Emissions
Test Report

EUT Name: Sensor Unit of the Angle Detection System

Model No.: ADS 410

CFR 47 Part 15.247: 2018 and RSS 247: 2017

Prepared for:

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Requester / Applicant:	Mr. Kosoric
Name of Equipment:	Sensor Unit of the Angle Detection System
Model No.	ADS 410
Type of Equipment:	Intentional Radiator
Application of Regulations:	CFR 47 Part 15.247: 2018 and RSS 247: 2017
Test Dates:	November 20, 2017 to November 22, 2017

Guidance Documents:

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v04

Test Methods:

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v04

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TUV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the Executive Summary of this report.

This report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government. This report shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.

Colton Aliff		Josie Sabado	
Test Engineer	Date June 21, 2018	A2LA Signatory	Date June 21, 2018

Testing Cert #3331.02 **US1131** **2932M-1**

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1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.247: 2018 and RSS 247: 2017 based on the results of testing performed on November 20, 2017 to November 22, 2017 on the Sensor Unit of the Angle Detection System Model ADS 410 manufactured by Dragan Technologies, Inc. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

The Display Unit (FCC ID: 2AODQ1DK207A8 IC: 23492-18DKJ1032A1) as well as the Sensor Unit (FCC ID: 2AODQ1DK207S4 IC: 23492-18DKJ1032S4) of the Angle Detection System "ADS 410" under assessment contain the same radio portion. Therefore all conducted test results from testing of the Display Unit are leveraged for separate certification of the Sensor Unit. Radiated Spurious Emissions was performed with a test set-up comprising the complete ADS with both units since this represents the intended and only possible use condition. The units cannot operate as intended while separated.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report. The 902 MHz to 928 MHz frequency band is covered in this document.

The Display Unit of the Angle Detection System was deemed to be the worst case EUT in all tests. The data in this report reflects the worst case test setup, as well as the similarities of both units in the combined ADS 410. Both units were tested together as a system, as they cannot operate as intended while separated.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.4	Test Parameters (Measured)	Result
Spurious Emission in Transmit Mode	CFR47 15.209, RSS-GEN Sect.8.9	Class B	**Complied**
Restricted Bands of Operation	CFR47 15.205, RSS GEN Sect.8.10	Class B	**Complied**
AC Power Conducted Emission	CFR47 15.207, RSS-GEN Sect.8.8	Class B	**Complied**
Occupied Bandwidth	CFR47 15.247 (a2), RSS 247 Sect. 5.2.1	See plots	**Complied**
Maximum Output Power	CFR47 15.247 (b), RSS 247 Sect. 5.4.4	10.328 dBm	**Complied**
Peak Power Spectral Density	CFR47 15.247 (e), RSS 247 Sect. 5.2.2	4.84 dBm/3kHz	**Complied**
Out of Band Emission	CFR47 15.247 (d), RSS 247 Sect.5.5	30 MHz - 10 GHz < -29.72 dBm/100kHz	**Complied**

Note: This test report covers 902 MHz to 928 MHz band.

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

None

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America EMC test facilities located at 1279 Quarry Lane, Ste. A, Pleasanton, CA, 94566, and 5015 Brandin Court, Fremont, CA 94538, are recognized by the Commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Pleasanton Registration No. US1131). The laboratory Scopes of Accreditation include Title 47 CFR Parts 15, 18 and 90. The accreditations are updated every three years.

2.1.2 A2LA

TUV Rheinland of North America EMC test facilities are accredited by the American Association for Laboratory Accreditation (A2LA). The laboratories have been assessed and accredited by A2LA in accordance with ISO Standard 17025:2005 (Testing Certificate #3331.02). The Scope of Laboratory Accreditation includes emission and immunity testing. The accreditations are updated annually.

2.1.3 Industry Canada

The Pleasanton 5-meter Semi-Anechoic Chamber, Registration No. 2932M-1, has been accepted by Industry Canada to perform testing to 3 and 5 meters based on the test procedures described in ANSI C63.4-2009.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America EMC test facilities located at 1279 Quarry Lane, Ste. A, Pleasanton, CA, 94566, and 5015 Brandin Court, Fremont, CA 94538, have been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0268

2.1.5 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 1279 Quarry Ln, Pleasanton, CA 94566 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 Test Facilities

Test facilities are located at 1279 Quarry Lane, Ste. A, Pleasanton, California 94566, U.S.A. and 5015 Brandin Court, Fremont, CA 94538, U.S.A. (Fremont is the Pleasanton Annex).

2.2.1 Emission Test Facility

The Semi-Anechoic Chambers and AC Line Conducted measurement facilities used to collect radiated and conducted emissions data have been constructed in accordance with ANSI C63.7:1992. The Fremont 10 meter semi-anechoic chamber has been measured in accordance with and verified to comply with the theoretical volumetric normalized site attenuation of ANSI C63.4:2014 and SVSWR requirements of CISPR 16-1-4 Consol. Ed. 3.0 (2010-04), at test distances of 3 and 10 meters. The site is listed with the FCC and accredited by A2LA (Testing Certificate #3331.02). The Pleasanton 5 meter semi-anechoic chamber has been verified to comply with the theoretical volumetric normalized site attenuation of ANSI C63.4:2014 and SVSWR requirements of CISPR 16-1-4 Consol. Ed. 3.0 (2010-04) at a test distance of 3 meters. The site is listed with the FCC and accredited by A2LA (Testing Certificate #3331.02).

2.2.2 Immunity Test Facility

ESD, EFT, Surge, PQF: These tests are performed in an environmentally controlled room with a 3.7 m x 3.7 m x 3.175 mm thick aluminum floor connected to PE ground. For ESD testing, tabletop equipment is placed on an insulated mat with a surface resistivity of 109 Ohms/square on a 1.6 m x 0.8 m x 0.8 m high non-conductive table with a 3.175 mm copper top (Horizontal Coupling Plane). The HCP is connected to the main ground plane via a low impedance ground strap through two 470 kΩ resistors. The Vertical Coupling Plane consists of an aluminum plate 50 cm x 50 cm x 3.175 mm thick. The VCP is connected to the main ground plane via a low impedance ground strap through two 470 kΩ resistors. For each of the other tests, the HCP is removed.

RF Field Immunity testing is performed in a 5m or 10m semi-anechoic chamber with absorber added to floor.

RF Conducted and Magnetic Field Immunity testing is performed on a 4.9 m x 3.7 m x 3.175 mm thick aluminum ground plane which is connected to one end of the anechoic chamber.

All test areas allow a minimum distance of 1 meter from the EUT to walls or conducting objects.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities; it is equal to the positive square root of the sum of the variances or co-variances of these other quantities, weighted according to how the measurement result varies with changes in these quantities. The term *standard uncertainty* is the result of a measurement expressed as a standard deviation.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.2 Measurement Uncertainty

Per CISPR 16-4-2	**U_{lab}**	**U_{cispr}**
Radiated Disturbance @ 10 meters		
30 – 1,000 MHz	2.25 dB	4.51 dB
Radiated Disturbance @ 3 meters		
30 – 1,000 MHz	2.26 dB	4.52 dB
1 – 6 GHz	2.12 dB	4.25 dB
6 – 18 GHz	2.47 dB	4.93 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	1.09 dB	2.18 dB

Disturbance Power		
30 MHz – 300 MHz	3.92 dB	4.3 dB

Voltech PM6000A

The estimated combined standard uncertainty for harmonic current and flicker measurements is ± 5.0%.	Per CISPR 16-4-2 Methods

2.3.3 Measurement Uncertainty Immunity

The estimated combined standard uncertainty for ESD immunity measurements is ± 8.2%.	Per IEC 61000-4-2
The estimated combined standard uncertainty for radiated immunity measurements is ± 4.10 dB.	Per IEC 61000-4-3
The estimated combined standard uncertainty for conducted immunity measurements with CDN is ± 3.66 dB	Per IEC 61000-4-6
The estimated combined standard uncertainty for power frequency magnetic field immunity is ± 2.9%.	Per IEC 61000-4-8

Thermo KeyTek EMC Pro

The estimated combined standard uncertainty for EFT fast transient immunity measurements is ± 2.6%.
The estimated combined standard uncertainty for surge immunity measurements is ± 2.6%.
The estimated combined standard uncertainty for voltage variation and interruption measurements is ± 1.74%.

The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

3 Product Information

3.1 Product Description

The Model ADS 410, Sensor Unit of the Angle Detection System, is a portable system used in the mining industry capable of operating on one channel at 915 MHz.

3.2 Equipment Configuration

A description of the equipment configuration is given in the Test Plan Section. The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was connected to rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of an EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation.

The final configuration was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.3 Operating Mode

A description of the operation mode is given in the Test Plan Section. In the case of an EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

The final operating mode was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.4 Unique Antenna Connector

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 CFR47 Parts 15.211, 15.213, 15.217, 15.219, or 15.221.

3.4.1 Results

The Sensor Unit of the Angle Detection System employs a Dipole which is externally connected through Reverse Polarity SMA (RP-SMA) connector.

Refer to Table 10 for additional antenna information.

4 Emissions

Testing was performed in accordance with CFR 47 Part 15.247: 2018 and RSS 247: 2017. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

4.1 Output Power Requirements

The maximum output power requirement is the maximum conducted power delivered to the transmitting antenna under specified conditions of measurements in the presence of modulation.

The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b):2018 and RSS 247: 2017 Sect. 5.4.4.

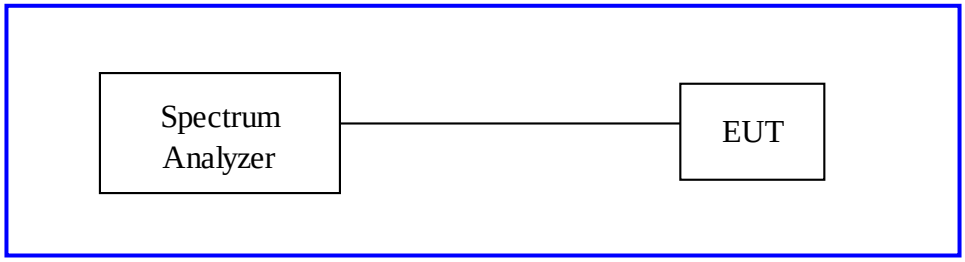
The maximum transmitted powers are:

Band 902 - 928 MHz: 1 W

4.1.1 Test Method

The Display unit was used in this test, the radio and RF path are identical for both units.

Test Setup:



The method described in section 9.1.1 of "KDB 558074 – DTS Measurement Guidance v04" applies and was used.

4.1.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 2: RF Output Power at the Antenna Port – Test Results

Test Conditions: Conducted Measurement, Normal Temperature				
Antenna Type: external dipole (RP-SMA)		**Power Setting:** See test plan		
Max. Directional Gain: +1.2 dBi				
Signal State: Modulated at 100%.				
Ambient Temp.: 24° C		**Relative Humidity:** 39%		
Operating Channel (MHz)	**Measured Power [dBm]**	**Limit [dBm]**	**Margin [dB]**	**Supplied Voltage [% of Nominal]**
914.75	10.238	30.00	-19.122	85%
914.75	10.27	30.00	-19.13	100%
915.00	10.328	30.00	-19.672	115%
Note: Note: All insertion loss corrections are accounted for in the measurement plots.				

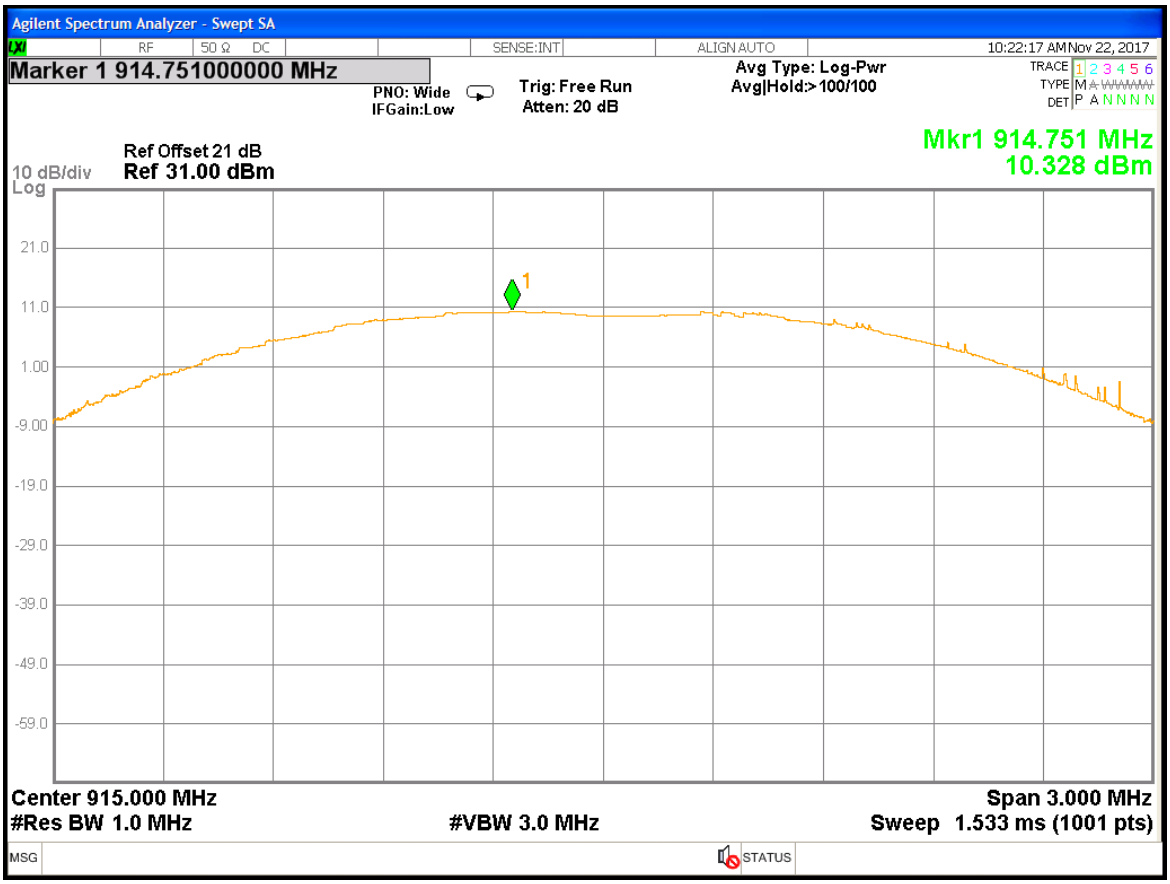


Figure 1 : Maximum peak conducted output power, 915MHz (85%)

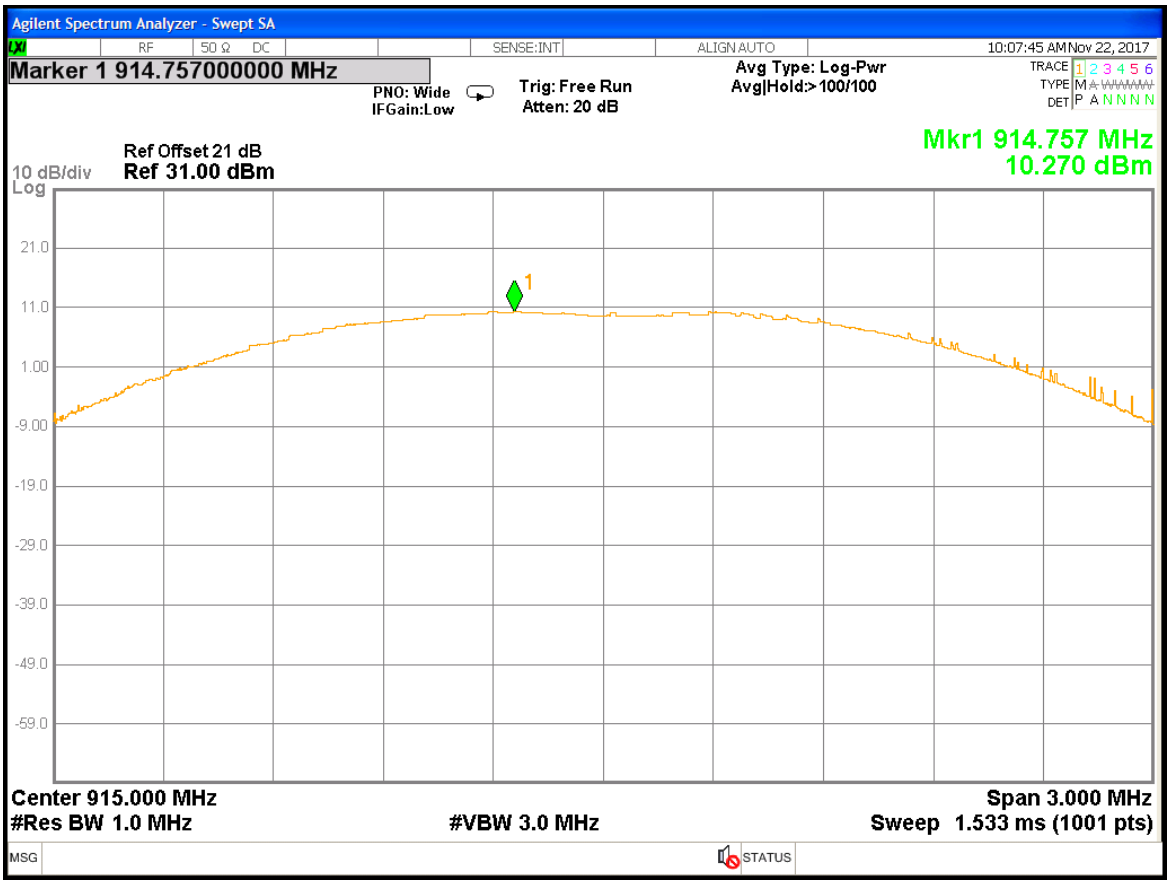


Figure 2 : Maximum peak conducted output power, 915 MHz (100%)

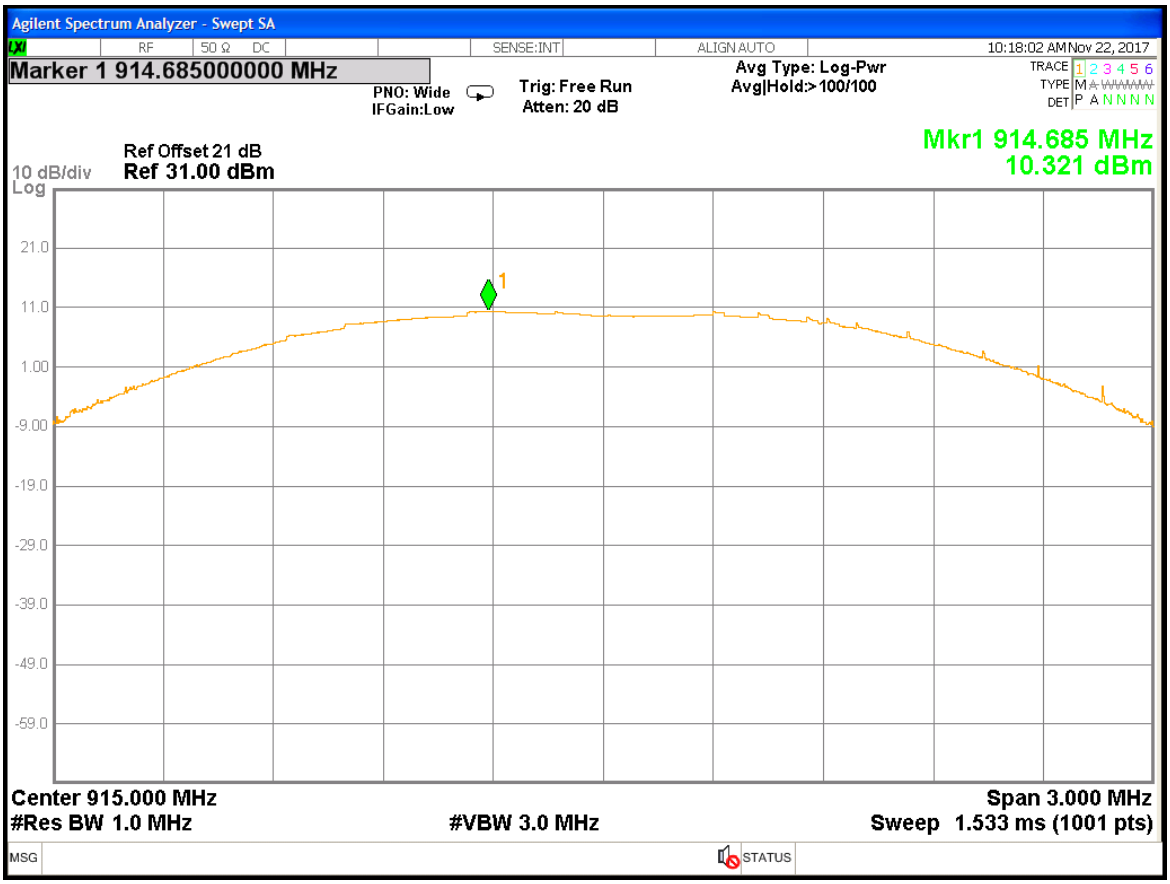


Figure 3 : Maximum peak conducted output power, 915 MHz (115%)

4.2 Occupied Bandwidth

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

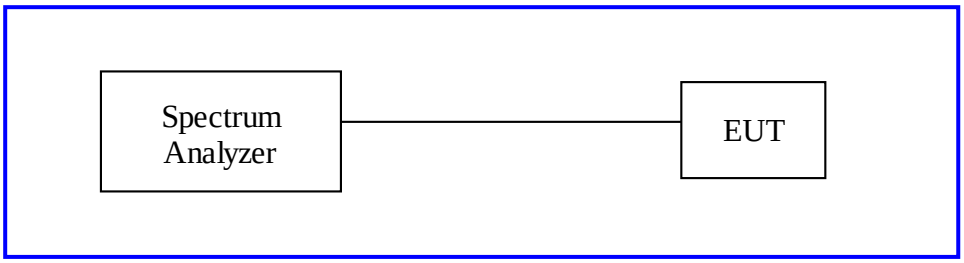
The minimum 6 dB bandwidth shall be at least 500 kHz.

4.2.1 Test Method

The Display unit was used in this test, the radio and RF path are identical for both units.

The conducted method was used to measure the occupied bandwidth according to ANSI C63.10:2013 Section 11.8. The measurement was performed with modulation per CFR47 15.247(a)(2) 2018 and RSS 247 Sect. 5.2.1:2017. Measurements were performed on 1 channel of 915 MHz, a 6 dB bandwidth was used.

Test Setup:



4.2.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 3: Occupied Bandwidth – Test Results

Test Conditions: Conducted Measurement, Normal Temperature		
Antenna Type: external dipole (RP-SMA)		**Power Setting:** See test plan
Signal State: Modulated at 100%.		
Ambient Temp.: 24° C		**Relative Humidity:** 39%
Bandwidth (MHz)		
Freq. (MHz)	**6dB Bandwidth (kHz)**	**99% Bandwidth (KHz)**
915	661.8	772.21
Note: None		

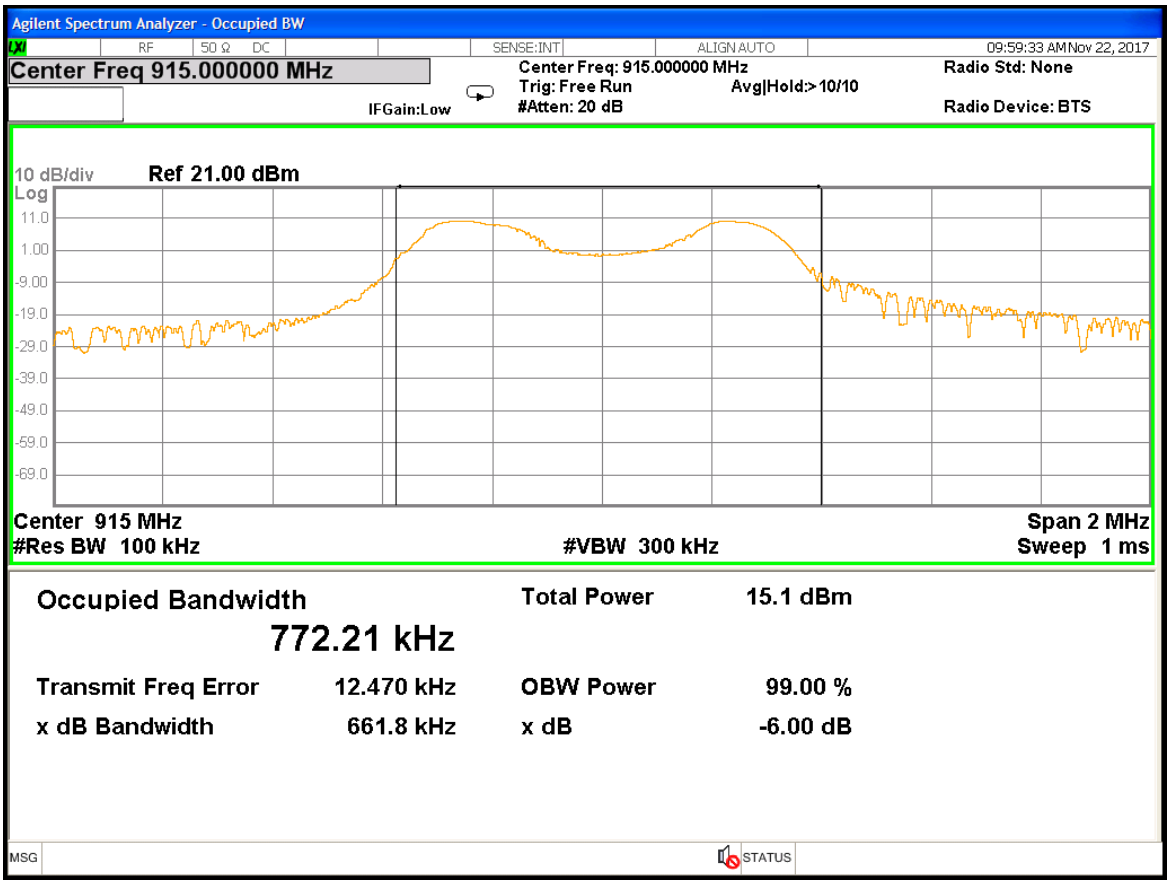


Figure 4 : 6dB & 99% Occupied Bandwidth, 915 MHz

4.3 Peak Power Spectral Density

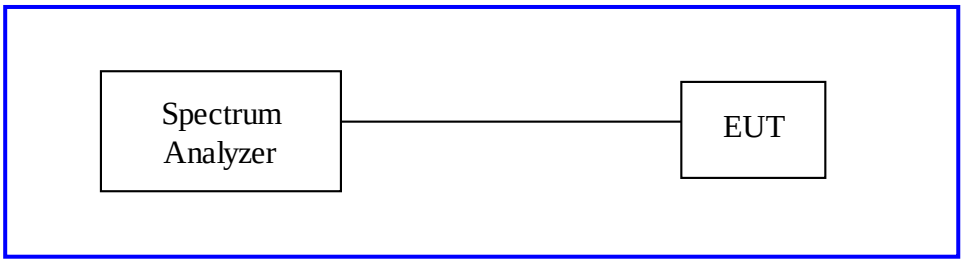
According to the CFR47 Part 15.247 (e) and RSS 247 Sect.5.2.2, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

4.3.1 Test Method

The Display unit was used in this test, the radio and RF path are identical for both units.

The conducted method was used to measure the channel power output per ANSI C63.10-2013 Section 11.10.2. The measurement was performed with modulation per CFR47 Part 15.247 (e) and RSS 247 Sect.5.2.2.

Test Setup:



4.3.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 4: Peak Power Spectral Density – Test Results

Test Conditions: Conducted Measurement, Normal Temperature				
Antenna Type: external dipole (RP-SMA)			**Power Setting:** See test plan	
Signal State: Modulated at 100%.				
Ambient Temp.: 24° C			**Relative Humidity:** 39%	
Peak Power Spectral Density				
Freq. (MHz)	**Measured PSD [dBm/100kHz]**	**Calculated PSD [dBm/3kHz]**	**Limit [dBm/3kHz]**	**Margin [dB]**
915	10.39	-4.84	8	-12.84
Note: All insertion loss corrections are accounted for in the measurement plots. 2. PSD (dBm/100kHz) is used to calculate PSD (dBm/3kHz) using the following formula: PSD (dBm/3kHz) = PSD (dBm/100kHz) – 15.23dB.				

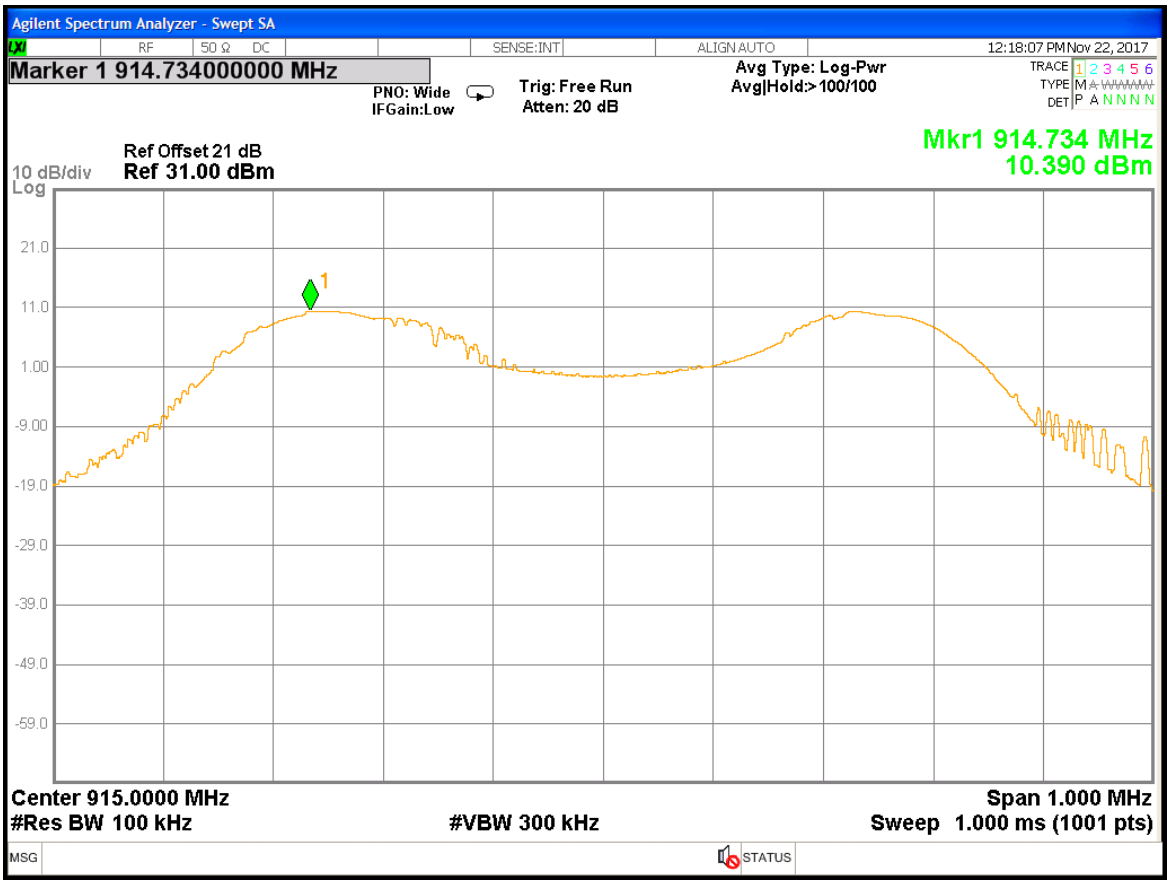


Figure 5: Power Spectral Density, 915 MHz

4.4 Out of Band Emissions

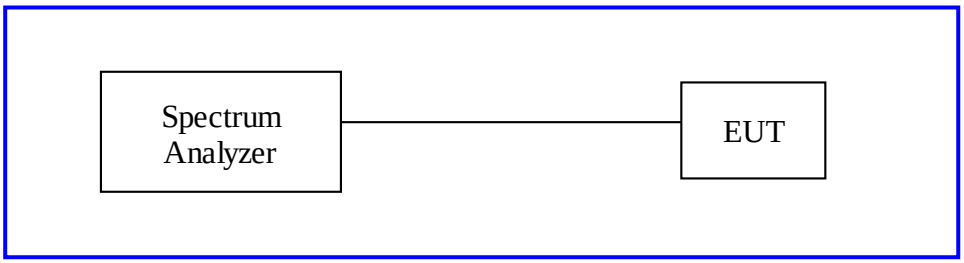
Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmitting mode; per requirement of CFR47 15.247(d), RSS-247 Sect. 5.5.

4.4.1 Test Method

The Display unit was used in this test, the radio and RF path are identical for both units.

The conducted method was used to measure the undesirable emission requirement.

Test Setup:



The method described in section 11 of "KDB 558074 – DTS Measurement Guidance v04" applies and was used.

4.4.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 5: Out of Band Emissions including the Band-Edge – Test Results

Test Conditions: Conducted Measurement, Normal Temperature					
Antenna Type: external dipole (RP-SMA)			**Power Setting:** See test plan		
Signal State: Modulated					
Ambient Temp.: 24° C			**Relative Humidity:** 39%		
Non-Restricted Frequency Band Emissions					
Operating Freq. (MHz)	**Measured Freq. (MHz)**	**Measured (dBm)**	**Limit (dBm)**	**Plot**	**Result**
915	29.49	-52.605	-9.61	6	Pass
915	932.67	-45.53	-9.61	7	Pass
915	4.825	-43.284	-9.61	8	Pass
Note:					

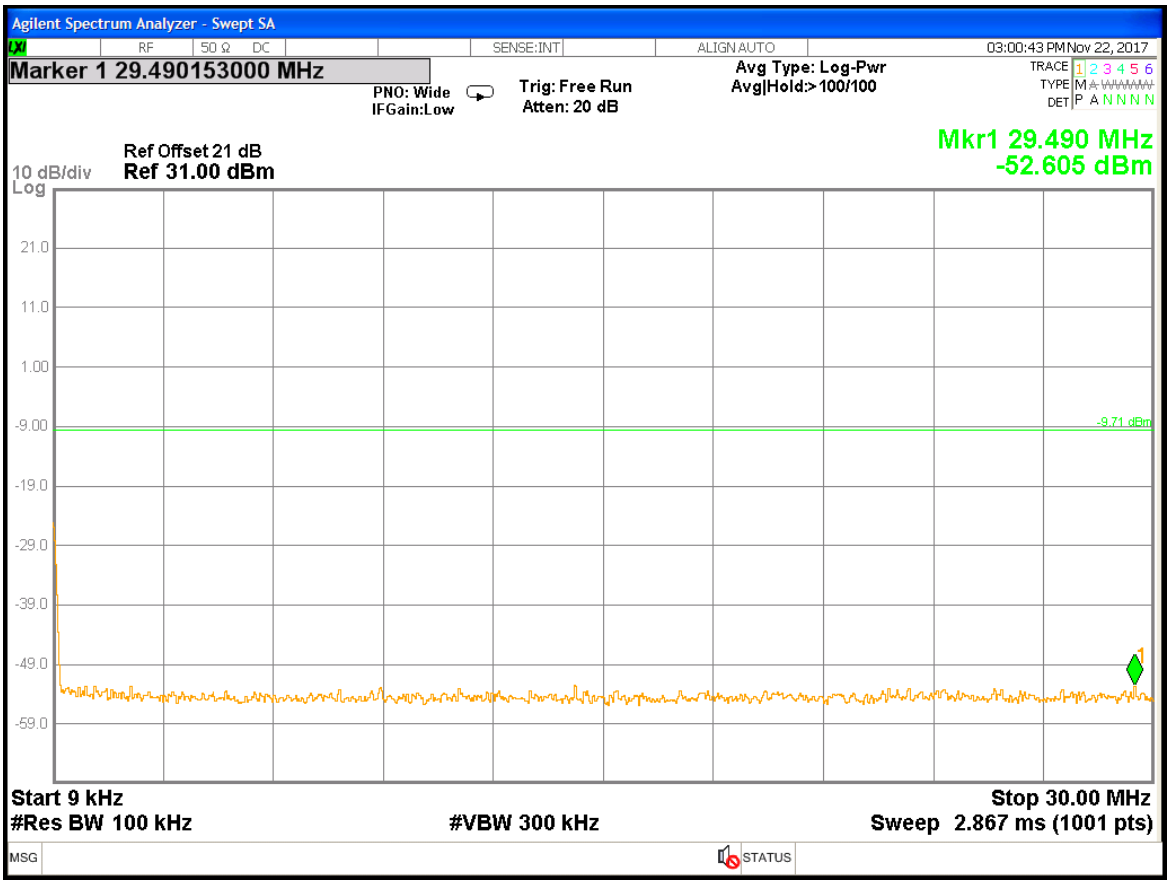


Figure 6: Out of Band Emissions at 915 MHz, .009-30MHz

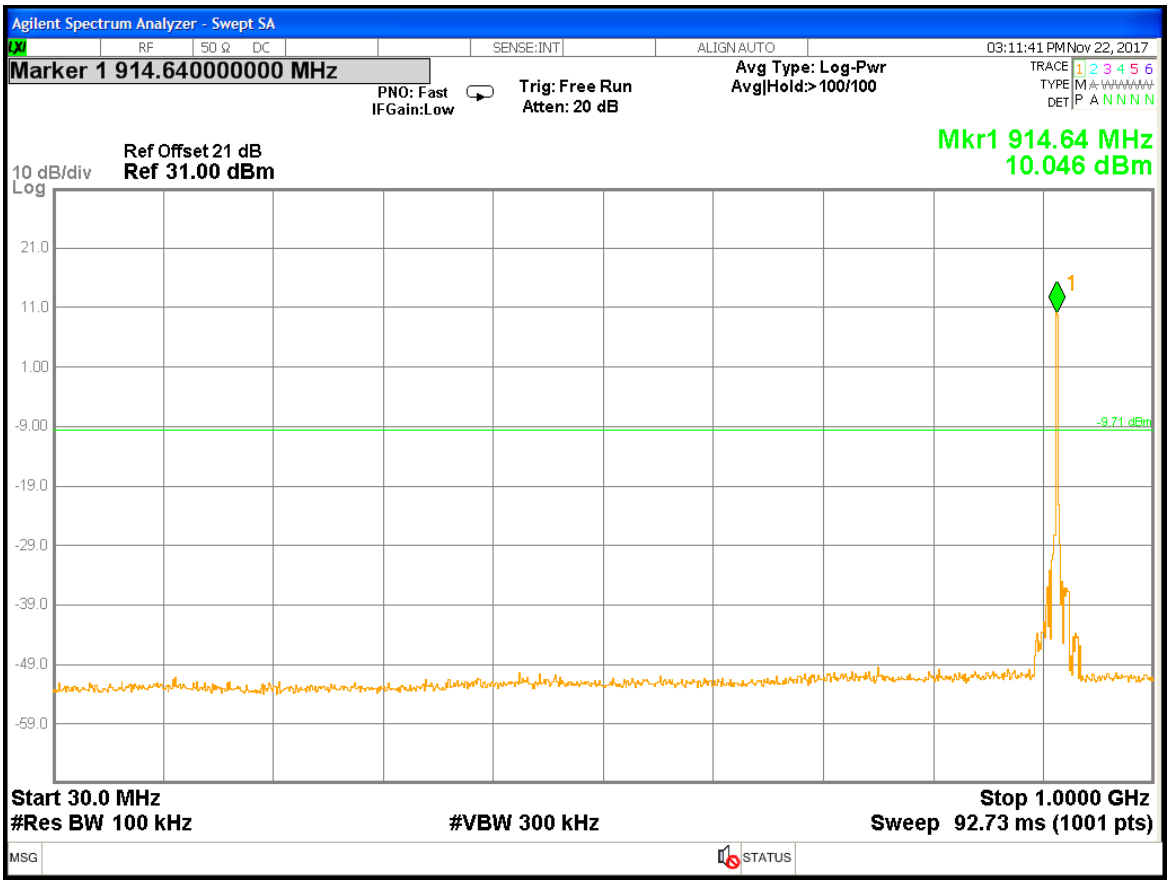


Figure 7: Out of Band Emissions at 915 MHz, 30-1000MHz

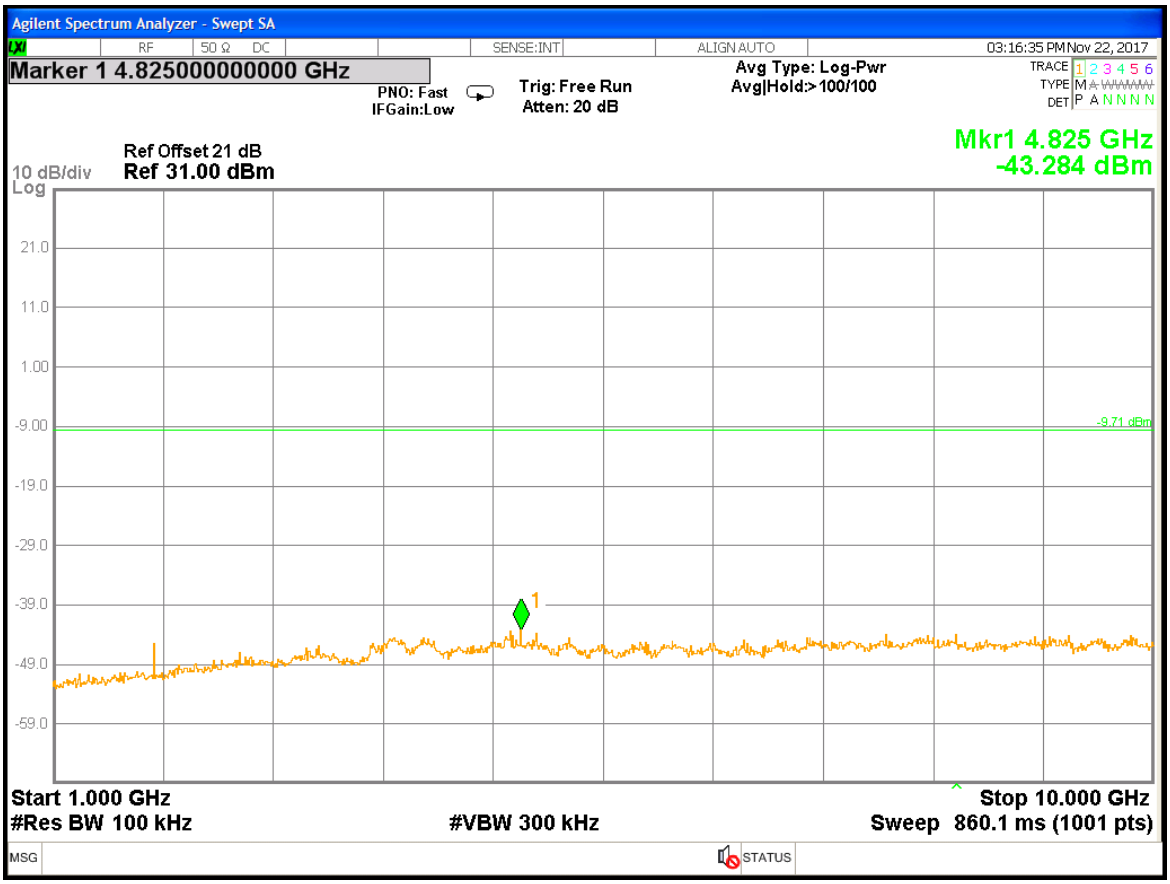


Figure 8: Out of Band Emissions at 915 MHz, 1000-1000MHz

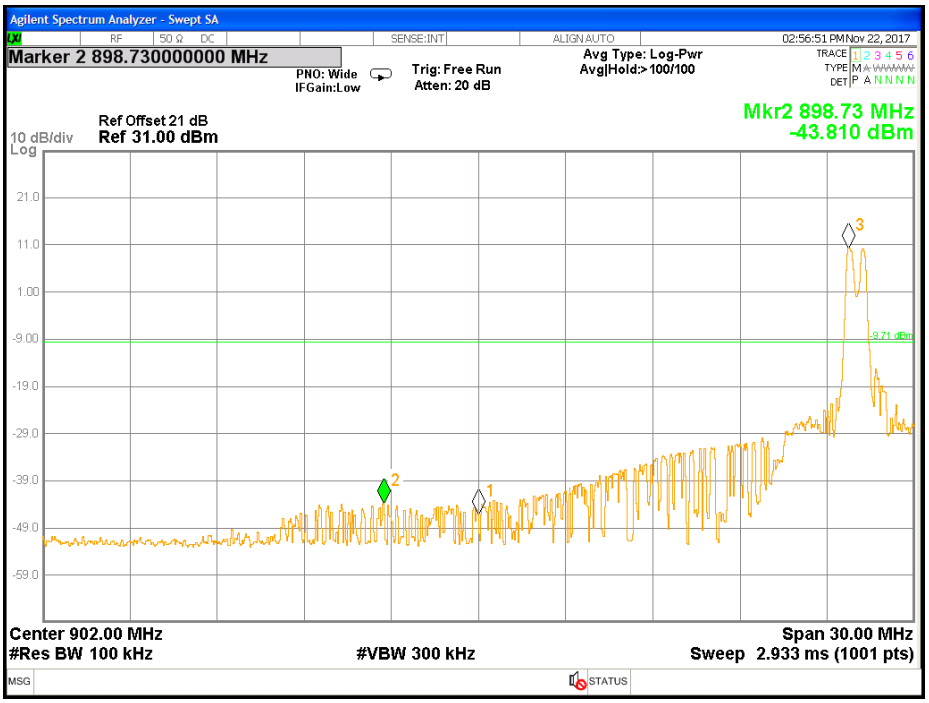


Figure 9: Conducted Emissions at 902 MHz Edge, 902-928MHz

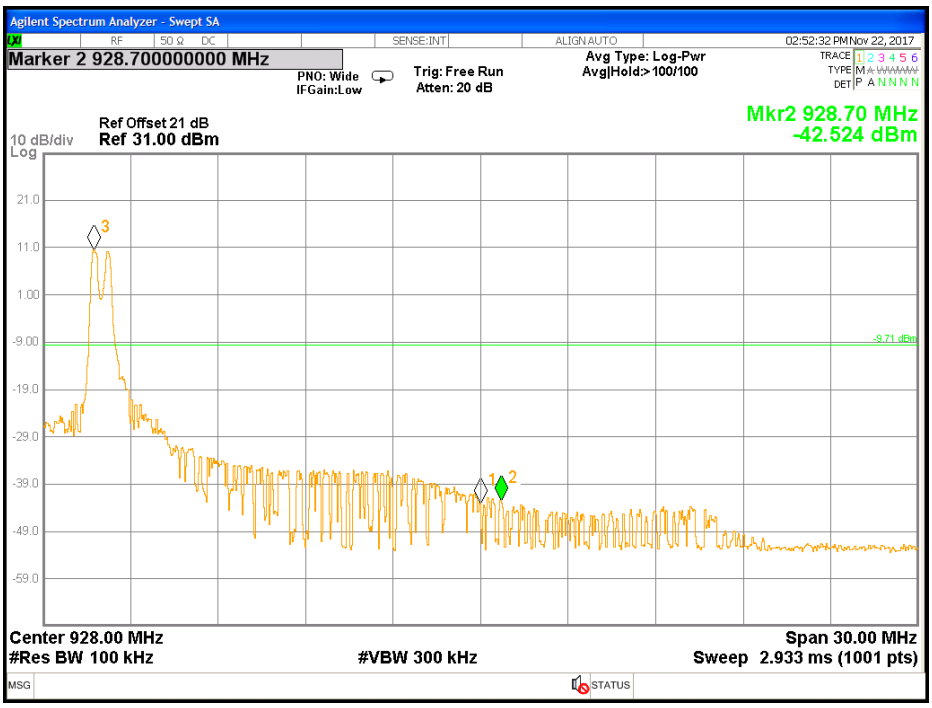


Figure 10: Conducted Emissions at 928 MHz Edge, 902-928MHz

4.5 Transmit Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS 247 Sect.5.5.

4.5.1 Test Methodology

Both the Display Unit and Sensor Unit were tested together as a system, the below results are applicable to both units.

4.5.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

4.5.1.2 Final Test

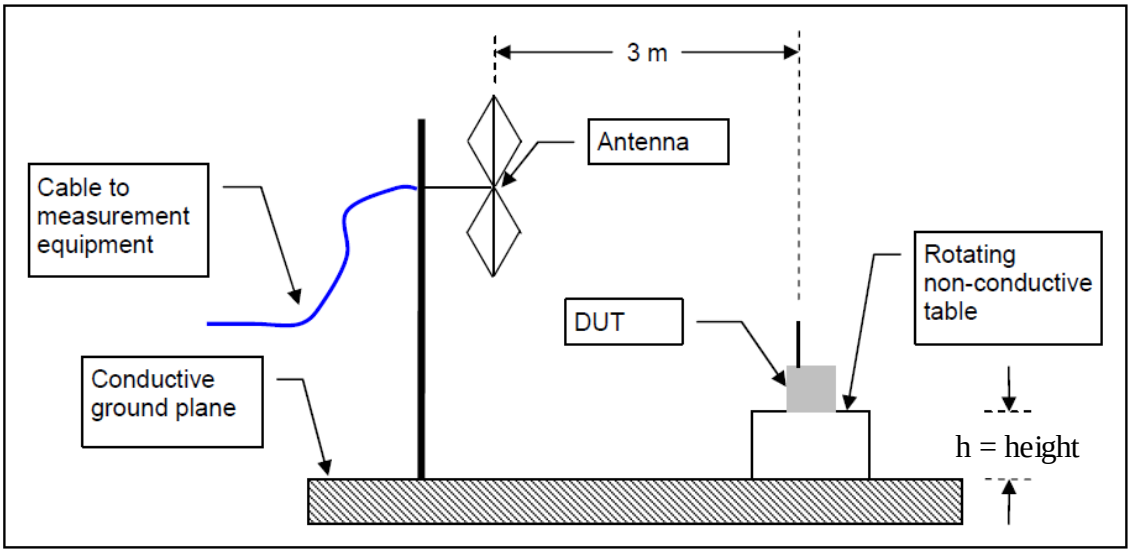
For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

4.5.1.3 Deviations

None.

Test Setup:

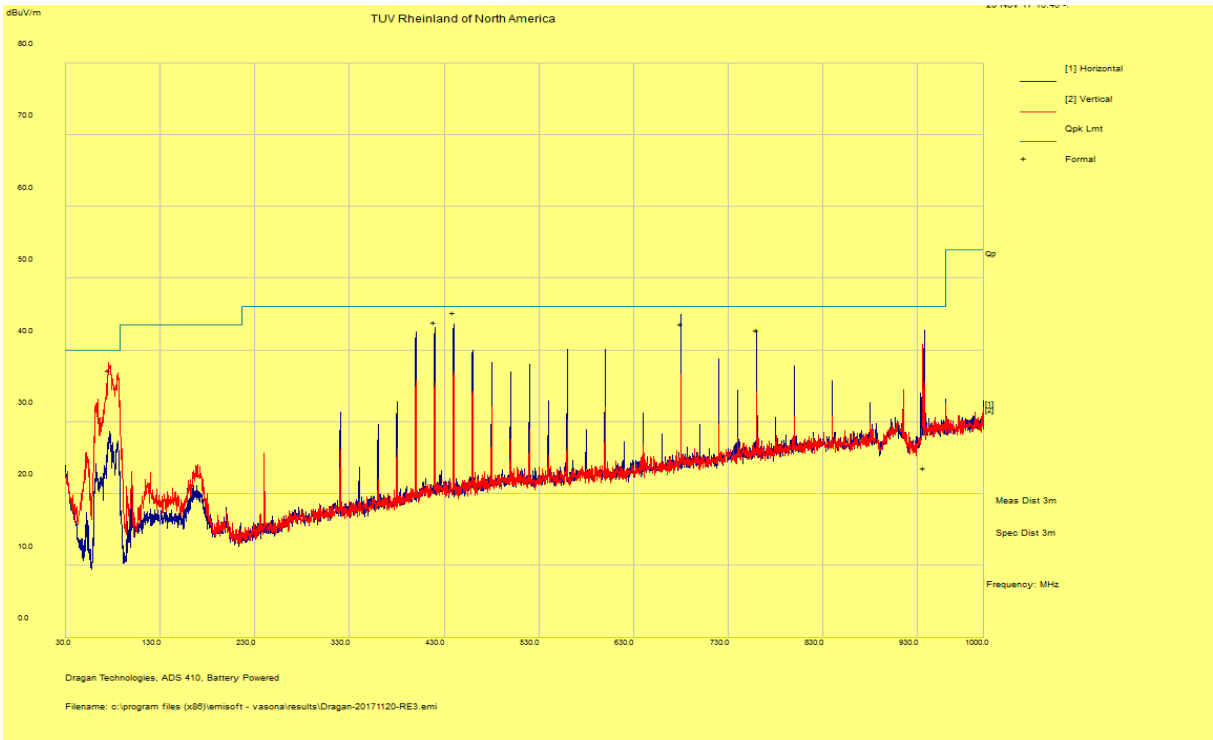


Where h = 80cm for <1GHz and 150cm for >1GHz

SOP 1 Radiated Emissions		Tracking # 31860384.001 Page 1 of 10	
EUT Name	Sensor Unit of the Angle Detection System	**Date**	Nov 20, 2017
EUT Model	ADS 410	**Temp / Hum in**	24° C / 34%rh
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	Normal Operating mode	**Line AC / Freq**	120 Vac / 60 Hz
Standard	CFR47 Part 15 Subpart C, RSS-247, RSS-GEN	**RBW / VBW**	120 kHz/ 300 kHz
Dist/Ant Used	3m / JB3	**Performed by**	Colton Aliff

30 MHz – 1 GHz Transmit at 915 MHz

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
420.00	50.94	4.31	-11.31	43.94	QP	H	204	168	46.00	-2.06
440.00	52.17	4.37	-11.31	45.23	QP	H	172	160	46.00	-0.77
680.00	46.16	5.01	-7.53	43.65	QP	H	103	150	46.00	-2.36
759.99	44.29	5.20	-6.68	42.81	QP	H	105	178	46.00	-3.19
936.77	21.85	5.60	-3.80	23.65	QP	H	104	60	46.00	-22.35
75.72	54.53	2.93	-20.18	37.28	QP	V	117	254	40.00	-2.72

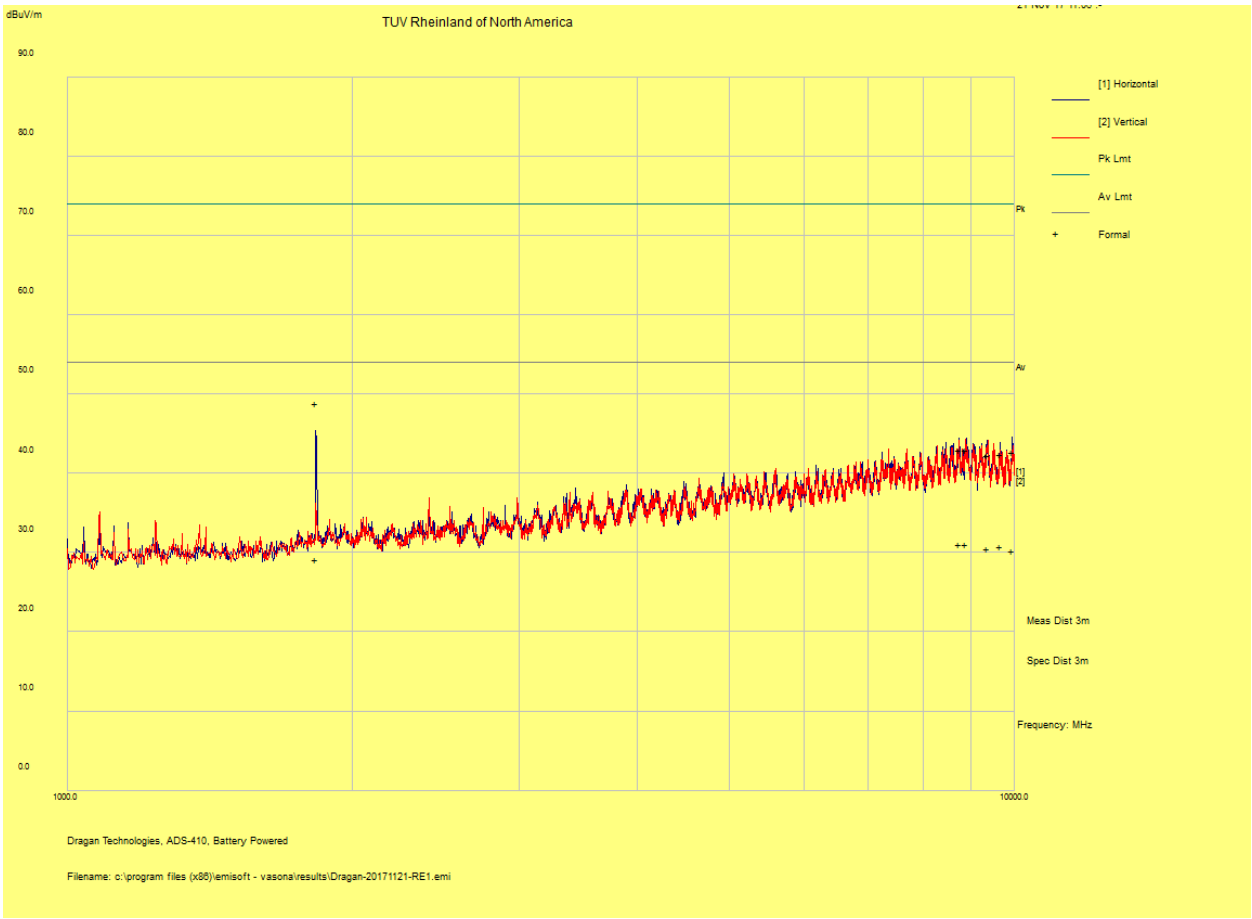


Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

SOP 1 Radiated Emissions		Tracking # 31860384.001 Page 2 of 10	
EUT Name	Sensor Unit of the Angle Detection System	**Date**	Nov 20, 2016
EUT Model	ADS 410	**Temp / Hum in**	21° C / 37%rh
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	Normal Operating mode	**Line AC / Freq**	120 Vac / 60 Hz
Standard	CFR47 Part 15 Subpart C, RSS-247, RSS-GEN	**RBW / VBW**	1 MHz/ 3 MHz
Dist/Ant Used	3m – EMCO3115	**Performed by**	Colton Aliff

1 – 10 GHz Transmit at 915MHz

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
1830.45	75.58	1.10	-27.86	48.82	Peak	H	126	302	74.00	-25.18
1830.45	55.85	1.10	-27.86	29.10	Ave	H	126	302	54.00	-24.90



Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note:

4.6 AC Conducted Emissions

Testing was performed in accordance with ANSI C63.10 section 6.2. These test methods are listed under the laboratory's A2LA Scope of Accreditation.

This test measures the levels emanating from the EUT's AC input port, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

The AC conducted emissions of equipment under test shall not exceed the values in CFR47 Part 15.207: 2018 and RSS Gen: 2017 Sect. 8.8.

4.6.1 Test Methodology

The Display unit was used in this test, the radio and RF path are identical for both units. As is the 12V DC input power.

A test program that controls instrumentation and data logging was used to automate the AC Power Line Conducted emission test procedure. The frequency range of interest was divided into sub-ranges such as to yield a frequency resolution of 9 kHz. Each phase and neutral of the AC power line were measured with respect to ground. Measurements were performed using a set of 50µH / 50Ω LISNs.

Testing is performed in Lab 5. The setup photographs clearly identify which site was used. The vertical ground plane used in the semi-anechoic chamber is a 2m x 2m solid aluminum frame and panel, and it is bonded to the horizontal ground plane.

In the case of tabletop equipment, the EUT is placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane and 40cm from a vertical ground reference plane. The rear of the EUT was positioned flush with the backside of the table and directly over the LISNs. The power and I/O cables were routed over the edge of the table and bundled approximately 40cm from the ground plane. Support equipment was powered from a separate LISN.

4.6.1.1 Deviations

There were no deviations from this test methodology.

4.6.2 Test Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 6: AC Conducted Emissions – Test Results

Test Conditions: Conducted Measurement at Normal Conditions only		
Antenna Type: external dipole (RP-SMA)	**Power Level:** See Test Plan	
AC Power: 12V DC	**Configuration:** Tabletop	
Ambient Temperature: 22° C	**Relative Humidity:** 37% RH	
Configuration	**Frequency Range**	**Test Result**
Line 1 (Hot)	0.15 to 30 MHz	Pass

Line 2 (Neutral)	0.15 to 30 MHz	Pass

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EUT Name	Sensor Unit of the Angle Detection System	**Date**	Nov 21, 2017
EUT Model	ADS 410	**Temp / Hum in**	23° C / 37% rh
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	Normal Operating mode	**Line DC**	12V
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 1	**Performed by**	Colton Aliff

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV		Line	dBuV	dB	
0.163	33.83	9.82	0.05	43.70	QP	Live	65.31	-21.60	Pass
0.163	7.33	9.82	0.05	17.20	Ave	Live	55.31	-38.10	Pass
0.172	33.96	9.82	0.05	43.83	QP	Live	64.84	-21.01	Pass
0.172	5.83	9.82	0.05	15.70	Ave	Live	54.84	-39.14	Pass
0.182	32.79	9.83	0.05	42.66	QP	Live	64.40	-21.74	Pass
0.182	5.82	9.83	0.05	15.70	Ave	Live	54.40	-38.70	Pass
0.195	29.50	9.82	0.04	39.36	QP	Live	63.83	-24.47	Pass
0.195	6.07	9.82	0.04	15.93	Ave	Live	53.83	-37.90	Pass
24.005	27.74	10.08	-0.06	37.77	QP	Live	60.00	-22.23	Pass
24.005	27.20	10.08	-0.06	37.22	Ave	Live	50.00	-12.78	Pass
29.822	28.63	10.12	-0.06	38.69	QP	Live	60.00	-21.31	Pass
29.822	9.89	10.12	-0.06	19.95	Ave	Live	50.00	-30.05	Pass

Spec Margin = QP./Ave. - Limit, ± Uncertainty

Combined Standard Uncertainty $u_c(y) = \pm 1.2$ dB Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence

Notes: EUT was setup as table top equipment and continuously transmitting.

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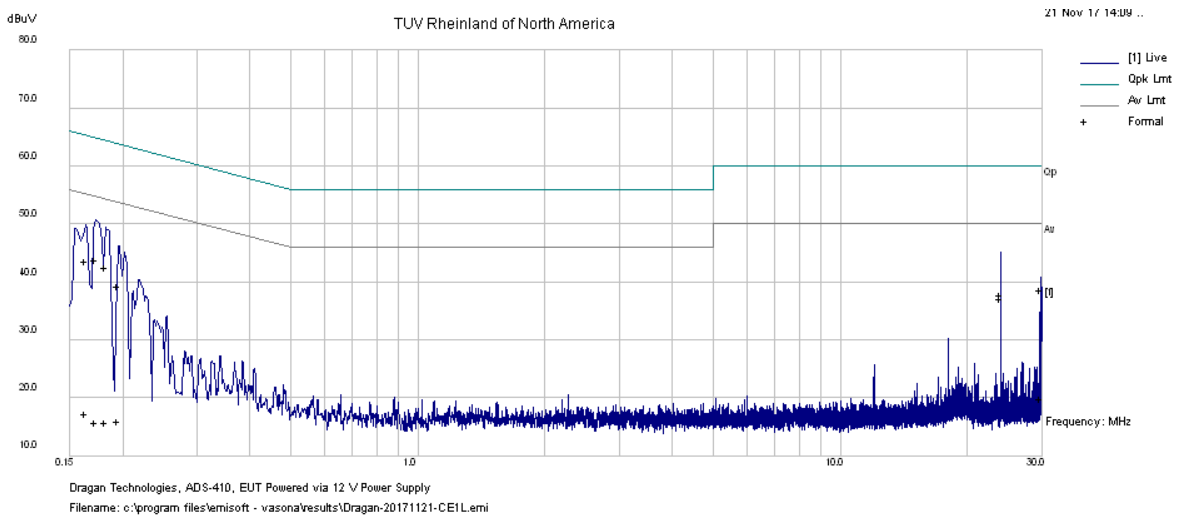
EUT Name	Sensor Unit of the Angle Detection System	**Date**	Nov 21, 2017
EUT Model	ADS 410	**Temp / Hum in**	23° C / 37% rh
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	Normal Operating mode	**Line DC**	12V
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 1	**Performed by**	Colton Aliff

150 kHz to 30 MHz Plot for Line 1 (Hot)



SOP 2 Conducted Emissions

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EUT Name	Sensor Unit of the Angle Detection System	**Date**	Nov 21, 2017
EUT Model	ADS 410	**Temp / Hum in**	23° C / 37% rh
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	Normal Operating mode	**Line DC**	12V
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 2	**Performed by**	Colton Aliff

Frequency	Raw	Limiter	Ins. Loss	Level	Detector	Line	Limit	Margin	Result
MHz	dBuV	dB	dB	dBuV		Line	dBuV	dB	
0.174	33.67	9.82	0.05	43.54	QP	Neutral	64.75	-21.21	0.174
0.174	8.95	9.82	0.05	18.82	Ave	Neutral	54.75	-35.93	0.174
0.187	31.32	9.82	0.04	41.19	QP	Neutral	64.15	-22.96	0.187
0.187	5.35	9.82	0.04	15.22	Ave	Neutral	54.15	-38.94	0.187
0.204	26.33	9.83	0.04	36.20	QP	Neutral	63.44	-27.24	0.204
0.204	2.76	9.83	0.04	12.63	Ave	Neutral	53.44	-40.80	0.204
24.005	25.49	10.08	-0.06	35.51	QP	Neutral	60.00	-24.49	24.005
24.005	24.84	10.08	-0.06	34.86	Ave	Neutral	50.00	-15.14	24.005
29.832	26.25	10.12	-0.06	36.31	QP	Neutral	60.00	-23.69	29.832
29.832	5.60	10.12	-0.06	15.66	Ave	Neutral	50.00	-34.34	29.832
30.000	30.54	10.12	-0.06	40.60	QP	Neutral	60.00	-19.40	30.000
30.000	21.25	10.12	-0.06	31.31	Ave	Neutral	50.00	-18.69	30.000

Spec Margin = QP./Ave. - Limit, ± Uncertainty

Combined Standard Uncertainty $u_c(y) = \pm 1.2$ dB Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence

Notes: EUT was setup as table top equipment and continuously transmitting.

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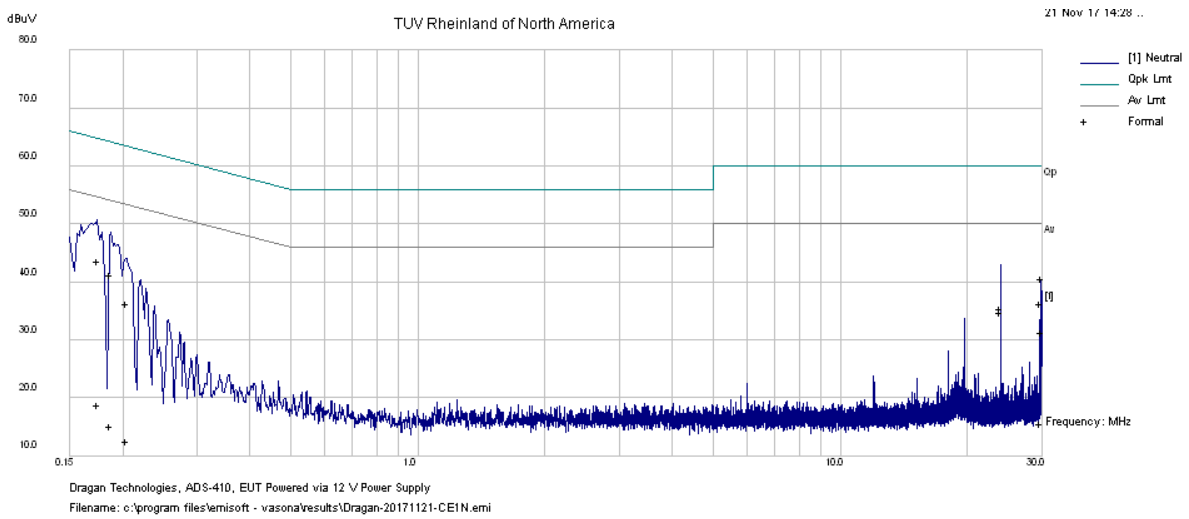
EUT Name	Sensor Unit of the Angle Detection System	**Date**	Nov 21, 2017
EUT Model	ADS 410	**Temp / Hum in**	23° C / 37% rh
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	Normal Operating mode	**Line DC**	12V
Standard	CFR47 Part 15.207 and RSS Gen	**RBW / VBW**	9 kHz / 30 kHz
Lab/LISN	Lab #5 /Com-Power, Line 2	**Performed by**	Colton Aliff

150 kHz to 30 MHz Plot for Line 2 (Neutral)



5 Test Equipment List

5.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
Bilog Antenna	Sunol Sciences	JB3	A102606	06/15/2017	06/15/2018
Horn Ant. (1-18GHz)	EMCO	3115	9710-5301	10/08/2017	10/08/2018
Antenna (18-40 GHz)	Com-Power	AHA-840	105005	01/21/2018	01/21/2019
Spectrum Analyzer	Agilent	N9030A	MY52350885	01/21/2018	01/21/2019
EMI Receiver	Rohde & Schwarz	ESU	100364	01/21/2018	01/21/2019
Preamplifier	Sonoma Instruments	310	185516	01/21/2018	01/21/2019
Preamplifier	HP	8449B	3008A01014	01/22/2018	01/22/2019
Notch Filter	Micro-Tronics	BRM50716	037	06/15/2017	06/15/2018

6 EMC Test Plan

6.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

6.2 Customer

Table 7: Customer Information

Company Name	Dragan Technologies, Inc.
Address	41 Omands Creek Blvd.
City, State, Zip	Winnipeg MB R2R 2V2 Canada
Country	USA
Phone	204-775-2445

Table 8: Technical Contact Information

Name	Mr. Kosoric
E-mail	chris.wakeham@embertech.com
Phone	204-775-2445

6.3 Equipment Under Test (EUT)

Table 9: EUT Specifications

EUT Specifications	
Dimensions	Height: 5.5 in (140mm) Length: 9 in (230mm) Width: 6.5 in (165mm)
DC Input	12V
Environment	Outdoor
Operating Temperature Range:	-25 to 80 degrees C
Multiple Feeds:	☐ Yes and how many ☒ No
Hardware Version	
Firmware Version	
RF Software Version	
Operating Mode	DTS
Transmitter Frequency Band	902.2 – 927.8 MHz, only transmitting at 915 MHz
Max. Rated Power Output	See Channel Planning Table.
Power Setting @ Operating Channel	See Channel Planning Table.
Antenna Type	Dipole connected through FCC part 15 compliant Reverse Polarity SMA
Antenna Gain	1.2 dBi
Modulation Type	☐ AM ☐ FM ☐ DSSS ☐ OFDM ☒ Other describe: GFSK
Data Rate	1Mbps
TX/RX Chain (s)	Single
Type of Equipment	☒ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☒ Other: Portable
Note:	

Table 10: Antenna Information

Number	Antenna Type	Description	Max Gain (dBi)
Antenna 1	½-wave center-fed dipole	Linx Technologies HW Series ½-wave center-fed dipole, 50-Ohm, Whip antenna - Part No. ANT-916-CW-HW	1.2

Table 11: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
None	-	-	-	-
Note: None.				

Table 12: Support Equipment

Equipment	Manufacturer	Model	Serial	Used for
Battery	Dragan Technologies	-	-	Provide power to EUT
Sensor Unit	Dragan Technologies	-	-	Provided signal for the EUT to read
Note: None.				

Table 13: Description of Sample used for Testing

Device	Serial	RF Connection	CFR47 Part 15.247
Sensor Unit of the Angle Detection System	-	FCC Part 15 compliant RP-SMA connector	AC Conducted Emissions Band Edge Emissions, Radiated Spurious Emissions Peak Transmit Power, Peak Power Spectral Density, Occupied Bandwidth, Band-Edge, Out-of-Band Emissions

Table 14: Description of Test Configuration used for Radiated Measurement.

Device	Antenna	Mode	Setup Photo (X-Axis)	Setup Photo (Y-Axis)	Setup Photo (Z-Axis)
Display Unit	external dipole (RP-SMA)	Transceiver	EUT Upright	EUT lying down with display perpendicular to ground plane	EUT lying down with display parallel to ground plane
Note: Y-Axis was determined to be the worst-case due to the display. The Display Unit (FCC ID: 2AODQ1DK207A8 IC: 23492-18DKJ1032A1) as well as the Sensor Unit (FCC ID: 2AODQ1DK207S4 IC: 23492-18DKJ1032S4) of the Angle Detection System "ADS 410" under assessment contain the same radio portion. Therefore all conducted test results from testing of the Display Unit are leveraged for separate certification of the Sensor Unit. Radiated Spurious Emissions was performed with a test set-up comprising the complete ADS with both units since this represents the intended and only possible use condition. The units cannot operate as intended while separated.					

6.4 Test Specifications

Table 15: Test Specifications

Emissions and Immunity	
Standard	**Requirement**
CFR 47 Part 15.247: 2018	All
RSS 247 Issue 1, 2017	All

END OF REPORT