



CERTIFICATION TEST REPORT

Report Number. : 4789633488-E2V2

Applicant : SAMSUNG ELECTRONICS CO., LTD.
129 SAMSUNG-RO, YEONGTONG-GU, SUWON-SI,
GYEONGGI-DO, 16677, KOREA

Model : SM-G996B/DS, SM-G996B

FCC ID : A3LSMG996B

EUT Description : GSM/WCDMA/LTE/5G NR Phone + BT/BLE, DTS/UNII a/b/g/n/ac/ax,
UWB, WPT and NFC

Test Standard(s) : FCC CFR47 PART 22 SUBPART H
FCC CFR47 PART 24 SUBPART E
FCC CFR47 PART 27 SUBPART F,H,L,M
FCC CFR47 PART 90 SUBPART S

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Testing Laboratory
TL-637

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	11/16/20	Initial issue	Sungeun Lee
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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: SAMSUNG ELECTRONICS CO., LTD.

EUT DESCRIPTION: GSM/WCDMA/LTE/5G NR Phone + BT/BLE, DTS/UNII a/b/g/n/ac/ax, UWB, WPT and NFC

MODEL NUMBER: SM-G996B/DS, SM-G996B

SERIAL NUMBER: R3CN811HW2B, R3CN811HW1E, R3CN80DGAXT (CONDUCTED); 48a3c710441f7ece, 48a3c711d41f7ece (RADIATED)

DATE TESTED: SEP 07, 2020 – NOV 16, 2020;

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC PART 22H, 24E, 27F, H, L, M and 90S	Pass

UL Korea, Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Korea, Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Korea, Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Korea, Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by IAS, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL Korea, Ltd. By:



Junwhan Lee
Suwon Lab Engineer
UL Korea, Ltd.

Tested By:



Sungeun Lee
Suwon Lab Engineer
UL Korea, Ltd.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with following methods.

1. FCC CFR 47 Part 2.
2. FCC CFR 47 Part 22.
3. FCC CFR 47 Part 24.
4. FCC CFR 47 Part 27.
5. FCC CFR 47 Part 90.
6. ANSI TIA-603-E, 2016
7. ANSI C63.26, 2015
8. KDB 971168 D01 Power Meas License Digital Systems v03r01

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 218 Maeyeong-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16675, Korea. Line conducted emissions are measured only at the 218 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

218 Maeyeong-ro	
☒	Chamber 1
☒	Chamber 2
☐	Chamber 3

UL Korea, Ltd. is accredited by IAS, Laboratory Code TL-637. The full scope of accreditation can be viewed at <https://www.iasonline.org/wp-content/uploads/2017/05/TL-637-cert-New.pdf>.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

$EIRP = \text{PSA reading with EUT worst orientation (dBm)} + \text{Path loss (dB)} - \text{cable loss (between the SG and substitution antenna)} + \text{Substitution Antenna Factor (dBi)}$

$ERP = \text{PSA reading with EUT worst orientation (dBm)} + \text{Path loss (dB)} - \text{cable loss (between the SG and substitution antenna)}$

(Path loss = Signal generator output – PSA reading with substitution antenna)

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	3.01 dB
Radiated Disturbance, 9 kHz to 30 MHz	1.72 dB
Radiated Disturbance, 30 MHz to 1 GHz	4.26 dB
Radiated Disturbance, 1 GHz to 18 GHz	5.90 dB
Radiated Disturbance, Above 18 GHz	5.49 dB

Uncertainty figures are valid to a confidence level of 95%.

4.4. DECISION RULE

Decision rule for statement(s) of conformity is based on Procedure 1, Clause 4.4.2 in IEC Guide 115:2007.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a GSM/WCDMA/LTE/5G NR Phone + BT/BLE, DTS/UNII a/b/g/n/ac/ax, UWB, WPT and NFC. This test report addresses the WWAN operational mode.

This report covers the Samsung models SM-G996B/DS and SM-G996B. These models are identical in hardware except SM-G996B has single SIM tray. With some pre-scan, model SM-G996B/DS was set for final test.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum average radiated ERP / EIRP output powers as follows:

Note : Conducted output power results were excerpted from RF exposure test report (4789633488-S1 FCC Report SAR).

GSM

FCC Part 22/24						
Band	Frequency Range [MHz]	Modulation	Conducted		Radiated	
			Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
GSM850	824~849	GPRS	32.72	1868.91	29.32	855.07
		EGPRS	29.24	839.16	23.52	224.91
GSM1900	1850~1910	GPRS	29.61	913.34	31.19	1315.22
		EGPRS	26.39	435.72	28.30	676.08

WCDMA

FCC Part 22/24/27						
Band	Frequency Range [MHz]	Modulation	Conducted		Radiated	
			Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
Band 5	824~849	Rel. 99	23.75	237.30	21.16	130.62
		HSDPA	22.31	170.13	19.41	87.30
Band 4	1710~1755	Rel. 99	23.06	202.34	23.07	202.77
		HSDPA	21.56	143.17	21.12	129.42
Band 2	1850~1910	Rel. 99	22.82	191.31	22.91	195.43
		HSDPA	21.34	136.14	20.98	125.31

LTE Band 12

FCC Part 27							
Band	Frequency Range [MHz]	BandWidth [MHz]	Modulation	Conducted		Radiated	
				Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
Band 12	699 ~ 716	10	QPSK	23.98	250.06	18.75	74.99
			16QAM	23.28	212.84	17.45	55.59
			64QAM	22.14	163.80		
			256QAM	19.26	84.27		
		5	QPSK	24.14	259.43	18.38	68.87
			16QAM	23.50	223.63	17.54	56.75
			64QAM	22.24	167.47		
			256QAM	19.24	83.96		
		3	QPSK	24.20	263.19	18.31	67.76
			16QAM	23.29	213.08	17.28	53.46
			64QAM	22.40	173.77		
			256QAM	19.43	87.70		
		1.4	QPSK	24.09	256.19	18.20	66.07
			16QAM	23.28	212.71	17.07	50.93
			64QAM	22.22	166.54		
			256QAM	19.11	81.39		

LTE Band 13

FCC Part 27							
Band	Frequency Range [MHz]	BandWidth [MHz]	Modulation	Conducted		Radiated	
				Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
Band 13	777 ~ 787	10	QPSK	23.86	243.14	18.83	76.38
			16QAM	22.99	198.99	17.59	57.41
			64QAM	22.15	164.19		
			256QAM	19.11	81.52		
		5	QPSK	23.93	247.06	18.74	74.82
			16QAM	23.27	212.23	17.92	61.94
			64QAM	22.20	165.82		
			256QAM	19.26	84.40		

LTE Band 25

FCC Part 24							
Band	Frequency Range [MHz]	BandWidth [MHz]	Modulation	Conducted		Radiated	
				Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
Band 25	1850 ~ 1915	20	QPSK	22.85	192.95	24.21	263.63
			16QAM	22.31	170.20	22.88	194.09
			64QAM	21.36	136.77		
			256QAM	18.44	69.82		
		15	QPSK	23.12	205.21	23.92	246.60
			16QAM	22.27	168.49	22.86	193.20
			64QAM	21.37	136.96		
			256QAM	18.26	67.00		
		10	QPSK	23.11	204.44	23.82	240.99
			16QAM	22.15	164.19	22.90	194.98
			64QAM	21.27	134.07		
			256QAM	18.27	67.18		
		5	QPSK	23.09	203.70	23.90	245.47
			16QAM	22.52	178.62	22.85	192.75
			64QAM	21.47	140.13		
			256QAM	18.55	71.67		
		3	QPSK	23.15	206.57	24.16	260.62
			16QAM	22.19	165.67	23.03	200.91
			64QAM	21.31	135.33		
			256QAM	18.25	66.79		
		1.4	QPSK	23.00	199.66	24.18	261.82
			16QAM	22.44	175.38	23.00	199.53
			64QAM	21.33	135.94		
			256QAM	18.23	66.60		

LTE Band 26 (Part 90)

FCC Part 90							
Band	Frequency Range [MHz]	BandWidth [MHz]	Modulation	Conducted		Radiated	
				Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
Band 26	814 ~ 824	15	QPSK	23.86	243.36	17.36	54.45
			16QAM	23.16	207.03	16.42	43.85
			64QAM	22.09	161.82		
			256QAM	19.08	80.84		
		10	QPSK	23.61	229.82	17.00	50.12
			16QAM	23.02	200.51	15.60	36.31
			64QAM	21.80	151.32		
			256QAM	18.67	73.62		
		5	QPSK	23.44	220.55	17.83	60.67
			16QAM	22.87	193.62	17.01	50.23
			64QAM	21.66	146.64		
			256QAM	18.48	70.48		
		3	QPSK	23.50	223.71	18.06	63.97
			16QAM	22.85	192.55	17.03	50.47
			64QAM	21.72	148.49		
			256QAM	18.63	72.93		
		1.4	QPSK	23.34	215.99	16.04	40.18
			16QAM	22.47	176.77	14.79	30.13
			64QAM	21.53	142.33		
			256QAM	18.51	70.92		

LTE Band 26 (Part 22)

FCC Part 22							
Band	Frequency Range [MHz]	BandWidth [MHz]	Modulation	Conducted		Radiated	
				Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
Band 26	824 ~ 849	15	QPSK	24.13	258.89	19.95	98.86
			16QAM	23.45	221.36	18.82	76.21
			64QAM	22.20	166.13		
			256QAM	19.22	83.63		
		10	QPSK	23.98	249.93	20.32	107.65
			16QAM	23.34	215.77	19.92	98.17
			64QAM	21.95	156.75		
			256QAM	19.16	82.35		
		5	QPSK	23.90	245.42	20.61	115.08
			16QAM	23.28	212.91	19.22	83.56
			64QAM	21.97	157.47		
			256QAM	19.07	80.68		
		3	QPSK	23.91	246.16	20.48	111.69
			16QAM	23.40	218.70	19.44	87.90
			64QAM	22.27	168.47		
			256QAM	19.13	81.92		
		1.4	QPSK	23.89	244.86	20.39	109.40
			16QAM	23.37	217.36	19.27	84.53
			64QAM	22.08	161.28		
			256QAM	19.16	82.44		

LTE Band 41 (PC2)

FCC Part 27							
Band	Frequency Range [MHz]	BandWidth [MHz]	Modulation	Conducted		Radiated	
				Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
Band 41	2496 ~ 2690	20	QPSK	24.22	264.24	27.29	535.80
			16QAM	23.49	223.24	26.21	417.83
			64QAM	22.36	172.08		
			256QAM	19.41	87.23		
		15	QPSK	24.21	263.59	26.98	498.88
			16QAM	23.49	223.36	25.43	349.14
			64QAM	22.31	170.25		
			256QAM	19.46	88.29		
		10	QPSK	24.11	257.34	25.55	358.92
			16QAM	23.57	227.30	25.22	332.66
			64QAM	22.31	170.25		
			256QAM	19.19	82.92		
		5	QPSK	24.41	275.80	25.67	368.98
			16QAM	23.50	224.02	27.29	535.80
			64QAM	22.70	186.23		
			256QAM	19.47	88.59		

LTE Band 66

FCC Part 27							
Band	Frequency Range [MHz]	BandWidth [MHz]	Modulation	Conducted		Radiated	
				Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
Band 66	1710 ~ 1780	20	QPSK	23.16	206.98	23.88	244.34
			16QAM	22.50	177.64	22.42	174.58
			64QAM	21.31	135.09		
			256QAM	18.39	68.98		
		15	QPSK	23.39	218.18	24.47	279.90
			16QAM	22.58	181.14	22.67	184.93
			64QAM	21.69	147.54		
			256QAM	18.77	75.30		
		10	QPSK	23.41	219.24	24.58	287.08
			16QAM	22.65	184.28	23.45	221.31
			64QAM	21.50	141.36		
			256QAM	18.79	75.60		
		5	QPSK	23.38	217.95	23.88	244.34
			16QAM	22.61	182.41	22.87	193.64
			64QAM	21.44	139.38		
			256QAM	18.73	74.63		
		3	QPSK	23.50	223.88	23.86	243.22
			16QAM	22.48	177.21	23.16	207.01
			64QAM	21.61	144.72		
			256QAM	18.70	74.17		
		1.4	QPSK	23.37	217.20	23.79	239.33
			16QAM	22.45	175.87	22.62	182.81
			64QAM	21.56	143.11		
			256QAM	18.54	71.37		

LTE Band 2

LTE Band 2(Frequency range: 1850-1910 MHz) is covered by LTE Band 25 (Frequency range: 1850-1915 MHz) due to overlapping frequency range, same maximum tune-up limit and same channel bandwidth.

LTE Band 4

LTE Band 4 (Frequency range: 1710-1755 MHz) is covered by LTE Band 66 (Frequency range: 1710-1780 MHz) due to overlapping frequency range, same maximum tune-up limit and same channel bandwidth.

LTE Band 5

LTE Band 5 (Frequency range: 824-849 MHz) is covered by LTE Band 26 (Frequency range: 814-849 MHz) due to overlapping frequency range, same maximum tune-up limit and same channel bandwidth.

LTE Band 17

LTE Band 17 (Frequency range: 704-716 MHz) is covered by LTE Band 12 (Frequency range: 699-716 MHz) due to overlapping frequency range, same maximum tune-up limit and same channel bandwidth.

LTE Band41(PC3)

LTE Band 41(PC3, Frequency range : 2496-2690 MHz) is covered by LTE Band 41(PC2) (Frequency range: 2496-2690 MHz) due to same frequency range, same channel bandwidth and maximum tune-up limit is higher than LTE Band41(PC3).

NR Band n5

FCC Part 22								
Band	Frequency Range [MHz]	BandWidth [MHz]	Modulation	Mode	Conducted		Radiated	
					Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
n5	824-849	20	DFT-s OFDM	QPSK	24.55	285.10	22.04	159.96
				16QAM	23.50	223.87	21.03	126.77
				64QAM	22.00	158.49		
				256QAM	19.94	98.63		
			CP-OFDM	QPSK	22.97	198.15		
		15	DFT-s OFDM	QPSK	24.58	287.08	21.76	149.97
				16QAM	23.61	229.61	20.54	113.24
				64QAM	22.04	159.96		
				256QAM	20.04	100.93		
			CP-OFDM	QPSK	22.92	195.88		
		10	DFT-s OFDM	QPSK	24.54	284.45	21.93	155.96
				16QAM	23.40	218.78	21.91	155.24
				64QAM	21.89	154.53		
				256QAM	20.04	100.93		
			CP-OFDM	QPSK	22.96	197.70		
		5	DFT-s OFDM	QPSK	24.60	288.40	21.98	157.76
				16QAM	23.55	226.46	21.27	133.97
				64QAM	22.10	162.18		
				256QAM	20.10	102.33		
			CP-OFDM	QPSK	22.98	198.61		

NR Band n66

FCC Part 27								
Band	Frequency Range [MHz]	BandWidth [MHz]	Modulation	Mode	Conducted		Radiated	
					Avg [dBm]	Avg [mW]	Avg [dBm]	Avg [mW]
n66	1710 ~ 1780	20	DFT-s OFDM	QPSK	23.69	233.88	20.53	112.98
				16QAM	22.49	177.42	20.08	101.86
				64QAM	20.95	124.45		
				256QAM	18.99	79.25		
			CP-OFDM	QPSK	21.85	153.11		
		15	DFT-s OFDM	QPSK	23.77	238.23	20.48	111.69
				16QAM	22.75	188.36	19.80	95.50
				64QAM	21.25	133.35		
				256QAM	19.23	83.75		
			CP-OFDM	QPSK	22.21	166.34		
		10	DFT-s OFDM	QPSK	24.07	255.27	20.53	112.98
				16QAM	22.66	184.50	19.81	95.72
				64QAM	21.20	131.83		
				256QAM	19.23	83.75		
			CP-OFDM	QPSK	22.05	160.32		
		5	DFT-s OFDM	QPSK	23.38	217.77	20.35	108.39
				16QAM	22.43	174.98	19.82	95.94
				64QAM	20.79	119.95		
				256QAM	18.92	77.98		
			CP-OFDM	QPSK	21.72	148.59		

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a internal antenna for the [List the bands supported] with a maximum peak gain as follow:

Frequency (MHz)	Peak Gain (dBi)
GSM 1900 / WCDMA Band 2/ LTE Band 2 / LTE Band 25 1850 ~ 1915 MHz	-1.05
LTE Band 4 / LTE Band 66 / NR Band n66 1710 ~ 1780 MHz	-0.56
GSM 850 / WCDMA Band 5 / LTE Band 5 / LTE Band 26 / NR Band n5 814 ~ 849 MHz	-4.25
LTE Band 12 / LTE Band 17 699 ~ 716 MHz	-7.10
LTE Band 13 777 ~ 787 MHz	-6.64
LTE Band 41 2496 ~ 2690 MHz	-1.53

5.4. WORST-CASE ORIENTATION

Following modes should be considered as worst-case scenario for all other measurements.

- GSM GPRS/EGPRS
- UMTS REL 99/HSDPA

For all LTE/5G NR Bands, the worst-case scenario for all measurements is based on the average conducted output power measurement investigation results. Output power measurements were measured on QPSK, 16QAM, 64QAM and 256QAM modulations. It was found that QPSK and 16QAM results were worst case. All testing was performed using QPSK and 16QAM modulations to represent the worst case. However, the out of band emissions and spurious radiation were only performed on bandwidth and RB offset(with RB size 1) with the highest conducted power in QPSK.

Highest power setting for each bands				
LTE Band	Frequency (MHz)	Bandwidth (MHz)	RB size	RB offset
12	700.5	3	1	14
	707.5		1	0
	714.5		1	14
13	779.5	5	1	0
	782.0		1	0
	784.5		1	24
25	1851.5	3	1	14
	1882.5		1	0
	1913.5		1	0
26 (Part 90)	821.5	15	1	0
26 (Part 22)	831.5	15	1	0
	841.5		1	0
41 (PC2)	2506.0	20	1	49
	2593.0		1	49
	2680.0		1	49
66	1711.5	3	1	0
	1745.0		1	14
	1778.5		1	0
NR Band	Frequency (MHz)	Bandwidth (MHz)	RB size	RB offset
5	826.5	5	1	1
	836.5		1	1
	846.5		1	1
66	1715.0	10	1	26
	1745.0		1	26
	1775.0		1	26

The fundamental and radiated spurious emission were investigated in three orthogonal orientations X, Y and Z, it was determined that below orientation was worst-case orientation for each band.

Band	ERP/EIRP			RSE		
	X	Y	Z	X	Y	Z
GSM850	-	-	O	-	-	O
GSM1900	O	-	-	-	-	O
WCDMA B5	-	-	O	-	-	O
WCDMA B4	O	-	-	O	-	-
WCDMA B2	O	-	-	O	-	-
LTE B12	-	-	O	-	-	O
LTE B13	-	-	O	-	-	O
LTE B25	O	-	-	O	-	-
LTE B26	-	-	O	-	-	O
LTE B41	O	-	-	-	O	-
LTE B66	-	O	-	-	O	-
NR Band n5	-	-	O	-	-	O
NR Band n66	-	O	-	-	O	-

Note : For ERP/EIRP testing, the EUT didn't attached with travel adapter. But radiated spurious testing, the EUT attached with travel adapter for the worst case condition. The EUT is continuously communicated with the call box during the tests.

5.5. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Charger	SAMSUNG	EP-TA800	R37KAT21494SE3	N/A
Data Cable	SAMSUNG	EP-DA705BBE	N/A	N/A

I/O CABLE

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	DC Power	1	C Type	Shielded	1.0m	N/A

TEST SETUP

The EUT is continuously communicated with the call box during the tests.

The diagram illustrates a typical setup for measuring conducted emissions from an EUT. The EUT is connected to a Combiner, which splits the signal to both the Communication Test Set and the Spectrum Analyzer. The Communication Test Set (Rohde & Schwarz FSW 5007) is used for frequency domain measurements, while the Spectrum Analyzer (FLSA) is used for time domain measurements.

```
graph LR; EUT[EUT] --- Combiner[Combiner]; Combiner --- CTS[Communication Test Set]; Combiner --- SA[Spectrum Analyzer];
```

The diagram illustrates the experimental setup for measuring the radiation pattern of a horn antenna. The setup includes the following components and connections:

- Communication Test Set:** A blue and white device with a screen and various controls. It is connected to an **AC Main** and an **Adapter**.
- Adapter:** A small black box connected to the Communication Test Set and the **EUT**.
- EUT (Equipment Under Test):** A small black box connected to the Adapter and the horn antenna.
- Horn Antenna:** A red and white horn-shaped antenna connected to the EUT.
- Receiver:** A blue and white device connected to the Communication Test Set and the horn antenna.

The diagram shows the signal path and the antenna's radiation pattern, which is represented by a series of red lines emanating from the horn antenna.

6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List				
Description	Manufacturer	Model	S/N	Cal Due
Antenna, Tuned Dipole 400~1000 MHz	ETS	3121D DB4	00164753	01-31-21
Directional Antenna	Cobham	FPA3-0.8-6.0R/1329	110367-0003	N/A
Directional Antenna	Cobham	FPA3-0.8-6.0R/1329	80108-0004	N/A
Antenna, Horn, 40 GHz	ETS	3116C	00166155	08-04-22
Preamplifier	ETS	3116C-PA	00168841	08-06-21
Antenna, Horn, 40 GHz	ETS	3116C	00168645	10-02-21
Antenna, Bilog, 30MHz-1GHz	SCHWARZBECK	VULB9163	750	08-19-22
Antenna, Bilog, 30MHz-1GHz	SCHWARZBECK	VULB9163	845	08-13-22
Antenna, Bilog, 30MHz-1GHz	SCHWARZBECK	VULB9163	749	08-13-22
Antenna, Horn, 18 GHz	ETS	3115	00167211	07-27-22
Antenna, Horn, 18 GHz	ETS	3115	00161451	08-15-22
Antenna, Horn, 18 GHz	ETS	3117	00168724	07-27-22
Antenna, Horn, 18 GHz	ETS	3117	00168717	08-15-22
Communications Test Set	R&S	CMW500	115331	08-03-21
DC Power Supply	Agilent / HP	E3640A	MY54226395	08-05-21
Preamplifier, 1000 MHz	Sonoma	310N	341282	08-03-21
Preamplifier, 1000 MHz	Sonoma	310N	370599	08-06-21
Preamplifier, 1000 MHz	Sonoma	310N	351741	08-03-21
Preamplifier, 18 GHz	Miteq	AFS42-00101800-25-S-42	1876511	08-03-21
Preamplifier, 18 GHz	Miteq	AFS42-00101800-25-S-42	2029169	08-04-21
Preamplifier, 18 GHz	Miteq	AFS42-00101800-25-S-42	1896138	08-03-21
Spectrum Analyzer	Keysight	N3090B	MY57143717	08-05-21
EMI Test Receive, 40 GHz	R&S	ESU40	100439	08-03-21
EMI Test Receive, 40 GHz	R&S	ESU40	100457	08-03-21
Directional Antenna	Cobham	FPA3-0.8-6.0R/1329	80108-0004	N/A
High Pass Filter 1.2GHz	Micro-Tronics	HPM50108-02	G005	08-05-21
High Pass Filter 1.2GHz	Micro-Tronics	HPM50108-02	G006	08-05-21
High Pass Filter 2.8GHz	Micro-Tronics	HPM50111-02	010	08-05-21
High Pass Filter 2.8GHz	Micro-Tronics	HPM50111-02	011	08-05-21
High Pass Filter 4GHz	Micro-Tronics	HPM50118-02	G001	08-05-21
High Pass Filter 4GHz	Micro-Tronics	HPM50118-02	G002	08-05-21
Attenuator	PASTERNAK	PE7087-10	A009	08-05-21
Attenuator	PASTERNAK	PE7087-10	A001	08-03-21
Attenuator	PASTERNAK	PE7087-10	A008	08-03-21
Attenuator	PASTERNAK	PE7004-10	2	08-04-21
Attenuator	PASTERNAK	PE7395-10	A011	08-05-21
Antenna, Loop, 9kHz-30MHz	R&S	HFH2-Z2	100418	10-02-21
Temperature Chamber	ESPEC	SH-642	93001109	08-04-21
Power Splitter	MINI-CIRCUITS	WA1534	UL001	02-05-21
Power Splitter	MINI-CIRCUITS	WA1534	UL002	02-05-21
UL Software				
Description	Manufacturer	Model	Version	
Antenna port test software	UL	CLT	Ver 2.5	

7. SUMMARY TABLE

FCC Part Section	Test Description	Test Limit	Test Condition	Test Result
2.1049	Occupied Band width (99%)	N/A	Conducted	Pass
22.917(a) 24.238(a) 27.53(c),(g),(h) 90.691	Band Edge / Conducted Spurious Emission	-13dBm		Pass
27.53(m)	Conducted Spurious Emission	-25 dBm		Pass
27.53(m) 90.691	Emission mask	Section 9.2.2		Pass
2.1046	Conducted output power	N/A		Pass
22.355 24.235 27.54 90.213	Frequency Stability	2.5PPM		Pass
22.913(a)(5)	Effective Radiated Power	38.5 dBm	Radiated	Pass
90.635(b)		50 dBm		Pass
27.50(c)(10) 27.50(b)(10)		34.77 dBm		Pass
24.232(c) 27.50(h)(2)	Equivalent Isotropic Radiated Power	33dBm		Pass
27.50(d)(4)		30dBm		Pass
22.917(a) 24.238(a) 27.53 (c),(g),(h) 90.691	Radiated Spurious Emission	-13dBm		Pass
27.53 (m)		-25dBm		Pass

8. PEAK TO AVERAGE RATIO

Test Procedure

Per KDB 971168 D01 Power Meas License Digital Systems v03r01;

The transmitter output was connected to a CMW500 Test Set and configured to operate at maximum power. The PAR were measured on the Spectrum Analyzer.

Test Spec

In addition, when the transmitter power is measured in terms of average value, the peak-to-average ratio of the power shall not exceed 13 dB.

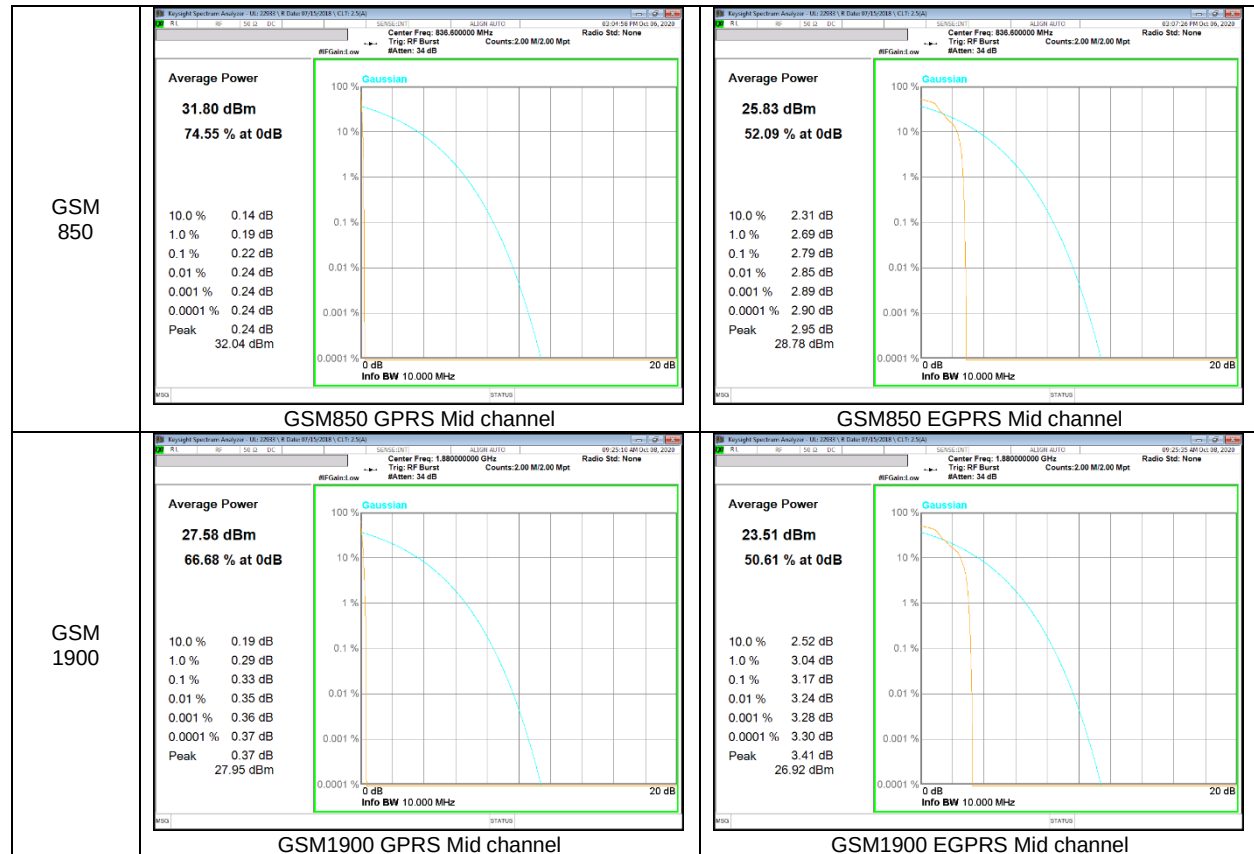
Note

5G NR: All Waveforms (CP-OFDM vs DFT-s OFDM) and modulations (QPSK, 16QAM, 64QAM, 256QAM) 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.

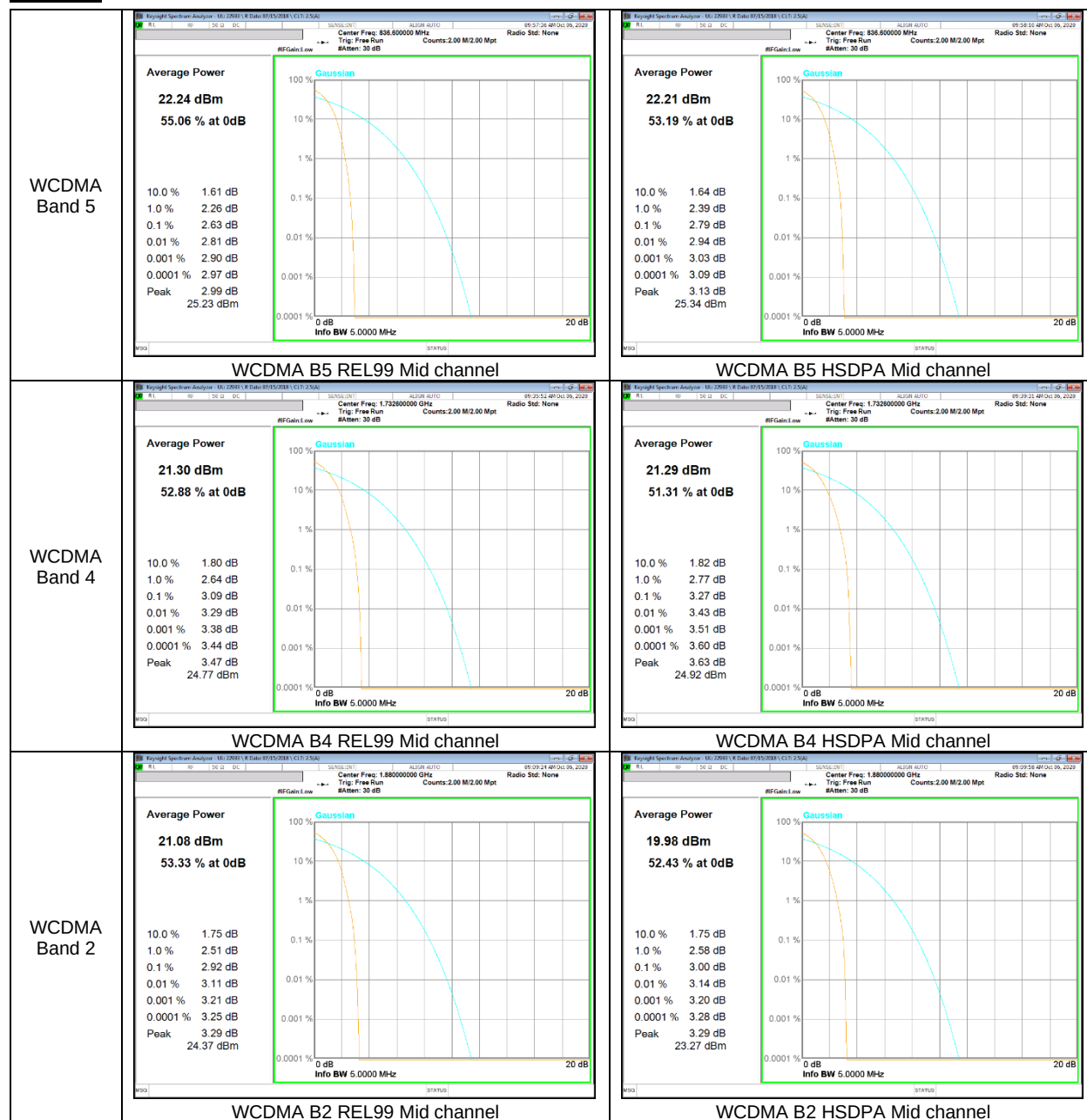
RESULTS

8.1. CONDUCTED PEAK TO AVERAGE RESULT

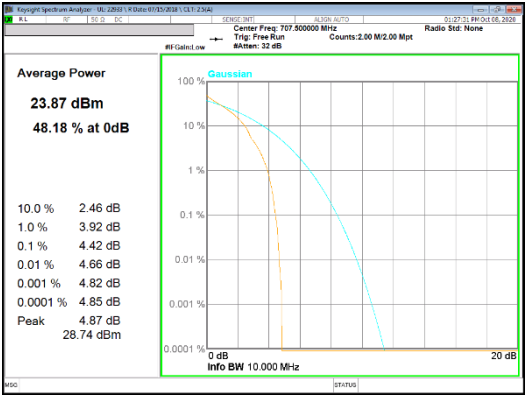
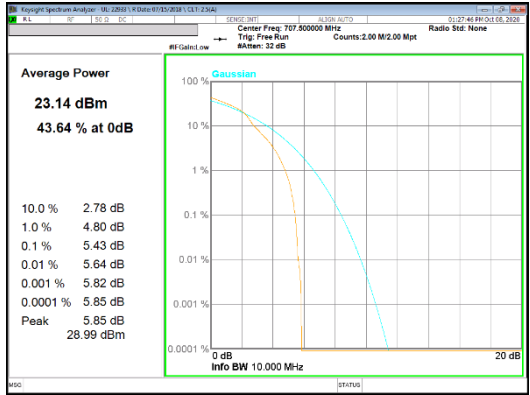
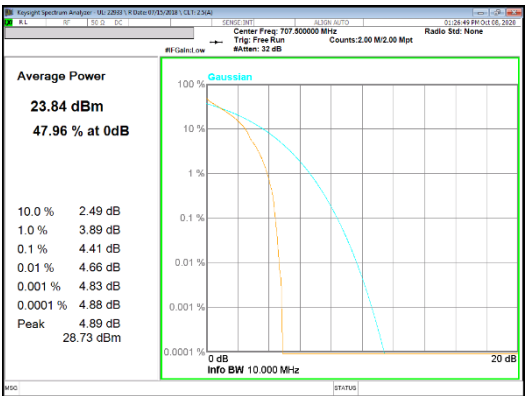
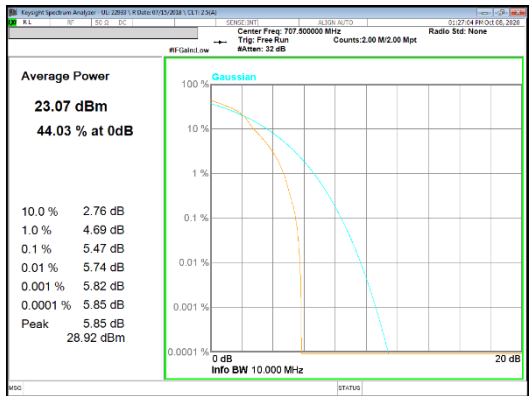
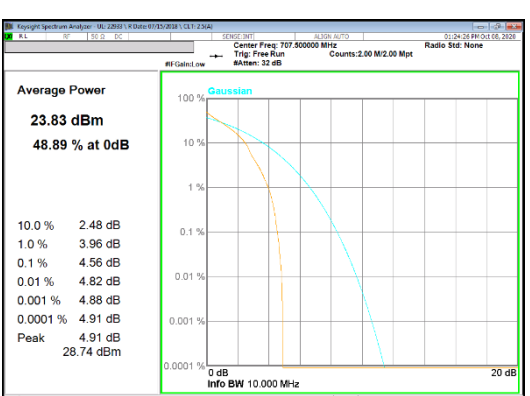
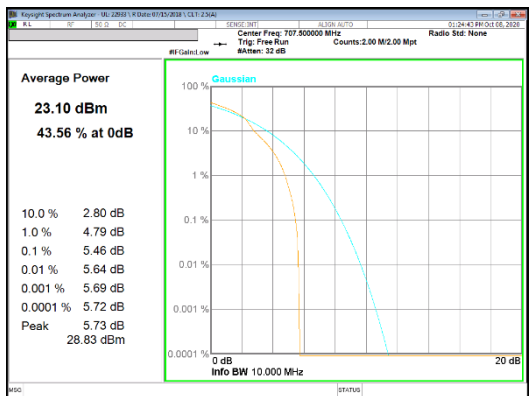
GSM

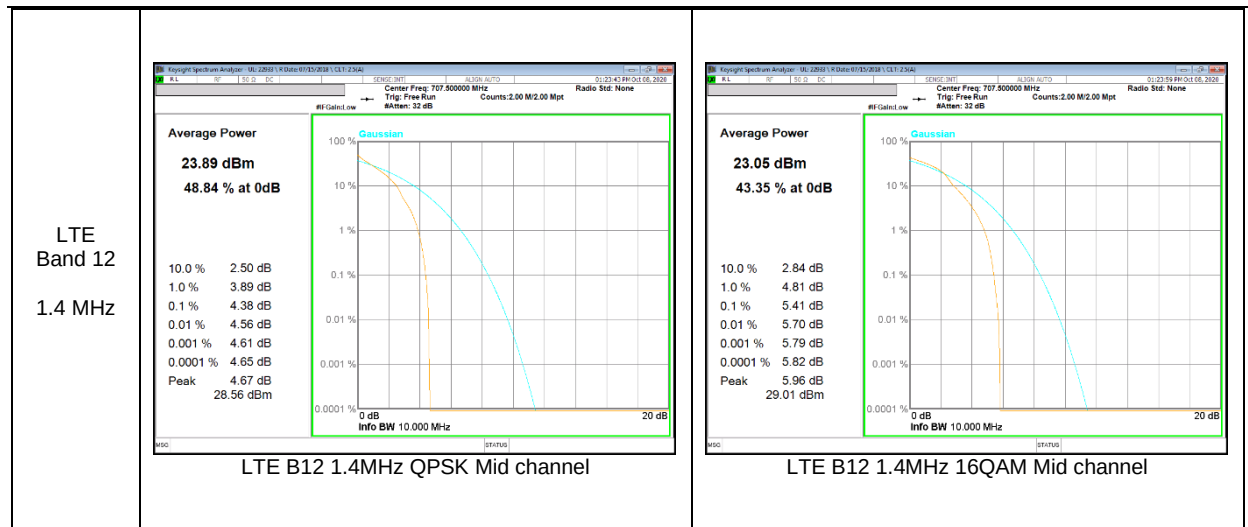


WCDMA

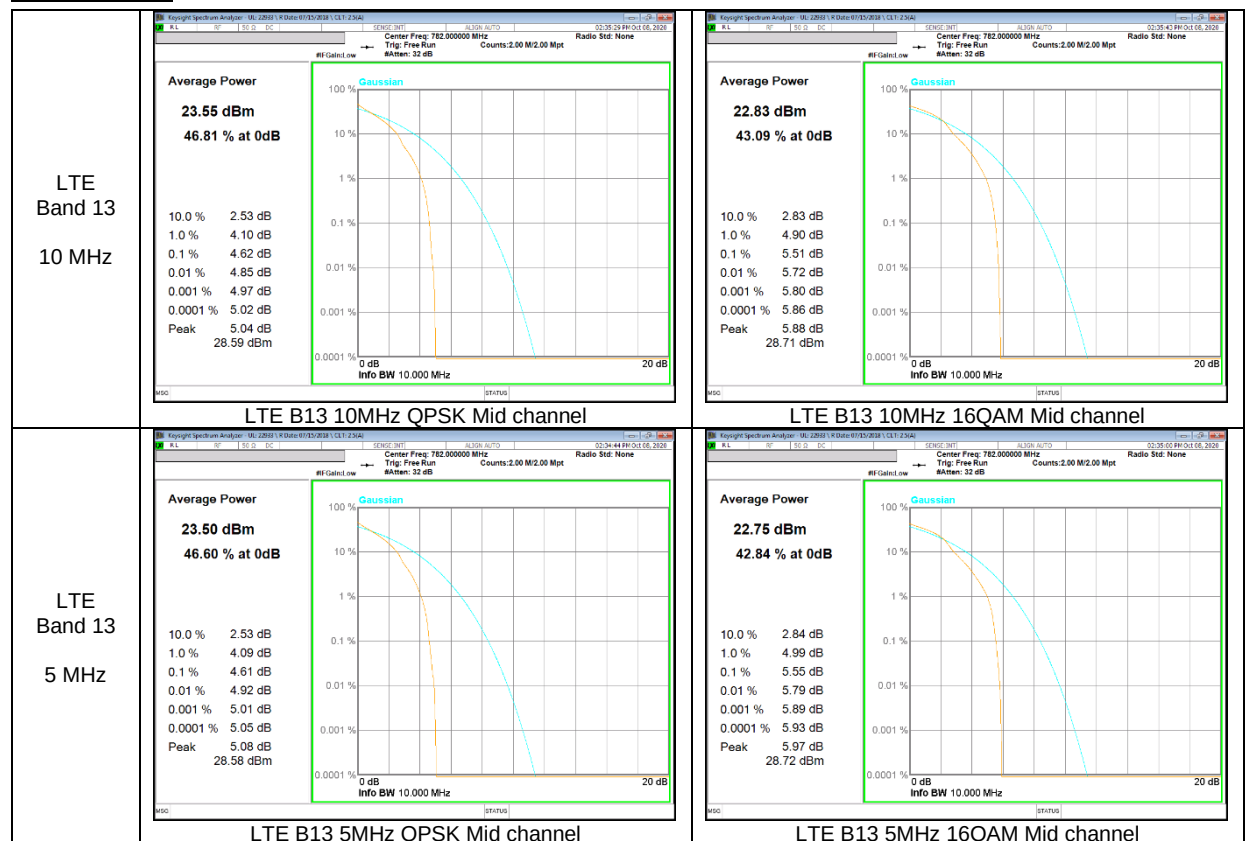


LTE Band 12

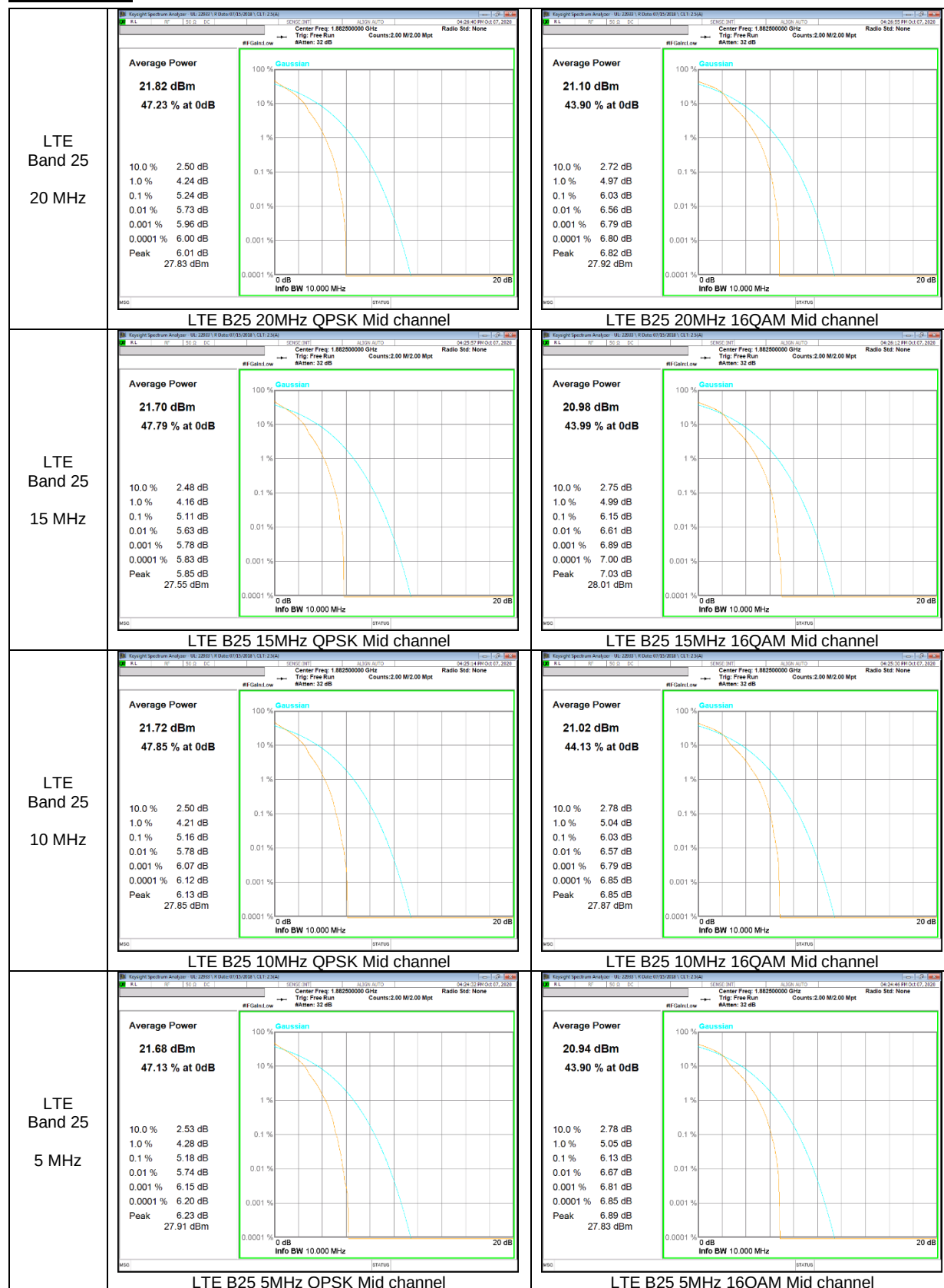
LTE Band 12 10 MHz	 LTE B12 10MHz QPSK Mid channel	 LTE B12 10MHz 16QAM Mid channel
LTE Band 12 5 MHz	 LTE B12 5MHz QPSK Mid channel	 LTE B12 5MHz 16QAM Mid channel
LTE Band 12 3 MHz	 LTE B12 3MHz QPSK Mid channel	 LTE B12 3MHz 16QAM Mid channel

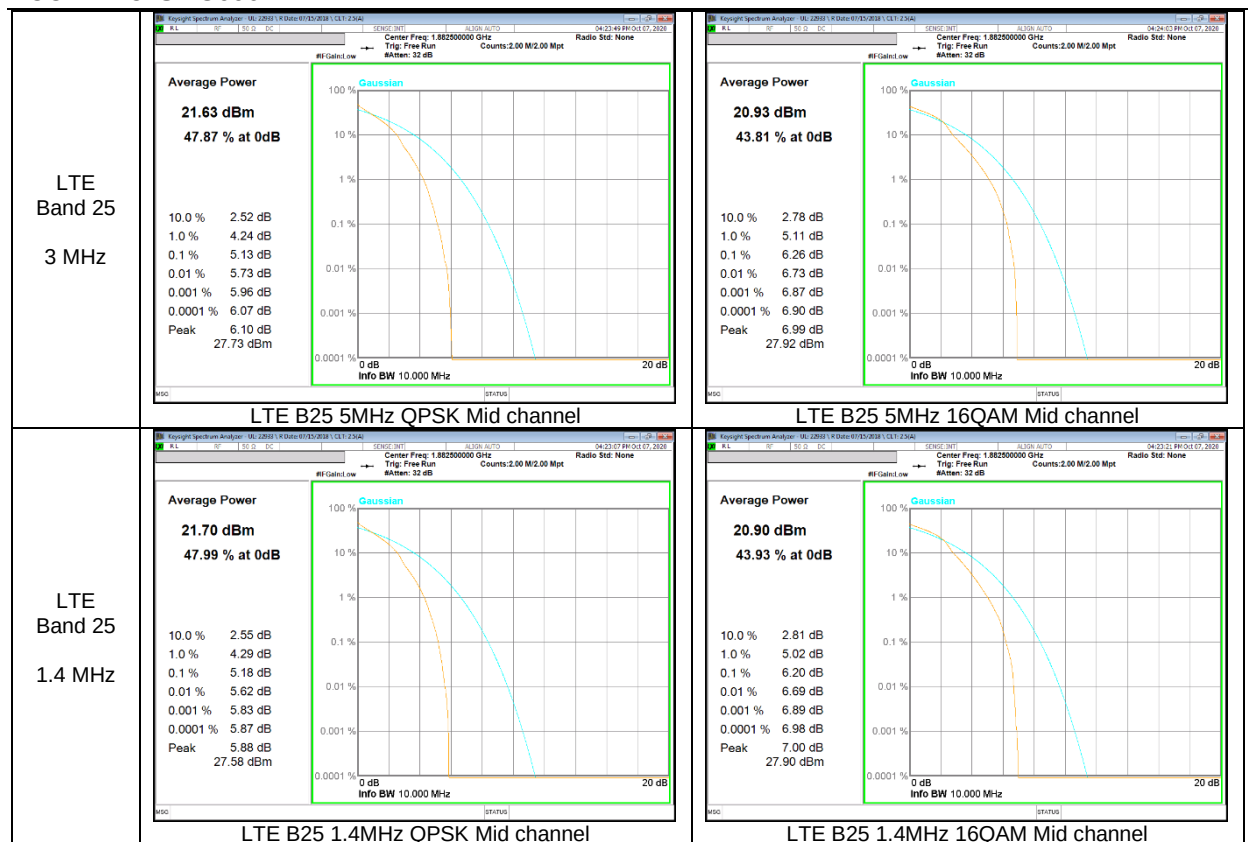


LTE Band 13

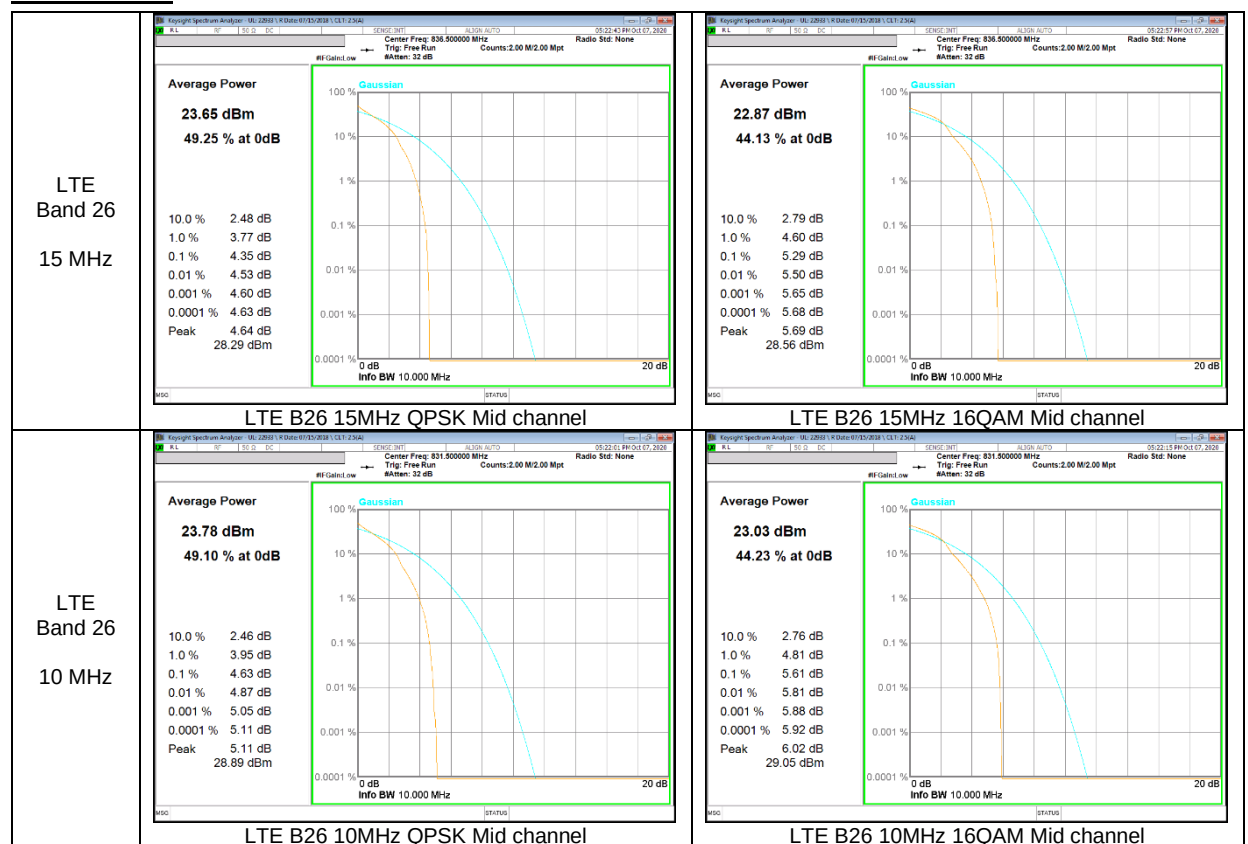


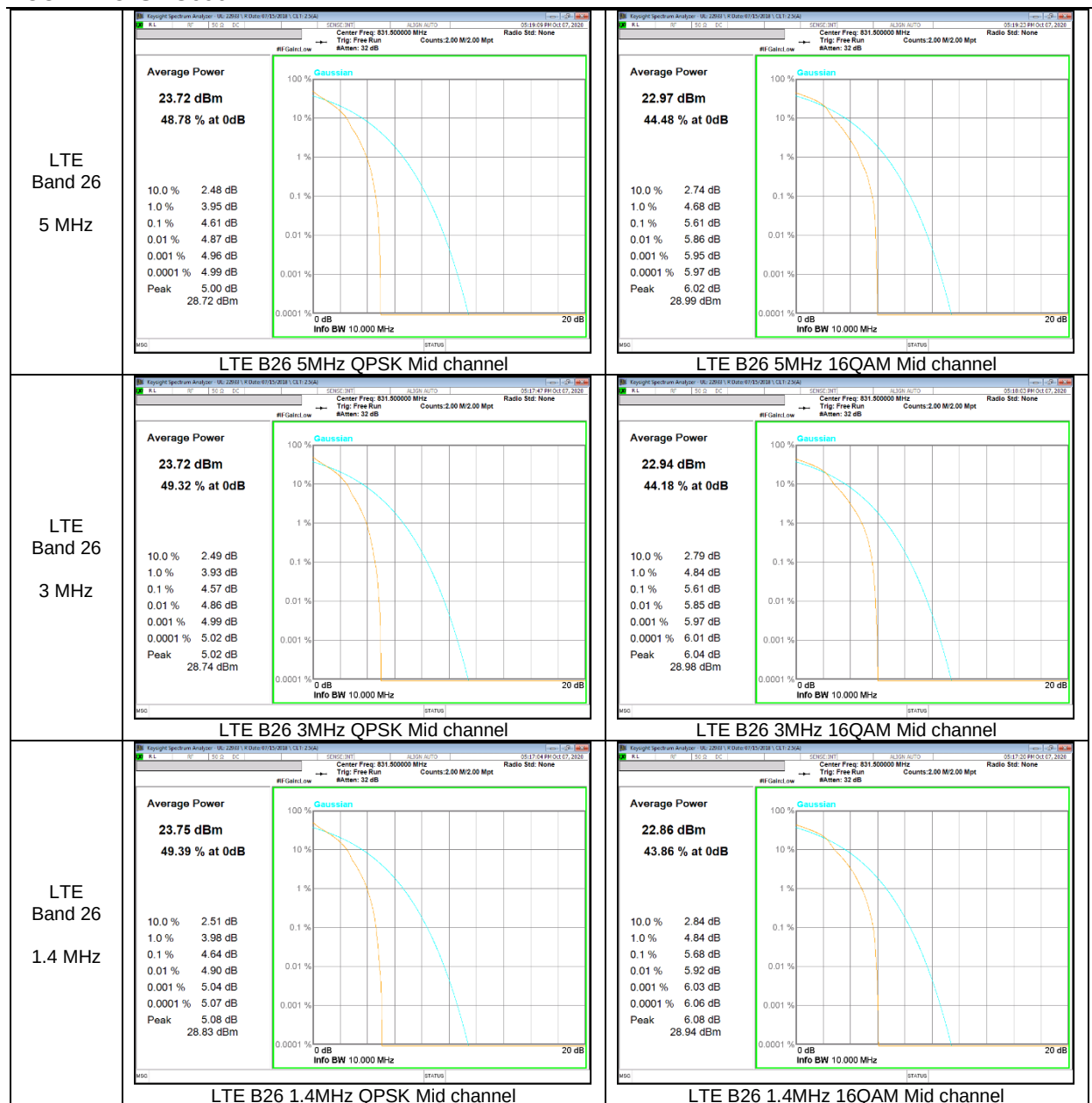
LTE Band 25



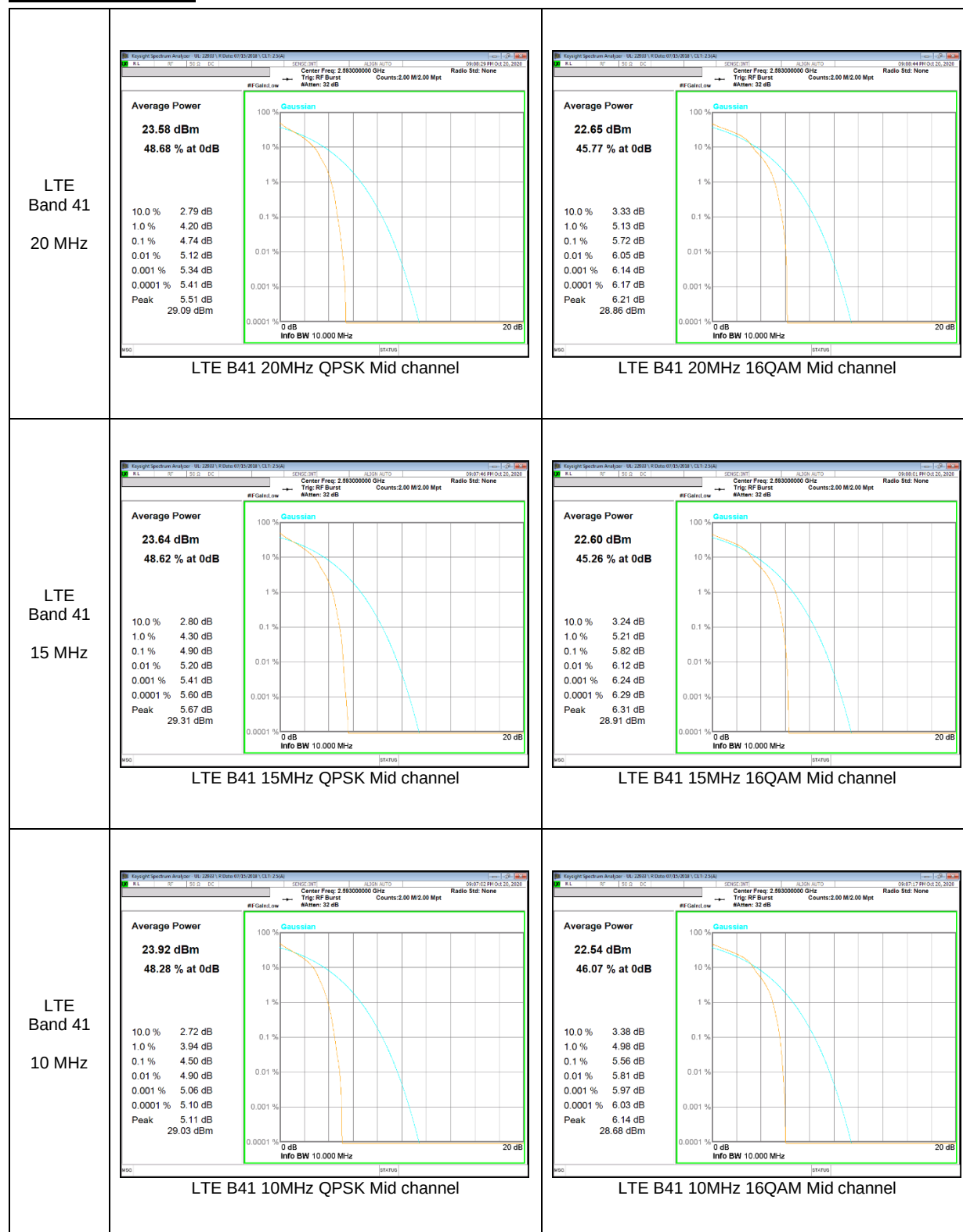


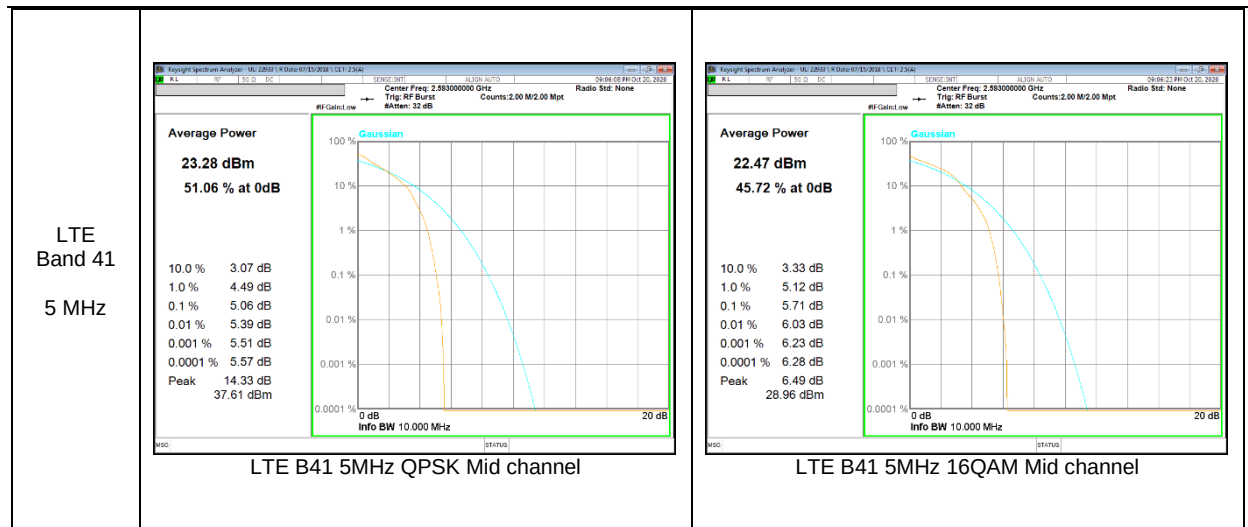
LTE Band 26



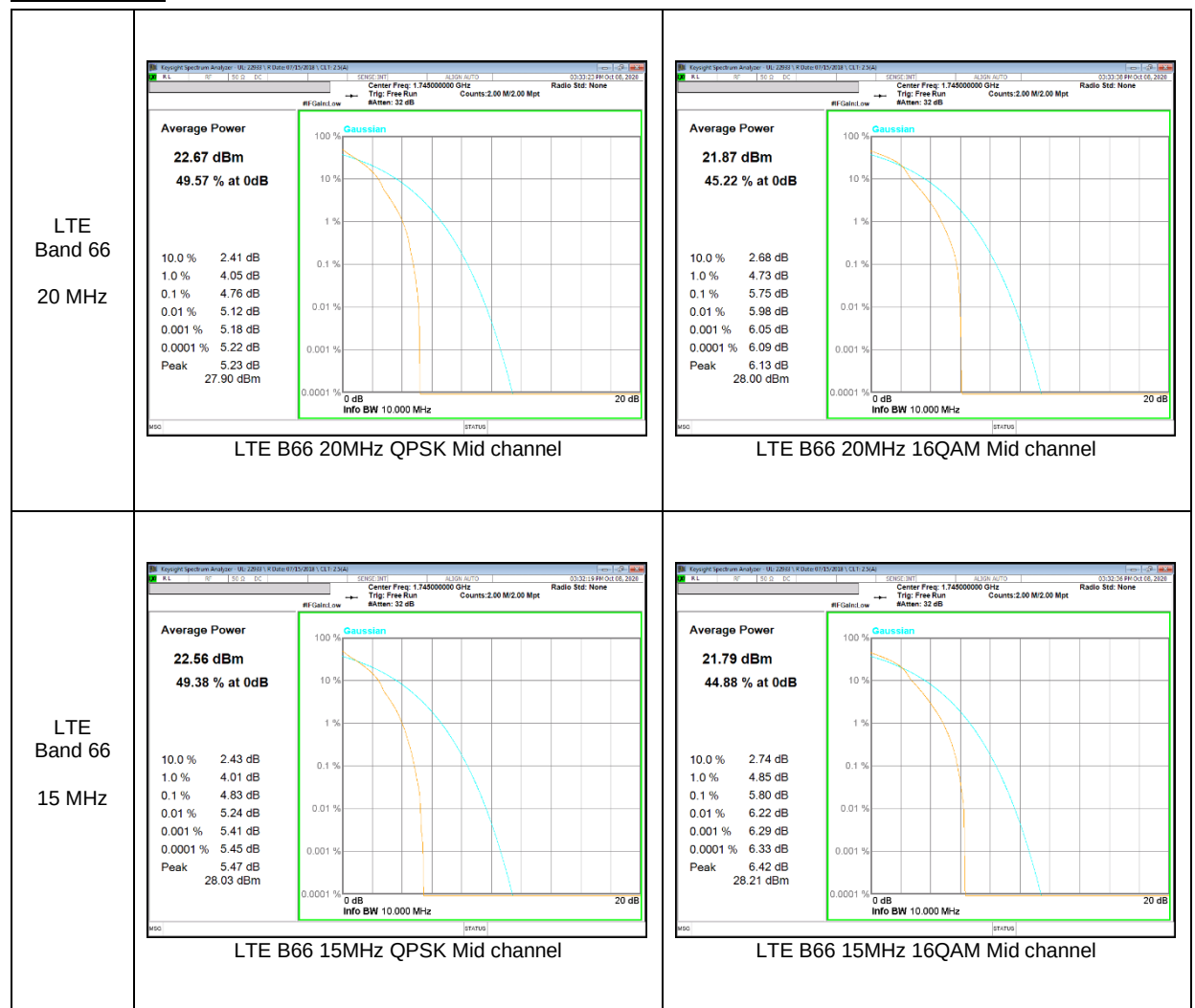


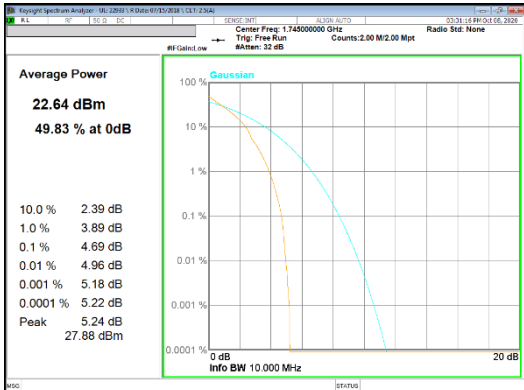
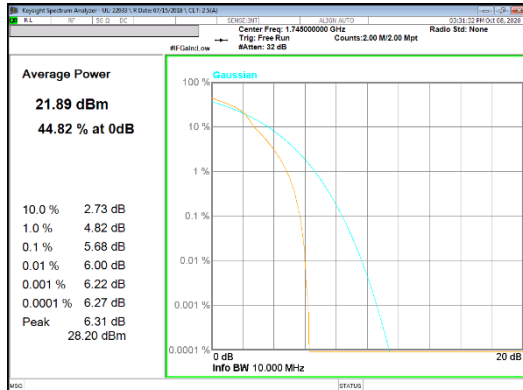
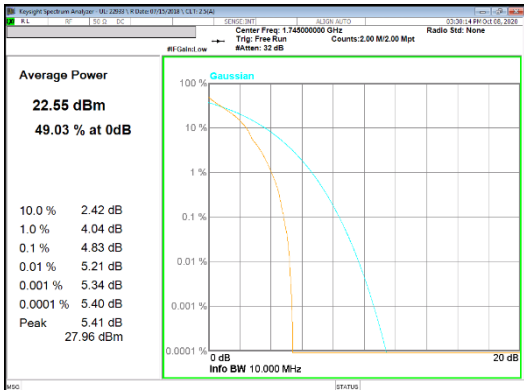
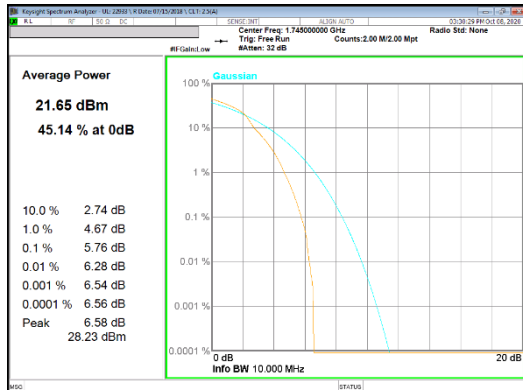
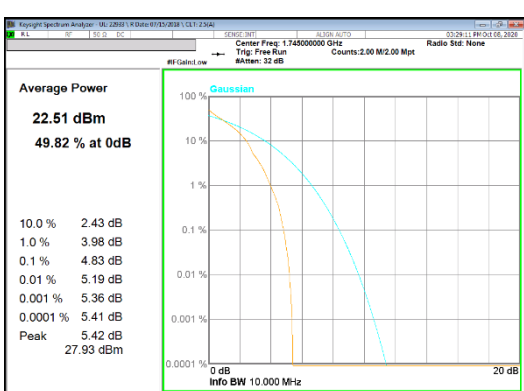
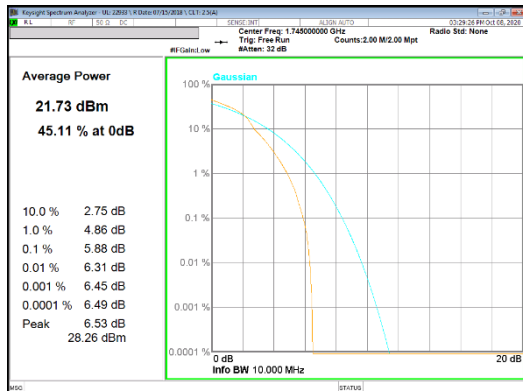
LTE Band 41 (PC2)

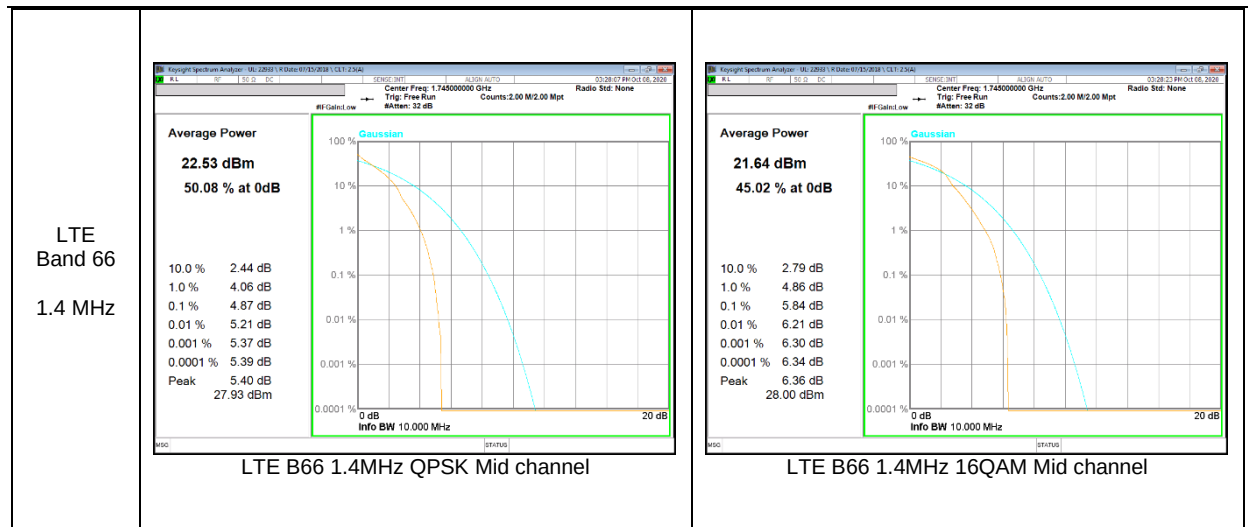




LTE Band 66



LTE Band 66 10 MHz	 Average Power 22.64 dBm 49.83 % at 0dB <table><tr><td>10.0 %</td><td>2.39 dB</td></tr><tr><td>1.0 %</td><td>3.89 dB</td></tr><tr><td>0.1 %</td><td>4.69 dB</td></tr><tr><td>0.01 %</td><td>4.96 dB</td></tr><tr><td>0.001 %</td><td>5.18 dB</td></tr><tr><td>0.0001 %</td><td>5.22 dB</td></tr><tr><td>Peak</td><td>5.24 dB</td></tr><tr><td></td><td>27.88 dBm</td></tr></table> LTE B66 10MHz QPSK Mid channel	10.0 %	2.39 dB	1.0 %	3.89 dB	0.1 %	4.69 dB	0.01 %	4.96 dB	0.001 %	5.18 dB	0.0001 %	5.22 dB	Peak	5.24 dB		27.88 dBm	 Average Power 21.89 dBm 44.82 % at 0dB <table><tr><td>10.0 %</td><td>2.73 dB</td></tr><tr><td>1.0 %</td><td>4.82 dB</td></tr><tr><td>0.1 %</td><td>5.68 dB</td></tr><tr><td>0.01 %</td><td>6.00 dB</td></tr><tr><td>0.001 %</td><td>6.22 dB</td></tr><tr><td>0.0001 %</td><td>6.27 dB</td></tr><tr><td>Peak</td><td>6.31 dB</td></tr><tr><td></td><td>28.20 dBm</td></tr></table> LTE B66 10MHz 16QAM Mid channel	10.0 %	2.73 dB	1.0 %	4.82 dB	0.1 %	5.68 dB	0.01 %	6.00 dB	0.001 %	6.22 dB	0.0001 %	6.27 dB	Peak	6.31 dB		28.20 dBm
10.0 %	2.39 dB																																	
1.0 %	3.89 dB																																	
0.1 %	4.69 dB																																	
0.01 %	4.96 dB																																	
0.001 %	5.18 dB																																	
0.0001 %	5.22 dB																																	
Peak	5.24 dB																																	
	27.88 dBm																																	
10.0 %	2.73 dB																																	
1.0 %	4.82 dB																																	
0.1 %	5.68 dB																																	
0.01 %	6.00 dB																																	
0.001 %	6.22 dB																																	
0.0001 %	6.27 dB																																	
Peak	6.31 dB																																	
	28.20 dBm																																	
LTE Band 66 5 MHz	 Average Power 22.55 dBm 49.03 % at 0dB <table><tr><td>10.0 %</td><td>2.42 dB</td></tr><tr><td>1.0 %</td><td>4.04 dB</td></tr><tr><td>0.1 %</td><td>4.83 dB</td></tr><tr><td>0.01 %</td><td>5.21 dB</td></tr><tr><td>0.001 %</td><td>5.34 dB</td></tr><tr><td>0.0001 %</td><td>5.40 dB</td></tr><tr><td>Peak</td><td>5.41 dB</td></tr><tr><td></td><td>27.96 dBm</td></tr></table> LTE B66 5MHz QPSK Mid channel	10.0 %	2.42 dB	1.0 %	4.04 dB	0.1 %	4.83 dB	0.01 %	5.21 dB	0.001 %	5.34 dB	0.0001 %	5.40 dB	Peak	5.41 dB		27.96 dBm	 Average Power 21.65 dBm 45.14 % at 0dB <table><tr><td>10.0 %</td><td>2.74 dB</td></tr><tr><td>1.0 %</td><td>4.67 dB</td></tr><tr><td>0.1 %</td><td>5.76 dB</td></tr><tr><td>0.01 %</td><td>6.28 dB</td></tr><tr><td>0.001 %</td><td>6.54 dB</td></tr><tr><td>0.0001 %</td><td>6.56 dB</td></tr><tr><td>Peak</td><td>6.58 dB</td></tr><tr><td></td><td>28.23 dBm</td></tr></table> LTE B66 5MHz 16QAM Mid channel	10.0 %	2.74 dB	1.0 %	4.67 dB	0.1 %	5.76 dB	0.01 %	6.28 dB	0.001 %	6.54 dB	0.0001 %	6.56 dB	Peak	6.58 dB		28.23 dBm
10.0 %	2.42 dB																																	
1.0 %	4.04 dB																																	
0.1 %	4.83 dB																																	
0.01 %	5.21 dB																																	
0.001 %	5.34 dB																																	
0.0001 %	5.40 dB																																	
Peak	5.41 dB																																	
	27.96 dBm																																	
10.0 %	2.74 dB																																	
1.0 %	4.67 dB																																	
0.1 %	5.76 dB																																	
0.01 %	6.28 dB																																	
0.001 %	6.54 dB																																	
0.0001 %	6.56 dB																																	
Peak	6.58 dB																																	
	28.23 dBm																																	
LTE Band 66 3 MHz	 Average Power 22.51 dBm 49.82 % at 0dB <table><tr><td>10.0 %</td><td>2.43 dB</td></tr><tr><td>1.0 %</td><td>3.98 dB</td></tr><tr><td>0.1 %</td><td>4.83 dB</td></tr><tr><td>0.01 %</td><td>5.19 dB</td></tr><tr><td>0.001 %</td><td>5.36 dB</td></tr><tr><td>0.0001 %</td><td>5.41 dB</td></tr><tr><td>Peak</td><td>5.42 dB</td></tr><tr><td></td><td>27.93 dBm</td></tr></table> LTE B66 3MHz QPSK Mid channel	10.0 %	2.43 dB	1.0 %	3.98 dB	0.1 %	4.83 dB	0.01 %	5.19 dB	0.001 %	5.36 dB	0.0001 %	5.41 dB	Peak	5.42 dB		27.93 dBm	 Average Power 21.73 dBm 45.11 % at 0dB <table><tr><td>10.0 %</td><td>2.75 dB</td></tr><tr><td>1.0 %</td><td>4.86 dB</td></tr><tr><td>0.1 %</td><td>5.88 dB</td></tr><tr><td>0.01 %</td><td>6.31 dB</td></tr><tr><td>0.001 %</td><td>6.45 dB</td></tr><tr><td>0.0001 %</td><td>6.49 dB</td></tr><tr><td>Peak</td><td>6.53 dB</td></tr><tr><td></td><td>28.26 dBm</td></tr></table> LTE B66 3MHz 16QAM Mid channel	10.0 %	2.75 dB	1.0 %	4.86 dB	0.1 %	5.88 dB	0.01 %	6.31 dB	0.001 %	6.45 dB	0.0001 %	6.49 dB	Peak	6.53 dB		28.26 dBm
10.0 %	2.43 dB																																	
1.0 %	3.98 dB																																	
0.1 %	4.83 dB																																	
0.01 %	5.19 dB																																	
0.001 %	5.36 dB																																	
0.0001 %	5.41 dB																																	
Peak	5.42 dB																																	
	27.93 dBm																																	
10.0 %	2.75 dB																																	
1.0 %	4.86 dB																																	
0.1 %	5.88 dB																																	
0.01 %	6.31 dB																																	
0.001 %	6.45 dB																																	
0.0001 %	6.49 dB																																	
Peak	6.53 dB																																	
	28.26 dBm																																	



LTE Band 2

LTE Band 2(Frequency range: 1850-1910 MHz) is covered by LTE Band 25 (Frequency range: 1850-1915 MHz) due to overlapping frequency range, same maximum tune-up limit and same channel bandwidth.

LTE Band 4

LTE Band 4 (Frequency range: 1710-1755 MHz) is covered by LTE Band 66 (Frequency range: 1710-1780 MHz) due to overlapping frequency range, same maximum tune-up limit and same channel bandwidth.

LTE Band 5

LTE Band 5 (Frequency range: 824-849 MHz) is covered by LTE Band 26 (Frequency range: 814-849 MHz) due to overlapping frequency range, same maximum tune-up limit and same channel bandwidth.

LTE Band 17

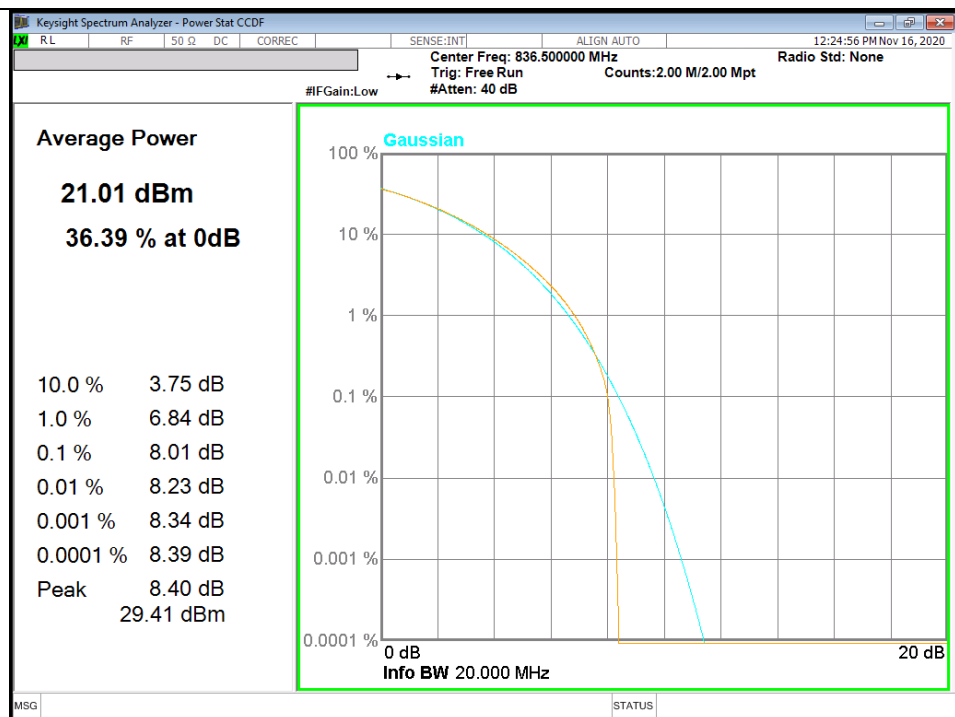
LTE Band 17 (Frequency range: 704-716 MHz) is covered by LTE Band 12 (Frequency range: 699-716 MHz) due to overlapping frequency range, same maximum tune-up limit and same channel bandwidth.

LTE Band41(PC3)

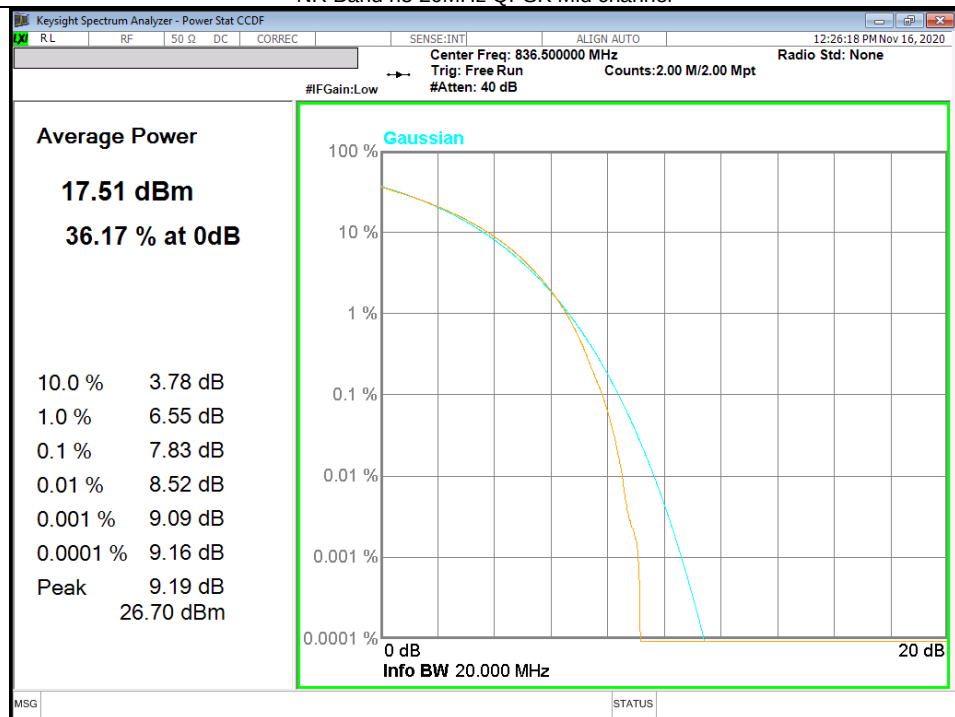
LTE Band 41(PC3, Frequency range : 2496-2690 MHz) is covered by LTE Band 41(PC2) (Frequency range: 2496-2690 MHz) due to same frequency range, same channel bandwidth and maximum tune-up limit is higher than LTE Band41(PC3).

NR Band n5

NR Band n5
20 MHz
CP-OFDM

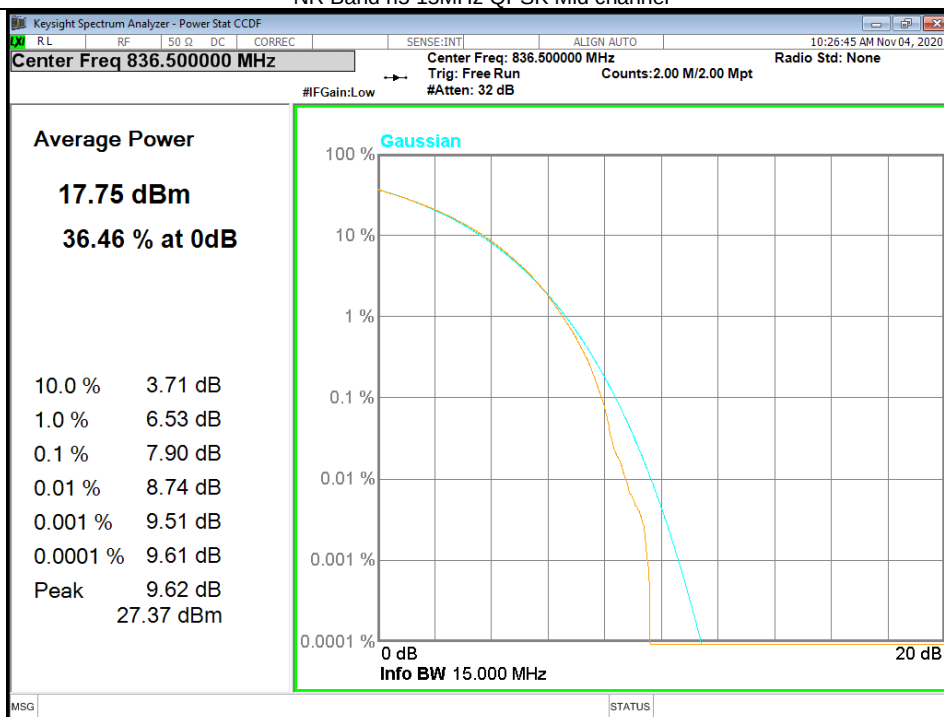
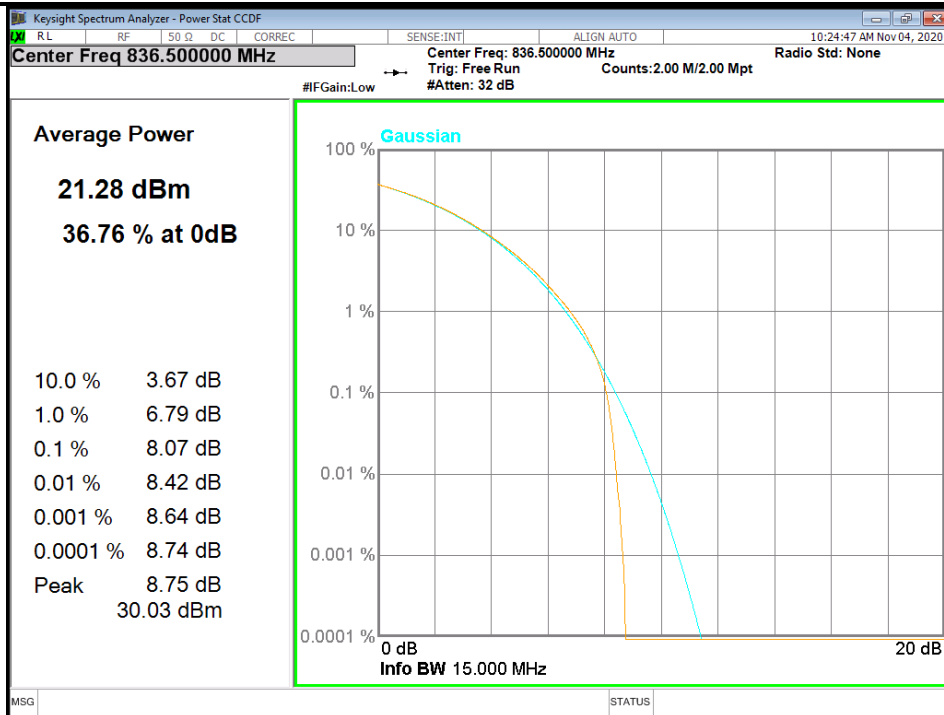


NR Band n5 20MHz QPSK Mid channel

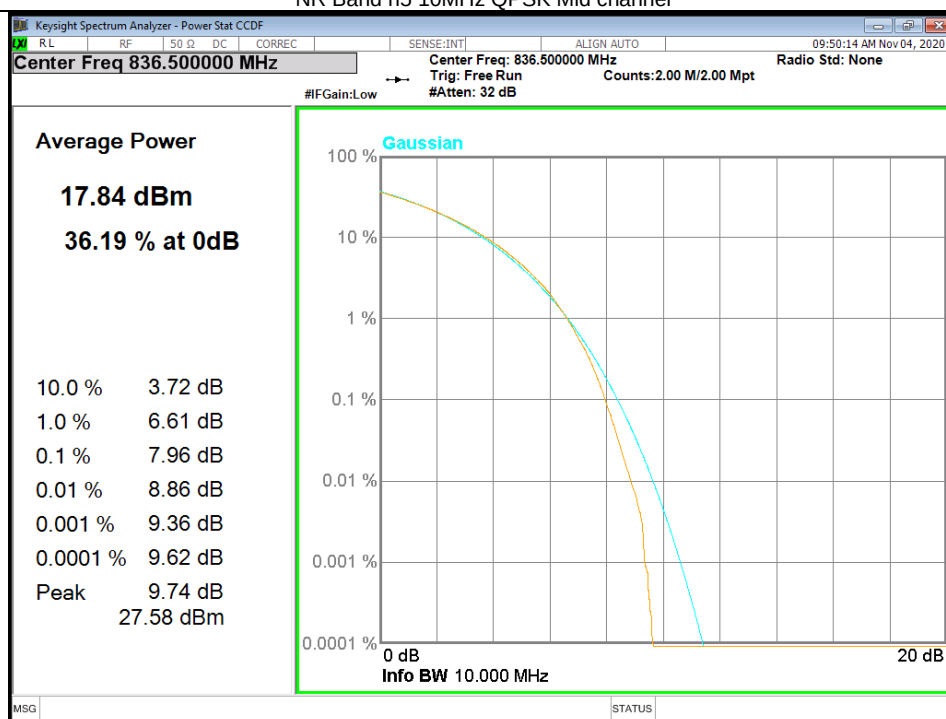
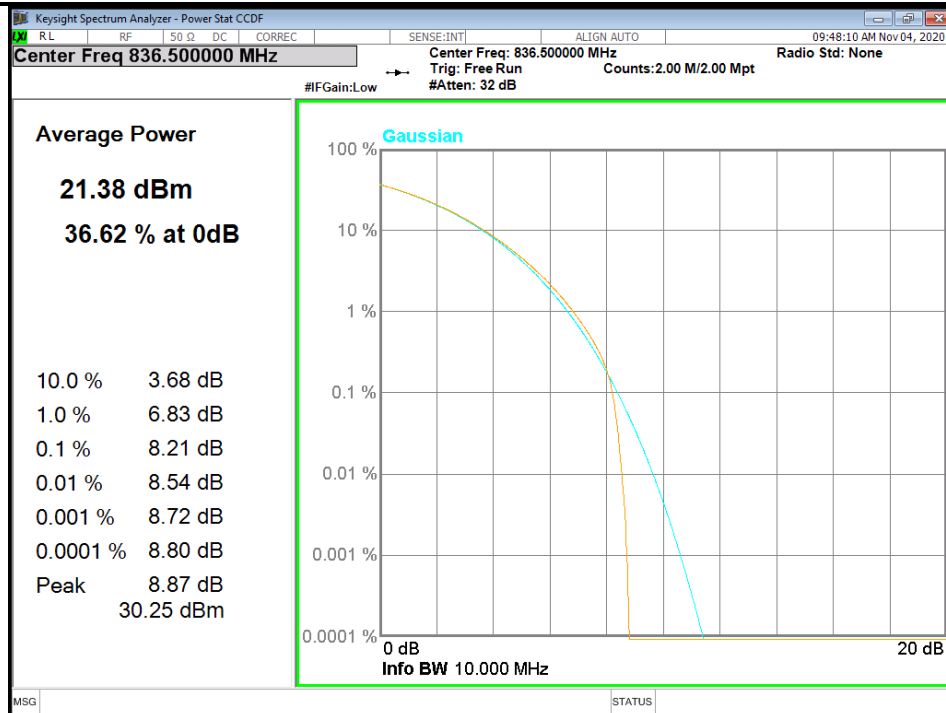


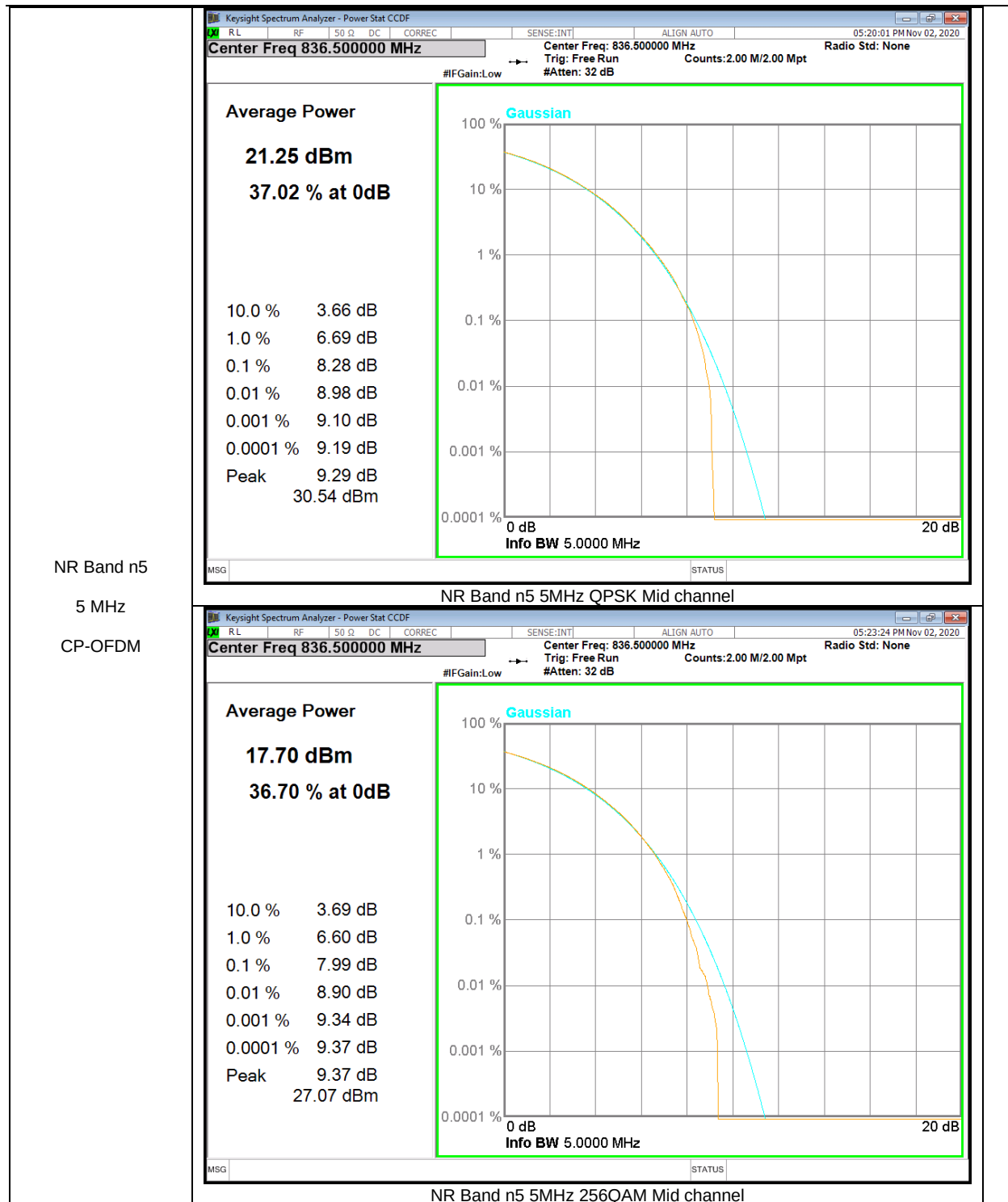
NR Band n5 20MHz 256QAM Mid channel

NR Band n5
15 MHz
CP-OFDM



NR Band n5
10 MHz
CP-OFDM



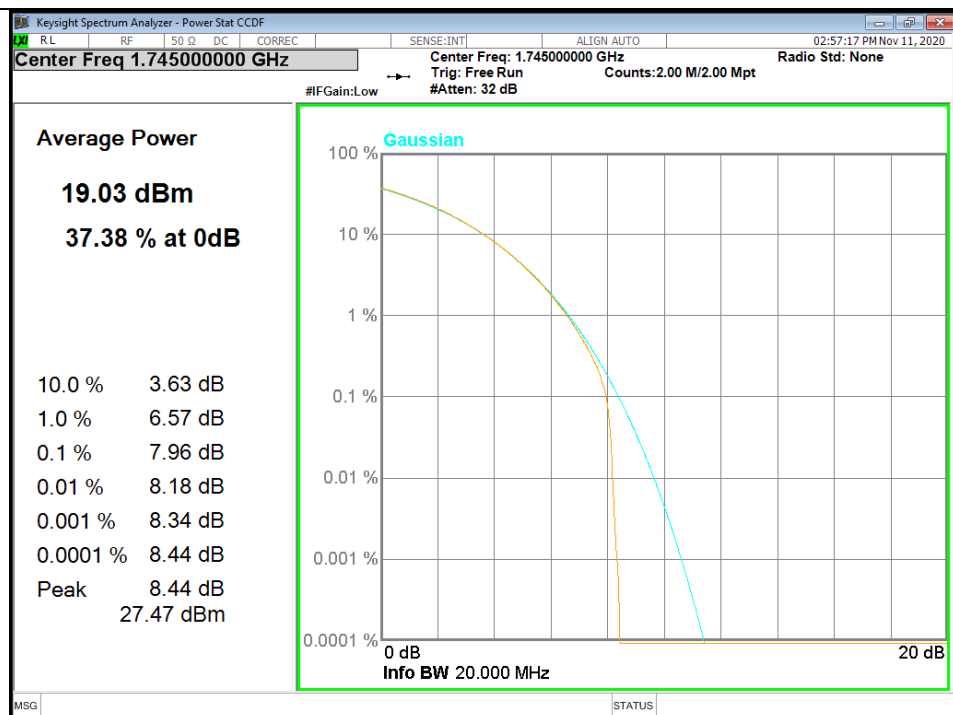


NR Band n66

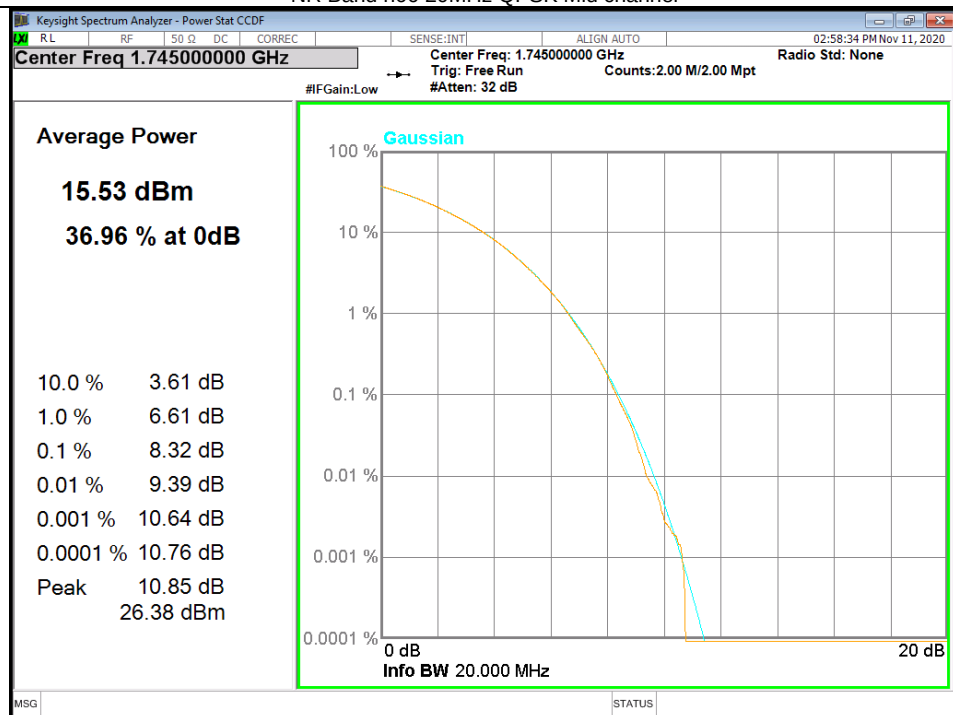
NR Band n66

20 MHz

CP-OFDM



NR Band n66 20MHz QPSK Mid channel

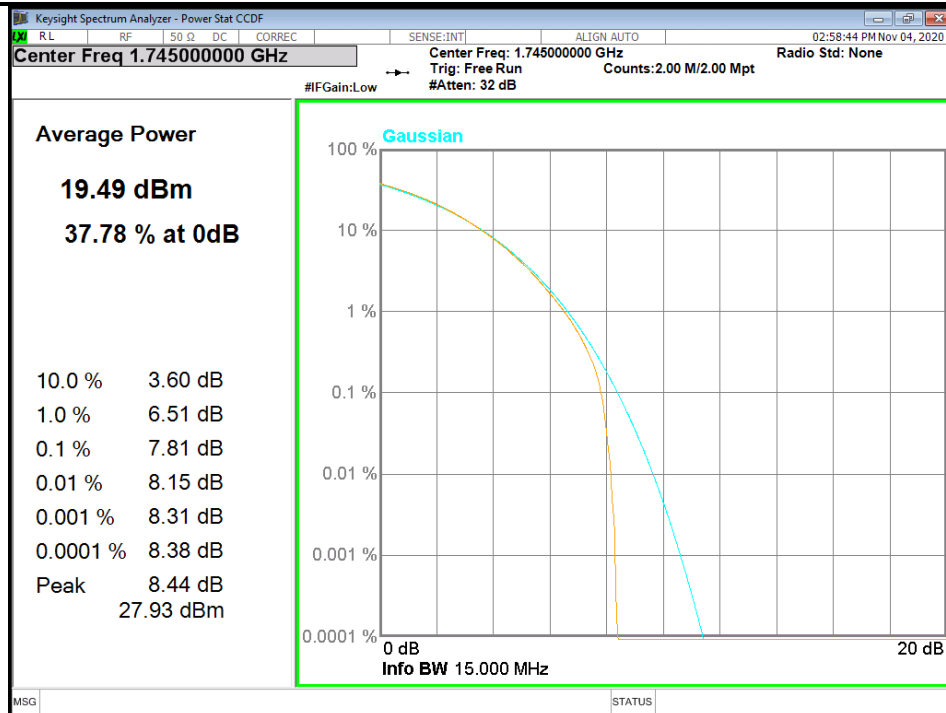


NR Band n66 20MHz 256QAM Mid channel

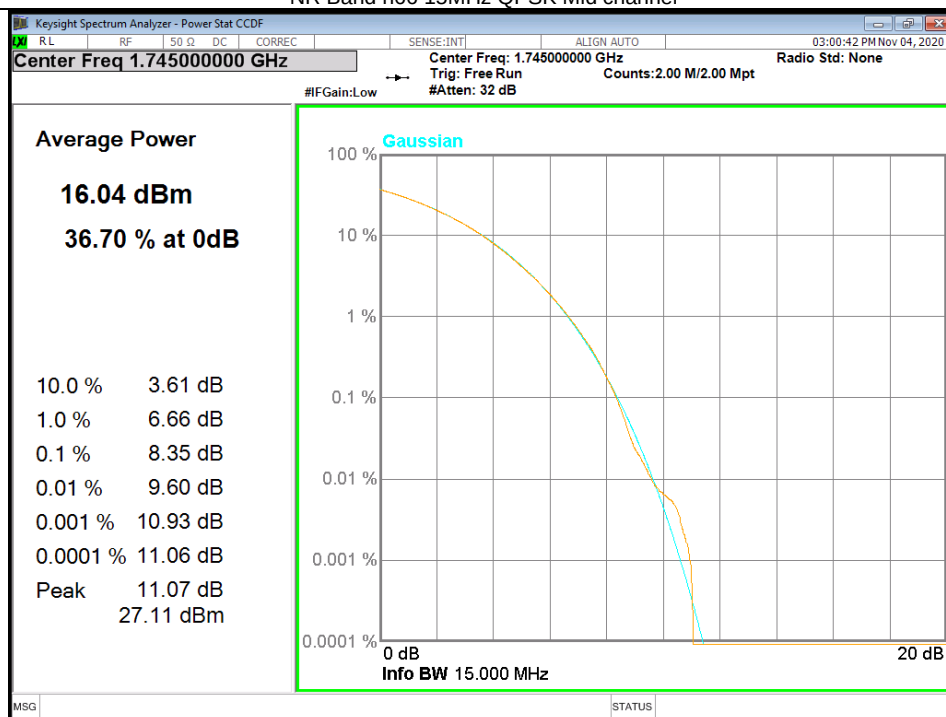
NR Band n66

15 MHz

CP-OFDM



NR Band n66 15MHz QPSK Mid channel

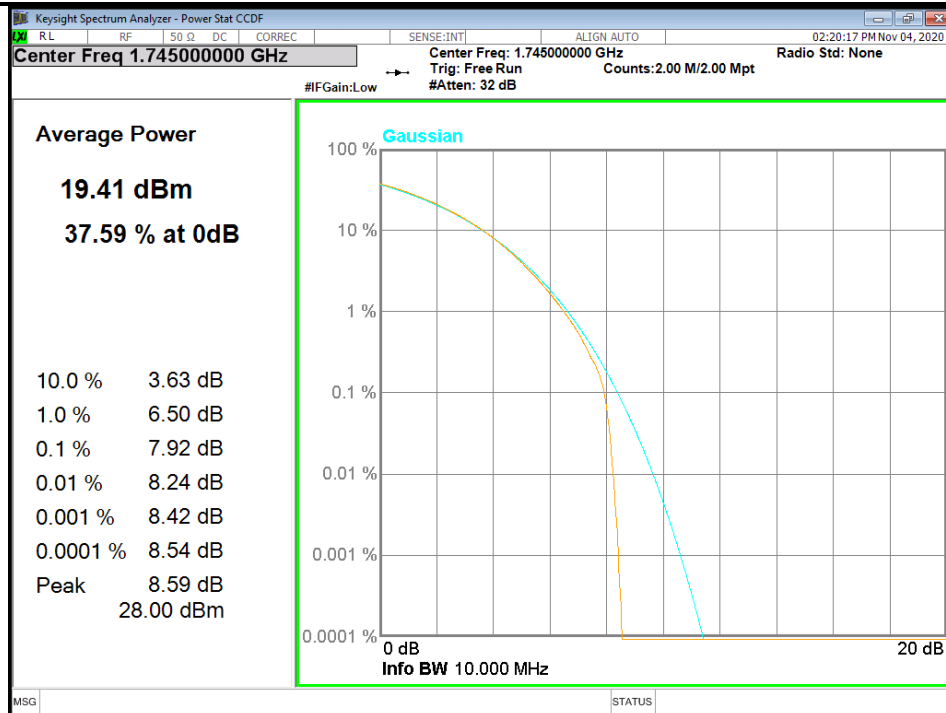


NR Band n66 15MHz 256QAM Mid channel

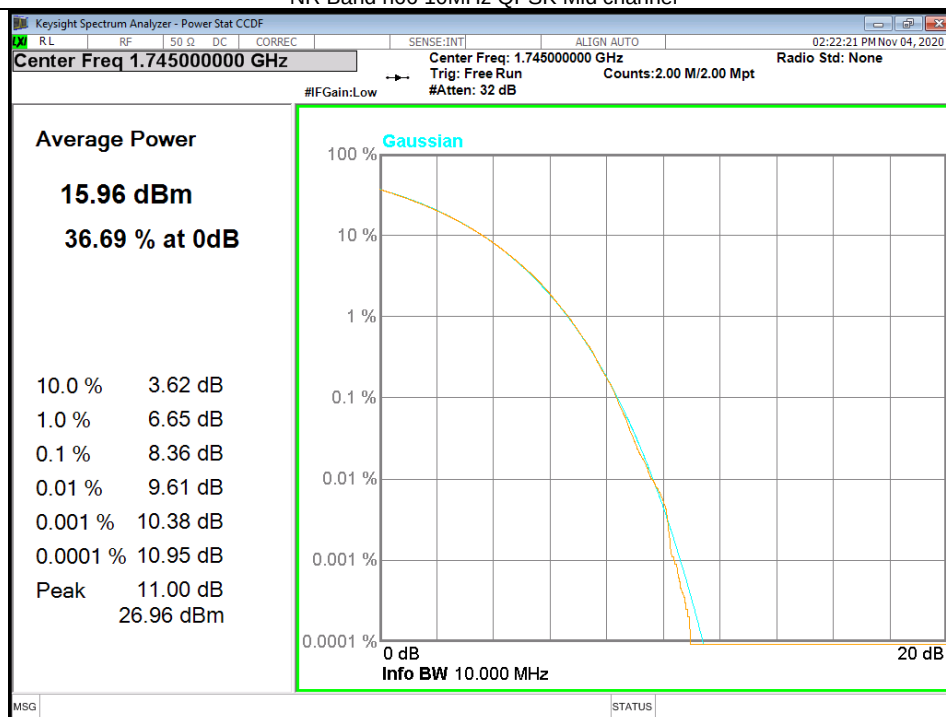
NR Band n66

10 MHz

CP-OFDM



NR Band n66 10MHz QPSK Mid channel

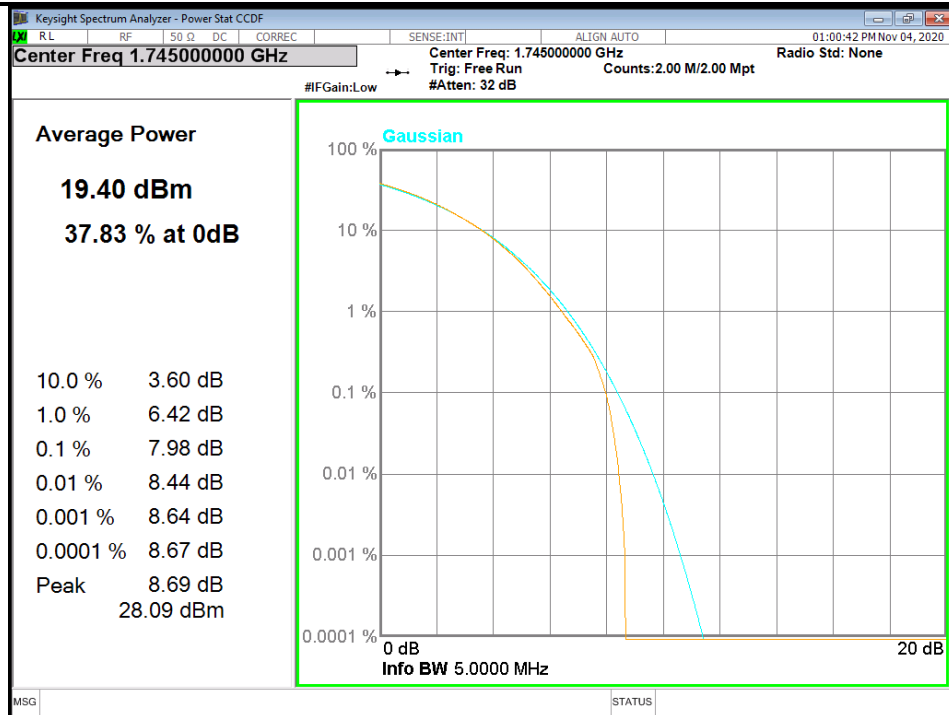


NR Band n66 10MHz 256QAM Mid channel

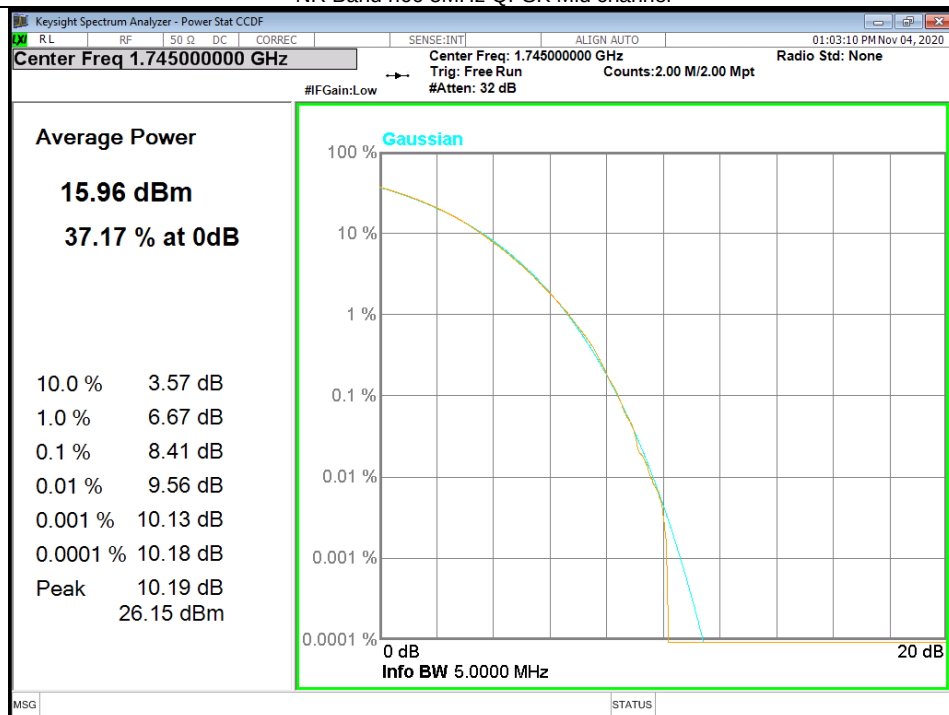
NR Band n66

5 MHz

CP-OFDM



NR Band n66 5MHz QPSK Mid channel



NR Band n66 5MHz 256QAM Mid channel

9. LIMITS AND CONDUCTED RESULTS

9.1. OCCUPIED BANDWIDTH

RULE PART(S)

FCC: §2.1049

LIMITS

For reporting purposes only

TEST PROCEDURE

The transmitter output was connected to a calibrated coaxial cable and coupler, the other end of which was connected to a spectrum analyzer. The occupied bandwidth was measured with the spectrum analyzer at the middle channel in each band. The -26dB bandwidth was also measured and recorded.

(KDB 971168 D01 Power Meas License Digital Systems v03r01)

Note

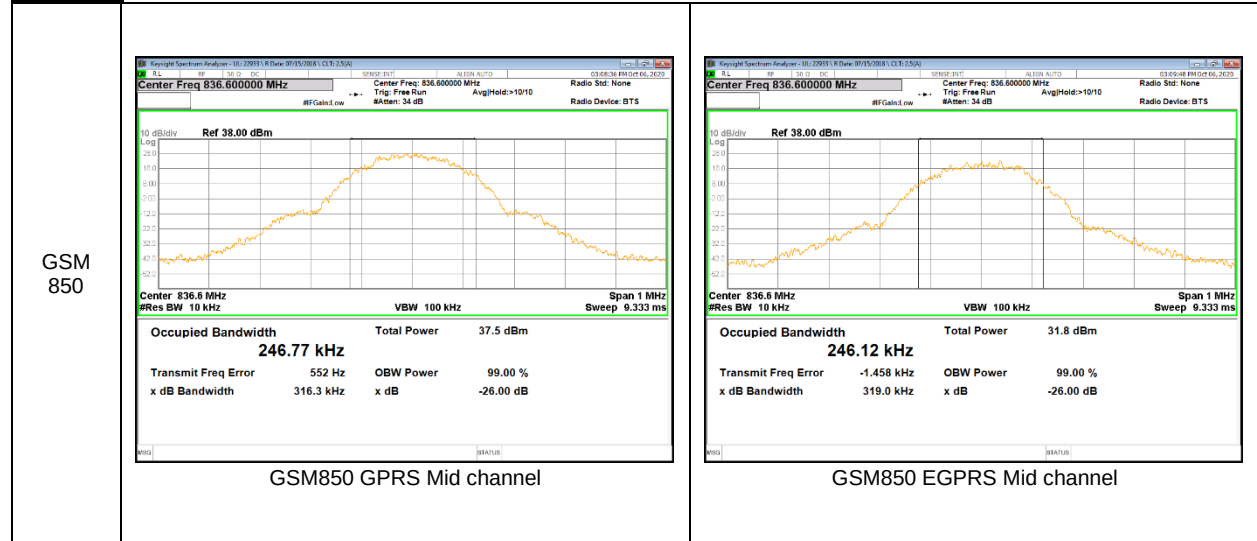
5G NR: All Waveforms (CP-OFDM vs DFT-s OFDM) were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.

RESULTS

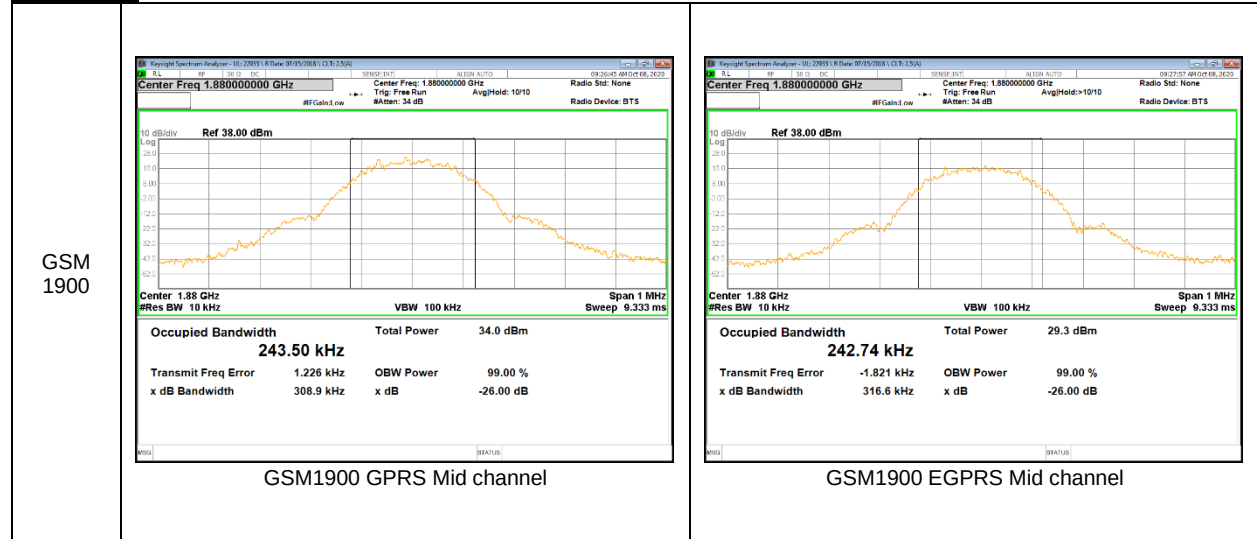
There is no limit required and power is the same for low, middle and high channel; therefore, only middle channel was tested.

9.1.1. OCCUPIED BANDWIDTH RESULTS

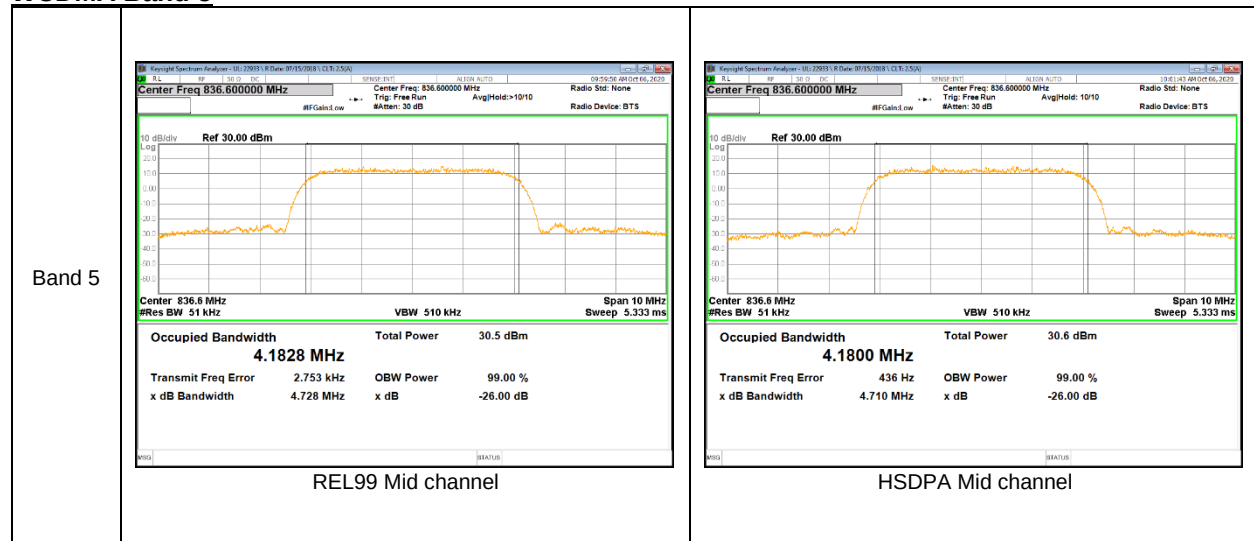
GSM 850



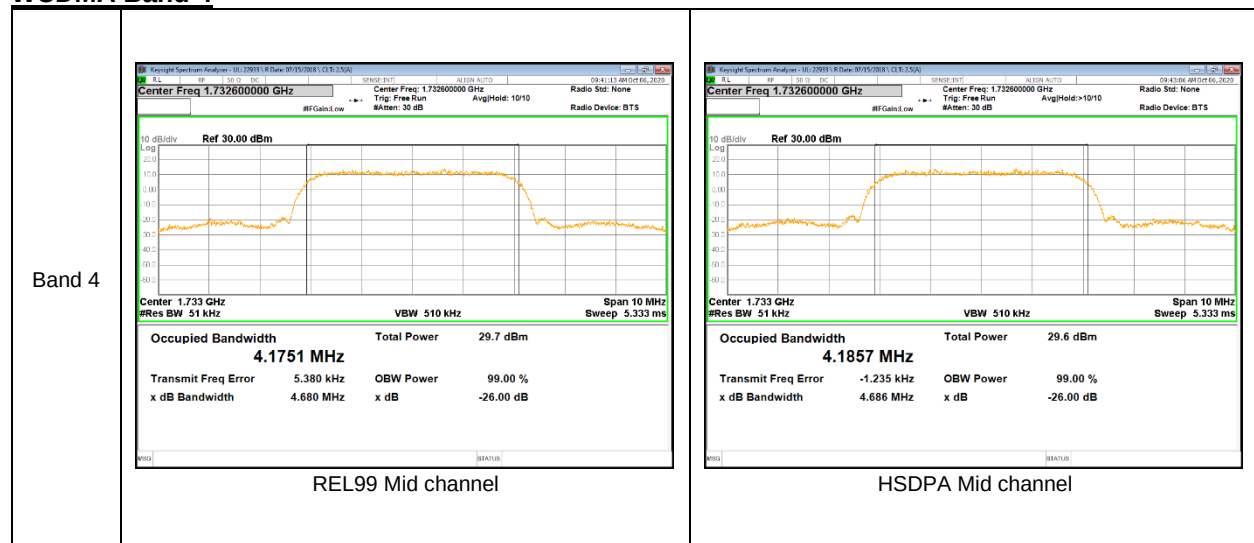
GSM 1900



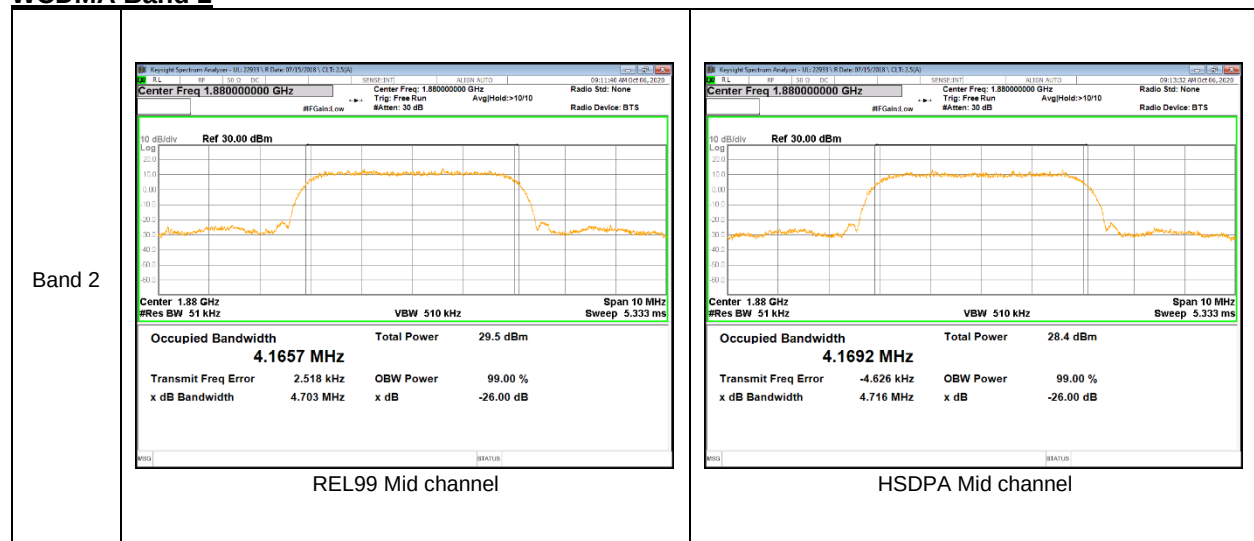
WCDMA Band 5



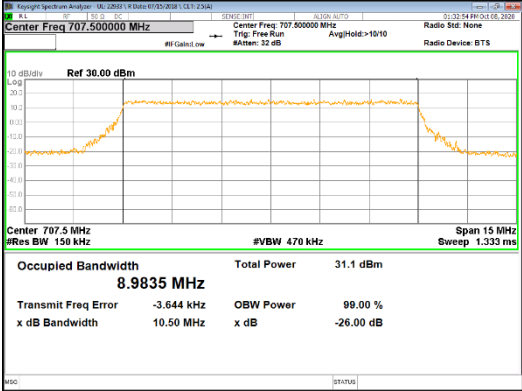
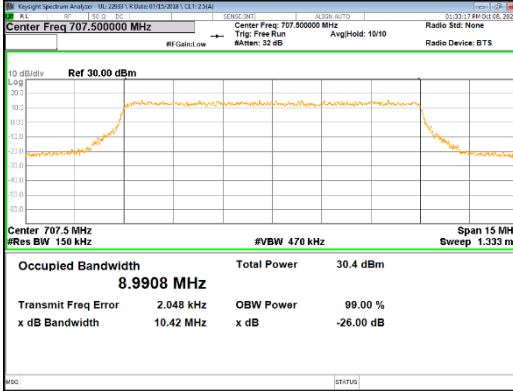
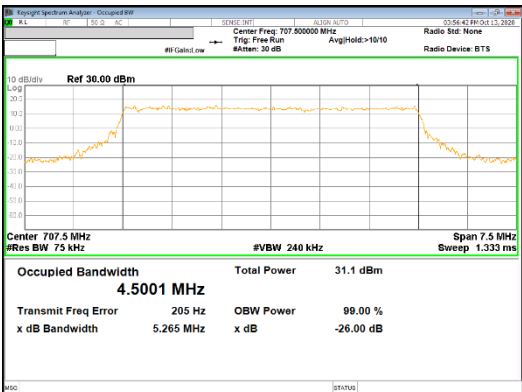
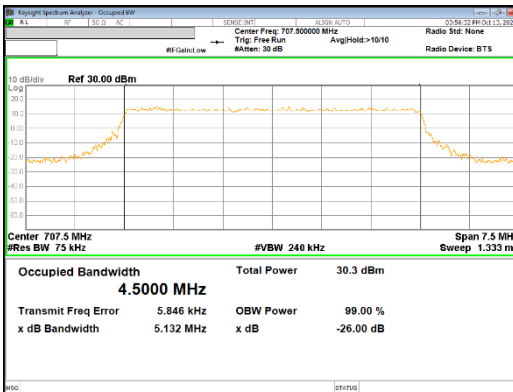
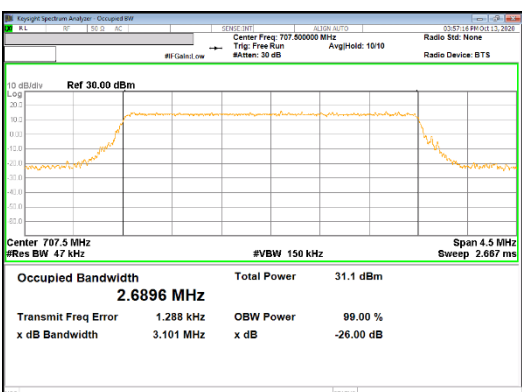
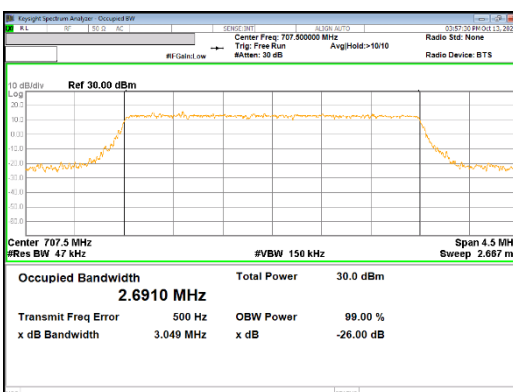
WCDMA Band 4

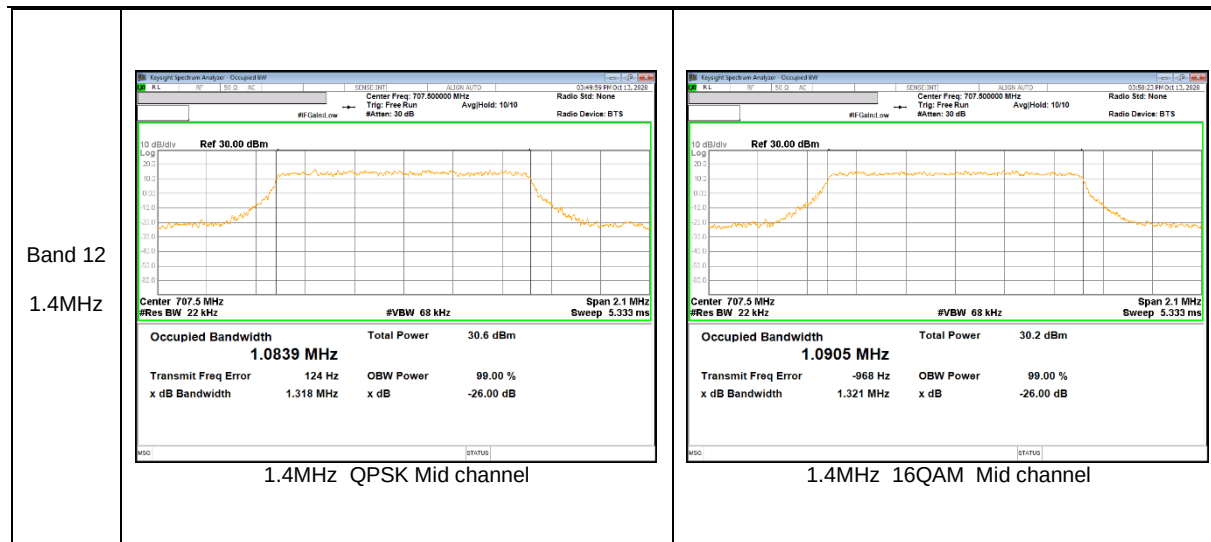


WCDMA Band 2



LTE Band 12

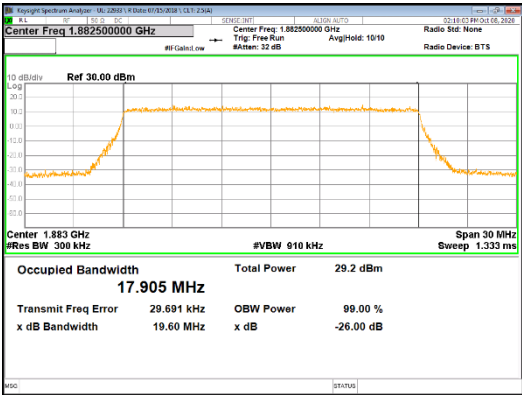
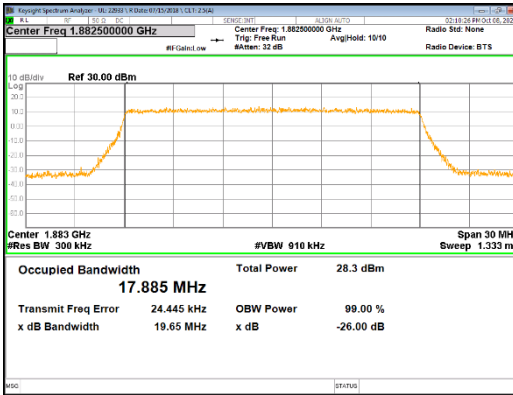
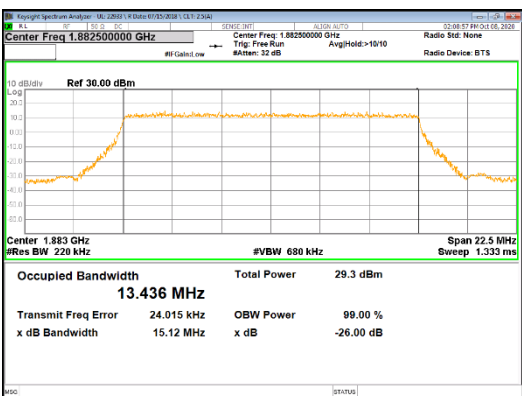
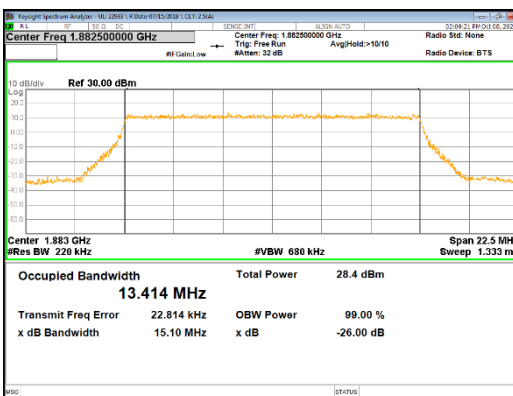
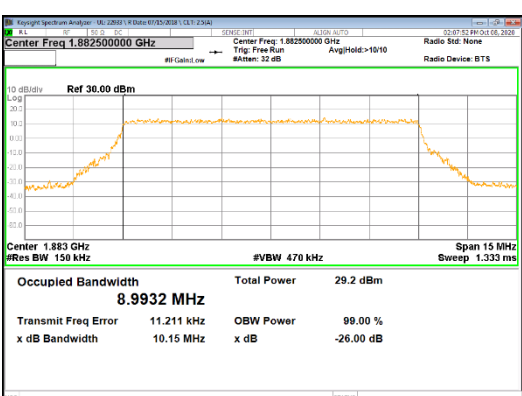
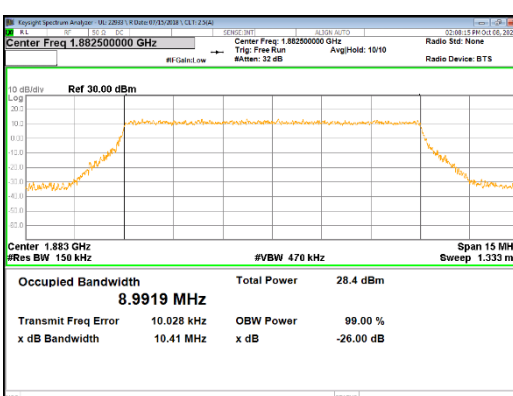
Band 12 10MHz	 10MHz QPSK Mid channel	 10MHz 16QAM Mid channel
Band 12 5MHz	 5MHz QPSK Mid channel	 5MHz 16QAM Mid channel
Band 12 3MHz	 3MHz QPSK Mid channel	 3MHz 16QAM Mid channel



LTE Band 13



LTE Band 25

Band 25 20MHz	 20MHz QPSK Mid channel	 20MHz 16QAM Mid channel
Band 25 15MHz	 15MHz QPSK Mid channel	 15MHz 16QAM Mid channel
Band 25 10MHz	 10MHz QPSK Mid channel	 10MHz 16QAM Mid channel