Tantalus Systems Corp.

SC-5420

Report of Measurements

per

Industry Canada RSS-247 Issue 1 & RSS-GEN Issue 4

and

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

Revision 1.0
July 28 2016

Reviewed By:	**Parm Singh, Director EMC Department**	July 28 2016 **Date**
Tested By:	**Aman Jathaul, EMC Project Manager**	July 28 2016 **Date**

Test Report Summary

FCC 15.247 / IC RSS-247

Frequency Hopping 902.17 – 927.83MHz communication Module

FCC ID: OZFSC5420 **IC:** 3669A-SC5420

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

Index

List of Figures

List **of** Tables

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. – SC-5420
	120V A.C. – SC-5420

Test Facilities

Founded in 1994 by a group of experienced certification and testing experts, QAI is an independent third-party testing, inspection and certification organization which serves the building industry, government and individuals with cost effective solutions through our in-house capabilities / services, and an established world-wide network of qualified affiliates. To help get your product to market, trust the provider that many leading global manufacturers do: QAI.

British Columbia
QAI Laboratories Inc.
Main Laboratory/Headquarters
3980 North Fraser Way,
Burnaby, BC V5J Canada

Ontario
QAI Laboratories Inc.
1081 Meyerside Drive, Unit #14
Mississauga, ON L5T 1M4 Canada

Washington
QAI Laboratories Ltd.
834 80TH Street SW, Suite 200,
Everett, WA 98203-7008 USA

Virginia
QAI Laboratories Ltd.
1047 Zachary Taylor Hwy,
Suite A Huntly, VA 22640 USA

California
QAI Laboratories Ltd.
8385 White Oak Avenue Rancho
Cucamonga, CA 91730 USA

Oklahoma
QAI Laboratories Ltd.
108th East Avenue,
Tulsa, OK 74116 USA

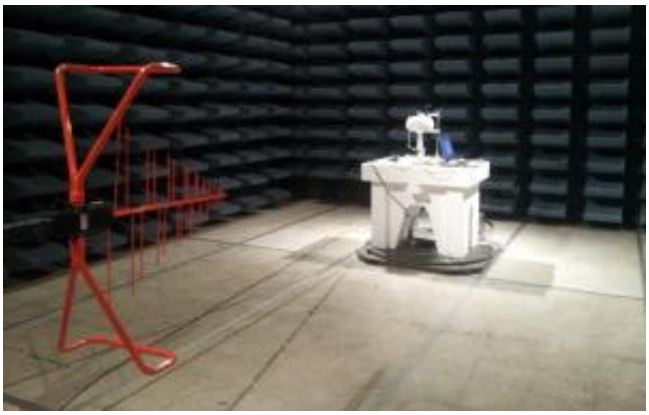
QAI EMC ACCREDITATION

QAI EMC is your one-stop regulatory compliance partner for electromagnetic compatibility (EMC) and electromagnetic interference (EMI). Products are tested to the latest and applicable EMC/EMI requirements for domestic and international markets. QAI EMC goes above and beyond being a testing facility—we are your regulatory compliance partner. QAI EMC has the capability to perform RF Emissions and Immunity for all types of electronics manufacturing including Industrial, Scientific, Medical, Information Technology, Telecom, Wireless, Automotive, Marine and Avionics.

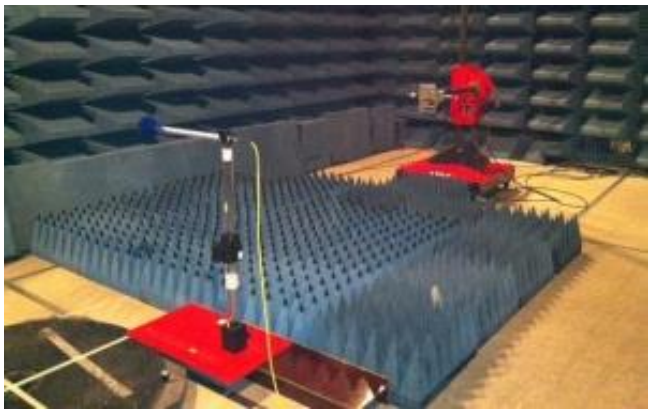
EMC Laboratory Location	FCC Designation (3m SAC)	IC Registration (3m SAC)	A2LA Certificate
Burnaby, BC Canada	CA9543	21146-1	3657.02
Everett, Washington USA	307482	11876A-1	3657.02

Headquarters & EMC Laboratory in Burnaby, BC

EMC Laboratory in Everett, Washington



3 m Semi-Anechoic Chamber (SAC) in Burnaby, BC



3 m Semi-Anechoic Chamber (SAC) in Burnaby, BC

10 m Open Area Test Site (OATS) in British Columbia, Canada

5 m Semi-Anechoic Chamber (SAC) in Everett, Washington

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
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
LISN (150kHz-30MHz)	Fischer	FCC-LISN-50-25-2	9928	Feb 22 2016	Feb 22 2019
Loop Antenna (0.009-30MHz)	Emco	6502	2178	Aug 21 2014	Aug 21 2017
Pre-amplifier (0.1-18GHz)	AH systems	PAM-0118	189	Conditional Use	Conditional Use
High Pass Filter	Minicircuit	VHF-1300+	-	Conditional Use	Conditional Use
High Pass Filter	Minicircuit	VHF-5500+	-	Conditional Use	Conditional Use

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 SC-5420 is a streetlight controller that allows electrical utilities to remotely operate and monitor the status of a streetlight infrastructure using Tantalus' 902-928MHz LAN network.

Product ID: SC-5420
Manufacturer: Tantalus Systems Corp.

LAN Controller
Part Numbers: 100-0169-G
Serial number: 0015FC41E

Carrier Board
Part Numbers: 100-0198-A
Serial number: 0017A3414

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 SC-5420 complies with the requirements of FCC CFR47 and the requirements of Industry Canada RSS-247.

Section II: IC RSS-247 Iss.1 & 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-247 Iss. 1 / RSS-GEN Iss. 4 Emissions Testing

Test Results – Summary

Testing was performed pursuant to Industry Canada RSS-247 Issue 1 and RSS_GEN Issue 4.

Test	Standard	Description	Result
Radiated Emissions Idle Mode	RSS-GEN 7.1	The radiated emissions are measured in the 0.009 - 1000MHz range	Complies
Conducted Emissions Idle Mode	EN55022	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-247 5.5 RSS-GEN 6.1	The radiated emissions are measured in the 0.009 -9280MHz range	Complies
Output Power and EIRP Emissions	RSS-247 5.4(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 June 27th 2016

TEST STANDARD: RSS-GEN 7.1.2

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: June 24th 2016

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: June 28th 2016

TEST STANDARD: RSS-247 Iss.1 Frequency Hopping Systems 902-928MHz Band.

MINIMUM STANDARD: **5.1 – Frequency Hopping Systems (FHSs)**

FHSs employ a spread spectrum technology in which the carrier is modulated with coded information in a conventional manner, causing a conventional spreading of the radio frequency (RF) energy around the carrier frequency. The carrier frequency is not fixed, but changes at fixed intervals under the direction of a coded sequence.

FHSs 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 requirements in this section in case the transmitter is presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of frequency hopping equipment and must distribute its transmissions over the minimum number of hopping channels specified in this section.

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

(1) The bandwidth of a frequency hopping channel is the -20 dB emission bandwidth, measured with the hopping stopped. The system's radio frequency (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, whereas the long-term distribution appears evenly distributed.

(2) FHSs 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, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W. 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.

(3) For FHSs 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 20 dB bandwidth of the hopping channel shall be 500 kHz.

5.4 (1) Transmitter Output Power and e.i.r.p. Requirements

(1) For FHSs 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).

5.5 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 RF 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

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 performed as per ANSI C63.4:2014 and ANSI C63.10:2013

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. Below 1GHz EUT was set up on 80cm high table and above 1GHz EUT was rasied to 150cm on insulated support and absorbers were layout on the ground plane. Please refer to test setup picture in this report for more details.

EMISSIONS DATA: See Appendix A for results.

Test	Standard	Results
Spread Spectrum Method of Modulation	RSS-247 5.1	This product meets the requirements of a Frequency Hopping Spread Spectrum (FHSS) system operating in the 902-928MHz band
Output Power and EIRP	RSS-247 5.4(1)	See the Measurement Data section in Part 4 of this Section. The output EIRP is a maximum of 355mW. The conducted output power is 468mW.
Out of Band Emissions	RSS-247 5.5 RSS-GEN 6.13 & 8.9	See Tables 3 - 6 in Appendix A. All radiated emissions were within the specified limit.

Low Data Rate

Channel Bandwidth	RSS-247 5.1(1)	See Figures 8 - 10 in Appendix A. The 20dB bandwidth was measured to be 144.2 kHz.
Channel Separation	RSS-247 5.1(2)	See Figure 12 in Appendix A. The Channel separation was measured to be 319.8 kHz.
Number of Hopping Channels	RSS-247 5.1(3)	See Figures 13 -16 in Appendix A. The number of frequencies used is 50.
Hopping Channels Time of Occupancy	RSS-247 5.1(3)	See Figures 17 and 18 in Appendix A; the time of occupancy is 4.3 4milliseconds at an interval of 1.56 seconds. This is equal to an average time “ON” of 55.6 mSecs within a 20 second period.

High Data Rate

Channel Bandwidth	RSS-247 5.1(1)	See Figures 21 - 23 in Appendix A. The 20dB bandwidth was measured to be 297.8 kHz.
Channel Separation	RSS-247 5.1(2)	See Figure 24 in Appendix A. The Channel separation was measured to be 320 kHz.
Number of Hopping Channels	RSS-247 5.1(3)	See Figures 25 - 28 in Appendix A. The number of frequencies used is 50.
Hopping Channels Time of Occupancy	RSS-247 5.1(3)	See Figures 29 and 30 in Appendix A. The time of occupancy is 1.15mS mSecs at an interval of 0.158 seconds. This is equal to an average time “ON” of 145.6 mSecs within a 20 second period.

Communication Data Rate to Certifed OEM Part 15 Device

Channel Bandwidth	RSS-247 5.1(1)	See Figures 33 - 35 in Appendix A. The 20dB bandwidth was measured to be 156.6 kHz.
Channel Separation	RSS-247 5.1(2)	See Figure 36 in Appendix A. The Channel separation was measured to be 200 kHz.
Number of Hopping Channels	RSS-247 5.1(3)	See Figures 37 – 45 in Appendix A. The number of frequencies used is 120.
Hopping Channels Time of Occupancy	RSS-247 5.1(3)	See Figures 46 and 47 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: June 24th 2016

TEST STANDARD: RSS-247 Iss.1 5.4 – 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 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.

EIRP measurements

Freq(MHz)	Corrected Field at 3m (dBµV/m)	3m EIRP (dBm)
902.17	120.7	25.5
915	119.2	24.0
927.83	119.8	24.6

Conducted Output Power measurements

Freq(MHz)	Meas. Output Power (dBm)	Correction Factor* (dB)	Output Power (dBm)
902.17	-4.5	31.2	26.7
915	-4.6	31.3	26.7
927.83	-4.6	31.2	26.6

* Correction Factor accounts for a nominal 30dB attenuator and 1dB cable loss.

PERFORMANCE: Complies.

Part 5: Out of Band Emissions

DATE: June 27th 2016

TEST STANDARD: RSS-247 5.5

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, 2014 and ANSI C63.10:2013.

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: 2014 and ANSI C63.10:2013.

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: June 24th 2016

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 3 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: An integrated antenna is used on this product and it is not field replaceable.

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: June 27th 2016

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

Freq(MHz)	Corrected Field at 3m (dBµV/m)	3m EIRP (dBm)
902.17	120.7	25.5
915	119.2	24.0
927.83	119.8	24.6

Conducted Output Power measurements

Freq(MHz)	Meas. Output Power (dBm)	Correction Factor* (dB)	Output Power (dBm)
902.17	-4.5	31.2	26.7
915	-4.6	31.3	26.7
927.83	-4.6	31.2	26.6

* Correction Factor accounts for a nominal 30dB attenuator and 1dB 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 SC-5420

Unintentional Radiated Emissions

Since the product is placed on top of a light standard, for which older models are normally made of metal rather than composite material that is not reflective, the following tests were done with the unit placed on top of a metal cover that would simulate the effect of the light standard. A verification test was made ithat was in complete compliance with ANSI 63.4, 2014 to ensure that this test method did not actually suppress emmissions.

Idle Mode

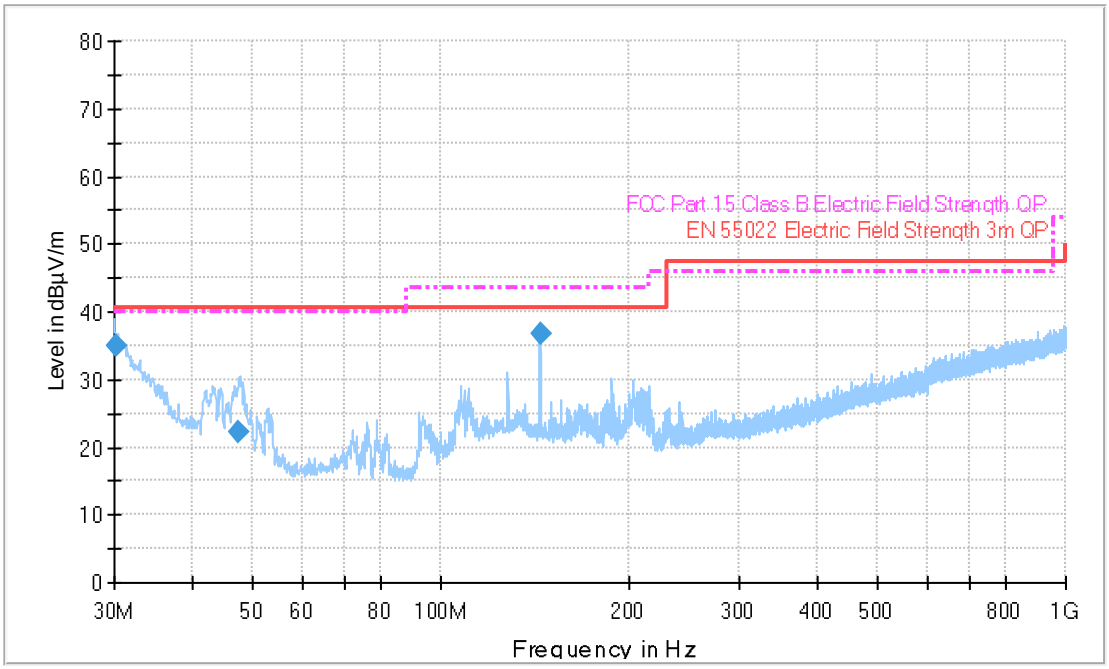


Figure 1: FCC Class B Emissions - 3m (EUT placed on top of a metal plate)

Table 1: FCC Class B Emissions - 3m (EUT placed on top of a metal plate)*

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.153720	35.0	1000.000	120.000	121.0	V	62.0	26.9	5.5	40.5
47.417840	22.1	1000.000	120.000	156.0	V	62.0	16.8	18.4	40.5
144.026840	36.6	1000.000	120.000	164.0	H	339.0	20.1	3.9	40.5

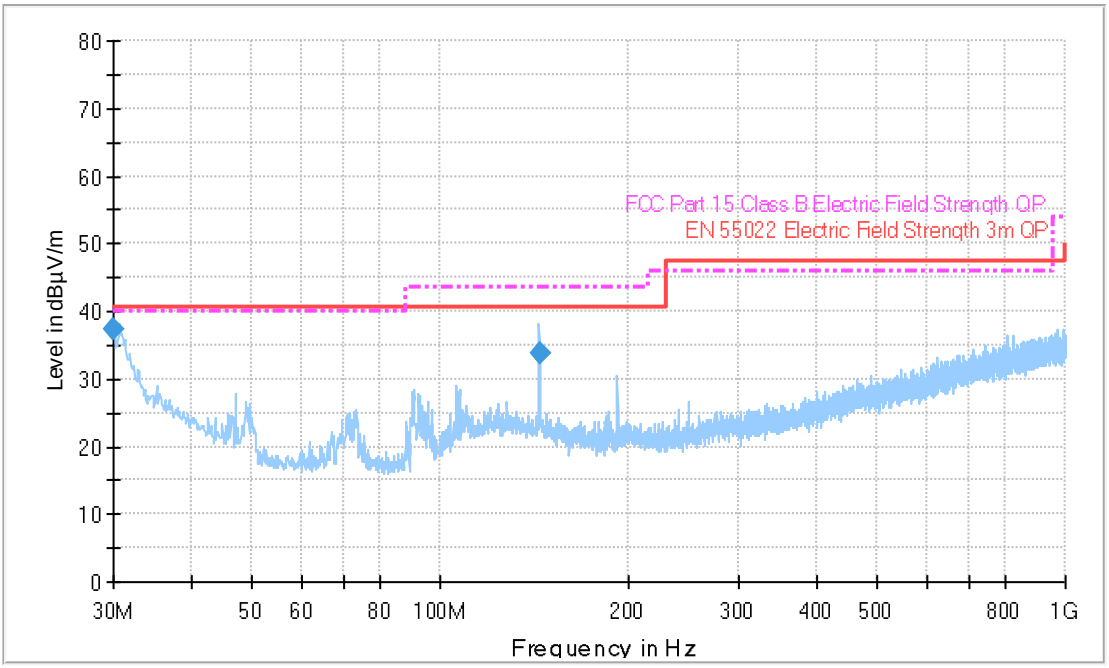


Figure 2: FCC Class B Emissions - 3m (In accordance to ANSI 63.4, 2014)

Table 2: FCC Class B Emissions - 3m (In accordance to ANSI 63.4, 2014)*

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.065294	37.4	1000.000	120.000	100.0	H	0.0	26.9	3.1	40.5
144.023300	36.6	1000.000	120.000	100.0	H	339.0	20.1	3.9	40.5

*From the above results it can be seen that the worst case exmissions are when the EUT is placed on a mteal plate. This same configuration was used to test emissions in transmit mode to ensure that worst case conditions are always tested.

Transmit Mode

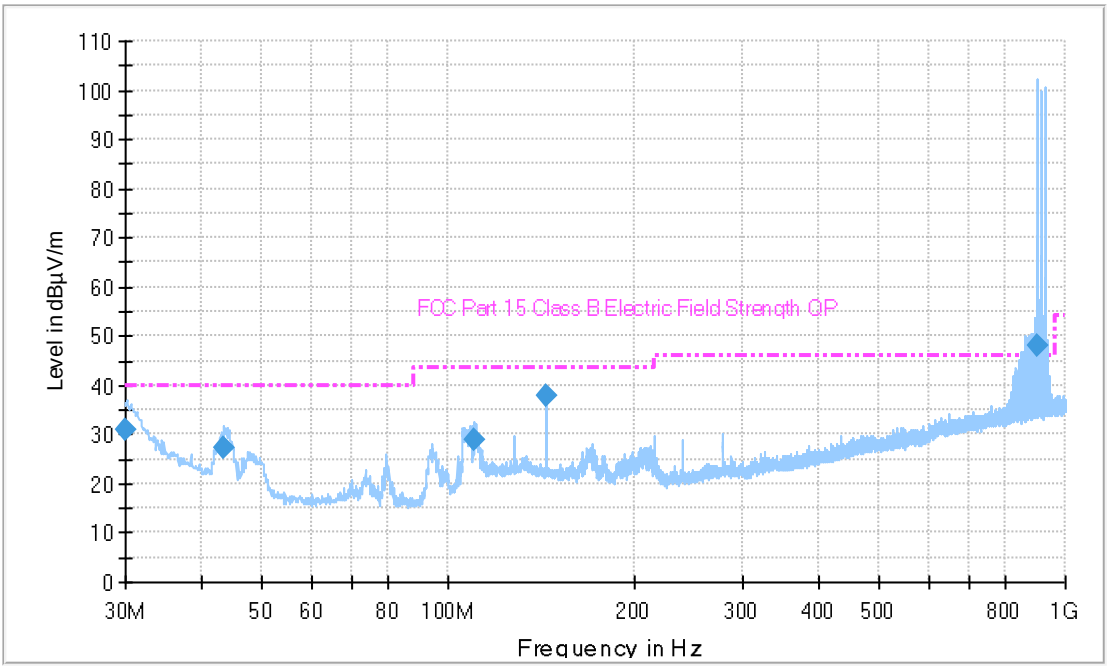


Figure 3: FCC Class B Emissions - 3m (EUT placed on top of a metal plate)

Note: Frequency signals above the limit lines are **fundamental frequencies** between 902-928MHz and the spurious emmissions on either side of these frequencies are governed by **band edge compliance.**

Table 3: FCC Class B Emissions - 3m* (EUT placed on top of a metal plate)

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Margin (dB)	Limit (dBµV/m)
30.037777	31.1	1000.000	120.000	166.0	V	96.0	9.4	9.4
43.432280	27.1	1000.000	120.000	100.0	V	1.0	13.4	13.4
110.182400	28.8	1000.000	120.000	100.0	V	44.0	11.7	11.7
144.013400	37.9	1000.000	120.000	167.0	H	345.0	2.6	2.6
899.537040	48.2	1000.000	120.000	234.0	V	187.0	71.8	< -20dBc**

* Unintentional emissions were measured from 0.009Mhz -1000MHz.

** The emission at 899.537MHz was derived from the fundamental intentional emission at the lower band edge at 902.17MHz. This emission is governed by band edge compliance in which emissions must be lower than 20dBc of the fundamental emission.

In accordance with 15.31(o) emissions that are 20dB below the permissible value have not been reported.

A.C. Mains Conducted Emissions

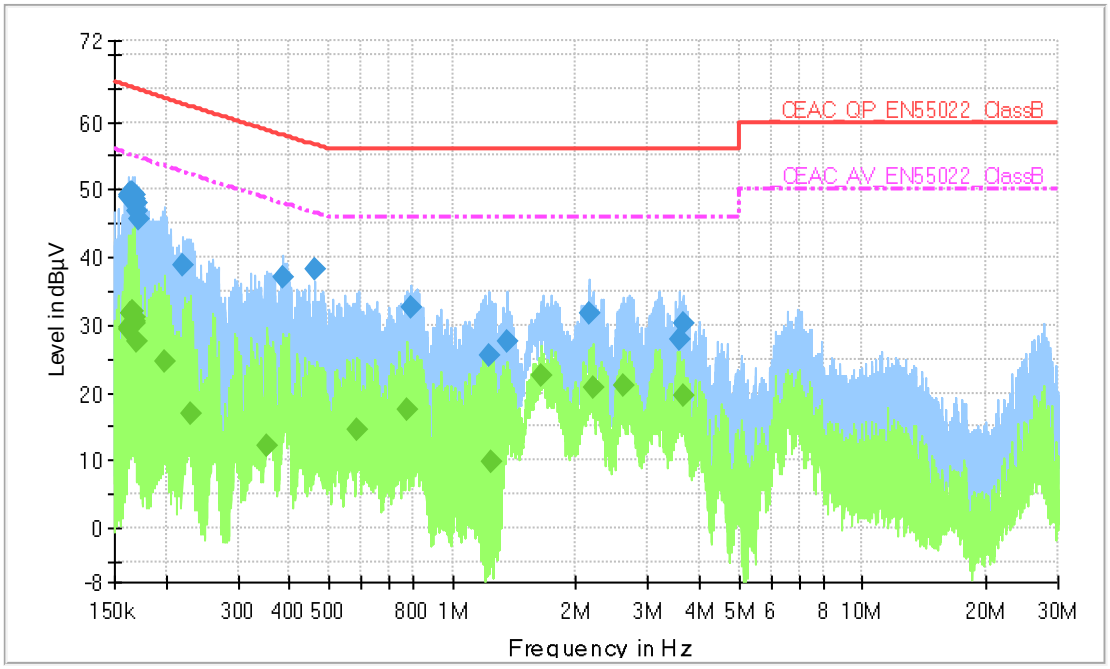
FCC/CE Class B - Emissions

Table 4: AC Conducted Emissions, 120V AC 60Hz, Line 1

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Average Limit (dBµV)
0.154720	24.6	1000.000	9.000	GND	L1	0.5	31.1	55.7
0.266227	23.7	1000.000	9.000	GND	L1	0.4	27.3	51.0
0.409580	22.5	1000.000	9.000	GND	L1	0.4	25.0	47.5
0.464086	21.9	1000.000	9.000	GND	L1	0.4	24.7	46.6
0.678498	30.2	1000.000	9.000	GND	L1	0.4	15.8	46.0
0.680535	29.7	1000.000	9.000	GND	L1	0.4	16.3	46.0
0.682579	28.4	1000.000	9.000	GND	L1	0.4	17.6	46.0
0.684628	27.9	1000.000	9.000	GND	L1	0.4	18.1	46.0
0.686684	27.4	1000.000	9.000	GND	L1	0.4	18.6	46.0
0.688747	27.3	1000.000	9.000	GND	L1	0.4	18.7	46.0
0.690815	27.5	1000.000	9.000	GND	L1	0.4	18.5	46.0
0.719712	26.8	1000.000	9.000	GND	L1	0.4	19.2	46.0
0.724041	25.4	1000.000	9.000	GND	L1	0.4	20.6	46.0
1.115025	21.7	1000.000	9.000	GND	L1	0.4	24.3	46.0
1.359040	23.1	1000.000	9.000	GND	L1	0.4	22.9	46.0
1.910964	22.3	1000.000	9.000	GND	L1	0.5	23.7	46.0
2.609123	14.1	1000.000	9.000	GND	L1	0.5	31.9	46.0
4.991268	12.4	1000.000	9.000	GND	L1	0.5	33.6	46.0
0.154720	24.6	1000.000	9.000	GND	L1	0.5	31.1	55.7
0.266227	23.7	1000.000	9.000	GND	L1	0.4	27.3	51.0

Table 5: AC Conducted Emissions, 120V AC 60Hz, Line 2

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Average Limit (dBµV)
0.160549	26.3	1000.000	9.000	GND	L1	0.5	29.1	55.4
0.161515	27.6	1000.000	9.000	GND	L1	0.5	27.7	55.3
0.163627	29.2	1000.000	9.000	GND	L1	0.5	26.0	55.2
0.164119	29.7	1000.000	9.000	GND	L1	0.5	25.5	55.2
0.164612	29.7	1000.000	9.000	GND	L1	0.5	25.5	55.2
0.165767	29.8	1000.000	9.000	GND	L1	0.5	25.3	55.1
0.166265	29.7	1000.000	9.000	GND	L1	0.5	25.4	55.1
0.166764	29.3	1000.000	9.000	GND	L1	0.5	25.7	55.0
0.167265	29.2	1000.000	9.000	GND	L1	0.5	25.8	55.0
0.169962	26.8	1000.000	9.000	GND	L1	0.5	28.1	54.9
0.225300	18.3	1000.000	9.000	GND	L1	0.4	34.1	52.4
0.390785	20.7	1000.000	9.000	GND	L1	0.4	27.2	47.9
0.520616	15.2	1000.000	9.000	GND	L1	0.4	30.8	46.0
0.808187	17.9	1000.000	9.000	GND	L1	0.4	28.1	46.0
1.242124	14.6	1000.000	9.000	GND	L1	0.4	31.4	46.0
1.758831	22.0	1000.000	9.000	GND	L1	0.5	24.0	46.0
2.151383	21.5	1000.000	9.000	GND	L1	0.5	24.5	46.0
3.592522	19.1	1000.000	9.000	GND	L1	0.5	26.9	46.0
3.624984	18.5	1000.000	9.000	GND	L1	0.5	27.5	46.0



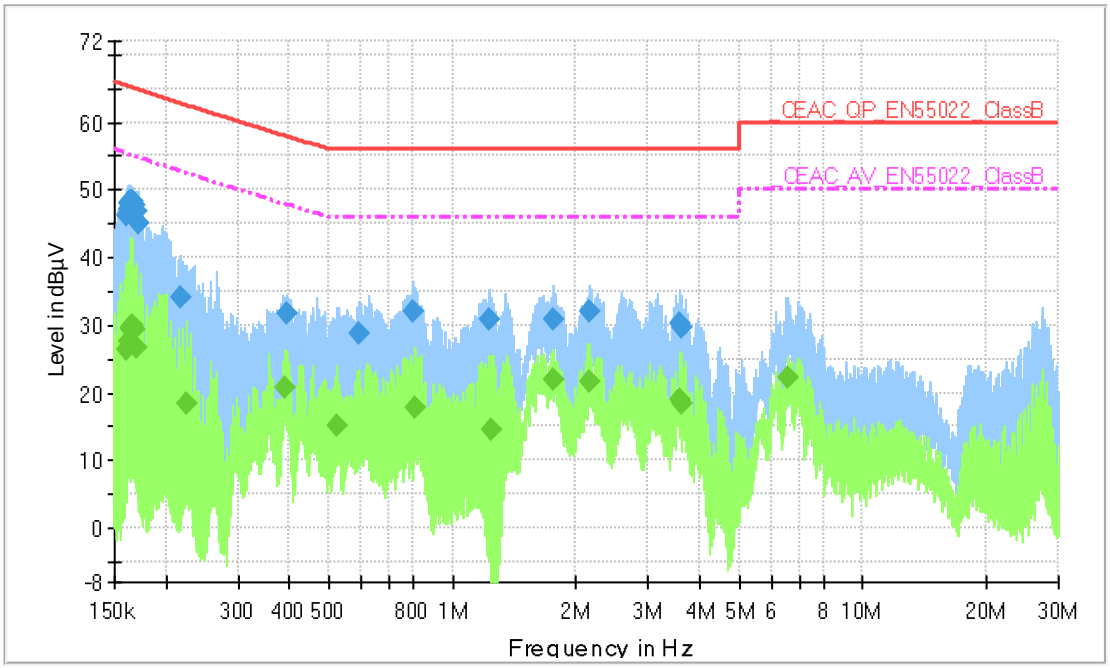


Figure 4: 120V AC Conducted Emissions - Line 1 and Line 2

Table 6: 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)
0.185217	25.9	1000.000	9.000	GND	L1	0.5	28.2	54.1
0.185774	25.7	1000.000	9.000	GND	L1	0.5	28.4	54.1
0.189335	25.6	1000.000	9.000	GND	L1	0.5	28.3	53.9
0.204278	26.2	1000.000	9.000	GND	L1	0.5	27.0	53.2
0.258621	24.9	1000.000	9.000	GND	L1	0.4	26.3	51.2
0.391958	26.8	1000.000	9.000	GND	L1	0.4	21.1	47.9
0.394316	26.5	1000.000	9.000	GND	L1	0.4	21.3	47.8
0.395500	26.4	1000.000	9.000	GND	L1	0.4	21.4	47.8
0.521658	22.4	1000.000	9.000	GND	L1	0.4	23.6	46.0
0.532723	20.6	1000.000	9.000	GND	L1	0.4	25.4	46.0
0.716840	18.3	1000.000	9.000	GND	L1	0.4	27.7	46.0
1.237168	17.5	1000.000	9.000	GND	L1	0.4	28.5	46.0
1.593127	30.5	1000.000	9.000	GND	L1	0.4	15.5	46.0
2.501862	22.1	1000.000	9.000	GND	L1	0.5	23.9	46.0
2.532050	22.3	1000.000	9.000	GND	L1	0.5	23.7	46.0
3.654086	15.2	1000.000	9.000	GND	L1	0.5	30.8	46.0
6.669502	21.8	1000.000	9.000	GND	L1	0.6	28.2	50.0
7.655897	14.9	1000.000	9.000	GND	L1	0.6	35.1	50.0
10.501946	14.8	1000.000	9.000	GND	L1	0.6	35.2	50.0

Table 7: 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)
0.166764	30.7	1000.000	9.000	GND	L1	0.5	24.3	55.0
0.168945	28.9	1000.000	9.000	GND	L1	0.5	26.0	54.9
0.221062	20.9	1000.000	9.000	GND	L1	0.4	31.7	52.6
0.396688	24.3	1000.000	9.000	GND	L1	0.4	23.5	47.8
0.527952	21.7	1000.000	9.000	GND	L1	0.4	24.3	46.0
0.621990	20.2	1000.000	9.000	GND	L1	0.4	25.8	46.0
1.229771	16.4	1000.000	9.000	GND	L1	0.4	29.6	46.0
1.533753	30.0	1000.000	9.000	GND	L1	0.4	16.0	46.0
1.549160	29.9	1000.000	9.000	GND	L1	0.4	16.1	46.0
1.561597	30.3	1000.000	9.000	GND	L1	0.4	15.7	46.0
1.570990	30.5	1000.000	9.000	GND	L1	0.4	15.5	46.0
1.578860	30.4	1000.000	9.000	GND	L1	0.4	15.6	46.0
1.591536	30.4	1000.000	9.000	GND	L1	0.4	15.6	46.0
1.604312	30.2	1000.000	9.000	GND	L1	0.4	15.8	46.0
1.630175	29.5	1000.000	9.000	GND	L1	0.4	16.5	46.0
2.408621	23.2	1000.000	9.000	GND	L1	0.5	22.8	46.0
2.590932	22.3	1000.000	9.000	GND	L1	0.5	23.7	46.0
3.635870	15.9	1000.000	9.000	GND	L1	0.5	30.1	46.0
6.589985	25.7	1000.000	9.000	GND	L1	0.6	24.3	50.0
7.414905	20.8	1000.000	9.000	GND	L1	0.6	29.2	50.0

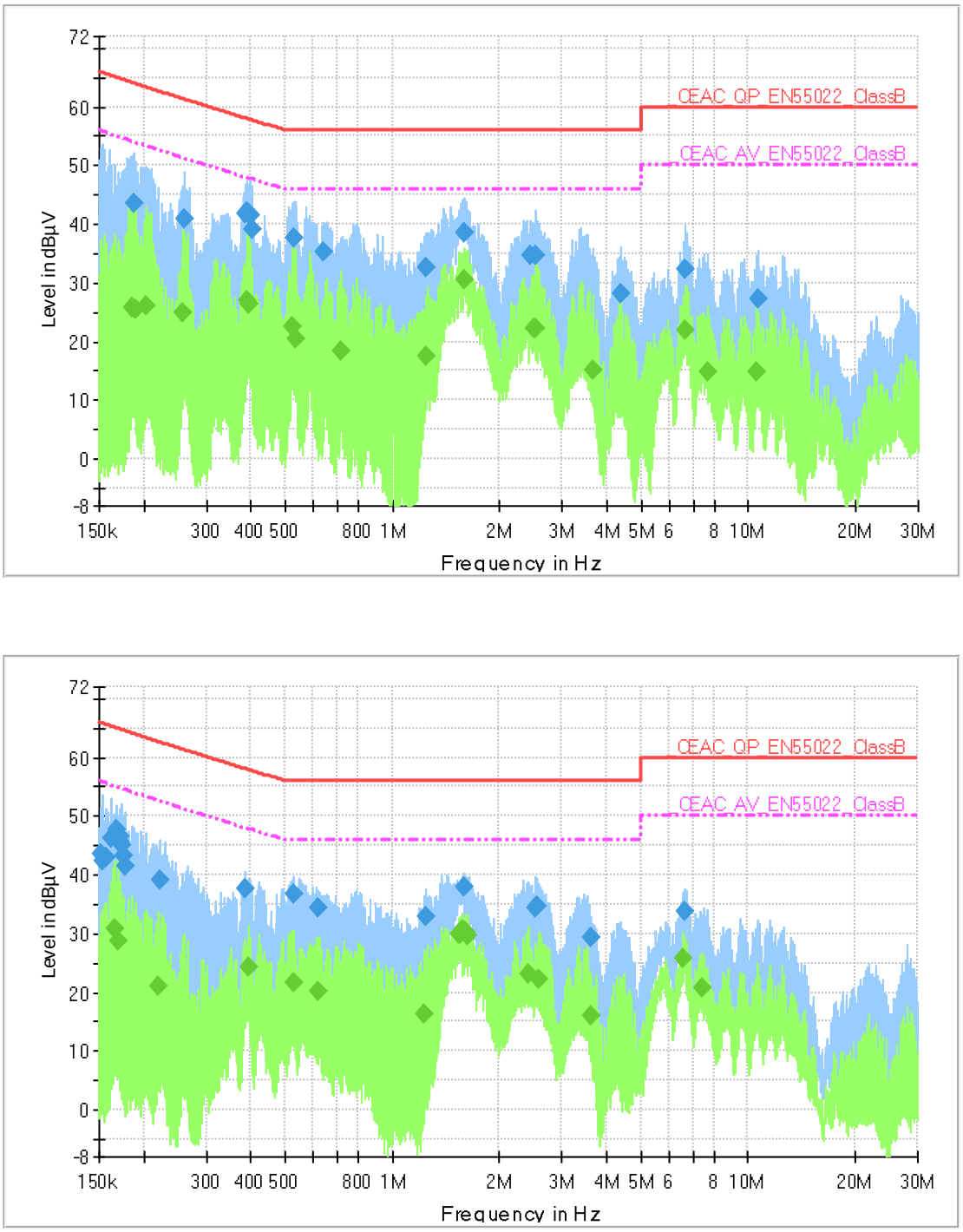


Figure 5: 240V AC Conducted Emissions - Line 1 and Line 2

FHSS Compliance Tests

Output Power

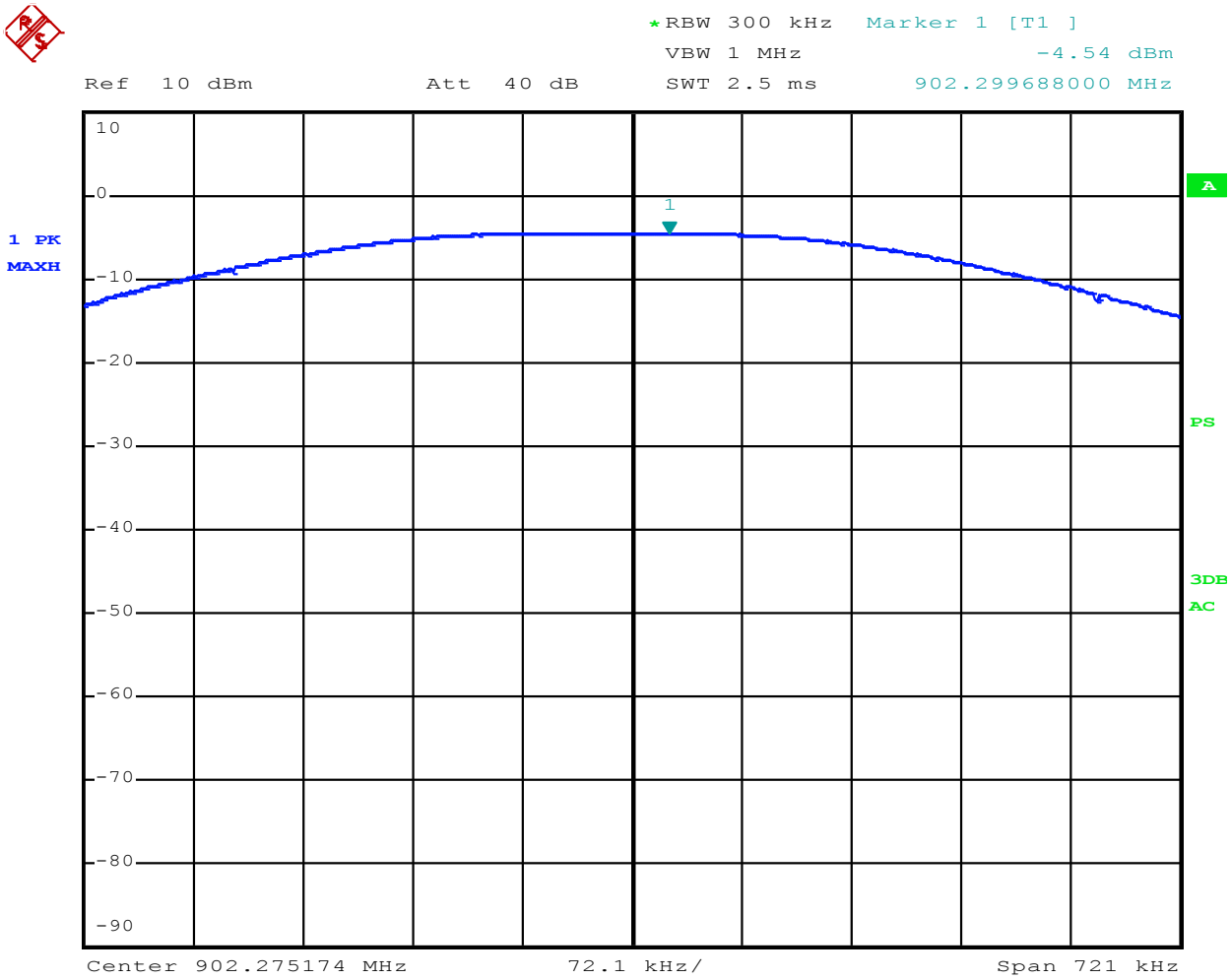


Figure 6: Output Power at LOW Frequency

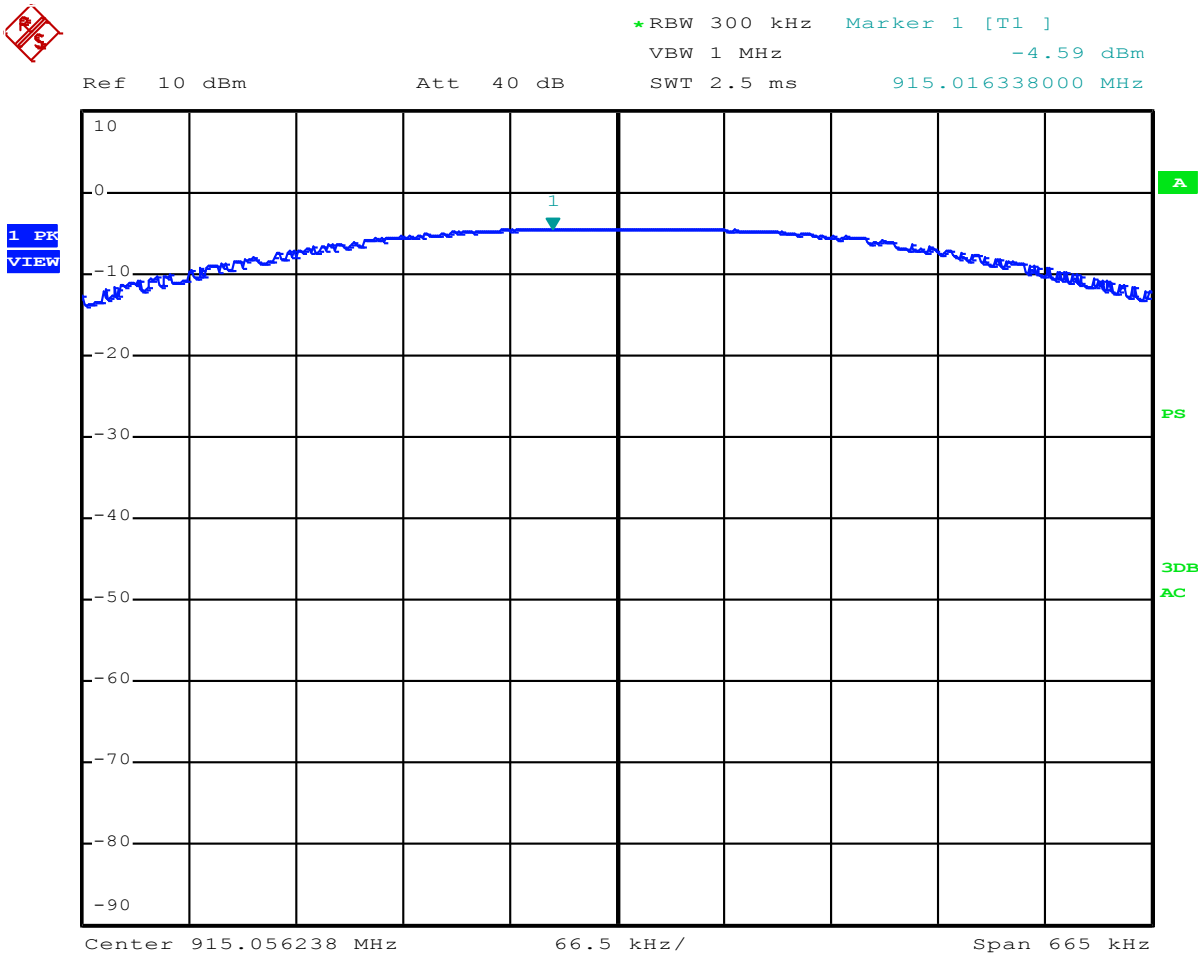
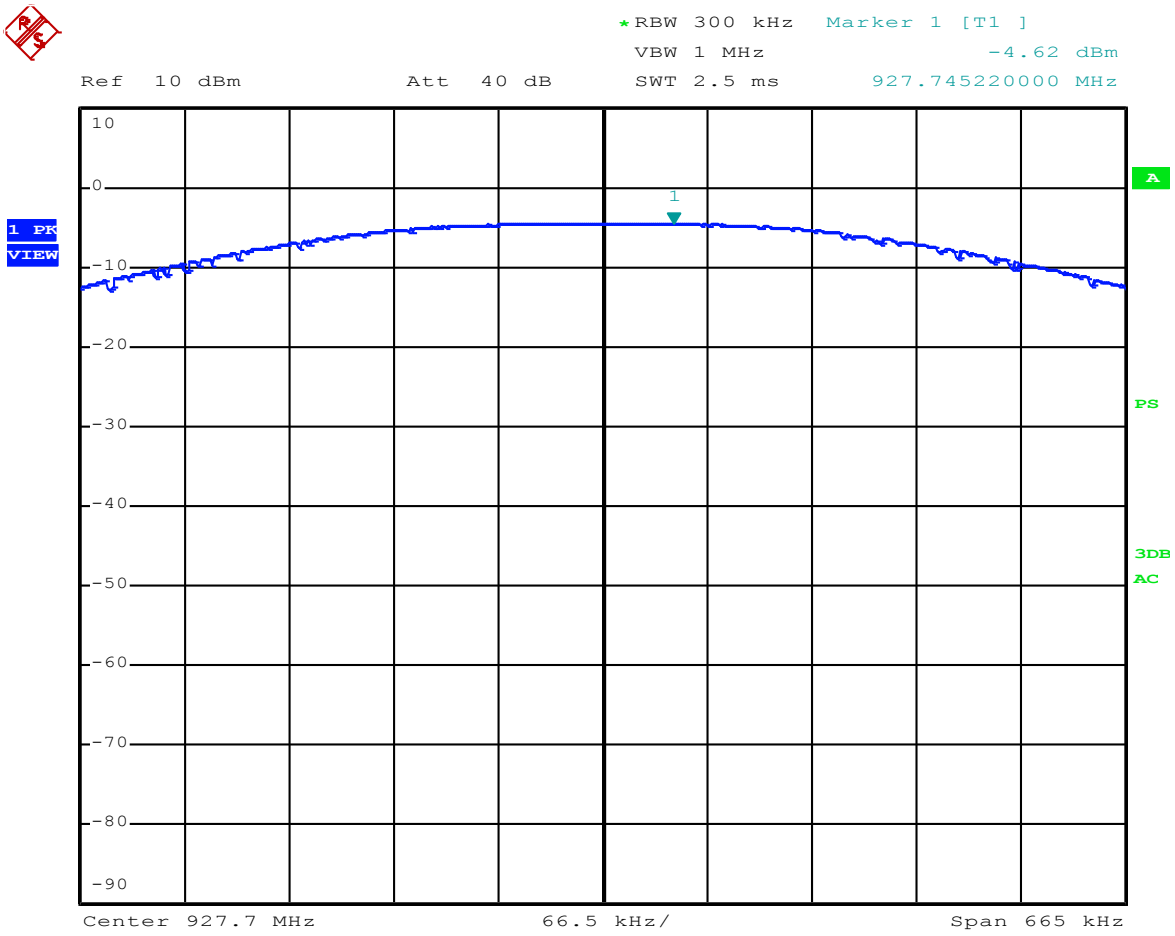


Figure 7: Output Power at MID Frequency

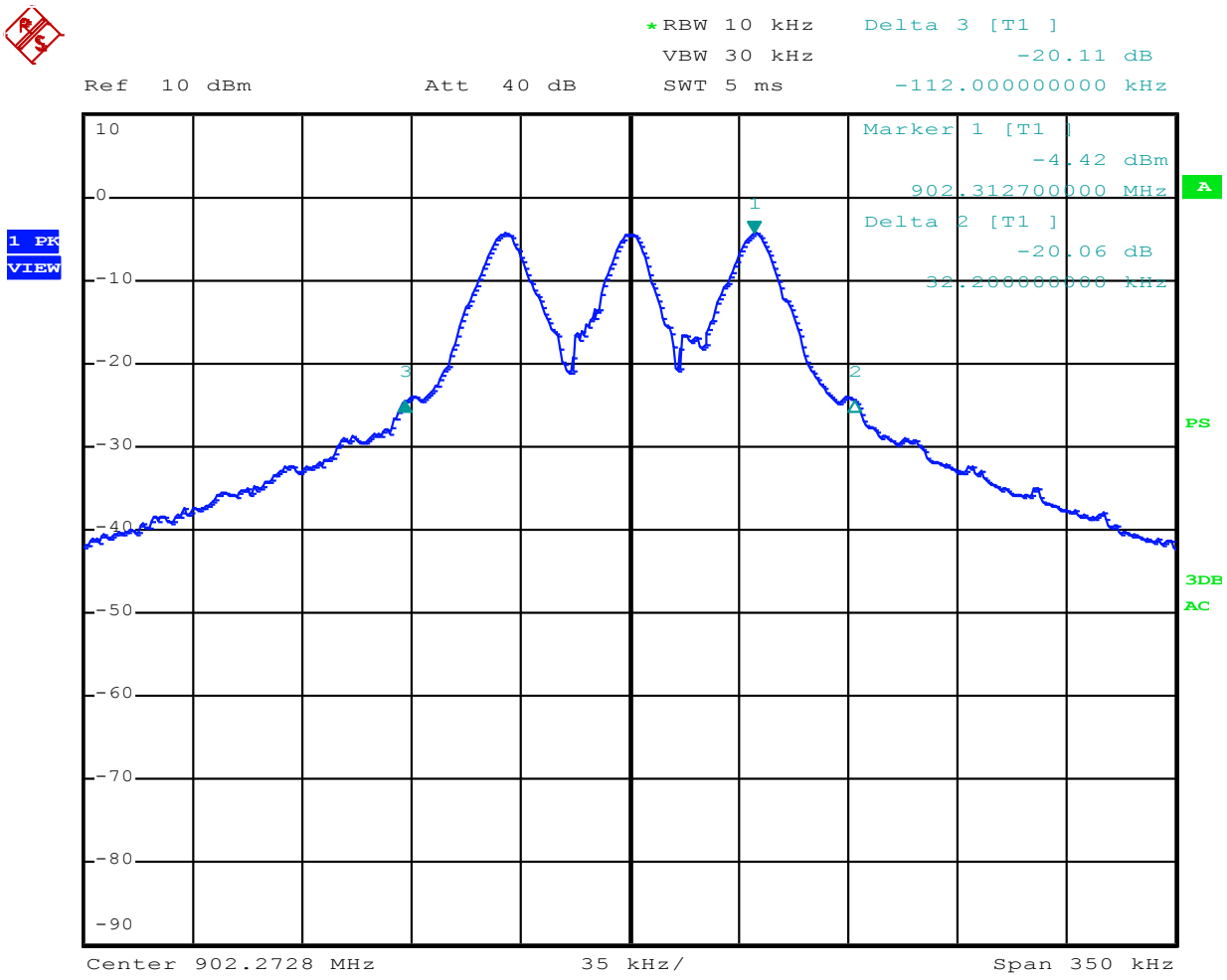


Date: 27.JUN.2016 15:35:41

Figure 8: Output Power at HIGH Frequency

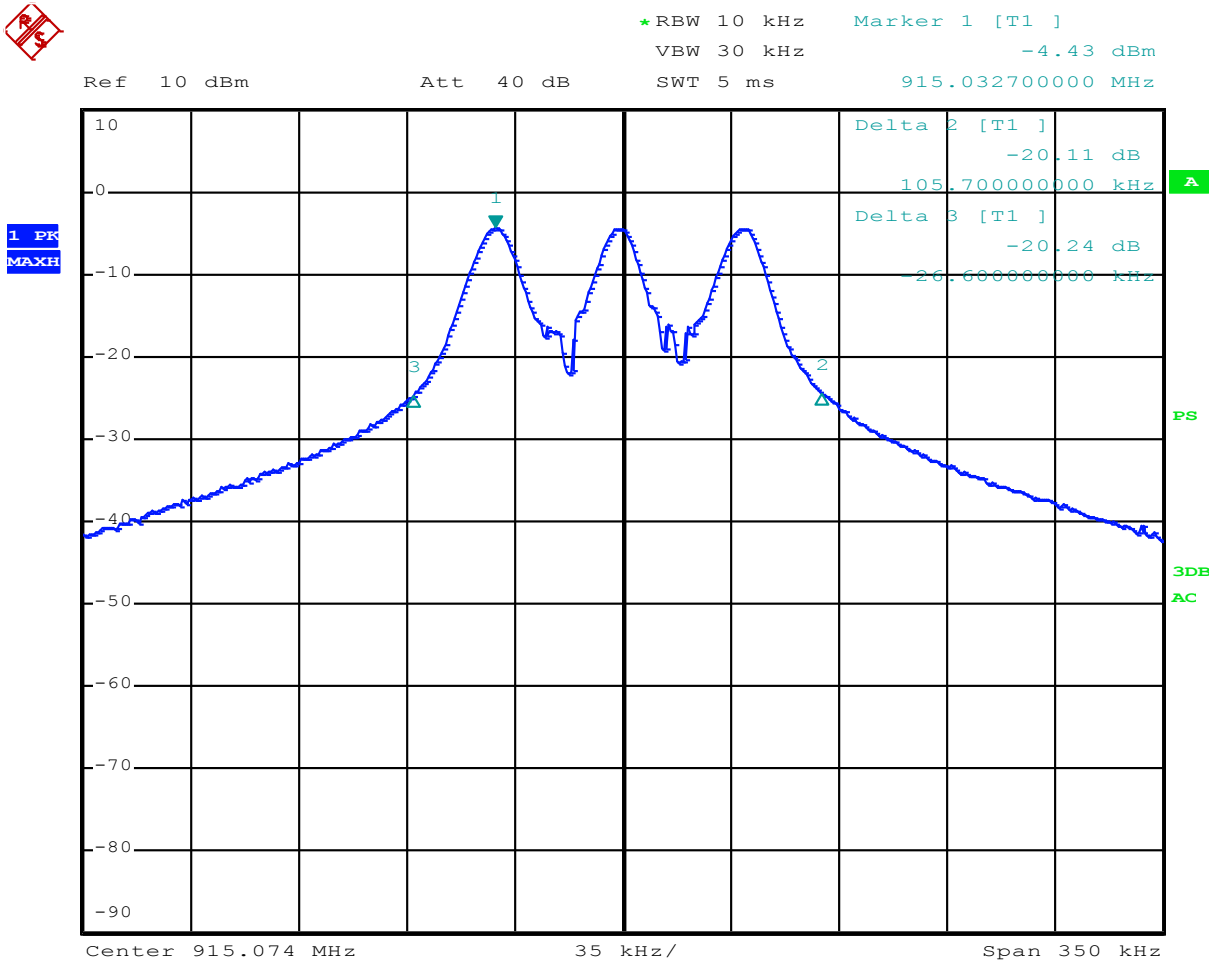
Low Data Rate Tests

20 dB Bandwidth



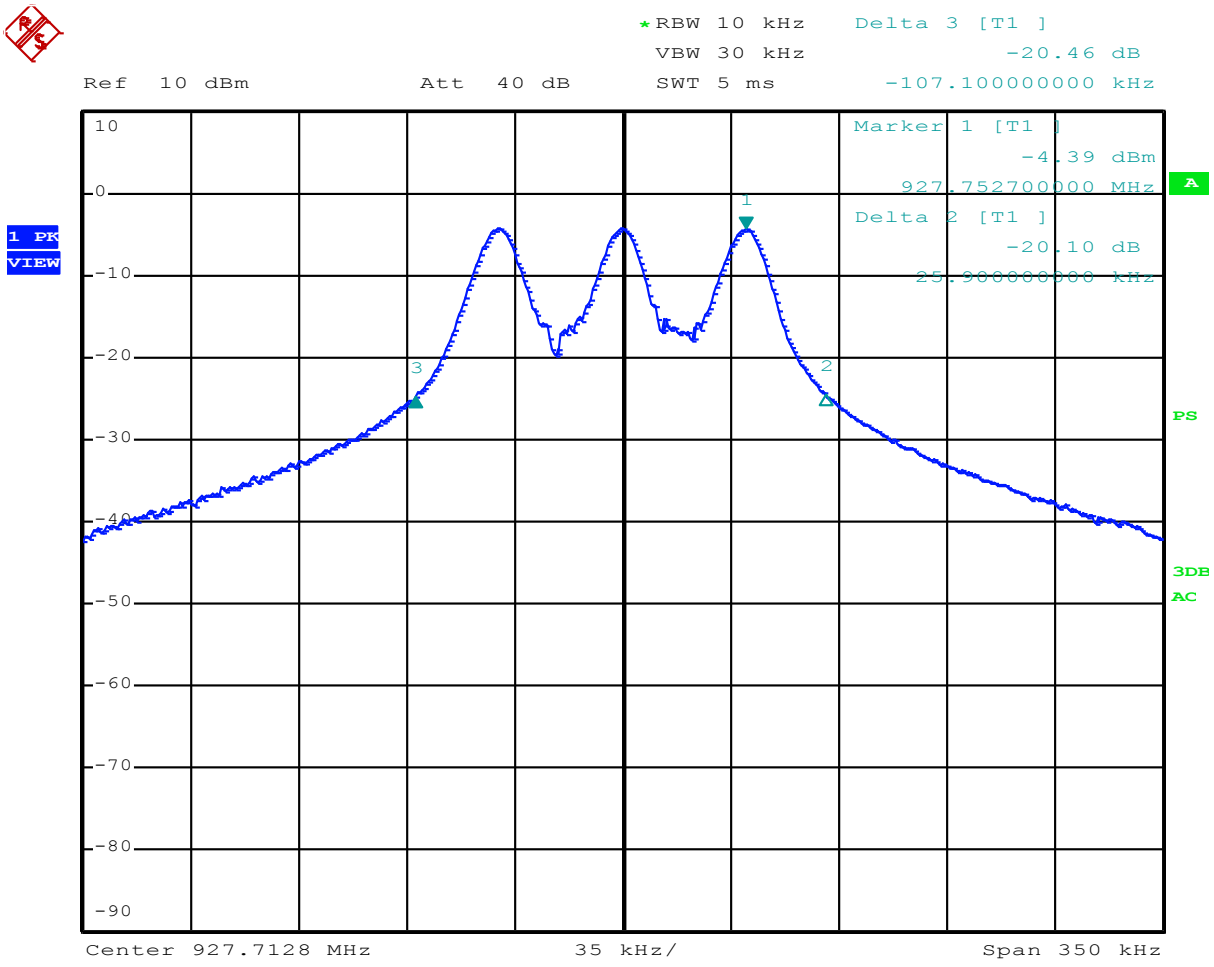
Date: 27.JUN.2016 15:20:15

Figure 9: 20dB Bandwidth at LOW Frequency – 144.2 kHz



Date: 27.JUN.2016 15:18:39

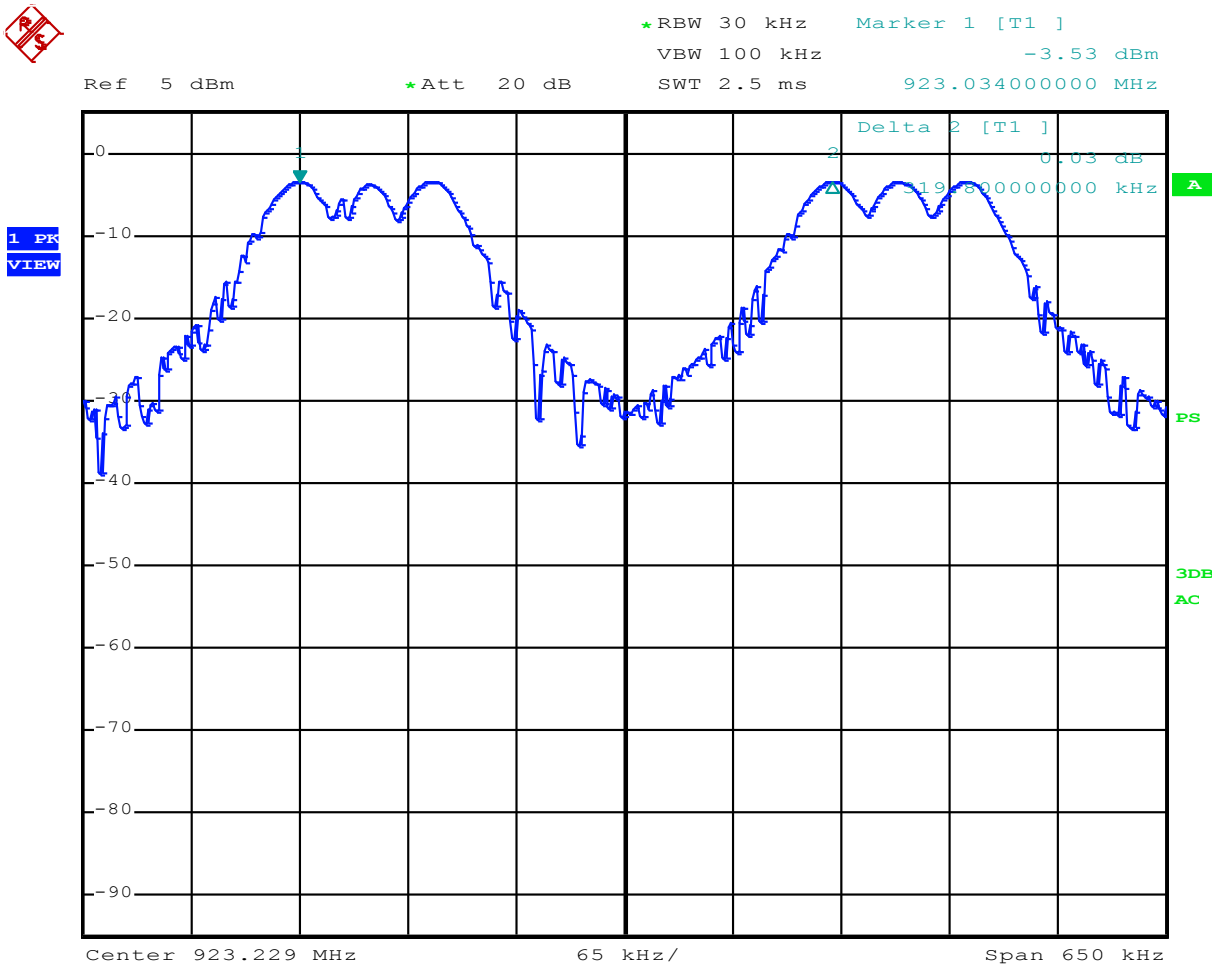
Figure 10: 20dB Bandwidth at MID Frequency – 132.3 kHz



Date: 27.JUN.2016 15:16:53

Figure 11: 20dB Bandwidth at HIGH Frequency – 133 kHz

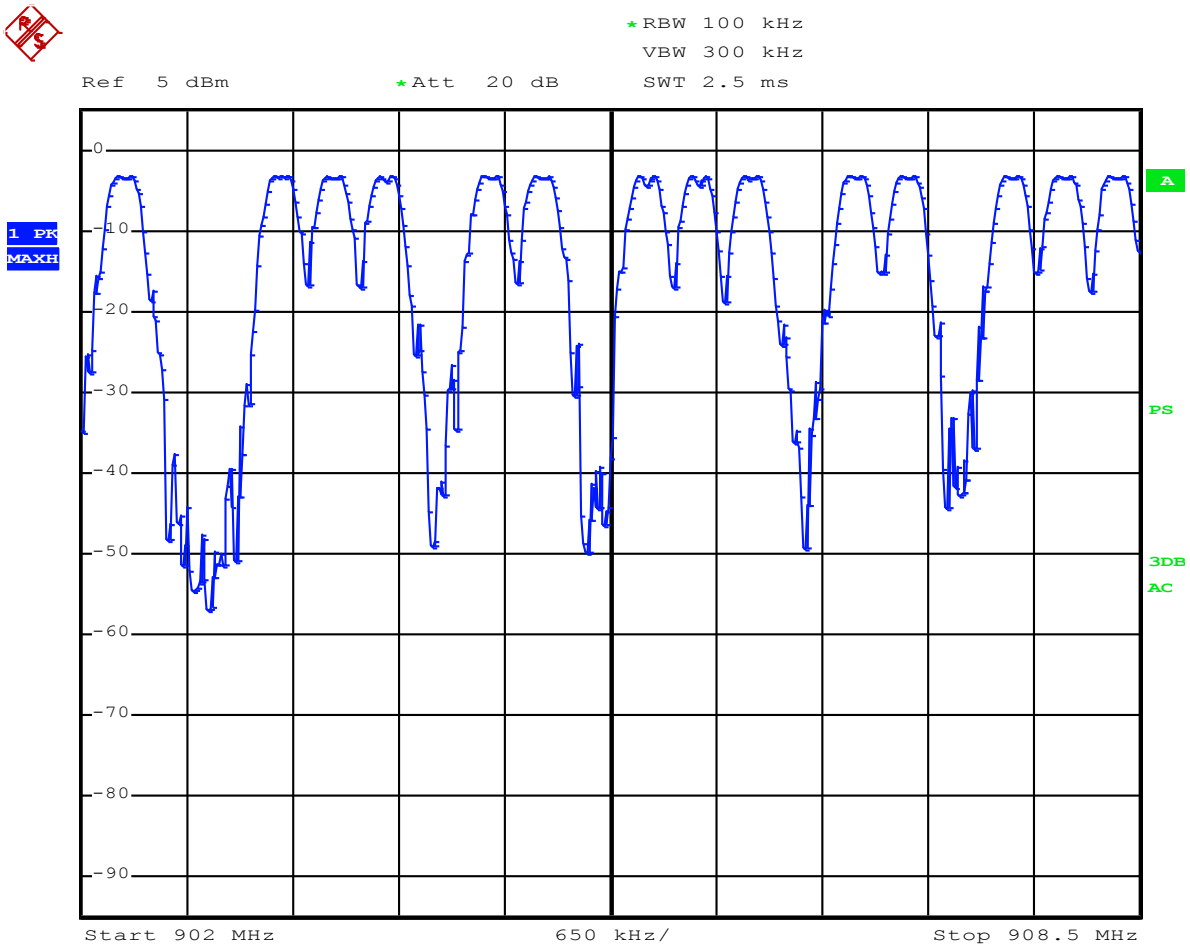
Channel Separation



Date: 27.JUN.2016 16:56:50

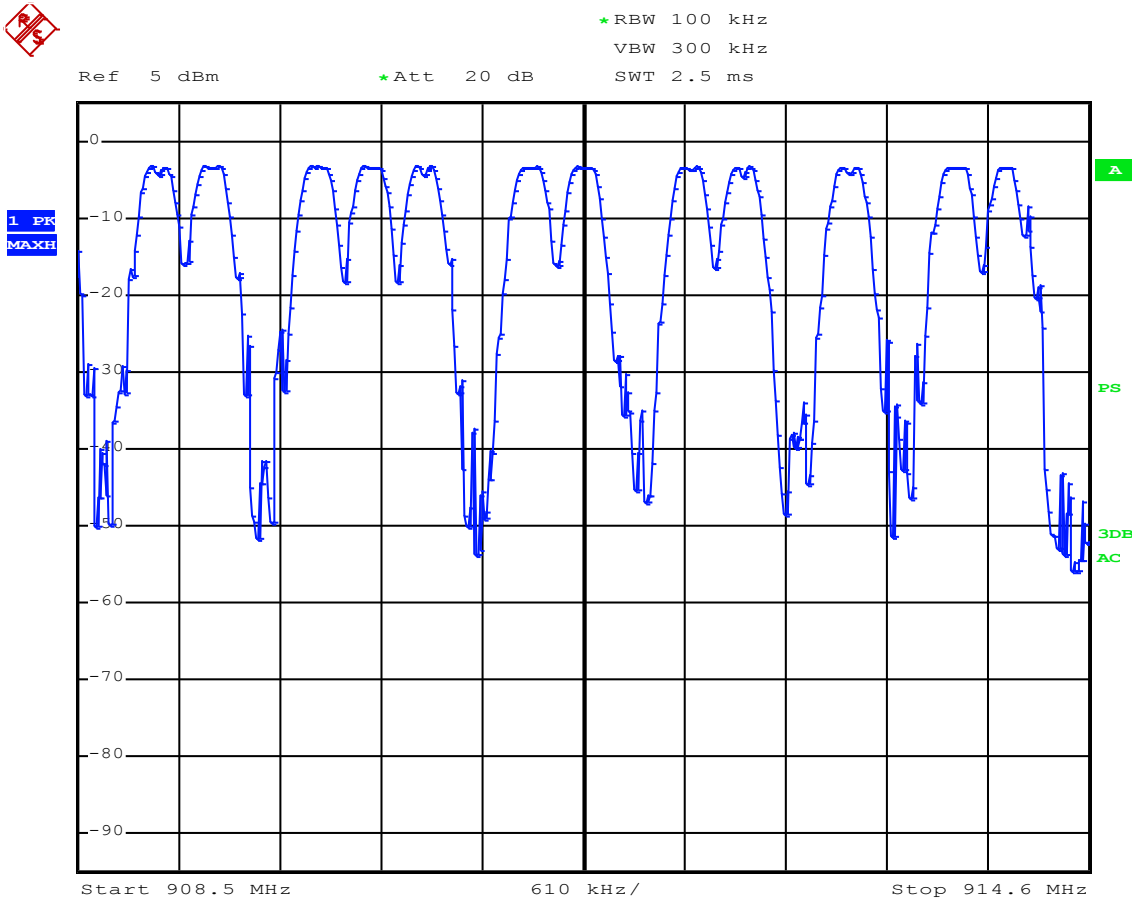
Figure 12: Channel Separation = 319.8 kHz

Number of Hopping Channels



Date: 27.JUN.2016 16:39:52

Figure 13: Number of Hopping Frequencies 902MHz to 908MHz - 14 Frequencies



Date: 27.JUN.2016 16:48:35

Figure 14: Number of Hopping Frequencies 908MHz to 915MHz - 12 Frequencies

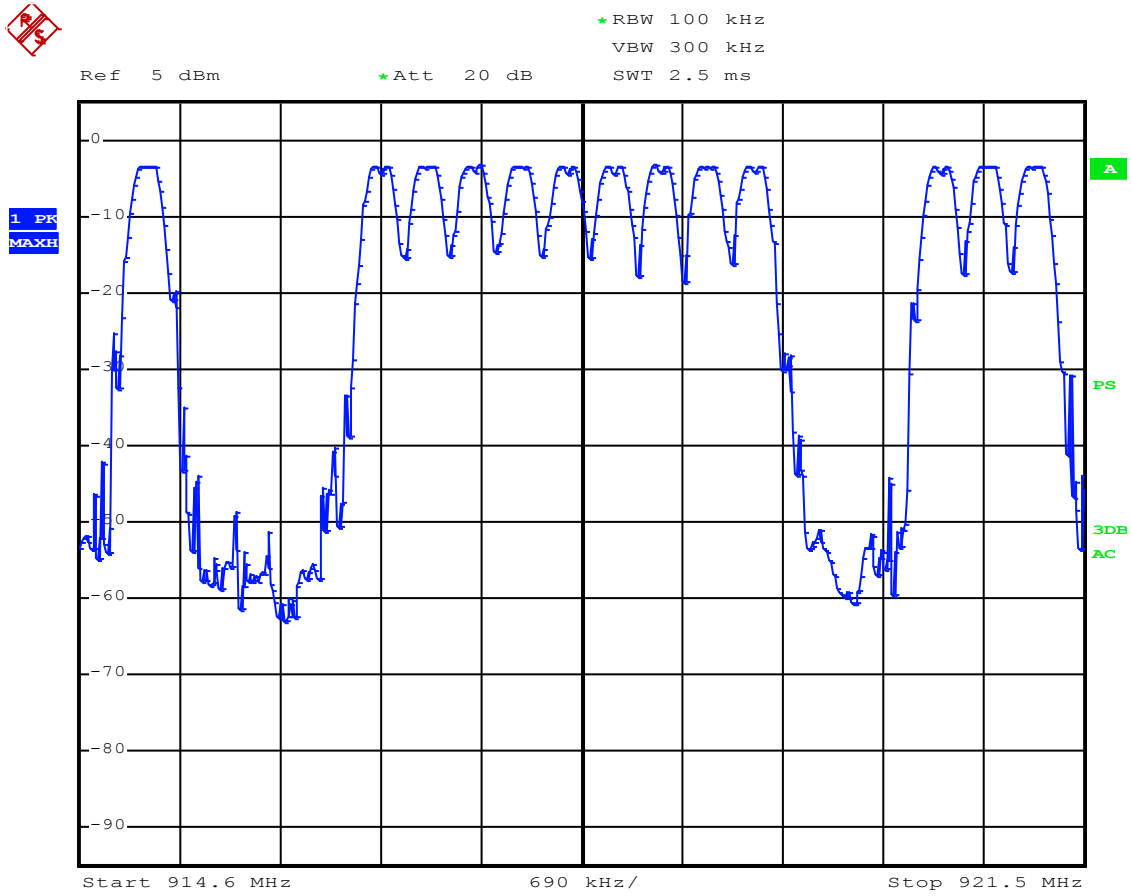
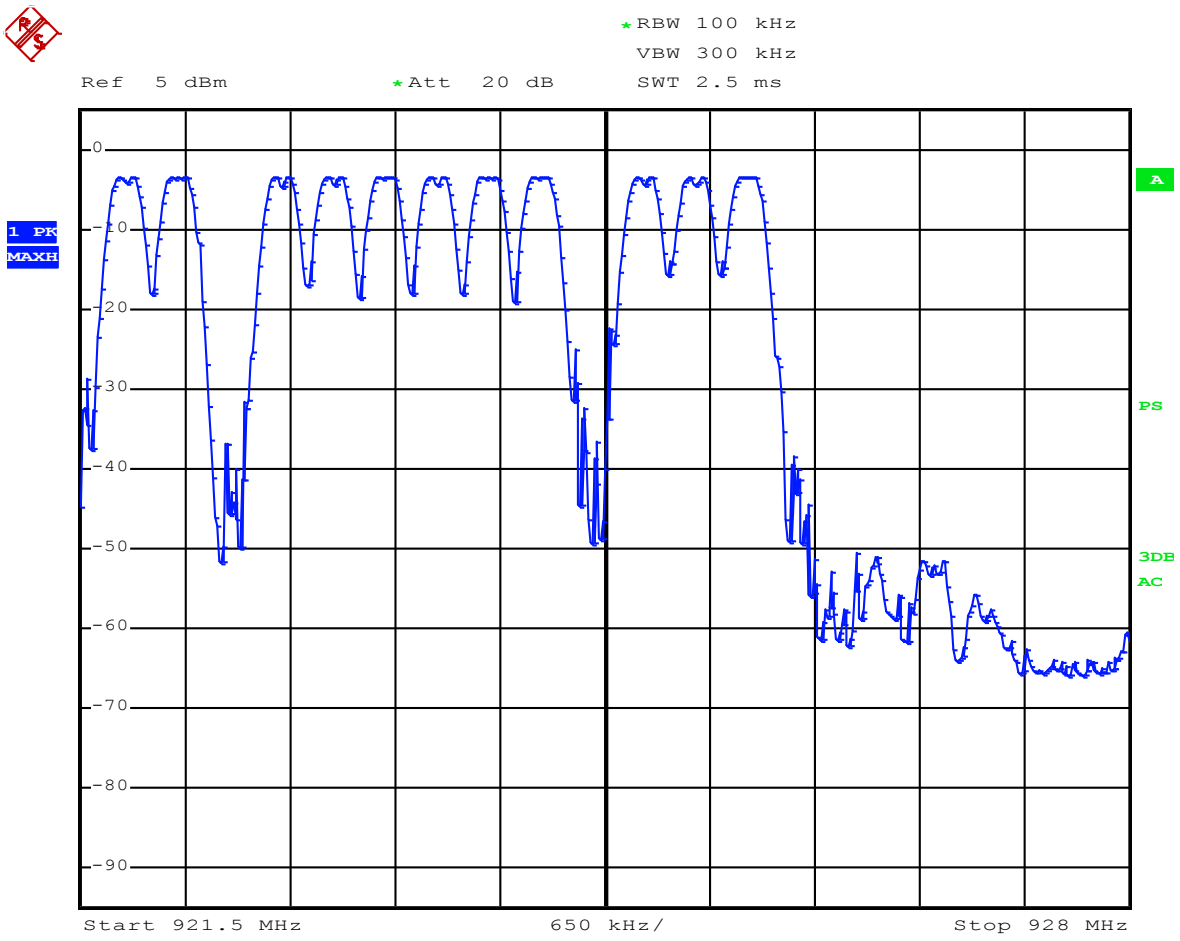


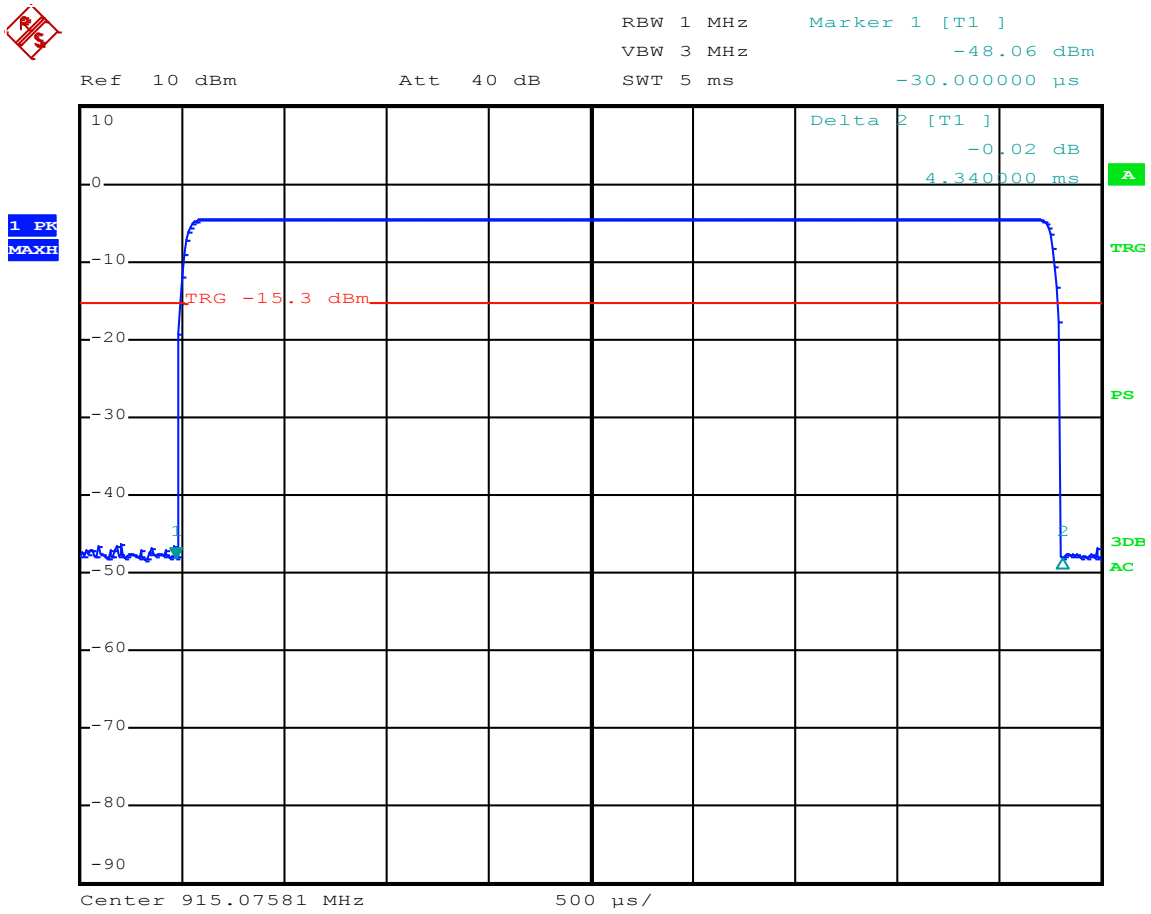
Figure 15: Number of Hopping Frequencies 915MHz to 921MHz - 13 Frequencies



Date: 27.JUN.2016 16:50:58

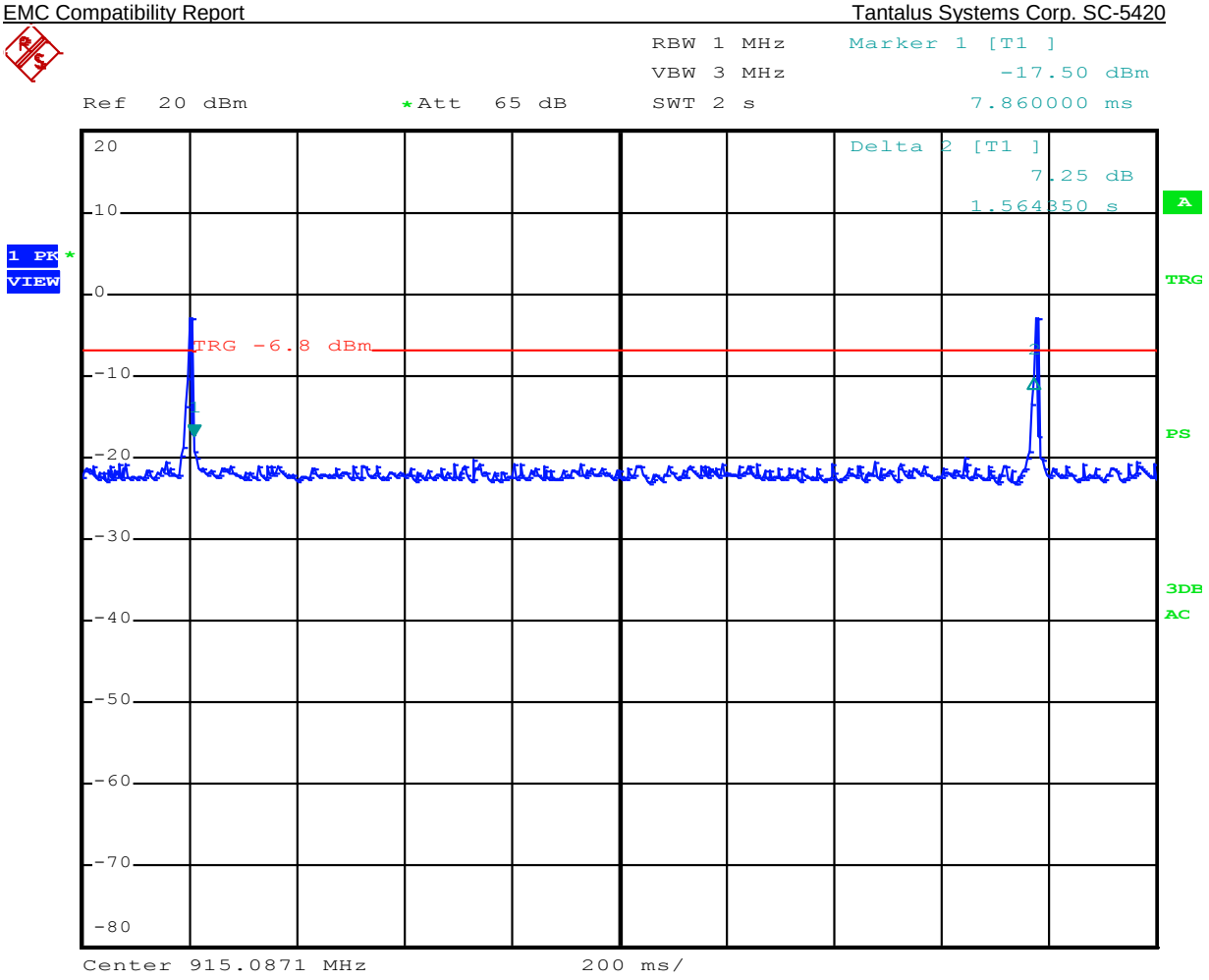
Figure 16: Number of Hopping Frequencies 921MHz to 928MHz - 11 Frequencies

Dwell Time and Time of Occupancy



Date: 27.JUN.2016 15:37:31

Figure 17: Dwell Time – 4.34mS

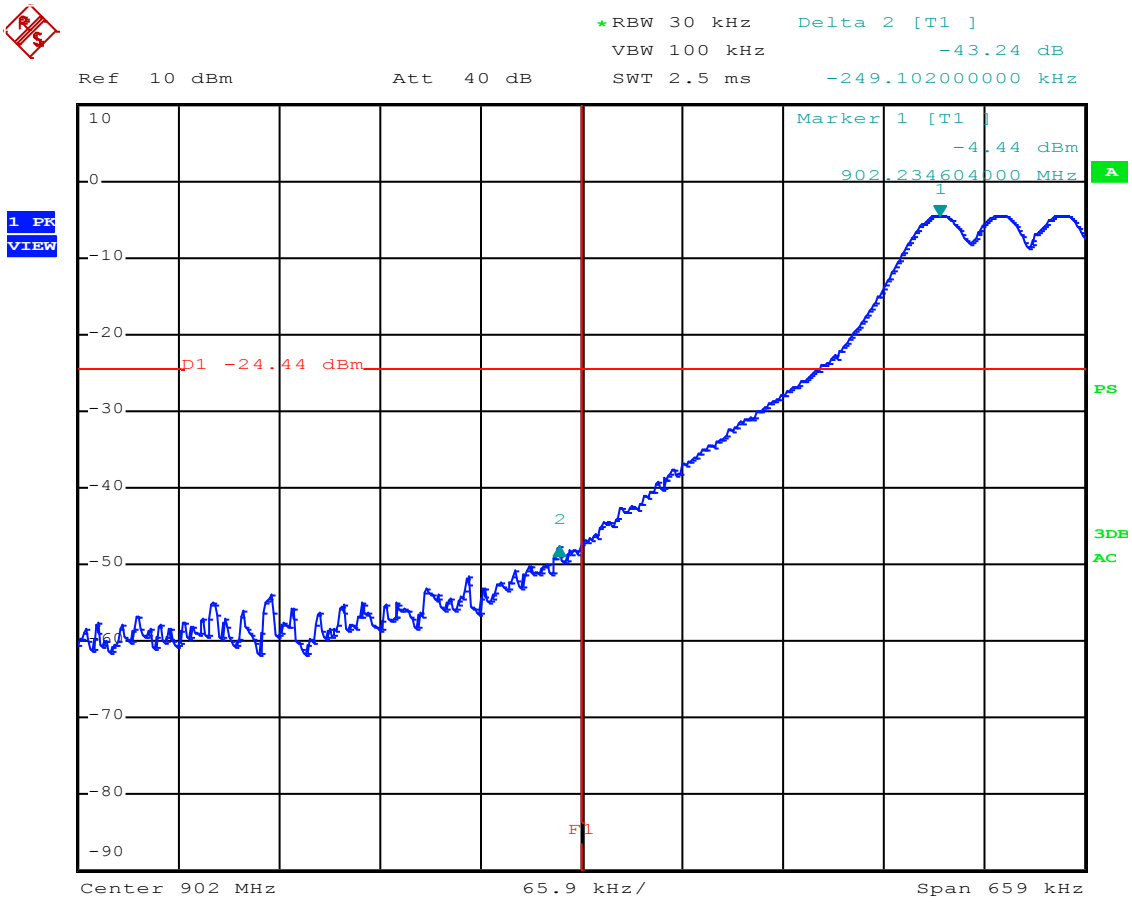


Date: 27.JUN.2016 17:02:24

Figure 18: Time Occupancy Per Frequency – 55.6mS*

*(***** Time betwen 2 consecutive transmissions on the same frequency is 1.56 Seconds, dwell time per frequency is 4.34mS, therefore occupancy time per frequency within a 20 Second period is 55.6mS)*

Channel Bandedge



Date: 27.JUN.2016 15:22:25

Figure 19: Low Channel Bandedge

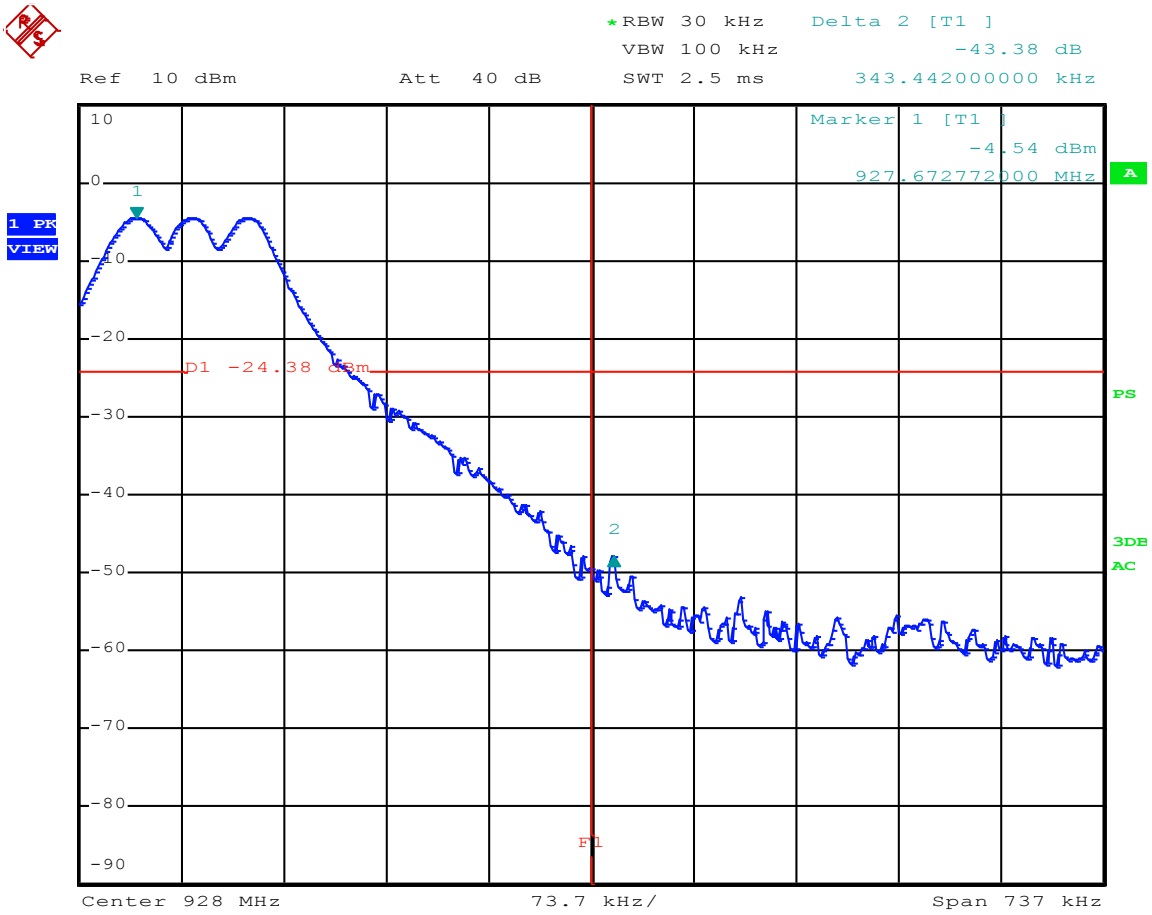
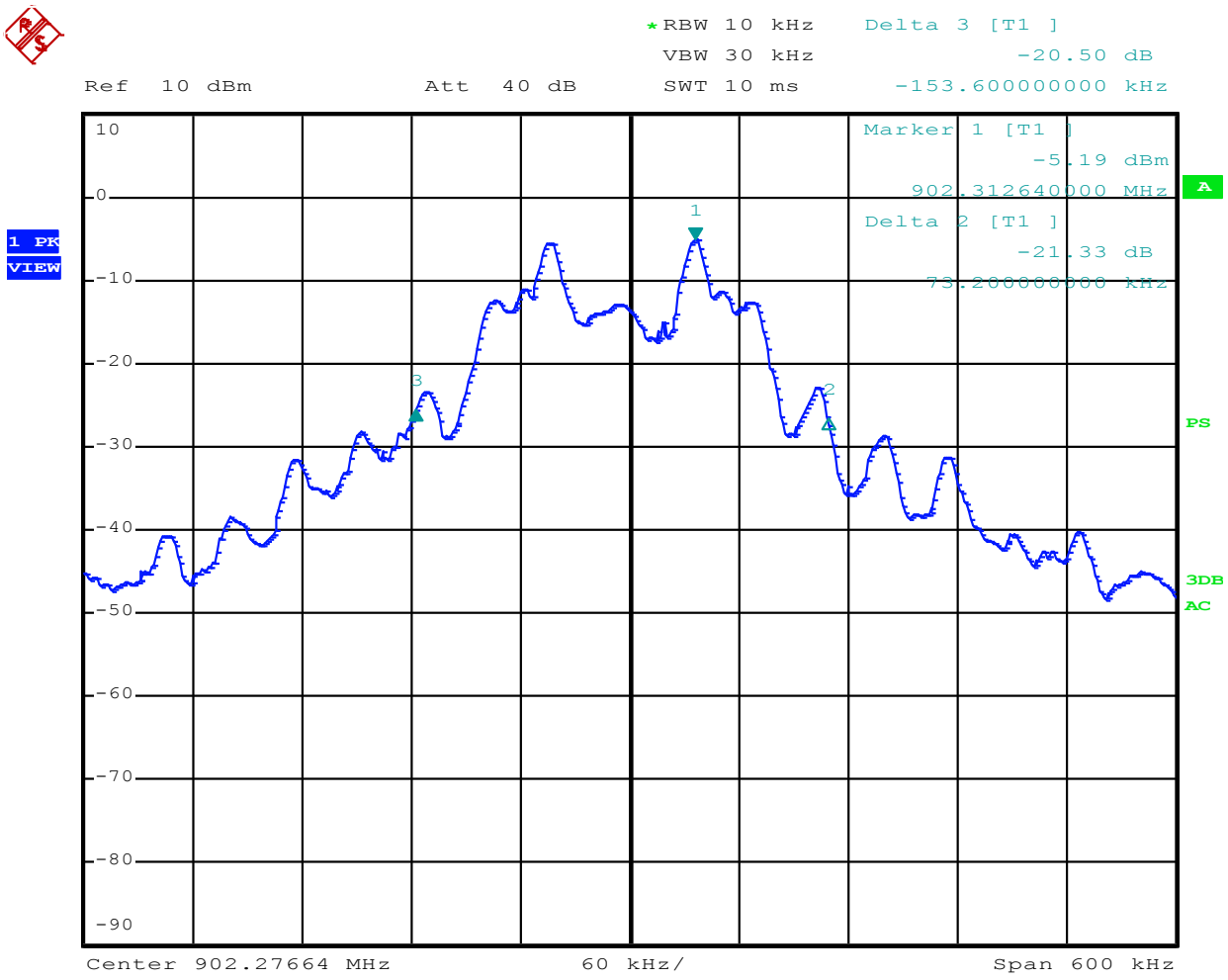


Figure 20: High Channel Bandedge

High Data Rate Tests

20 dB Bandwidth



Date: 27.JUN.2016 13:53:04

Figure 21: 20dB Bandwidth at LOW Frequency – 226.2 kHz

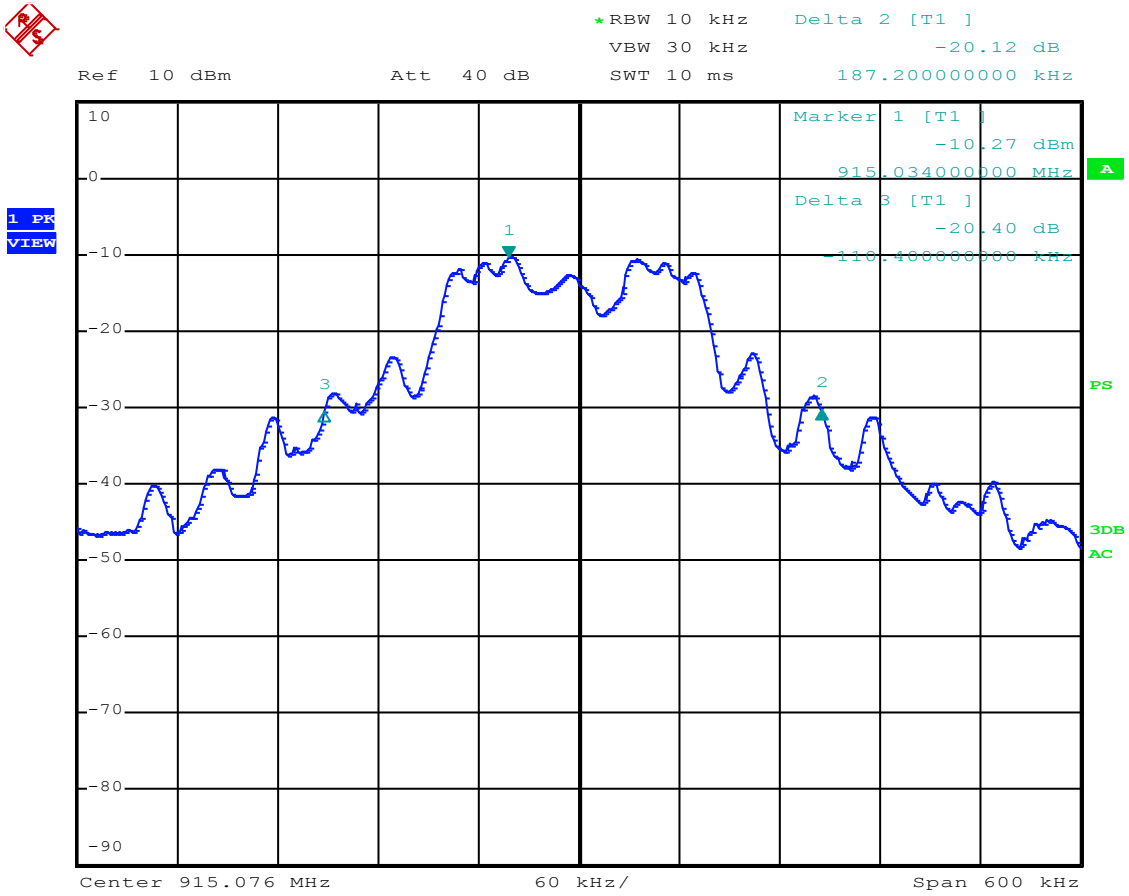
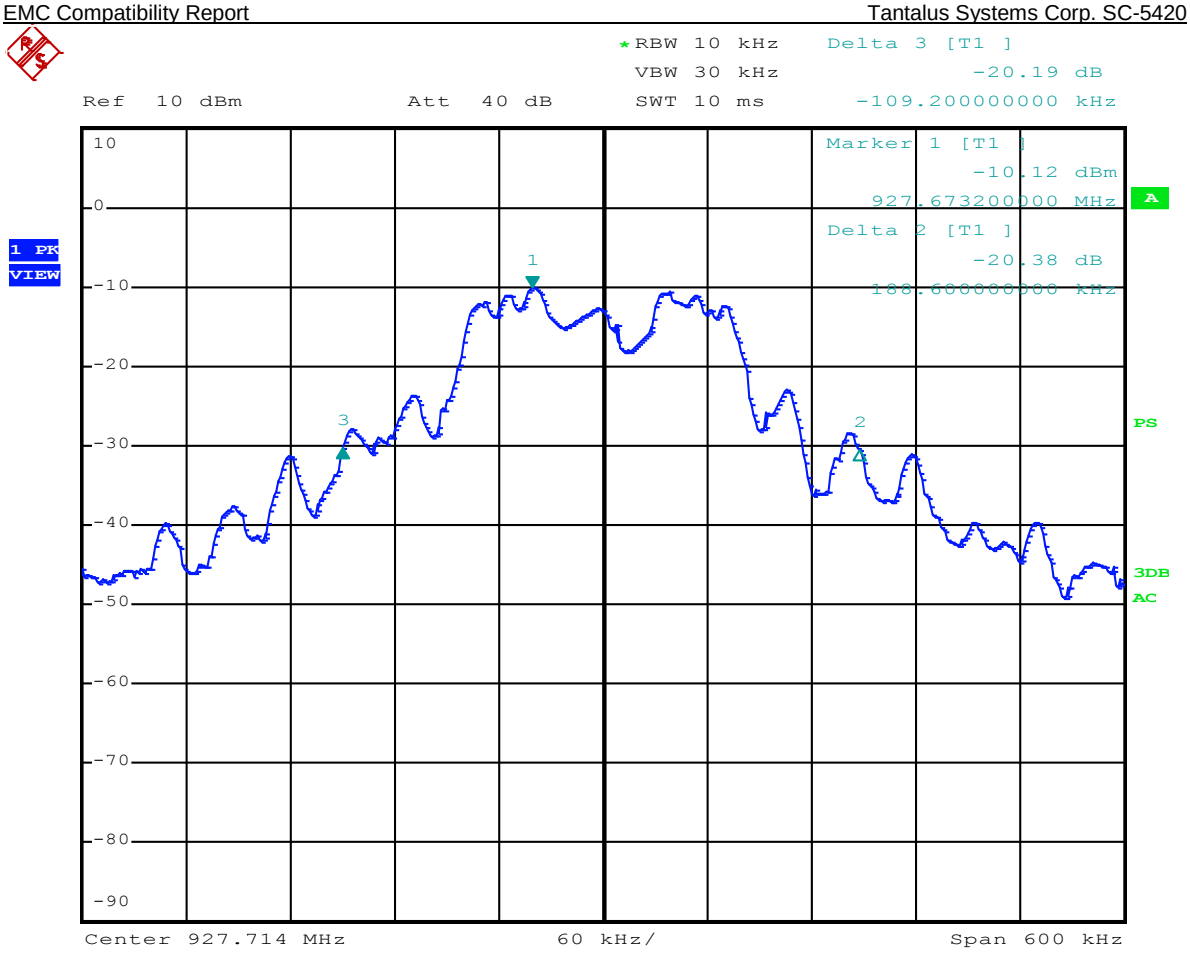


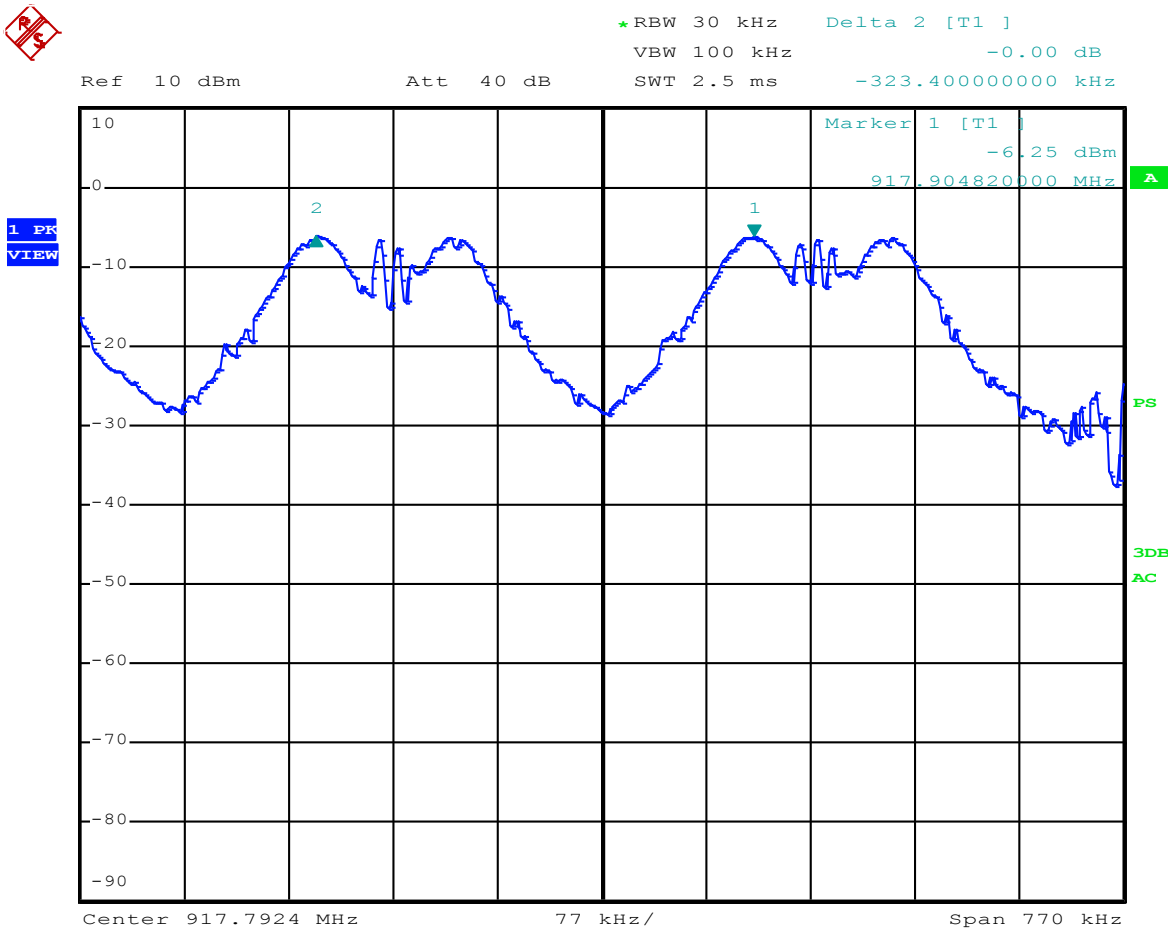
Figure 22: 20dB Bandwidth at MID Frequency – 297.6 kHz



Date: 27.JUN.2016 13:22:56

Figure 23: 20dB Bandwidth at HIGH Frequency – 297.8 kHz

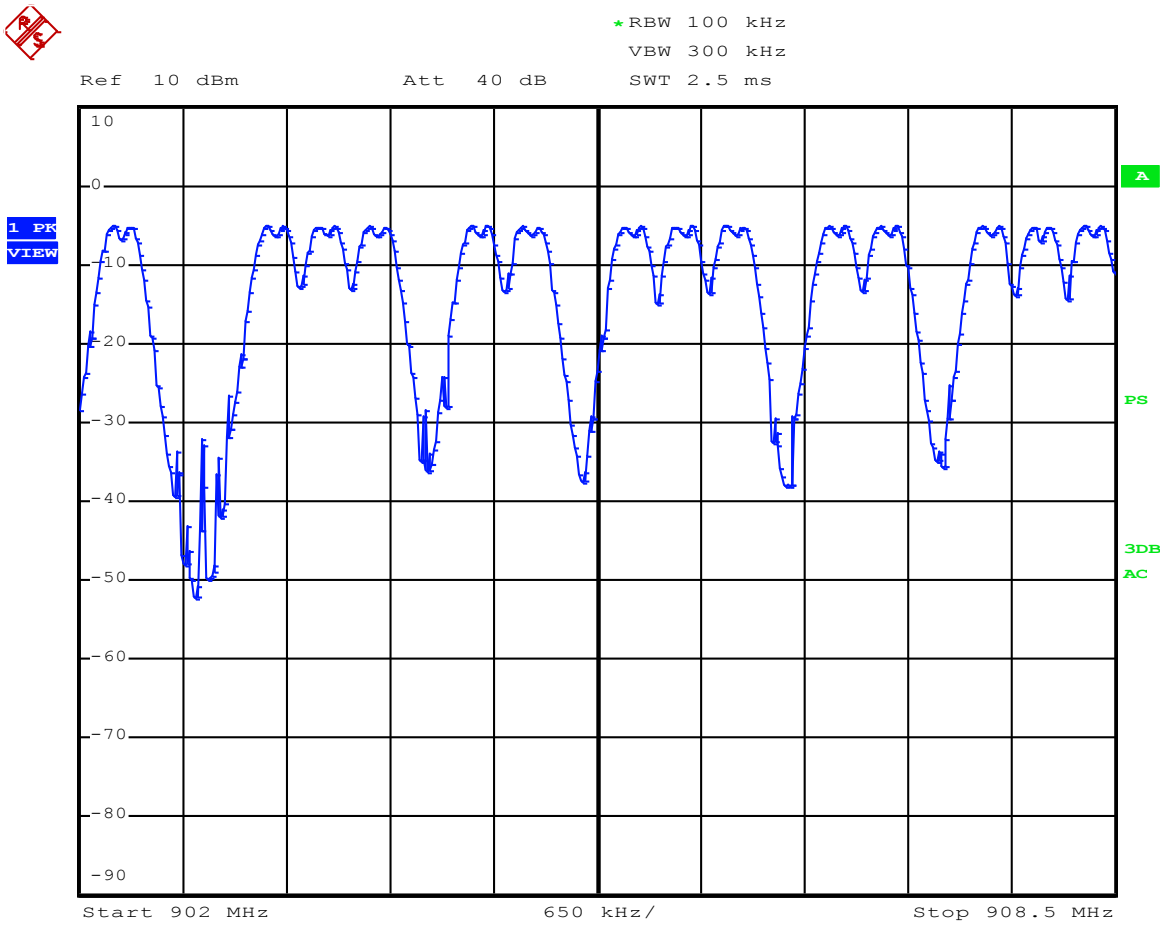
Channel Separation



Date: 27.JUN.2016 14:54:18

Figure 24: Channel Separation = 320 kHz

Number of Hopping Channels



Date: 27.JUN.2016 14:20:07

Figure 25: Number of Hopping Frequencies 902MHz to 908MHz - 14 Frequencies

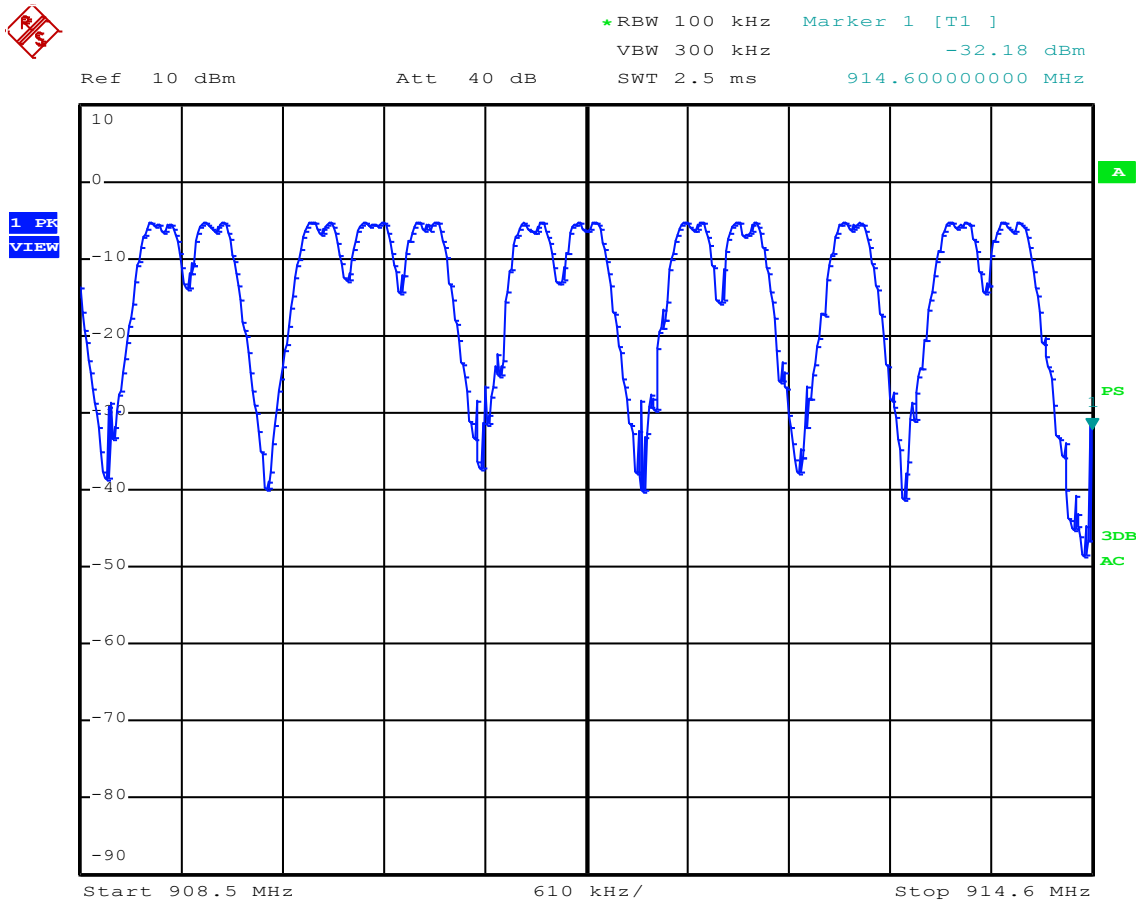
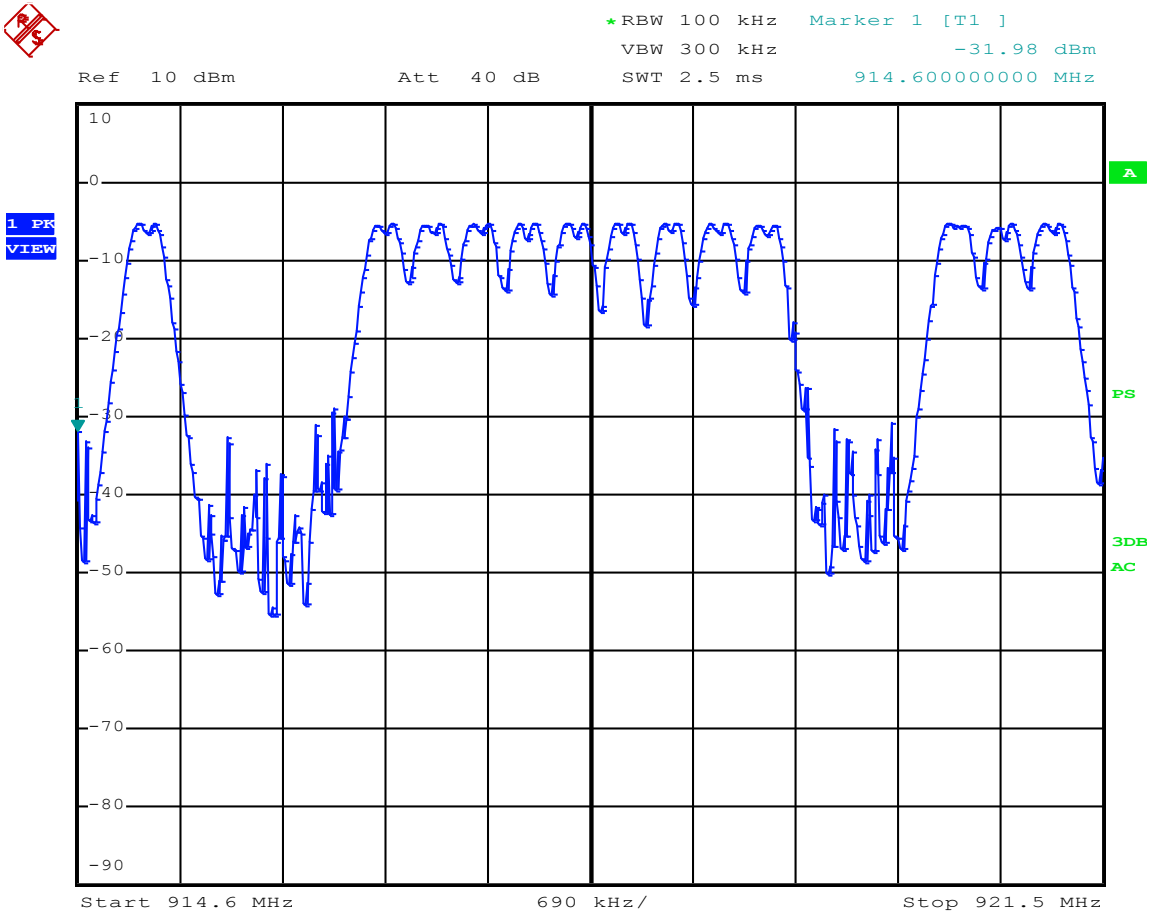
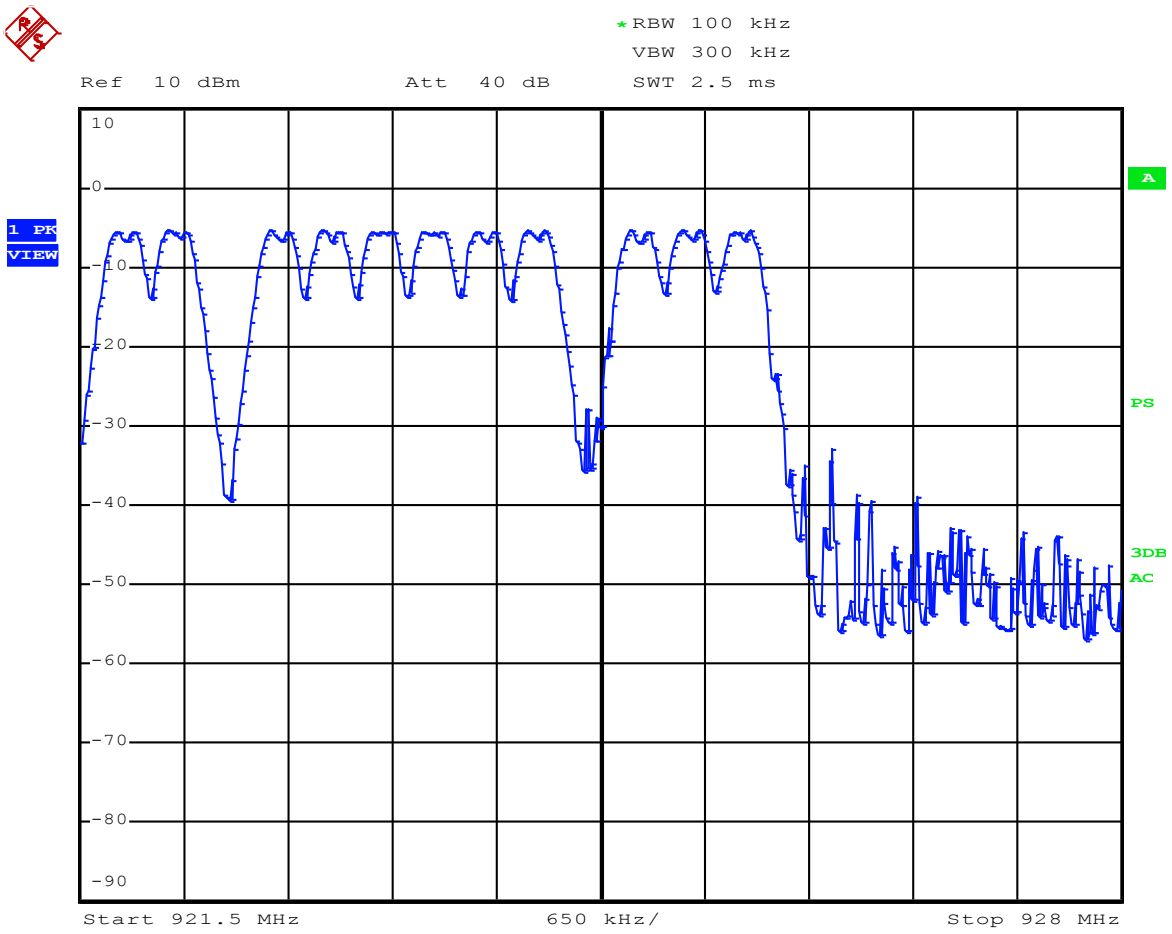


Figure 26: Number of Hopping Frequencies 908MHz to 9015MHz - 12 Frequencies



Date: 27.JUN.2016 14:23:57

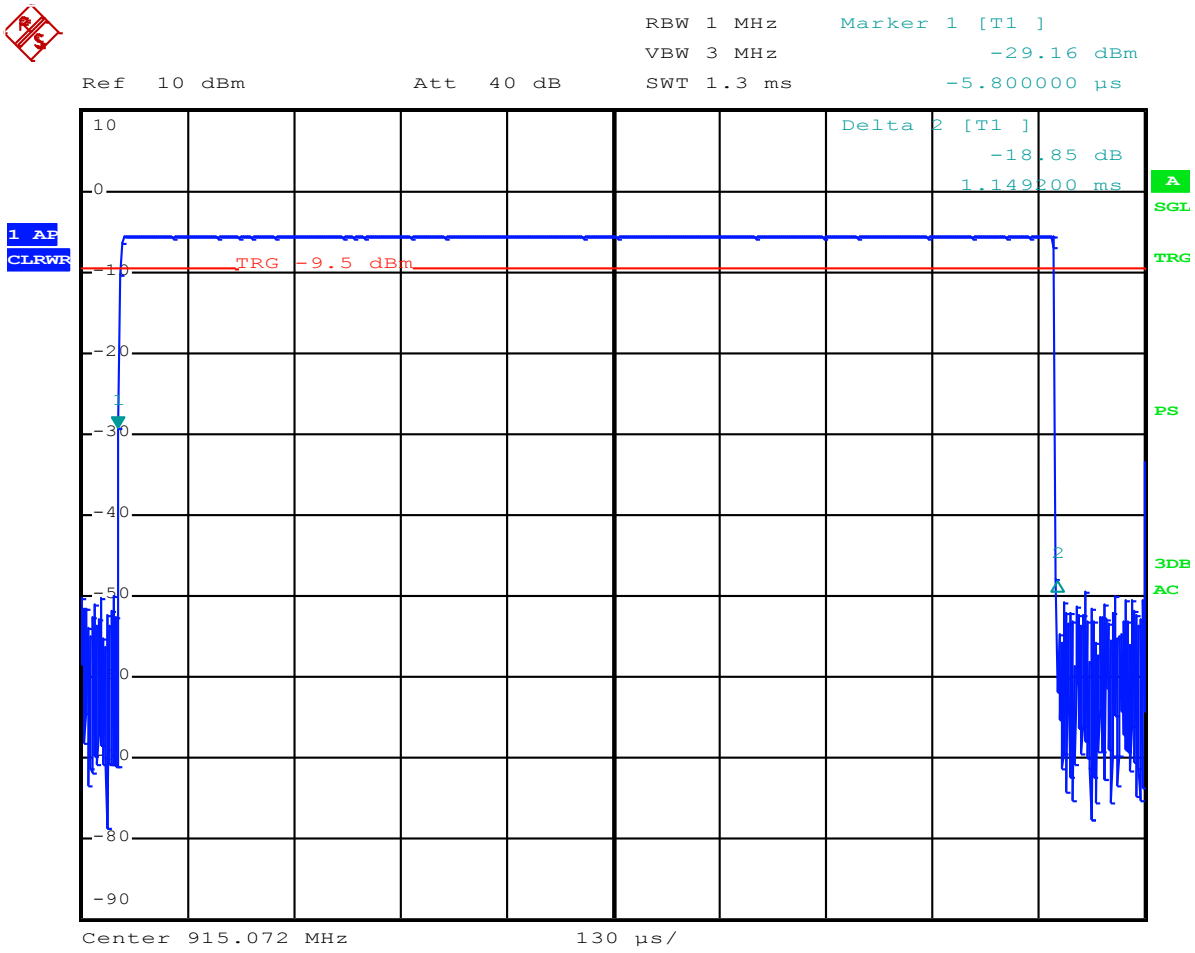
Figure 27: Number of Hopping Frequencies 915MHz to 922MHz - 13 Frequencies



Date: 27.JUN.2016 14:25:30

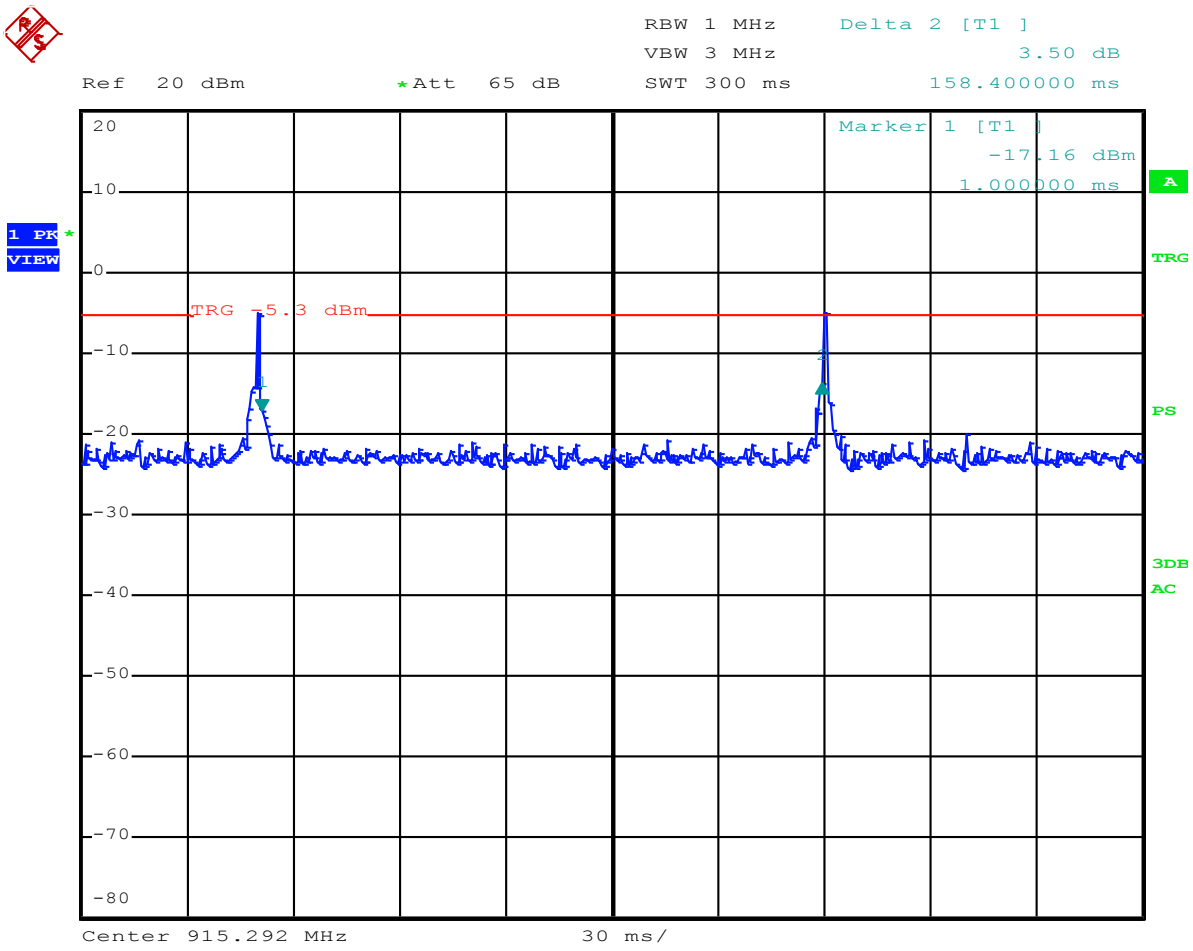
Figure 28: Number of Hopping Frequencies 921.5MHz to 928MHz - 11 Frequencies

Dwell Time and Time of Occupancy



Date: 27.JUN.2016 14:35:17

Figure 29: Dwell Time – 1.15mS

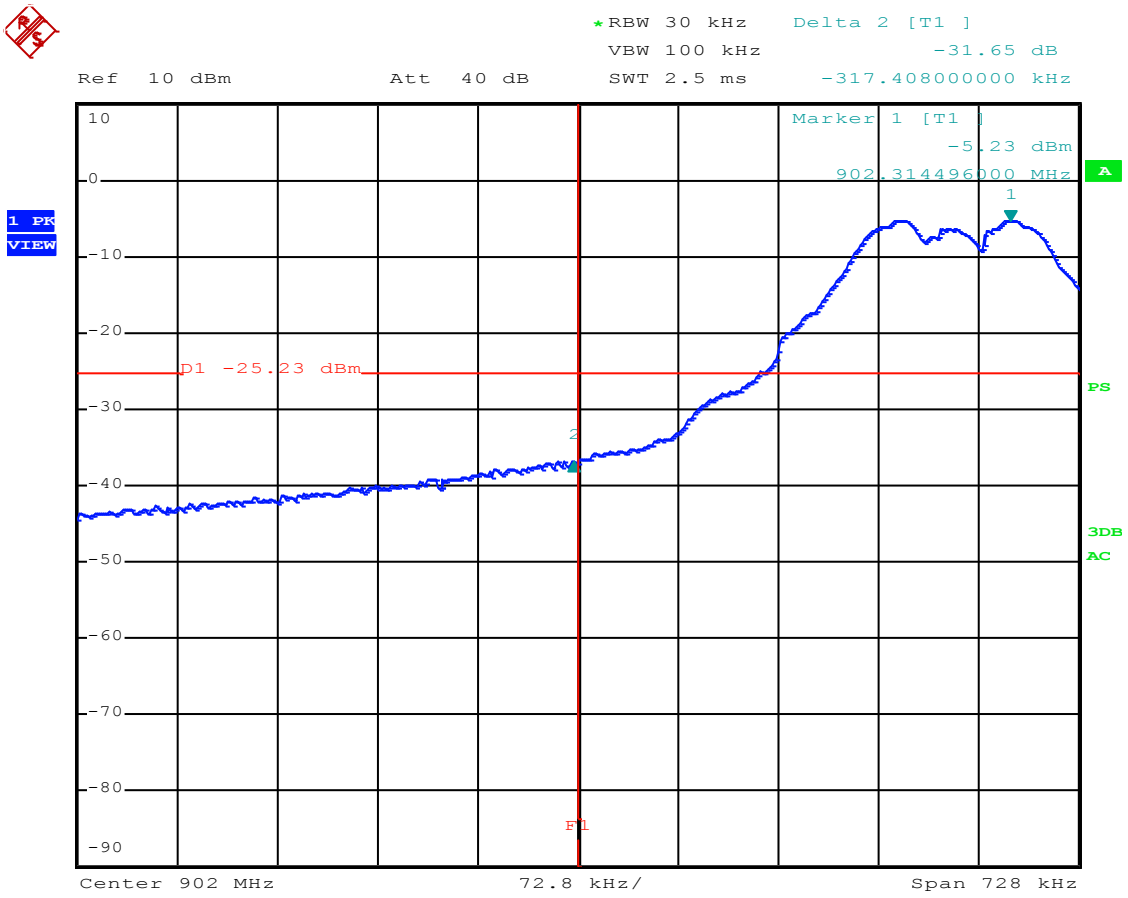


Date: 27.JUN.2016 14:43:41

Figure 30: Time Occupancy Per Frequency – 145.6mS*

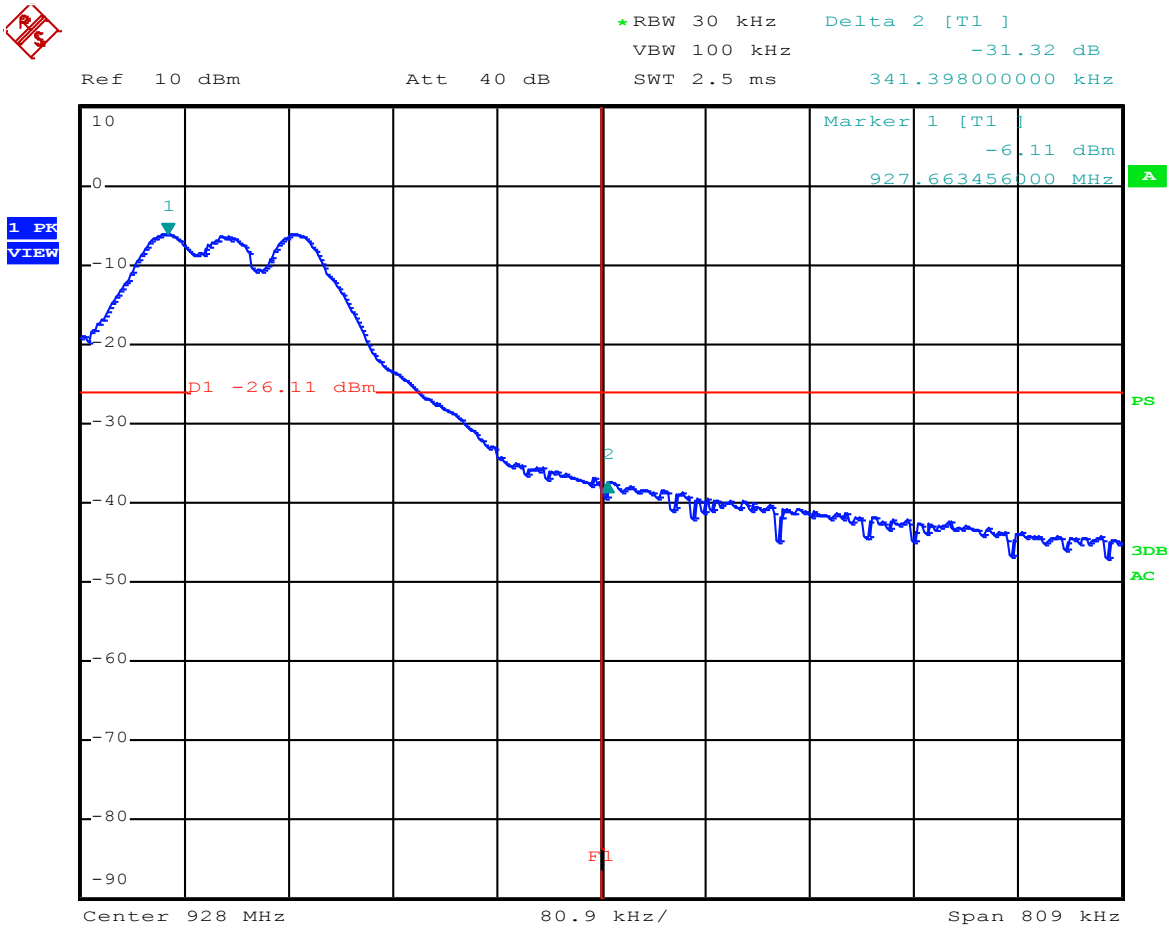
*(***** Time betwen 2 consecutive transmissions on the same frequency is 0.158 Seconds, dwell time per frequency is 1.15mS, therefore occupancy time per frequency within a 20 Second period is 145.6 mS)*

Channel Bandedge



Date: 27.JUN.2016 13:46:50

Figure 31: Low Channel Bandedge

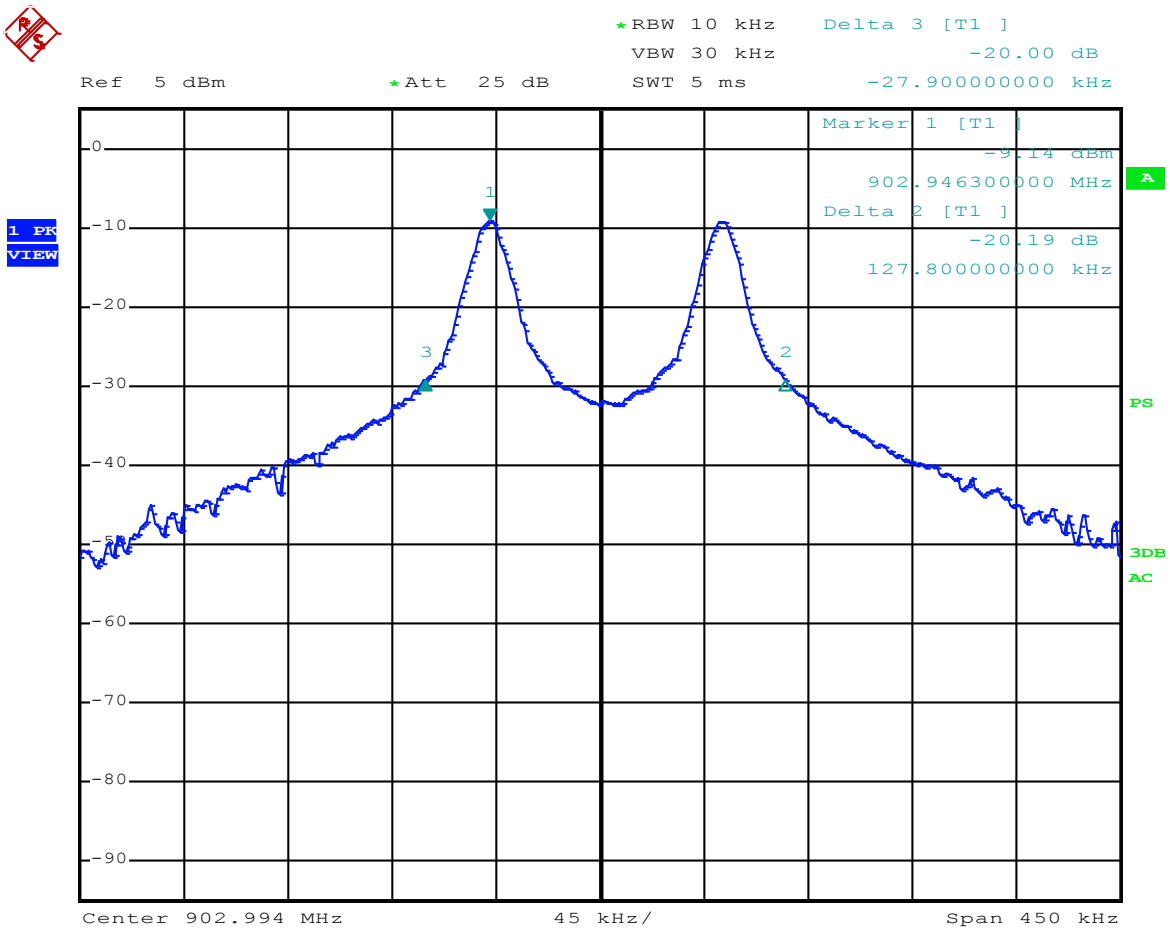


Date: 27.JUN.2016 13:55:45

Figure 32: High Channel Bandedge

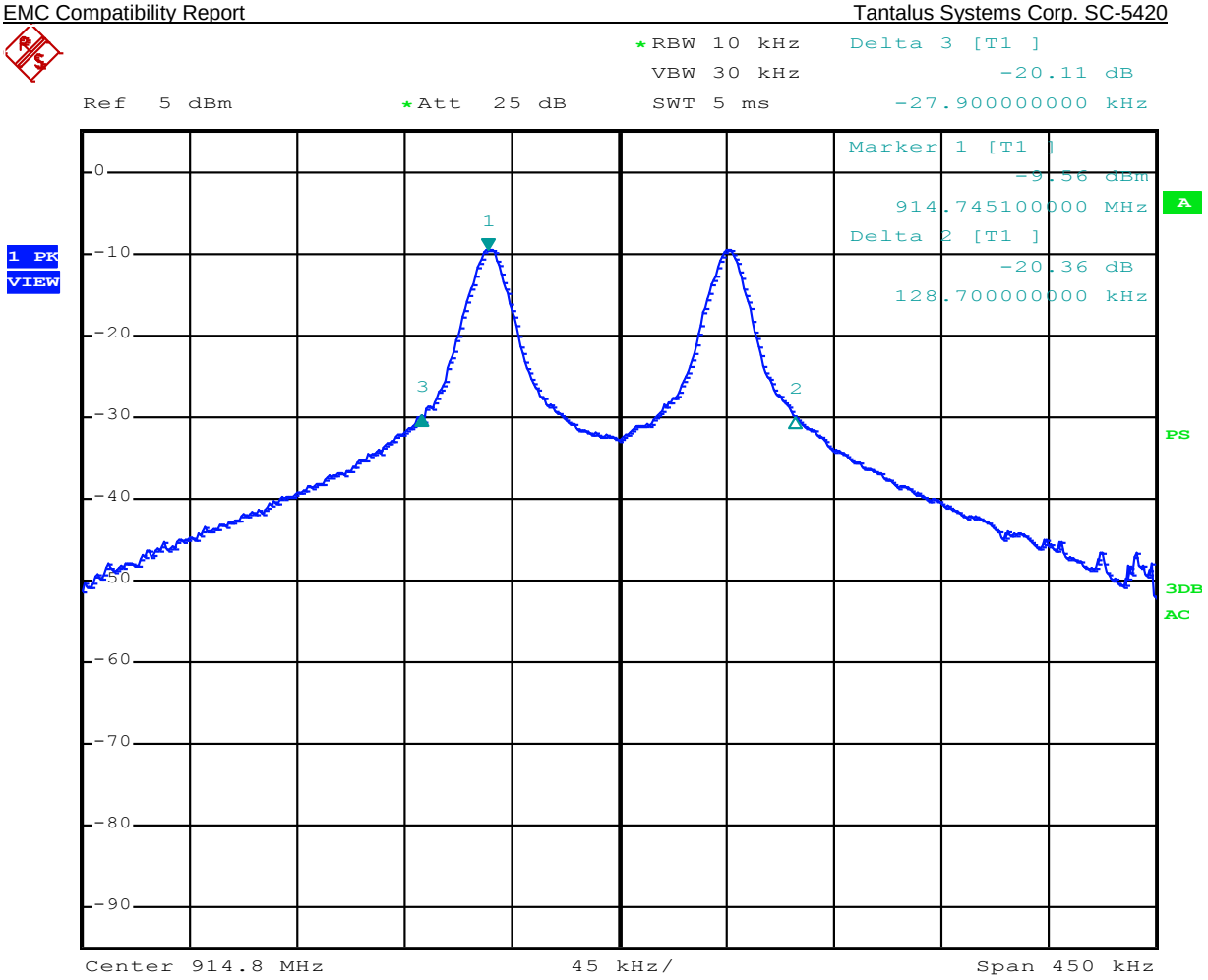
Tests when unit is communicating to OEM Part 15 approved Device

20 dB Bandwidth



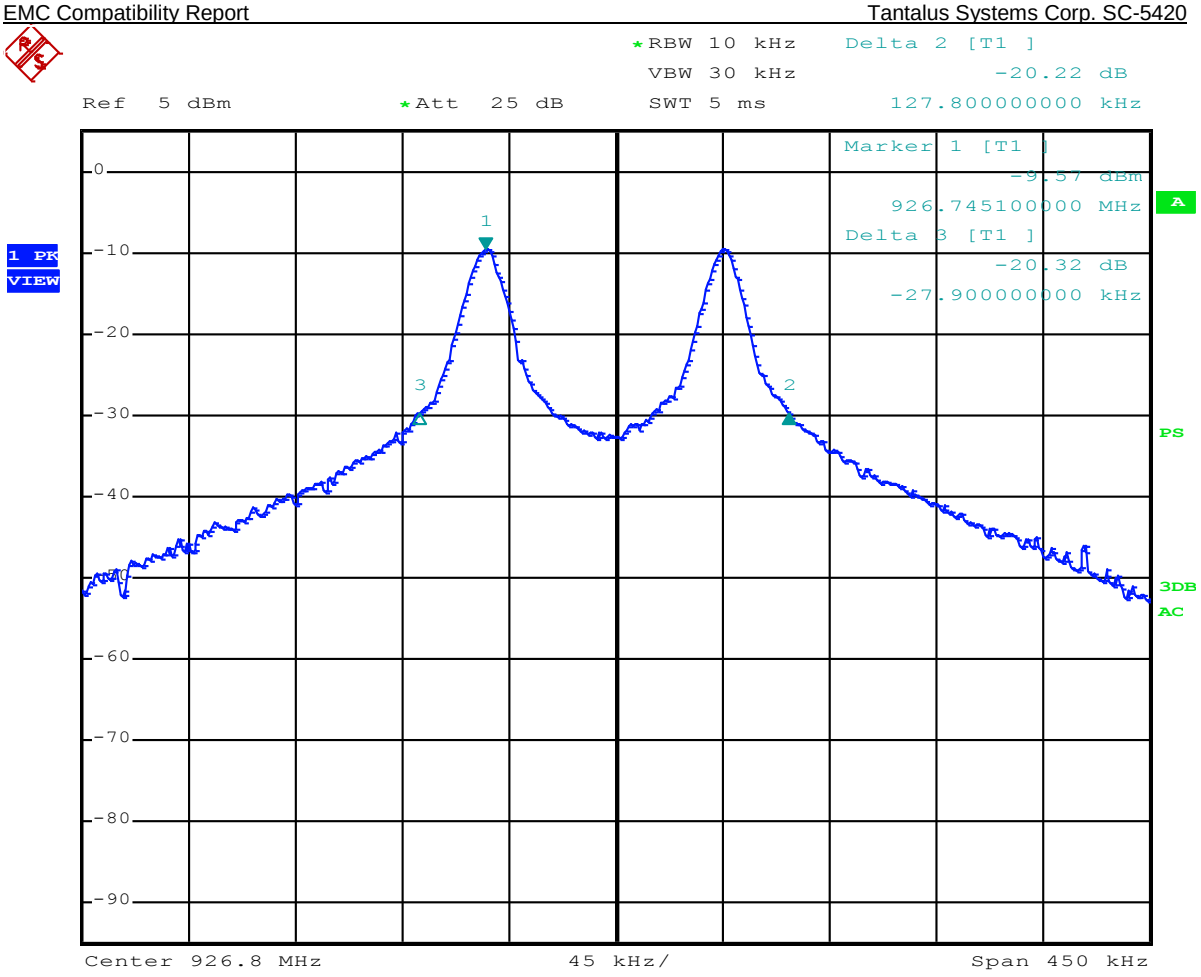
Date: 28.JUN.2016 09:08:49

Figure 33: 20dB Bandwidth at LOW Frequency – 155.7 kHz



Date: 28.JUN.2016 09:43:35

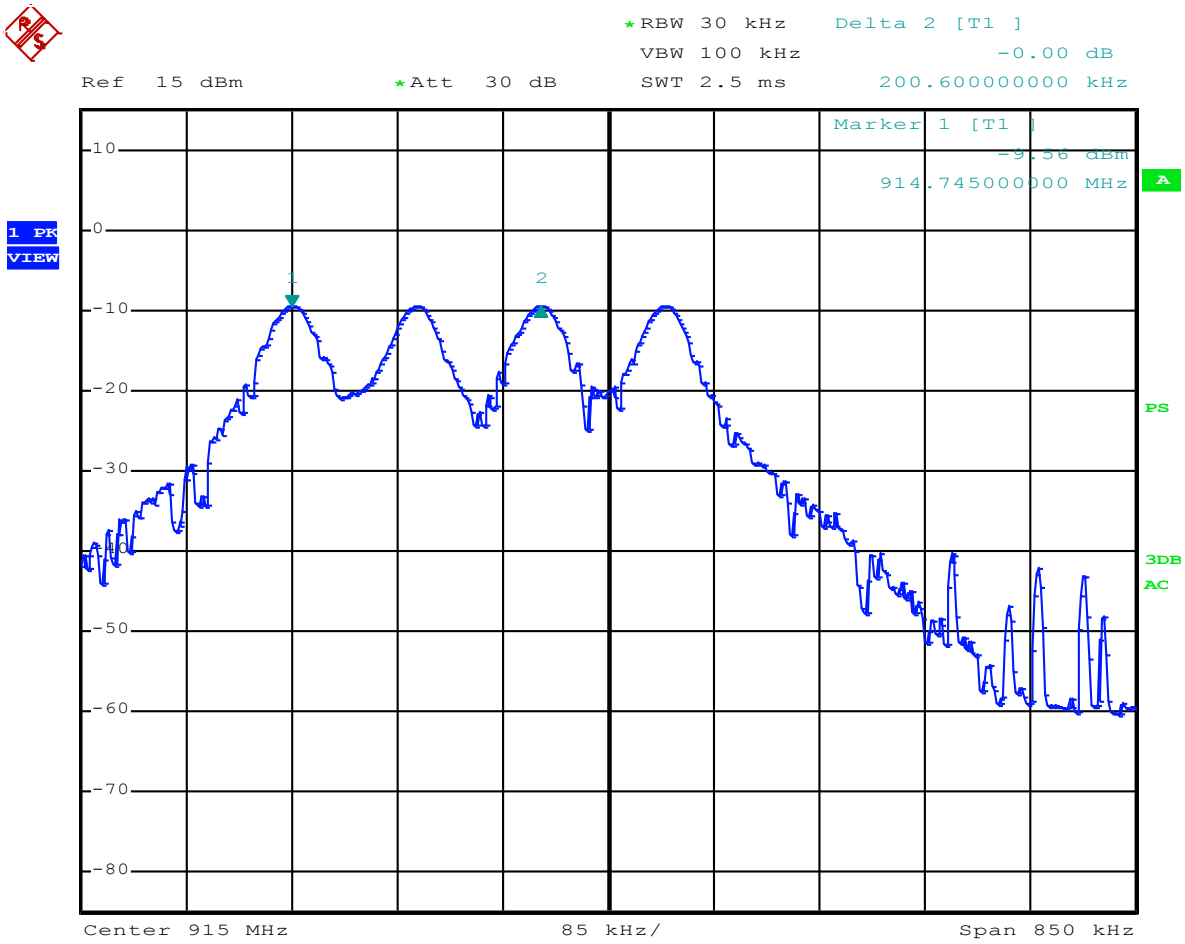
Figure 34: 20dB Bandwidth at MID Frequency – 156.6 kHz



Date: 28.JUN.2016 09:25:52

Figure 35: 20dB Bandwidth at HIGH Frequency – 155.7 kHz

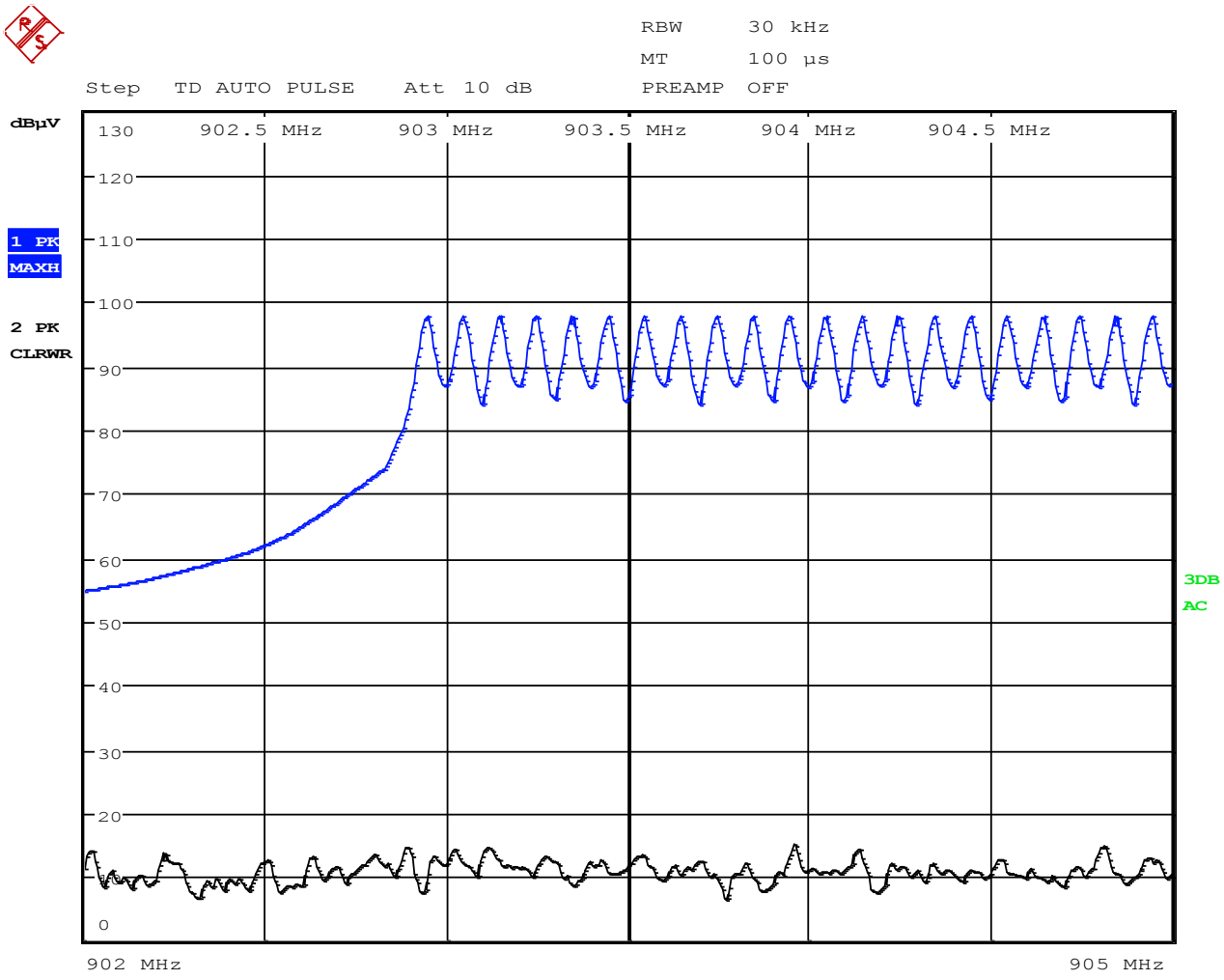
Channel Separation



Date: 28.JUN.2016 10:12:46

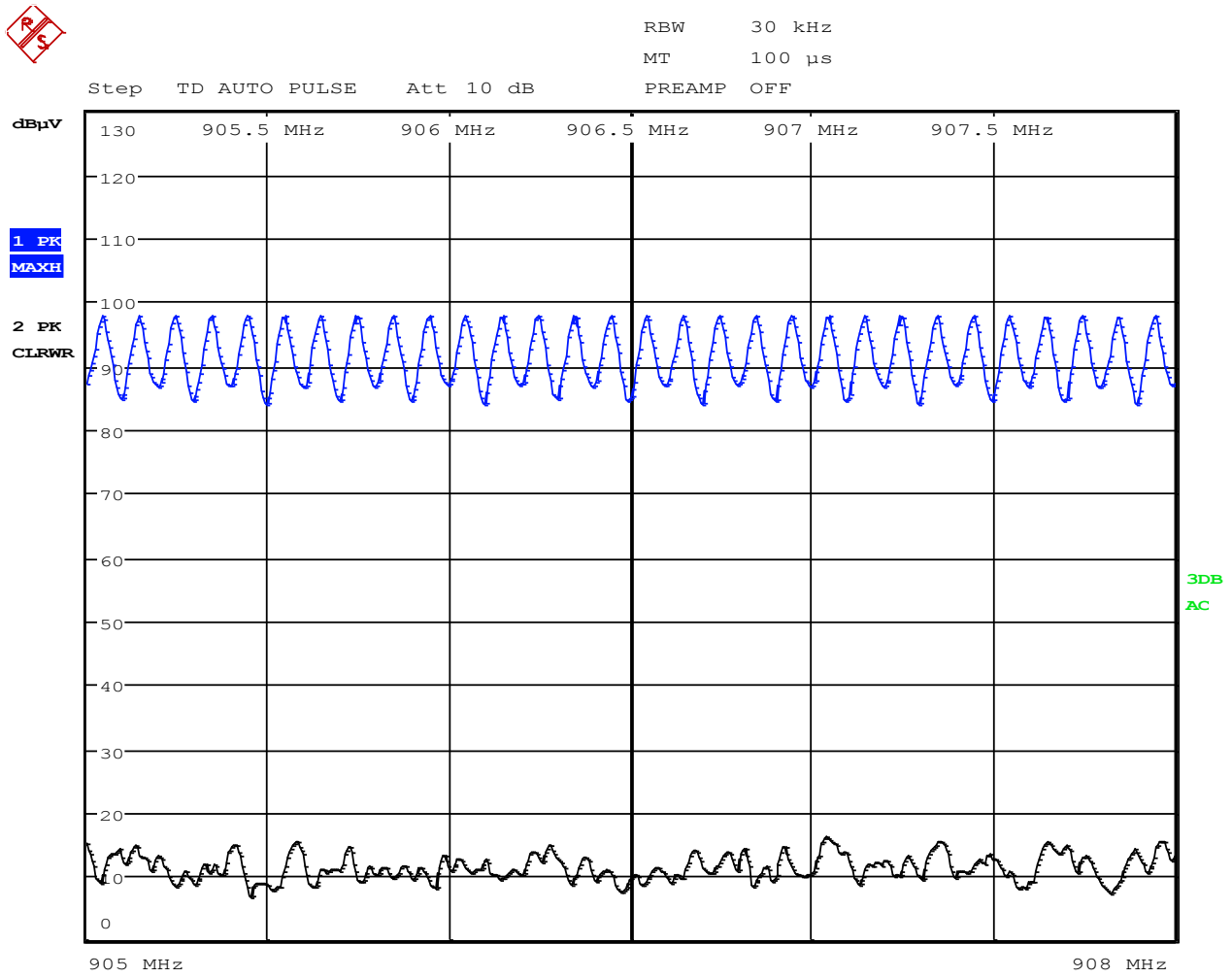
Figure 36: Channel Separation = 200kHz

Number of Hopping Channels



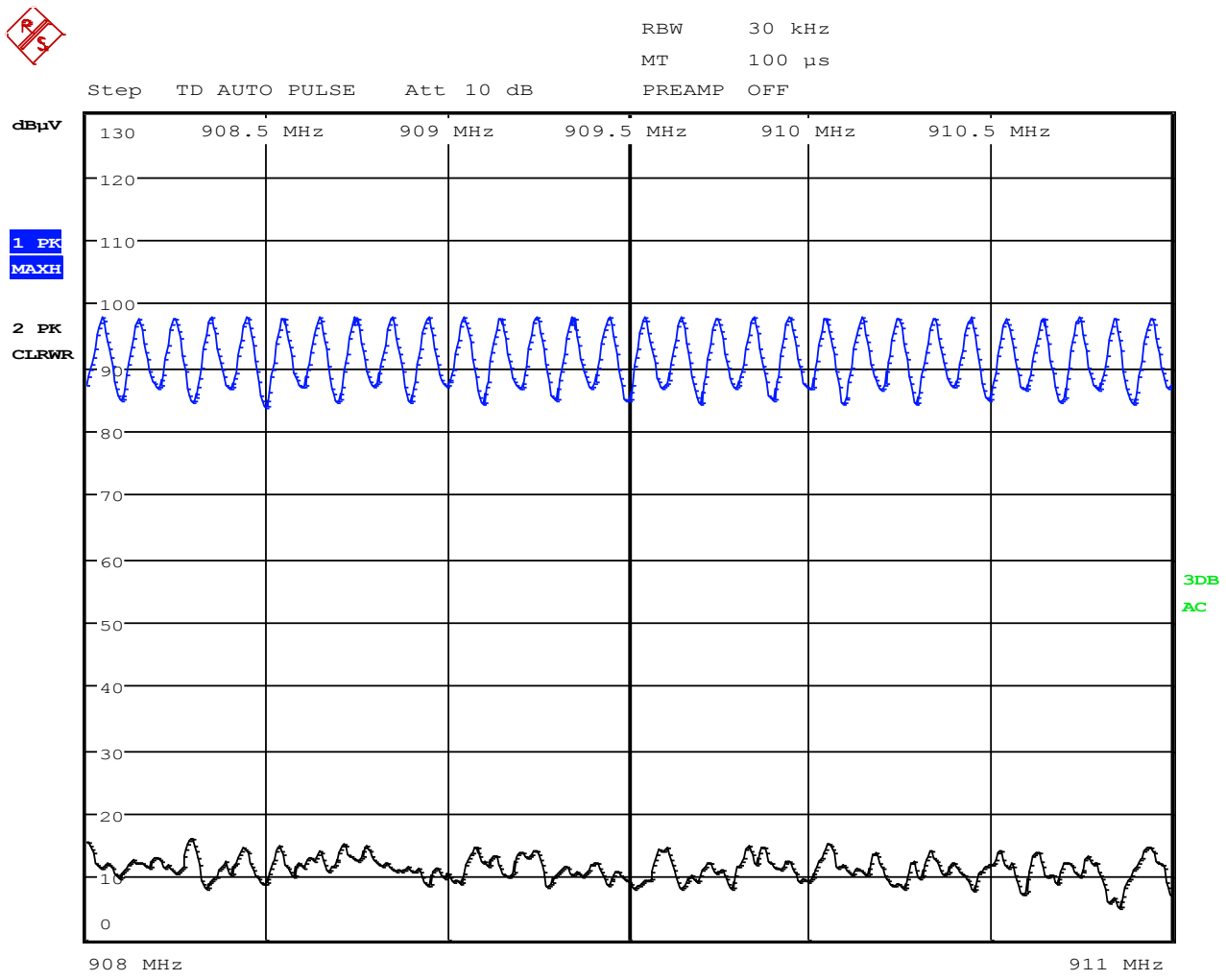
Date: 28.JUN.2016 16:37:40

Figure 37: Number of Hopping Frequencies 902MHz to 905MHz - 10 Frequencies



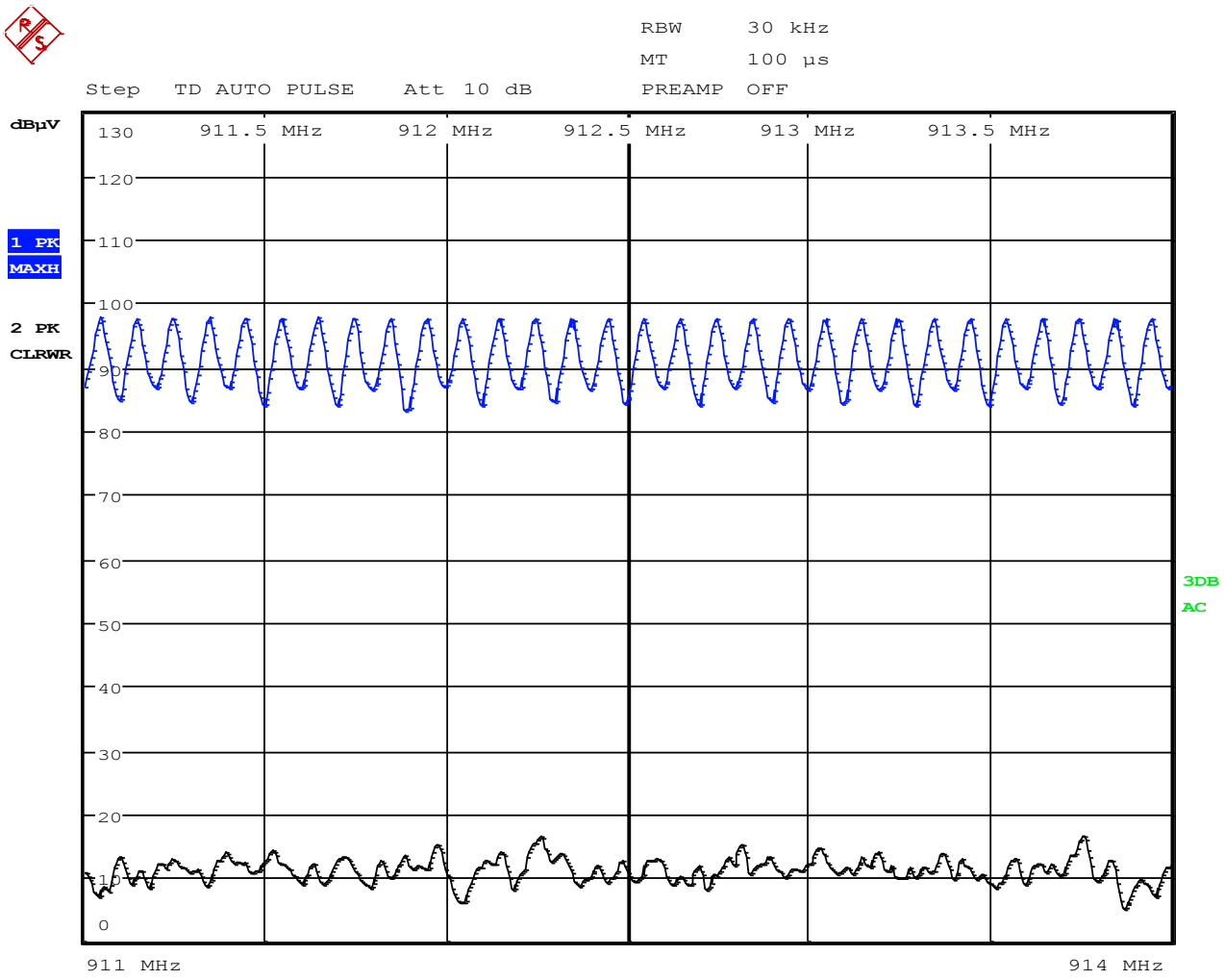
Date: 28.JUN.2016 16:52:59

Figure 38: Number of Hopping Frequencies 905MHz to 908MHz - 15 Frequencies



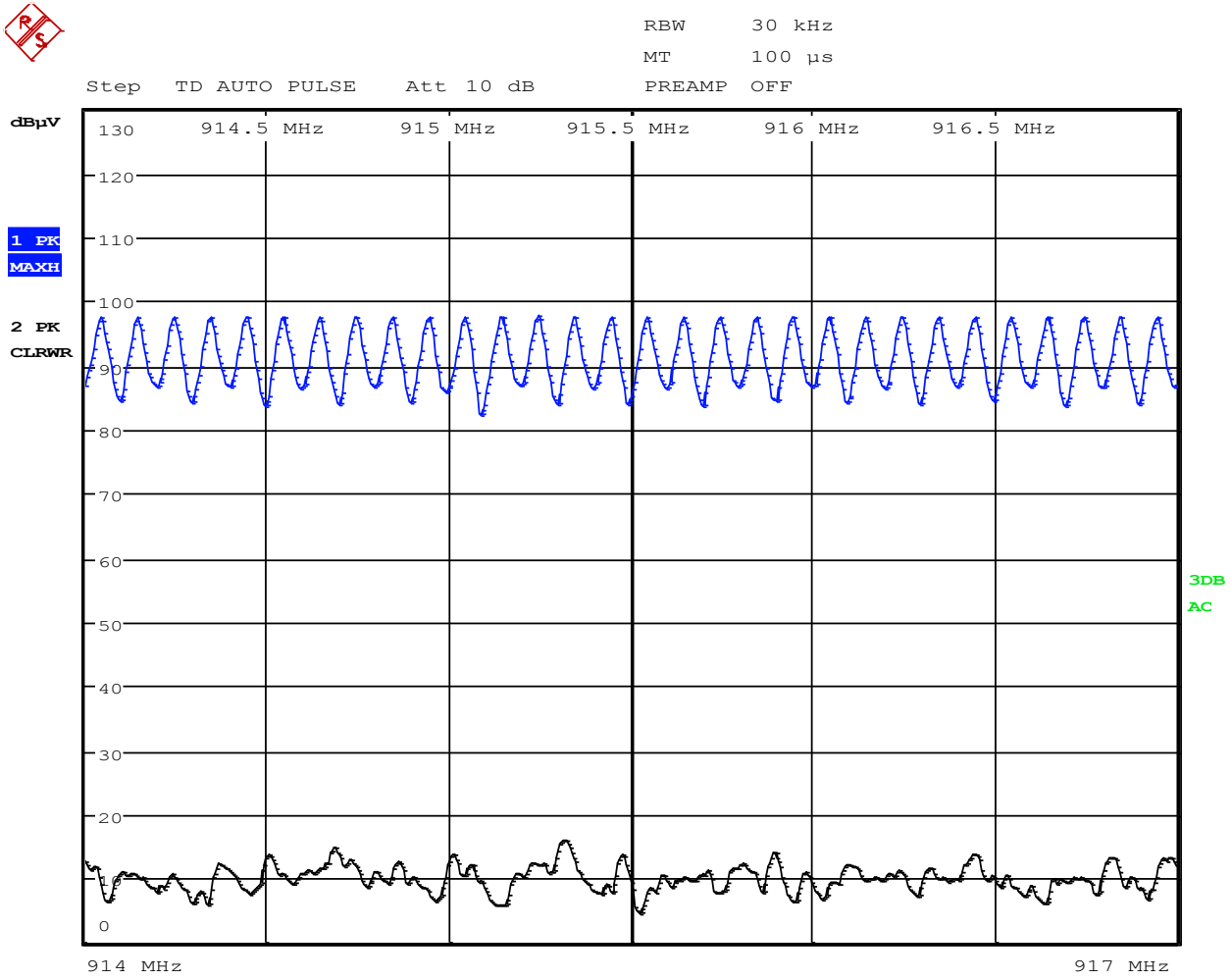
Date: 28.JUN.2016 17:15:00

Figure 39: Number of Hopping Frequencies 908MHz to 911MHz - 15 Frequencies



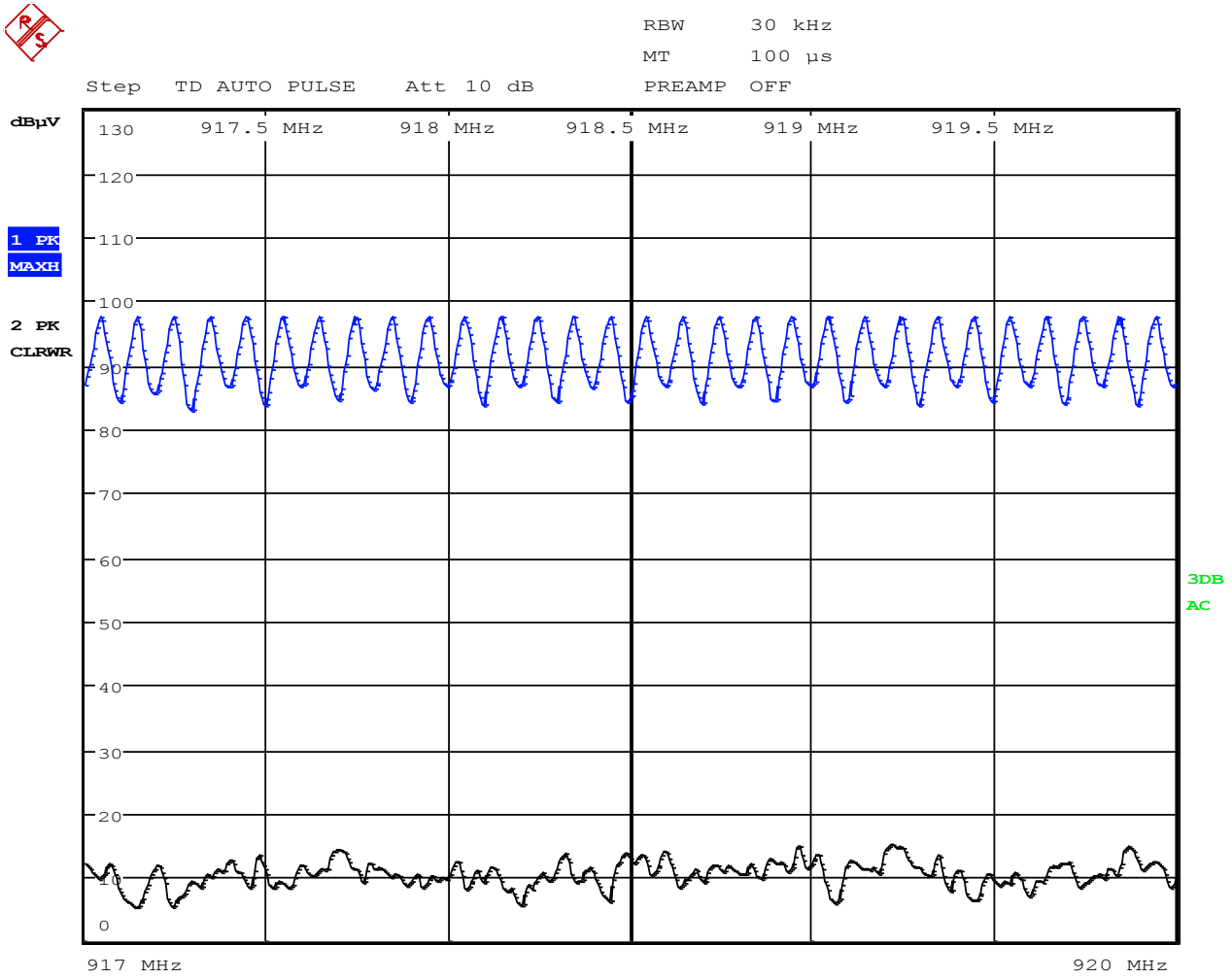
Date: 28.JUN.2016 17:32:48

Figure 40: Number of Hopping Frequencies 911MHz to 914MHz - 15 Frequencies



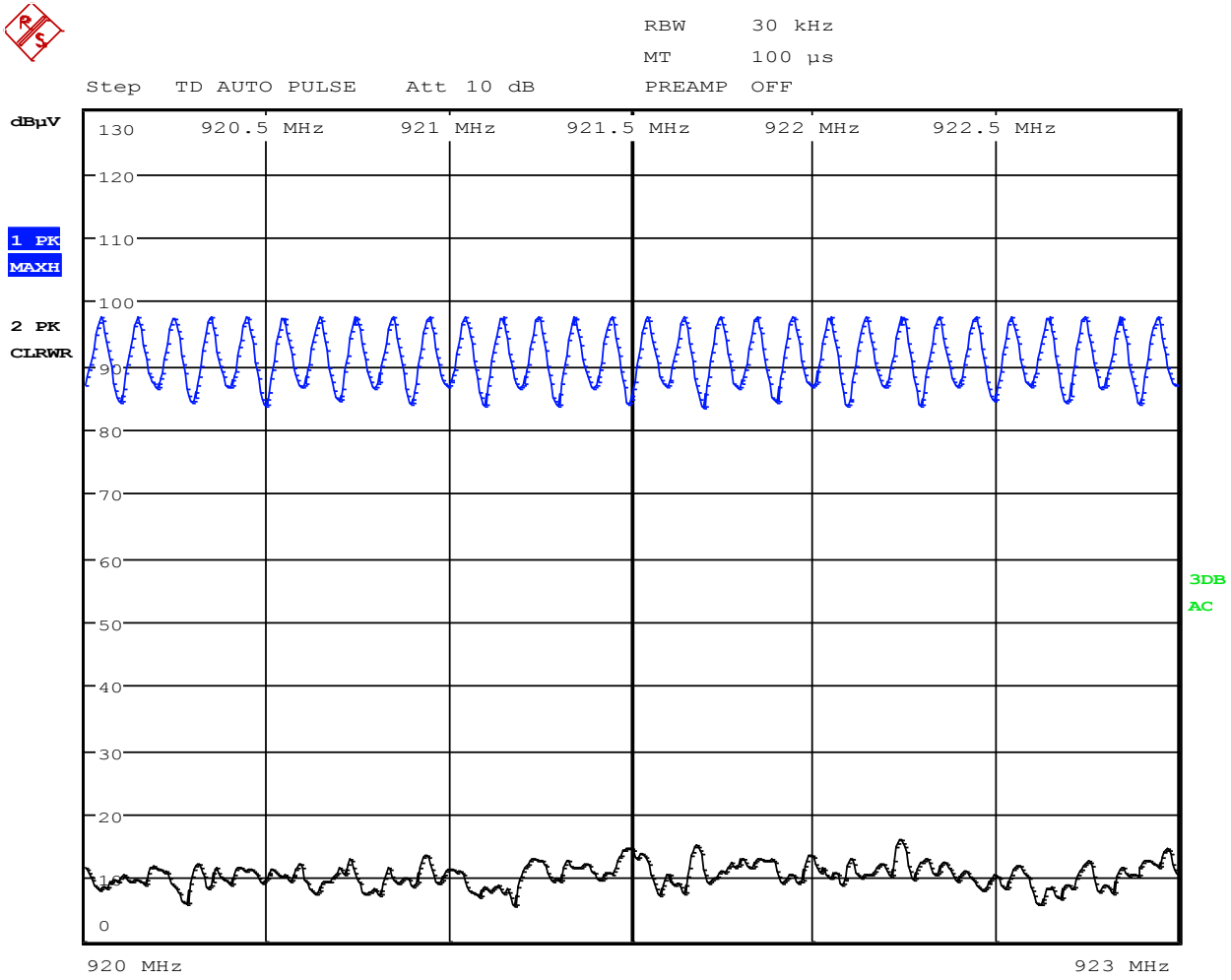
Date: 28.JUN.2016 17:49:12

Figure 41: Number of Hopping Frequencies 914MHz to 917MHz - 15 Frequencies



Date: 28.JUN.2016 18:04:28

Figure 42: Number of Hopping Frequencies 917MHz to 920MHz - 15 Frequencies



Date: 28.JUN.2016 18:21:04

Figure 43: Number of Hopping Frequencies 920MHz to 923MHz - 15 Frequencies

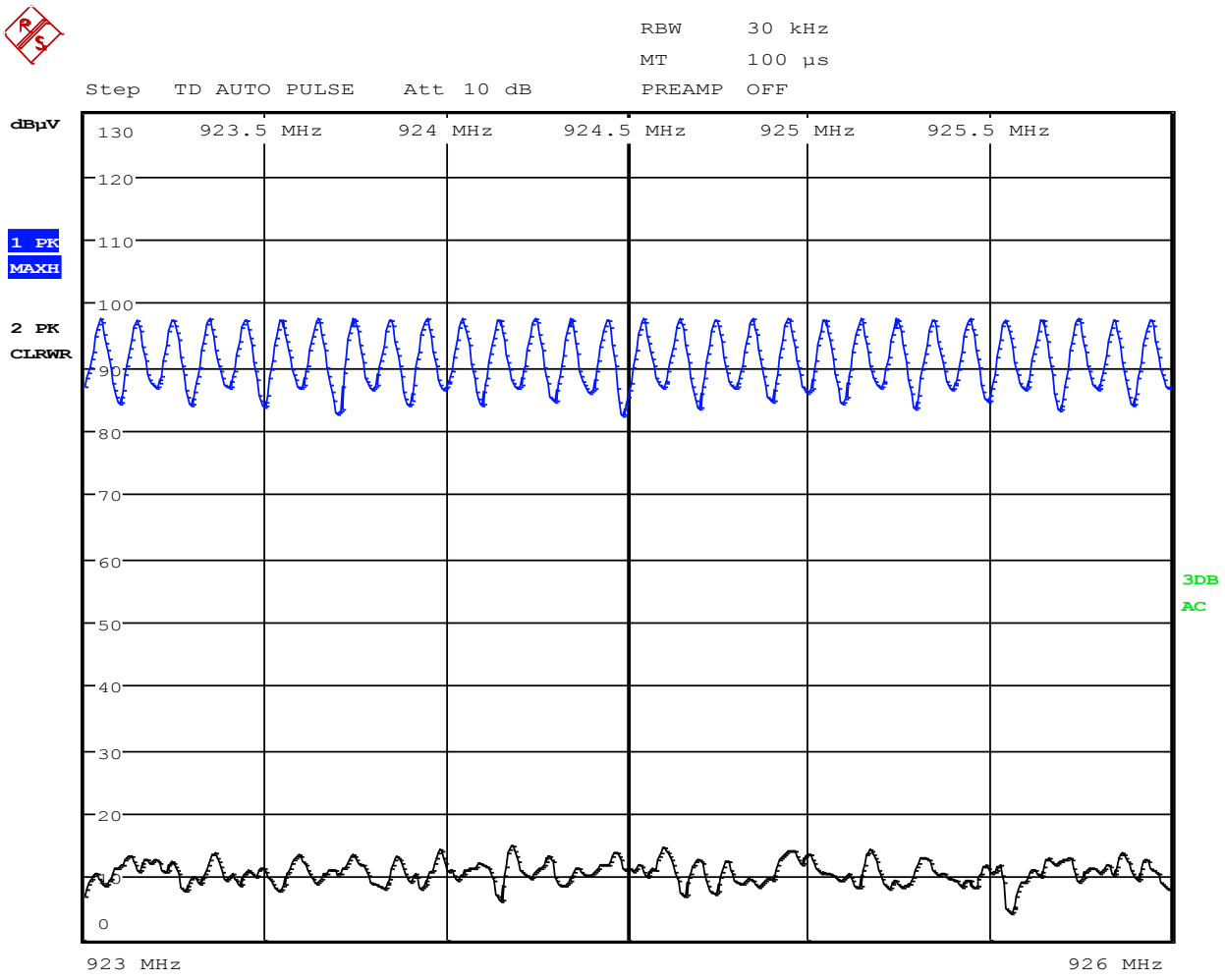


Figure 44: Number of Hopping Frequencies 923MHz to 926MHz - 15 Frequencies

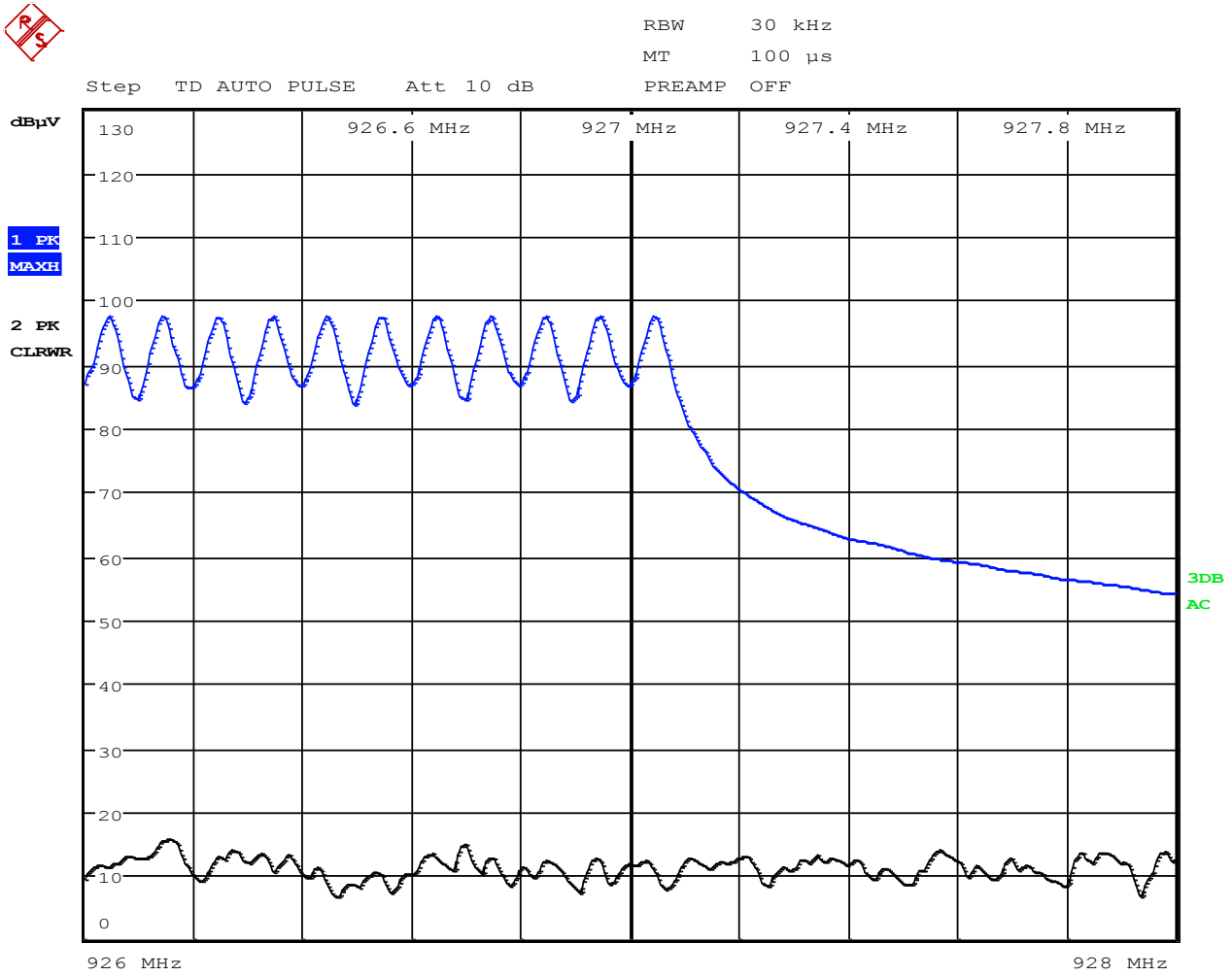
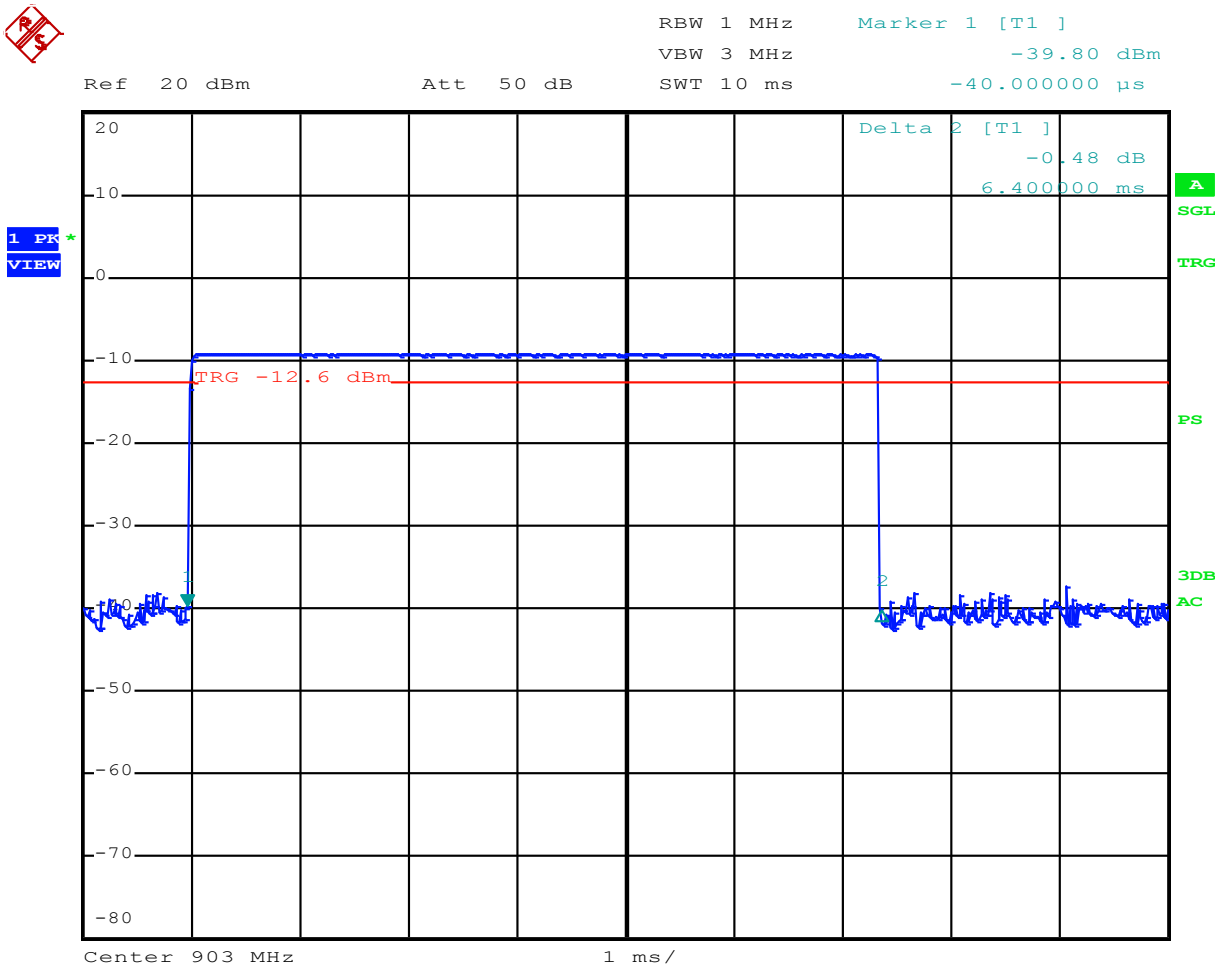


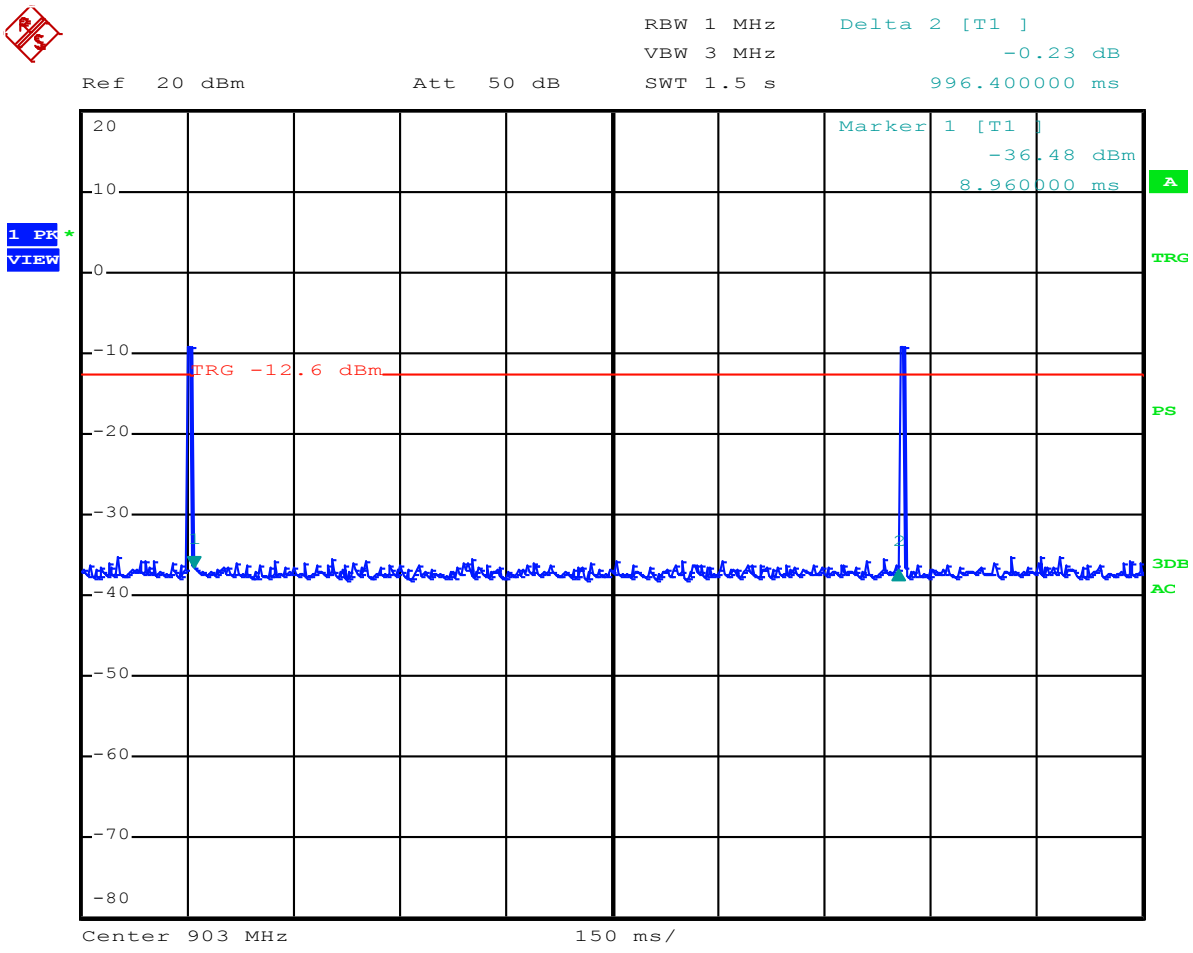
Figure 45: Number of Hopping Frequencies 926MHz to 928MHz - 5 Frequencies

Dwell Time and Time of Occupancy



Date: 28.JUN.2016 09:58:05

Figure 46: Dwell Time – 6.4mS



Date: 28.JUN.2016 09:59:20

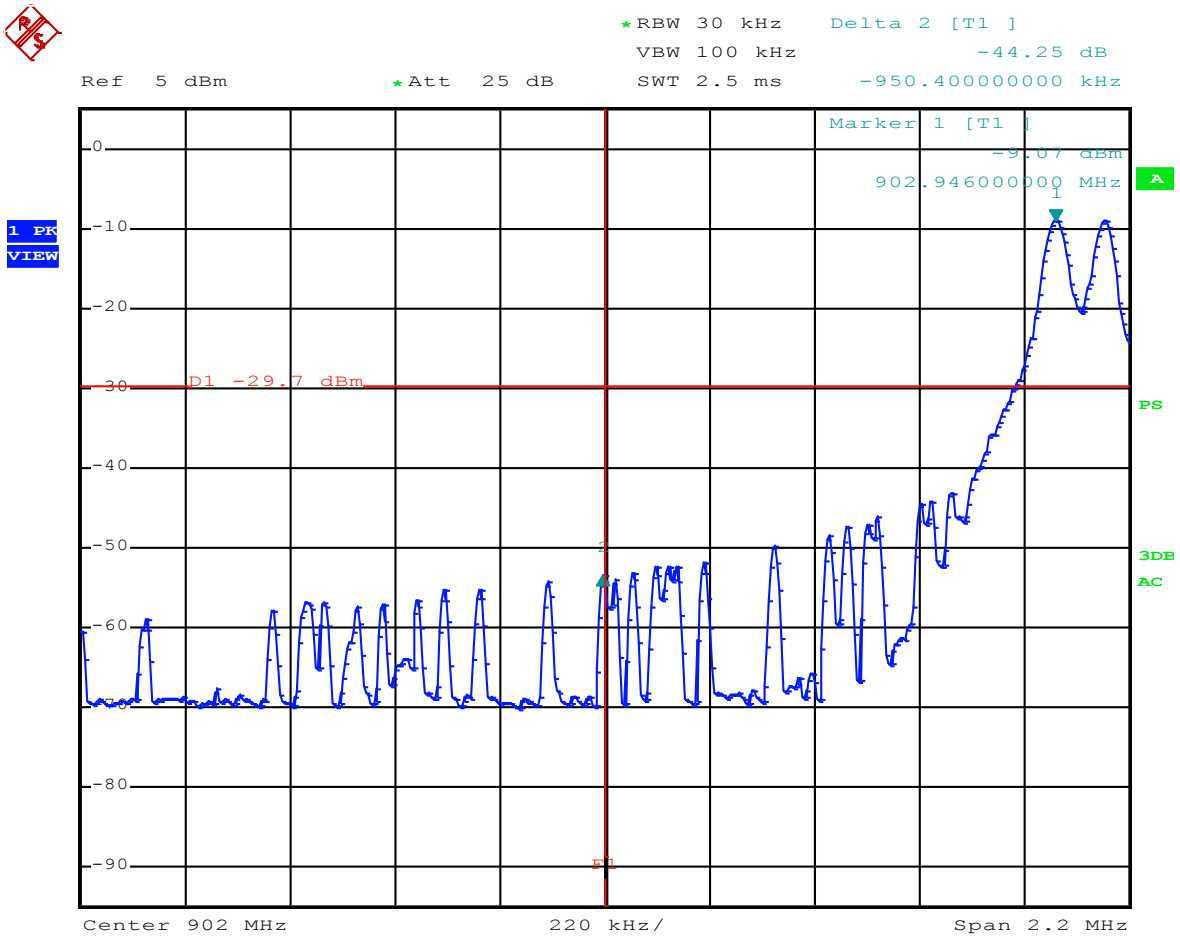
Figure 47: Time Occupancy Per Frequency – 1.067mS*

*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.

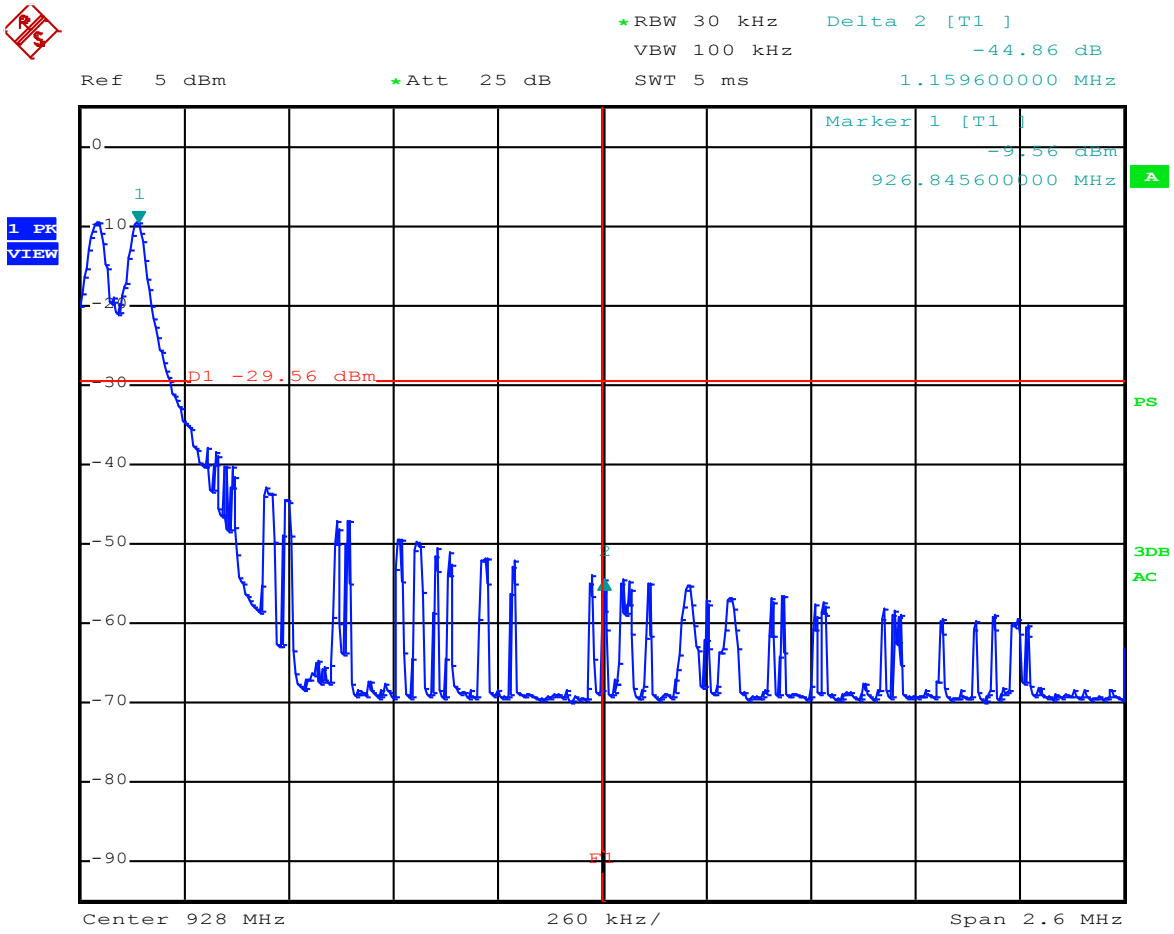
Therefore the time of occupancy per frequency is 0.0064*20/120 Seconds or 1.067mS in 20 Seconds.

Channel Bandedge



Date: 28.JUN.2016 09:15:58

Figure 48: Low Channel Bandedge



Date: 28.JUN.2016 09:35:05

Figure 49: High Channel Bandedge

Radiated Spurious Harmonics

Measurement Date: June 27th , 2016

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)
2706.9	V	56.4	54	27.3	**25.0**	66.15	74	**7.8**
2706.6	H	61.8	54	27.3	**19.5**	68.38	74	**5.6**
3608.6	V	50.9	54	27.3	**30.4**	60.6	74	**13.4**
3608.6	H	45.3	54	27.3	**36.0**	55.67	74	**18.3**
4511.3	V	48.4	54	27.3	**33.0**	56.57	74	**17.4**
4511.3	H	44.5	54	27.3	**36.8**	56.15	74	**17.9**
5413.7	V	48.8	54	27.3	**32.5**	54.09	74	**19.9**
5413.7	H	54.9	54	27.3	**26.4**	64.79	74	**9.2**
8120.5	V	48.0	54	27.3	**33.3**	58.96	74	**15.0**
8120.5	H	43.3	54	27.3	**38.0**	54.86	74	**19.1**
9022.7	V	49.4	54	27.3	**32.0**	60.26	74	**13.7**
9022.7	H	49.4	54	27.3	**32.0**	60.05	74	**14.0**

Table 8: Harmonics at Low Frequency

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	45.4	54	27.3	**35.9**	55.21	74	**18.8**
2745.4	H	45.2	54	27.3	**36.1**	54.61	74	**19.4**
3660.1	V	52.6	54	27.3	**28.7**	63.86	74	**10.1**
3660.1	H	50.9	54	27.3	**30.4**	63.23	74	**10.8**
4575.3	V	45.4	54	27.3	**35.9**	55.8	74	**18.2**
4575.3	H	49.4	54	27.3	**31.9**	60.77	74	**13.2**
7320.6	V	52.1	54	27.3	**29.2**	63.84	74	**10.2**
7320.6	H	53.4	54	27.3	**27.9**	65.6	74	**8.4**
8235.7	V	44.4	54	27.3	**36.9**	56.41	74	**17.6**
8235.7	H	44.2	54	27.3	**37.1**	56.24	74	**17.8**
9150	V	49.0	54	27.3	**32.3**	59.9	74	**14.1**
9150	H	47.6	54	27.3	**33.7**	59.75	74	**14.3**

Table 9: Harmonics at Mid Frequency

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)
2783.15	V	49.9	54	27.3	**31.4**	62.22	74	**11.8**
2783.15	H	54.6	54	27.3	**26.7**	65.47	74	**8.5**
3711.5	V	49.9	54	27.3	**31.4**	63.73	74	**10.3**
3711.4	H	50.0	54	27.3	**31.3**	63.86	74	**10.1**
4638.5	V	47.1	54	27.3	**34.2**	57.67	74	**16.3**
4638.7	H	49.7	54	27.3	**31.6**	61.83	74	**12.2**
7421.7	V	48.2	54	27.3	**33.1**	59.44	74	**14.6**
7421.7	H	49.3	54	27.3	**32.0**	61.14	74	**12.9**
8349.5	V	45.3	54	27.3	**36.0**	57.37	74	**16.6**
8349.5	H	45.5	54	27.3	**35.8**	58.04	74	**16.0**

Table 10: Harmonics at High Frequency

Appendix B: Test Setup Photos

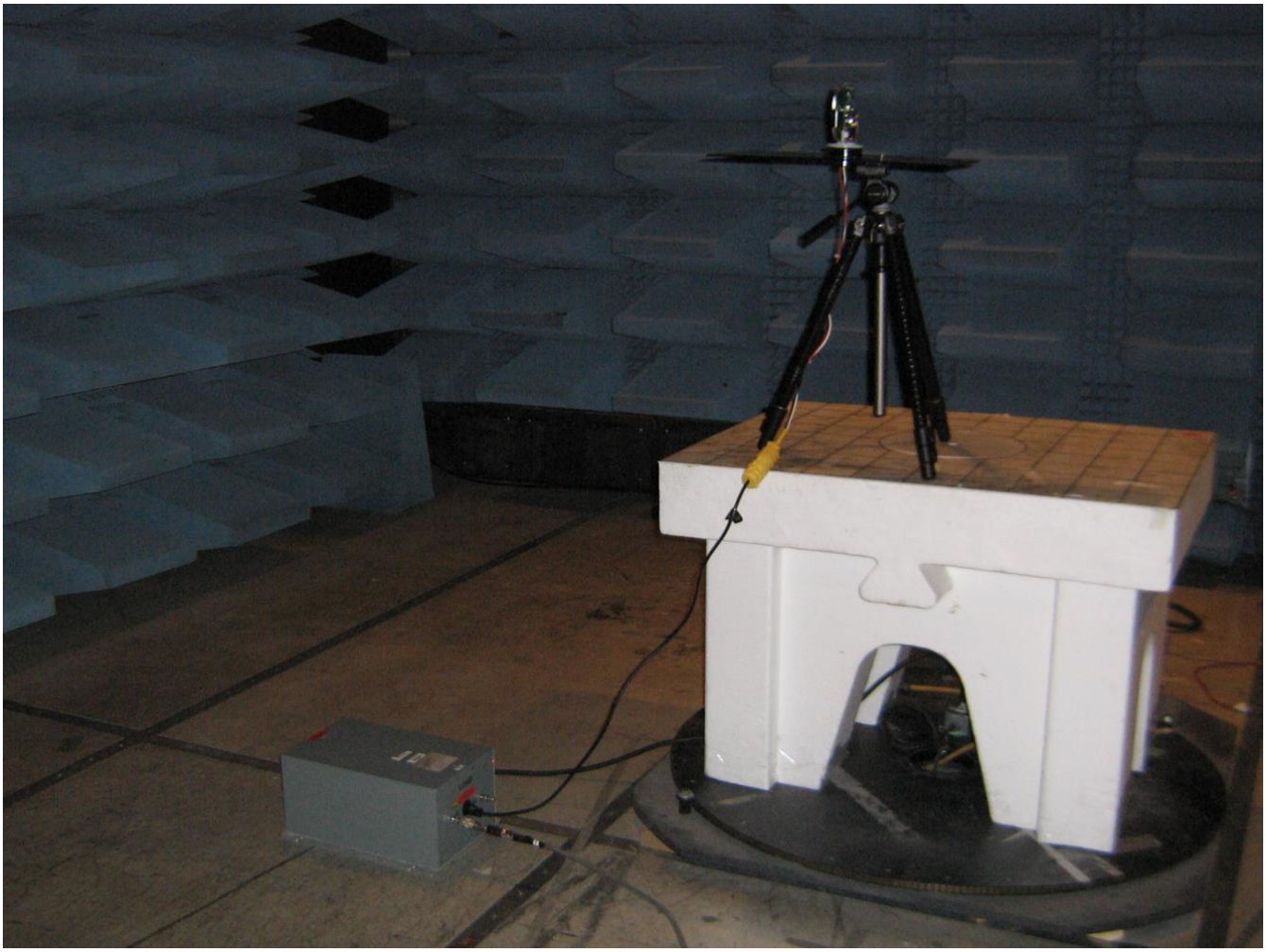
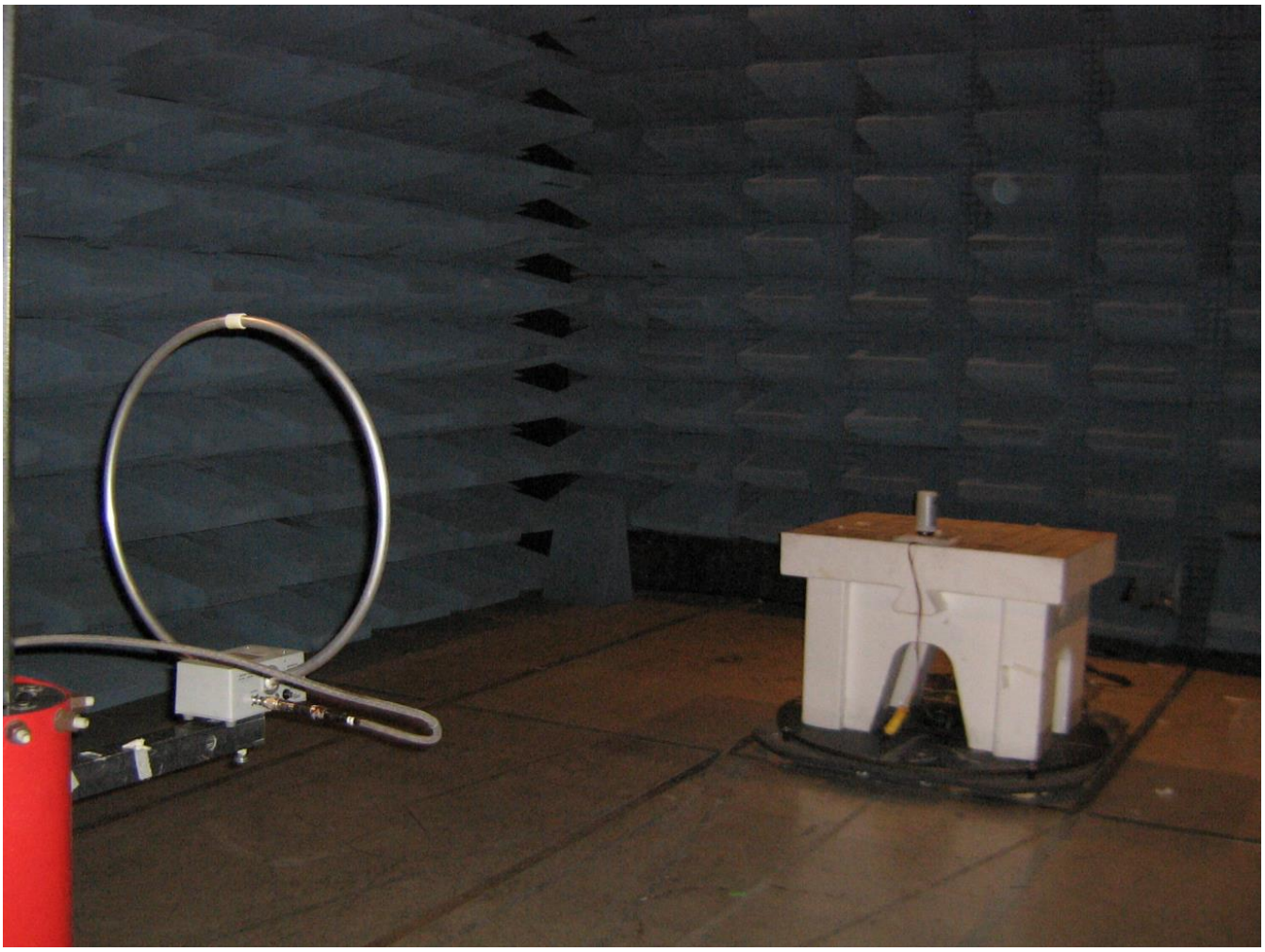
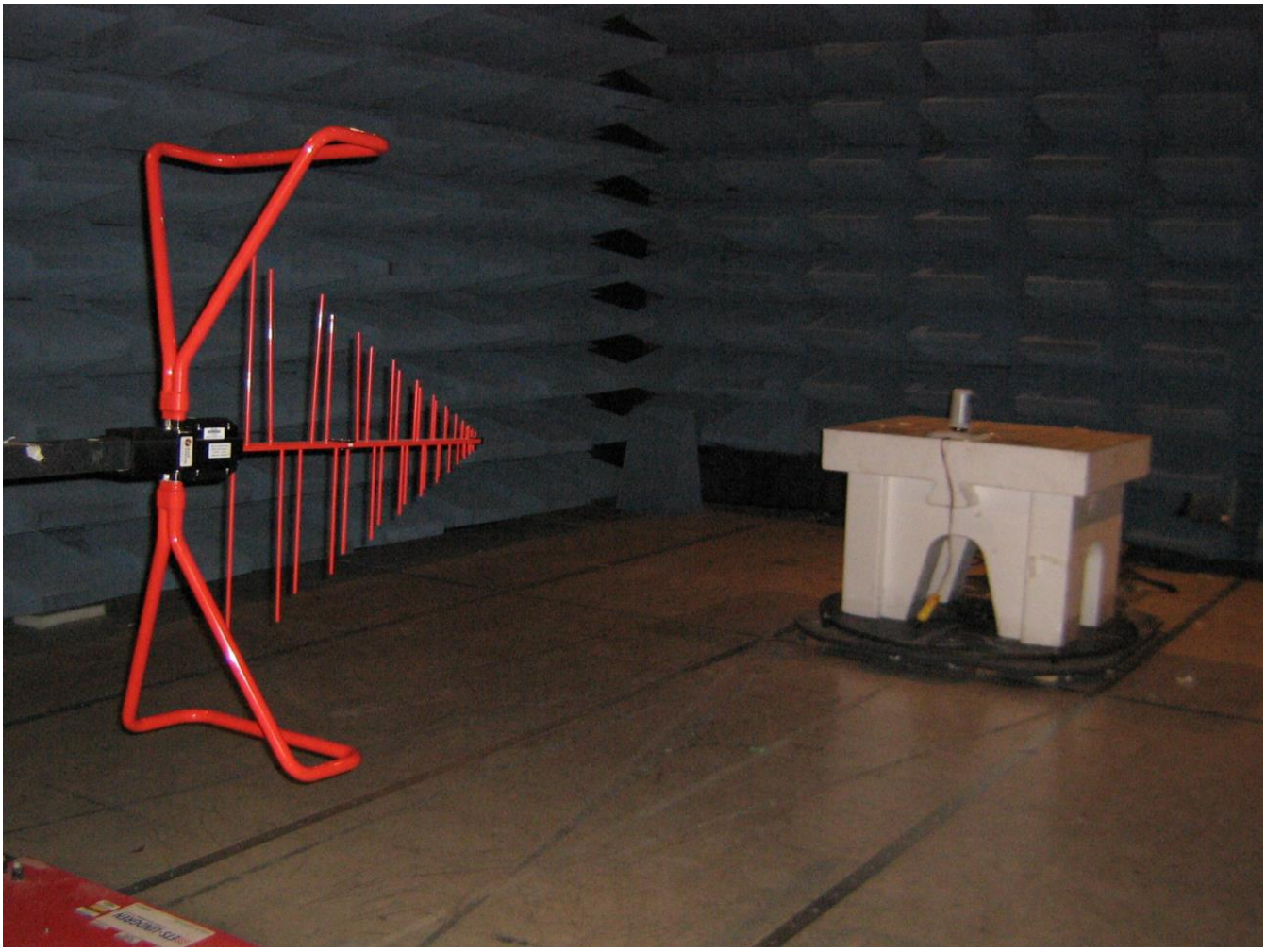


Figure 50: AC Conducted Test Setup



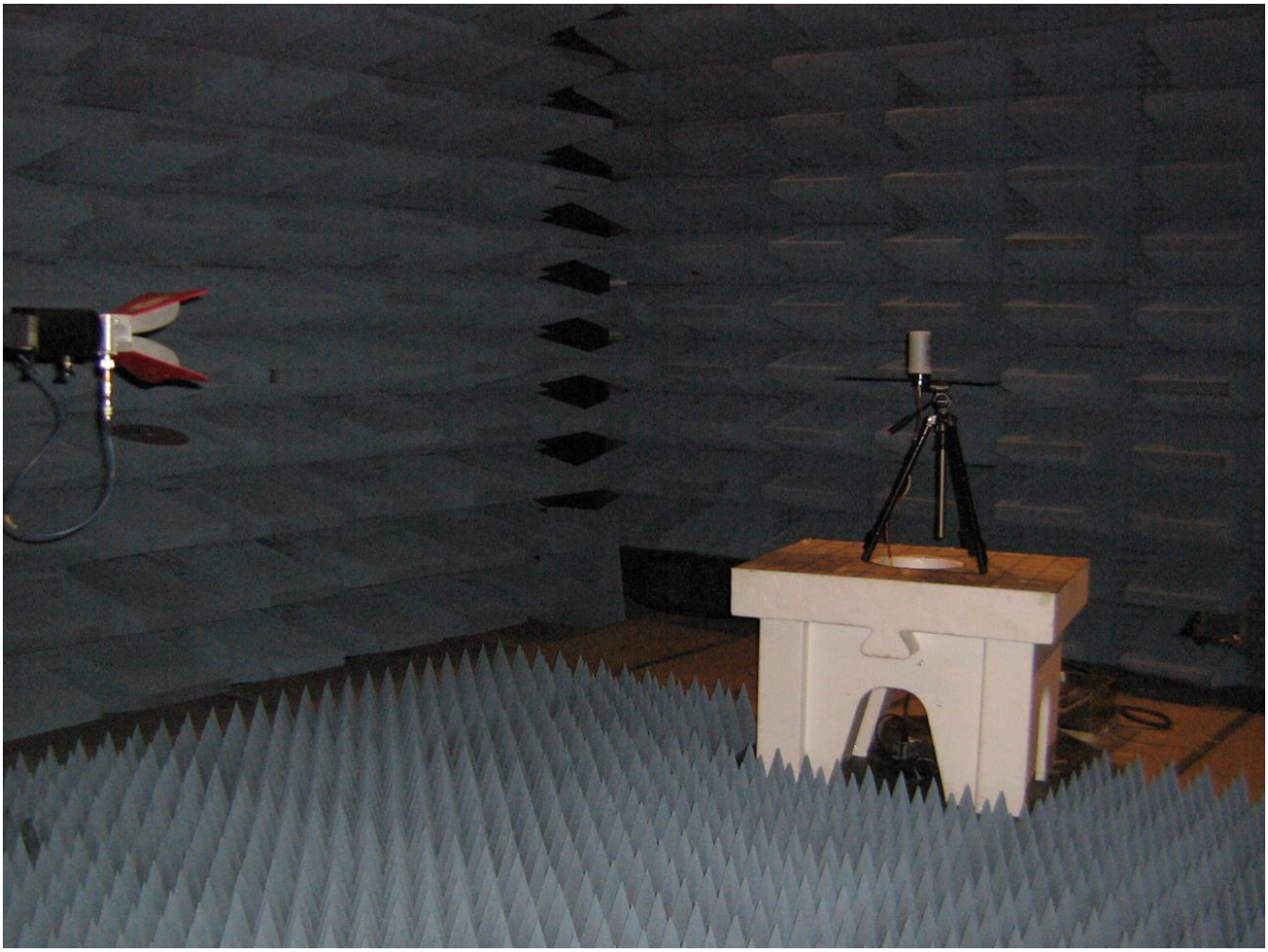
Intentional / Unintentional Radiated Emmission 0.009 – 30 MHz setup

Figure 51: Emissions Test Setup – Intentional / Unintentional Radiated Emissions



Intentional / Unintentional Radiated Emmission 30 – 1000 MHz setup.

Figure 52: Emissions Test Setup – Intentional / Unintentional Radiated Emissions



Intentional Radiated Emmissions 1000 – 10000 MHz setup.

Figure 53: Emissions Test Setup – Intentional Harmonics