

Wireless test report – 374442-1TRFWL

Applicant:

TEKTELIC Communications Inc.

Product Name:

DISH Macro Gateway

Model:

T0006034 A

Model Variants:

T0006031, T0006032, T0006033

FCC ID:

2ALEPT0006326

Specifications:

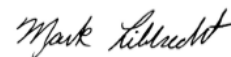
◆ FCC 47 CFR Part 27

Miscellaneous wireless communications services

Date of issue: June 13, 2019

Test engineer(s): Mark Libbrecht, Wireless/EMC Specialist

Signature:



Alvin Liu, EMC/RF Specialist

Signature:



Reviewed by: Kevin Rose, Wireless/EMC Specialist

Signature:



Test location(s)

Company name	Nemko Canada Inc.		
Address	303 River Road	292 Labrosse Avenue	130 Saltsman Drive
City	Ottawa	Pointe-Claire	Cambridge
Province	Ontario	Quebec	Ontario
Postal code	K1V 1H2	H9R 5L8	N3E 0B2
Country	Canada	Canada	Canada
Telephone	+1 613 737 9680	+1 514 694 2684	+1 519 650 4811
Facsimile	+1 613 737 9691	+1 514 694 3528	+1 519 650 4811
Toll free	+1 800 563 6336		
Website	www.nemko.com	www.nemko.com	www.nemko.com
Site number	FCC: CA2040; IC: 2040A-4 (3 m SAC)	FCC: CA2041; IC: 2040G-5 (3 m SAC)	FCC: CA0101

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	TEKTELIC Communications Inc.
Address	7657 10th Street NE
City	Calgary
Province/State	AB
Postal/Zip code	T2E 8X2
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 27	Miscellaneous wireless communications services
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1.3 Test methods

ANSI C63.26 v2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
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1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Date of issue	Details of changes made to test report
TRF	May 17, 2019	Original report issued
R1TRF	June 13, 2019	Updated power limit for fixed base station ERP, added relevant test method, updated modulation type



Section 2. Summary of test results

2.1 FCC Part 27 test results

Part	Test description	Verdict
\$27.50(c)	Power limits and Duty cycle	Pass
\$27.53(g)	Conducted spurious emissions	Pass
\$27.53(g)	Radiated spurious emissions	Pass
\$27.54	Frequency stability	Pass
\$2.1049	Occupied bandwidth	Pass

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	May 7, 2019
Nemko sample ID number	1

3.2 EUT information

Product name	DISH Macro Gateway
Model	T0006034
Serial number	1918K0003
Part number	T0006034 A

3.3 Technical information

Operating band	722 – 728 MHz
Operating frequency	722.9, 723.5, 724.1, 724.7, 725.3, 725.9, 726.5, 727.1 MHz
Modulation type	LoRa – LTE 500 kHz single carrier and dual carrier
Power requirements	48 V _{DC} @ 1 A, 48 V _{DC} PoE
Emission designator	563KF7D
Antenna information	There are two antennas that can be used with this product: WTTX-OMNI07250910-10-NJ – High gain (8dBi gain in 722-728MHz band) WTTX-ONMI720730900930-5-NJ – Medium gain: (5dBi gain in 722-728MHz band) For radiated emission test, external antenna is not provided EUT used a 50 Ω termination.

3.4 Product description and theory of operation

The Gateway serves as a conduit between LoRa nodes and a cloud based network server. The gateway receives RF signals from one or many nodes, demodulates and forwards the information to a connected network server and vice versa, receiving data from a network server, modulating to RF and transmitted to the nodes

3.5 EUT exercise details

- Set EUT in continuous Tx mode using SSH interface
- EUT worked at two modes of operation: single transmit carrier and two simultaneous carrier

3.6 EUT setup diagram

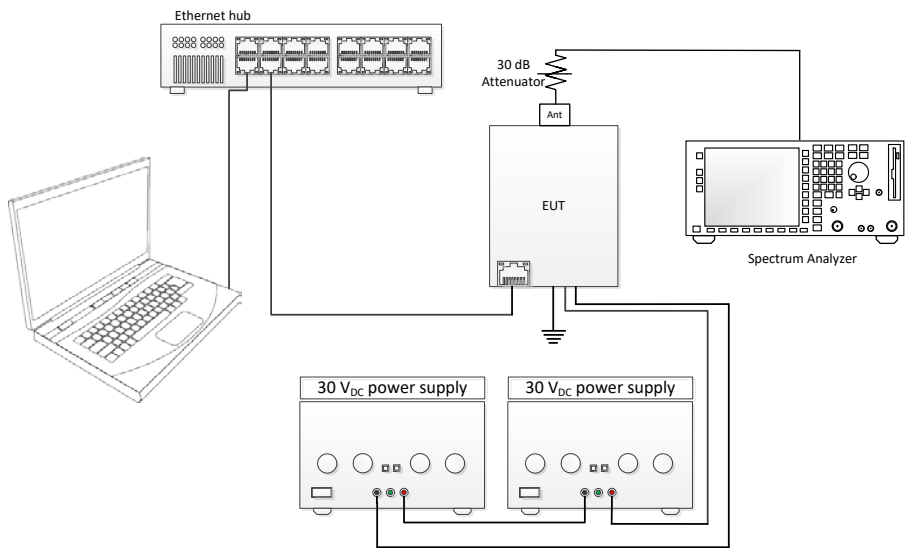


Figure 3.6-1: Setup diagram

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

Model T0006034 has the maximum capability which was tested as a representative for all other model variants

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages $\pm 5\%$, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of $K = 2$ with 95% certainty.

Table 6.1-1: Measurement uncertainty

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA003012	1 year	Aug. 22/19
Flush mount turntable	SUNAR	FM2022	FA003006	—	NCR
Controller	SUNAR	SC110V	FA002976	—	NCR
Antenna mast	SUNAR	TLT2	FA003007	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESR26	FA002969	1 year	Jun. 1/19
Horn antenna (1–18 GHz)	ETS-Lindgren	3117	FA002911	1 year	Aug. 16/19
Preamp (1–18 GHz)	ETS-Lindgren	124334	FA002956	1 year	Sept. 18/19
Bilog antenna (30–2000 MHz)	SUNAR	JB1	FA003009	1 year	Sept. 6/19
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	Nov 12/19
50 Ω coax cable	Huber + Suhner	None	FA003044	1 year	Nov 12/19
Receiver/spectrum analyzer	Rohde & Schwarz	FSW	FA002969	1 year	Jun-01-2019
30 V _{DC} Power source	GwInstek	3060D	—	—	NCR
30 V _{DC} Power source	GwInstek	3060D	—	—	NCR
Temperature chamber	Espec	EPX-4H	FA003033	—	NCR

Note: NCR - no calibration required

Section 8. Testing data

8.1 FCC 27.50(c) Peak output power at RF antenna connector

8.1.1 Definitions and limits

Part 27.50(c) The following power and antenna height requirements apply to stations transmitting in the 600 MHz band and the 698-746 MHz band:

- (1) Fixed and base stations transmitting a signal with an emission bandwidth of 1 MHz or less must not exceed an effective radiated power (ERP) of 1000 watts

8.1.2 Test summary

Test date	May 9, 2019	Temperature	23 °C
Test engineer	Alvin Liu Mark Libbrecht	Air pressure	975 mbar
Verdict	Pass	Relative humidity	33 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

Test receiver settings for CCDF measurement:

Detector mode	Sample
Resolution bandwidth	>OBW
Trace mode	Clear write
Measurement time	Auto
Samples	Enough to stabilize trace

8.1.4 Test data

Table 8.1-1: Peak output power measurements and ERP calculations results for single carrier

Channel	Frequency, MHz	Conducted output power			Antenna gain, dBi	ERP, dBm	ERP limit, dBm	Margin, dB
		Average, dBm	PAPR 0.1%, dB	Peak, dBm				
Low	722.9	29.9	0.6	30.5	8.00	36.4	60.0	23.6
Mid	725.9	30.1	0.6	30.7	8.00	36.6	60.0	23.4
Customer	726.5	30.0	0.6	30.6	8.00	36.5	60.0	23.5
High	727.1	29.8	0.7	30.5	8.00	36.4	60.0	23.6

Note: peak power = average power + PAPR 0.1%; ERP = peak power + antenna gain +/- 2.15

Table 8.1-2: Peak output power measurements and ERP calculations results for two carrier

Channel	Frequency, MHz	Conducted output power			Antenna gain, dBi	ERP, dBm	ERP limit, dBm	Margin, dB
		Average, dBm	PAPR 0.1%, dB	Peak, dBm				
Low	722.9	29.7	3.3	33.0	8.00	38.9	60.0	21.1
Mid	725.9	29.8	3.3	33.1	8.00	39.0	60.0	21.0
High	727.1	29.8	3.3	33.1	8.00	39.0	60.0	21.0

Note: peak power = average power + PAPR 0.1%; ERP = peak power + antenna gain - 2.15



Figure 8.1-1: Output power sample plot for single carrier

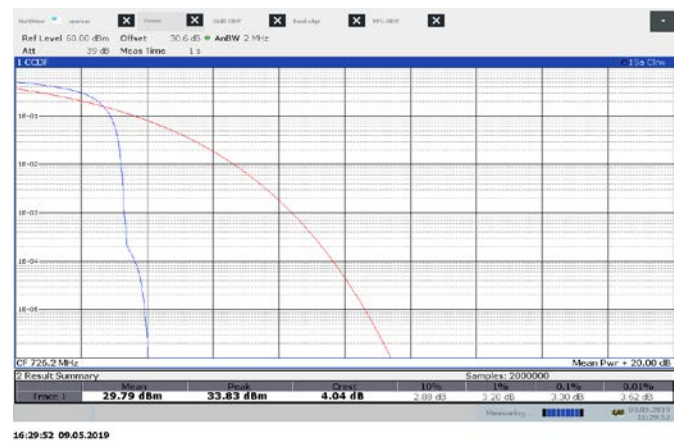


Figure 8.1-2: Output power sample plot for two carrier

8.2 FCC 27.53(g) Spurious emissions at RF antenna connector

8.2.1 Definitions and limits

FCC Part 27.53 (g): For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $43 + 10 \log(P)$ dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

8.2.2 Test summary

Test date	May 9, 2019	Temperature	23 °C
Test engineer	Alvin Liu Mark Libbrecht	Air pressure	975 mbar
Verdict	Pass	Relative humidity	33 %

8.2.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.

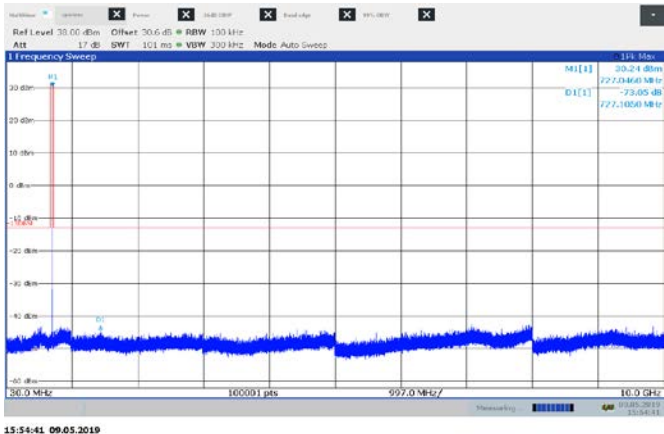
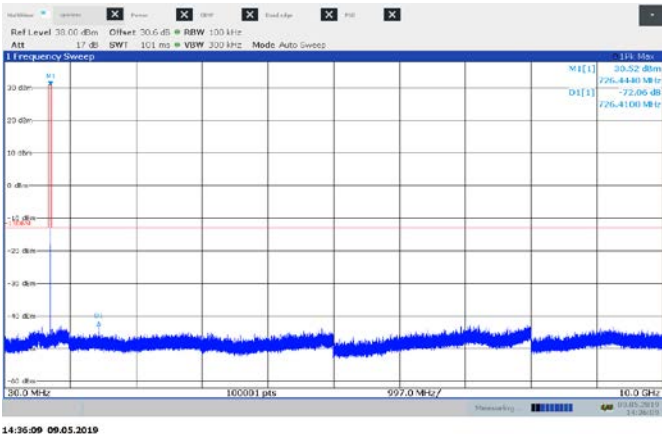
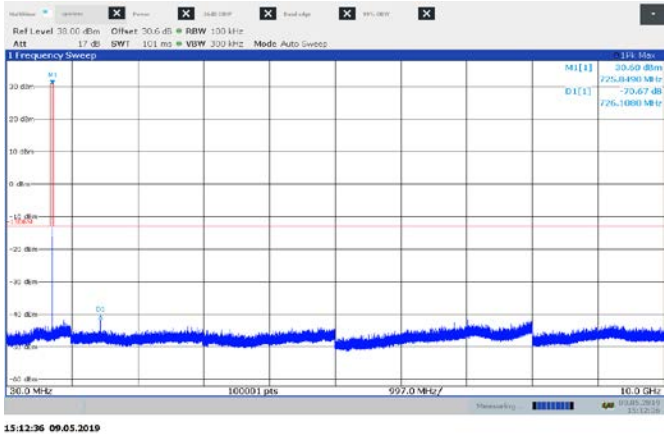
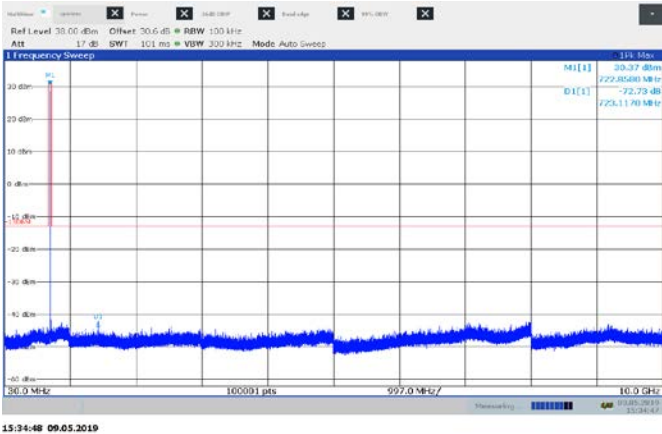
Spectrum analyser settings for conducted spurious emissions measurements:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for band edge measurements:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	RMS
Trace mode:	Average-Power (count:100)

8.2.4 Test data



8.2.4 Test data continued

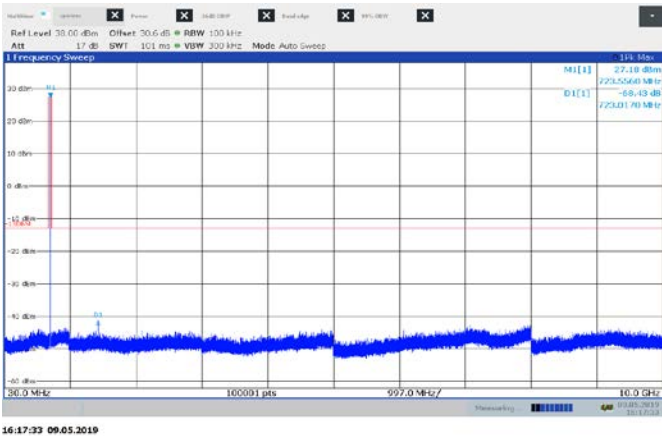


Figure 8.2-5: Conducted Spurious emissions - two carrier low channel

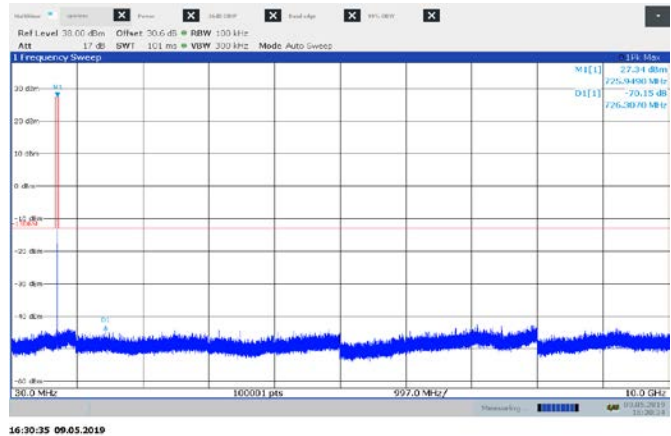


Figure 8.2-6: Conducted Spurious emissions - two carrier mid channel

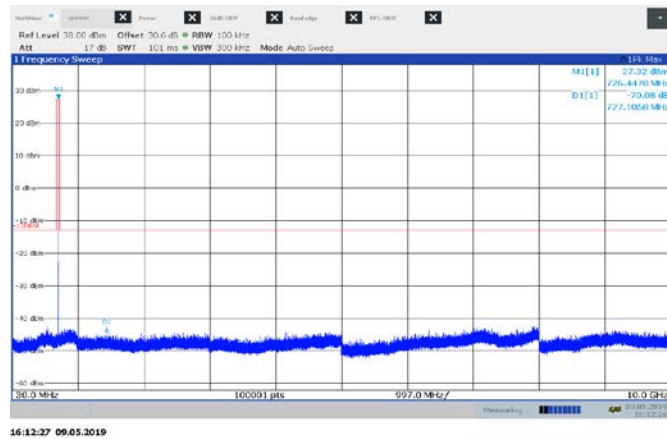


Figure 8.2-7: Conducted Spurious emissions - two carrier high channel

8.2.4 Test data continued



Figure 8.2-8: Lower band edge for single carrier

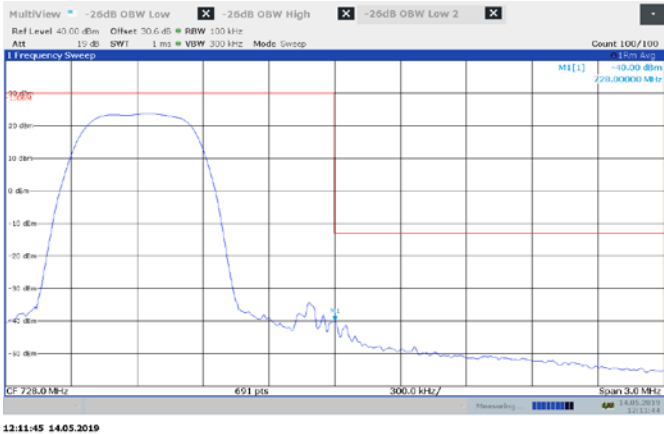


Figure 8.2-9: Upper band edge for single carrier

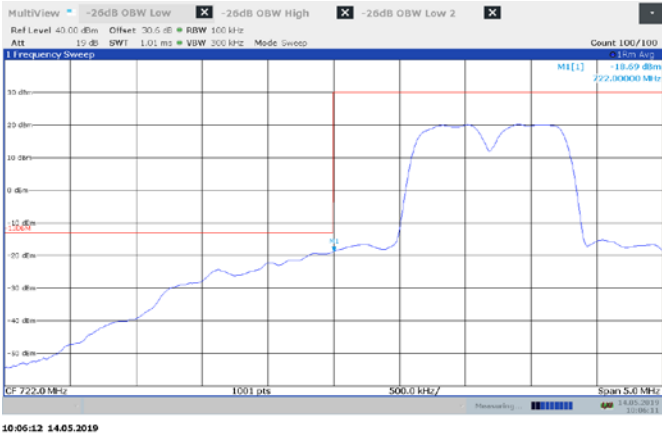


Figure 8.2-10: Lower band edge for two carrier



Figure 8.2-11: Upper band edge for two carrier

8.3 FCC 27.53(g) Radiated spurious emissions

8.3.1 Definitions and limits

FCC Part 27.53 (g): For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $43 + 10 \log(P)$ dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

8.3.2 Test summary

Test date	May 9, 2019	Temperature	23 °C
Test engineer	Alvin Liu Mark Libbrecht	Air pressure	975 mbar
Verdict	Pass	Relative humidity	33 %

8.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
Radiated measurements were performed at a distance of 3 m.
Radiated emissions were performed while antenna connector was terminated with 50 Ω load.

Receiver/spectrum analyzer settings for frequencies below 1 GHz:

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak (Preview measurement), Quasi-peak (Final measurement)
Trace mode	Max Hold
Measurement time	100 ms (Peak preview measurement), 100 ms (Quasi-peak final measurement)

Receiver/spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak (Preview measurement) Peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	100 ms (Peak preview measurement), 100 ms (Peak and CAverage final measurement)

8.3.4 Test data

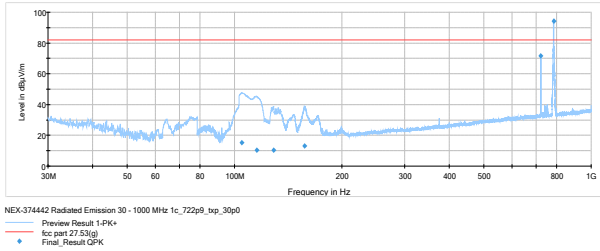


Figure 8.3-1: Radiated Spurious emission 30-1000 MHz (1c_low channel)

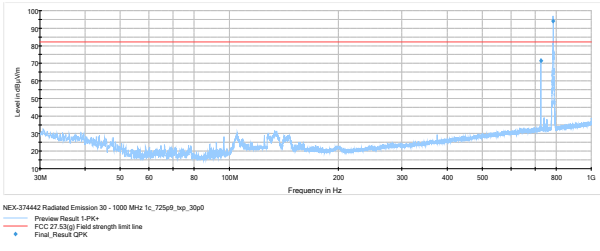


Figure 8.3-2: Radiated Spurious emission 30-1000 MHz (1c_mid channel)

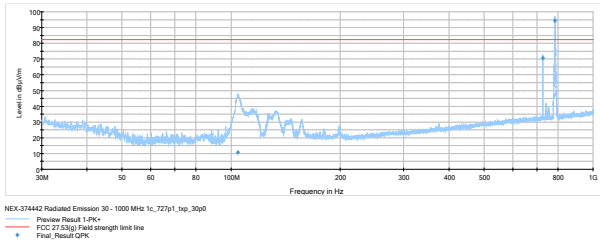


Figure 8.3-3: Radiated Spurious emission 30-1000 MHz (1c_high channel)

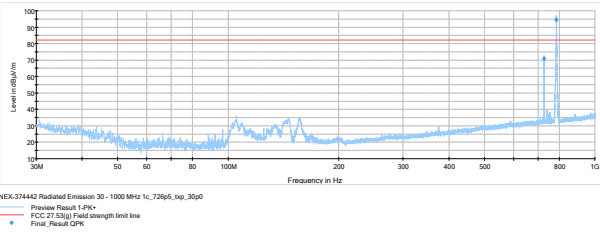


Figure 8.3-4: Radiated Spurious emission 30-1000 MHz (1c_customer channel)

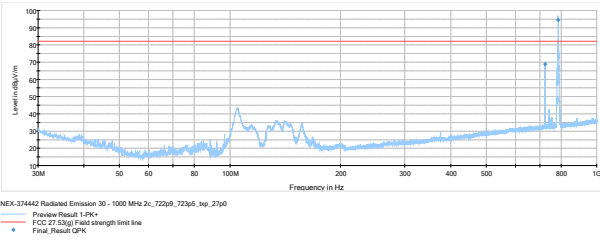


Figure 8.3-5: Radiated Spurious emission 30-1000 MHz (2c_low channel)

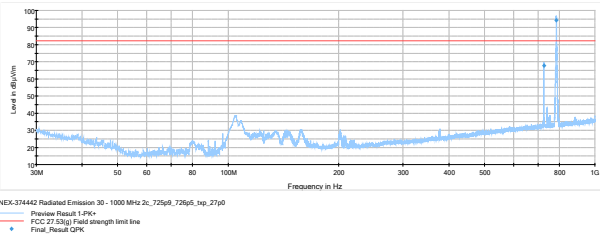


Figure 8.3-6: Radiated Spurious emission 30-1000 MHz (2c_mid channel)

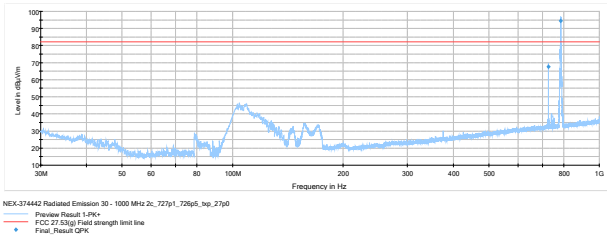


Figure 8.3-7: Radiated Spurious emission 30-1000 MHz (2c_high channel)

Note: the frequency spot over red line is a LTE uplink signal at 785 MHz.

8.3.4 Test data continued

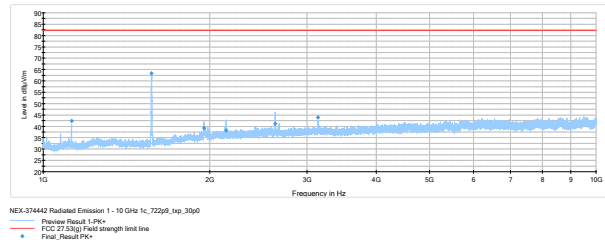


Figure 8.3-8: Radiated Spurious emission 1-10 GHz (1c_low channel)

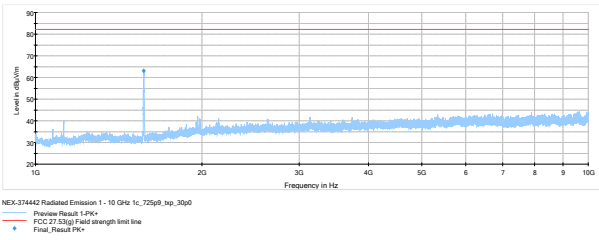


Figure 8.3-9: Radiated Spurious emission 1-10 GHz MHz (1c_mid channel)

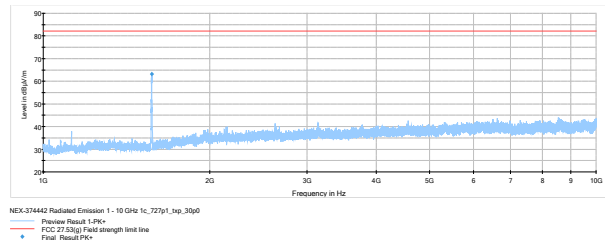


Figure 8.3-10: Radiated Spurious emission 1-10 GHz (1c_high channel)

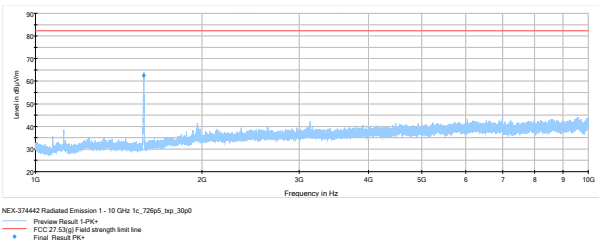


Figure 8.3-11: Radiated Spurious emission 1-10 GHz (1c_customer channel)

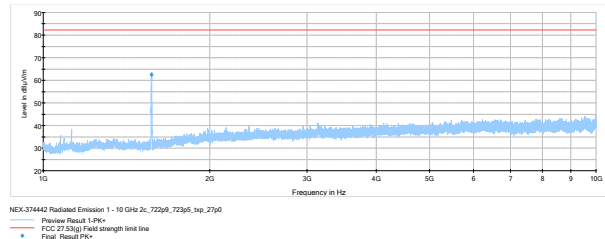


Figure 8.3-12: Radiated Spurious emission 1-10 GHz (2c_low channel)

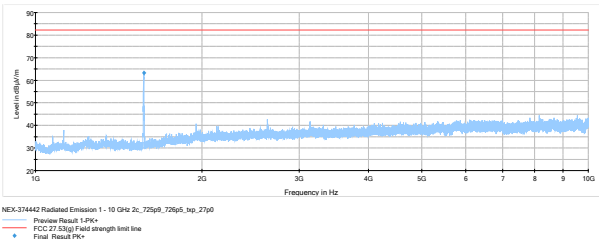


Figure 8.3-13: Radiated Spurious emission 1-10 GHz (2c_mid channel)

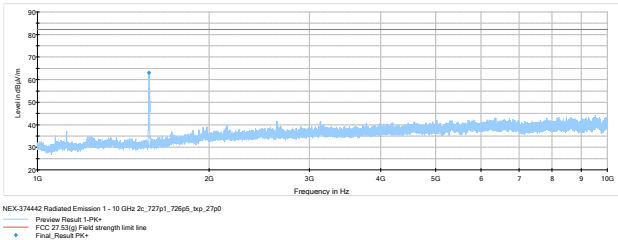


Figure 8.3-14: Radiated Spurious emission 1-10 GHz (2c_high channel)

8.4 FCC 27.54 Frequency stability

8.4.1 Definitions and limits

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

8.4.2 Test summary

Test date	May 10, 2019	Temperature	24 °C
Test engineer	Alvin Liu Mark Libbrecht	Air pressure	974 mbar
Verdict	Pass	Relative humidity	47 %

8.4.3 Observations, settings and special notes

26 dBc points including frequency tolerance were assessed to remain within assigned band.
Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	10 kHz
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.4.4 Test data

Table 8.4-1: Lower 26 dBc frequency cross result

Frequency tolerance measurements:				
Test conditions		Frequency (MHz)		Offset (MHz)
+60 °C, Nominal		722.6183		0
+50 °C, Nominal		722.6183		0
+40 °C, Nominal		722.6183		0
+30 °C, Nominal		722.6183		0
+20 °C, +15 %		722.6173		-0.001
+20 °C, Nominal		722.6183		Reference
+20 °C, -15 %		722.6123		-0.006
+10 °C, Nominal		722.6183		0
0 °C, Nominal		722.6183		0
-10 °C, Nominal		722.6176		-0.001
-20 °C, Nominal		722.6136		-0.005
-30 °C, Nominal		722.6146		-0.004
-40 °C, Nominal		722.6176		-0.001
Operating range including frequency drift measurements:				
Assigned lower frequency (MHz)	Measured 26 dBc (MHz)	Max frequency drift, (MHz)		26 dBc including drift (MHz)
		Negative	Positive	
722.000	722.6183	-0.005	0	722.6136

Table 8.4-2: Upper 26 dBc frequency cross result

Frequency tolerance measurements:				
Test conditions		Frequency (MHz)		Offset (MHz)
+60 °C, Nominal		727.3687		0
+50 °C, Nominal		727.3687		0
+40 °C, Nominal		727.3707		+0.002
+30 °C, Nominal		727.3687		0
+20 °C, +15 %		727.3687		0
+20 °C, Nominal		727.3687		Reference
+20 °C, -15 %		727.3747		+0.006
+10 °C, Nominal		727.3687		0
0 °C, Nominal		727.3717		+0.003
-10 °C, Nominal		727.3687		0
-20 °C, Nominal		727.3697		+0.001
-30 °C, Nominal		727.3687		0
-40 °C, Nominal		727.3717		+0.003
Operating range including frequency drift measurements:				
Assigned upper frequency (MHz)	Measured 26 dBc (MHz)	Max frequency drift, (MHz)		26 dBc including drift (MHz)
		Negative	Positive	
728.000	727.3687	0	+0.006	727.3747

8.5 Part 2.1049 Occupied bandwidth

8.5.1 Definitions and limits

The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

8.5.2 Test summary

Test date	May 9, 2019	Temperature	23 °C
Test engineer	Alvin Liu Mark Libbrecht	Air pressure	975 mbar
Verdict	Pass	Relative humidity	33 %

8.5.3 Observations, settings and special notes

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	≥1 % of span
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.5.4 Test data

Table 8.5-1: 26 dB bandwidth results for single carrier

Frequency, MHz	26 dB bandwidth, MHz
722.9 (low channel)	0.553
725.9 (mid channel)	0.557
726.5 (customer channel)	0.563
727.1 (high channel)	0.555

Table 8.5-2: 26 dB bandwidth results for two carrier

Frequency, MHz	26 dB bandwidth, MHz
723.2 (low channel)	1.181
726.2 (mid channel)	1.177
726.8 (high channel)	1.179

8.5.4 Test data continued

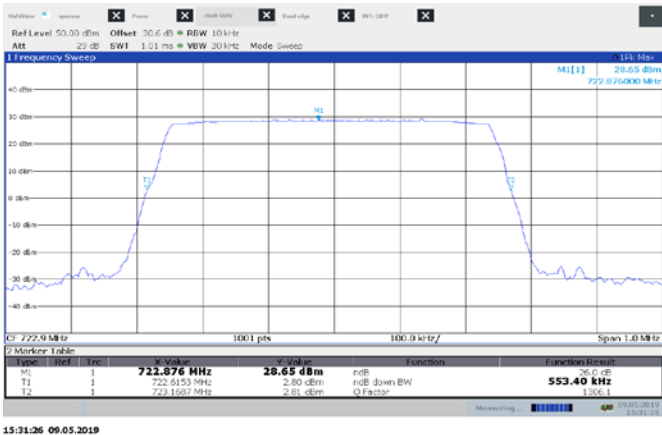


Figure 8.5-1: 26 dB bandwidth for single carrier low channel

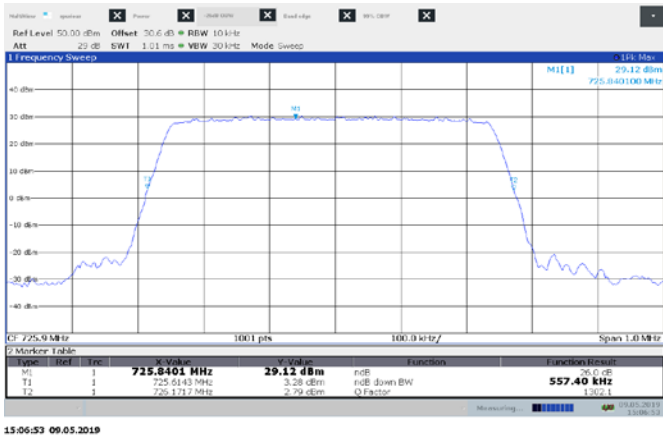


Figure 8.5-2: 26 dB bandwidth for single carrier mid channel

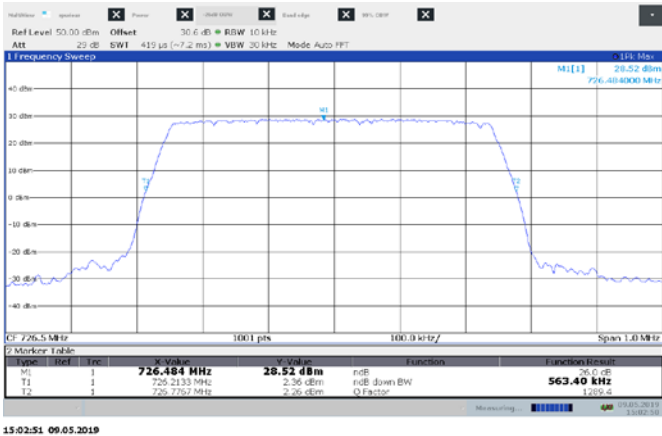


Figure 8.5-3: 26 dB bandwidth for single carrier customer channel

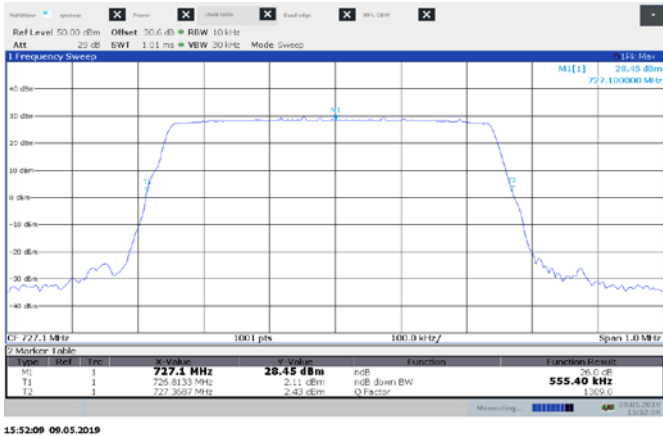


Figure 8.5-4: 26 dB bandwidth for single carrier high channel

8.5.4 Test data continued

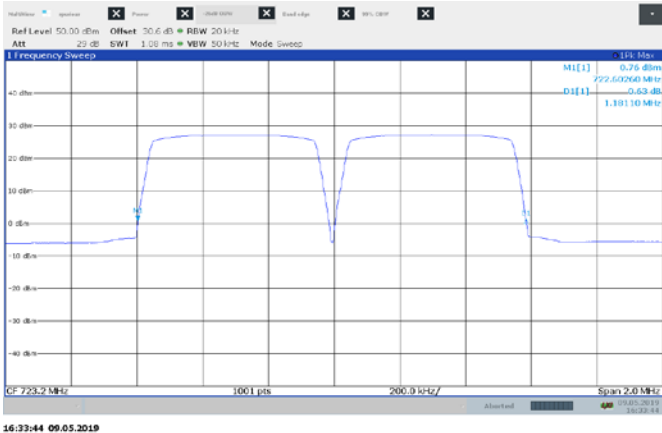


Figure 8.5-5: 26 dB bandwidth for two carrier low channel

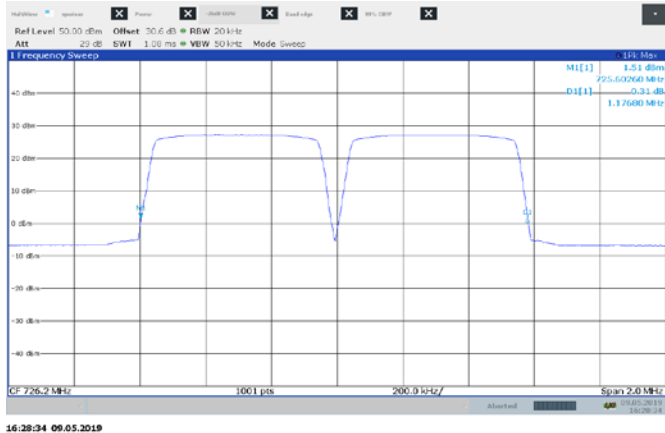


Figure 8.5-6: 26 dB bandwidth for two carrier mid channel

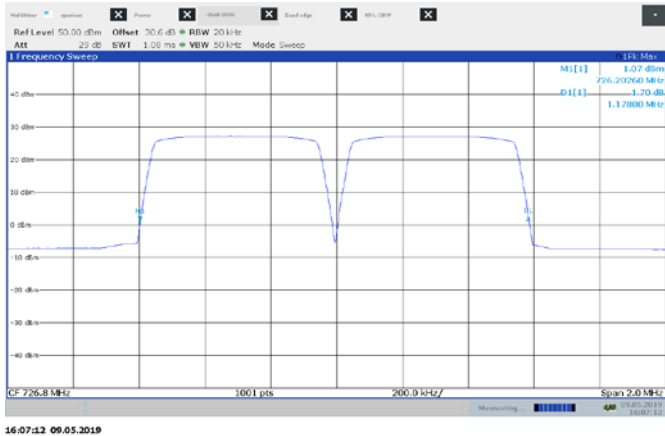
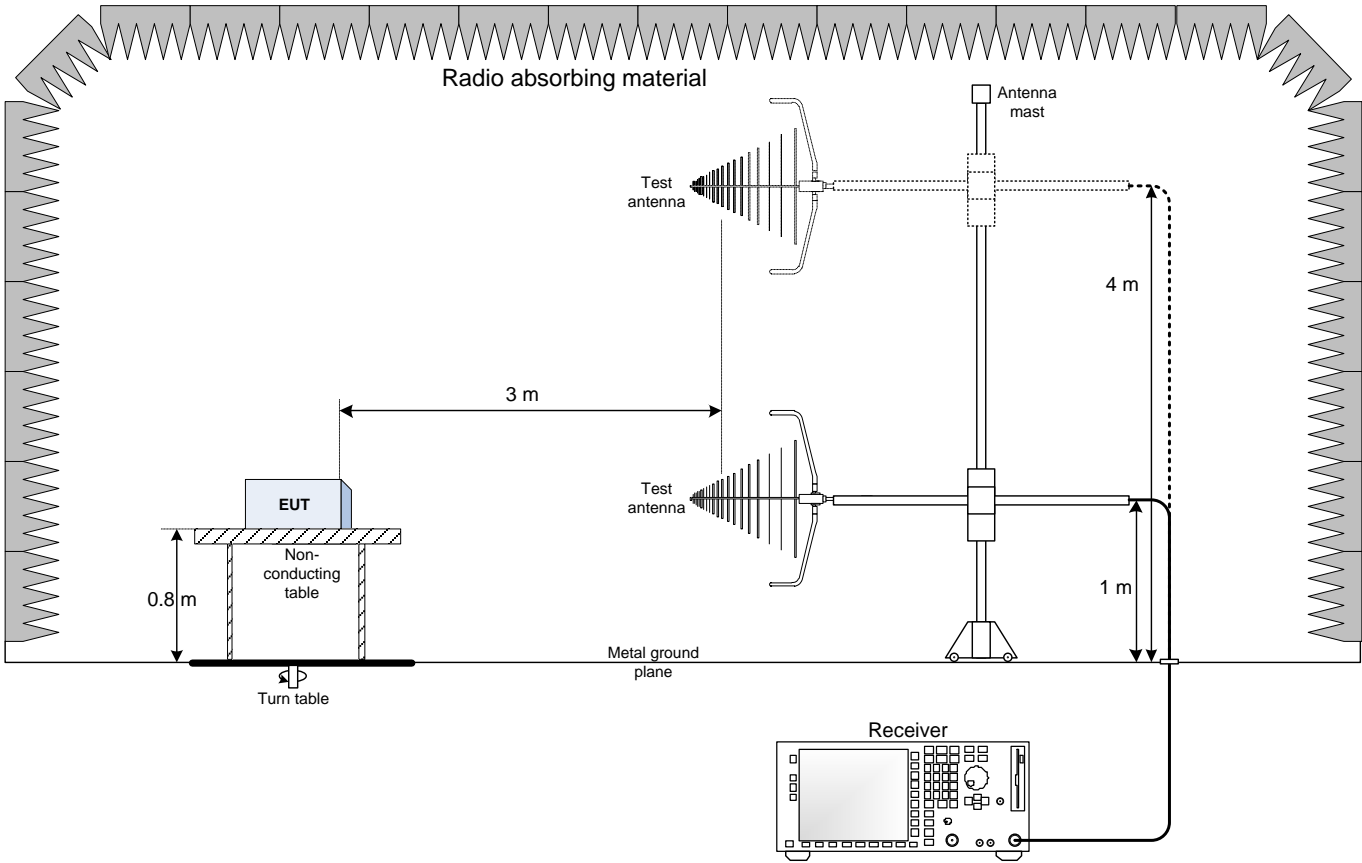


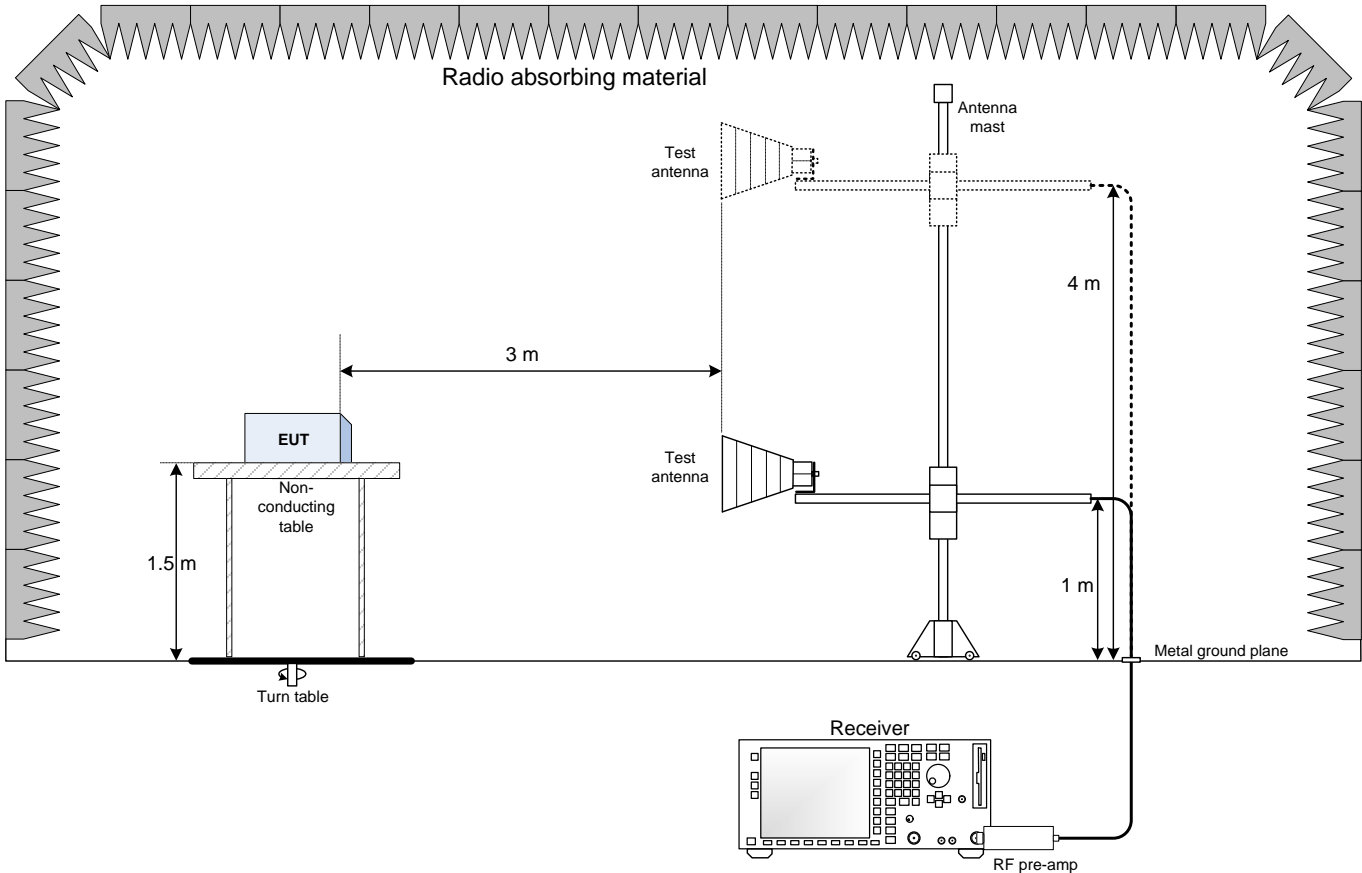
Figure 8.5-7: 26 dB bandwidth for two carrier high channel

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Antenna port set-up

