Test Report

INTENTIONAL RADIATOR TESTS ACCORDING TO ARIB STD-T66 REQUIREMENTS

Equipment Under Test:	Bluetooth Audio Module
Model:	WT32i
Brand:	Bluegiga
Manufacturer:	Bluegiga Oy Sinikalliontie 5 A FI-02630 ESPOO FINLAND
Customer:	Bluegiga Oy Sinikalliontie 5 A FI-02630 ESPOO FINLAND

FINAS
Finnish Accreditation Service
T004 (EN ISO/IEC 17025)

Date:	16.10.2013	Date:	16.10.2013
Issued by:	Niko Kotsalo Testing Engineer	Checked by:	Ari Honkala Product Line Manager

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Equipment Under Test (EUT)

Bluetooth module	
Brand:	Bluegiga
Model:	WT32i
Type:	-
Serial no:	-
HW version:	-
SW version:	-

Description of the EUT

The EUT is a Bluetooth audio module that supports Bluetooth 3.0. This report includes only the Classic Bluetooth test results.

The EUT includes a PSU that is used to regulate the input voltage in such way that if the input voltage changes ± 10 %, the internal supply voltages of the EUT remain within ±1 % of the nominal value. Testing with only nominal voltage of 3.3 Vdc was therefore deemed to be sufficient.

The module is Bluetooth qualified and the interference prevention function is based on Adaptive Frequency Hopping defined in the Bluetooth standard as required by the Ordinance Regulating Radio Equipment, Article 9-4-9, and the Regulation for Enforcement of the Radio Law, Article 6-2-3.

Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing

Ratings and declarations

Operating Frequency Range (OFR):	2402 – 2480 MHz
Channels:	79
Channel separation:	1 MHz
Conducted power:	6.83 dBm
Transmission technique:	FHSS
Modulation:	GFSK, π/4 DQPSK, 8DPSK
Antenna type:	Chip Antenna
External antenna connector type:	W.FL connector
Chip antenna gain:	3.29 dBi
External ½λ antenna	2.76 dBi

Power Supply

Battery Operated	
Operating Voltage Range	2.7 – 4.2 VDC
Tested by using external power supply and 3.3 VDC voltage level.	

Mechanical Size of the EUT

Length: 23.9 mm	Width: 15.0 mm	Height: 1.45 mm

Peripherals

DC power supply Thandar TS3021S.

Disclaimer

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SUMMARY OF TESTING

Ordinance reference	Description of Test	Result
Article 14	Antenna power, tolerances for antenna power	PASS
Article 5	Frequency tolerance	PASS
Article 6 and 49.20	Occupied Bandwidth (99%), Spread Bandwidth (90%) and Spreading Factor	PASS
Article 7	Transmission spurious emissions	PASS
Article 24	Limitation of collateral emission of receiver	PASS
Article 49.20	Holding time of the hopping frequency	PASS

Test methods

References:	Tests were performed according to the methods presented in standards EN 300 328-1 v1.7.1.

EUT Test Conditions During Testing

The EUT was in continuous transmit or receiving mode during all the tests.

The hopping was stopped and the EUT was configured into the wanted channel or the EUT was hopping continuously between the channels depending of the test. Normal modulation and duty cycle were applied in all tests except for frequency tolerance measurement that was performed with unmodulated signal.

According to the customers declaration the internal supply voltages of the EUT are regulated. Therefore tests were performed using only the nominal input voltage level.

Following channels were used during the tests when the hopping was stopped:
Channel LOW (CH 1) = 2402 MHz
Channel MID (CH 40) = 2441 MHz
Channel HIGH (CH 79) = 2480 MHz

The EUT was controlled by using Bluesuite software.
The following packet types were used for the testing.

DH5 Packet type = 15
Packet size = 339

2DH5 Packet type = 30
Packet size = 679

3DH5 Packet type = 31
Packet size = 1021

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

Antenna power and tolerances

Standard:	EN 300 328	
Limit:	ARIB-T66	
Tested by:	NKO	
Date:	2.10.2013	
Humidity:	20 %	
Temperature:	22.8 °C	
Measurement uncertainty	± 0.49 dB	Level of confidence 95 % (k = 2)

Limits: 3 mW/MHz; 2 400 – 2483.5 MHz

Antenna POWER TOLERANCE: -80% to +20%

Test procedure

Total power is measured by using power meter.

The average power level was measured in continuous hopping transmit mode.

Test Results

Table 1. Measured Antenna powers

Packet Type	Reading (dBm)	Reading (mW)	Spread BW (MHz)	Result (mW/MHz)	Limit (mW/MHz)	Margin (mW/MHz)	Result
DH5	6.83	4.82	78.7699	0.0612	3	2.94	PASS
2DH5	5.09	3.23	78.9700	0.0409	3	2.96	PASS
3DH5	5.06	3.21	78.9649	0.0406	3	2.96	PASS

Table 2. Tolerances of antenna power

Packet Type	Declared antenna power (mW/MHz)	-80% limit	+20% limit	Maximum measured power (mW/MHz)	Deviation %	Result
DH5	0,061	0,012	0,073	0,0612	-0,03	PASS
2DH5	0,041	0,008	0,049	0,0409	-0,04	PASS
3DH5	0,041	0,008	0,049	0,0406	0,01	PASS

Power tolerance is calculated by using the following formula:

Power tolerance = {[(Measured power)-(Rated Cond. P)] / (Rated Cond. P)} × 100

* Rated Cond. P: Rated Conducted power

Frequency tolerance

Standard:	EN 300 328	
Limit:	ARIB-T66	
Tested by:	NKO	
Date:	30.9.2013	
Humidity:	20 %	
Temperature:	22.7 °C	
Measurement uncertainty	$\pm$ 4.758x10^{-8}	Level of confidence 95 % (k = 2)
Limit:	±50 ppm	

Test procedure

Frequency tolerance was measured by using frequency counter function of the spectrum analyzer.

Test Results

Table 3. 1 Mbps Data rate, DH5

Channel	Low	Mid	High
Channel Frequency [MHz]	2402	2441	2480
Reading Frequency [MHz]	2401.990024	2440.989846	2479.989671
Frequency error [kHz]	-9.976	-10.154	-10.329
Frequency error [ppm]	-4.153	-4.160	-4.165
Margin [ppm]	45.85	45.84	45.835
Result	PASS	PASS	PASS

Table 4. 2 Mbps Data rate, 2DH5

Channel	Low	Mid	High
Channel Frequency [MHz]	2402	2441	2480
Reading Frequency [MHz]	2401.990009	2440.989855	2479.990010
Frequency error [kHz]	-9.991	-10.145	-9.990
Frequency error [ppm]	-4.159	-4.156	-4.028
Margin [ppm]	45.84	45.84	45.972
Result	PASS	PASS	PASS

Table 5. 3 Mbps Data rate, 3DH5

Channel	Low	Mid	High
Channel Frequency [MHz]	2402	2441	2480
Reading Frequency [MHz]	2401.990023	2440.989864	2479.989683
Frequency error [kHz]	-9.977	-10.136	-10.317
Frequency error [ppm]	-4.154	-4.153	-4.160
Margin [ppm]	45.85	45.85	45.840
Result	PASS	PASS	PASS

99% Occupied Bandwidth, Spreading Bandwidth and Spreading rate

Standard:	EN 300 328	
Limit:	ARIB-T66	
Tested by:	NKO	
Date:	29.7.2013	
Humidity:	20 %	
Temperature:	22.7 °C	
Measurement uncertainty	± 1.78 dB	Level of confidence 95 % (k = 2)

99% Occupied bandwidth test procedure

99% Occupied Bandwidth was measured with the occupied bandwidth function of the test receiver. The limit for 99% occupied bandwidth is ≤ 83.5 MHz.

Table 6. Test results for 99% Occupied Bandwidth

Data rate [Mbps]	Limit [MHz]	99% BW [MHz]	Result
1	≤83.5	78.5817	PASS
2	≤83.5	78.5817	PASS
3	≤83.5	78.5817	PASS

90% Spread Bandwidth Test Procedure:

90% Spread Bandwidth was measured with the occupied bandwidth function of the test receiver. The limit for 90% spread bandwidth is ≥ 500 kHz. The symbol rate for Bluetooth is 1 Msymbols/s. The spreading factor is calculated by dividing the 90 % spread bandwidth with the symbol rate.

Table 7. 90% Spread bandwidth and spreading factor results

Data rate [Mbps]	Fl	Fh	90% BW Limit [kHz]	Spreading factor limit	90% BW [MHz] / Spreading Factor	Result
1	2401.45297	2480.22287	≥ 500	> 5	78.7699	PASS
2	2401.48082	2480.45080	≥ 500	> 5	78.9700	PASS
3	2401.47829	2480.44320	≥ 500	> 5	78.9649	PASS

Transmission spurious emissions

Standard:	EN 300 328
Limit:	ARIB-T66
Tested by:	NKO
Date:	27.9.2013
Humidity:	29 %
Temperature:	22.5 °C
Measurement uncertainty	± 2.96 dB Level of confidence 95 % (k = 2)
Limits:	-26.02 dBm (< 2387 MHz) -16.02 dBm (2387 MHz – 2400 MHz) -16.02 dBm (2483.5 MHz – 2496.5 MHz) -26.02 dBm (> 2496.5 MHz)

Unwanted spurious emissions are measured in the frequency range of 30 MHz – 12.5 GHz. The resolution bandwidth is 1 MHz for all measurements.

1 Mbps, DH5

Table 8. Channel low

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
909.50	Peak	-63.49	-26.02	37.47	PASS
2400.00	Peak	-26.05	-16.02	10.03	PASS
6966.00	Peak	-31.42	-26.02	5.40	PASS

Table 9. Channel mid

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
965.60	Peak	-40.25	-26.02	14.23	PASS
6983.00	Peak	-31.88	-26.02	5.86	PASS

Table 10. Channel high

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
873.00	Peak	-39.74	-26.02	13.72	PASS
2483.50	Peak	-37.91	-16.02	21.89	PASS
12142.00	Peak	-30.99	-26.02	4.97	PASS

2 Mbps, 2DH5

Table 11. Channel low

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
826.60	Peak	-39.16	-26.02	13.14	PASS
2400.00	Peak	-19.41	-16.02	3.39	PASS
6950.00	Peak	-31.86	-26.02	5.84	PASS
12442.00	Peak	-31.30	-26.02	5.28	PASS

Table 12. Channel mid

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
850.50	Peak	-40.12	-26.02	14.10	PASS
12359.00	Peak	-31.47	-26.02	5.45	PASS

Table 13. Channel high

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
915.10	Peak	-40.62	-26.02	14.60	PASS
2483.50	Peak	-38.25	-16.02	22.23	PASS
12142.00	Peak	-31.10	-26.02	5.08	PASS

3 Mbps, 3DH5

Table 14. Channel low

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
820.00	Peak	-39.41	-26.02	13.39	PASS
2400.00	Peak	-19.24	-16.02	3.22	PASS
12392.00	Peak	-30.18	-26.02	4.16	PASS

Table 15. Channel mid

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
916.50	Peak	-39.68	-26.02	13.66	PASS
11743.00	Peak	-32.25	-26.02	6.23	PASS

Table 16. Channel high

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
889.80	Peak	-40.60	-26.02	14.58	PASS
2485.00	Peak	-40.45	-16.02	24.43	PASS
12425.00	Peak	-31.50	-26.02	5.48	PASS

Limitation of collateral emission of receiver

Standard:	EN 300 328
Limit:	ARIB-T66
Tested by:	NKO
Date:	30.9.2013
Humidity:	20 %
Temperature:	22.7 °C
Measurement uncertainty	± 2.96 dB Level of confidence 95 % (k = 2)
Limits:	-53.98 dBm (<1000 MHz) -46.99 dBm (>1 GHz)

Unwanted spurious emissions are measured in the frequency range of 30 MHz – 12.5 GHz. The resolution bandwidth for measurements is 1 MHz.

1 Mbps

Table 17. Channel mid

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
965.60	Peak	-70.75	-53.98	16.77	PASS
2439.60	Peak	-64.09	-46.99	17.10	PASS
12159.00	Peak	-61.43	-46.99	14.44	PASS

2 Mbps

Table 18. Channel mid

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
916.50	Peak	-71.42	-53.98	17.44	PASS
2440.00	Peak	-63.39	-46.99	16.40	PASS
12475.00	Peak	-62.07	-46.99	15.08	PASS

3 Mbps

Table 19. Channel mid

Frequency (MHz)	Detector	Level (dBm)	Limit (dBm)	Margin (dBm)	Result
764.90	Peak	-70.65	-53.98	16.67	PASS
2440.00	Peak	-64.47	-46.99	17.48	PASS
11709.00	Peak	-63.12	-46.99	16.13	PASS

Holding Time of Hopping Frequency

Standard:	EN 300 328	
Limit:	ARIB-T66	
Tested by:	NKO	
Date:	30.9.2013	
Humidity:	20 %	
Temperature:	22.7 °C	
Measurement uncertainty	± 2.96 dB	Level of confidence 95 % (k = 2)
Limits:		

Test was made by using zero span mode of the spectrum analyzer and the EUT was hopping continuously.

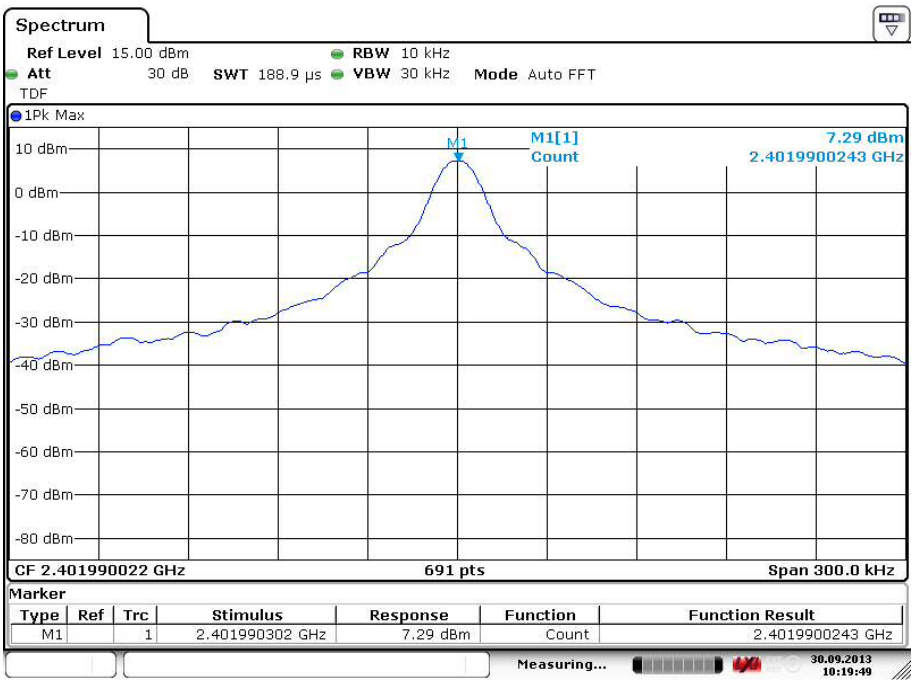
Data rate (Mbps)	**1**	**2**	**3**
Spread BW (MHz)	78.7699	78.9700	78.9649
Diffusion rate (spread BW / data rate)	78.7699	39.48499	26.3216367
Measurement period (diffusion rate x 0.4)	31.50796	15.793996	10.5286547
Measured channel occupancy time	2.92899	2.93478	2.94638
Number of transmissions in measurement period	74	38	25
Result	PASS	PASS	PASS
Specific Averaging period (seconds)	0.4		
Number of Hopping Channels	79		

Annex A

Manufacturer	Type	Serial no	Cal due date
ROHDE & SCHWARZ			
Signal Analyzer	FSV 40	101068	2014-03-22
Test software	EMC32	-	-
BOONTON			
Power meter	4300	87105ED	2013-12-31
Power sensor	51100(9E)	33745	2013-12-31
PENDULUM			
Frequency Standard	GPS-88	SM 968615	2015-03-18
HUBER+SUHNER			
Attenuator 10dB	6810.17B	-	2014-08-16

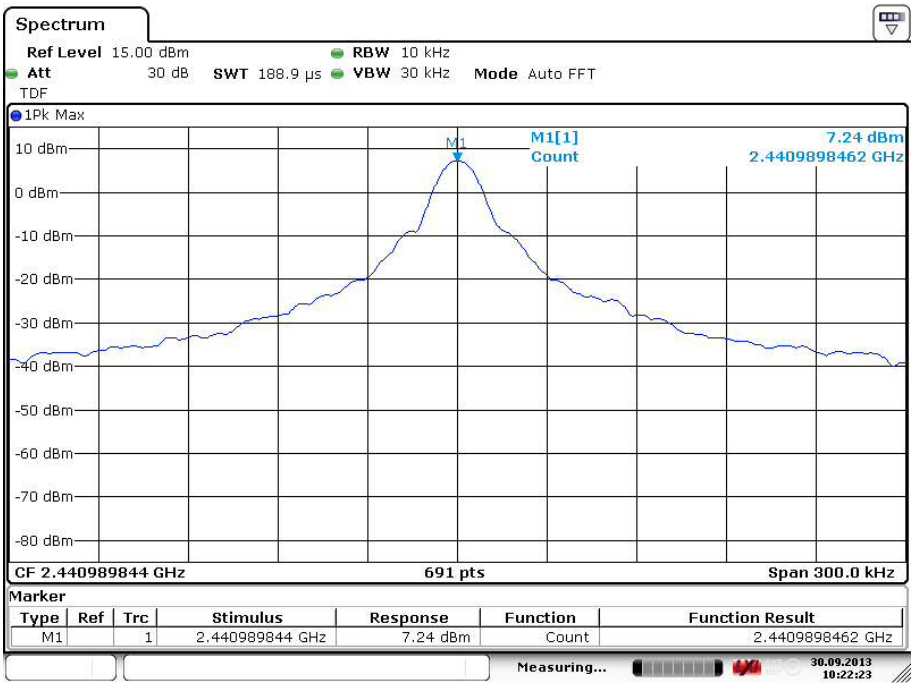
ANNEX A

This annex contains the graphical data recorded during the tests and the pictures of the EUT.



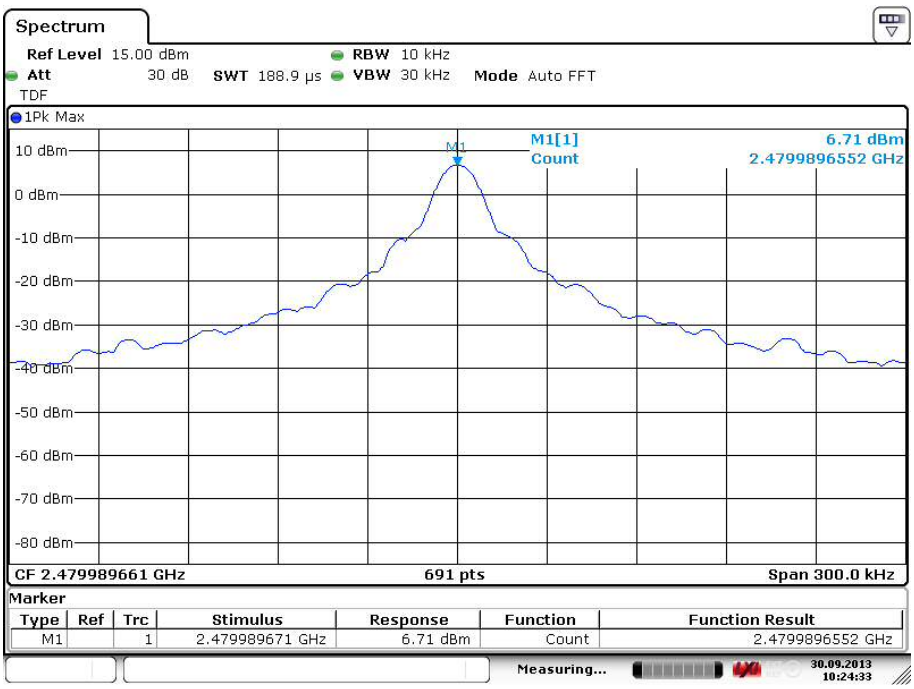
Date: 30.SEP.2013 10:19:49

Graph 1. Frequency tolerance 1 Mbps low channel.



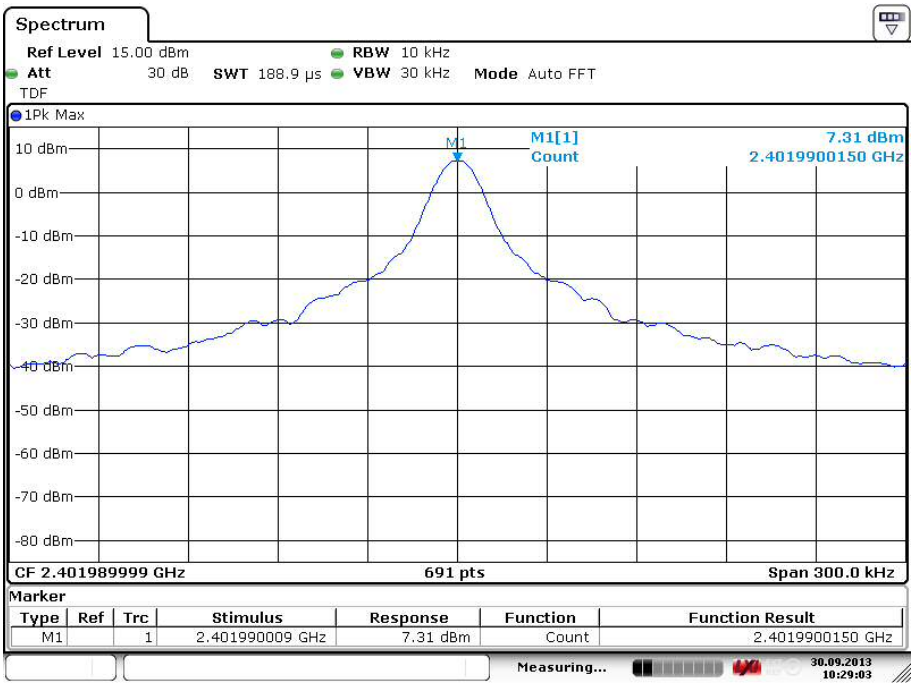
Date: 30.SEP.2013 10:22:23

Graph 2. Frequency tolerance 1 Mbps middle channel.



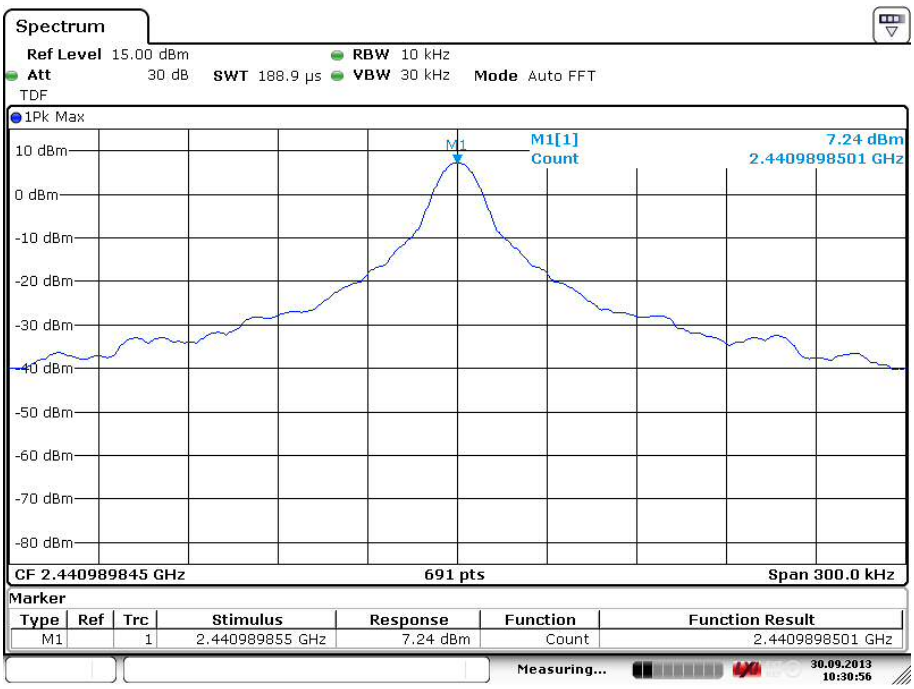
Date: 30.SEP.2013 10:24:33

Graph 3. Frequency tolerance 1 Mbps channel high.



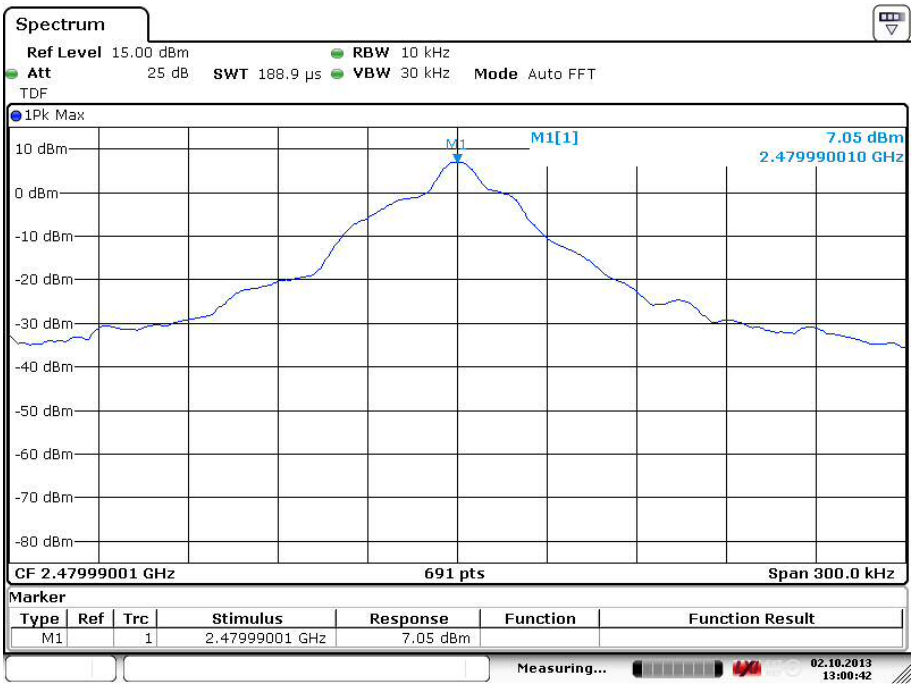
Date: 30.SEP.2013 10:29:03

Graph 4. Frequency tolerance 2 Mbps channel low.



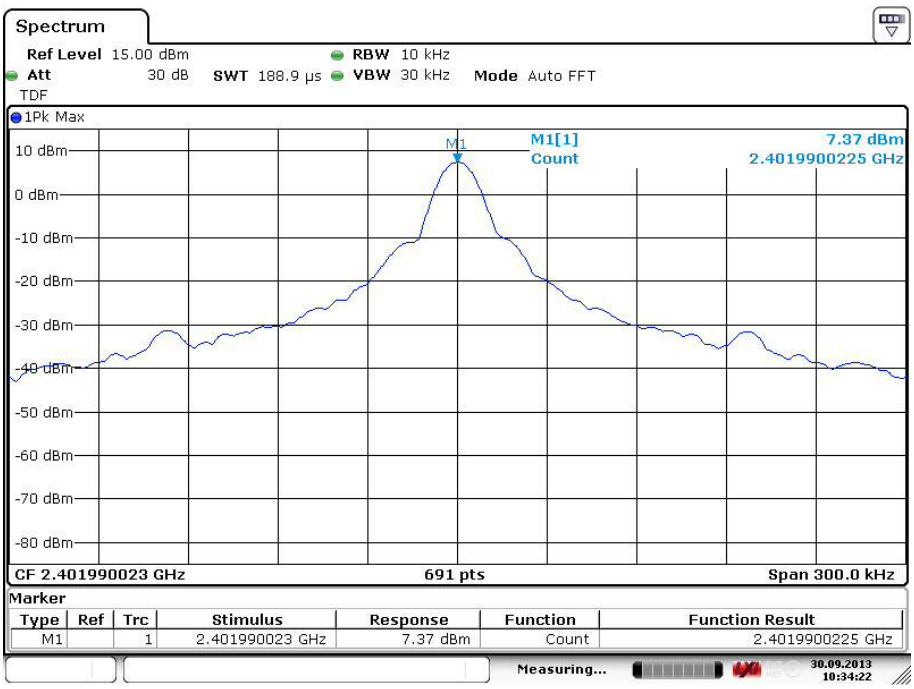
Date: 30.SEP.2013 10:30:56

Graph 5. Frequency tolerance 2 Mbps middle channel.



Date: 2.OCT.2013 13:00:42

Graph 6. Frequency tolerance 2 Mbps channel high.



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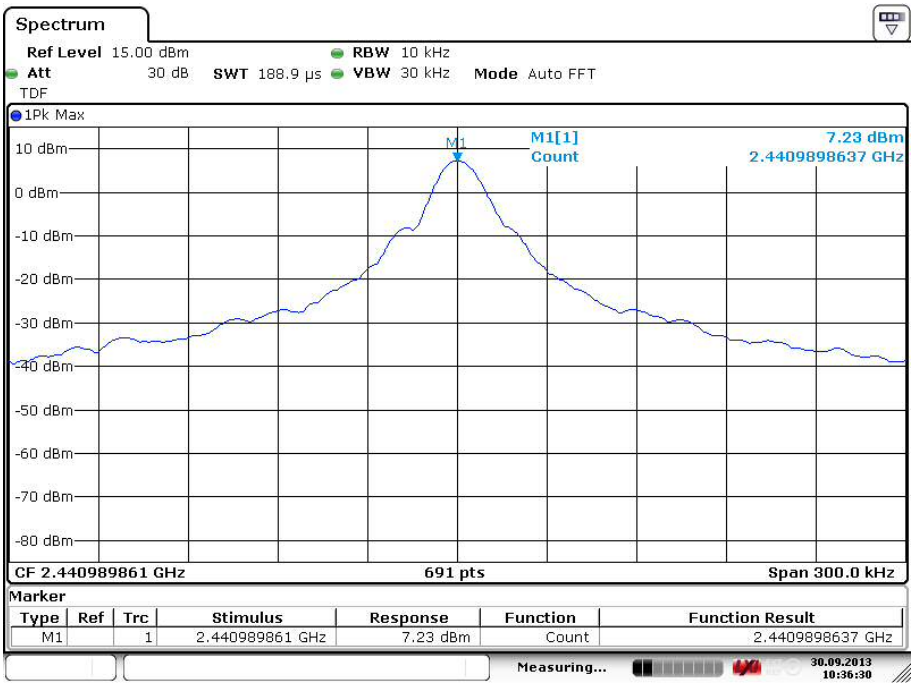
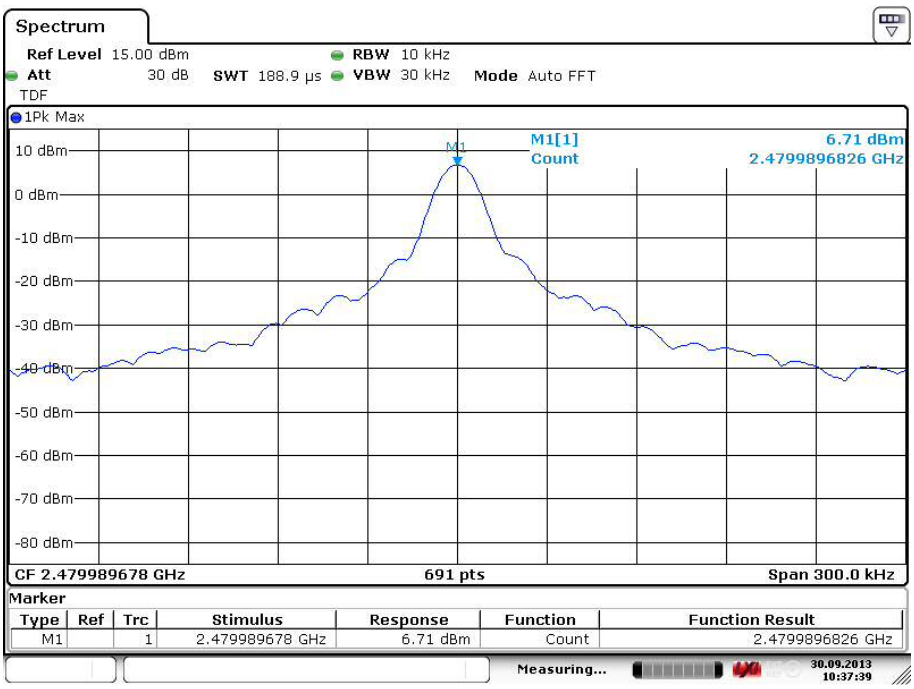
Graph 7. Frequency tolerance 3 Mbps channel low.



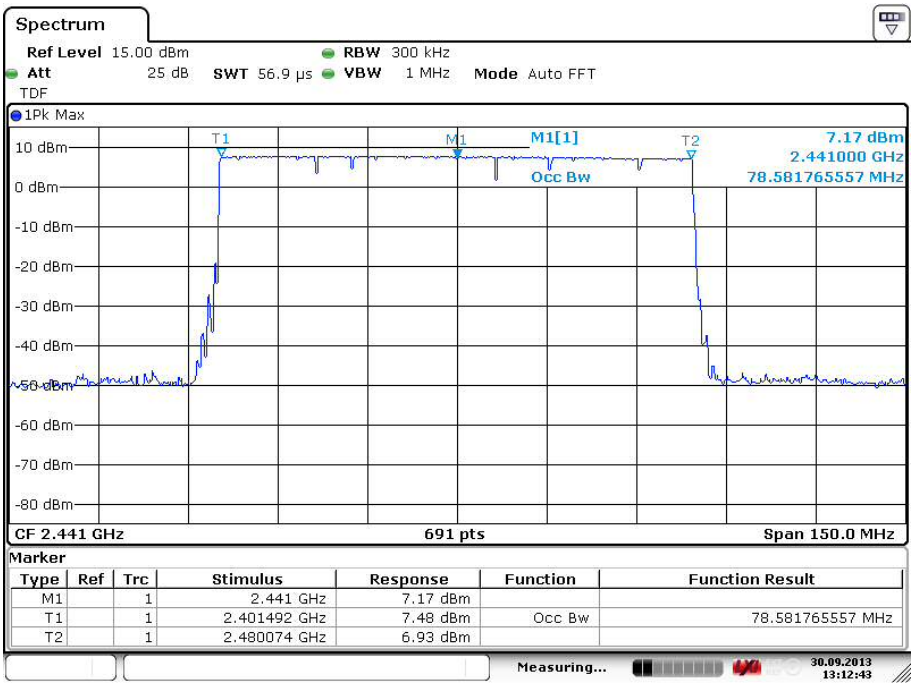
Date: 30.SEP.2013 10:36:30

Graph 8. Frequency tolerance 3 Mbps middle channel.



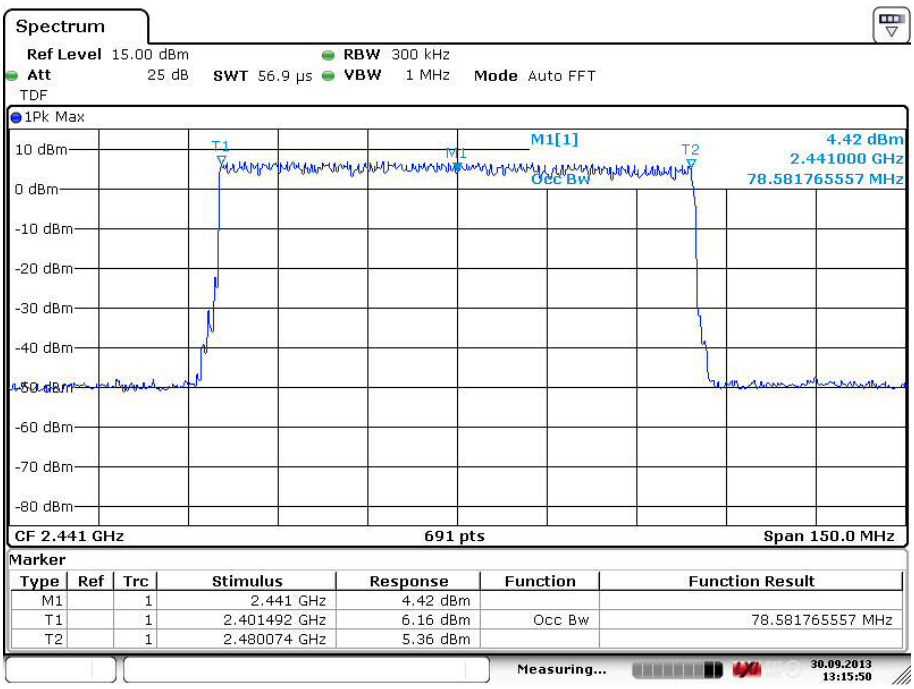
Date: 30.SEP.2013 10:37:39

Graph 9. Frequency tolerance 3 Mbps channel high.



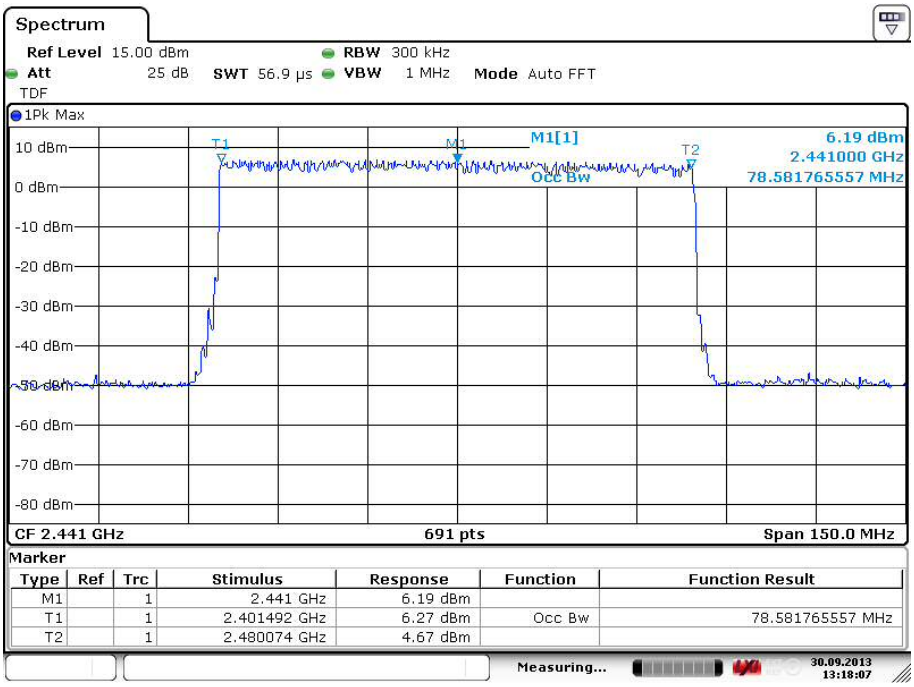
Date: 30.SEP.2013 13:12:43

Graph 10. 99% Occupied Bandwidth 1 Mbps.



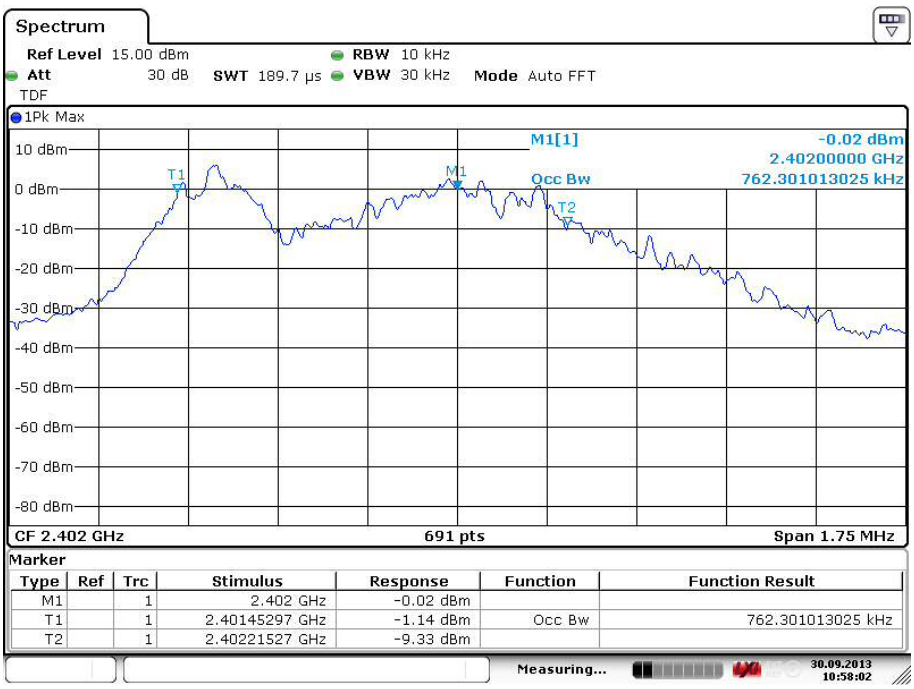
Date: 30.SEP.2013 13:15:50

Graph 11. 99% Occupied Bandwidth 2 Mbps.



Date: 30.SEP.2013 13:18:06

Graph 12. 99% Occupied Bandwidth 3 Mbps.

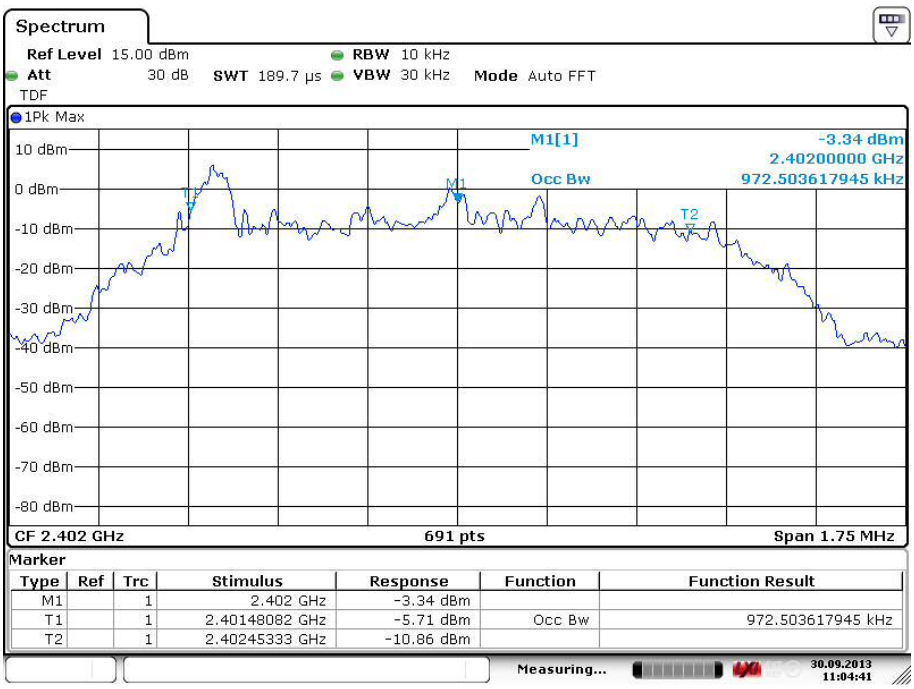


Date: 30.SEP.2013 10:58:02

Graph 13. Spreading bandwidth 1 Mbps FL.

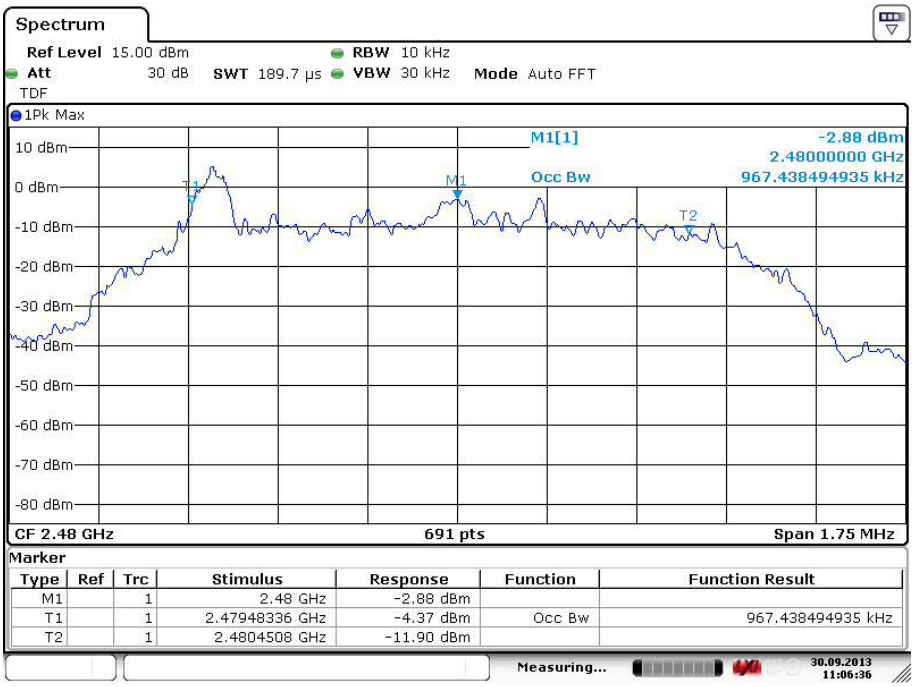
Date: 30.SEP.2013 11:01:02

Graph 14. Spreading bandwidth 1 Mbps FH.



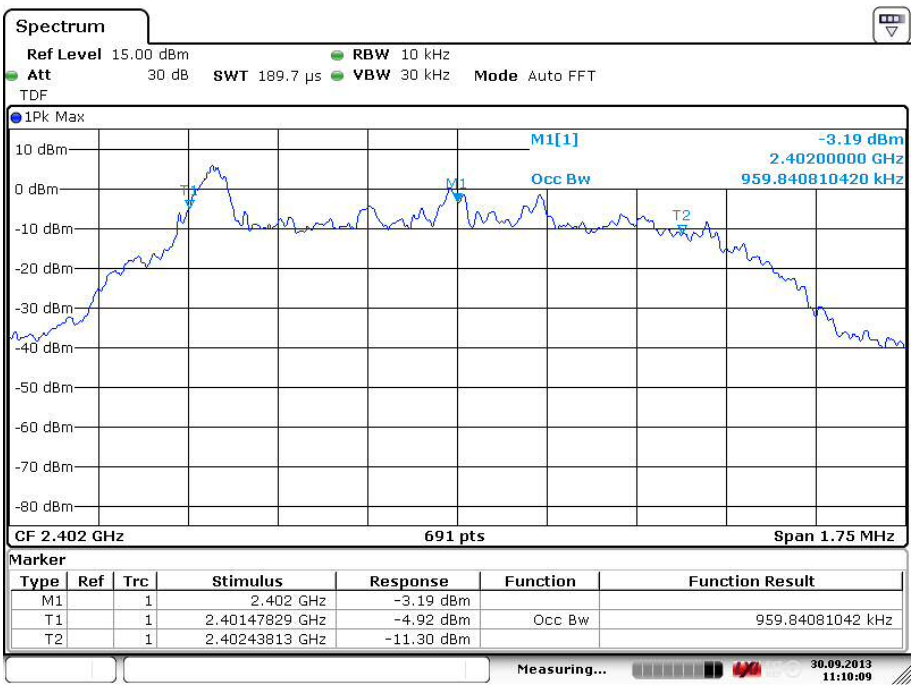
Date: 30.SEP.2013 11:04:41

Graph 15. Spreading bandwidth 2 Mbps FL.



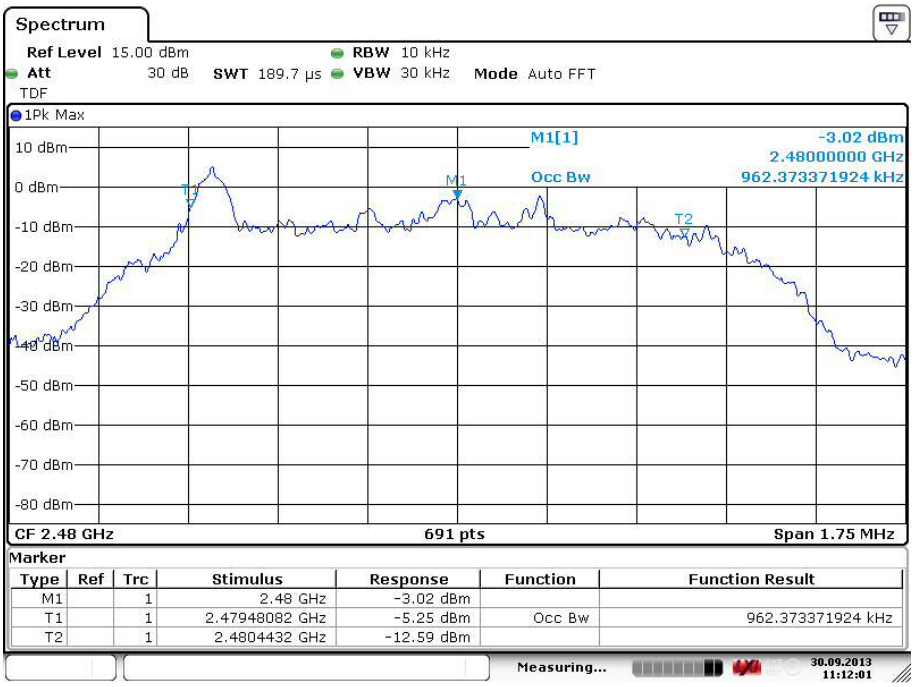
Date: 30.SEP.2013 11:06:36

Graph 16. Spreading bandwidth 2 Mbps FH.



Date: 30.SEP.2013 11:10:08

Graph 17. Spreading bandwidth 3 Mbps FL.



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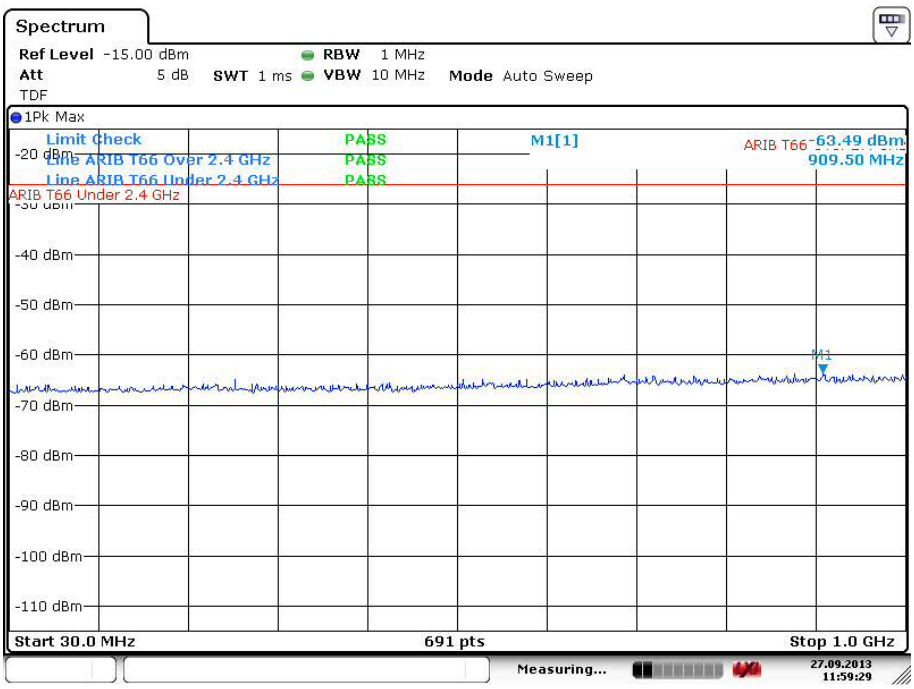
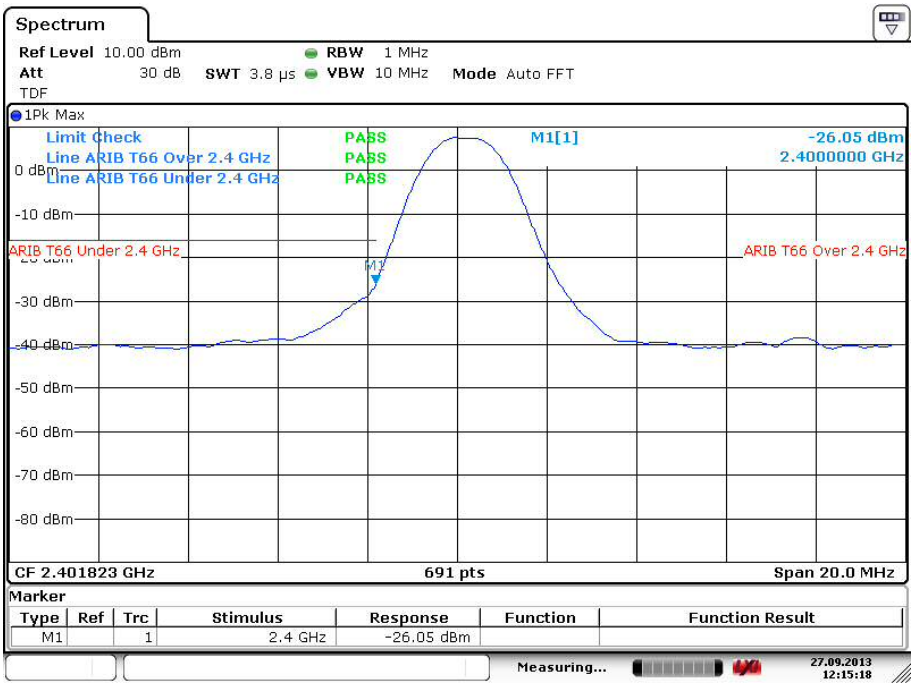
Graph 18. Spreading bandwidth 3 Mbps FH.



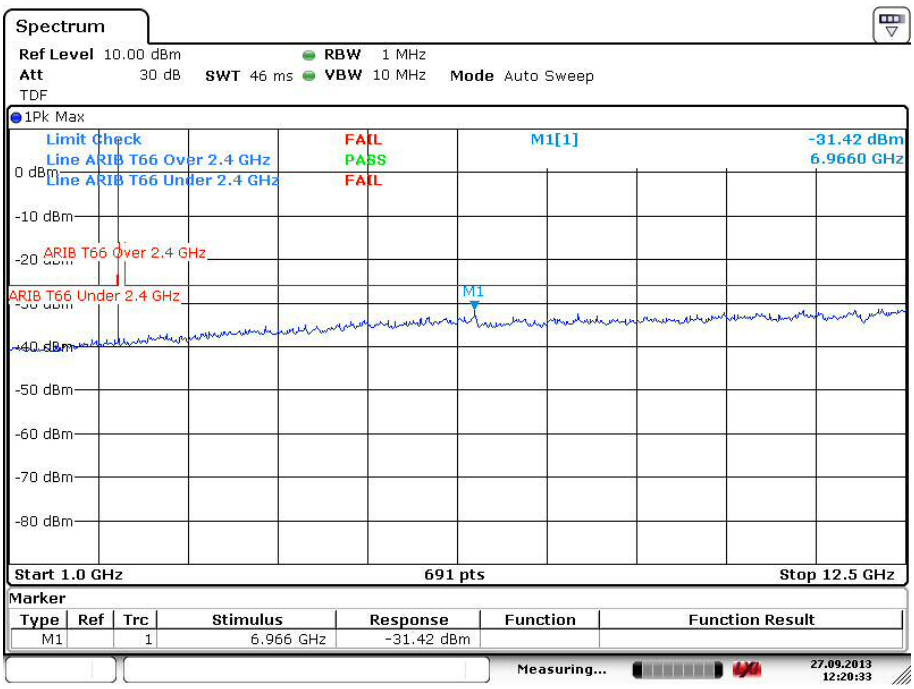
Date: 27.SEP.2013 11:59:29

Graph 19. Tx spurious emissions 1 Mbps channel low 30 – 1000 MHz.



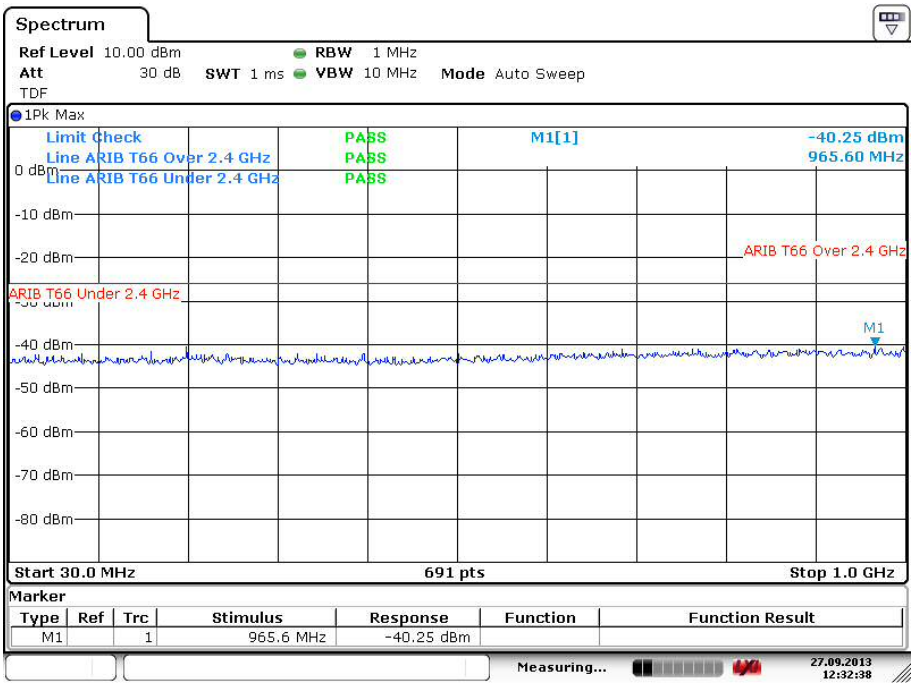
Date: 27.SEP.2013 12:15:18

Graph 20. Tx spurious emissions 1 Mbps channel low 2.4 GHz.



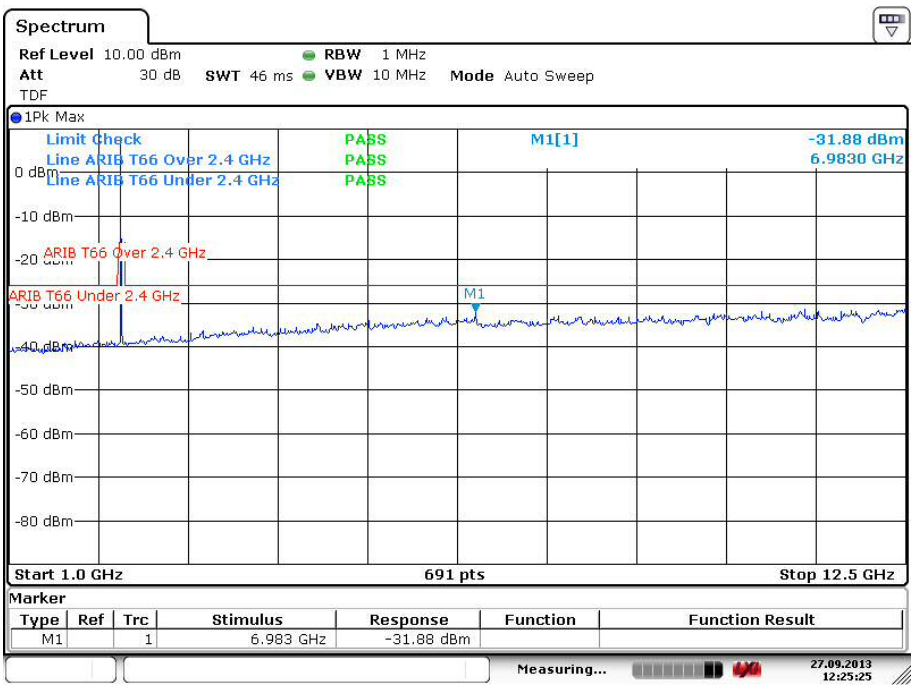
Date: 27.SEP.2013 12:20:33

Graph 21. Tx spurious emissions 1 Mbps channel low 1.0 – 12.5 GHz. (Note: FAIL reading on screen is false, as the limit is exceeded inside the allowed band.)



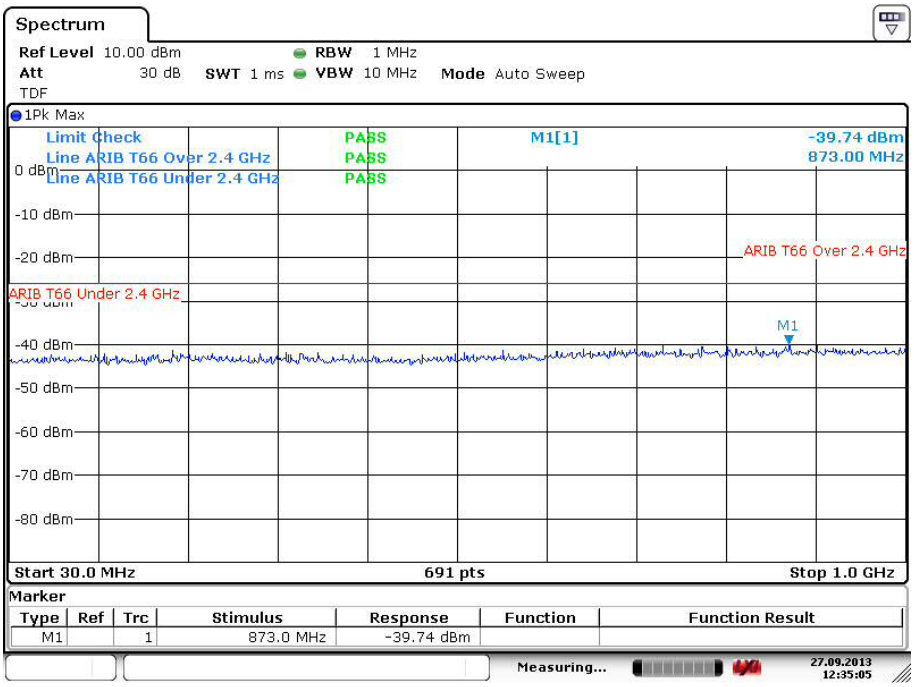
Date: 27.SEP.2013 12:32:38

Graph 22. Tx spurious emissions 1 Mbps channel mid 30 – 1000 MHz.



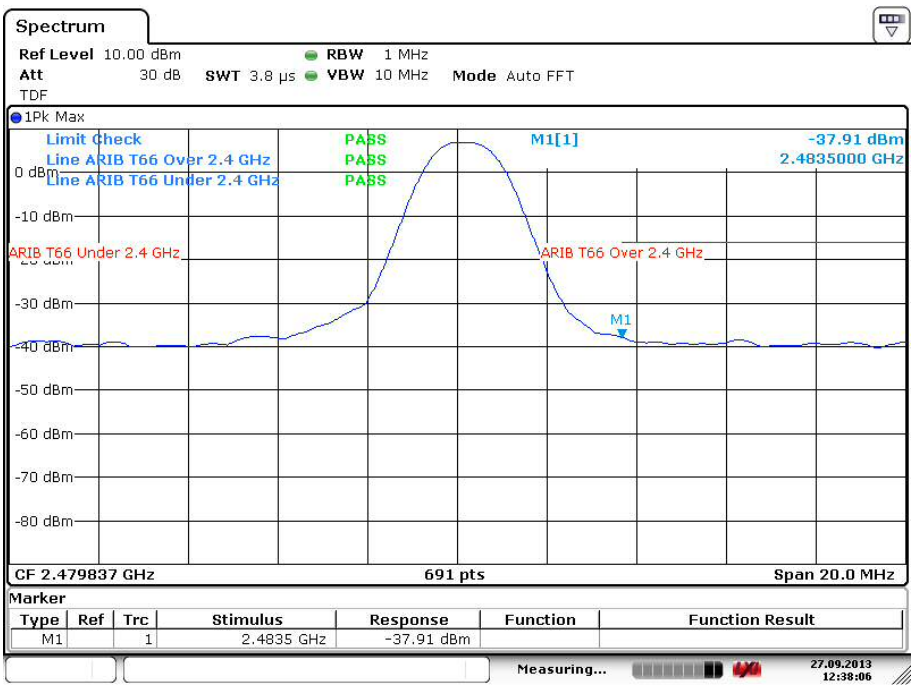
Date: 27.SEP.2013 12:25:25

Graph 23. Tx spurious emissions 1 Mbps channel mid 1.0 – 12.5 GHz.



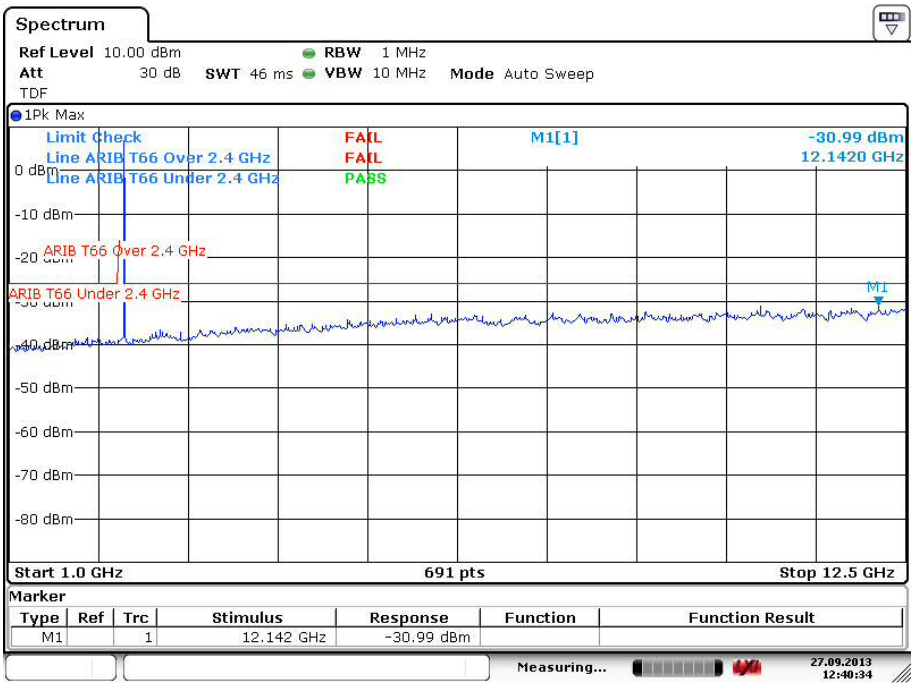
Date: 27.SEP.2013 12:35:05

Graph 24. Tx spurious emissions 1 Mbps channel high 30 – 1000 MHz.



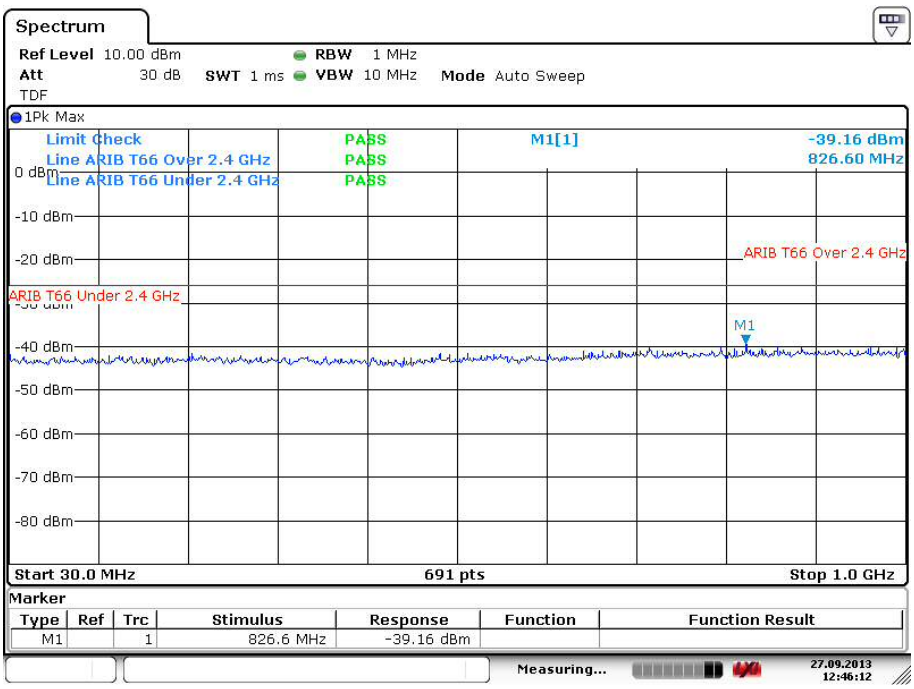
Date: 27.SEP.2013 12:38:06

Graph 25. Tx spurious emissions 1 Mbps channel high 2.4 GHz.

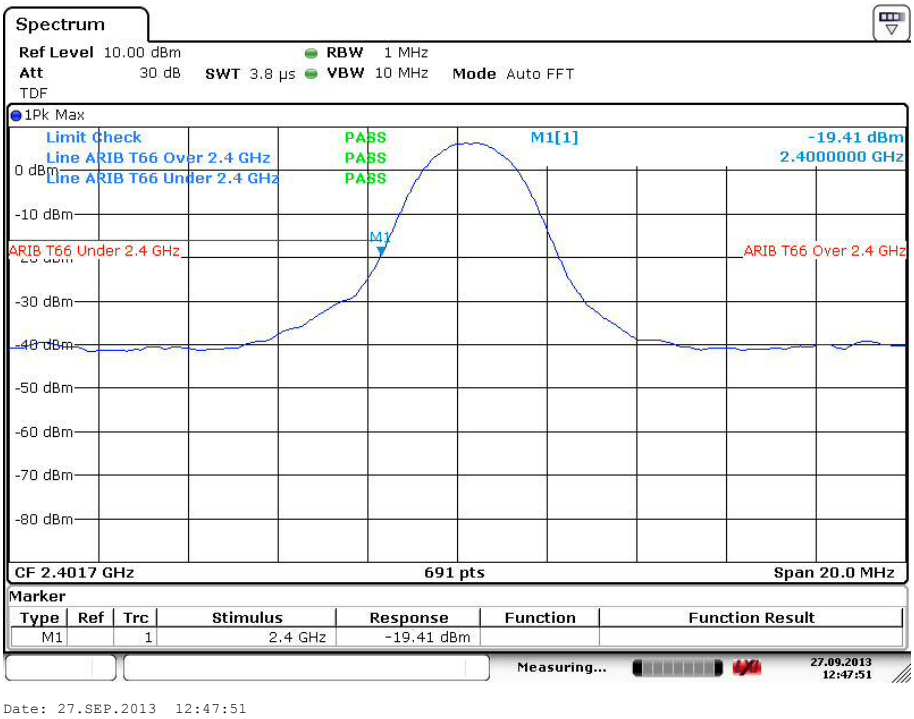


Date: 27.SEP.2013 12:40:34

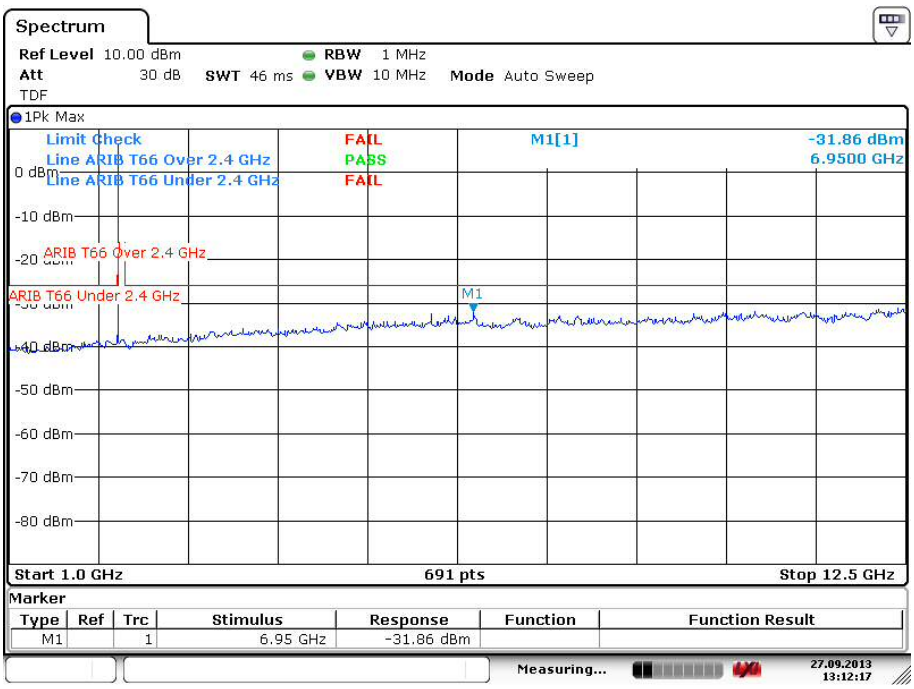
Graph 26. Tx spurious emissions 1 Mbps channel high 1.0 – 12.5 GHz. (Note: FAIL reading on screen is false, as the limit is exceeded inside the allowed band.)



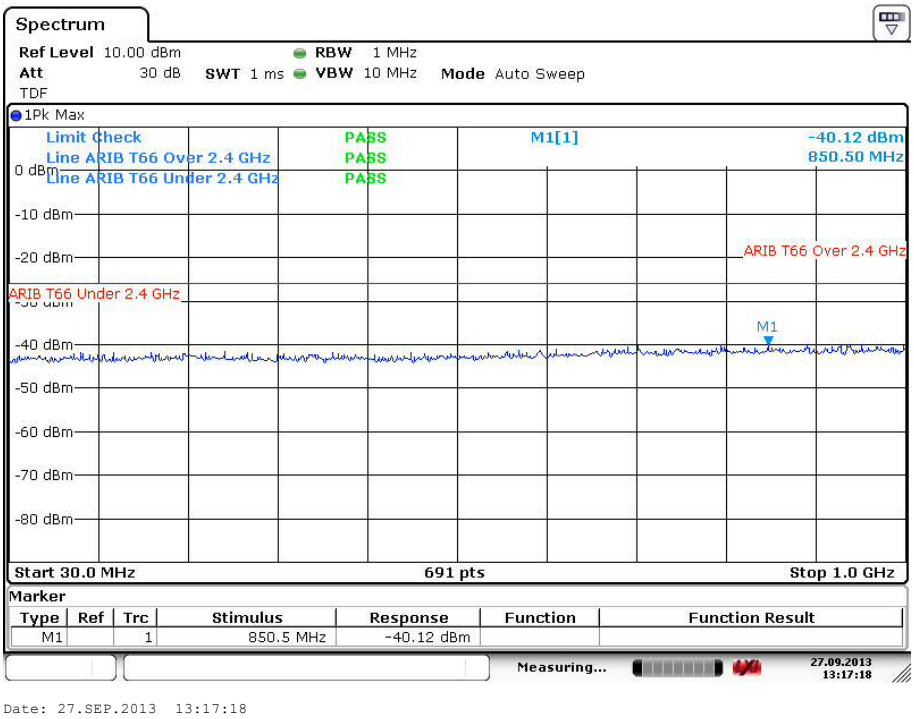
Graph 27. Tx spurious emissions 2 Mbps channel low 30 – 1000 MHz.



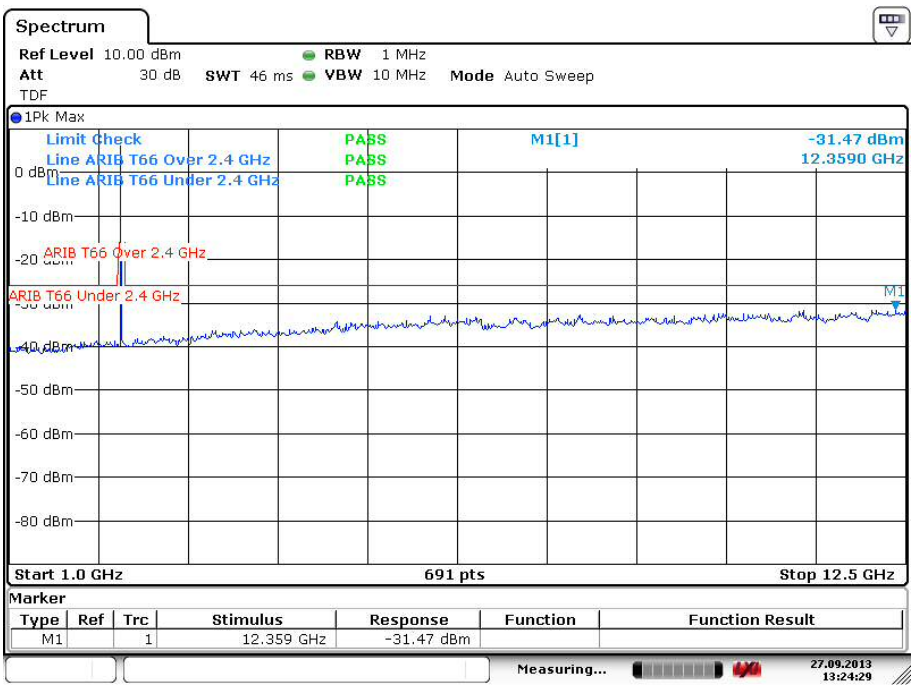
Graph 28. Tx spurious emissions 2 Mbps channel low 2.4 GHz.



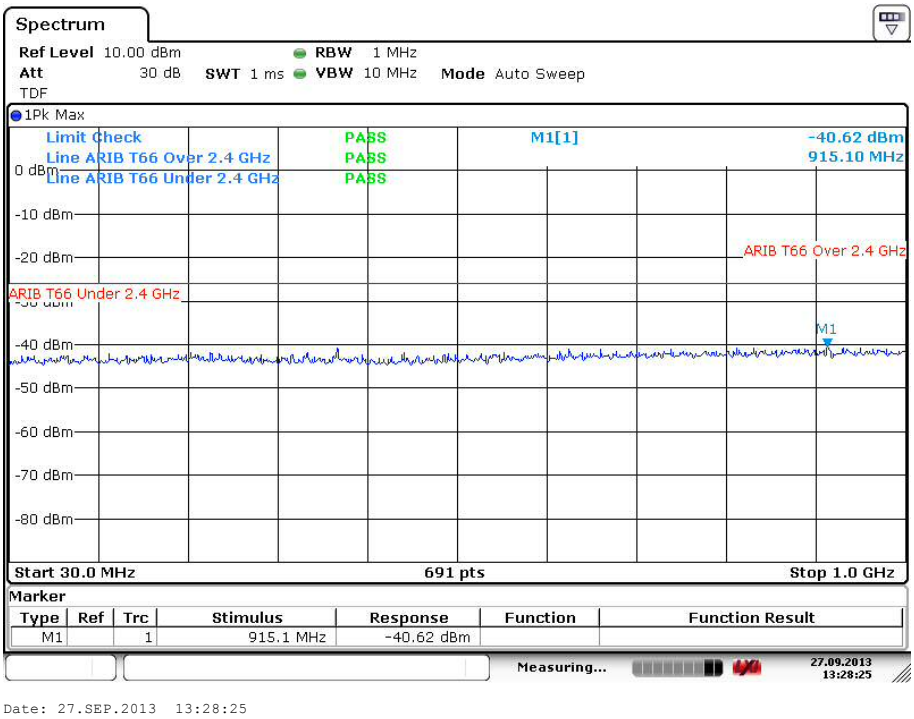
Graph 29. Tx spurious emissions 2 Mbps channel low 1.0 – 12.5 GHz. (Note: FAIL reading on screen is false, as the limit is exceeded inside the allowed band.)



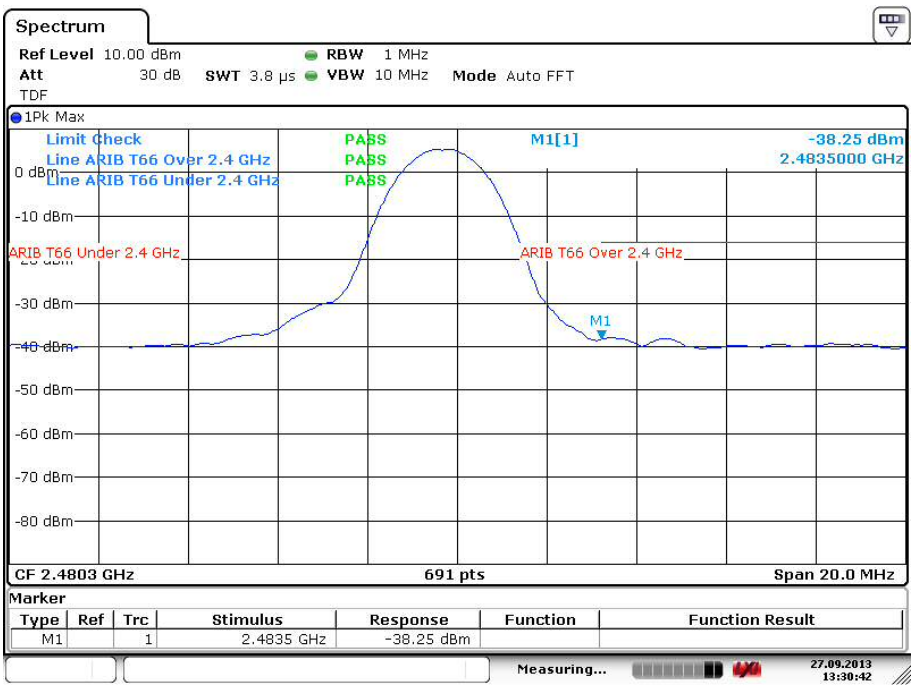
Graph 30. Tx spurious emissions 2 Mbps channel mid 30 – 1000 MHz.



Graph 31. Tx spurious emissions 2 Mbps channel mid 1.0 – 12.5 GHz.

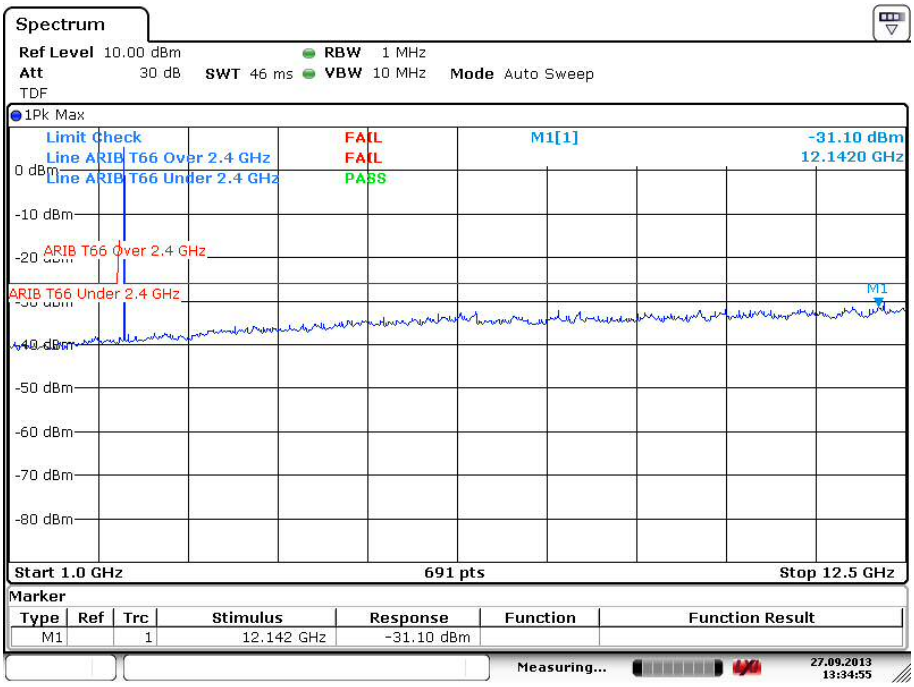


Graph 32. Tx spurious emissions 2 Mbps channel high 30 – 1000 MHz.



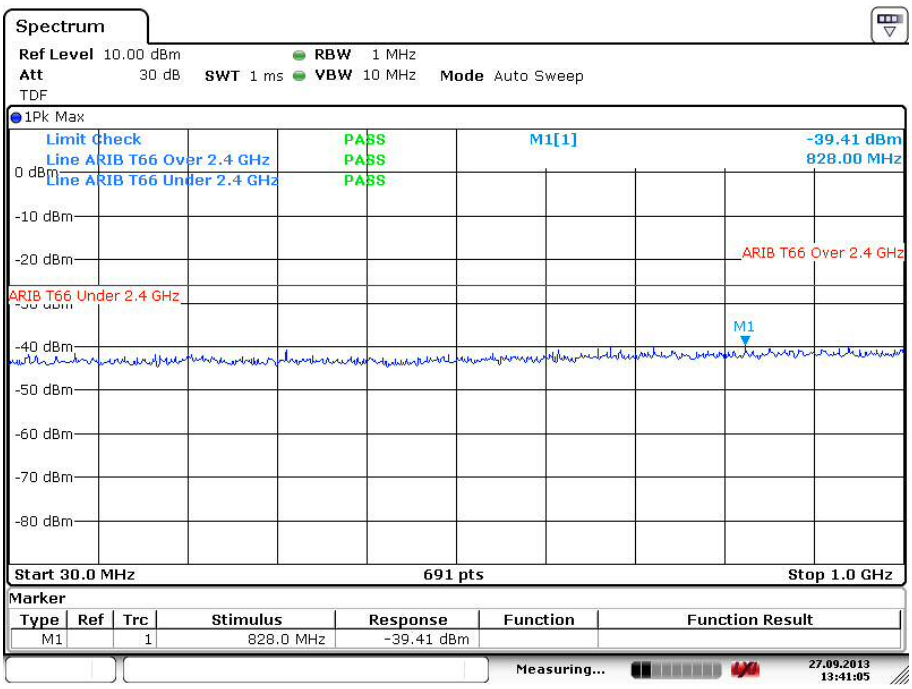
Date: 27.SEP.2013 13:30:42

Graph 33. Tx spurious emissions 2 Mbps channel high 2.4 GHz.



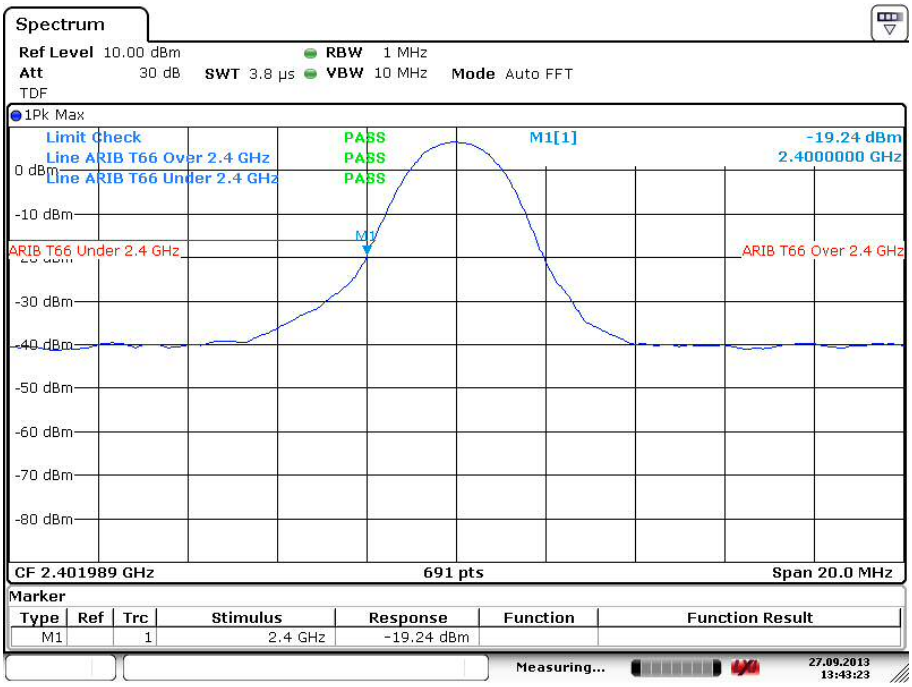
Date: 27.SEP.2013 13:34:55

Graph 34. Tx spurious emissions 2 Mbps channel high 1.0 – 12.5 GHz. (Note: FAIL reading on screen is false, as the limit is exceeded inside the allowed band.)



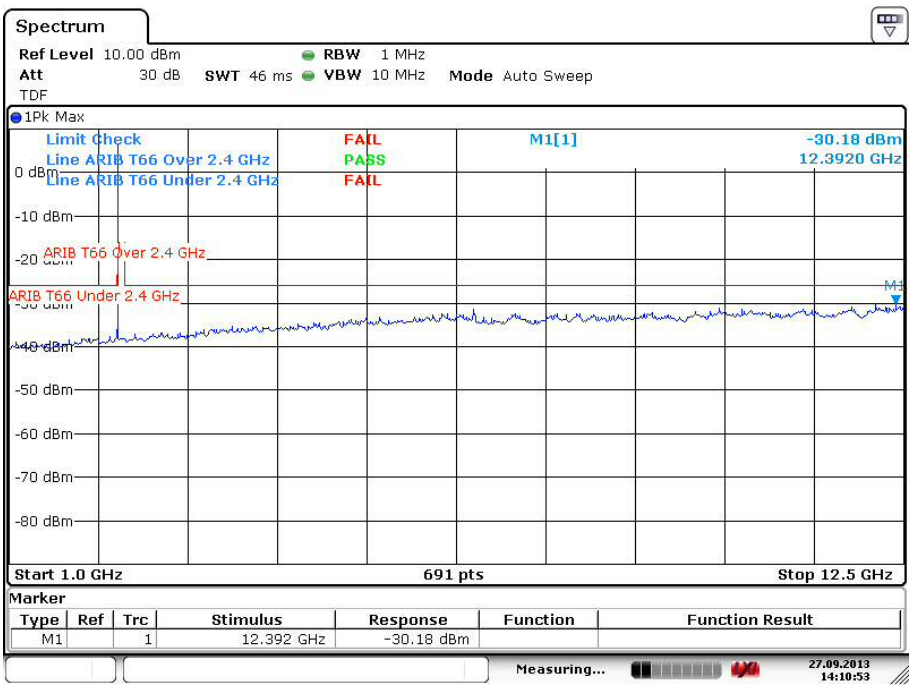
Date: 27.SEP.2013 13:41:05

Graph 35. Tx spurious emissions 3 Mbps channel low 30 – 1000 MHz.

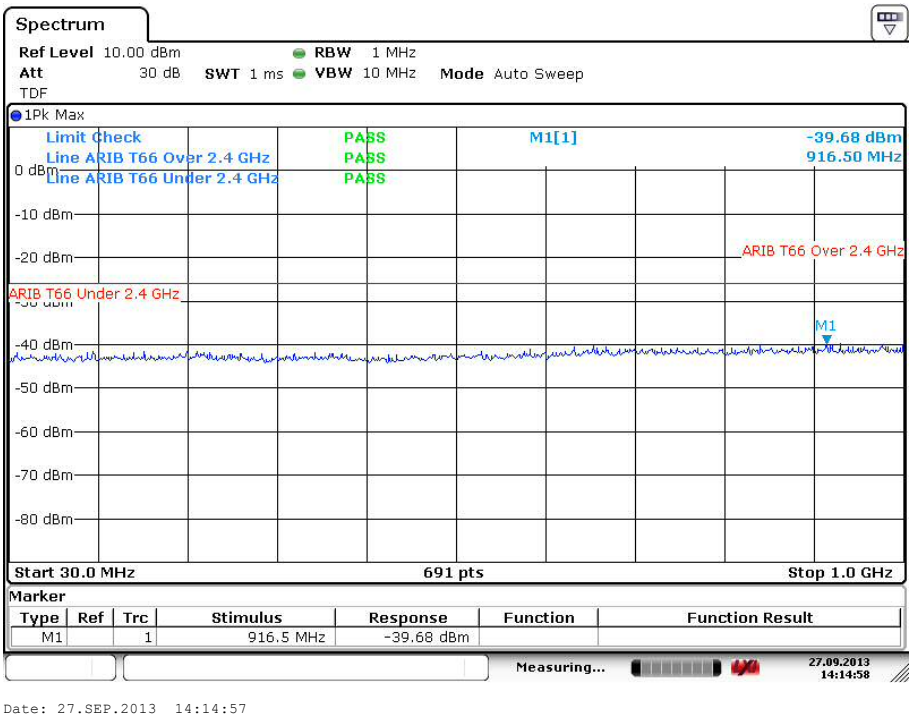


Date: 27.SEP.2013 13:43:23

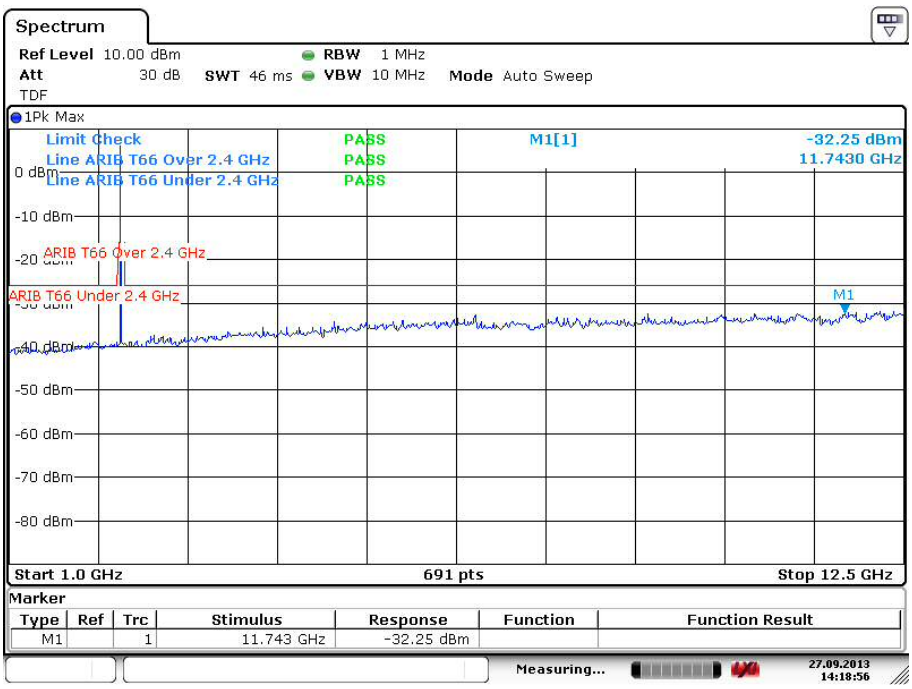
Graph 36. Tx spurious emissions 3 Mbps channel low 2.4 GHz.



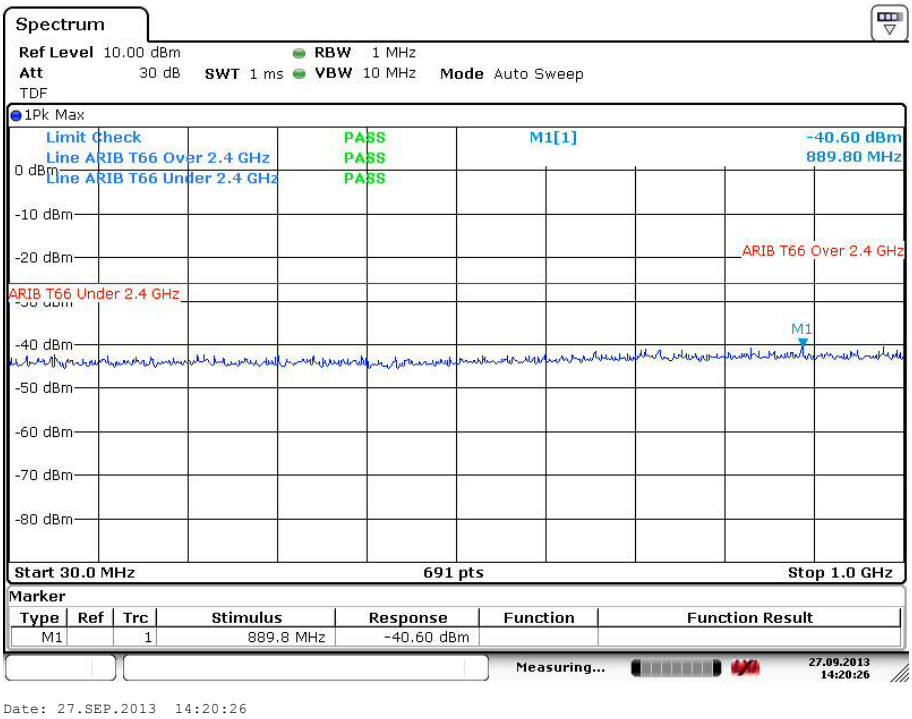
Graph 37. Tx spurious emissions 3 Mbps channel low 1.0 – 12.5 GHz. (Note: FAIL reading on screen is false, as the limit is exceeded inside the allowed band.)



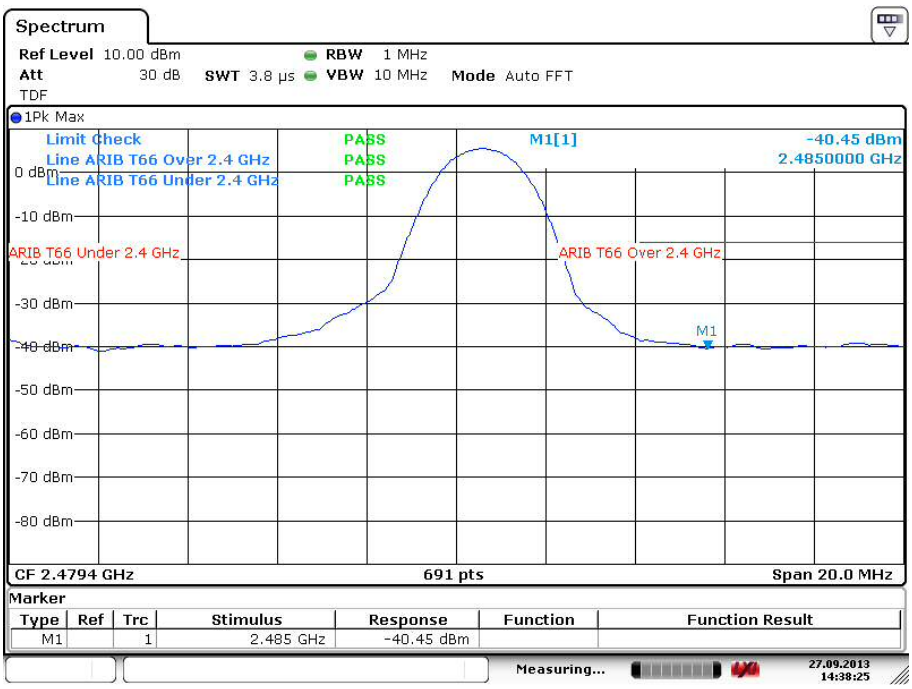
Graph 38. Tx spurious emissions 3 Mbps channel mid 30 – 1000 MHz.



Graph 39. Tx spurious emissions 3 Mbps channel mid 1.0 – 12.5 GHz.

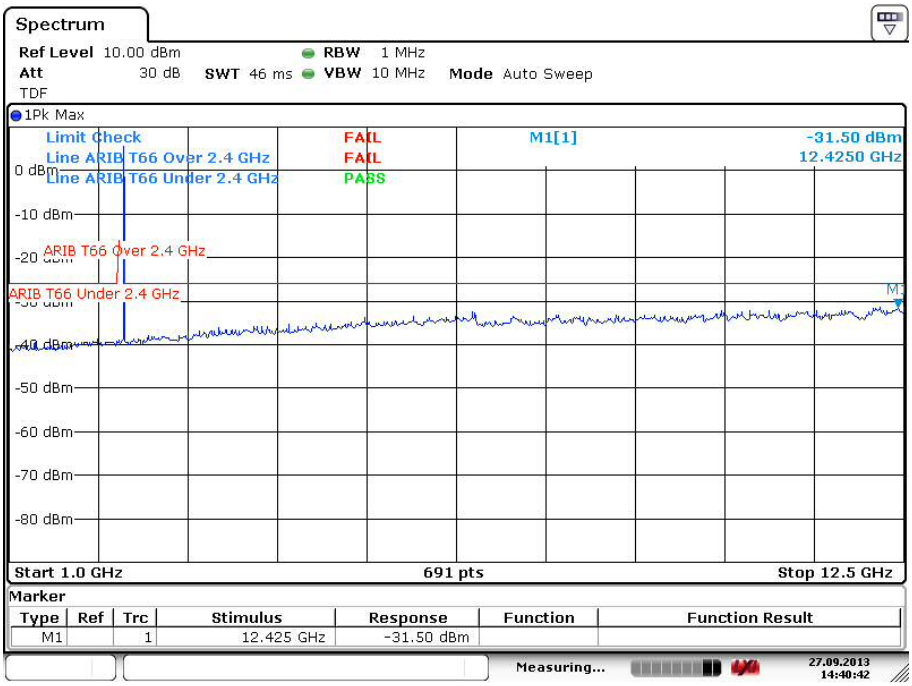


Graph 40. Tx spurious emissions 3 Mbps channel high 30 – 1000 MHz.



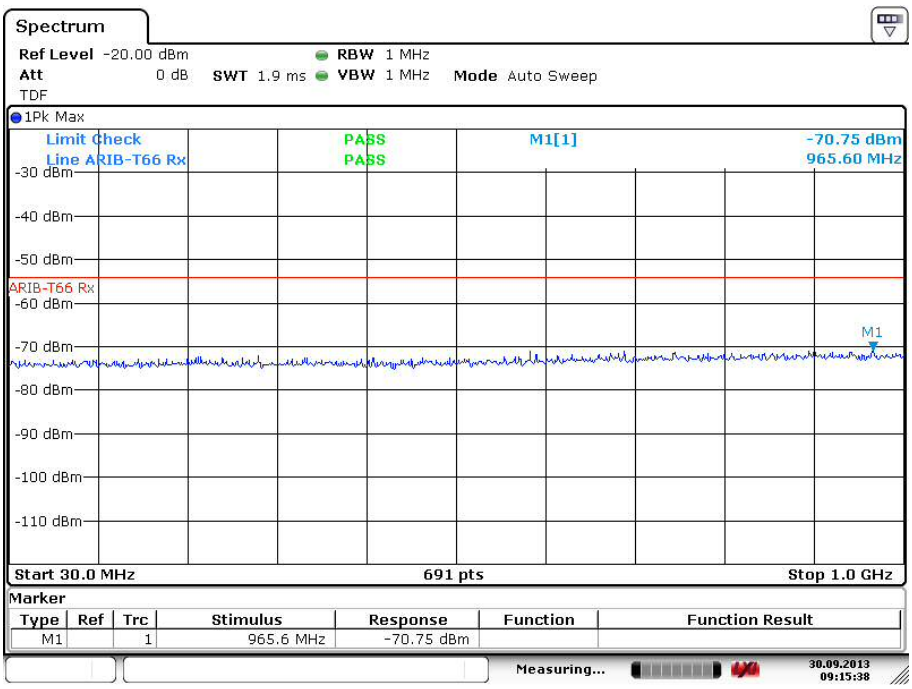
Date: 27.SEP.2013 14:38:25

Graph 41. Tx spurious emissions 3 Mbps channel high 2.4 GHz.



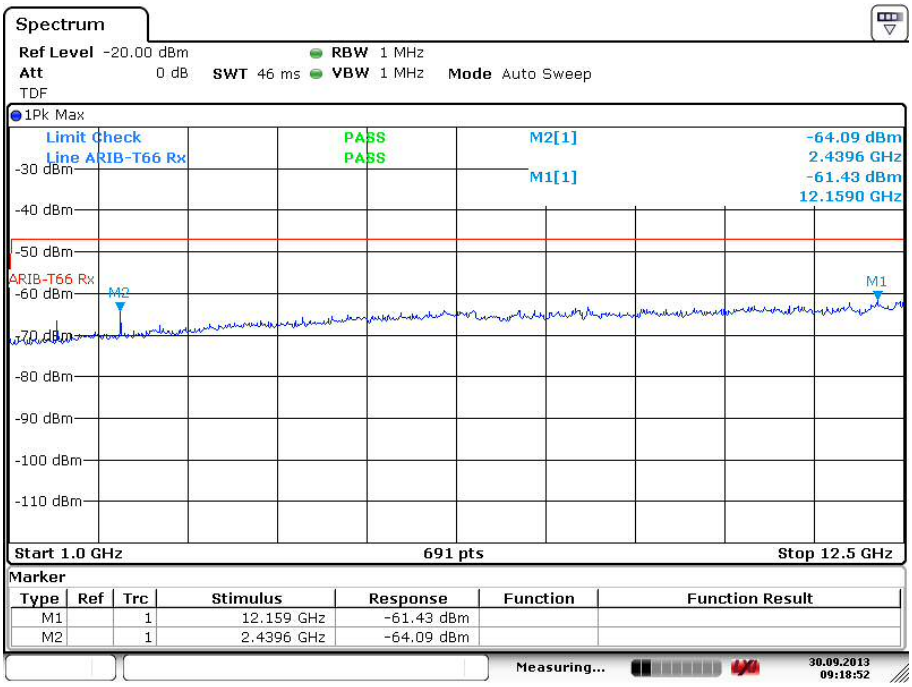
Date: 27.SEP.2013 14:40:42

Graph 42. Tx spurious emissions 3 Mbps channel high 1.0 – 12.5 GHz. (Note: FAIL reading on screen is false, as the limit is exceeded inside the allowed band.)



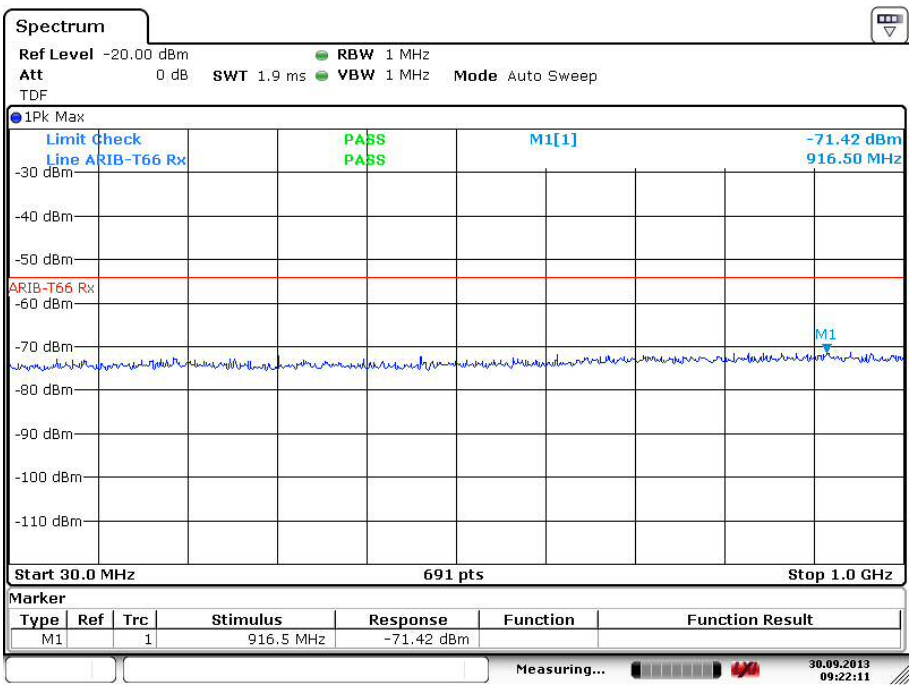
Date: 30.SEP.2013 09:15:38

Graph 43. Rx spurious emissions 1 Mbps middle channel 30 MHz - 1 GHz.



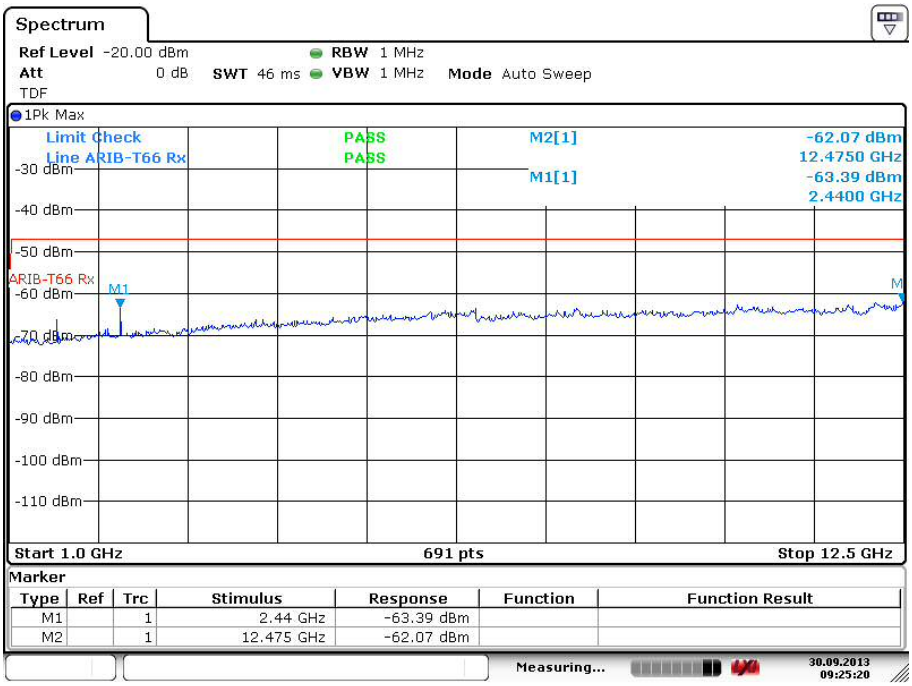
Date: 30.SEP.2013 09:18:52

Graph 44. Rx spurious emissions 1 Mbps middle channel 1.0 – 12.5 GHz.



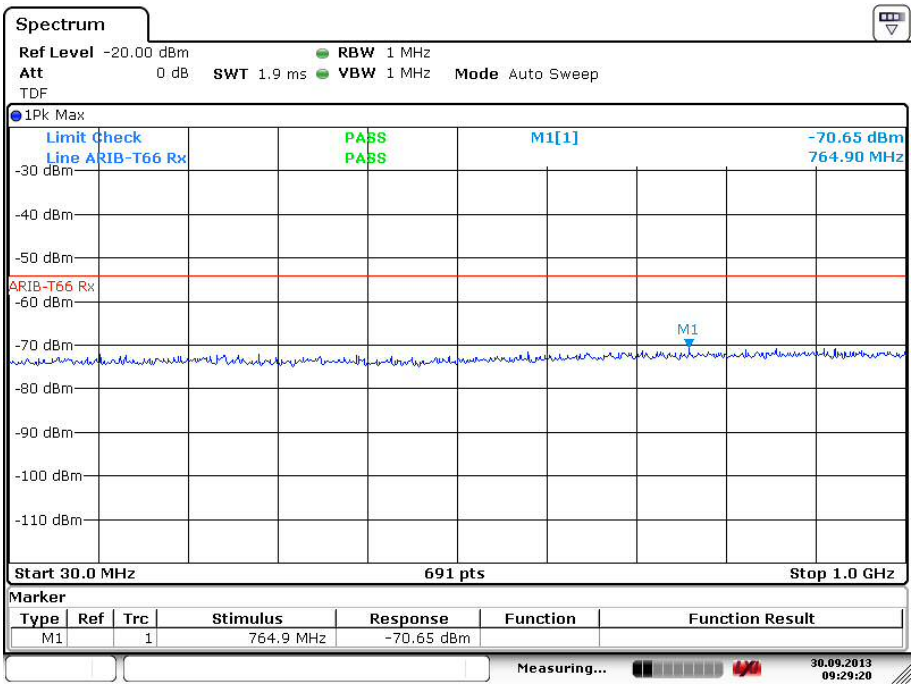
Date: 30.SEP.2013 09:22:11

Graph 45. Rx spurious emissions 2 Mbps middle channel 30 MHz – 1 GHz.



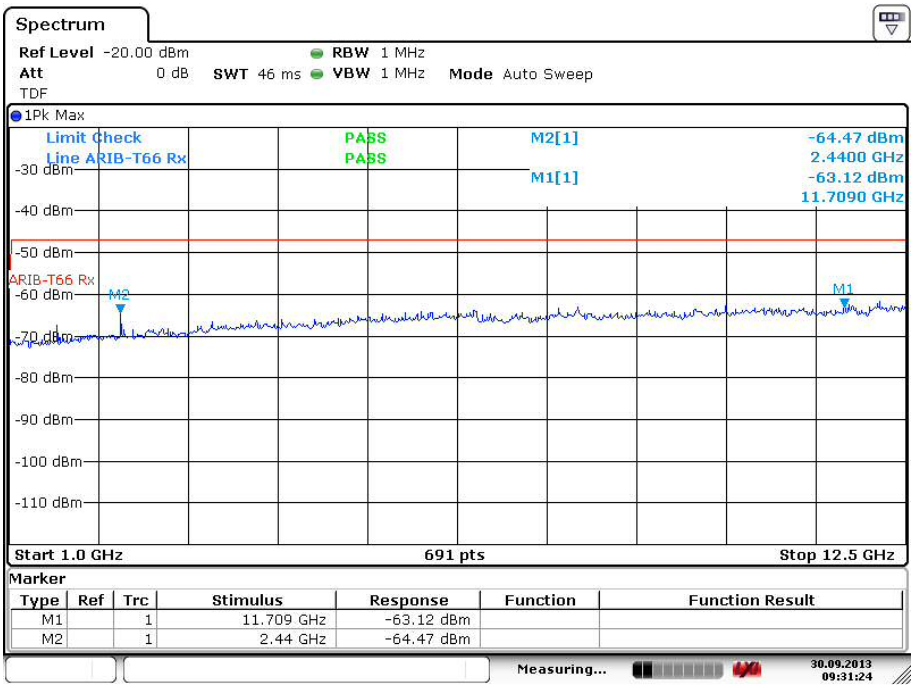
Date: 30.SEP.2013 09:25:19

Graph 46. Rx spurious emissions 2 Mbps middle channel 1 GHz – 12.5 GHz.



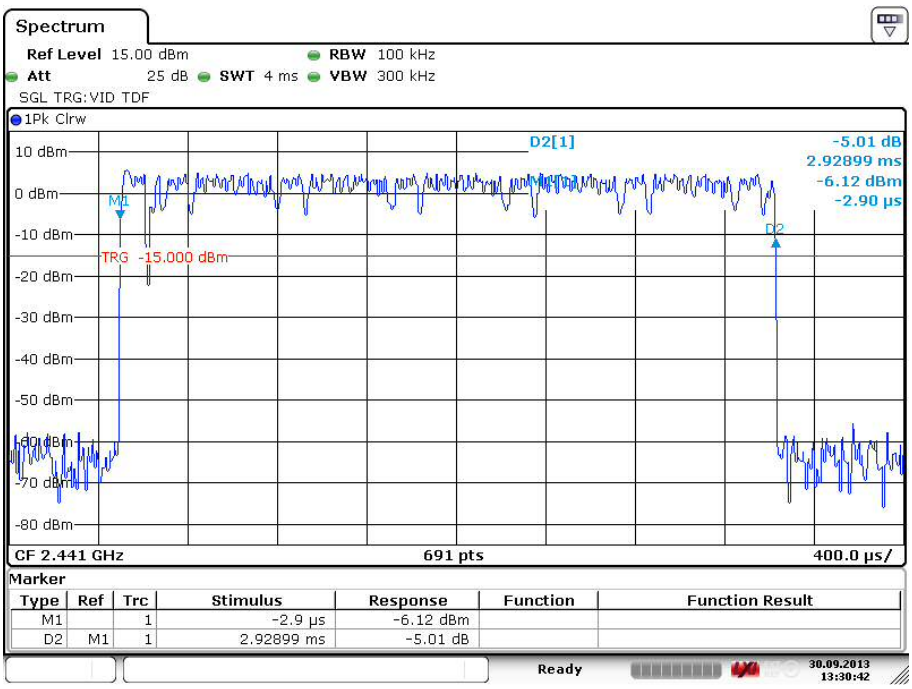
Date: 30.SEP.2013 09:29:19

Graph 47. Rx spurious emissions 3 Mbps middle channel 30 MHz – 1 GHz.



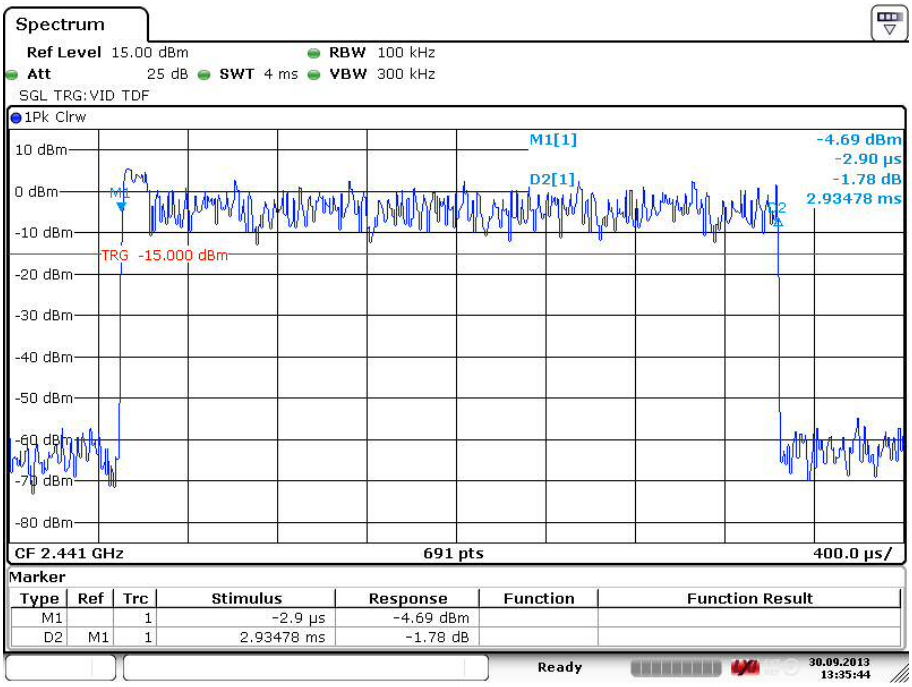
Date: 30.SEP.2013 09:31:23

Graph 48. Rx spurious emissions 3 Mbps middle channel 1 GHz – 12.5 GHz.



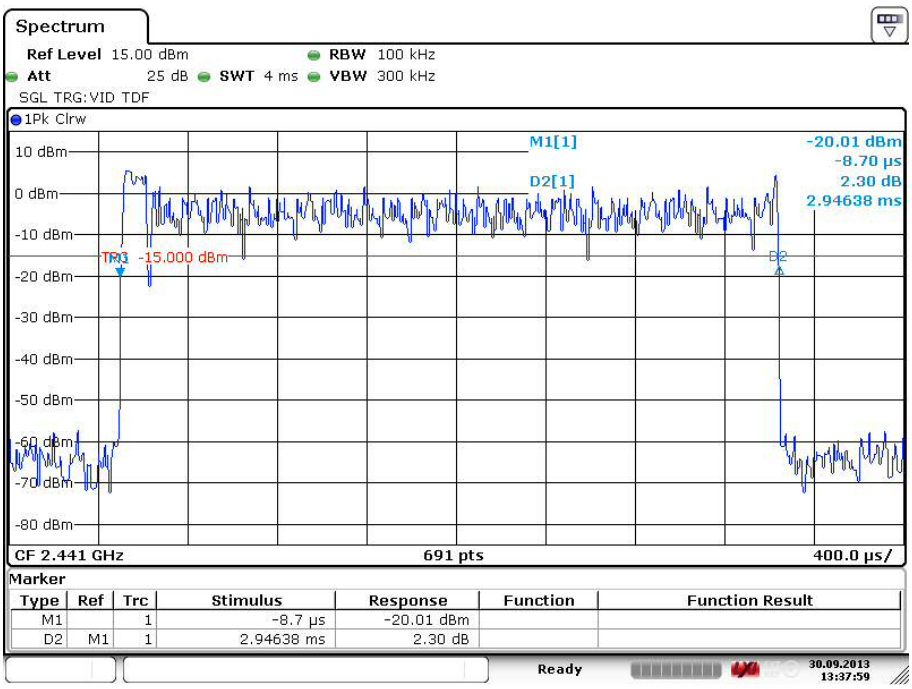
Date: 30.SEP.2013 13:30:41

Graph 49. Channel occupancy time 1 Mbps.



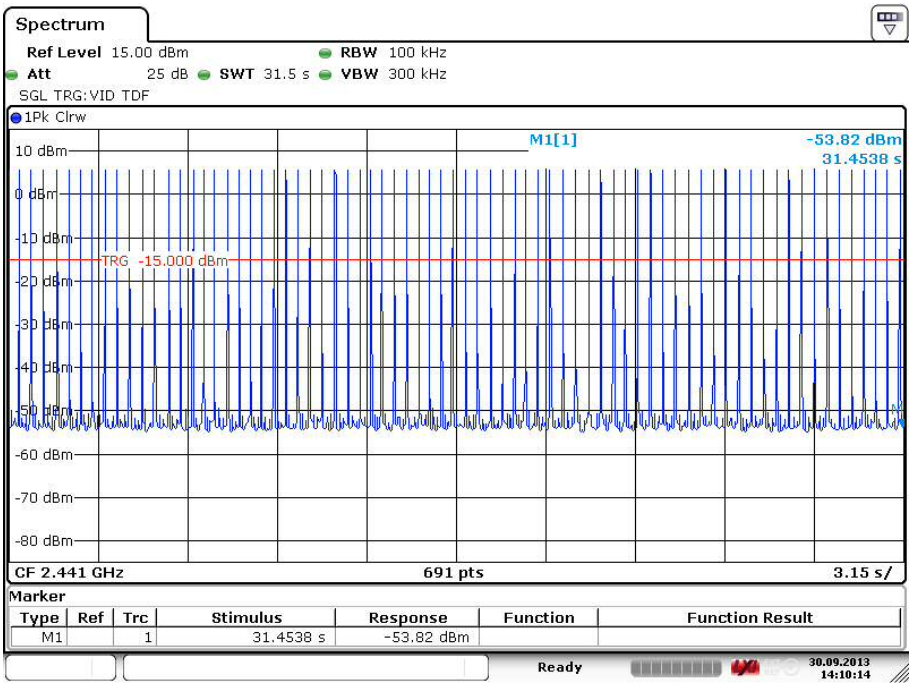
Date: 30.SEP.2013 13:35:44

Graph 50. Channel occupancy time 2 Mbps.



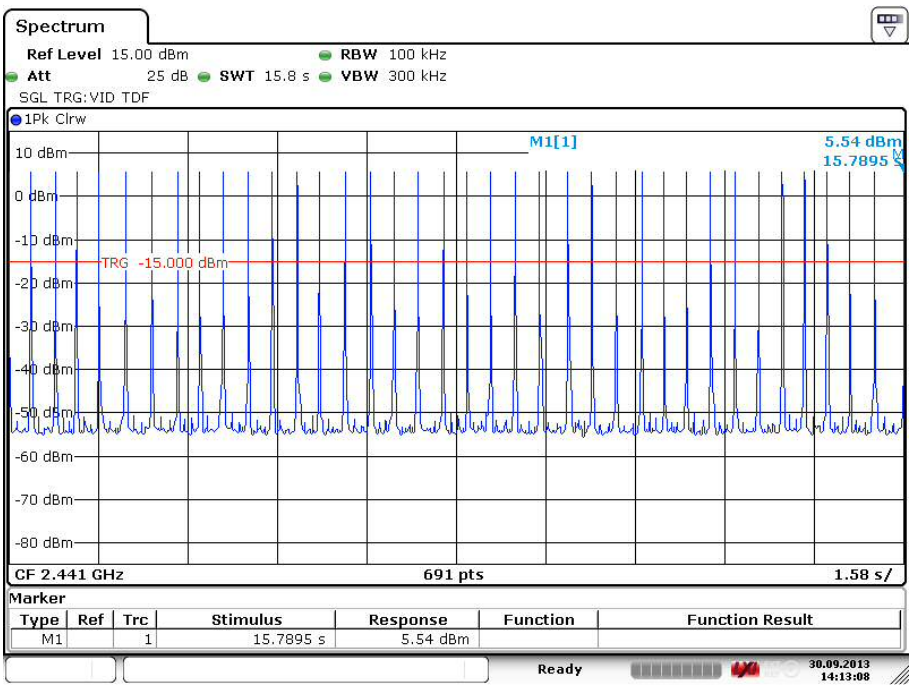
Date: 30.SEP.2013 13:37:58

Graph 51. Channel occupancy time 3 Mbps.



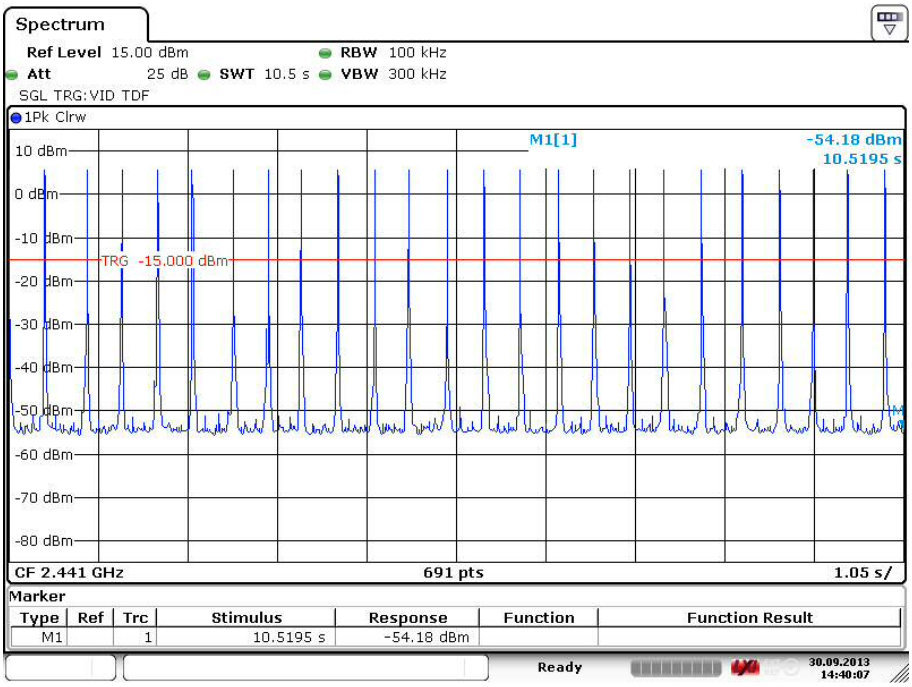
Date: 30.SEP.2013 14:10:13

Graph 52. Residence time of hopping frequency 1 Mbps.



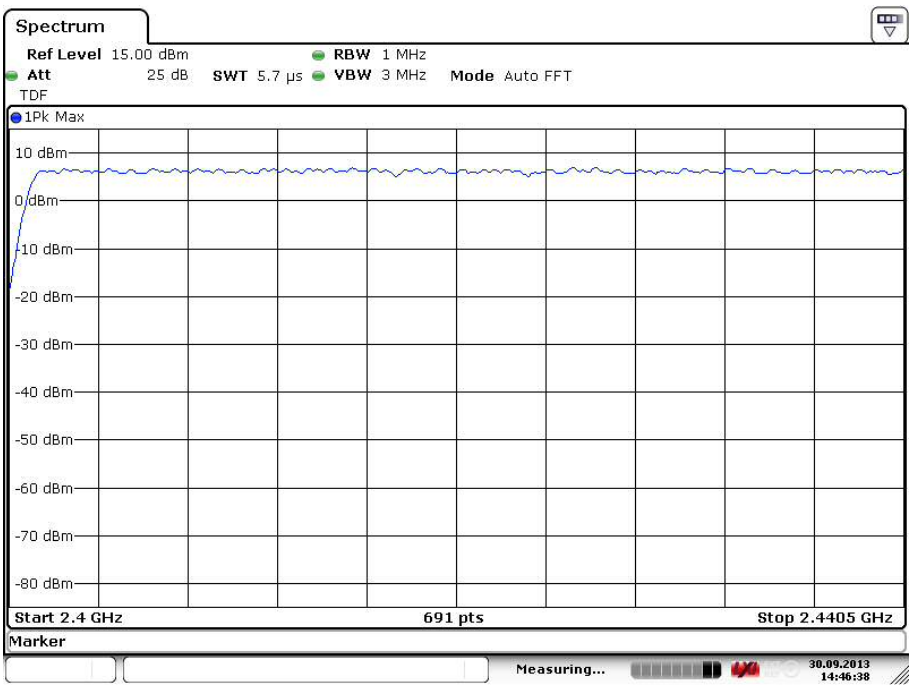
Date: 30.SEP.2013 14:13:08

Graph 53. Residence time of hopping frequency 2 Mbps.



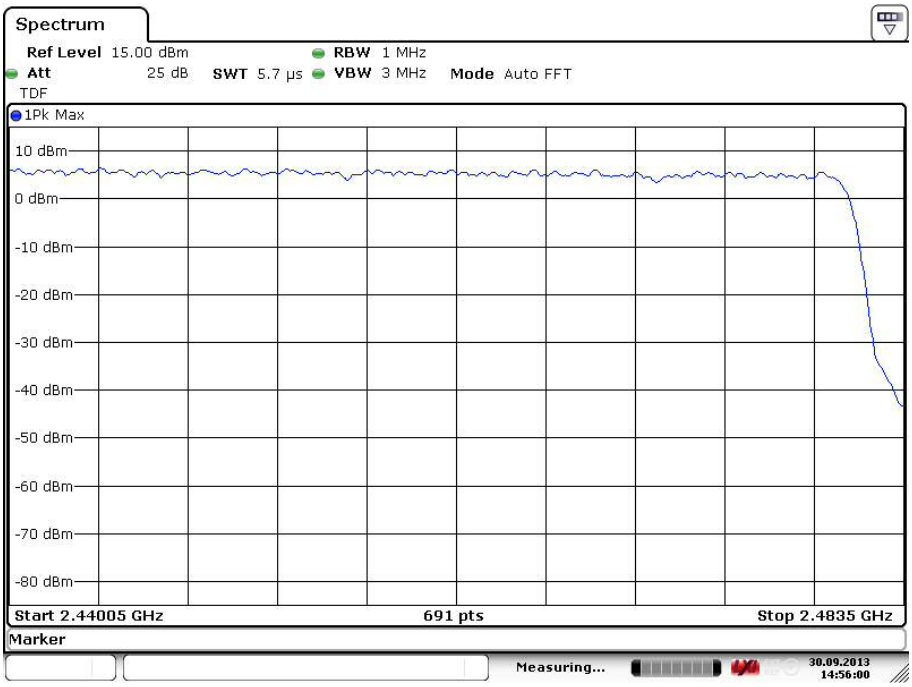
Date: 30.SEP.2013 14:40:07

Graph 54. Residence time of hopping frequency 3 Mbps.



Date: 30.SEP.2013 14:46:38

Graph 55. Number of hopping channels 1 – 39.

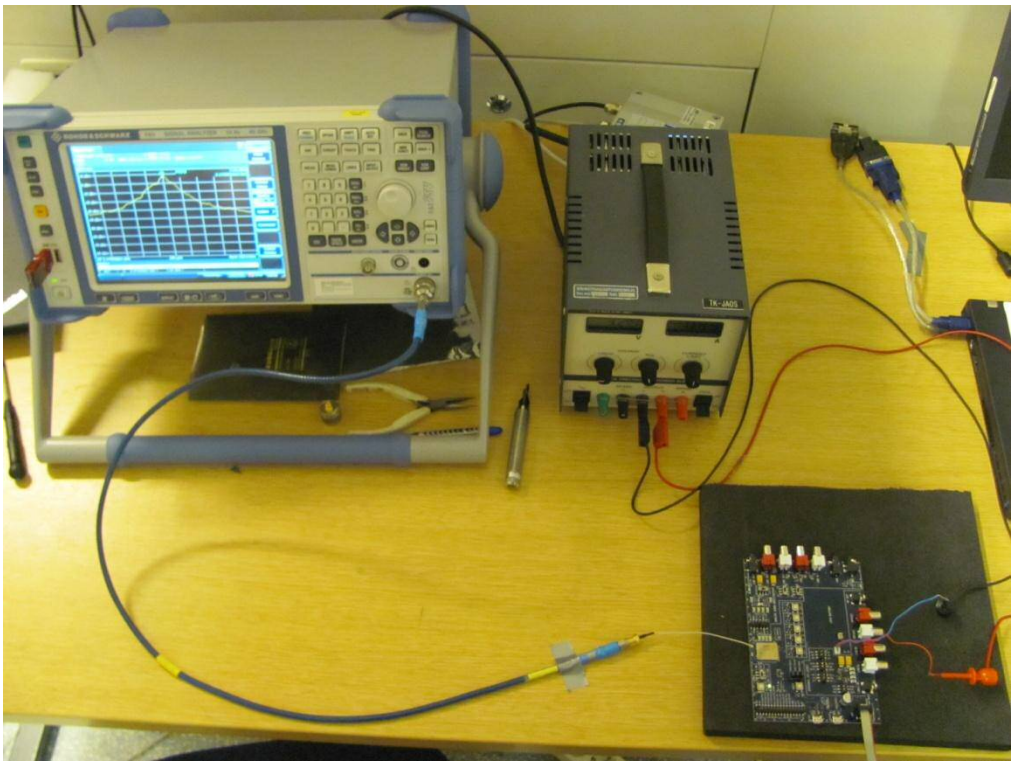


Date: 30.SEP.2013 14:55:59

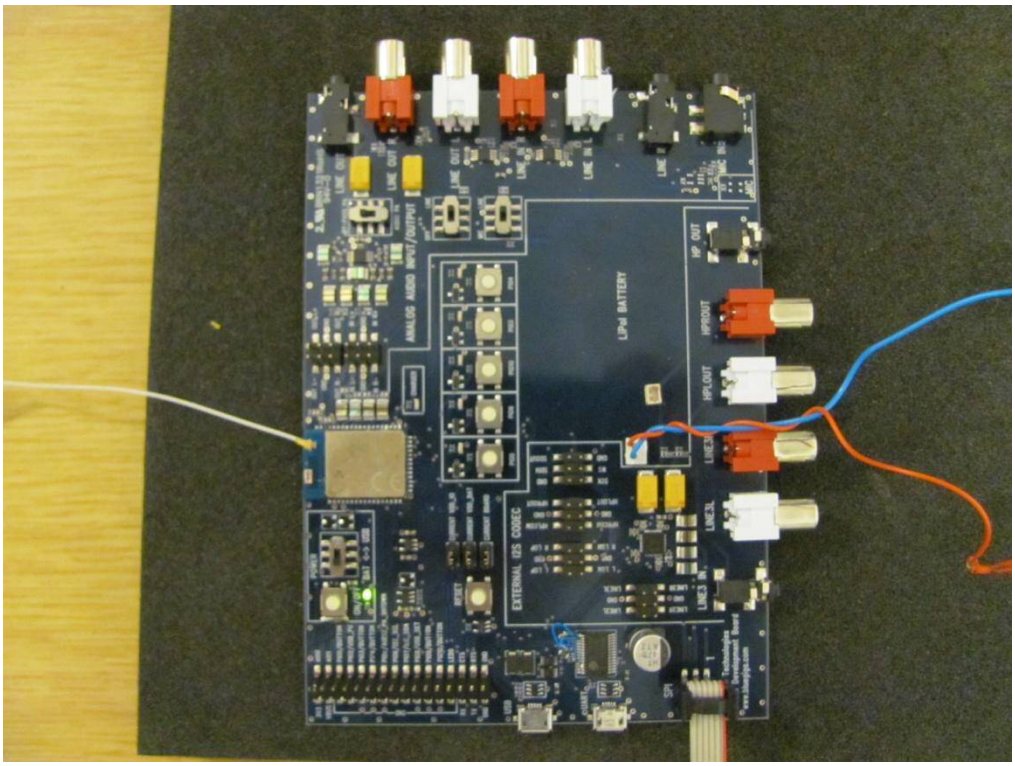
Graph 56. Number of hopping channels 40 – 79.

ANNEX B

This annex contains the photographs of the EUT and test setup.



Photograph 1. Test setup.



Photograph 2. The EUT with the evaluation board.