

# Tantalus Systems Corp.

## TR-1905

### Report of Measurements

per

**Industry Canada RSS-210 Issue 8**

and

**FCC CFR47 Part 15/B; FCC CFR47 Part 15/C – 15.247**

Revision 1.0  
June 13, 2014

<b>Reviewed By:</b>	<hr/> <b>Parm Singh, EMC Division Manager</b>	<hr/> June 13 2014 <b>Date</b>
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<b>Tested By:</b>	<hr/> <b>Aman Jathaul, EMC Project Manager</b>	<hr/> June 13 2014 <b>Date</b>
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**Quality Auditing Institute**  
**19473 Fraser Way, Pitt Meadows, BC, V3Y 2V4, Canada**

## **Test Report Summary**

FCC 15.247 / IC RSS-210

Frequency Hopping 902.17 – 927.83MHz communication Module

**FCC ID:** OZFDC1905 **IC:** 3669A-DC1905

**Organization Requesting Report:** Tantalus Systems Corp.

**Contact:** Mark Fairburn, RF Design Engineer

**Test Organization:** Quality Auditing Institute Ltd.

**Contact:** Aman Jathaul, EMC Project Manager

**Test Personnel:** Aman Jathaul

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## **Section 1: Information for Test Report of Measurements**

TESTED BY: Aman Jathaul

### **ENVIRONMENTAL CONDITIONS:**

Day 1: May 13 2014  
Day 2: May 14 2014  
Day 3: May 15 2014  
Day 4: May 16 2014  
Day 5: May 20 2014  
Day 6: May 21 2014

Temperature: 22.1°C, R.H.: 40.3%, Barometric Pressure: 1013.8 mBar.  
Temperature: 24.5°C, R.H.: 39.4%, Barometric Pressure: 1012.8 mBar.  
Temperature: 26.7°C, R.H.: 39.3%, Barometric Pressure: 1014.8 mBar.  
Temperature: 26.1°C, R.H.: 39.7%, Barometric Pressure: 1012.3 mBar.  
Temperature: 27.3°C, R.H.: 39.0%, Barometric Pressure: 1012.0 mBar.  
Temperature: 27.4°C, R.H.: 40.2%, Barometric Pressure: 1012.3 mBar.

### **Test Facilities**

**Main Laboratory Headquarters:** Quality Auditing Institute  
Headquarters Location/Address: 16 – 211 Schoolhouse Street, Coquitlam, BC, 3K 4X9, Canada

**Associated Laboratory:** Quality Auditing Institute (Remote Location)

EMC Test Laboratory Location/Address: 19473 Fraser Way, Pitt Meadows, BC, V3Y 2V4, Canada

FCC Designation Number: CA9543

Industry Canada Test Site Registration Number (3m SAC): 9543B-1

Standard Council of Canada: ISO/IEC 17025:2005 Accredited Laboratory No. 743

International Accreditation Service Inc.: ISO/IEC 17025:2005 Accredited Laboratory: No. TL-239

### **Test Equipment List**

Device	Model Number	Equipment Description	Serial No.	Last Cal	Next Cal
Antenna	Sunol Sciences JB3	Biconilog Antenna (30MHz-3GHz)	A042004	Mar 12, 2012	Mar 12, 2015
EMI Receiver	Rohde & Schwarz ESU40	EMI Receiver (20Hz-40GHz)	100011	June 26, 2012	June 26, 2015
LISN	FCC-LISN-50-25-2	LISN (150kHz-30MHz)	241036	Nov 30, 2012	Nov 30, 2015
Turntable	ETS Lindgren 2165	00043677	N/A	N/A	N/A
Mast	ETS Lindgren 2165	00077487	N/A	N/A	N/A

Note: All the equipments have 3-years calibration cycle.

### **Measurement Uncertainty**

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-5}$ MHz
Radiated Emissions	$\pm 3$ dB
Temperature	$\pm 1^\circ\text{C}$
Humidity	$\pm 5$ %
DC and low frequency voltages	$\pm 3$ %

**Company Tested**

NAME: Tantalus Systems Corp.

ADDRESS: 301-3480 Gilmore Way  
Burnaby, BC V5G 4Y1  
Canada

CONTACT PERSON: Mr. Mark Fairburn

PHONE NUMBER: 1-604-299-0458 x:229

**Equipment Under Test**

## THE TEST SYSTEM:

The Tantalus Systems TR-1905 is a streetlight LAN repeater that allows electrical utilities to extend the LAN coverage.

Product ID: TR-1905  
Manufacturer: Tantalus Systems Corp.

LAN Controller  
Part Numbers: 100-0148-I  
Serial number: 00186510B2

Power Supply  
Part Numbers: 100-0162  
Serial number: 00186510B2

TEST SETUP: This EUT is designed to communicate with other LAN devices in the Tantalus Utility Network (TUNet®) and employs a Frequency Hopping Spread Spectrum (FHSS) system operating on the 902-928 MHz band for LAN communication.

## CABLING:

Cable	Pins	Connector	Load/Termination	Shielded	Ferrites
Power	3	Terminal	No	No	No

MODIFICATIONS: No modifications were made for this unit to pass.

CONCLUSION: The TR-1905 complies with the requirements of FCC CFR47 and the requirements of Industry Canada RSS-210.



## **Section II: IC RSS-210 Iss.8 & FCC CFR47 Part 15/B Report of Measurements**

### **Markings**

According to FCC Section 15.19 and ICES 003, a statement similar to the following must be included on an identification label, which also uniquely identifies the Manufactured date, either explicitly or through a Serial number etc.:

“This equipment complies with FCC Rules, Part 15 and Industry Canada’s ICES 003 for a Class B Digital Device. Operation is subject to two conditions:

- 1) This device may not cause harmful interference, and
- 2) This device must accept any interference that may cause any undesired operation”

Additionally, if the manufacturer markets product to Quebec, the following supplemental information should be added to the label:

“Cet Appareil numerique de la Classe B respecte toutes les exigences du Reglement sur le material brouilleur du Canada.”

### **Labeling**

According to FCC Section 15.105, and ICES 003, the following statement must be included in a prominent location in your User’s Manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

It is also required according to FCC Part B Section 15.21 that a caution is included such as:

Caution: Changes or modifications to this equipment, not expressly approved by the manufacturer could void the user’s authority to operate the equipment.

This product is License Exempt for FCC and IC. There is a requirement for this product to be submitted for certification and requires both an FCC ID and an IC ID number to be added to the labels in accordance with FCC CFR47 Part 2 Subpart J (2.901 to 2.956) as well as IC Self-Marking standards.

## **Section III: IC RSS-210 Issue 8 Emissions Testing**

### **Test Results – Summary**

Testing was performed pursuant to Industry Canada RSS-210 Issue 8.

<b>Test</b>	<b>Standard</b>	<b>Description</b>	<b>Result</b>
Radiated Emissions Idle Mode Subclause 8.2	RSS-210 2.2(b)	The radiated emissions are measured in the 0.009 - 9280MHz range	Complies
Conducted Emissions Idle Mode Subclause 8.3	EN55022 Class A Limits	The Conducted Emissions are measured on the phase and neutral power lines in the 0.15 – 30.0 MHz range	Complies
Radiated Emissions Transmit Mode	RSS-210 A8.5	The radiated emissions are measured in the 0.009 -9280MHz range	Complies
Output Power and EIRP Emissions	RSS-210 A8.4(1)	Output power will not exceed 1 Watt and the E.I.R.P. will not exceed 4 Watts	Complies

## **Part 1 – Radiated Emissions Testing**

DATE April 03, 2014

TEST STANDARD: RSS-210 2.2(b)

TEST SETUP: The EUT was operated and tested at 240Vac and 120Vac 60Hz in its normal mode of operation. It was in receive mode for these tests.

MINIMUM STANDARD: Class B Limit:

Frequency (MHz)	Field Strength ( $\mu\text{V}/\text{m}$ )	Measurement Distance (m)
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

METHOD OF MEASUREMENT: Measurements were made using a spectrum analyzer with a 9kHz RBW, Peak detector. Any emissions that are close to the limit are measured using a test receiver with a 9kHz bandwidth, CISPR Quasi-Peak detector as well as an averaging meter. The EUT was set up in a 3 meter semi-anechoic chamber, using the manufacturer's specified normal cabling configuration, with all cables over 1 meter in length bundled at 1 meter and retained from the floor. A typical application was tested.

Emissions in both horizontal and vertical polarization were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots.

EMISSIONS DATA: See Appendix A for corresponding frequencies.

PERFORMANCE: Complies.

## **Part 2 – Conducted Emissions Testing**

DATE: April 01, 2014

TEST STANDARD: EN55022

MINIMUM STANDARD: Class B Limit:

TEST SETUP: The EUT was connected to the conducted emissions LISN apparatus. The device was operated and tested at 240Vac and 120Vac 60Hz.

MINIMUM STANDARD: Class A Limit:

Frequency (MHz)	Conducted Limit (dB $\mu$ V)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

METHOD OF MEASUREMENT: Measurements were made using a spectrum analyzer with a 9kHz RBW, Peak detector. Any emissions that are close to the limit are measured using a test receiver with a 9kHz bandwidth, CISPR Quasi-Peak detector as well as an averaging meter.

MEASUREMENT DATA: See Appendix A for Plots.

EMISSIONS DATA: See Appendix A for corresponding frequencies.

PERFORMANCE: Complies.

## **Part 3 – Radiated Emissions – Transmit Mode**

DATE: April 03, 2014

TEST STANDARD: RSS-210 Iss.8 Annex 8 Frequency Hopping Systems 902-928MHz Band.

MINIMUM STANDARD: **A8.1 – Frequency Hopping Systems (General Conditions)**

Frequency hopping systems are spread spectrum systems in which the carrier is modulated with coded information in a conventional manner causing a conventional spreading of the RF energy about the carrier frequency. The frequency of the carrier is not fixed but changes at fixed intervals under the direction of a coded sequence. Frequency hopping systems are not required to employ all available hopping frequencies during each transmission. However the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream.

Incorporation of intelligence into a frequency hopping system that enables it to recognize other users of the band and to avoid occupied frequencies is permitted, provided that the frequency hopping system does it individually, and independently chooses or adapts its hopset. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

**(a)** The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system RF bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset while the long-term distribution appears evenly distributed.

**(b)** 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. 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.

**(c)** For frequency hopping systems in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20 second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

### **A8.4 Transmitter Output Power and e.i.r.p. Requirements**

**(1)** For frequency hopping systems operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p. shall not exceed 1 W, if the hopset uses less than 50 hopping channels. As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power (see RSS-Gen).

### A8.5 Out-of-band Emissions

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced 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 Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB.

**TEST SETUP:** The EUT was operated and tested at 240Vac and 120V 60Hz for the tests and the unit was transmitting at its maximum rate based on the energy that it could sustain in normal operation.

**METHOD OF MEASUREMENT:** Measurements were made using a spectrum analyzer. The EUT was set up in a 3 meter Semi-Anechoic test site, using the manufacturer's specified normal cabling configuration, with all cables over 1 meter in length bundled at 1 meter and retained from the floor.

Emissions in both horizontal and vertical polarization were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots.

All frequencies 0.009 -1000MHz were tested at 3m and all frequencies 1GHz and up were tested at 1m in accordance with ANSI c63.4.

**EMISSIONS DATA:** See Appendix A for results.

Test	Standard	Results
Spread Spectrum Method of Modulation	RSS-210 A8.1	This product meets the requirements of a Frequency Hopping Spread Spectrum (FHSS) system operating in the 902-928MHz band
Output Power and EIRP	RSS-210 A8.4(1)	See the Measurement Data section in Part 4 of this Section. The output EIRP is a maximum of 0.759W. The conducted output power is 550mW.
Out of Band Emissions	RSS-210 A8.5	See Tables 6 - 8 in Appendix A. All radiated emissions were within the RSS-210 A8.5 limit.

**Low Data Rate**

Channel Bandwidth	RSS-210 A8.1(a)	See Figures 6 - 8 in Appendix A. The 20dB bandwidth was measured to be 114.4 kHz.
Channel Separation	RSS-210 A8.1(c)	See Figure 9 in Appendix A. The Channel separation was measured to be 256 kHz.
Number of Hopping Channels	RSS-210 A8.1(c)	See Figures 10 -13 in Appendix A. The number of frequencies used is 50.
Hopping Channels Time of Occupancy	RSS-210 A8.1(c)	See Figures 14 and 15 in Appendix A; the time of occupancy is 4.33 milliseconds at an interval of 1.9 seconds. This is equal to an average time "ON" of 46.3 mSecs within a 20 second period.

**High Data Rate**

Channel Bandwidth	RSS-210 A8.1(a)	See Figures 18 - 20 in Appendix A. The 20dB bandwidth was measured to be 318.9 kHz.
Channel Separation	RSS-210 A8.1(c)	See Figure 21 in Appendix A. The Channel separation was measured to be 320.6 kHz.
Number of Hopping Channels	RSS-210 A8.1(c)	See Figures 22 - 27 in Appendix A. The number of frequencies used is 54.
Hopping Channels Time of Occupancy	RSS-210 A8.1(c)	See Figures 28 and 29 in Appendix A; the time of occupancy is 617 microseconds at an interval of 0.104 seconds. This is equal to an average time "ON" of 143 mSecs within a 20 second period.

**Communication Data Rate to Certified OEM Part 15 Device**

Channel Bandwidth	RSS-210 A8.1(a)	See Figures 31 - 33 in Appendix A. The 20dB bandwidth was measured to be 157.4 kHz.
Channel Separation	RSS-210 A8.1(c)	See Figure 21 in Appendix A. The Channel separation was measured to be 200.6 kHz.
Number of Hopping Channels	RSS-210 A8.1(c)	See Figures 35 - 43 in Appendix A. The number of frequencies used is 120.
Hopping Channels Time of Occupancy	RSS-210 A8.1(c)	See Figures 31 and 32 in Appendix A; the time of occupancy is 6.46 milliseconds at an interval of 120 seconds. This is equal to an average time "ON" of 1.076mSecs within a 20 second period.

PERFORMANCE:                      Complies.



## **Part 4 – Output Power and EIRP Emissions**

DATE: April 05, 2014

TEST STANDARD: RSS-210 Iss.8 A8.4 – Frequency Hopping Spread Spectrum Systems 902-928MHz

MINIMUM STANDARD: For frequency hopping systems operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p. shall not exceed 1 W, if the hopset uses less than 50 hopping channels.

TEST SETUP: Refer to setup in Part 3 above.

METHOD OF MEASUREMENT: The Antenna is connected directly to the PCB using a coaxial pigtail; the conducted output power was measured at this point. A 30dB attenuator was used to protect the instrumentation. See Figures 13-15.

EIRP was measured at the 3m distance and the measurement was adjusted to account for cable loss and Antenna factor.

### **EIRP measurements**

<b>Freq(MHz)</b>	<b>Corrected Field at 3m (dBµV/m)</b>	<b>3m EIRP (dBm)</b>
902.17	118.2	22.98
915	118.3	23.08
927.83	120.22	25.00

### **Conducted Output Power measurements**

<b>Freq(MHz)</b>	<b>Meas. Output Power (dBm)</b>	<b>Correction Factor* (dB)</b>	<b>Output Power (dBm)</b>
902.17	-11.77	40.5	28.73
915	-11.73	40.5	28.77
927.83	-11.67	40.5	28.83

\* Correction Factor accounts for a nominal 40dB attenuator and 0.5dB cable loss.

PERFORMANCE: Complies.

## **Part 5: Out of Band Emissions**

DATE: April 05, 2014

TEST STANDARD: RSS-210 A8.5

MINIMUM STANDARD: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the radio frequency power that is produced 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 Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB.

TEST SETUP: Refer to the setup in Part 3 above.

METHOD OF MEASUREMENT: Measurements were made using a horn antenna connected directly into a spectrum analyzer. The EUT was set up in a 1 meter open field test site, using the manufacturer's specified normal cabling configuration, with all cables over 1 meter in length bundled at 1 meter and retained from the floor. An application which transmitted a constant CW at the highest output power was used.

Emissions in the horizontal and vertical polarization were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots.

Due to the presence of high ambient noise making it impossible to measure an emission at the required distance, the measurement was performed at 1 meter distance and the limit is adjusted per EN61000-6-3:2001

The following formula was used to convert the maximum field strength (FS) in volts/meter to calculate the EUT output power (TP) in Watts:

$$TP = ((FS \times D) \times 2) / (30 \times G)$$

Where D is the distance in meters between the two antennas and G is the EUT antenna numerical gain referenced to isotropic gain.

MEASUREMENT DATA: See Tables 6 to 8 in Appendix A.

PERFORMANCE: Complies.

## **Section IV: FCC CFR47 Part 15/C Report of Measurements**

### **General**

Tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 15 – Subpart C - Intentional Radiators. The Testing was performed pursuant to ANSI 63.4, 2003.

Additionally, the specific section used for compliance is 15.247 – Operation within the bands 902-928MHz – limited to frequency hopping intentional radiator. This includes the use of the FCC Public Notice DA 00-705 (Filing and Measurement Guidelines for Frequency hopping Spread Spectrum Systems) that was used as a guide to the tests that were performed.

### **Labeling Requirements**

Please refer to labeling requirements as outlined above in Section 1.

### **Test Results - Summary**

Testing was performed pursuant to ANSI 63.4, 2003.

<b>Test</b>	<b>Standard</b>	<b>Description</b>	<b>Result</b>
Radiated Emissions Idle Mode	FCC Part 15 Subpart B Class B Limits	The radiated emissions are measured in the 0.009 - 9280MHz range	Complies
Conducted Emissions Idle Mode	FCC Part 15 Subpart B Class B Limits	The conducted emissions are measured on the phase and neutral power lines in the 0.15 – 30.0 MHz range.	Complies
Antenna Requirement	FCC Part 15 Subpart 15.203	Proper Antenna is specified and used	Complies
Radiated Emissions Transmit Mode – Frequency Hopping Spread Spectrum Operation	FCC Part 15 Subpart C 15.247	Radiated emission characteristics for Spread Spectrum devices operating in the range 902-928 MHz that use the Spread Spectrum Modulation technique. Emissions are measured in the 0.009 - 9280MHz range.	Complies

## **Part 1 – Radiated Emission Testing**

DATE: April 02, 2014

TEST STANDARD: FCC CFR47, Part 15, Subpart B Class B and Subpart C-Section 15.247

TEST VOLTAGE: 240Vac 60Hz

TEST SETUP: The equipment was set up in a 3-meter semi-anechoic chamber. Emissions in both horizontal and vertical polarization's were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots. In cases where the presence of high ambient noise makes it impossible to measure an emission at the required distance, the measurement is performed at a closer distance and the limit is adjusted 20dB per Decade using the formula

$$20 \cdot \log(d_1/d_2)$$

Where d1 is the required distance and d2 is the new distance.

MINIMUM STANDARD: When the EUT is operating in Receive mode FCC Part 15 Subpart B Unintentional Radiators Limits for a Class B product.:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

DEVICE DESCRIPTIONS: Refer to the Equipment Under Test information in the Section 1 above, for EUT Descriptions.

CABLING DETAILS: The EUT was set up using the manufacturer's specified normal cabling configuration.

CABLING:

Cable	Pins	Connector	Load/Termination	Shielded	Ferites
Power	3	Terminal	No	No	No

MODIFICATIONS: No modifications were required for the devices to pass the test.

MEASUREMENT DATA: See Appendix A for Plots.

EMISSIONS DATA: See Table 1 in Appendix A for corresponding frequencies. Emissions that were attenuated by more than 20dB from the permissible value are not reported in accordance with 15.31(o). The device was tested to 10MHz since it uses clock circuitry at this frequency.

PERFORMANCE: Complies.

## **Part 2 – Antenna Requirement – 15.203**

### **2.1 APPLICABLE REGULATIONS:**

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

### **2.2 RESULTS:**

The Part 15 device inside the EUT is comprised of a proprietary design antenna that is soldered to the PCB by means of a coaxial cable. The entire module is underneath a clear plastic cover that is sealed at installation by the utility company and cannot be accessed.

### **PERFORMANCE:**

Complies.

## **Part 3 – Conducted Emissions Tests – 15.207**

### 3.1 Applicable Regulations

**15.207 - (a)** Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (db $\mu$ V)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

### 3.2 RESULT

MEASUREMENT DATA:

See Appendix A for Plots.

EMISSIONS DATA:

See Tables 3 - 4 and Figures 1 – 2 in Appendix A for corresponding data.

PERFORMANCE:

Complies.

## **Part 4 – Frequency Hopping Spread Spectrum Operation – 15.247**

### **4.1 APPLICABLE REGULATIONS:**

**15.247(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 pseudorandomly 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.

**(i)** For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

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

**(2)** For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

**(d)** 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) (see Section 15.205(c)).

**(g)** Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

#### 4.2 TEST PROCEDURES:

##### TEST STANDARD:

FCC CFR47, Part 15, Subpart C 15.247

##### DEVICE DESCRIPTIONS:

Refer to the Equipment Under Test Section, above, for EUT Descriptions.

##### TEST SETUP:

Frequency Range Measured	30MHz – 10000MHz
Test Distance	1m and 3m
Test Instrumentation Resolution	120kHz (30MHz to 1000MHz) 1MHz (1000MHz to 10000MHz)
Receive Antenna Scan Height	1m – 4m
Receive Antenna Polarization	Vertical and Horizontal

##### CABLING DETAILS:

Cable	Pins	Connector	Load/Termination	Shielded	Ferrites
Power	3	Terminal	No	No	No

#### 4.3 RESULTS:

In all 3 configurations a minimum of at least 50 frequencies are used. A pseudorandom sequence is used at the transmitter and in order to receive the packet successfully the receiver must hop in synchronization with the transmitter. All frequencies are used equally.

##### MODIFICATIONS

No modifications were required for the devices to pass the test.

##### MEASUREMENT DATA:

See Figures 3-44 in Appendix A.

##### PERFORMANCE:

Complies.



## **Part 5: Output Power and EIRP Emissions**

DATE: April 08, 2014

TEST STANDARD: FCC 15.247(b)(2) – Hopping Frequency Systems 902-928MHz

MINIMUM STANDARD: **15.247(b)(2)** – For the band 902-928MHz, the transmitter output power shall not exceed 1.0 watt and the E.I.R.P shall not exceed 4W for systems employing at least 50 Hopping Channels.

TEST SETUP: Refer to setup in Part 1 above.

METHOD OF MEASUREMENT: The Antenna is connected directly to the PCB using a coaxial pigtail; the conducted output power was measured at this point. A 30dB attenuator was used to protect the instrumentation. See Figures 13 - 15.

EIRP was measured at the 3m distance and the measurement was adjusted to account for cable loss and Antenna factor.

### MEASUREMENT DATA:

#### EIRP measurements

Freq(MHz)	Corrected Field at 3m (dBμV/m)	3m EIRP (dBm)
902.17	124.02	22.98
915	123.78	23.08
927.83	123.33	25.00

#### Conducted Output Power measurements

Freq(MHz)	Meas. Output Power (dBm)	Correction Factor* (dB)	Output Power (dBm)
902.17	-11.77	40.5	28.73
915	-11.73	40.5	28.77
927.83	-11.67	40.5	28.83

\* Correction Factor accounts for a 40dB attenuator and 0.5dB cable loss.

PERFORMANCE: Complies.

## **Part 6: Restricted Bands Review – 15.205(b)**

### 6.1 APPLICABLE REGULATIONS:

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

### 6.2 RESULTS

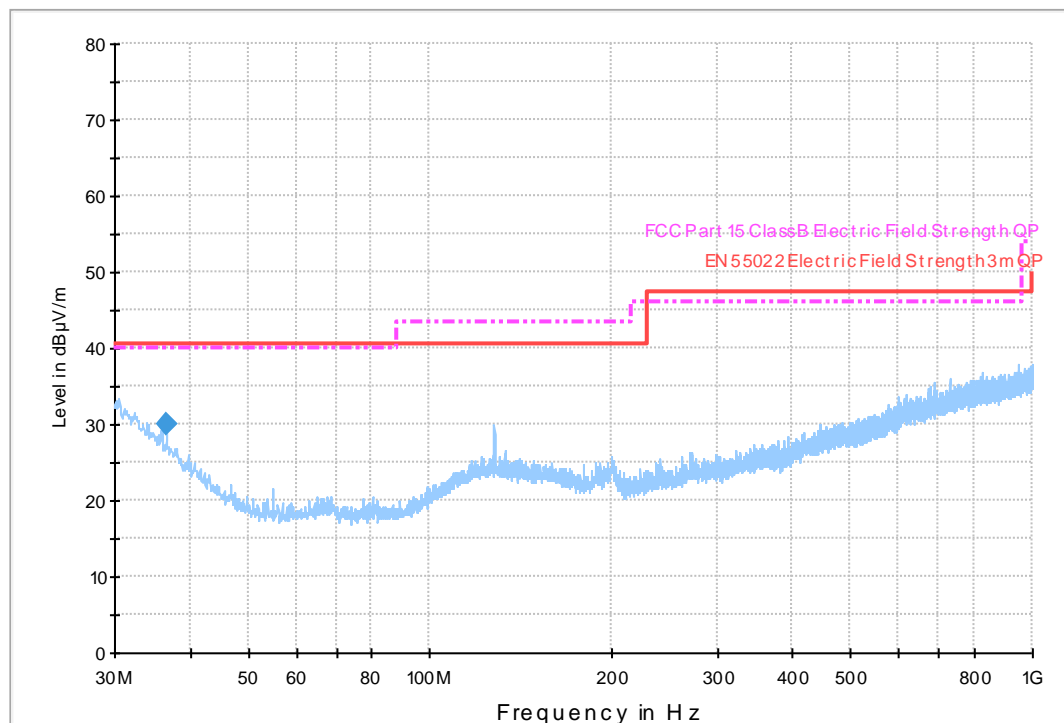
All of the measurements for the Part 15 device were made when the EUT was set into transmitting mode to allow measurements of spurious emissions. The spurious frequencies that have been identified to fall into restricted bands are the various harmonics generated from 902 to 928 MHz. The restricted bands affected are 2655-2900MHz, 3600-4400MHz, 4500-5150MHz, 5350- 5460MHz, 7250-7750MHz, 8025-8500MHz and 9000-9200MHz.

### EMISSIONS DATA:

See Tables 6 -8 in Appendix A for corresponding data.

## Appendix A: Test Plots TR-1905

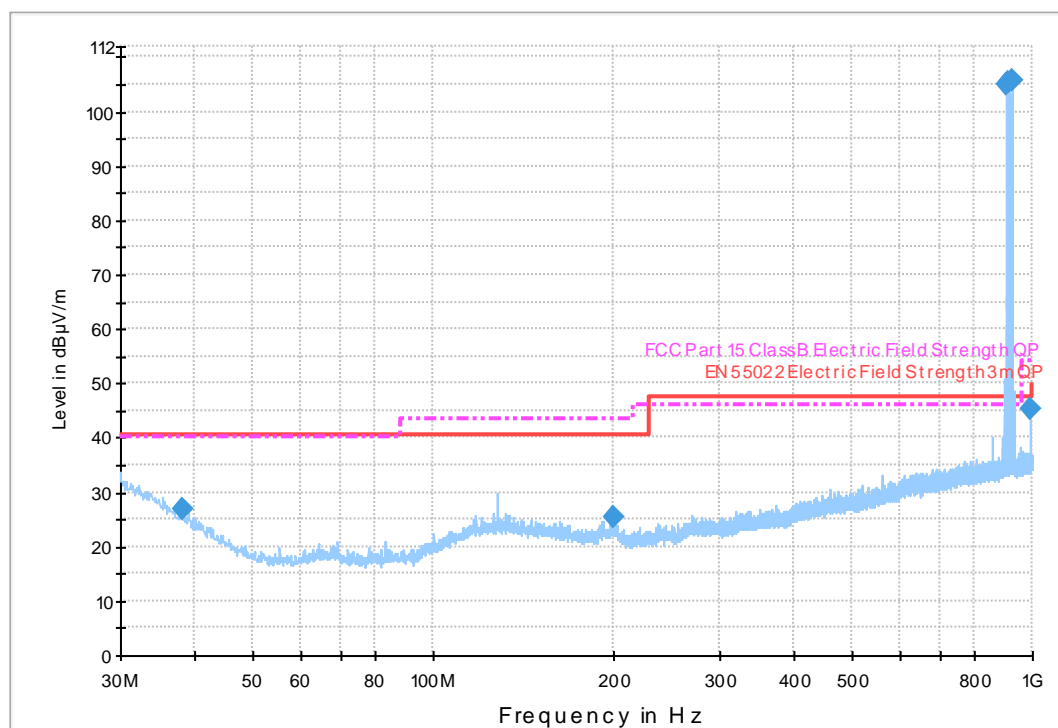
### Unintentional Radiated Emissions, Idle Mode



**Table 1: FCC Class B Emissions, Idle Mode - 3m\***

Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Margin (dB)	Limit (dBμV/m)
36.596	30.1	1000	120	150.0	V	90	9.9	40

\* Unintentional emissions were measured from 0.009Mhz -1000MHz. In accordance with 15.31(o) emissions that are 20dB below the permissible value have not been reported.

**Intentional Radiated Emissions, Tx Mode**

Frequency signals above the limit lines are fundamental frequencies between 902-928MHz

**Table 2: FCC Class B Emissions, Tx Mode - 3m\***

Frequency (MHz)	QuasiPeak (dB $\mu$ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Margin (dB)	Limit (dB $\mu$ V/m)
38.148000	27.0	1000.000	120.000	100	H	30.0	13.0	40
199.362000	25.2	1000.000	120.000	100	V	300.0	18.3	43.5
992.143000	45.2	1000.000	120.000	150	H	240.0	8.8	54

\* Unintentional emissions were measured from 0.009MHz -1000MHz. In accordance with 15.31(o) emissions that are 20dB below the permissible value have not been reported.

## **A.C. Mains Conducted Emissions**

FCC/CE Class A - Emissions

**Table 3: AC Conducted Emissions, Line 1**

120VAC 60Hz

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.183907	16.7	1000.000	9.000	On	L1	0.5	37.5	54.2
0.267216	11.9	1000.000	9.000	On	L1	0.4	39.1	51.0
0.317947	10.8	1000.000	9.000	On	L1	0.4	38.7	49.5
0.400076	9.5	1000.000	9.000	On	L1	0.4	38.2	47.7
0.450130	10.9	1000.000	9.000	On	L1	0.4	35.9	46.8
0.651428	4.2	1000.000	9.000	On	L1	0.4	41.8	46.0
0.961772	4.6	1000.000	9.000	On	L1	0.5	41.4	46.0
1.254525	2.9	1000.000	9.000	On	L1	0.5	43.1	46.0
1.797501	0.8	1000.000	9.000	On	L1	0.5	45.2	46.0
3.052216	1.0	1000.000	9.000	On	L1	0.6	45.0	46.0

## 240VAC 60Hz

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.167758	16.6	1000.000	9.000	On	L1	0.5	38.4	55.0
0.200406	22.8	1000.000	9.000	On	L1	0.5	30.6	53.4
0.265089	15.2	1000.000	9.000	On	L1	0.4	35.8	51.0
0.303060	14.1	1000.000	9.000	On	L1	0.4	35.8	49.9
0.432498	13.9	1000.000	9.000	On	L1	0.4	33.2	47.1
0.434229	13.8	1000.000	9.000	On	L1	0.4	33.3	47.1
0.698613	4.1	1000.000	9.000	On	L1	0.5	41.9	46.0
0.959853	5.4	1000.000	9.000	On	L1	0.5	40.6	46.0
1.249522	4.4	1000.000	9.000	On	L1	0.5	41.6	46.0
1.848491	1.7	1000.000	9.000	On	L1	0.5	44.4	46.0
2.880391	0.6	1000.000	9.000	On	L1	0.6	45.4	46.0

**Table 4: AC Conducted Emissions, Line 2**

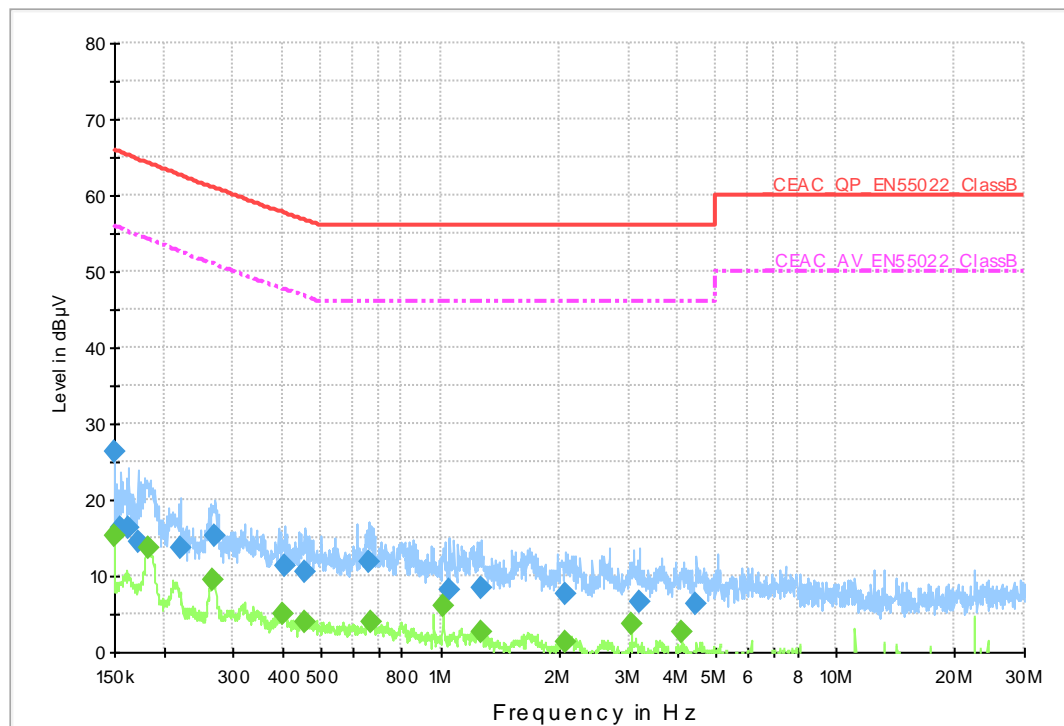
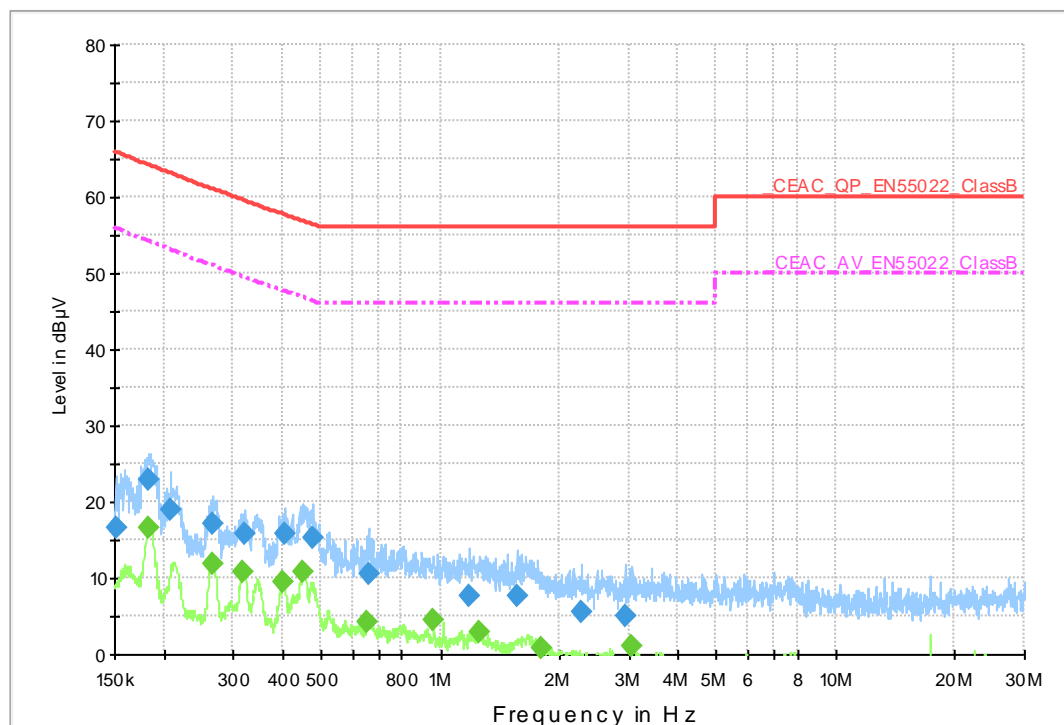
120VAC 60Hz

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	15.2	1000.000	9.000	On	L1	0.6	40.8	56.0
0.183907	13.8	1000.000	9.000	On	L1	0.5	40.4	54.2
0.264560	9.5	1000.000	9.000	On	L1	0.4	41.5	51.0
0.397685	4.9	1000.000	9.000	On	L1	0.4	42.9	47.8
0.456470	4.0	1000.000	9.000	On	L1	0.4	42.7	46.7
0.665904	4.0	1000.000	9.000	On	L1	0.4	42.0	46.0
1.017111	6.0	1000.000	9.000	On	L1	0.5	40.0	46.0
1.262067	2.7	1000.000	9.000	On	L1	0.5	43.3	46.0
2.071464	1.2	1000.000	9.000	On	L1	0.5	44.8	46.0
3.052216	3.8	1000.000	9.000	On	L1	0.6	42.2	46.0
4.069745	2.5	1000.000	9.000	On	L1	0.6	43.5	46.0

## 240VAC 60Hz

Frequency (MHz)	Average (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.150000	15.1	1000.000	9.000	On	L1	0.6	40.9	56.0
0.171144	14.2	1000.000	9.000	On	L1	0.5	40.6	54.8
0.199607	23.7	1000.000	9.000	On	L1	0.5	29.7	53.4
0.265619	12.5	1000.000	9.000	On	L1	0.4	38.5	51.0
0.304274	8.8	1000.000	9.000	On	L1	0.4	41.1	49.9
0.498416	3.7	1000.000	9.000	On	L1	0.4	42.3	46.0
0.664575	3.1	1000.000	9.000	On	L1	0.4	42.9	46.0
1.017111	5.8	1000.000	9.000	On	L1	0.5	40.2	46.0
1.264591	3.0	1000.000	9.000	On	L1	0.5	43.0	46.0
2.138754	2.6	1000.000	9.000	On	L1	0.5	43.4	46.0
3.052216	4.0	1000.000	9.000	On	L1	0.6	42.0	46.0
3.690191	1.5	1000.000	9.000	On	L1	0.6	44.5	46.0



**Figure 1: 120V AC Conducted Emissions - Line 1 and Line 2**

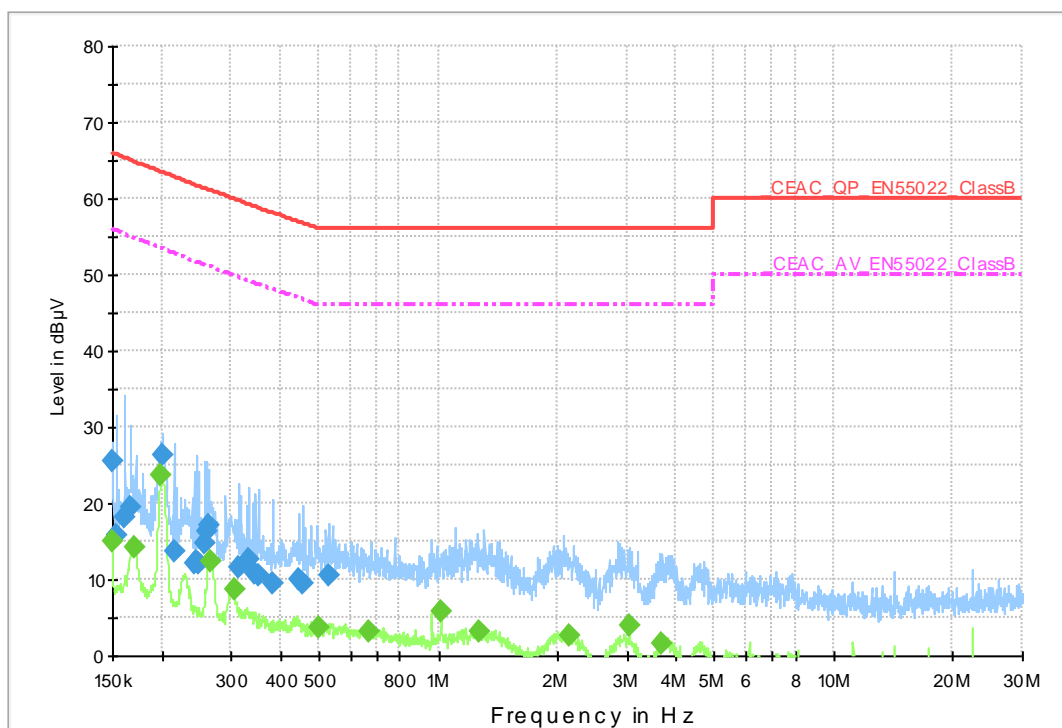
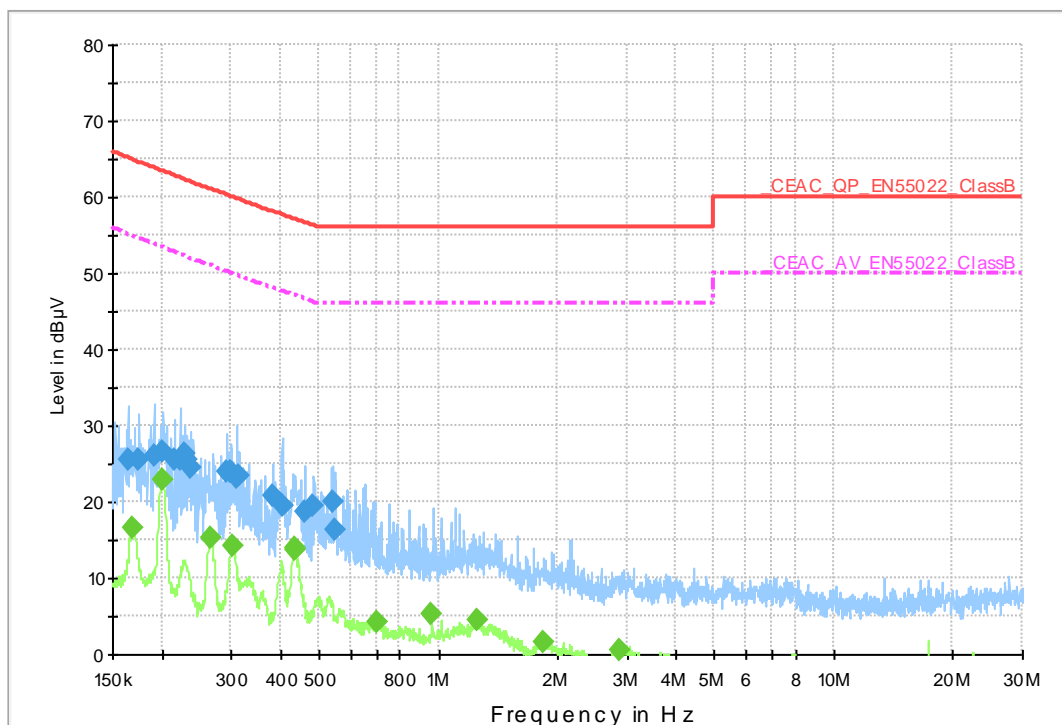
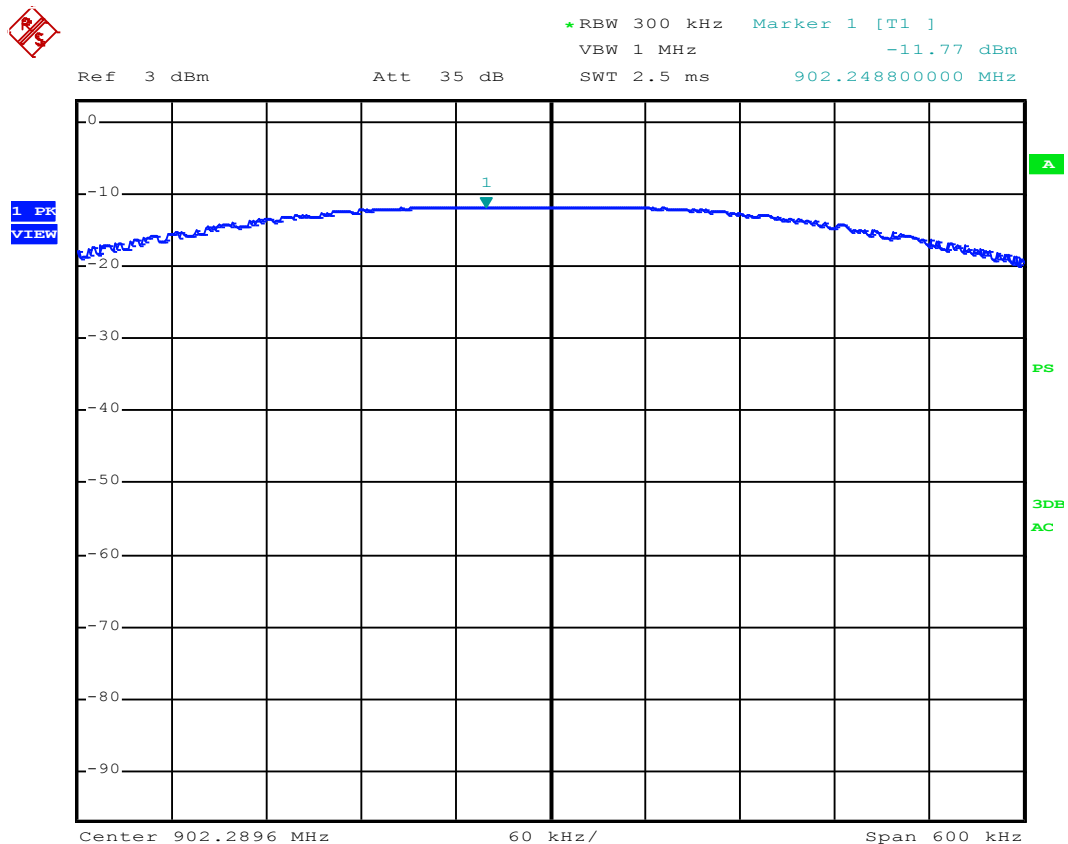


Figure 2: 240V AC Conducted Emissions - Line 1 and Line 2

## FHSS Compliance Tests

### Output Power

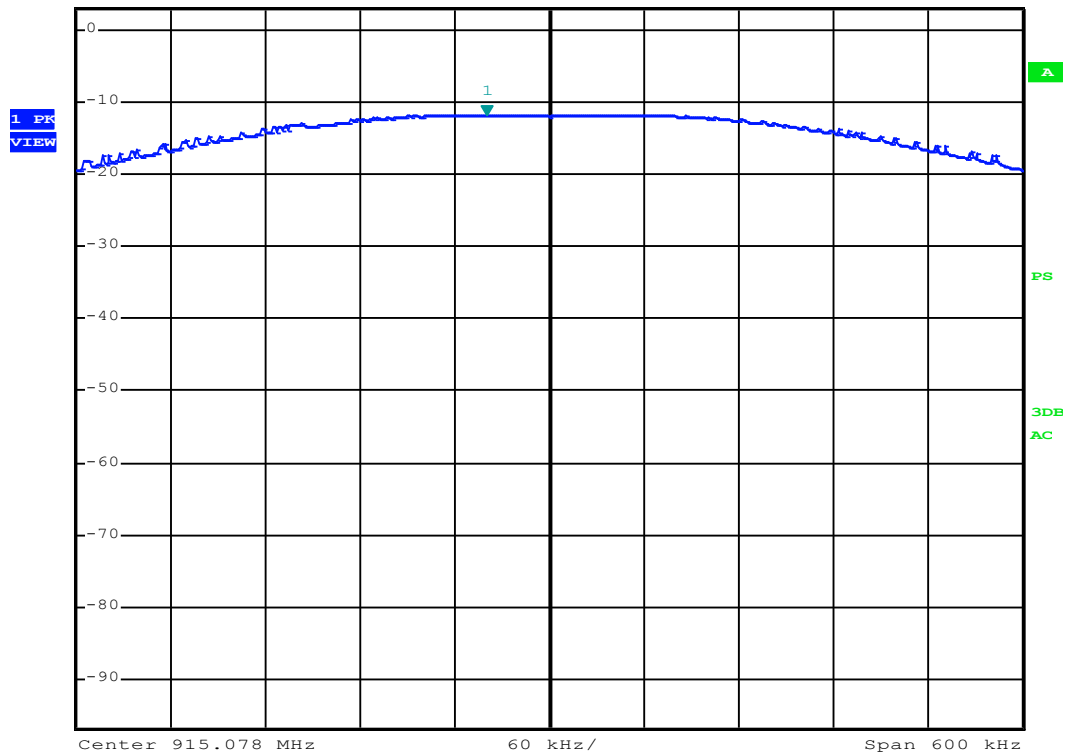


Date: 14.MAY.2014 11:26:37

**Figure 3: Output Power at LOW Frequency**



\*RBW 300 kHz Marker 1 [T1 ]  
VBW 1 MHz -11.73 dBm  
Ref 3 dBm Att 35 dB SWT 2.5 ms 915.038400000 MHz

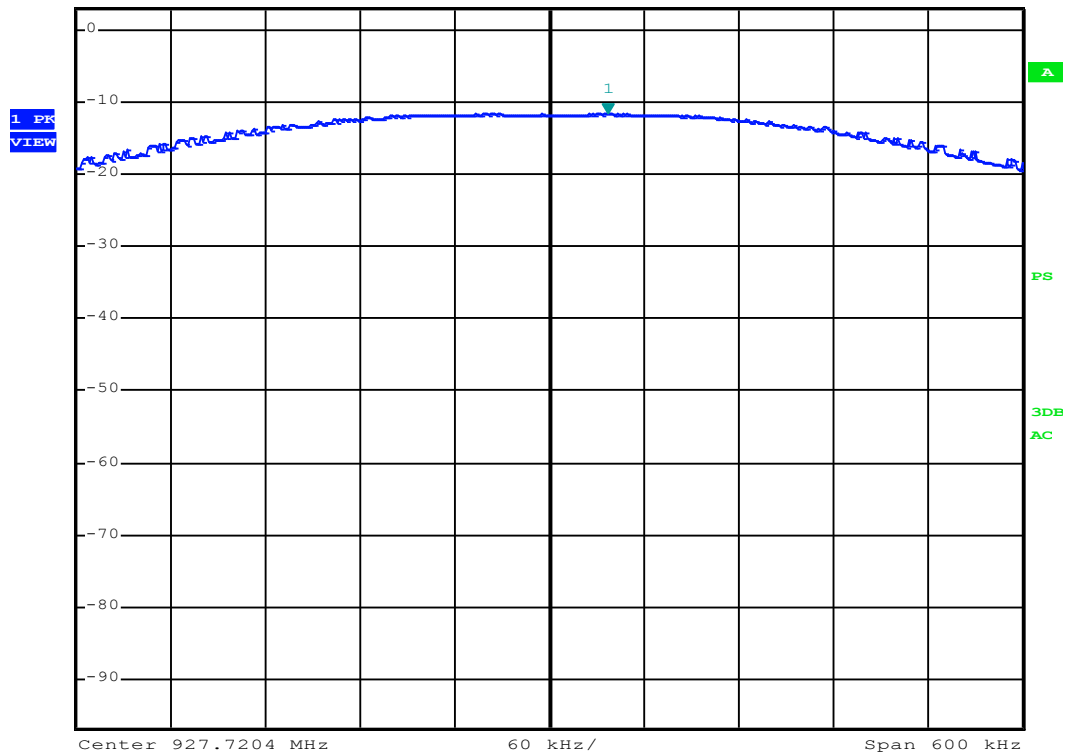


Date: 14.MAY.2014 11:27:25

**Figure 4: Output Power at MID Frequency**



★ RBW 300 kHz Marker 1 [T1 ]  
VBW 1 MHz -11.67 dBm  
Ref 3 dBm Att 35 dB SWT 2.5 ms 927.757600000 MHz

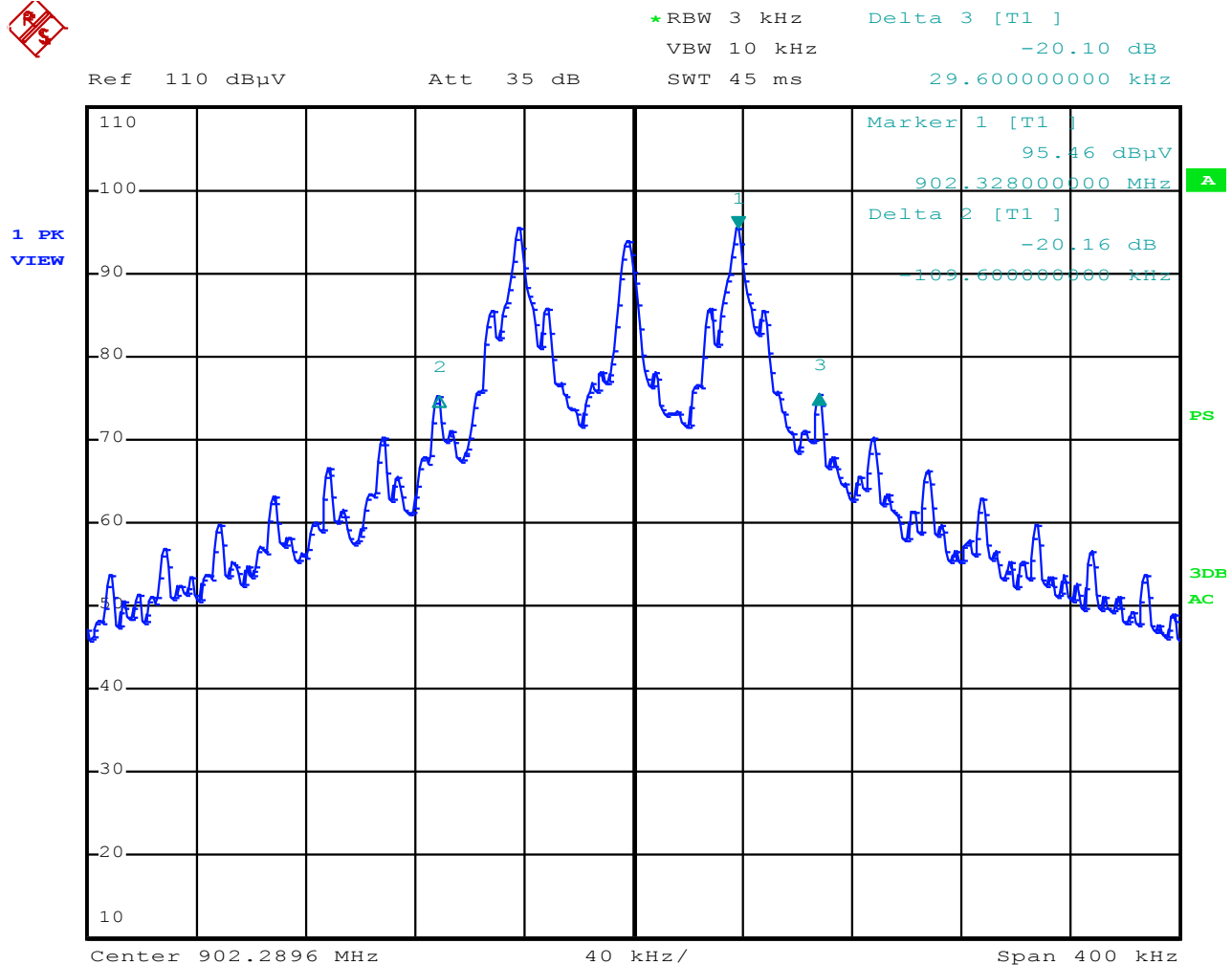


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**Figure 5: Output Power at HIGH Frequency**

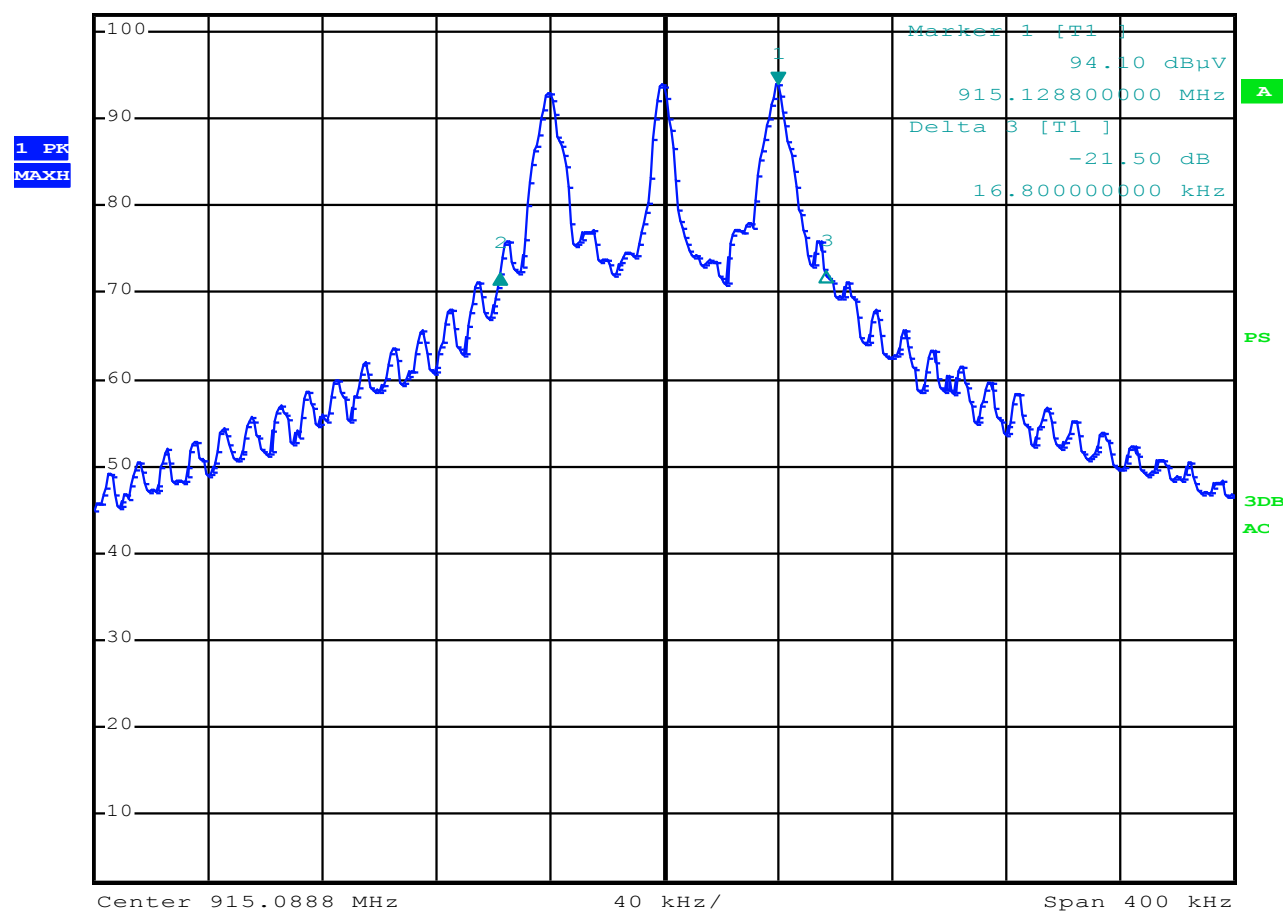
## Low Data Rate Tests

### 20 dB Bandwidth



Date: 14.MAY.2014 11:23:28

Figure 6: 20dB Bandwidth at LOW Frequency – 112.8 kHz



Date: 14.MAY.2014 10:05:45

**Figure 7: 20dB Bandwidth at MID Frequency – 114.4 kHz**



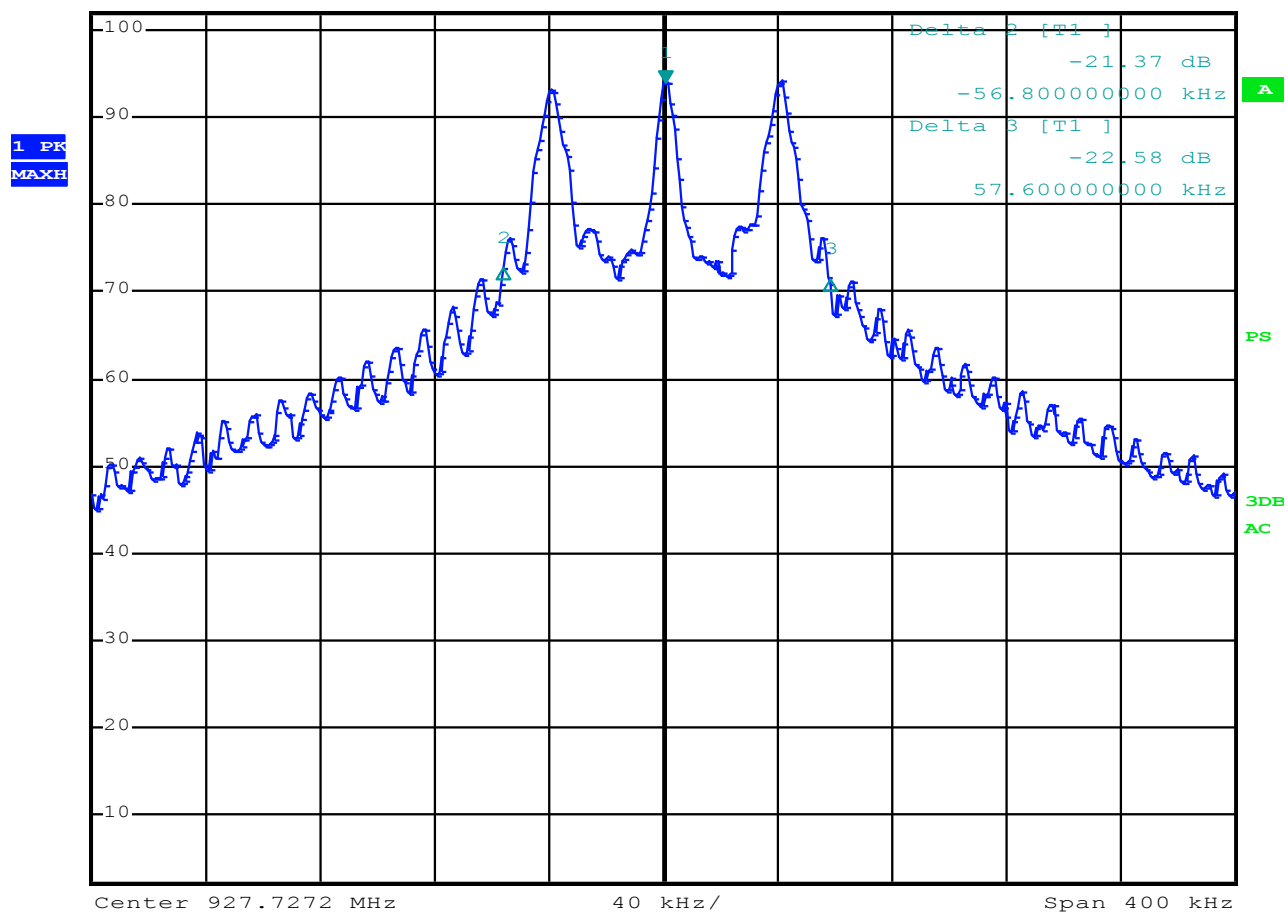
\*RBW 3 kHz      Marker 1 [T1 ]  
VBW 10 kHz      94.11 dBμV  
SWT 45 ms      927.728000000 MHz

Ref 102 dBμV

\*Att 10 dB

SWT 45 ms

927.728000000 MHz



Date: 14.MAY.2014 10:09:06

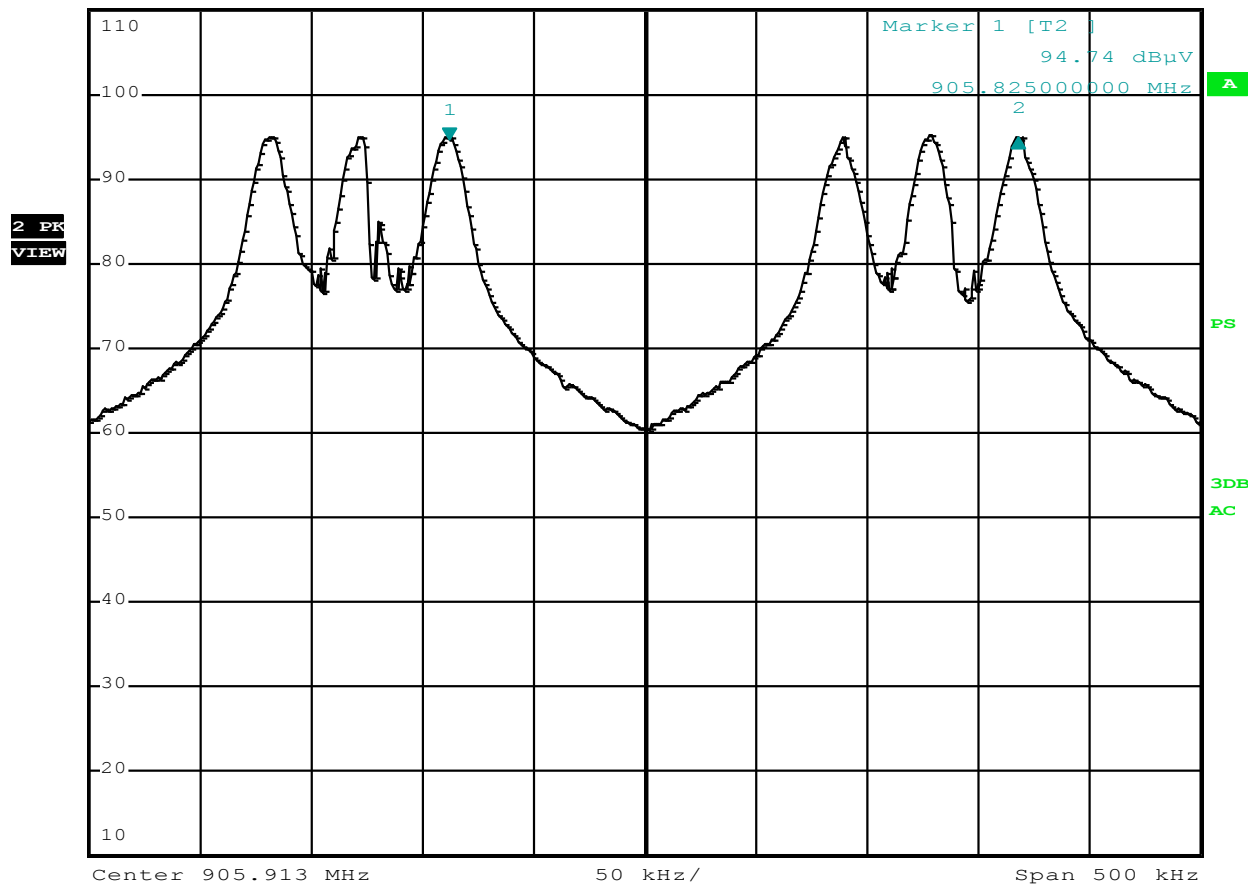
**Figure 8: 20dB Bandwidth at HIGH Frequency – 114.4 kHz**



## Channel Separation



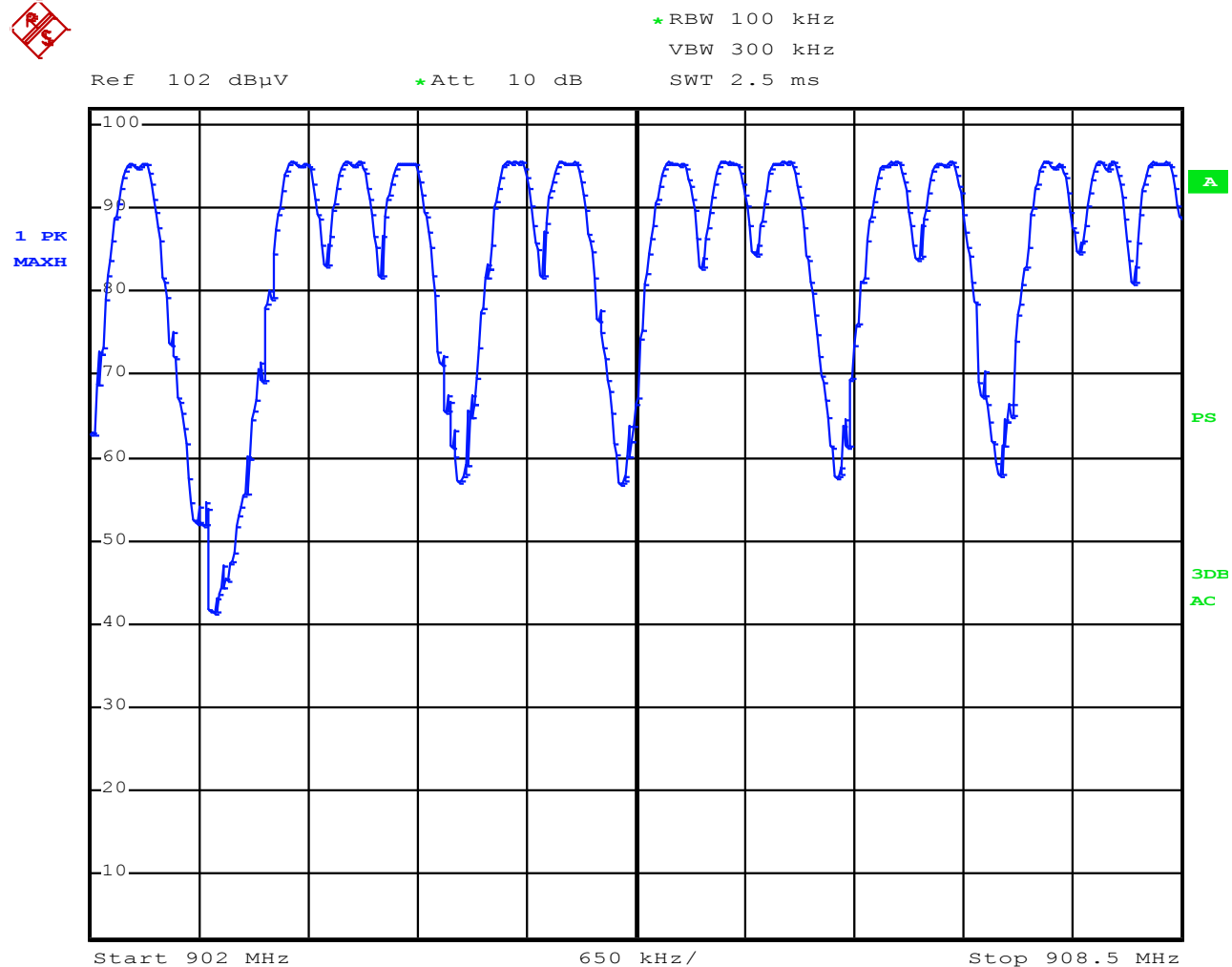
★ RBW 10 kHz      Delta 2 [T2 ]  
★ VBW 3 kHz      0.15 dB  
Ref 110 dBμV      Att 35 dB      SWT 20 ms      256.00000000 kHz



Date: 14.MAY.2014 11:10:34

Figure 9: Channel Separation = 256.0 kHz

## Number of Hopping Channels

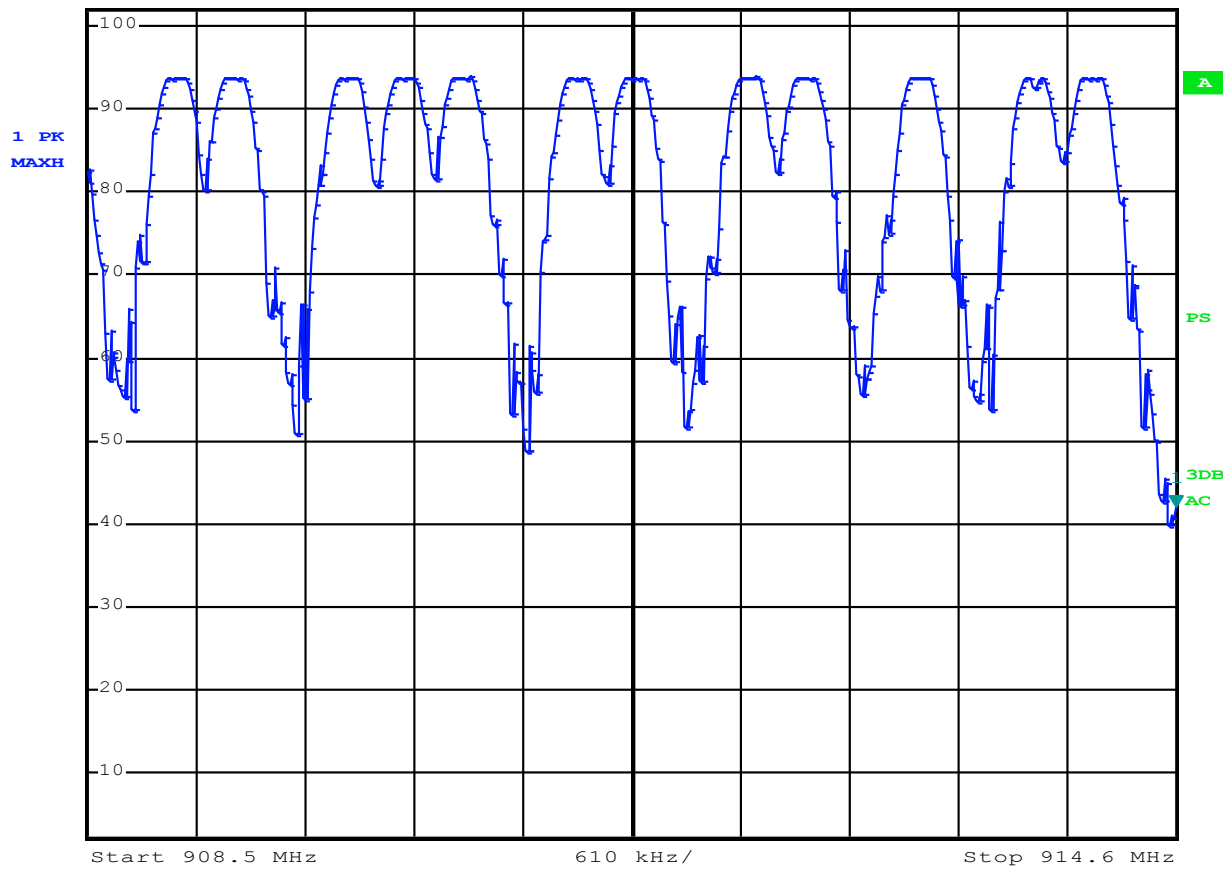


Date: 14.MAY.2014 10:15:10

**Figure 10: Number of Hopping Frequencies 902MHz to 908MHz - 14 Frequencies**

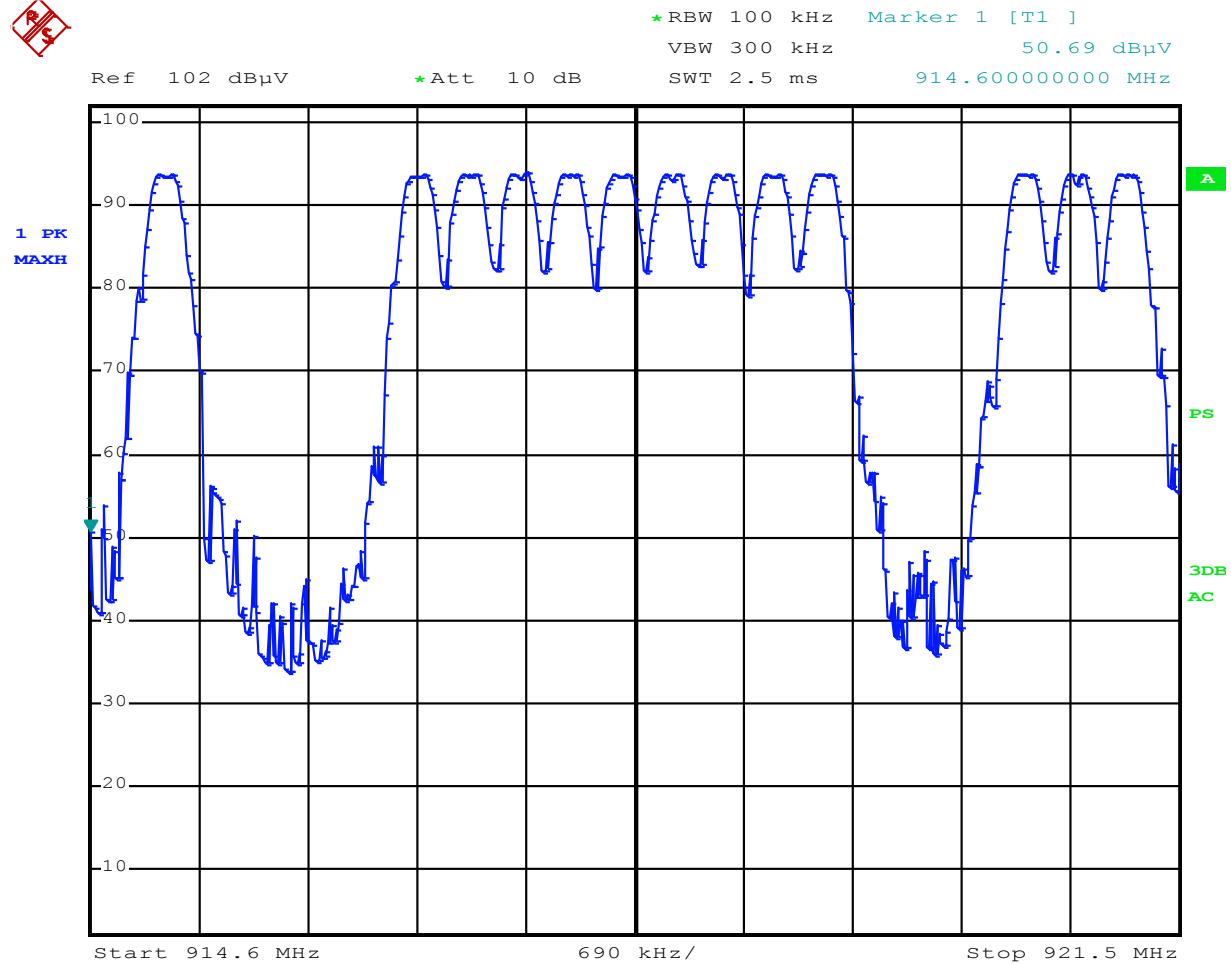


\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz 42.09 dBμV  
Ref 102 dBμV \*Att 10 dB SWT 2.5 ms 914.600000000 MHz



Date: 14.MAY.2014 10:19:33

**Figure 11: Number of Hopping Frequencies 908MHz to 914.6MHz - 12 Frequencies**

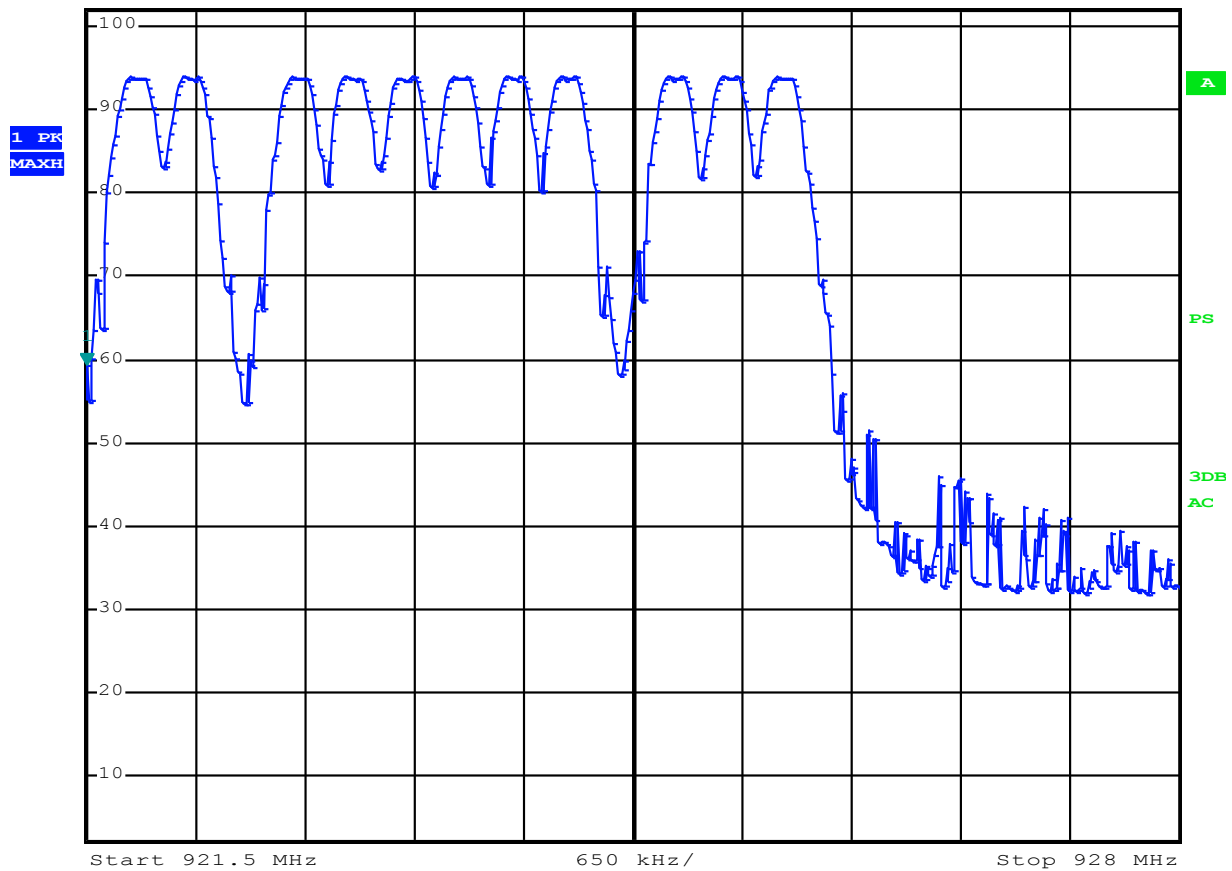


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**Figure 12: Number of Hopping Frequencies 914.6MHz to 921.5MHz - 13 Frequencies**



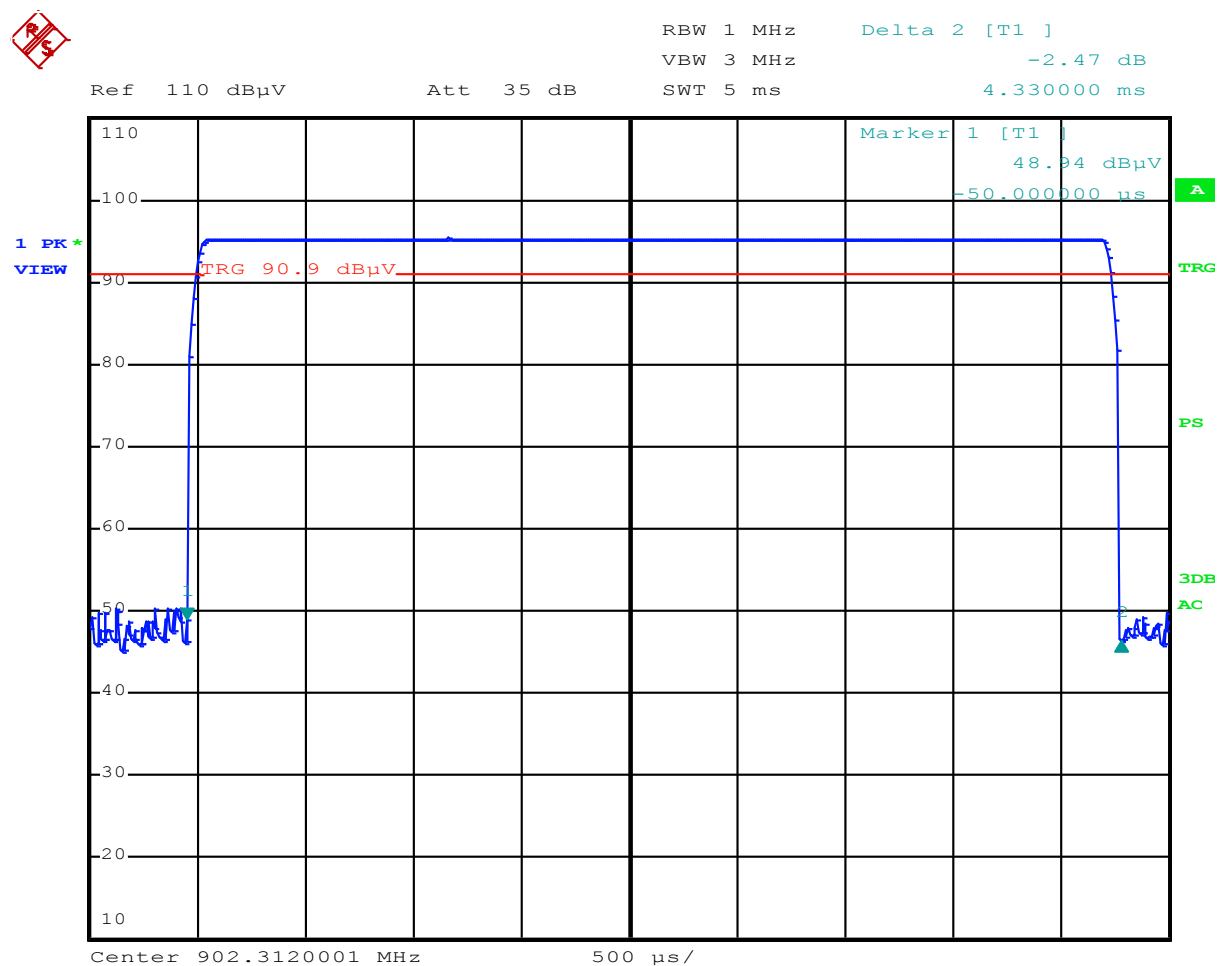
\*RBW 100 kHz Marker 1 [T1 ]  
VBW 300 kHz 59.23 dBμV  
Ref 102 dBμV \*Att 10 dB SWT 2.5 ms 921.500000000 MHz



Date: 14.MAY.2014 10:23:21

Figure 13: Number of Hopping Frequencies 921.5MHz to 928MHz - 11 Frequencies

## Dwell Time and Time of Occupancy



Date: 14.MAY.2014 10:38:27

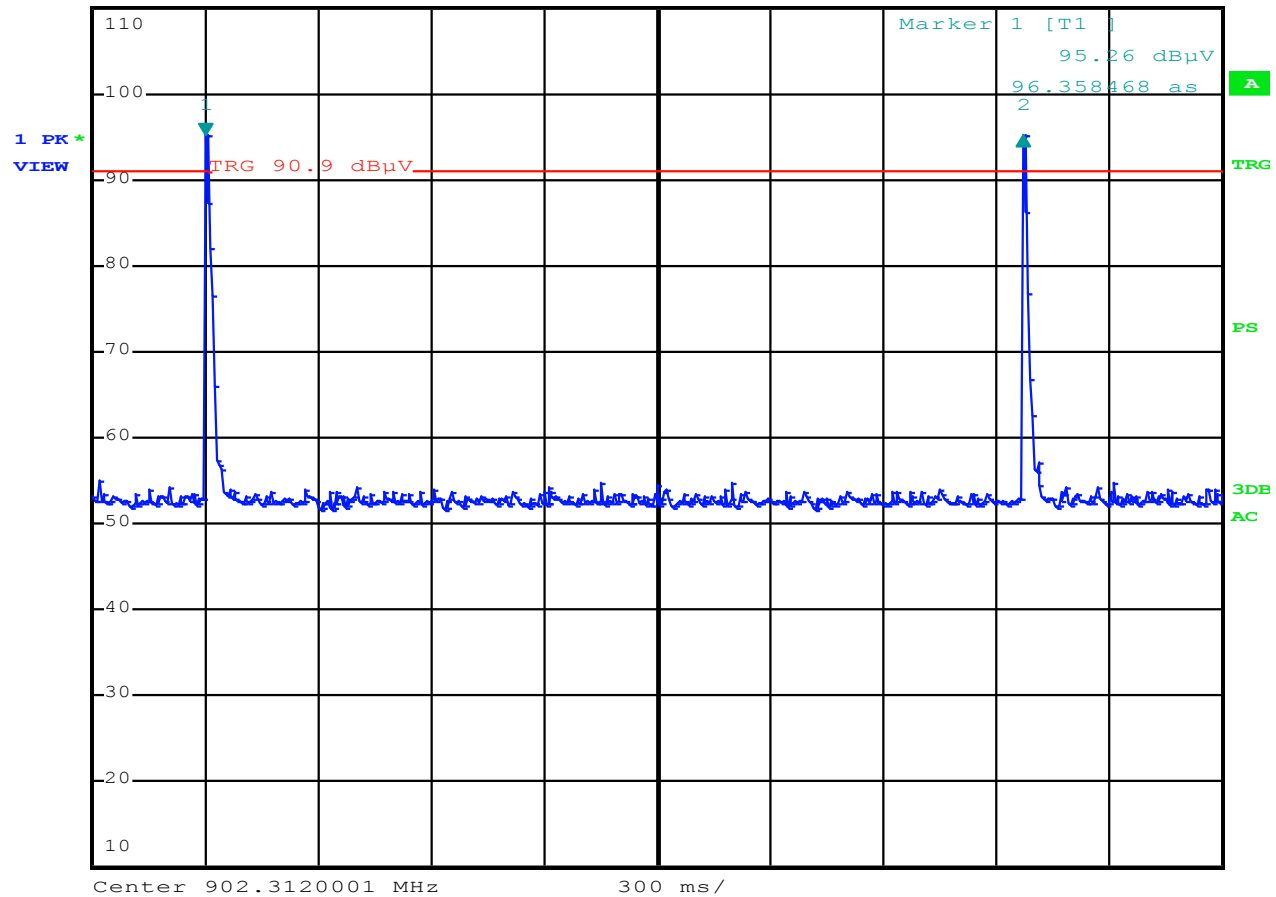
**Figure 14: Dwell Time – 4.33mS**



RBW 1 MHz Delta 2 [T1 ]  
VBW 3 MHz 0.04 dB  
SWT 3 s 2.172000 s

Ref 110 dBμV

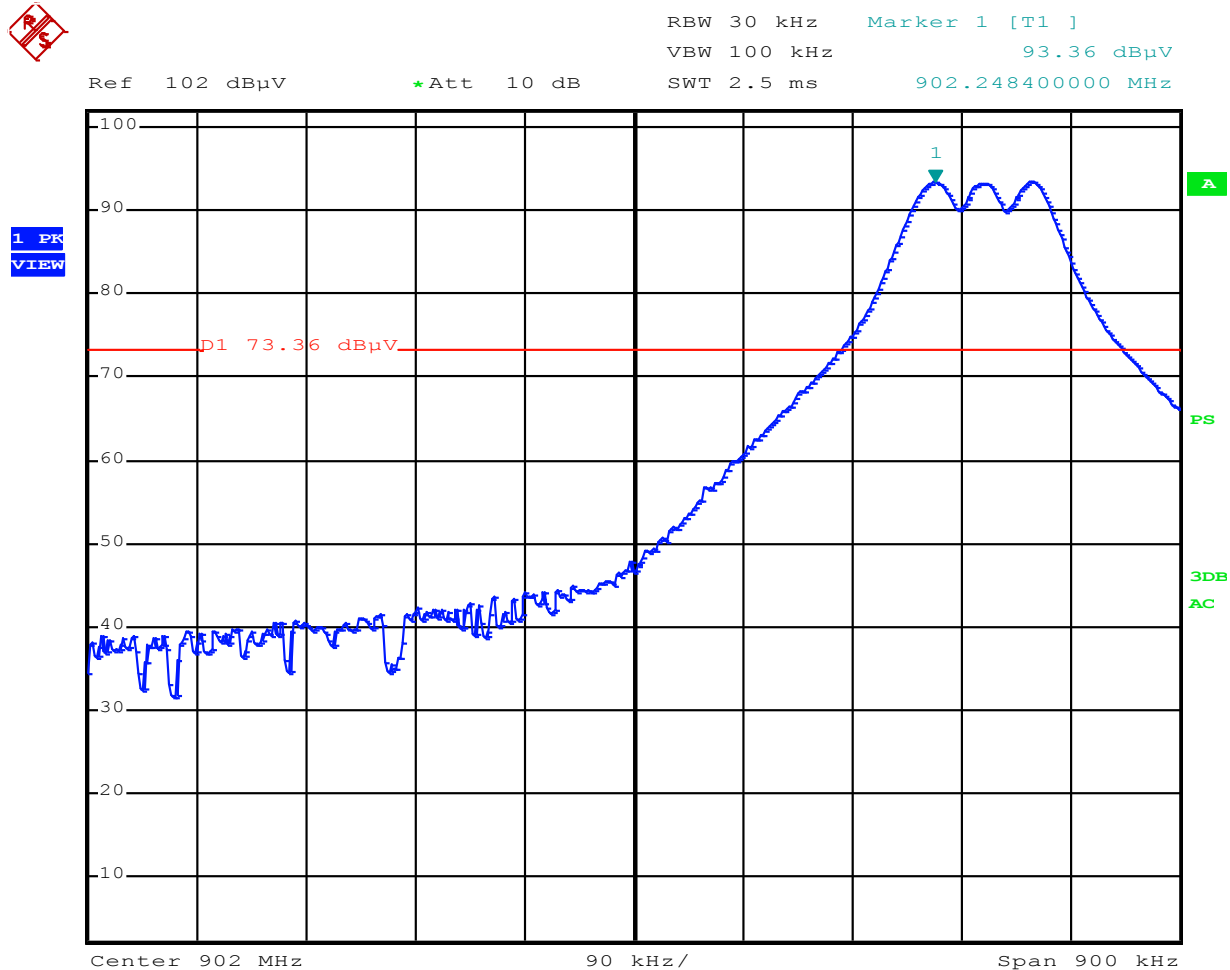
Att 35 dB



Date: 14.MAY.2014 10:41:12

**Figure 15: Time Occupancy Per Frequency – 46.32mS\***

(\* Time between 2 consecutive transmissions on the same frequency is 2.17 Seconds, dwell time per frequency is 4.33 mS, therefore occupancy time per frequency within a 20 Second period is 39.9mS)

**Channel Bandedge**

Date: 14.MAY.2014 08:38:52

**Figure 16: Low Channel Bandedge**





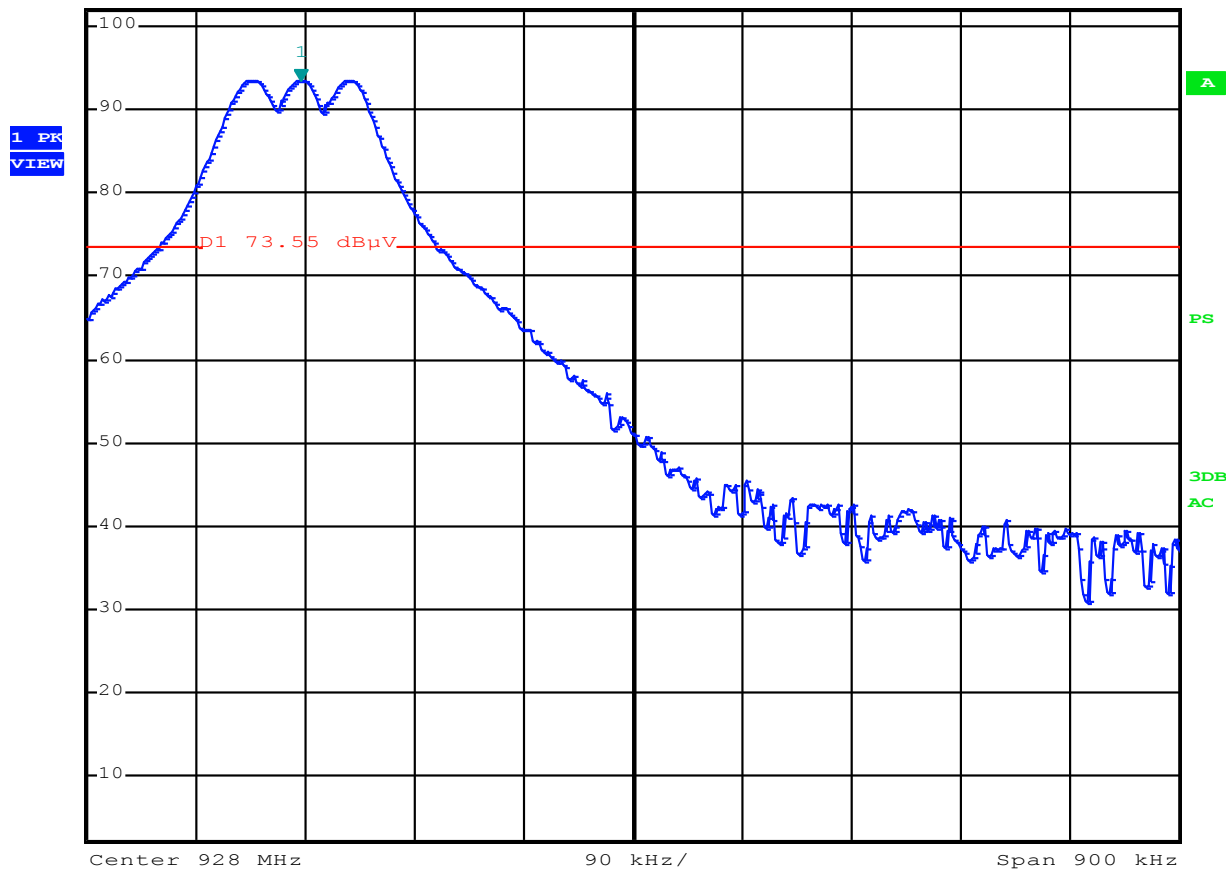
\*RBW 30 kHz Marker 1 [T1 ]  
VBW 100 kHz 93.55 dBμV  
SWT 2.5 ms 927.726400000 MHz

Ref 102 dBμV

\*Att 10 dB

SWT 2.5 ms

927.726400000 MHz

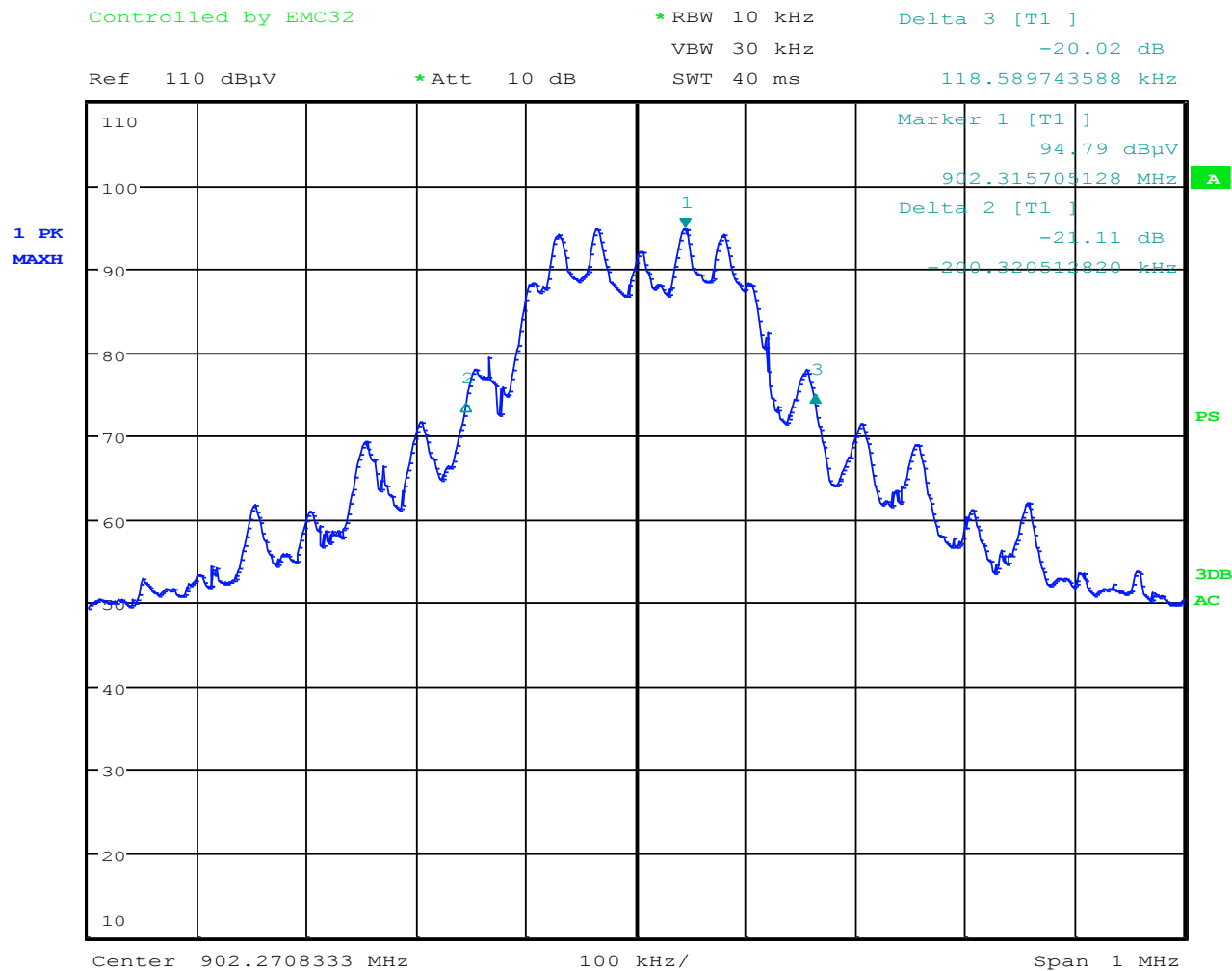


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Figure 17: High Channel Bandedge

## High Data Rate Tests

### 20 dB Bandwidth



TTTTTT

Date: 16.MAY.2014 15:20:49

Figure 18: 20dB Bandwidth at LOW Frequency – 318.8 kHz

Controlled by EMC32

\* RBW 10 kHz

Delta 3 [T1 ]

VBW 30 kHz

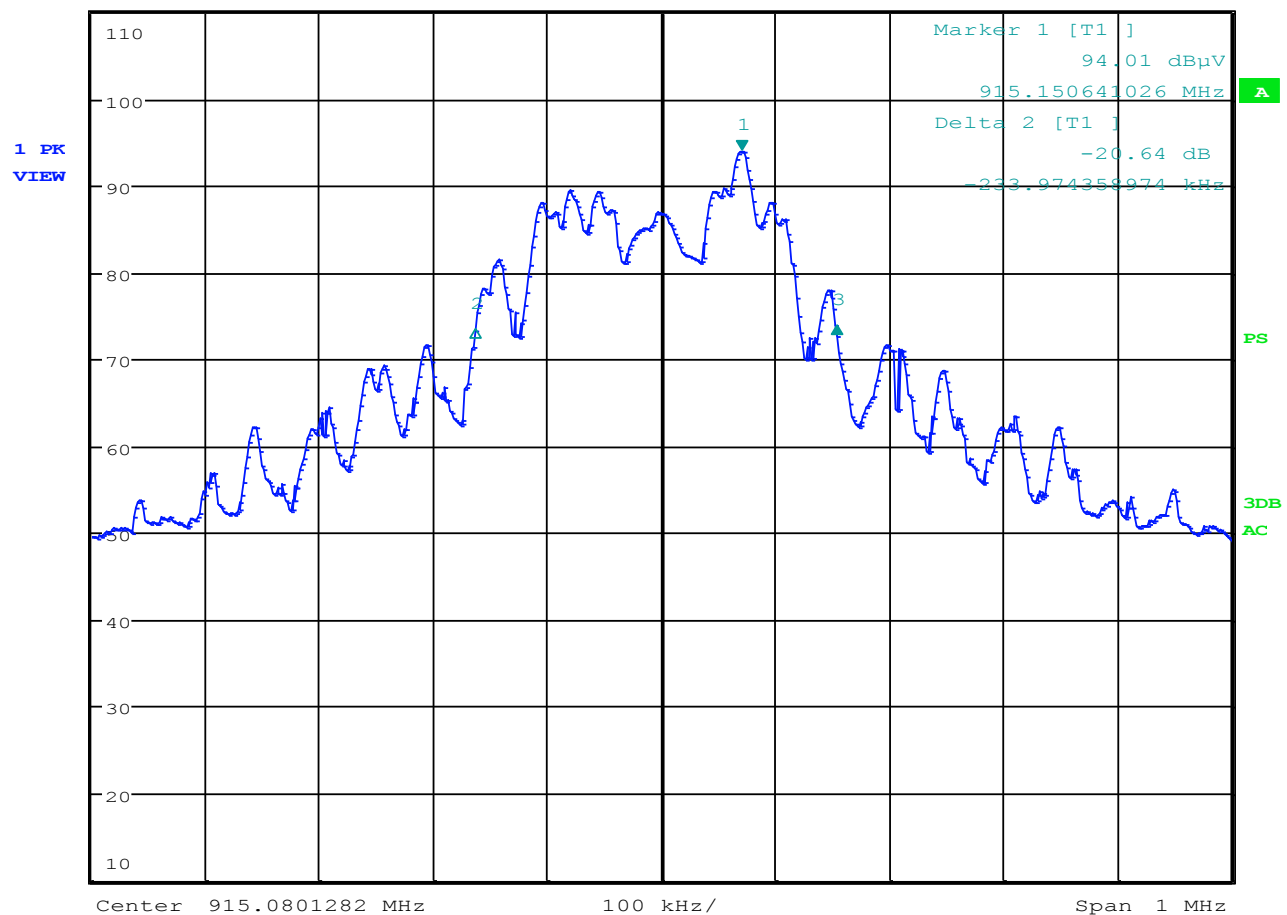
-20.35 dB

Ref 110 dBμV

\* Att 10 dB

SWT 40 ms

83.33333333 kHz



TTTTTT

Date: 16.MAY.2014 15:13:28

Figure 19: 20dB Bandwidth at MID Frequency – 317.3 kHz

Controlled by EMC32

\*RBW 10 kHz

Delta 2 [T1 ]

VBW 30 kHz

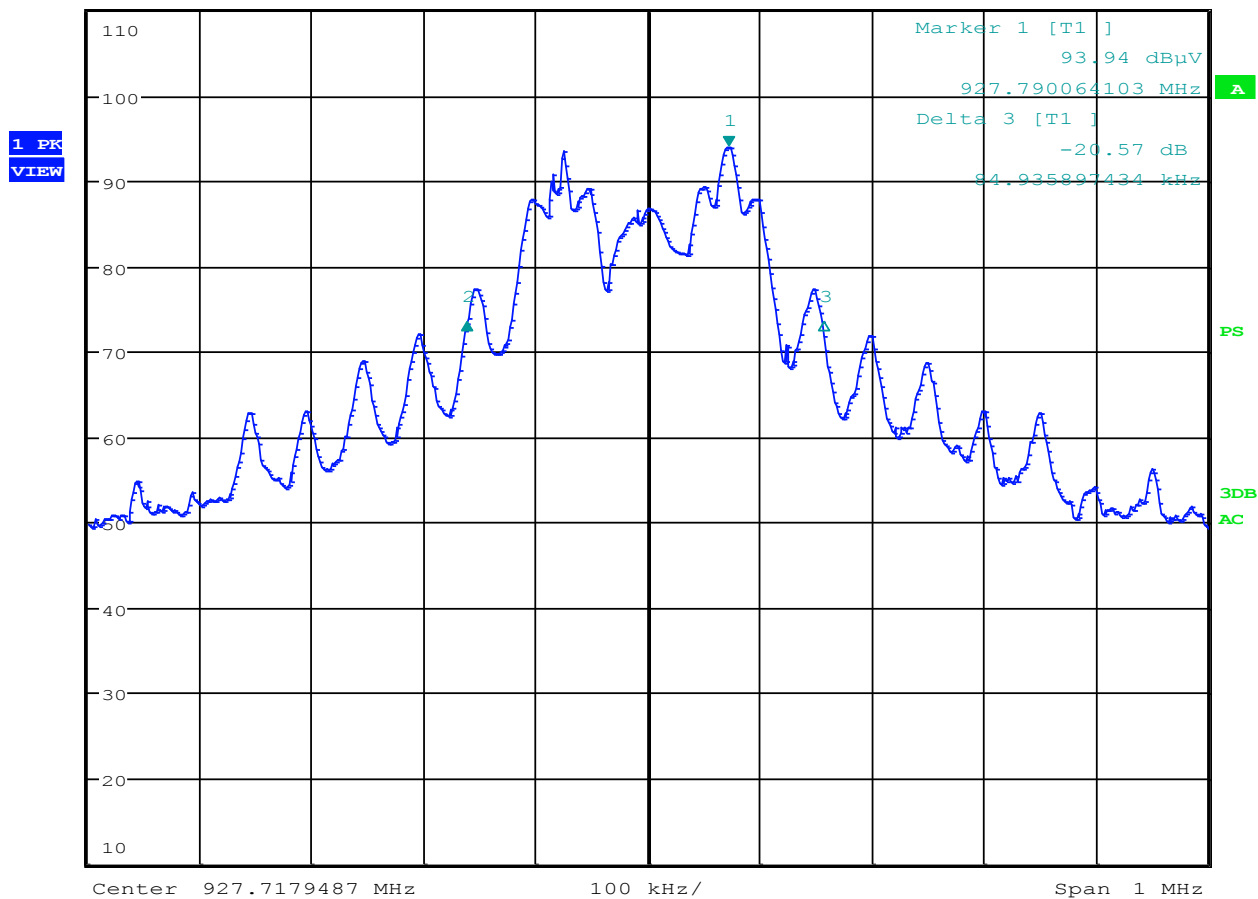
-20.56 dB

Ref 110 dBμV

\*Att 10 dB

SWT 40 ms

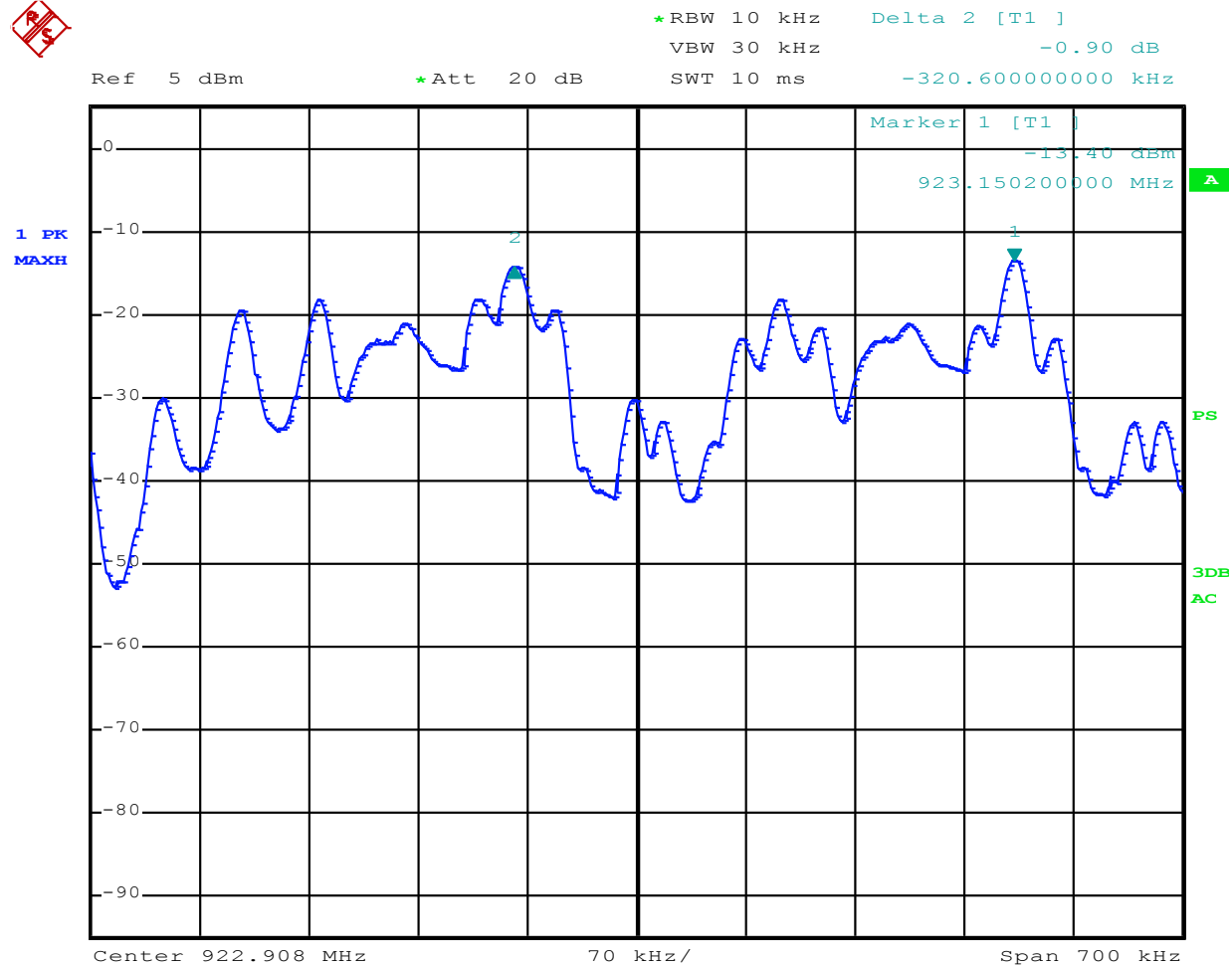
-233.974358973 kHz



TTTTTT

Date: 16.MAY.2014 15:40:49

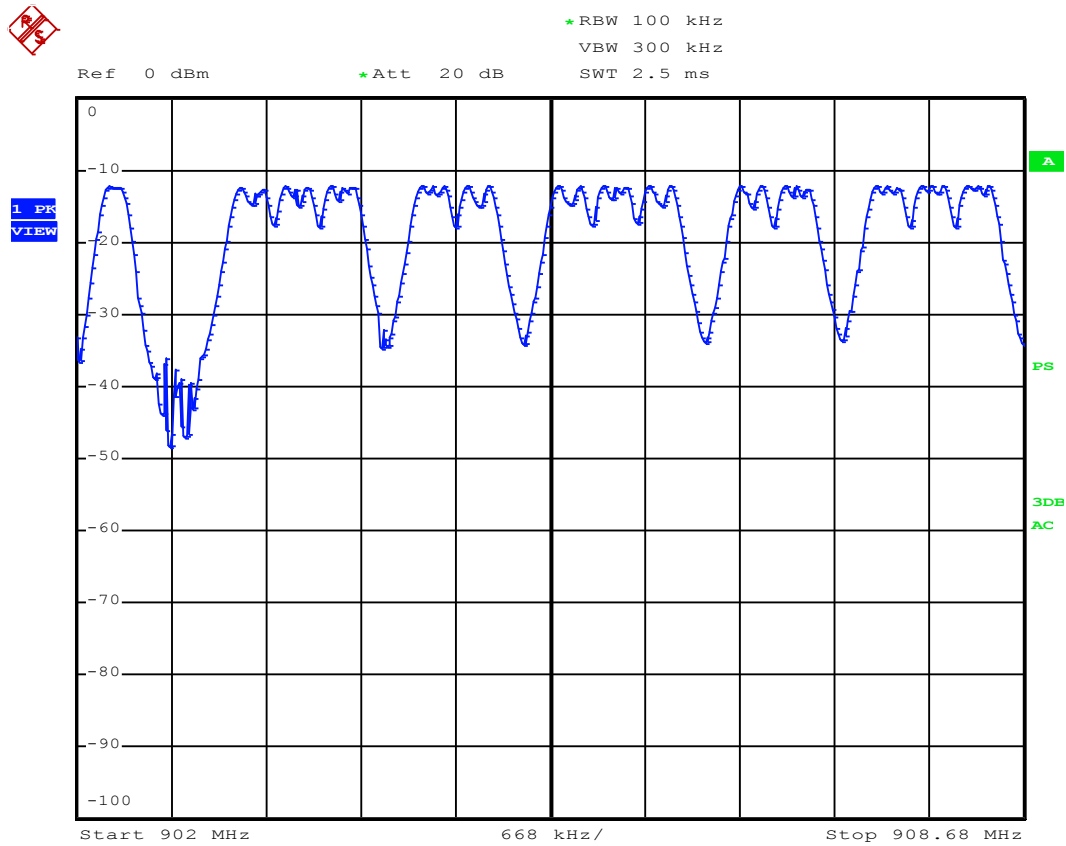
**Figure 20: 20dB Bandwidth at HIGH Frequency – 318.9 kHz**

**Channel Separation**

Date: 14.MAY.2014 16:19:25

**Figure 21: Channel Separation = 320.6kHz**

## Number of Hopping Channels



Date: 14.MAY.2014 15:55:16

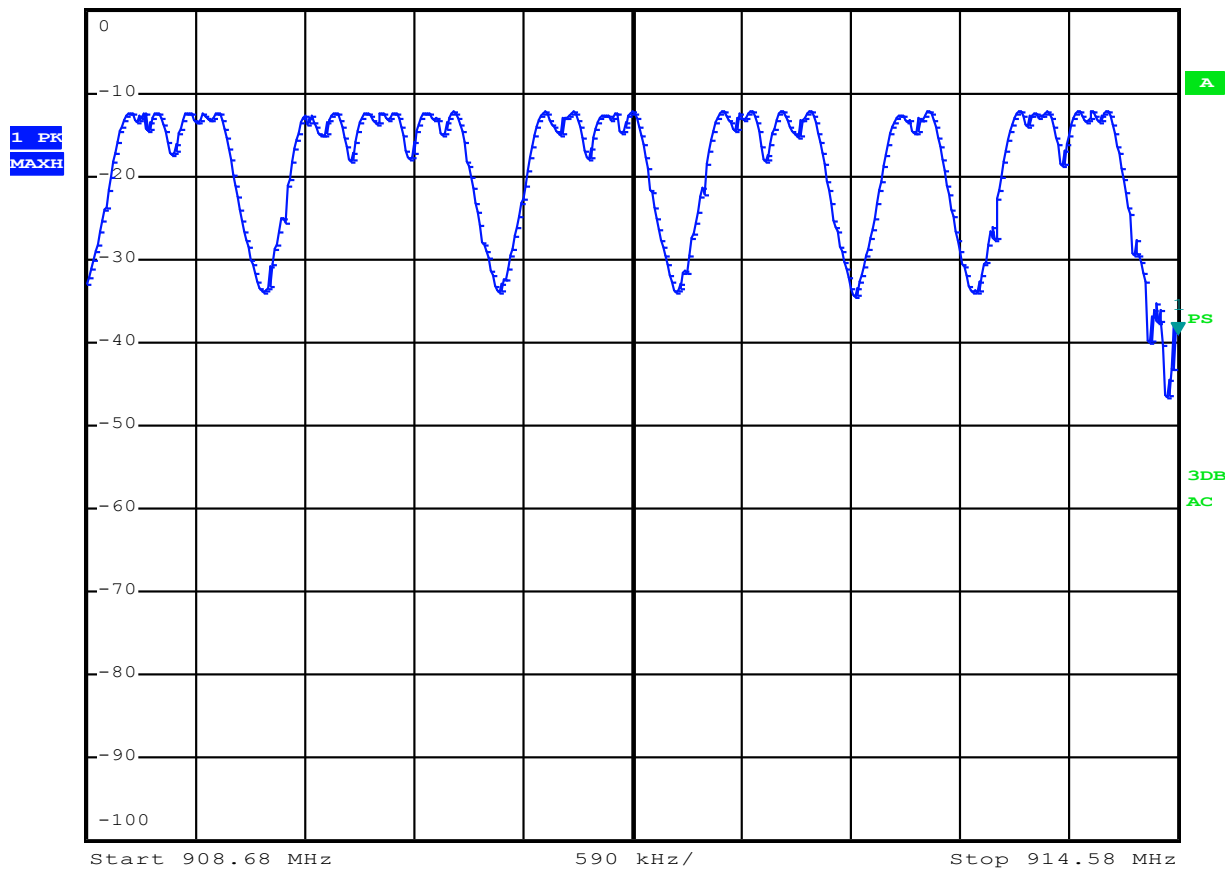
**Figure 22: Number of Hopping Frequencies 902MHz to 908.7MHz - 14 Frequencies**



\*RBW 100 kHz Marker 1 [T1 ]

VBW 300 kHz -38.96 dBm

Ref 0 dBm \*Att 20 dB SWT 2.5 ms 914.58000000 MHz



Date: 14.MAY.2014 15:57:28

**Figure 23: Number of Hopping Frequencies 908.7MHz to 9014.6MHz - 12  
Frequencies**



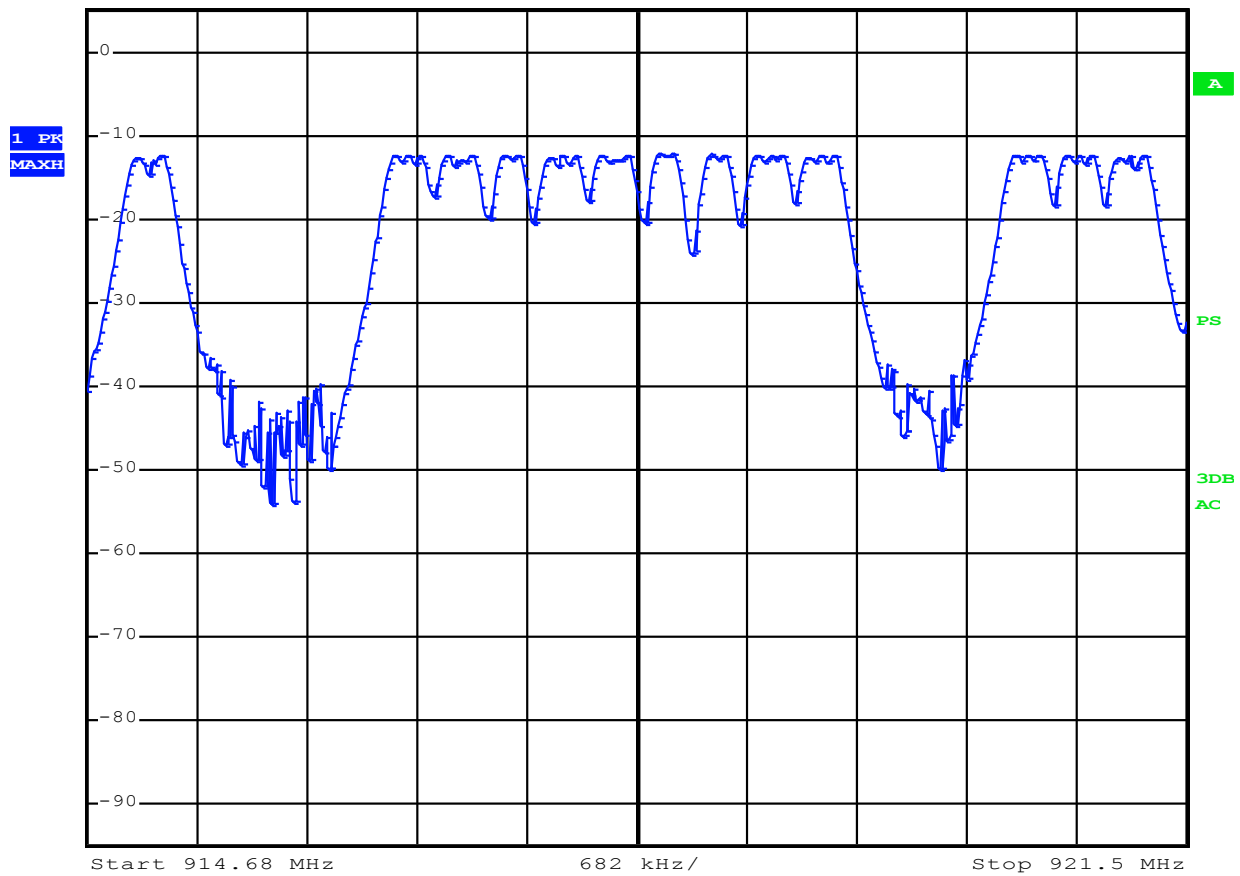
\*RBW 100 kHz

VBW 300 kHz

Ref 5 dBm

\*Att 20 dB

SWT 2.5 ms



Date: 14.MAY.2014 16:00:33

**Figure 24: Number of Hopping Frequencies 914.7MHz to 921.5MHz - 13 Frequencies**





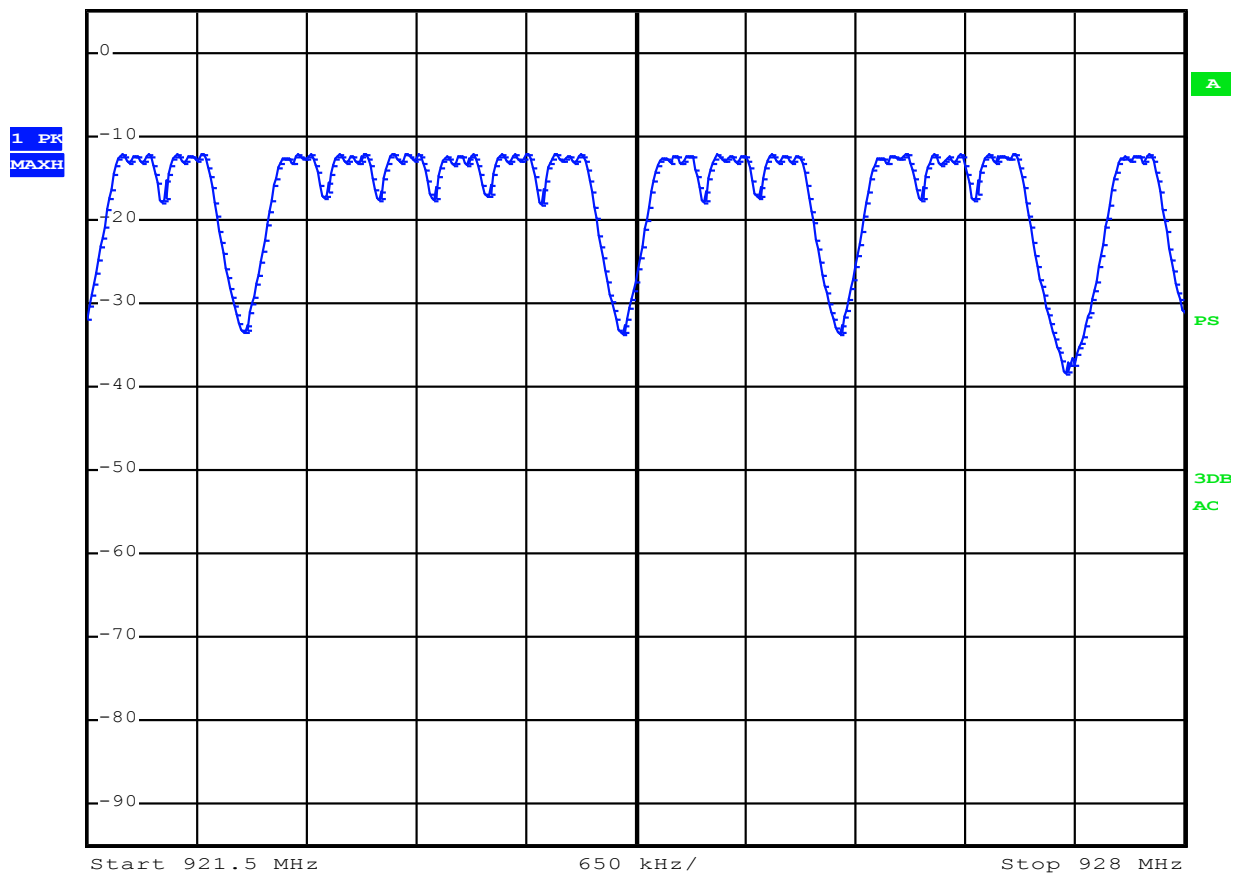
\*RBW 100 kHz

VBW 300 kHz

Ref 5 dBm

\*Att 20 dB

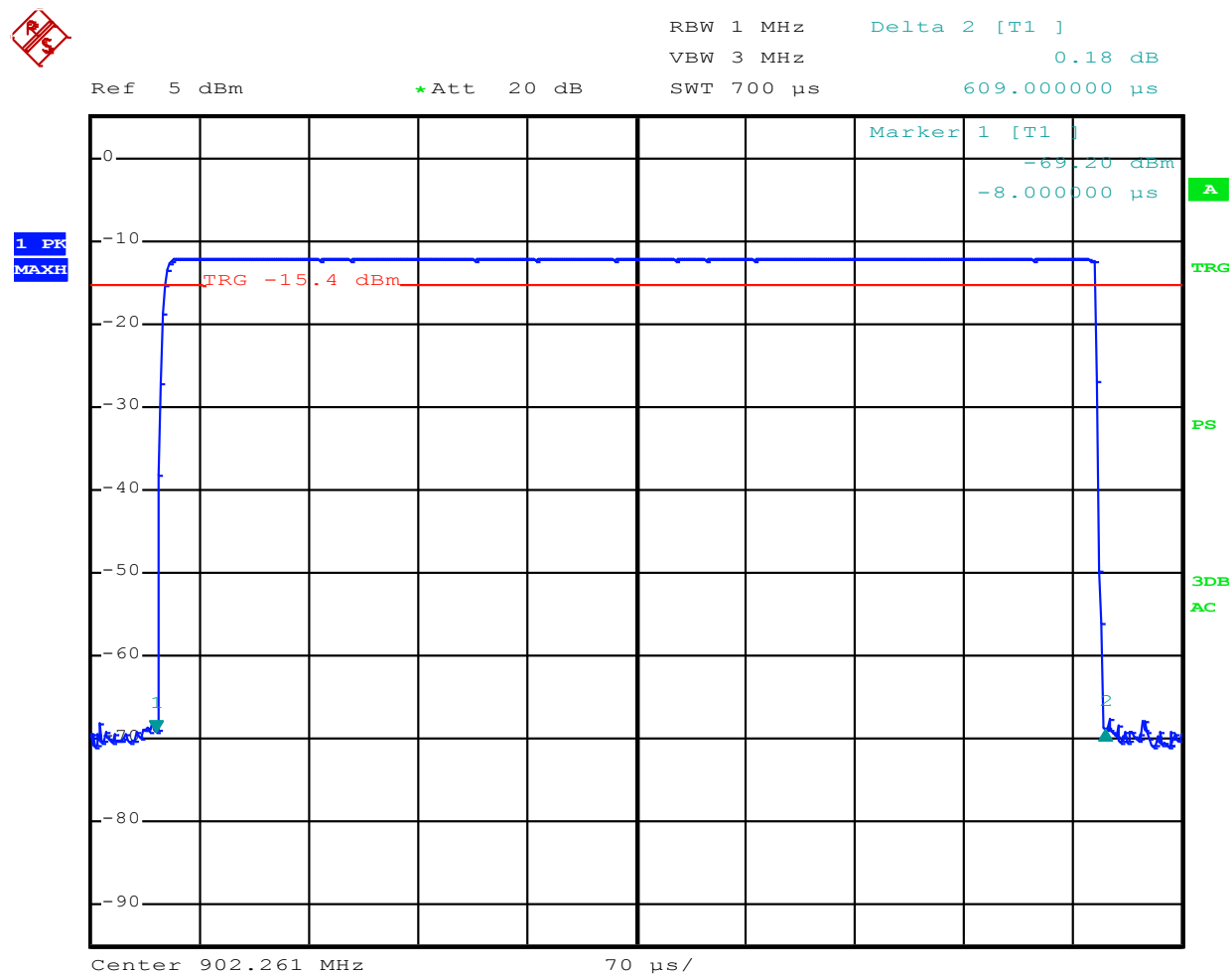
SWT 2.5 ms



Date: 14.MAY.2014 16:05:26

**Figure 25: Number of Hopping Frequencies 921.5MHz to 928MHz - 15 Frequencies**

## Dwell Time and Time of Occupancy



Date: 14.MAY.2014 16:40:30

Figure 26: Dwell Time – 617  $\mu$ s



RBW 1 MHz Delta 2 [T1 ]

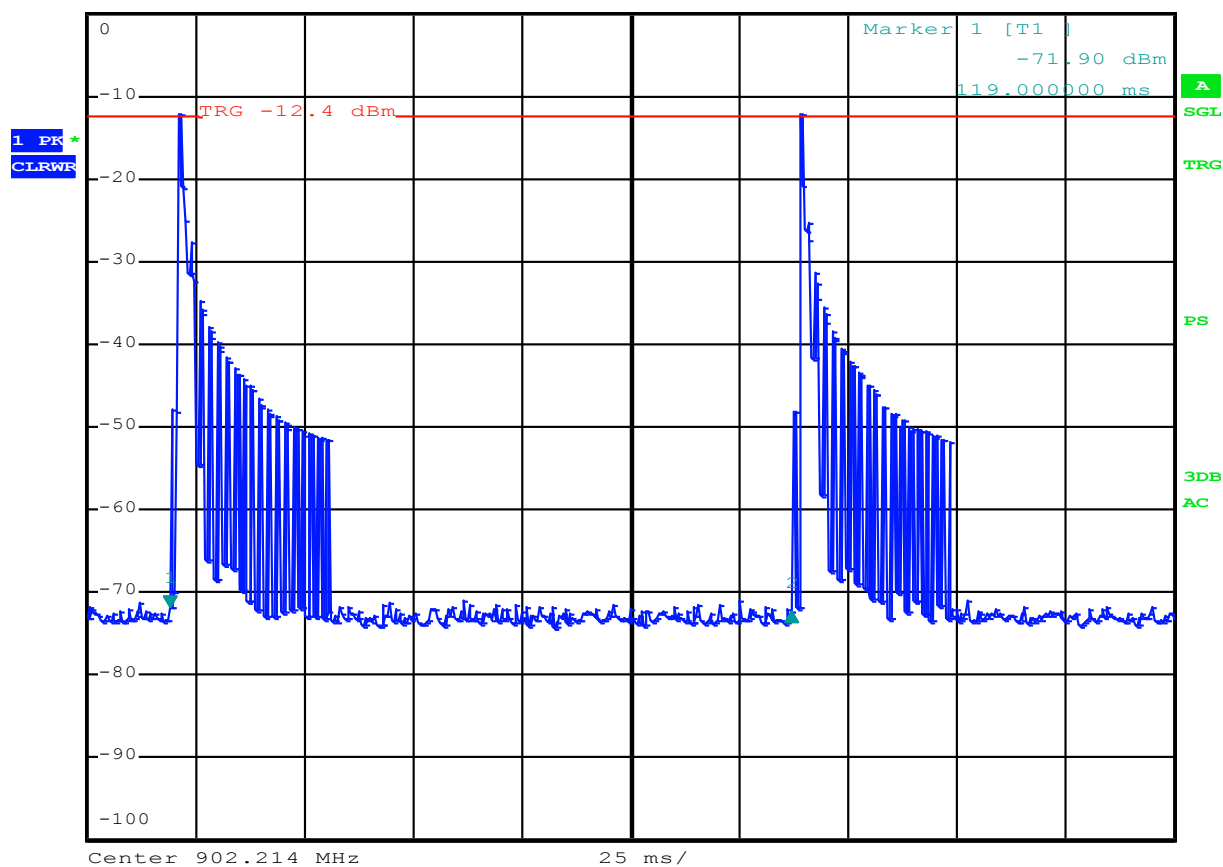
VBW 3 MHz -0.37 dB

Ref 0 dBm

\*Att 15 dB

SWT 250 ms

143.000000 ms



Date: 15.MAY.2014 09:05:39

**Figure 27: Time Occupancy Per Frequency – 143ms\***

(\* Time between 2 consecutive transmissions on the same frequency is 0.143 Seconds, dwell time per frequency is 0.617mS, therefore occupancy time per frequency within a 20 Second period is 86.3 mS)

### Channel Bandedge



\* RBW 10 kHz

Delta 2 [T1]

VBW 30 kHz

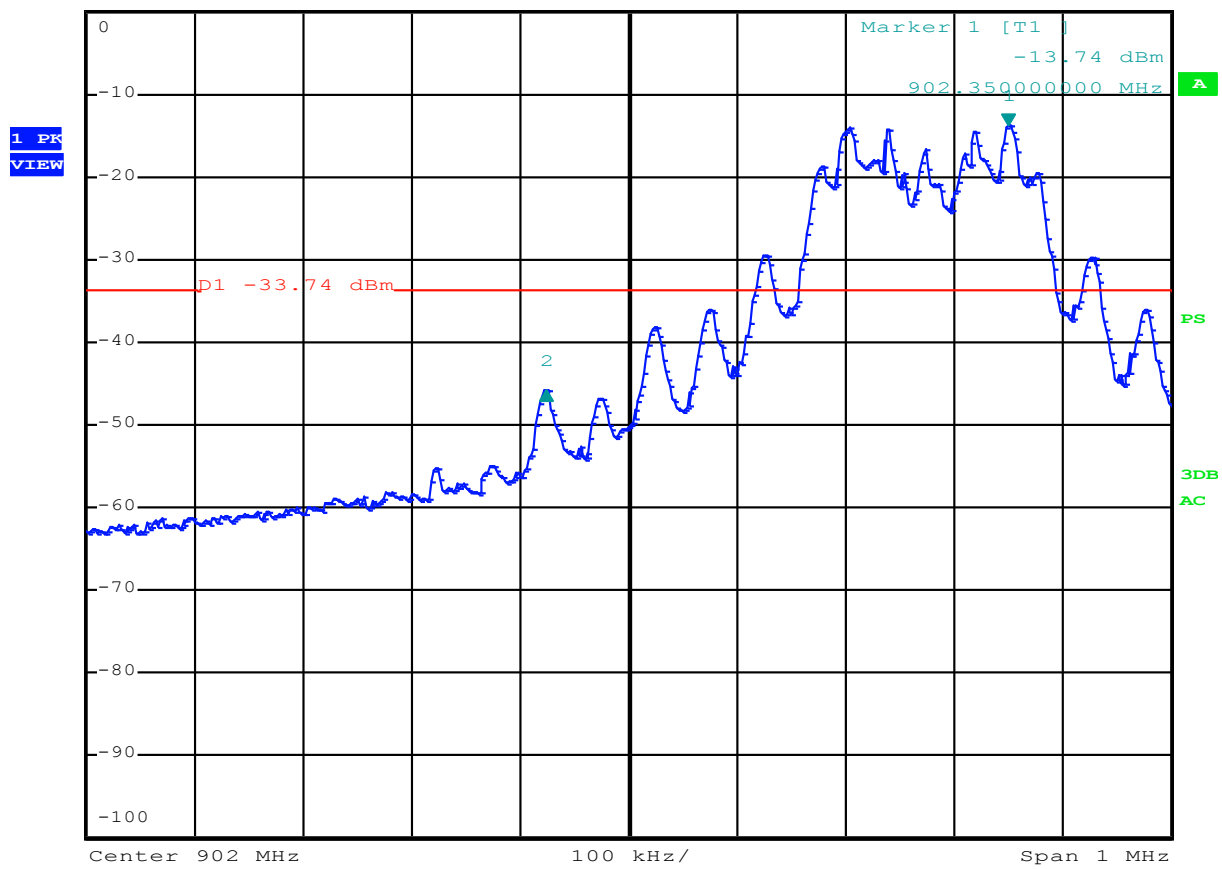
-32.07 dB

Ref 0 dBm

\* Att 20 dB

SWT 10 ms

-426.000000000 kHz



Date: 14.MAY.2014 15:42:55

Figure 28: Low Channel Bandedge

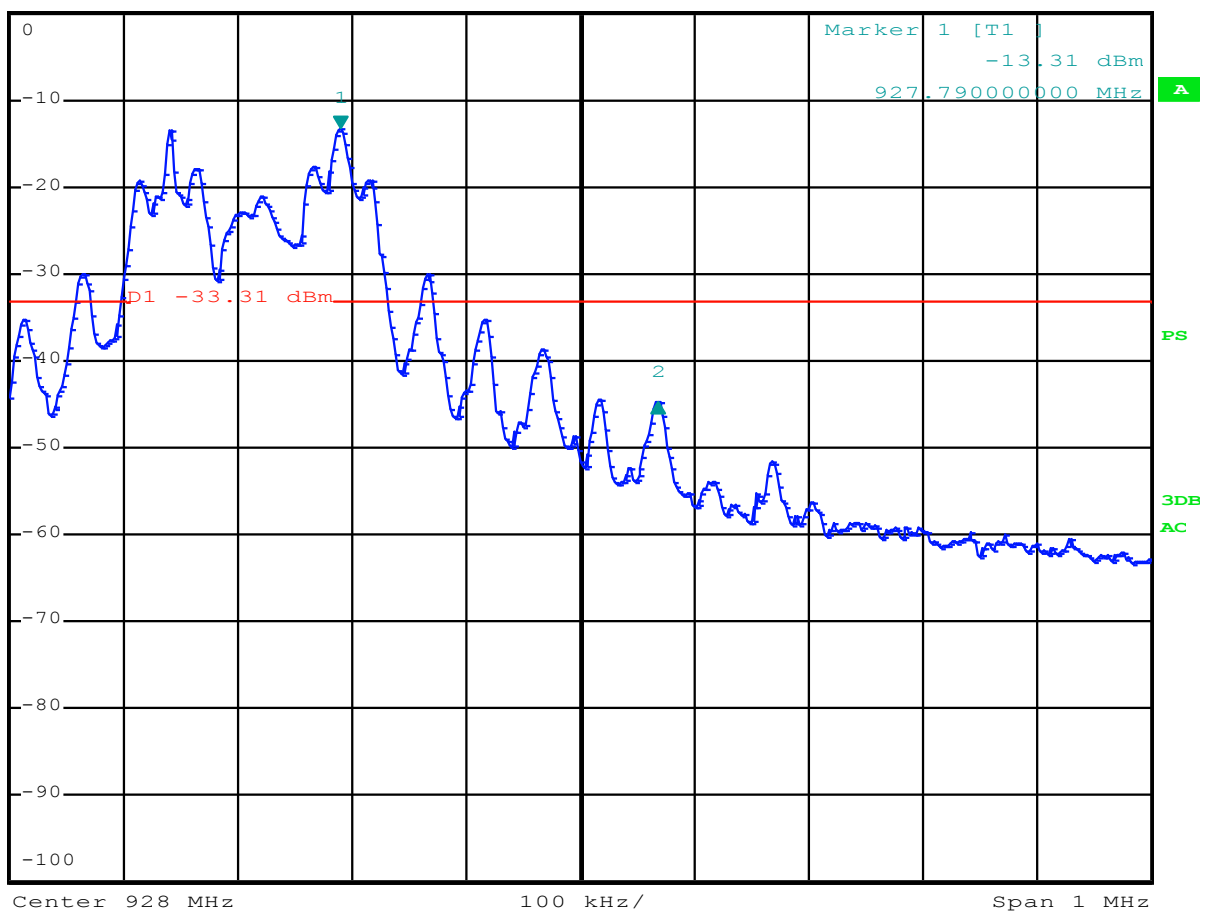


\*RBW 10 kHz Delta 2 [T1 ]  
VBW 30 kHz -31.37 dB  
SWT 10 ms 278.000000000 kHz

Ref 0 dBm

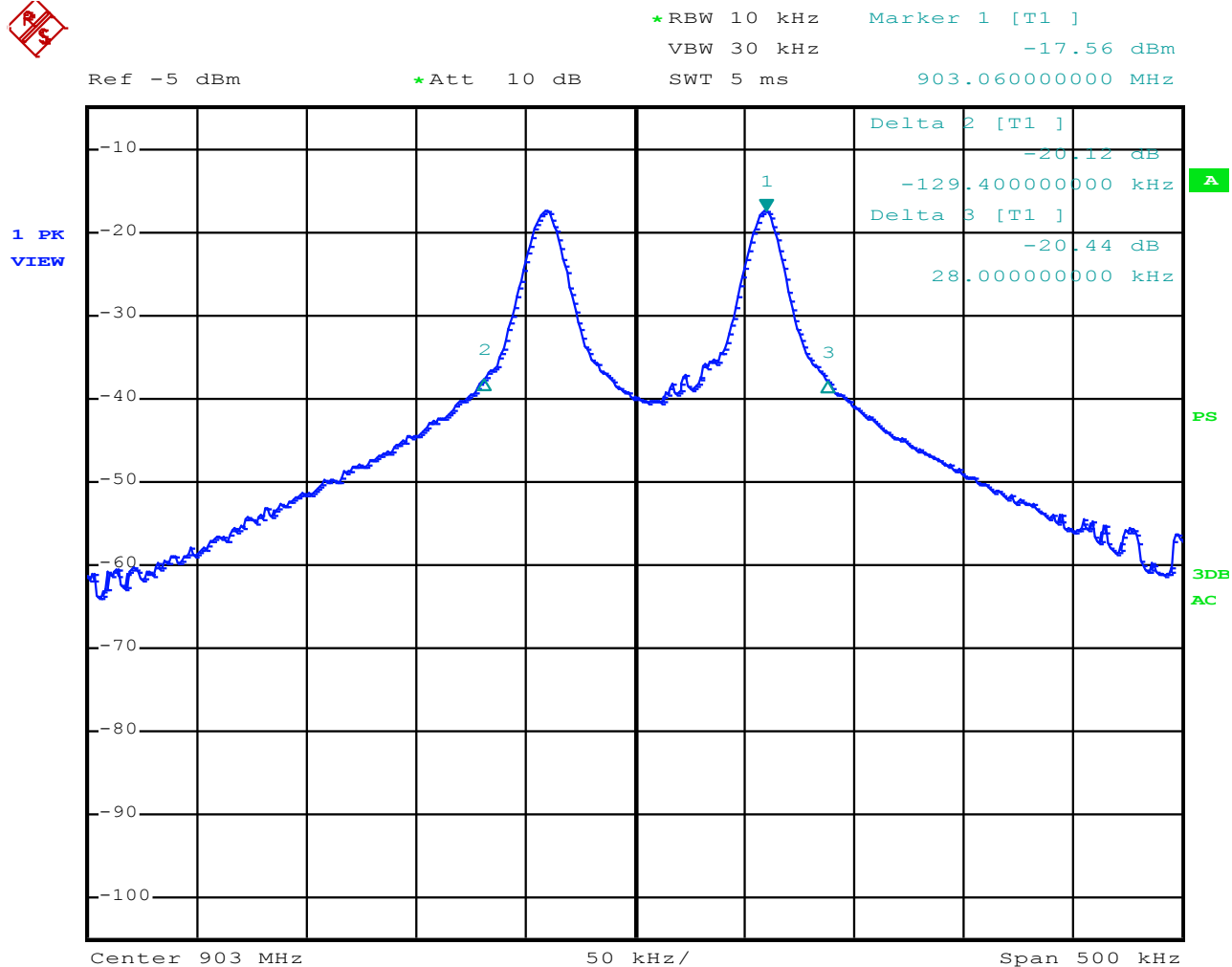
\*Att 20 dB

1 PK  
VIEW



Date: 14.MAY.2014 15:45:27

Figure 29: High Channel Bandedge

**Tests when unit is communicating to OEM Part 15 approved Device****20 dB Bandwidth**

Date: 15.MAY.2014 11:21:18

**Figure 30: 20dB Bandwidth at LOW Frequency – 157.4 kHz**



\*RBW 10 kHz Delta 3 [T1 ]  
VBW 30 kHz -20.24 dB  
SWT 5 ms 128.000000000 kHz

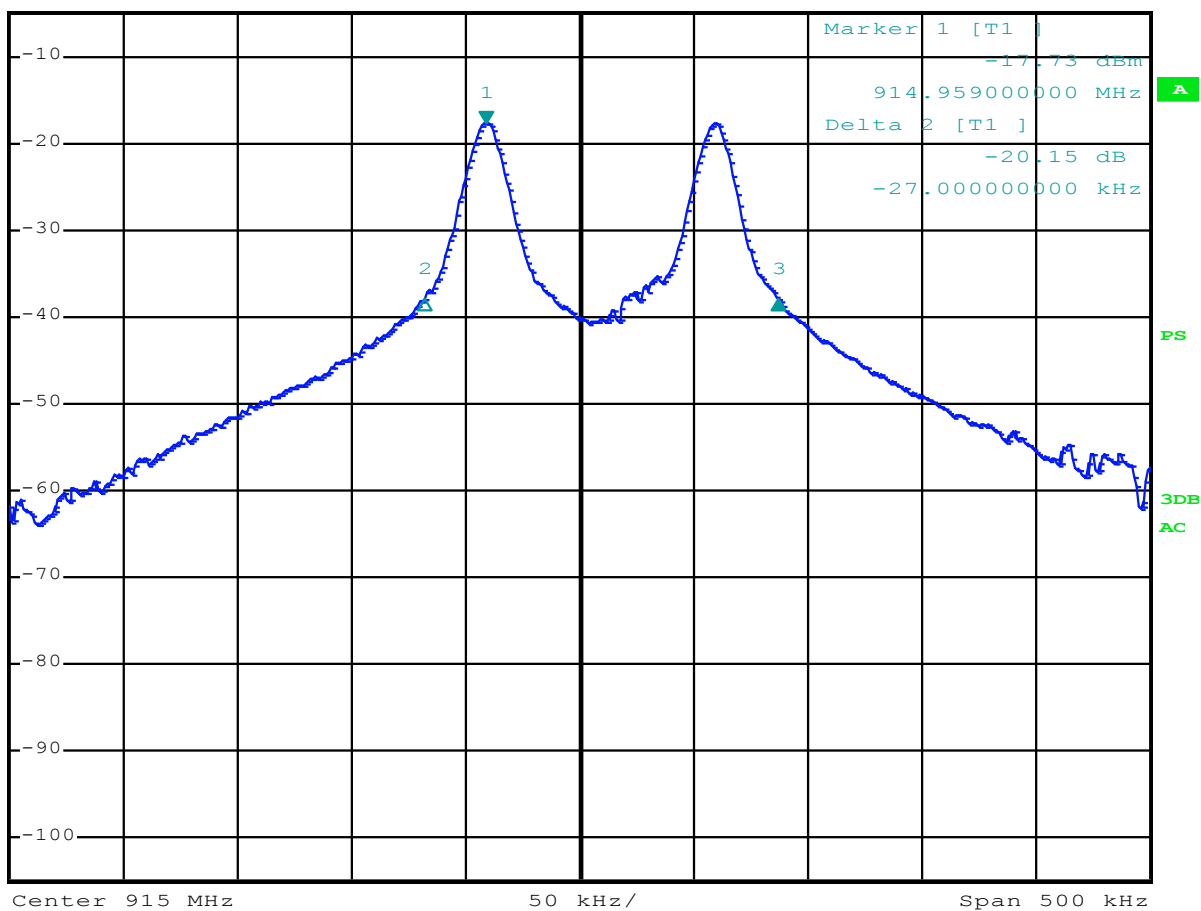
Ref -5 dBm

\*Att 10 dB

SWT 5 ms

128.000000000 kHz

1 PK  
VIEW



Date: 15.MAY.2014 12:37:54

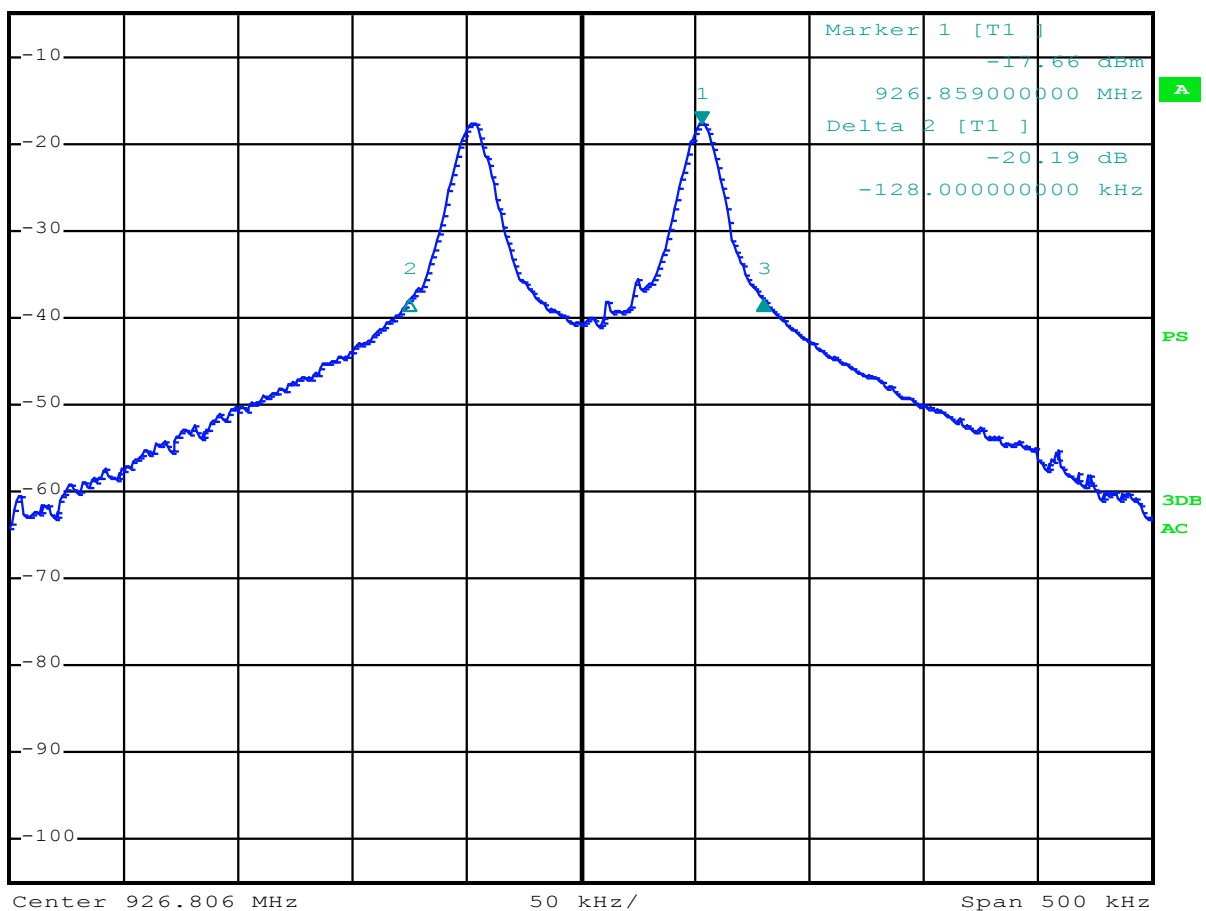
Figure 31: 20dB Bandwidth at MID Frequency – 155.0 kHz



\*RBW 10 kHz Delta 3 [T1 ]  
VBW 30 kHz -20.30 dB  
SWT 5 ms 27.000000000 kHz

Ref -5 dBm

\*Att 10 dB

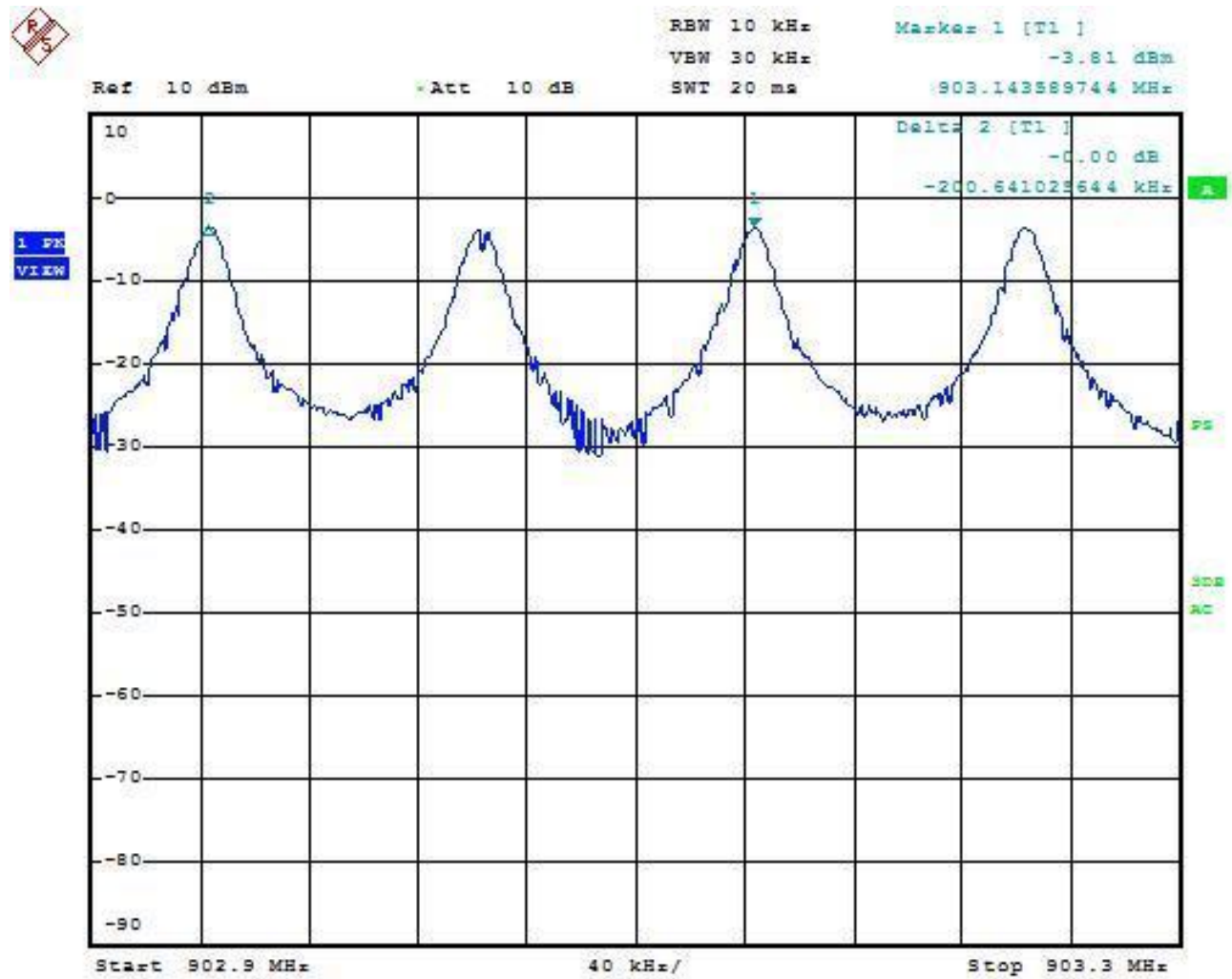
1 PK  
VIEW

Date: 15.MAY.2014 12:27:55

Figure 32: 20dB Bandwidth at HIGH Frequency – 155.0 kHz

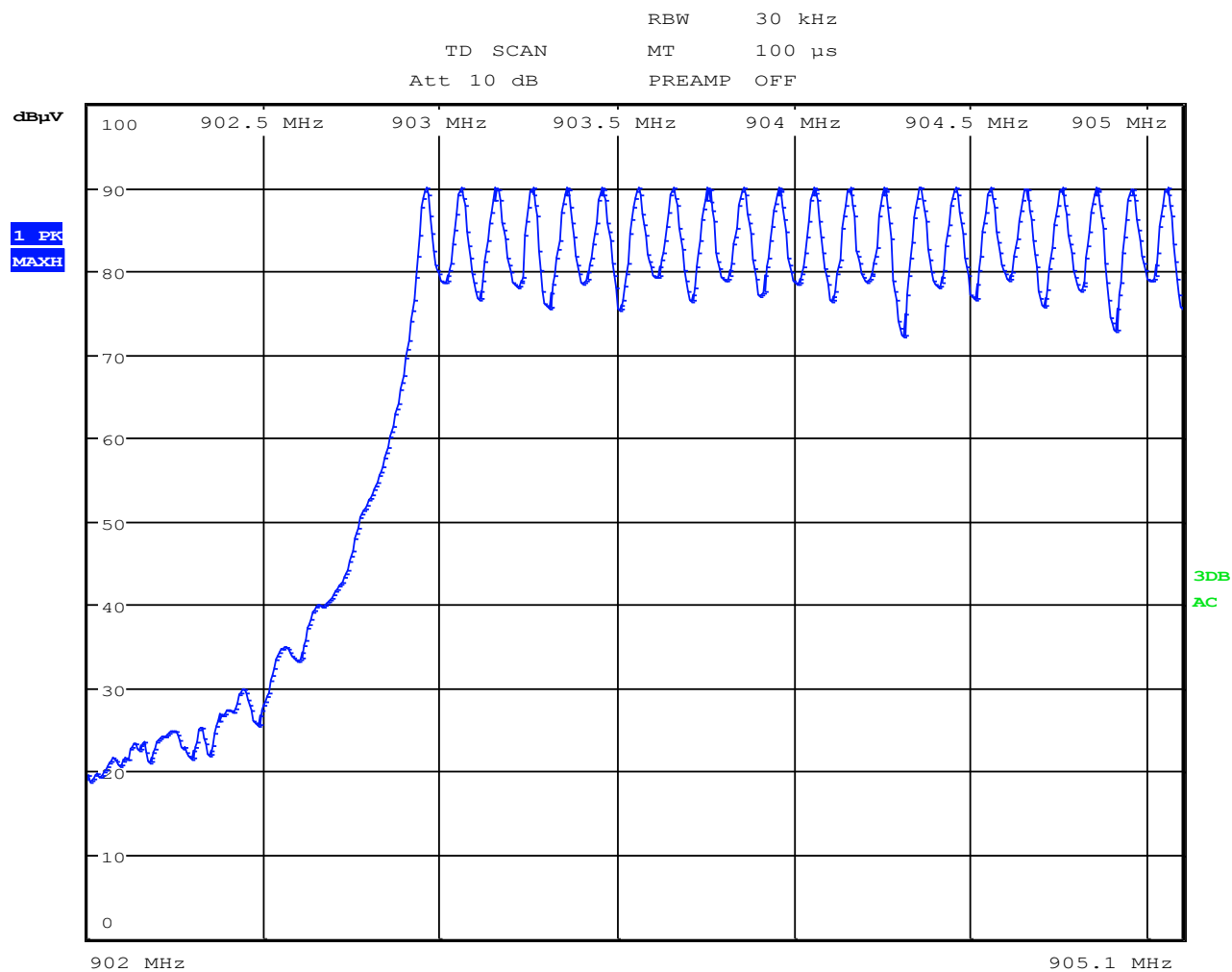


## Channel Separation



**Figure 33: Channel Separation = 200.6kHz**

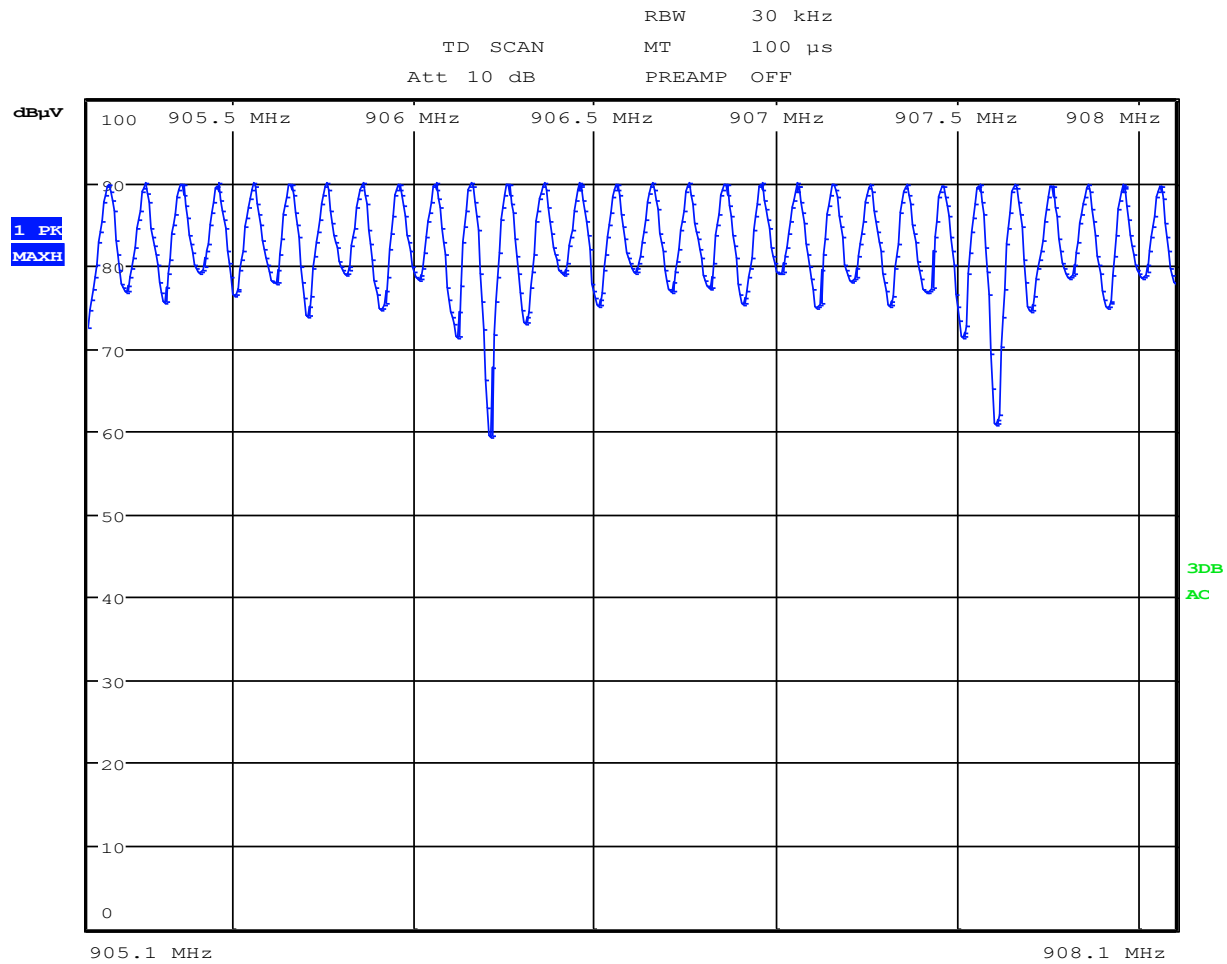
### Number of Hopping Channels



TTTTTT

Date: 16.MAY.2014 21:27:27

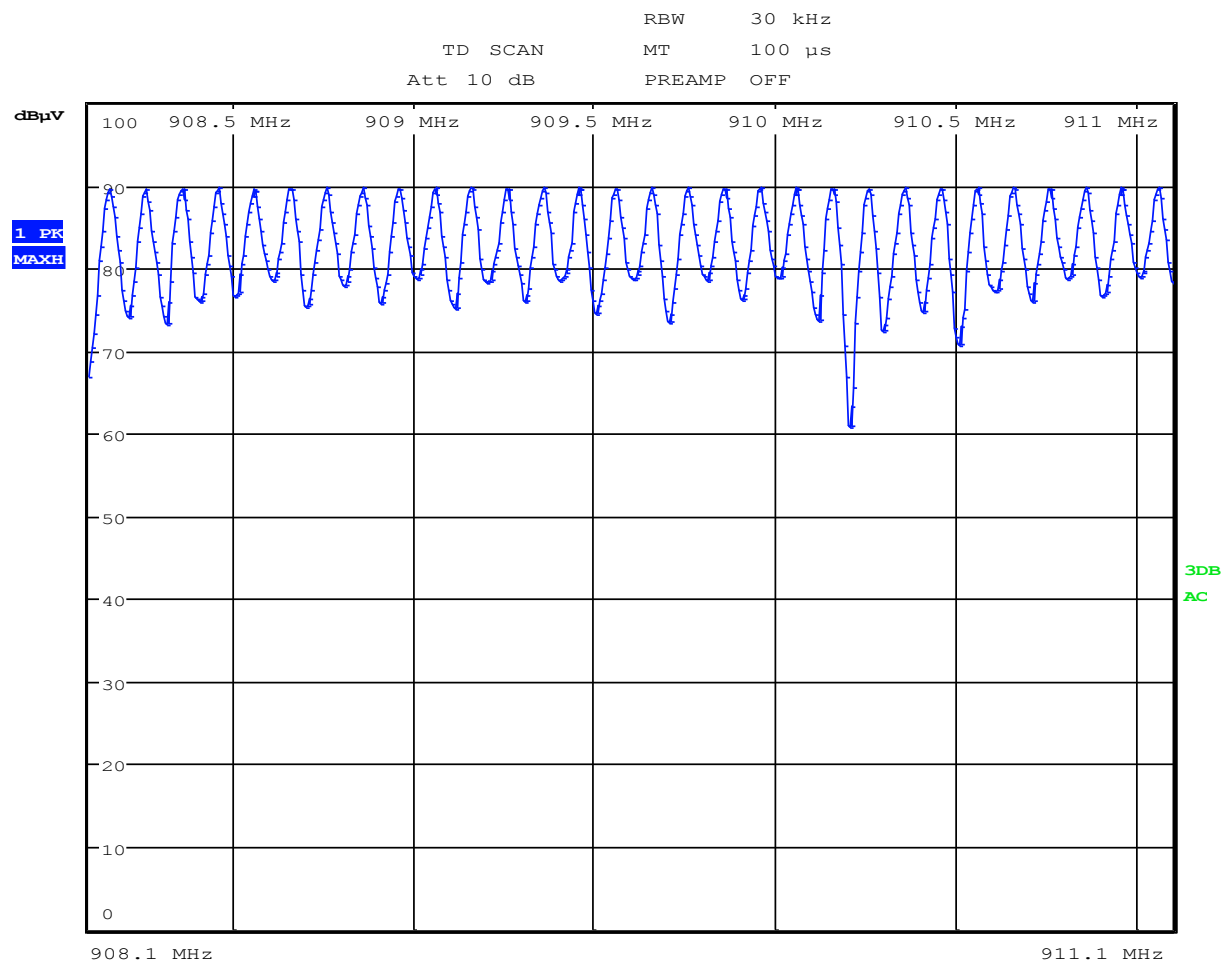
**Figure 34: Number of Hopping Frequencies 902MHz to 905MHz - 11 Frequencies**



TTTTTT

Date: 16.MAY.2014 22:23:51

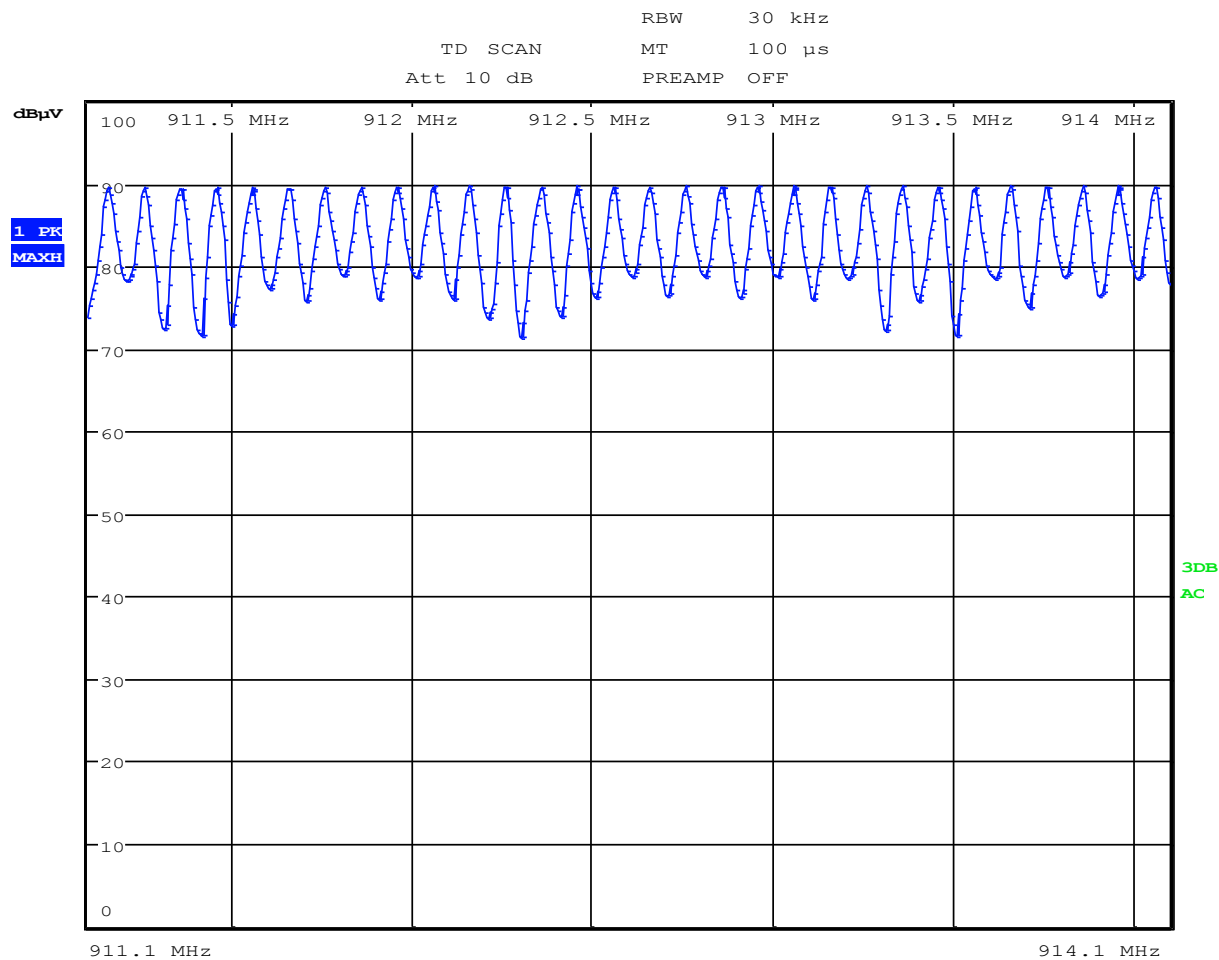
**Figure 35: Number of Hopping Frequencies 905MHz to 908MHz - 15 Frequencies**



TTTTTT

Date: 20.MAY.2014 15:30:04

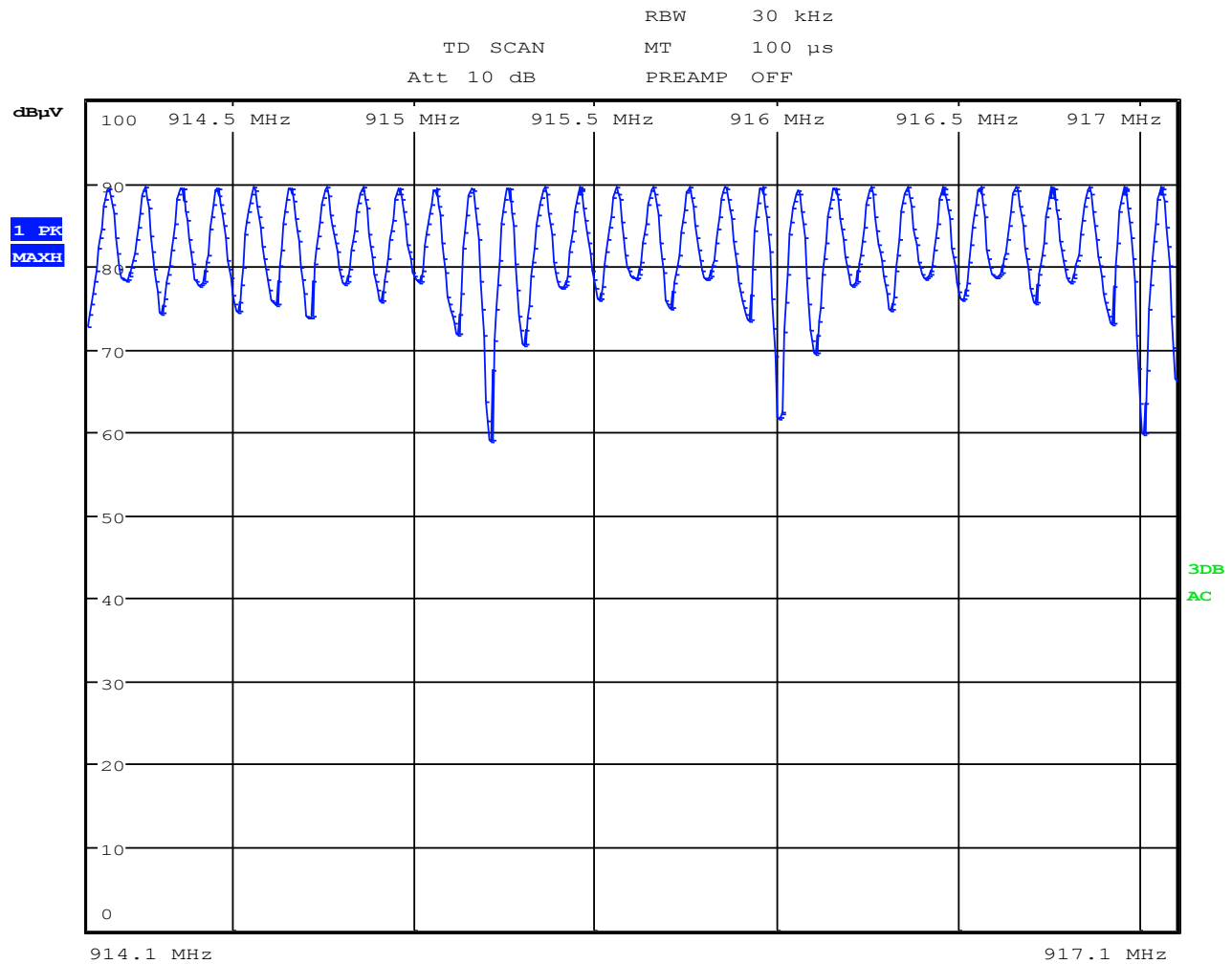
**Figure 36: Number of Hopping Frequencies 908MHz to 911MHz - 15 Frequencies**



TTTTTT

Date: 20.MAY.2014 18:01:00

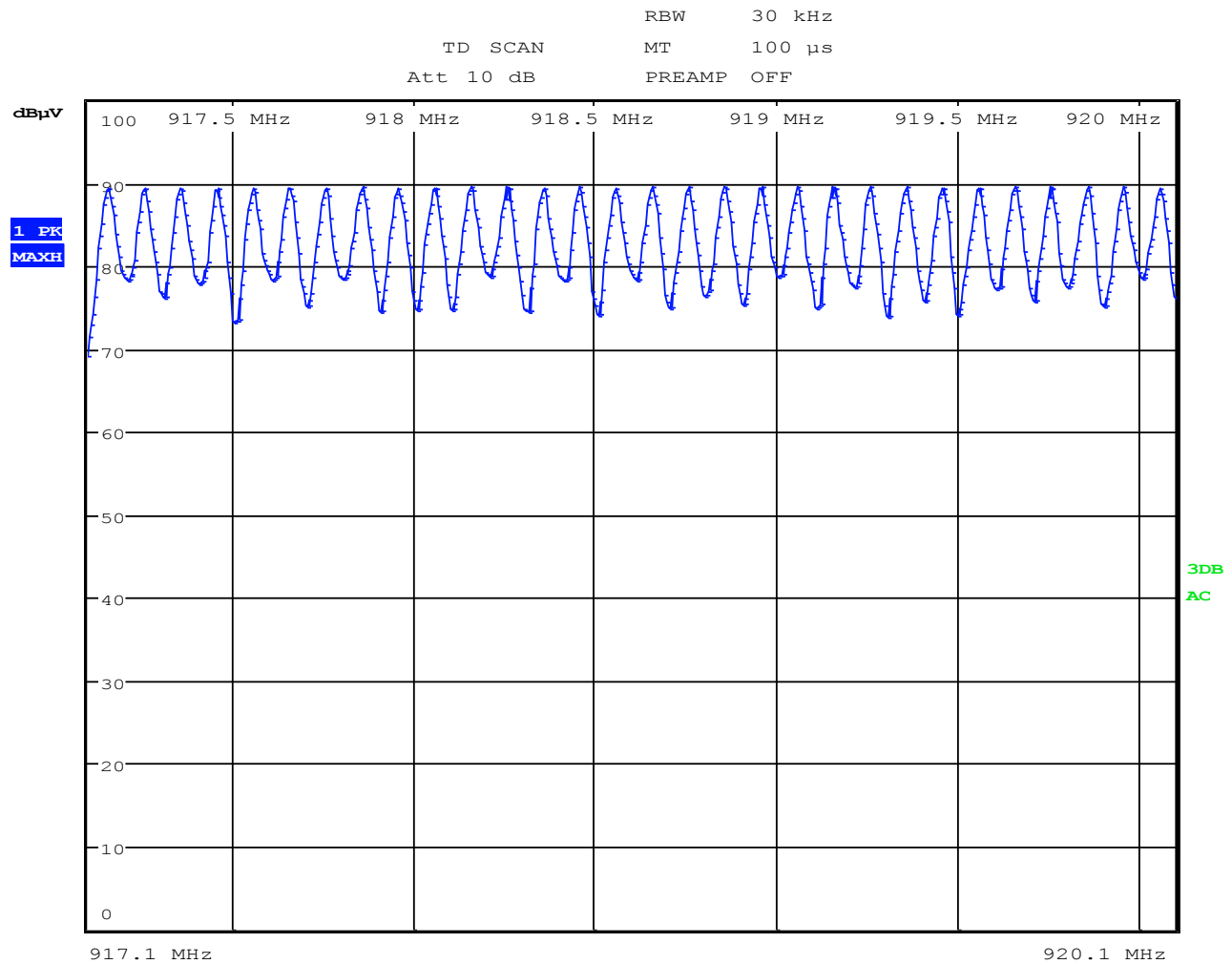
**Figure 37: Number of Hopping Frequencies 911MHz to 914MHz - 15 Frequencies**



TTTTTT

Date: 20.MAY.2014 19:02:25

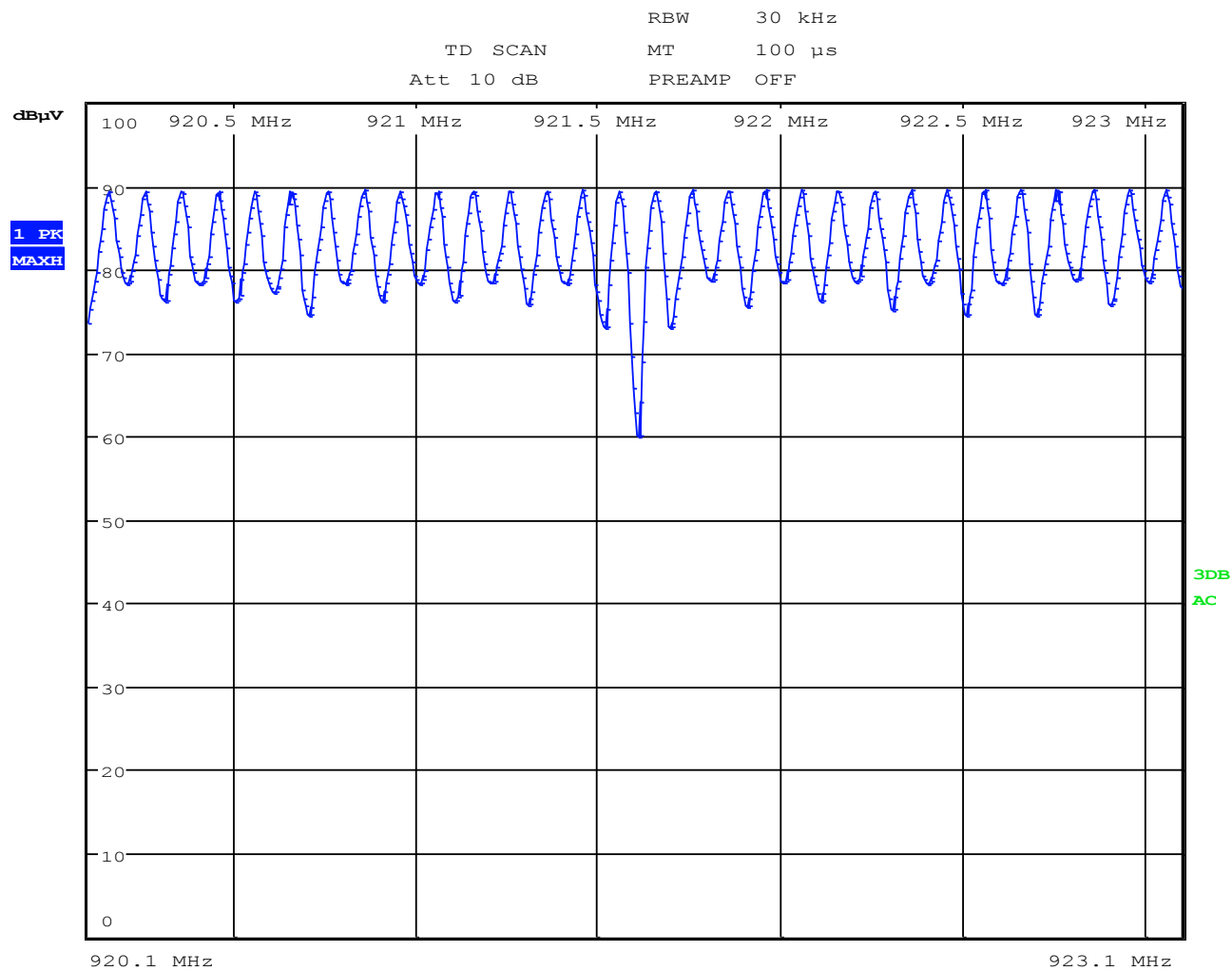
**Figure 38: Number of Hopping Frequencies 914MHz to 917MHz - 15 Frequencies**



TTTTTT

Date: 20.MAY.2014 20:13:31

**Figure 39: Number of Hopping Frequencies 917MHz to 920MHz - 15 Frequencies**

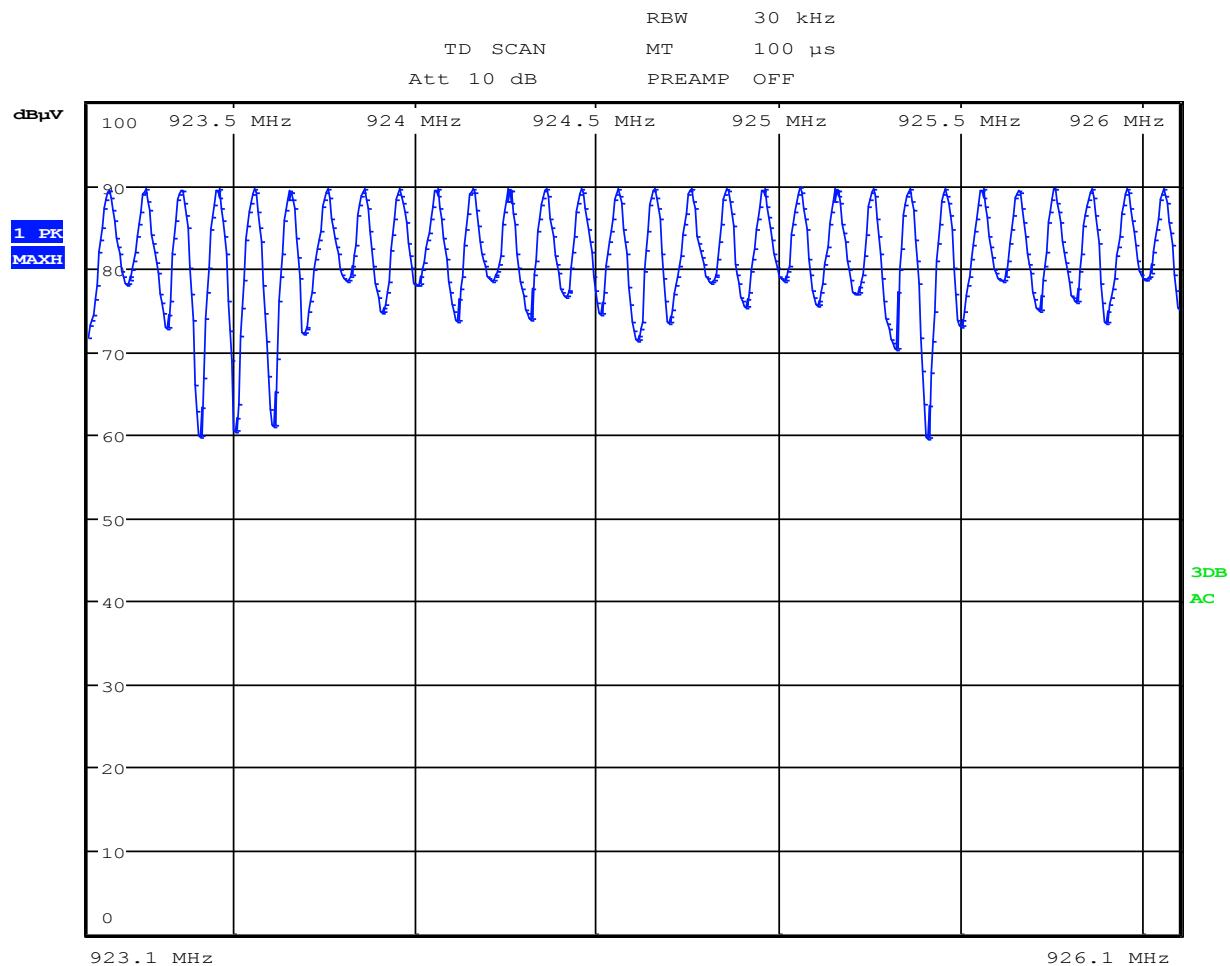


TTTTTT

Date: 20.MAY.2014 22:19:06

**Figure 40: Number of Hopping Frequencies 920MHz to 922MHz - 15 Frequencies**

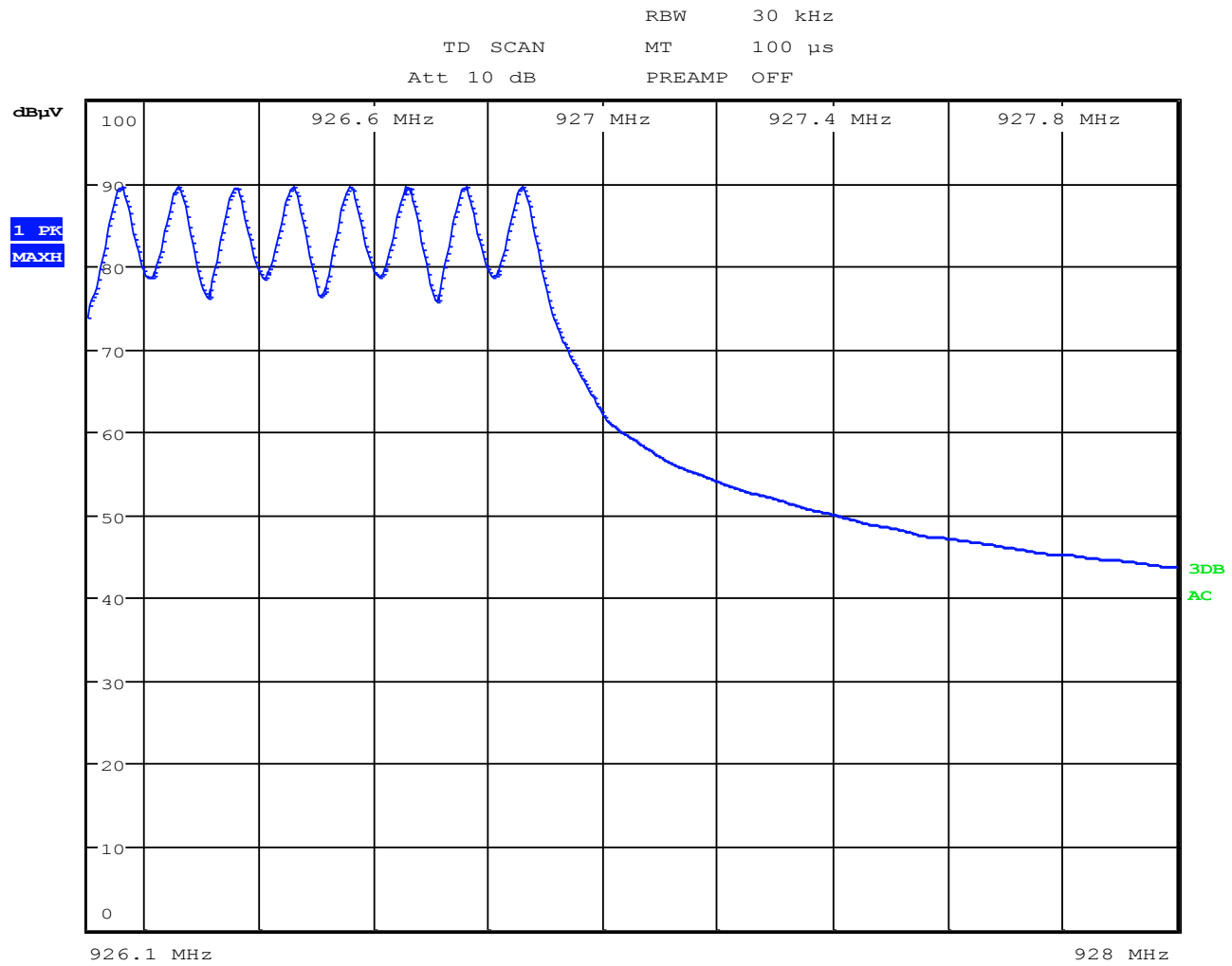




TTTTTT

Date: 21.MAY.2014 19:57:48

**Figure 41: Number of Hopping Frequencies 923MHz to 926MHz - 15 Frequencies**

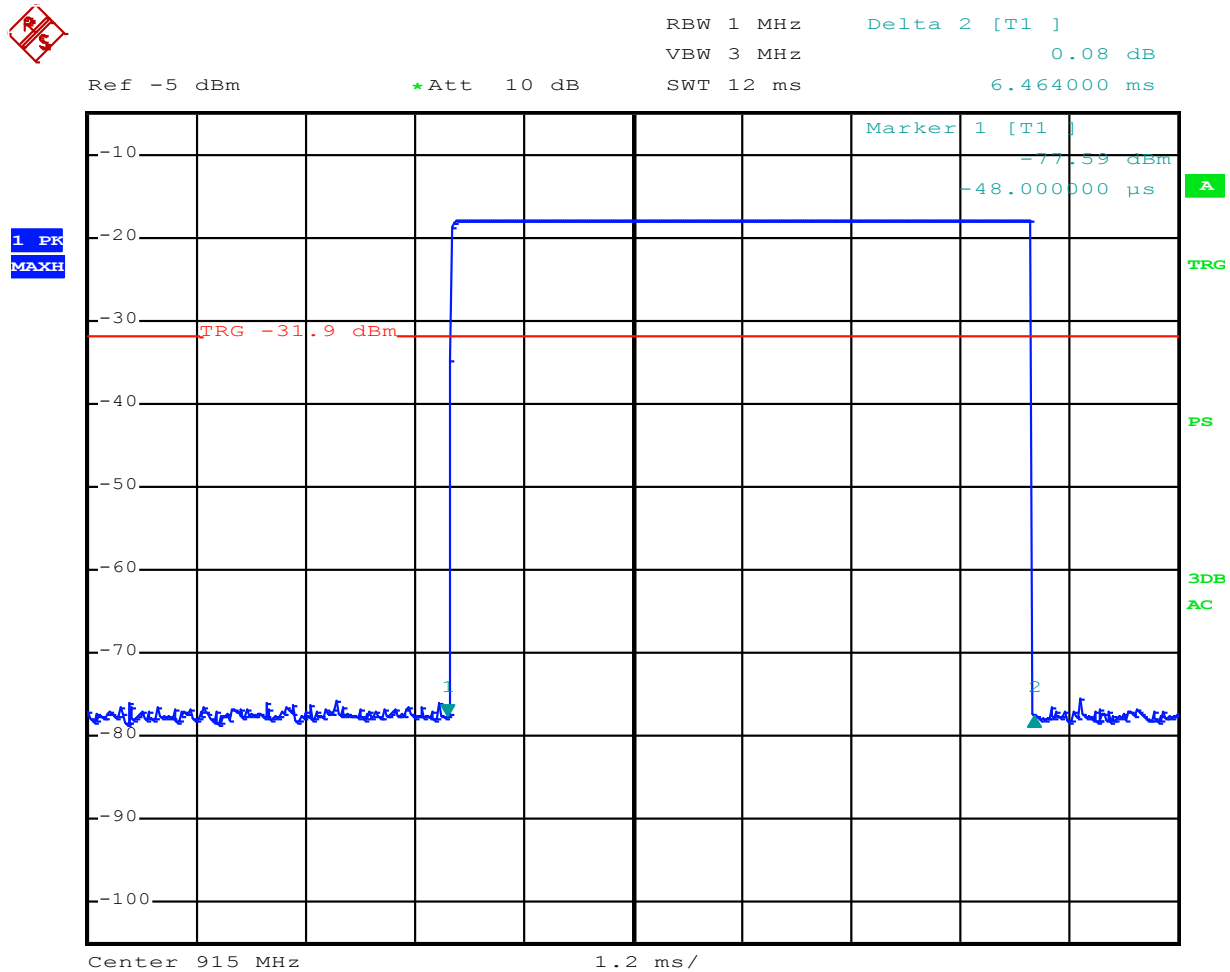


TTTTTT

Date: 21.MAY.2014 22:32:47

**Figure 42: Number of Hopping Frequencies 926MHz to 928MHz - 4 Frequencies**

### Dwell Time and Time of Occupancy



Date: 15.MAY.2014 12:46:26

**Figure 43: Dwell Time – 6.46mS**



RBW 1 MHz

Delta 2 [T1 ]

VBW 3 MHz

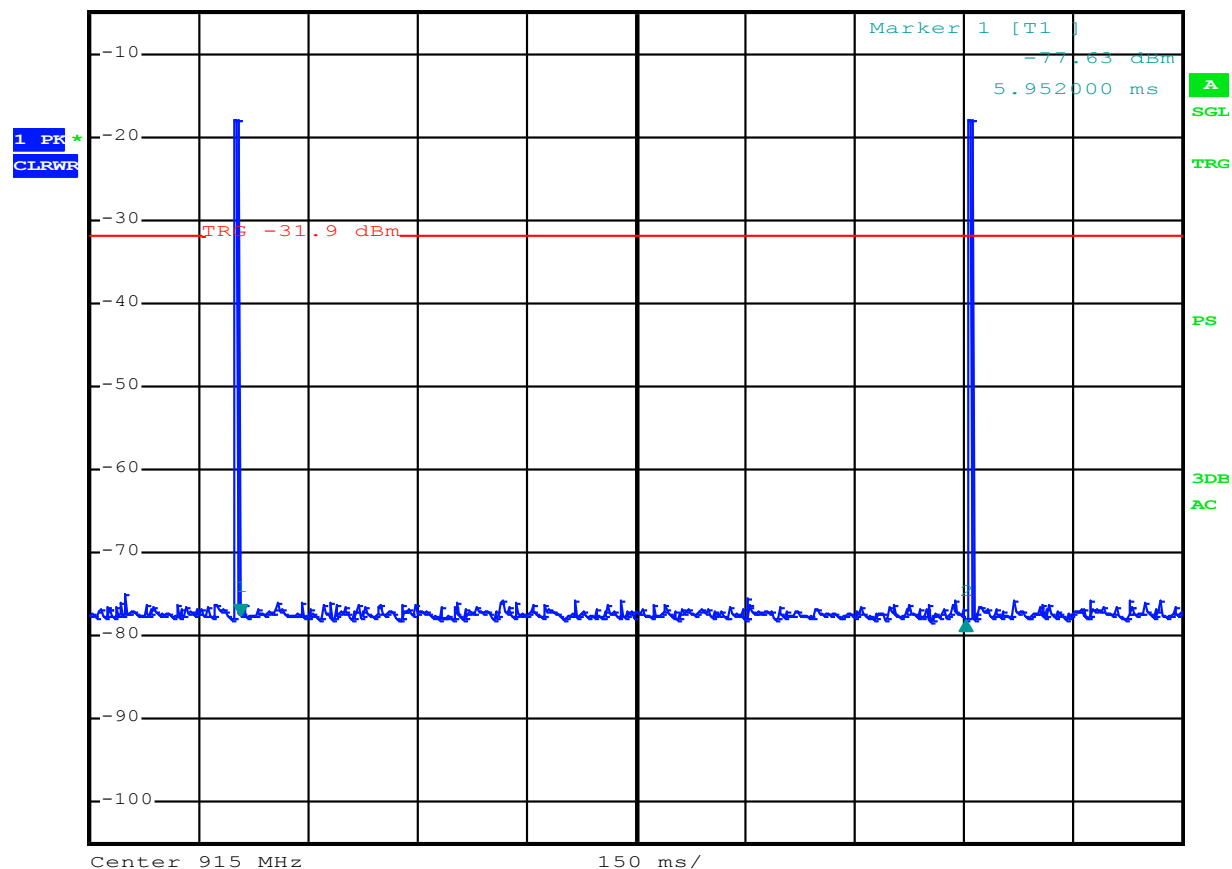
-0.34 dB

Ref -5 dBm

\*Att 10 dB

SWT 1.5 s

997.048000 ms



Date: 15.MAY.2014 12:49:48

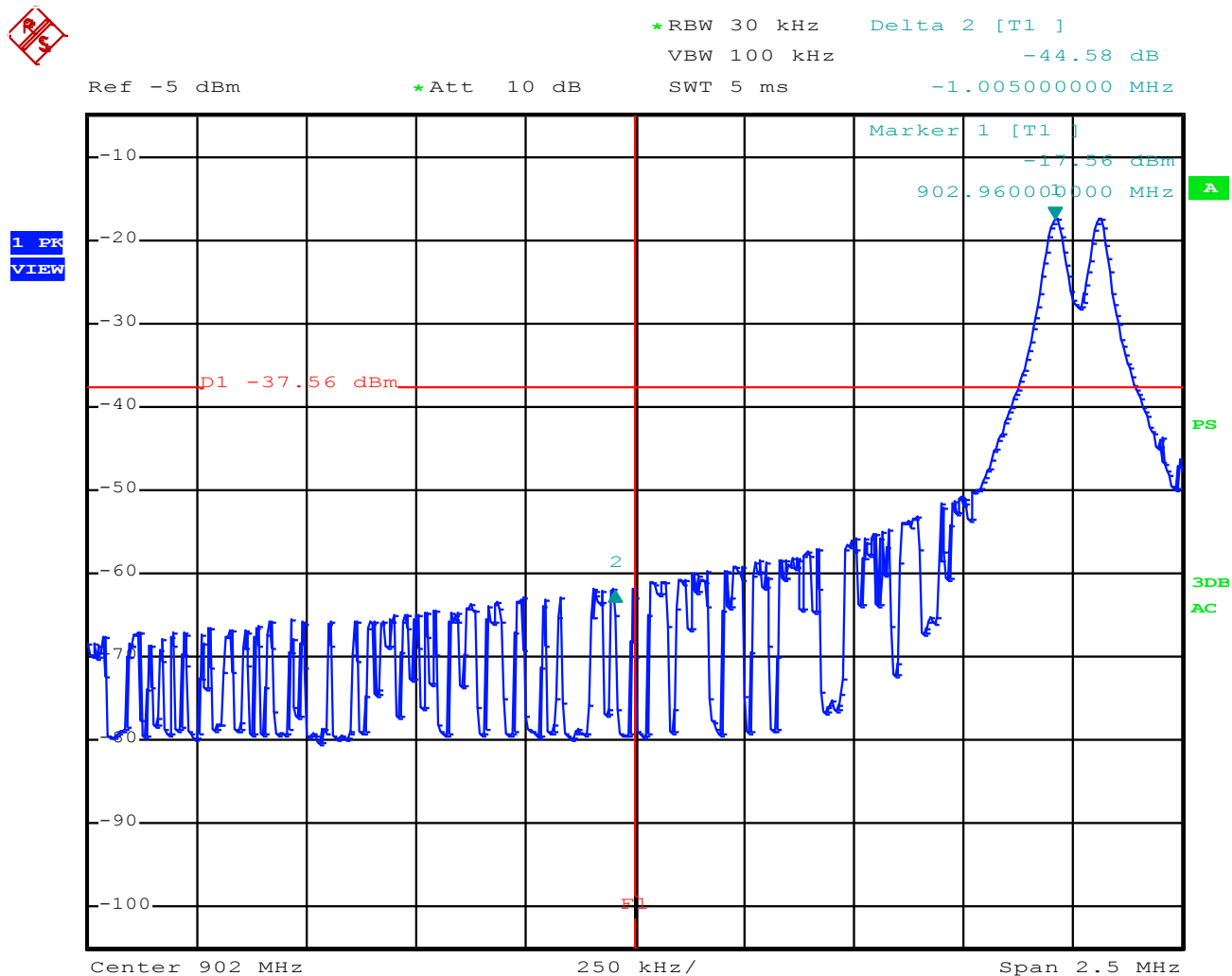
**Figure 44: Time Occupancy Per Frequency – 1.076 milli-Seconds\***

\*Figure 42 indicates that the interval between the frequency of interest and the nearest adjacent frequency in the pseudo random hopping list is 1 second. (A wide RBW was used to capture the nearest adjacent channel).

There are 120 channels in the pseudo random sequence so the next time the same channel will be used will be in 120 seconds.

Therefore the time of occupancy per frequency is 0.00646/120 Seconds or 1.076mS in 20 Seconds.

### Channel Bandedge



Date: 15.MAY.2014 11:35:23

Figure 45: Low Channel Bandedge



\*RBW 30 kHz

Delta 2 [T1 ]

VBW 100 kHz

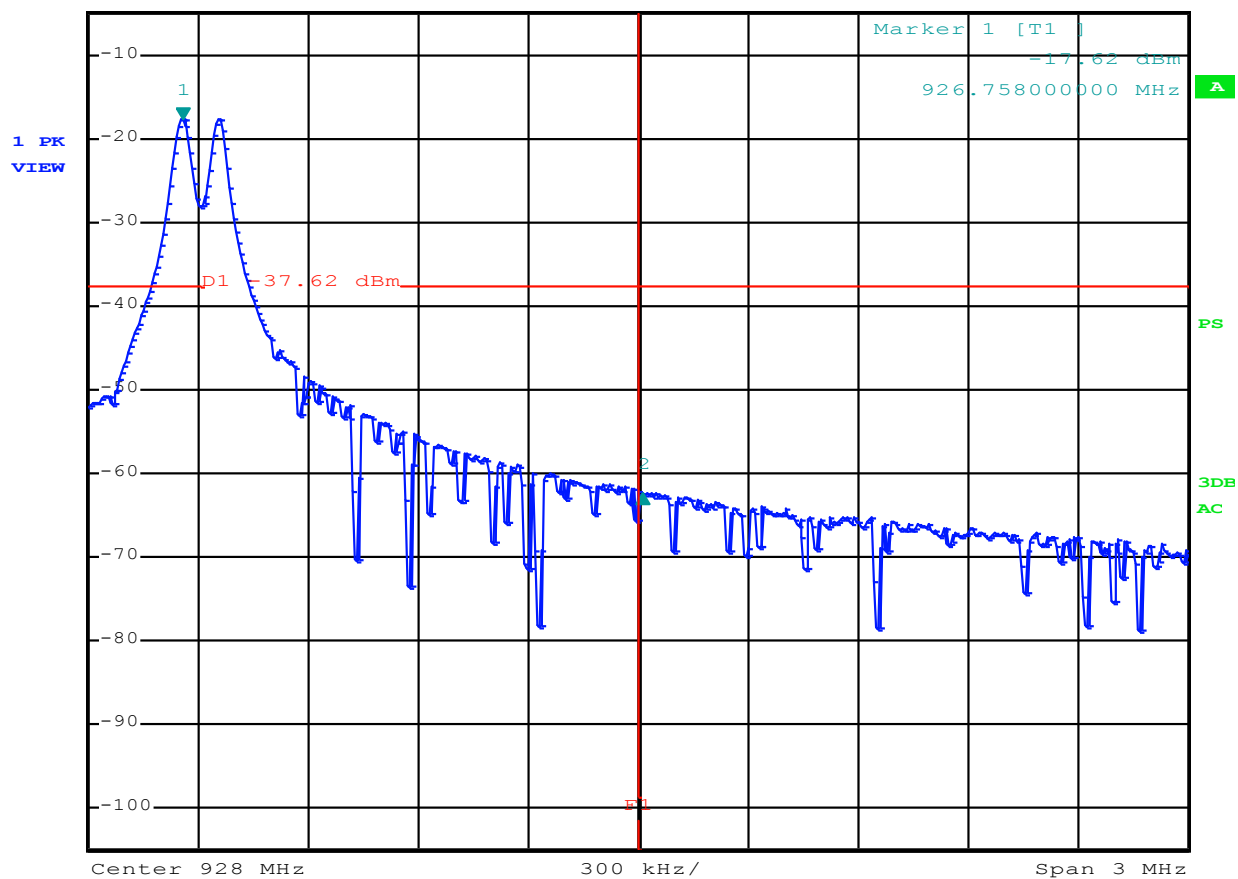
-44.79 dB

Ref -5 dBm

\*Att 10 dB

SWT 5 ms

1.254000000 MHz



Date: 15.MAY.2014 12:22:23

Figure 46: High Channel Bandedge

**Radiated Spurious Harmonics**

Measurement Date: July 1, 2013

**Setup:**

Correction factor includes antenna, cables.

NOTE: The EUT worst case "ON" time was measured to be 6.46 ms per 100ms. This equates to a duty cycle correction factor of -23.8 dB that has been applied to the measured average values in accordance with 15.35(c). In accordance with 15.31(o) emissions that are 20dB below the permissible value have not been reported.

Frequency	Pol.	Corrected Value	Average Limit at 3m	Duty Cycle Correction	Delta Limit-Meas.	Peak Limit at 3m	Delta Limit-Meas
(MHz)		(dBuV/m)	(dBuV/m)	(dB)	(dB)	dB(uV/m)	(dB)
<b>2706.9</b>	V	57.5	54	23.8	<b>20.3</b>	74	<b>16.5</b>
<b>2706.6</b>	H	60.3	54	23.8	<b>17.5</b>	74	<b>13.7</b>
<b>3608.4</b>	H	63.2	54	23.8	<b>14.6</b>	74	<b>10.8</b>
<b>3608.6</b>	V	61.9	54	23.8	<b>15.9</b>	74	<b>12.1</b>
<b>4511.2</b>	H	67.3	54	23.8	<b>10.5</b>	74	<b>6.7</b>
<b>4510.2</b>	V	66.7	54	23.8	<b>11.1</b>	74	<b>7.3</b>
<b>5413.5</b>	V	68.6	54	23.8	<b>9.2</b>	74	<b>5.4</b>
<b>5413.6</b>	H	70.7	54	23.8	<b>7.1</b>	74	<b>3.3</b>
<b>8120.2</b>	H	54.4	54	23.8	<b>23.4</b>	74	<b>19.6</b>
<b>8120.2</b>	V	53.8	54	23.8	<b>24</b>	74	<b>20.2</b>
<b>9022.2</b>	H	48.5	54	23.8	<b>29.3</b>	74	<b>25.5</b>
<b>9022.2</b>	V	51.0	54	23.8	<b>26.8</b>	74	<b>23</b>

**Table 5: Harmonics at Low Frequency**

Frequency	Pol.	Corrected Value	Average Limit at 3m	Duty Cycle Correction	Delta Limit-Meas.	Peak Limit at 3m	Delta Limit-Meas
(MHz)		(dBuV/m)	(dBuV/m)	(dB)	(dB)	dB(uV/m)	(dB)
<b>2745.4</b>	H	<b>67.3</b>	54	23.8	<b>10.5</b>	74	<b>6.7</b>
<b>2745.4</b>	V	<b>63.5</b>	54	23.8	<b>14.3</b>	74	<b>10.5</b>
<b>3660.7</b>	V	<b>62.4</b>	54	23.8	<b>15.4</b>	74	<b>11.6</b>
<b>3659.8</b>	H	<b>64.9</b>	54	23.8	<b>12.9</b>	74	<b>9.1</b>
<b>4574.9</b>	H	<b>64.0</b>	54	23.8	<b>13.8</b>	74	<b>10</b>
<b>4574.9</b>	V	<b>63.7</b>	54	23.8	<b>14.1</b>	74	<b>10.3</b>
<b>7320.7</b>	H	<b>57.5</b>	54	23.8	<b>20.3</b>	74	<b>16.5</b>
<b>7320.7</b>	V	<b>55.2</b>	54	23.8	<b>22.6</b>	74	<b>18.8</b>
<b>8235.7</b>	V	<b>48.8</b>	54	23.8	<b>29</b>	74	<b>25.2</b>
<b>8235.7</b>	H	<b>48.0</b>	54	23.8	<b>29.8</b>	74	<b>26</b>
<b>9150.6</b>	H	<b>46.9</b>	54	23.8	<b>30.9</b>	74	<b>27.1</b>
<b>9150.6</b>	V	<b>49.5</b>	54	23.8	<b>28.3</b>	74	<b>24.5</b>

**Table 6: Harmonics at Mid Frequency**



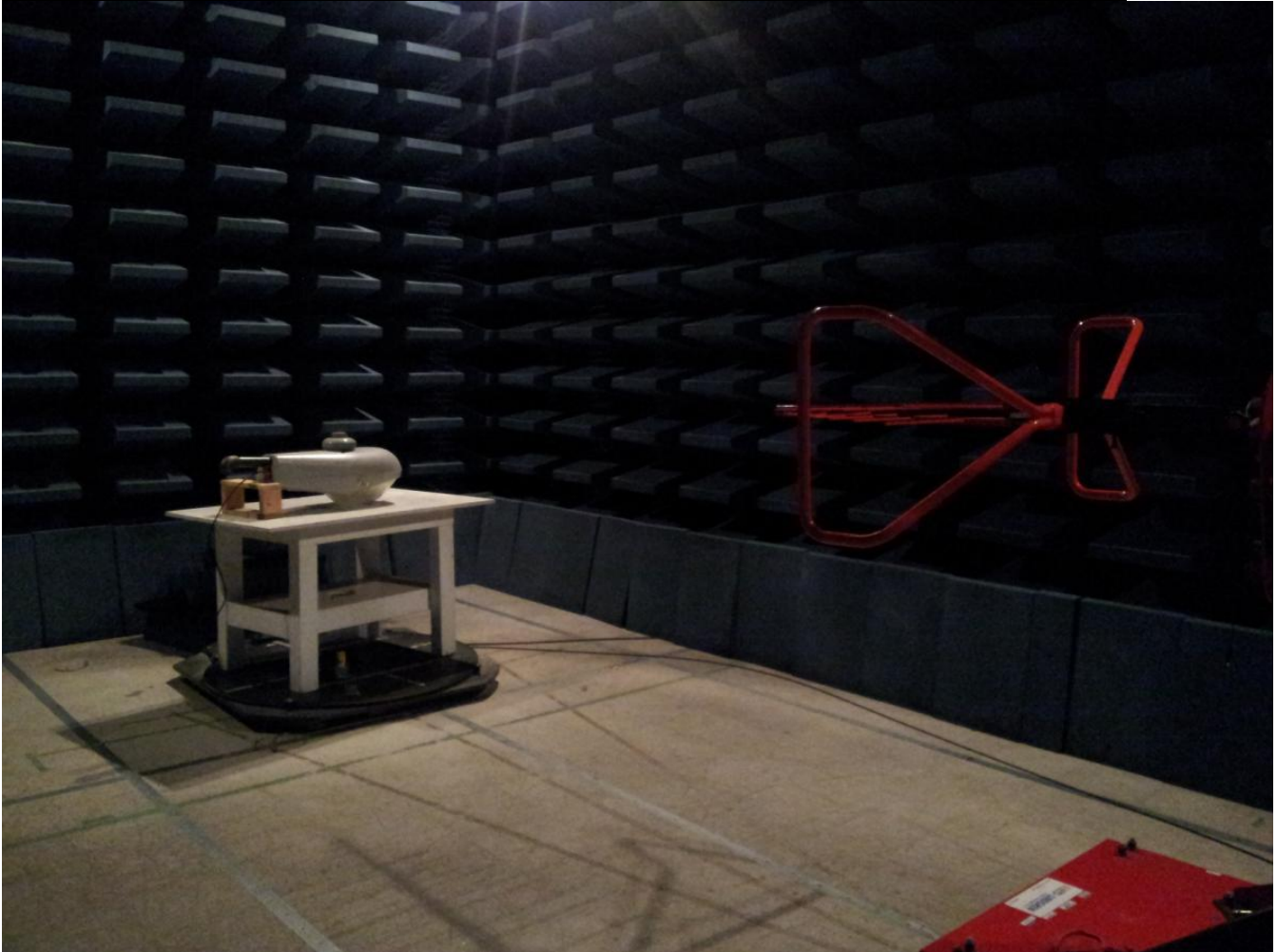
Frequency	Pol.	Corrected Value	Average Limit at 3m	Duty Cycle Correction	Delta Limit-Meas.	Peak Limit at 3m	Delta Limit-Meas
(MHz)		(dBuV/m)	(dBuV/m)	(dB)	(dB)	dB(uV/m)	(dB)
<b>2783.4</b>	H	<b>65.8</b>	54	23.8	<b>12</b>	74	<b>8.2</b>
<b>2783.4</b>	V	<b>63.7</b>	54	23.8	<b>14.1</b>	74	<b>10.3</b>
<b>3711.5</b>	H	<b>65.6</b>	54	23.8	<b>12.2</b>	74	<b>8.4</b>
<b>3711.4</b>	V	<b>66.7</b>	54	23.8	<b>11.1</b>	74	<b>7.3</b>
<b>4638.1</b>	H	<b>62.9</b>	54	23.8	<b>14.9</b>	74	<b>11.1</b>
<b>4638.1</b>	V	<b>61.6</b>	54	23.8	<b>16.2</b>	74	<b>12.4</b>
<b>7421.5</b>	H	<b>61.1</b>	54	23.8	<b>16.7</b>	74	<b>12.9</b>
<b>7421.5</b>	V	<b>59.3</b>	54	23.8	<b>18.5</b>	74	<b>14.7</b>
<b>8348.7</b>	H	<b>49.4</b>	54	23.8	<b>28.4</b>	74	<b>24.6</b>
<b>8349.4</b>	V	<b>50.7</b>	54	23.8	<b>27.1</b>	74	<b>23.3</b>

**Table 7: Harmonics at High Frequency**

## Appendix B: Test Setup Photos



Figure 47: AC Conducted Test Setup



Intentional / Unintentional Radiated Emission 30 – 1000 MHz setup.

**Figure 48: Emissions Test Setup – Intentional / Unintentional Radiated Emissions**



Intentional Radiated Emissions 1000 – 10000 MHz setup.

**Figure 49: Emissions Test Setup – Intentional Harmonics**