Tantalus Systems Corp.

DA-1710

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
Feb 15, 2016

Reviewed By:	**Parm Singh, Director Technical & Business Development**	Feb 15 2016 **Date**

Tested By:	**Aman Jathaul, EMC Project Manager**	Feb 15 2016 **Date**

Test Report Summary

FCC 15.247 / IC RSS-210

Frequency Hopping 902.17 – 927.83MHz communication Module

FCC ID: OZFDA1710 **IC:** 3669A-DA1710

Organization Requesting Report:	Tantalus Systems Corp.
Contact:	Mark Fairburn, Sr. 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

Testing Details

TESTED BY:	Aman Jathaul
TEST CONDITIONS:	Temperature: 22.1ºC, R.H.: 40.3%, Barometric Pressure: 1013.8 mBar.
TEST VOLTAGE:	240V A.C. – DA-1710
	120V A.C. – DA-1710

Test Facilities

Laboratory Headquarters:

Quality Auditing Institute Ltd.
16-211 Schoolhouse Street
Coquitlam BC, Canada, 3K 4X9

EMC Test Laboratory (Canada):

Malcolm Knapp Research Forest
14500 Silver Valley Road
Maple Ridge, BC, Canada, V4R 2R3

FCC Test Site Registration Number:	226383
FCC Designation Number:	CA9543
Industry Canada Test Site Registration Number (3m SAC):	9543B-1
Standard Council of Canada ISO/IEC 17025:	2005 Accredited Laboratory #743
International Accreditation Service Inc. ISO/IEC 17025:	2005 Accredited Laboratory #TL-239

EMC Test Laboratory (US):

834 80th St SW Suite 200
Everett, WA, 98203, USA.

FCC Test Site Registration Number:	307482
FCC Designation Number:	US1151
Industry Canada Test Site Registration Number (3m SAC):	11876A
ISO/IEC 17025:	A2LA Cert. No: 3657.01

Test Equipment List

Device	Manufacturer	Model Number	Serial No.	Next Cal	Next Cal
Biconilog Antenna (30MHz-3GHz)	Sunol Sciences	JB3	A120106	Sep 24 2014	Sep 24 2017
Biconical Antenna (30MHz-200MHz)	EMCO	3110B	9903-3260	May 7 2013	May 7 2016
Log Periodic Antenna (200-1000MHz)	Electrometrics	LPA2	1189	Sep 8 2014	Sep 8 2017
Horn Antenna (1-18Ghz)	Sunol Sciences	DRH 118	A052804	Aug 21 2014	Aug 21 2017
EMI Receiver (20Hz-40GHz)	Rhode & Schwarz	ESU40	100011	Nov 20 2014	Nov 20 2017
Spectrum Analyzer (9kHz-40GHz)	Rhode & Schwarz	FSP	1726A00566	Nov 3 2013	Nov 3 2016
Pre-amplifier (0.1-1300MHz)	HP	8447F		Jan 18 2014	Jan 18 2017
Pre-amplifier (1-26.5GHz)	HP	8449B	2933A00198	May 3 2013	May 3 2016
LISN (150kHz-30MHz)	Fischer	FCC-LISN-50-25-2	9928	Nov 30 2012	Nov 30 2015

Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	±1 x 10-5 MHz
Radiated Emissions	±3 dB
Temperature	±1°C
Humidity	±5 %
DC and low frequency voltages	±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 DA-1710 acts as a bridge modem that allows electrical utilities to operate remotely various distribution control devices via Tantalus' 902-928MHz LAN network. The DA-1710 communicates with the control device using common serial protocols that are sent to the device across the wireless LAN.

Product ID: DA-1710
Manufacturer: Tantalus Systems Corp.

LAN Controller
Part Numbers: 100-0181-D
Serial number: 0015FC41E

Carrier Board
Part Numbers: 100-0179-D
Serial number: 0015FC41F

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 DA-1710 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 Apparreil 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 intereference 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.

Test	Standard	Description	Result
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 November 19, 2015

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 (µV/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: October 30, 2015

TEST STANDARD: EN55022

MINIMUM STANDARD: Class B Limit:

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

MINIMUM STANDARD: Class A Limit:

Frequency (MHz)	Conducted Limit (dBµV)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

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: Novermber 19, 2015

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 3.55W. The conducted output power is 794mW.
Out of Band Emissions	RSS-210 A8.5	See Tables 2 - 5 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 112.8 kHz.
Channel Separation	RSS-210 A8.1(c)	See Figure 9 in Appendix A. The Channel separation was measured to be 320.5 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 4.3 milliseconds at an interval of 1.9 seconds. This is equal to an average time “ON” of 41 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 316 kHz.
Channel Separation	RSS-210 A8.1(c)	See Figure 21 in Appendix A. The Channel separation was measured to be 320 kHz.
Number of Hopping Channels	RSS-210 A8.1(c)	See Figures 22 - 25 in Appendix A. The number of frequencies used is 54.
Hopping Channels Time of Occupancy	RSS-210 A8.1(c)	See Figures 26 and 27 in Appendix A. The time of occupancy is 0.869 mSecs at an interval of 0.652 seconds. This is equal to an average time “ON” of 26.3 mSecs within a 20 second period.

Communication Data Rate to Certifed OEM Part 15 Device

Channel Bandwidth	RSS-210 A8.1(a)	See Figures 30 - 32 in Appendix A. The 20dB bandwidth was measured to be 165.1 kHz.
Channel Separation	RSS-210 A8.1(c)	See Figure 33 in Appendix A. The Channel separation was measured to be 200 kHz.
Number of Hopping Channels	RSS-210 A8.1(c)	See Figures 34 - 42 in Appendix A. The number of frequencies used is 120.
Hopping Channels Time of Occupancy	RSS-210 A8.1(c)	See Figures 43 and 44 in Appendix A; the time of occupancy is 6.40 milliseconds at an interval of 120 seconds. This is equal to an average time “ON” of 1.067mSecs within a 20 second period.

PERFORMANCE: Complies.

Part 4 – Output Power and EIRP Emissions

DATE: November 19, 2015

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 DA-1710 housing using a coaxial pigtail; the conducted output power was measured at this point. A 30dB attenuator was used to protect the instumentattion. See Figures 13-15.

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

2 different antennas were measured.

EIRP measurements – 5dBi Antenna

Freq(MHz)	Corrected Field at 3m (dBµV/m)	3m EIRP (dBm)
902.17	130.7	35.5
915	129.9	34.7
927.83	130.4	35.2

EIRP measurements – 3dB MEG Antenna

Freq(MHz)	Corrected Field at 3m (dBµV/m)	3m EIRP (dBm)
902.17	127.1	31.9
915	125.8	30.6
927.83	126.0	30.8

Conducted Output Power measurements

Freq(MHz)	Meas. Output Power (dBm)	Correction Factor* (dB)	Output Power (dBm)
902.17	-2.0	30.8	28.8
915	-1.8	30.6	28.8
927.83	-1.6	30.6	29.0

* Correction Factor accounts for a nominal 30dB attenuator and 0.5dB cable loss.

PERFORMANCE: Complies.

Part 5: Out of Band Emissions

DATE: November 19, 2015

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.

Test	Standard	Description	Result
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 Sprectrum 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: November 10, 2015

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*Log (d1/d2)

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. Emmisions 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 is for limited modular approval. It does not use a proprietary antenna, but the device is professionally installed and the user manual explicitly states that only 2 types of antenna can be used.

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 µH/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 (dbµV)**	
	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, 2013

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 SMA connector; the conducted output power was measured at this point. A 30dB attenuator was used to protect the instumentation. 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 – 5dBi Antenna

Freq(MHz)	Corrected Field at 3m (dBµV/m)	3m EIRP (dBm)
902.17	130.7	35.5
915	129.9	34.7
927.83	130.4	35.2

EIRP measurements – 3dB MEG Antenna

Freq(MHz)	Corrected Field at 3m (dBµV/m)	3m EIRP (dBm)
902.17	127.1	31.9
915	125.8	30.6
927.83	126.0	30.8

Conducted Output Power measurements

Freq(MHz)	Meas. Output Power (dBm)	Correction Factor* (dB)	Output Power (dBm)
902.17	-2.0	30.8	28.8
915	-1.8	30.6	28.8
927.83	-1.6	30.6	29.0

* Correction Factor accounts for a nominal 30dB 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 DA-1710

Unintentional Radiated Emissions

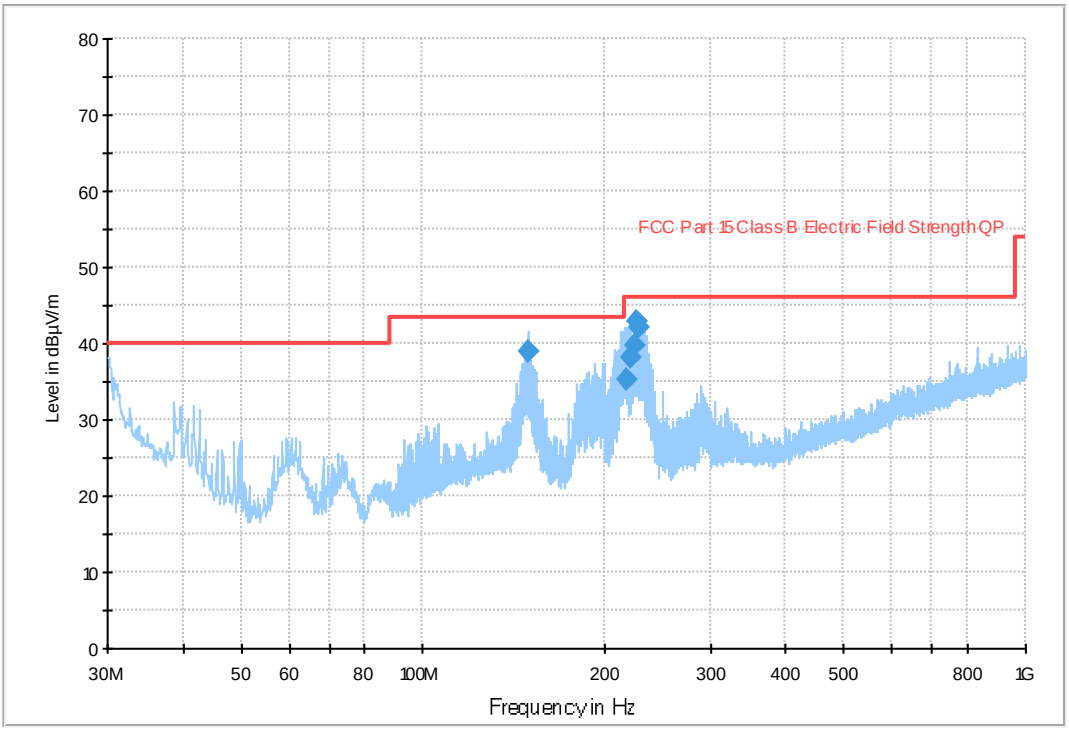


Table 1: FCC Class B Emissions - 3m*

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Margin (dB)	Limit (dBµV/m)
150.02472	39	1000	120	100	V	205	**20.5**	4.5
217.42724	41.2	1000	120	123	H	108	**18.9**	4.8
220.48732	38.1	1000	120	137	H	117	**19.1**	7.9
224.3008	39.6	1000	120	100	H	86	**19.2**	6.4
226.38512	42.9	1000	120	149	H	103	**19.2**	3.1
227.3452	42.1	1000	120	133	H	84	**19.2**	3.9

* 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

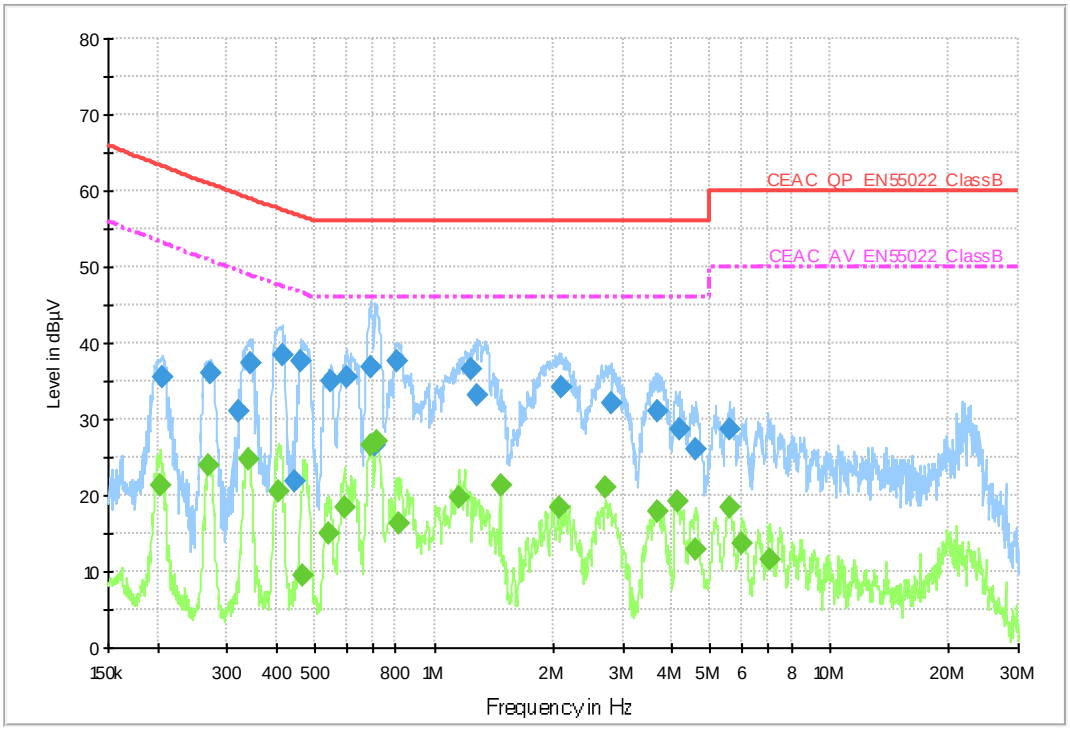
FCC/CE Class B - Emissions

Table 2: AC Conducted Emissions, 120V AC 60Hz, Line 1

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.202418	21.4	1000.000	9.000	On	L1	0.5	**31.9**	53.3
0.269360	23.8	1000.000	9.000	On	L1	0.4	**27.1**	50.9
0.339617	24.7	1000.000	9.000	On	L1	0.4	**24.3**	49.0
0.404093	20.5	1000.000	9.000	On	L1	0.4	**27.1**	47.6
0.466613	9.5	1000.000	9.000	On	L1	0.4	**37.0**	46.5
0.539884	15.1	1000.000	9.000	On	L1	0.4	**30.9**	46.0
0.591856	18.3	1000.000	9.000	On	L1	0.4	**27.7**	46.0
0.691669	26.7	1000.000	9.000	On	L1	0.5	**19.3**	46.0
0.712712	27.0	1000.000	9.000	On	L1	0.5	**19.0**	46.0
0.818063	16.2	1000.000	9.000	On	L1	0.5	**29.8**	46.0
1.158165	19.8	1000.000	9.000	On	L1	0.5	**26.2**	46.0
1.469025	21.3	1000.000	9.000	On	L1	0.5	**24.7**	46.0
2.063203	18.4	1000.000	9.000	On	L1	0.5	**27.6**	46.0
2.723674	20.9	1000.000	9.000	On	L1	0.5	**25.1**	46.0
3.653510	17.9	1000.000	9.000	On	L1	0.6	**28.1**	46.0
4.118827	19.3	1000.000	9.000	On	L1	0.6	**26.7**	46.0
4.578917	13.0	1000.000	9.000	On	L1	0.6	**33.0**	46.0
5.558170	18.5	1000.000	9.000	On	L1	0.6	**31.5**	50.0
6.020612	13.6	1000.000	9.000	On	L1	0.6	**36.4**	50.0
7.035953	11.5	1000.000	9.000	On	L1	0.6	**38.5**	50.0

Table 3: AC Conducted Emissions, 120V AC 60Hz, Line 2

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.203229	13.0	1000.000	9.000	On	L1	0.5	**40.3**	53.3
0.272065	19.2	1000.000	9.000	On	L1	0.4	**31.6**	50.8
0.338939	8.8	1000.000	9.000	On	L1	0.4	**40.2**	49.0
0.407335	21.3	1000.000	9.000	On	L1	0.4	**26.3**	47.6
0.472241	18.6	1000.000	9.000	On	L1	0.4	**27.8**	46.4
0.545305	11.6	1000.000	9.000	On	L1	0.4	**34.4**	46.0
0.598994	16.9	1000.000	9.000	On	L1	0.4	**29.1**	46.0
0.718431	22.1	1000.000	9.000	On	L1	0.5	**23.9**	46.0
0.809931	10.5	1000.000	9.000	On	L1	0.5	**35.5**	46.0
1.195787	13.4	1000.000	9.000	On	L1	0.5	**32.6**	46.0
1.469025	20.3	1000.000	9.000	On	L1	0.5	**25.7**	46.0
2.063203	13.9	1000.000	9.000	On	L1	0.5	**32.1**	46.0
2.701994	13.1	1000.000	9.000	On	L1	0.5	**32.9**	46.0
3.581237	13.1	1000.000	9.000	On	L1	0.6	**32.9**	46.0
3.653510	13.8	1000.000	9.000	On	L1	0.6	**32.2**	46.0
4.201949	11.5	1000.000	9.000	On	L1	0.6	**34.5**	46.0
5.602768	14.1	1000.000	9.000	On	L1	0.6	**35.9**	50.0
7.035953	9.1	1000.000	9.000	On	L1	0.6	**40.9**	50.0
20.862360	16.9	1000.000	9.000	On	L1	0.8	**33.1**	50.0
23.850681	12.5	1000.000	9.000	On	L1	0.8	**37.5**	50.0



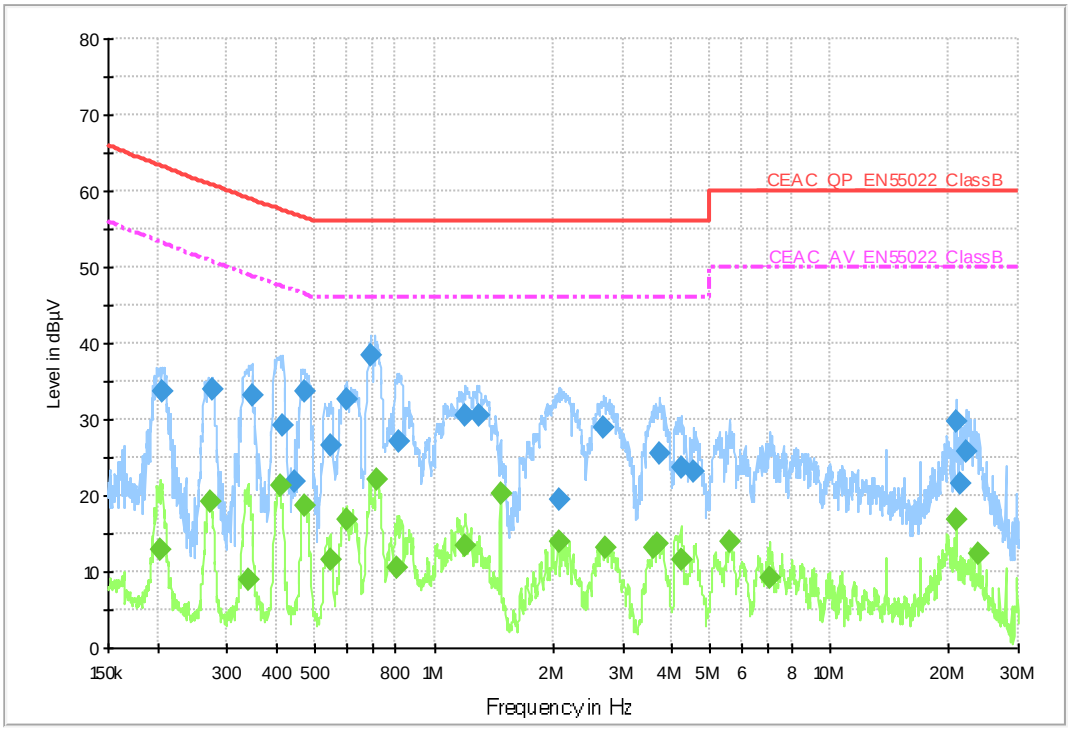


Figure 1: 120V AC Conducted Emissions - Line 1 and Line 2

Table 4: AC Conducted Emissions, 240V AC 60Hz, Line 1

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.269360	20.2	1000.000	9.000	On	L1	0.4	**30.7**	50.9
0.303060	15.5	1000.000	9.000	On	L1	0.4	**34.4**	49.9
0.370825	15.1	1000.000	9.000	On	L1	0.4	**33.2**	48.3
0.411425	14.9	1000.000	9.000	On	L1	0.4	**32.6**	47.5
0.494448	10.0	1000.000	9.000	On	L1	0.4	**36.1**	46.1
0.679342	21.3	1000.000	9.000	On	L1	0.5	**24.7**	46.0
0.758252	21.4	1000.000	9.000	On	L1	0.5	**24.6**	46.0
0.822981	15.3	1000.000	9.000	On	L1	0.5	**30.7**	46.0
0.893237	13.9	1000.000	9.000	On	L1	0.5	**32.1**	46.0
0.959853	16.1	1000.000	9.000	On	L1	0.5	**29.9**	46.0
1.469025	21.8	1000.000	9.000	On	L1	0.5	**24.2**	46.0
1.666079	15.0	1000.000	9.000	On	L1	0.5	**31.0**	46.0
1.833776	14.1	1000.000	9.000	On	L1	0.5	**31.9**	46.0
2.773095	19.6	1000.000	9.000	On	L1	0.5	**26.4**	46.0
4.061622	14.8	1000.000	9.000	On	L1	0.6	**31.2**	46.0
4.999684	11.8	1000.000	9.000	On	L1	0.6	**34.2**	46.0
6.679780	12.8	1000.000	9.000	On	L1	0.6	**37.2**	50.0
7.651864	14.4	1000.000	9.000	On	L1	0.6	**35.6**	50.0
8.574866	14.1	1000.000	9.000	On	L1	0.6	**35.9**	50.0
9.842380	15.5	1000.000	9.000	On	L1	0.6	**34.5**	50.0

Table 5: AC Conducted Emissions, 240V AC 60Hz, Line 2

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.204450	18.7	1000.000	9.000	On	L1	0.5	**34.5**	53.2
0.270980	29.9	1000.000	9.000	On	L1	0.4	**20.9**	50.8
0.308559	24.5	1000.000	9.000	On	L1	0.4	**25.3**	49.8
0.336241	23.2	1000.000	9.000	On	L1	0.4	**25.9**	49.1
0.373054	9.1	1000.000	9.000	On	L1	0.4	**39.2**	48.3
0.407335	23.5	1000.000	9.000	On	L1	0.4	**24.1**	47.6
0.444766	24.5	1000.000	9.000	On	L1	0.4	**22.4**	46.9
0.497421	14.5	1000.000	9.000	On	L1	0.4	**31.5**	46.0
0.687535	30.4	1000.000	9.000	On	L1	0.5	**15.6**	46.0
0.758252	28.6	1000.000	9.000	On	L1	0.5	**17.4**	46.0
0.963696	21.4	1000.000	9.000	On	L1	0.5	**24.6**	46.0
1.007001	20.4	1000.000	9.000	On	L1	0.5	**25.6**	46.0
1.062817	16.2	1000.000	9.000	On	L1	0.5	**29.8**	46.0
1.528916	25.0	1000.000	9.000	On	L1	0.5	**21.0**	46.0
1.591249	26.4	1000.000	9.000	On	L1	0.5	**19.6**	46.0
1.652817	22.1	1000.000	9.000	On	L1	0.5	**23.9**	46.0
1.790332	22.4	1000.000	9.000	On	L1	0.5	**23.6**	46.0
2.915129	21.7	1000.000	9.000	On	L1	0.6	**24.3**	46.0
4.053515	20.4	1000.000	9.000	On	L1	0.6	**25.6**	46.0
4.979745	17.0	1000.000	9.000	On	L1	0.6	**29.0**	46.0

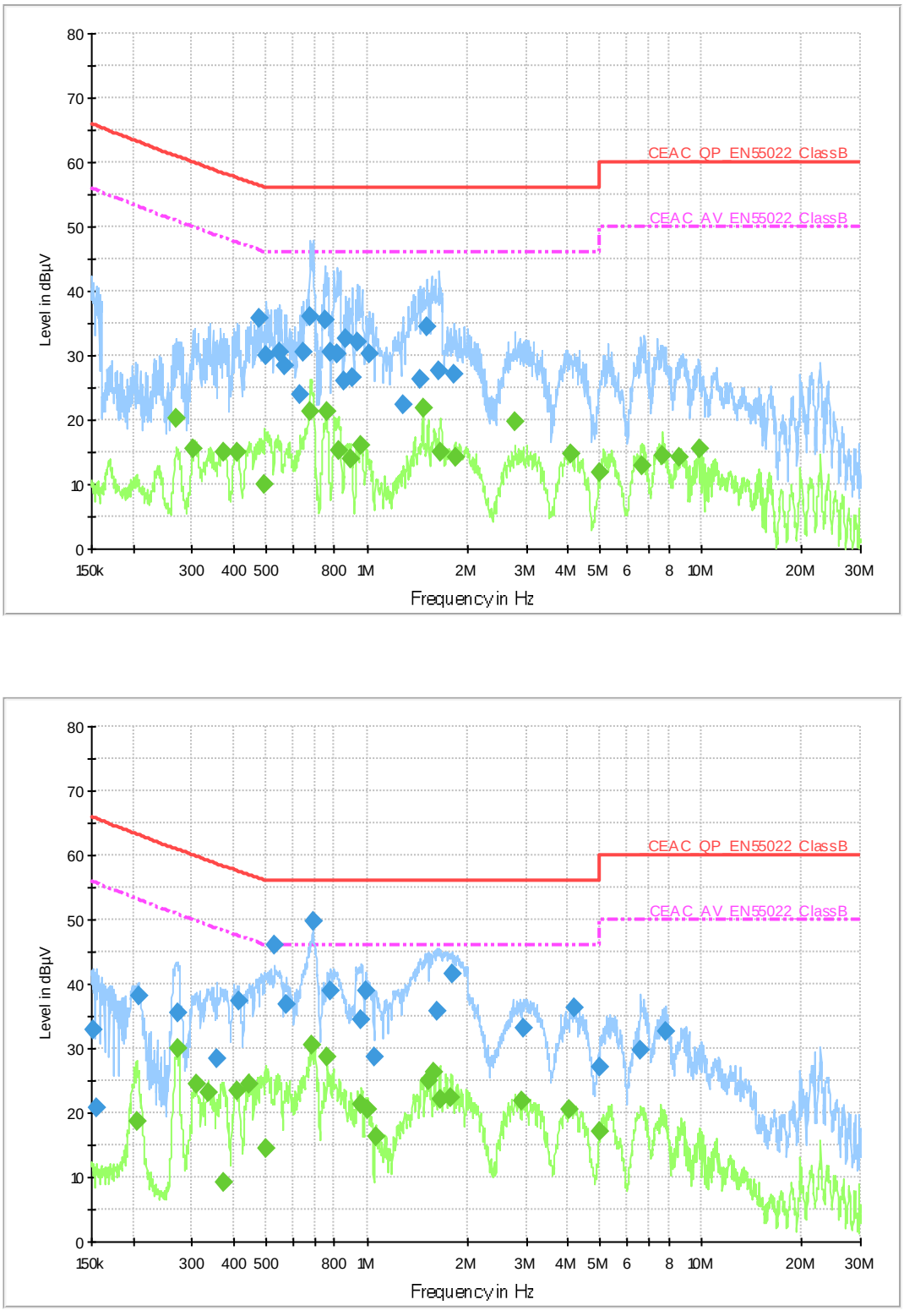
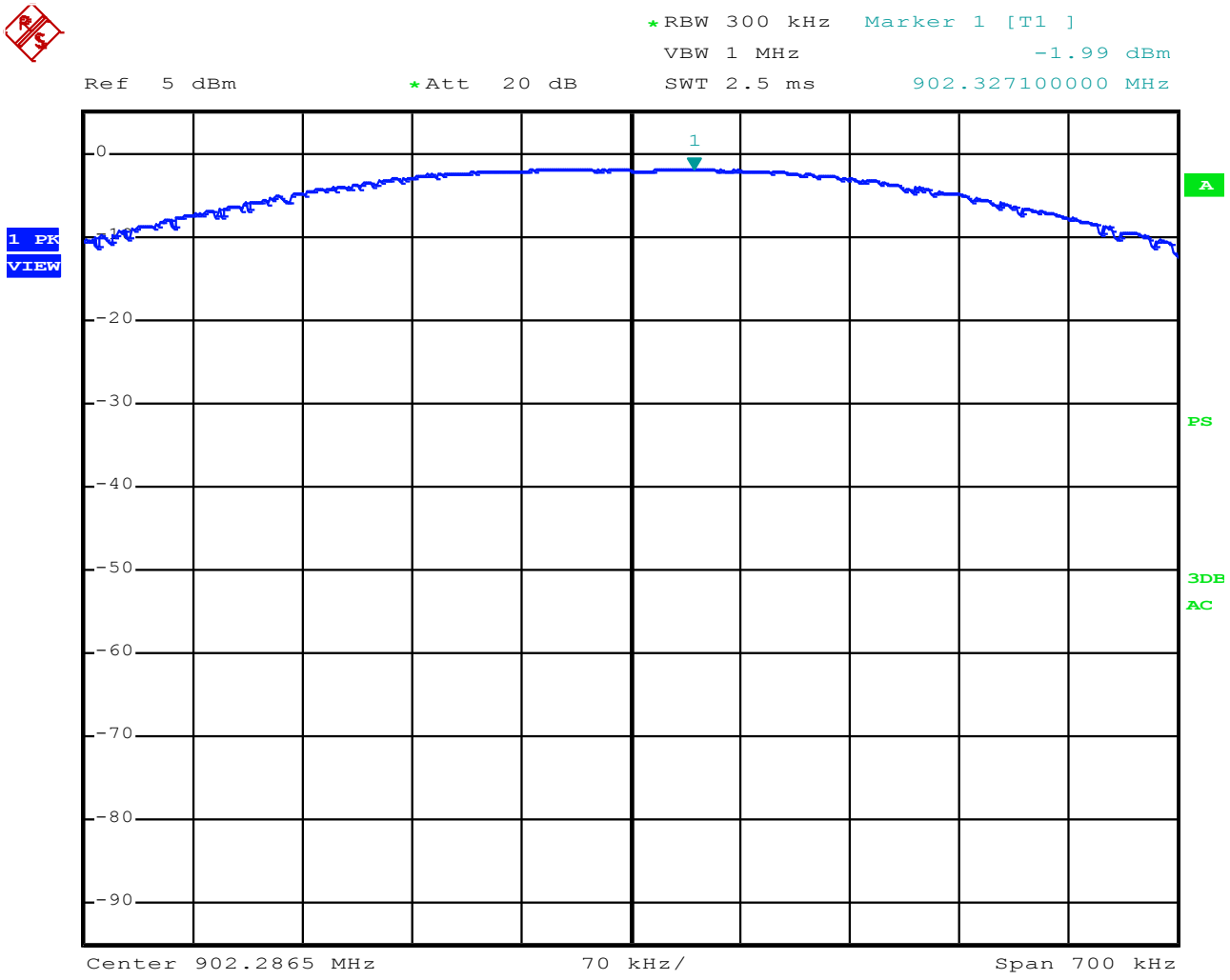


Figure 2: 240V AC Conducted Emissions - Line 1 and Line 2

FHSS Compliance Tests

Output Power



Date: 5.NOV.2015 12:13:36

Figure 3: Output Power at LOW Frequency

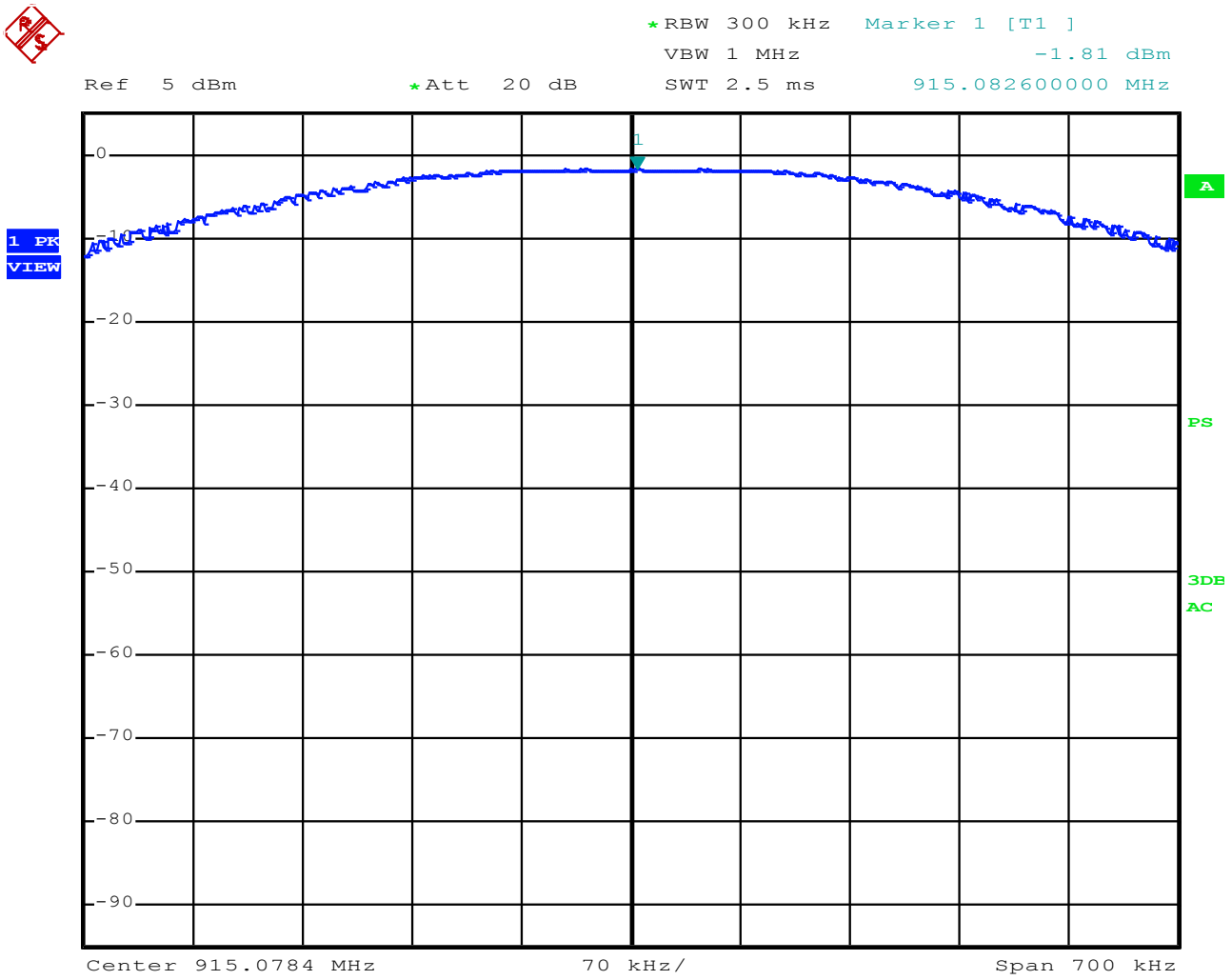


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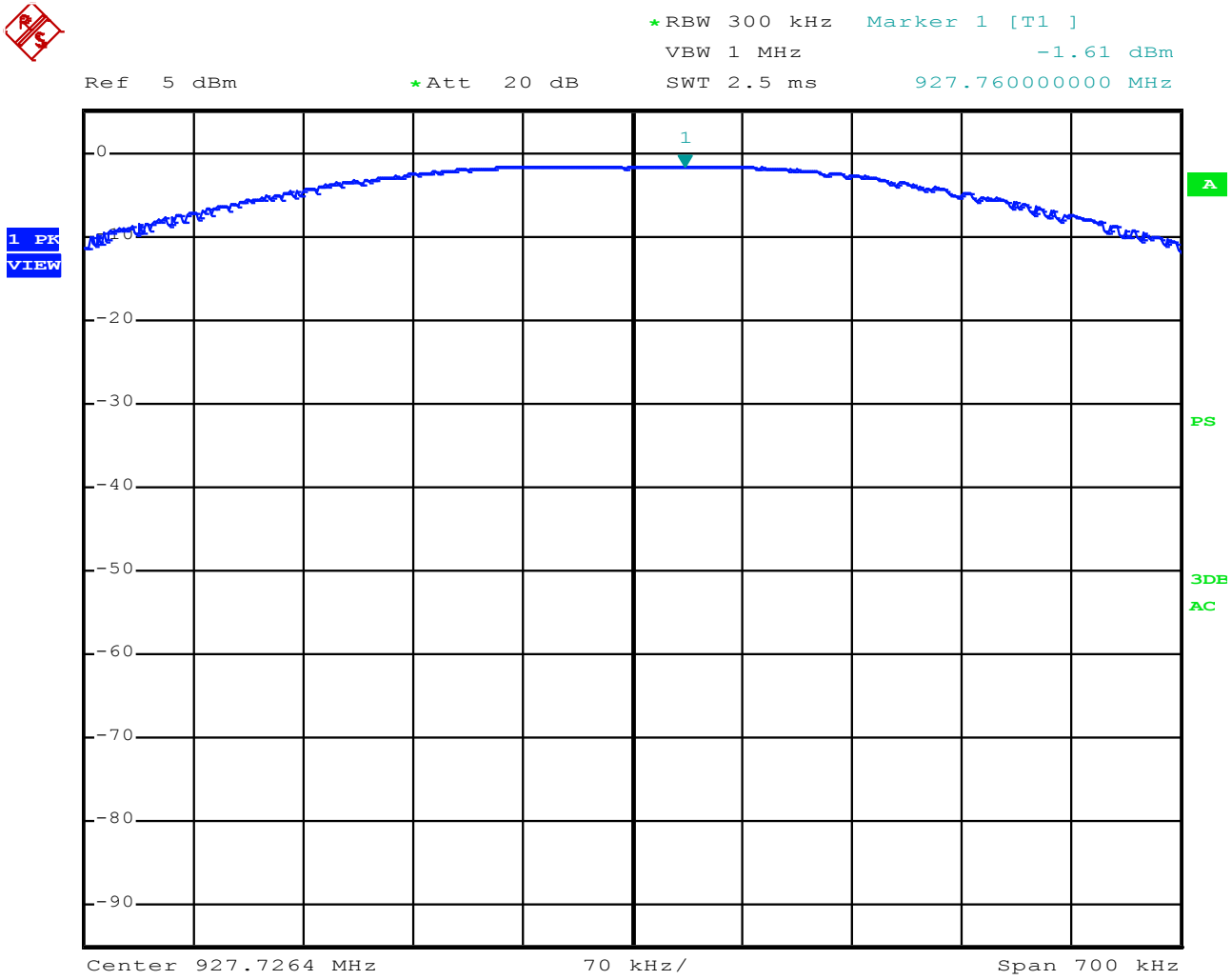
Figure 4: Output Power at MID Frequency



Date: 5.NOV.2015 12:16:11

Figure 5: Output Power at HIGH Frequency

Low Data Rate Tests

20 dB Bandwidth

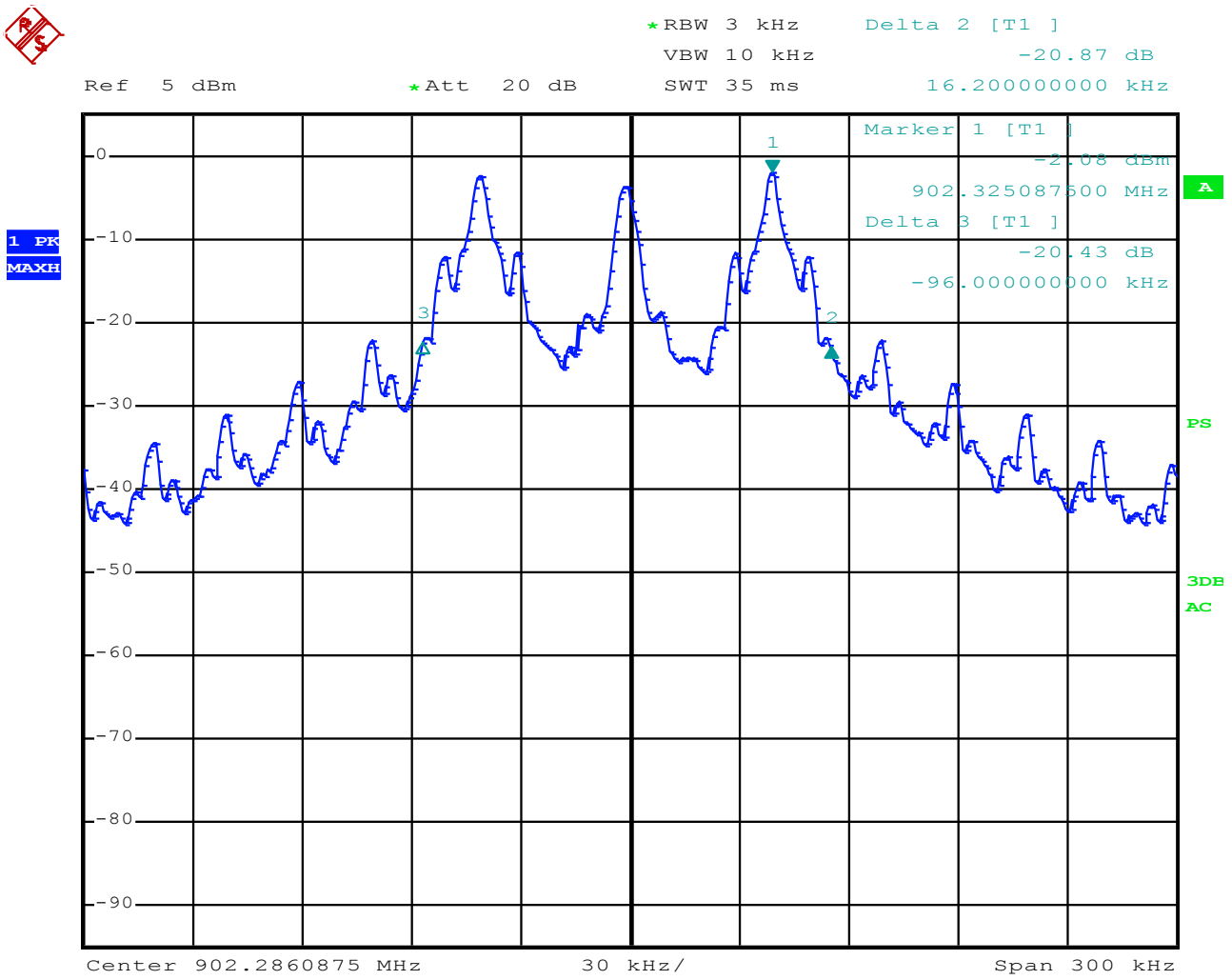


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Figure 6: 20dB Bandwidth at LOW Frequency – 112.2 kHz

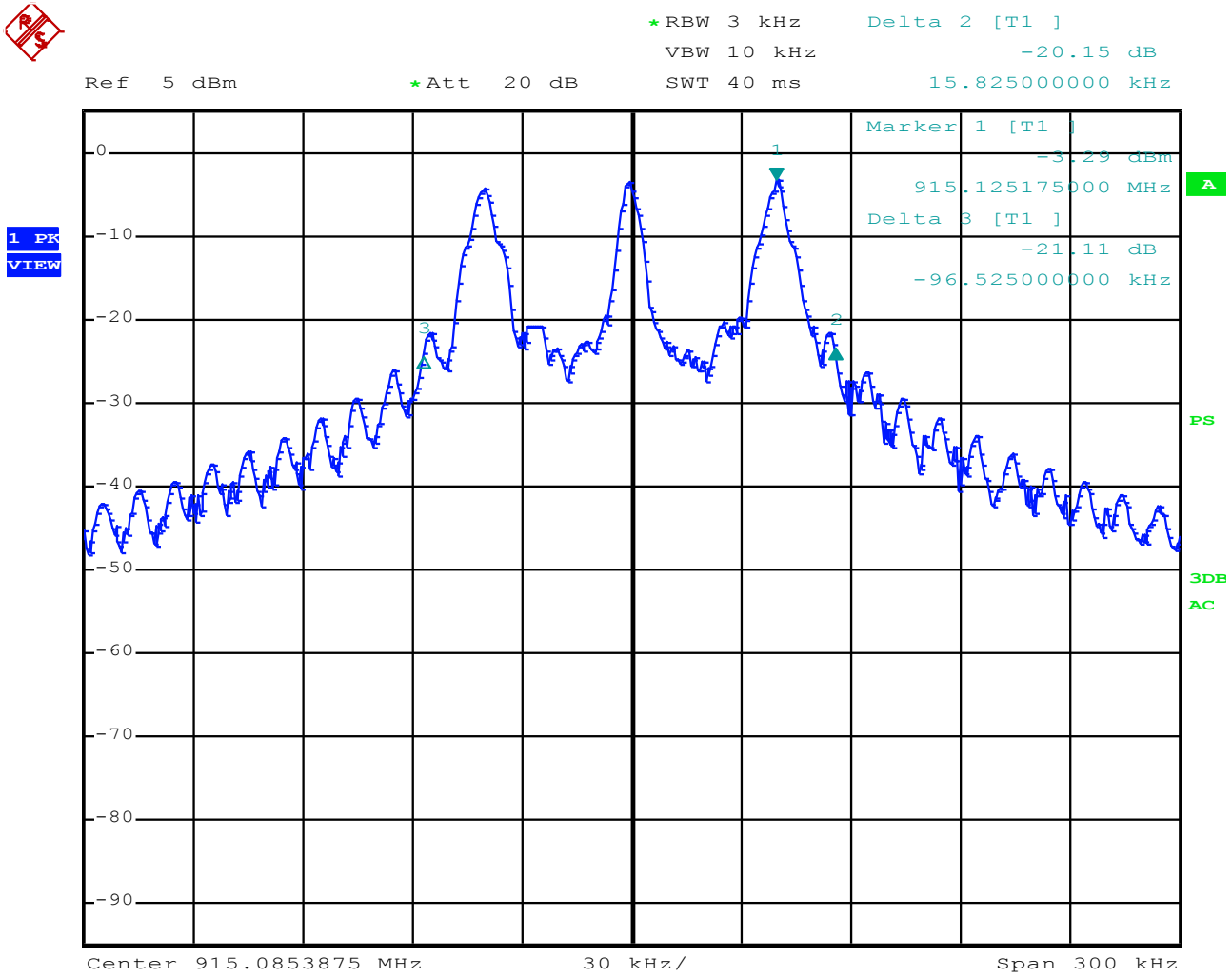

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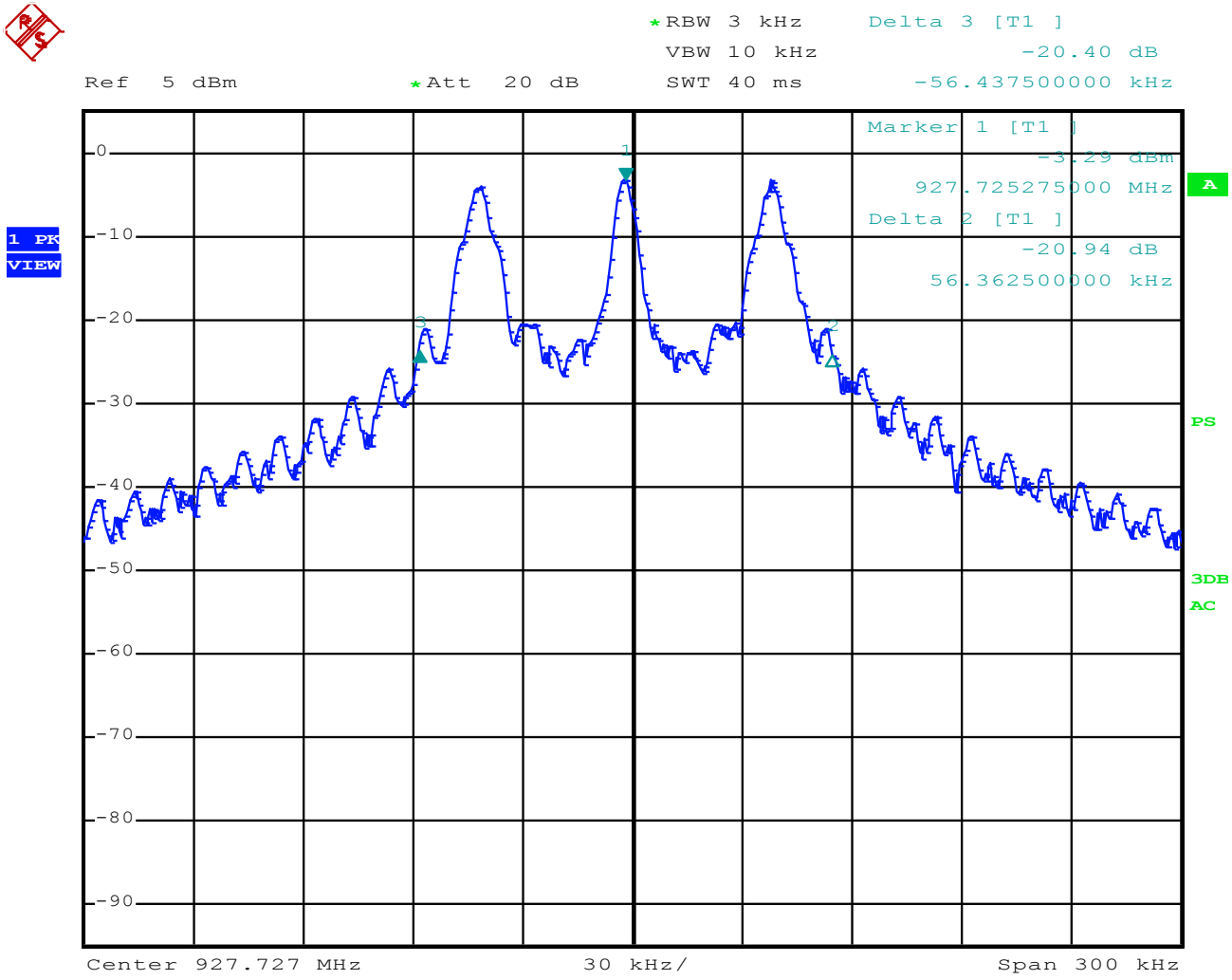
Figure 7: 20dB Bandwidth at MID Frequency – 112.4 kHz



Date: 5.NOV.2015 11:32:03

Figure 8: 20dB Bandwidth at HIGH Frequency – 112.8 kHz

Channel Separation

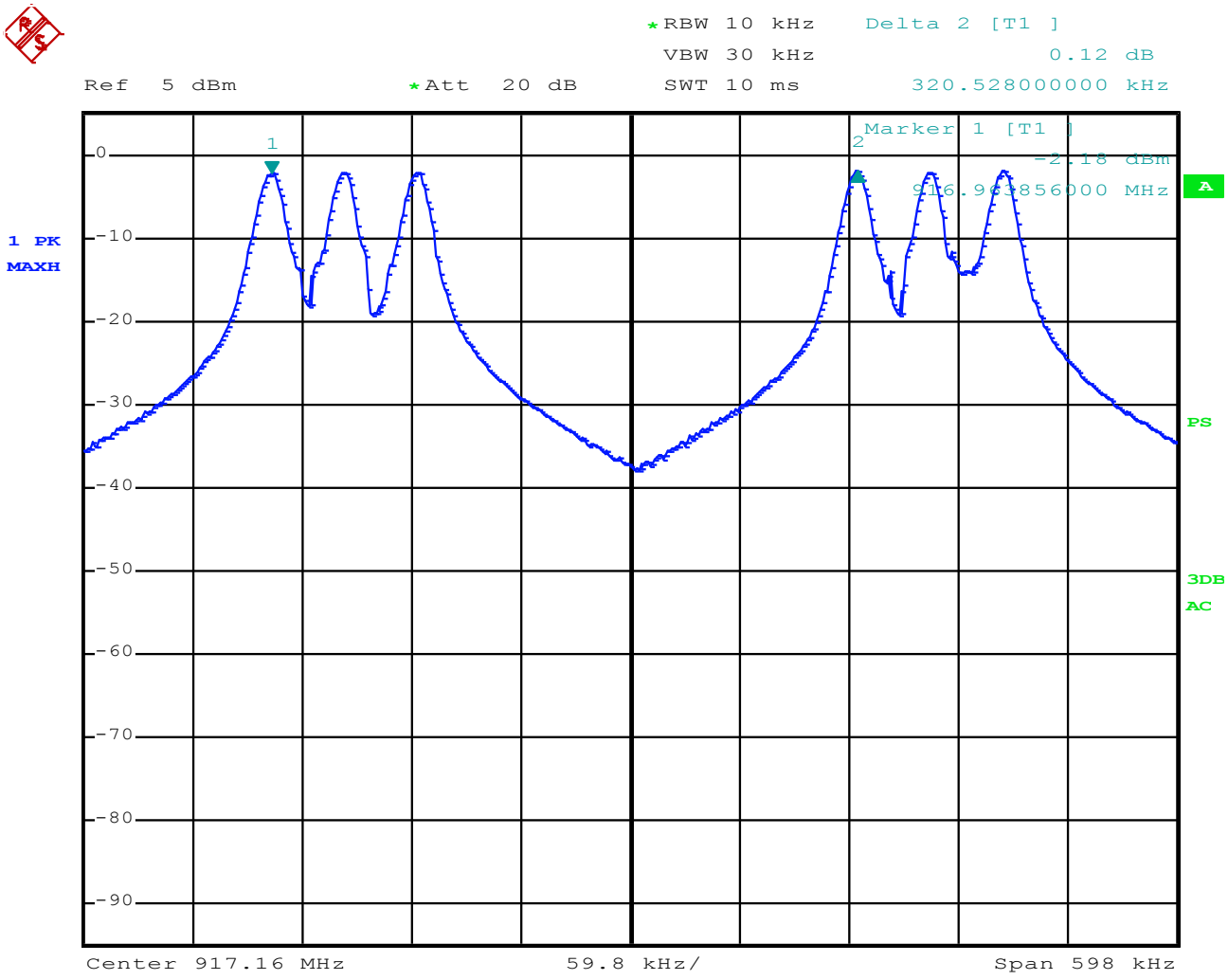


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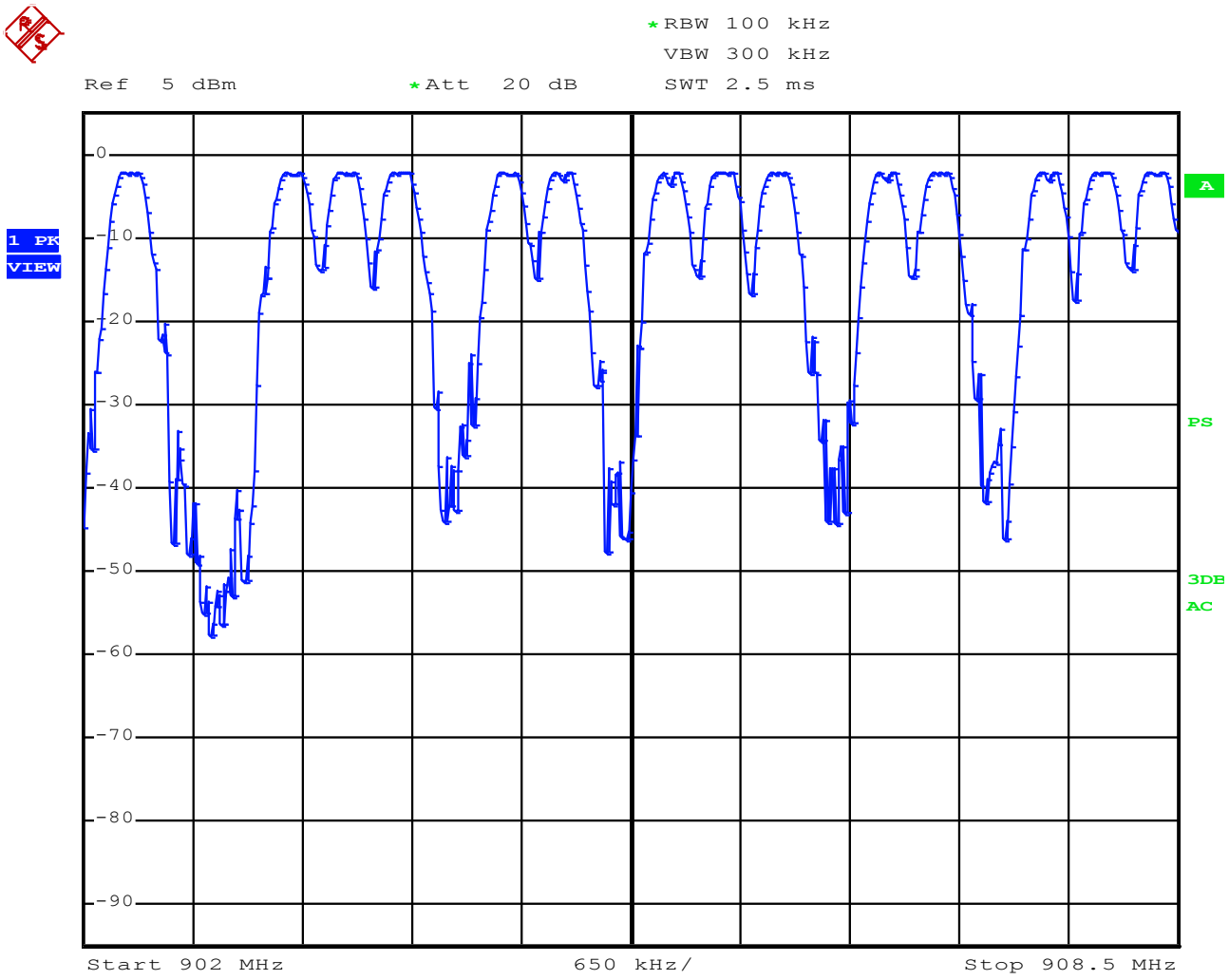
Figure 9: Channel Separation = 320.5 kHz

Number of Hopping Channels



Date: 5.NOV.2015 16:10:44

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

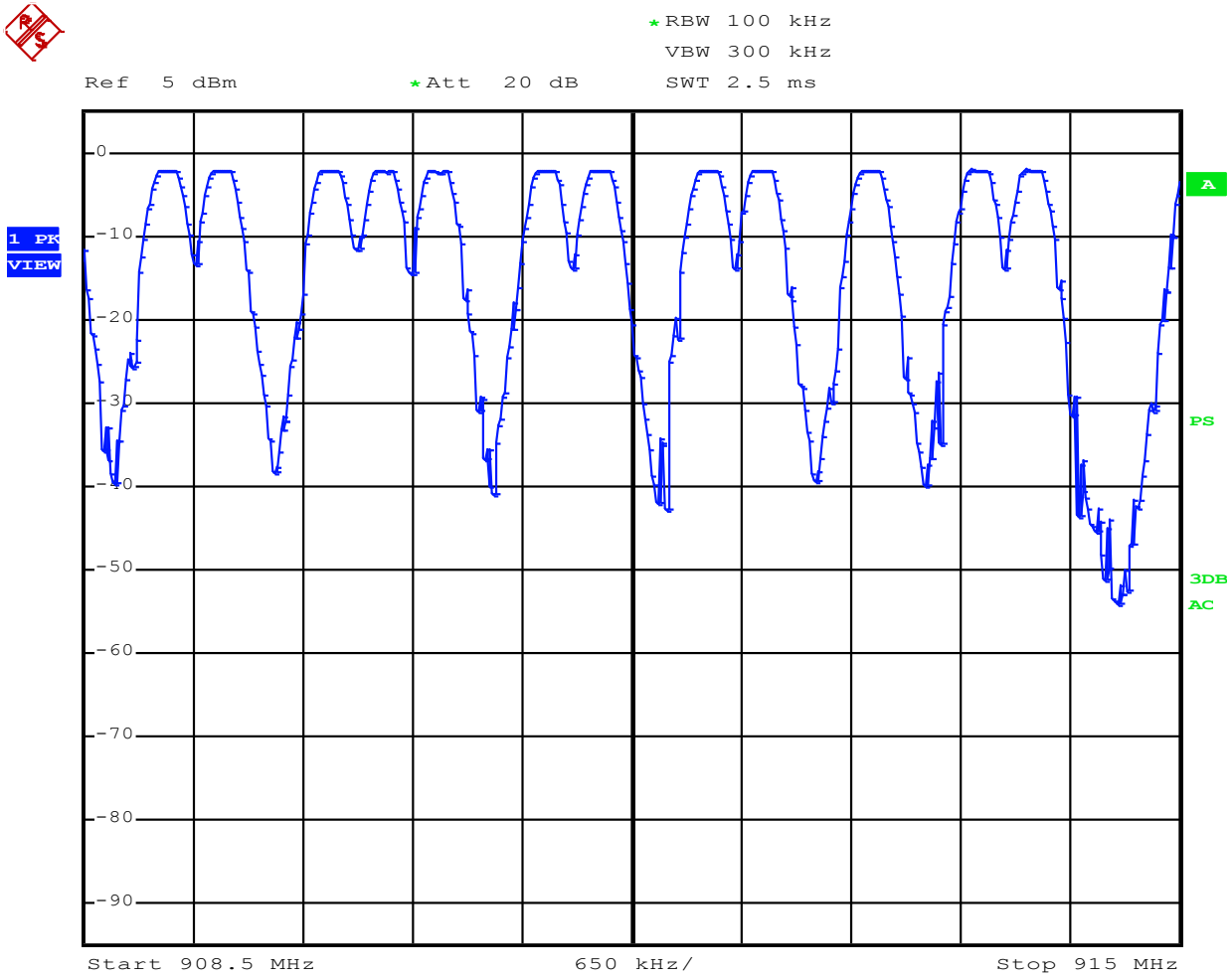


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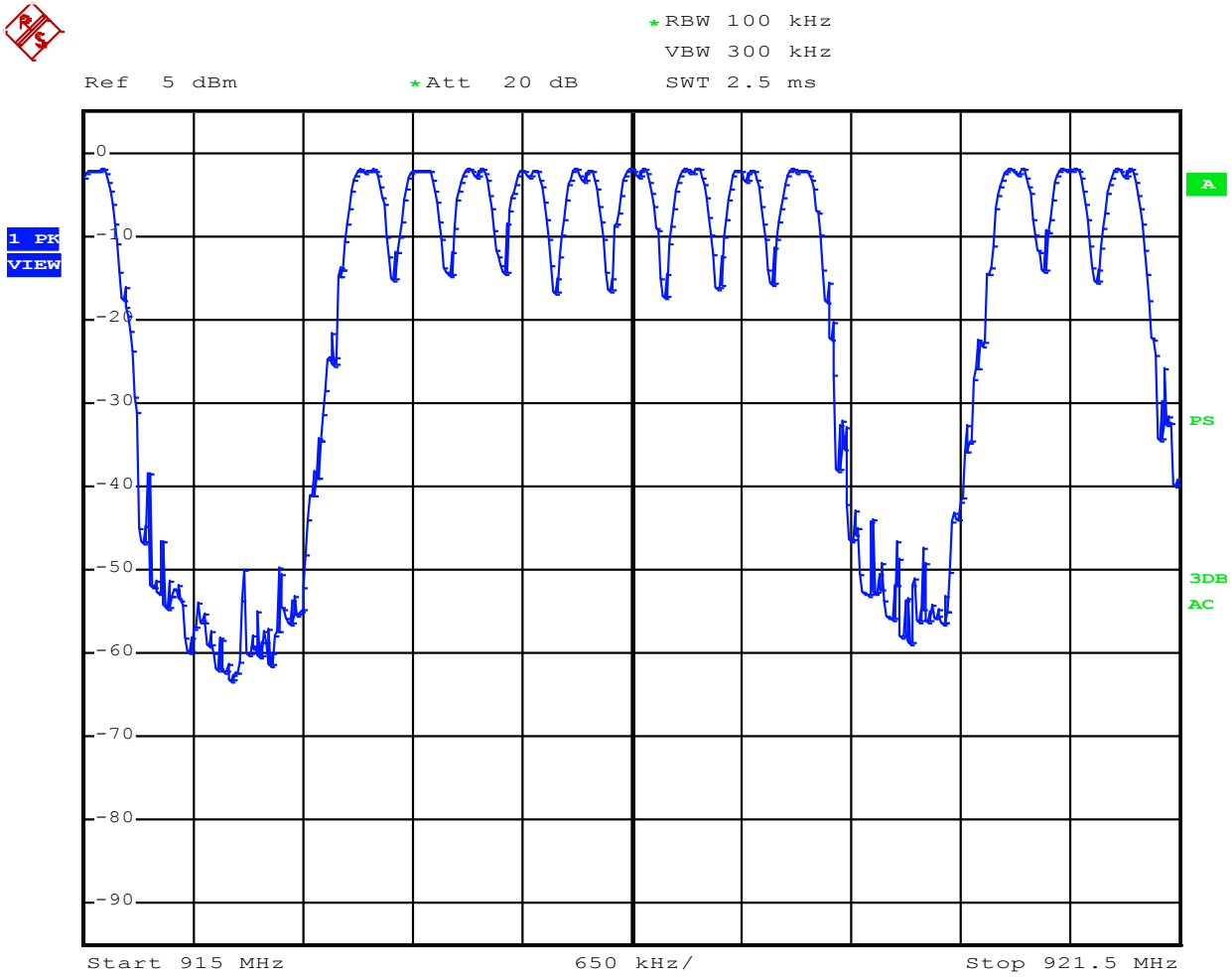
Figure 11: Number of Hopping Frequencies 908MHz to 915MHz - 12 Frequencies



Date: 5.NOV.2015 16:17:10

Figure 12: Number of Hopping Frequencies 915MHz to 921MHz - 13 Frequencies

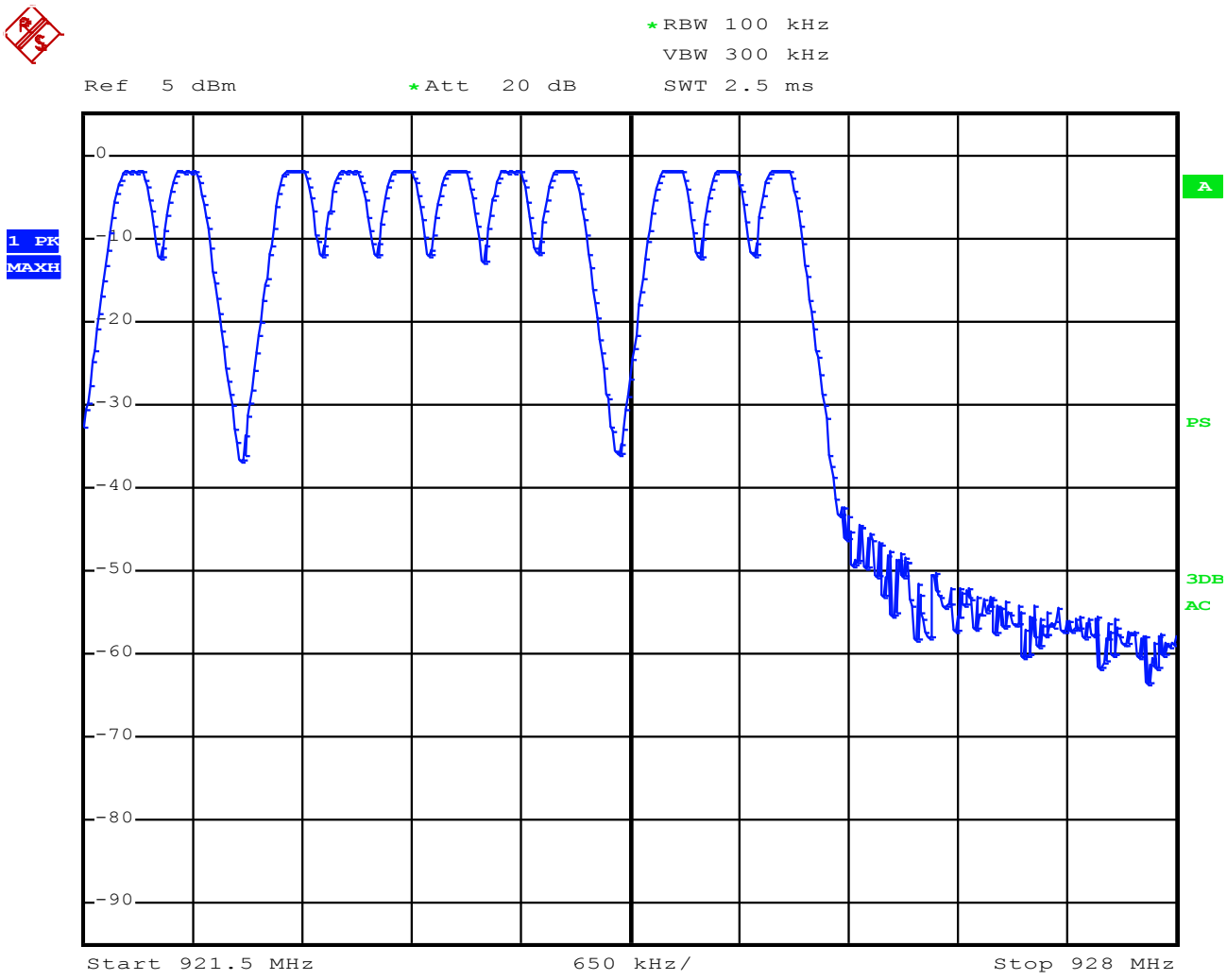


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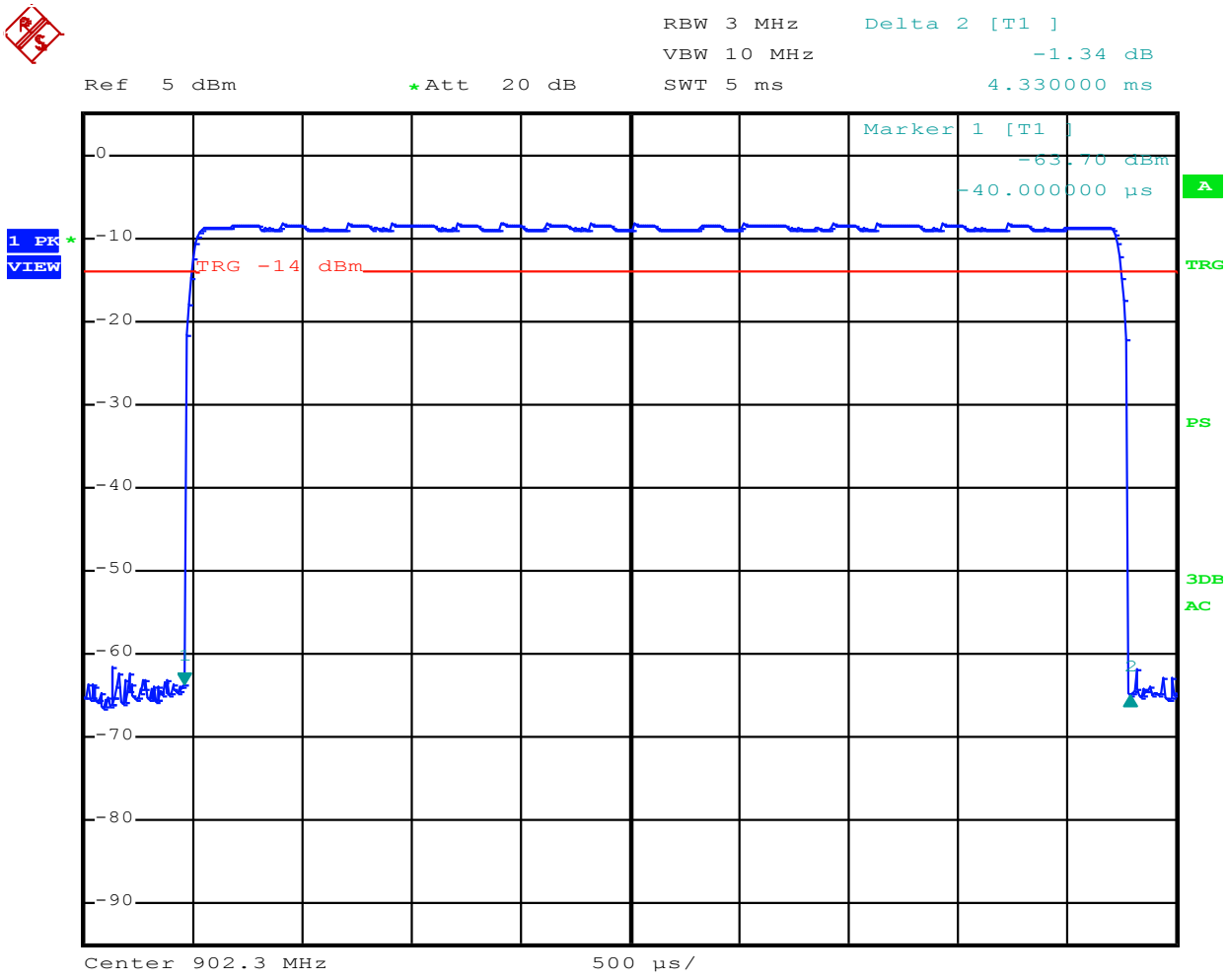
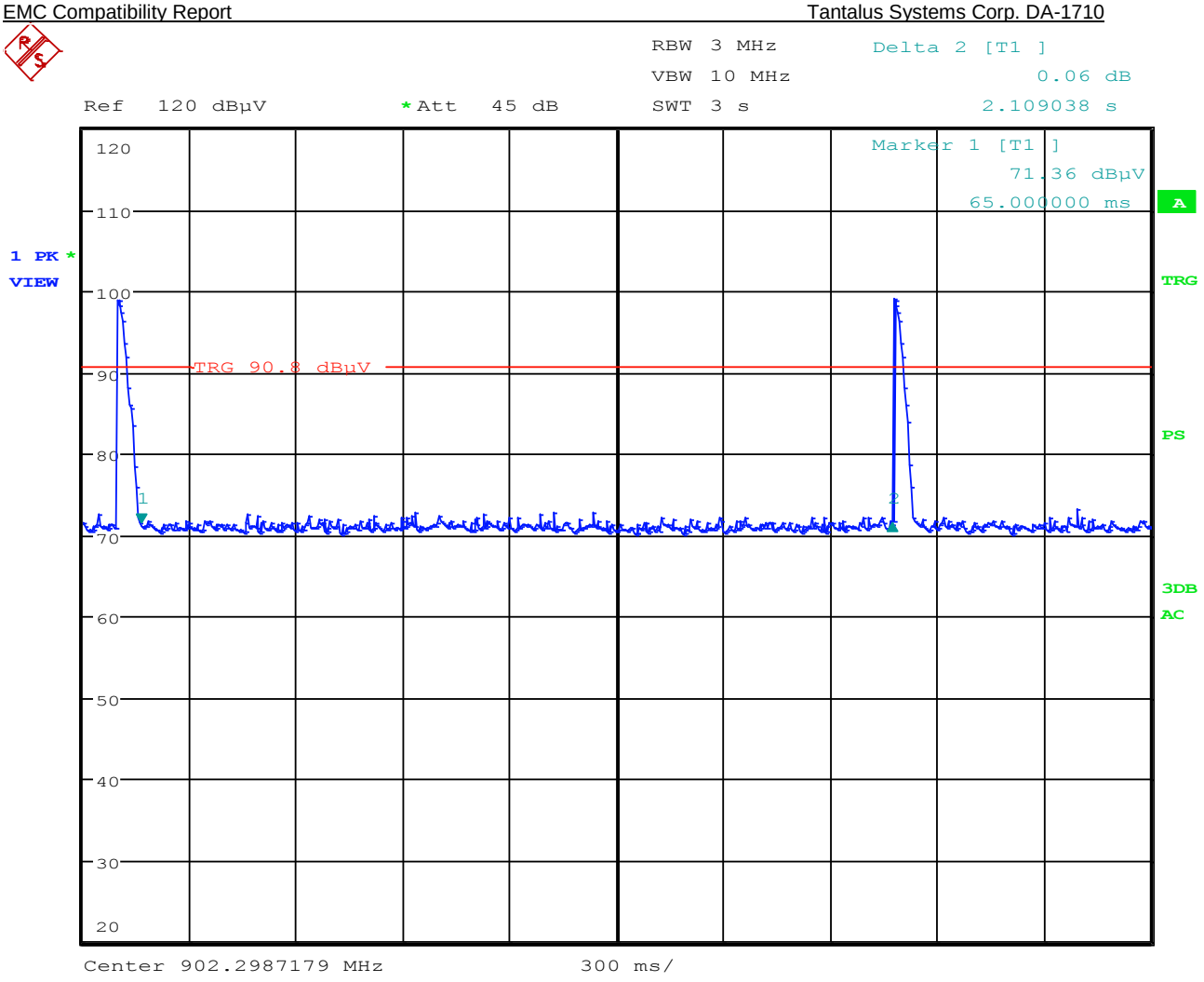
Figure 13: Number of Hopping Frequencies 921MHz to 928MHz - 11 Frequencies

Dwell Time and Time of Occupancy



Date: 5.NOV.2015 17:14:10

Figure 14: Dwell Time – 4.3mS

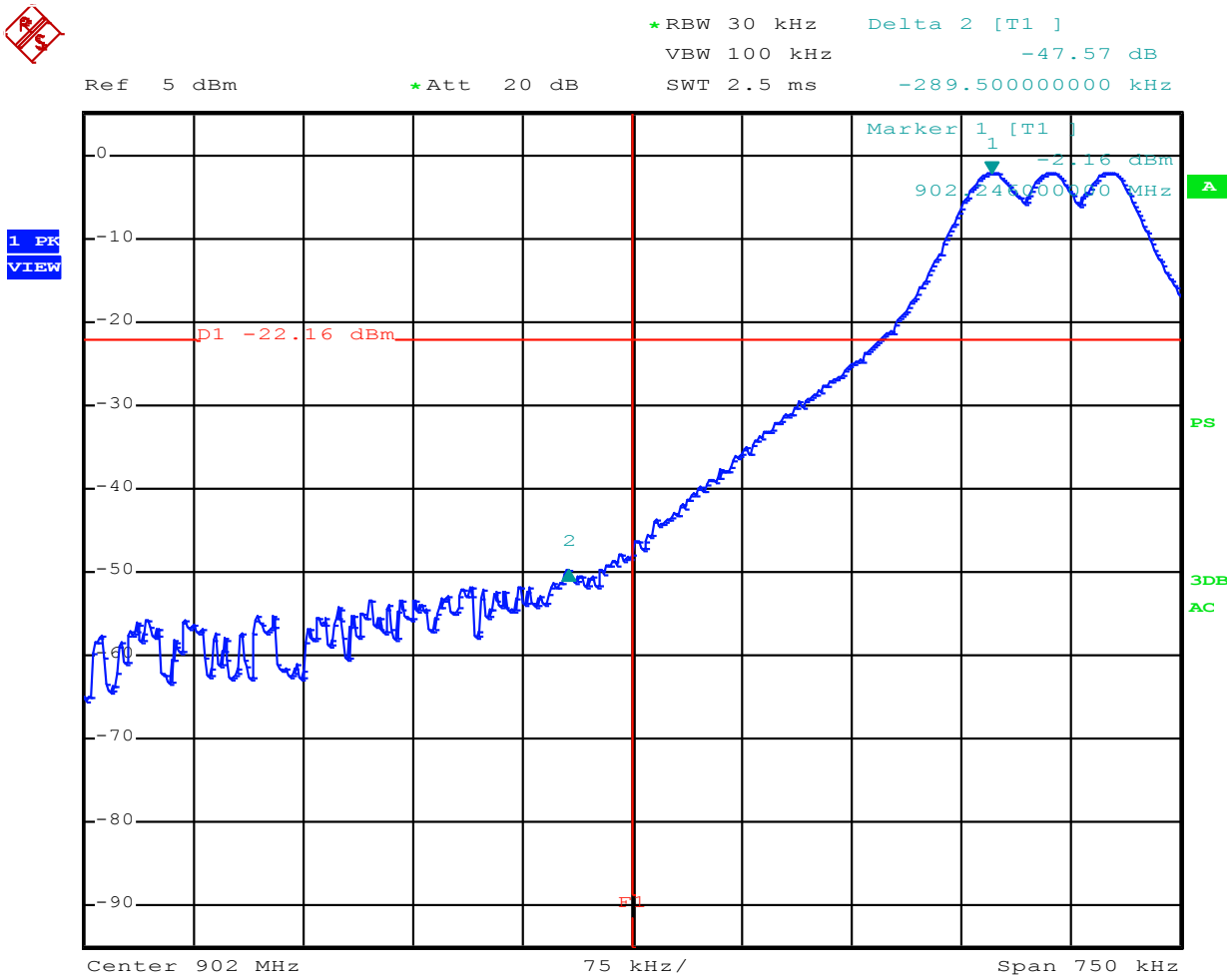


Date: 17.NOV.2015 16:42:05

Figure 15: Time Occupancy Per Frequency – 41mS*

*(***** Time betwen 2 consecutive transmissions on the same frequency is 2.1 Seconds, dwell time per frequency is 4.30mS, therefore occupancy time per frequency within a 20 Second period is 41mS)*

Channel Bandedge



Date: 5.NOV.2015 12:09:43

Figure 16: Low Channel Bandedge

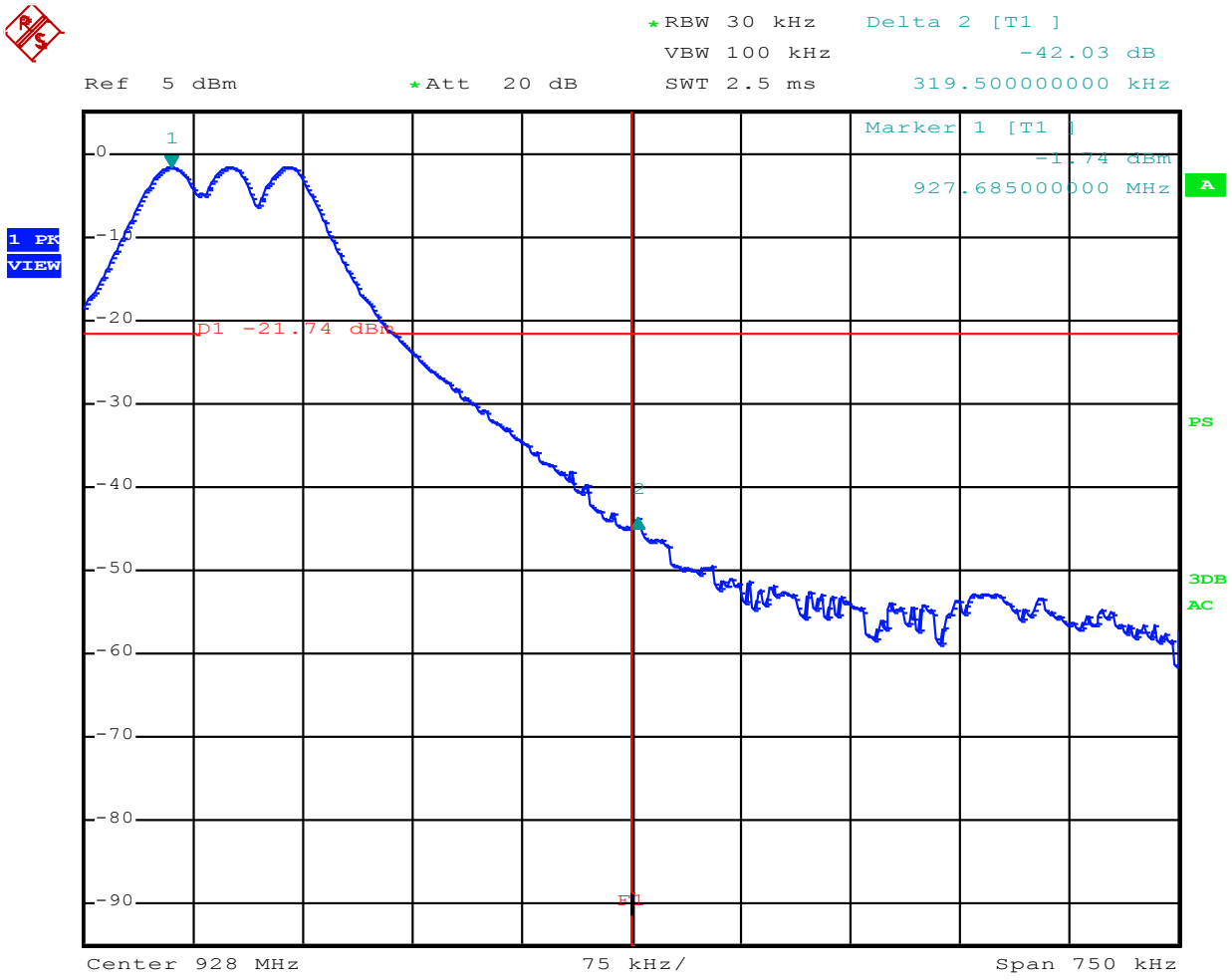


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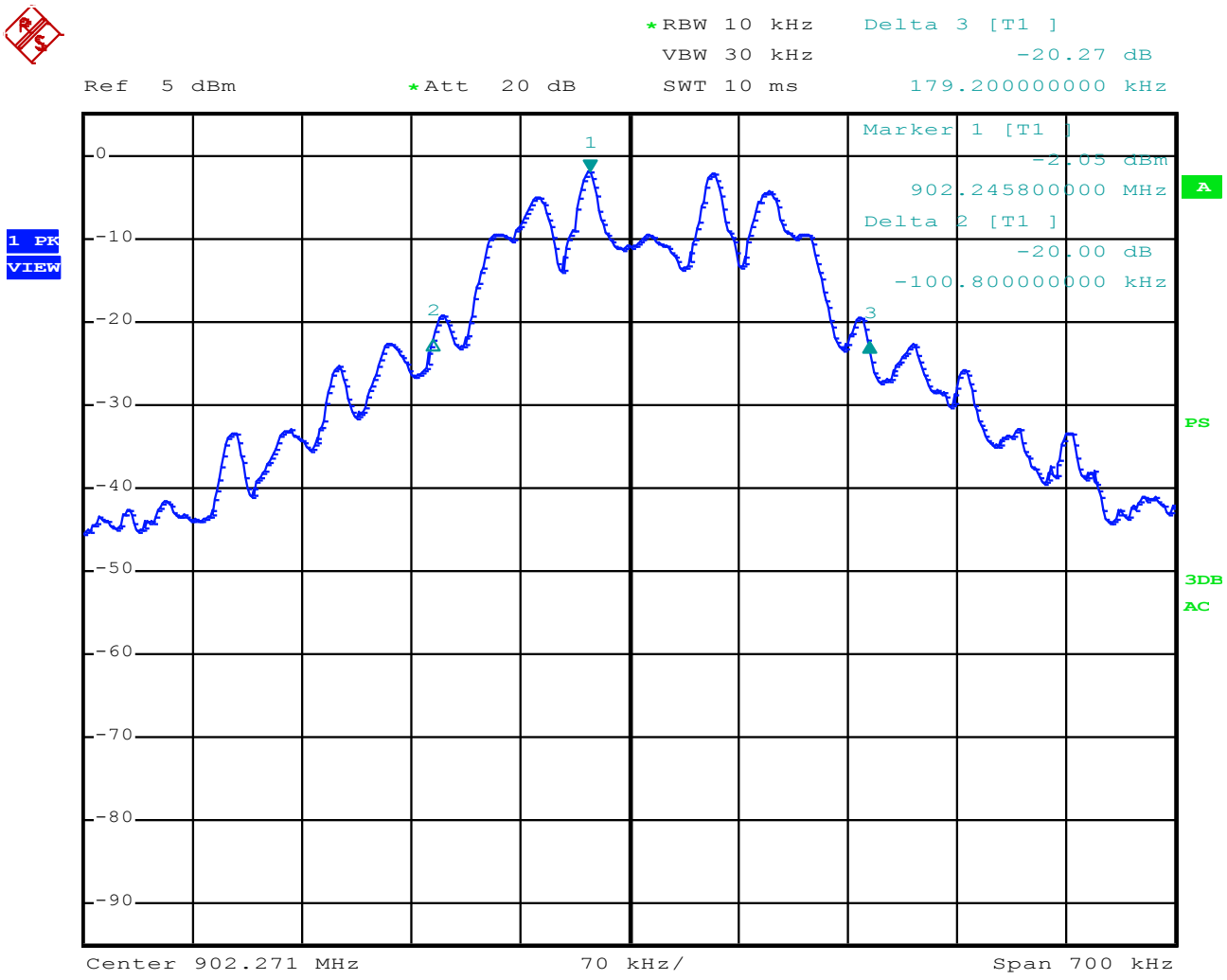
Figure 17: High Channel Bandedge

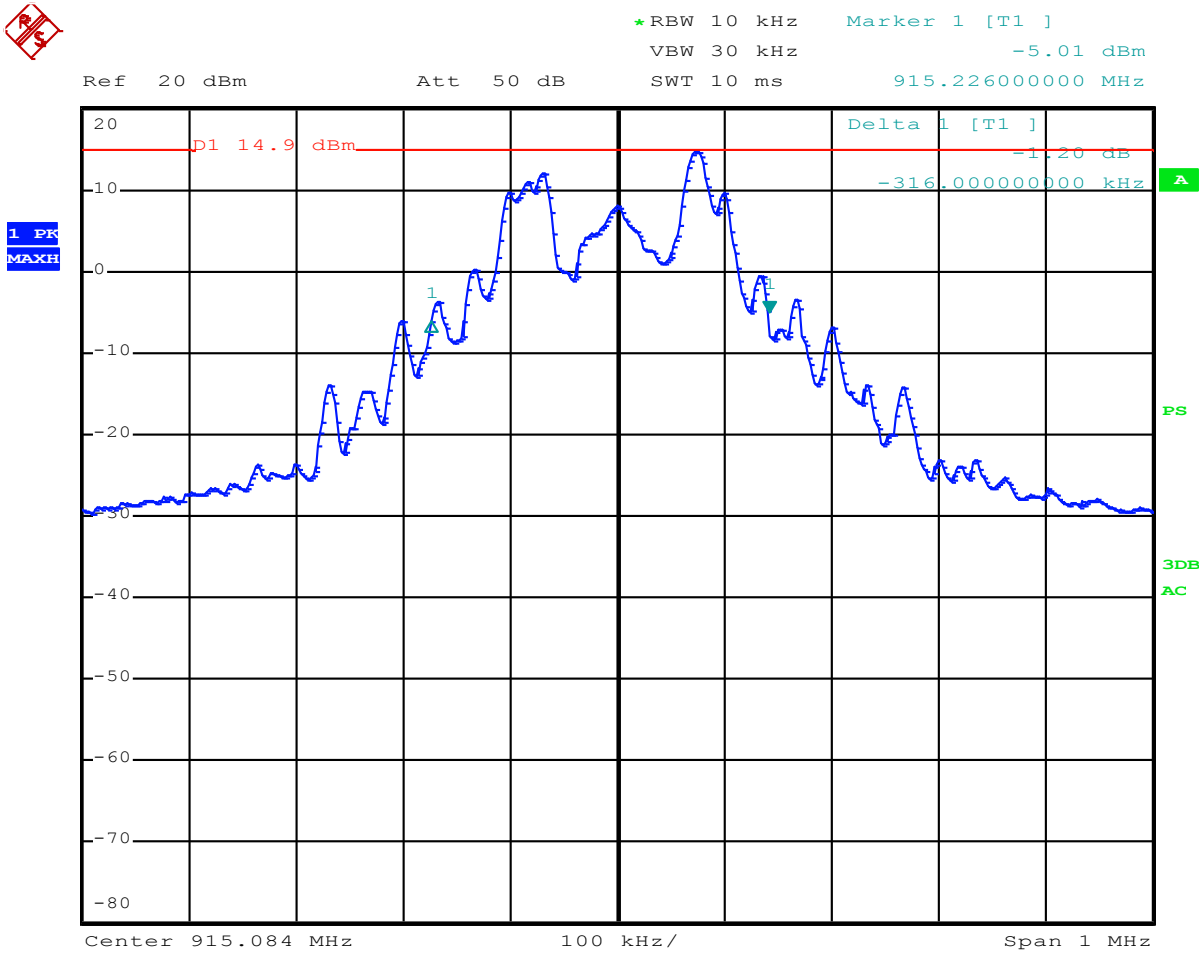
High Data Rate Tests

20 dB Bandwidth



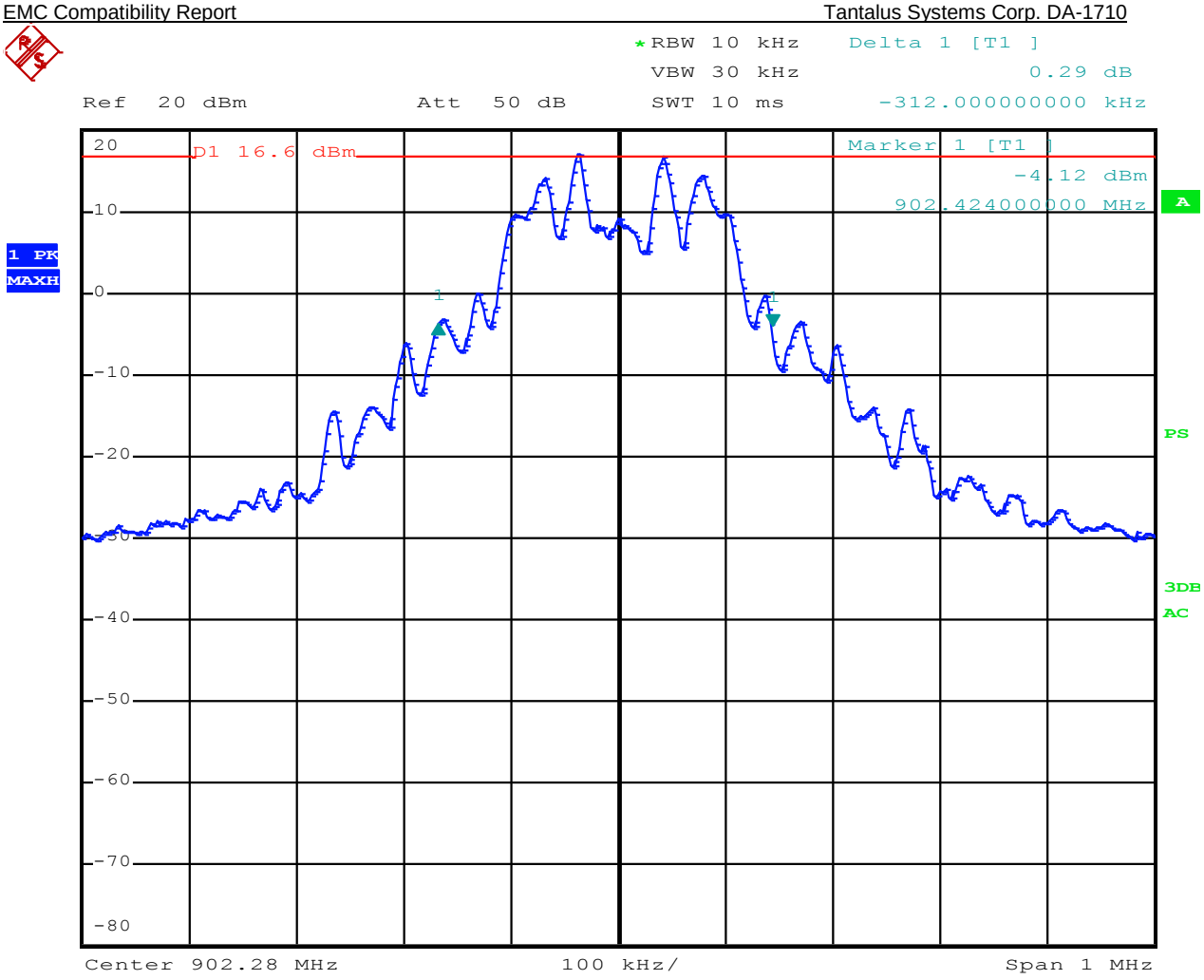
Date: 6.NOV.2015 15:35:07

Figure 18: 20dB Bandwidth at LOW Frequency – 279 kHz



Date: 21.DEC.2015 11:09:33

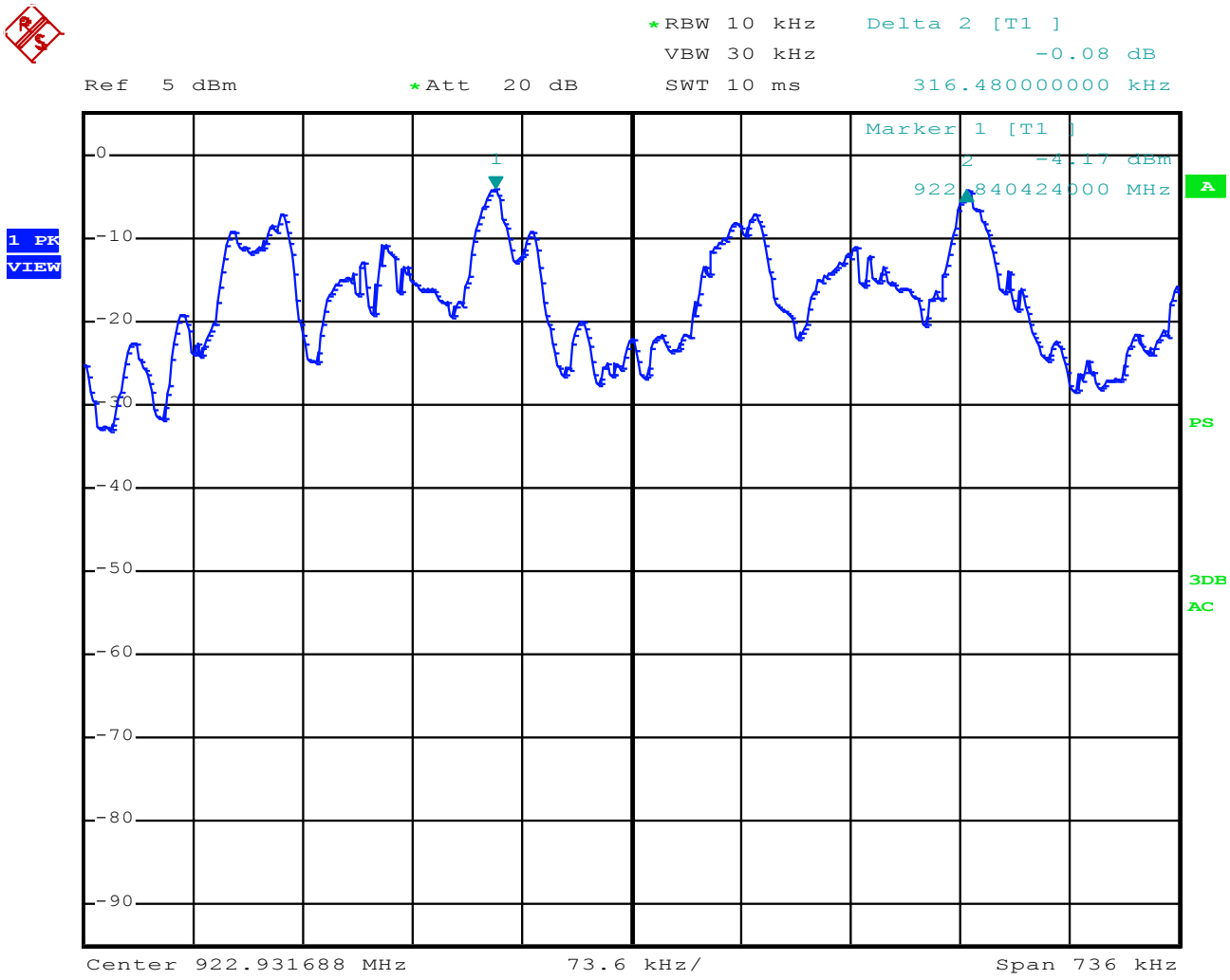
Figure 19: 20dB Bandwidth at MID Frequency – 316 kHz



Date: 21.DEC.2015 11:11:19

Figure 20: 20dB Bandwidth at HIGH Frequency – 312 kHz

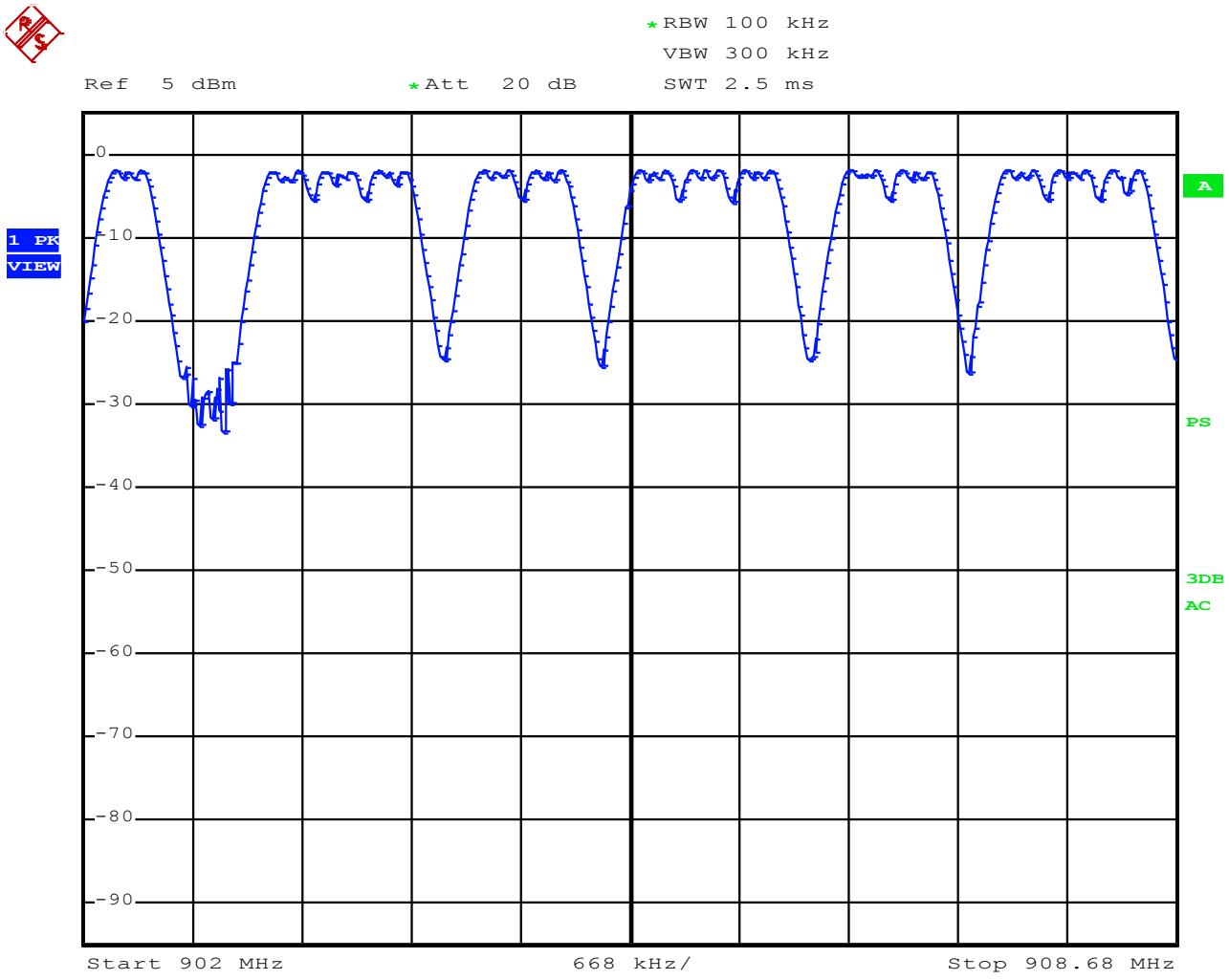
Channel Separation



Date: 6.NOV.2015 16:49:47

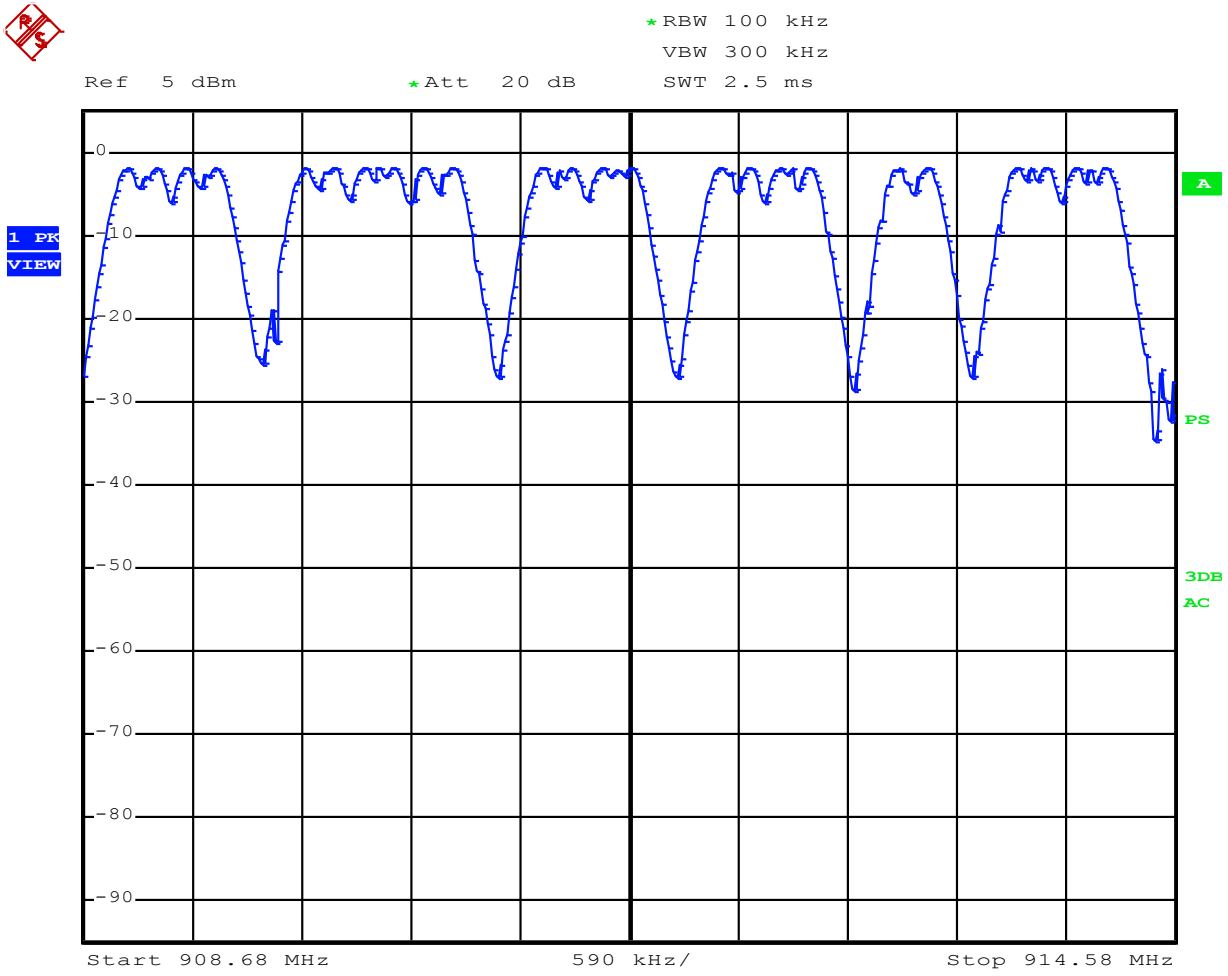
Figure 21: Channel Separation = 320 kHz

Number of Hopping Channels



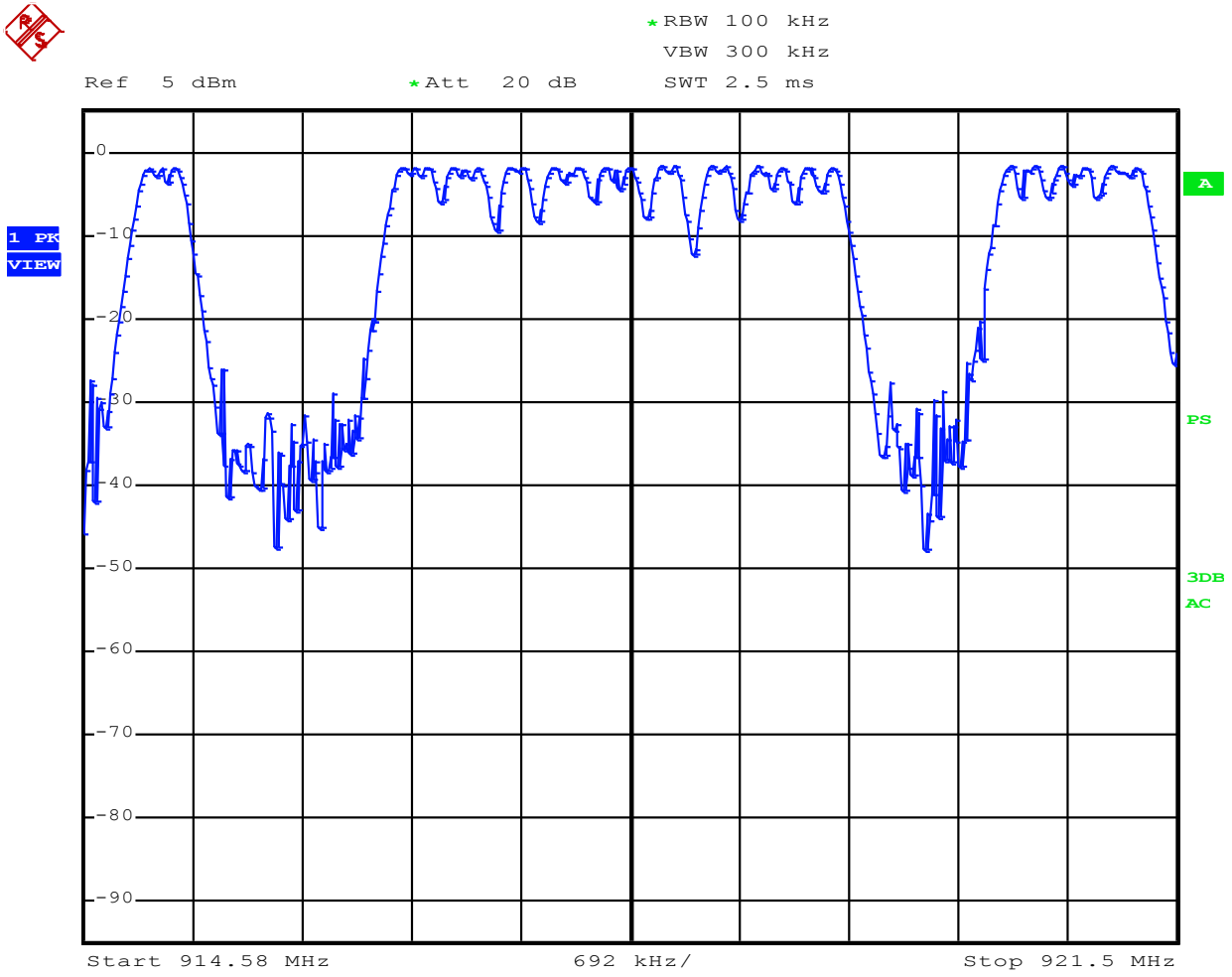
Date: 6.NOV.2015 16:09:12

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



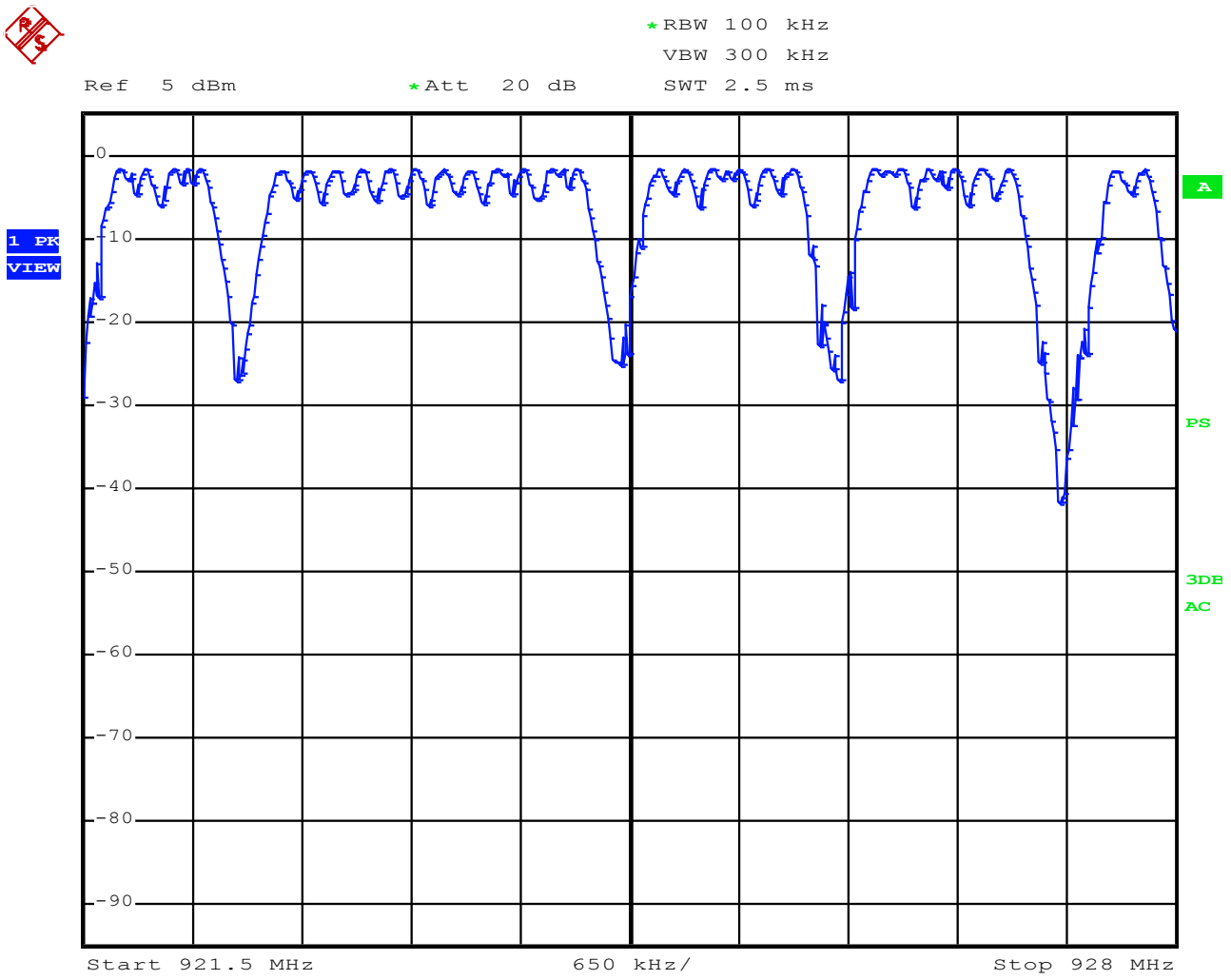
Date: 6.NOV.2015 16:11:13

Figure 23: Number of Hopping Frequencies 908.7MHz to 9014.5MHz - 12 Frequencies



Date: 6.NOV.2015 16:13:08

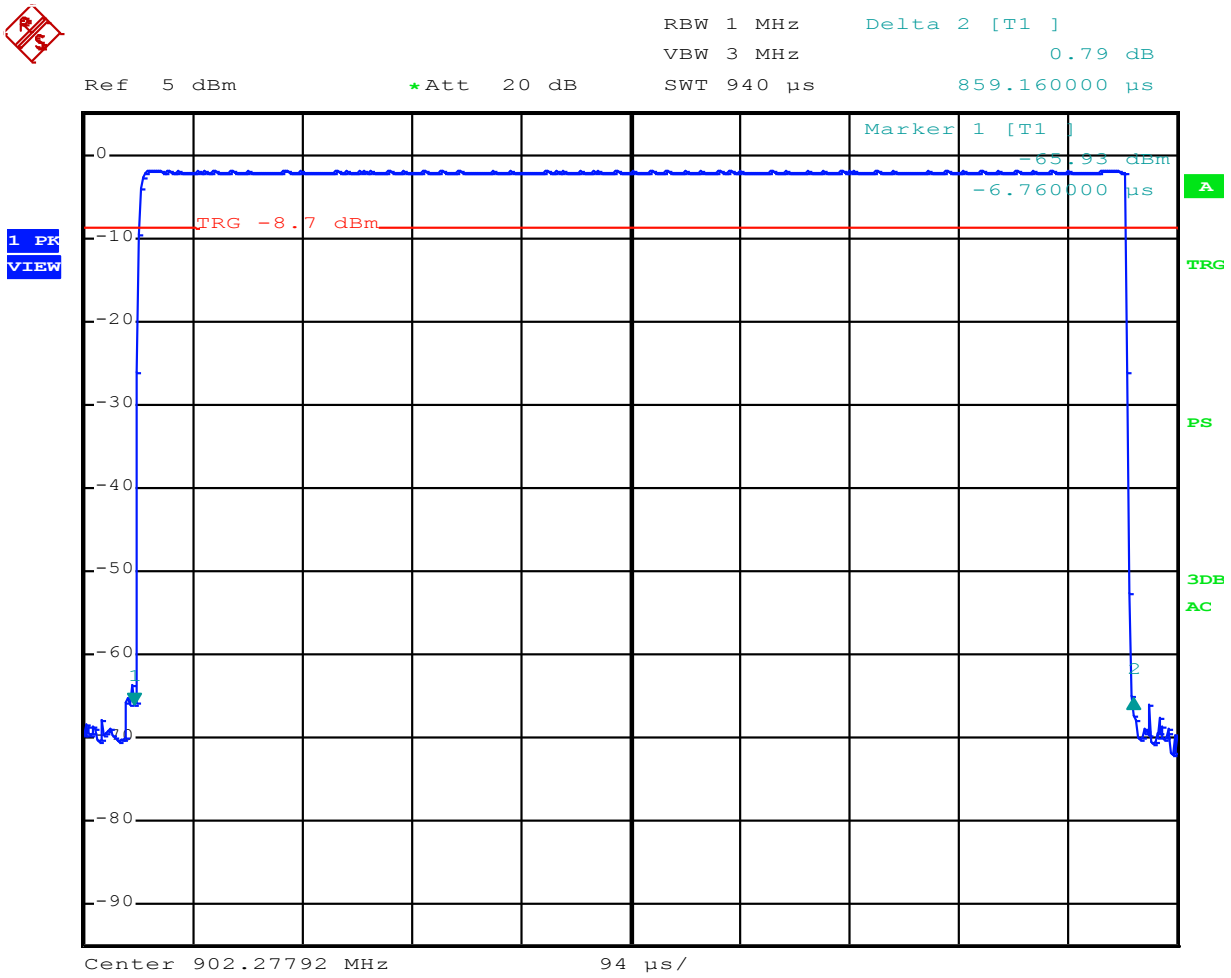
Figure 24: Number of Hopping Frequencies 914.5MHz to 921.5MHz - 13 Frequencies



Date: 6.NOV.2015 16:14:19

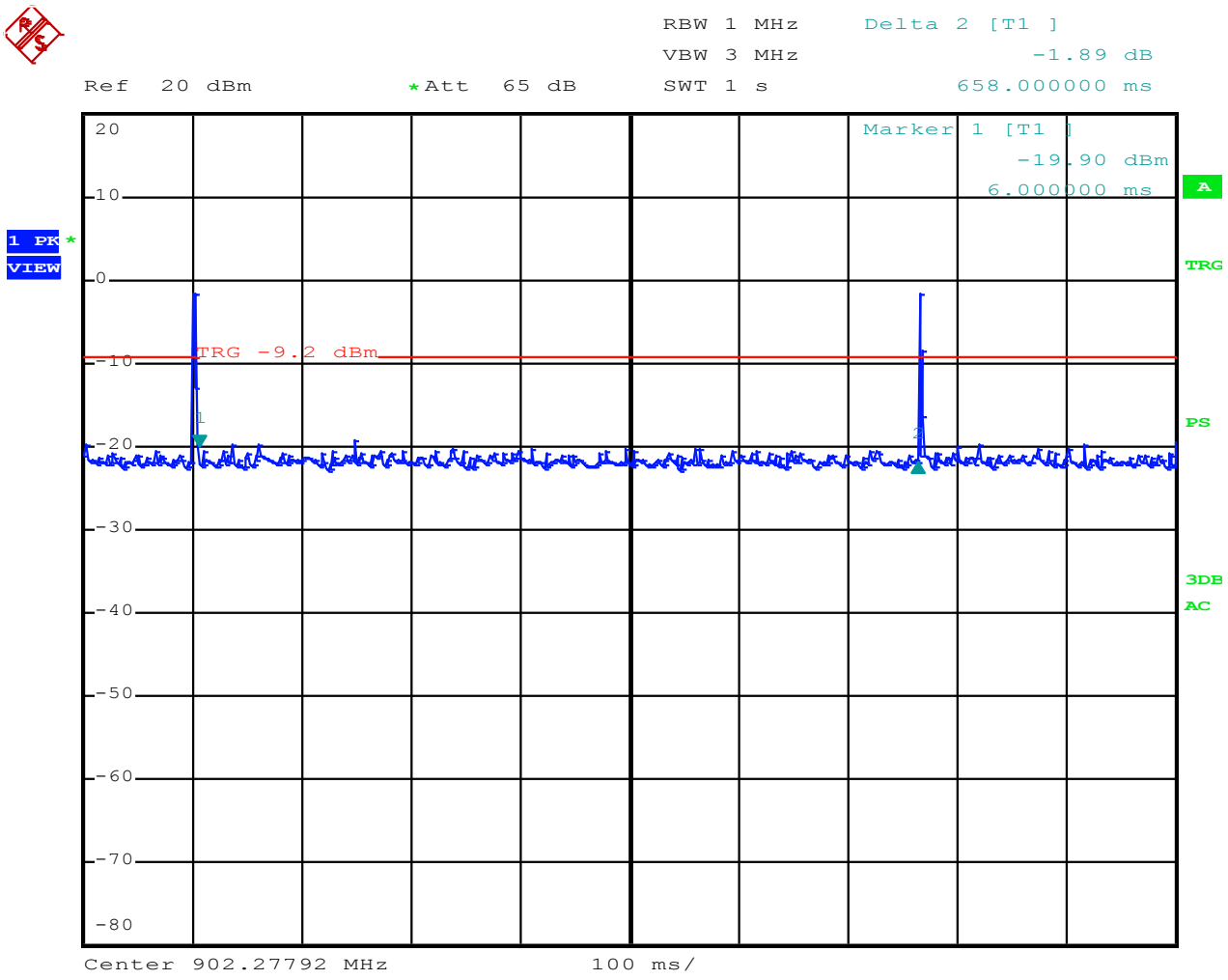
Figure 25: Number of Hopping Frequencies 921.5MHz to 928MHz - 15 Frequencies

Dwell Time and Time of Occupancy



Date: 6.NOV.2015 16:54:33

Figure 26: Dwell Time – 869.2uS

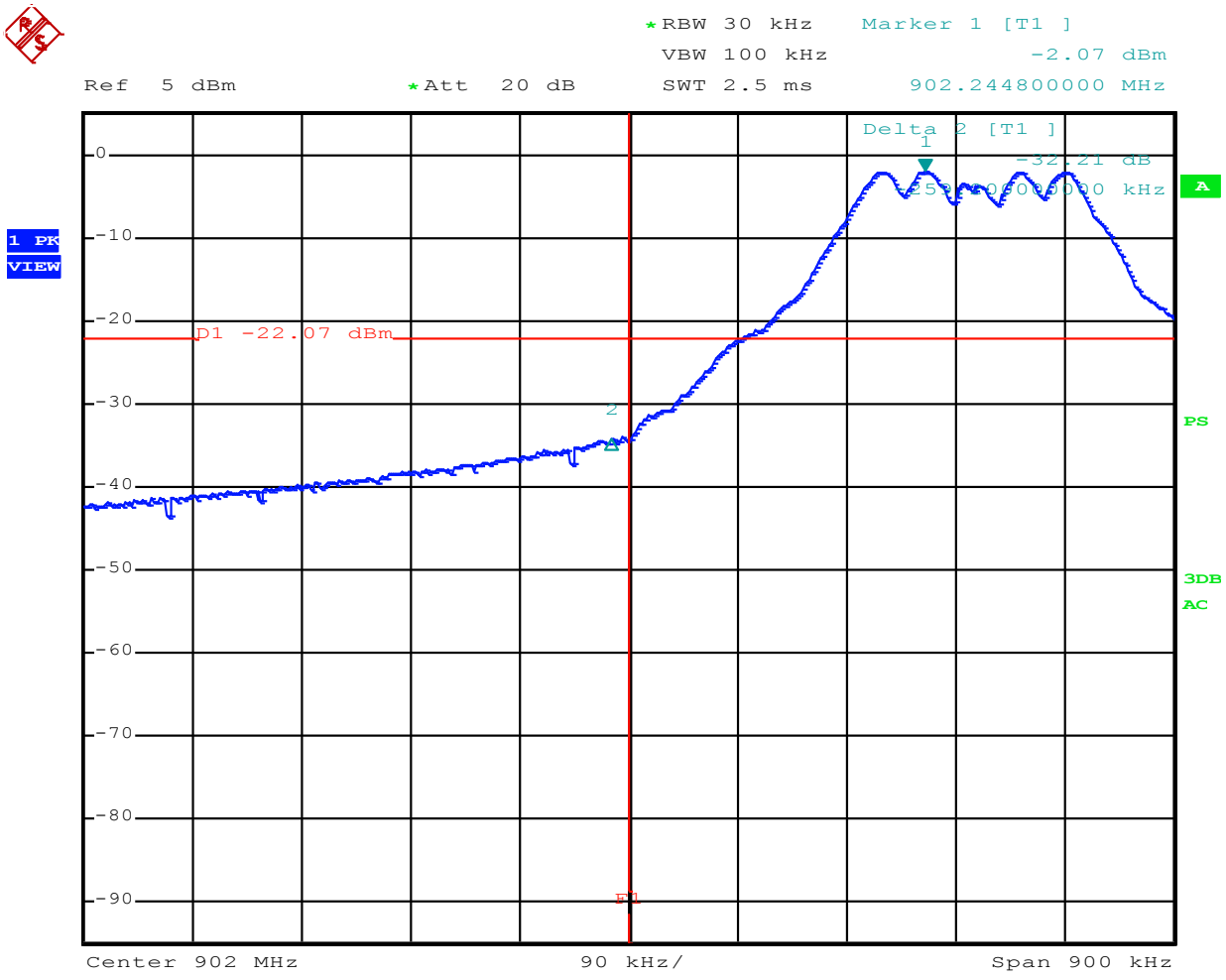


Date: 6.NOV.2015 17:01:52

Figure 27: Time Occupancy Per Frequency – 26.3mS*

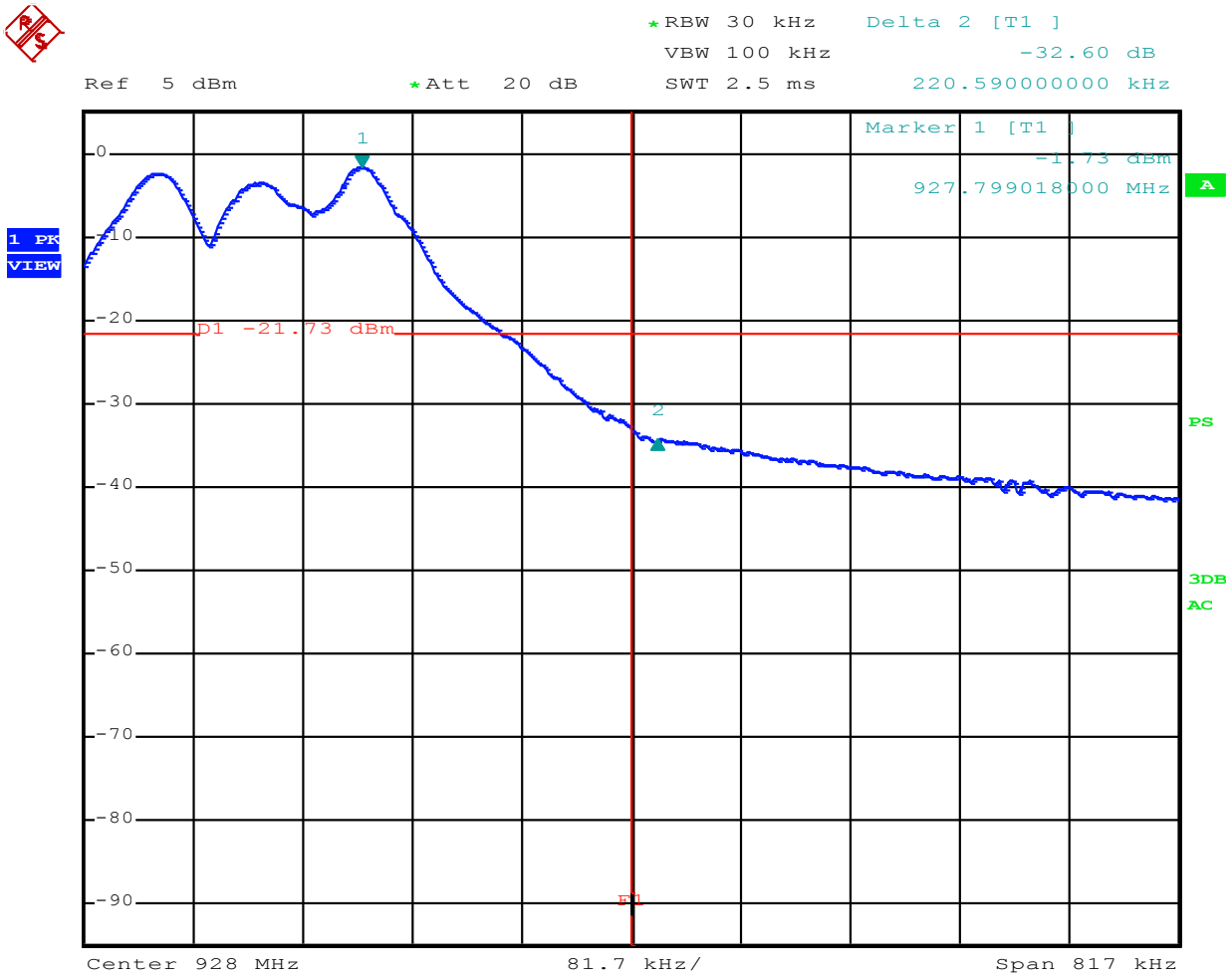
*(***** Time betwen 2 consecutive transmissions on the same frequency is 0.652 Seconds, dwell time per frequency is 0.859mS, therefore occupancy time per frequency within a 20 Second period is 26.3 mS)*

Channel Bandedge



Date: 6.NOV.2015 16:00:46

Figure 28: Low Channel Bandedge

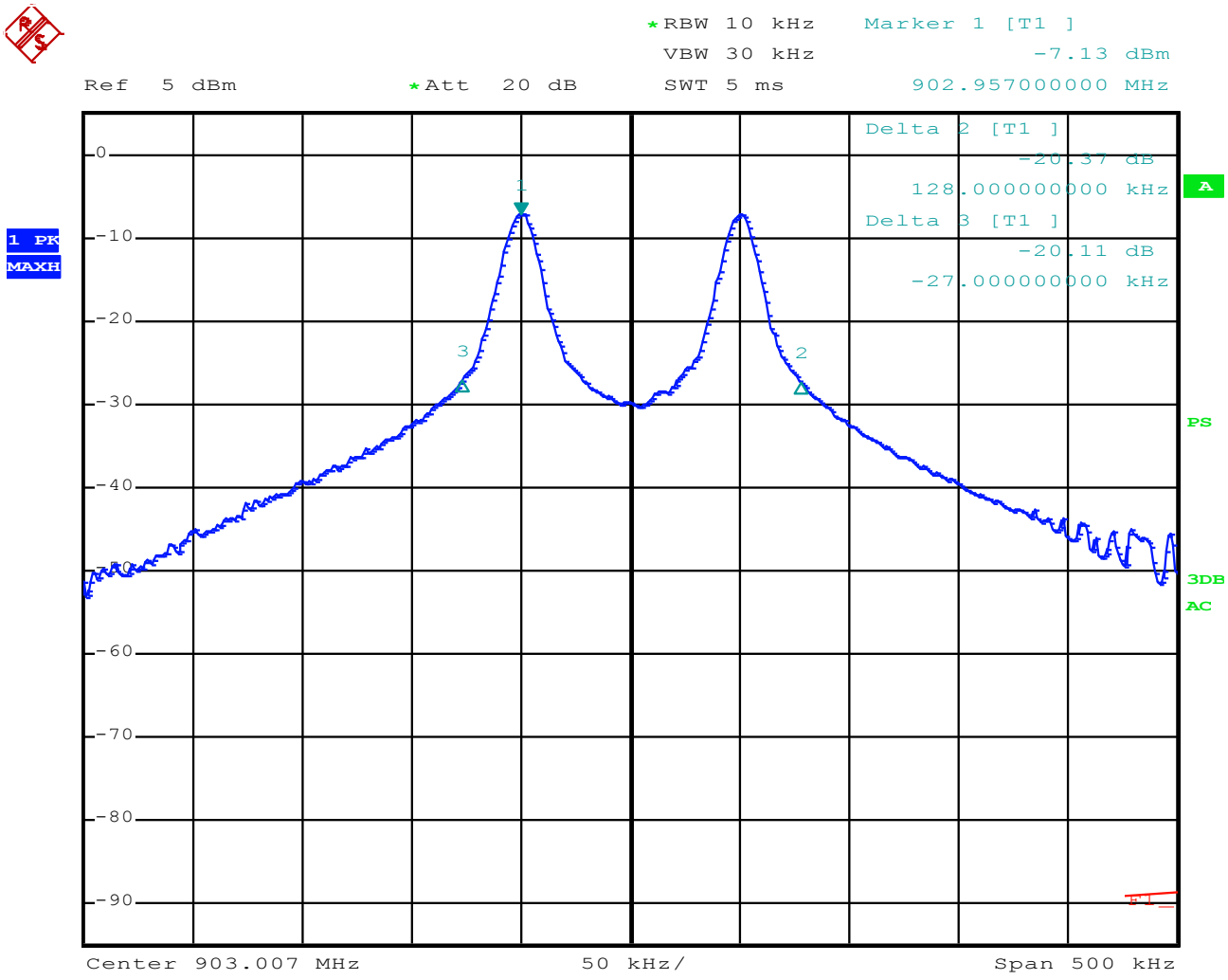


Date: 6.NOV.2015 16:03:09

Figure 29: High Channel Bandedge

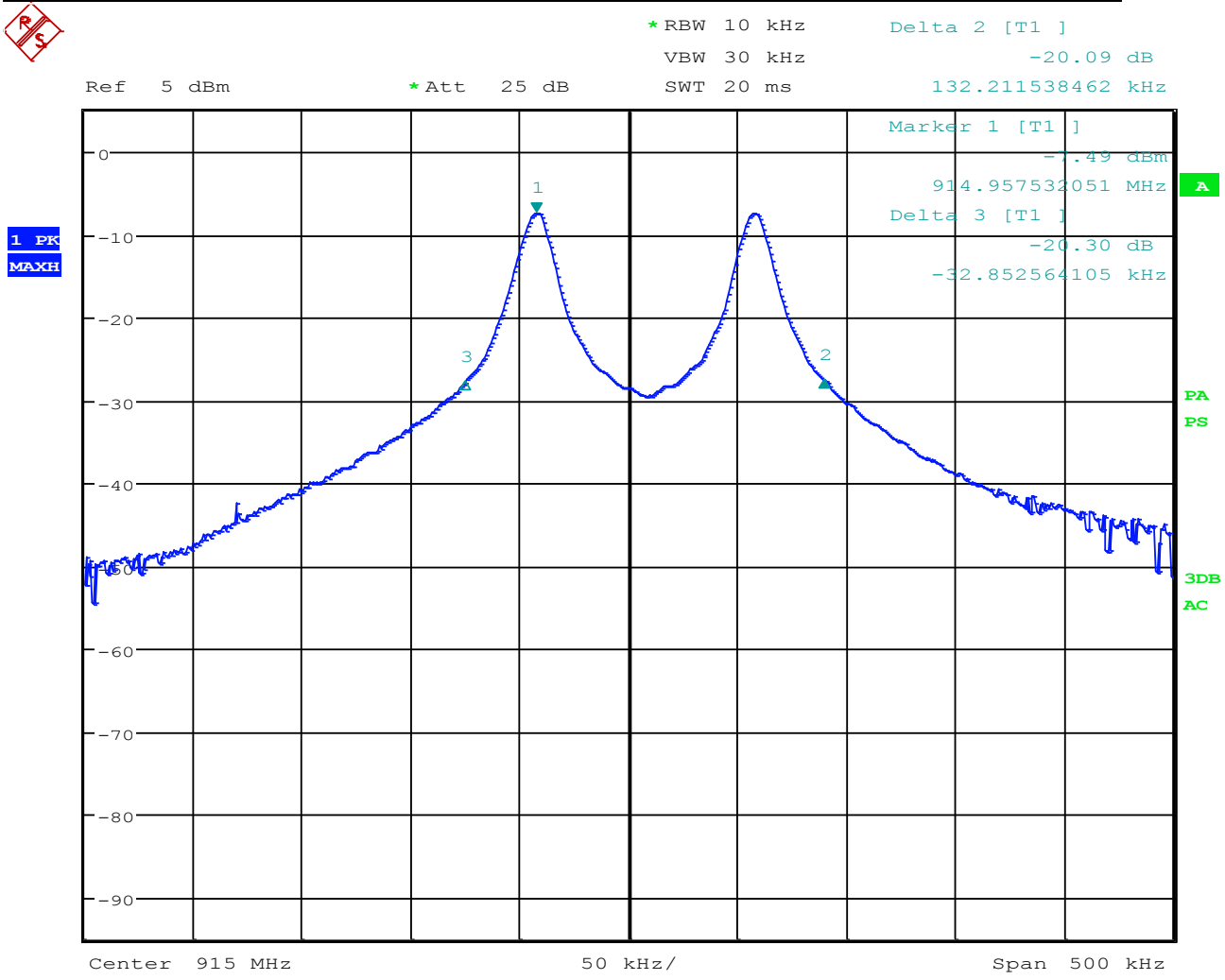
Tests when unit is communicating to OEM Part 15 approved Device

20 dB Bandwidth



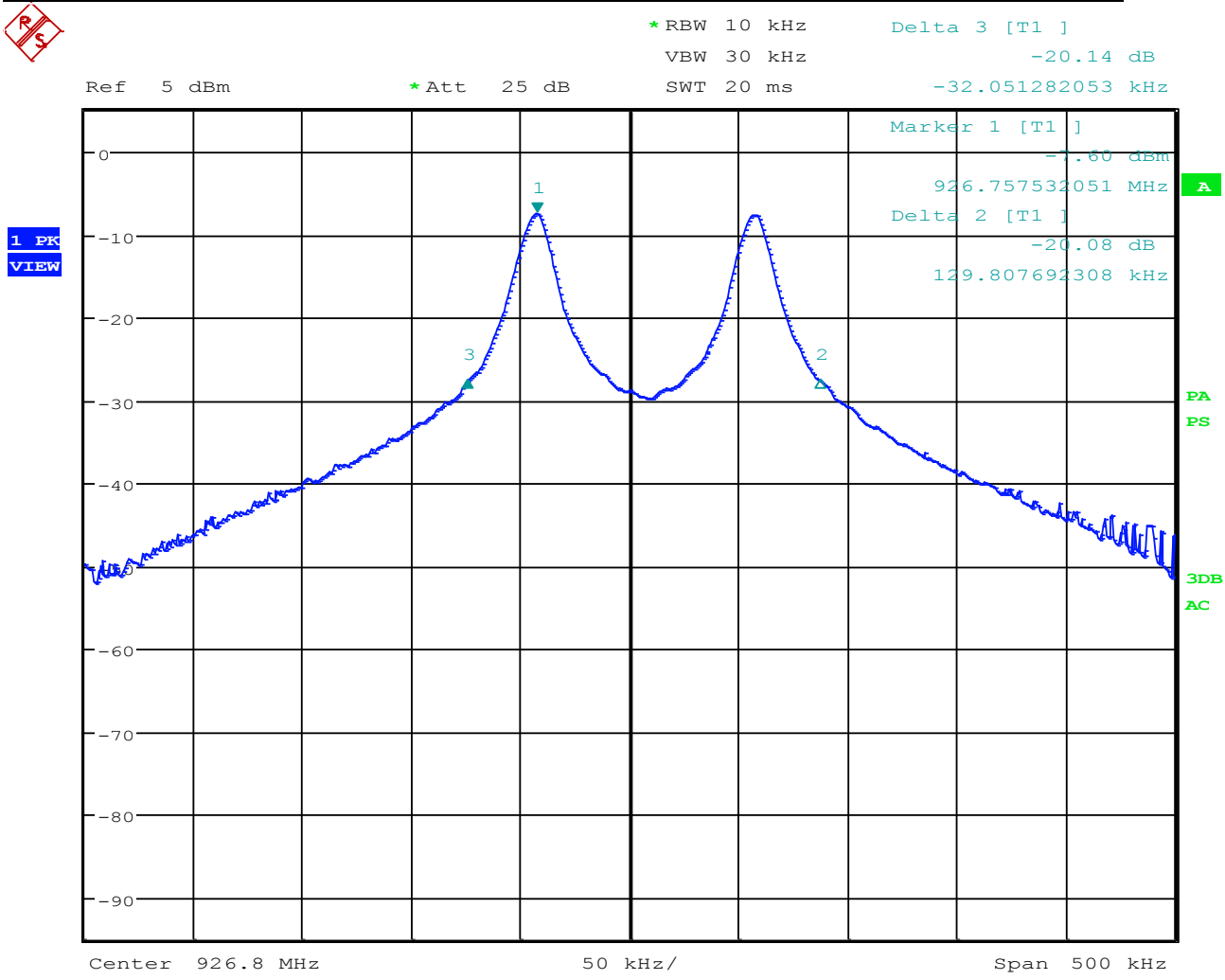
Date: 9.NOV.2015 12:11:11

Figure 30: 20dB Bandwidth at LOW Frequency – 156 kHz



Date: 10.NOV.2015 15:23:49

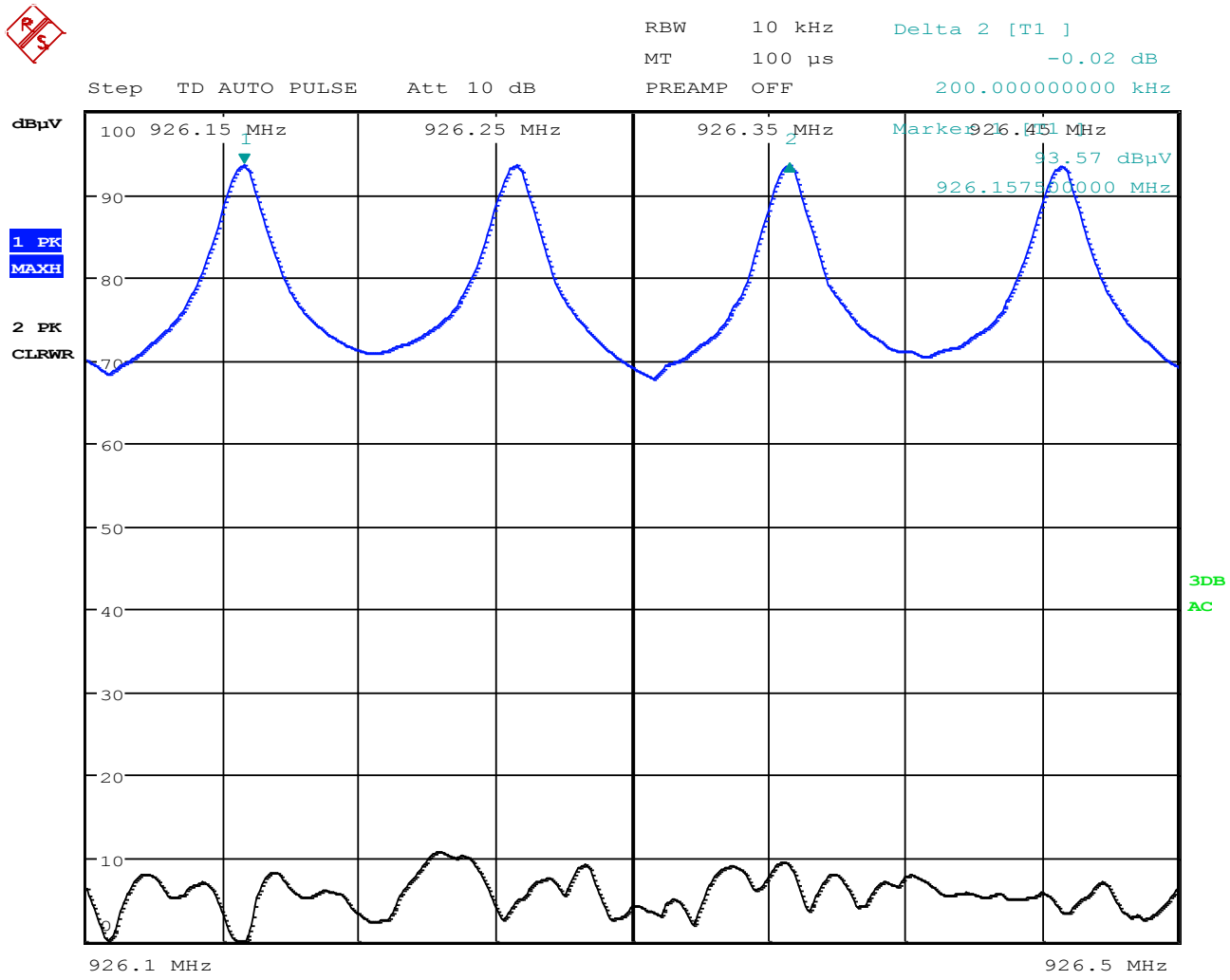
Figure 31: 20dB Bandwidth at MID Frequency – 165.1 kHz



Date: 10.NOV.2015 14:57:09

Figure 32: 20dB Bandwidth at HIGH Frequency – 161.9 kHz

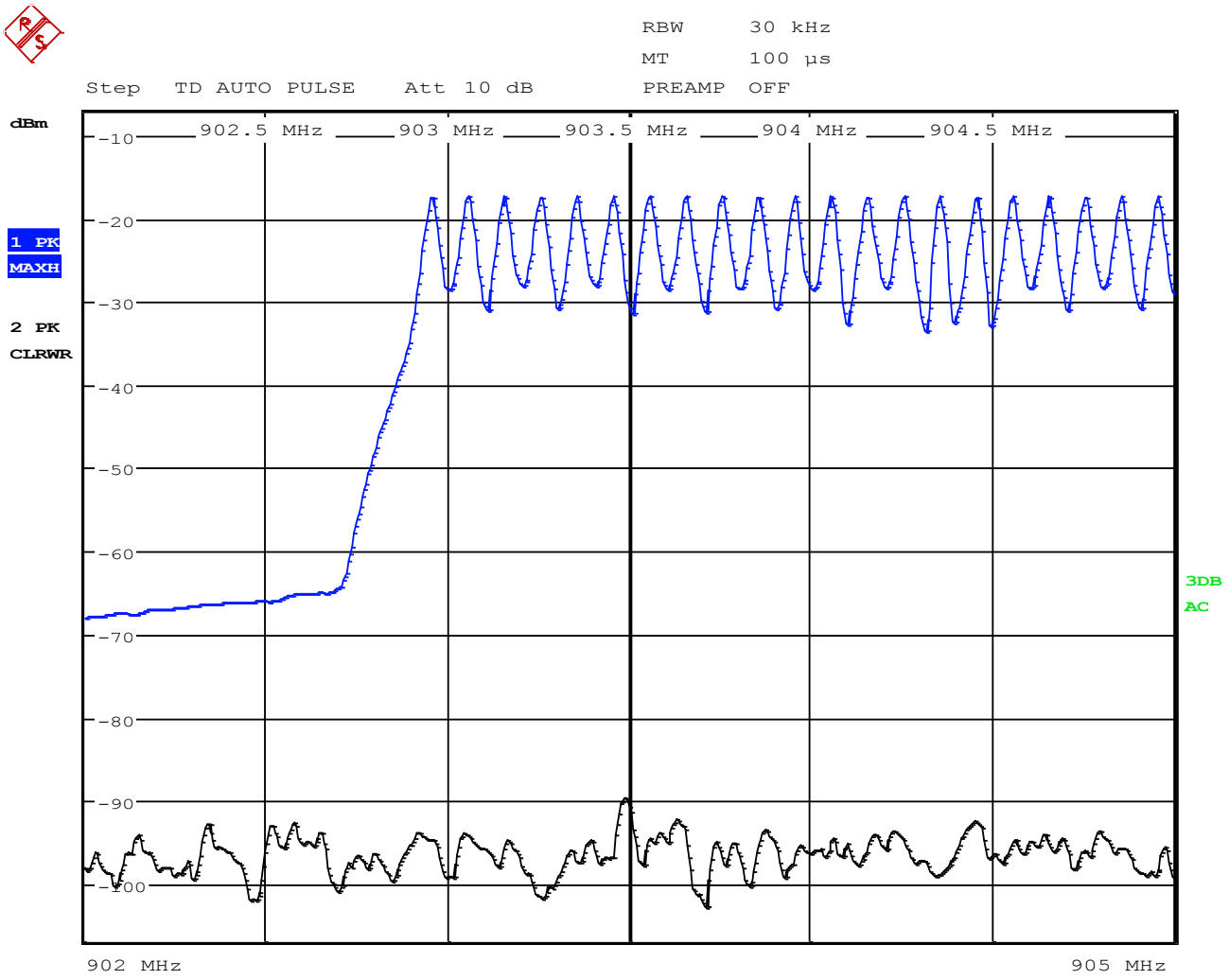
Channel Separation



Date: 17.NOV.2015 14:41:02

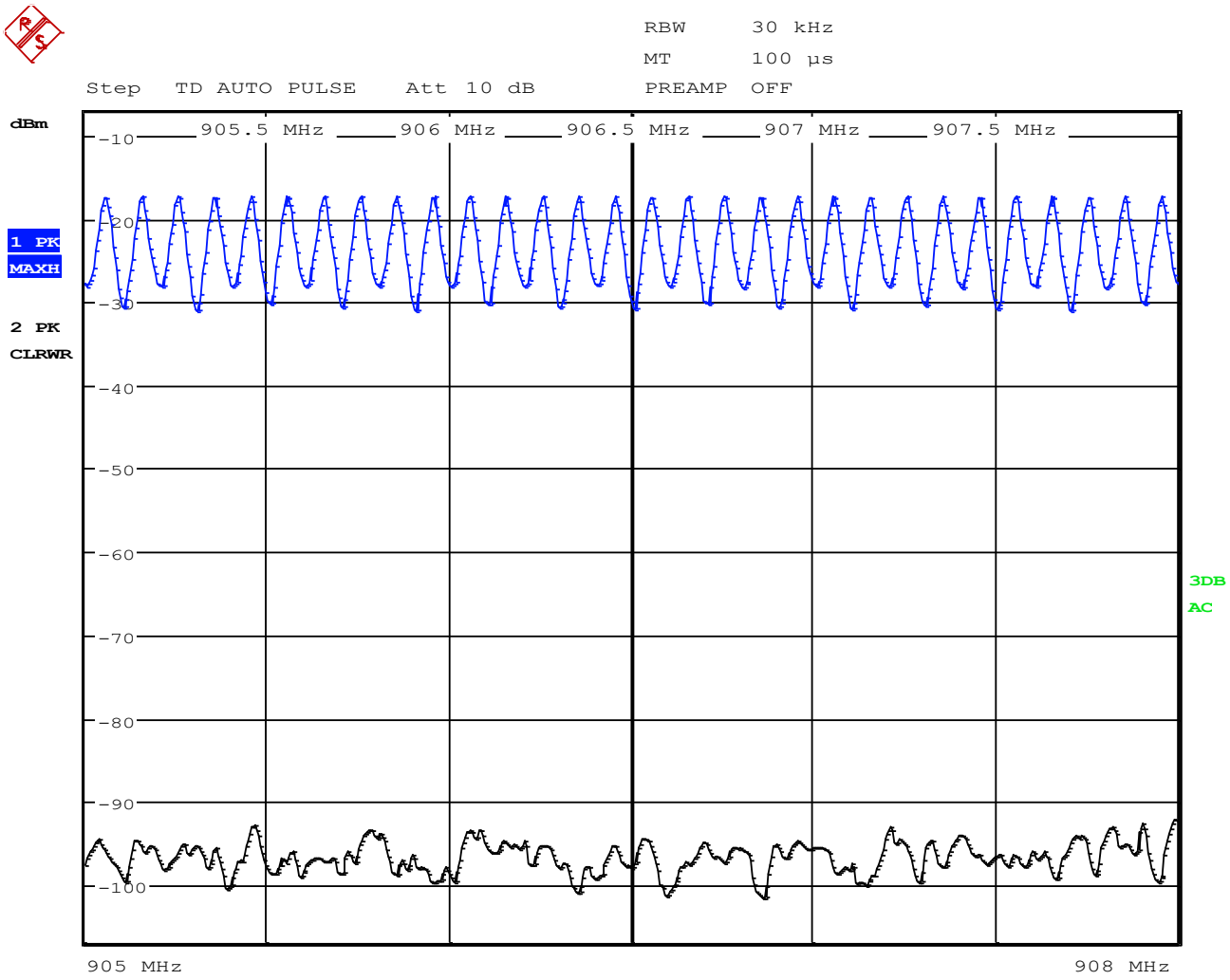
Figure 33: Channel Separation = 200kHz

Number of Hopping Channels



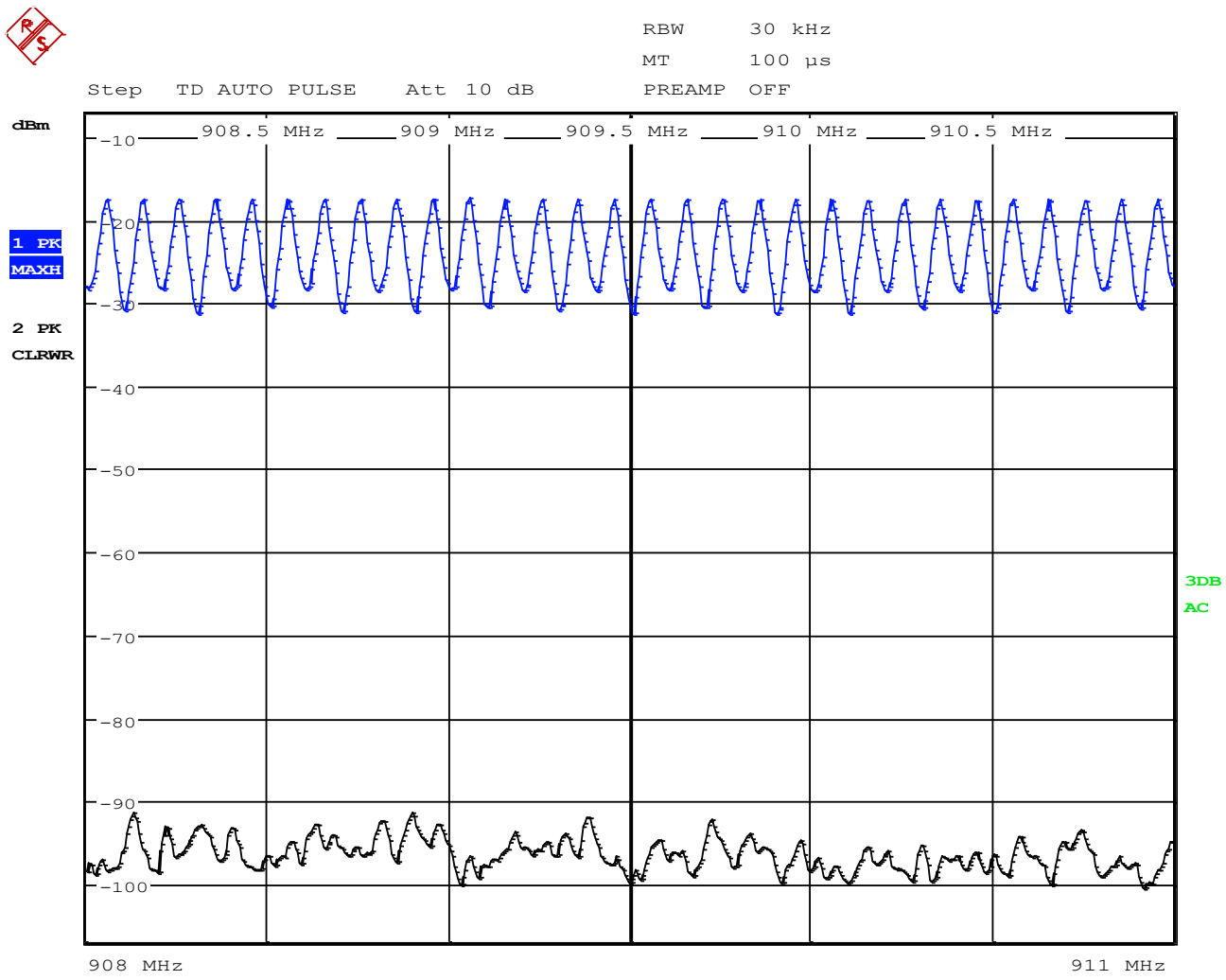
Date: 12.NOV.2015 23:20:48

Figure 34: Number of Hopping Frequencies 902MHz to 905MHz - 10 Frequencies



Date: 13.NOV.2015 12:23:09

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



Date: 13.NOV.2015 14:14:27

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

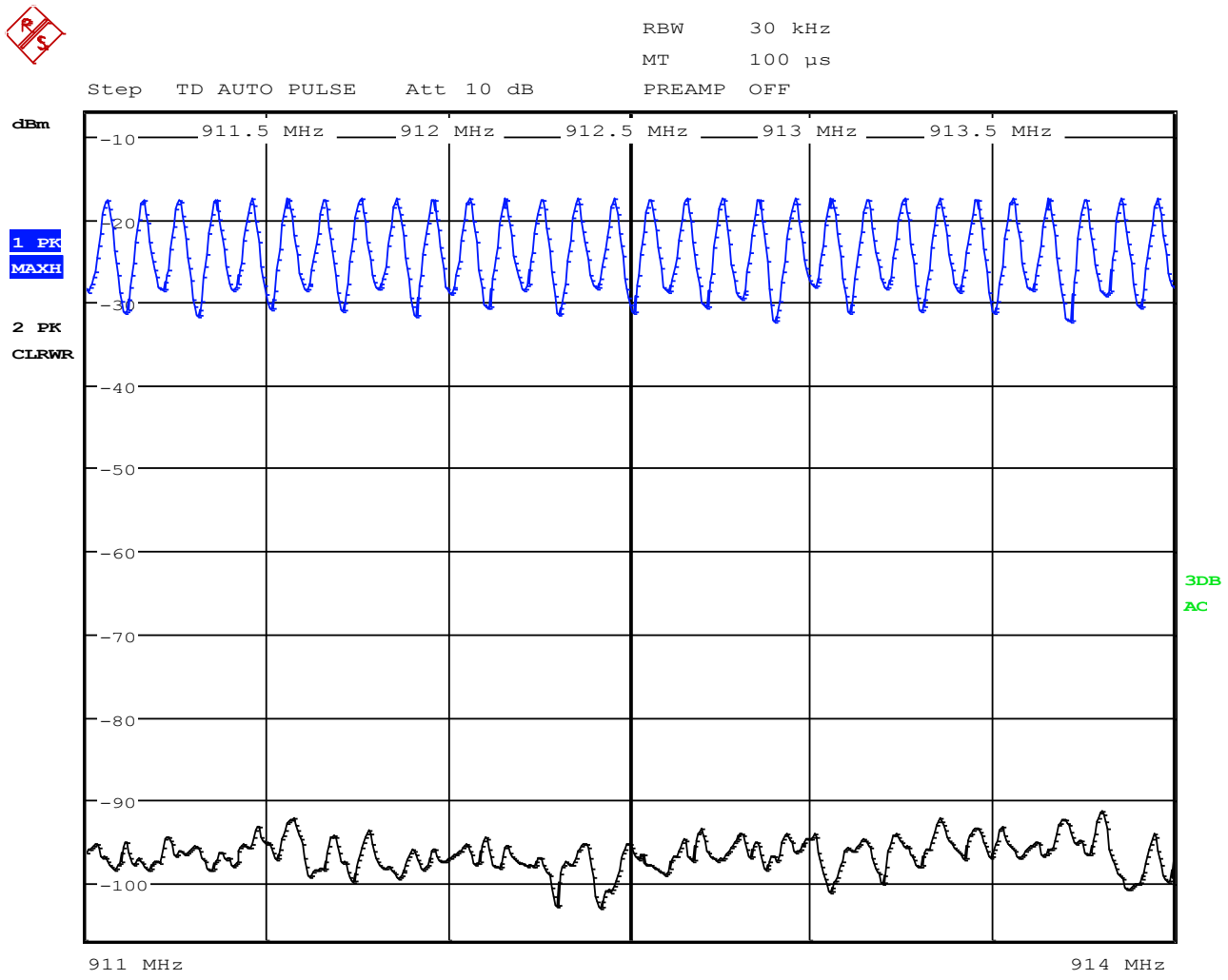
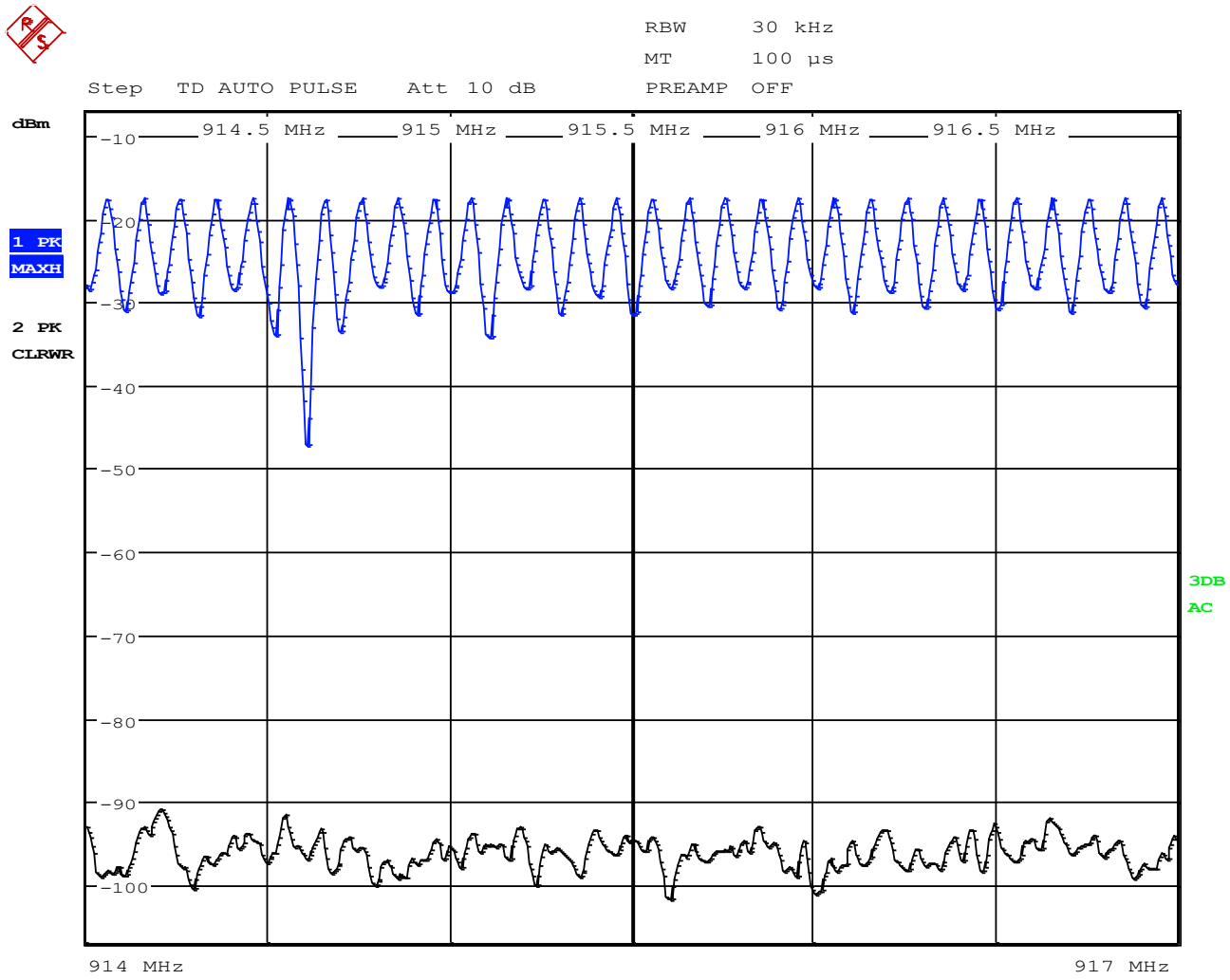


Figure 37: Number of Hopping Frequencies 911MHz to 914MHz - 15 Frequencies



Date: 13.NOV.2015 16:01:32

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

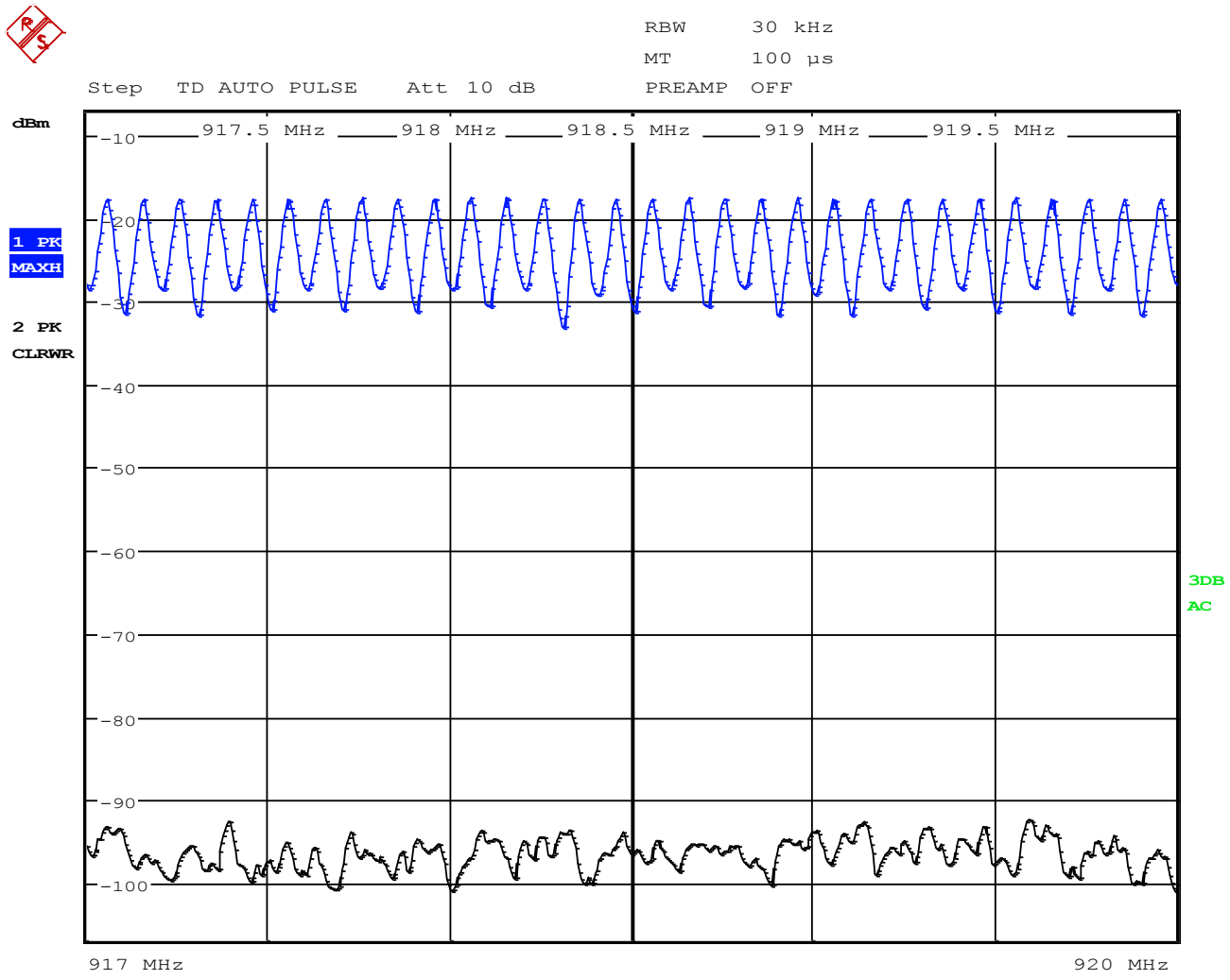
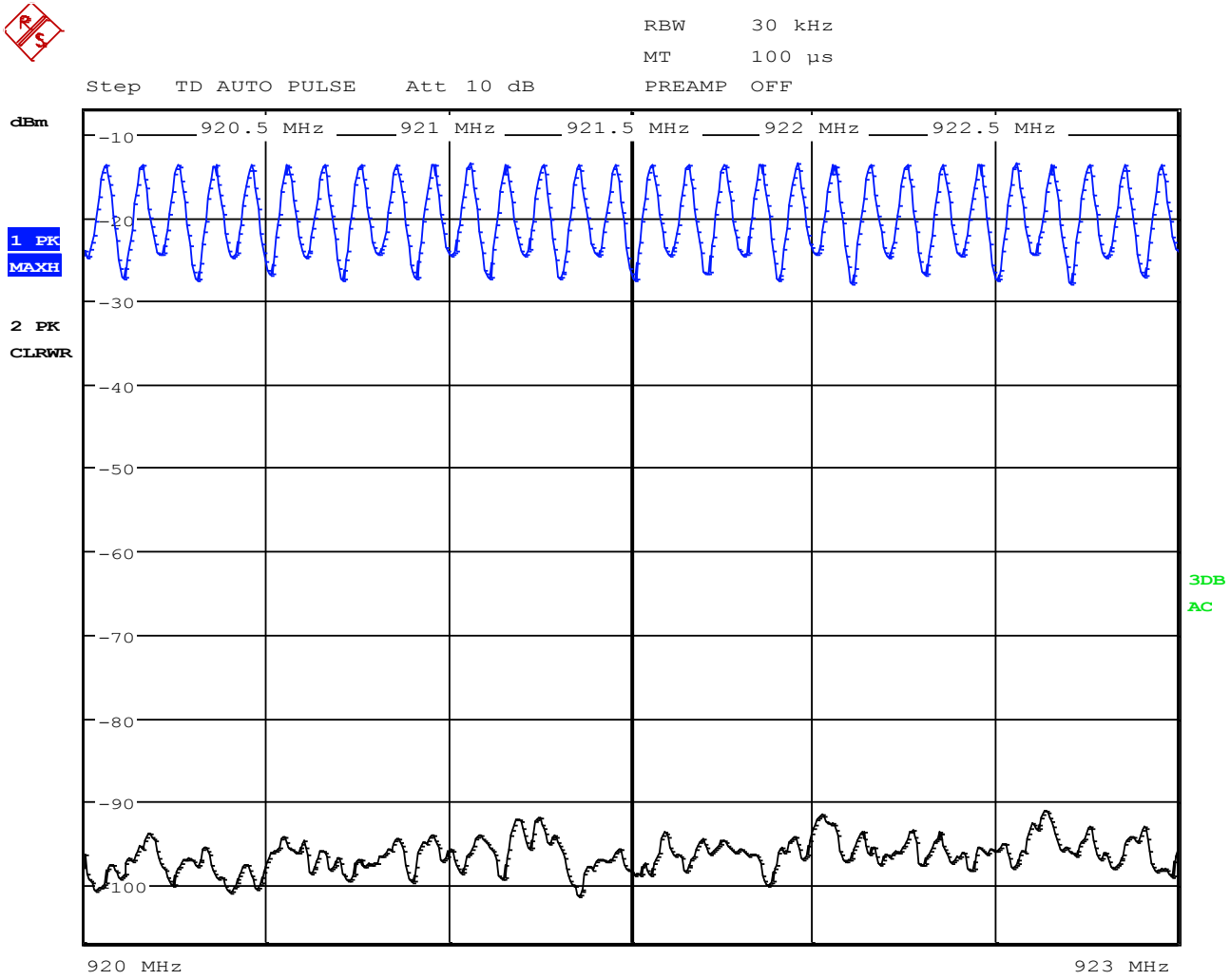


Figure 39: Number of Hopping Frequencies 917MHz to 920MHz - 15 Frequencies



Date: 13.NOV.2015 21:49:11

Figure 40: Number of Hopping Frequencies 920MHz to 923MHz - 15 Frequencies

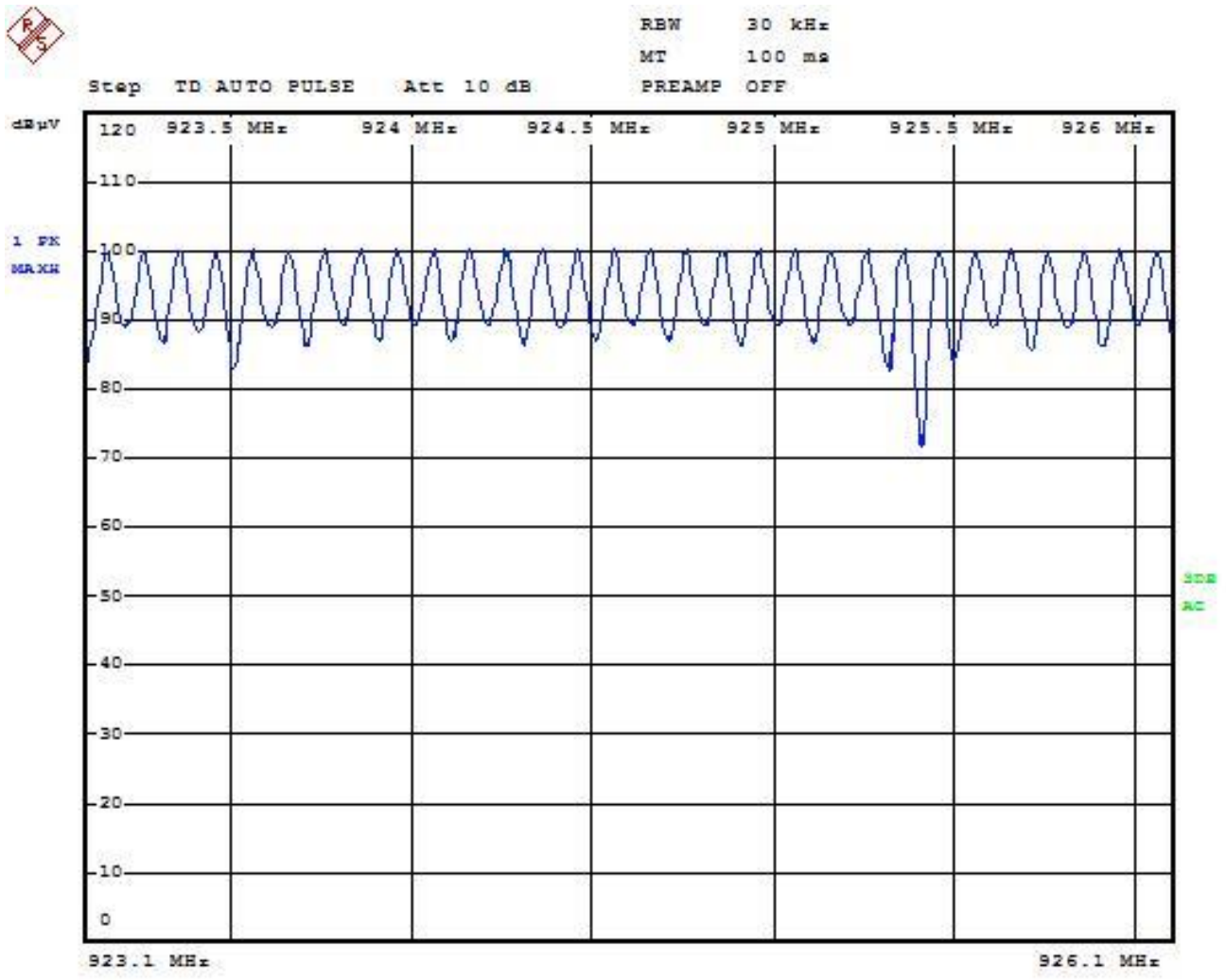
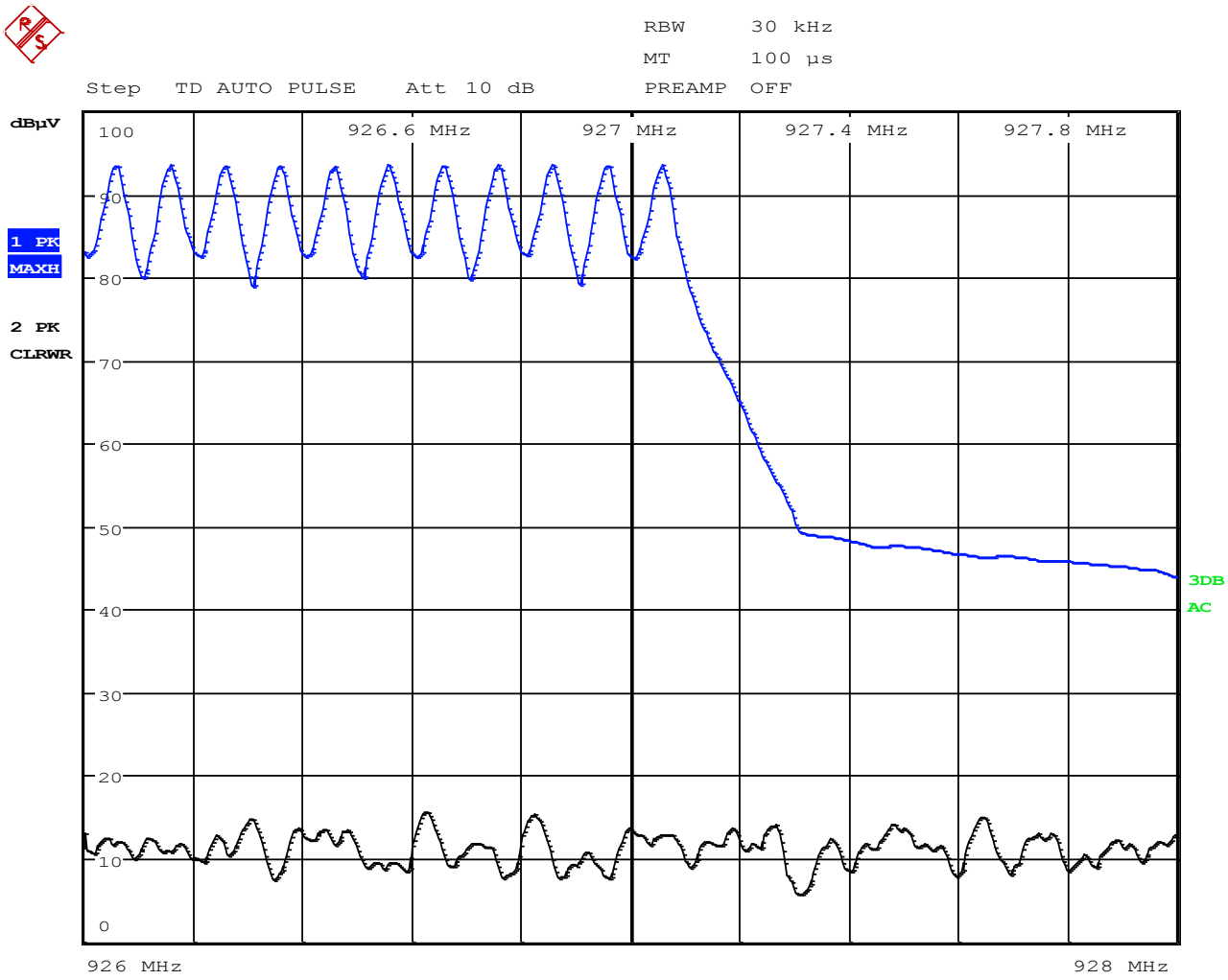


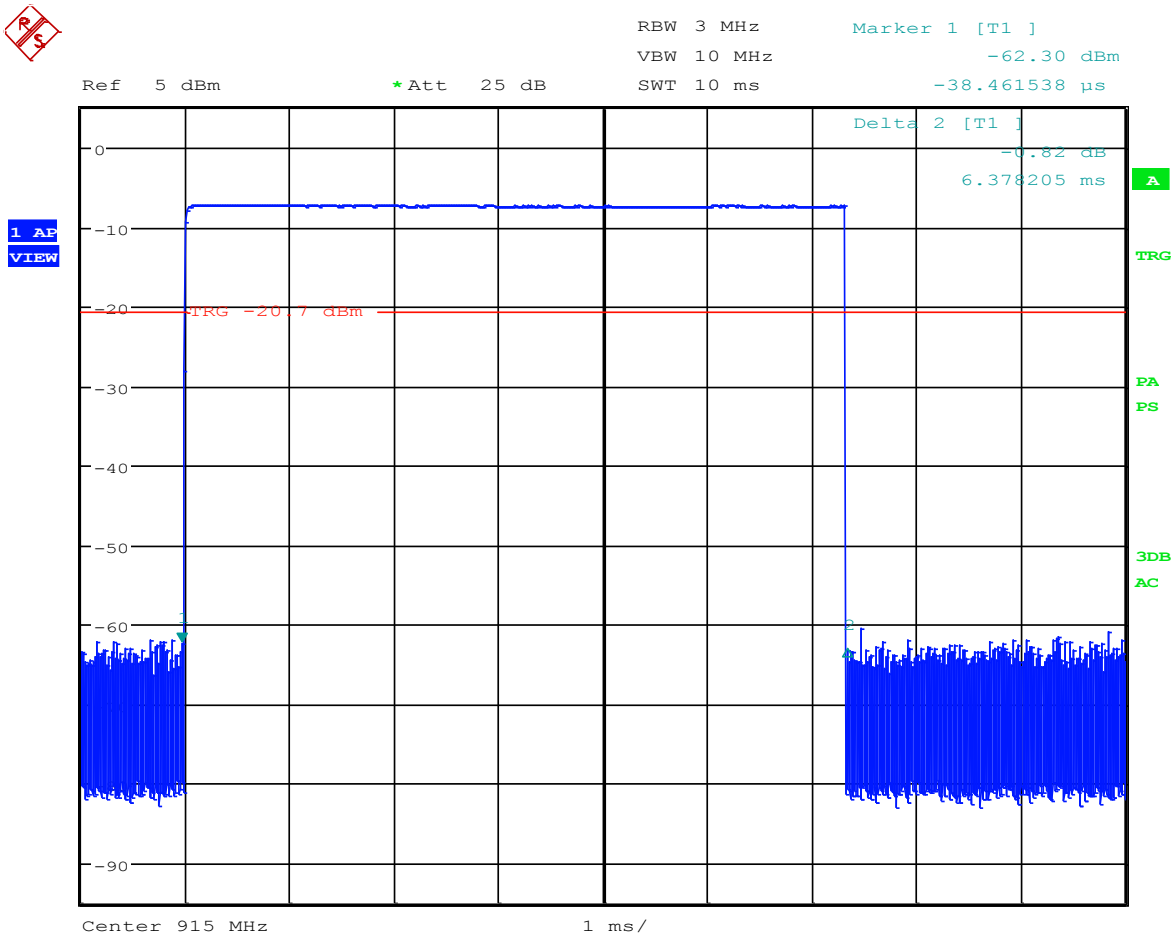
Figure 41: Number of Hopping Frequencies 923MHz to 926MHz - 15 Frequencies



Date: 17.NOV.2015 15:09:30

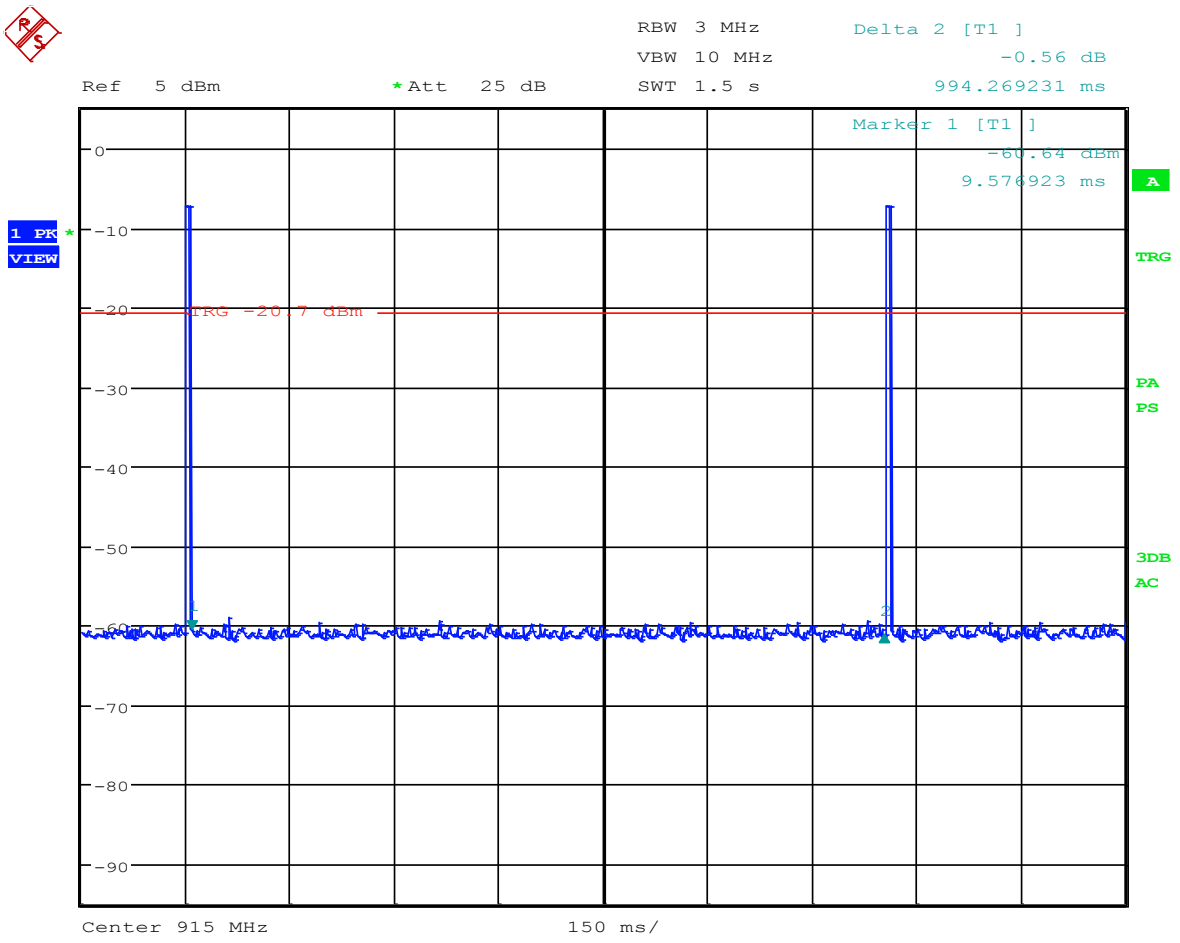
Figure 42: Number of Hopping Frequencies 926MHz to 928MHz - 5 Frequencies

Dwell Time and Time of Occupancy



Date: 10.NOV.2015 15:44:56

Figure 43: Dwell Time – 6.4mS



Date: 10.NOV.2015 15:47:07

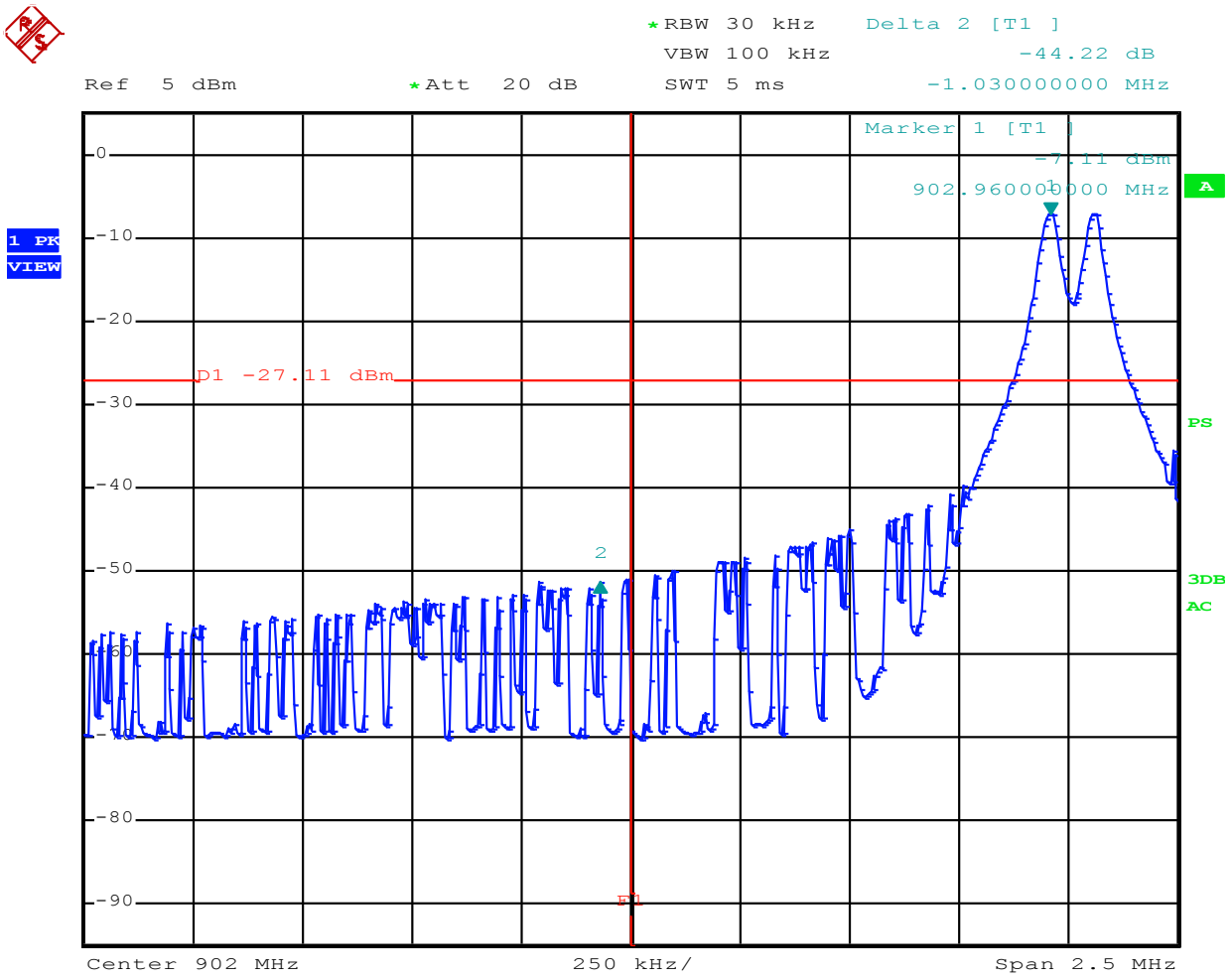
Figure 44: Time Occupancy Per Frequency – 1.067mS*

*Figure 42 indicates that the interval between the frequency of interest and the nearest adjacent frequency in the pseudo random hopping list is 1 seconds. (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 0.0064/120 Seconds or 1.067mS in 20 Seconds.

Channel Bandedge



Date: 9.NOV.2015 12:19:24

Figure 45: Low Channel Bandedge

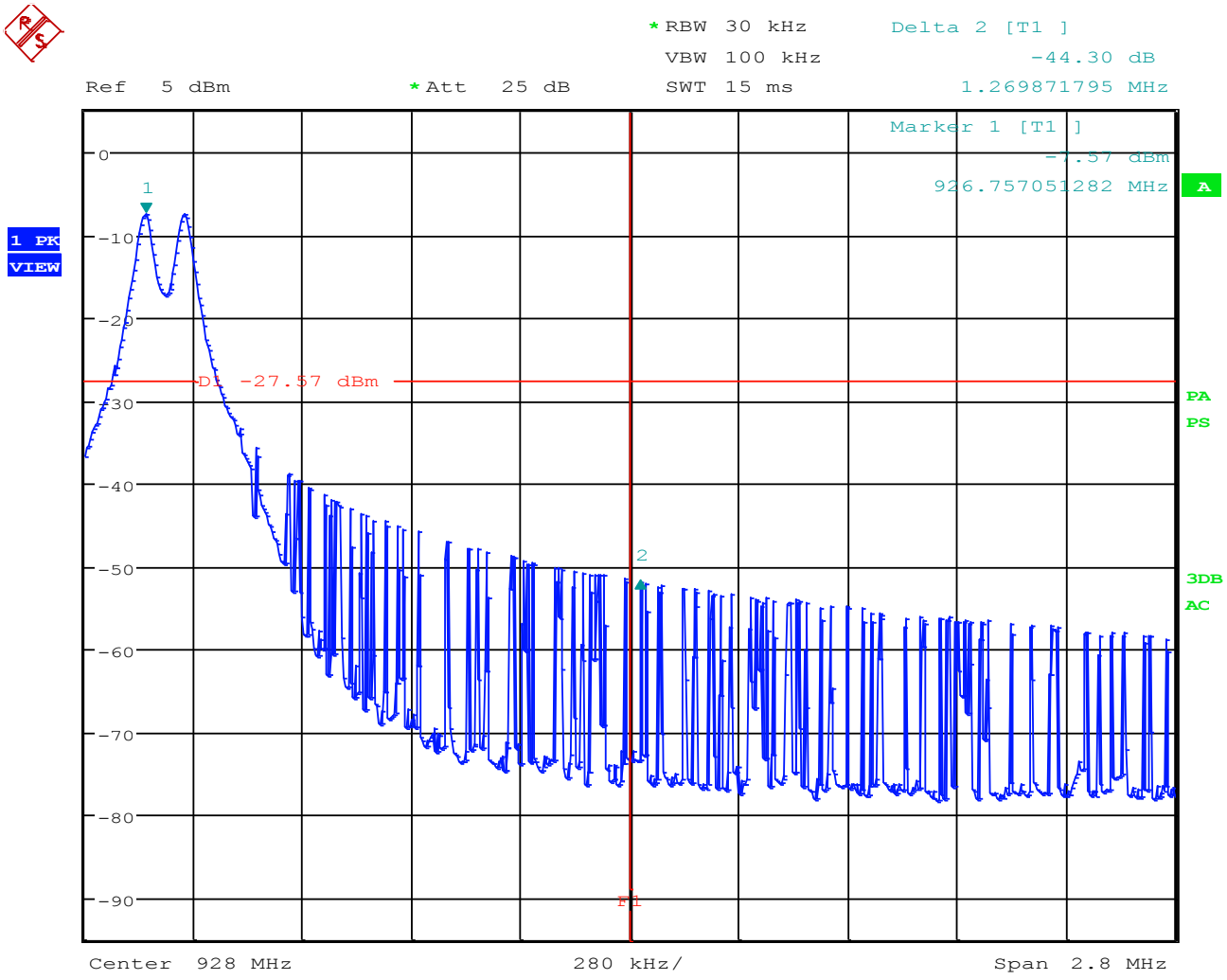


Figure 46: High Channel Bandedge

Radiated Spurious Harmonics

Measurement Date: November 19, 2015

Emmissions for different data rates:

The modulation type does not change for the different data rates. All data rates use FSK modulation and since this type of modulation provides a constant power envelope only one data rate was measured to show compliance of spurious emmissions. The emmissions at the lowest data rate were measured since this data rate has the smallest duty cycle correction factor that can be applied to the average emission value.

Setup:

Correction factor includes antenna factor, cable loss and pre-amp gain (if used).

NOTE: The EUT longest dwell time per frequency was measured to be 4.3 ms per 100ms. This equates to a duty cycle correction factor of -27.3 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 (Avg. Detector)	Average Limit at 3m	Duty Cycle Correction	Delta Limit-Meas.	Corrected Value (Peak Detector)	Peak Limit at 3m	Delta Limit-Meas
(MHz)		(dBuV/m)	(dBuV/m)	(dB)	(dB)	(dBuV/m)	dB(uV/m)	(dB)
2706.6	H	52.8	54	27.3	**28.5**	59.52	74	**14.48**
3608.6	H	51.0	54	27.3	**30.4**	57.77	74	**16.23**
4511.3	H	47.1	54	27.3	**34.2**	55.42	74	**18.58**
5413.7	H	56.0	54	27.3	**25.3**	65.31	74	**8.69**
8120.5	H	50.6	54	27.3	**30.7**	59.22	74	**14.78**
9022.7	H	49.1	54	27.3	**32.2**	57.16	74	**16.84**

Table 6: Harmonics at Low Frequency – 3dB MEG Antenna

Frequency	Pol.	Corrected Value (Avg. Detector)	Average Limit at 3m	Duty Cycle Correction	Delta Limit-Meas.	Corrected Value (Peak Detector)	Peak Limit at 3m	Delta Limit-Meas
(MHz)		(dBuV/m)	(dBuV/m)	(dB)	(dB)	(dBuV/m)	dB(uV/m)	(dB)
2706.9	V	53.3	54	27.3	**28.0**	60.28	74	**13.72**
2706.6	H	54.8	54	27.3	**26.5**	61.04	74	**12.96**
3608.6	V	50.2	54	27.3	**31.1**	57.01	74	**16.99**
3608.6	H	51.0	54	27.3	**30.3**	57.97	74	**16.03**
4511.3	H	45.2	54	27.3	**36.1**	54.38	74	**19.62**
5413.7	V	53.4	54	27.3	**27.9**	61.36	74	**12.64**
5413.7	H	56.3	54	27.3	**25.0**	63.88	74	**10.12**
8120.5	V	45.4	54	27.3	**35.9**	54.67	74	**19.33**
8120.5	H	47.5	54	27.3	**33.8**	58.07	74	**15.93**
9022.7	V	46.3	54	27.3	**35.0**	55.01	74	**18.99**
9022.7	H	47.2	54	27.3	**34.1**	56.11	74	**17.89**

Table 7: Harmonics at Low Frequency – 5dBi Antenna

Frequency	Pol.	Corrected Value (Avg. Detector)	Average Limit at 3m	Duty Cycle Correction	Delta Limit-Meas.	Corrected Value (Peak Detector)	Peak Limit at 3m	Delta Limit-Meas
(MHz)		(dBuV/m)	(dBuV/m)	(dB)	(dB)	(dBuV/m)	dB(uV/m)	(dB)
2745.4	H	53.5	54	27.3	**27.8**	60.38	74	**13.62**
3660.1	H	57.2	54	27.3	**24.1**	64.35	74	**9.65**
4575.3	H	50.4	54	27.3	**30.9**	59.5	74	**14.5**
7320.6	H	47.3	54	27.3	**34.0**	56.77	74	**17.23**
8235.7	H	48.2	54	27.3	**33.1**	57.53	74	**16.47**
9150	H	48.7	54	27.3	**32.6**	56.85	74	**17.15**

Table 8: Harmonics at Mid Frequency – 3dB MEG Antenna

Frequency	Pol.	Corrected Value (Avg. Detector)	Average Limit at 3m	Duty Cycle Correction	Delta Limit-Meas.	Corrected Value (Peak Detector)	Peak Limit at 3m	Delta Limit-Meas
(MHz)		(dBuV/m)	(dBuV/m)	(dB)	(dB)	(dBuV/m)	dB(uV/m)	(dB)
2745.4	V	49.4	54	27.3	**31.9**	56.37	74	**17.63**
2745.4	H	52.1	54	27.3	**29.2**	58.46	74	**15.54**
3660.1	V	52.5	54	27.3	**28.8**	59.88	74	**14.12**
3660.1	H	56.6	54	27.3	**24.7**	62.31	74	**11.69**
4575.3	V	47.5	54	27.3	**33.8**	55.77	74	**18.23**
4575.3	H	49.5	54	27.3	**31.8**	59.07	74	**14.93**
7320.6	H	46.5	54	27.3	**34.8**	55.73	74	**18.27**
8235.7	H	45.2	54	27.3	**36.1**	55.33	74	**18.67**
9150	V	46.1	54	27.3	**35.2**	54.95	74	**19.05**
9150	H	47.0	54	27.3	**34.3**	55.55	74	**18.45**

Table 9: Harmonics at Mid Frequency – 5dBi Antenna

Frequency	Pol.	Corrected Value (Avg. Detector)	Average Limit at 3m	Duty Cycle Correction	Delta Limit-Meas.	Corrected Value (Peak Detector)	Peak Limit at 3m	Delta Limit-Meas
(MHz)		(dBuV/m)	(dBuV/m)	(dB)	(dB)	(dBuV/m)	dB(uV/m)	(dB)
2783.2	H	55.5	54	27.3	**25.8**	62.03	74	**11.97**
3711.4	H	52.0	54	27.3	**29.3**	58.83	74	**15.17**
7421.7	H	48.6	54	27.3	**32.7**	57.81	74	**16.19**
8349.5	H	46.8	54	27.3	**34.5**	55.66	74	**18.34**

Table 10: Harmonics at High Frequency – 3dB MEG Antenna

Frequency	Pol.	Corrected Value (Avg. Detector)	Average Limit at 3m	Duty Cycle Correction	Delta Limit-Meas.	Corrected Value (Peak Detector)	Peak Limit at 3m	Delta Limit-Meas
(MHz)		(dBuV/m)	(dBuV/m)	(dB)	(dB)	(dBuV/m)	dB(uV/m)	(dB)
2783.2	V	48.4	54	27.3	**32.9**	54.48	74	**19.52**
2783.2	H	50.8	54	27.3	**30.5**	57.44	74	**16.56**
3711.5	V	47.2	54	27.3	**34.1**	54.78	74	**19.22**
3711.4	H	48.1	54	27.3	**33.2**	55.28	74	**18.72**
7421.7	V	45.2	54	27.3	**36.1**	55.51	74	**18.49**
7421.7	H	50.3	54	27.3	**31.0**	59.81	74	**14.19**
8349.5	H	45.2	54	27.3	**36.1**	55.76	74	**18.24**

Table 11: Harmonics at High Frequency – 5dBi Antenna

Appendix B: Test Setup Photos

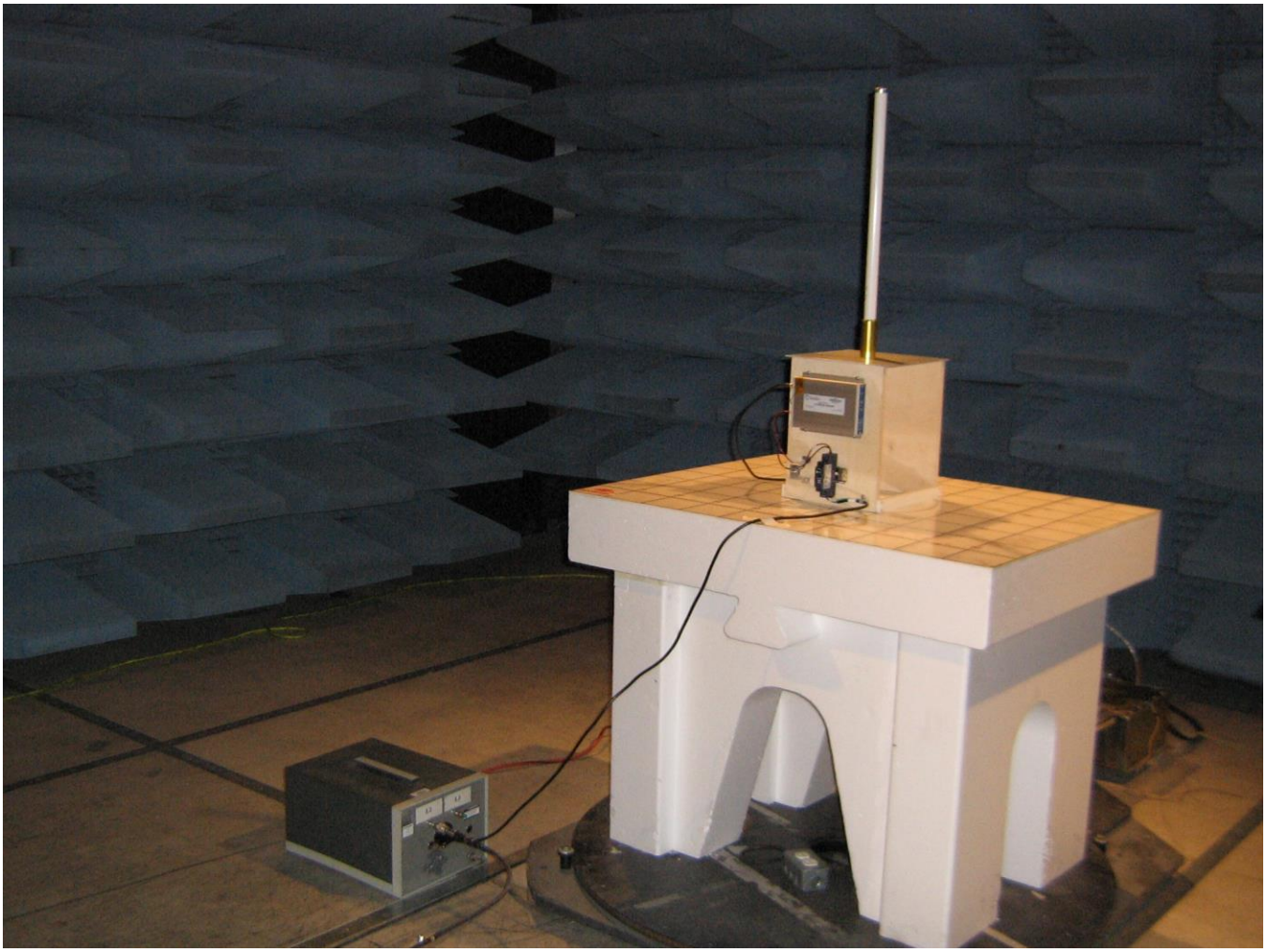


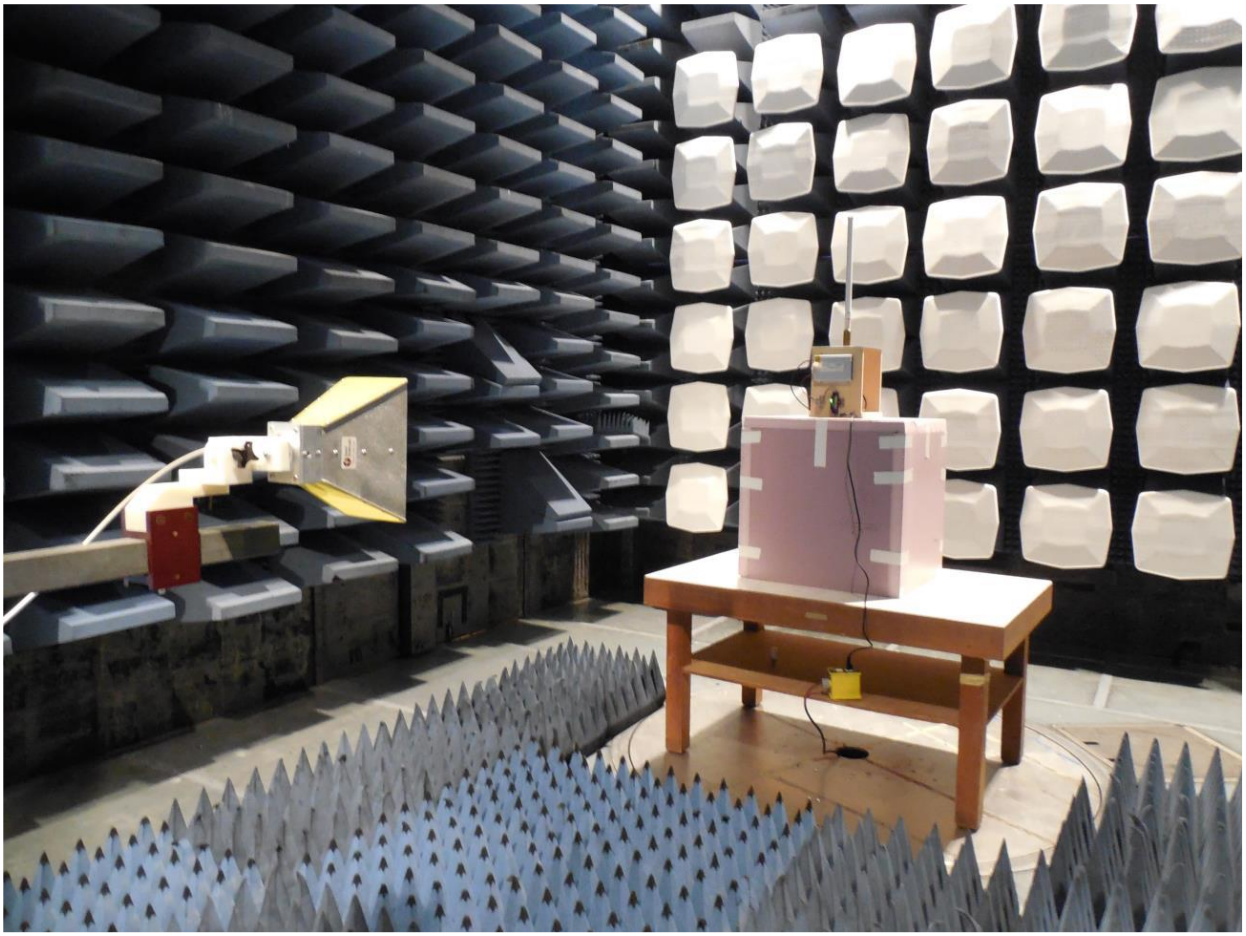
Figure 47: AC Conducted Test Setup

Intentional / Unintentional Radiated Emmission 9kHz – 30 MHz setup.

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

Intentional / Unintentional Radiated Emmission 30 – 1000 MHz setup.

Figure 49: Emissions Test Setup – Intentional / Unintentional Radiated Emissions



Intentional Radiated Emmissions 1000 – 10000 MHz setup.

Figure 50: Emissions Test Setup – Intentional Harmonics