



2360

Radio Test Report

Domo Tactical Communications

NIM2113

47 CFR Part 27 Effective Date 1st October 2018

47 CFR Part 2 Effective Date 1st October 2018

Test Date: 22nd January 2019 to 25th January 2019

Report Number: 01-11147-1-19 Issue 01

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Certificate of Test 11147-1

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of FCC Parts 27. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	NIM2113
Model Number:	NIM2113
Unique Serial Number:	NIM-1001
Applicant:	Domo Tactical Communications Fusion 2, 1100 Parkway Whiteley, Hampshire, PO15 7AB
Proposed FCC ID	XRF-NIM2113
Full measurement results are detailed in Report Number:	01-11147-1-19 issue 01
Test Standards:	47 CFR Part 27 Effective Date 1st October 2018 47 CFR Part 2 Effective Date 1st October 2018

NOTE:

Certain tests were not performed based upon manufacturer's declarations. Certain other requirements are subject to manufacturer declaration only and have not been tested/verified. For details refer to section 3 of this report.

This report only pertains to the operation of the equipment to 47CFR part 27, for details of testing to other rule parts please see RN report: 01-11147-2-19 (Parts 22 & 24).

DEVIATIONS:

No deviations have been applied.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Date Of Test: 22nd January 2019 to 25th January 2019

Test Engineer:

Approved By:

Radio Approvals Manager

Customer

Representative:



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2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Domo Tactical Communications Fusion 2, 1100 Parkway Whiteley, Hampshire PO15 7AB	
Manufacturer of EUT	Domo Tactical Communications	
Full Name of EUT	NIM2113	
Model Number of EUT	NIM2113	
Serial Number of EUT	NIM-1001	
Date Received	22 nd January 2019	
Date of Test:	22 nd January 2019 to 25 th January 2019	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	25 th January 2019	
Main Function	Vehicle mount LTE base station	
Information Specification	Height	232mm
	Width	453mm
	Depth	417mm
	Weight	27kg
	Voltage	24V DC nominal
	Current	54A (1300W)

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Vehicle mounted
Choice of model(s) for type tests	Production prototype
Antenna details	Not specified
Antenna port	Yes
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2152.5 MHz
Lowest Signal generated in EUT	Not specified
Hardware Version	SA4336 issue 1
Software Version	GUI 6.1.30 F-30
Firmware Version	6.0 R-1 build 116 image 151
Type of Equipment	Base station
Technology Type	Cellular
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	2110- 2155 MHz
EUT Declared Modulation Parameters	Device supports UMTS/LTE QPSK
EUT Declared Power level	+46dBm Peak (UMTS), +43dBm Peak (LTE)
EUT Declared Signal Bandwidths	5MHz (QPSK)
EUT Declared Channel Spacing's	UMTS/LTE 5MHz.
EUT Declared Duty Cycle	up to 100%
Unmodulated carrier available?	No
Declared frequency stability	1ppm
RX Parameters	
Alignment range – receiver	N/A
EUT Declared RX Signal Bandwidth	N/A
Receiver Signal Level (RSL)	N/A
Method of Monitoring Receiver BER	N/A

2.3 Functional description

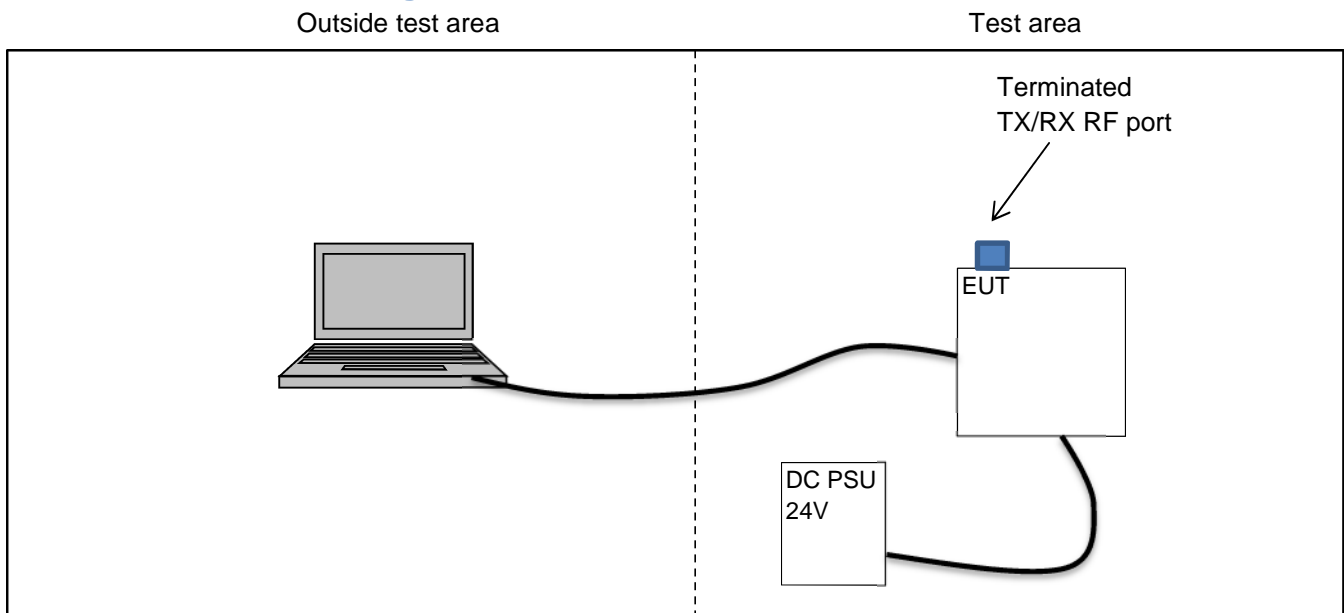
19" rack mounted device providing cellular downlink connectivity in the following bands: Band 5 GSM, band 2 UMTS and LTE, Band 4 UMTS and LTE.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 10	EUT generating a UMTS signal of 40W @ 2112.5 MHz	Yes
Mode 11	EUT generating a UMTS signal of 40W @ 2132.5 MHz	Yes
Mode 12	EUT generating a UMTS signal of 40W @ 2152.5 MHz	Yes
Mode 13	EUT generating a LTE signal of 25W @ 2117.5 MHz	Yes
Mode 14	EUT generating a LTE signal of 25W @ 2132.5 MHz	Yes
Mode 15	EUT generating a LTE signal of 25W @ 2147.5 MHz	Yes

Note: This report only pertains to the operation of the equipment to 47CFR part 27, for details of testing to other rule parts please see RN reports: 01-11147-2-19 (Parts 22 & 24).

2.5 Emissions configuration



The unit was powered from a DC supply at 24 V DC. The unit was configured for maximum power on each of low, Middle and high channels in the relevant operating bands as listed in the modes section (2.4) and detailed below.

For conducted RF tests the RF ports were connected via suitable attenuation and filtering where required and connected directly to a spectrum analyser, with losses accounted for in the measurement results. For radiated tests a suitable attenuator and load were used to terminate the TX port.

The equipment does not operate on all available channels and top, middle and bottom channels for each band and radio services are:

Mode	Cellular service	Band	Transmit power (W)	Bottom channel (MHz)	Middle channel (MHz)	Top channel (MHz)
10	UMTS	Band 4	40	2112.5		
11					2132.5	
12						2152.5
13	LTE	Band 4	25	2117.5		
14					2132.5	
15						2147.5

In addition to the above table the EUT transmits the same waveform at all frequencies in all bands, and the measured duty cycles for test modes are as follows:

Band	On time (ms)	Period (ms)	Duty cycle (%)	Duty Cycle (dB)
UMTS	-	-	100.0	0
LTE	4.752	10.92	43.5	3.6

2.5.1 Signal leads

Port Name	Cable Type	Connected
Sync In	SMA	No
Sync Out	SMA	No
Power	4-pin connector	Yes
Antenna Port 1	N-type connector	Yes
Antenna Port 2-6	N-type connector	No
Ethernet Port 1	Unscreened	Yes
Ethernet Port 2-6	Unscreened	No
Data	Custom	No
Spectrum Scanner	SMA	No
WiFi Antenna Port	SMA	No
GPS Antenna Port	SMA	No
Remote port	Custom	No

Note: Ports marked not connected above are not used in this equipment configuration and application.

3 Summary of test results

The NIM2113 was tested for compliance to the following standard(s) :

47 CFR Part 27 Effective Date 1st October 2018
47 CFR Part 2 Effective Date 1st October 2018

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. Spurious emissions at antenna terminals	FCC Part 27 Clause 27.53(a)(g)(h)(m)2 FCC Part 2 Clause 2.1051	PASSED ¹
2. RF Power Output	FCC Part 27 Clause 27.50(c)(d)(a)(h) FCC Part 2 Clause 2.1046	PERFORMED ²
3. Frequency stability	FCC Part 2 Clause 2.1055	PASSED ³
4. Occupied bandwidth	FCC Part 2 Clause 2.1049	PASSED
5. Field strength of spurious radiations	FCC Part 27 Clause 27.53(a)(g)(h)(m)2 FCC Part 2 Clause 2.1053	PASSED ¹
6. Band edge emissions	FCC Part 27 Clause 27.53(a)(g)(h)(m)2 FCC Part 2 Clause 2.1051	PASSED
7. Modulation characteristics	FCC Part 2 Clause 2.1047	PROVIDED ⁴

¹ Spectrum investigated started at a frequency of 30MHz up to a frequency of 22GHz based on 10 times the highest channel of 2152.5 MHz.

² Power limits are referenced to ERP in the rule parts and are decided upon at time of licensing and based on geographical location.

³ Test not performed, please see frequency stability results in RN report 01-11147-2-19 for stability information in GSM mode.

⁴ Modulation characteristics information provided in section 2.2.

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	FCC Part 27	2018	Miscellaneous Wireless Communications Services
4.1.2	47CFR part 2J	2018	Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations
4.1.3	KDB 971168 D01 v03	2017	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement Guidance for Certification of Licensed Digital Transmitters
4.1.4	ANSI C63.26	2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

4.2 Deviations

No deviations were applied.

4.3 Tests at extremes of temperature & voltage

The following test conditions were used to simulate testing at nominal or extremes.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	24V DC
T minimum	0 °C	V minimum	20.4V DC
T maximum	50 °C	V maximum	27.6V DC

Extremes of voltage are based upon manufacturer's declaration.

Extremes of temperature are based upon FCC rules requirements and manufacturers declarations.

The ambient test conditions of humidity and pressure in the laboratory were as specified in each specific test section within this report

5 Tests, methods and results

5.1 Spurious emissions at antenna terminals

5.1.1 Test methods

Test Requirements:	FCC Part 27 Clause 27.53 [Reference 4.1.1 of this report] FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 2015 Clause 5.5 [Reference 4.1.4 of this report]
Limits:	FCC Part 22 Clause 27.53 [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. EUT was tested using modes 10 – 15. Modes are specified in section 2.4 of this report.

5.1.3 Test procedure

Tests were made in accordance with the test method noted above using the measuring equipment listed in the 'Test Equipment' Section. The EUT was set up to transmit at full power for the appropriate band and modulation scheme (see section 2.5) using an ancillary laptop connected to the Ethernet port of the EUT. Attenuation was used between the EUT TX port and the analyser. Measurements were made and plots taken in the required Resolution bandwidths using an RMS detector with max hold and duty cycle offset applied. LTE measurements in the range 2 – 2.105 GHz and 2.16 – 2.21 GHz and 2nd harmonics were made using an RMS detector and max hold.

Tests were performed in test site N.

5.1.4 Test equipment

E420, E755, E777, E866

See Section 8 for more details

5.1.5 Test results

Temperature of test environment	18-23°C
Humidity of test environment	30-42%
Pressure of test environment	101kPa

For band edge results please refer to section 5.6 within this report

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Low channel	2112.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
4226.0	-30.5	-17.5

Note: Plots shown as additional traces on mid channel plots.

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Mid channel	2132.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
4264.5	-30.2	-17.2

Plots
Plot of conducted emissions 10 MHz – 2100 MHz range
Plot of conducted emissions 2165 MHz – 3 GHz range
Plot of conducted emissions 3 GHz – 22 GHz range

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
High channel	2152.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
4303.9	-30.4	-17.4

Note: Plots shown as additional traces on mid channel plots.

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Low channel	2117.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
2105	-14.6	-1.6
4235.0	-20.51	-7.5

Note: General Plots shown as additional traces on mid channel plots. Conducted emissions at lower band edge is on a separate plot.

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Mid channel	2132.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
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4262.6	-23.8	-10.8
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Plots
Plot of conducted emissions 10 MHz – 2000 MHz range
Plot of conducted emissions 2 GHz – 2.105 GHz range
Plot of conducted emissions 2.160 GHz – 2.210 GHz range
Plot of conducted emissions 2.210 GHz – 3 GHz range
Plot of conducted emissions 3 GHz – 22 GHz range Peak detector
Plot of conducted emissions 4.2 GHz – 4.32 GHz range RMS detector

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
High channel	2147.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
2160	-15.0	-2.0
4291.9	-23.5	-10.5

Note: General Plots shown as additional traces on mid channel plots. Conducted emissions at upper band edge is on a separate plot.

Results are also presented graphically in section 6.

LIMITS:

Parts 27.53 (h) for operation in the 2110-2200 MHz band

Absolute limits are determined from the relative limit as per example:

Limits based on $43+10\log P$. dB attenuation below Output power in Watts: i.e. +20dBm = 0.1W therefore:

$$43+10*\log 0.1 = 33\text{dB}. +20\text{dBm} - 33 = -13\text{dBm}.$$

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 2.8 dB

5.2 RF Power Output

5.2.1 Test methods

Test Requirements:	FCC Part 27 Clause 27.53(a)(g)(h)(m2) [Reference 4.1.1 of this report] FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 2015 Clause 5.2 [Reference 4.1.4 of this report]
Limits:	FCC Part 27 Clause 27.53(a)(g)(h)(m2) [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. EUT was tested in modes 10 – 15.

5.2.3 Test procedure

Tests were made in accordance with the test method noted above using the measuring equipment listed in the 'Test Equipment' Section. The EUT was set up to transmit at full power for the appropriate band and modulation scheme (see section 2.5) using an ancillary laptop connected to the Ethernet port of the EUT. Attenuation was used between the EUT TX port and the analyser. An RMS detector was set and Channel power was measured using the channel power function, plots were taken. Additionally where required the analyser CCDF function was used to determine PAPR (0.1%) and the PSD function was used to determine spectral power density.

5.2.4 Test equipment

E420, E755, E777, E866

See Section 8 for more details

5.2.5 Test results

Temperature of test environment	18-23°C
Humidity of test environment	30-42%
Pressure of test environment	101kPa

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Low channel	2112.5 MHz

Test conditions		Average Power (dBm)	Duty cycle offset (dB)	TX power (dBm)	TX Power (W)	PK to Average Power ratio (dB)
Temp Ambient	Volts Nominal	38.54	0.0	38.54	7.1	Not measured

Note: Peak to average ratio is dependent on modulation type and not channel frequency, therefore only middle channel results are shown.

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Mid channel	2132.5 MHz

Test conditions		Average Power (dBm)	Duty cycle offset (dB)	TX power (dBm)	TX Power (W)	PK to Average Power ratio (dB)
Temp Ambient	Volts Nominal	38.17	0.0	38.17	6.5	9.24

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Top channel	2152.5 MHz

Test conditions		Average Power (dBm)	Duty cycle offset (dB)	TX power (dBm)	TX Power (W)	PK to Average Power ratio (dB)
Temp Ambient	Volts Nominal	37.95	0.0	37.95	6.2	Not measured

Note: Peak to average ratio is dependent on modulation type and not channel frequency, therefore only middle channel results are shown.

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Low channel	2117.5 MHz

Test conditions		Average Power (dBm)	Duty cycle offset (dB)	TX power (dBm)	TX Power (W)	PK to Average Power ratio (dB)
Temp Ambient	Volts Nominal	35.50	3.6	39.1	8.1	Not measured

Note: Peak to average ratio is dependent on modulation type and not channel frequency, therefore only middle channel results are shown.

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Mid channel	2132.5 MHz

Test conditions		Average Power (dBm)	Duty cycle offset (dB)	TX power (dBm)	TX Power (W)	PK to Average Power ratio (dB)
Temp Ambient	Volts Nominal	34.59	3.6	38.19	6.6	11.62

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz

Mod Scheme	LTE
High channel	2147.5 MHz

Test conditions		Average Power (dBm)	Duty cycle offset (dB)	TX power (dBm)	TX Power (W)	PK to Average Power ratio (dB)
Temp Ambient	Volts Nominal	34.85	3.6	38.45	7.0	Not measured

Note: Peak to average ratio is dependent on modulation type and not channel frequency, therefore only middle channel results are shown.

PSD measurements:

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Low channel	2112.5 MHz
Mid channel	2132.5 MHz
High channel	2152.5 MHz

Channel	TX power density (dBm/MHz)	Duty Cycle offset (dB)	TX power density (dBm/MHz)	TX power density (W/MHz)
Low channel	32.68	0.0	32.68	1.9
Mid channel	32.71	0.0	32.71	1.9
High channel	32.83	0.0	32.83	1.9

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Low channel	2117.5 MHz
Mid channel	2132.5 MHz
High channel	2147.5 MHz

Channel	TX power density (dBm/MHz)	Duty Cycle offset (dB)	TX power density (W/MHz)	
Low channel	30.78	3.6	34.38	2.7
Mid channel	28.33	3.6	31.93	1.6
High channel	29.28	3.6	32.88	1.9

Results are also presented graphically in section 6

LIMITS:

Power limits (and PSD) are referenced to ERP in the rule parts and are decided upon at time of licensing and based on geographical location. PAPR (0.1% CCDF) Limit <13dB.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
< ± 1 dB.

5.3 Frequency stability

Test not performed; please see frequency stability results in RN report 01-11147-2-19 for stability information in GSM mode.

5.4 Occupied bandwidth

5.4.1 Test methods

Test Requirements: FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method: ANSI C63.26 2015 Clause 5.4 [Reference 4.1.4 of this report]

Limits: None

5.4.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. EUT was tested in modes 10 – 15.

5.4.3 Test procedure

Tests were made in accordance with the test method noted above using the measuring equipment listed in the 'Test Equipment' Section. The EUT was set up to transmit at full power for the appropriate band and modulation scheme (see section 2.5) using an ancillary laptop connected to the Ethernet port of the EUT. Attenuation was used between the EUT TX port and the analyser. A peak detector and max-hold was set and using the bandwidth function of the analyser the 99% Bandwidth was measured and indicated on the plots taken.

5.4.4 Test equipment

E420, E755, E777, E866

See Section 8 for more details

5.4.5 Test results

Temperature of test environment 18-23°C
Humidity of test environment 30-42%
Pressure of test environment 101kPa

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Low channel	2112.5 MHz

Occupied BW (MHz)	
	4.135
Plot reference	11147-1 UMTS bottom

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Mid channel	2132.5 MHz

Occupied BW (MHz)	
	4.131
Plot reference	11147-1 UMTS middle

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
High Channel	2152.5 MHz

Occupied BW (MHz)	
	4.127
Plot reference	11147-1 UMTS top

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Low channel	2117.5 MHz

Occupied BW (MHz)	
	4.508
Plot reference	11147-1 LTE bottom

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Mid channel	2132.5 MHz

Occupied BW (MHz)	
	4.519
Plot reference	11147-1 LTE middle

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
High Channel	2147.5 MHz

Occupied BW (MHz)	
	4.499
Plot reference	11147-1 LTE top

Results are also presented graphically in section 6

LIMITS:

Emissions to be contained within the applicable emissions mask/band edges.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
< $\pm 1.9\%$

5.5 Field strength of spurious radiations

5.5.1 Test methods

Test Requirements:	FCC Part 22 Clause 27.53 [Reference 4.1.1 of this report] FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 2015 Clause 5.5 [Reference 4.1.4 of this report]
Limits:	FCC Part 27 Clause 27.53 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was tested in an ALSE and ambient conditions were monitored. The EUT was examined in its declared normal use position. The transmit port was terminated into a 30dB Attenuator and a 50Ohm load. EUT was tested across all required modes as specified in section 2.4 of this report.

5.5.3 Test procedure

Tests were made in accordance with the test method noted above using the measuring equipment listed in the 'Test Equipment' Section. Peak field strength pre-scans using the field strength method were performed. The EUT's emissions were maximised by rotating it 360 degrees. This method was used to determine any signals for substitution. A Peak detector was used for measurements.

30MHz - 1GHz.

The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. Where required a Substitution method was performed using tuned dipoles / a calibrated bi-conical antenna. Measurement distance of 3metres was used.

1GHz – 22GHz.

The measuring antenna was used in both Horizontal and Vertical polarisations. Where required a Substitution method was performed using standard gain horn antennas. Measurement distances used were: 1 – 6 GHz at 3metres, 6 – 18 GHz at 1.2metres and 18 – 22 GHz at 0.3metres.

Tests were performed in test site M.

5.5.4 Test equipment

E268, E410, E411, E453, E517, E602, E634, E743, LPE364, TMS814, TMS82

See Section 8 for more details

5.5.5 Test results

Temperature of test environment	17-20°C
Humidity of test environment	40-45%
Pressure of test environment	101kPa

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Low channel	2112.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No emissions observed within 20dB of limits				

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Mid channel	2132.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No emissions observed within 20dB of limits				

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
High channel	2152.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No emissions observed within 20dB of limits				

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Low channel	2117.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No emissions observed within 20dB of limits				

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Mid channel	2132.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No emissions observed within 20dB of limits				

Setup Table

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
High channel	2147.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No emissions observed within 20dB of limits				

LIMITS:

Parts 27.53 (h) for operation in the 2110-2200 MHz band

Absolute limits are determined from the relative limit as per example:

Limits based on $43+10\log P$. dB attenuation below Output power in Watts: i.e. +20dBm = 0.1W therefore:

$$43+10*\log 0.1 = 33\text{dB}. +20\text{dBm} - 33 = -13\text{dBm}$$

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
30MHz - 1GHz ± 3.9 dB, 1 – 18 GHz ± 3.5 dB, 18 – 27 GHz ± 3.9 dB

5.6 Band edge emissions

5.6.1 Test methods

Test Requirements:	FCC Part 27 Clause 27.53 [Reference 4.1.1 of this report] FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 2015 Clause 5.5 [Reference 4.1.4 of this report]
Limits:	FCC Part 27 Clause 27.53 [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. EUT was tested using modes 10 – 15. Modes are specified in section 2.4 of this report.

5.6.3 Test procedure

Tests were made in accordance with the test method noted above using the measuring equipment listed in the 'Test Equipment' Section. The EUT was set up to transmit at full power for the appropriate band and modulation scheme (see section 2.5) using an ancillary laptop connected to the Ethernet port of the EUT. Attenuation was used between the EUT TX port and the analyser. Measurements were made and plots taken in the required Resolution bandwidths using an RMS detector with trace averaging and duty cycle offset for LTE mode.

Tests were performed in test site N.

5.6.4 Test equipment

E420, E755, E777, E866

See Section 8 for more details

5.6.5 Test results

Temperature of test environment	18-23°C
Humidity of test environment	30-42%
Pressure of test environment	101kPa

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	UMTS
Low channel	2112.5 MHz
High channel	2152.5 MHz

	Lower band edge (2110MHz)	Upper band edge (2200MHz)
(dBm)	-15.71	-16.09
Plot reference	11147-1 UMTS bottom	11147-1 UMTS top

Band	2110 - 2200 MHz
Power Level	46 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE
Low channel	2117.5 MHz
High channel	2147.5 MHz

	Lower band edge (2110MHz)	Upper band edge (2200MHz)
(dBm)	-16.7	-15.5
Plot reference	11147-1 LTE bottom	11147-1 LTE top

Note: 3.6dB added to results for duty cycle correction.

Results are also presented graphically in section 6

LIMITS:

Parts 27.53 (h) for operation in the 2110-2200 MHz band. 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.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
 $< \pm 2.8$ dB

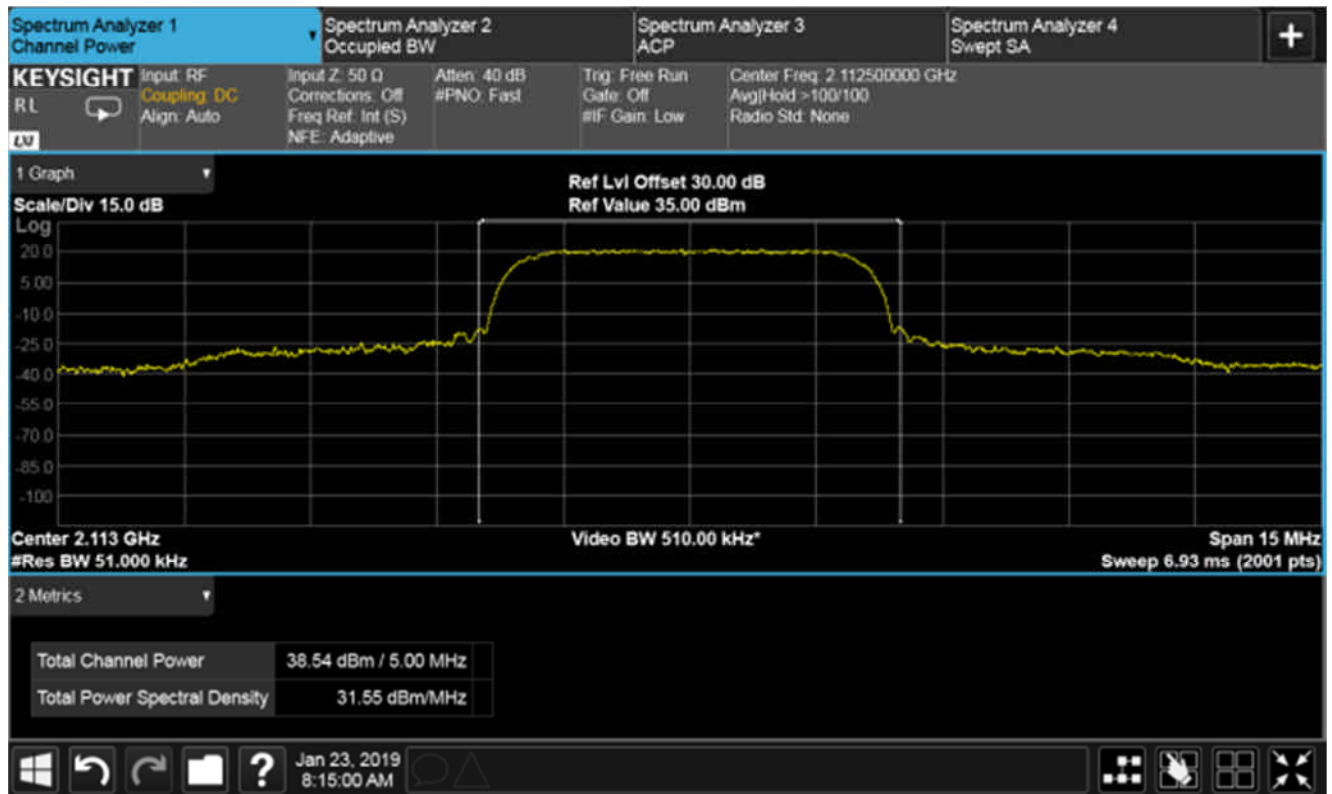
5.7 Modulation characteristics

EUT uses digital modulation techniques. Modulation schemes and information is detailed in section 2.2 of this report.

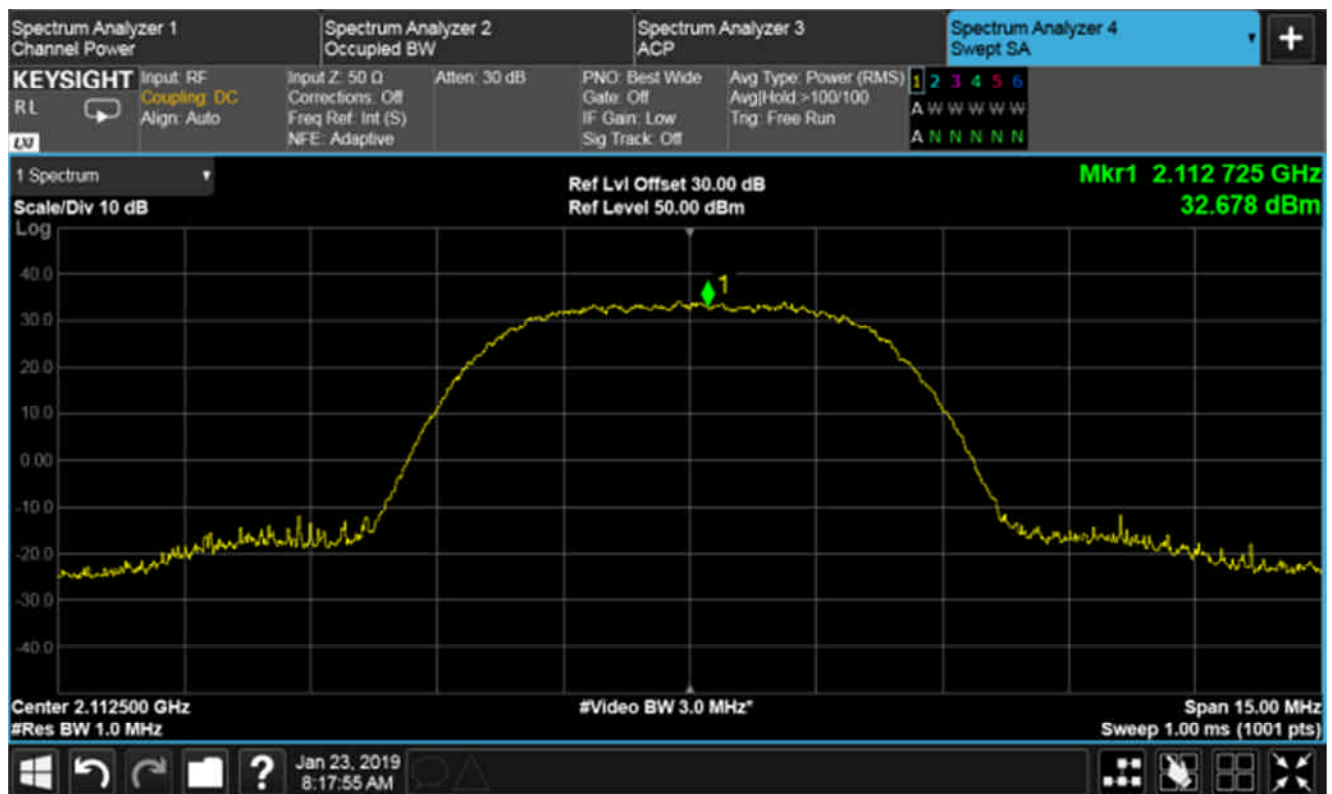
6 Plots/Graphical results

6.1 RF Power Output

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation UMTS, Low Channel 2112.5 MHz

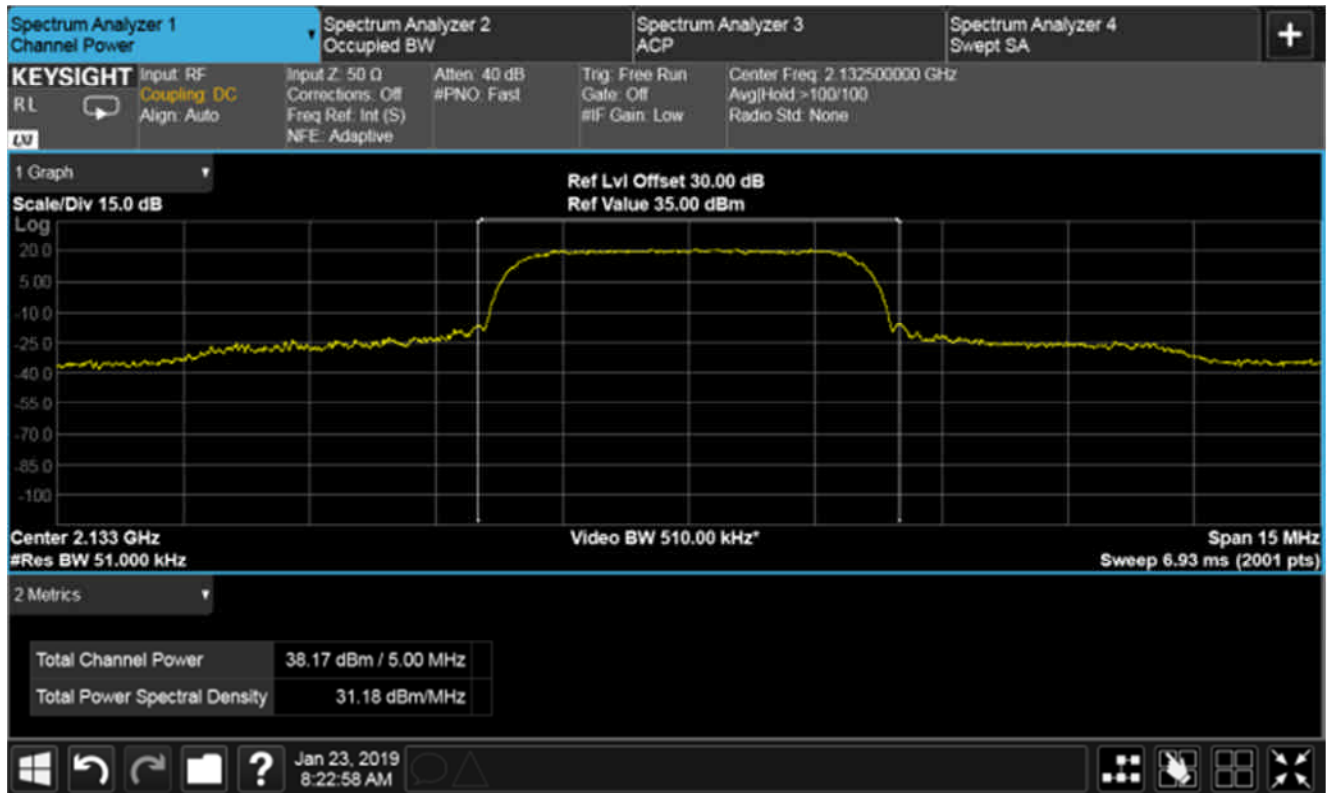


Plot of Channel power

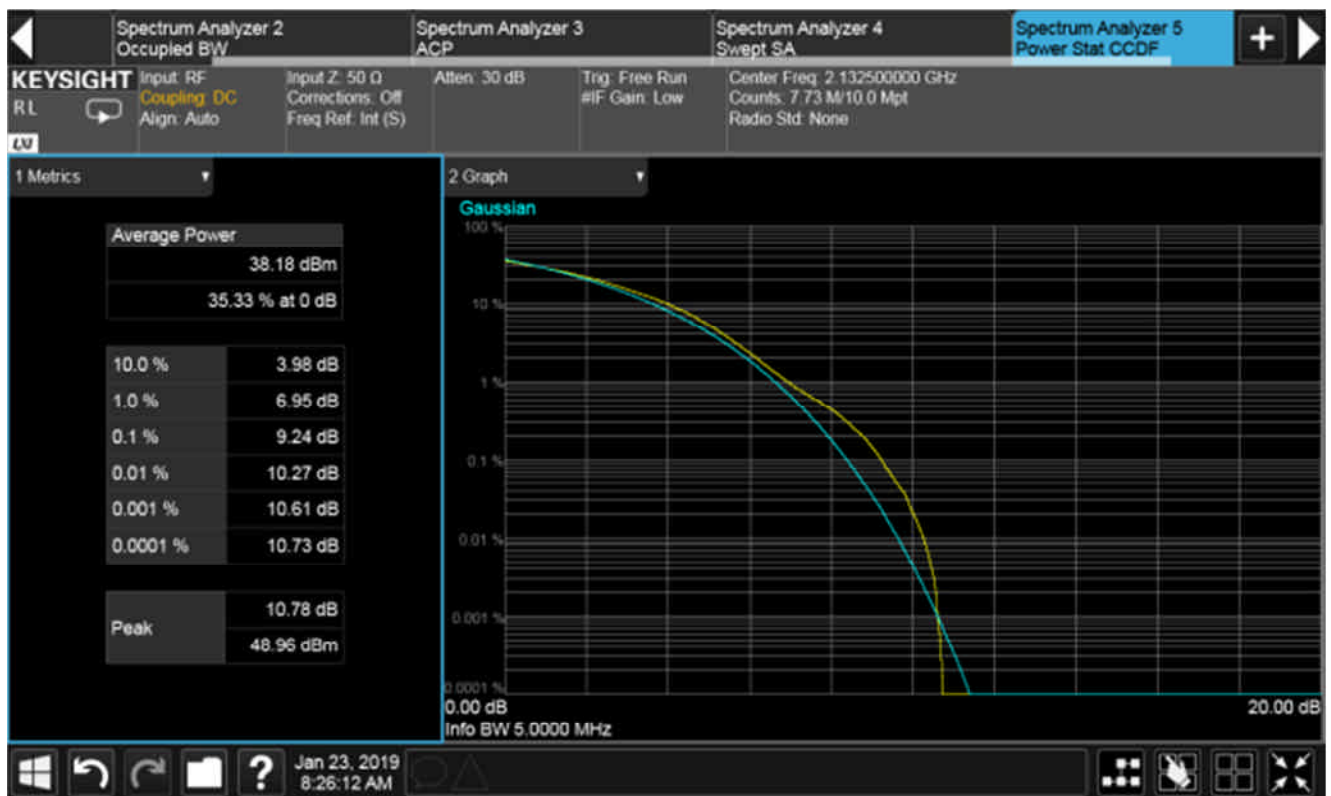


Plot of PSD

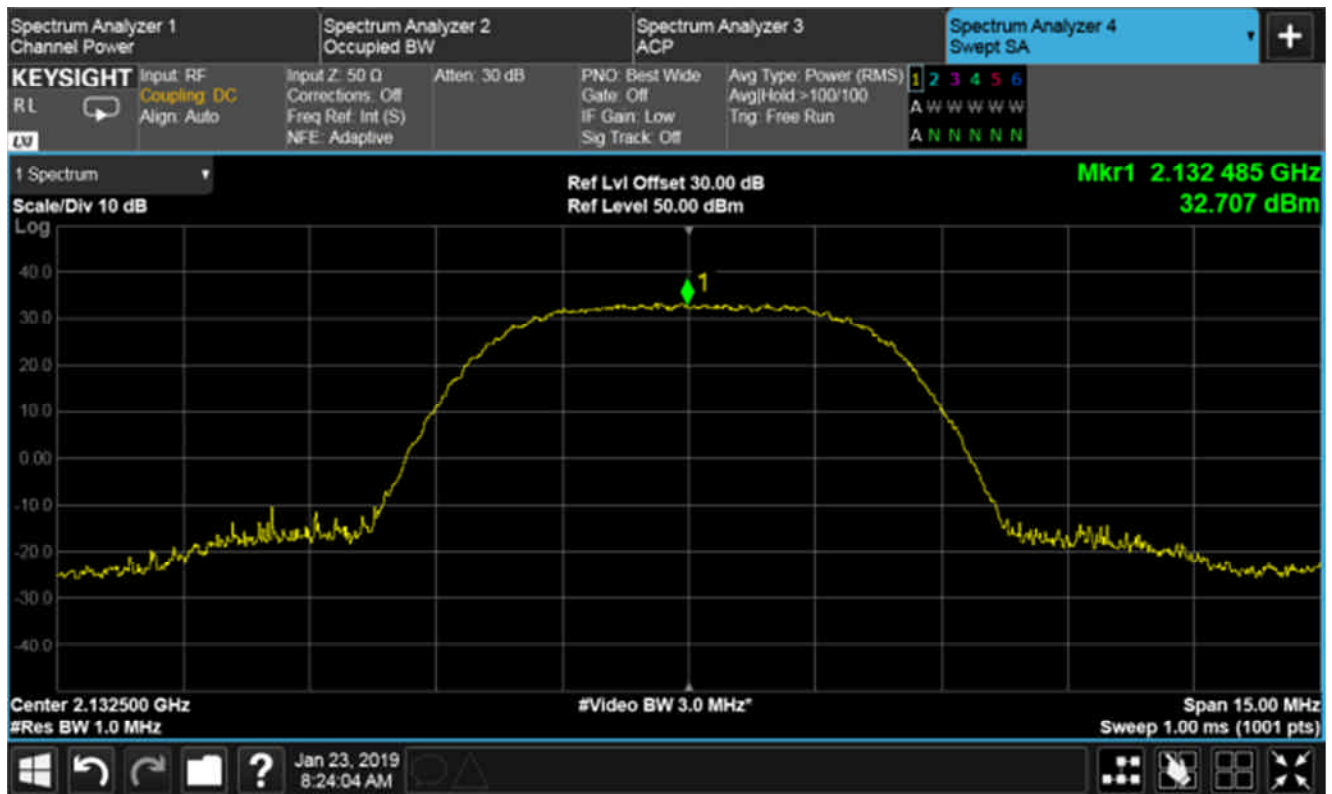
RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation UMTS,
Mid Channel 2132.5 MHz



Plot of Channel power

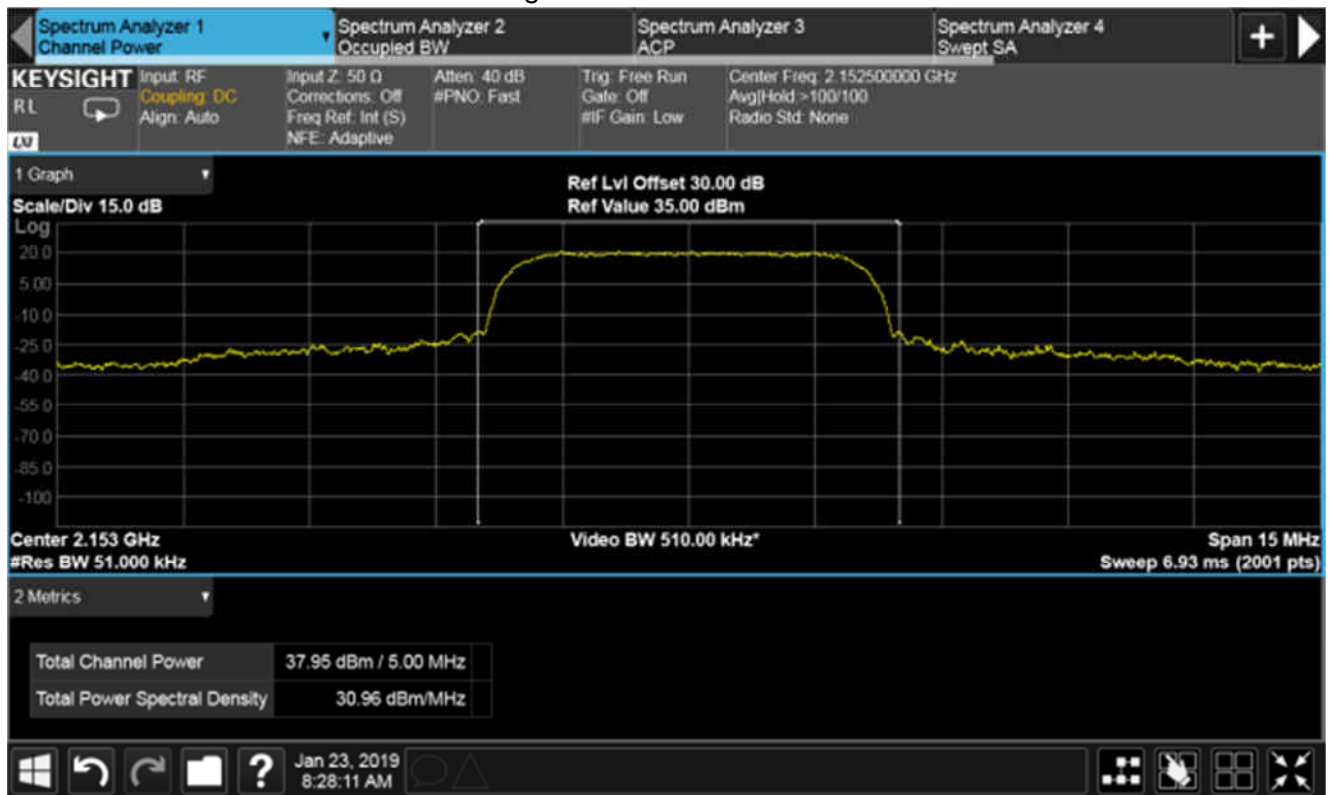


Plot of Peak to Average power ratio

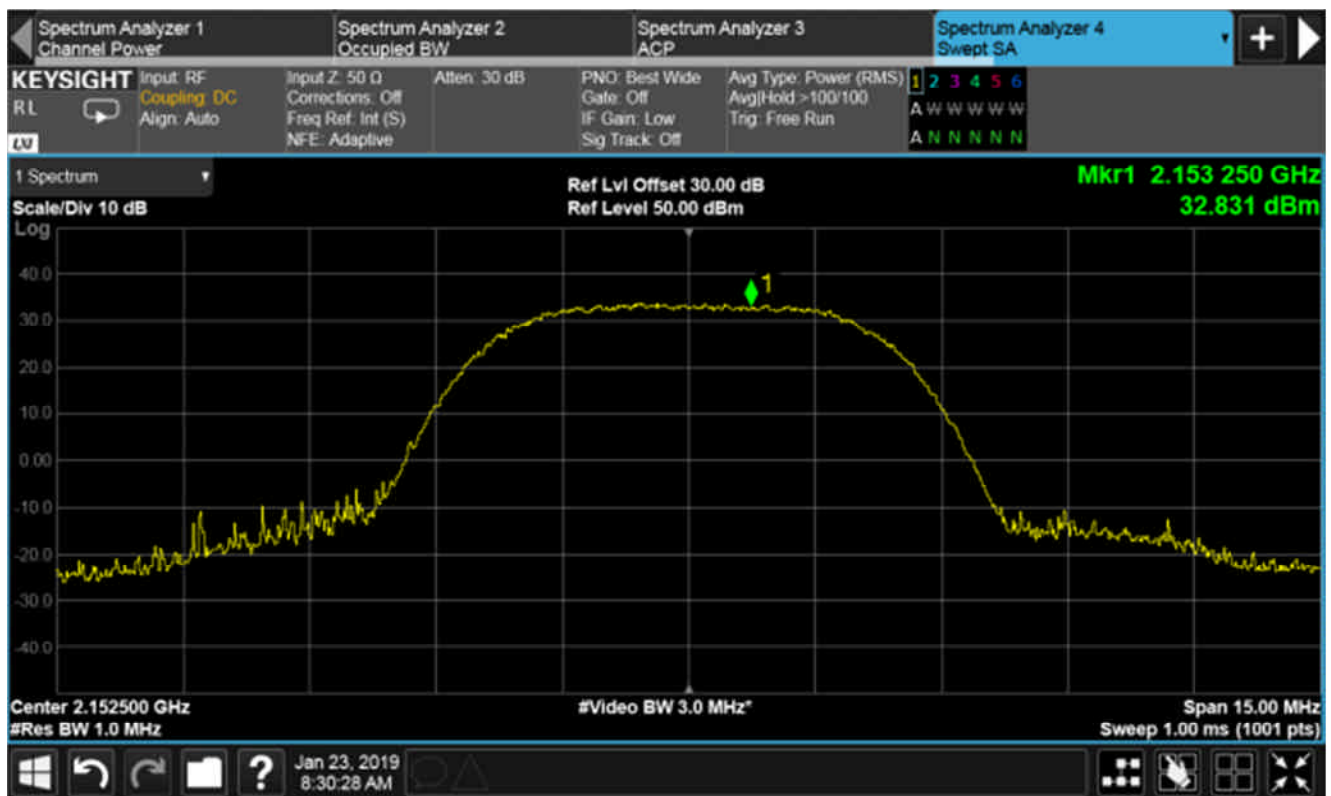


Plot of PSD

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation UMTS,
High Channel 2152.5 MHz

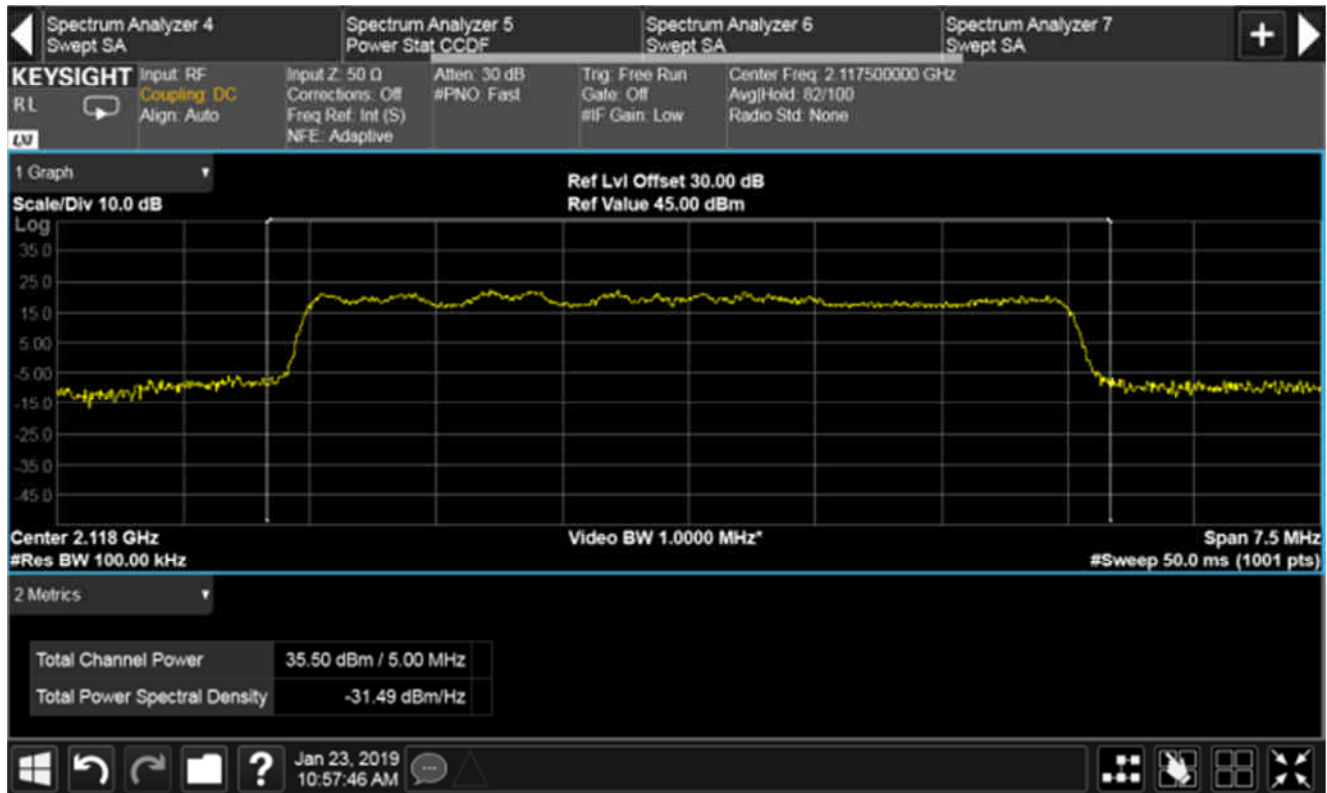


Plot of Channel power

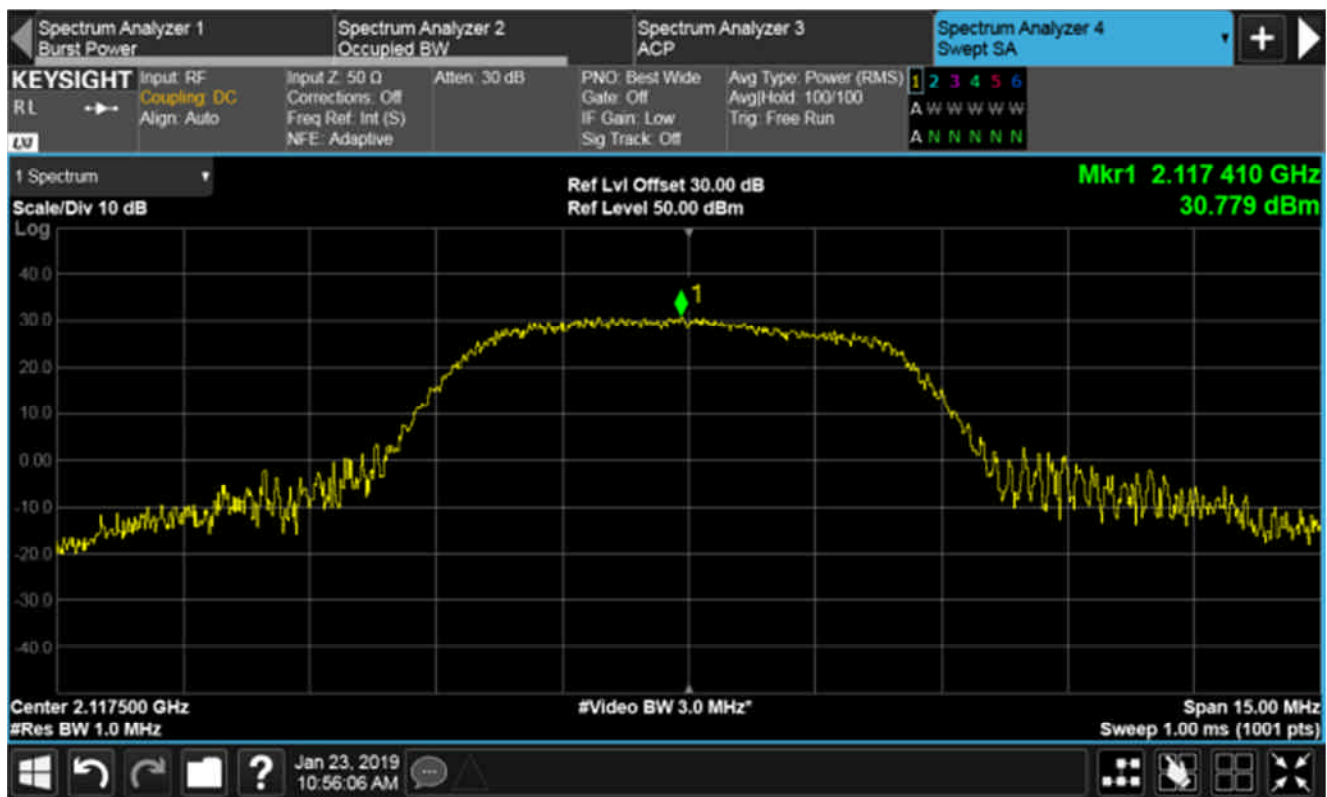


Plot of PSD

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation LTE,
Low Channel 2117.5 MHz

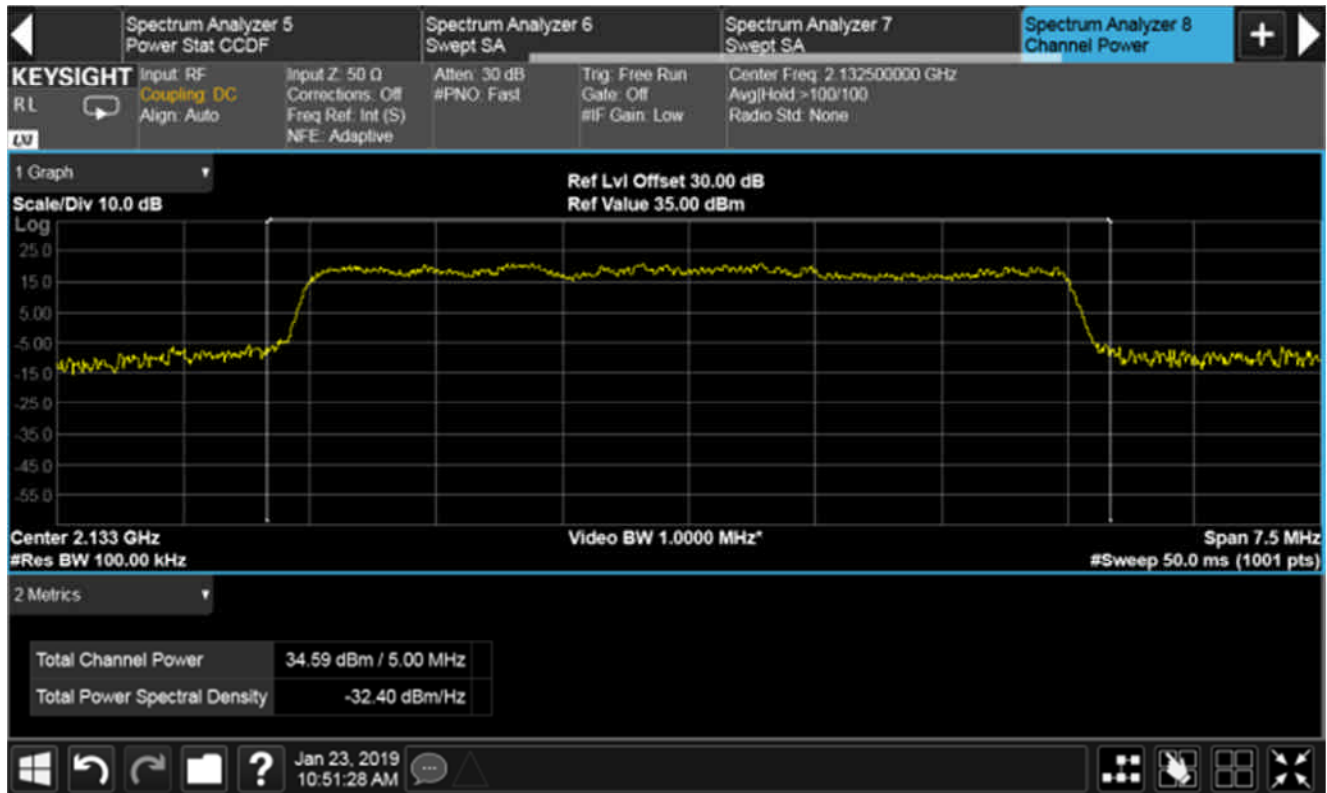


Plot of Channel power

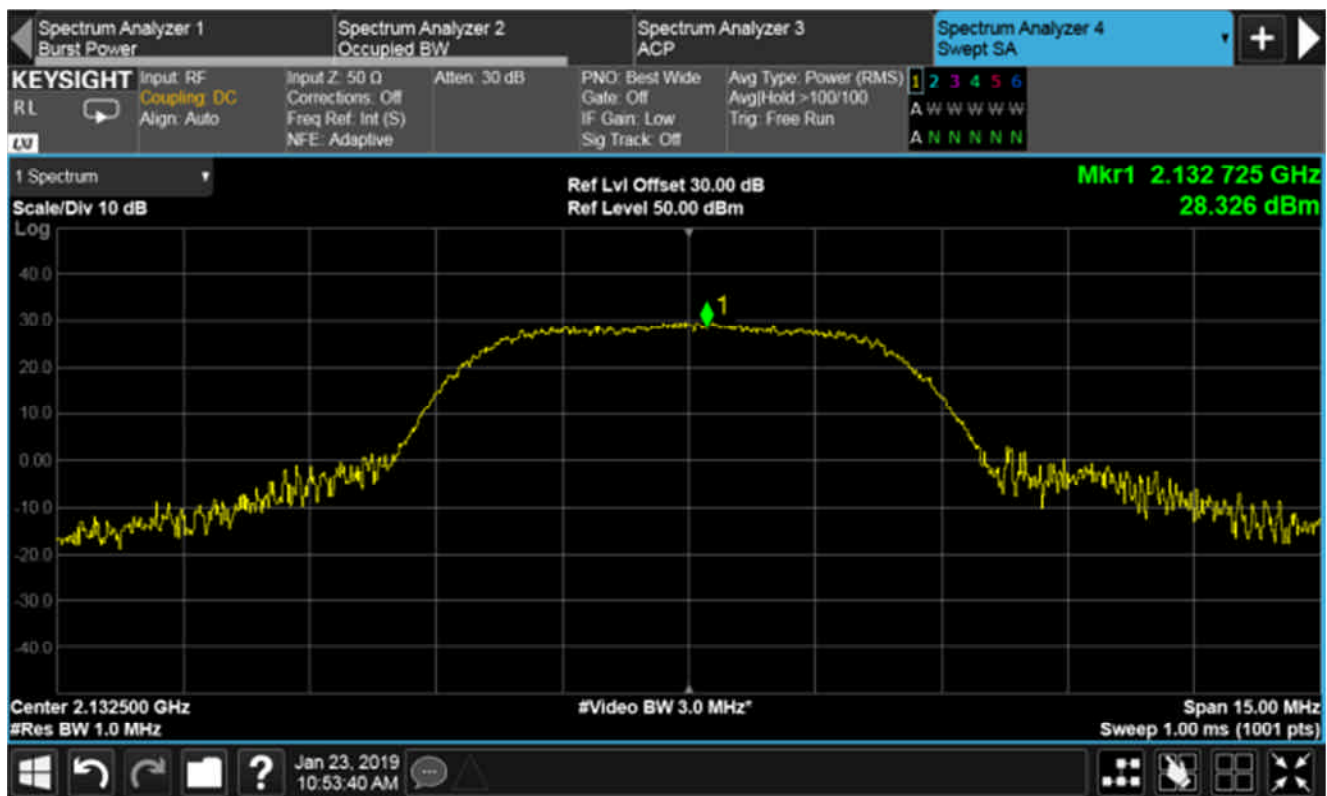


Plot of PSD

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation LTE,
Mid Channel 2132.5 MHz

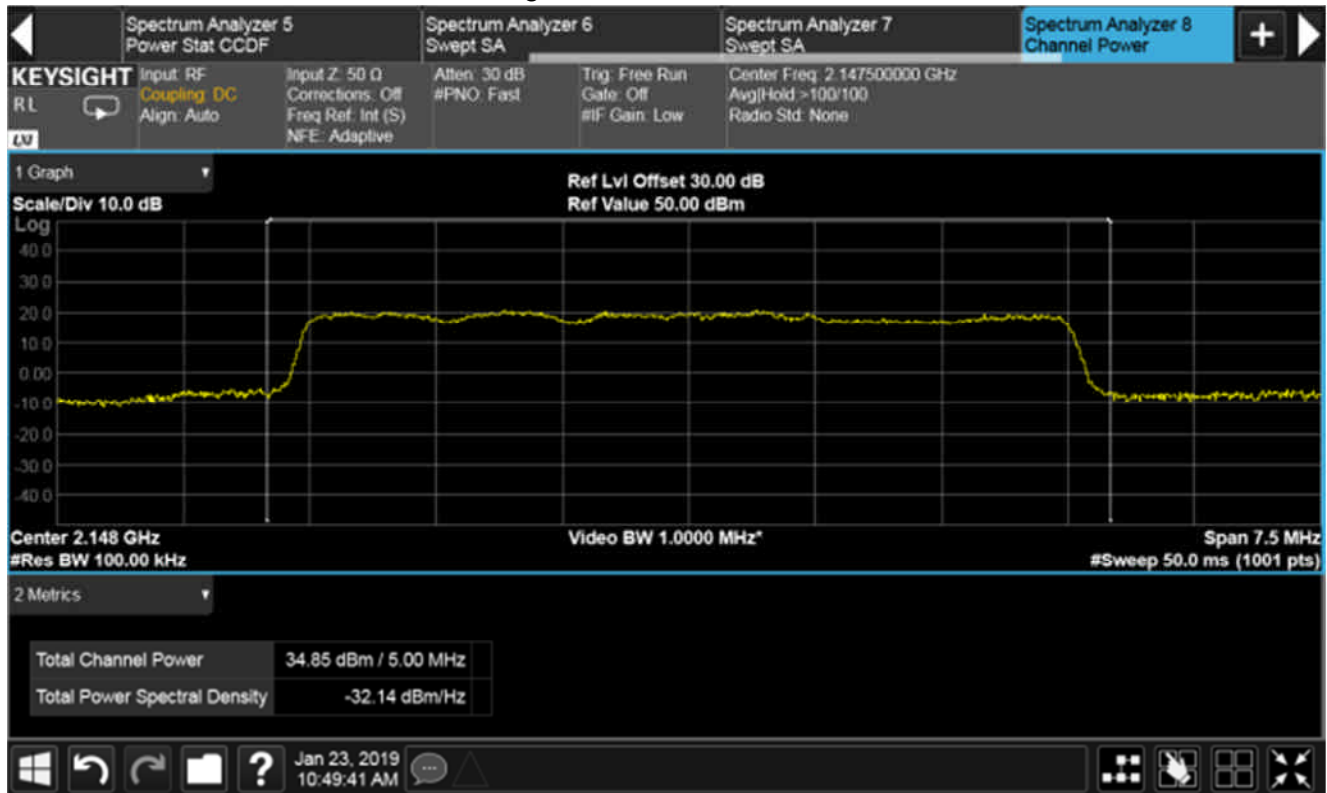


Plot of Channel power

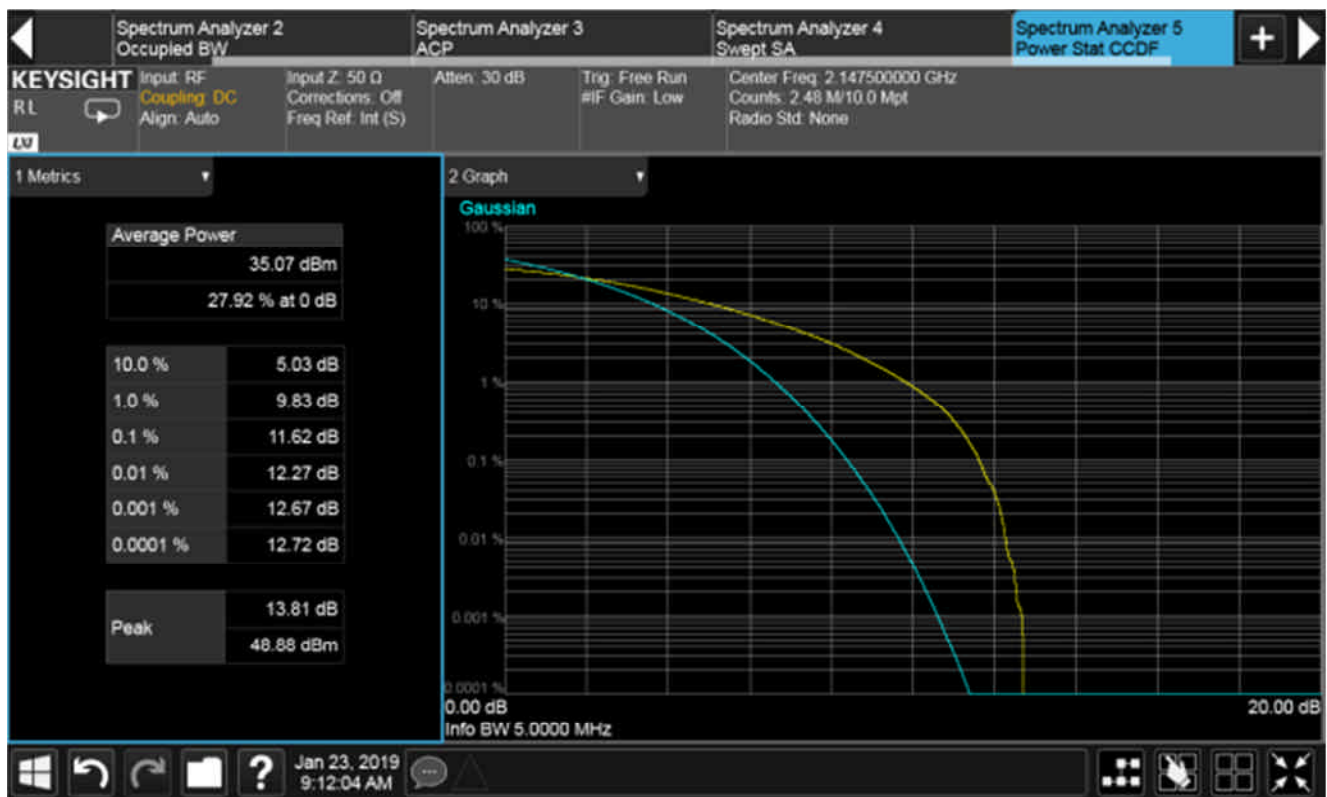


Plot of PSD

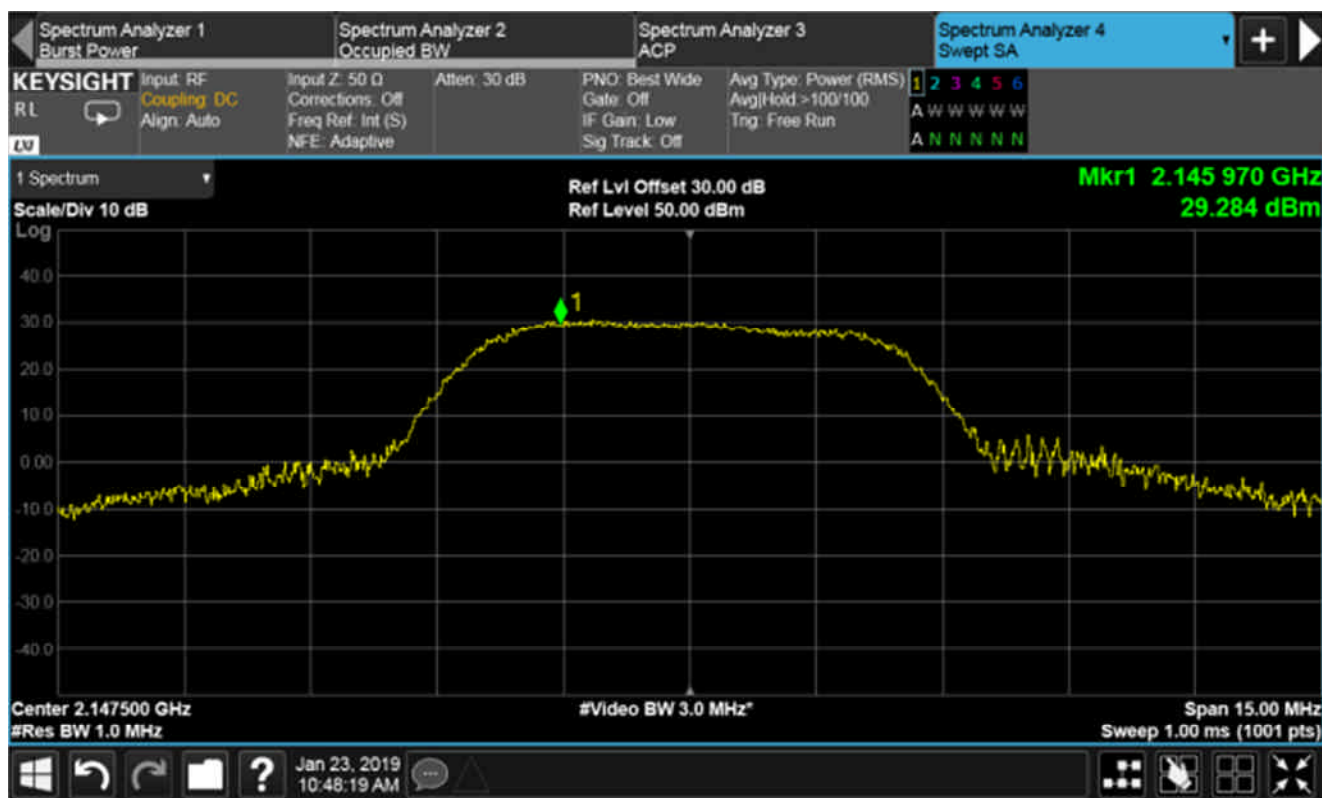
RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation LTE,
High Channel 2147.5 MHz



Plot of Channel power



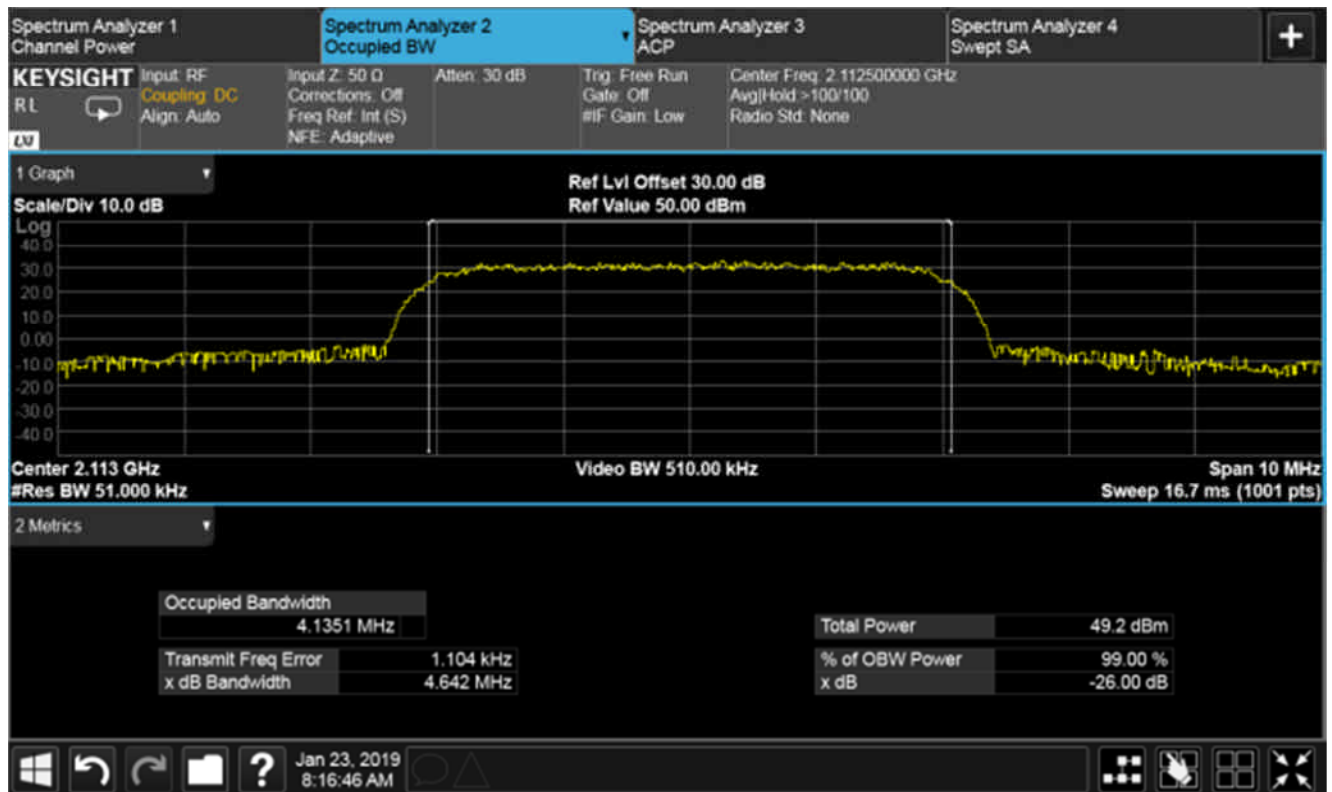
Plot of Peak to Average power ratio



Plot of PSD

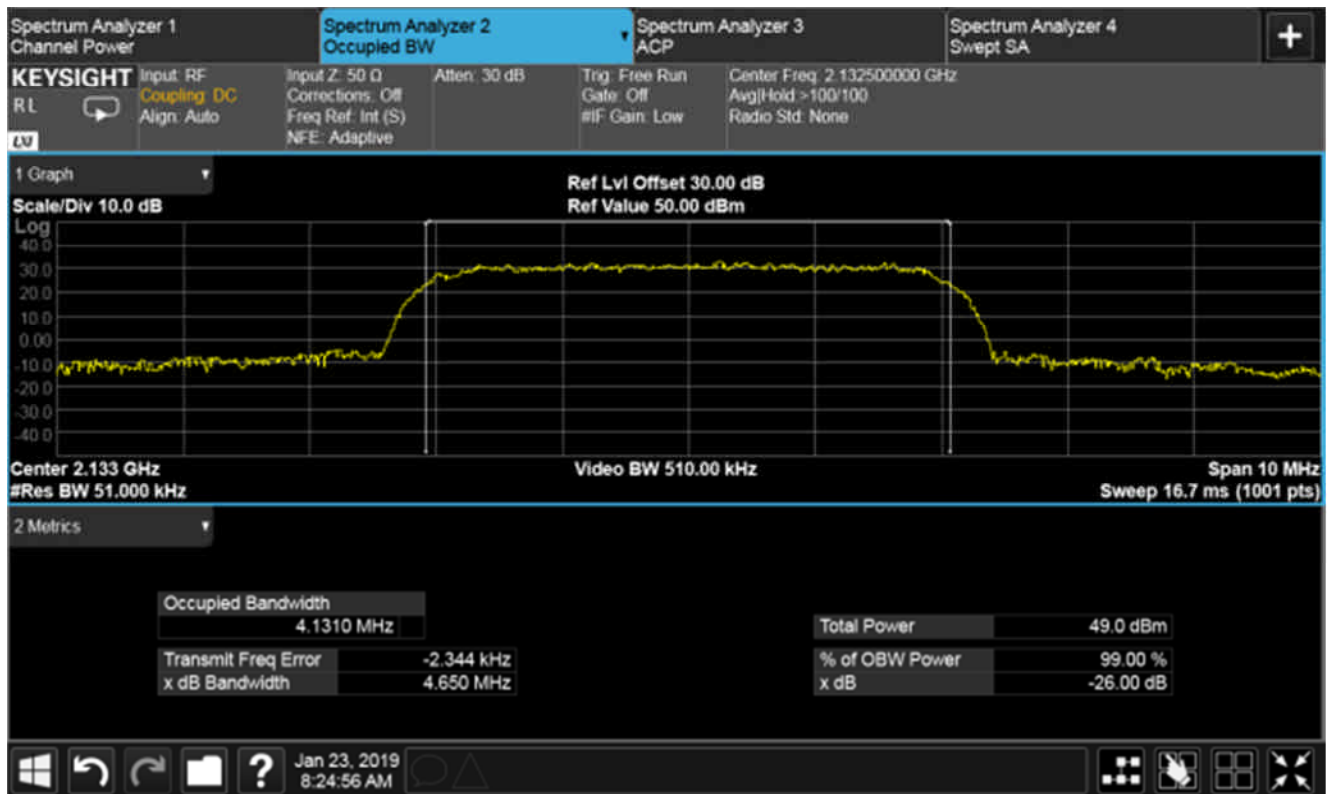
6.2 Occupied bandwidth

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation UMTS,
Low Channel 2112.5 MHz



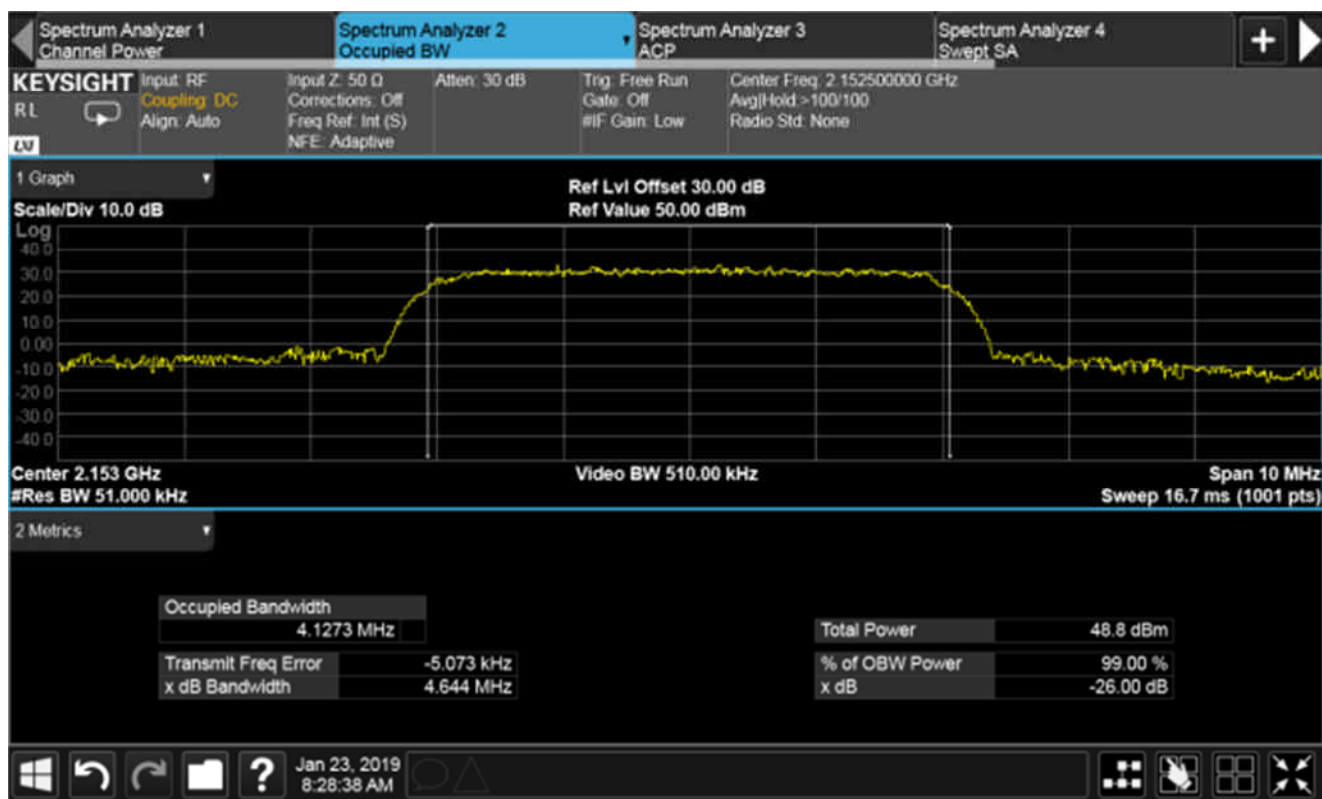
Plot of occupied BW

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation UMTS,
Mid Channel 2132.5 MHz



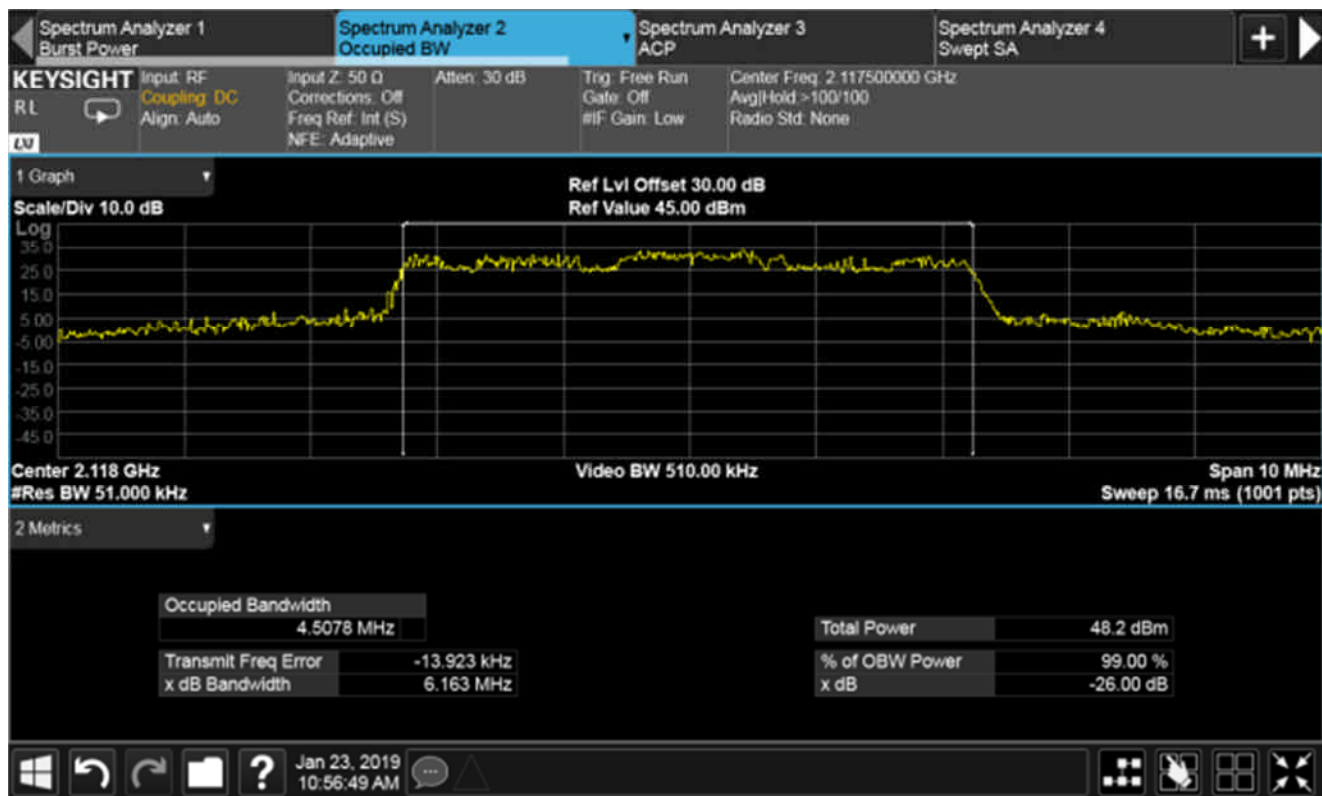
Plot of occupied BW

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation UMTS,
High Channel 2152.5 MHz



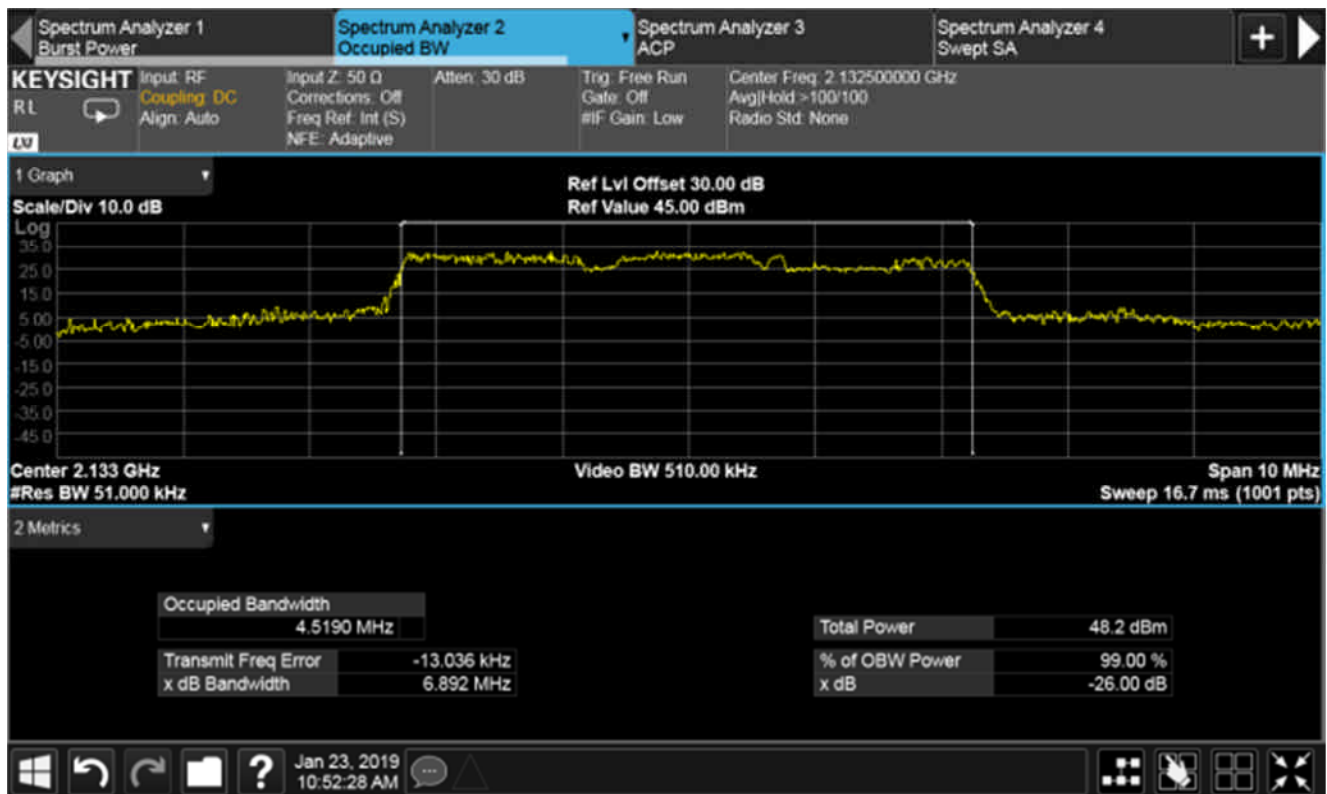
Plot of occupied BW

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation LTE,
Low Channel 2117.5 MHz



Plot of occupied BW

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation LTE,
Mid Channel 2132.5 MHz



Plot of occupied BW

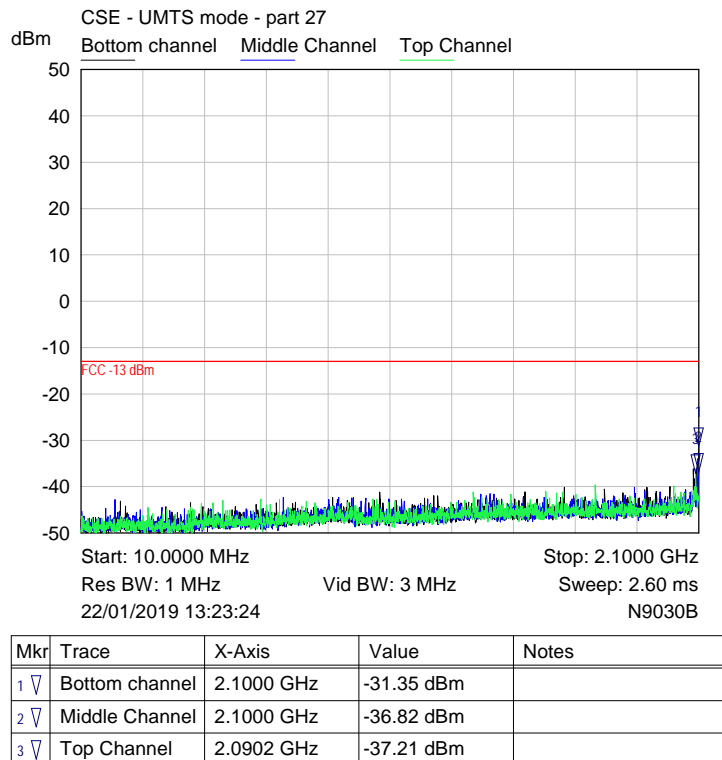
RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation LTE,
High Channel 2147.5 MHz



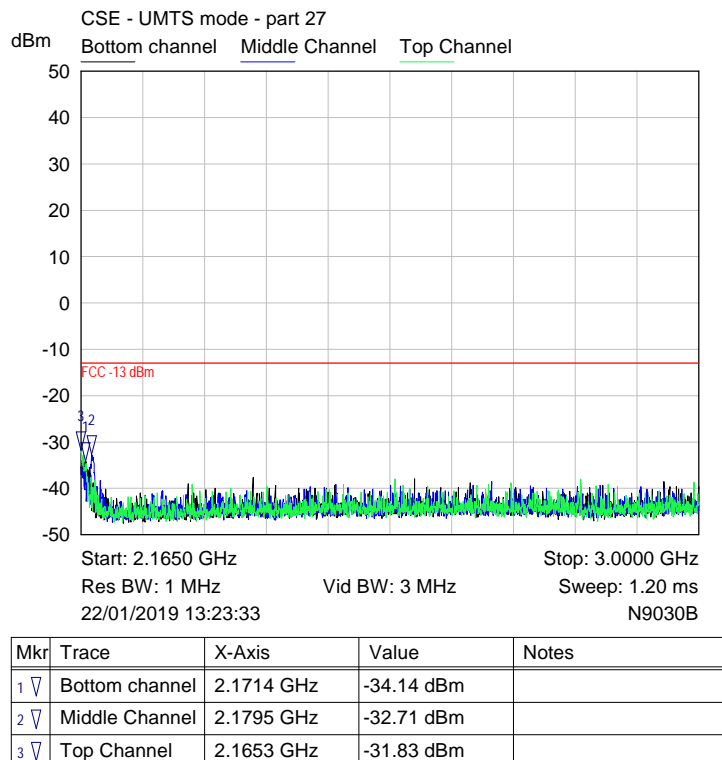
Plot of occupied BW

6.3 Spurious emissions at antenna terminals

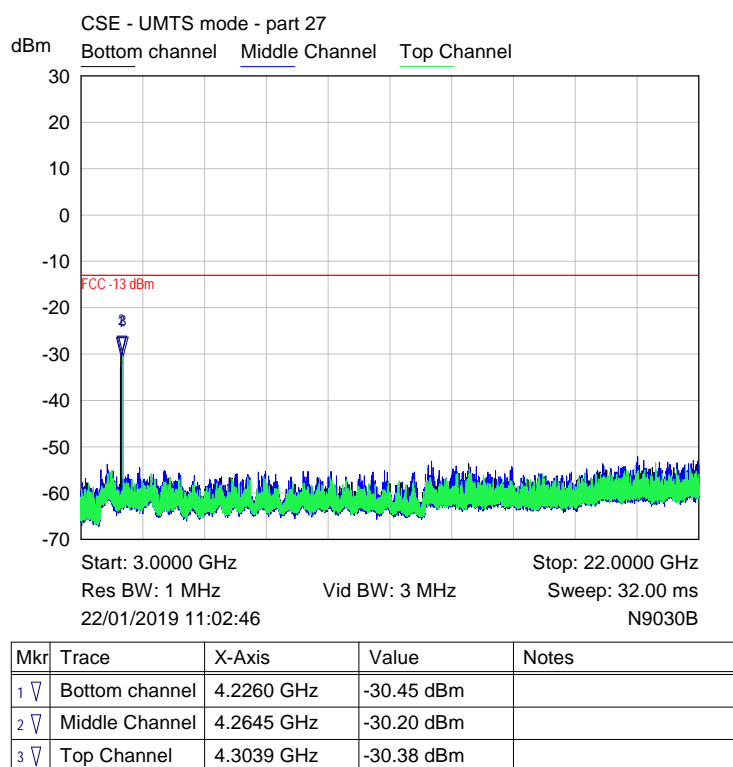
RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation UMTS,
Low Channel 2112.5 MHz, Mid Channel 2132.5 MHz, & High Channel 2152.5 MHz



Plot of conducted emissions 10 MHz – 2100 MHz range

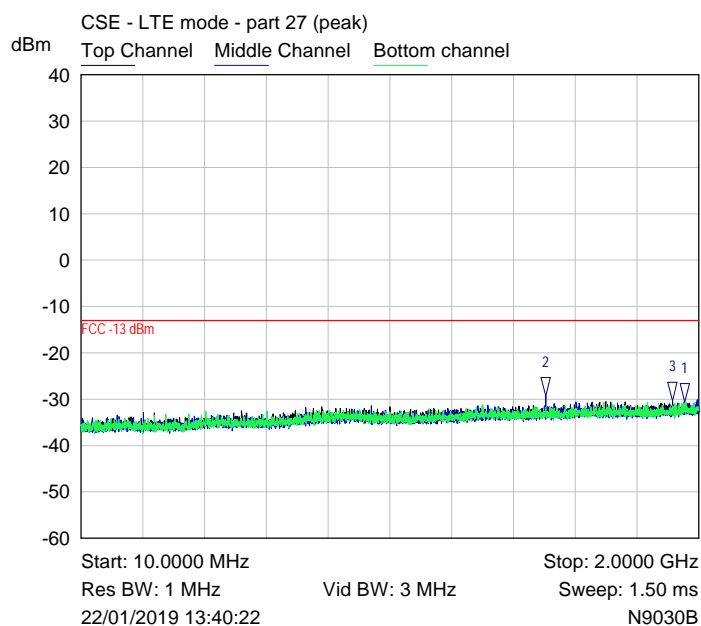


Plot of conducted emissions 2165 MHz – 3000 GHz range



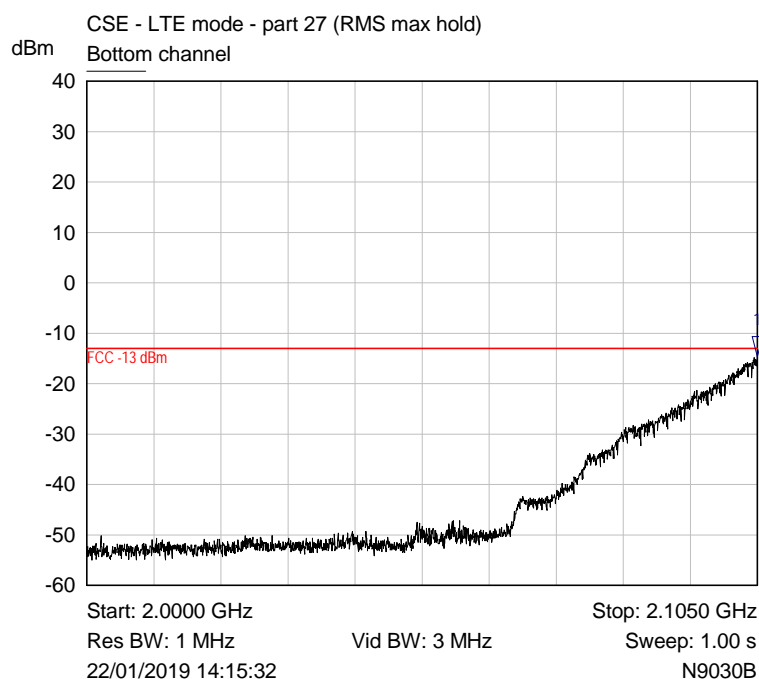
Plot of conducted emissions 3 GHz – 22 GHz range

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation LTE,
Low Channel 2117.5 MHz, Mid Channel 2132.5 MHz, & High Channel 2147.5 MHz



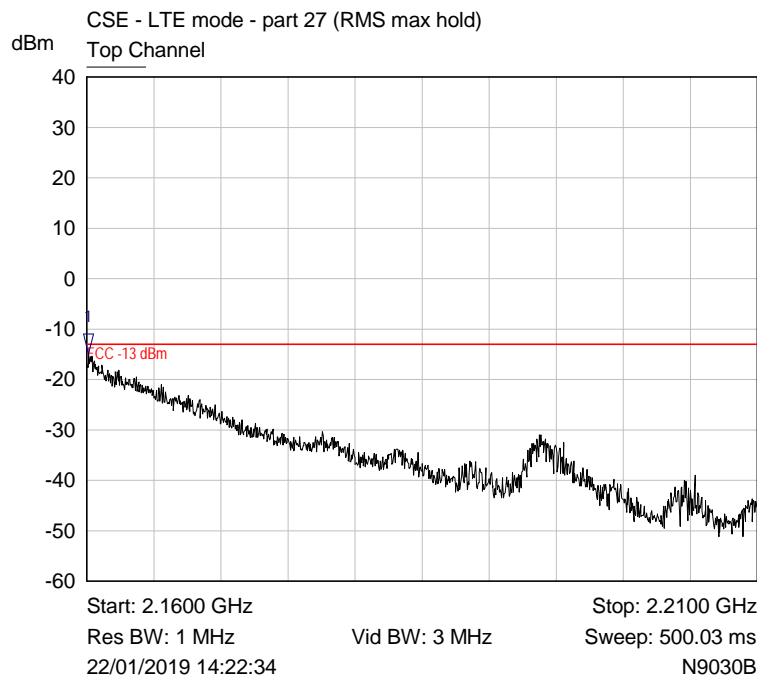
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom channel	1.9562 GHz	-30.61 dBm	
2 ▽	Middle Channel	1.5068 GHz	-29.38 dBm	
3 ▽	Top Channel	1.9164 GHz	-30.29 dBm	

Plot of conducted emissions 10 MHz – 2000 MHz range



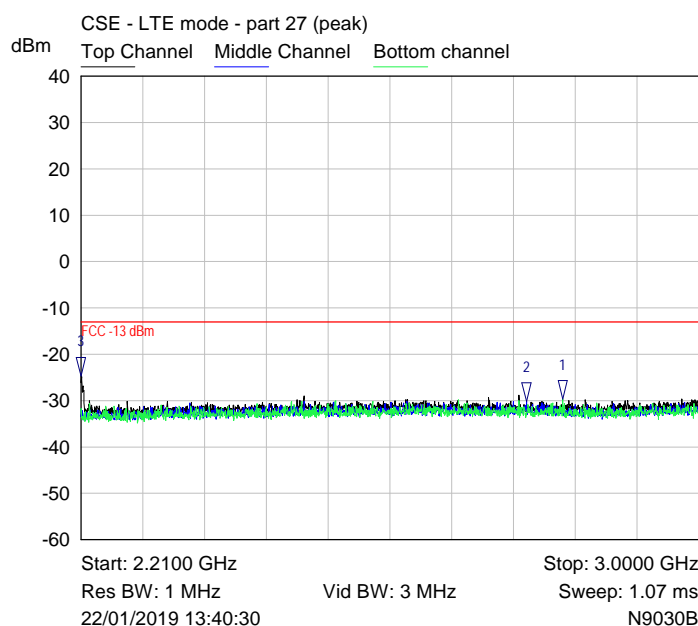
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom channel	2.1050 GHz	-14.60 dBm	Worst case channel

Plot of conducted emissions 2 GHz – 2.105 GHz range



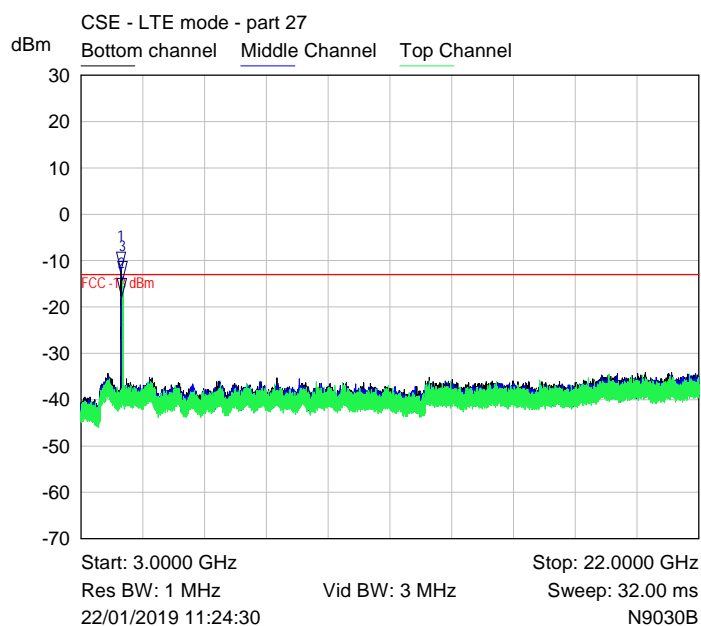
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Top Channel	2.1602 GHz	-14.98 dBm	Worst case channel

Plot of conducted emissions 2.16 GHz – 2.21 GHz range



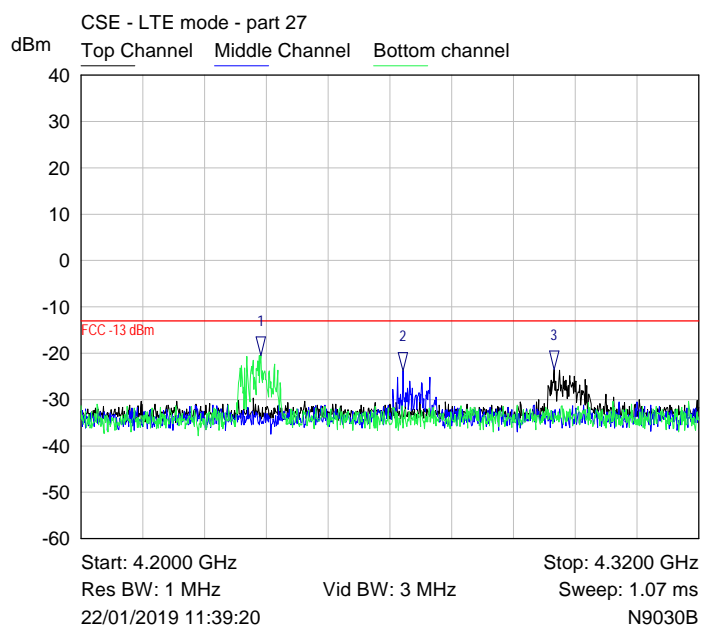
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom channel	2.8257 GHz	-29.69 dBm	
2 ▽	Middle Channel	2.7799 GHz	-30.09 dBm	
3 ▽	Top Channel	2.2100 GHz	-24.62 dBm	

Plot of conducted emissions 2.21 GHz – 3 GHz range



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom channel	4.2350 GHz	-12.09 dBm	
2 ▽	Middle Channel	4.2621 GHz	-17.84 dBm	
3 ▽	Top Channel	4.2920 GHz	-14.24 dBm	

Plot of conducted emissions 3 GHz – 22 GHz range (peak)

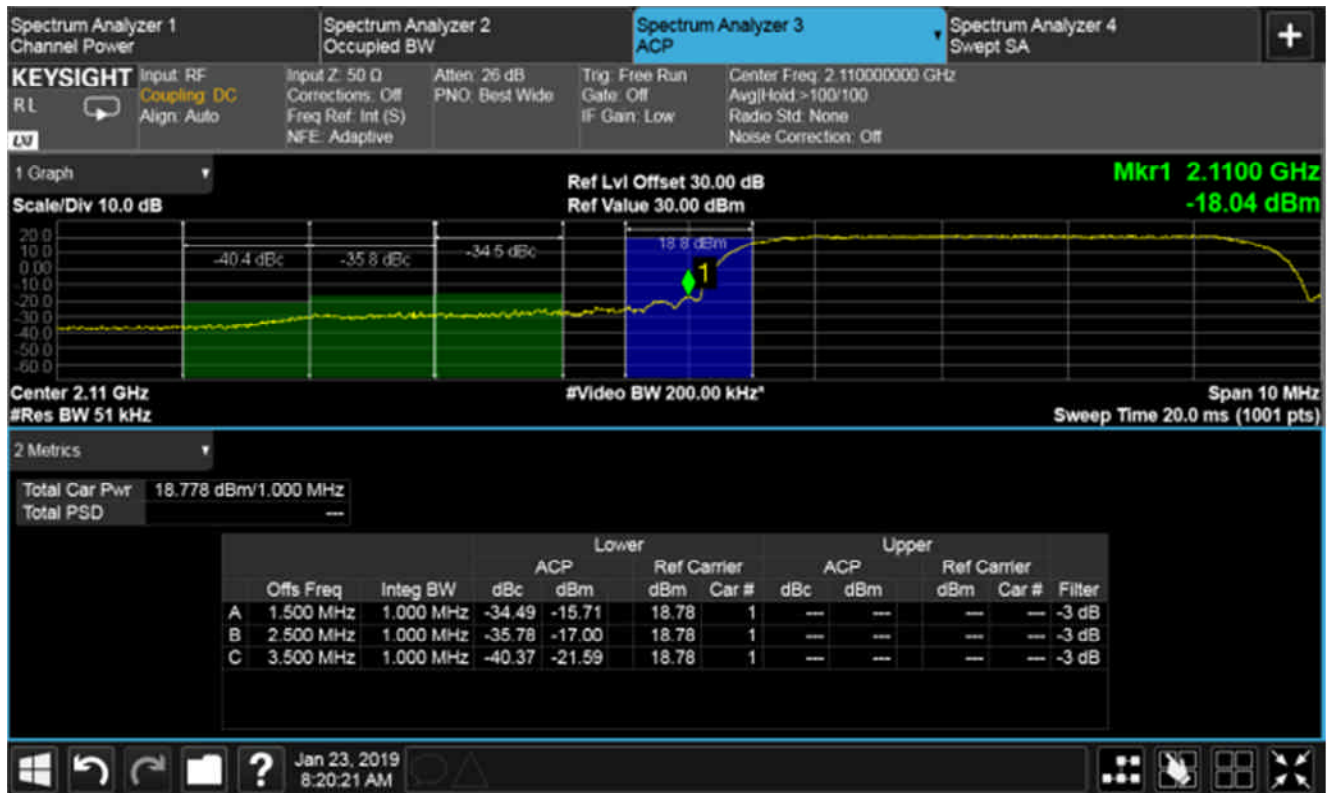


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom channel	4.2350 GHz	-20.51 dBm	RMS - max hold
2 ▽	Middle Channel	4.2626 GHz	-23.77 dBm	RMS - max hold
3 ▽	Top Channel	4.2919 GHz	-23.46 dBm	RMS - max hold

Plot of conducted emissions 4.2 GHz – 4.32 GHz range (RMS – max held)

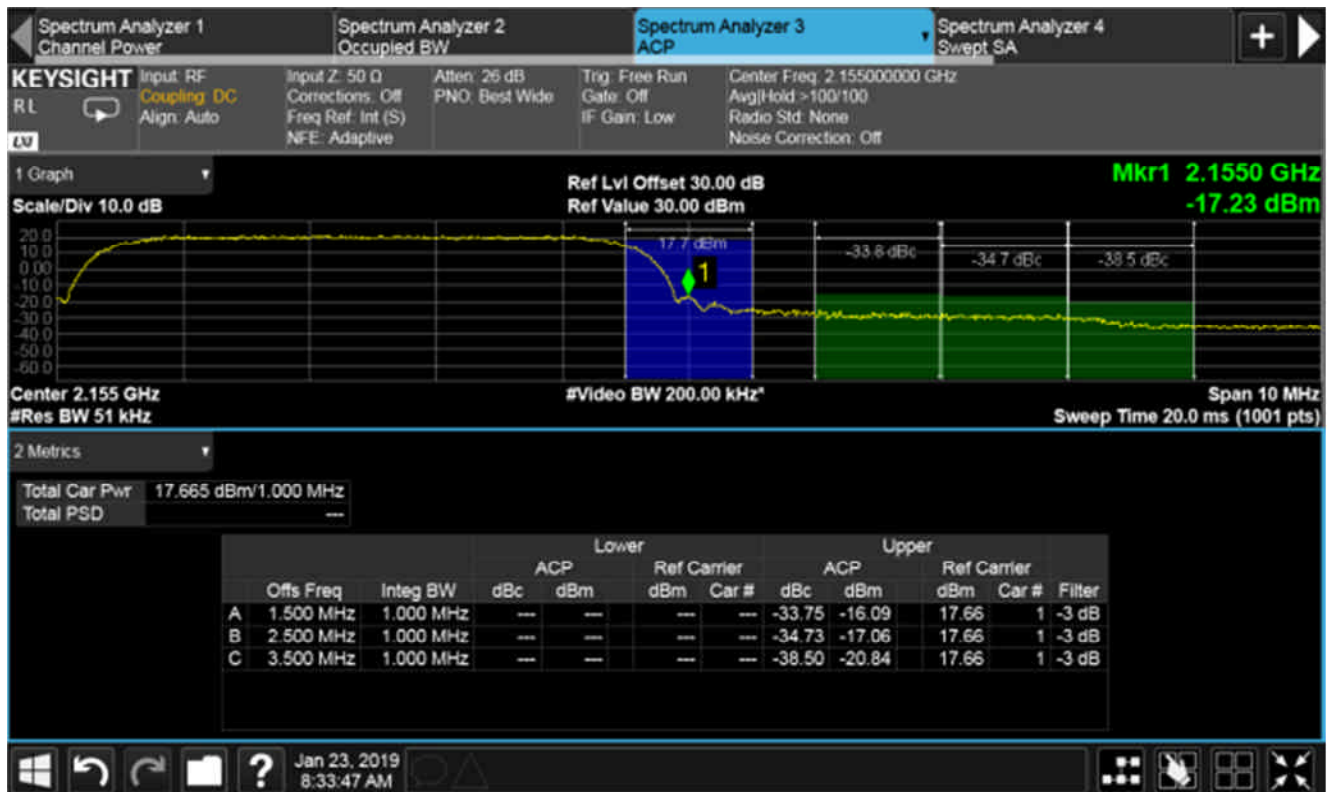
6.5 Band edge emissions

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation UMTS,
Low Channel 2112.5 MHz



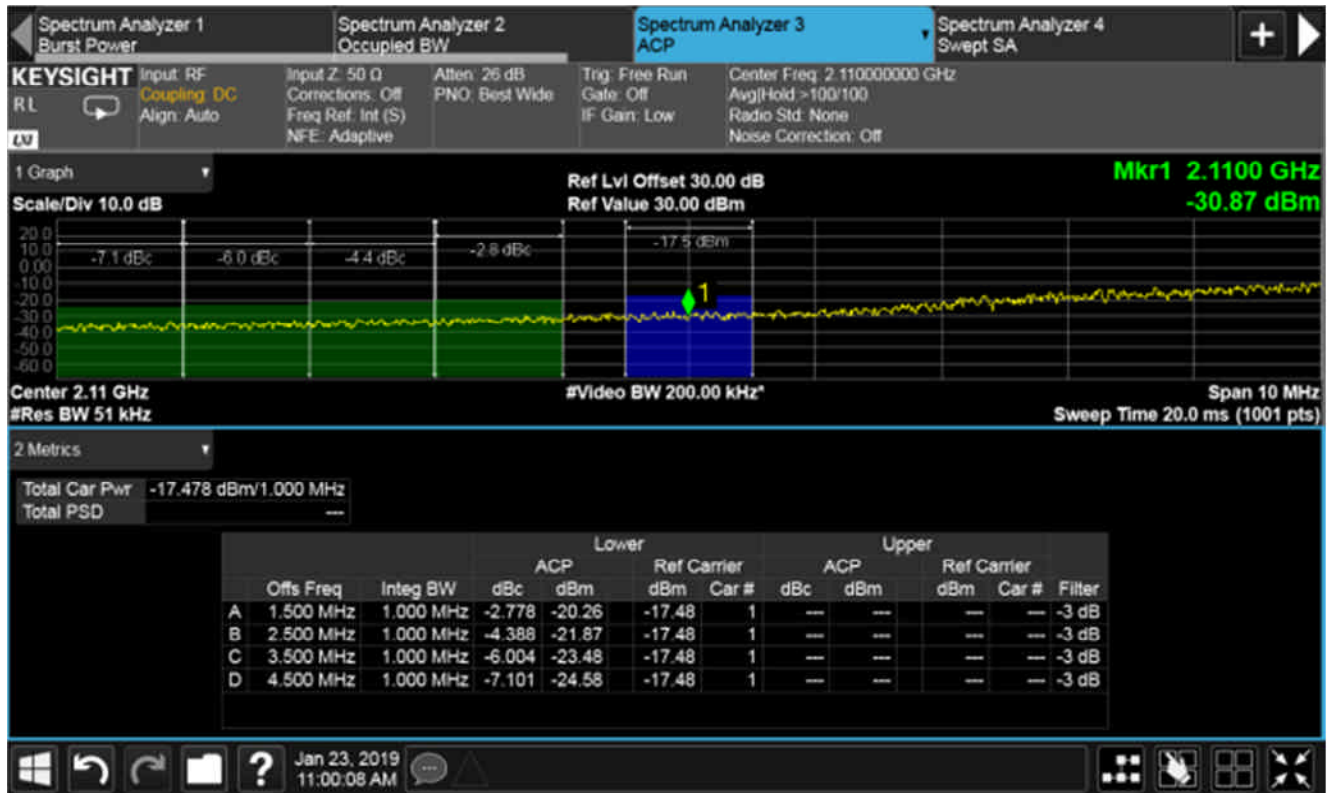
Plot of lower band edge for Low channel

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation UMTS,
Channel 2152.5 MHz



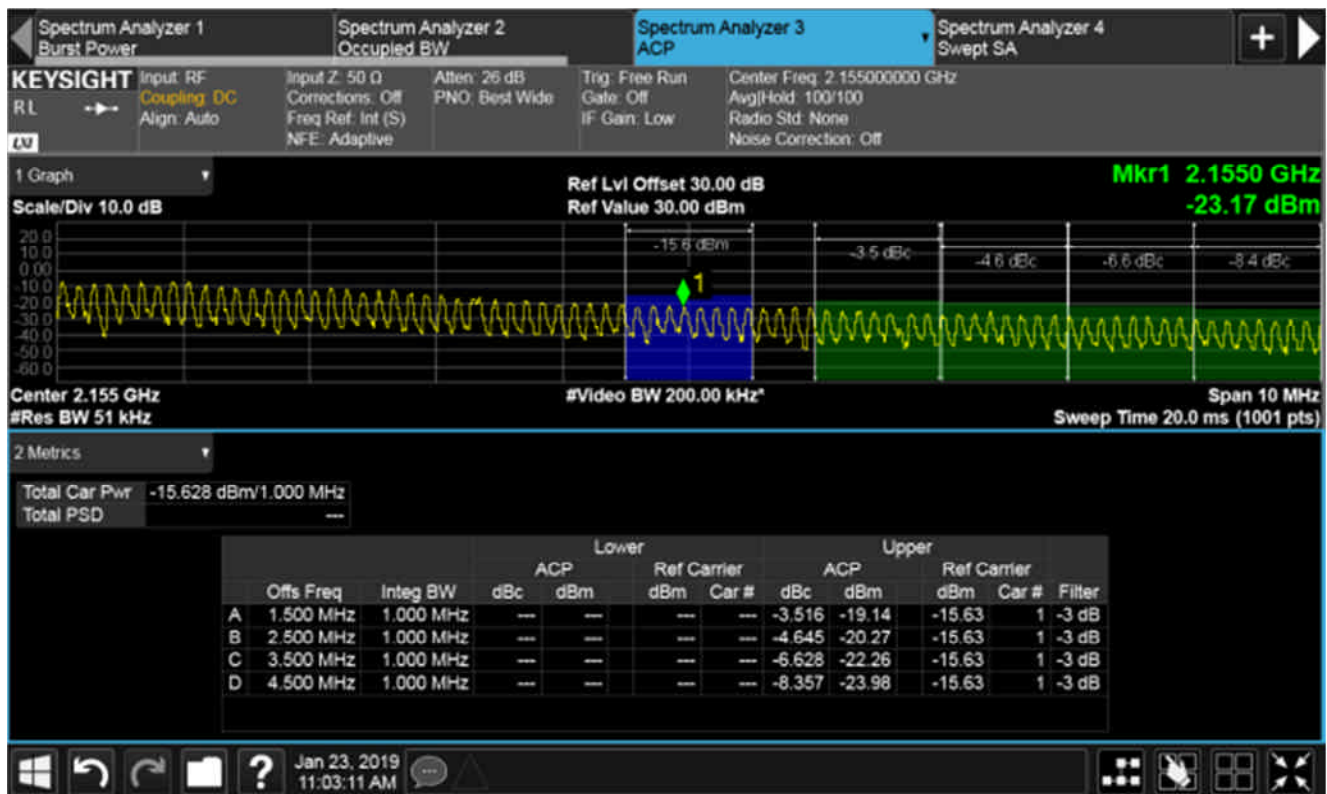
Plot of upper band edge for High channel

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation LTE,
Low Channel 2117.5 MHz



Plot of lower band edge for Low channel

RF Parameters: Band 2110-2200 MHz, Power +46 dBm, Channel Spacing 5 MHz, Modulation LTE,
Channel 2147.5 MHz



Plot of upper band edge for High channel

7 Photographs

For confidentiality purposes, photographs are not included at client's request.

8 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E268	BHA 9118	Horn Antenna 1-18 GHz	Schaffner	05-Apr-2018	12 months
E410	N5181A	Signal Generator 3 GHz MXG	Agilent Technologies	13-Jul-2018	36 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	10-Jul-2018	12 months
E420	E4438C	Signal Generator 250 kHz - 3.0 GHz	Agilent Technologies	14-Aug-2017	24 months
E453	20240-20-AA	Horn Std Gain 17.6 - 26.7 GHz	FMI Ltd	29-May-2018	12 months
E517	E4421B	Signal Generator 250kHz - 3.0GHz	Hewlett Packard	30-Aug-2017	24 months
E602	MG3692A	Signal Generator 10MHz - 20GHz	Anritsu	30-Jan-2017	24 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	09-Jan-2018	24 months
E656	75-A-MFN-06	Attenuator 6dB 75W Bi-Directional	Bird Electronics	07-Feb-2018	12 months
E743	RR2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	12-Feb-2018	12 months
E755	N9030B	PXA 3Hz to 50GHz	Keysight	04-Jun-2018	12 months
E777	MG3695B	Signal Generator 8MHz - 50GHz	Anritsu	20-Jun-2018	12 months
E843	G3RUH	10 MHz GPS Disciplined oscillator	James Miller	07-Dec-2018	3 months
E853	C-2.4PKP-1501-500mm	Cable 2.4mm to 2.92mm 50cm Yellow	Intelliconnect	21-Jan-2019	12 months
E866	42N50A	30dB 50W attenuator	Anritsu	21-Jan-2019	12 months
LPE364	CBL6112A	Antenna Bilog 30MHz - 2GHz	Chase Electronics Ltd	21-Mar-2018	24 months
S032	177	True RMS Multimeter	Fluke	26-Mar-2018	12 months
S036	FMH1 420	Temperature & Humidity Test Chamber	JTS Ltd	N/A	N/A
TMS80	206-3722	Digital Thermometer & K Probe	RS Components Ltd	21-Nov-2018	12 months
TMS814	MP627A	Antenna Doublet 200-1700 MHz	Anritsu	22-May-2018	12 months
TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	17-Dec-2018	12 months

9 Auxiliary and peripheral equipment

9.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	XHR33-33	DC Power Supply	Xantrex	E00116403
2	GD6000	Laptop PC	General Dynamics	Dev, Dev2

9.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
No ancillary RN equipment used.				

10 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

10.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

10.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

11 Description of test sites

Site A Radio / Calibration Laboratory and anechoic chamber

Site B Semi-anechoic chamber
FCC Registration No. 293246
IC Registration No. 5612A-4

Site B1 Control Room for Site B

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

Site H 3m Semi-anechoic chamber (indoor OATS)
FCC Registration No. 293246
IC Registration No. 5612A-2

Site J Screened Room

Site K Screened Room (Control Room for Site M)

Site M 3m Semi-anechoic chamber (indoor OATS)
FCC Registration No. 293246
IC Registration No. 5612A-3

Site N Radio Laboratory

Site Q Fully-anechoic chamber

Site
OATS 3m and 10m Open Area Test Site
FCC Registration No. 293246
IC Registration No. 5612A-1

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

12 Abbreviations and units

%	Percent	LBT	Listen Before Talk
µA/m	microAmps per metre	LO	Local Oscillator
µV	microVolts	mA	milliAmps
µW	microWatts	max	maximum
AC	Alternating Current	kPa	Kilopascal
ALSE	Absorber Lined Screened Enclosure	Mbit/s	MegaBits per second
AM	Amplitude Modulation	MHz	MegaHertz
Amb	Ambient	mic	Microphone
ATPC	Automatic Transmit Power Control	min	minimum
BER	Bit Error Rate	mm	milliMetres
°C	Degrees Celsius	ms	milliSeconds
C/I	Carrier / Interferer	mW	milliWatts
CEPT	European Conference of Postal and Telecommunications Administrations	NA	Not Applicable
COFDM	Coherent OFDM	nom	Nominal
CS	Channel Spacing	nW	nanoWatt
CW	Continuous Wave	OATS	Open Area Test Site
dB	decibel	OFDM	Orthogonal Frequency Division Multiplexing
dBµA/m	decibel relative to 1µA/m	ppm	Parts per million
dBµV	decibel relative to 1µV	PRBS	Pseudo Random Bit Sequence
dBc	decibel relative to Carrier	QAM	Quadrature Amplitude Modulation
dBm	decibel relative to 1mW	QPSK	Quadrature Phase Shift Keying
DC	Direct Current	R&TTE	Radio and Telecommunication Terminal Equipment
DTA	Digital Transmission Analyser	Ref	Reference
EIRP	Equivalent Isotropic Radiated Power	RF	Radio Frequency
ERP	Effective Radiated Power	RFC	Remote Frequency Control
EU	European Union	RSL	Received Signal Level
EUT	Equipment Under Test	RTP	Room Temperature and Pressure
FM	Frequency Modulation	RTPC	Remote Transmit Power Control
FSK	Frequency Shift Keying	Rx	Receiver
g	Grams	s	Seconds
GHz	GigaHertz	SINAD	Signal to Noise And Distortion
Hz	Hertz	Tx	Transmitter
IF	Intermediate Frequency	V	Volts
kHz	kiloHertz		