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Test report

268950-6TRFWL

Date of issue: March 25, 2015

Applicant:

TableTop Media

Product:

ZIOSK

Model:

Z400

FCC ID:

XOX-Z400

Specification:

- FCC 47 CFR Part 15 Subpart C, §15.247

  Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

Test location

Company name	Nemko Canada Inc.
Address	303 River Road
City	Ottawa
Province	Ontario
Postal code	K1V 1H2
Country	Canada
Telephone	+1 613 737 9680
Facsimile	+1 613 737 9691
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC ID: 176392 (3 m semi anechoic chamber)

Tested by	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Date	March 25, 2015
Reviewer Signature	

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.

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	TableTop Media
Address	12404 Park Central Drive Ste 350
City	Dallas
Province/State	TX
Postal/Zip code	75251
Country	United States

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

1.3 Test methods

DA 00-705 Released March 30, 2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

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 #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]
§15.207(a)	Conducted limits	Not applicable[3]

Notes: [1] Measurements were performed with fully charged battery

[2] The Antennas are located within the enclosure of EUT and not user accessible.

[3] EUT is battery operated

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Pass
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Not applicable
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Pass
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Not applicable
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Pass
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Not applicable
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	September 15, 2014
Nemko sample ID number	1

3.2 EUT information

Product name	ZIOSK
Model	Z400
Serial number	001EC0890C7C

3.3 Technical information

Operating band	2400–2483.5 MHz
Operating frequency	2402–2480 MHz
Modulation type and data rate	8-DPSK, DQPSK
Emission designator	F1D
Power requirements	7.4 V_{DC} Lithium battery
Antenna information	0.83 dBi The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The Ziosk is a wireless, battery operated touch screen device with a 7" LCD display, used for pay-at-the-table applications in casual dining restaurants. The device can display menu items, specials, entertainment and local area information; it can also process credit card payments and print receipts.

3.5 EUT exercise details

EUT was connected to Laptop via internal (not user accessible) USB connector and Android shell commands were used to control channel, modulation and data rate settings.

3.6 EUT setup diagram

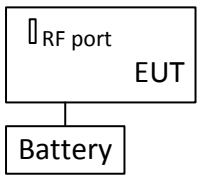


Figure 3.6-1: *Setup diagram*

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

None

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 ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Nemko Canada Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 “Uncertainty in EMC measurements.” Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

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	FA002047	1 year	Mar. 18/15
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Oct. 24/14
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Mar. 12/15
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Mar. 10/15
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 23/15
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Jan. 27/15

Note: NCR - no calibration required

Section 8. Testing data

8.1 FCC 15.247(a)(1) Frequency hopping requirements

8.1.1 Definitions and limits

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

8.1.2 Test summary

Test date	November 21, 2014	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	32 %

8.1.3 Observations, settings and special notes

Carrier Frequency Separation spectrum analyzer settings:

Hopping mode	Enabled
Resolution bandwidth	≥ 1% of the span
Video bandwidth	≥ RBW
Frequency span	Wide enough to capture the peaks of two adjacent channels
Detector mode	Peak
Trace mode	Max Hold

Number of Hopping Frequencies spectrum analyzer settings:

Hopping mode	Enabled
Resolution bandwidth	≥ 1% of the span
Video bandwidth	≥ RBW
Frequency span	The frequency band of operation
Detector mode	Peak
Trace mode	Max Hold

Time of Occupancy (Dwell Time) spectrum analyzer settings:

Hopping mode	Enabled
Resolution bandwidth	1 MHz
Video bandwidth	≥ RBW
Frequency span	Zero, centered on a hopping channel
Detector mode	Peak
Trace mode	Max Hold

20 dB Bandwidth spectrum analyzer settings:

Hopping mode	Disabled
Resolution bandwidth	≥ 1% of the 20 dB bandwidth
Video bandwidth	≥ RBW
Frequency span	2 to 3 times the 20 dB bandwidth, centered on a hopping channel
Detector mode	Peak
Trace mode	Max Hold

8.1.4 Test data

Table 8.1-1: *20 dB bandwidth results for DQPSK*

Frequency, MHz	20 dB bandwidth, MHz	2/3 of 20 dB BW, MHz
2402	1.312	0.875
2441	1.310	0.873
2480	1.312	0.875

Table 8.1-2: *20 dB bandwidth results for 8-DPSK*

Frequency, MHz	20 dB bandwidth, MHz	2/3 of 20 dB BW, MHz
2402	1.418	0.945
2441	1.421	0.974
2480	1.421	0.974

Carrier frequency separation is 1 MHz. Minimum requirement is 2/3 of 20 dB BW (for systems with an output power less than 21 dBm) which is 0.974 MHz.

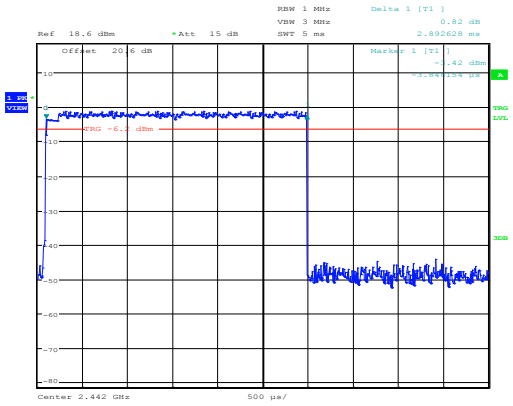


Figure 8.1-1: *Carrier frequency separation*

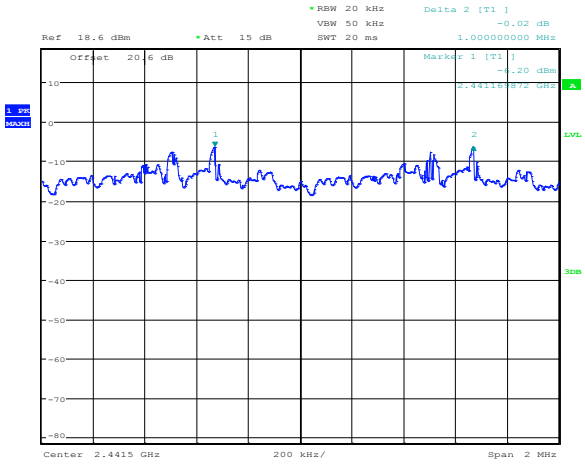


Figure 8.1-2: *Carrier frequency separation*

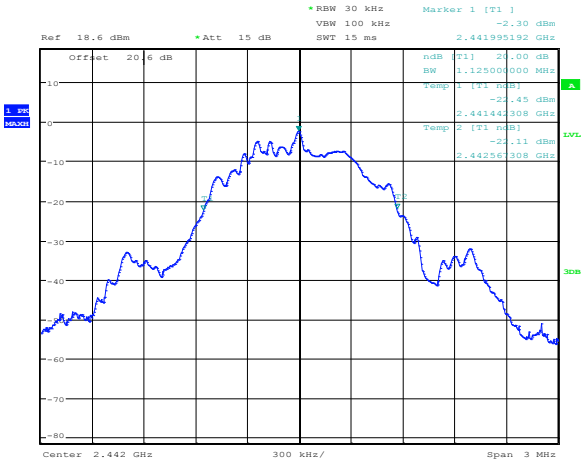


Figure 8.1-3: *20 dB bandwidth, sample plot*

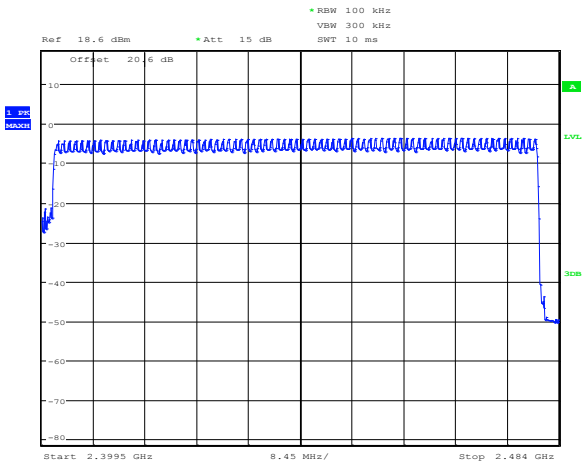


Figure 8.1-4: *Number of hopping channels (79)*

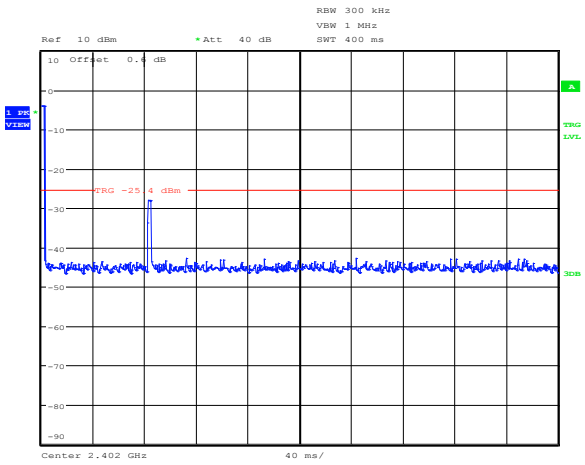


Figure 8.1-5: *Number of hop per single channel (4)*

Pulse width is 2.893 ms.

Dwell time calculation. T_{DWELL} = 2.893 ms within 0.4 s × 79 channels= 228.547 ms. Dwell time limit is 400 ms.

Number of hopping channels is 79. Minimum required number is 15.

8.2 FCC 15.247(b) Transmitter output power and e.i.r.p. requirements

8.2.1 Definitions and limits

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

8.2.2 Test summary

Test date	November 21, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	31 %

8.2.3 Observations, settings and special notes

The EUT employs 79 channels. Spectrum analyser settings:

Resolution bandwidth	≥20 dB bandwidth of the emission being measured
Video bandwidth	≥ RBW
Detector mode	Peak
Trace mode	Max hold

8.2.4 Test data

Table 8.2-1: *Output power measurements results for DQPSK*

Frequency, MHz	Output power, dBm		Power margin, dB	Antenna gain, dBi	EIRP, dBm		EIRP margin, dB
	Measured	Limit			Calculated	Limit	
2402	-1.62	30.00	31.62	0.83	-0.79	36.00	36.79
2441	-0.92	30.00	30.92	0.83	-0.09	36.00	36.09
2480	-0.55	30.00	30.55	0.83	0.28	36.00	35.72

Table 8.2-2: *Output power measurements results for 8DPSK*

Frequency, MHz	Output power, dBm		Power margin, dB	Antenna gain, dBi	EIRP, dBm		EIRP margin, dB
	Measured	Limit			Calculated	Limit	
2402	-1.22	30.00	31.22	0.83	-0.39	36.00	36.39
2441	-0.53	30.00	30.53	0.83	0.30	36.00	35.70
2480	-0.21	30.00	30.21	0.83	0.62	36.00	35.38

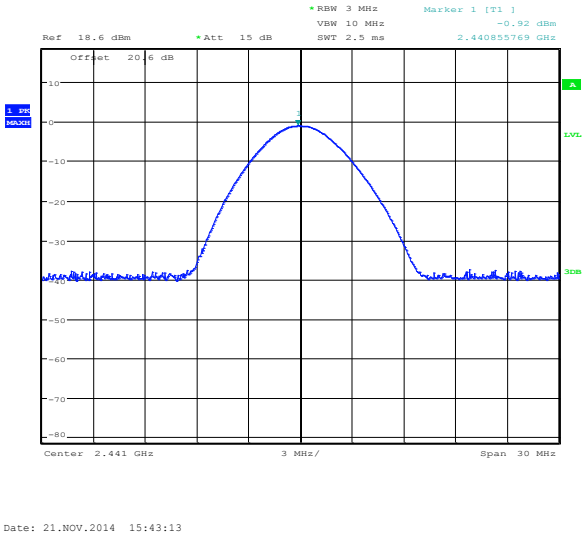


Figure 8.2-1: *Output power on DQPSK, sample plot*

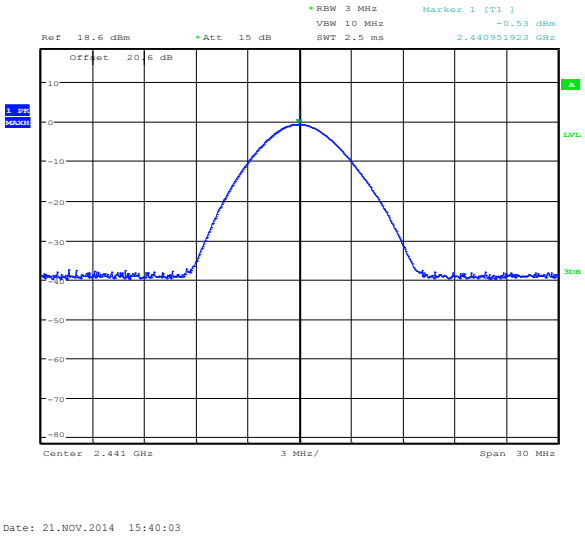


Figure 8.2-2: *Output power on 8 DPSK, sample plot*

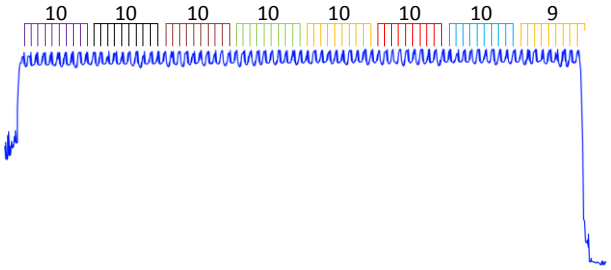


Figure 8.2-3: *Number of channels*

8.3 FCC 15.247(d) Spurious (out-of-band) emissions

8.3.1 Definitions and limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Table 8.3-1: *FCC §15.209 – Radiated emission limits*

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.3-2: *Restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.3.2 Test summary

Test date	November 24, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	31 %

8.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic. Radiation emission measurements were performed at a distance of 3 m. No emissions were detected within 20 dB of the specification limit except for the band edges, therefore none are reported as per FCC §15.31(o).

Spectrum analyser settings for measurements within restricted bands below 1 GHz:

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

Spectrum analyser settings for peak measurements within restricted bands above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for average measurements within restricted bands above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	10 Hz
Detector mode	Peak
Trace mode	Max Hold

8.3.4 Test data

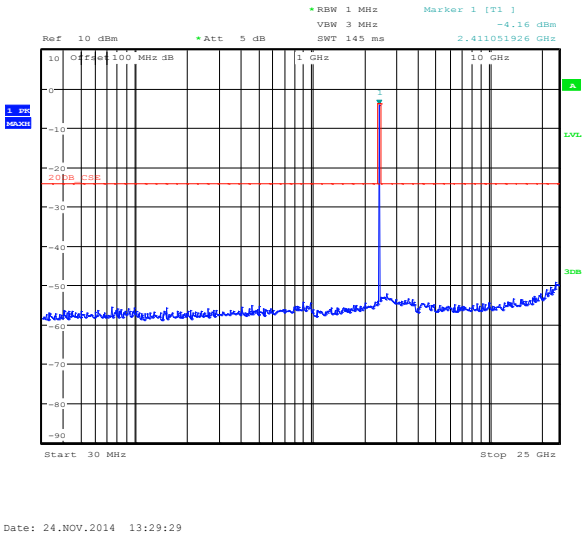


Figure 8.3-1: *Conducted spurious emissions outside restricted bands for DQPSK, low channel*

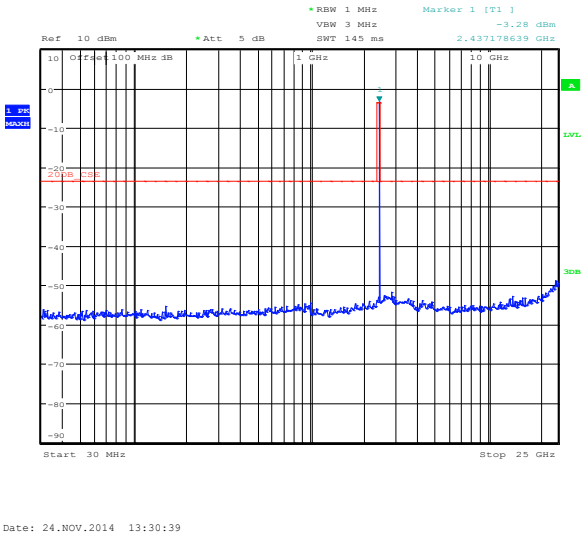


Figure 8.3-2: *Conducted spurious emissions outside restricted bands for DQPSK, mid channel*

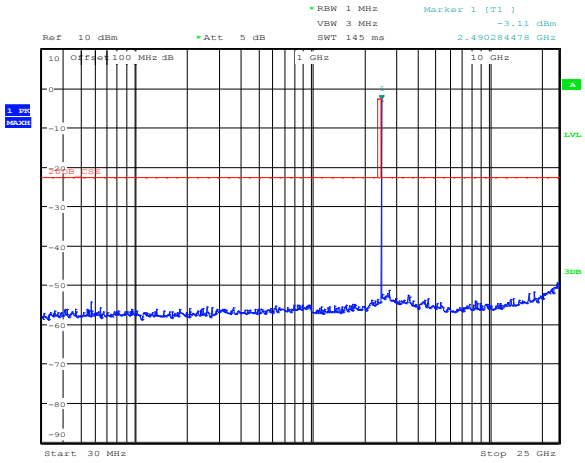


Figure 8.3-3: *Conducted spurious emissions outside restricted bands for DQPSK, high channel*

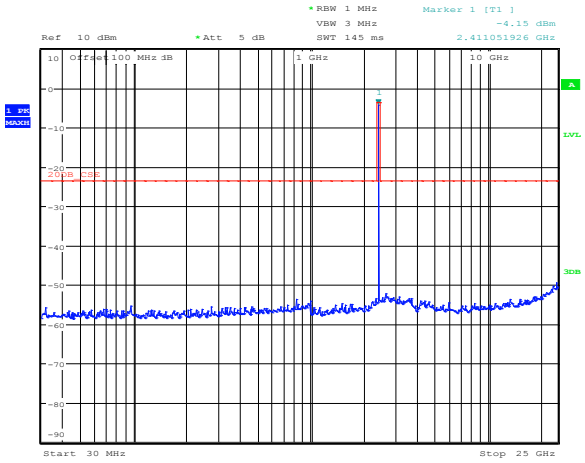


Figure 8.3-4: *Conducted spurious emissions outside restricted bands for 8-DPSK, low channel*

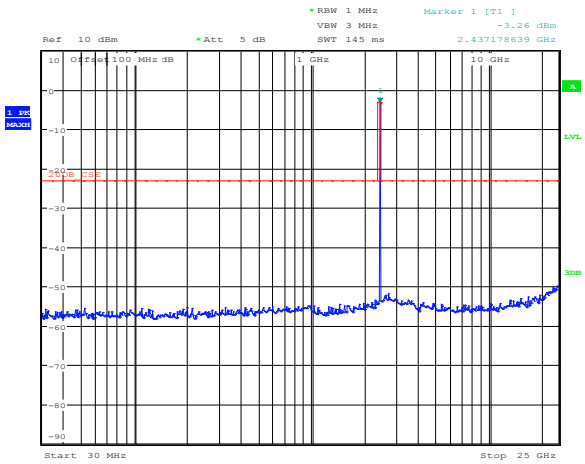


Figure 8.3-5: *Conducted spurious emissions outside restricted bands for 8-DPSK, mid channel*

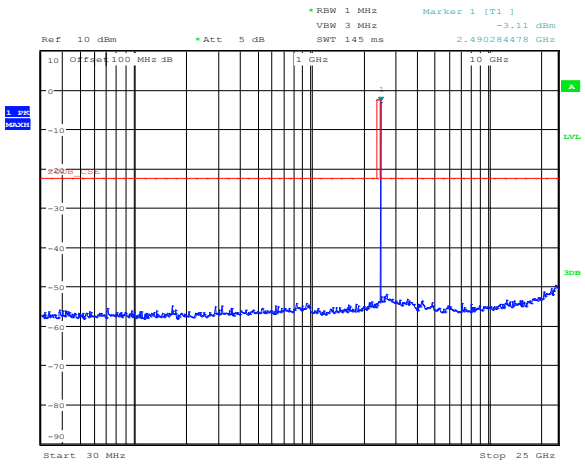


Figure 8.3-6: *Conducted spurious emissions outside restricted bands for 8-DPSK, high channel*

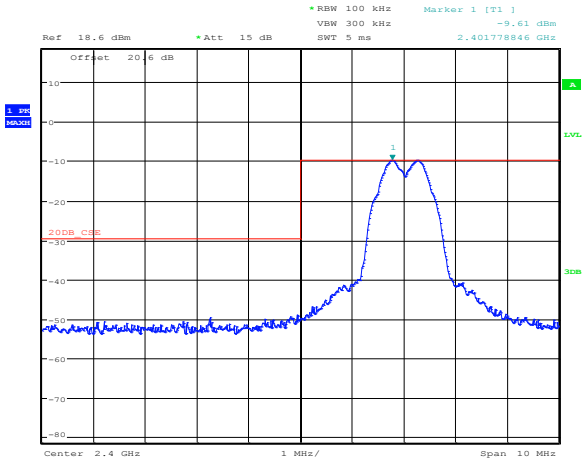


Figure 8.3-7: *Conducted spurious emissions at the lower band edge, DQPSK, hopping off*

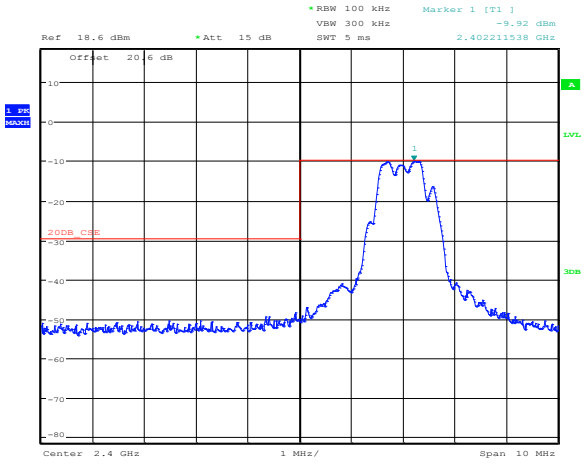


Figure 8.3-8: *Conducted spurious emissions at the lower band edge, 8-DPSK, hopping off*

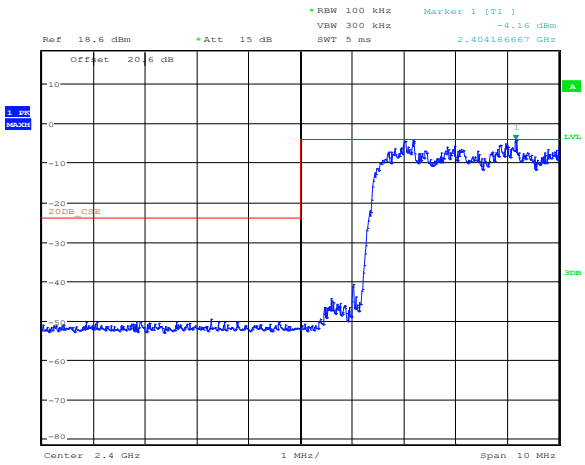


Figure 8.3-9: *Conducted spurious emissions at the lower band edge, hopping on, worst case*

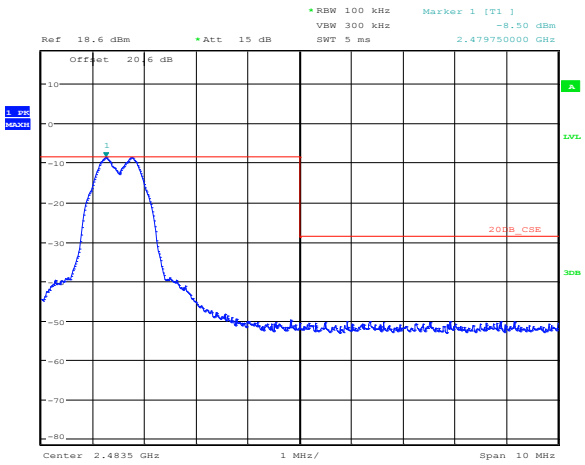


Figure 8.3-10: *Conducted spurious emissions at the upper band edge, DQPSK, hopping off*

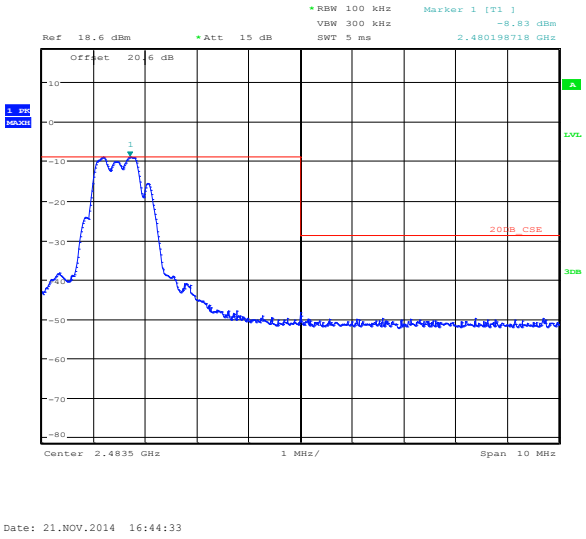


Figure 8.3-11: *Conducted spurious emissions at the upper band edge, 8-DPSK, hopping off*

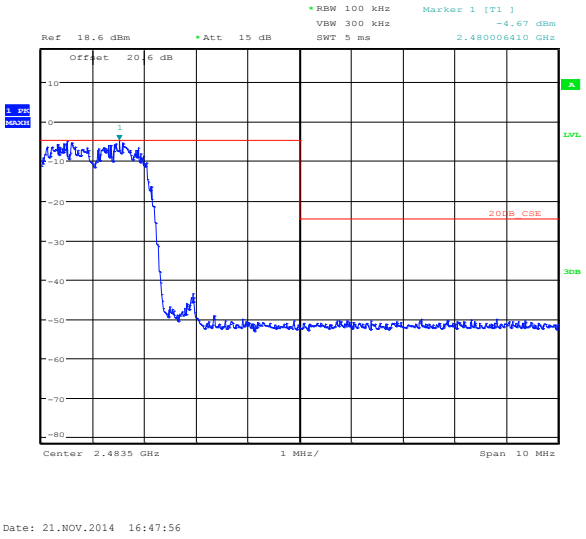


Figure 8.3-12: *Conducted spurious emissions at the upper band edge, hopping on, worst case*

Table 8.3-3: *Band edges measurements results for DQPSK*

Channel	Frequency, MHz	Peak field strength, dBµV/m		Peak margin, dB	Average, dBµV/m		Average margin, dB
		Measured	Limit		Measured	Limit	
Low	2390	32.27	74.00	41.73	32.27	54.00	21.73
High	2483.5	55.42	74.00	18.58	47.98	54.00	6.02

Note: lower band edge peak field strength measurement results were below average limit, therefore no further measurement was performed at this frequency.

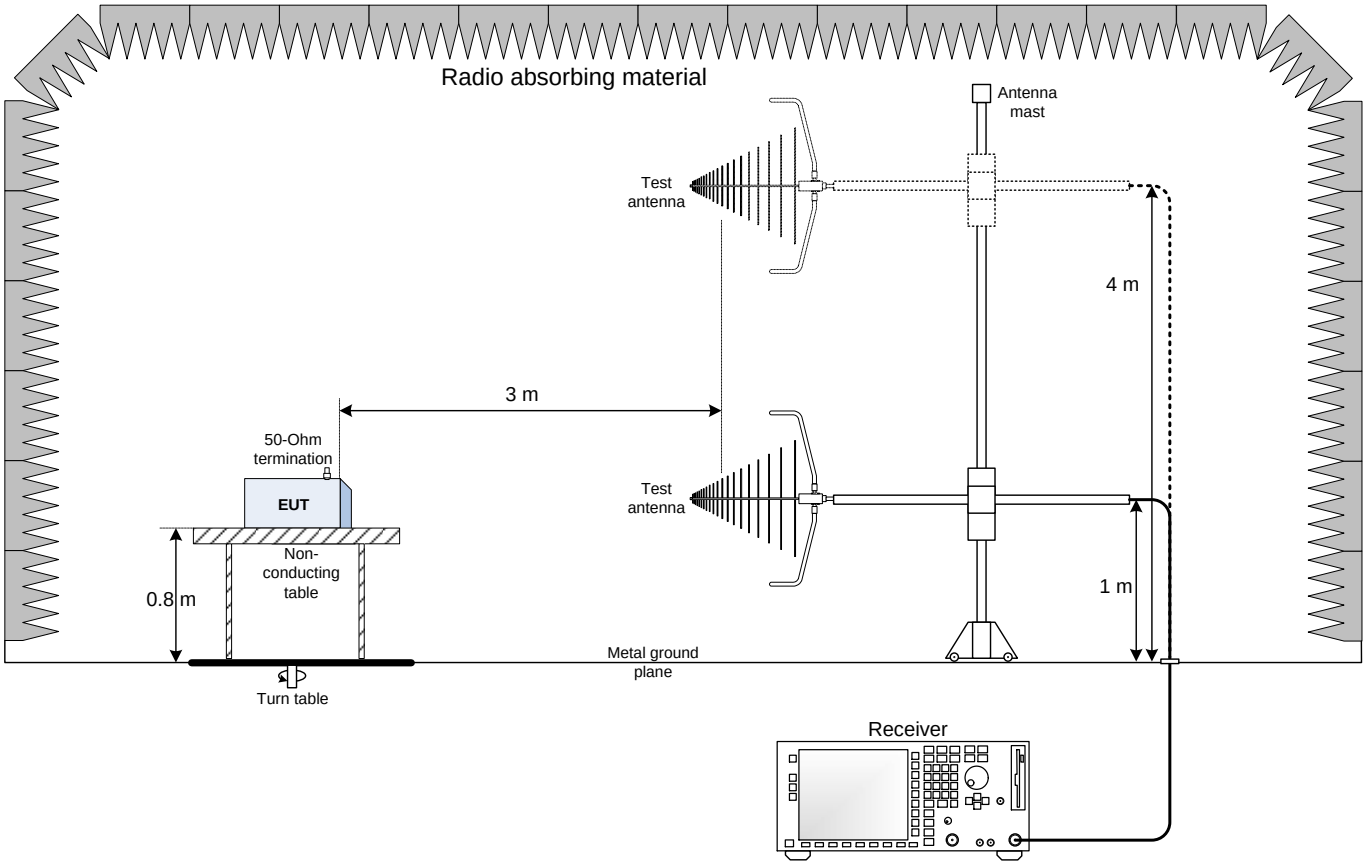
Table 8.3-4: *Band edges measurements results for 8DPSK*

Channel	Frequency, MHz	Peak field strength, dBµV/m		Peak margin, dB	Average, dBµV/m		Average margin, dB
		Measured	Limit		Measured	Limit	
Low	2390	32.41	74.00	41.59	32.41	54.00	21.59
High	2483.5	55.74	74.00	18.26	47.98	54.00	6.02

Note: lower band edge peak field strength measurement results were below average limit, therefore no further measurement was performed at this frequency.

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Antenna terminal set-up