DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29507456

Test Report No:
77535RRF.004A1

Test Report
USA FCC Part 90

(*) Identification of item tested	nRF91
(*) Trademark	nRF91
(*) Model and /or type reference	nRF9151
Other identification of the product	FCC ID: 2ANPO00nRF9151 IC: 24529-NRF9151
(*) Features	LTE Cat-M1, LTE NB1&NB2 HW version: nRF9151 LACA AA SW version: mfw_nrf91x1_2.0.0
Applicant	NORDIC SEMICONDUCTOR ASA Otto Nielsens Veg 12, 7052 Trondheim, Norway
Test method requested, standard	USA FCC Part 90 (10-1-22 Edition). ANSI C63.26-2015. KDB 971168 D01 Power Meas License Digital Systems v03r01, April. 2018.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	José Manuel Gómez Galván EMC Consumer & RF Lab. Manager  Firmado digitalmente por 53680346W JOSE MANUEL GOMEZ (C:A29507456)
Date of issue	2024-04-04
Report template No	FDT08_24 (*) "Data provided by the client"

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Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample model nRF9151 DK is a Development Kit that has nRF9151 IOT Module and GPS. The nRF9151 is capable of LTE Cat-M1, Cat-NB1&NB2 and GPS. The Development kit contains antennas for cellular and GPS.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by: The client.

Id	Control Number	Description	Model	HW version:	Serial Nº	Date of Reception	Application
S/01	77535C/025_.1	nRF91	nRF9151	nRF9151 LACA CB0	1051231716	2024-01-08	Element Under Test
S/01	77535C/022_.1	SMA Cable	-	-	-	2024-01-08	Auxiliary Element
S/01	77535C/013_.1	USB Cable	-	-	-	2024-01-08	Auxiliary Element
S/02	77535C/027_.1	nRF91	nRF9151	nRF9151 LACA CB0	1051275581	2024-01-08	Element Under Test
S/02	77535C/023_.1	SMA Cable	-	-	-	2024-01-08	Auxiliary Element
S/02	77535C/015_.1	USB Cable	-	-	-	2024-01-08	Auxiliary Element
S/03	77535C/026_.1	nRF91	nRF9151	nRF9151 LACA CB0	1051261483	2024-01-08	Element Under Test
S/03	77535C/012_.1	USB Cable	-	-	-	2023-12-15	Auxiliary Element

Notes referenced to samples during the project:

Id	Type
S/01	Conducted tests.
S/02	Conducted tests: but the RF Output Power tests.
S/03	Radiated tests.

Test sample description

Ports……:	Port name and description	Cable					
		Specified max length [m]	Attached during test	Shielded	Coupled to patient(3)		
	LTE RF	2	☒	☒	☐		
	GPS	2	☐	☐	☐		
Supplementary information to the ports……:	-						
Rated power supply ..... :	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: 3.0-5.5V, nominal 3.8V					
	☐	DC:					
Rated Power..... :	1W						

Clock frequencies..... :	32kHz, 32MHz			
Other parameters ..... :	Temperature range: -40C..+85C			
Software version..... :	mfw_nrf91x1_2.0.0			
Hardware version ..... :	nRF9151 LACA AA			
Dimensions in cm (W x H x D) ... :	155x64x9mm			
Mounting position ..... :	☒	Table top equipment		
	☐	Wall/Ceiling mounted equipment		
	☐	Floor standing equipment		
	☐	Hand-held equipment		
	☐	Other:		
Modules/parts..... :	Module/parts of test item		Type	Manufacturer
	-		-	-
Accessories (not part of the test item) ..... :	Description		Type	Manufacturer
	-		-	-
Documents as provided by the applicant..... :	Description		File name	Issue date
	-		-	-

(3) Only for Medical Equipment

Identification of the client

NORDIC SEMICONDUCTOR ASA

Otto Nielsens Vei 12, 7052 Trondheim, Norway

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2024-01-18
Date (finish)	2024-02-22

Document history

Report number	Date	Description
77535RRE.004	2024-03-21	First release.
77535RRF.004A1	2024-04-04	Second release. Typos corrected about NB1 and NB2 references. This report replaces and cancels 77535RRF.004.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

In the semi-anechoic chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Carmen Vázquez, Sergio Carrasco, Antonio Maireles, Rafael Fernández.

Used instrumentation:

Control No.	Equipment	Model	Manufacturer	Next Calibration
7760	Digital Multimeter	175	FLUKE	2024-11
8002	TEMPERATURE CHAMBER MK56 BINDER	MK 56	BINDER	2024-04
6157	Signal and Spectrum Analyzer 10 Hz - 40 GHz	FSV40	ROHDE AND SCHWARZ	2025-01
8849	Wideband Radio Communication Tester	CMW500	ROHDE AND SCHWARZ	2025-10
6794	Shielded Room	S101	ETS LINDGREN	N/A
9229	Wideband Radio Communication Tester	CMW500	ROHDE AND SCHWARZ	2024-06
6250	Attenuator DC, 26.5 GHz, 10 dB, 2W	TWSMAG2	TECHNIWAVE	2025-02
2215	Power Divider DC-25 GHz	5333-104	PICOSECOND PULSE LABS	2024-07
6667	Wideband Radio Communication Tester	CMW500	ROHDE AND SCHWARZ	2024-06
6791	SEMIANECHOIC ABSORBER LINED	FACT 3 200 STP	ETS LINDGREN	N/A
6792	SHIELDED ROOM	S101	ETS LINDGREN	N/A
6666	EMI TEST RECEIVER 2Hz-44GHz	ESW44	ROHDE AND SCHWARZ	2024-03
6143	Biconical/Log Antenna 30 MHz - 6 GHz	3142E	ETS LINDGREN	2027-01
6021	Attenuator 3 dB, 2W, DC-6GHz	50HN-03	JFW	2025-02
6496	Horn Antenna 1-18 GHz	BBHA 9120 D	SCHWARZBECK MESS-ELEKTRONIK	2026-12
3783	PRE-AMPLIFIER G>30dB 1GHz-18GHz	BLMA 0118-3A	BONN ELEKTRONIK	2025-02
8856	Pre-Amplifier G>30dB 17-40GHz	BLMA 1840-4A	BONN ELEKTRONIK	2025-01
4657	Horn Antenna 18-40 GHz	BBHA 9170	SCHWARZBECK MESS-ELEKTRONIK	2026-06
4848	SOFTWARE FOR EMC/RF TESTING	EMC32	ROHDE AND SCHWARZ	N/A

Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M

Summary

Appendix A: LTE Cat-M1 Band 26.

FCC PART 90		
Requirement – Test case	**Verdict**	**Remark**
FCC 90.635 (b): RF output power	P	
FCC 2.1047: Modulation characteristics	P	
FCC 90.213: Frequency stability	P	
FCC 2.1049: Occupied Bandwidth	P	
FCC 90.691: Spurious emissions at antenna terminals	P	
FCC 90.691: Spurious emissions at antenna terminals (Emission mask requirements for EA-based systems)	P	
FCC 90.691: Radiated emissions	P	
Supplementary information and remarks: None.		

Appendix B: LTE Cat NB2 Band 26.

FCC PART 90		
Requirement – Test case	**Verdict**	**Remark**
FCC 90.635 (b): RF output power	P	
FCC 2.1047: Modulation characteristics	P	
FCC 90.213: Frequency stability	P	
FCC 2.1049: Occupied Bandwidth	P	
FCC 90.691: Spurious emissions at antenna terminals	P	
FCC 90.691: Spurious emissions at antenna terminals (Emission mask requirements for EA-based systems)	P	
FCC 90.691: Radiated emissions	P	
Supplementary information and remarks: None.		

Appendix A: Test results for FCC 90: LTE Cat-M1 Band 26

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TEST CONDITIONS

(*): Declared by the Applicant.

POWER SUPPLY (*):

Vnormal: 3.8 Vdc.
Vminimum: 3.0 Vdc
Vmaximum: 5.5 Vdc

Type of Power Supply: Internal DC.

ANTENNA (*):

Band	Gain (dBi)	Type
LTE Cat-M1 26	+2.7	SMD

TEST FREQUENCIES:

LTE Cat-M1 Band 26. Sub-band 814-824 MHz. QPSK and 16QAM:

	Channel (Frequency, MHz)				
	BW=1.4 MHz	BW=3 MHz	BW=5 MHz	BW=10 MHz	BW=15 MHz
Low	26697 (814.7)	26705 (815.5)	26715 (816.5)	N/A	N/A
Middle	26740 (819)	26740 (819)	26740 (819)	26740 (819)	N/A
High	26783 (823.3)	26775 (822.5)	26765 (821.5)	N/A	N/A

LTE Cat-M1 Band 26. Cross-rule Channel (824 MHz). QPSK and 16QAM:

Channel (Frequency, MHz)				
BW=1.4 MHz	BW=3 MHz	BW=5 MHz	BW=10 MHz	BW=15 MHz
26790 (824)	26790 (824)	26790 (824)	26790 (824)	26790 (824)

RF Output Power

Limits

FCC §90.635 (b): The maximum output power of the transmitter for mobile stations is 100 Watts (20 dBW).

Method

The conducted RF output power measurements were made at the RF output terminals of the EUT using the power meter of the Universal Radio Communication tester R&S CMW500, selecting maximum transmission power of the EUT and different modes of modulation.

The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

The maximum effective radiated power e.r.p. is calculated from the maximum equivalent isotropically radiated power (e.i.r.p.) by subtracting 2.15 dB:

E.R.P. = E.I.R.P. - 2.15 dB

Test Setup

Results

CONDUCTED AVERAGE POWER:

Measurements required on one frequency near top channel and one frequency near bottom channel, according to ANSI C63.26.

LTE Cat-M1 Band 26. Sub-band 814-824 MHz:

Worst-case of RF Power is BW=5 MHz, High Channel, QPSK, RB Size=1, RB Offset=2, Narrowband=0.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
5	Low 26715	816.5	QPSK	1	0	22.75
				1	2	22.88
				1	5	22.84
				3	0	21.9
				3	1	21.87
				3	3	21.92
				6	0	21.92
			16QAM	1	0	22.55
				1	2	22.68
				1	5	22.67
				3	0	21.65
				3	1	21.61
				3	3	21.66
				5	0	20.53
	High 26765	821.5	QPSK	1	0	22.9
				1	2	23
				1	5	22.9
				3	0	21.86
				3	1	21.84
				3	3	21.88
				6	0	21.94
			16QAM	1	0	22.59
				1	2	22.79
				1	5	22.7
				3	0	21.68
				3	1	21.64
				3	3	21.69
				5	0	20.54

BW=5 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
LOW	22.88	2.7	25.58	23.43
HIGH	23	2.7	25.7	23.55
MAX:	23		25.7	23.55

BW=5 MHz. 16QAM:

MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
LOW	22.68	2.7	25.38	23.23
HIGH	22.79	2.7	25.49	23.34
MAX:	22.79		25.49	23.34

LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz:

Worst-case of RF Power is BW=1.4 MHz, Single Channel, QPSK, RB Size=1, RB Offset=2, Narrowband=0.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
1.4	Single 26790	824	QPSK	1	0	22.86
				1	2	23.06
				1	5	22.94
				3	0	21.86
				3	1	21.93
				3	3	21.97
				6	0	21.05
			16QAM	1	0	21.88
				1	2	21.91
				1	5	21.89
				3	0	20.91
				3	1	20.87
				3	3	20.91
				5	0	20.81

BW=10 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
MIDDLE	23.06	2.7	25.76	23.61
MAX:	23.06		25.76	23.61

BW=10 MHz. 16QAM:

MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG EIRP(dBm)	RAD. POWER AVG ERP(dBm)
MIDDLE	21.91	2.7	24.61	22.46
MAX:	21.91		24.61	22.46

Measurement uncertainty (dB) <±1.11

Verdict

Pass

Frequency Stability

Limits

FCC § 90.213: Frequency stability.

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

Table 1 to § 90.213(a)—Minimum Frequency Stability

Frequency range (MHz)	Fixed and base stations (Parts per million (ppm))	Mobile stations	
		Over 2 watts output power (Parts per million (ppm))	2 watts or less output power (Parts per million (ppm))
809–824	1.5	2.5	2.5

(b) For the purpose of determining the frequency stability limits, the power of a transmitter is considered to be the maximum rated output power as specified by the manufacturer.

Method

The frequency tolerance measurements over temperature variations were made over the temperature range of -40ºC to +85ºC. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10ºC steps from -40ºC up to +85ºC.
The supply voltage was varied between 85% and 115% of nominal voltage.

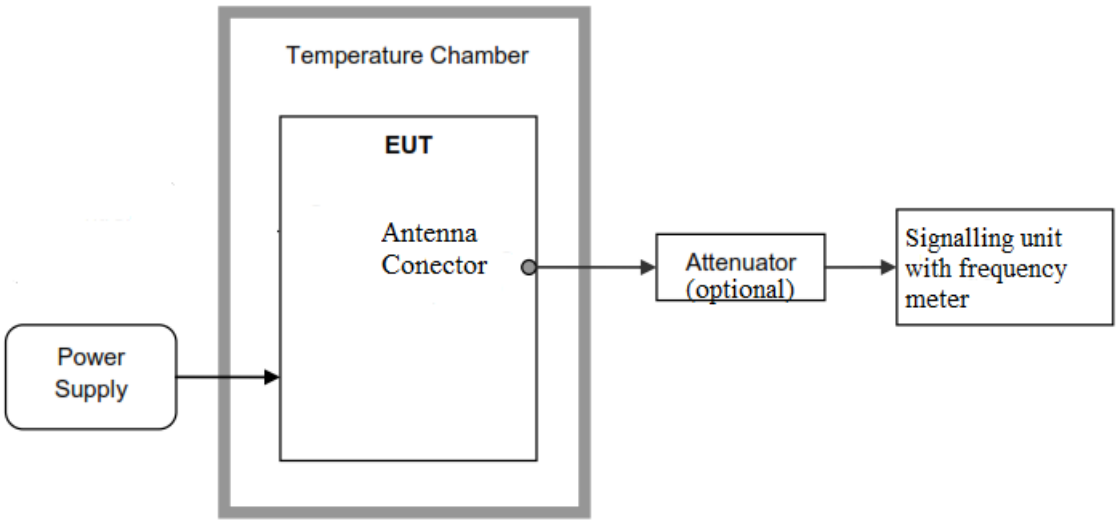
Temperature and voltage range of testing has been extended to the maximum and minimum values declared by customer.

The EUT was set in “Radio Resource Control (RRC) mode” in the middle channel using the Universal Radio Communication tester R&S CMW500 and the maximum frequency error was measured using the built-in calibrated frequency meter.
The worst case LTE mode for conducted power was used for the test.

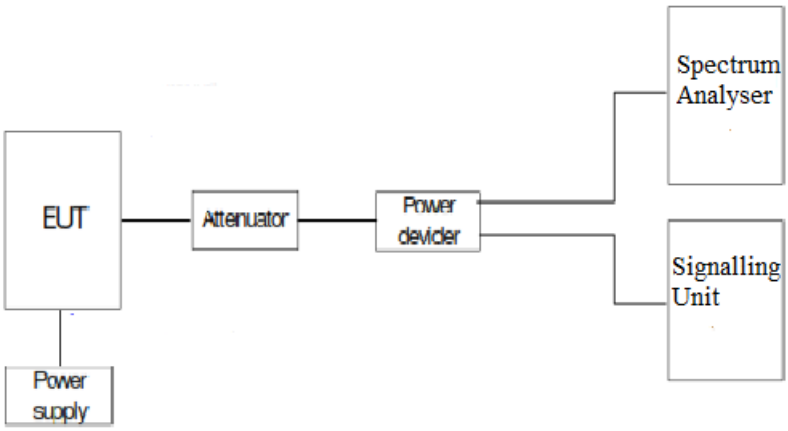
The reference point measurements were made at the RF output terminals of the EUT using an attenuator. power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test Setup

1. Frequency Tolerance:



2. Reference Frequency Points fL and fH:



Results

LTE Cat-M1 Band 26. Sub-band 814-824 MHz:

The worst case modulation in terms of Frequency Stability is BW=10 MHz, QPSK.

1. Frequency Tolerance:

- **Frequency Stability over Temperature Variations:**

Temperature (ºC)	Frequency Error (Hz)	Frequency Error (ppm)
85	1.39	0.001697192
80	0.74	0.000903541
70	-1.99	-0.002429792
60	-1.12	-0.001367521
+50	-5.89	-0.007191697
+40	3.82	0.004664225
+30	-1.92	-0.002344322
+20	3.72	0.004542125
+10	0.46	0.000561661
0	-6.36	-0.007765568
-10	-6.73	-0.008217338
-20	-4.29	-0.005238095
-30	1.43	0.001746032
-40	-5.79	-0.007069597

- **Frequency Stability over Voltage Variations.**

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	5.5	3.19	0.003894994
Vmin	3	6.13	0.007484737

Measurement uncertainty (Hz) <± 249.55

Results

PASS

Modulation Characteristics

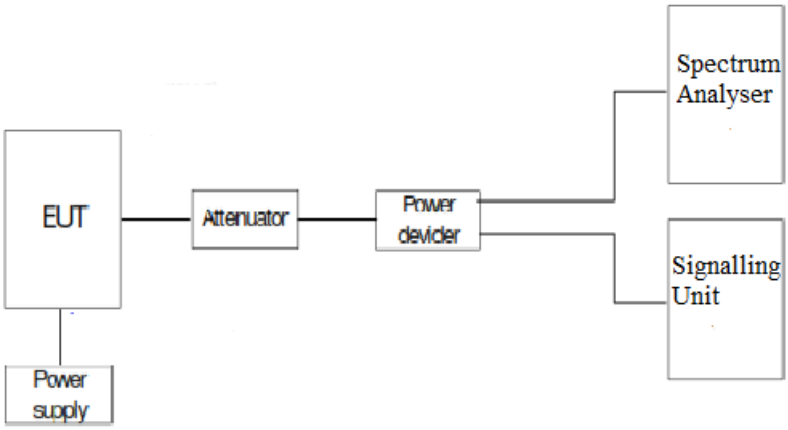
Limits

FCC §2.1047 Measurements required: Modulation characteristics.

Method

For LTE the EUT operates with QPSK and 16QAM modes in which the information is digitised and coded into a bit stream. The RF transmission is multiplexed using Orthogonal Frequency Division Multiplexing (OFDM) using different possible arrangement of subcarriers (Resource Blocks RB).

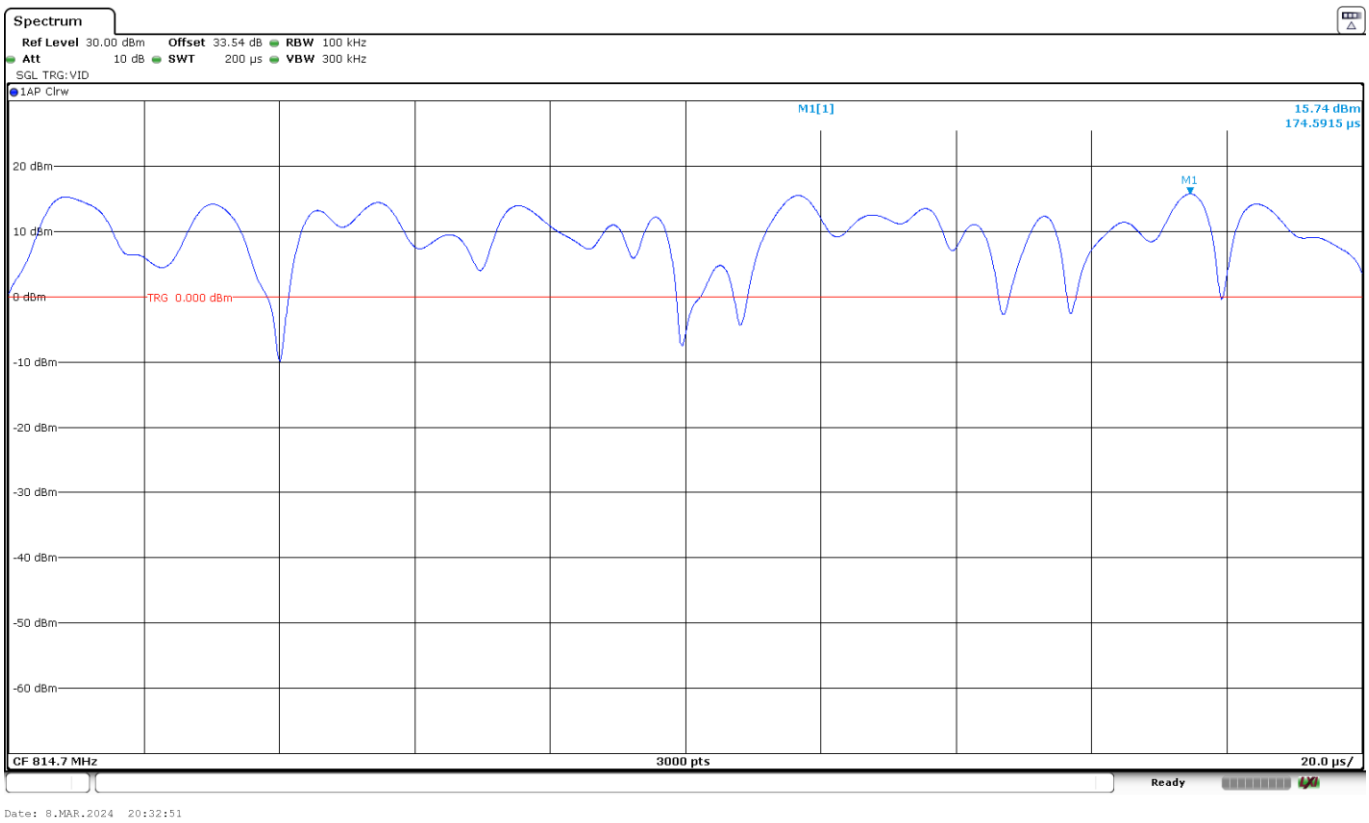
Test Setup



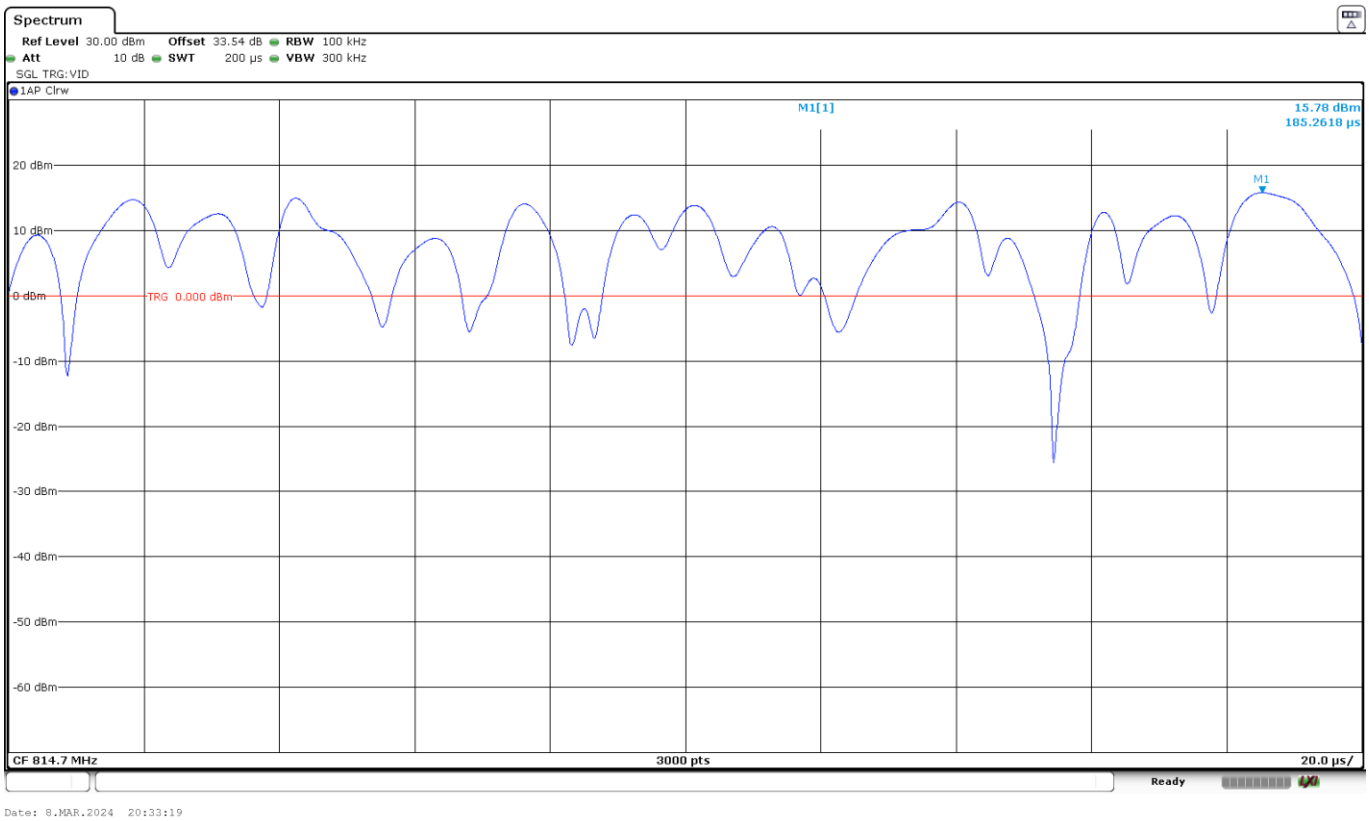
Results

The following plots show the modulation schemes in the EUT.

LTE Cat-M1 Band 26. Sub-band 814-824 MHz: BW = 1.4 MHz. QPSK.



LTE Cat-M1 Band 26. Sub-band 814-824 MHz: BW = 1.4 MHz. 16QAM.



Occupied Bandwidth

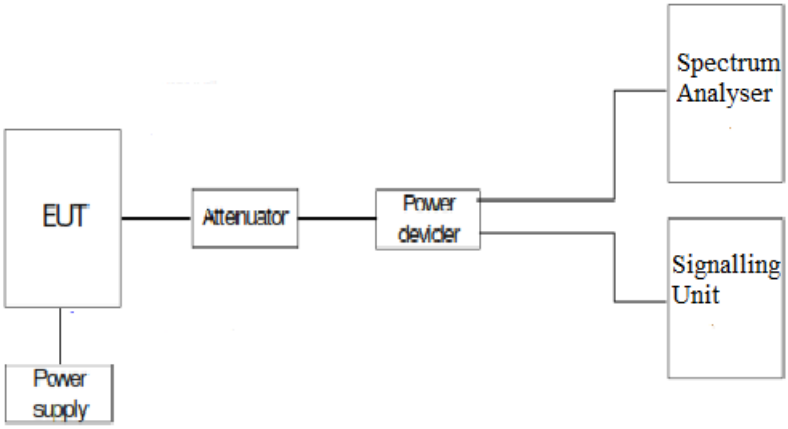
Limits

FCC §2.1049. Measurements required: Occupied bandwidth.

Method

The occupied bandwidth measurement was performed at the output terminals of the EUT using an attenuator. power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation. The 99% occupied bandwidth and the -26 dBc bandwidth were measured directly using the built-in bandwidth measuring option of spectrum analyser.

Test Setup



Results

LTE Bands: The worst case of Occupied Bandwidth corresponds to all Resource Blocks (RB) with Offset 0, regardless the nominal bandwidth selected.

LTE Cat-M1 Band 26. Sub-band 814-824 MHz:

LTE Cat-M1 Band 26. Sub-band 814-824 MHz. BW = 1.4 MHz. QPSK. RB Size = All. Narrowband=0.

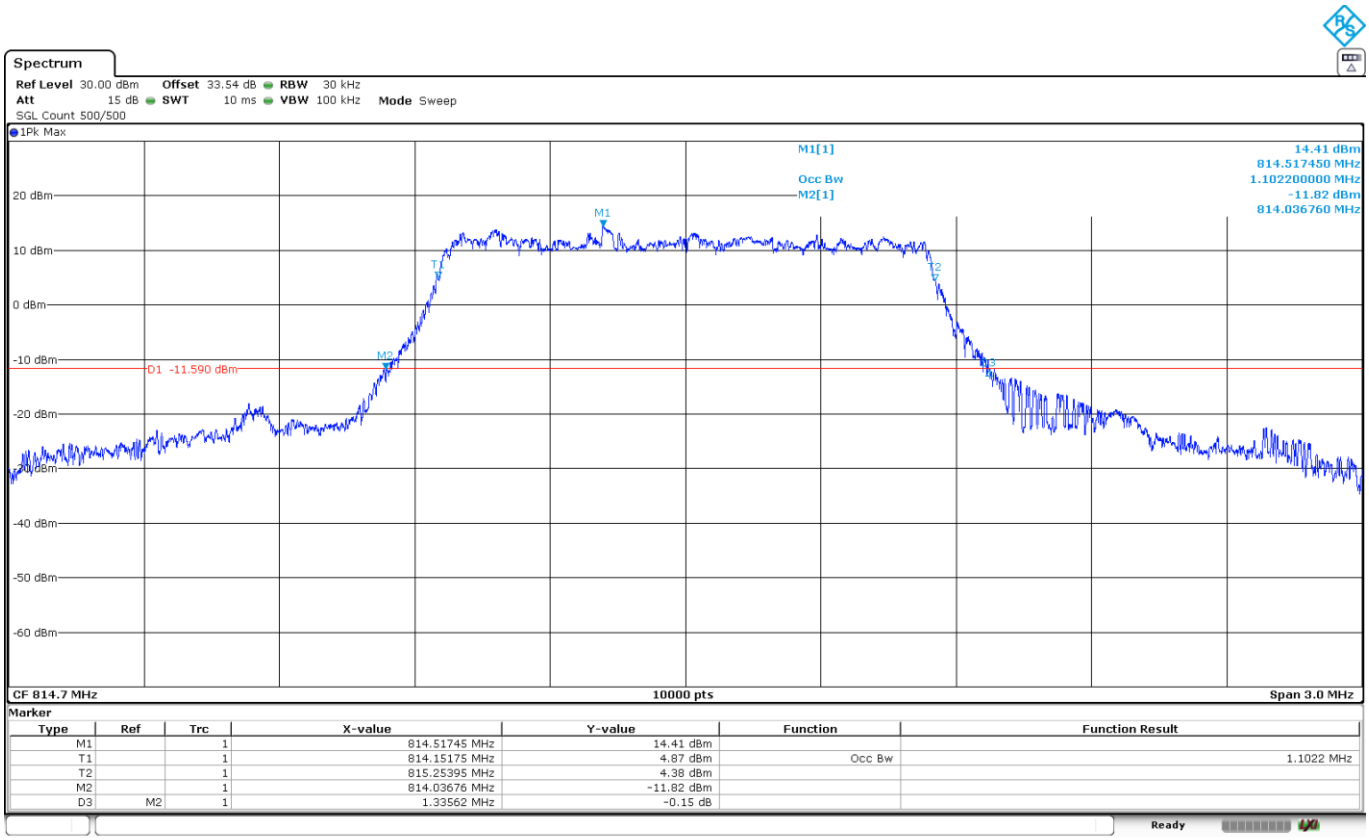
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	1.10220	1.09770
-26 dBc Bandwidth (MHz)	1.33562	1.35834
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-M1 Band 26. Sub-band 814-824 MHz. BW = 1.4 MHz. 16QAM. RB Size = All. Narrowband=0.

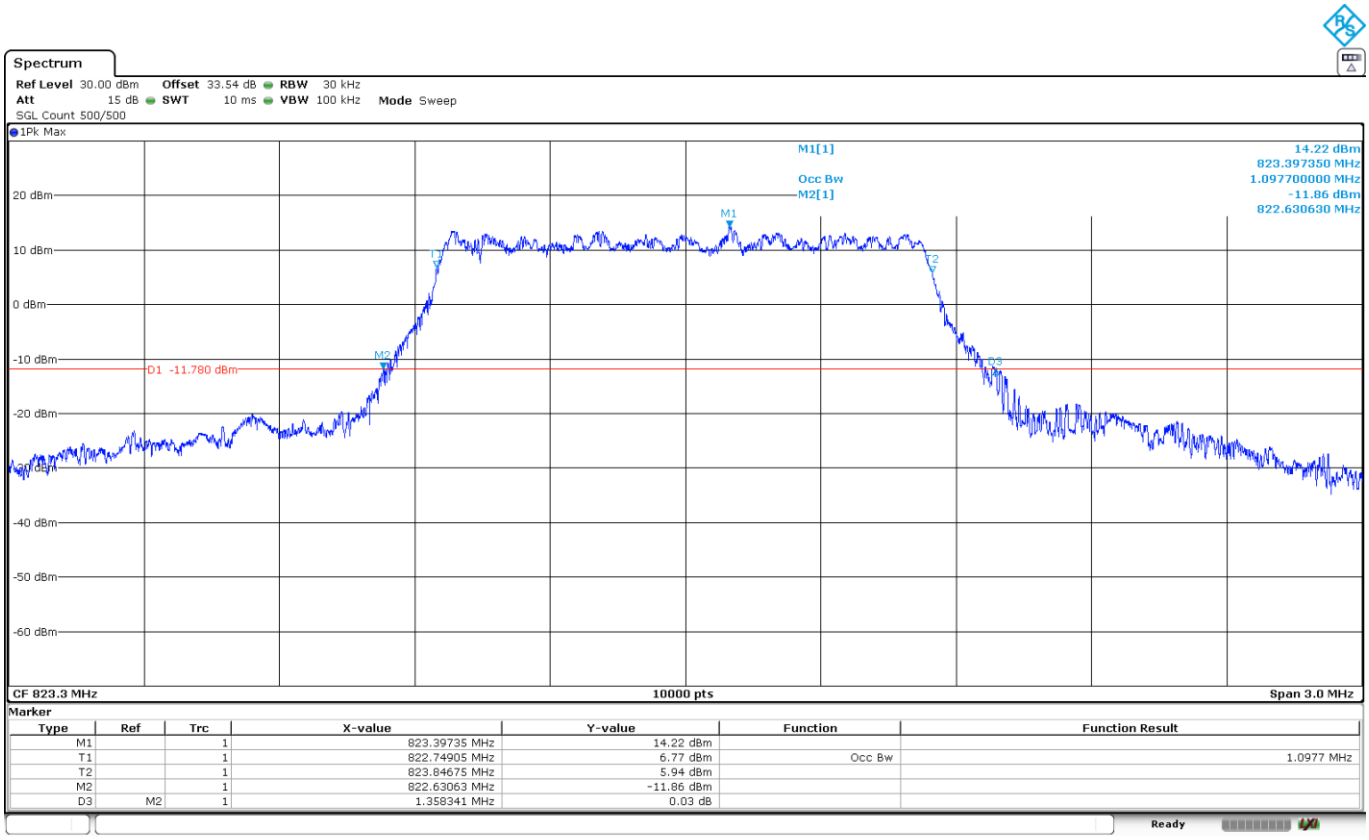
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	0.95010	0.93660
-26 dBc Bandwidth (MHz)	1.30468	1.32004
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-M1 Band 26. Sub-band 814-824 MHz. BW = 1.4 MHz. QPSK. Narrowband=0.

Low Channel:

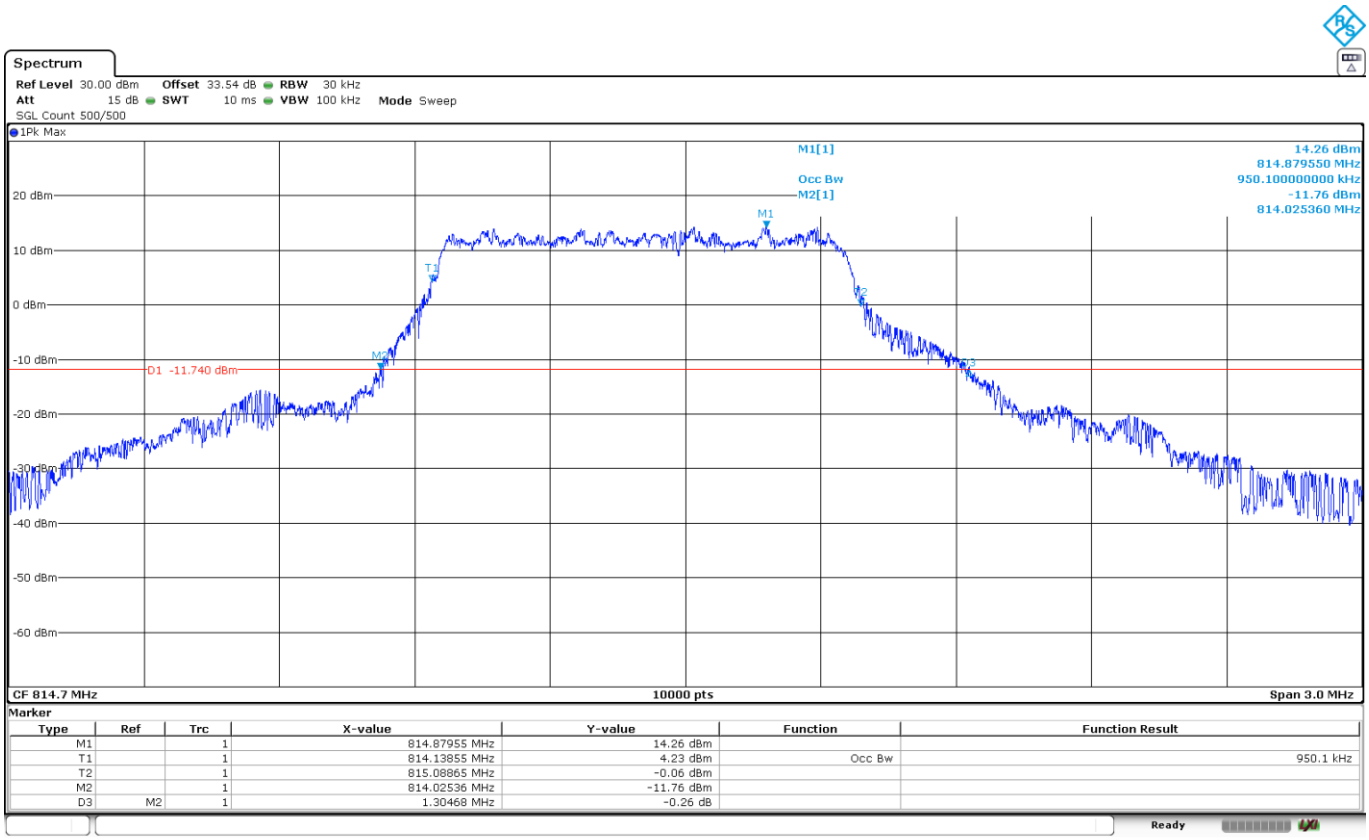


High Channel:

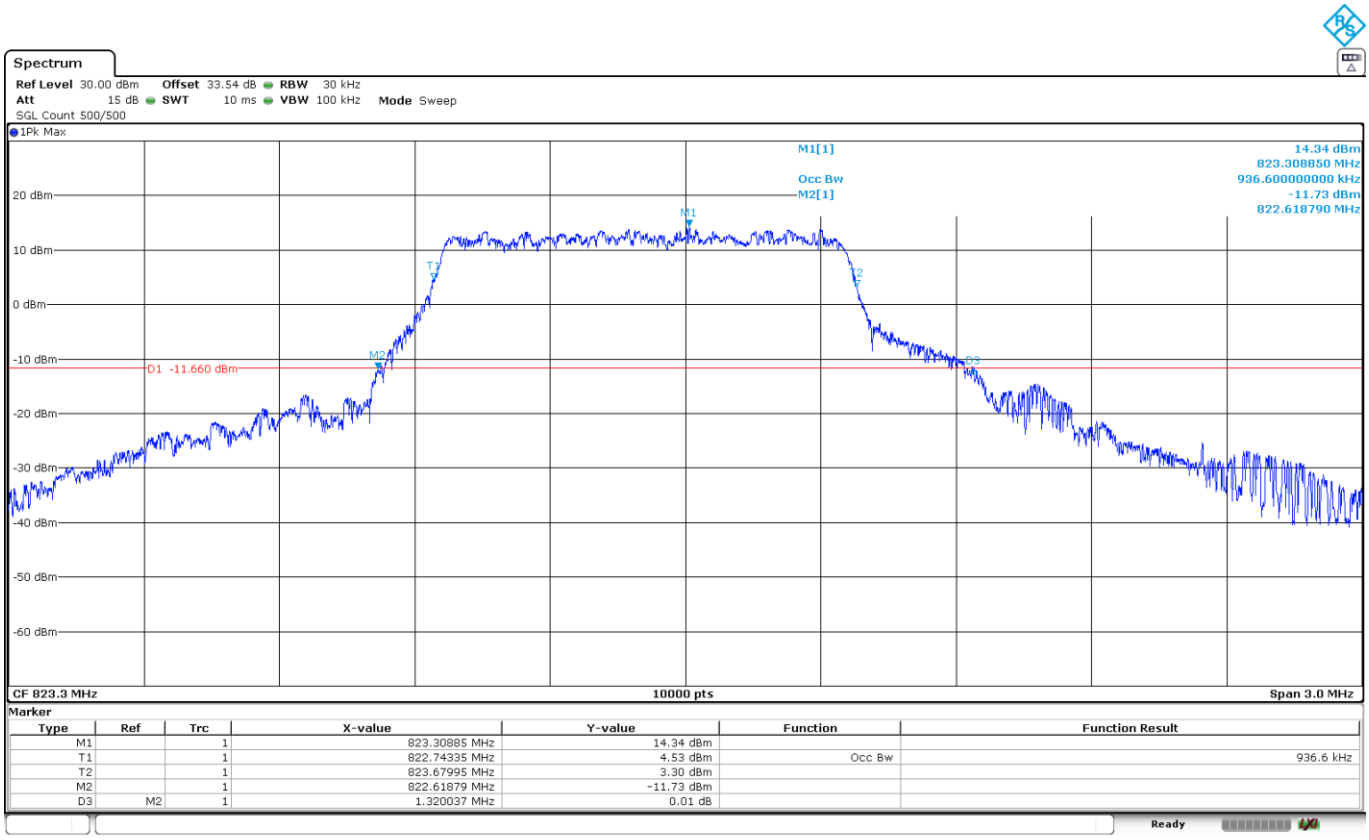


LTE Cat-M1 Band 26. Sub-band 814-824 MHz. BW = 1.4 MHz. 16QAM. Narrowband=0.

Low Channel:



High Channel:



LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz:

LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz. BW = 1.4 MHz. QPSK. RB Size = All. Narrowband=0.

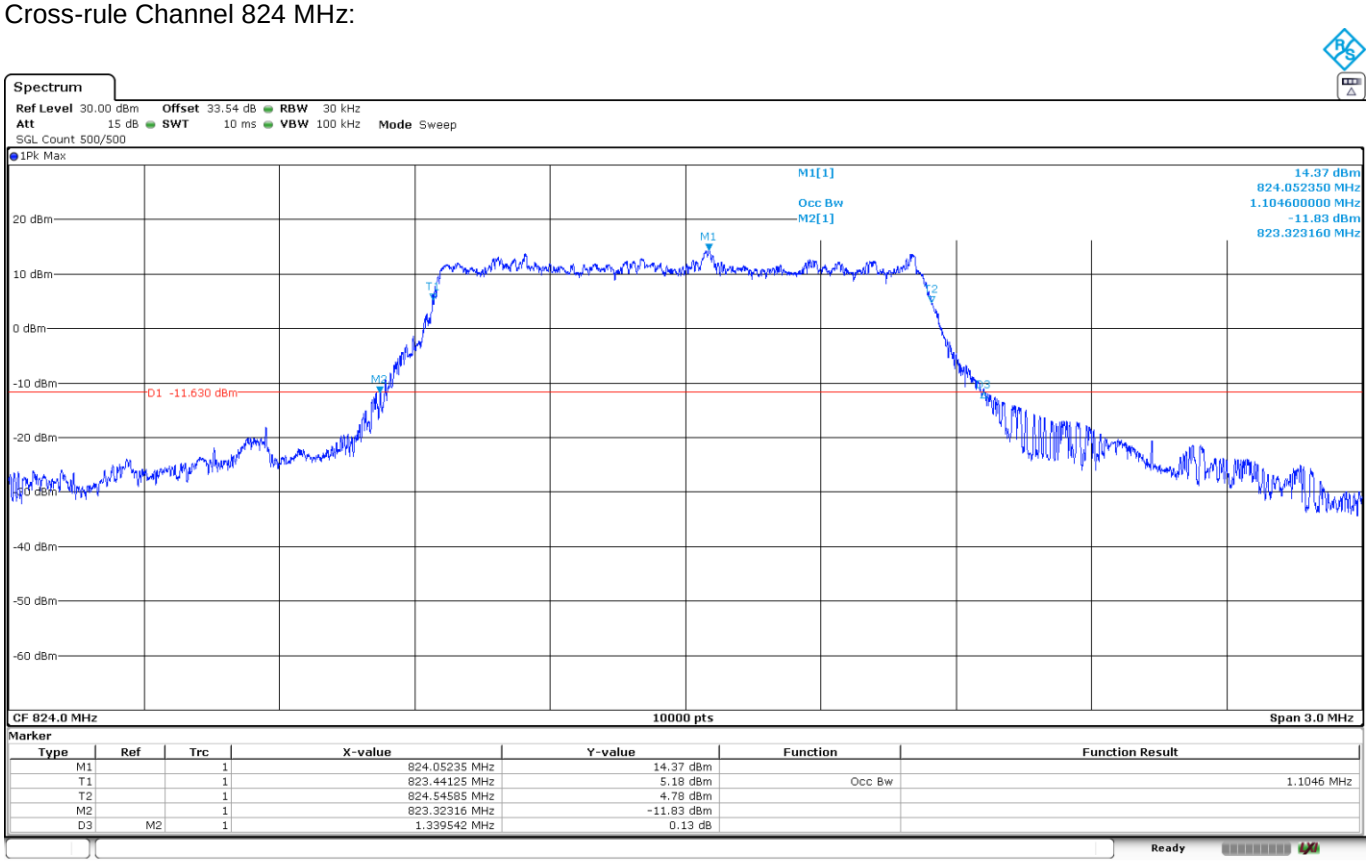
	Single Channel
99% Occupied Bandwidth (MHz)	1.10460
-26 dBc Bandwidth (MHz)	1.33954
Measurement uncertainty (kHz)	<±4.67

LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz. BW = 1.4 MHz. 16QAM. RB Size = All. Narrowband=0.

	Single Channel
99% Occupied Bandwidth (MHz)	0.94320
-26 dBc Bandwidth (MHz)	1.29143
Measurement uncertainty (kHz)	<±4.67

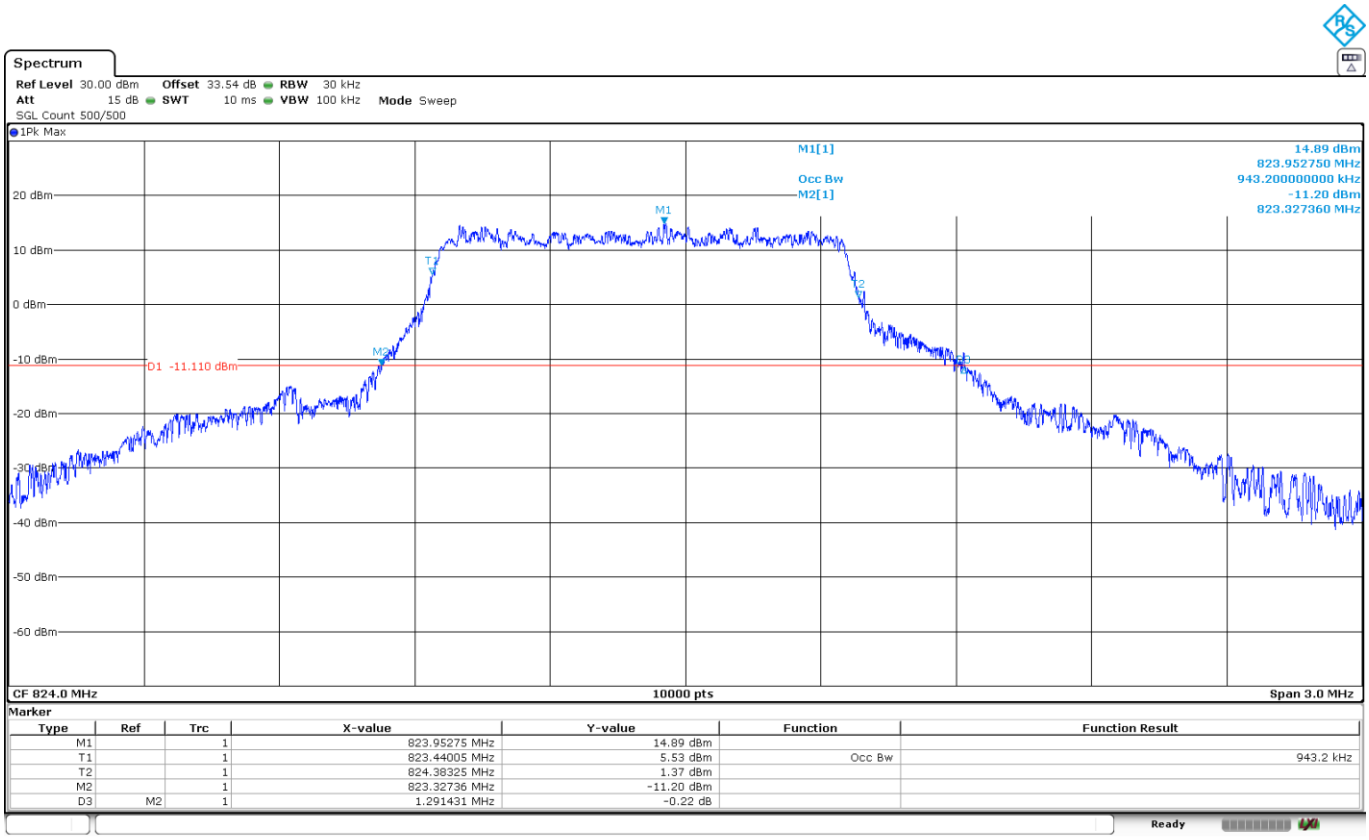
LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz. BW = 1.4 MHz. QPSK. Narrowband=0.

Cross-rule Channel 824 MHz:



LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz. BW = 1.4 MHz. 16QAM. Narrowband=0.

Cross-rule Channel 824 MHz:



Spurious emissions at antenna terminals

Limits

FCC §2.1051. Measurements required: Spurious emissions at antenna terminals.

FCC §90.691:

(a) Out-of-band emission requirement shall apply only to the “outer” channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

(1) For any frequency removed from the EA licensee's frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 116 Log10(f/6.1) decibels or 50 + 10 Log10(P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz.

(2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 43 + 10Log10(P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

(b) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

Method

The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50 Ohm attenuator and a power divider.
The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

The configuration of Resource Blocks and modulation which is the worst case for conducted power was used.

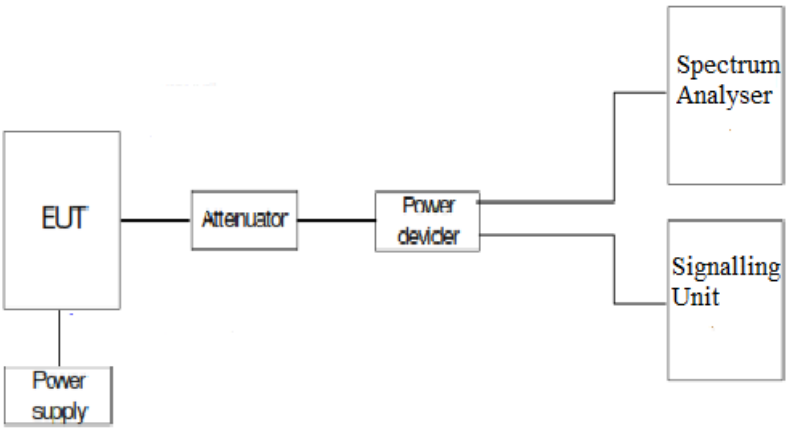
Measurement Limit:

According to specification. the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB. P in watts.

At Po transmitting power. the specified minimum attenuation becomes 43+10log (Po). and the level in dBm relative Po becomes:

$$Po\ (dBm) – [43 + 10 \log (Po \text{ in mwatts}) - 30] = - 13\ dBm$$

Test Setup


EUT
Attenuator
Power devider
Spectrum Analyser
Signalling Unit
Power supply

Results

Test performed on the worst-case modulation, RB Size and RB Offset.

LTE Cat-M1 Band 26. Sub-band 814-824 MHz:
BW = 5 MHz. QPSK. RB Size=1. RB Offset=0. Narrowband=0.

Frequency range 9 KHz - 10 GHz:

- Low Channel: No spurious frequencies detected at less than 20 dB below the limit.

- High Channel: No spurious frequencies detected at less than 20 dB below the limit.

LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz:
BW = 1.4 MHz. QPSK. RB Size=1. RB Offset=2. Narrowband=0.

Frequency range 9 KHz - 10 GHz:

- Single Channel: No spurious frequencies detected at less than 20 dB below the limit.

Measurement uncertainty (dB): <±2.76

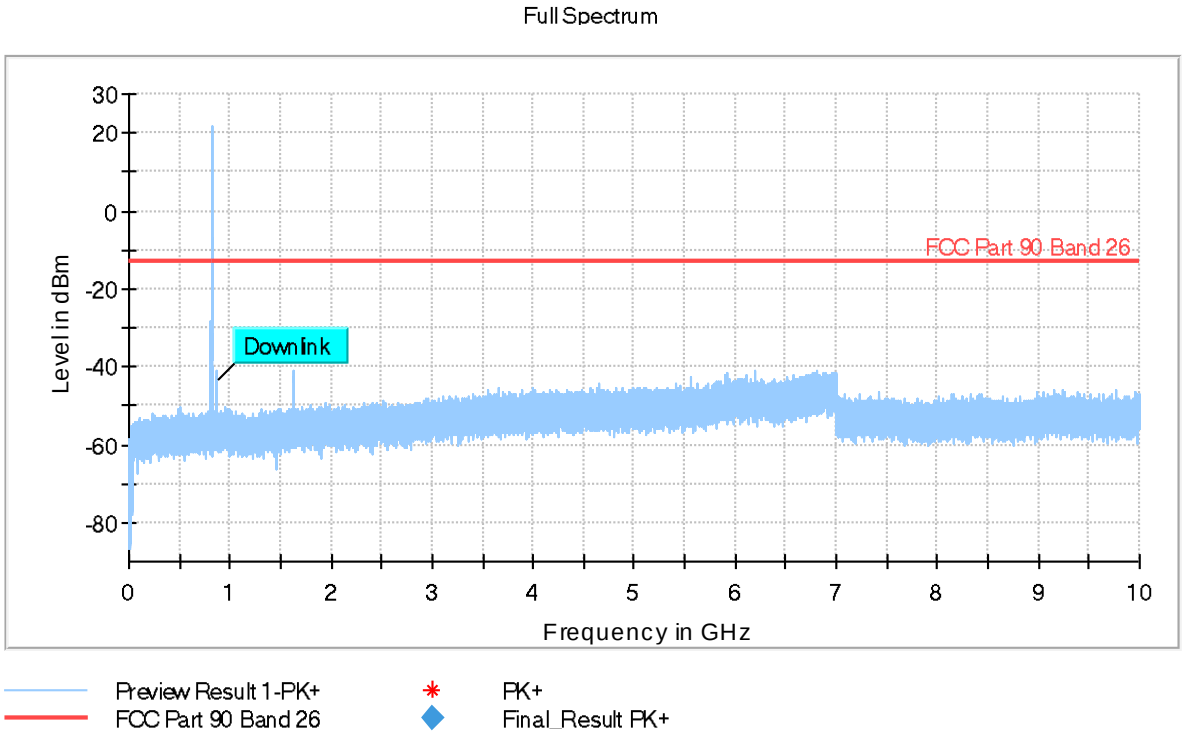
Verdict

PASS

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
9 kHz - 150 kHz	14.1 Hz	PK+	300 Hz	Coupled	0 dB
150 kHz - 30 MHz	932.812 Hz	PK+	10 kHz	Coupled	0 dB
30 MHz - 1 GHz	30.312 kHz	PK+	100 kHz	Coupled	0 dB
1 GHz - 2 GHz	31.25 kHz	PK+	100 kHz	Coupled	0 dB
2 GHz - 3 GHz	31.25 kHz	PK+	100 kHz	Coupled	0 dB
3 GHz - 4 GHz	31.25 kHz	PK+	100 kHz	Coupled	0 dB
4 GHz - 5 GHz	31.25 kHz	PK+	100 kHz	Coupled	0 dB
5 GHz - 6 GHz	31.25 kHz	PK+	100 kHz	Coupled	0 dB
6 GHz - 7 GHz	31.25 kHz	PK+	100 kHz	Coupled	0 dB
7 GHz - 8 GHz	31.25 kHz	PK+	100 kHz	Coupled	0 dB
8 GHz - 9 GHz	31.25 kHz	PK+	100 kHz	Coupled	0 dB
9 GHz - 10 GHz	31.25 kHz	PK+	100 kHz	Coupled	0 dB

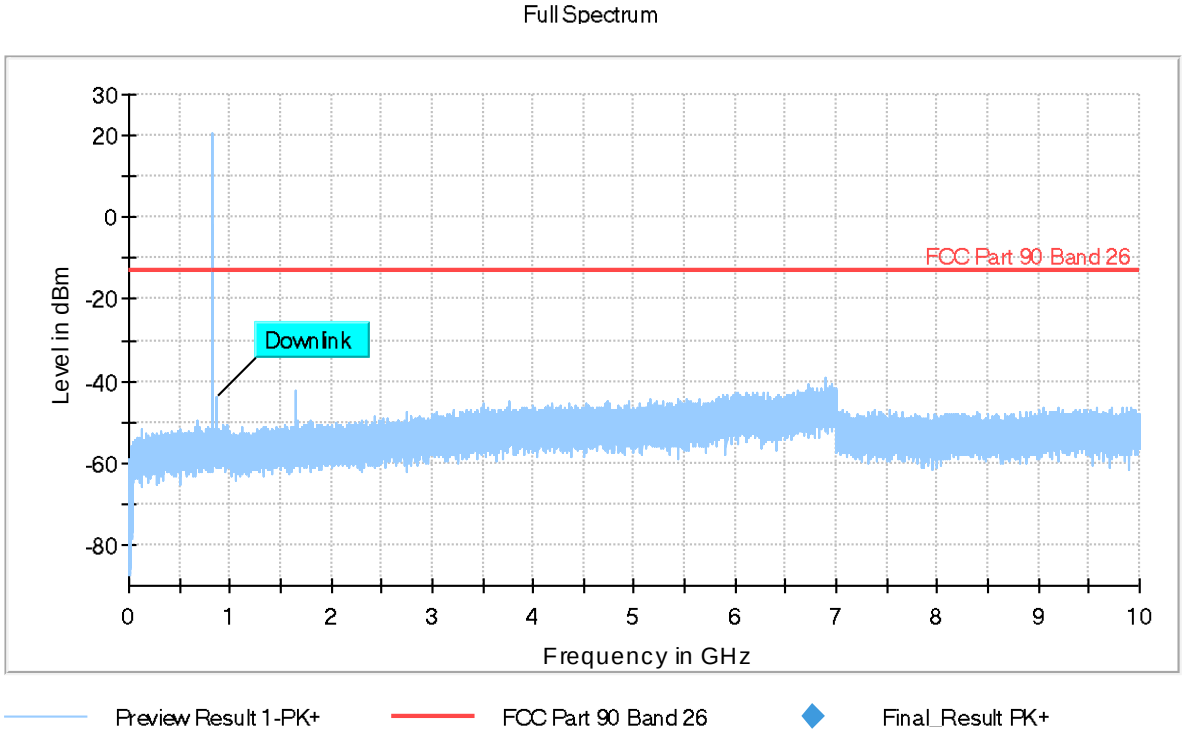
LTE Cat-M1 Band 26. Sub-band 814-824 MHz:
BW = 5 MHz. QPSK. RB Size=1. RB Offset=0. Narrowband=0.

Low Channel:



The peak above the limit is the carrier frequency.

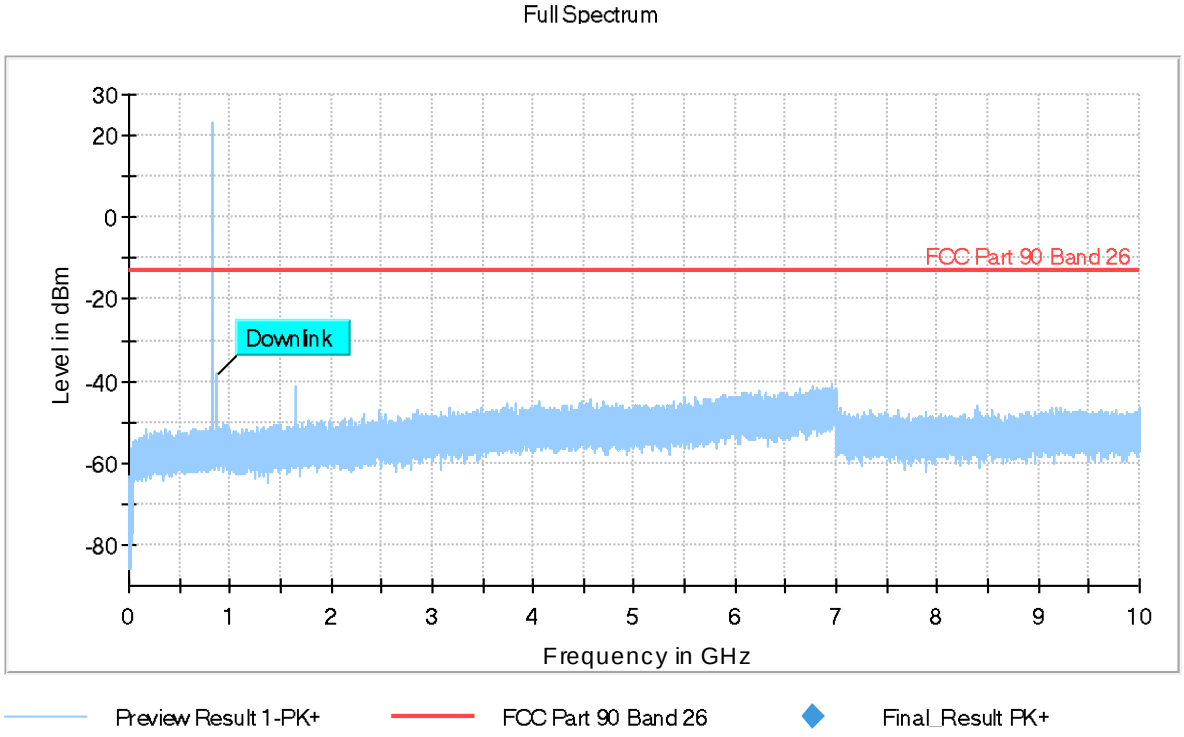
High Channel:



The peak above the limit is the carrier frequency.

LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz:
BW = 1.4 MHz. QPSK. RB Size=1. RB Offset=2. Narrowband=0.

Single Channel:



The peak above the limit is the carrier frequency.

Spurious Emissions at Antenna Terminals at Block Edges

Limits

* FCC §2.1051:

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.

Compliance with these rules is based on the use of measurement instrumentation employing a reference bandwidth as follows:

In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

* FCC §90.691:

(a) Out-of-band emission requirement shall apply only to the “outer” channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

> (1) For any frequency removed from the EA licensee's frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 116 Log10(f/6.1) decibels or 50 + 10 Log10(P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz.
>
> (2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 43 + 10Log10(P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

Method

The EUT RF output connector was connected to a spectrum analyzer and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50-Ohm attenuator and a power splitter.

The reading of the spectrum analyser is corrected with the path loss of the connection between the output terminal of the EUT and the input of the spectrum analyzer.

The configuration of modulation which is the worst case for conducted power was used.

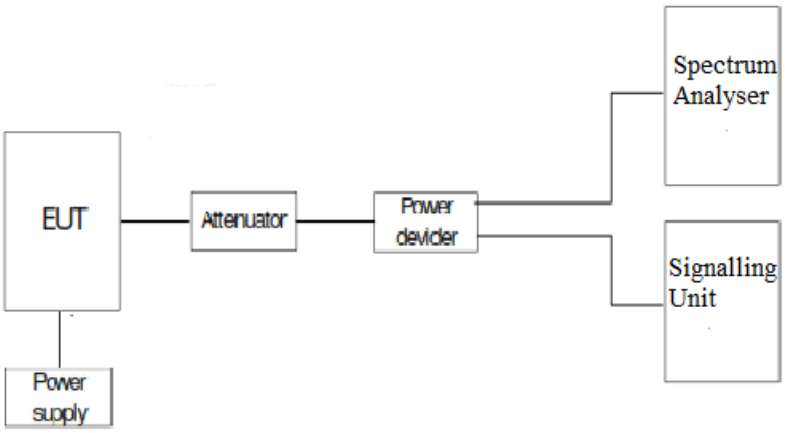
As stated in FCC §2.1051, in the 1 MHz bands immediately outside and adjacent to the frequency block or band a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

Measurement Limit:

At Po transmitting power, the specified minimum attenuation 43 + 10 log10 p (watts) for any frequency removed from the EA licensee's frequency block greater than 37.5 kHz becomes:

$$Po\ (dBm) - [43 + 10 \log (Po\ in\ mwatts) - 30] = -13\ dBm$$

Test Setup


Spectrum Analyser
EUT
Attenuator
Power devider
Signalling Unit
Power supply

Results

Sub-band 814-824 MHz:

Preliminary measurements determined the BW=1.4 MHz, QPSK as the worst case. Results attached are for this worst-case configuration.

LTE Cat-M1 Band 26. QPSK.	Narrowband=0. RB Size=1. RB Offset=0. BW=1.4 MHz	Narrowband=0. RB Size=1. RB Offset=0. BW=3 MHz	Narrowband=0. RB Size=1. RB Offset=0. BW=5 MHz	Narrowband=0. RB Size=1. RB Offset=0. BW=10 MHz
Maximum measured level at Low Block Edge at antenna port (dBm)	-13.4	-27.82	-25.2	-37.24

LTE Cat-M1 Band 26. QPSK.	Narrowband=0. RB Size=6. RB Offset=0. BW=1.4 MHz	Narrowband=0. RB Size=6. RB Offset=0. BW=3 MHz	Narrowband=0. RB Size=6. RB Offset=0. BW=5 MHz	Narrowband=0. RB Size=6. RB Offset=0. BW=10 MHz
Maximum measured level at Low Block Edge at antenna port (dBm)	-20.32	-22.59	-18.8	-23.88

LTE Cat-M1 Band 26. QPSK.	Narrowband=All. RB Size=1. RB Offset=Max. BW=1.4 MHz	Narrowband=All. RB Size=1. RB Offset=Max. BW=3 MHz	Narrowband=All. RB Size=1. RB Offset=Max. BW=5 MHz	Narrowband=All. RB Size=1. RB Offset=Max. BW=10 MHz
Maximum measured level at High Block Edge at antenna port (dBm)	-14.17	-30.66	-25.97	-37.5

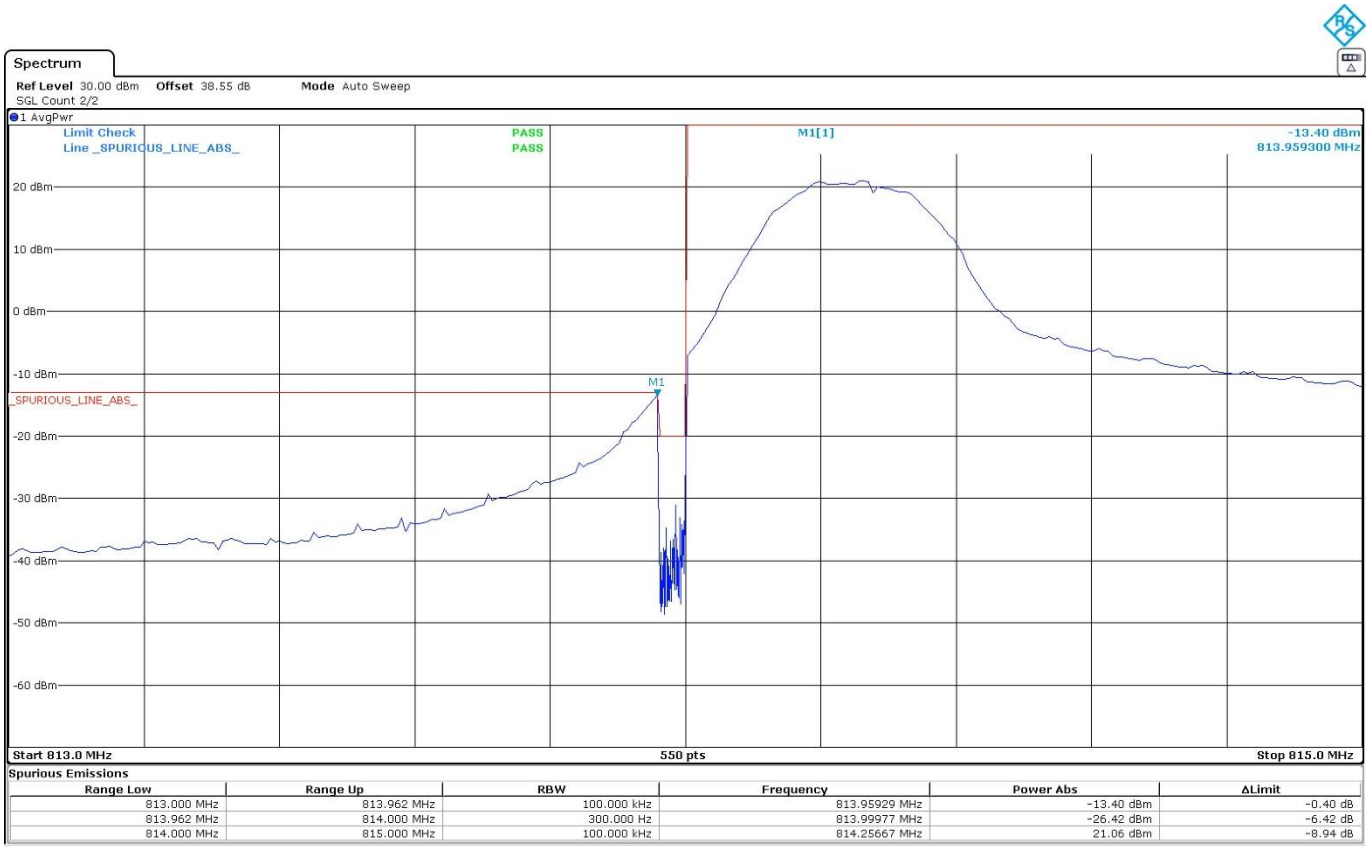
LTE Cat-M1 Band 26. QPSK.	Narrowband=All. RB Size=6. RB Offset=1. BW=1.4 MHz	Narrowband=All. RB Size=6. RB Offset=1. BW=3 MHz	Narrowband=All. RB Size=6. RB Offset=1. BW=5 MHz	Narrowband=All. RB Size=6. RB Offset=1. BW=10 MHz
Maximum measured level at High Block Edge at antenna port (dBm)	-20.23	-22.67	-18.75	-25.06

Measurement uncertainty (dB): <±2.76

Verdict

Pass

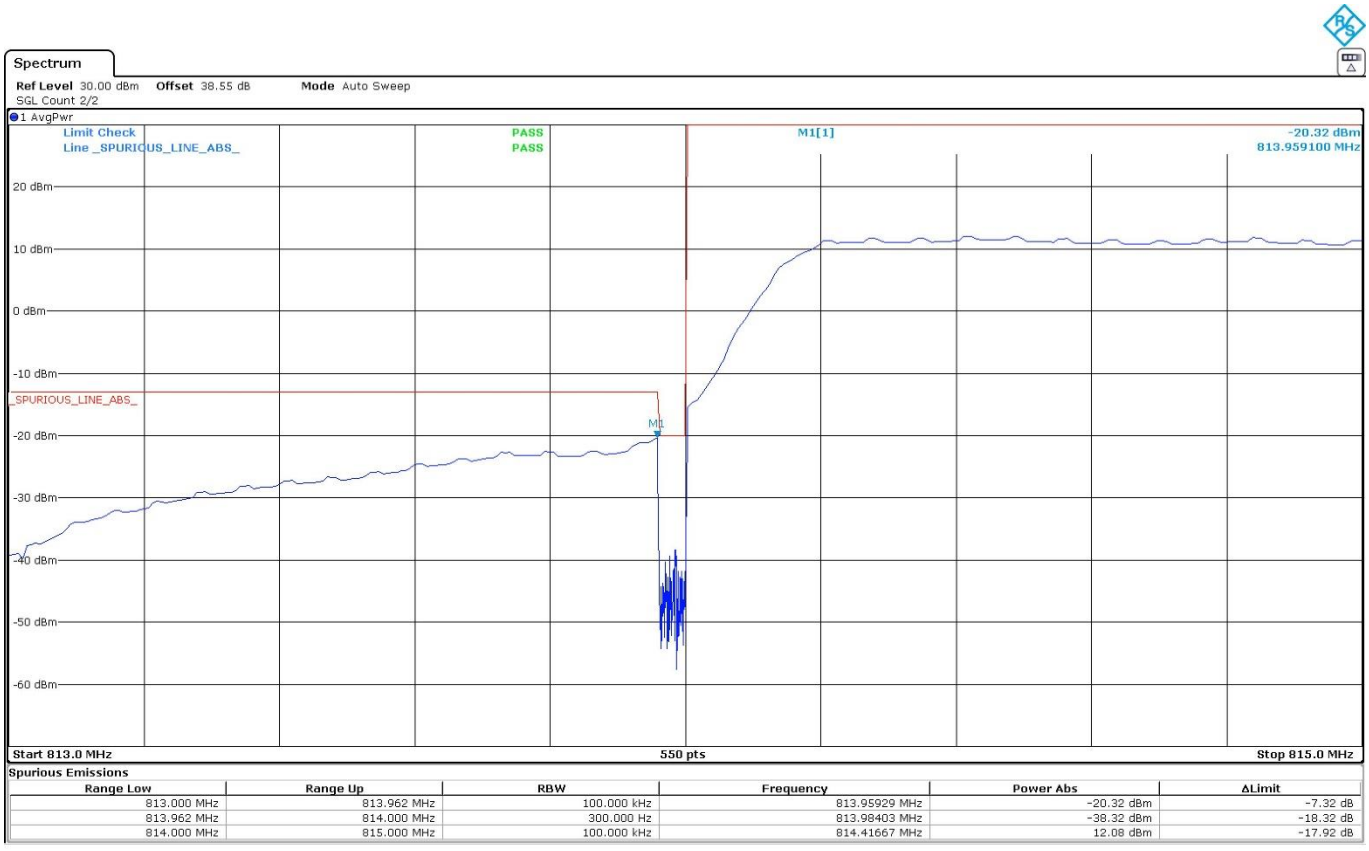
Sub-band 814-824 MHz. EA MASK: BW=1.4 MHz. RB Size=1. RB Offset=0. Narrowband=0. Low Block Edge:



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
813.000 MHz	813.962 MHz	100.000 kHz	813.95929 MHz	-13.40 dBm	-0.40 dB
813.962 MHz	814.000 MHz	300.000 Hz	813.99977 MHz	-26.42 dBm	-6.42 dB
814.000 MHz	815.000 MHz	100.000 kHz	814.25667 MHz	21.06 dBm	-8.94 dB

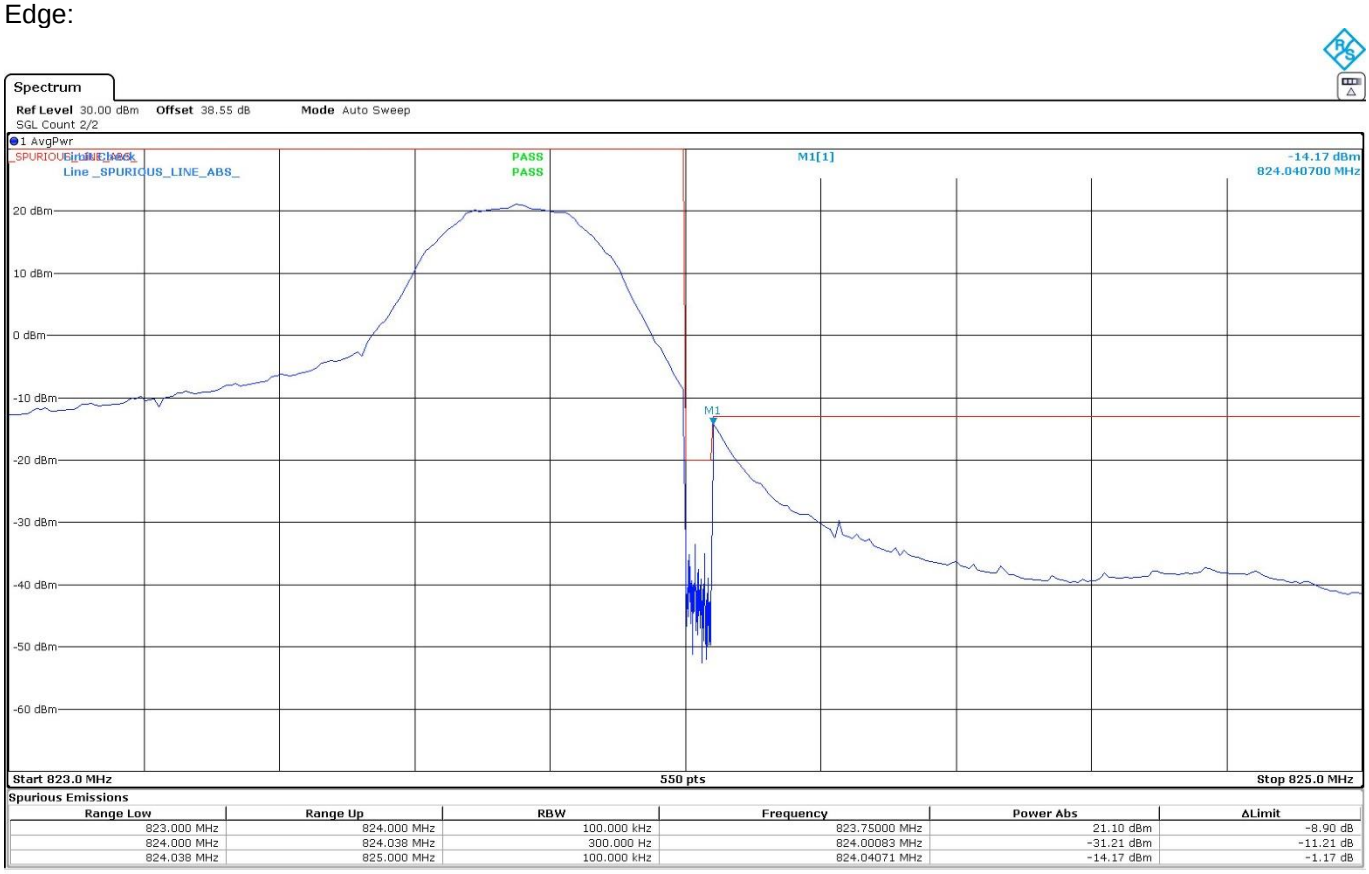
Sub-band 814-824 MHz. EA MASK: BW=1.4 MHz. RB Size=6. RB Offset=0. Narrowband=0. Low Block Edge:



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
813.000 MHz	813.962 MHz	100.000 kHz	813.95929 MHz	-20.32 dBm	-7.32 dB
813.962 MHz	814.000 MHz	300.000 Hz	813.98403 MHz	-38.32 dBm	-18.32 dB
814.000 MHz	815.000 MHz	100.000 kHz	814.41667 MHz	12.08 dBm	-17.92 dB

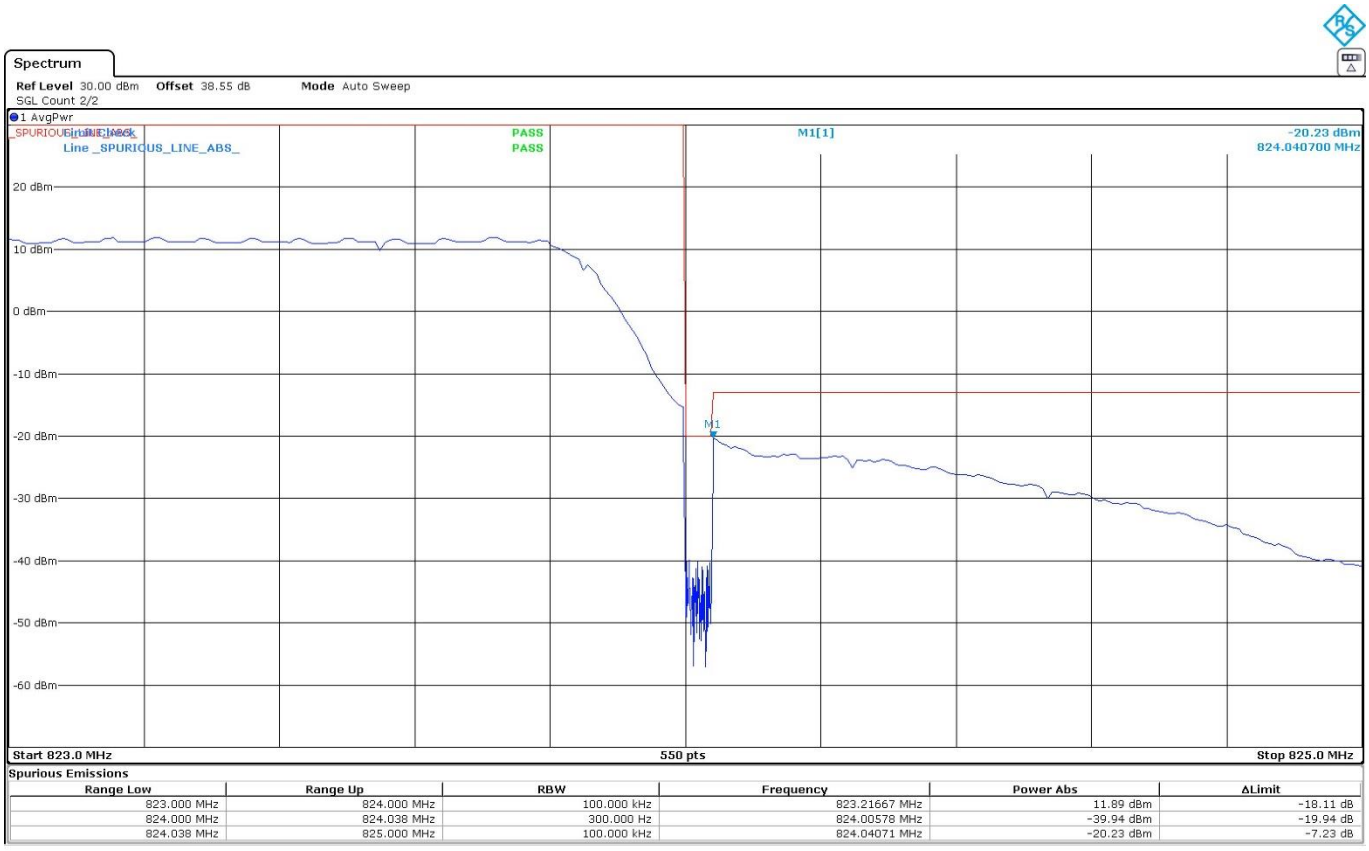
Sub-band 814-824 MHz. EA MASK: BW=1.4 MHz. RB Size=1. RB Offset=Max. Narrowband=All. High Block Edge:



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
823.000 MHz	824.000 MHz	100.000 kHz	823.75000 MHz	21.10 dBm	-8.90 dB
824.000 MHz	824.038 MHz	300.000 Hz	824.00083 MHz	-31.21 dBm	-11.21 dB
824.038 MHz	825.000 MHz	100.000 kHz	824.04071 MHz	-14.17 dBm	-1.17 dB

Sub-band 814-824 MHz. EA MASK: BW=1.4 MHz. RB Size=6. RB Offset=1. Narrowband=All. High Block Edge:



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
823.000 MHz	824.000 MHz	100.000 kHz	823.21667 MHz	11.89 dBm	-18.11 dB
824.000 MHz	824.038 MHz	300.000 Hz	824.00578 MHz	-39.94 dBm	-19.94 dB
824.038 MHz	825.000 MHz	100.000 kHz	824.04071 MHz	-20.23 dBm	-7.23 dB

Radiated Emissions

Limits

FCC §90.691:

For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

Method

The measurement was performed with the EUT inside an anechoic chamber. The spectrum was scanned from 30 MHz to at least the 10th harmonic of the High frequency generated within the equipment.

The EUT was placed on a high non-conductive stand at a 3 meter distance from the measuring antenna.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the height and polarization of the measuring antenna. The maximum meter reading was recorded.

MEASUREMENT LIMIT:

According to specification, the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB, P in watts.
At Po transmitting power, the specified minimum attenuation becomes 43+10log (Po), and the level in dBm relative Po becomes:

$$Po\ (dBm) - [43 + 10 \log (Po\ in\ mwatts) - 30] = -13\ dBm$$

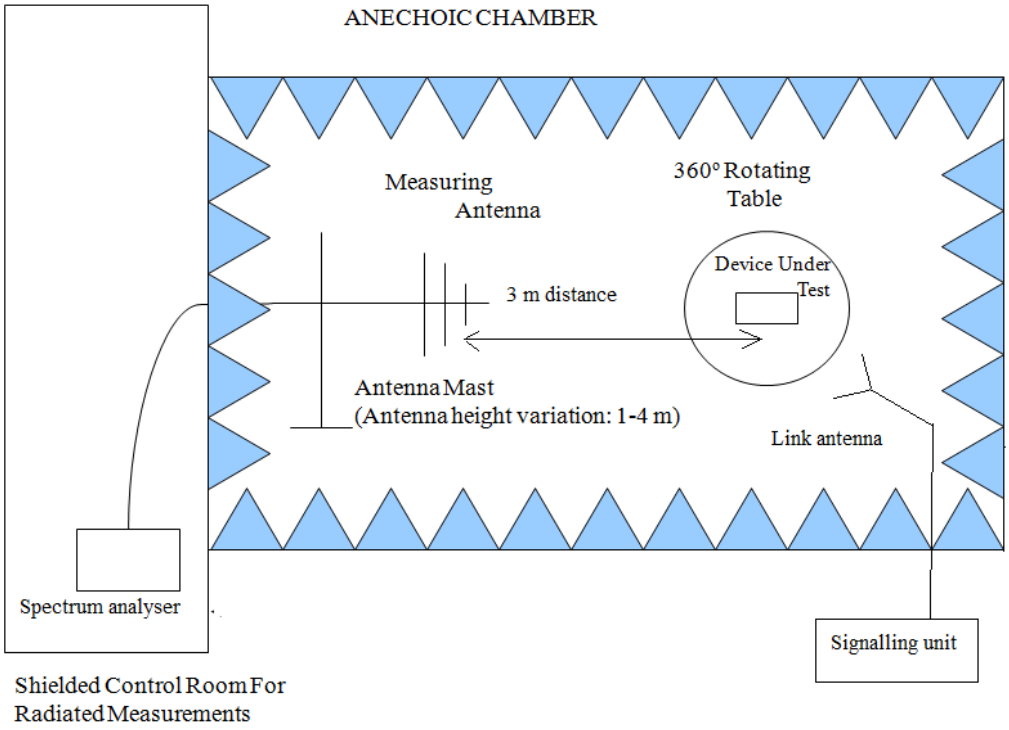
The maximum field strength (dBµV/m) of each detected emission at less than 20 dB respect to the limit is converted to an equivalent EIRP level (dBm) according to ANSI C63.26 with the formula:

EIRP (dBm) = E (dBµV/m) + 20 log(D) - 104.8; where D is the measurement distance (in the far field region) in m. D = 3 m

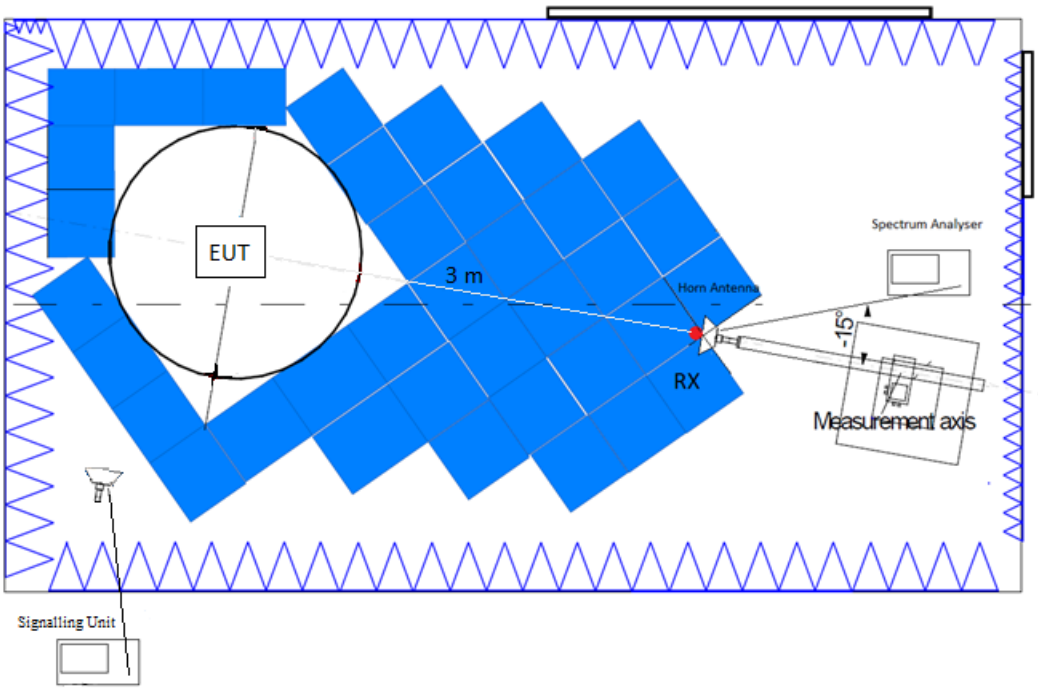
A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

Test Setup

Radiated measurements below 1 GHz:



Radiated measurements above 1 GHz:



Results

Measurements required on one frequency near top channel and one frequency near bottom channel, according to FCC § 15.31 (m).

LTE Cat-M1 Band 26. Sub-band 814-824 MHz:

A preliminary scan determined the BW=5 MHz, QPSK. RB Size=1, RB Offset=5, Narrowband=0 as the worst-case. The next results are for this worst-case configuration.

Frequency range 30 MHz - 1 GHz:

- LOW CHANNEL:

No spurious frequencies at less than 20 dB below the limit.

- HIGH CHANNEL:

No spurious frequencies at less than 20 dB below the limit.

Frequency range 1 - 8.5 GHz:

- LOW CHANNEL:

No spurious frequencies at less than 20 dB below the limit.

- HIGH CHANNEL:

No spurious frequencies at less than 20 dB below the limit.

Measurement uncertainty (dB): < ±5.35 for f ≥ 30 MHz up to 1 GHz
< ±4.32 for f ≥ 1 GHz up to 8.5 GHz

Verdict

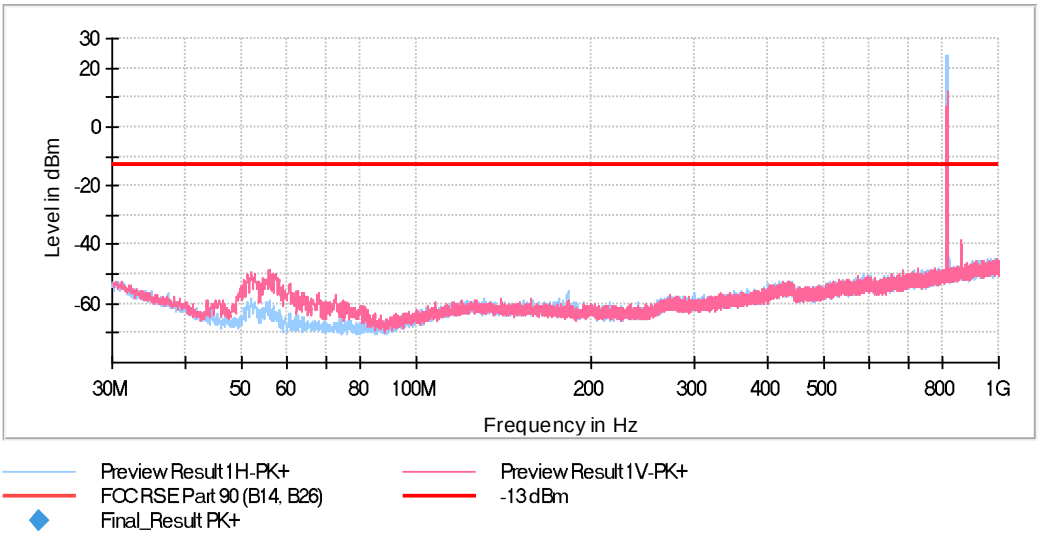
Pass

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	30.312 kHz	PK+	100 kHz	Coupled	0 dB
1 GHz - 8.5 GHz	234.375 kHz	PK+	1 MHz	1 s	0 dB

LTE Cat-M1 Band 26. Sub-band 814-824 MHz:

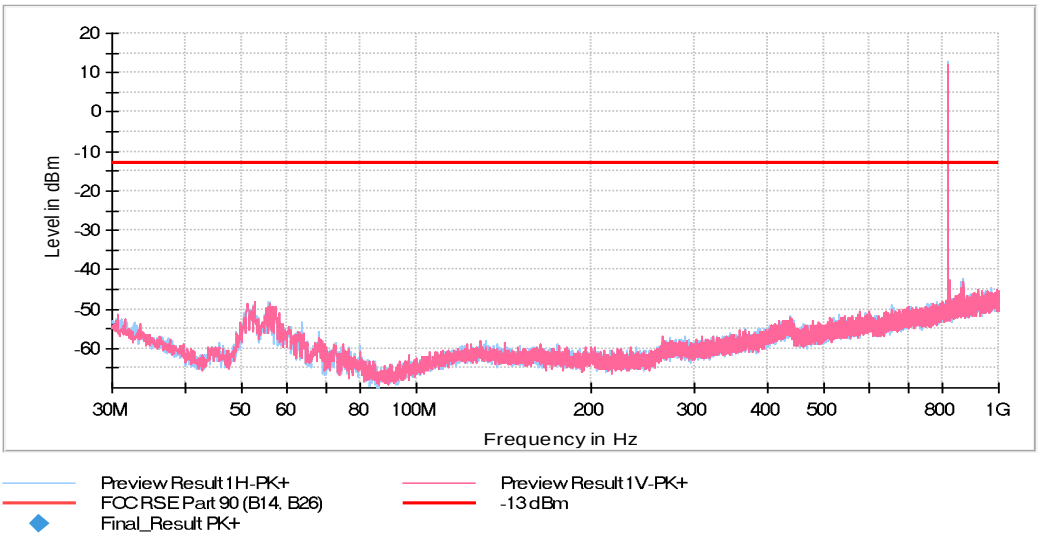
FREQUENCY RANGE 30 MHz - 1 GHz:

- LOW CHANNEL:



The peak above the limit is the carrier frequency:
LTE Cat-M1 Band 26, 819 MHz

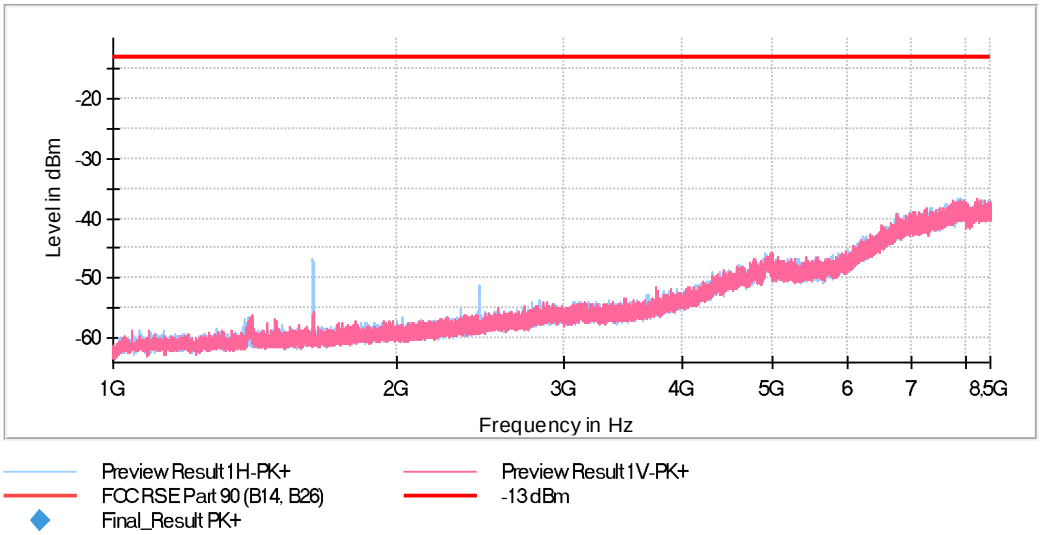
- HIGH CHANNEL:



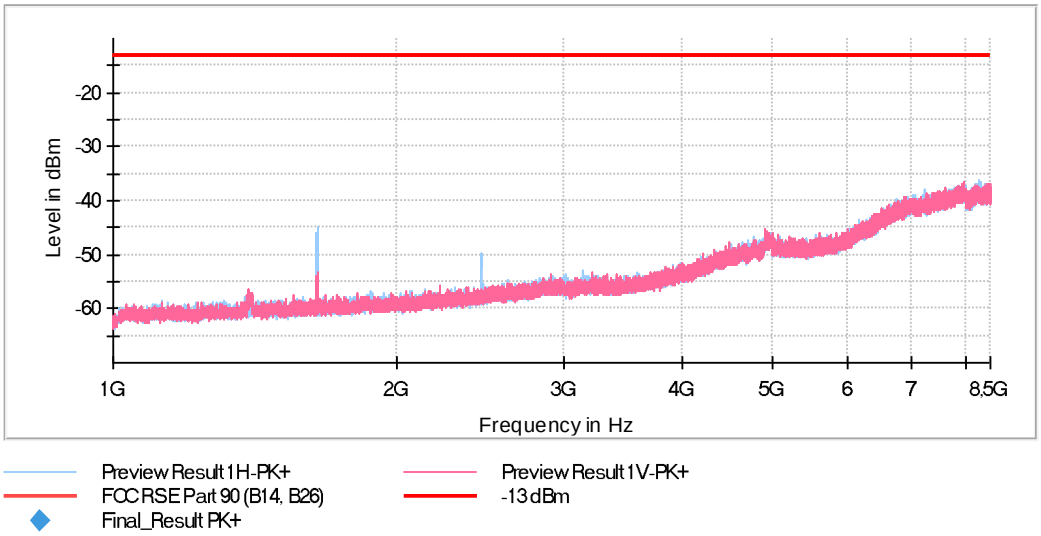
The peak above the limit is the carrier frequency:
LTE Cat-M1 Band 26, 819 MHz

FREQUENCY RANGE 1 - 8.5 GHz:

- LOW CHANNEL:



- HIGH CHANNEL:



LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz:

A preliminary scan determined the QPSK, BW=1.4 MHz, RB Size=1, RB Offset=2, Narrowband=0 as the worst case. The next results are for this worst-case configuration.

- SINGLE CHANNEL (Cross-rule Channel 824 MHz):

Frequency range 30 MHz - 1 GHz:

No spurious frequencies at less than 20 dB below the limit.

Frequency range 1 - 8.5 GHz:

No spurious frequencies at less than 20 dB below the limit.

Measurement uncertainty (dB): < ±5.35 for f ≥ 30 MHz up to 1 GHz
< ±4.32 for f ≥ 1 GHz up to 8.5 GHz

Verdict

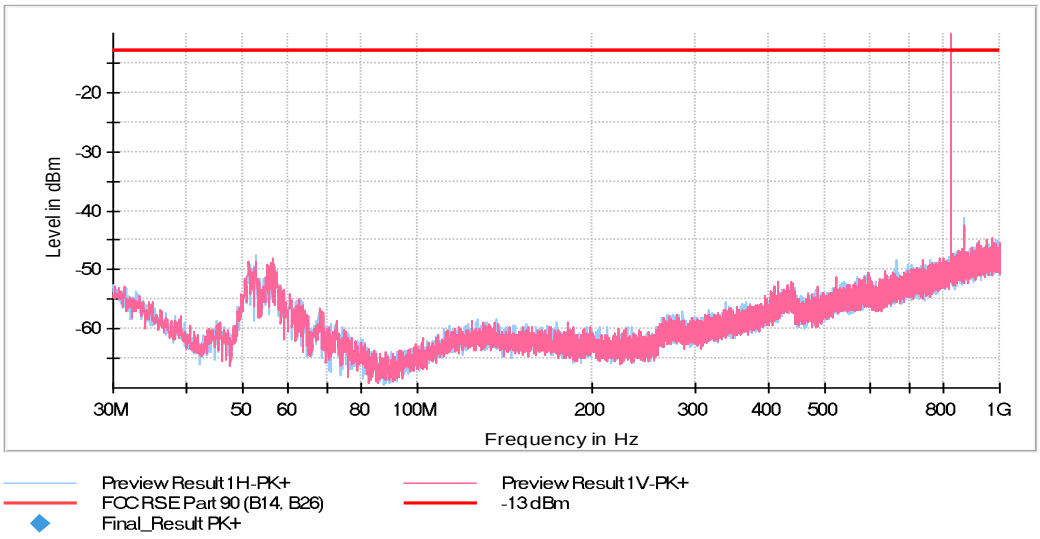
Pass

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	30.312 kHz	PK+	100 kHz	Coupled	0 dB
1 GHz - 8.5 GHz	234.375 kHz	PK+	1 MHz	1 s	0 dB

LTE Cat-M1 Band 26. Cross-rule Channel 824 MHz:

FREQUENCY RANGE 30 MHz - 1 GHz:

- SINGLE CHANNEL (Cross-rule Channel 824 MHz):



The peak above the limit is the carrier frequency:
LTE Cat-M1 Band 26, 824 MHz

FREQUENCY RANGE 1 - 8.5 GHz:

- SINGLE CHANNEL (Cross-rule Channel 824 MHz):