SGS

Test Report

INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 C and INDUSTRY CANADA REQUIREMENTS

Equipment Under Test:	2.4 GHz Transceiver
Type/ Model:	DRC-DR D3
Manufacturer:	Scanreco AB Årsta Skolgränd 22 SE-47144 Stockholm SWEDEN
Customer:	Scanreco AB Årsta Skolgränd 22 SE-47144 Stockholm SWEDEN
FCC Rule Part:	15.247: 2012
IC Rule Part:	RSS-210, Issue 8, 2010 RSS-GEN Issue 4, 2014
KDB:	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems DA 00-705 (March 30, 2000)

Date: February 6, 2015

Issued by:

Timo Hietala
Testing Engineer

Date: February 6, 2015

Checked by:

Janne Nyman
Compliance Specialist

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Equipment Under Test (EUT)

Wireless System-on-Module

Type/ Model:	DRC-DR D3
Serial Number:	-

DRC-DR D3 is a 2.4 GHz radio module that supports frequency hopping.

The sample had an antenna connector and an external antenna.

Conducted measurements were made with the sample having an external antenna. Measurements were made from the antenna connector (SMA).

Classification of the device

Fixed device	☐
Mobile Device (Human body distance > 20cm)	☒
Portable Device (Human body distance < 20cm)	☐

Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

Ratings and declarations

Operating Frequency Range (OFR):	2405 – 2480 MHz
Channels:	16
Channel separation:	5 MHz
Conducted power:	19.84 dBm
Transmission technique:	FHSS
Modulation:	GFSK
Integrated antenna gain:	-
External antenna gain:	4.0 dBi

Power Supply

The following wall charger was used during the tests (supplied with 115 V/ 60 Hz).

Charger:

Manufacturer:	Friwo Mobile Power Gmbh
Model:	FW7600/05
Serial number:	-
Input voltage:	100-240 VAC
Rated current:	0.09A max
Rated frequency:	50-60 Hz
Output voltage:	5 V DC
Output current:	0.65A max

Disclaimer

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SUMMARY OF TESTING

Test Specification	Description of Test	Result
§15.207(a) / RSS-GEN 8.8	Conducted Emissions on Power Supply Lines	**PASS**
§15.247(b)(1) / RSS-210 8.4	Maximum Peak Conducted Output Power	**PASS**
15.247(a)(1) / RSS-210 A8.1	Hopping Channel Carrier Frequency Separation	**PASS**
§15.247(a)(1)(iii) / RSS-210 A8.1	Number of Hopping Frequencies	**PASS**
§15.247(a)(1)(iii) / RSS-210 A8.1	Average Time of Occupancy of Hopping Frequency	**PASS**
§15.247(a)(1) / RSS-210 A8.1	20 dB Bandwidth	**PASS**
RSS-GEN 6.6	99 % Occupied Bandwidth	**PASS**
§15.247(d) / RSS-210 A8.5	100 kHz Bandwidth of Frequency Band Edges and Conducted Spurious Emissions	**PASS**
§15.209(a), §15.247(d) / RSS-210 A8.5 / RSS-GEN 8.10	Radiated Emissions Within The Restricted Bands	**PASS**
§15.209 / RSS-GEN 8.9	Unintentional Radiated Emissions	**PASS**

EUT Test Conditions during Testing

The EUT was configured into the wanted channel and was in continuous transmit mode during all the tests.

Following channels were used during the tests:

Channel	Frequency/ MHz
LOW	2405
MID	2440
HIGH	2480

Test Facility

☐ Testing Location / address: FCC registration number: **90598**	SGS Fimko Ltd Särkiniementie 3 FI-00210, HELSINKI FINLAND
☒ Testing Location / address: FCC registration number: **178986** Industry Canada registration number: **8708A-2**	SGS Fimko Ltd Karakaarenkuja 4 FI-02610, ESPOO FINLAND

Conducted Emissions In The Frequency Range 150 kHz - 30 MHz.

Standard:	ANSI C63.10	(2013)
Tested by:	RRE	
Date:	14.11.2014	
Temperature:	22.8 °C	
Humidity:	37 % RH	
Barometric pressure:	1004 hPa	
Measurement uncertainty:	± 2.9 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.207 (a)

Conducted disturbance voltage was measured with an artificial main network from 150 kHz to 30 MHz with 4.5 kHz steps and a resolution bandwidth of 9 kHz. Measurements were carried out with peak and average detectors.
During the test the EUT was powered from the separate power supply (115VAC / 60 Hz) through the LISN.

Frequency of emission (MHz)	**Conducted limit (dBµV)**	
	Quasi-peak	**Average**
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

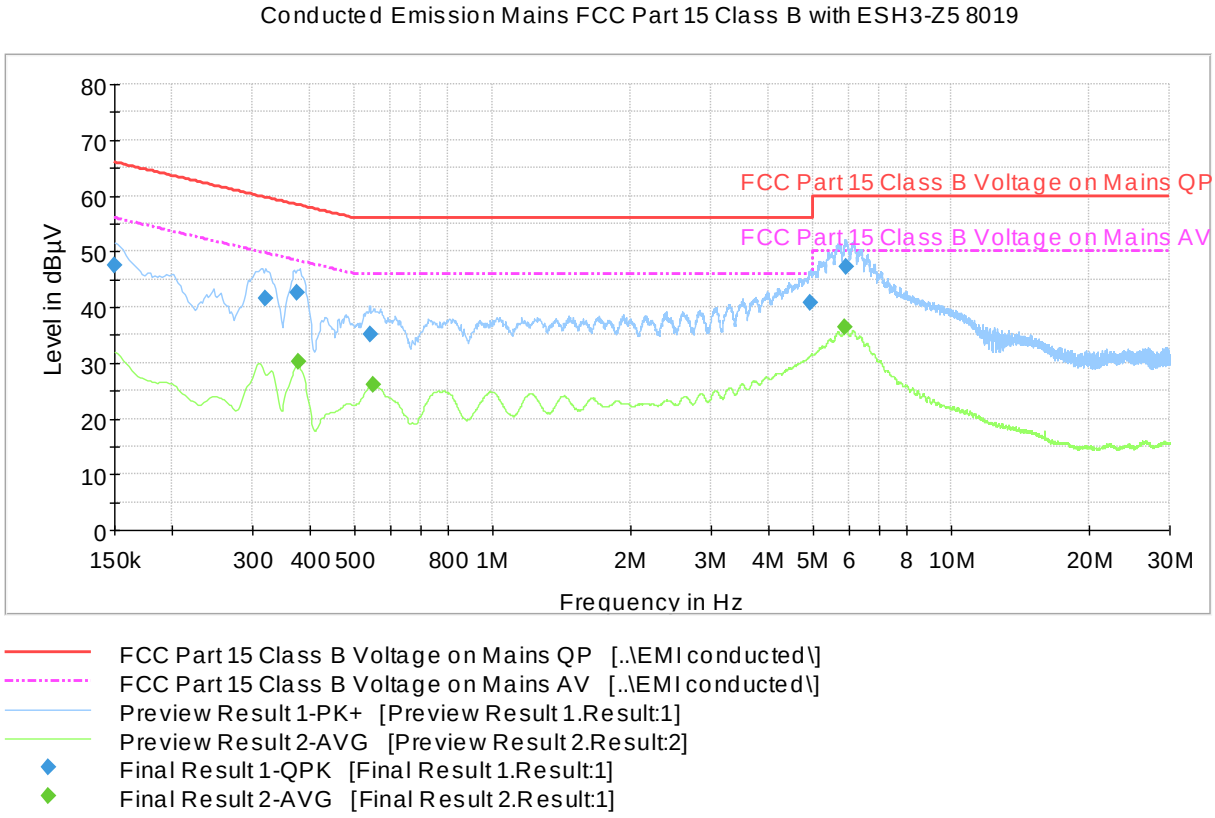

Figure 1. The measured curves with peak- and average detector

Final measurements from the worst frequencies

Table 1. Final results (QP).

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	PE	Line	Margin (dB)	Limit (dBµV)	Comment
0.150000	47.5	9.000	GN	N	18.5	66.0	PASS
0.321000	41.4	9.000	GN	N	18.3	59.7	PASS
0.375000	42.6	9.000	GN	N	15.7	58.4	PASS
0.541500	35.1	9.000	GN	N	20.9	56.0	PASS
4.939750	40.9	9.000	GN	L1	15.1	56.0	PASS
5.902750	47.3	9.000	GN	L1	12.7	60.0	PASS

Table 2. Final results (AV).

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	PE	Line	Margin (dB)	Limit (dBµV)	Comment
0.377250	30.2	9.000	GN	L1	18.1	48.3	PASS
0.550500	26.1	9.000	GN	L1	19.9	46.0	PASS
5.889250	36.3	9.000	GN	L1	13.7	50.0	PASS

Maximum Peak Conducted Output Power

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	30.-31.10.2014	
Humidity:	40 % RH	
Temperature:	22.7 °C	
Measurement uncertainty	± 2.87dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(b) (1)

For frequency hopping systems operating in the 2400-2483.5 MHz, employing at least 75 channels limit is 1.0 Watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

Results:

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
Low	19.38	20.97	1.59	PASS
Mid	19.84	20.97	1.13	PASS
High	17.40	20.97	3.57	PASS

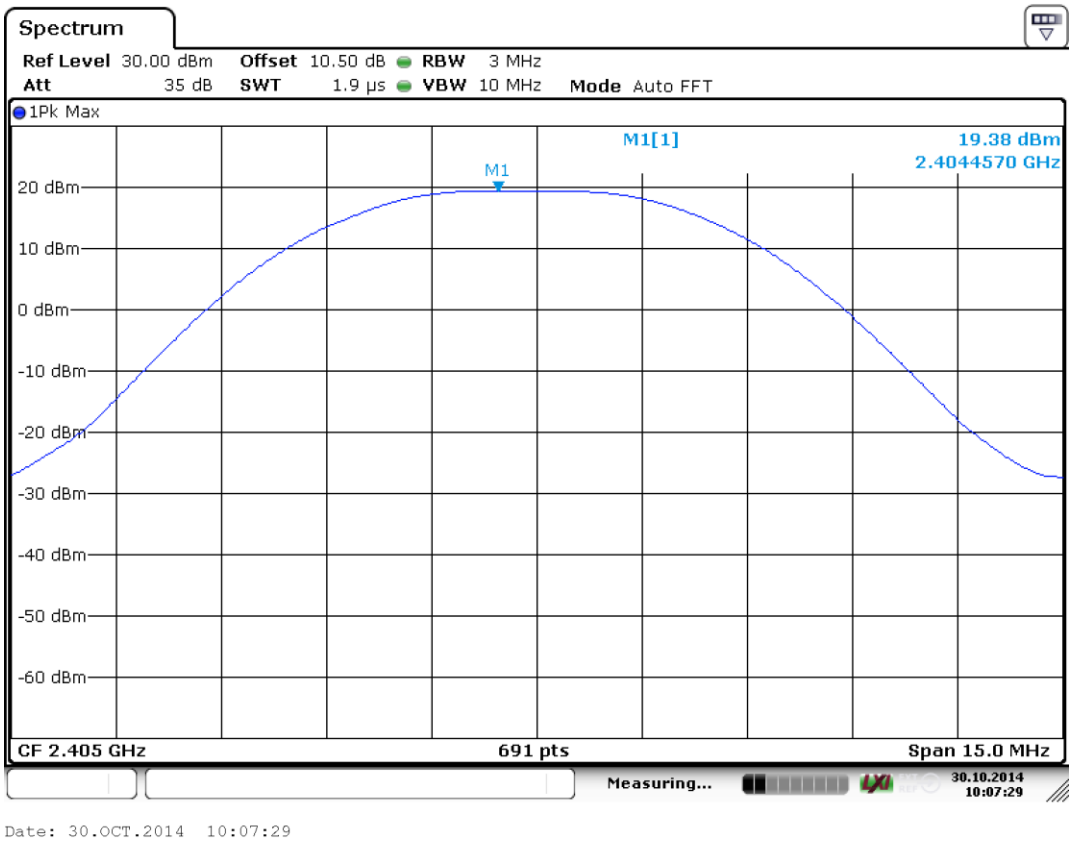

Figure 2. 1 Mbps Channel LOW.

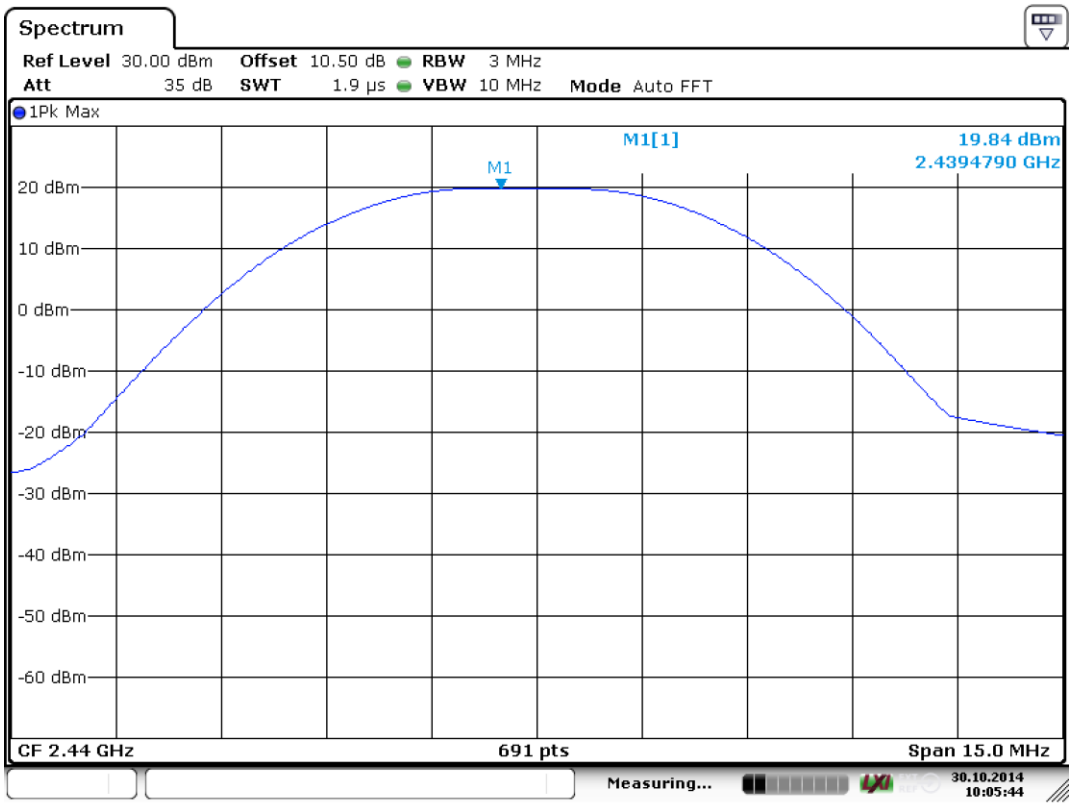

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Figure 3. 1 Mbps Channel MID.

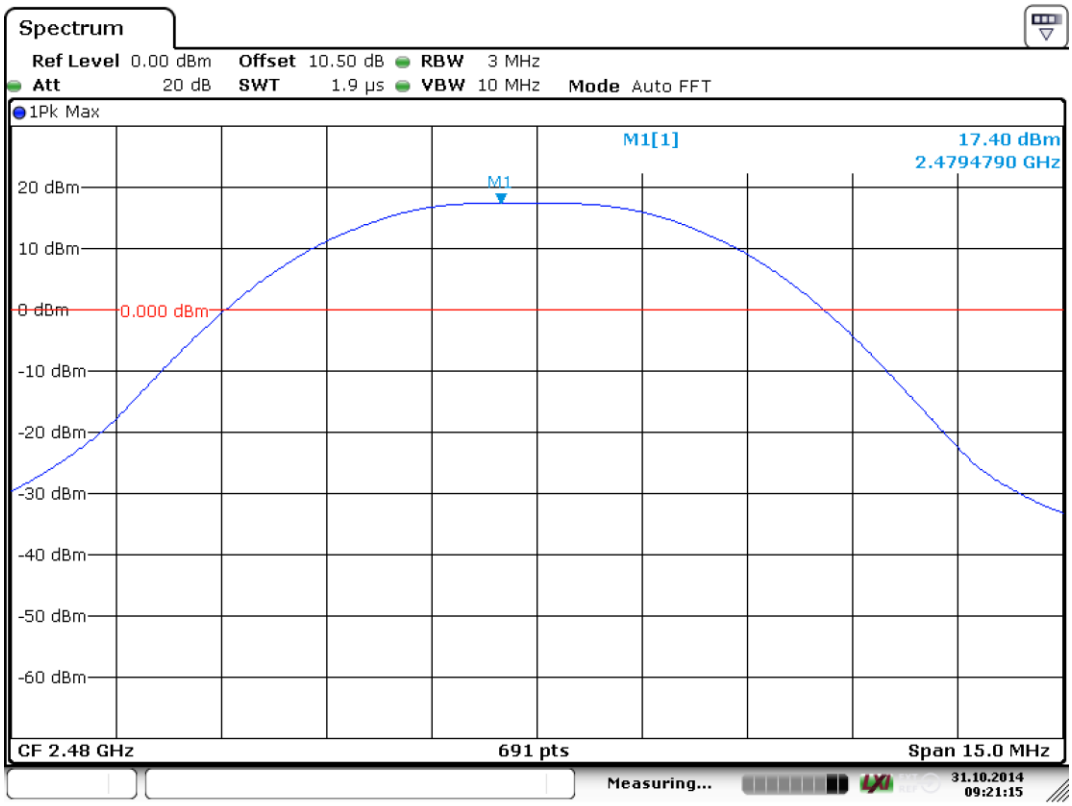

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Figure 4. 1 Mbps Channel HIGH.

Transmitter Radiated Emissions 30 MHz to 26.5 GHz

Standard:	ANSI C63.10	(2013)
Tested by:	RRE	
Date:	14. and 19.11.2014 and 4.2.2015	
Temperature:	21 - 22 °C	
Humidity:	35 - 41 % RH	
Measurement uncertainty	± 4.51 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)

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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a)**.**

The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables).
The result value is the measured value corrected with the correction factor.

The measurements above 1 GHz were performed by using a peak detector and a Duty Cycle correction factor(dB) -21.35 dB, see chapter: Duty cycle correction factor, Transmit time in 100 ms.

The measurements were performed with the EUT being in three orthogonal positions (X, Y, Z). Below 1 GHz the measurements were performed at MID channel, above 1 GHz the measurements were performed at LOW, MID and HIGH channels..

Test results with external antenna

Final results 30 – 1000 MHz:

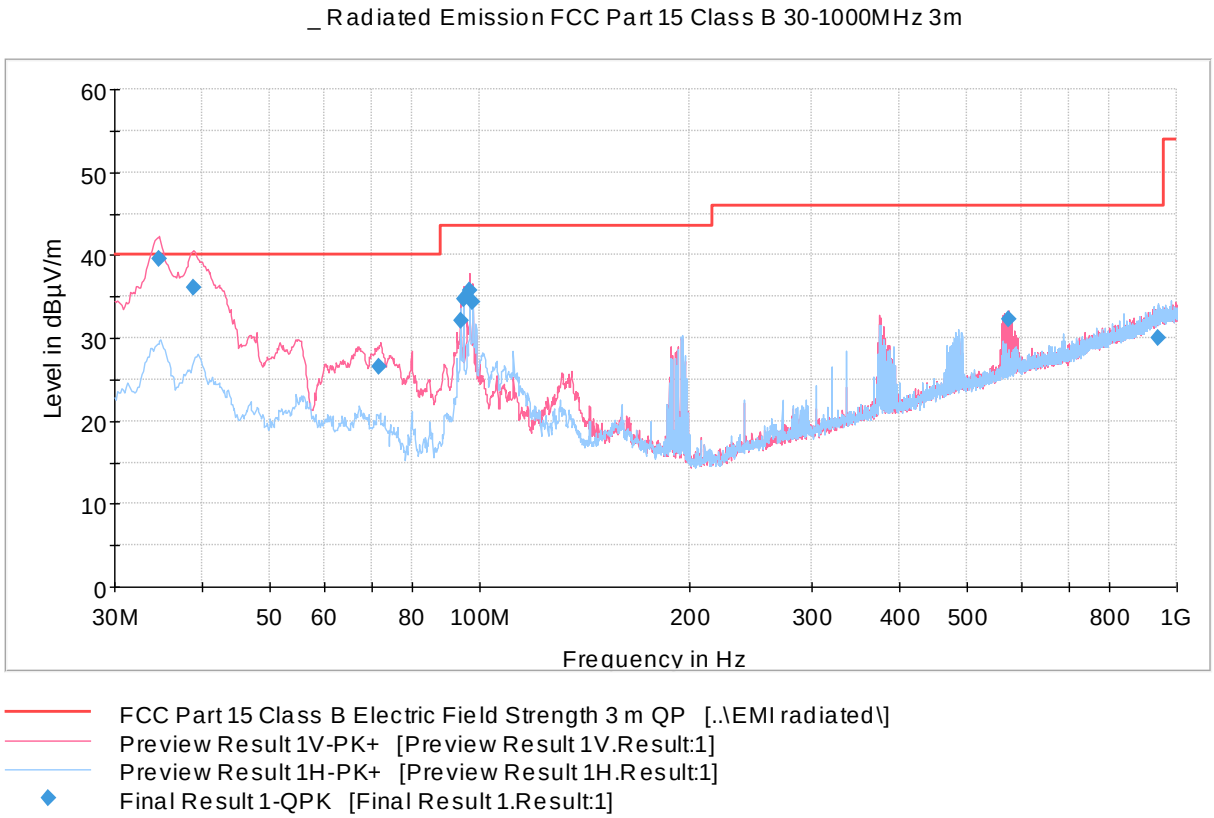

Figure 5. Measured curve with peak-detector. Channel MID.

Final measurements from the worst frequencies

Table 3. Final results 30 – 1000 MHz (QP).

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
34.805000	39.6	1000.0	120.000	100.0	V	76.0	14.4	0.4	40.0	PASS
38.875000	36.1	1000.0	120.000	100.0	V	76.0	14.6	3.9	40.0	PASS
71.955000	26.5	1000.0	120.000	100.0	V	306.0	12.8	13.5	40.0	PASS
93.985000	32.0	1000.0	120.000	100.0	V	45.0	9.0	11.5	43.5	PASS
94.995000	34.7	1000.0	120.000	100.0	V	56.0	9.1	8.8	43.5	PASS
97.005000	35.7	1000.0	120.000	100.0	V	34.0	9.5	7.8	43.5	PASS
97.995000	34.4	1000.0	120.000	100.0	V	46.0	9.6	9.1	43.5	PASS
572.995000	32.2	1000.0	120.000	100.0	V	166.0	22.2	13.8	46.0	PASS
940.495000	30.0	1000.0	120.000	100.0	H	345.0	28.0	16.0	46.0	PASS

Final results 1.0 – 26.5 GHz:

Table 4. LOW channel (RBW 100 kHz, VBW 300 kHz)

Frequency (MHz)	Peak dBc	Margin (dB)	Limit dBc	Comment
7213.3	-45.0	25.0	-20.0	PASS
9621.9	-41.7	21.7	-20.0	PASS

Table 5. HIGH channel (RBW 100 kHz, VBW 300 kHz)

Frequency (MHz)	Peak dBc	Margin (dB)	Limit dBc	Comment
7438.4	-45.9	25.9	-20.0	PASS

Radiated emissions in restricted bands 1 GHz – 26.5 GHz

Table 6. HIGH channel (RBW 1000 kHz, VBW 3000 kHz)

Frequency (MHz)	Peak			Average		
	Result (dBµV/m)	Limit (dBµV/m)	Margin dB	Result (dBµV/m)	Limit (dBµV/m)	Margin dB
7438.4	62.3	74.0	11.7	41.0	54.0	13.0
9921.8	63.3	74.0	10.7	42.0	54.0	12.0

Band edge compliance:

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

LOW (2405 MHz), below 2390 MHz:

Detector (RBW: 1MHz)	Result (dBµV/m)	Margin (dB)	Limit (dBµV/m)	Comment
Peak	60.4	13.6	74.0	PASS
Average	39.1	14.9	54.0	PASS

LOW (2405 MHz), 2390-2400 MHz:

Detector (RBW: 100 kHz)	Result (dBc)	Margin (dB)	Limit (dBc)	Comment
Peak	-56.2	36.2	-20.0	PASS

HIGH (2480 MHz), above 2483.5 MHz:

Detector (RBW: 1MHz)	Result (dBµV/m)	Margin (dB)	Limit (dBµV/m)	Comment
Peak	72.2	1.8	74.0	PASS
Average	50.9	3.1	54.0	PASS

Conducted Spurious Emissions 30 MHz to 26.5 GHz and Band Edge

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	31.10.2014	
Temperature:	22.7 °C / 22.9 °C	
Humidity:	40 % / 41 % RH	

FCC Rule: 15.247 (d)

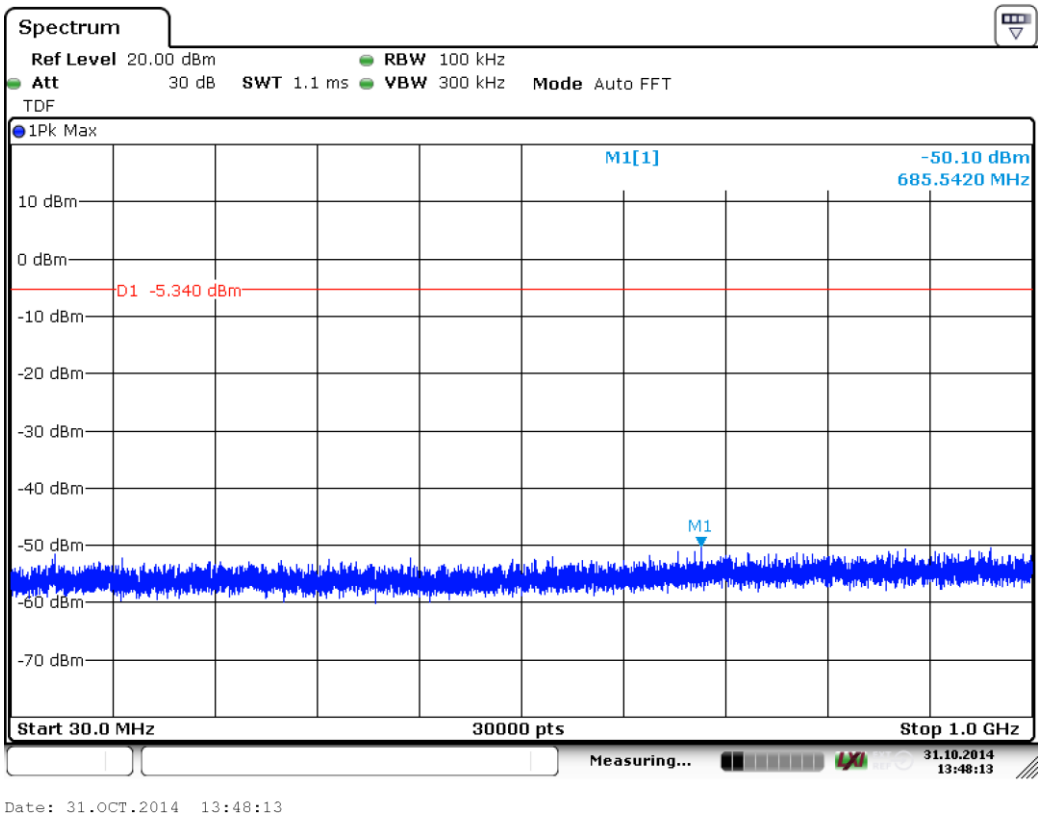

Figure 6. Low channel conductive emission 30 MHz to 1000 MHz.

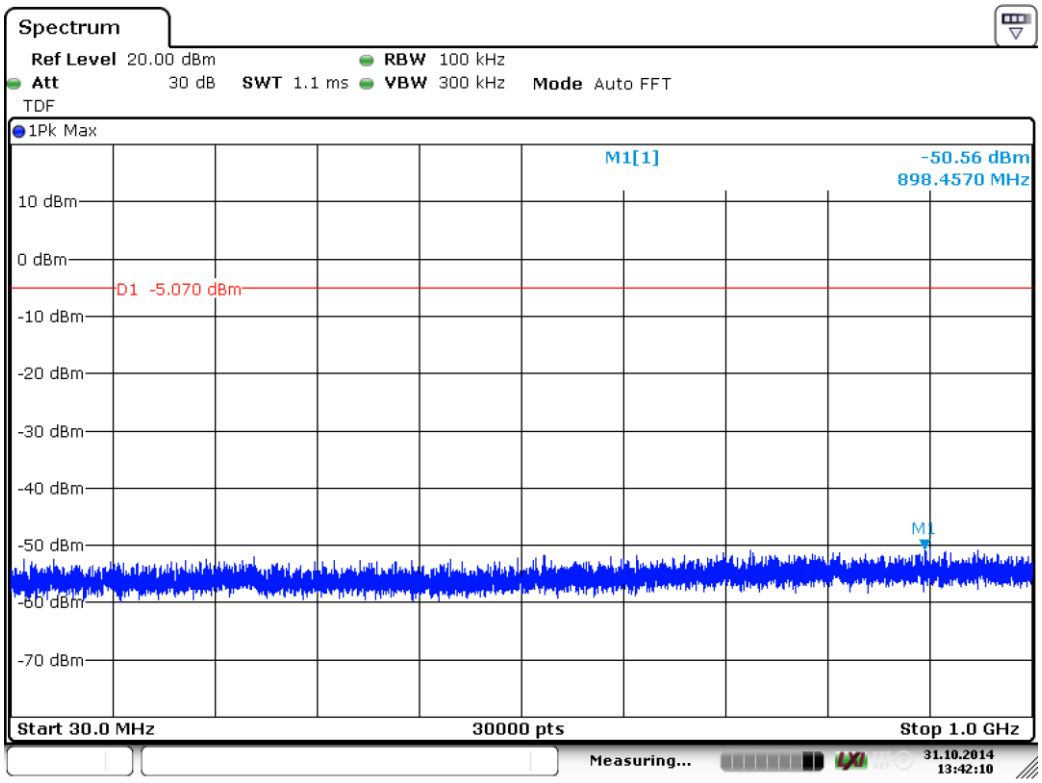

Figure 7. Mid channel conductive emission 30 MHz to 1000 MHz.

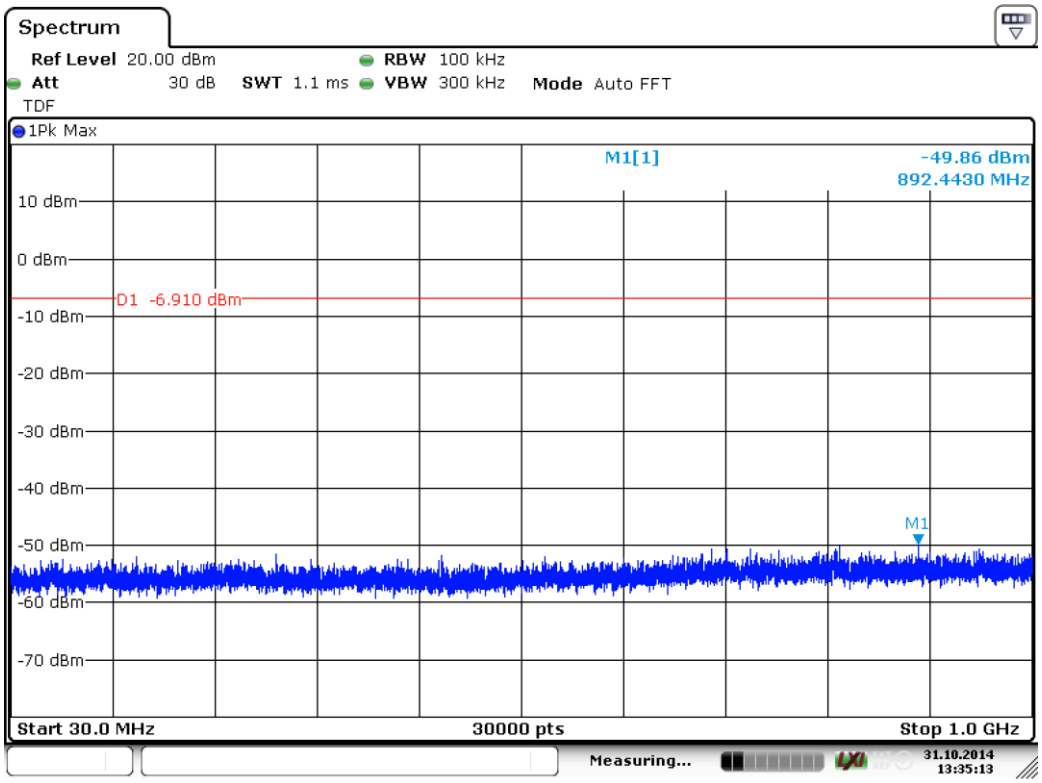

Figure 8. High channel conductive emission 30 MHz to 1000 MHz.

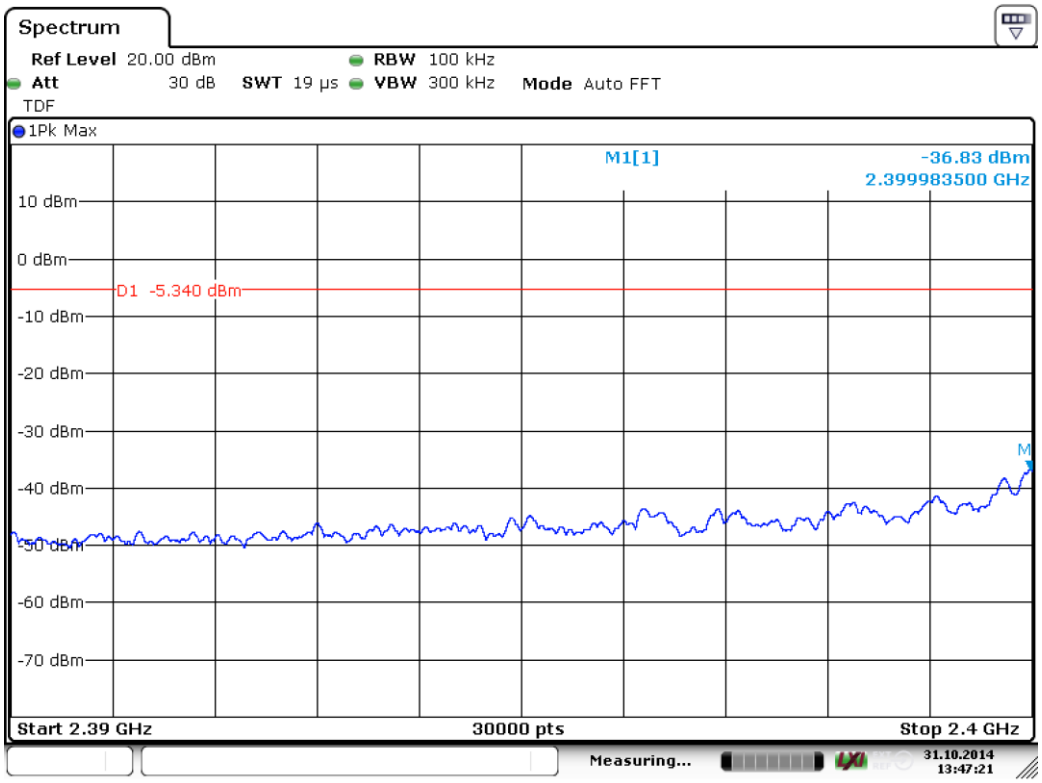

Figure 9. Low channel conductive emission at low band edge.

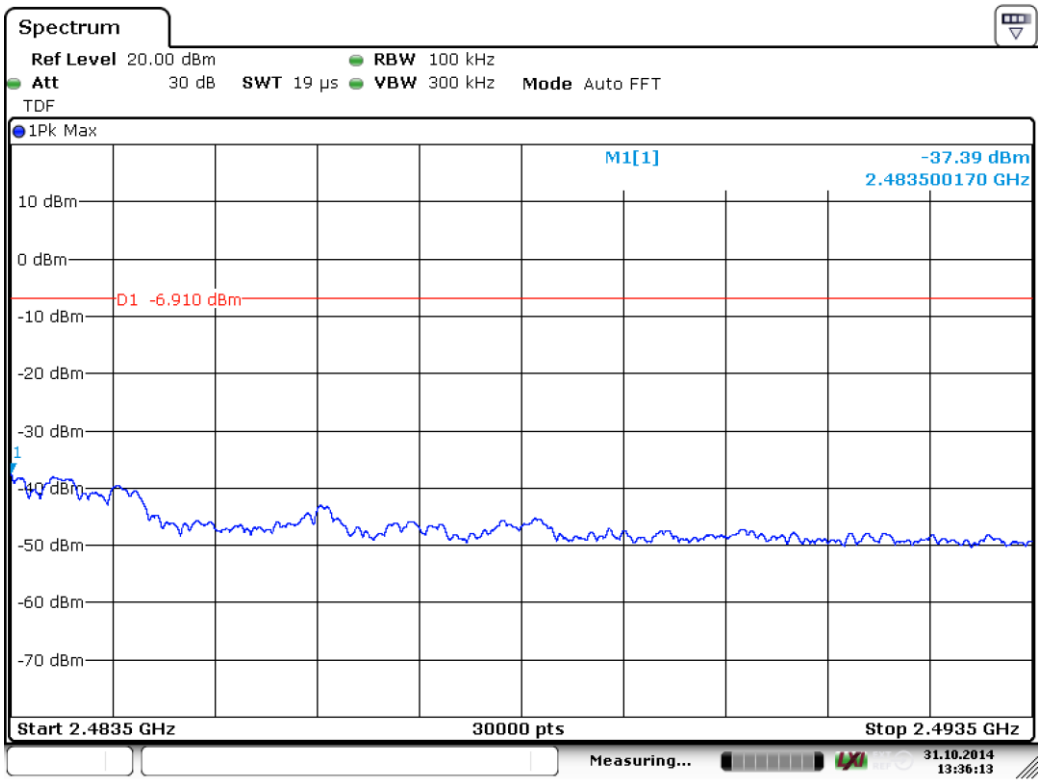

Figure 10. High channel conductive emission at high band edge.

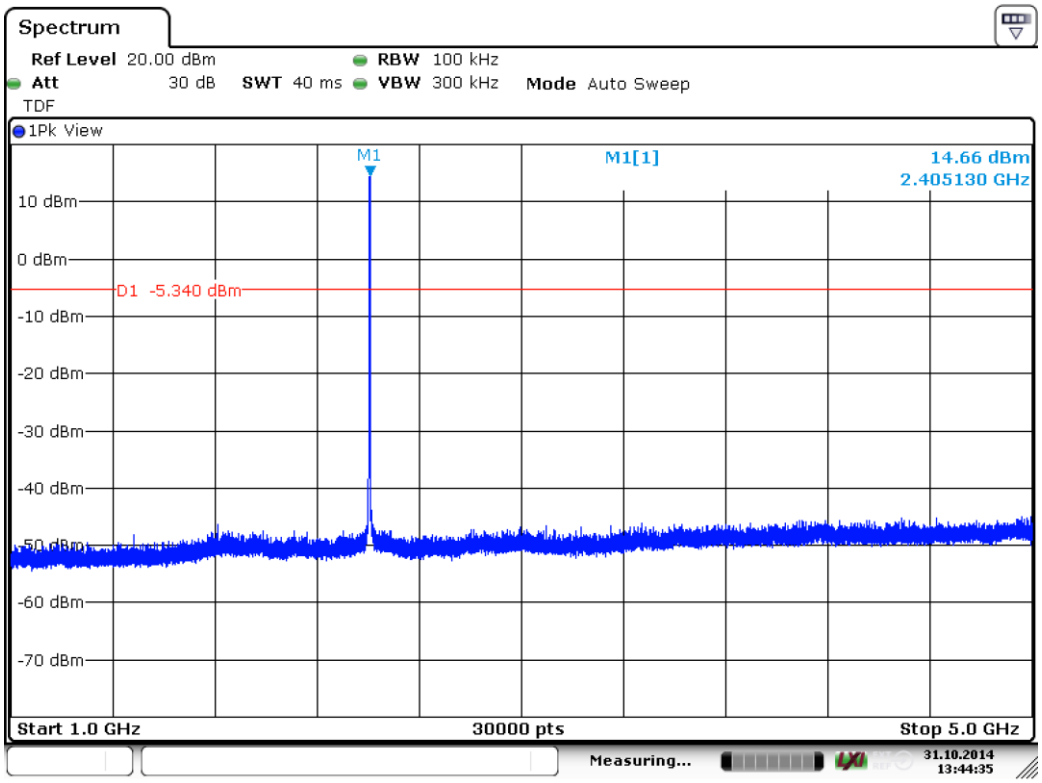

Figure 11. Low channel conductive emission 1 GHz to 5 GHz.

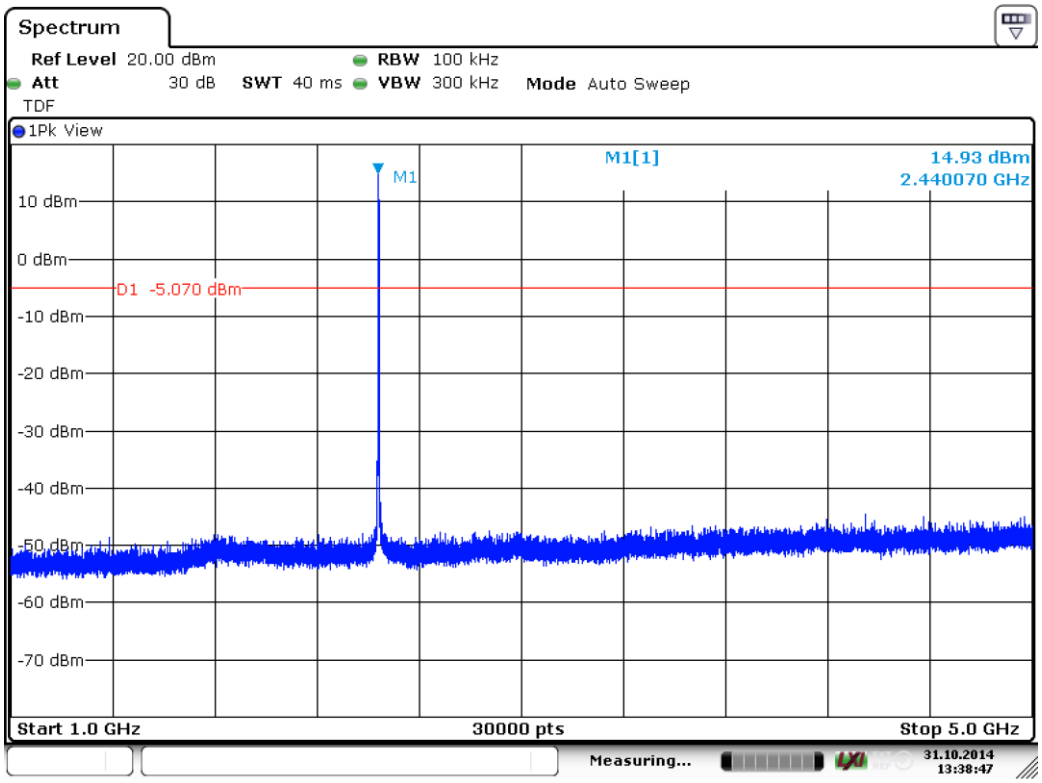

Figure 12. Mid channel conductive emission 1 GHz to 5 GHz.

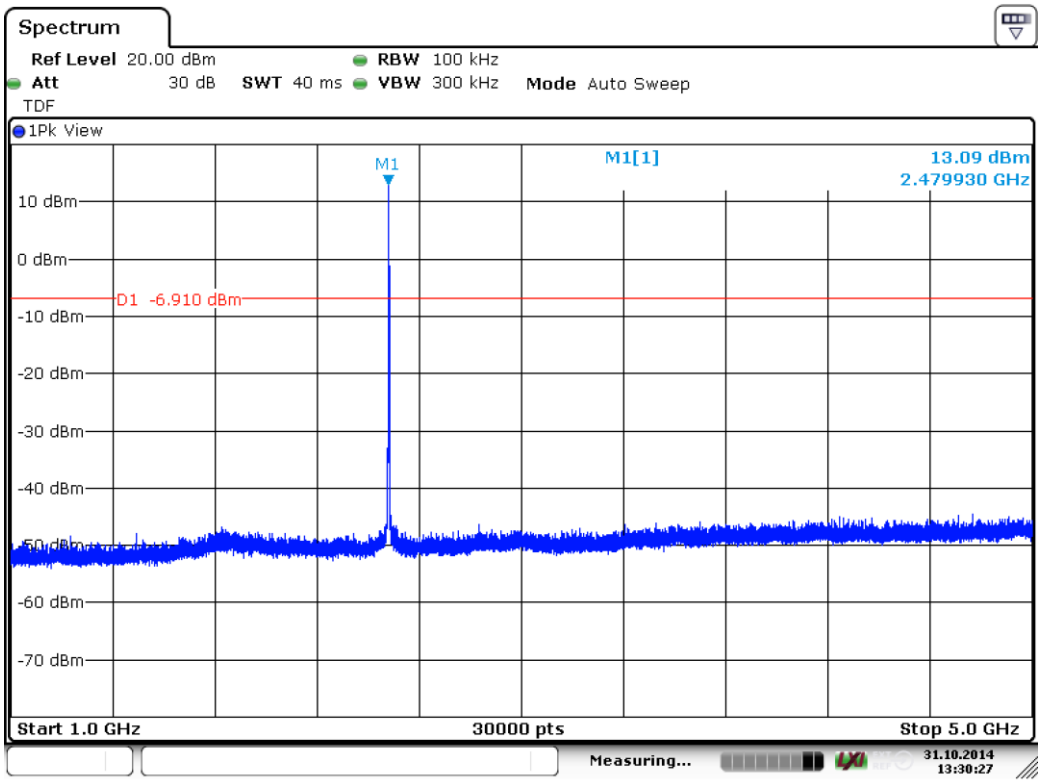

Figure 13. High channel conductive emission 1 GHz to 5 GHz.

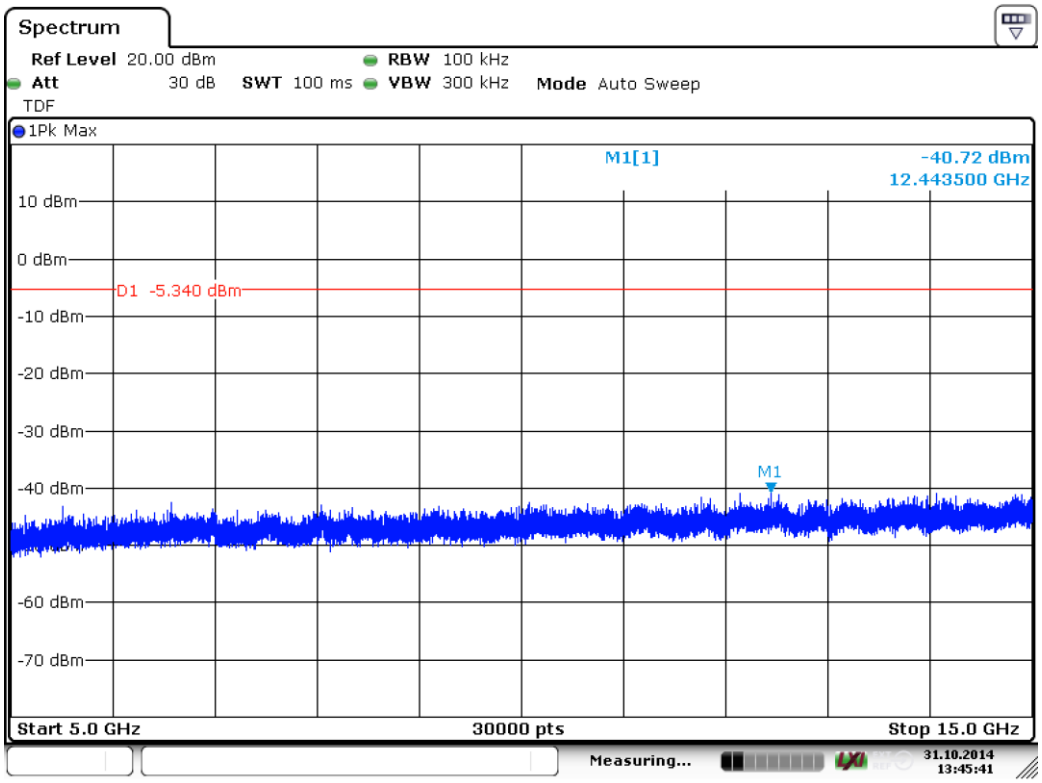

Figure 14. Low channel conductive emission 5 GHz to 15 GHz.

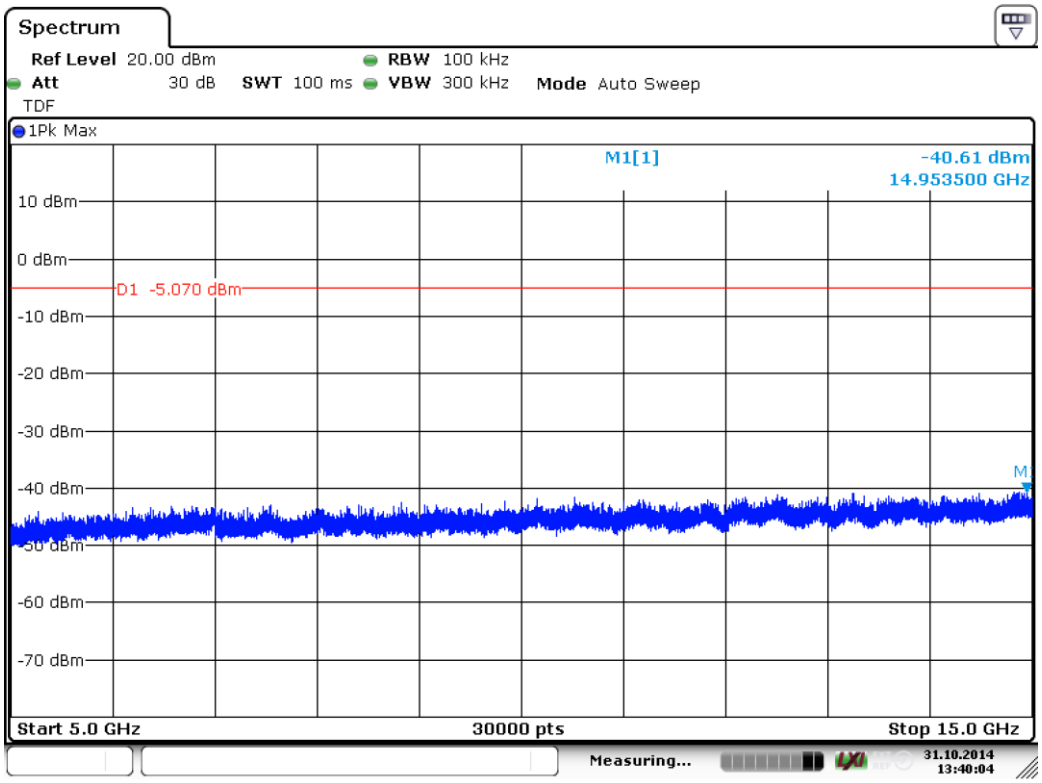

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Figure 15. Mid channel conductive emission 5 GHz to 15 GHz.

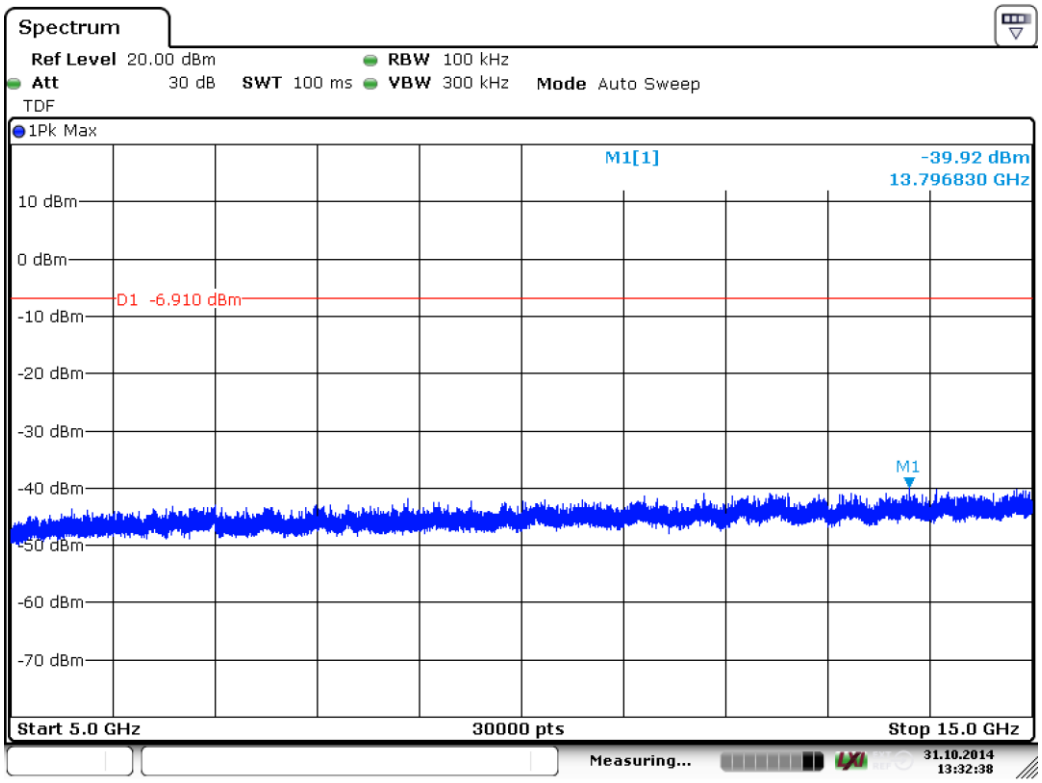

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Figure 16. High channel conductive emission 5 GHz to 15 GHz.

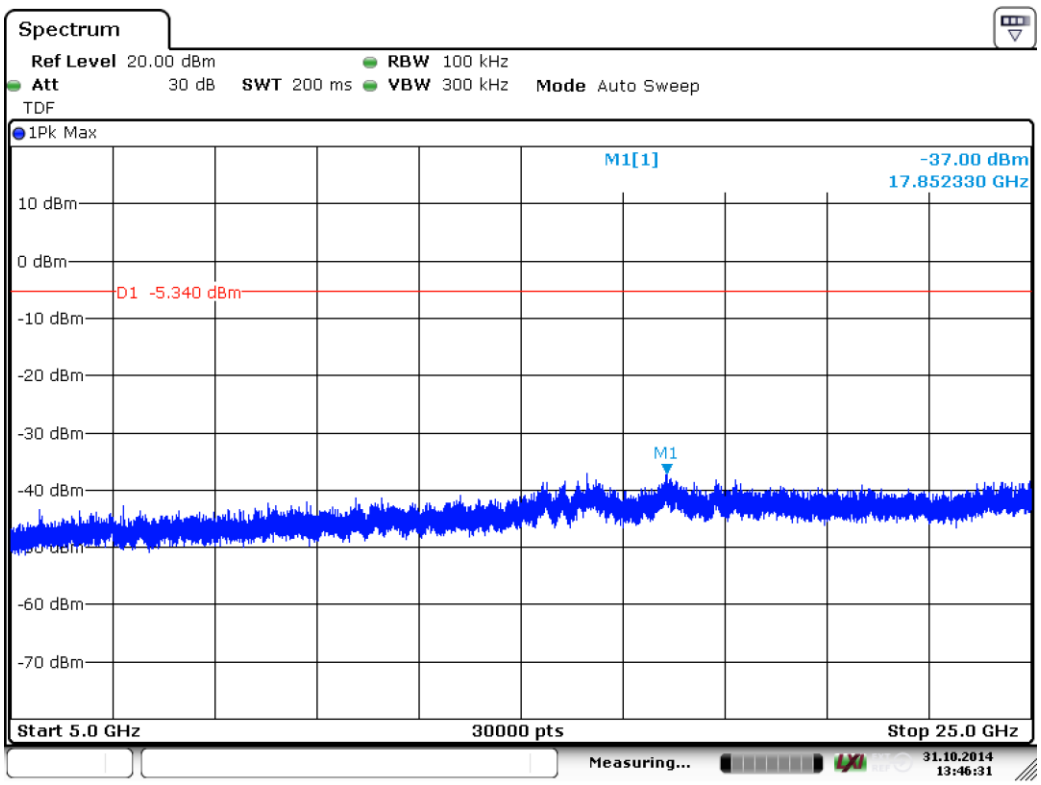

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Figure 17. Low channel conductive emission 15 GHz to 25 GHz.

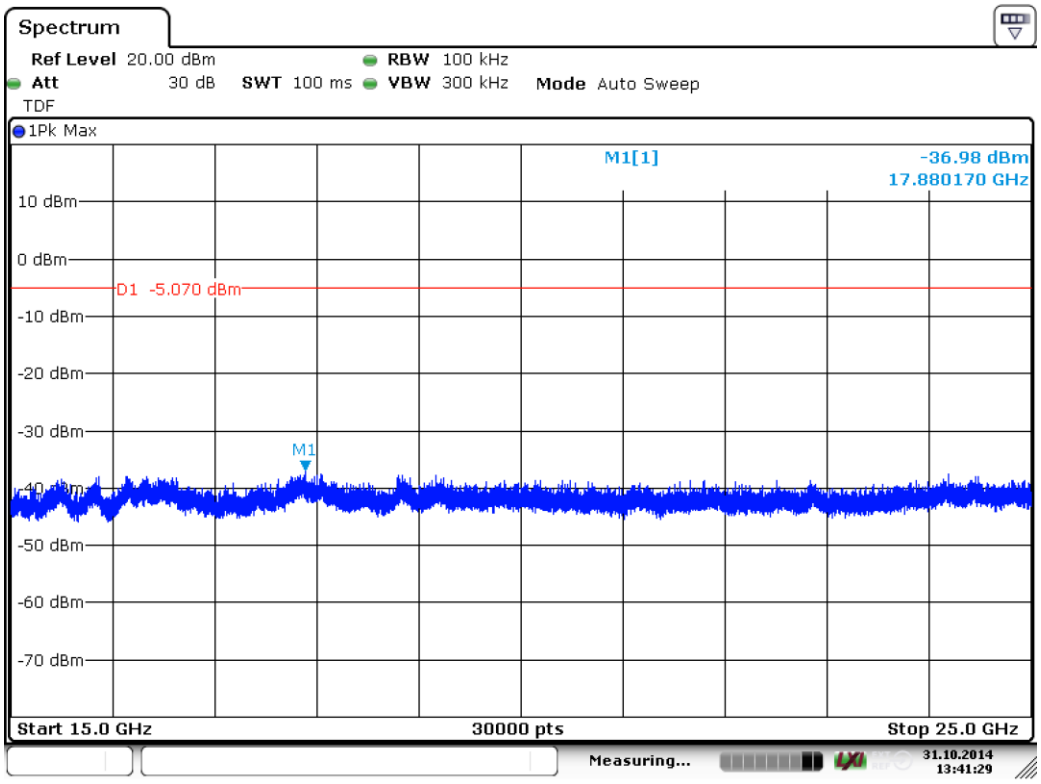

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Figure 18. Mid channel conductive emission 15 GHz to 25 GHz.

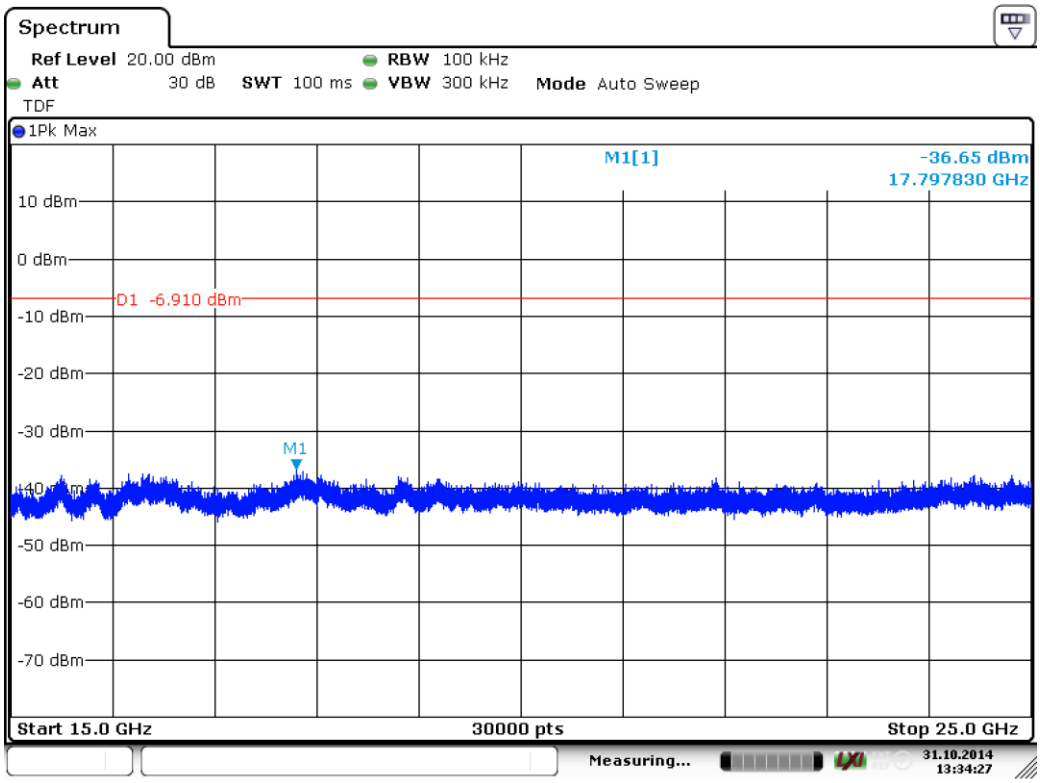

Figure 19. High channel conductive emission 15 GHz to 25 GHz.

20 dB Bandwidth of the Hopping Channel

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	31.10.2014	
Temperature:	22.7 °C	
Humidity:	37 % RH	

FCC Rule: 15.247(a)(1)

Results:

Table 7. 20 dB bandwidth test results.

Channel	20 dB BW [kHz]
Low	2822.0
Mid	2836.0
High	2822.0

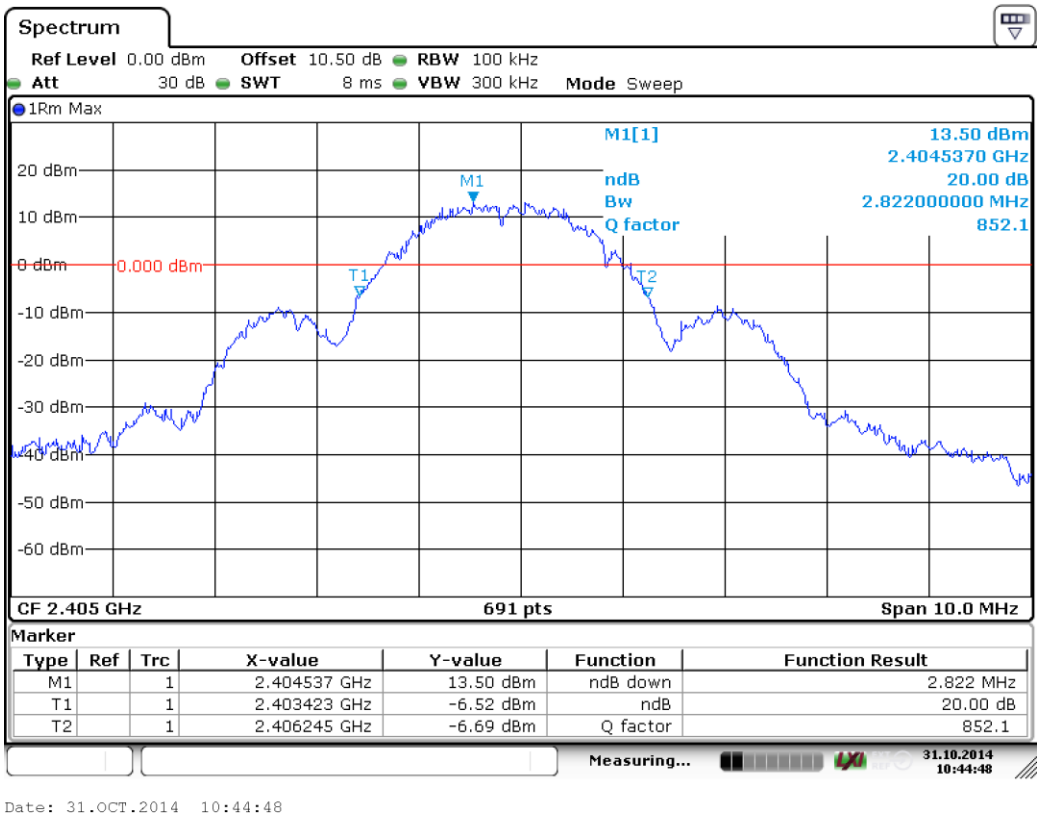

Figure 20. 20 dB channel BW. Channel LOW.

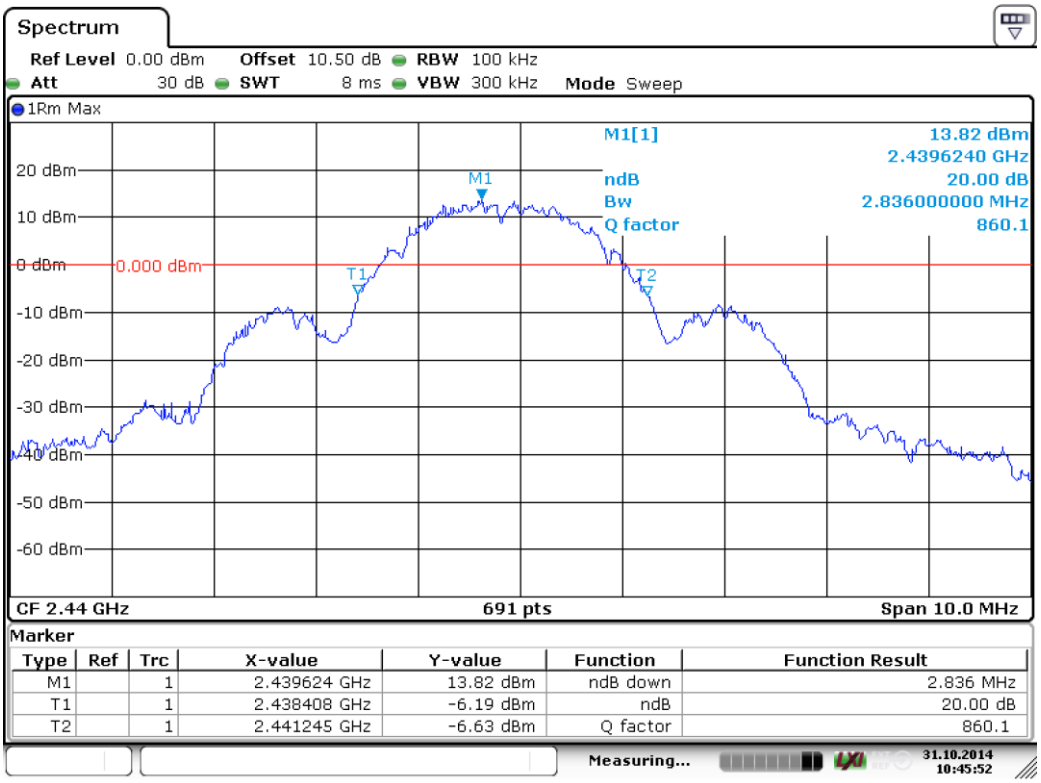

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Figure 21. 20 dB channel BW. Channel MID.

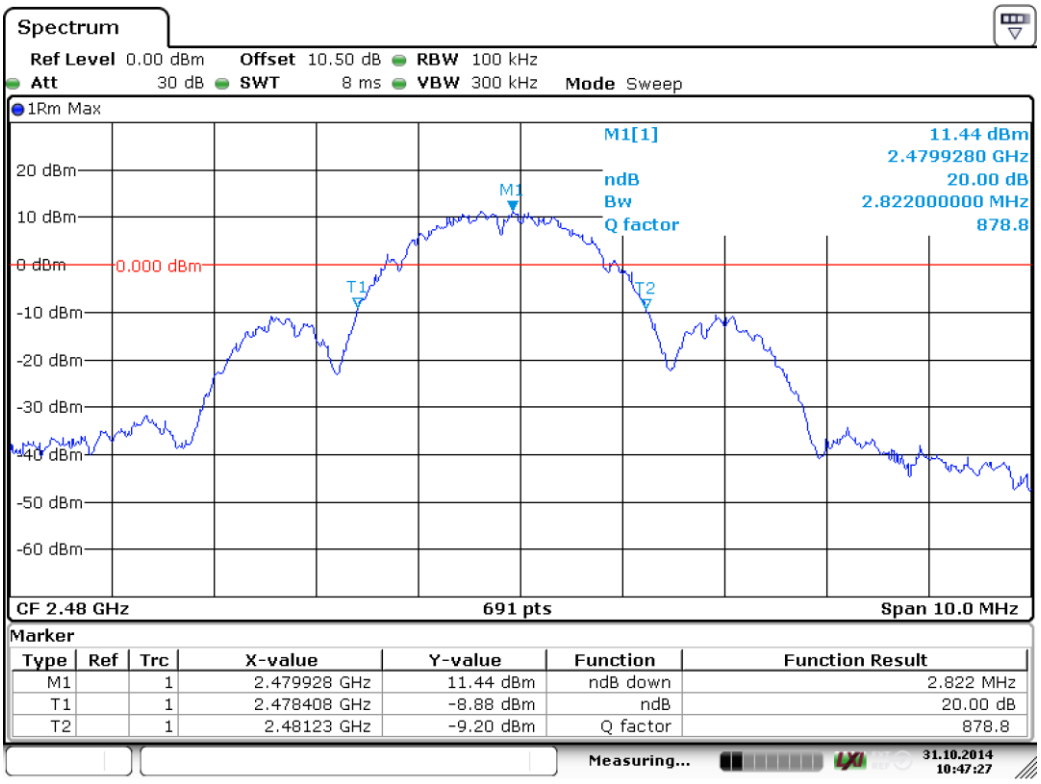

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Figure 22. 20 dB channel BW. Channel HIGH.

Hopping Channel Carrier Frequencies Separation

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	31.10.2014	
Temperature:	22.7 °C	
Humidity:	37 % RH	

FCC Rule: 15.247(a)(1)

Frequency hopping systems with an output power less than 125mW shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or 2/3 of the 20 dB bandwidth of the hopping channel, whichever is greater.

Test result

Table 8. Hopping channel carrier frequencies separation test result.

Data rate	Measured separation	Measured 20 dB BW	Limit	Result
1 Mbps	5.022 MHz	2.822 MHz	1.881 MHz	PASS
Limit:	25 kHz or 2/3 or the 20 dB bandwidth of the hopping channel whichever is greater			

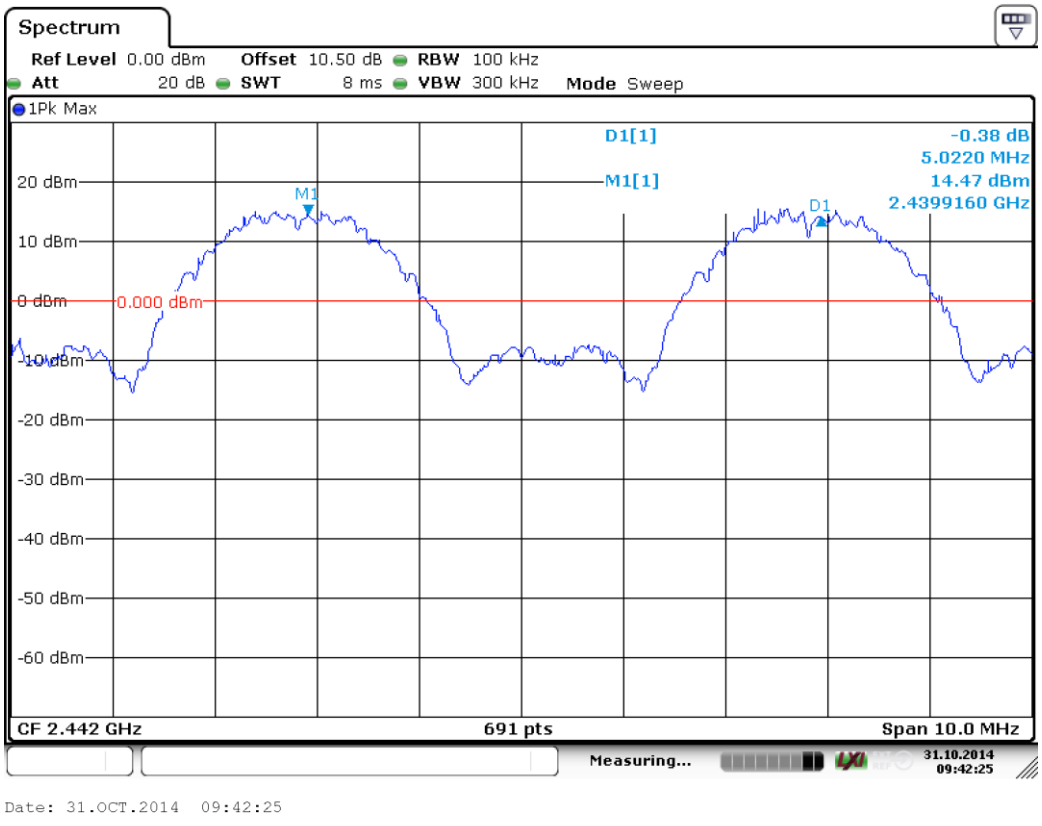

Figure 23. Measured hopping channels carrier frequency separation.

Number of Hopping Channels

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	31.10.2014	
Temperature:	22.7 °C / 23.1 °C	
Humidity:	37 % / 38 % RH	

FCC Rule: 15.247(a)(1)(iii)

For frequency hopping systems operating in the 2400 – 2483.5 MHz band shall use at least 15 channels.
Channels measured: 16
Result: PASS

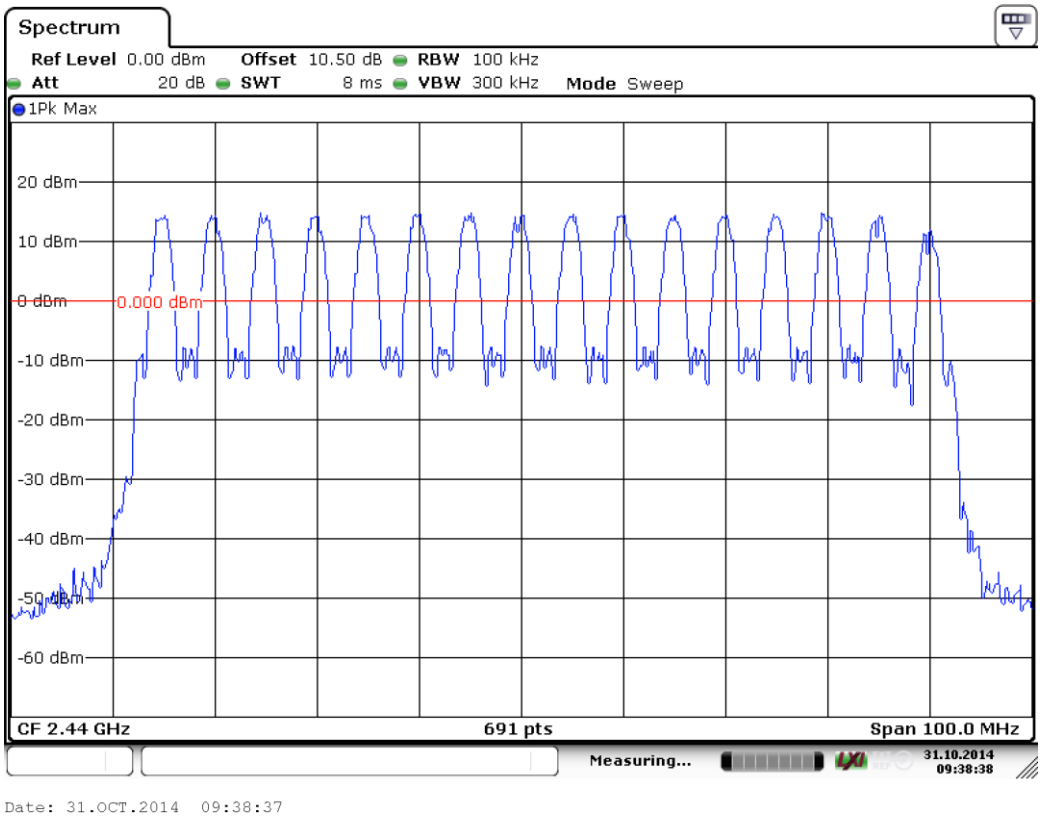

Figure 24. 16 channels.

Average Time of Occupancy of Hopping Frequency

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	31.10.2014	
Temperature:	22.7 °C	
Humidity:	37 % RH	

FCC Rule: 15.247(a)(1)(iii)

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.

Time of occupancy calculation:
Number of channels = 16
Measurement period = 0.4 s x 16 = 6.4 s
Number of transmission cycles in measurement period = 83
Time of occupancy = (single duration) x (repetition) = 4.2783 ms x 83 times = 355.1 ms

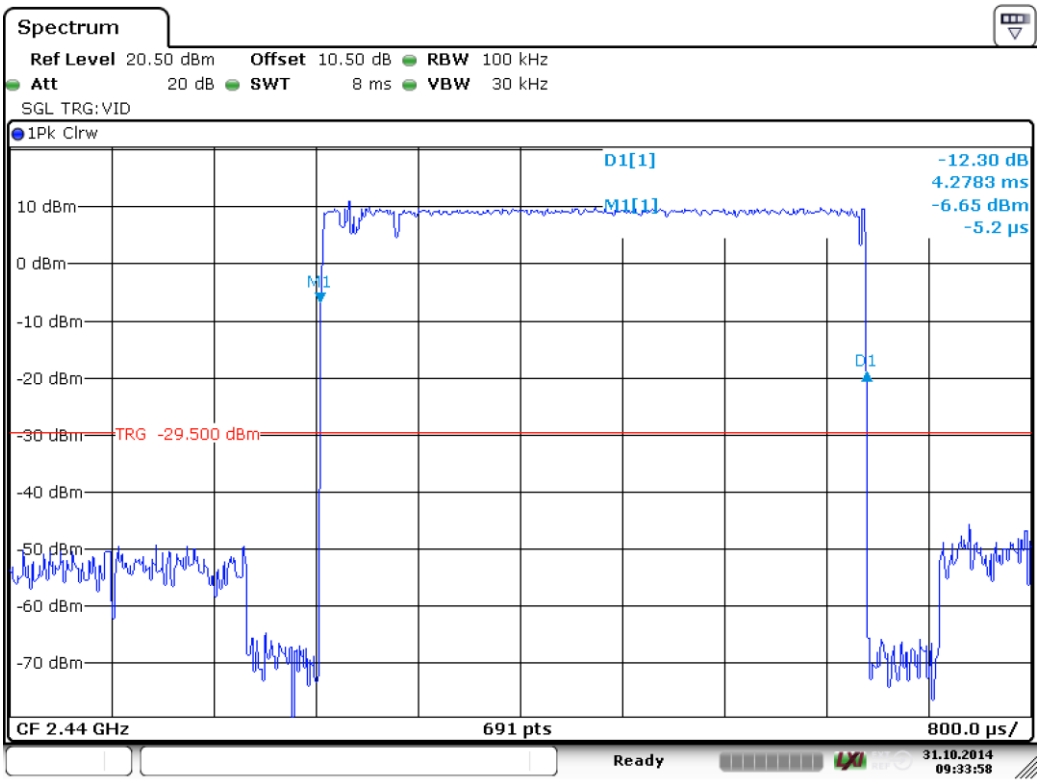

Figure 25. One channel dwell time.

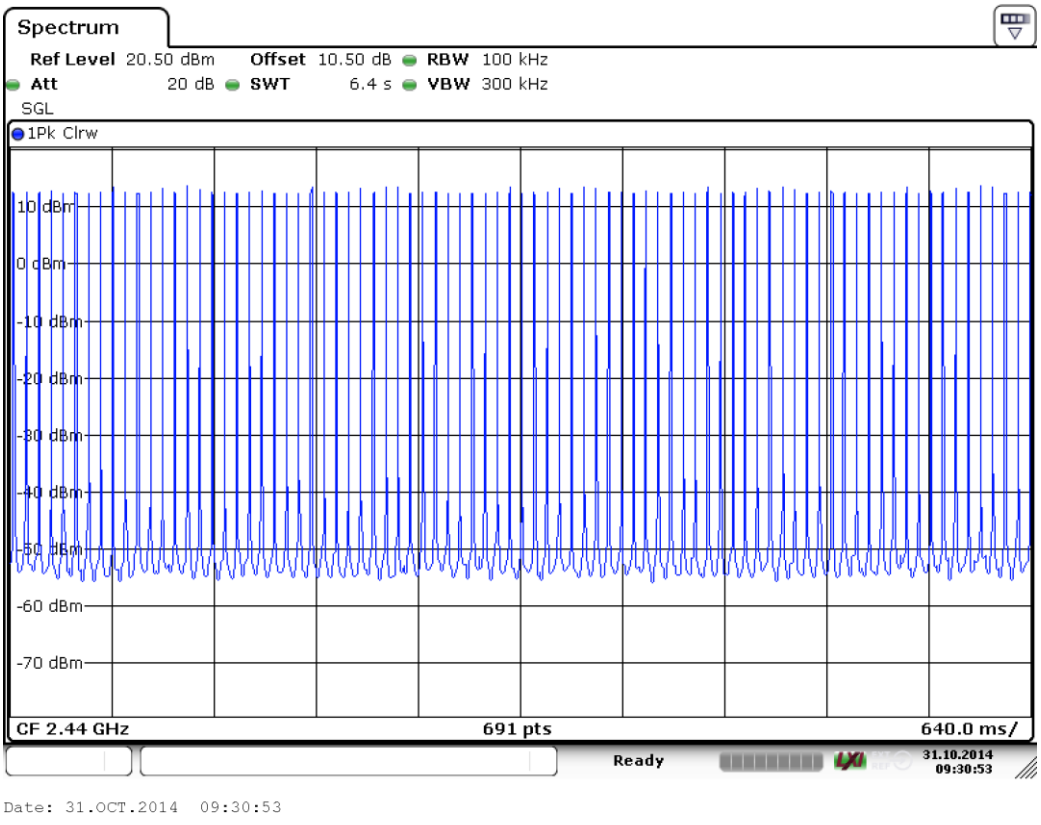

Figure 26. Hopping on, number of transmissions, channel 2440MHz, 83 transmissions

Duty cycle correction factor, Transmit time in 100 ms

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	31.10.2014	
Temperature:	22.7 °C	
Humidity:	37 % RH	

Spectrum analyzer with zero span was used to investigate spectrum.

15.35(c) Unless otherwise specified, e.g.§ 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

Test data

Pulse period (T) = 6.4s/83=77.1ms

Pulses/100ms=2

Length of one pulse = 4.278ms

DutyCycleCorrectionFactor=20*log(Tocc/100)=20*log(2*4.278/100)=-21.35dB

99% Occupied Power Bandwidth

Standard:	RSS-GEN	(2014)
Tested by:	PKA	
Date:	31.10.2014	
Temperature:	22.7 °C	
Humidity:	37 % RH	

RSS-GEN 4.7.

Table 9.

Channel	99% BW [MHz]	Limit	Result
Low	2.633	-	PASS
Mid	2.633	-	PASS
High	2.604	-	PASS

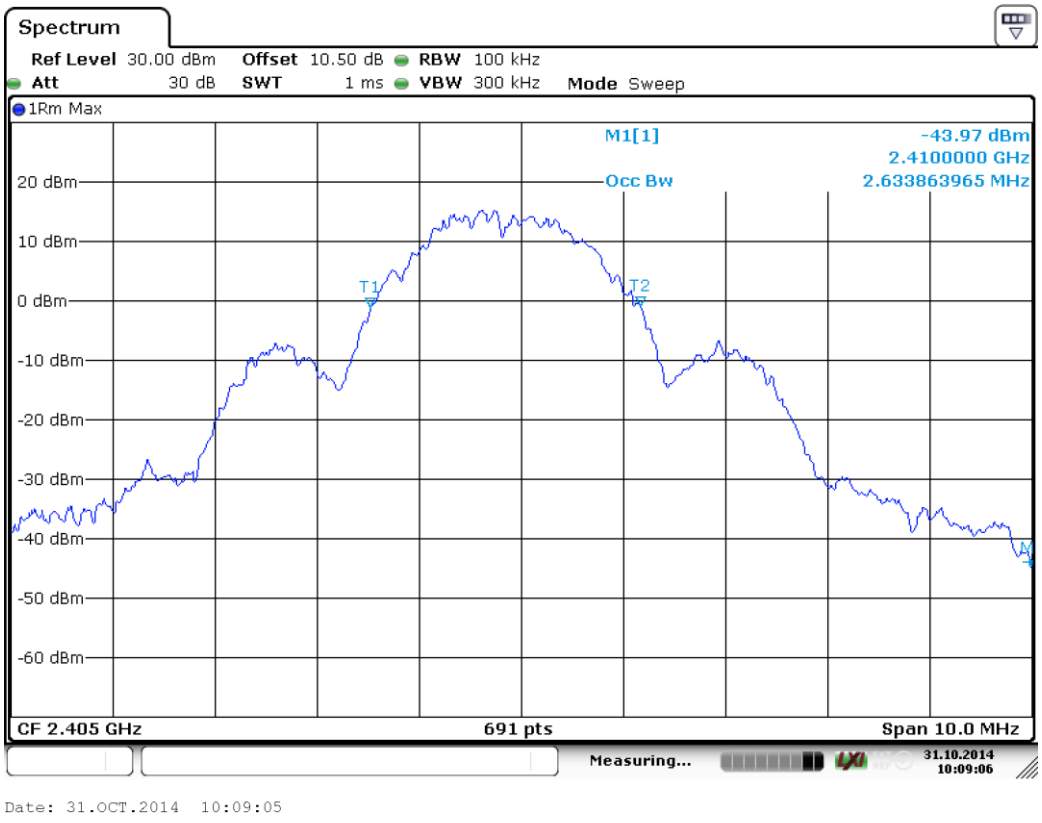

Figure 27. Low channel 99% Occupied Power Bandwidth.

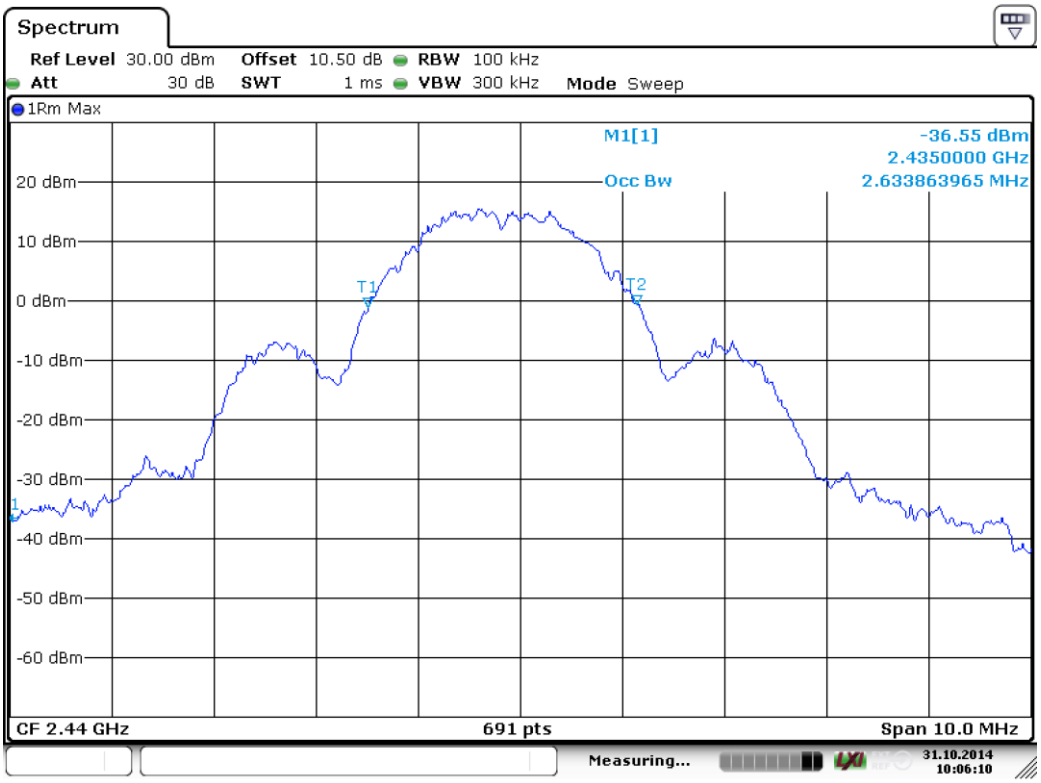

Figure 28. Mid channel 99% Occupied Power Bandwidth.

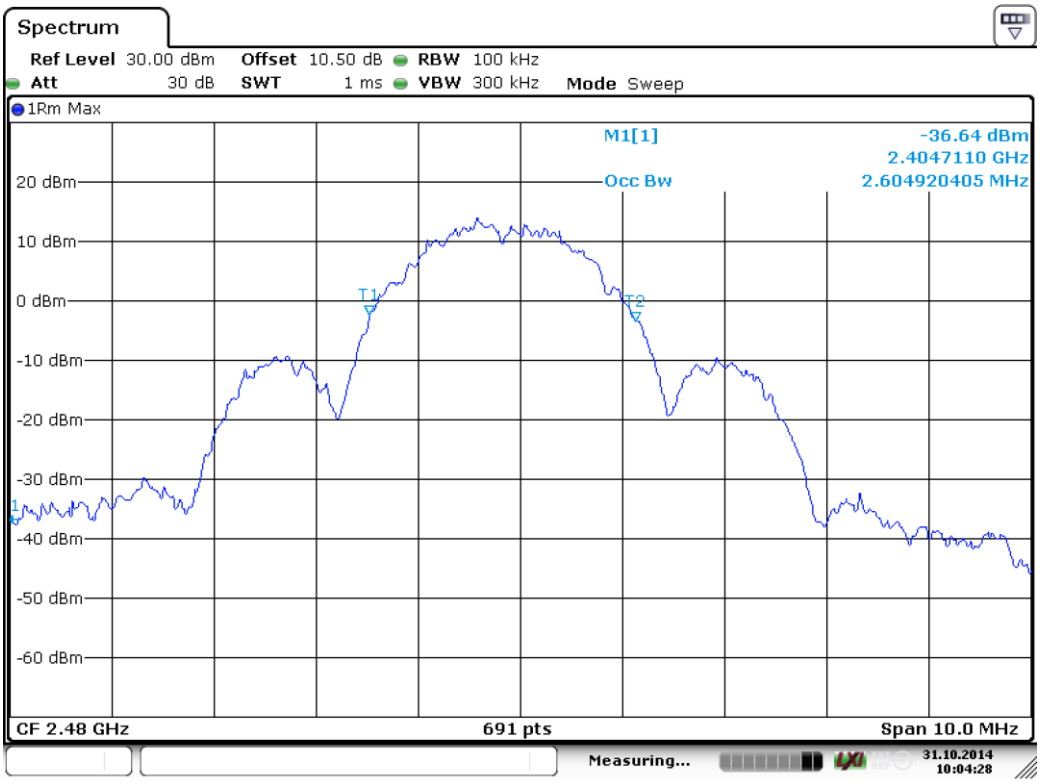

Figure 29. High channel 99% Occupied Power Bandwidth.

LIST OF TEST EQUIPMENT

Conducted Emissions

Equipment	Manufacturer	Type	Serial no	Inv.no
TEST RECEIVER	ROHDE & SCHWARZ	ESU 26	100185	8453
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-
PULSE LIMITER	ROHDE & SCHWARZ	ESH3-Z2	#1	8359
LISN	ROHDE & SCHWARZ	ESH3-Z5	863794/014	8019
AC Power Source	CALIFORNIA INSTRUMENTS	5001 iX Series II	58209	7826

Radiated Emissions

Equipment	Manufacturer	Type	Serial no	Inv.no
TEST RECEIVER	ROHDE & SCHWARZ	ESU 26	100185	8453
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-
ANTENNA (30-1000 MHz)	SCHWARZBECK	VULB 9168	8168-503	8911
ANTENNA MAST	DEISEL	MA240	240/455	5017
TURNTABLE	DEISEL	DS420	-	5015
CONTROLLER	COMTEST	HD100	100/457	5018
AC Power Source	CALIFORNIA INSTRUMENTS	5001 iX Series II	58209	7826

All used measurement equipment was calibrated (if required).