QAM

Note:

1. For radiated emission below 1GHz, select the worst radiated emission channel (above 1GHz) for final testing.
2. For radiated emission above 1GHz, according to 3GPP 36.521 Section 6.6.3.1.4, choose the lowest, 5MHz & highest channel bandwidth for final test.
3. The output power for QPSK, 16QAM, and measured value of is 16QAM higher than QPSK mode. Therefore, only Modulation characteristics, occupied bandwidth and Peak to average ratio items had been tested under QPSK, 16QAM modes, the other test items were performed under 16QAM mode only.

Test Condition:

Test Item	Environmental Conditions	Input Power	Tested By
Maximum Output Power	25deg. C, 63%RH	120Vac, 60Hz	James Yang
Modulation Characteristics	25deg. C, 63%RH	120Vac, 60Hz	James Yang
Frequency Stability	25deg. C, 63%RH	120Vac, 60Hz	James Yang
Occupied Bandwidth	25deg. C, 63%RH	120Vac, 60Hz	James Yang
Peak To Average Ratio	25deg. C, 63%RH	120Vac, 60Hz	James Yang
Conducted Emission	25deg. C, 63%RH	120Vac, 60Hz	James Yang
Radiated Emission	22deg. C, 66%RH	120Vac, 60Hz	Greg Lin

3.3 Description of Support Units

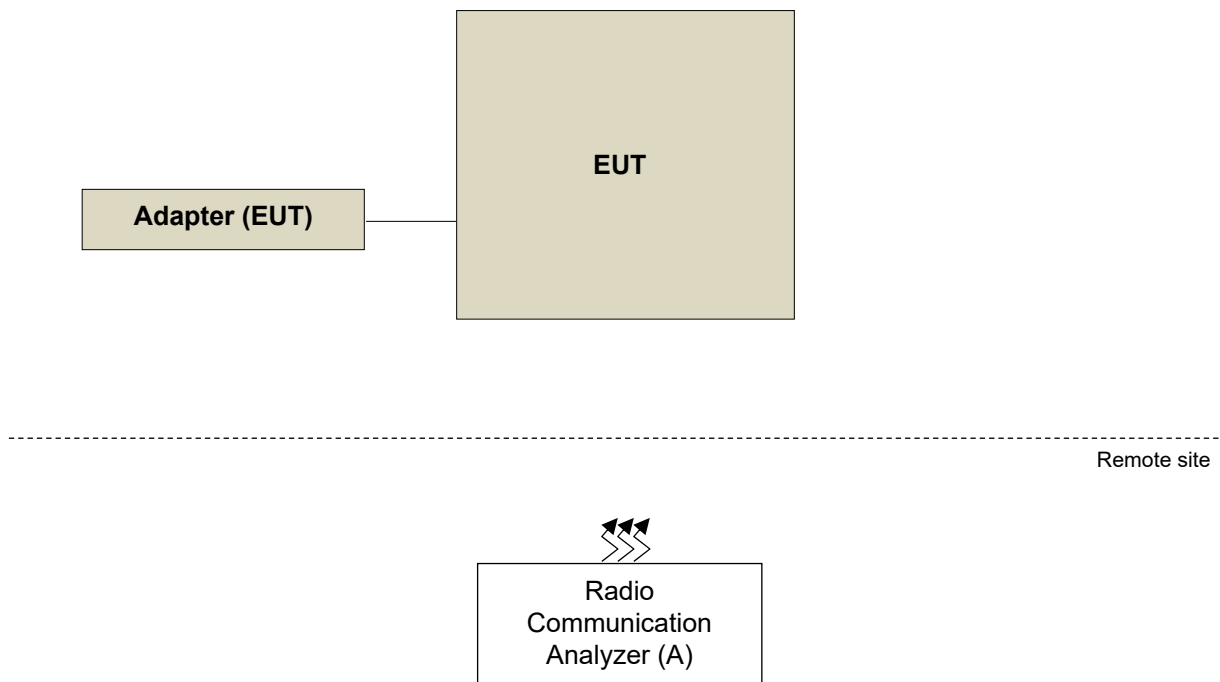
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Radio Communication Analyzer	Anritsu	MT8821C	6261806803	NA	-

Note:

1. All power cords of the above support units are non-shielded (1.8m).
2. Item A acted as a communication partner to transfer data.

3.3.1 Configuration of System under Test



3.4 General Description of Applied Standards and References

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

Test standard:

FCC 47 CFR Part 2

FCC 47 CFR Part 96

ANSI/TIA/EIA-603-E-2016

All test items have been performed and recorded as per the above standards.

References Test Guidance:

KDB 971168 D01 Power Meas License Digital Systems v03r01

KDB 940660 D01 Part 96 CBRS Eqpt v03

All test items have been performed as a reference to the above KDB test guidance.

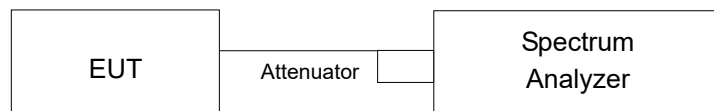
4 Test Types and Results

4.1 Maximum Output Power Measurement

4.1.1 Limits of Maximum Output Power Measurement

Device		Maximum EIRP (dBm/10 MHz)
☒	End User Device	23
☐	Category A CBSD	30
☐	Category B CBSD	47

4.1.2 Test Setup



4.1.3 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer KEYSIGHT	N9030B	MY57140953	Jul. 06, 2021	Jul. 05, 2022
Radio Communication Analyzer Anritsu	MT8821C	6201462755	Feb. 07, 2021	Feb. 07, 2022
RF cable	JB200	Cable-OVEN-02	NA	NA
DC-6GHz 20dB 50W Fixed attenuator Woken	MDC9331N-20	0724	Jun. 24, 2020	Jun. 23, 2022
STANDARD TEMPERATURE & HUMIDITY CHAMBER TERCHY	MHU-225AU	911033	Nov. 24, 2020	Nov. 23, 2021
AC Power Supply Extech	CFW-105	E000603	NA	NA
Digital Multimeter Fluke	87-III	70360742	Jun. 24, 2021	Jun. 23, 2022

Note: The calibration interval of the above test instruments is 12/24 months and the calibrations are traceable to NML/ROC and NIST/USA.

4.1.4 Test Procedures

Conducted output power measurement

- a. Connect the DUT transmitter output to the spectrum analyzer via coaxial cable while ensuring proper impedance matching.
- b. Set span to at least 1.5 times the OBW.
- c. Set RBW = 1-5% of the OBW, not to exceed 1 MHz.
- d. Set VBW $\geq 3 \times$ RBW.
- e. Set number of points in sweep $\geq 2 \times$ span / RBW.
- f. Sweep time = auto-couple.
- g. Detector = RMS (power averaging).
- h. If the EUT can be configured to transmit continuously (i.e., burst duty cycle $\geq 98\%$), then set the trigger to free run.
- i. If the EUT cannot be configured to transmit continuously (i.e., burst duty cycle $< 98\%$), then use a sweep trigger with the level set to enable triggering only on full power bursts and configure the EUT to transmit at full power for the entire duration of each sweep. Ensure that the sweep time is less than or equal to the transmission burst duration.
- j. Trace average at least 100 traces in power averaging (i.e., RMS) mode.
- k. Compute the power by integrating the spectrum across the OBW of the signal using the instrument's band or channel power measurement function, with the band/channel limits set equal to the OBW band edges. If the instrument does not have a band or channel power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.
- l. For per 10MHz method, channel power integrating bandwidth 10MHz is used for bandwidth 5M, 10M, 15M and 20M. For full power method, channel power integrating bandwidth 10MHz is used for bandwidth 5M, 10M, integrating bandwidth 15MHz is used for bandwidth 15M, integrating bandwidth 20MHz is used for bandwidth 20M.

Maximum EIRP

The relevant equation for determining the maximum ERP or EIRP from the measured RF output power is given in Equation as follows:

$$\text{ERP or EIRP} = P_{\text{Meas}} + G_T$$

where

ERP or EIRP effective radiated power or equivalent isotropically radiated power, respectively
(expressed in the same units as P_{Meas} , e.g., dBm or dBW)

P_{Meas} measured transmitter output power or PSD, in dBm or dBW

G_T gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP)

4.1.5 Deviation from Test Standard

No deviation.

4.1.6 EUT Operating Conditions

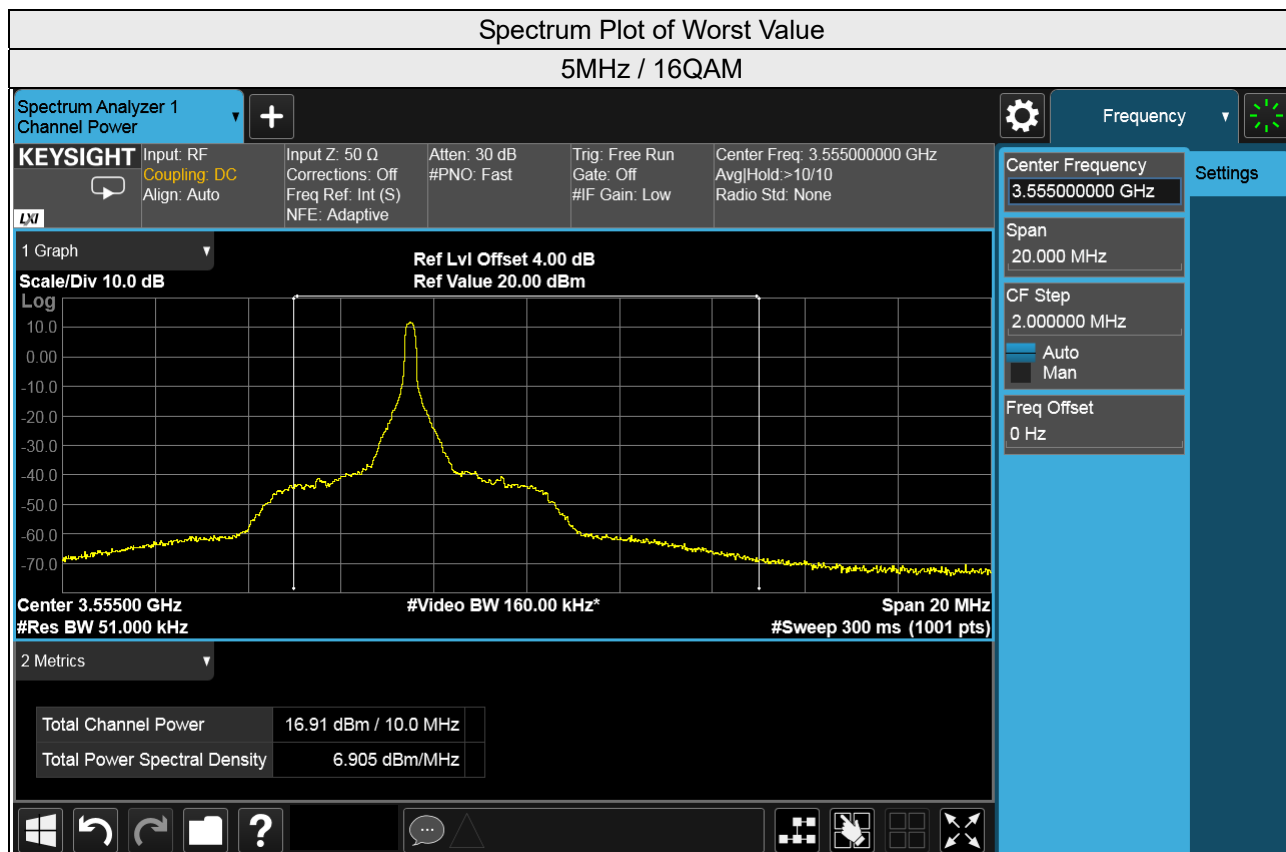
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.1.7 Test Results

Conducted Output Power (dBm/10MHz)

LTE Band 48						
BW	MCS Index	RB Size	RB Offset	Low	Mid	High
		Channel		55340	55990	56640
		Frequency (MHz)		3560	3625	3690
20M	QPSK	1	0	15.58	14.58	13.66
		1	50	15.97	14.90	13.94
		1	99	15.53	14.61	13.75
		50	0	15.54	14.56	13.74
		50	25	15.74	14.75	13.87
		50	50	15.57	14.68	13.69
		100	0	13.18	13.12	12.63
	16QAM	1	0	15.73	14.85	13.82
		1	50	16.16	15.15	14.20
		1	99	15.82	14.85	13.88
		50	0	15.85	14.84	13.92
		50	25	15.90	14.98	14.20
		50	50	15.70	14.77	13.81
		100	0	13.19	13.22	12.65
BW	MCS Index	Channel		55315	55990	56665
		Frequency (MHz)		3557.5	3625	3692.5
15M	QPSK	1	0	15.02	14.09	13.12
		1	37	15.46	14.48	13.40
		1	74	15.12	14.17	13.15
		36	0	15.02	14.20	13.13
		36	19	15.20	14.24	13.47
		36	39	15.01	14.05	13.24
		75	0	14.06	13.96	13.55
	16QAM	1	0	15.21	14.29	13.41
		1	37	15.61	14.69	13.60
		1	74	15.21	14.31	13.31
		36	0	15.28	14.26	13.34
		36	19	15.37	14.46	13.62
		36	39	15.21	14.34	13.31
		75	0	14.13	13.97	13.52

LTE Band 48						
BW	MCS Index	RB Size	RB Offset	Low	Mid	High
		Channel		55290	55990	56690
		Frequency (MHz)		3555	3625	3695
10M	QPSK	1	0	15.82	15.00	14.05
		1	24	16.24	15.33	14.28
		1	49	15.84	14.85	13.97
		25	0	15.84	14.89	14.01
		25	12	15.95	15.08	14.18
		25	25	15.84	14.98	13.97
		50	0	15.84	14.85	13.97
	16QAM	1	0	16.08	15.14	14.10
		1	24	16.47	15.46	14.45
		1	49	16.05	15.19	14.18
		25	0	16.03	15.09	14.10
		25	12	16.16	15.23	14.40
		25	25	16.05	15.09	14.17
		50	0	16.07	15.17	14.12
BW	MCS Index	Channel		55265	55990	56715
		Frequency (MHz)		3552.5	3695	3697.5
5M	QPSK	1	0	16.30	15.34	14.33
		1	12	16.65	15.68	14.66
		1	24	16.25	15.31	14.31
		12	0	16.34	15.43	14.39
		12	6	16.43	15.52	14.58
		12	13	16.26	15.44	14.46
		25	0	16.37	15.48	14.47
	16QAM	1	0	16.55	15.36	14.53
		1	12	16.91	16.08	15.05
		1	24	16.54	15.44	14.67
		12	0	16.57	15.37	14.45
		12	6	16.63	15.52	14.53
		12	13	16.44	15.36	14.35
		25	0	16.47	15.50	14.48



Maximum EIRP (dBm/ 10MHz)

LTE Band 48						
BW	MCS Index	RB Size	RB Offset	Low	Mid	High
		Channel		55340	55990	56640
		Frequency (MHz)		3560	3625	3690
20M	QPSK	1	0	21.48	20.48	19.56
		1	50	21.87	20.80	19.84
		1	99	21.43	20.51	19.65
		50	0	21.44	20.46	19.64
		50	25	21.64	20.65	19.77
		50	50	21.47	20.58	19.59
		100	0	19.08	19.02	18.53
	16QAM	1	0	21.63	20.75	19.72
		1	50	22.06	21.05	20.10
		1	99	21.72	20.75	19.78
		50	0	21.75	20.74	19.82
		50	25	21.80	20.88	20.10
		50	50	21.60	20.67	19.71
		100	0	19.09	19.12	18.55
BW	MCS Index	Channel		55315	55990	56665
		Frequency (MHz)		3557.5	3625	3692.5
15M	QPSK	1	0	20.92	19.99	19.02
		1	37	21.36	20.38	19.30
		1	74	21.02	20.07	19.05
		36	0	20.92	20.10	19.03
		36	19	21.10	20.14	19.37
		36	39	20.91	19.95	19.14
		75	0	19.96	19.86	19.45
	16QAM	1	0	21.11	20.19	19.31
		1	37	21.51	20.59	19.50
		1	74	21.11	20.21	19.21
		36	0	21.18	20.16	19.24
		36	19	21.27	20.36	19.52
		36	39	21.11	20.24	19.21
		75	0	20.03	19.87	19.42

*Note: EIRP (dBm / 10MHz) = Conducted Output Power (dBm / 10MHz) + Antenna Gain (dBi)

LTE Band 48						
BW	MCS Index	RB Size	RB Offset	Low	Mid	High
		Channel		55290	55990	56690
		Frequency (MHz)		3555	3625	3695
10M	QPSK	1	0	21.72	20.90	19.95
		1	24	22.14	21.23	20.18
		1	49	21.74	20.75	19.87
		25	0	21.74	20.79	19.91
		25	12	21.85	20.98	20.08
		25	25	21.74	20.88	19.87
		50	0	21.74	20.75	19.87
	16QAM	1	0	21.98	21.04	20.00
		1	24	22.37	21.36	20.35
		1	49	21.95	21.09	20.08
		25	0	21.93	20.99	20.00
		25	12	22.06	21.13	20.30
		25	25	21.95	20.99	20.07
		50	0	21.97	21.07	20.02
BW	MCS Index	Channel		55265	55990	56715
		Frequency (MHz)		3552.5	3695	3697.5
5M	QPSK	1	0	22.20	21.24	20.23
		1	12	22.55	21.58	20.56
		1	24	22.15	21.21	20.21
		12	0	22.24	21.33	20.29
		12	6	22.33	21.42	20.48
		12	13	22.16	21.34	20.36
		25	0	22.27	21.38	20.37
	16QAM	1	0	22.45	21.26	20.43
		1	12	22.81	21.98	20.95
		1	24	22.44	21.34	20.57
		12	0	22.47	21.27	20.35
		12	6	22.53	21.42	20.43
		12	13	22.34	21.26	20.25
		25	0	22.37	21.40	20.38

*Note: EIRP (dBm / 10MHz) = Conducted Output Power (dBm / 10MHz) + Antenna Gain (dBi)

Full Conducted Output Power (dBm / 20MHz)

LTE Band 48						
BW	MCS Index	RB Size	RB Offset	Low	Mid	High
		Channel		55340	55990	56640
		Frequency (MHz)		3560	3625	3690
20M	QPSK	1	0	15.72	14.74	13.85
		1	50	16.02	15.11	14.07
		1	99	15.63	14.68	13.76
		50	0	15.64	14.66	13.78
		50	25	15.82	14.90	14.09
		50	50	15.64	14.75	13.83
		100	0	15.64	14.68	13.71
	16QAM	1	0	15.81	14.89	13.90
		1	50	16.24	15.29	14.29
		1	99	15.95	14.99	13.90
		50	0	15.81	14.94	14.05
		50	25	16.08	15.03	14.20
		50	50	15.88	14.97	13.92
		100	0	15.92	15.00	13.90

Full Conducted Output Power (dBm / 15MHz)

BW	MCS Index	Channel		55315	55990	56665
		Frequency (MHz)		3557.5	3625	3692.5
15M	QPSK	1	0	15.17	14.19	13.34
		1	37	15.64	14.59	13.61
		1	74	15.19	14.28	13.26
		36	0	15.23	14.19	13.20
		36	19	15.35	14.42	13.60
		36	39	15.18	14.18	13.23
		75	0	15.21	14.16	13.34
	16QAM	1	0	15.45	14.46	13.55
		1	37	15.79	14.73	13.74
		1	74	15.30	14.50	13.44
		36	0	15.37	14.49	13.51
		36	19	15.50	14.59	13.72
		36	39	15.31	14.35	13.50
		75	0	15.36	14.38	13.51

Full Conducted Output Power (dBm / 10MHz)

LTE Band 48						
BW	MCS Index	RB Size	RB Offset	Low	Mid	High
		Channel		55290	55990	56690
		Frequency (MHz)		3555	3625	3695
10M	QPSK	1	0	15.82	15.00	14.05
		1	24	16.24	15.33	14.28
		1	49	15.84	14.85	13.97
		25	0	15.84	14.89	14.01
		25	12	15.95	15.08	14.18
		25	25	15.84	14.98	13.97
		50	0	15.84	14.85	13.97
	16QAM	1	0	16.08	15.14	14.10
		1	24	16.47	15.46	14.45
		1	49	16.05	15.19	14.18
		25	0	16.03	15.09	14.10
		25	12	16.16	15.23	14.40
		25	25	16.05	15.09	14.17
		50	0	16.07	15.17	14.12
BW	MCS Index	Channel		55265	55990	56715
		Frequency (MHz)		3552.5	3695	3697.5
5M	QPSK	1	0	16.30	15.34	14.33
		1	12	16.65	15.68	14.66
		1	24	16.25	15.31	14.31
		12	0	16.34	15.43	14.39
		12	6	16.43	15.52	14.58
		12	13	16.26	15.44	14.46
		25	0	16.37	15.48	14.47
	16QAM	1	0	16.55	15.36	14.53
		1	12	16.91	16.08	15.05
		1	24	16.54	15.44	14.67
		12	0	16.57	15.37	14.45
		12	6	16.63	15.52	14.53
		12	13	16.44	15.36	14.35
		25	0	16.47	15.50	14.48

Full EIRP (dBm / 20MHz)

LTE Band 48						
BW	MCS Index	RB Size	RB Offset	Low	Mid	High
		Channel		55340	55990	56640
		Frequency (MHz)		3560	3625	3690
20M	QPSK	1	0	21.62	20.64	19.75
		1	50	21.92	21.01	19.97
		1	99	21.53	20.58	19.66
		50	0	21.54	20.56	19.68
		50	25	21.72	20.80	19.99
		50	50	21.54	20.65	19.73
		100	0	21.54	20.58	19.61
	16QAM	1	0	21.71	20.79	19.80
		1	50	22.14	21.19	20.19
		1	99	21.85	20.89	19.80
		50	0	21.71	20.84	19.95
		50	25	21.98	20.93	20.10
		50	50	21.78	20.87	19.82
		100	0	21.82	20.90	19.80

*Note: Full EIRP (dBm / 20MHz) = Full Conducted Output Power (dBm / 20MHz) + Antenna Gain (dBi)

Full EIRP (dBm / 15MHz)

BW	MCS Index	Channel		55315	55990	56665
		Frequency (MHz)		3557.5	3625	3692.5
15M	QPSK	1	0	21.07	20.09	19.24
		1	37	21.54	20.49	19.51
		1	74	21.09	20.18	19.16
		36	0	21.13	20.09	19.10
		36	19	21.25	20.32	19.50
		36	39	21.08	20.08	19.13
		75	0	21.11	20.06	19.24
	16QAM	1	0	21.35	20.36	19.45
		1	37	21.69	20.63	19.64
		1	74	21.20	20.40	19.34
		36	0	21.27	20.39	19.41
		36	19	21.40	20.49	19.62
		36	39	21.21	20.25	19.40
		75	0	21.26	20.28	19.41

*Note: Full EIRP (dBm / 15MHz) = Full Conducted Output Power (dBm / 15MHz) + Antenna Gain (dBi)

Full EIRP (dBm / 10MHz)

LTE Band 48						
BW	MCS Index	RB Size	RB Offset	Low	Mid	High
		Channel		55290	55990	56690
		Frequency (MHz)		3555	3625	3695
10M	QPSK	1	0	21.72	20.90	19.95
		1	24	22.14	21.23	20.18
		1	49	21.74	20.75	19.87
		25	0	21.74	20.79	19.91
		25	12	21.85	20.98	20.08
		25	25	21.74	20.88	19.87
		50	0	21.74	20.75	19.87
	16QAM	1	0	21.98	21.04	20.00
		1	24	22.37	21.36	20.35
		1	49	21.95	21.09	20.08
		25	0	21.93	20.99	20.00
		25	12	22.06	21.13	20.30
		25	25	21.95	20.99	20.07
		50	0	21.97	21.07	20.02
BW	MCS Index	Channel		55265	55990	56715
		Frequency (MHz)		3552.5	3695	3697.5
5M	QPSK	1	0	22.20	21.24	20.23
		1	12	22.55	21.58	20.56
		1	24	22.15	21.21	20.21
		12	0	22.24	21.33	20.29
		12	6	22.33	21.42	20.48
		12	13	22.16	21.34	20.36
		25	0	22.27	21.38	20.37
	16QAM	1	0	22.45	21.26	20.43
		1	12	22.81	21.98	20.95
		1	24	22.44	21.34	20.57
		12	0	22.47	21.27	20.35
		12	6	22.53	21.42	20.43
		12	13	22.34	21.26	20.25
		25	0	22.37	21.40	20.38

*Note: Full EIRP (dBm / 10MHz) = Full Conducted Output Power (dBm / 10MHz) + Antenna Gain (dBi)

4.2 Modulation Characteristics Measurement

4.2.1 Limits of Modulation Characteristics

N/A

4.2.2 Test Setup



4.2.3 Test Instruments

Refer to section 4.4.3 to get information of above instrument.

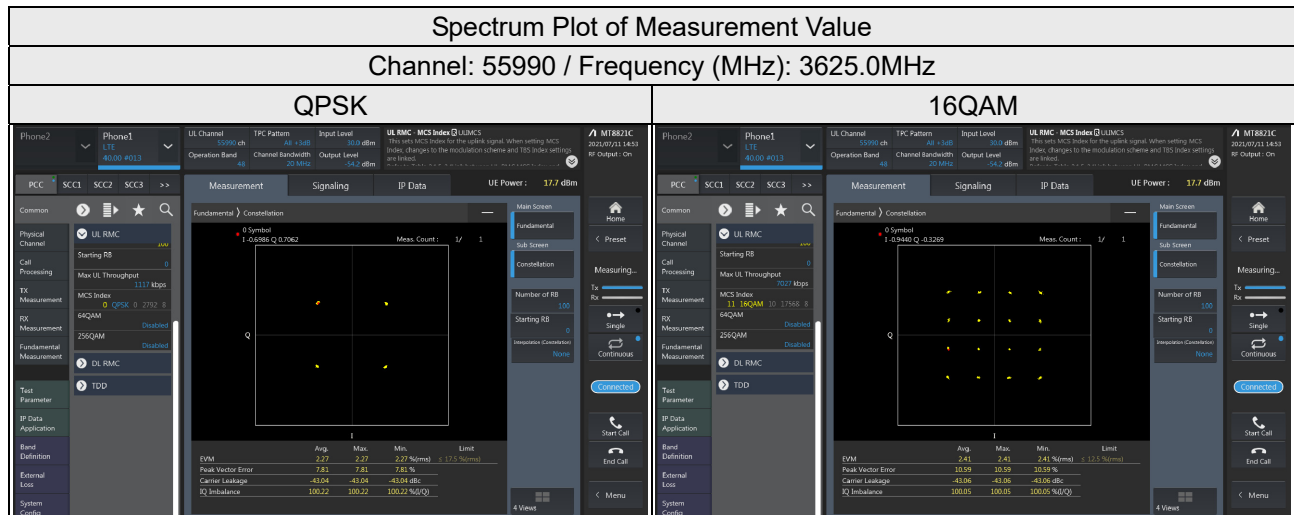
4.2.4 Deviation from Test Standard

No deviation.

4.2.5 EUT Operating Conditions

Connect the EUT to Communication Simulator via the antenna connector, The frequency band is set as EUT supported Modulation and Channels, the EUT output is matched with 50 ohm load, the waveform quality and constellation of the EUT was tested.

4.2.6 Test Results



4.3 Frequency Stability Measurement

4.3.1 Limits of Frequency Stability Measurement

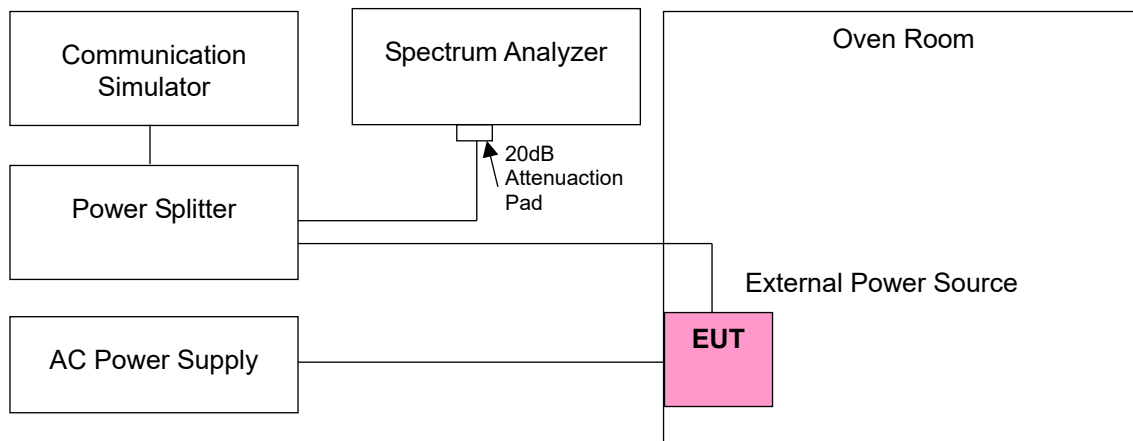
The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency band.

4.3.2 Test Procedure

- Device is placed at the oven room. The oven room could control the temperatures and humidity. Power warm up is at least 15 min and power applied should perform before recording frequency error.
- EUT is connected the external power supply to control the DC input power. The test voltage range is from minimum to maximum working voltage. Each step shall be record the frequency error rate.
- The temperature range step is 10 degrees in this test items. All temperature levels shall be hold the ± 0.5 °C during the measurement testing. The each temperature step shall be at least 0.5 hours, consider the EUT could be test under the stability condition.

Note: The frequency error was recorded frequency error from the communication simulator.

4.3.3 Test Setup



4.3.4 Test Results

Frequency Error vs. Voltage

Voltage (Vac)	LTE Band 48, Channel Bandwidth: 5MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
120	3552.500033	0.009	3697.500014	0.004
102	3552.500015	0.004	3697.500039	0.011
138	3552.500023	0.006	3697.500030	0.008

Note: The applicant defined the normal working voltage is from 102Vac to 138Vac.

Frequency Error vs. Temperature

Temp. (°C)	LTE Band 48, Channel Bandwidth: 5MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
0	3552.500023	0.006	3697.500033	0.009
10	3552.500026	0.007	3697.500021	0.006
20	3552.500023	0.006	3697.500037	0.010
30	3552.500023	0.006	3697.500027	0.007
40	3552.499984	-0.005	3697.499971	-0.008

Frequency Error vs. Voltage

Voltage (Vac)	LTE Band 48, Channel Bandwidth: 10MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
120	3555.000037	0.010	3695.000025	0.007
102	3555.000019	0.005	3695.000016	0.004
138	3555.000032	0.009	3695.000031	0.008

Note: The applicant defined the normal working voltage is from 102Vac to 138Vac.

Frequency Error vs. Temperature

Temp. (°C)	LTE Band 48, Channel Bandwidth: 10MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
0	3555.000021	0.006	3695.000033	0.009
10	3555.000022	0.006	3695.000016	0.004
20	3555.000029	0.008	3695.000023	0.006
30	3555.000027	0.008	3695.000011	0.003
40	3554.999966	-0.010	3694.999973	-0.007

Frequency Error vs. Voltage

Voltage (Vac)	LTE Band 48, Channel Bandwidth: 15MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
120	3557.500015	0.004	3692.500033	0.009
102	3557.500012	0.003	3692.500022	0.006
138	3557.500039	0.011	3692.500026	0.007

Note: The applicant defined the normal working voltage is from 102Vac to 138Vac.

Frequency Error vs. Temperature

Temp. (°C)	LTE Band 48, Channel Bandwidth: 15MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
0	3557.500028	0.008	3692.500036	0.010
10	3557.500022	0.006	3692.500023	0.006
20	3557.500021	0.006	3692.500026	0.007
30	3557.500029	0.008	3692.500021	0.006
40	3557.499974	-0.007	3692.499960	-0.011

Frequency Error vs. Voltage

Voltage (Vac)	LTE Band 48, Channel Bandwidth: 20MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
120	3560.000030	0.008	3690.000024	0.007
102	3560.000034	0.010	3690.000021	0.006
138	3560.000017	0.005	3690.000029	0.008

Note: The applicant defined the normal working voltage is from 102Vac to 138Vac.

Frequency Error vs. Temperature

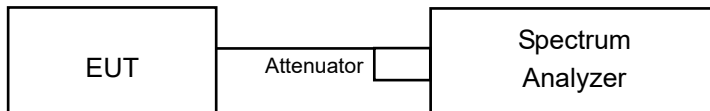
Temp. (°C)	LTE Band 48, Channel Bandwidth: 20MHz			
	Low Channel		High Channel	
	Frequency (MHz)	Frequency Error (ppm)	Frequency (MHz)	Frequency Error (ppm)
0	3560.000027	0.008	3690.000036	0.010
10	3560.000028	0.008	3690.000011	0.003
20	3560.000019	0.005	3690.000013	0.004
30	3560.000017	0.005	3690.000039	0.011
40	3559.999971	-0.008	3689.999985	-0.004

4.4 Emission Bandwidth Measurement

4.4.1 Limits of Emission Bandwidth Measurement

Reference only

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.3 to get information of above instrument.

4.4.4 Test Procedure

Occupied Bandwidth & 26dBc Bandwidth

- The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the spectrum analyzer shall be wide enough to see sufficient roll off of the signal to make the measurement.
- The nominal RBW shall be in the range of 1% to 5% of the anticipated OBW, and the VBW shall be set $\geq 3 \times \text{RBW}$.
- Set the reference level of the instrument as required to prevent the signal amplitude from exceeding the maximum spectrum analyzer input mixer level for linear operation.
NOTE—Step 1), step 2), and step 3) may require iteration to adjust within the specified tolerances.
- The dynamic range of the spectrum analyzer at the selected RBW shall be more than 10 dB below the target “-X dB” requirement, i.e., if the requirement calls for measuring the -26 dB OBW, the spectrum analyzer noise floor at the selected RBW shall be at least 36 dB below the reference level.
- Set spectrum analyzer detection mode to peak, and the trace mode to max hold.
- Determine the reference value by either of the following:
 - Set the EUT to transmit a modulated signal. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
 - Set the EUT to transmit an unmodulated carrier. Set the spectrum analyzer marker to the level of the carrier.
- Determine the “-X dB amplitude” as equal to (Reference Value - X). Alternatively, this calculation can be performed on the spectrum analyzer using the delta-marker measurement function.

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

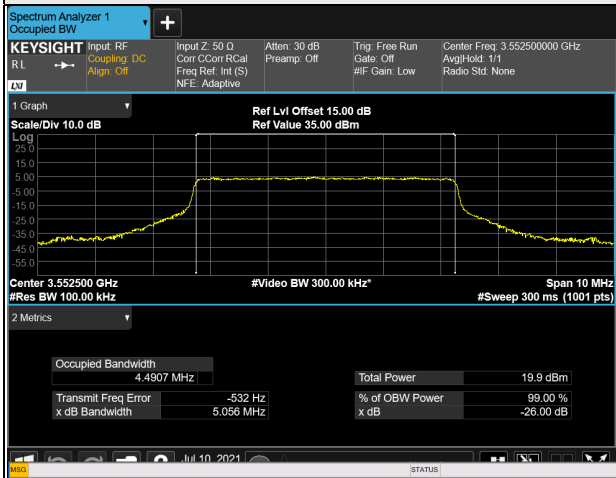
4.4.7 Test Result

Occupied Bandwidth

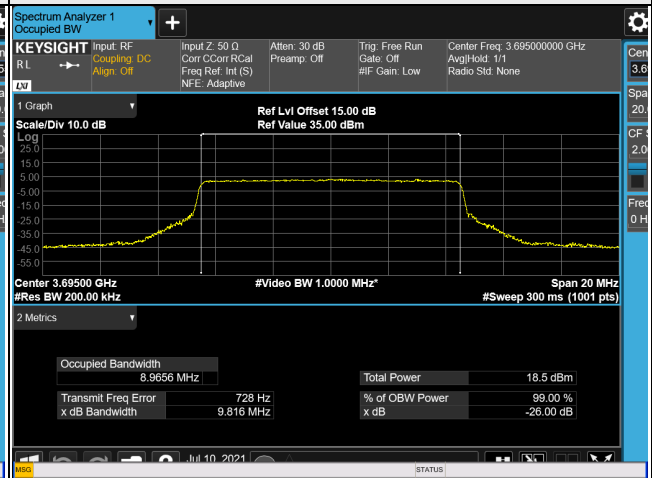
LTE Band 48, Channel Bandwidth 5MHz			
Channel	Frequency (MHz)	99% Occupied Bandwidth (MHz)	
		QPSK	16QAM
55265	3552.5	4.49	4.48
55990	3625.0	4.49	4.48
56715	3697.5	4.48	4.48
LTE Band 48, Channel Bandwidth 10MHz			
Channel	Frequency (MHz)	99% Occupied Bandwidth (MHz)	
		QPSK	16QAM
55290	3555.0	8.96	8.96
55990	3625.0	8.96	8.95
56690	3695.0	8.95	8.97
LTE Band 48, Channel Bandwidth 15MHz			
Channel	Frequency (MHz)	99% Occupied Bandwidth (MHz)	
		QPSK	16QAM
55315	3557.5	13.41	13.41
55990	3625.0	13.43	13.42
56665	3692.5	13.43	13.41
LTE Band 48, Channel Bandwidth 20MHz			
Channel	Frequency (MHz)	99% Occupied Bandwidth (MHz)	
		QPSK	16QAM
55340	3560.0	17.99	18.02
55990	3625.0	17.97	18.01
56640	3690.0	17.92	18.02

Spectrum Plot of Worst Value

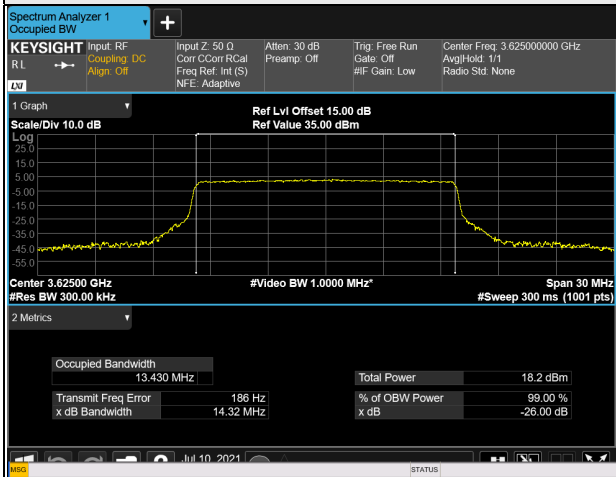
5MHz / QPSK



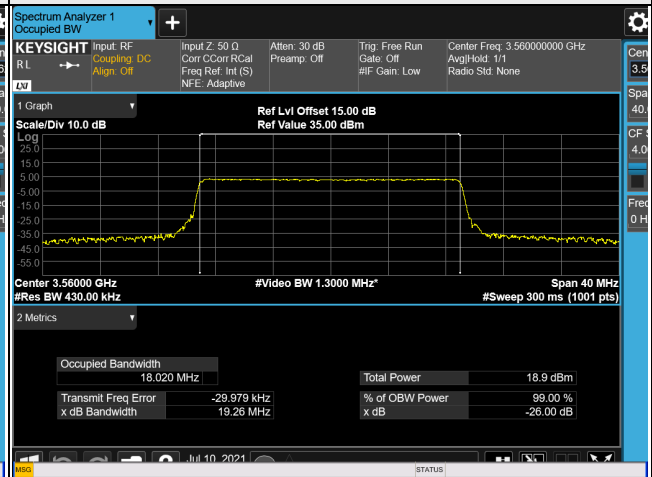
10MHz / 16QAM



15MHz / QPSK



20MHz / 16QAM

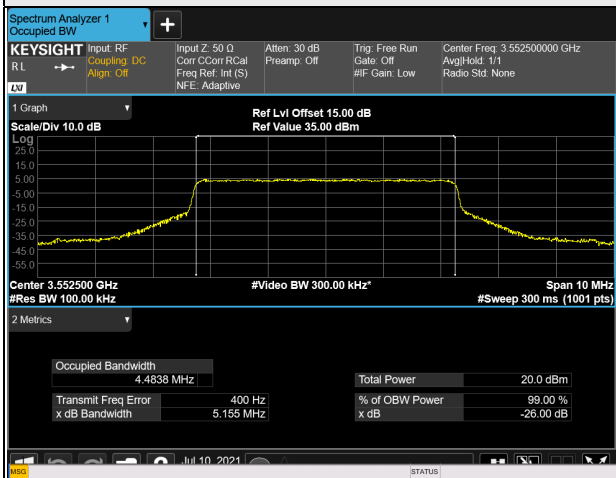


26dB Bandwidth

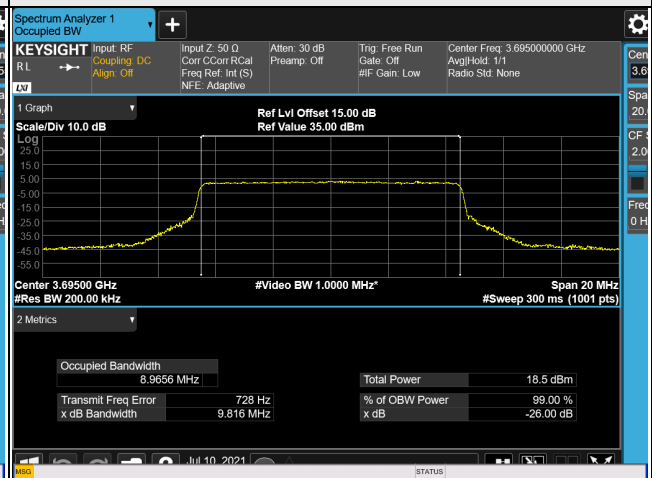
LTE Band 48, Channel Bandwidth 5MHz			
Channel	Frequency (MHz)	26dB Bandwidth (MHz)	
		QPSK	16QAM
55265	3552.5	5.06	5.16
55990	3625.0	5.07	5.16
56715	3697.5	5.13	5.06
LTE Band 48, Channel Bandwidth 10MHz			
Channel	Frequency (MHz)	26dB Bandwidth (MHz)	
		QPSK	16QAM
55290	3555.0	9.53	9.69
55990	3625.0	9.55	9.67
56690	3695.0	9.56	9.82
LTE Band 48, Channel Bandwidth 15MHz			
Channel	Frequency (MHz)	26dB Bandwidth (MHz)	
		QPSK	16QAM
55315	3557.5	14.34	14.35
55990	3625.0	14.32	14.27
56665	3692.5	14.30	14.27
LTE Band 48, Channel Bandwidth 20MHz			
Channel	Frequency (MHz)	26dB Bandwidth (MHz)	
		QPSK	16QAM
55340	3560.0	19.15	19.26
55990	3625.0	19.09	19.09
56640	3690.0	19.08	19.13

Spectrum Plot of Worst Value

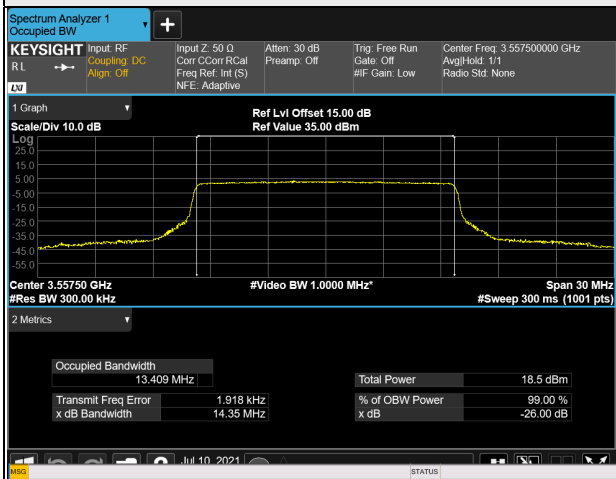
5MHz / 16QAM



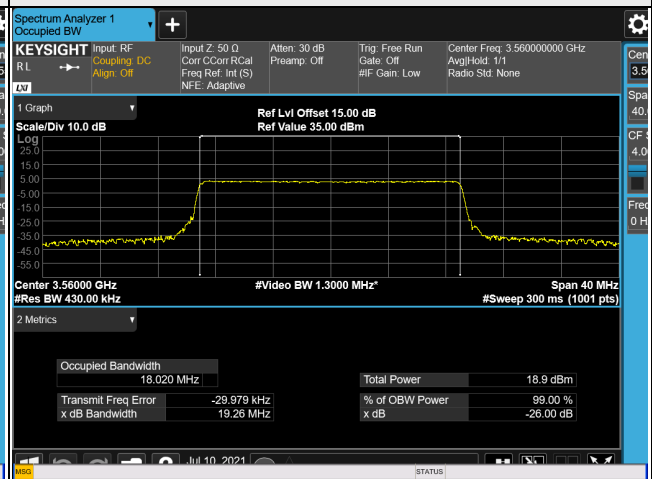
10MHz / 16QAM



15MHz / 16QAM



20MHz / 16QAM

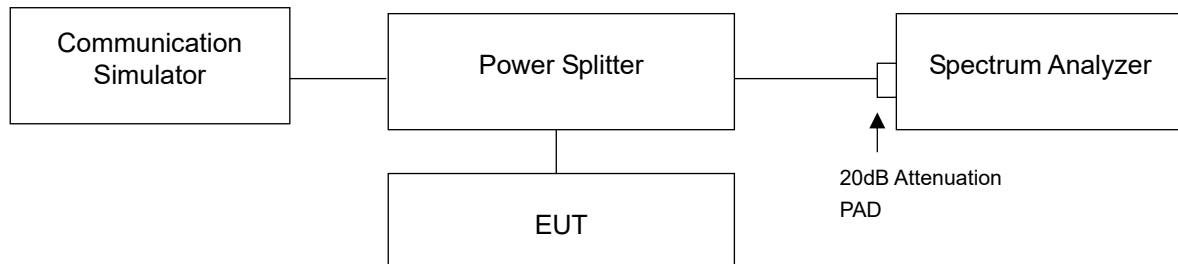


4.5 Peak to Average Ratio Measurement

4.5.1 Limits of Peak to Average Ratio Measurement

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

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.4.3 to get information of above instrument.

4.5.4 Test Procedures

- Set resolution/measurement bandwidth $\geq$ signal's occupied bandwidth;
- Set the number of counts to a value that stabilizes the measured CCDF curve;
- Record the maximum PAPR level associated with a probability of 0.1%.

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 EUT Operating Conditions

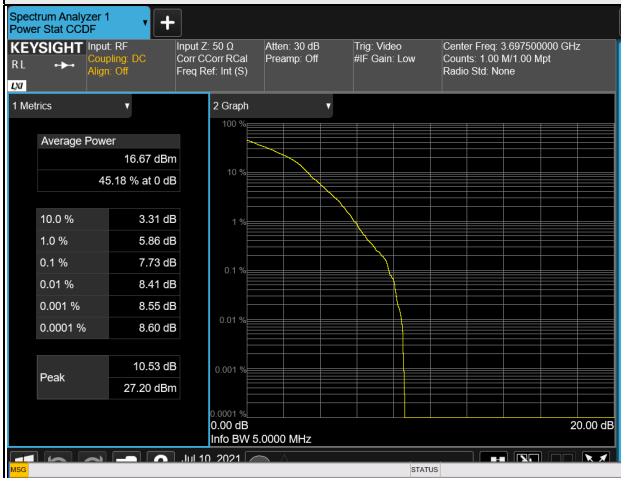
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.5.7 Test Results

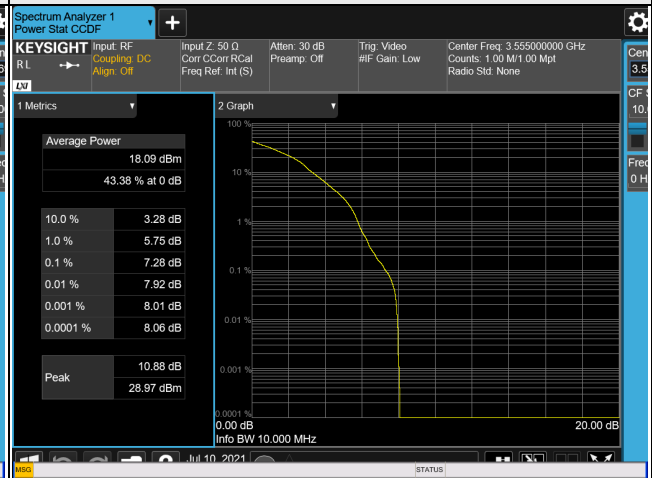
LTE Band 48, Channel Bandwidth 5MHz			
Channel	Frequency (MHz)	Peak To Average Ratio (dB)	
		QPSK	16QAM
55265	3552.5	6.76	7.30
55990	3625.0	6.48	7.35
56715	3697.5	6.68	7.73
LTE Band 48, Channel Bandwidth 10MHz			
Channel	Frequency (MHz)	Peak To Average Ratio (dB)	
		QPSK	16QAM
55290	3555.0	6.62	7.28
55990	3625.0	6.41	7.25
56690	3695.0	6.63	7.25
LTE Band 48, Channel Bandwidth 15MHz			
Channel	Frequency (MHz)	Peak To Average Ratio (dB)	
		QPSK	16QAM
55315	3557.5	6.32	7.08
55990	3625.0	6.73	7.32
56665	3692.5	6.86	6.81
LTE Band 48, Channel Bandwidth 20MHz			
Channel	Frequency (MHz)	Peak To Average Ratio (dB)	
		QPSK	16QAM
55340	3560.0	7.22	6.68
55990	3625.0	6.53	7.81
56640	3690.0	6.65	7.29

Spectrum Plot of Worst Value

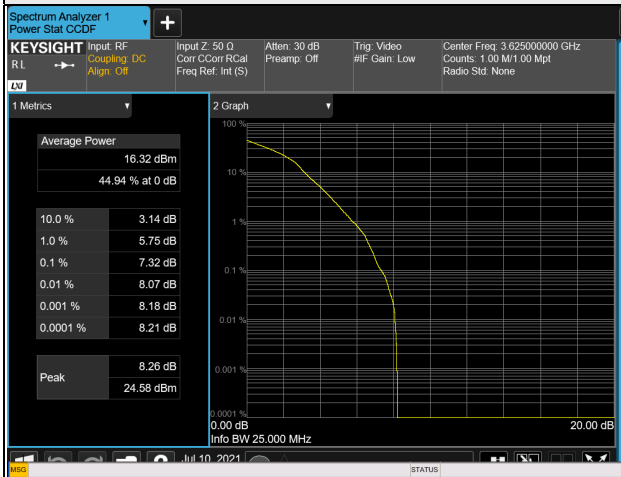
5MHz / 16QAM



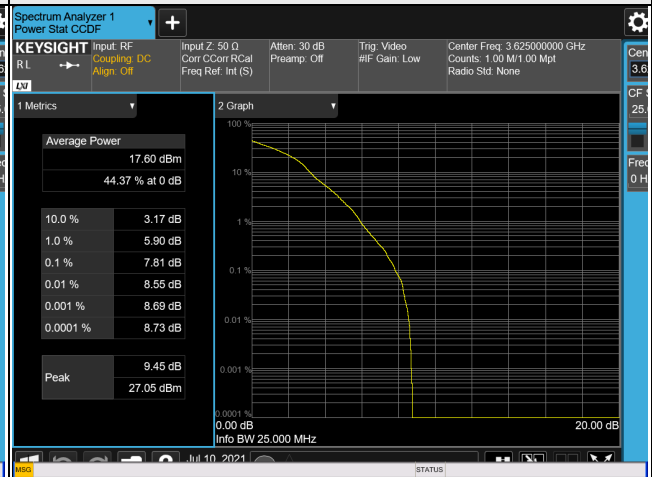
10MHz / 16QAM



15MHz / 16QAM



20MHz / 16QAM

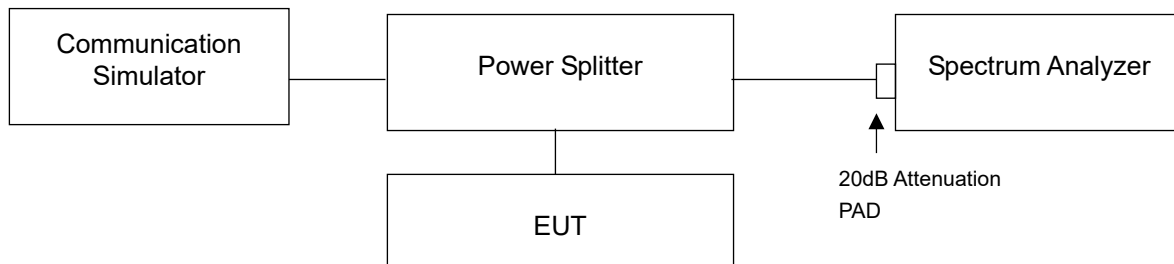


4.6 Conducted Spurious Emissions

4.6.1 Limits of Conducted Spurious Emissions Measurement

Power of any emissions outside the Fundamental	Limit
Within 0-10MHz above the Assigned Channel	-13 dBm/MHz
Within 0-10MHz below the Assigned Channel	
Greater than 10MHz above the Assigned Channel	-25 dBm/MHz
Greater than 10MHz below the Assigned Channel	
Power of any emission below 3530MHz	-40 dBm/MHz
Power of any emission above 3720MHz	

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.4.3 to get information of above instrument.

4.6.4 Test Procedure

- The EUT makes a phone call to the communication simulator. All measurements were done at low, middle and high operational frequency range.
- Measuring frequency range are from 9 kHz to 40GHz. 20dB attenuation pad is connected with spectrum. RBW=1MHz and VBW=3MHz is used for conducted emission measurement.
- Measuring frequency band edge, 20dB attenuation pad is connected with spectrum. 1% of the fundamental emission bandwidth is used for conducted emission measurement.
- For 5 MHz channel BW mode, extend the 1% range from 1M to 2M above and below the channel edge and then reduce the limit further by $10 \log (1000/100)=10\text{dB}$ (i.e. total $-13 + -10=-23\text{dB}$) to compensate for the integration from 100k to 1M.

4.6.5 Deviation from Test Standard

No deviation.

4.6.6 EUT Operating Conditions

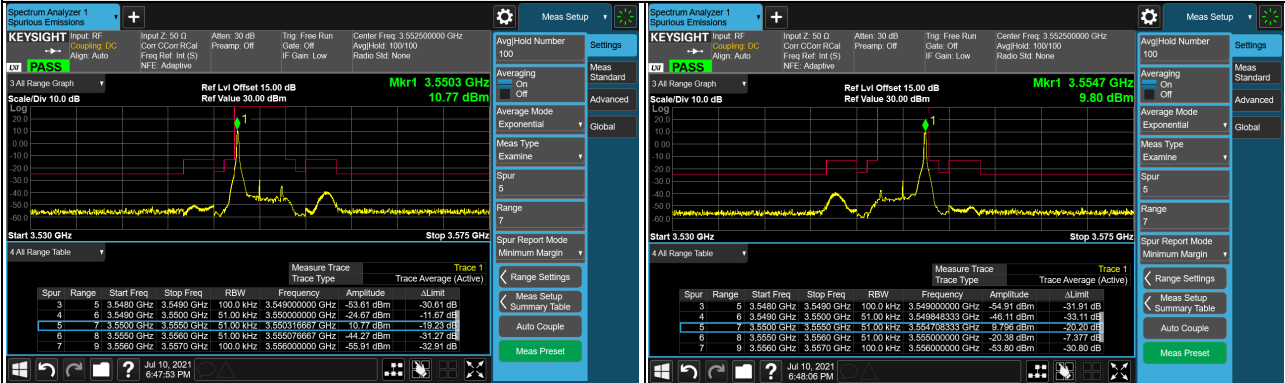
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.6.7 Test Results

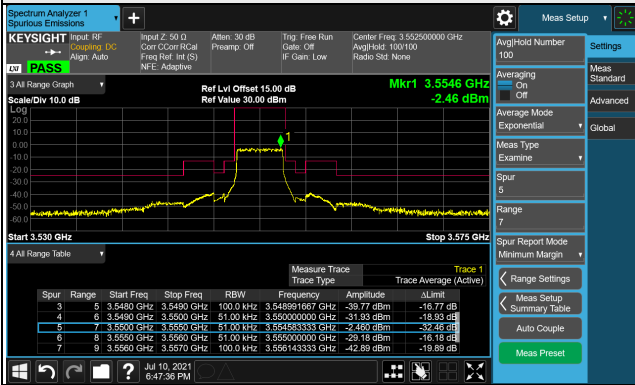
LTE Band 48, Channel Bandwidth 5MHz

Channel 55265 (3552.5MHz)

1RB

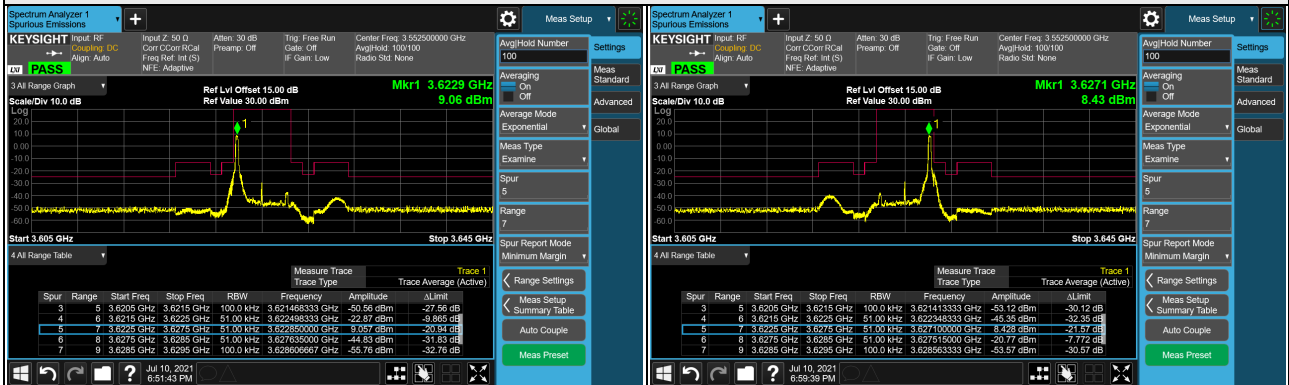


Full RB

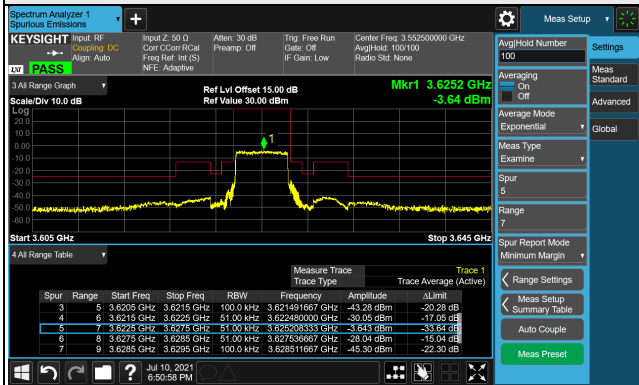


Channel 55990 (3625.0MHz)

1RB

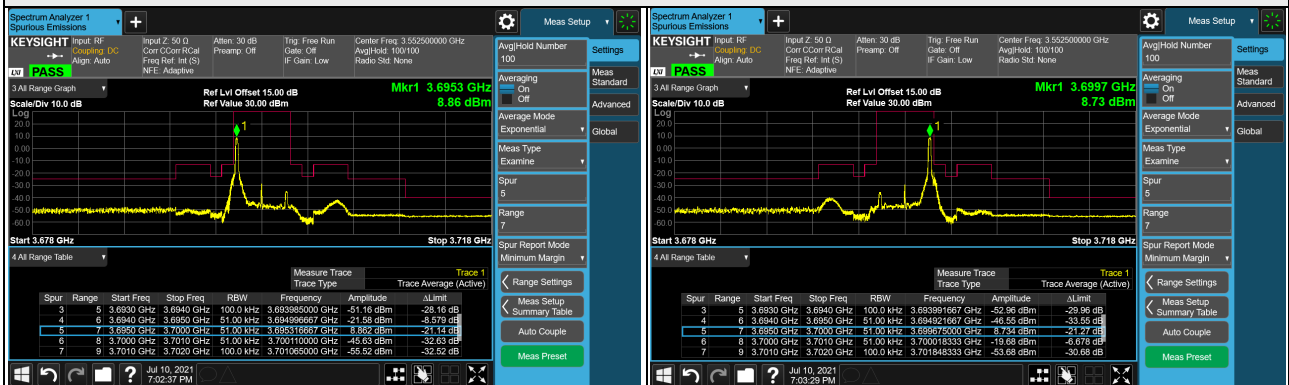


Full RB

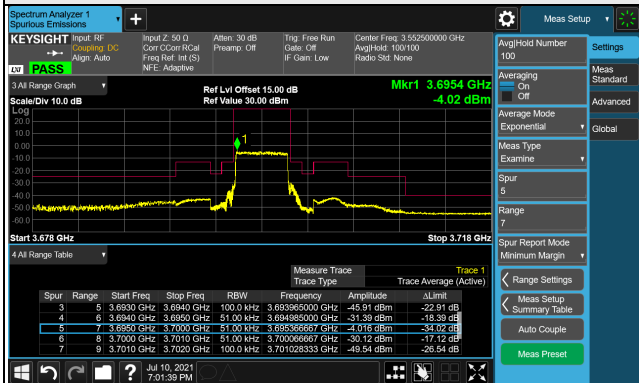


Channel 56715 (3697.5MHz)

1RB



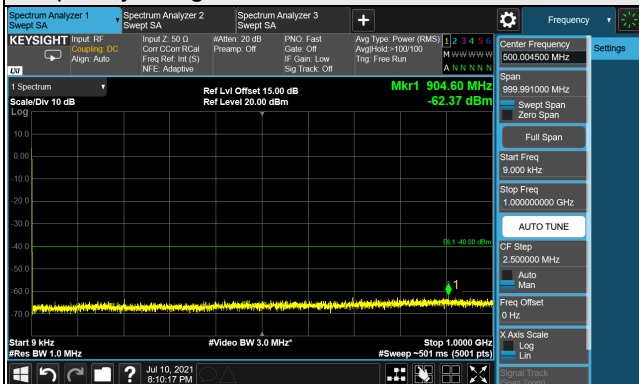
Full RB



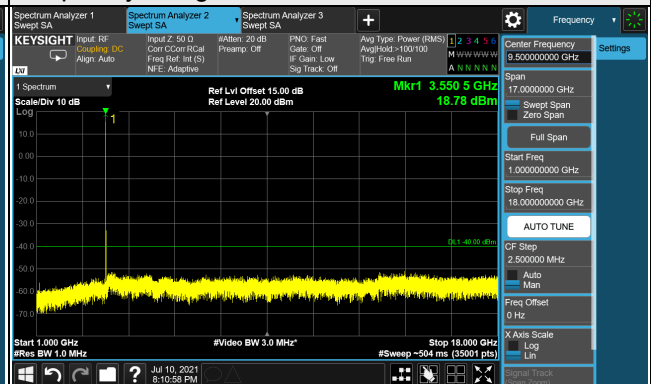
LTE Band 48, Channel Bandwidth 5MHz

Channel 55265 (3552.5MHz)

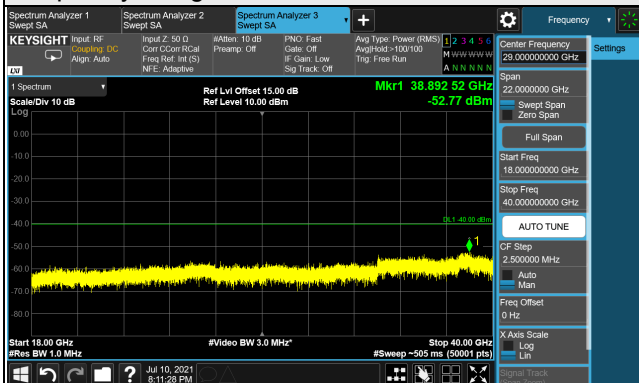
Frequency Range : 9kHz ~ 1GHz



Frequency Range : 1GHz ~ 18GHz



Frequency Range : 18GHz ~ 40GHz

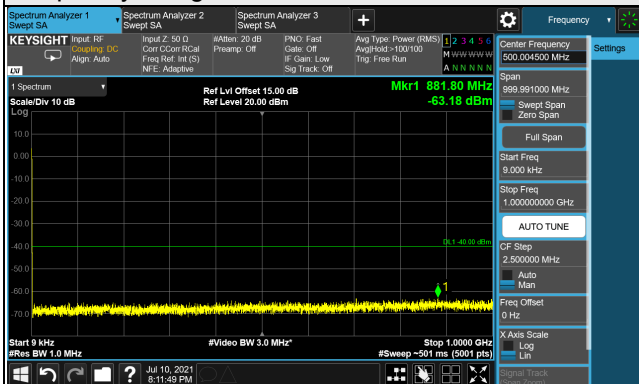


Note: The signal at 9 kHz is IF signal from spectrum analyzer.

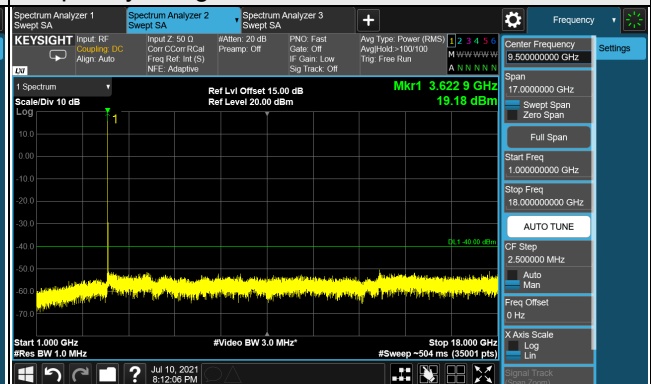
LTE Band 48, Channel Bandwidth 5MHz

Channel 55990 (3625.0MHz)

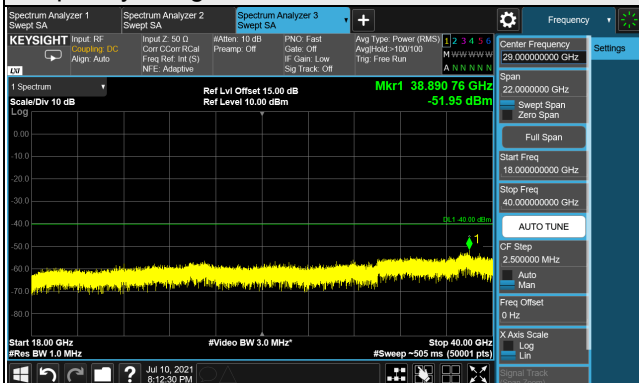
Frequency Range : 9kHz ~ 1GHz



Frequency Range : 1GHz ~ 18GHz



Frequency Range : 18GHz ~ 40GHz

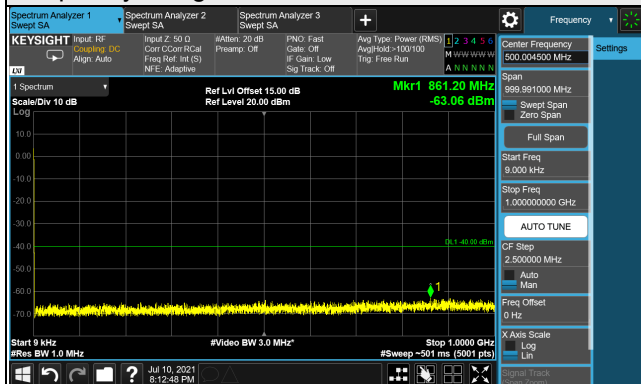


Note: The signal at 9 kHz is IF signal from spectrum analyzer.

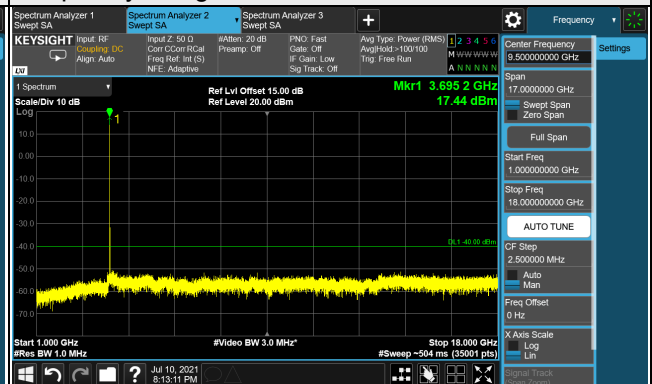
LTE Band 48, Channel Bandwidth 5MHz

Channel 56715 (3697.50MHz)

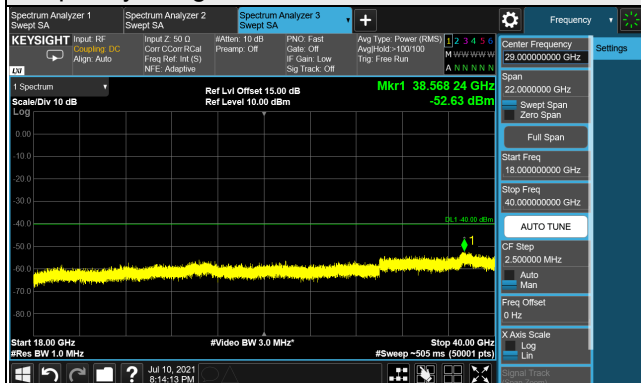
Frequency Range : 9kHz ~ 1GHz



Frequency Range : 1GHz ~ 18GHz



Frequency Range : 18GHz ~ 40GHz



Note: The signal at 9 kHz is IF signal from spectrum analyzer.

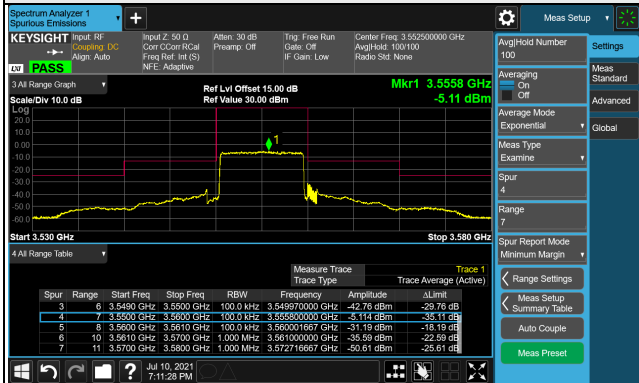
LTE Band 48, Channel Bandwidth 10MHz

Channel 55290 (3555.0MHz)

1RB

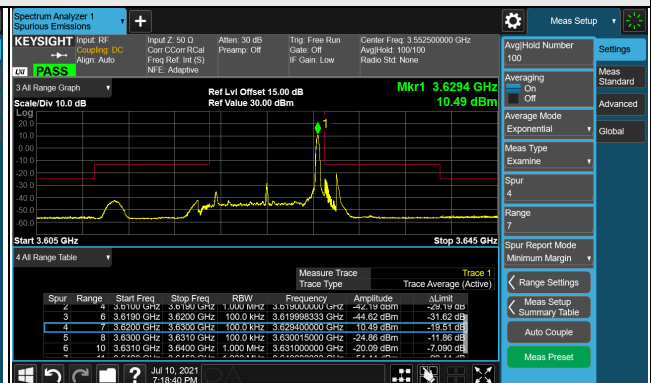
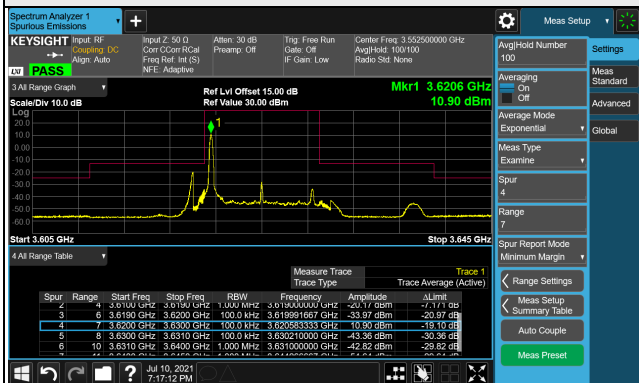


Full RB

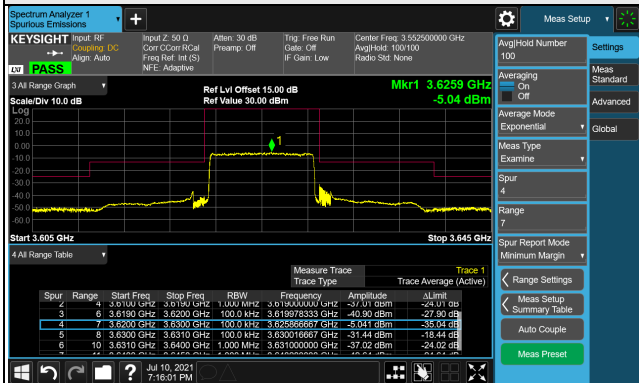


Channel 55990 (3625.00MHz)

1RB

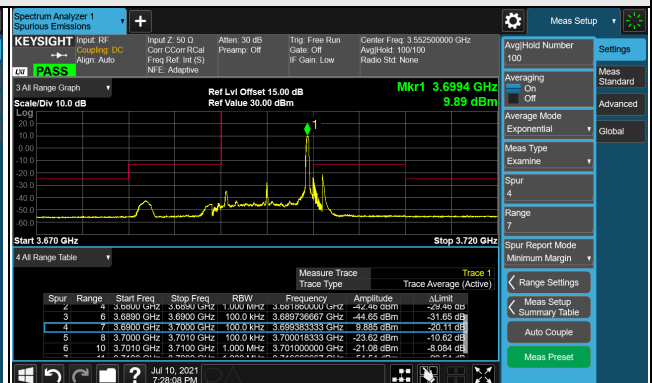
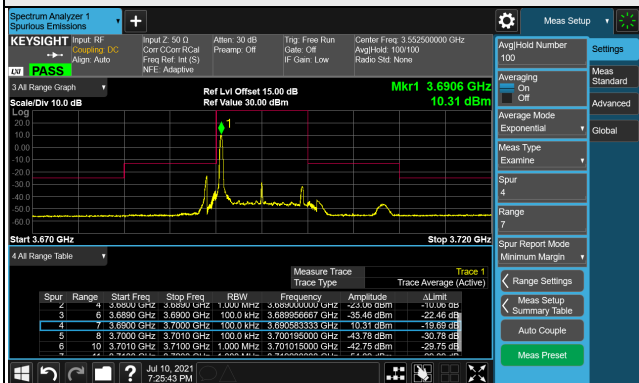


Full RB

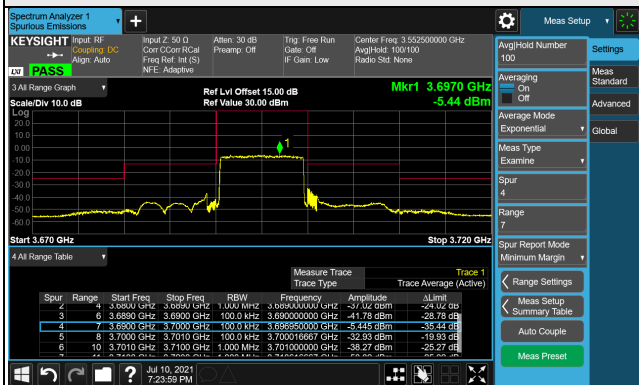


Channel 56690 (3695.0MHz)

1RB



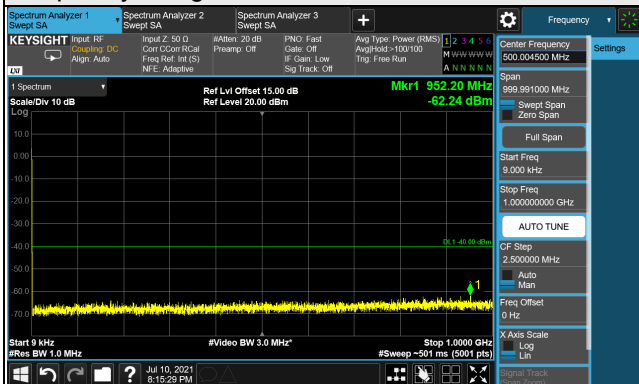
Full RB



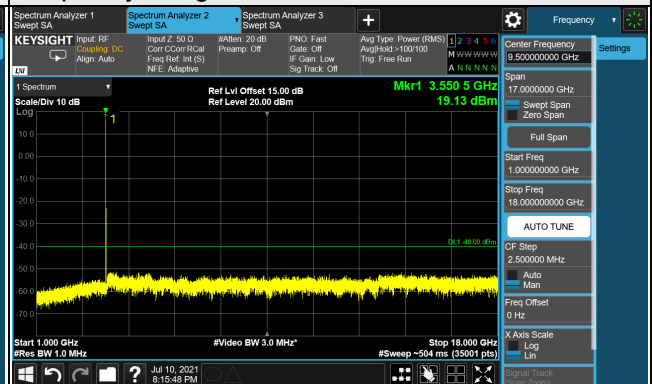
LTE Band 48, Channel Bandwidth 10MHz

Channel 55290 (3555.0MHz)

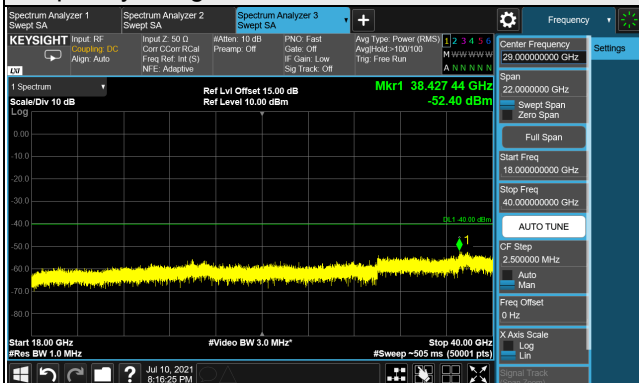
Frequency Range : 9kHz ~ 1GHz



Frequency Range : 1GHz ~ 18GHz



Frequency Range : 18GHz ~ 40GHz

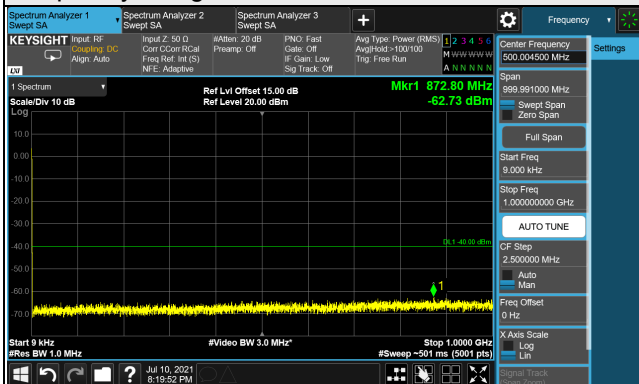


Note: The signal at 9 kHz is IF signal from spectrum analyzer.

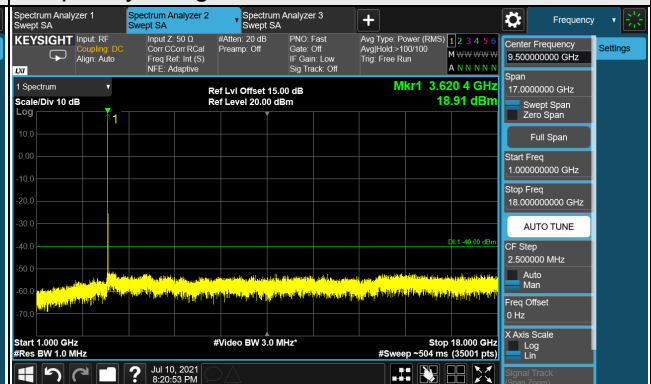
LTE Band 48, Channel Bandwidth 10MHz

Channel 55990 (3625.00MHz)

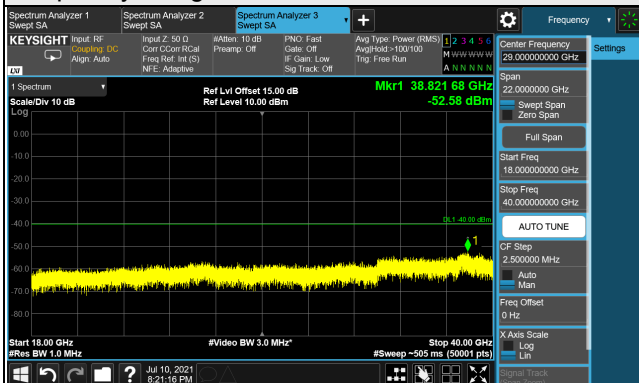
Frequency Range : 9kHz ~ 1GHz



Frequency Range : 1GHz ~ 18GHz



Frequency Range : 18GHz ~ 40GHz

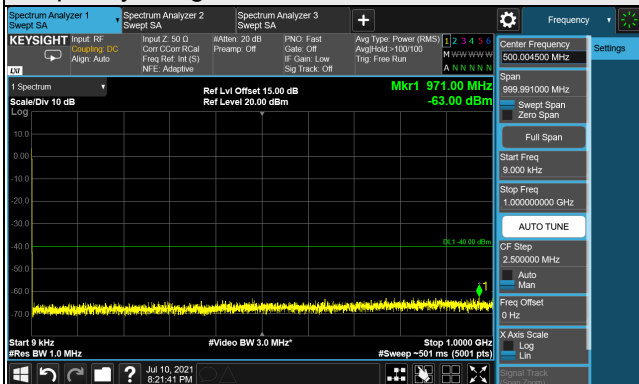


Note: The signal at 9 kHz is IF signal from spectrum analyzer.

LTE Band 48, Channel Bandwidth 10MHz

Channel 56690 (3695.0MHz)

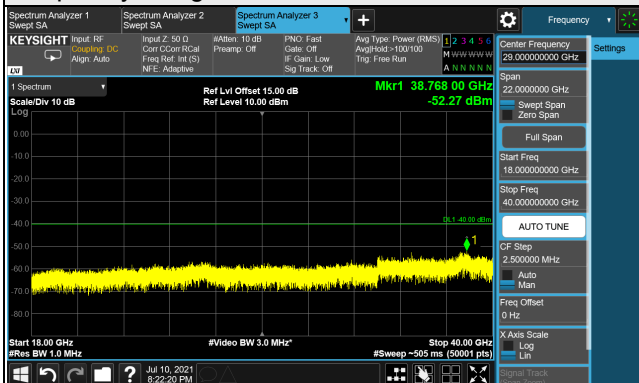
Frequency Range : 9kHz ~ 1GHz



Frequency Range : 1GHz ~ 18GHz



Frequency Range : 18GHz ~ 40GHz

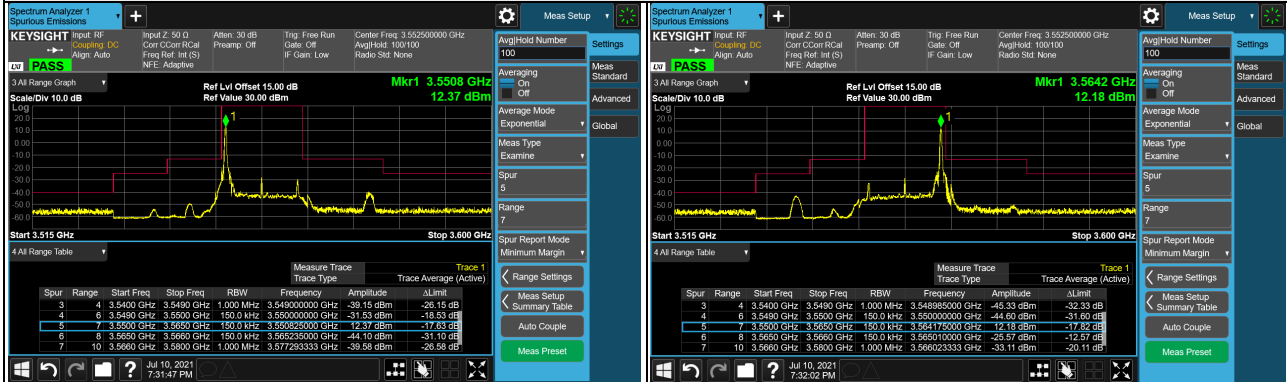


Note: The signal at 9 kHz is IF signal from spectrum analyzer.

LTE Band 48, Channel Bandwidth 15MHz

Channel 55315 (3557.50MHz)

1RB



Full RB

