

FCC ID: VBNAHFB-01 Test Report No: TYPEAPPR-1508717799-611

	19917.51	-21.68	compliant
64QAM-Modulation ANT1			
	19919.21	-21.75	compliant
64QAM-Modulation ANT2			
	19853.11	-21.99	compliant
64QAM-Modulation ANT3			
	19779.66	-21.86	compliant
64QAM-Modulation ANT4			
	19845.76	-22.07	compliant
256QAM-Modulation ANT1			
	19918.64	-22.28	compliant
256QAM-Modulation ANT2			
	19919.21	-21.83	compliant
256QAM-Modulation ANT3			
	19912.43	-21.91	compliant
256QAM-Modulation ANT4			
	19916.38	-22.12	compliant
Measurement Uncertainty:		3.6GHz ≤ f <8.	z: ±1.1dB, 6GHz: ±1.2dB, 0GHz: ±1.6dB, f: ±1.9dB

Table 20 Spurious Emissions (15 MHz Channel BW)

Config D Lower band edge:

	Carrier Frequer	ncy: 1940.0 MHz	
Frequency Range [MHz]	Emission Frequency [MHz]	Maximum Emission Level [dBm]	Result
QPSK-Modulation ANT1			
	1929.99	-32.37	compliant
QPSK-Modulation ANT2			
	1930.00	-32.30	compliant
QPSK-Modulation ANT3			
	1930.00	-31.86	compliant
QPSK-Modulation ANT4			
	1929.99	-31.66	compliant
16QAM-Modulation ANT1			
	1930.00	-32.33	compliant
16QAM-Modulation ANT2			
	1929.99	-32.19	compliant

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16QAM-Modulation ANT3			
	1929.99	-31.56	compliant
16QAM-Modulation ANT4			
	1930.00	-31.35	compliant
64QAM-Modulation ANT1			
	1930.00	-32.33	compliant
64QAM-Modulation ANT2			
	1930.00	-32.44	compliant
64QAM-Modulation ANT3			
	1929.98	-31.62	compliant
64QAM-Modulation ANT4		s-	
	1929.99	-31.34	compliant
256QAM-Modulation ANT1			
	1929.99	-31.78	compliant
256QAM-Modulation ANT2			
	1929.98	-32.65	compliant
256QAM-Modulation ANT3			
	1929.98	-31.88	compliant
256QAM-Modulation ANT4			
	1930.00	-31.39	compliant
Measurement U	ncertainty:	f < 1.0GH; 1.0GHz ≤ f <3. 3.6GHz ≤ f <8. 8.0GHz ≤	6GHz: ±1.2dB, 0GHz: ±1.6dB,

Table 21 Spurious Emissions (Lower band edge) (20 MHz CH BW)

Config D Upper band edge:

	Carrier Frequency: 1985.0 MHz					
Frequency Range [MHz]	Emission Frequency [MHz]	Maximum Emission Level [dBm]	Result			
QPSK-Modulation ANT1						
	1995.02	-31.15	compliant			
QPSK-Modulation ANT2						
	1995.00	-31.71	compliant			
QPSK-Modulation ANT3						
	1995.01	-32.16	compliant			
QPSK-Modulation ANT4						
	1995.00	-31.69	compliant			
16QAM-Modulation ANT1						
	1995.01	-31.42	compliant			

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16QAM-Modulation ANT2			
	1995.00	-32.09	compliant
16QAM-Modulation ANT3			
	1995.00	-31.99	compliant
16QAM-Modulation ANT4			
	1995.00	-31.64	compliant
64QAM-Modulation ANT1			
	1995.00	-31.28	compliant
64QAM-Modulation ANT2			
	1995.01	-32.10	compliant
64QAM-Modulation ANT3			
	1995.00	-31.89	compliant
64QAM-Modulation ANT4			
	1995.00	-31.32	compliant
256QAM-Modulation ANT1			
	1995.01	-30.65	compliant
256QAM-Modulation ANT2			
	1995.02	-31.96	compliant
256QAM-Modulation ANT3			
	1995.00	-31.63	compliant
256QAM-Modulation ANT4			
	1995.00	-31.06	compliant
		FEMALES SERVICE SERVICE SERVICES SERVIC	6GHz: ±1.2dB, .6GHz ≤ f <8.0GHz: ±1.6dB,

Table 22 Spurious Emissions (Upper band edge) (20 MHz CH BW)

Config D Spurious emissions:

Comig D Spurious Conssions.						
	Carrier Frequency: 1962.5 MHz					
Frequency Range [MHz]	Emission Frequency [MHz]	Maximum Emission Level [dBm]	Result			
QPSK-Modulation ANT1						
0.009 – 19950	19925.42	-21.84	compliant			
QPSK-Modulation ANT2						
	19914.69	-21.77	compliant			
QPSK-Modulation ANT3						
	19912.99	-21.59	compliant			
QPSK-Modulation ANT4						
	19914.69	-21.84	compliant			

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16QAM-Modulation ANT1			
	19921.47	-21.98	compliant
16QAM-Modulation ANT2			
	19918.64	-21.75	compliant
16QAM-Modulation ANT3			
	19846.89	-21.84	compliant
16QAM-Modulation ANT4		3	
	19916.95	-21.93	compliant
64QAM-Modulation ANT1			
	19921.47	-21.98	compliant
64QAM-Modulation ANT2			
	19924.29	-21.82	compliant
64QAM-Modulation ANT3			
	19915.25	-21.79	compliant
64QAM-Modulation ANT4			
	19923.16	-21.88	compliant
256QAM-Modulation ANT1			
	19920.90	-21.62	compliant
256QAM-Modulation ANT2			
	19921.47	-21.91	compliant
256QAM-Modulation ANT3			
	19915.25	-21.79	compliant
256QAM-Modulation ANT4			
	19509.60	-21.65	compliant
Measurement U	ncertainty:	f < 1.0GHz 1.0GHz ≤ f <3. 3.6GHz ≤ f <8. 8.0GHz ≤	6GHz: ±1.2dB, 0GHz: ±1.6dB,

Table 23 Spurious Emissions (20 MHz Channel BW)

The measured conducted emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

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4.5 Test No. 5: Field Strength of Spurious Radiation (§ 2.1053, § 2.1057, § 24.238)

4.5.1. Limits

Para. No. 24.238(a) The 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 $43 + 10 \log(P) dB$.

4.5.2. Test Configuration

The measurements were performed in an anechoic chamber. The radiated test site complies with the site attenuation requirements listed in ANSI C63.4 2003 and is listed with the FCC.

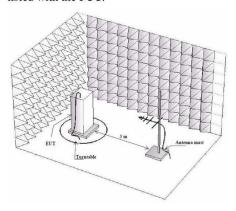


Figure 2 Test Configuration

Photographs of the EUT in the anechoic chamber are shown on page 95 of this measurement report.

4.5.3. Test Procedure and Results

TIA/EIA-603-C-2004, Section 2.2.12

The test was performed in a semi-anechoic shielded room. The EUT was placed on a non-conductive 0.8 m high table standing on the turntable. During the test in the frequency range 30 - 19950 MHz the distance from the EUT to the measuring antenna was 3 m. In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna were varied during the tests. The test was performed with the measuring antenna being both in horizontal and vertical polarizations.

Vertical and horizontal polarizations in the frequency range 30 - 19950 MHz was first measured by using the peak detector. During the peak detector scan the turntable was rotated from 0° to 360° with 30° step with the antenna heights 1.0 m and 2.5 m.

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The limit of -13 dBm has been calculated to correspond 84.4 dB (μ V/m). Spurious emissions closer than 20 dB to the limit was measured with average detector.

According to \S 2.1057, all emissions from the lowest radio frequency generated in the equipment, without going below 9 kHz, up to the 10th harmonic were investigated.

The antenna substitution method was used to determine the equivalent radiated power at spurious frequencies. The EUT was replaced with a reference substitution antenna with a known gain referenced to an isotropic radiator $G_{\text{Antenna}[dBi]}$. This antenna was fed with a signal at the spurious frequency $P_{\text{Gen}[dBm]}$. The level of the signal was adjusted to repeat the previously measured level. The resulting

EIRP is the signal level fed to the reference antenna corrected for gain referenced to an isotropic.

The formula below was used to calculate the EIRP of the EUT.

 $P_{EIRP[dbm]} = P_{Gen[dBm]} - L_{Cable[dB]} + G_{Antenna[dBi]}$

Worst case detected emission levels are reported in the following table (refer to spectral plots included on pages 96 for details). The antenna factor and cable loss is according to the manufacturer's specification.

Measure	d laboratory room ter	nperature and humid	ity during the tests	
Date	Temperature Min-Max:		Humidity Min-Max:	
31 March – 2 April 2019	22.5 °C	23.3 °C	14.2 RH%	19.5 RH%

Config A. B. C. D:

	Carrier Frequen	cy: 1962.5MHz	
Frequency Range [MHz]	Frequency Range [MHz]	Frequency Range [MHz]	Frequency Range [MHz]
QPSK-Modulation TX1			
30 - 19950	More than 20dB b	elow limit -13dBm	Compliant
Measurement Uncertainty:			±5.8dB

Table 24 Field Strength of Spurious Radiation (20 MHz Channel BW)

The measured emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

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5. TEST DATA AND SCREENSHOTS

5.1 Part List of the RF Measurement Test Equipment

No.	Test Equipment	Manufacturer & Type	Serial Number	Calibration date	Calibration due	Test No.
1	Signal Analyzer	Rohde & Schwarz: FSV 30	100781	07/2018	07/2019	1, 2, 3, 4
2	Signal Analyzer	Rohde & Schwarz: FSW 43	104600	10/2018	10/2019	1, 2, 3, 4
3	Vector Network Analyzer	Rohde & Schwarz: ZVA40	100146	07/2018	07/2019	1, 2, 3, 4
4	Vector Network Analyzer	Rohde & Schwarz: ZVL13	101177	07/2018	07/2019	1, 2, 3, 4
5	Calibration Unit	Rohde & Schwarz: ZV-Z54	100125	7/2018	7/2019	1, 2, 3, 4
6	Multimeter	Fluke 83	65870302	01/2019	01/2020	1, 2, 3, 4
7	Humidity and Temperature Indicator	Vaisala: HMI 31	P3730008	01/2019	01/2020	1, 2, 3, 4
8	DC Power Supply	Sorensen SGI80/188D-1AAA	0525A00545	cnn	ıa	1, 2, 3, 4
9	Attenuator	SHX:DTS 100G- 20dB-24G- 3.5mm(F,F)-B	14111101	cnn	¥	1, 2, 3, 4
10	EMI Test Receiver	R&S ESU40	100262/040	07/2018	07/2019	5
11	Horn Antenna	ETS-Lindgren 3116C-PA	150635	11/2018	11/2019	5
12	Horn Antenna	ETS-Lindgren ETS3115	6346	07/2018	08/2019	5
13	Bilog Antenna	Schaffner Chase CBL6112	2003	07/2018	07/2019	5
14	Humidity and temperature meter	Vaisala HM31	P3730008	03/2018	03/2019	5
15	Mast Controller	Maturo NCD/180 2	17210416	cnn	121	5
16	4 meter mast	Maturo TAM4.0-E	086/172109 15	cnn		5
17	Anechoic Chamber	S&MC	B83317- C6019	09/2016	09/2019	5
18	Amplifier	Miteq 4FSX4	902638	cnn		5

Table 25 Part List of the RF Measurement Test Equipment

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5.2 Spectral Plots

5.2.1. Test No. 2: Modulation Characteristics

No additional measurements are required for the modulation characteristics. Please refer to test no. 3, occupied bandwidth on page 18.

Screenshots below shows information about the modulations I/Q constellation form and modulation information table, displaying error to ideal modulation symbols.

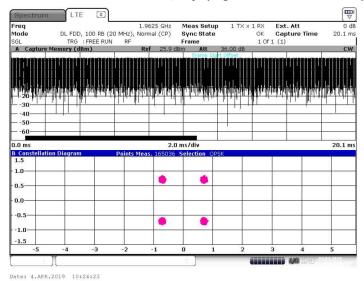


Figure 3 I/Q constellation diagram with capture buffer – QPSK (1962.5 MHz) (20MHz Channel BW)

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	1.9 .00 RB (20 MHz), Nor REE RUN RF	625 GHz Meas: mal (CP) Sync S Frame	State OK	Ext. A Captur 1 (1)	tt re Time	20.1
		Result Summar	У			
Frame Result 1/1	Min	Mean	Limit Max	Limit	Unit	
EVM PDSCH QPSK	3.53	3.53	3.53	18.50	%	
EVM PDSCH 16QAM				13.50	%	
EVM PDSCH 64QAM				9.00	%	
EVM PDSCH 256QAM					%	
Time Alignment Error 2,1					ns	
Time Alignment Error 3,1					ns	
Time Alignment Error 4,1					ns	
Results for Selection	Subframe(s) ALL	Selection	Antenna 1 Frame	Result 1/1		
EVM All	3.06	3.51	4.00		%	
EVM Phys. Channel	3.04	3.52	4.04		%	
EVM Phys. Signal	2.74	3.32	3.76		%	
Frequency Error	- 2.71	- 0.68	0.71		Hz	
Sampling Error	- 0.04	0.05	0.15		ppm	
IQ Offset	- 84.98	- 69.74	- 64.88		dB	
IQ Gain Imbalance	- 0.01	- 0.00	0.01		dB	
IQ Quadrature Error	- 0.08	0.04	0.17		.0	
RSTP	- 15.16	- 15.13	- 15.12		dBm	
OSTP	15.62	15.64	15.67		dBm	
Power	15.63	15.65	15.66		dBm	
Crest Factor		7.36			dB	

Figure 4 I/Q constellation table with I/Q error – QPSK (1962.5 MHz) (20MHz Channel BW)

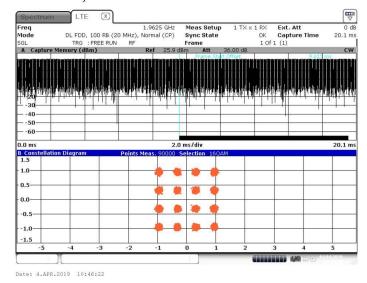


Figure 5 I/Q constellation diagram with capture buffer – 16QAM (1962.5 MHz) (20MHz Channel BW)

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	1.9 DD, 100 RB (20 MHz), Nor S : FREE RUN RF	9625 GHz Meas Setup mal (CP) Sync State Frame		. Att ture Time	20.1
		Result Summary			
Frame Result 1/1	Min	Mean Limit	Max Lir	nit Unit	
EVM PDSCH QPSK	2.67	2.67	2.67 18.	50 %	
EVM PDSCH 16QAM	4.75	4.75	4.75 13.	50 %	
EVM PDSCH 64QAM			9.	00 %	
EVM PDSCH 256QAM				%	
Time Alignment Error 2,	1			ns	
Time Alignment Error 3,	1			ns	
Time Alignment Error 4,	1			ns	
Results for Selection	n Subframe(s) ALL	Selection Antenn	na 1 Frame Result	1/1	
EVM All	3.69	3.99	4.66	%	
EVM Phys. Channel	3.71	4.02	4.70	%	
EVM Phys. Signal	2.89	3.43	3.91	%	
Frequency Error	- 2.20	- 0.31	3.77	Hz	
Sampling Error	- 0.18	0.02	0.14	ppm	
IQ Offset	- 89.81	- 71.25	- 67.75	dB	
IQ Gain Imbalance	- 0.01	- 0.00	0.01	dB	
IQ Quadrature Error	- 0.07	- 0.00	0.07	0	
RSTP	- 15.13	- 15.10	- 15.08	dBm	
OSTP	15.67	15.71	15.76	dBm	
Power	15.67	15.69	15.71	dBm	
Crest Factor		7.35		dB	

Figure 6 I/Q constellation table with I/Q error – 16QAM (1962.5 MHz) (20MHz Channel BW)

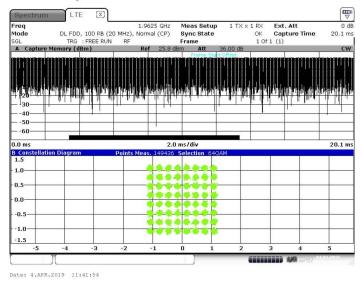


Figure 7 I/Q constellation diagram with capture buffer – 64QAM (1962.5 MHz) (20MHz Channel BW)

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	1.9 , 100 RB (20 MHz), Nori :FREE RUN RF	625 GHz Meas Setup mal (CP) Sync State Frame		Att ure Time 20.
		Result Summary		
Frame Result 1/1	Min	Mean Limit	Max Limi	Unit
EVM PDSCH QPSK			18.50) %
EVM PDSCH 16QAM			13.50	%
EVM PDSCH 64QAM	3.35	3.35	3.35 9.00	96
EVM PDSCH 256QAM				%
Time Alignment Error 2,1				ns
Time Alignment Error 3,1				ns
Time Alignment Error 4,1				ns
Results for Selection	Subframe(s) ALL	Selection Antenn	ia 1 Frame Result 1	/1
EVM All	3.09	3.34	3.46	%
EVM Phys. Channel	3.10	3.34	3.49	%
EVM Phys. Signal	2.87	3.33	3.82	%
Frequency Error	- 4.46	- 1.53	2.79	Hz
Sampling Error	- 0.19	0.01	0.16	ppm
IQ Offset	- 82.60	- 71.55	- 65.92	dB
IQ Gain Imbalance	- 0.01	0.00	0.02	dB
IQ Quadrature Error	- 0.09	- 0.01	0.13	0
RSTP	- 15.16	- 15.13	- 15.12	dBm
OSTP	15.59	15.70	15.81	dBm
Power	15.61	15.65	15.69	dBm
Crest Factor		7.35		dB

Figure 8 I/Q constellation table with I/Q error $-\,64QAM\,(1962.5\,MHz)\,(20MHz\,Channel\,BW)$

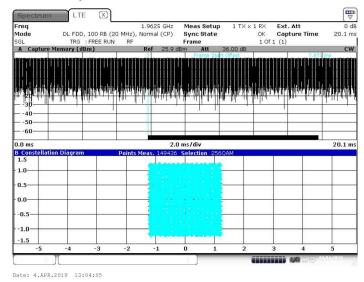


Figure 9 I/Q constellation diagram with capture buffer – 256QAM (1962.5 MHz) (20MHz Channel BW)

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Date: 4.APR.2019 11:40:52

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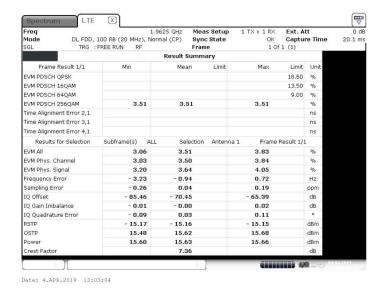


Figure 10 I/Q constellation table with I/Q error – 256QAM (1962.5 MHz) (20MHz Channel BW)

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5.2.2. Test No. 3: Occupied Bandwidth

The value 'Occ Bw' is the measured occupied bandwidth.

Config A ANT1:

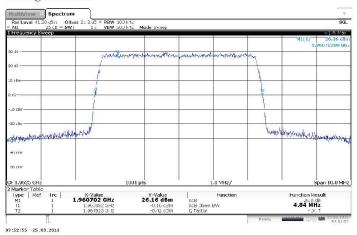


Figure 11 Occupied Bandwidth – QPSK (1962.5 MHz) (5MHz Channel BW)

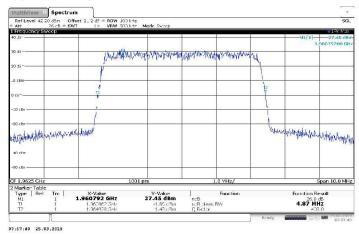


Figure 12 Occupied Bandwidth – 16QAM (1962.5 MHz) (5MHz Channel BW)

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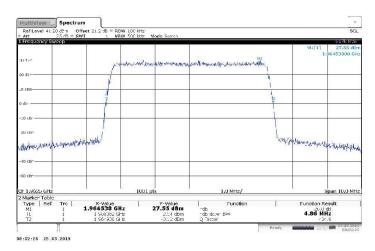


Figure 13 Occupied Bandwidth – 64QAM (1962.5 MHz) (5MHz Channel BW)

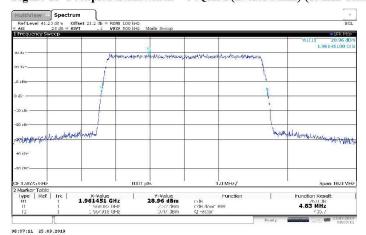


Figure 14 Occupied Bandwidth – 256QAM (1962.5 MHz) (5MHz Channel BW) Config B ANT1:

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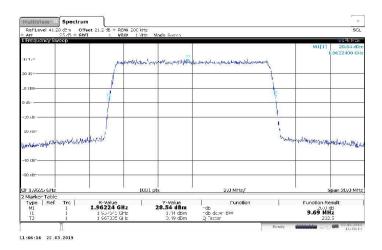


Figure 15 Occupied Bandwidth - QPSK (1962.5 MHz) (10MHz Channel BW)

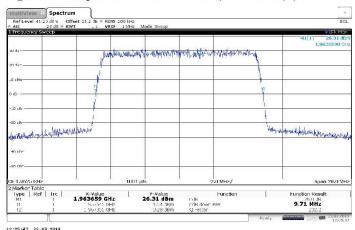


Figure 16 Occupied Bandwidth – 16QAM (1962.5 MHz) (10MHz Channel BW)



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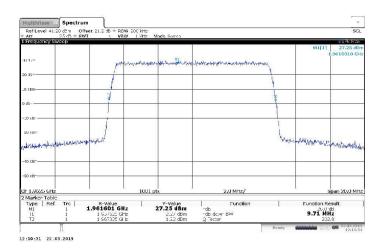


Figure 17 Occupied Bandwidth – 64QAM (1962.5 MHz) (10MHz Channel BW)

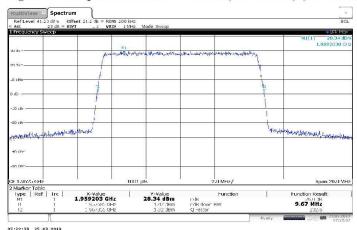


Figure 18 Occupied Bandwidth – 256QAM (1962.5 MHz) (10MHz Channel BW)

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Config C ANT1:

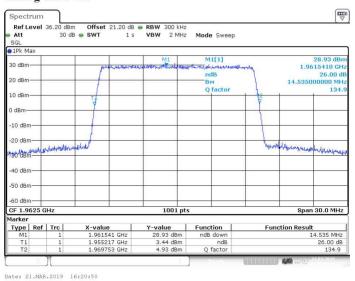


Figure 19 Occupied Bandwidth – QPSK (1962.5 MHz) (15MHz Channel BW)

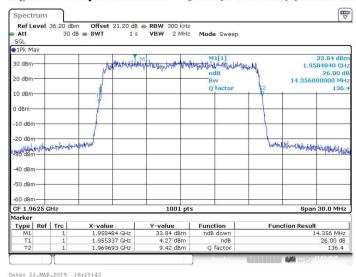


Figure 20 Occupied Bandwidth – 16QAM (1962.5 MHz) (15MHz Channel BW)

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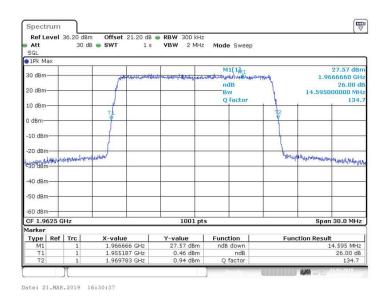


Figure 21 Occupied Bandwidth – 64QAM (1962.5 MHz) (15MHz Channel BW)

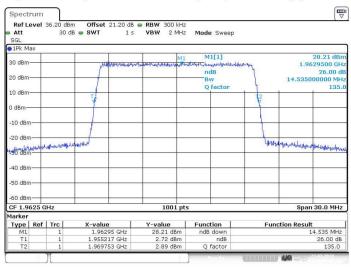


Figure 22 Occupied Bandwidth – 256QAM (1962.5 MHz) (15MHz Channel BW) $\,$

Config D ANT1:

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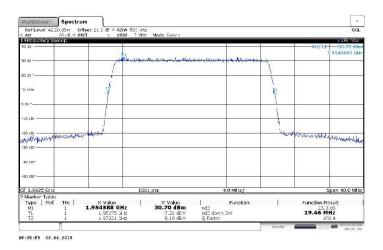


Figure 23 Occupied Bandwidth – QPSK (1962.5 MHz) (20MHz Channel BW)

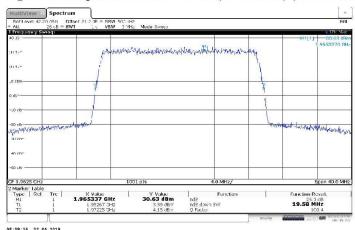


Figure 24 Occupied Bandwidth – 16QAM (1962.5 MHz) (20MHz Channel BW)