Frequency Stability with Voltage Variation:

The EUT was placed in a climatic chamber and allowed to stabilize at +20 degrees Celsius for at least 60 minutes. With the supply voltage of the EUT set to 85% of the nominal value, the frequency error was measure. This procedure was repeated at 100% and 115% of the nominal supply voltage value.

Config A:

Carrier Frequency: 1962.5 MHz						
Supply Voltage (DC) [V]	Ambient Temperature [°C]	Frequency Deviation		Manufacturer's Specification		Result
		[Hz]	[ppm]	[Hz]	[ppm]	
QPSK Modulation ANT1						
-40.8	20.0	-3.12159	-0.002	98	0.05	compliant
-48.0	20.0	2.19448	0.001	98	0.05	compliant
-55.2	20.0	-3.61768	-0.002	98	0.05	compliant
QPSK Modulation ANT2						
-40.8	20.0	-3.13719	-0.002	98	0.05	compliant
-48.0	20.0	-2.79056	-0.001	98	0.05	compliant
-55.2	20.0	-3.87497	-0.002	98	0.05	compliant
QPSK Modulation ANT3						
-40.8	20.0	-5.72314	-0.003	98	0.05	compliant
-48.0	20.0	-5.18504	-0.003	98	0.05	compliant
-55.2	20.0	-2.57781	-0.001	98	0.05	compliant
QPSK Modulation ANT4						
-40.8	20.0	-2.68755	-0.001	98	0.05	compliant
-48.0	20.0	3.90539	0.002	98	0.05	compliant
-55.2	20.0	4.99074	0.003	98	0.05	compliant
16QAM Modulation ANT1						
-40.8	20.0	-3.49721	-0.002	98	0.05	compliant
-48.0	20.0	-3.35745	-0.002	98	0.05	compliant
-55.2	20.0	-3.35059	-0.002	98	0.05	compliant
16QAM Modulation ANT2						
-40.8	20.0	-3.40505	-0.002	98	0.05	compliant
-48.0	20.0	-4.95458	-0.003	98	0.05	compliant
-55.2	20.0	4.06575	0.002	98	0.05	compliant
16QAM Modulation ANT3						
-40.8	20.0	-3.364748	-0.002	98	0.05	compliant
-48.0	20.0	-3.43216	-0.002	98	0.05	compliant
-55.2	20.0	2.21862	0.001	98	0.05	compliant
16QAM Modulation ANT4						

-40.8	20.0	3.43404	0.002	98	0.05	compliant
-48.0	20.0	-4.18726	-0.002	98	0.05	compliant
-55.2	20.0	3.71635	0.002	98	0.05	compliant
64QAM Modulation ANT1						
-40.8	20.0	-5.82566	-0.003	98	0.05	compliant
-48.0	20.0	2.92720	0.001	98	0.05	compliant
-55.2	20.0	-5.33603	-0.003	98	0.05	compliant
64QAM Modulation ANT2						
-40.8	20.0	-3.03459	-0.002	98	0.05	compliant
-48.0	20.0	-4.33715	-0.002	98	0.05	compliant
-55.2	20.0	-4.68909	-0.002	98	0.05	compliant
64QAM Modulation ANT3						
-40.8	20.0	-6.19950	-0.003	98	0.05	compliant
-48.0	20.0	-3.70637	-0.002	98	0.05	compliant
-55.2	20.0	3.61108	0.002	98	0.05	compliant
64QAM Modulation ANT4						
-40.8	20.0	-2.14041	-0.001	98	0.05	compliant
-48.0	20.0	-2.63439	-0.001	98	0.05	compliant
-55.2	20.0	-4.59284	-0.002	98	0.05	compliant
256QAM Modulation ANT1						
-40.8	20	-2.92606	-0.001	98	0.05	compliant
-48	20	4.43430	-0.002	98	0.05	compliant
-55.2	20	3.40496	0.002	98	0.05	compliant
256QAM Modulation ANT2						
-40.8	20	-1.77017	-0.001	98	0.05	compliant
-48	20	-5.36160	-0.003	98	0.05	compliant
-55.2	20	4.91527	0.003	98	0.05	compliant
256QAM Modulation ANT3						
-40.8	20	-3.41941	-0.002	98	0.05	compliant
-48	20	-2.51363	-0.001	98	0.05	compliant
-55.2	20	-3.99754	-0.002	98	0.05	compliant
256QAM Modulation ANT4						
-40.8	20	2.32137	0.001	98	0.05	compliant
-48	20	3.93911	0.002	98	0.05	compliant
-55.2	20	-4.29505	-0.002	98	0.05	compliant
Measurement Uncertainty:					±1.0 Hz	

Table 16 Frequency stability with voltage var. (20 MHz Channel BW)

The measured frequency stability was found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

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	06/2016	06/2017	1, 2, 3, 4, 6
2	Signal Analyzer	Rohde & Schwarz: FSQ 26	200206	01/2017	01/2018	1, 2, 3, 4, 6
3	Vector Network Analyzer	Rohde & Schwarz: ZVA40	100146	01/2017	01/2018	1, 2, 3, 4, 6
4	Vector Network Analyzer	Rohde & Schwarz: ZVL13	101177	07/2016	07/2017	1, 2, 3, 4, 6
5	Calibration Unit	Rohde & Schwarz: ZV-Z54	100125	06/2016	06/2017	1, 2, 3, 4, 6
6	Calibration Kit	Hewlett-Packard: HP85032B	2919A04843	07/2016	07/2017	1, 2, 3, 4, 6
7	Frequency Standard	Microsemi 8040	162230101016	09/2016	09/2017	6
8	Multimeter	Fluke 83	65870302	12/2016	12/2017	1, 2, 3, 4, 6
9	Humidity and Temperature Indicator	Vaisala: HMI 31	P3730008	01/2017	01/2018	1, 2, 3, 4, 6
10	DC Power Supply	Maxion: EA-PSI 8080-510	13314600001	cnn	-	1, 2, 3, 4, 6
11	DC Power Supply	Toellner: 8870	61247	cnn	-	1, 2, 3, 4, 6
12	Attenuator	Aeroflex/Weinschel: 66-20-33	BV3346	cnn	-	1, 2, 3, 4, 6
13	EMI Test Receiver	R&S ESU40	100262	05/2016	05/2017	5
14	Horn Antenna	ETS-Lindgren 3116C-PA	00206990	09/2016	09/2017	5
15	Horn Antenna	ETS-Lindgren ETS3115	92148	06/2016	06/2017	5
16	Bilog Antenna	Chase CBL6112B	2003	06/2016	06/2017	5
17	Humidity and temperature meter	Vaisala HM34	G3330003	05/2016	05/2017	5
18	Mast Controller	Maturo NCD/180 2	17210416	cnn	-	5
19	4 meter mast	Maturo TAM4.0-E	086/17210915	cnn	-	5
20	Anechoic Chamber	S&MC	B83317-C6019	09/2016	09/2019	5
21	Amplifier	Miteq 4FSX4	902638	cnn	-	5

Table 17 Part List of the RF Measurement Test Equipment

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 14.

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

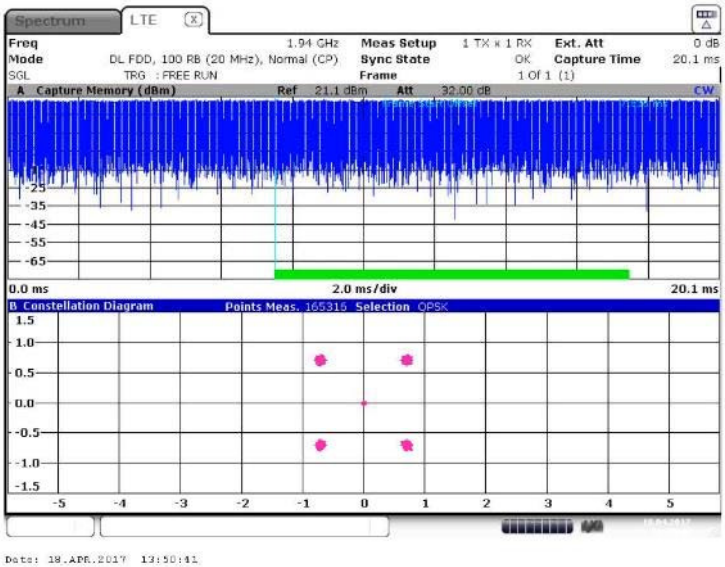


Figure 5 I/Q constellation diagram with capture buffer – QPSK (1940.0 MHz) (20MHz Channel BW)

Spectrum | LTE

Freq	1.94 GHz	Meas Setup	1 TX x 1 RX	Ext. Att	0 dB
Mode	DL FDD, 100 RB (20 MHz), Normal (CP)	Sync State	OK	Capture Time	20.1 ms
SGL	TRG : FREE RUN	Frame	1 Of 1 (1)		

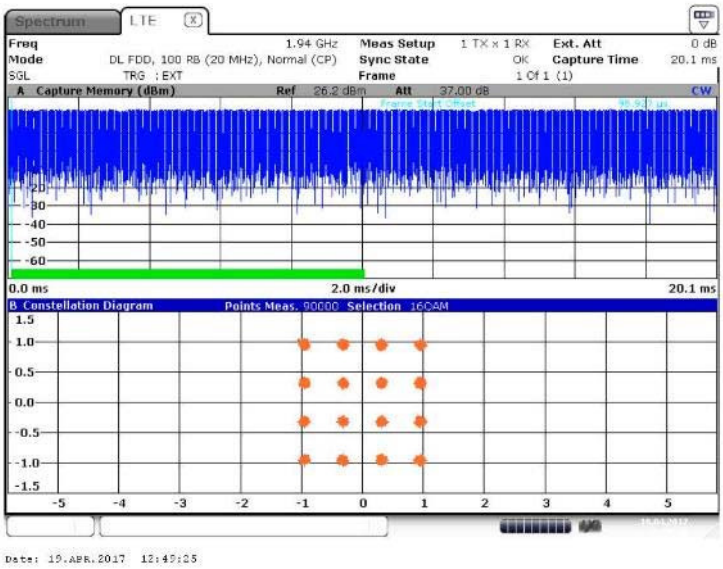
Result Summary

Frame Result 1/1	Min	Mean	Limit	Max	Limit	Unit
EVM PDSCH QPSK	1.84	1.84		1.84	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	1.45	1.82	2.20	%
EVM Phys. Channel	1.44	1.83	2.22	%
EVM Phys. Signal	1.33	1.65	1.99	%
Frequency Error	- 2.34	- 0.52	1.39	Hz
Sampling Error	- 0.05	0.02	0.08	ppm
IQ Offset	- 78.49	- 73.06	- 68.38	dB
IQ Gain Imbalance	- 0.01	- 0.00	0.00	dB
IQ Quadrature Error	- 0.04	0.01	0.03	°
RSTP	- 16.53	- 16.52	- 16.51	dBm
OSTP	14.25	14.27	14.28	dBm
Power	14.25	14.27	14.28	dBm
Crest Factor		9.14		dB

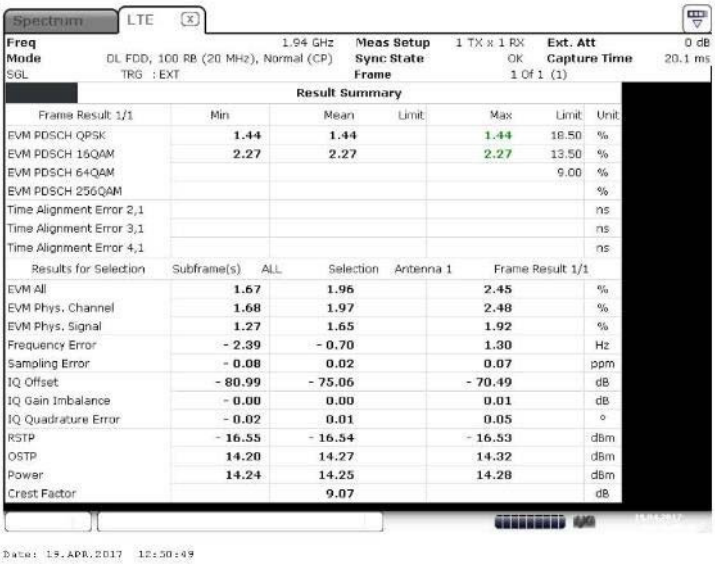
Date: 18.APR.2017 13:53:12

Figure 6 I/Q constellation table with I/Q error – QPSK (1940.0 MHz) (20MHz Channel BW)



Date: 19.APR.2017 12:49:25

Figure 7 I/Q constellation diagram with capture buffer – 16QAM (1940.0 MHz) (20MHz Channel BW)



Spectrum | LTE

Freq	1.94 GHz	Meas Setup	1 TX x 1 RX	Ext. Att	0 dB
Mode	DL FDD, 100 RB (20 MHz), Normal (CP)	Sync State	OK	Capture Time	20.1 ms
SGL	TRG : EXT	Frame	1 Of 1 (1)		

Result Summary

Frame Result 1/1	Min	Mean	Limit	Max	Limit	Unit
EVM PDSCH QPSK	1.44	1.44		1.44	18.50	%
EVM PDSCH 16QAM	2.27	2.27		2.27	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	1.67	1.96		2.45	%
EVM Phys. Channel	1.68	1.97		2.48	%
EVM Phys. Signal	1.27	1.65		1.92	%
Frequency Error	- 2.39	- 0.70		1.30	Hz
Sampling Error	- 0.08	0.02		0.07	ppm
IQ Offset	- 80.99	- 75.06		- 70.49	dB
IQ Gain Imbalance	- 0.00	0.00		0.01	dB
IQ Quadrature Error	- 0.02	0.01		0.05	°
RSTP	- 16.55	- 16.54		- 16.53	dBm
OSTP	14.20	14.27		14.32	dBm
Power	14.24	14.25		14.28	dBm
Crest Factor		9.07			dB

Date: 19.APR.2017 12:50:49

Figure 8 I/Q constellation table with I/Q error – 16QAM (1940.0 MHz) (20MHz Channel BW)

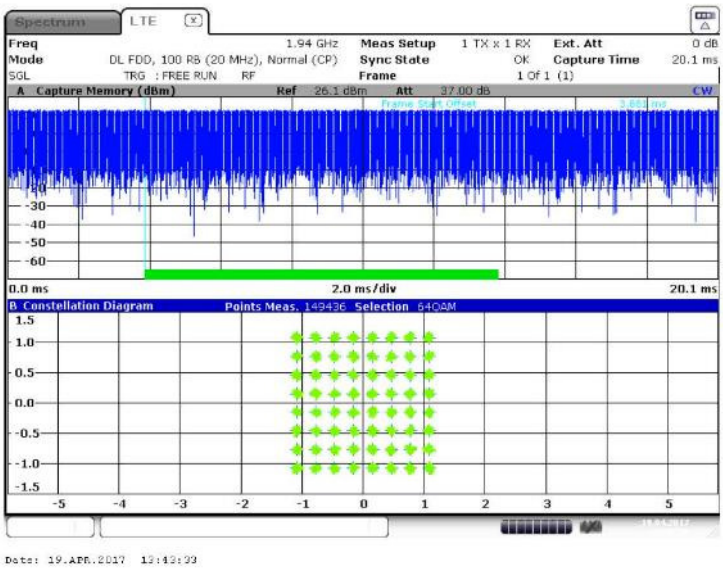


Figure 9 I/Q constellation diagram with capture buffer – 64QAM (1940.0 MHz) (20MHz Channel BW)

Figure 10 I/Q constellation table with I/Q error – 64QAM (1940.0 MHz) (20MHz Channel BW)

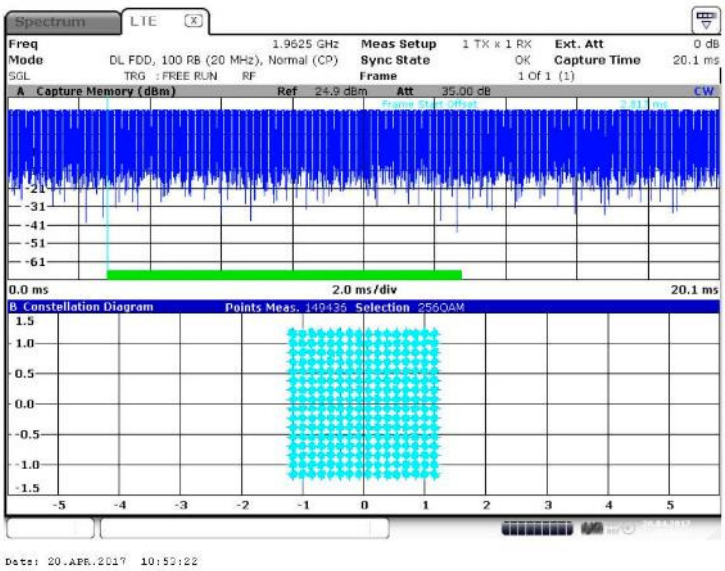
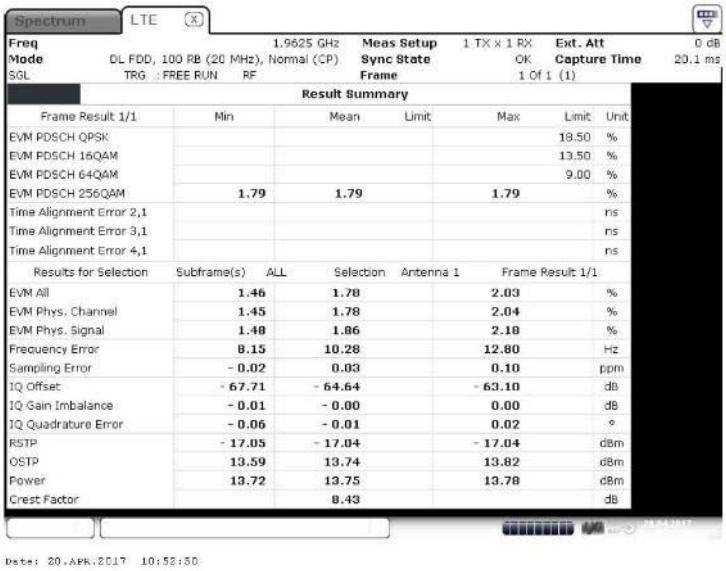


Figure 11 I/Q constellation diagram with capture buffer – 256QAM (1940.0 MHz) (20MHz Channel BW)



Spectrum | LTE

Freq	1.9625 GHz	Meas Setup	1 TX x 1 RX	Ext. Att	0 dB
Mode	DL FDD, 100 RB (20 MHz), Normal (CP)	Sync State	OK	Capture Time	20.1 ms
SGL	TRG : FREE RUN RF	Frame	1 Of 1 (1)		

Result Summary

Frame Result 1/1	Min	Mean	Limit	Max	Limit	Unit
EVM PDSCH QPSK					18.50	%
EVM PDSCH 16QAM					13.50	%
EVM PDSCH 64QAM					9.00	%
EVM PDSCH 256QAM	1.79	1.79		1.79		%
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	1.46	1.78	2.03	%
EVM Phys. Channel	1.45	1.78	2.04	%
EVM Phys. Signal	1.48	1.86	2.18	%
Frequency Error	8.15	10.28	12.80	Hz
Sampling Error	- 0.02	0.03	0.10	ppm
IQ Offset	- 67.71	- 64.64	- 63.10	dB
IQ Gain Imbalance	- 0.01	- 0.00	0.00	dB
IQ Quadrature Error	- 0.06	- 0.01	0.02	°
RSTP	- 17.05	- 17.04	- 17.04	dBm
OSTP	13.59	13.74	13.82	dBm
Power	13.72	13.75	13.78	dBm
Crest Factor		8.43		dB

Date: 20.APR.2017 10:52:50

Figure 12 I/Q constellation table with I/Q error – 256QAM (1940.0 MHz) (20MHz Channel BW)

5.2.2. Test No. 3: Occupied Bandwidth

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

Config A ANT1:

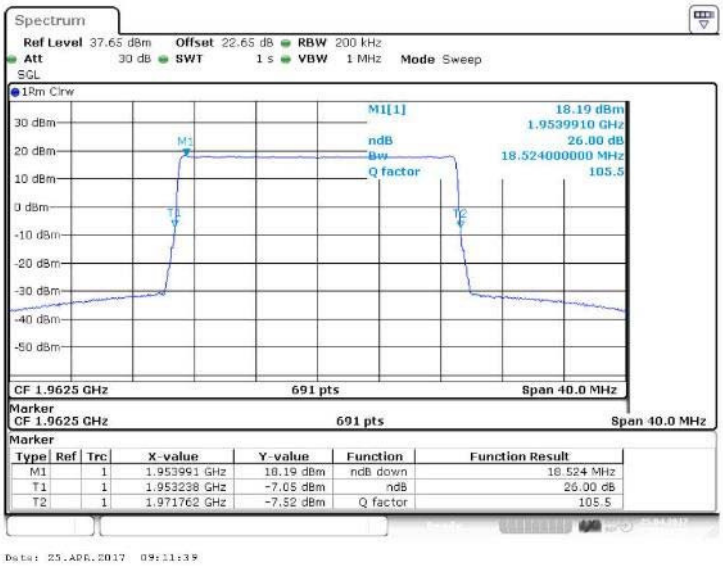


Figure 13 Occupied Bandwidth – QPSK (1962.5 MHz) (20MHz Channel BW)

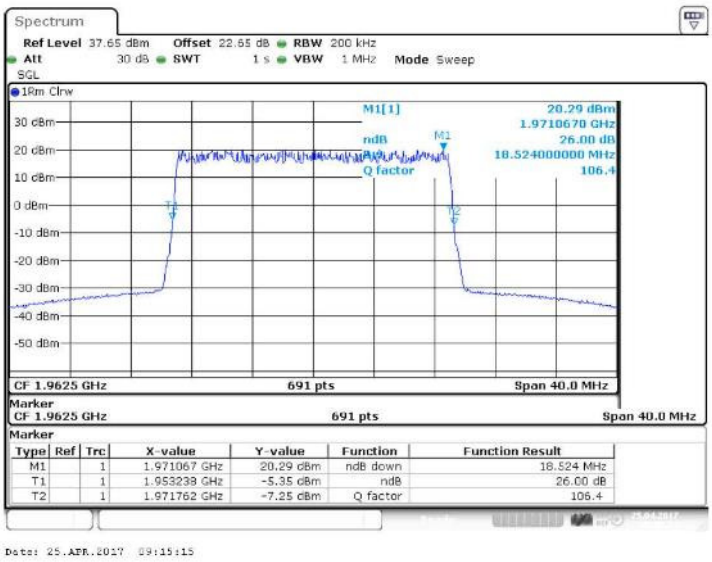


Figure 14 Occupied Bandwidth – 16QAM (1962.5 MHz) (20MHz Channel BW)

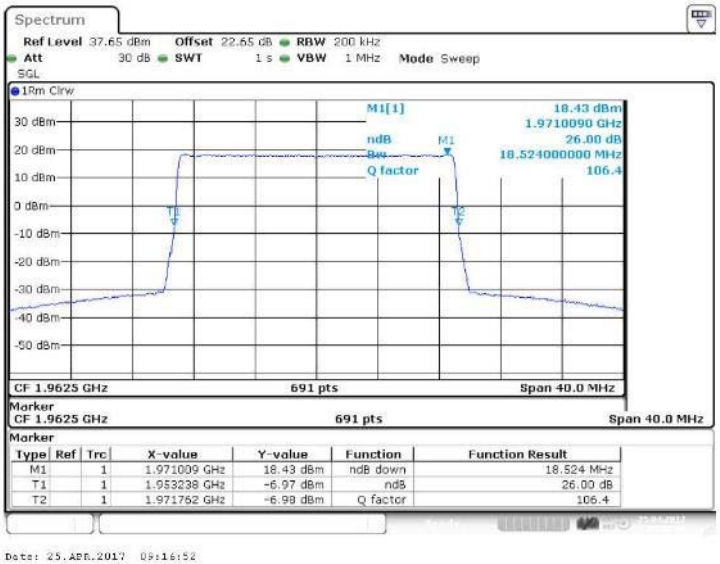


Figure 15 Occupied Bandwidth – 64QAM (1962.5 MHz) (20MHz Channel BW)

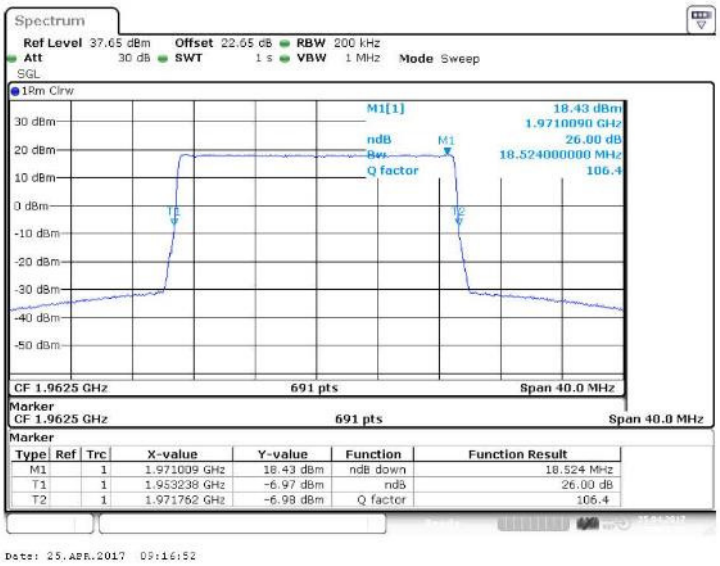


Figure 16 Occupied Bandwidth – 256QAM (1962.5 MHz) (20MHz Channel BW)

Config A ANT2:

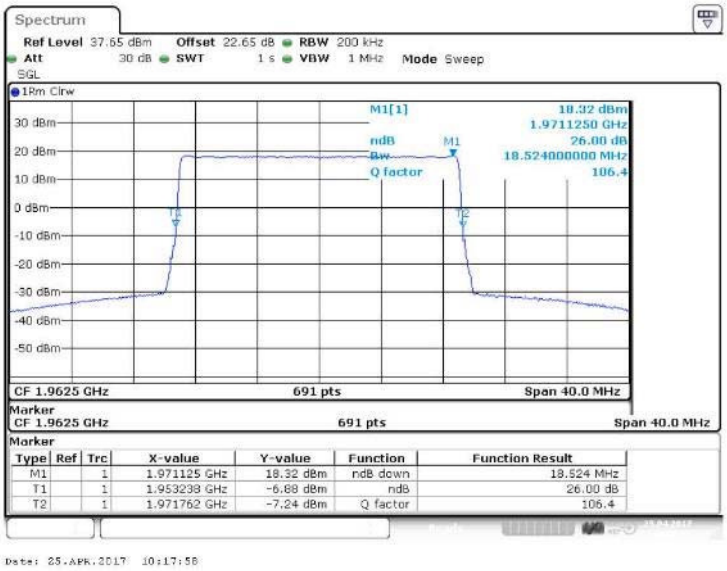


Figure 17 Occupied Bandwidth – QPSK (1962.5 MHz) (20MHz Channel BW)

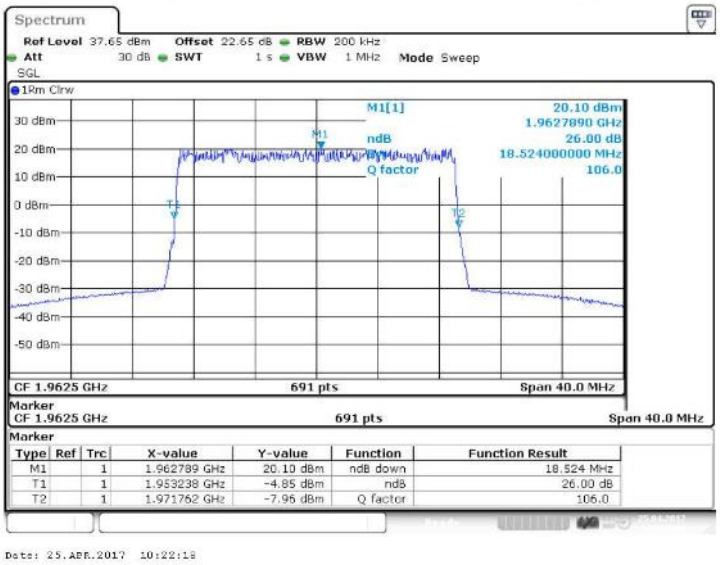


Figure 18 Occupied Bandwidth – 16QAM (1962.5 MHz) (20MHz Channel BW)

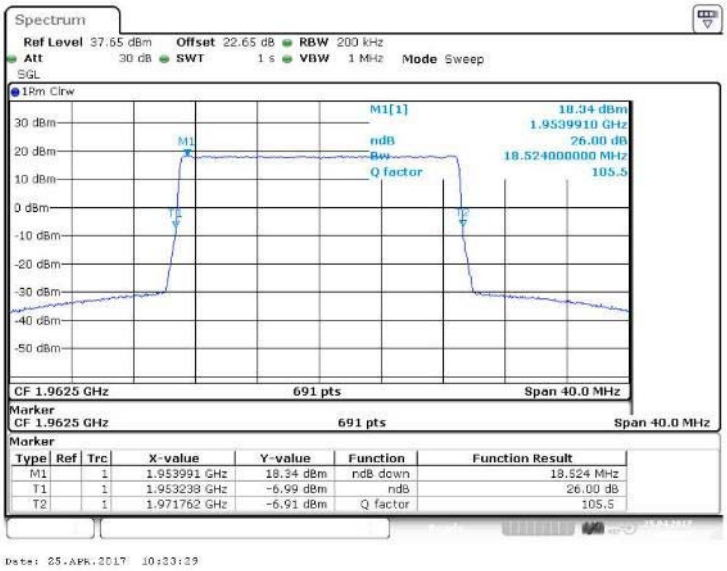


Figure 19 Occupied Bandwidth – 64QAM (1962.5 MHz) (20MHz Channel BW)

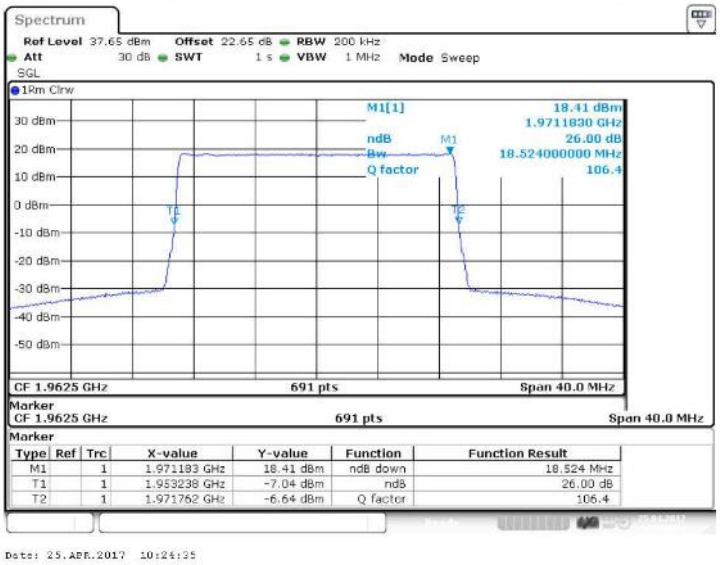


Figure 20 Occupied Bandwidth – 256QAM (1962.5 MHz) (20MHz Channel BW)

Config A ANT3:

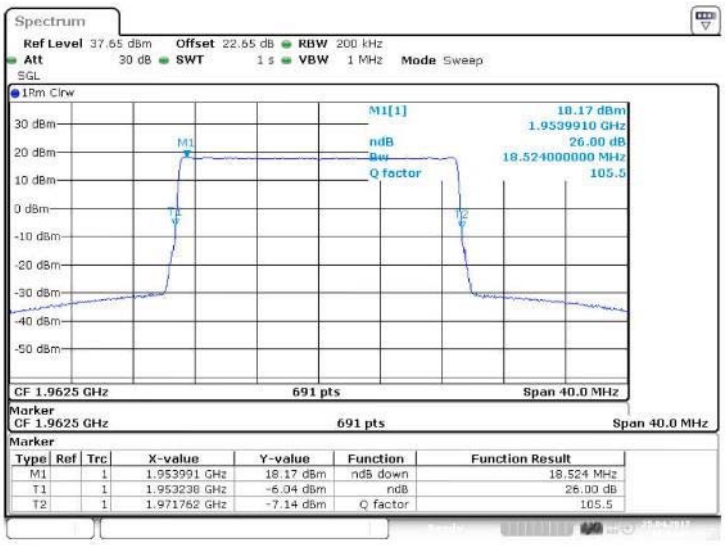


Figure 21 Occupied Bandwidth – QPSK (1962.5 MHz) (20MHz Channel BW)

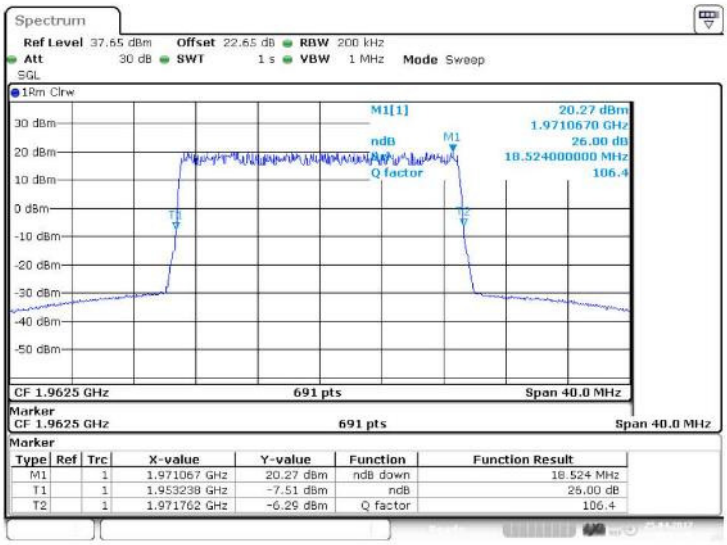


Figure 22 Occupied Bandwidth – 16QAM (1962.5 MHz) (20MHz Channel BW)

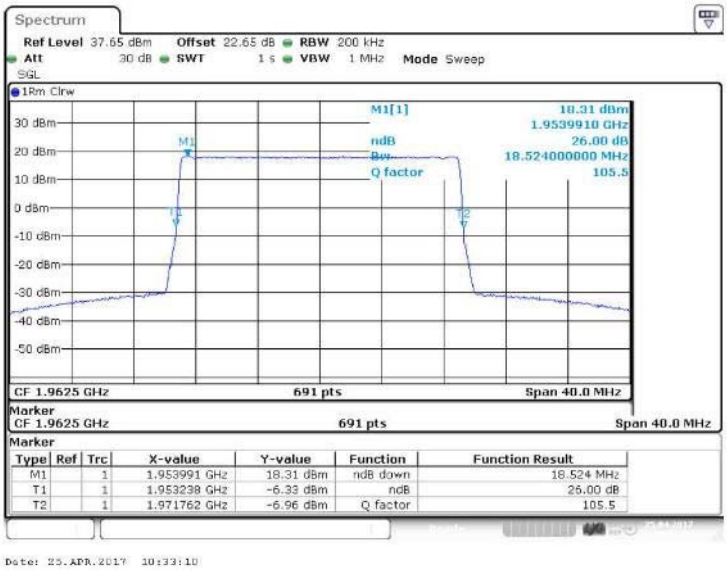


Figure 23 Occupied Bandwidth – 64QAM (1962.5 MHz) (20MHz Channel BW)

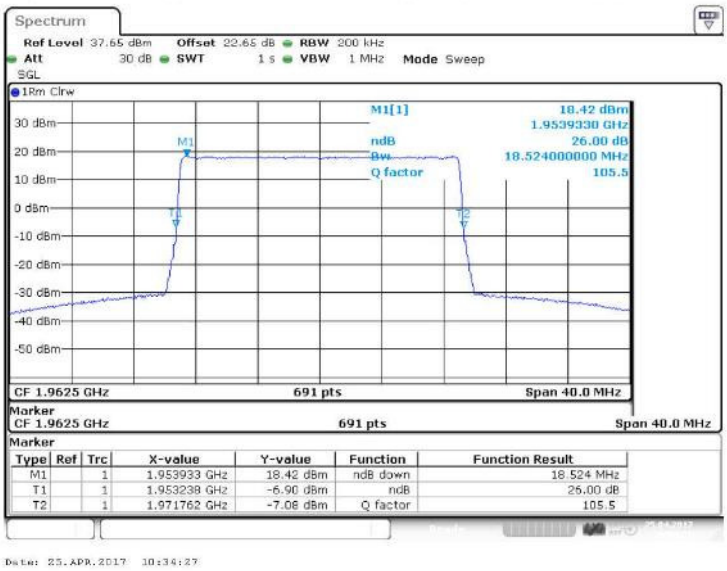


Figure 24 Occupied Bandwidth – 256QAM (1962.5 MHz) (20MHz Channel BW)

Config A ANT4:

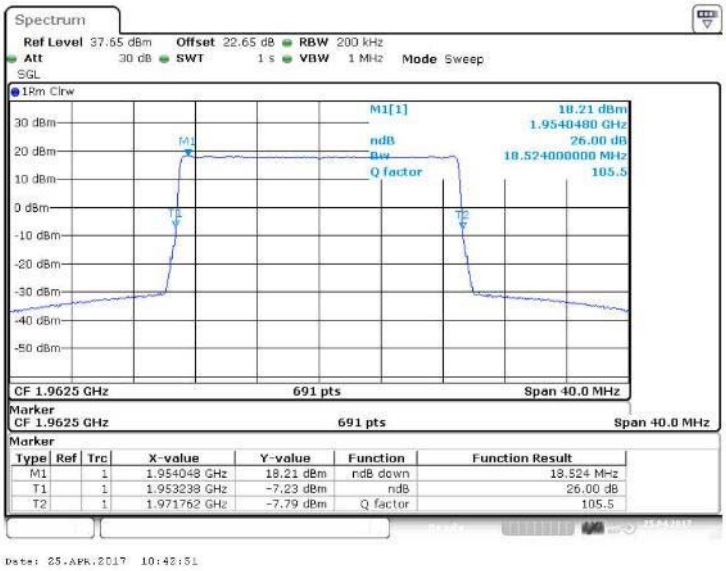


Figure 25 Occupied Bandwidth – QPSK (1962.5 MHz) (20MHz Channel BW)

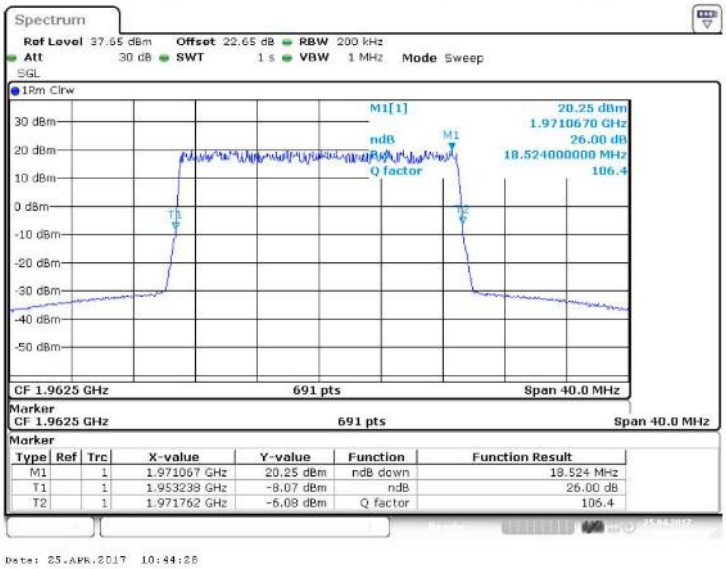


Figure 26 Occupied Bandwidth – 16QAM (1962.5 MHz) (20MHz Channel BW)

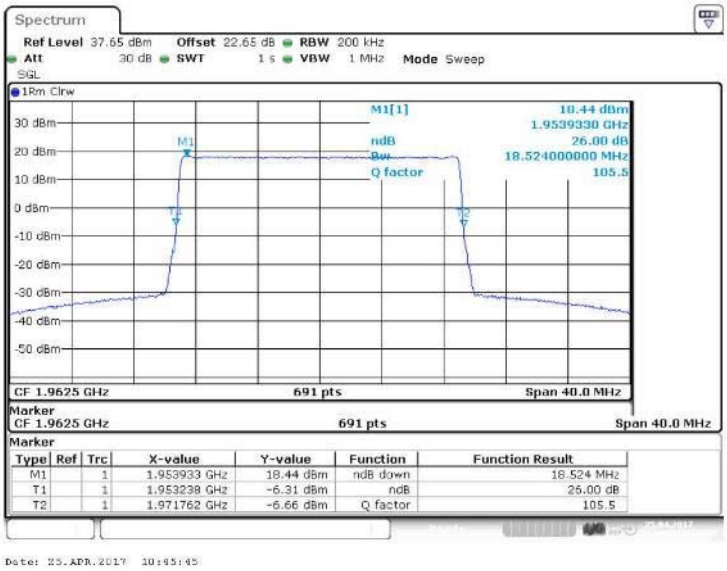


Figure 27 Occupied Bandwidth – 64QAM (1962.5 MHz) (20MHz Channel BW)

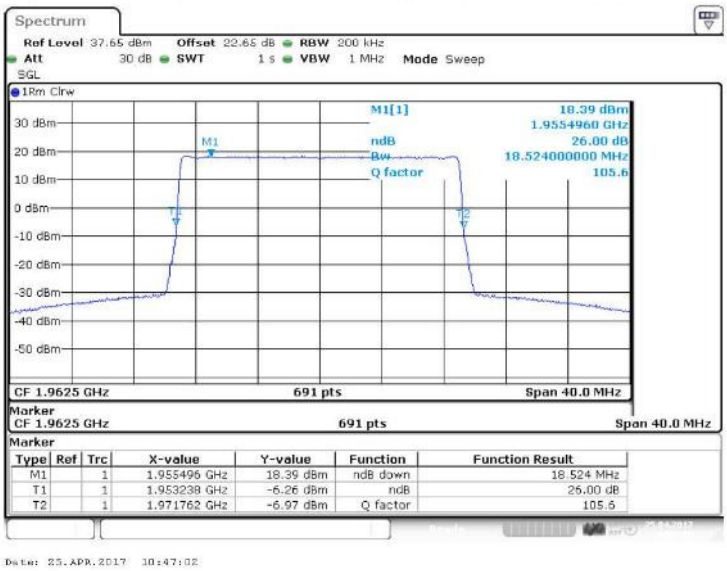


Figure 28 Occupied Bandwidth – 256QAM (1962.5 MHz) (20MHz Channel BW)

5.2.3. Test No. 4: Spurious Emissions at the Antenna Terminals

The external attenuation (cable loss of the setup) can be seen as the 'Offset' value in the screenshots. The external attenuation is frequency dependant. Thus the various 'Offset' values in the screenshots may differ.

Config A ANT1:

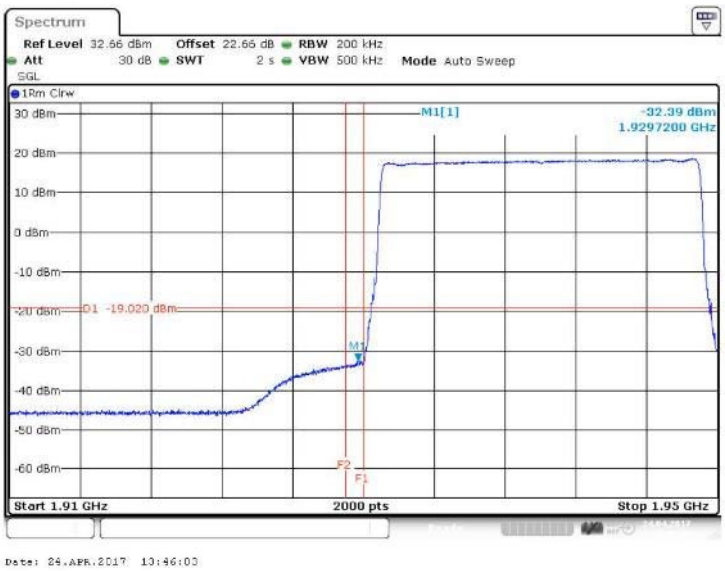


Figure 29 Spurious Emissions (Lower Band Edge) – QPSK (1940.0 MHz) (20MHz Channel BW)

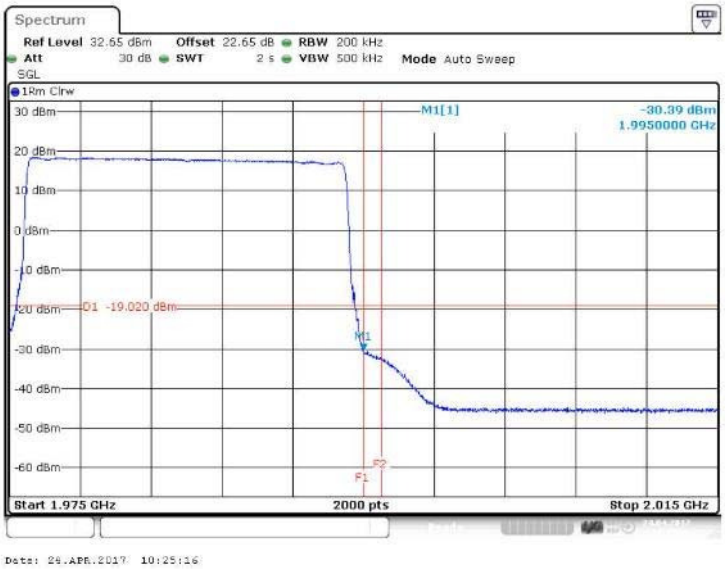


Figure 30 Spurious Emissions (Upper Band Edge) – QPSK (1985.0 MHz) (20MHz Channel BW)

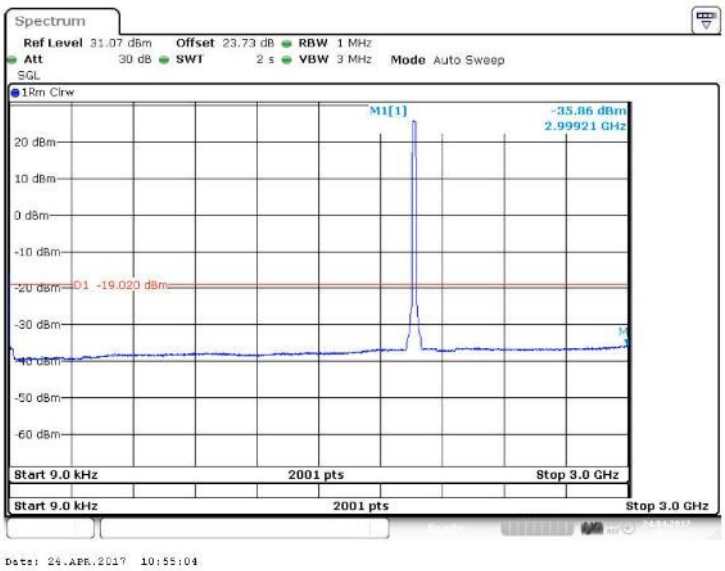


Figure 31 Spurious Emissions (9kHz – 3GHz) - QPSK (1962.5MHz) (20MHz Channel BW)

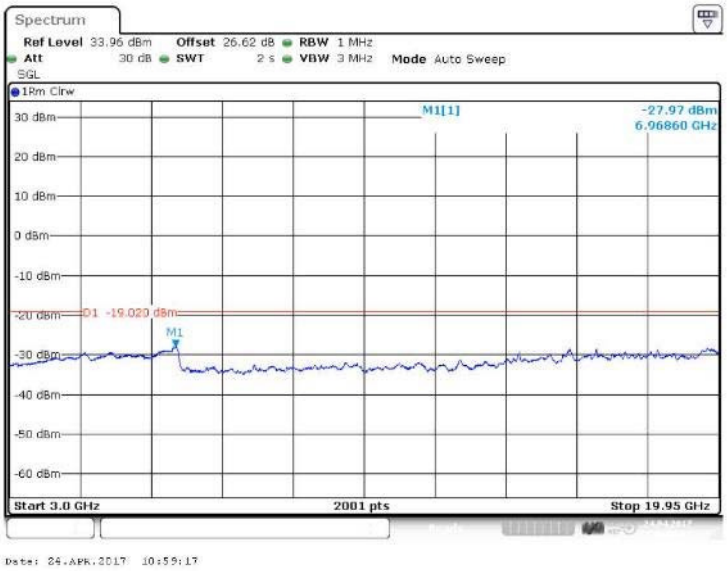


Figure 32 Spurious Emissions (3GHz – 19.950GHz) – QPSK (1962.5 MHz) (20MHz Channel BW)

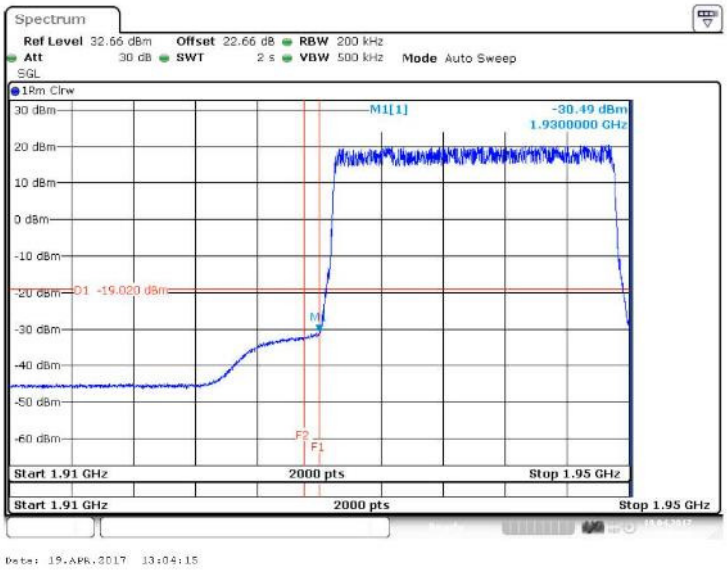


Figure 33 Spurious Emissions (Lower Band Edge) – 16QAM (1940.0 MHz) (20MHz Channel BW)

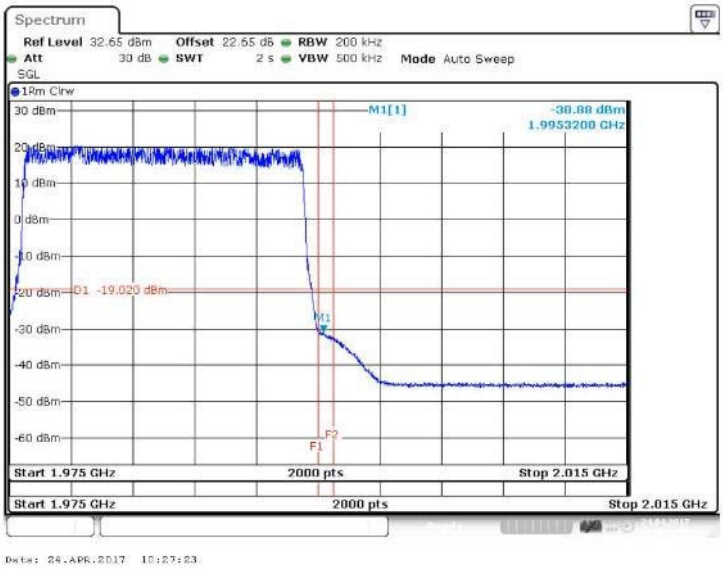


Figure 34 Spurious Emissions (Upper Band Edge) – 16QAM (1985.0 MHz) (20MHz Channel BW)

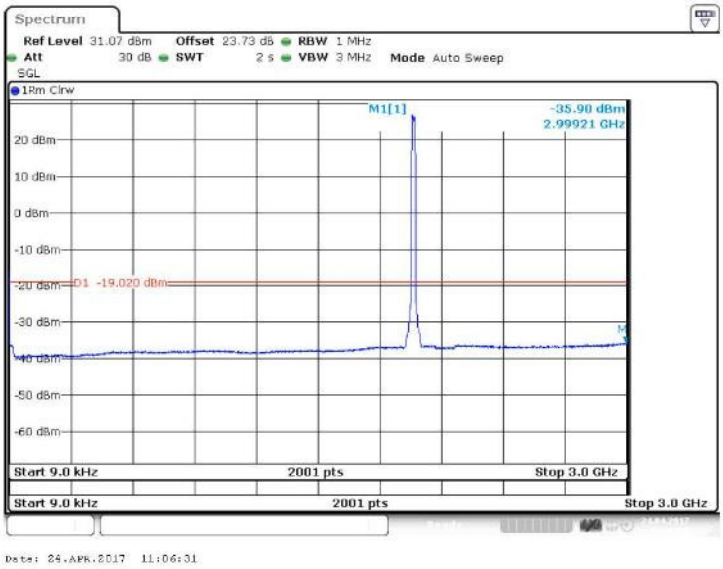


Figure 35 Spurious Emissions (9kHz – 3GHz) – 16QAM (1962.5 MHz) (20MHz Channel BW)

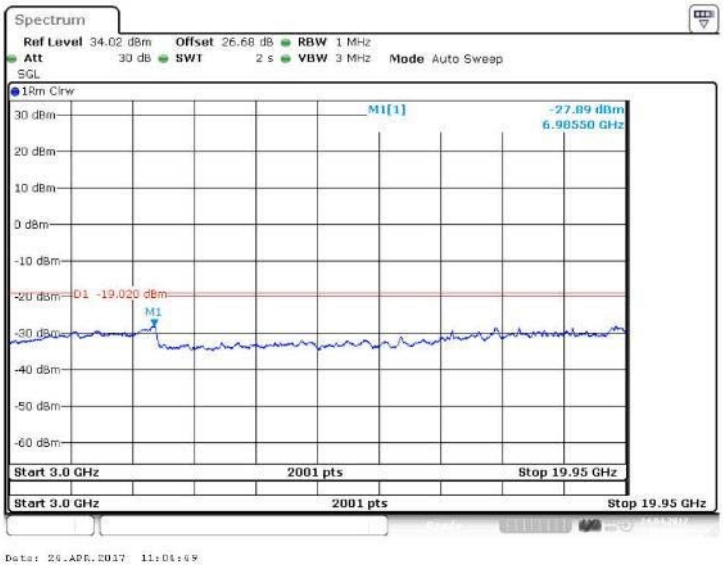


Figure 36 Spurious Emissions (3GHz – 19.950GHz) – 16QAM (1962.5 MHz) (20MHz Channel BW)

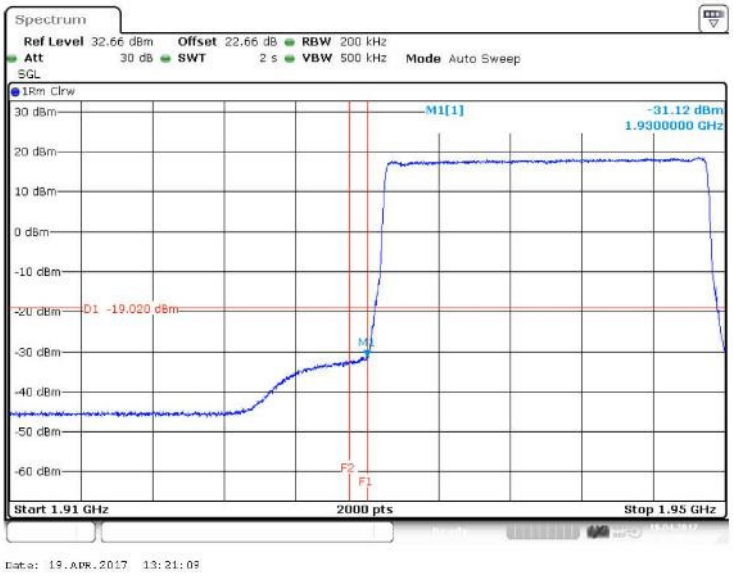
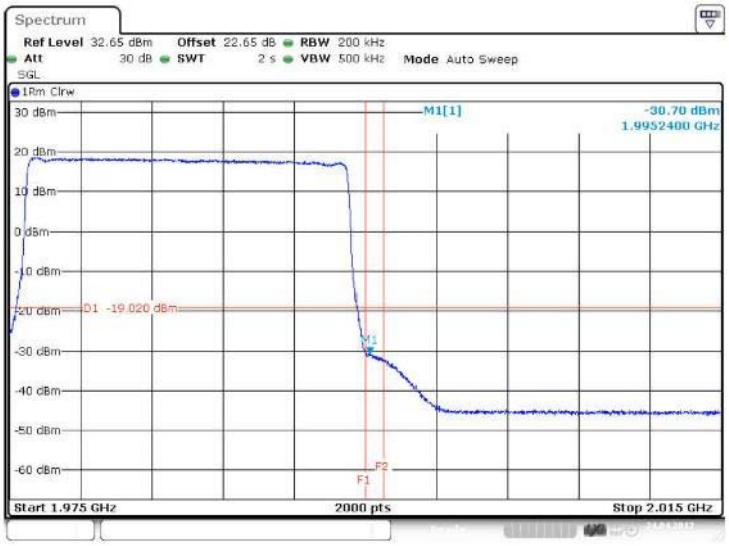
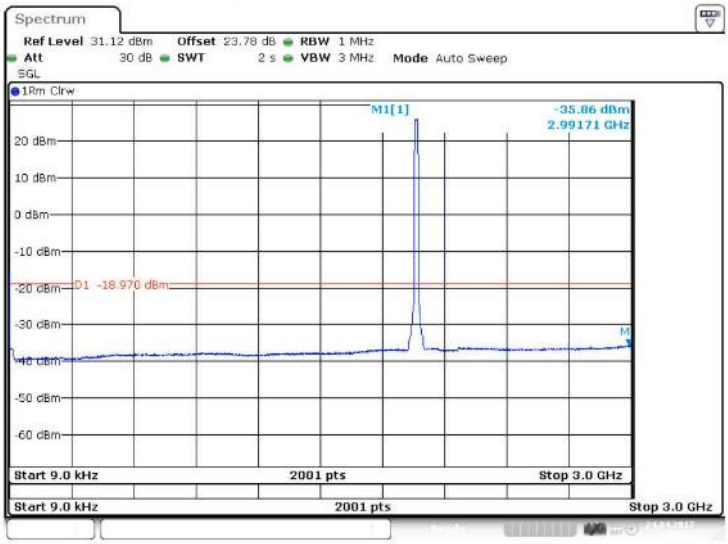


Figure 37 Spurious Emissions (Lower Band Edge) – 64QAM (1940.0 MHz) (20MHz Channel BW)



Date: 24.APR.2017 10:29:56

Figure 38 Spurious Emissions (Upper Band Edge) – 64QAM (1985.0 MHz) (20MHz Channel BW)



Date: 24.APR.2017 11:13:32

Figure 39 Spurious Emissions (9kHz – 3GHz) – 64QAM (1962.5 MHz) (20MHz Channel BW)

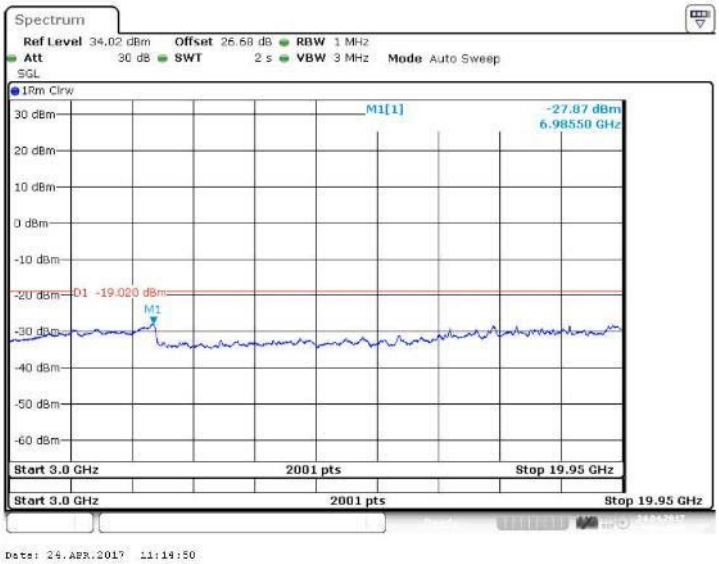


Figure 40 Spurious Emissions (3GHz – 19.950GHz) – 64QAM (1962.5 MHz) (20MHz Channel BW)

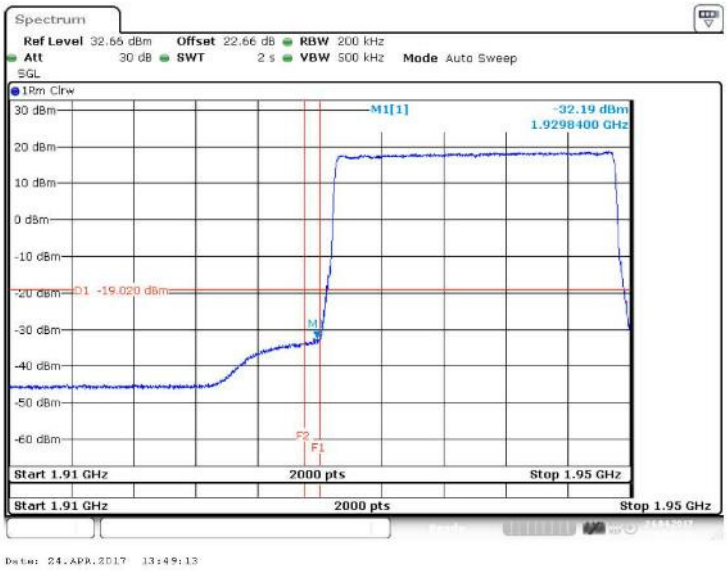


Figure 41 Spurious Emissions (Lower Band Edge) – 256QAM (1940.0 MHz) (20MHz Channel BW)

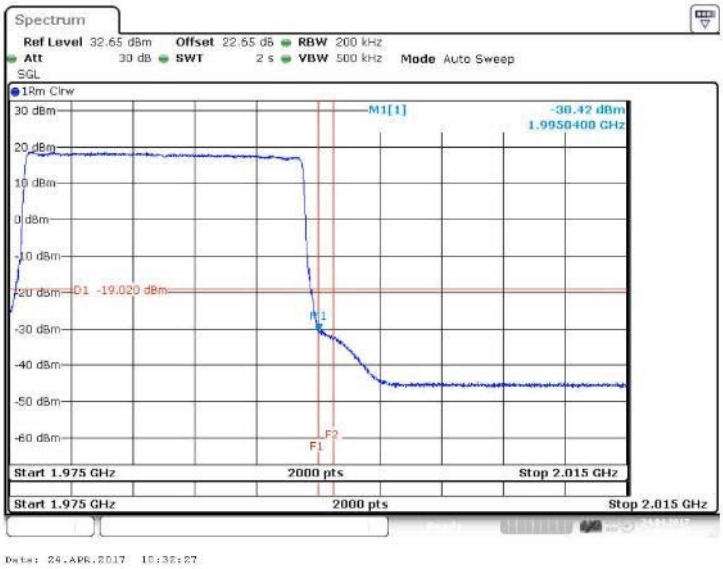


Figure 42 Spurious Emissions (Upper Band Edge) – 256QAM (1985.0 MHz) (20MHz Channel BW)

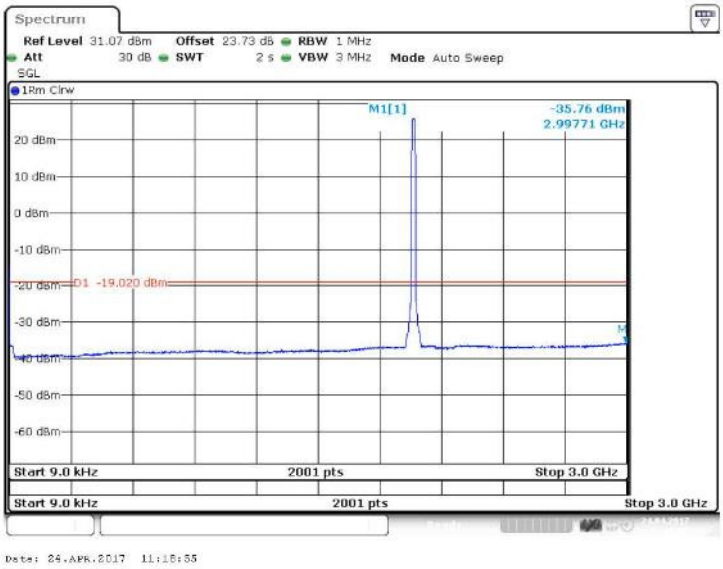


Figure 43 Spurious Emissions (9kHz – 3GHz) – 256QAM (1962.5 MHz) (20MHz Channel BW)

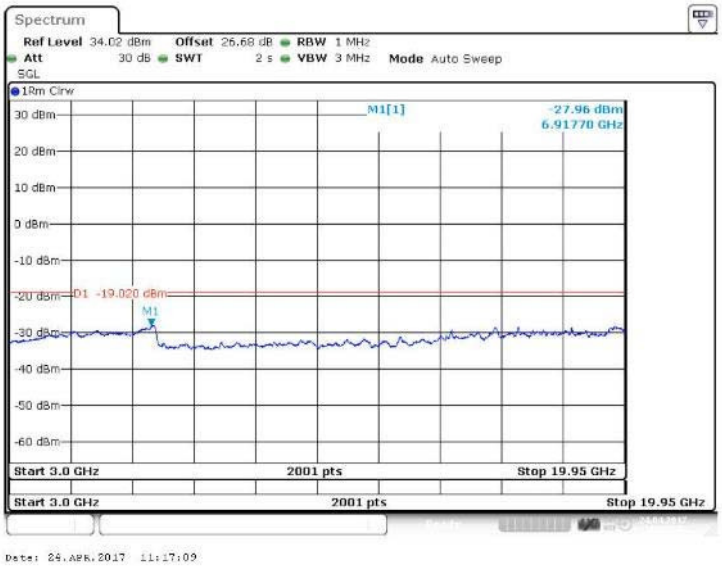


Figure 44 Spurious Emissions (3GHz – 19.950GHz) – 256QAM (1962.5 MHz) (20MHz Channel BW)

Config A ANT2:

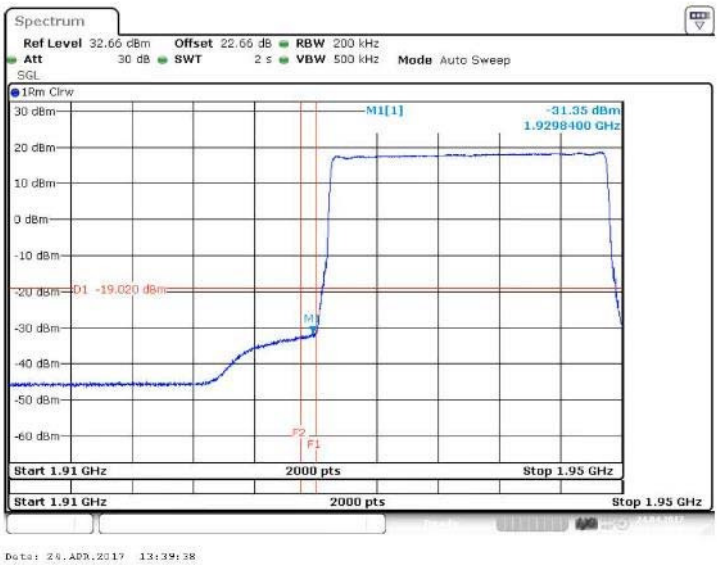


Figure 45 Spurious Emissions (Lower Band Edge) – QPSK (1940.0 MHz) (20MHz Channel BW)

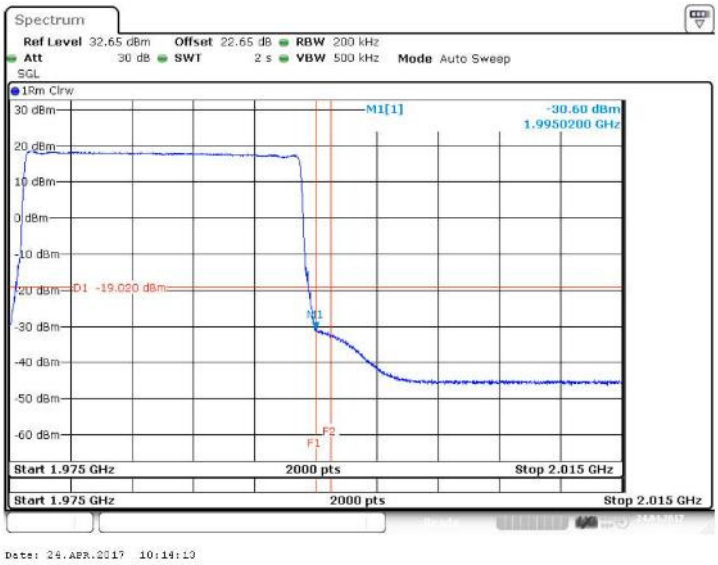


Figure 46 Spurious Emissions (Upper Band Edge) – QPSK (1985.0 MHz) (20MHz Channel BW)

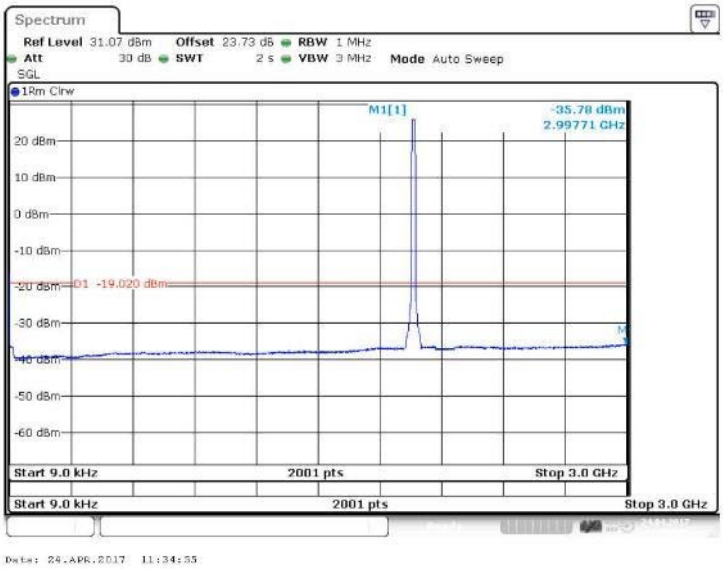


Figure 47 Spurious Emissions (9kHz – 3GHz) - QPSK (1962.5 MHz) (20MHz Channel BW)

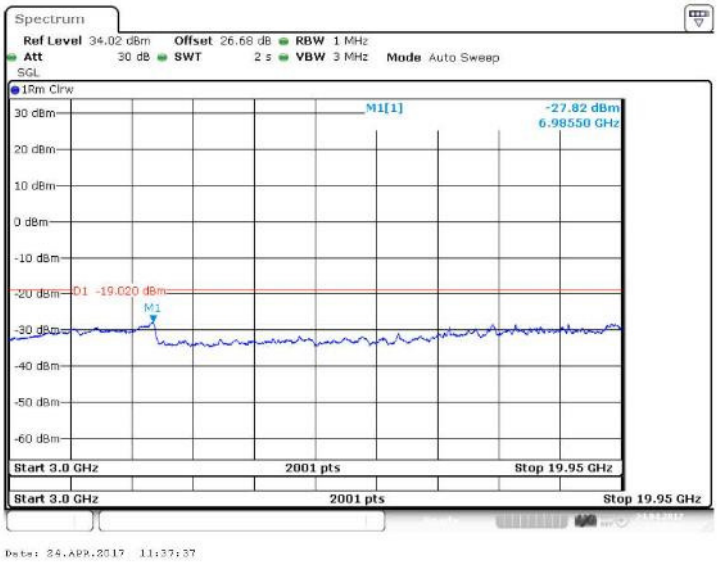


Figure 48 Spurious Emissions (3GHz – 19.950GHz) – QPSK (1962.5 MHz) (20MHz Channel BW)

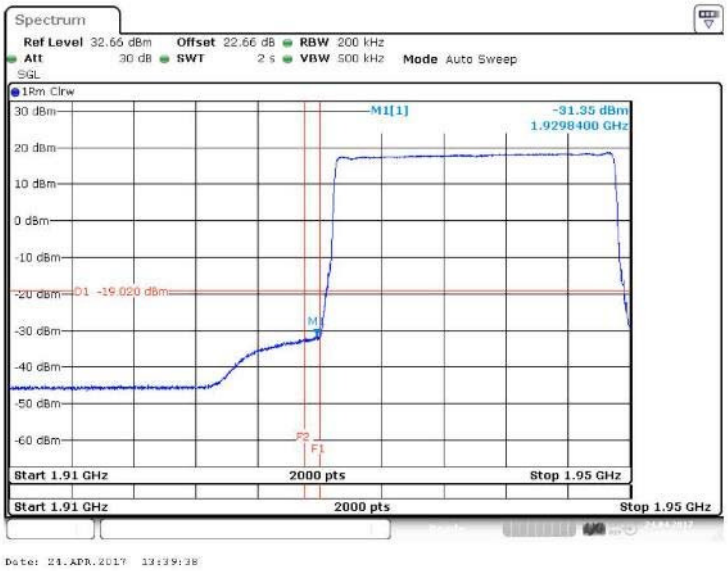


Figure 49 Spurious Emissions (Lower Band Edge) – 16QAM (1940.0 MHz) (20MHz Channel BW)

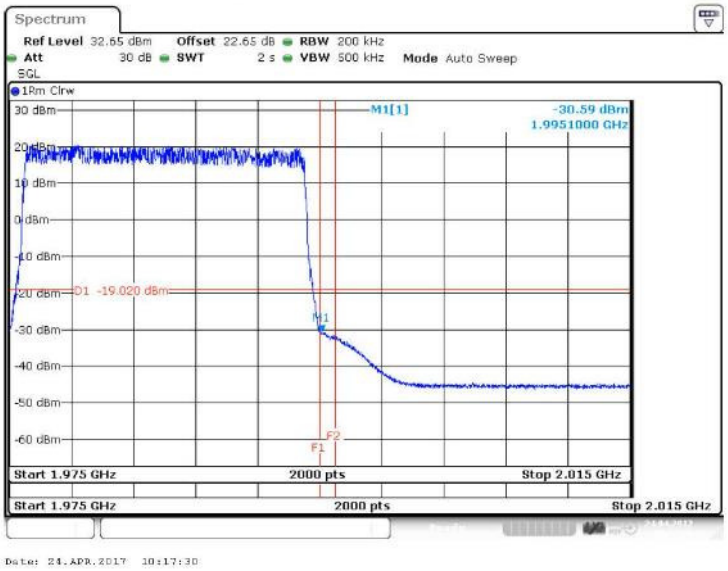


Figure 50 Spurious Emissions (Upper Band Edge) – 16QAM (1985.0 MHz) (20MHz Channel BW)