Tantalus Systems Corp.

PP-1316

Report of Measurements for FCC and IC Compliance

per

Industry Canada RSS-210 Issue 8

and

FCC CFR47 Part 15/C – 15.247

Revision 1.0

Oct 24, 2011

Approval		
Written By:	 **Ivan Chan, Tantalus Systems Corp.**	Oct 24, 2011 **Date**
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Reviewed By:	 **Amandeep Jathaul, Quality Auditing Institute**	Oct 24,2011 **Date**
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Quality Auditing Institute, Coquitlam BC, Canada
FCC Registration Number 226383
Industry Canada Registration Number 9543B-1

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Section 1: Information for Test Report of Measurements

Testing Details

TESTED BY: Dave Johanson

TEST CONDITIONS: Temperature and Humidity: 22°, 4 7%

TEST VOLTAGE: 120V A.C.

Test Facilities

Quality Auditing Institute Ltd.
16 – 211 Schoolhouse St.
Coquitlam BC, Canada, V3K 4X9

FCC Registration Number 226383
Industry Canada Registration Number 9543B-1

Test Equipment List

Device	Model Number	Equipment Description	Serial No.	Next Cal
Sunol Sciences	SM46C	Turntable	051204-2	N/R
Sunol Sciences	Custom	Mast Motor	TREML0001	N/R
Sunol Sciences	JB3	Antenna Biconilog 20-3000MHz	A120106	6-Mar-2014
Com-Power	AHA-118	Antenna Horn 1-18GHz	711040	11-Mar-2014
Com-Power	LI-115	LISN	241036	9-Mar-2014
Rohde & Schwarz	ESCI	EMI Receiver	100184	29-Feb-2014
Rohde & Schwarz	ESU40	EMI Receiver	100011	06-Mar-2012

Company Tested

NAME: Tantalus Systems Corp.

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

CONTACT PERSON: Mr. Ivan Chan

PHONE NUMBER: 1-604-299-0458 x:203

Equipment Under Test

THE TEST SYSTEM: EUT: Tantalus Systems have integrated a FCC-compliant FHSS transceiver inside an Itron SENTINEL 3-phase electric meter.

Manufacturer:	Tantalus Systems Corp.
Part Numbers:	000-0122-D
Serial number:	0009332054
FCC number:	OZFPP1316
IC number:	3669A-PP1316

AUX equipment: COM_POWER board

Manufacturer:	Tantalus Systems Corp.
Part Numbers:	200-0014-C
Serial number:	ENG01

TEST SETUP: This EUT is designed to communicate with a base unit using a Frequency Hopping Spread Spectrum (FHSS) system operating on the 902-928 MHz band. It has one antenna which is mounted on an antenna bracket external to the electronics but is fully enclosed by the 3-phase meter cover. To test the relevant parametrics, a coaxial pigtail was used for any conducted tests.

CABLING:

Cable	Pins	Connector	Load/Termination	Shielded	Ferrites
Power	2	Terminal	No	No	No

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

CONCLUSION: The PP-1316 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 A respecte toutes les exigences du Reglement sur le material broilleur due 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 and RSS-GEN using the procedures found in ANSI C63.4-2003 or later.

Test	Standard	Description	Result
Radiated Emissions Idle Mode Subclause 8.2	RSS-GEN 6	The radiated emissions are measured in the 30-1000MHz range	Complies
Conducted Emissions Idle Mode Subclause 8.3	RSS-GEN 7.2.2	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 30-9000MHz range	Complies
Output Power and EIRP Emissions	RSS-210 A8.4(1)	Output power shall not exceed 1.0 Watt	Complies

Part 1 – Radiated Emissions Testing

DATE Sept 08, 2011

TEST STANDARD: RSS-GEN 6.

TEST SETUP: The EUT was operated and tested at 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 Rohde & Schwarz EMI Test Receiver with a 120kHz RBW Quasi-peak detector. The EUT was set up 3 meters away from the receiving antenna in a semi-anechoic chamber 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. 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.

Due to physical size limitations of the semi-anechoic chamber, the measurement was performed at 3 meters distance and the limit is adjusted per EN61000-6-3:2001

$$L2 = L1(d1/d2)$$

Where L1 is the specified limit in µV/m at the distance d1. L2 is the new limit at the new distance d2.

EMISSIONS DATA: See Table 2 in Appendix A for corresponding frequencies.

PERFORMANCE: Complies.

Part 2 – Conducted Emission Testing

DATE: Sept 9, 2011

TEST STANDARD: RSS-GEN 7.2.2

MINIMUM STANDARD: Class B Limit:

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

MINIMUM STANDARD: Class B Limit:

Frequency (MHz)	Conducted Limit (dBµV)	
	Quasi-Peak	Average
0.15 – 0.50	66 to 56	56 to 46
0.50 – 5	56	46
5 – 30	60	50

METHOD OF MEASUREMENT: Measurements were made using a Rohde & Schwarz EMI Test Receiver with a 9kHz RBW Quasi-peak detector.

MEASUREMENT DATA: See Appendix A for Plots.

EMISSIONS DATA: See Table 3 to Table 6 in Appendix A for corresponding frequencies.

PERFORMANCE: Complies.

Part 3 – Radiated Emissions – Transmit Mode

DATE: Sept 8, 2011

TEST STANDARD: RSS-210 Iss.8 A8.5 – 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 120Vac 60Hz for the tests where the unit is in continuous transmit mode, the COM_POWER board was added to the EUT.

METHOD OF MEASUREMENT: Measurements were made using a spectrum analyzer. The EUT was set up 3 meters away from the receiving antenna in a semi-anechoic chamber 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.

EMISSIONS DATA: See Plots and Tables in Appendix A for corresponding data. A summary of the results is provided below as per the above requirements.

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
Channel Bandwidth	RSS-210 A8.1(a)	See Figure 4 to Figure 9 in Appendix A. The widest 20dB bandwidth was measured to be 72.1 kHz for the 20kHz frequency deviation modulation scheme, and 150.6 kHz for the 40kHz frequency deviation modulation scheme.
Channel Separation	RSS-210 A8.1(c)	See Figure 10 to Figure 15 in Appendix A. The widest Channel separation was measured to be 128.2 kHz for the 20kHz frequency deviation modulation scheme, and 258.0 kHz for the 40kHz frequency deviation modulation scheme.
Number of Hopping Channels	RSS-210 A8.1(c)	See Figure 16 to Figure 21 in Appendix A. The number of measured hops is 50 for both modulation schemes.
Hopping Channels time of Occupancy	RSS-210 A8.1(c)	See Figure 22 in Appendix A: the time of occupancy is 4.84 milliseconds at an interval of 2.45 seconds per Figure 23. This is equal to an average time "ON" of : 39.5 milliseconds within a 20 second period.
Output Power and EIRP	RSS-210 A8.4(1)	See the Measurement Data section in Part 4 of this Section. The output

		EIRP is a maximum of 0.211W (or 23.24dBm)
Out of Band Emissions	RSS-210 A8.5	See Plots Figure 24 to Figure 31 in Appendix A. All radiated emissions were within the RSS-210 A8.5 limit.

PERFORMANCE: Complies.

Part 4 – Output Power and EIRP Emissions

DATE: Sept 12, 2011

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: The EUT was operated and tested at 120Vac 60Hz for the tests where the unit is in continuous transmit mode, the COM_POWER board was added to the EUT.

METHOD OF MEASUREMENT: A SMA coaxial pigtail was soldered onto the coaxial pad on the PCB and a conducted measurement was performed across the frequency band with an attenuator protecting the spectrum analyzer.

The peak gain of the PP-1316 is 0dBi, hence a conducted test is representative of the worse case power output.

MEASUREMENT DATA:

Freq(MHz)	Reading (dBm)	External Attenuation (dB)	Total Value (dBm)	Total Value (W)
902.16	-12.56	35.8	23.24	0.211
915	-13.13	35.8	22.67	0.185
927.83	-13.76	35.8	22.04	0.160

PERFORMANCE: Complies.

Part 5: Out of Band Emissions

DATE: Sept 9, 2011

TEST STANDARD: RSS-210 Iss.8 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: The EUT was operated and tested at 120Vac 60Hz for the tests where the unit is in continuous transmit mode, the COM_POWER board was added to the EUT.

METHOD OF MEASUREMENT: Measurements were made using a horn antenna connected directly into a spectrum analyzer. The EUT was set up 3 meters away from the receiving antenna in a semi-anechoic chamber 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.

The EUT was set up 3 meters away from the receiving antenna in a semi-anechoic chamber test site for all emissions up to 10GHz. Emissions in both horizontal and vertical polarizations were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots. The EUT was programmable to broadcast on standalone frequencies at the low (902), middle (915) and high (928) channels; 2 channel hopping at the end frequencies (902.5 and 927.5); standalone hopping at the middle frequency (915) and full 50 channel hopping frequencies 902.5 to 927.5MHz. The maximized emissions signal strength was compared against the fundamental's peak power for compliance under Section 15.35(b).

After the peak position was determined, the VBW was changed to 10Hz and the results captured. A Duty Cycle Correction Factor was added to the emission limits of Section 15.209 as the dwell time per channel of the hopping signal is less than 100ms per transmission.

The calculation of the Duty Cycle Correction Factor is computed by analyzing the worst case "ON" time in any 100ms time period using the formula:

Correction Factor (dB) = 20*log(worst case ON time / 100ms)

For this product, the EUT worst case "ON" time was measured on Figure 22 to be 4.84ms per 100ms interval. This equates to a possible correction factor of –26.3dB, which is applied to the restricted bands limit column in Table 7 to Table 9.

MEASUREMENT DATA: See Table 7 to Table 9 in Appendix A. All limits in non-restricted bands are referenced against the amplitude of the fundamental frequency.

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. 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) was used as a guide to the tests to be performed.

Labeling Requirements

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

Test Results - Summary

Testing was performed pursuant to Industry Canada RSS-210 Issue 8 Section A8 using the procedures found in ANSI C63.4-2003 or later.

Test	Standard	Description	Result
Radiated Emissions Idle Mode	FCC Part 15 Subpart B Class B Limits	The radiated emissions are measured in the 30-1000MHz 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 30-9000MHz range.	Complies

Part 1 – Radiated Emission Testing

DATE: Sept 8, 2011

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

TEST VOLTAGE: 120Vac 60Hz

TEST SETUP: The equipment was set up 3 meters away from a receiving antenna in a semi-anechoic chamber test site. 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.

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	2	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.

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 EUT connects to its external antenna through either a length of coax, or by 2 mating SMA connectors. The external antenna is fully enclosed inside the Itron Sentinel 3-phase meter. As such, only professional installers have access to the antenna.

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

*Decreases with the log of frequency

3.2 RESULT

MEASUREMENT DATA: See Appendix A for Plots.

EMISSIONS DATA: See Table 3 to Table 6 in Appendix A for corresponding frequencies.

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 RBW	120kHz (30MHz to 1000MHz) 1MHz (1000MHz to 10000MHz)
Receive Antenna Scan Height	1m – 4m
Receive Antenna Polarization	Vertical and Horizontal

Measurements were made using a horn antenna connected directly into a spectrum analyzer. The EUT was set up 3 meters away from the receiving antenna in a semi-anechoic chamber 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.

The EUT was set up 3 meters away from the receiving antenna in a semi-anechoic chamber test site for all emissions up to 10GHz. Emissions in both horizontal and vertical polarizations were measured while rotating the EUT on a turntable to maximize the emissions signal strength and the results recorded on the attached plots. The EUT was programmable to broadcast on standalone frequencies at the low (902), middle (915) and high (928) channels; 2 channel hopping at the end frequencies (902.5 and 927.5); standalone hopping at the middle frequency (915) and full 50 channel hopping frequencies 902.5 to 927.5MHz. The maximized emissions signal strength was compared against the fundamental's peak power for compliance under Section 15.35(b).

After the peak position was determined, the VBW was changed to 10Hz and the results captured. A Duty Cycle Correction Factor was added to the emission limits of Section 15.209 as the dwell time per channel of the hopping signal is less than 100ms per transmission.

The calculation of the Duty Cycle Correction Factor is computed by analyzing the worst case "ON" time in any 100ms time period using the formula:

Correction Factor (dB) = 20*log(worst case ON time / 100ms)

For this product, the EUT worst case "ON" time was measured on Figure 22 to be 4.84ms per 100ms interval. This equates to a possible correction factor of -26.3dB, which is applied to the emissions data in Table 7 to Table 9.

CABLING DETAILS:

Cable	Pins	Connector	Load/Termination	Shielded	Ferrites
Power	2	Terminal	No	No	No

4.3 RESULTS:

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

MEASUREMENT DATA: See Plots Figure 4 to Figure 31 in Appendix A.

PERFORMANCE: Complies.

Part 5: Output Power and EIRP Emissions

DATE: Sept 12, 2011

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 for systems employing at least 50 Hopping Channels.

TEST SETUP: Refer to setup in Part 1 above.

METHOD OF MEASUREMENT: A SMA coaxial pigtail was soldered onto the coaxial pad on the PCB and a conducted measurement was performed across the frequency band with an attenuator protecting the spectrum analyzer.

The peak gain of the PP-1316 is 0dBi, hence a conducted test is representative of the worse case power output.

MEASUREMENT DATA:

Freq(MHz)	Reading (dBm)	External Attenuation (dB)	Total Value (dBm)	Total Value (W)
902.16	-12.56	35.8	23.24	0.211
915	-13.13	35.8	22.67	0.185
927.83	-13.76	35.8	22.04	0.160

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 RESULT

All of the measurements shown below were made when the EUT was set into a mode that only transmits a CW tone in order to facilitate measurements of the spurious emissions. The 20dB bandwidth of the CW signal is 97Hz, hence it is permissive to use a lower RBW of 1kHz to detect 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 Table 7 to Table 9 in Appendix A for corresponding data.

Appendix A: Test Plots

Unintentional Radiated Emissions

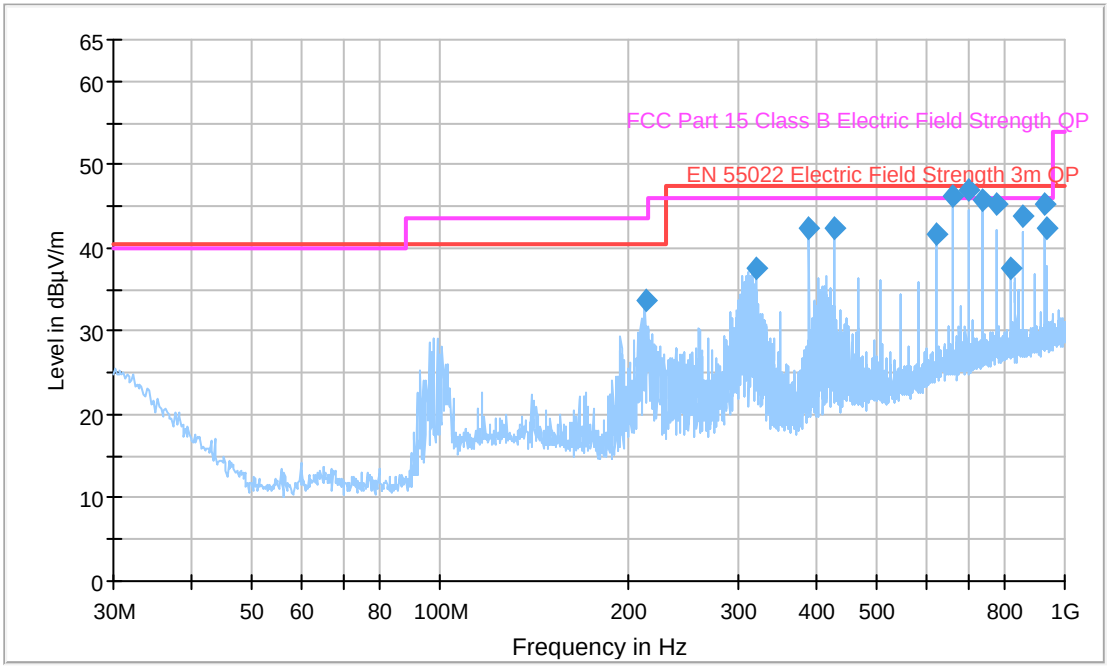

Figure 1: Unintentional Radiated Emissions – For Reference Only

Table 1: FCC 15/B Class B Emissions – 3m

Frequency (MHz)	Pol	Hgt (m)	Angle (deg)	QP Corrected Peak (dBµV/m)	QP Lmt (dBµV/m)	DelLim-Pk (dB)
663.00	H	1.19	240	45.3	46	-0.7
702.00	H	1.11	240	41.9	46	-4.1
741.00	H	1.02	227	41.8	46	-4.2
780.00	H	1.08	334	41.0	46	-5.0
819.00	H	1.05	338	40.3	46	-5.7
858.00	H	1.00	325	43.0	46	-3.0

Table 2: IC/CE Class B Emissions – 3m

Frequency (MHz)	Pol	Hgt (m)	Angle (deg)	QP Corrected Peak (dBµV/m)	QP Lmt (dBµV/m)	DelLim-Pk (dB)
663.00	H	1.19	240	45.3	47.5	-2.2
702.00	H	1.11	240	41.9	47.5	-5.6
741.00	H	1.02	227	41.8	47.5	-5.7
780.00	H	1.08	334	41.0	47.5	-6.5
819.00	H	1.05	338	40.3	47.5	-7.2
858.00	H	1.00	325	43.0	47.5	-4.5

A.C. Mains Conducted Emissions

FCC/CE Class B - Emissions
Table 3: AC Conducted Emissions - Line 1
120VAC 60Hz – Line 1 Quasi-Peaks

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.267216	41.2	1000.00	9.000	On	L1	0.1	19.8	61.0
0.312281	41.6	1000.00	9.000	On	L1	0.1	18.1	59.7
0.447440	36.9	1000.00	9.000	On	L1	0.1	20.0	56.9
0.492477	35.4	1000.00	9.000	On	L1	0.1	20.7	56.1
0.624661	33.2	1000.00	9.000	On	L1	0.2	22.8	56.0
0.671247	36.4	1000.00	9.000	On	L1	0.2	19.6	56.0

Table 4: AC Conducted Emissions - Line 1
120VAC 60Hz – Line 1 Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.266683	27.7	1000.00	9.000	On	L1	0.1	23.3	51.0
0.311657	26.9	1000.00	9.000	On	L1	0.1	22.8	49.7
0.447440	23.0	1000.00	9.000	On	L1	0.1	23.8	46.8
0.491494	22.9	1000.00	9.000	On	L1	0.1	23.2	46.1
0.672590	30.2	1000.00	9.000	On	L1	0.2	15.8	46.0
2.014324	21.7	1000.00	9.000	On	L1	0.2	24.3	46.0

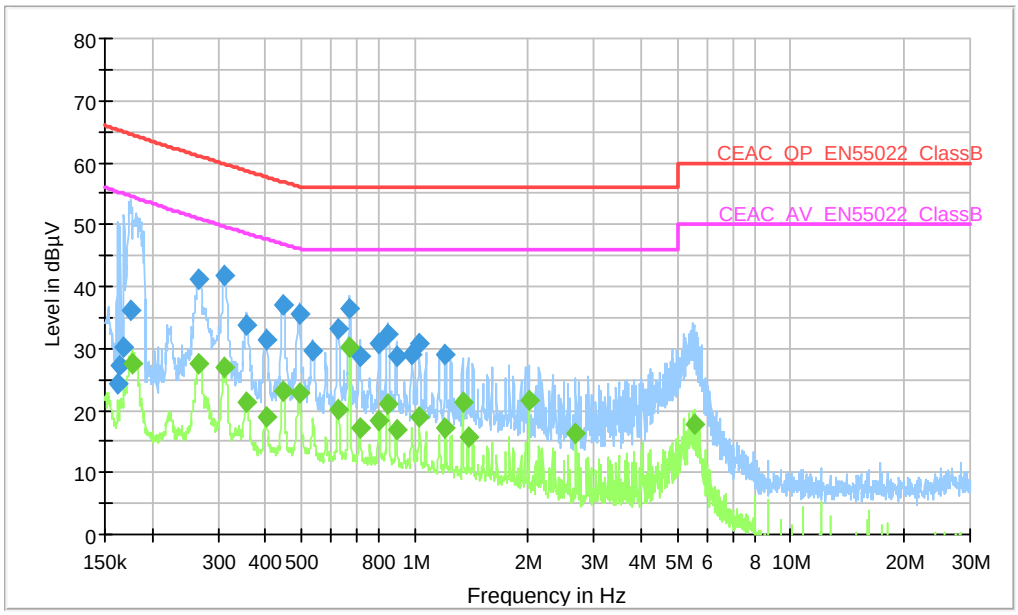

Figure 2: AC Conducted Emissions - Line 1

Table 5: AC Conducted Emission - Neutral
120VAC 60Hz – Neutral – Quasi-Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.267751	41.3	1000.00	9.000	On	L1	0.1	19.7	61.0
0.312281	41.8	1000.00	9.000	On	L1	0.1	17.9	59.7
0.446547	37.1	1000.00	9.000	On	L1	0.1	19.8	56.9
0.491494	36.0	1000.00	9.000	On	L1	0.1	20.1	56.1
0.625910	33.2	1000.00	9.000	On	L1	0.2	22.8	56.0
0.671247	36.8	1000.00	9.000	On	L1	0.2	19.2	56.0

Table 6: AC Conducted Emissions - Neutral
120VAC 60Hz – Neutral Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.267216	27.9	1000.00	9.000	On	L1	0.1	23.1	51.0
0.311035	26.8	1000.00	9.000	On	L1	0.1	22.9	49.7
0.446547	22.9	1000.00	9.000	On	L1	0.1	24.0	46.9
0.493462	22.7	1000.00	9.000	On	L1	0.1	23.4	46.1
0.672590	30.3	1000.00	9.000	On	L1	0.2	15.7	46.0
2.014324	21.9	1000.00	9.000	On	L1	0.2	24.1	46.0

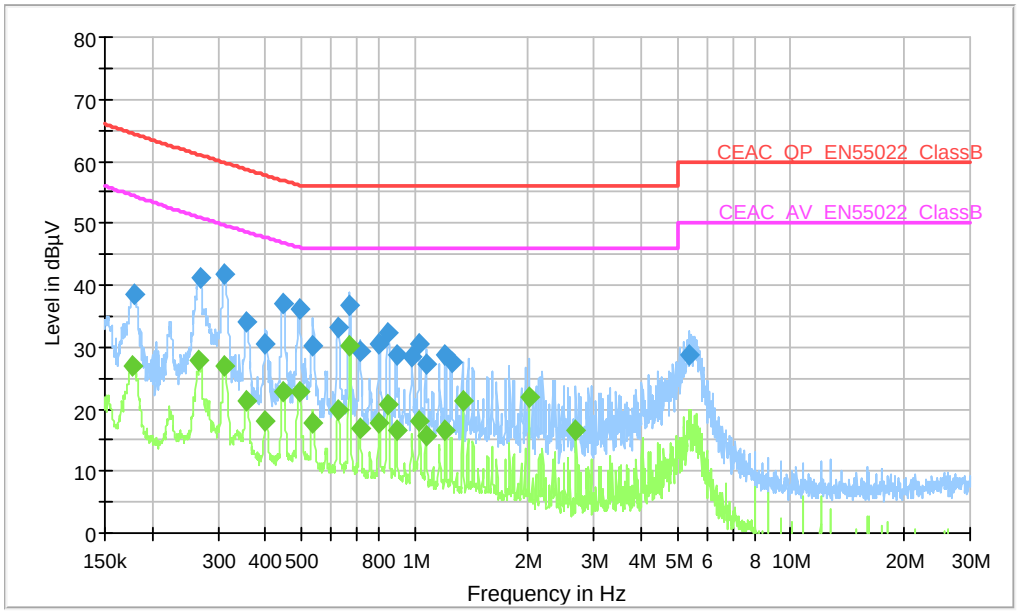

Figure 3: AC Conducted Emissions - Neutral

20 dB Bandwidth – 20kHz Frequency Deviation

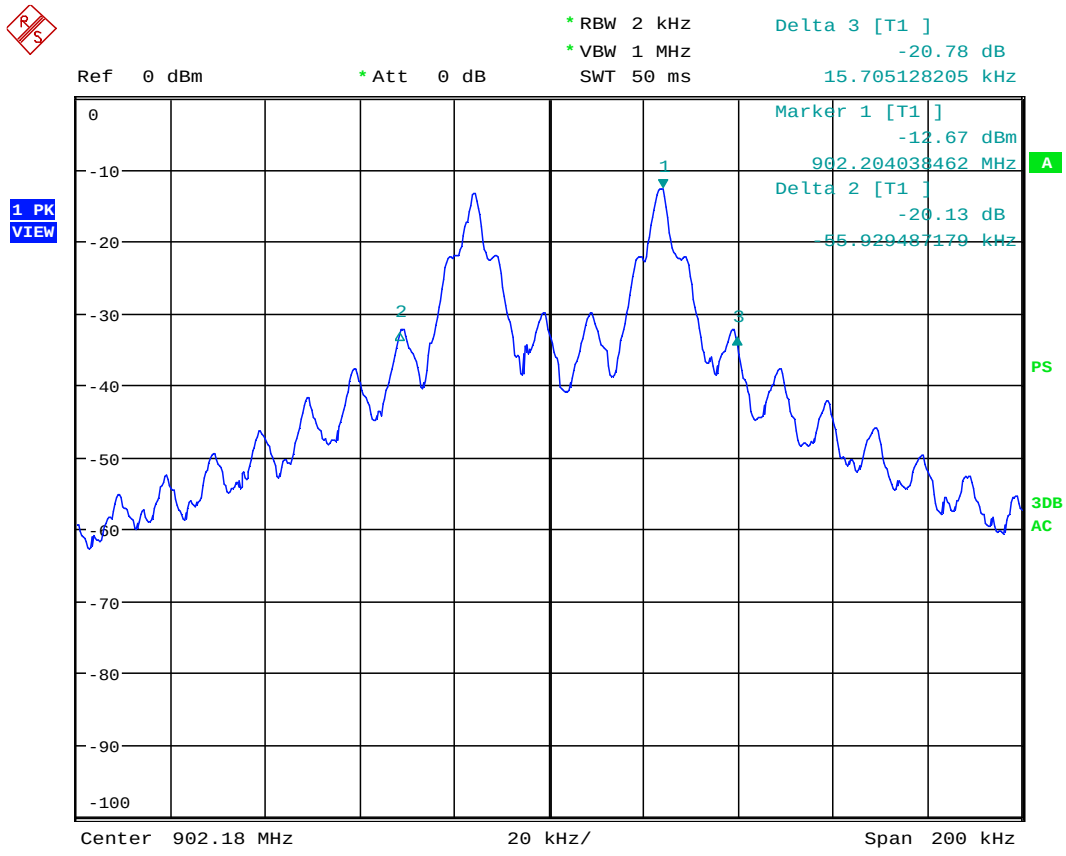

Figure 4: 20dB Bandwidth - Lower Frequency Band = 71.6kHz

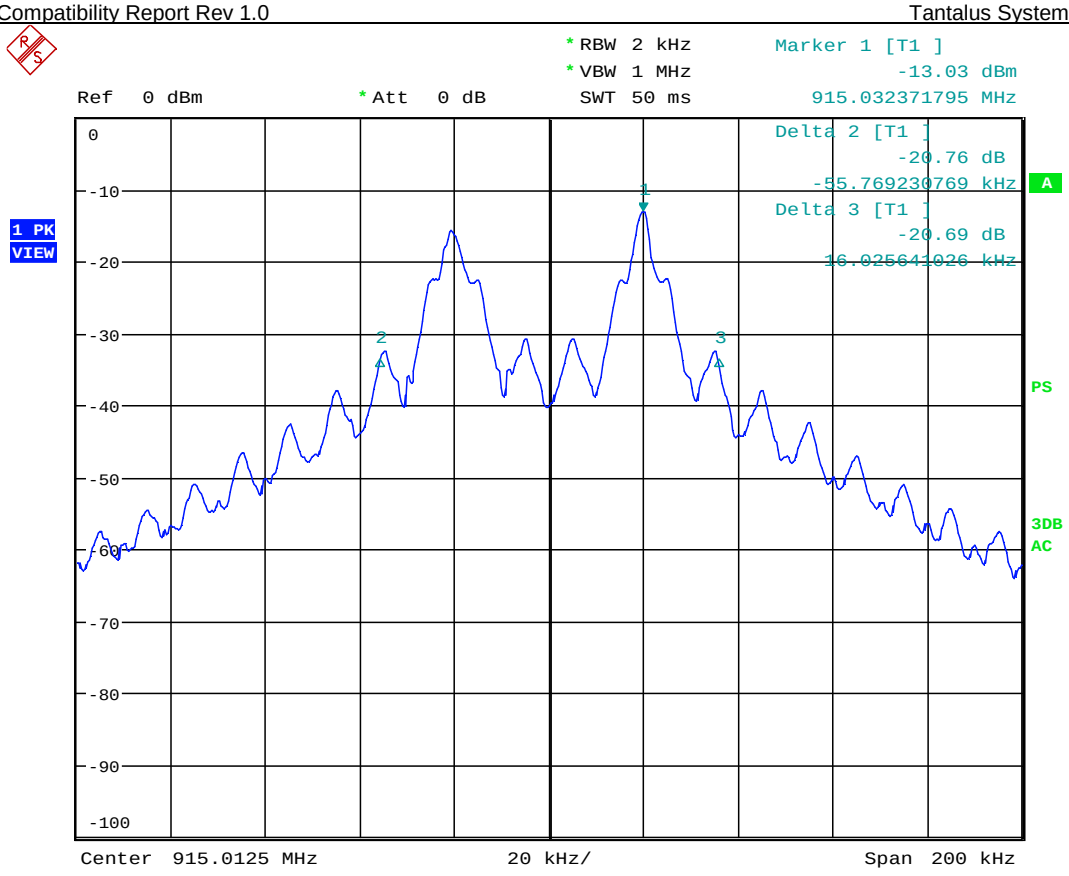

Figure 5: 20dB Bandwidth - Middle Frequency Band = 71.8kHz

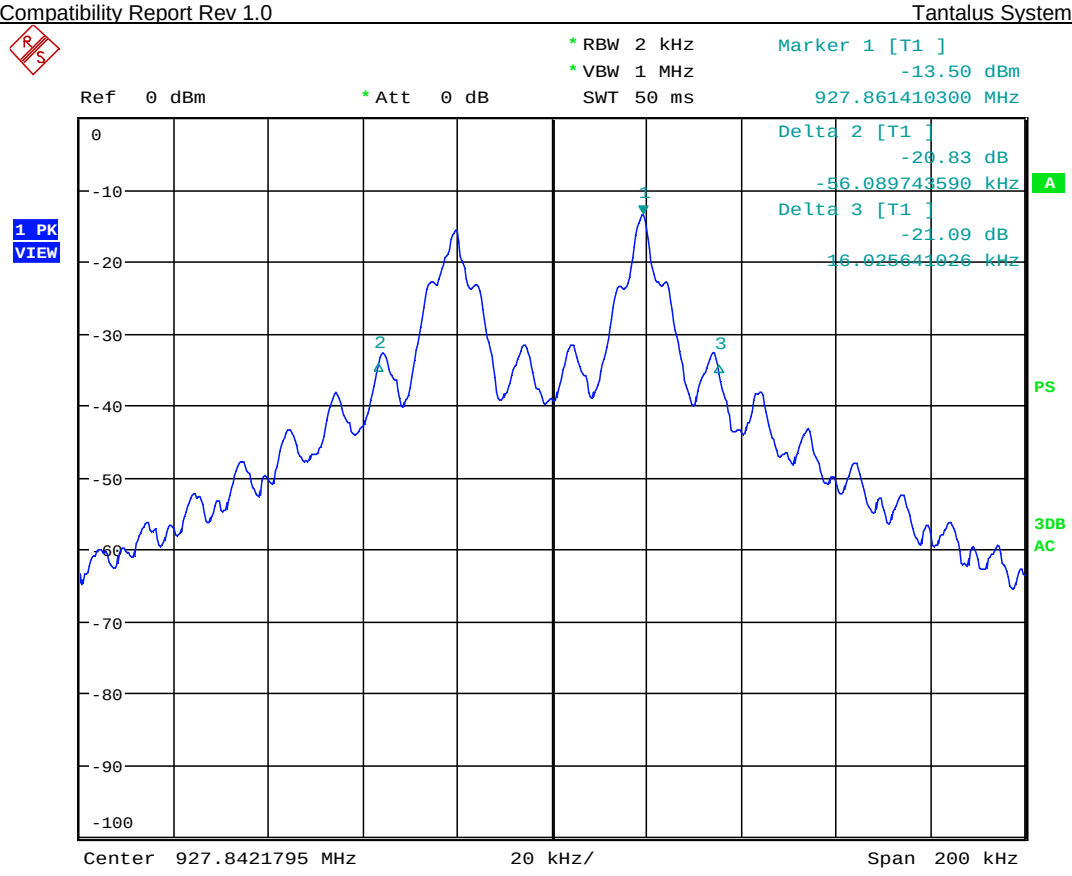

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Figure 6: 20dB Bandwidth - Upper Frequency Band = 72.1kHz

20 dB Bandwidth – 40kHz Frequency Deviation

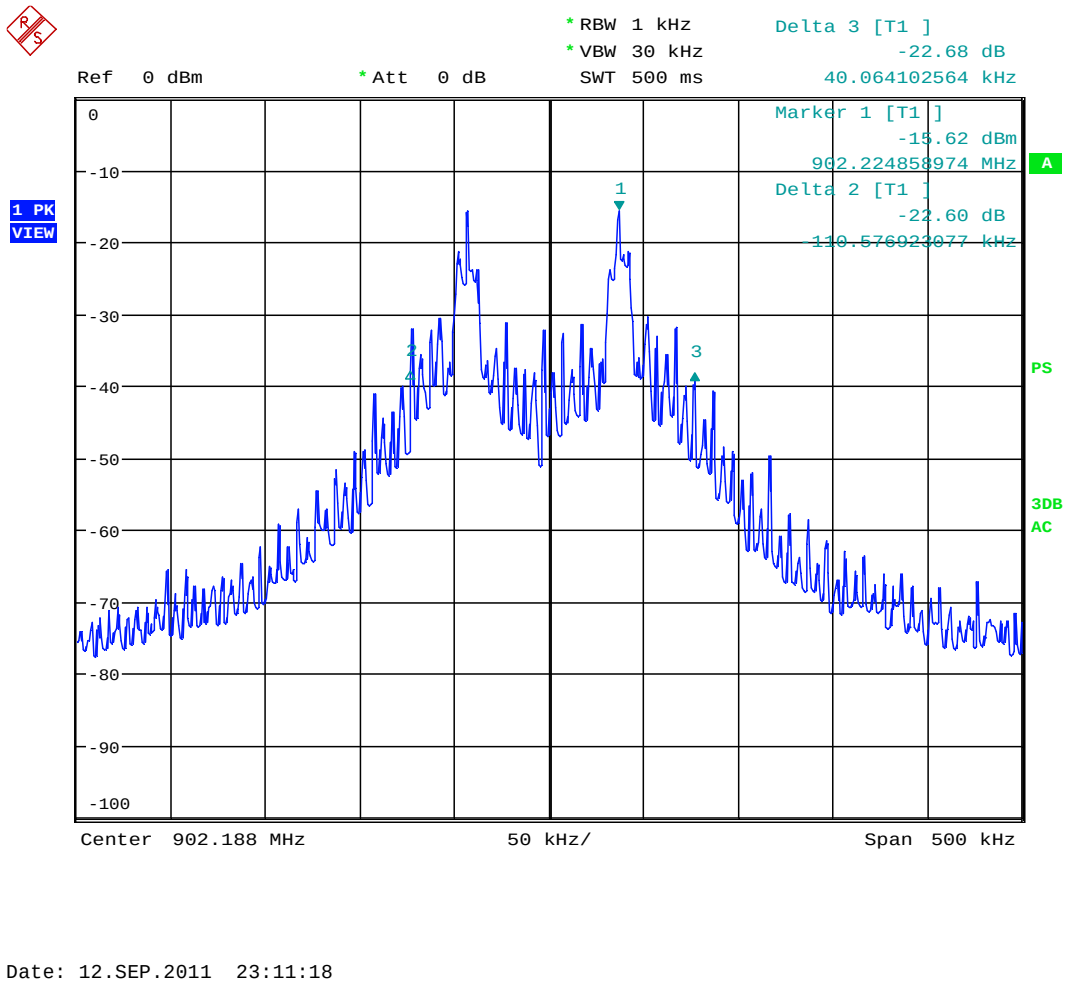

Figure 7: 20dB Bandwidth - Lower Frequency Band = 150.6kHz

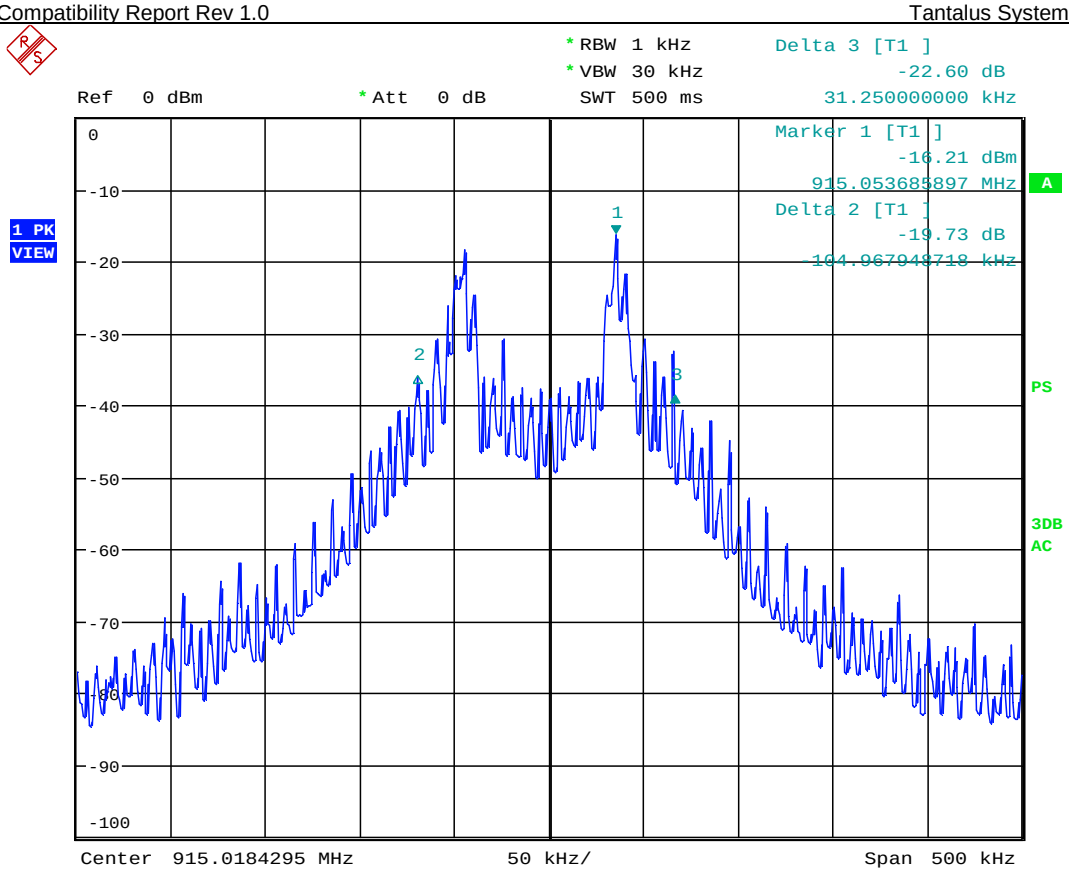

Figure 8: 20dB Bandwidth - Middle Frequency Band = 136.2kHz

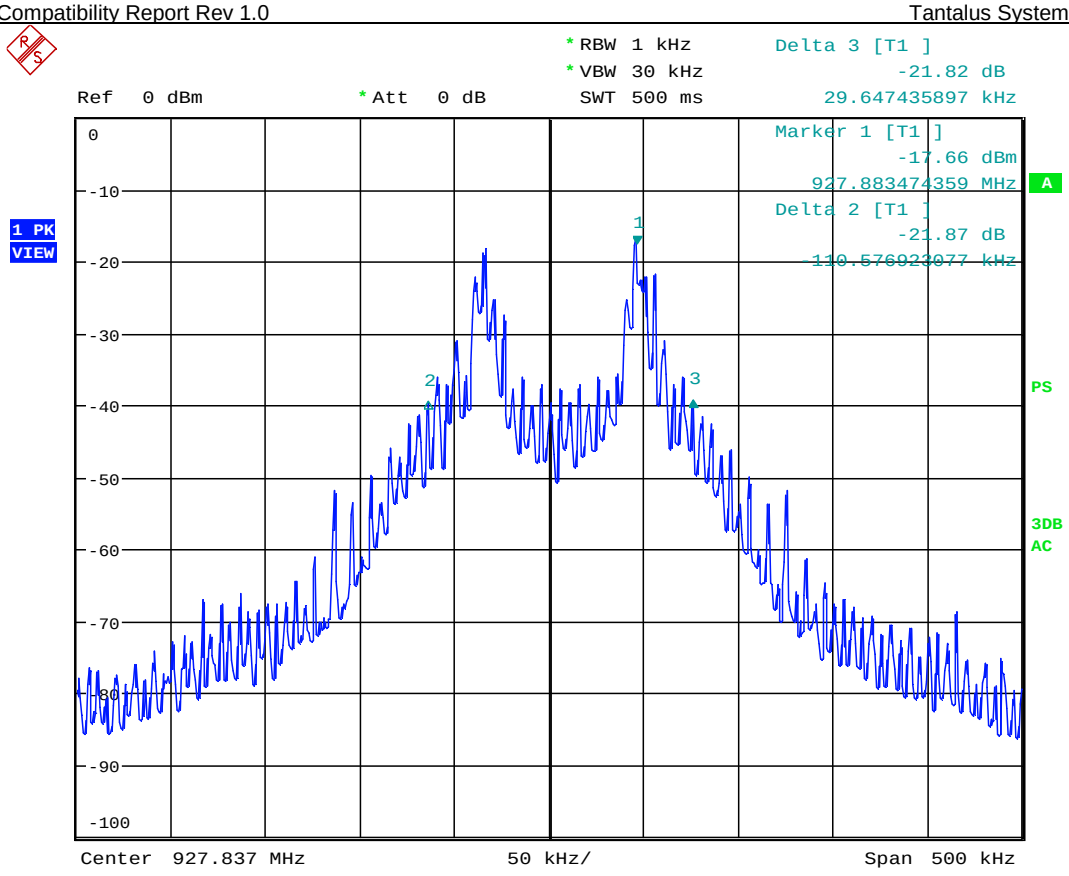

Figure 9: 20dB Bandwidth - Upper Frequency Band = 140.2kHz

Channel Separation – 20kHz Frequency Deviation

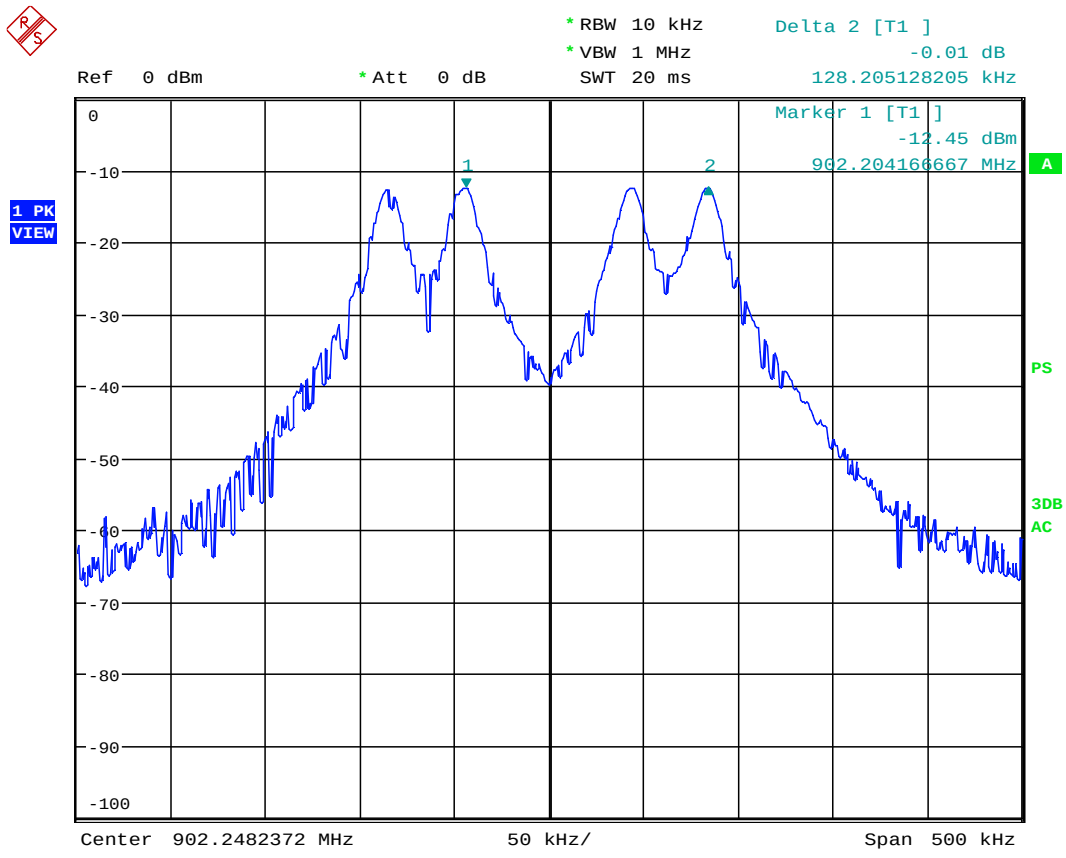

Figure 10: Channel Separation - Lower Frequency Band = 128.2kHz

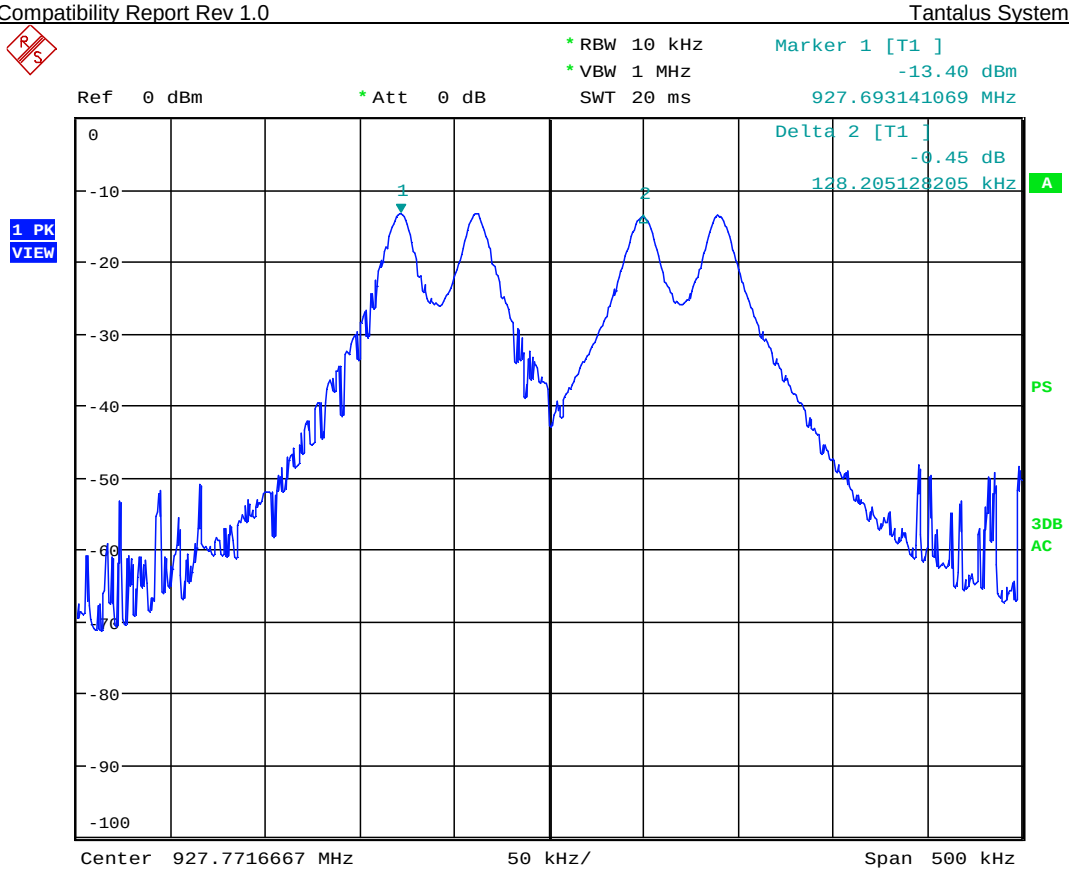

Figure 11: Channel Separation - Middle Frequency Band = 128.2kHz

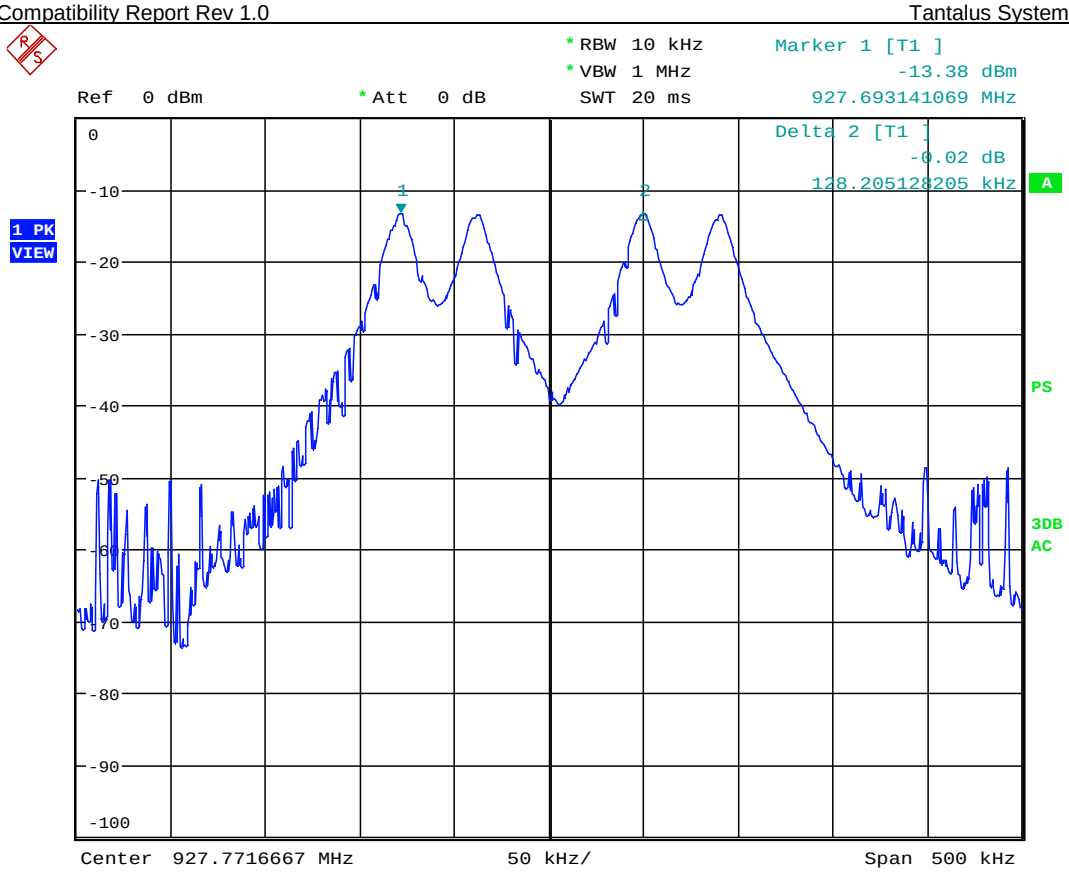

Figure 12: Channel Separation - Upper Frequency Band = 128.2kHz

Channel Separation – 40kHz Frequency Deviation

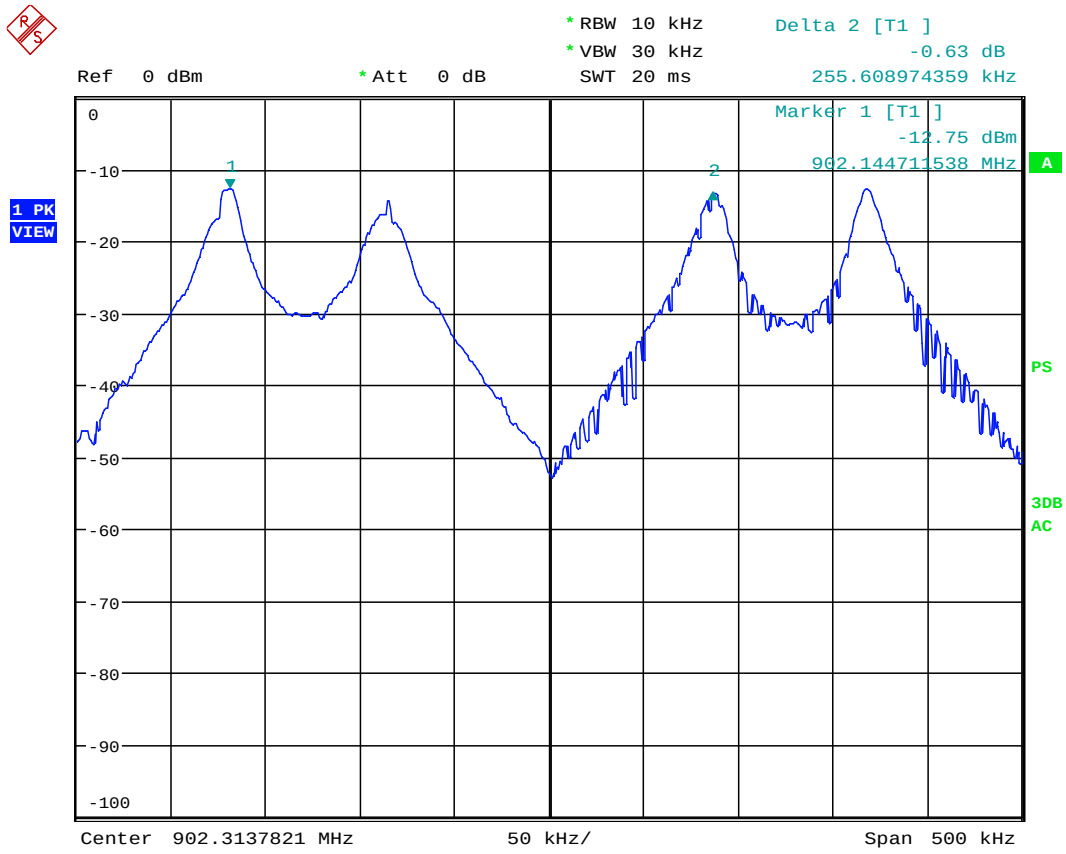

Figure 13: Channel Separation - Lower Frequency Band = 255.6kHz

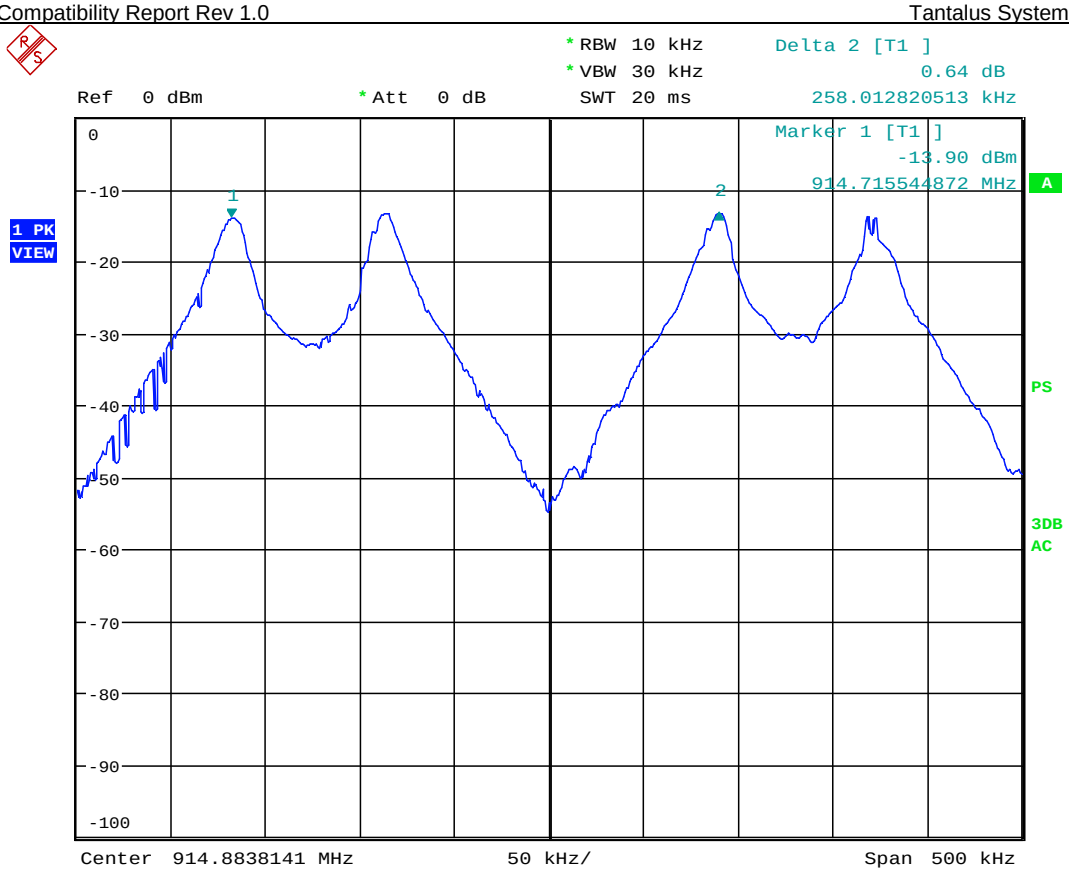

Figure 14: Channel Separation - Middle Frequency Band = 258.0kHz

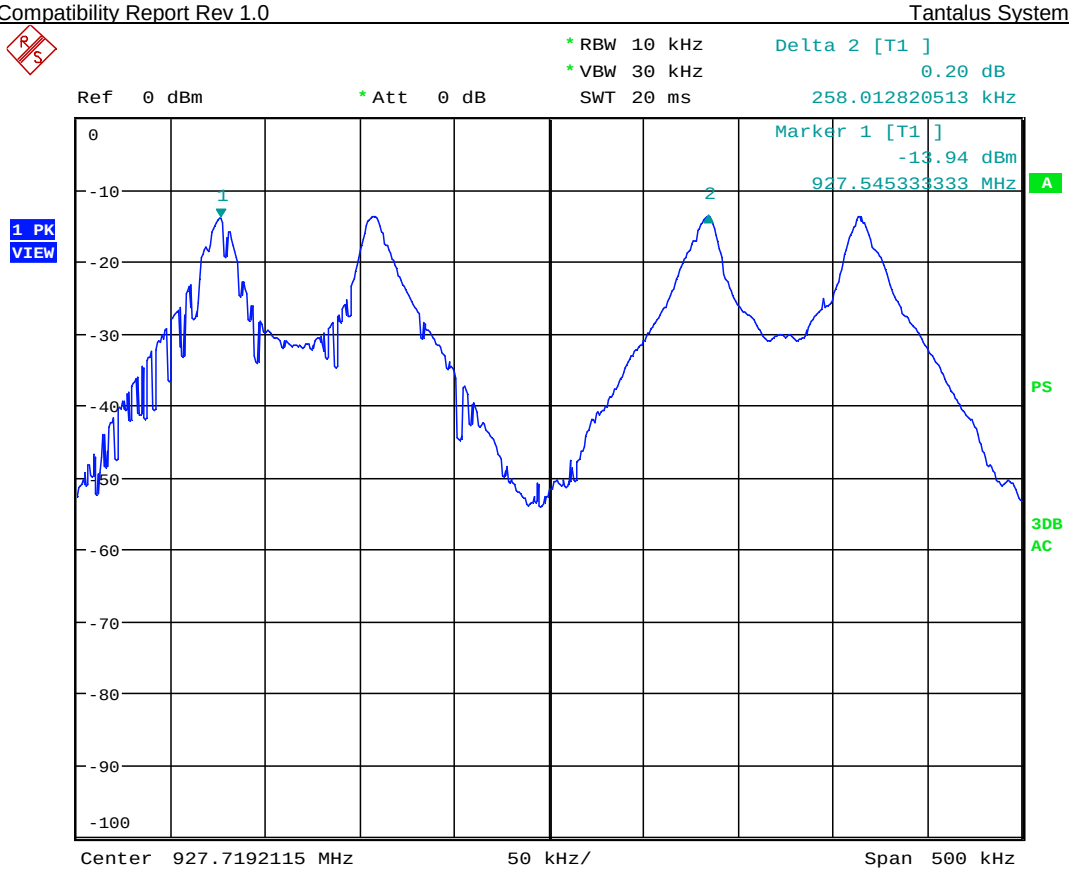

Figure 15: Channel Separation - Upper Frequency Band = 258.0kHz

Number of Hopping Channels – 20kHz Frequency Deviation

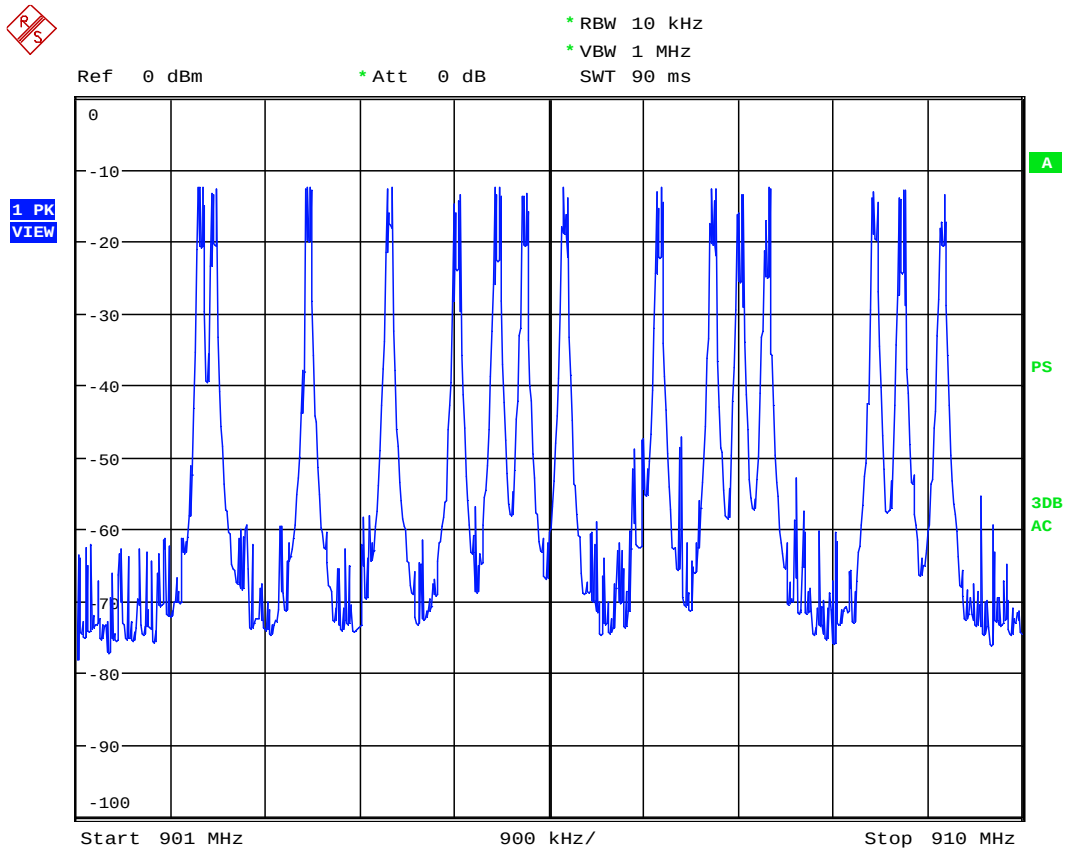

Figure 16: Number of Hopping Channels in Lower Frequency Band = 15

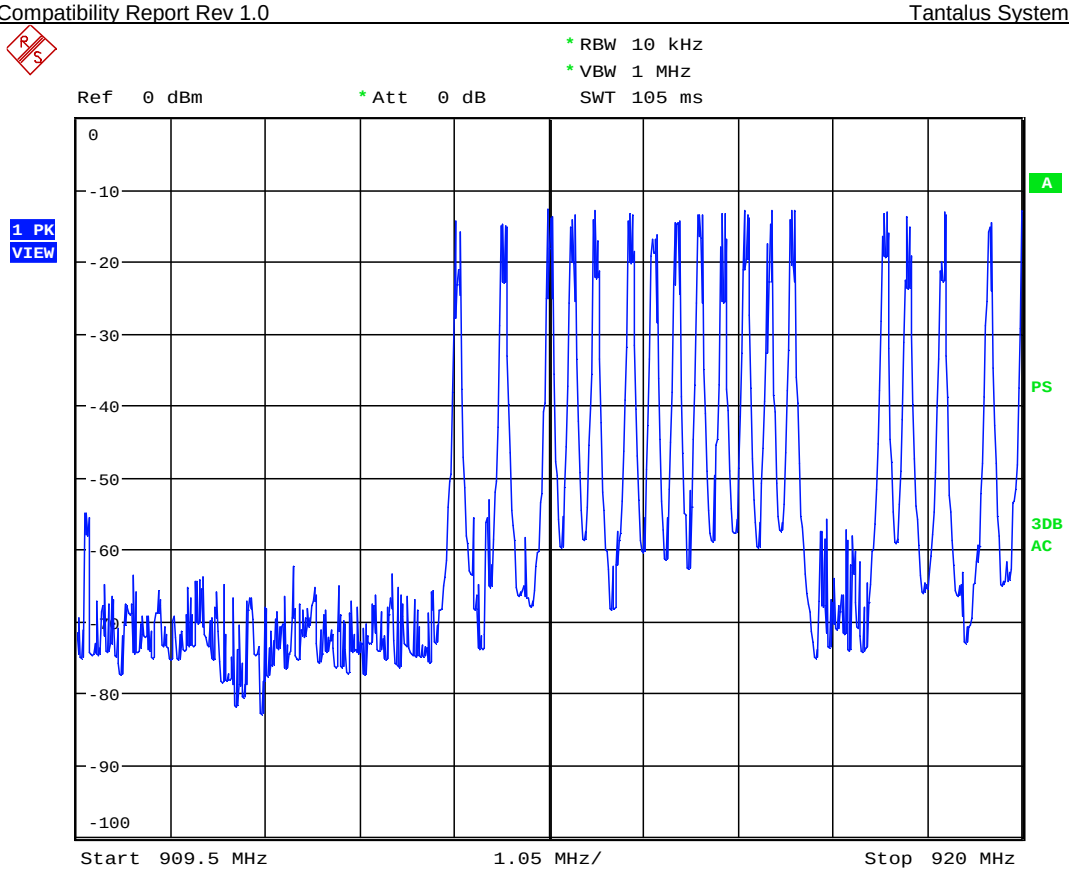

Figure 17: Number of Hopping Channels in Middle Frequency Band = 17

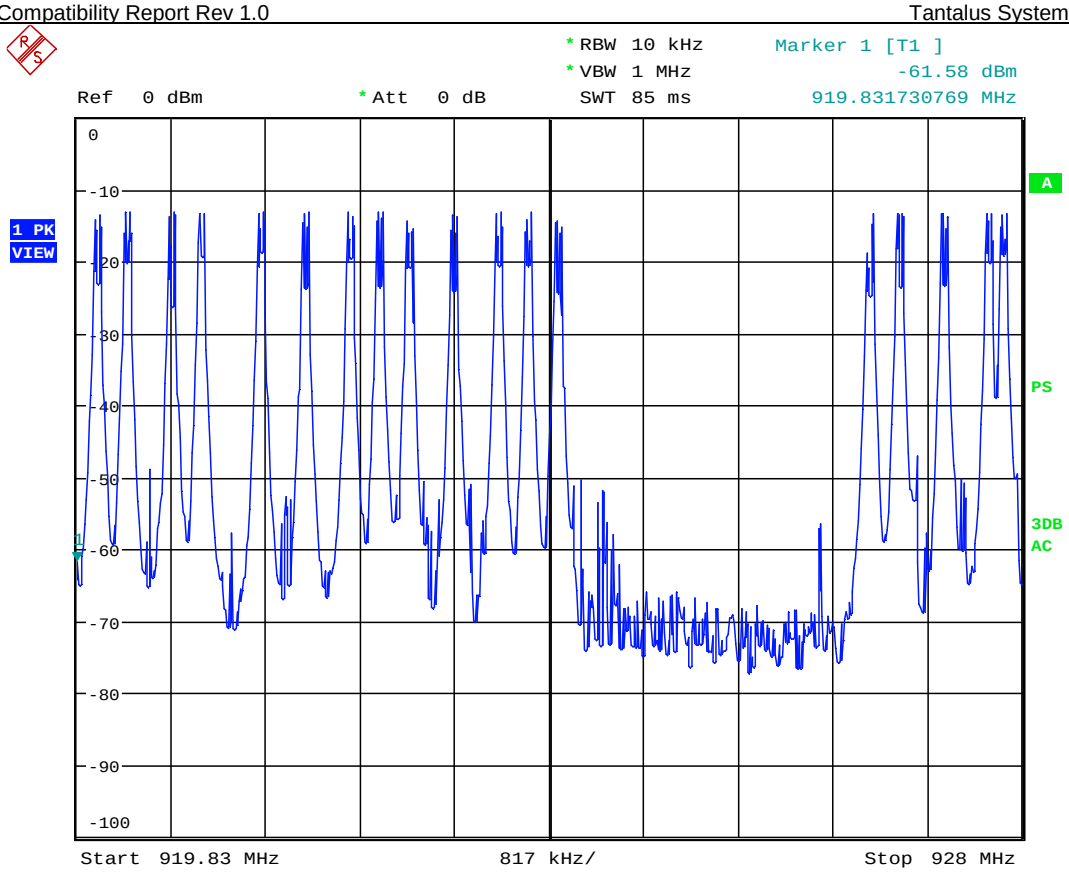

Figure 18: Number of Hopping Channels in Upper Frequency Band = 18

Total number of hops = 15 + 17 + 18 = 50

Number of Hopping Channels – 40kHz Frequency Deviation

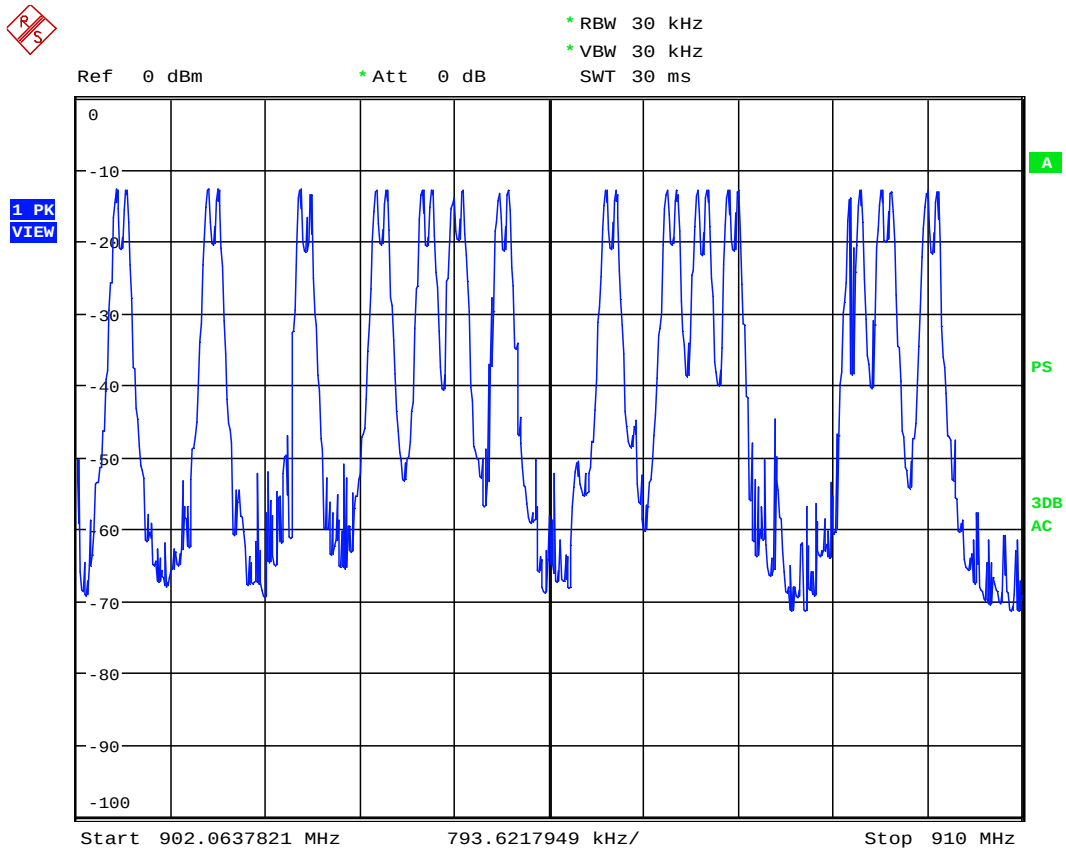

Figure 19: Number of Hopping Channels in Lower Frequency Band = 14

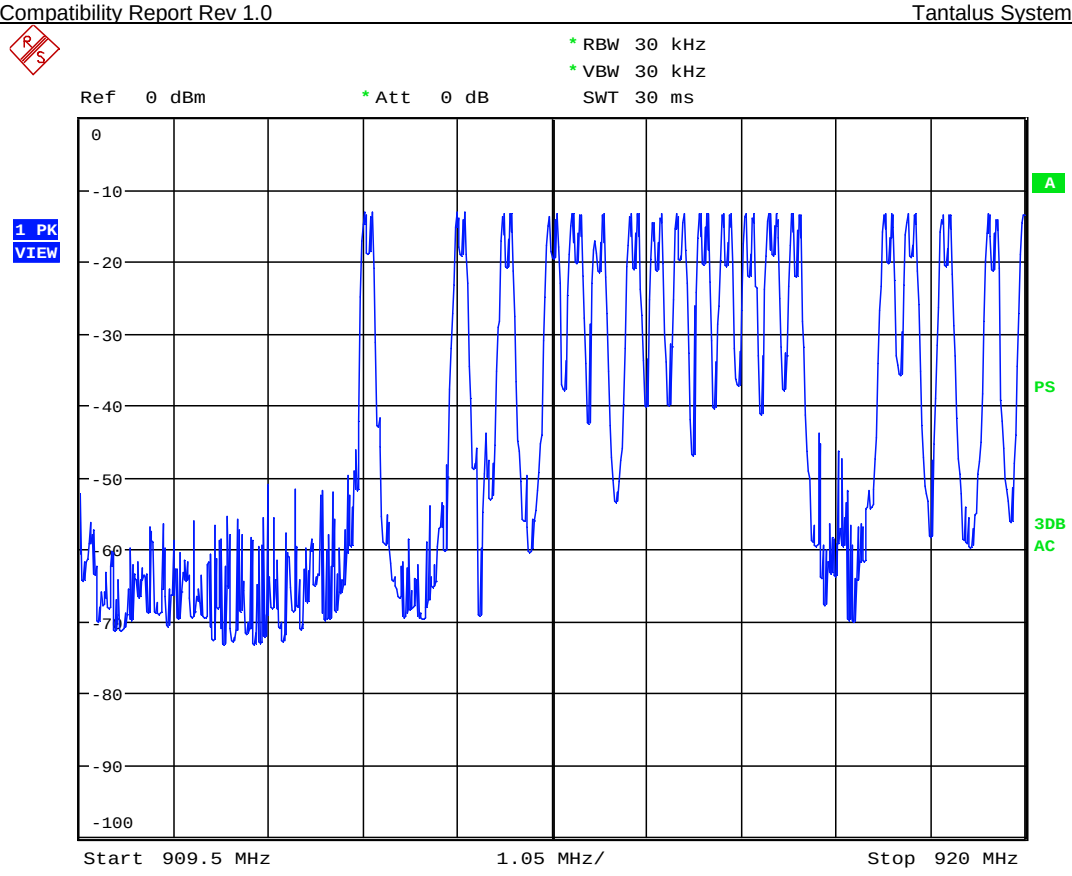

Figure 20: Number of Hopping Channels in Middle Frequency Band = 18

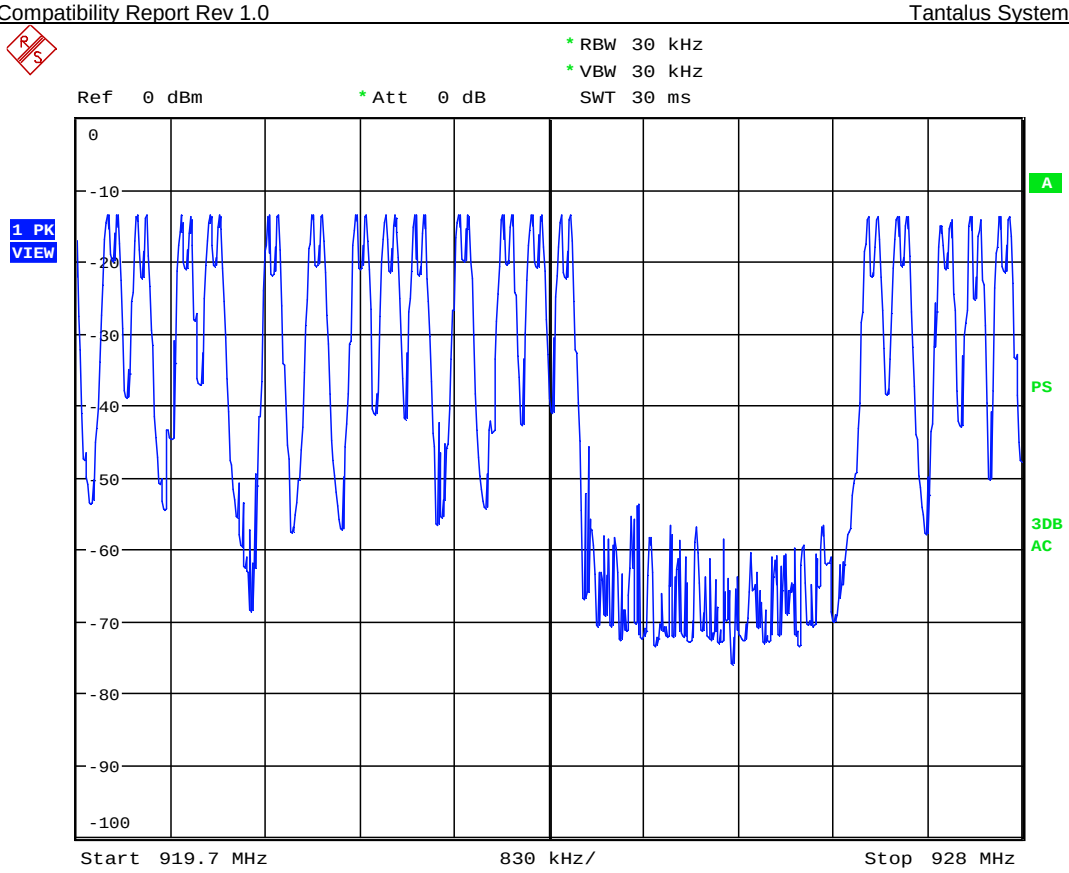

Figure 21: Number of Hopping Channels in Upper Frequency Band = 18

Total number of hops = 14 + 18 + 18 = 50

Hopping Channels Time of Occupancy

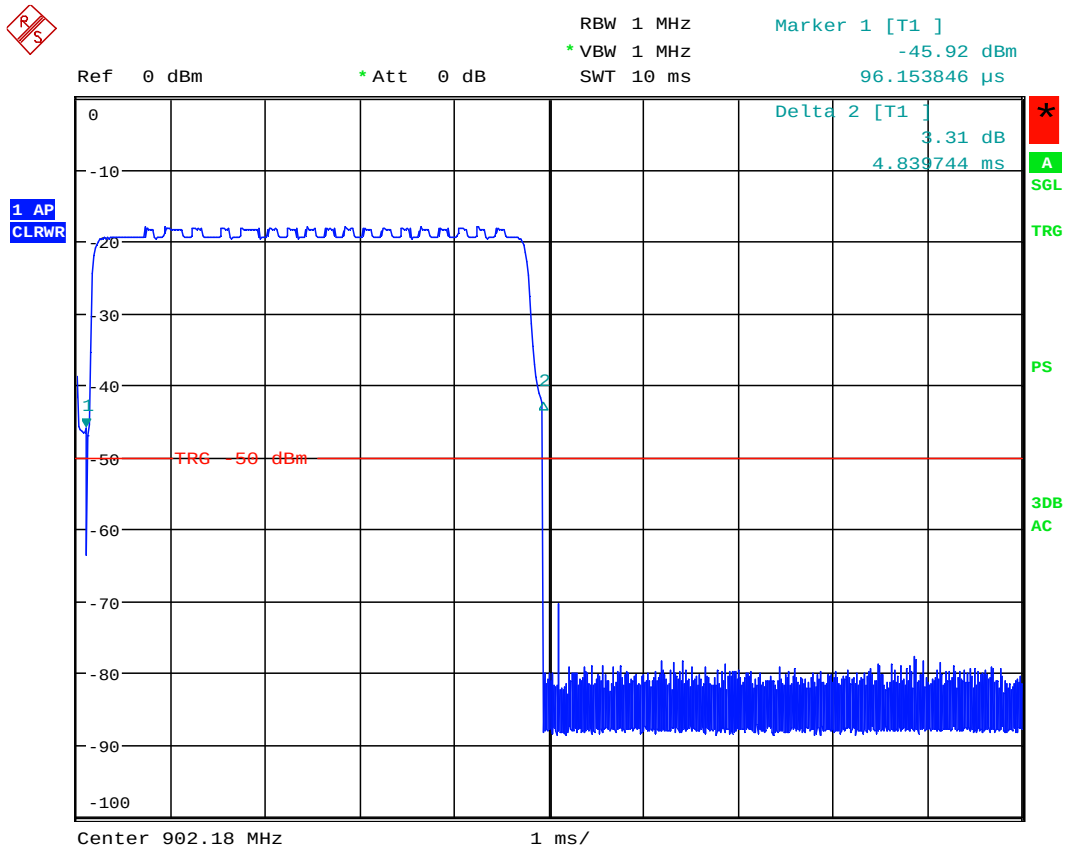

Figure 22: Time of Occupancy per Pulse = 4.84ms

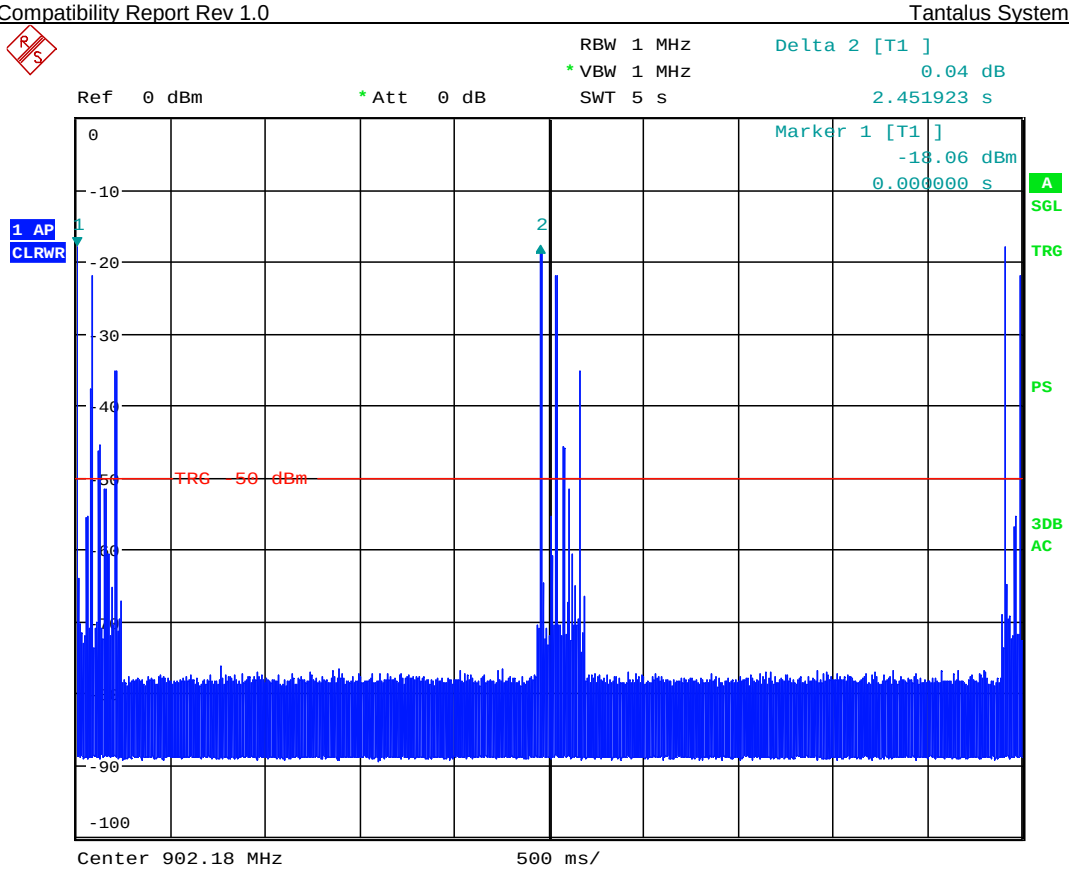

Figure 23: Measured Interval Between 2 Pulses = 2.45s

Channel Bandedge – 20kHz Frequency Deviation

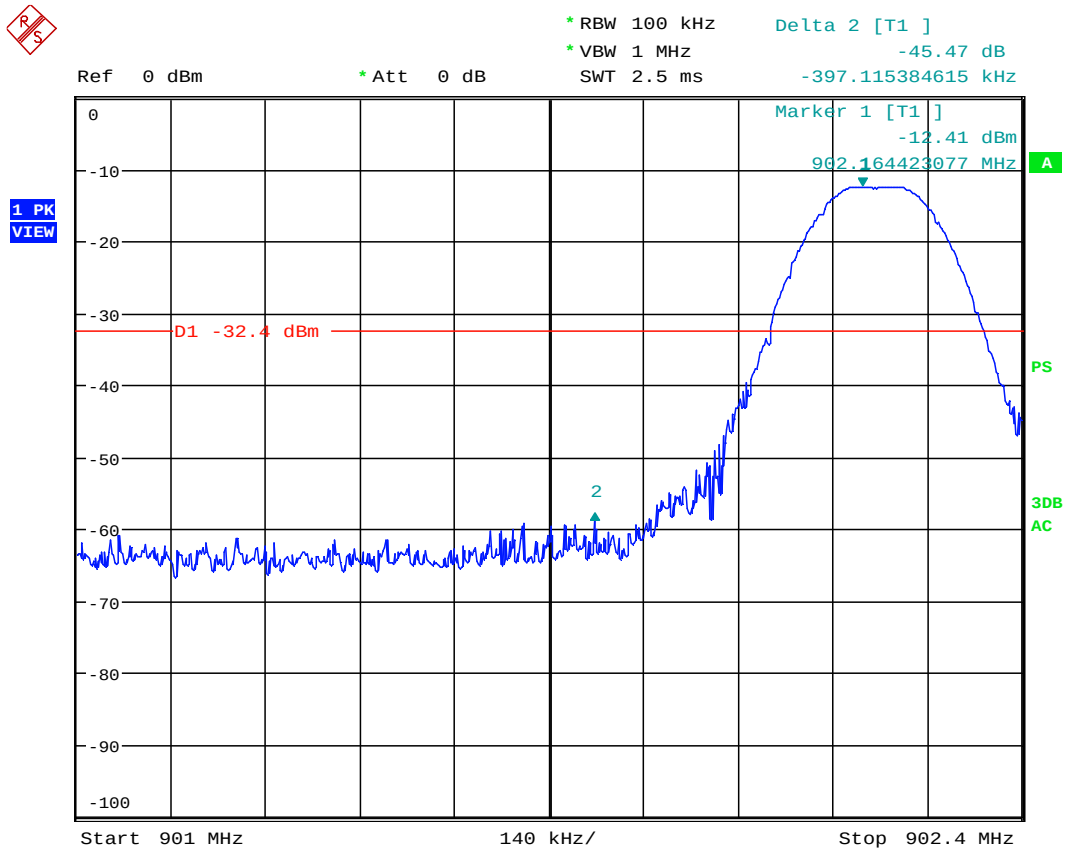

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Figure 24: Low Channel Bandedge - Nonhopping Plot

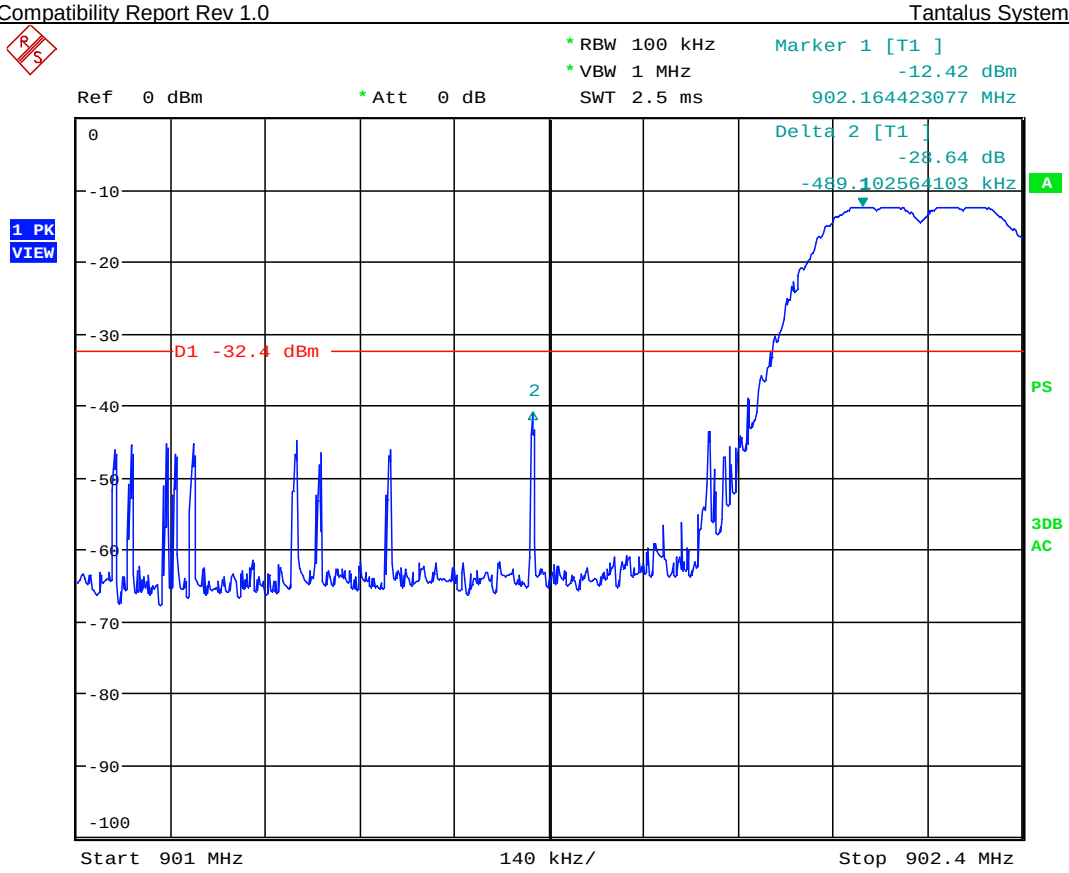

Figure 25: Low Channel Bandedge - Hopping Plot

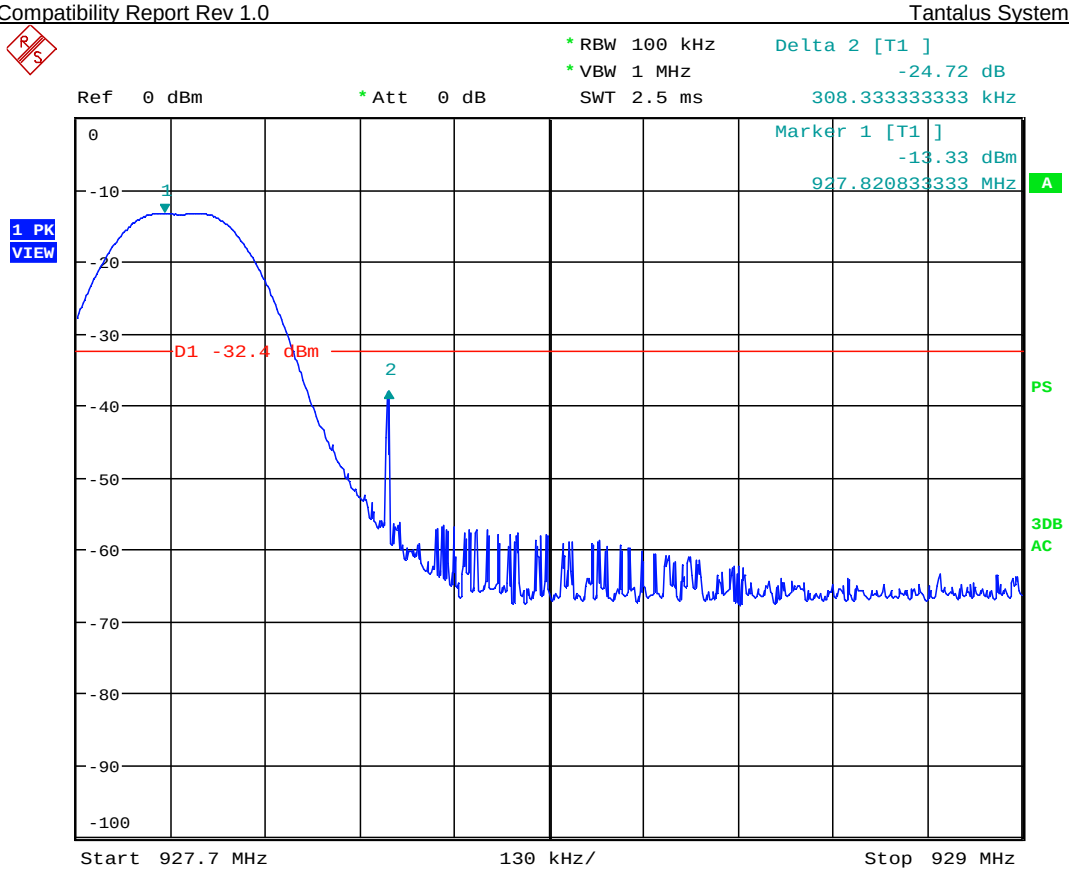

Figure 26: High Channel Bandedge - Nonhopping Plot

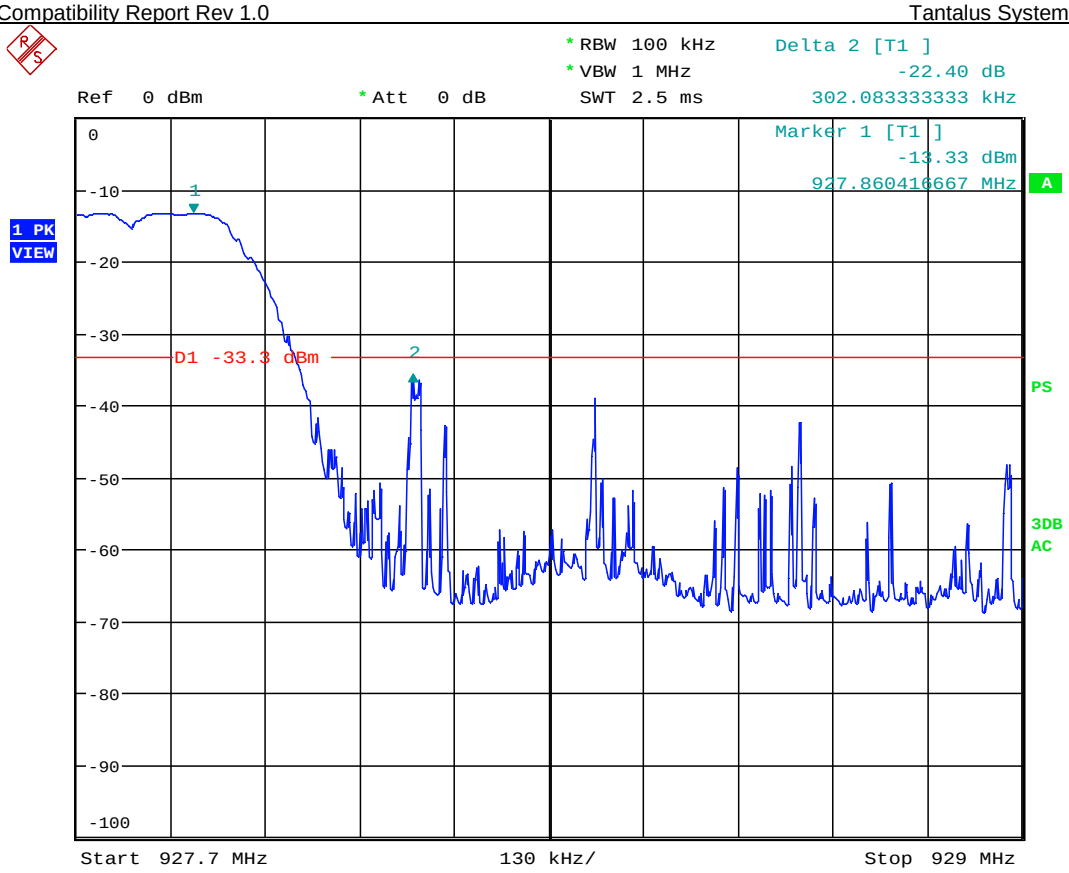

Figure 27: High Channel Bandedge - Hopping Plot

Channel Bandedge – 40kHz Frequency Deviation

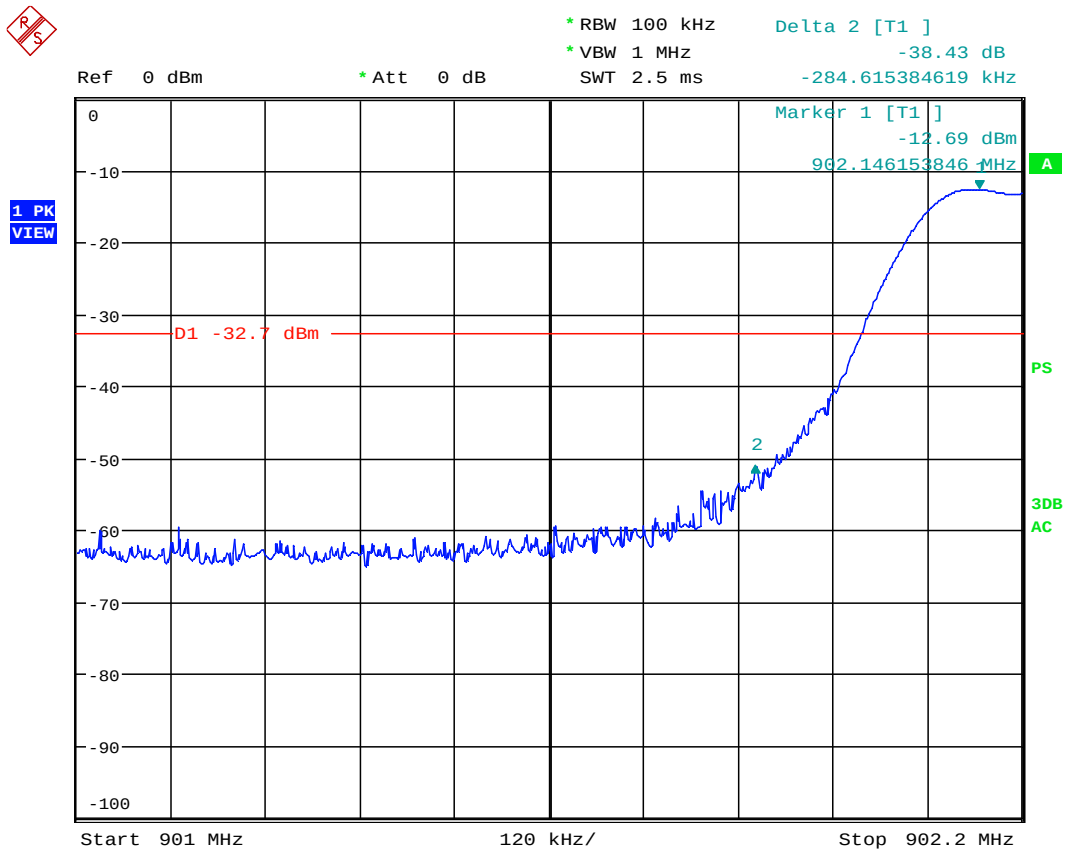

Figure 28: Low Channel Bandedge – Nonhopping Plot

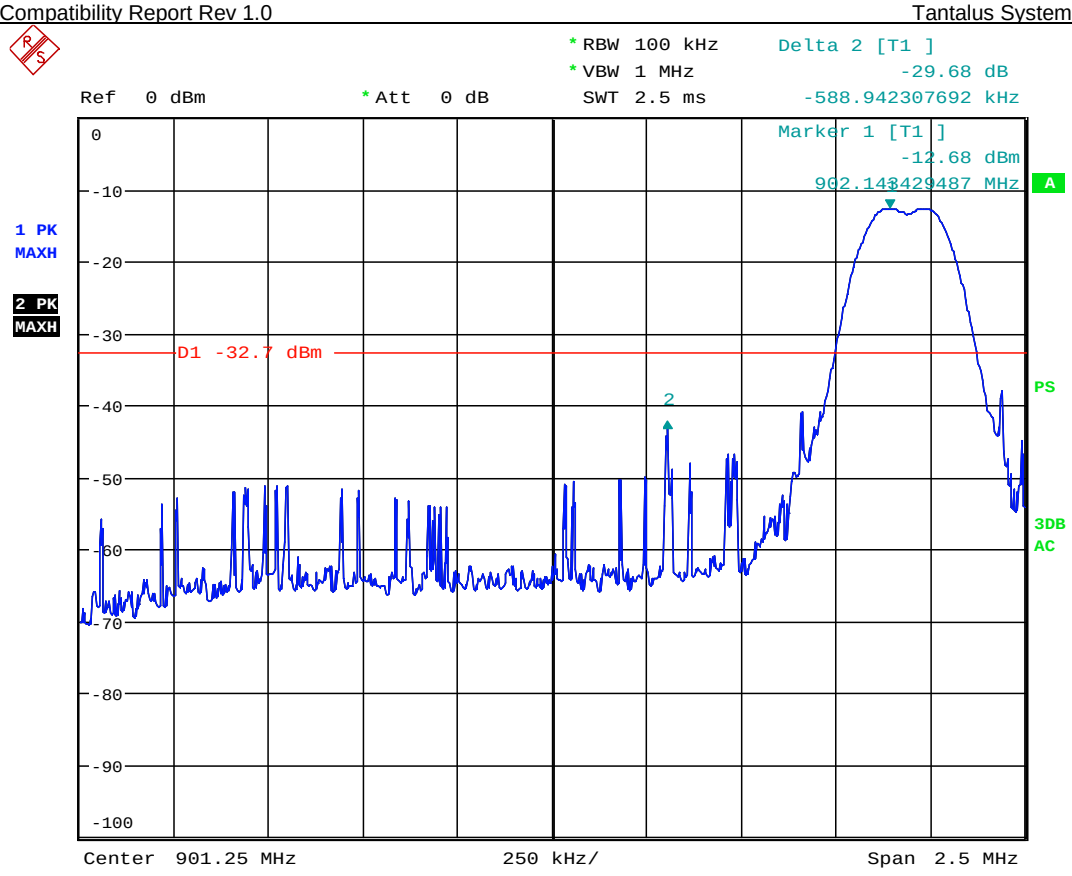

Figure 29: Low Channel Bandedge - Hopping Plot

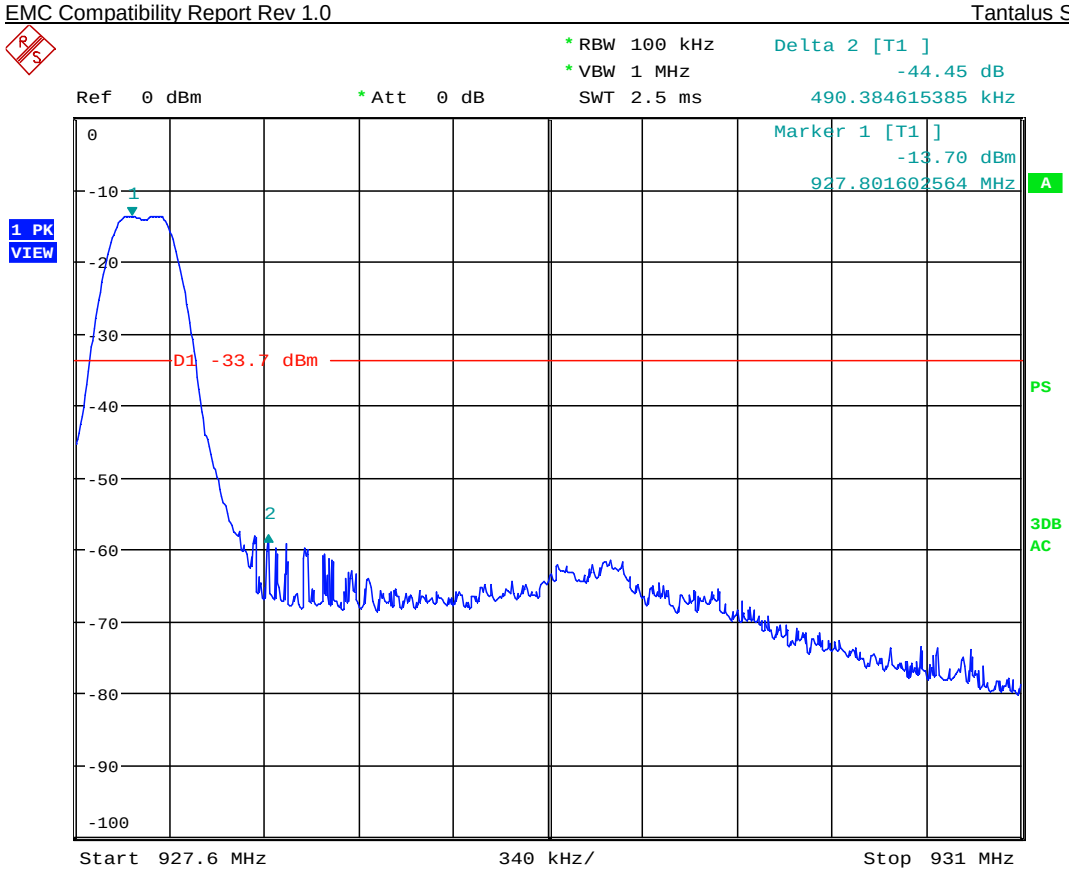

Figure 30: High Channel Bandedge - Nonhopping Plot

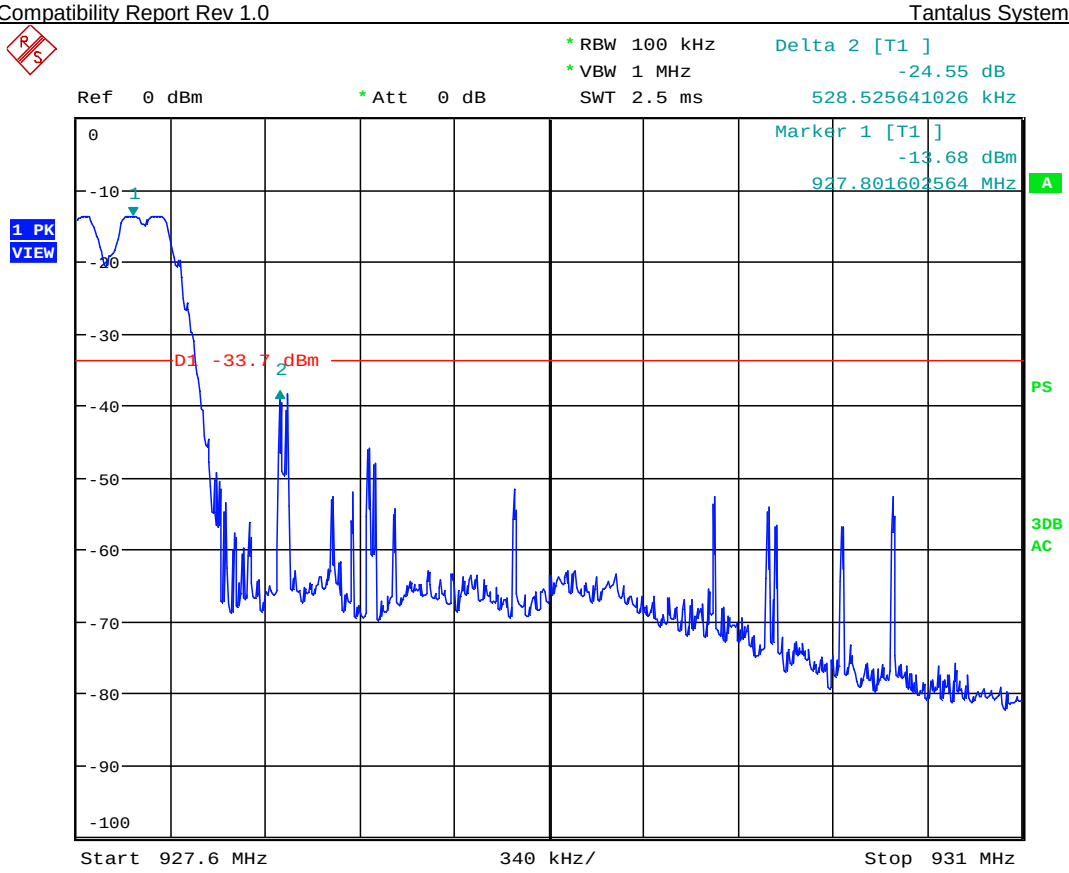

Figure 31: High Channel Bandedge - Hopping Plot

Measurement Settings for Harmonics at 3m:

RBW: 1MHz
VBW: 1MHz for Peak Measurements, 10Hz for Average Measurements
Span: 10MHz

NOTE: For this product, the EUT worst case "ON" time was measured on Figure 22 to be 4.84ms per 100ms. This equates to a possible duty cycle correction factor of -26.3dB, which is added to the Restricted Band Limit column in Table 7 to Table 9.

Table 7: Lower Frequency Worst Case Emissions Data

Restricted Band Freq. (MHz)	Corrected Peak (dBµV/m)	Corrected Average (dBµV/m)	Ant. Orient	Ant. Height	Table Orient (Deg)	Restricted Band Peak Limit (dBµV/m)	Restricted Band Average Limit (dBµV/m)	Duty Cycle Correction Factor	Peak Margin (dB)	Average Margin (dB)
2706.537	71.6	56.4	H	100	125	74	54	26.3	2.4	23.9
3608.715	69.7	54.9	H	125	0	74	54	26.3	4.3	25.4
4510.894	65.3	45.5	H	129	261	74	54	26.3	8.7	34.8
5413.073	64.9	37.5	H	115	256	74	54	26.3	9.1	42.8
8119.609	73.5	42.5	H	140	289	74	54	26.3	0.5	37.8
9021.788	65.5	45.5	H	100	243	74	54	26.3	8.5	34.8

Non-Restricted Band Freq. (MHz)	Corrected Peak (dBµV/m)	Corrected Average (dBµV/m)	Ant. Orient	Ant. Height	Table Orient (Deg)	Non-Restricted Band Peak Limit (dBµV/m)	Non-Restricted Band Average Limit (dBµV/m)	Duty Cycle Correction Factor	Peak Margin (dB)	Average Margin (dB)
902.1788	115.3	102	H	129	16	N/A	N/A	26.3	N/A	N/A
1804.357	71.8	58.4	V	157	86	95.3	54	26.3	23.5	21.9
6315.251	65.6	48.7	H	100	283	95.3	54	26.3	29.7	31.6
7217.429	73.1	51.8	H	101	294	95.3	54	26.3	22.2	28.5

Measurement Settings for Harmonics at 3m:

RBW: 1MHz
VBW: 1MHz for Peak Measurements, 10Hz for Average Measurements
Span: 10MHz

NOTE: For this product, the EUT worst case "ON" time was measured on Figure 22 to be 4.84ms per 100ms. This equates to a possible duty cycle correction factor of -26.3dB, which is added to the Restricted Band Limit column in Table 7 to Table 9.

Table 8: Middle Frequency Worst Case Emissions Data

Restricted Band Freq. (MHz)	Corrected Peak (dBµV/m)	Corrected Average (dBµV/m)	Ant. Orient	Ant. Height	Table Orient (Deg)	Restricted Band Peak Limit (dBµV/m)	Restricted Band Average Limit (dBµV/m)	Duty Cycle Correction Factor	Peak Margin (dB)	Average Margin (dB)
2745.024	73.3	58.1	H	160	126	74	54	26.3	0.7	22.2
3660.319	71.4	55.1	H	119	317	74	54	26.3	2.6	25.2
4575.039	65.9	50.7	H	130	316	74	54	26.3	8.1	29.6
7320.063	69.2	47.2	H	100	294	74	54	26.3	4.8	33.1
8235.07	73.5	45.0	H	100	279	74	54	26.3	0.5	35.3
9150.078	66.7	46.5	H	100	85	74	54	26.3	7.3	33.8

Non-Restricted Band Freq. (MHz)	Corrected Peak (dBµV/m)	Corrected Average (dBµV/m)	Ant. Orient	Ant. Height	Table Orient (Deg)	Non-Restricted Band Peak Limit (dBµV/m)	Non-Restricted Band Average Limit (dBµV/m)	Duty Cycle Correction Factor	Peak Margin (dB)	Average Margin (dB)
915.007	115.8	102.3	V	100	307	N/A	N/A	26.3	N/A	N/A
1830.001	75.4	62.9	H	145	33	95.8	54	26.3	20.4	17.4
5490.472	65.8	43.8	H	121	353	95.8	54	26.3	30.0	36.5
6405.055	68.5	51.0	H	102	276	95.8	54	26.3	27.3	29.3

Measurement Settings for Harmonics at 3m:
RBW: 1MHz
VBW: 1MHz for Peak Measurements, 10Hz for Average Measurements
Span: 10MHz

NOTE: For this product, the EUT worst case "ON" time was measured on Figure 22 to be 4.84ms per 100ms. This equates to a possible duty cycle correction factor of -26.3dB, which is added to the Restricted Band Limit column in Table 7 to Table 9.

Table 9: Upper Frequency Worst Case Emissions Data

Restricted Band Freq. (MHz)	Corrected Peak (dBµV/m)	Corrected Average (dBµV/m)	Ant. Orient	Ant. Height	Table Orient (Deg)	Restricted Band Peak Limit (dBµV/m)	Restricted Band Average Limit (dBµV/m)	Duty Cycle Correction Factor	Peak Margin (dB)	Average Margin (dB)
2783.514	71.2	55.4	H	113	102	74	54	26.3	2.8	24.9
3711.35	71.8	58.2	H	133	87	74	54	26.3	2.2	22.1
4639.188	66.1	50.7	H	114	305	74	54	26.3	7.9	29.6
7422.699	69.3	47.9	H	160	294	74	54	26.3	4.7	32.4
8350.534	70.0	44.8	H	180	303	74	54	26.3	4.0	35.5

Non-Restricted Band Freq. (MHz)	Corrected Peak (dBµV/m)	Corrected Average (dBµV/m)	Ant. Orient	Ant. Height	Table Orient (Deg)	Non-Restricted Band Peak Limit (dBµV/m)	Non-Restricted Band Average Limit (dBµV/m)	Duty Cycle Correction Factor	Peak Margin (dB)	Average Margin (dB)
927.836	116.5	109.3	H	129	19	N/A	N/A	26.3	N/A	N/A
1855.672	76.8	67.7	H	165	34	96.5	54	26.3	19.7	12.6
5567.024	65.3	46.0	H	112	10	96.5	54	26.3	31.2	34.3
6494.86	70.0	48.7	H	110	263	96.5	54	26.3	26.5	31.6
9278.371	63.9	43.5	H	174	24	96.5	54	26.3	32.6	36.8

Appendix B: Test Setup Photos

Figure 32 - AC Conducted Test Setup - Front View

Figure 33 - Emissions Test Setup – Radiated Emissions

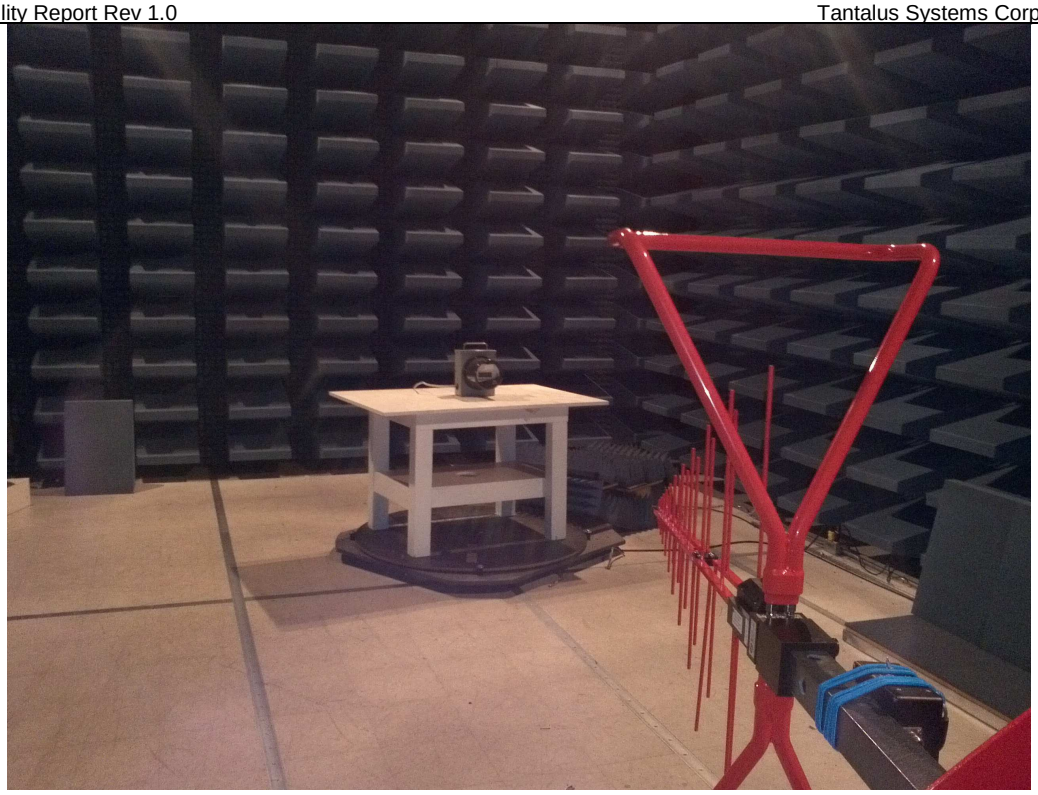

Figure 34 - Emissions Test Setup – Unintentional Radiated Emissions