Report on the FCC Testing of:

Fortecho Solutions Ltd
433 MHz RFiD Reader, Model: FS-1000-433
433 MHz Tag, Model: FST433

In accordance with FCC 47 CFR Part 15C

Prepared for: Fortecho Solutions Ltd
Solon House, 40A Peterborough Road
London, SW6 3BN
UNITED KINGDOM

FCC ID: 2ATM6-FS1000 (Reader) and 2ATM6-FST433 (Tag)

Add value.
Inspire trust.

COMMERCIAL-IN-CONFIDENCE

Document Number: 75945973-04 | Issue: 02

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Simon Bennett	Innovations Manager	Authorised Signatory	30 April 2020

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C. The sample tested was found to comply with the requirements defined in the applied rules.

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Graeme Lawler	Test Engineer	Testing	30 April 2020
Nandhini Mathivanan	Test Engineer	Testing	30 April 2020

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2018 for the tests detailed in section 1.3.

TÜV SÜD
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Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	27 November 2019
2	Amendment to error in table 2. Update to section 2.1	30 April 2020

Table 1

1.2 Introduction

Applicant	Fortecho Solutions Ltd
Manufacturer	Fortecho Solutions Ltd
Model Number(s)	433 MHz RFiD Reader, Model: FS-1000-433 433 MHz Tag, Model: FST433
Serial Number(s)	Reader: 0048-003-097 Tag: Not Serialised (75945973-TSR0041) Tag: Not Serialised (75945973-TSR0051)
Hardware Version(s)	Reader: HW-03 Tag: PC-0048-003-03-XX
Software Version(s)	Reader: 1.74 Tag: 0.044
Number of Samples Tested	1 reader and 2 tags
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2018
Order Number Date	0429 01-May-2019
Date of Receipt of EUT	10-June-2019 and 25-July-2019
Start of Test	09-July-2019
Finish of Test	13-August-2019
Name of Engineer(s)	Graeme Lawler and Nandhini Mathivanan
Related Document(s)	ANSI C63.10: 2013

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C is shown below.

Section	Specification Clause	Test Description	Result	Comments/Base Standard
Configuration and Mode: 433 MHz SRD Transceiver - Channel Tag (internal antenna)				
2.1	15.231 (a)(2)(3)	Manually Activated Transmitter	Declaration	
2.2	15.231 (b) and 15.205	Field Strength of Emissions	Pass	ANSI C63.10: 2013
2.3	15.231 (c)	20 dB Bandwidth	Pass	
Configuration and Mode: 433 MHz SRD Transceiver - Channel Reader (external antenna)				
2.2	15.231 (b) and 15.205	Field Strength of Emissions	Pass	ANSI C63.10: 2013

Table 2

1.4 Application Form

Equipment Description

Technical Description: *(Please provide a brief description of the intended use of the equipment)*	Fortecho RFID Reader 433 MHz, Single Channel
Manufacturer:	Fortecho Solutions Ltd
Model:	FS1000-433
Part Number:	SN-0048-003-XXX
Hardware Version:	HW-03
Software Version:	1.74
FCC ID (if applicable)	2ATM6-FST433
IC ID (if applicable)	Not Applicable

Intentional Radiators

Technology	Active RFiD Reader
Frequency Band (MHz)	433MHz
Conducted Declared Output Power (dBm)	10
Antenna Gain (dBi)	0
Supported Bandwidth(s) (MHz)	0.88 MHz
Modulation Scheme(s)	2GFSK
ITU Emission Designator	103KMFD
Bottom Frequency (MHz)	433.050
Middle Frequency (MHz)	433.920
Top Frequency (MHz)	434.790

Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	434.790 MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	433.050 MHz
Class A Digital Device (Use in commercial, industrial or business environment) ☒ Class B Digital Device (Use in residential environment only) ☐	

AC Power Source

AC supply frequency: Click to edit (Hz)	
Click or tap here to enter text. V	Max current: Click or tap here to enter text. A
Single Phase ☐ Three Phase ☐	

DC Power Source

Nominal voltage: 12 V
Extreme upper voltage: 14 V
Extreme lower voltage: 10 V
Max current: 5. A

Battery Power Source

Voltage: Click or tap here to enter text. V
End-point voltage: Click or tap here to enter text V *(Point at which the battery will terminate)*
Alkaline ☐ Leclanche ☐ Lithium ☐ Nickel Cadmium ☐ Lead Acid* ☐ **(Vehicle regulated)*
Other ☐ Please detail: Click to edit

Charging

Can the EUT transmit whilst being charged	Yes ☐ No ☒

Temperature

Minimum temperature: -20 °C	Maximum temperature: 80 °C

Antenna Characteristics

Antenna connector ☐ State impedance Click to edit Ohm
Temporary antenna connector ☐ State impedance Click to edit Ohm
Integral antenna ☐ Type Click to edit State impedance Click to edit dBi
External antenna ☒ Type BNC 50 ohm match State impedance 2 dBi

Ancillaries (if applicable)

Manufacturer: Click to edit	Part Number: Click to edit
Model: Click to edit	Country of Origin: Click to edit

I hereby declare that the information supplied is correct and complete.

Name: Will Damerell
Position held: Technical Director
Date: 25 November 2019

The manufacturer uses a standard 50 Ohm BNC connector for the device under test, but confirms that the device is intended for professional installation only. This is described in the user manual with details of the supplied antenna

Equipment Description

Technical Description: *(Please provide a brief description of the intended use of the equipment)*	433 MHz Active RFID Tag, Single Channel
Manufacturer:	Fortecho Solutions Ltd
Model:	FST433
Part Number:	Click to edit
Hardware Version:	PC-0048-003-03-XX
Software Version:	0.044
FCC ID (if applicable)	2ATM6-FS1000
IC ID (if applicable)	Not Applicable

Intentional Radiators

Technology	Active RFiD Tag
Frequency Band (MHz)	433 MHz
Conducted Declared Output Power (dBm)	10
Antenna Gain (dBi)	0
Supported Bandwidth(s) (MHz)	0.88 MHz
Modulation Scheme(s)	2GFSK
ITU Emission Designator	103KMFD
Bottom Frequency (MHz)	433.050
Middle Frequency (MHz)	433.920
Top Frequency (MHz)	434.790

Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	434.790 MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	433.050 MHz
Class A Digital Device (Use in commercial, industrial or business environment) ☒ Class B Digital Device (Use in residential environment only) ☐	

AC Power Source

AC supply frequency: Click to edit (Hz)	
Click to edit V	Max current: Click to edit A
Single Phase ☐ Three Phase ☐	

DC Power Source

Nominal voltage: Click to edit V
Extreme upper voltage: Click to edit V
Extreme lower voltage: Click to edit V
Max current: Click to edit. A

Battery Power Source

Voltage: 3 V
End-point voltage: 1.8 V *(Point at which the battery will terminate)*
Alkaline ☐ Leclanche ☐ Lithium ☒ Nickel Cadmium ☐ Lead Acid* ☐ **(Vehicle regulated)*
Other ☐ Please detail: Click to edit

Charging

Can the EUT transmit whilst being charged	Yes ☐ No ☒

Temperature

Minimum temperature: -20 °C	Maximum temperature: 80 °C

Antenna Characteristics

Antenna connector ☐ State impedance Click to edit Ohm
Temporary antenna connector ☐ State impedance Click to edit Ohm
Integral antenna ☒ Type ceramic 50 ohm matched State impedance Click to edit dBi
External antenna ☐ Type Click to edit State impedance Click to edit dBi

Ancillaries (if applicable)

Manufacturer: Click to edit	Part Number: Click to edit
Model: Click to edit	Country of Origin: Click to edit

I hereby declare that the information supplied is correct and complete.

Name: Will Damerell
Position held: Technical Director
Date: 25 November 2019

1.5 Product Information

1.5.1 Technical Description

Fortecho RFID Reader 433 MHz, Single Channel and 433 MHz Active RFID Tag, Single Channel.

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Serial Number: 0048-003-097			
0	As supplied by the customer	Not Applicable	Not Applicable
Serial Number: Not Serialised (75945973-TSR0041)			
0	As supplied by the customer	Not Applicable	Not Applicable
Serial Number: Not Serialised (75945973-TSR0051)			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3

1.8 Test Location

TÜV SÜD conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: 433 MHz SRD Transceiver - Channel Tag (internal antenna)		
Field Strength of Emissions	Graeme Lawler	UKAS
20 dB Bandwidth	Nandhini Mathivanan	UKAS
Configuration and Mode: 433 MHz SRD Transceiver - Channel Reader (external antenna)		
Field Strength of Emissions	Graeme Lawler	UKAS

Table 4

Office Address:

Octagon House
Concorde Way
Segensworth North
Fareham
Hampshire
PO15 5RL
United Kingdom

2 Test Details

2.1 Manually Activated Transmitter

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.231 (a)(2)(3)

2.1.2 Equipment Under Test

FST433

2.1.3 Test Method

A declaration was made by the manufacturer

2.1.4 Test Results

433 MHz SRD Transceiver - Channel Tag (internal antenna)

The manufacturer confirmed that the FST433 satisfies the following requirements:

A transmitter activated automatically shall cease transmission within 5 seconds after activation.

Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

2.2 Field Strength of Emissions

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.231 (b) and 15.205

2.2.2 Equipment Under Test and Modification State

FS-1000-433, S/N: 0048-003-097 - Modification State 0
FST433, S/N: Not Serialised (75945973-TSR0041) - Modification State 0

2.2.3 Date of Test

09-July-2019 to 10-July-2019

2.2.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.5 and 6.6.

The procedure specified in ANSI C63.10, clause 7.5 was used to determine the average value of pulsed emissions.

For the fundamental emission and harmonics of the fundamental above 1 GHz, a peak measurement has been performed and a duty cycle correction factor has been applied to determine the average level.

Spurious and fundamental harmonic emissions below 1 GHz have been measured using a CISPR Quasi Peak detector.

The limit lines on the plots show the worst case limits for emissions that occur within restricted bands as defined in FCC 15.205. Where final measurements are necessary, the correct limit is applied for the frequency measured.

2.2.5 Environmental Conditions

Ambient Temperature	19.5 - 20.9 °C
Relative Humidity	62.2 - 64.0 %

2.2.6 Test Results

433 MHz SRD Transceiver - Channel Tag (internal antenna)

Results for the Fundamental Emission

A duty cycle correction factor was made for period operation as follows:

Transmitter On-Time (ms)	Pulse Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
5	100	5	26.02

Table 5 Duty Cycle

Frequency (MHz)	Peak Level (dBµV/m) at 3m	Peak Level (µV/m) at 3m	Duty Cycle Correction Factor (dB)	Average Level (dBµV/m) at 3m	Average Level (µV/m) at 3m
433.925	83.55	15048.74	26.02	57.53	752.49

Table 6 - Field Strength of the Fundamental

Field Strength of Emission Results, 30 MHz to 1 GHz

Frequency (MHz)	Quasi-Peak Level (dBµV/m) at 3m	Quasi-Peak Level (µV/m) at 3m
867.846	56.62	677.64

Table 7 - Radiated Emissions Results

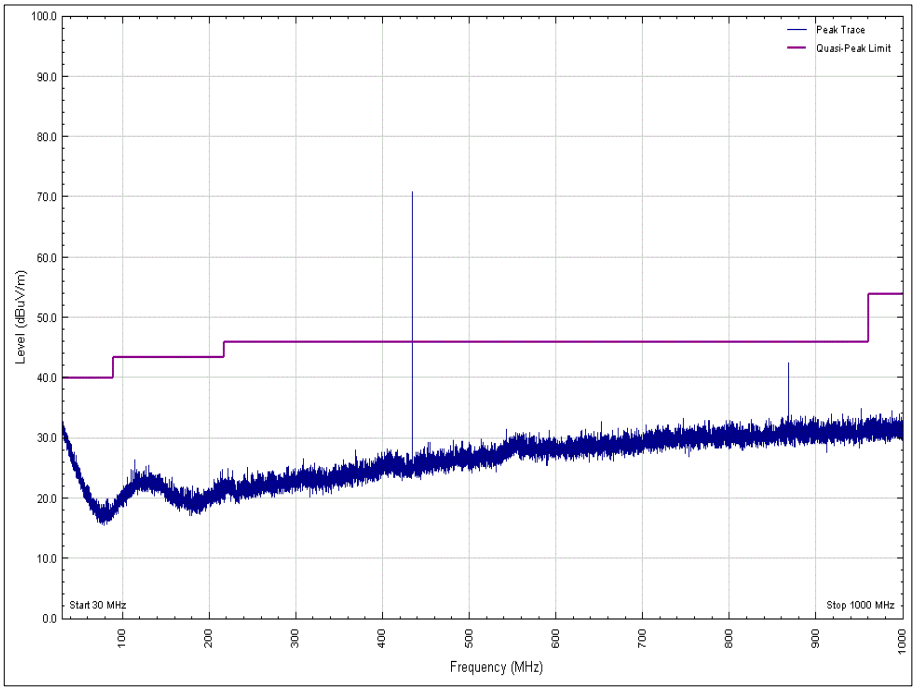

Figure 1 - 30 MHz to 1 GHz, X Orientation - Vertical Polarity

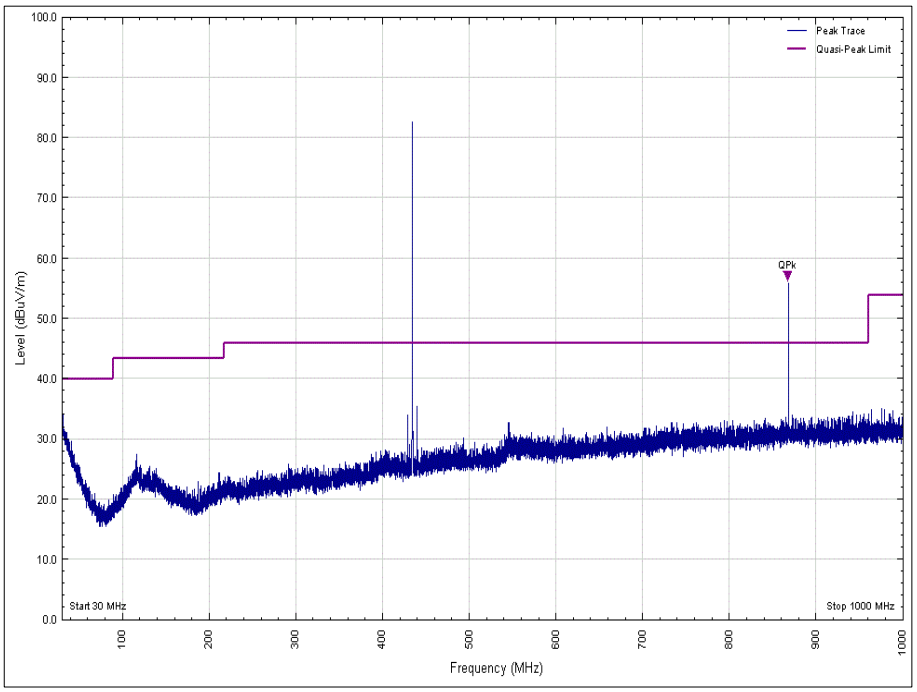

Figure 2 - 30 MHz to 1 GHz, X Orientation - Horizontal Polarity

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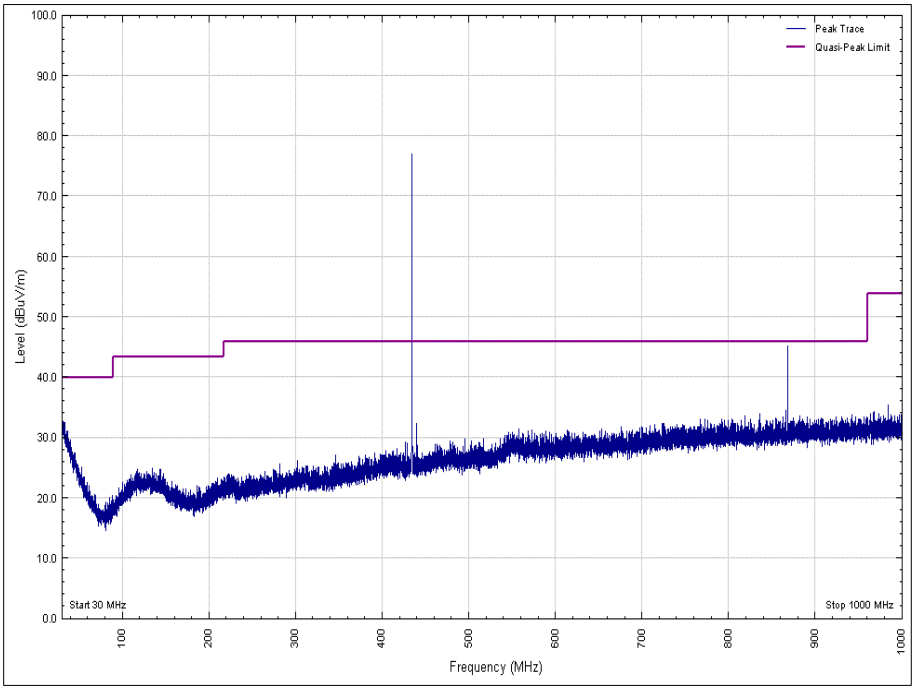

Figure 3 - 30 MHz to 1 GHz, Y Orientation - Vertical Polarity

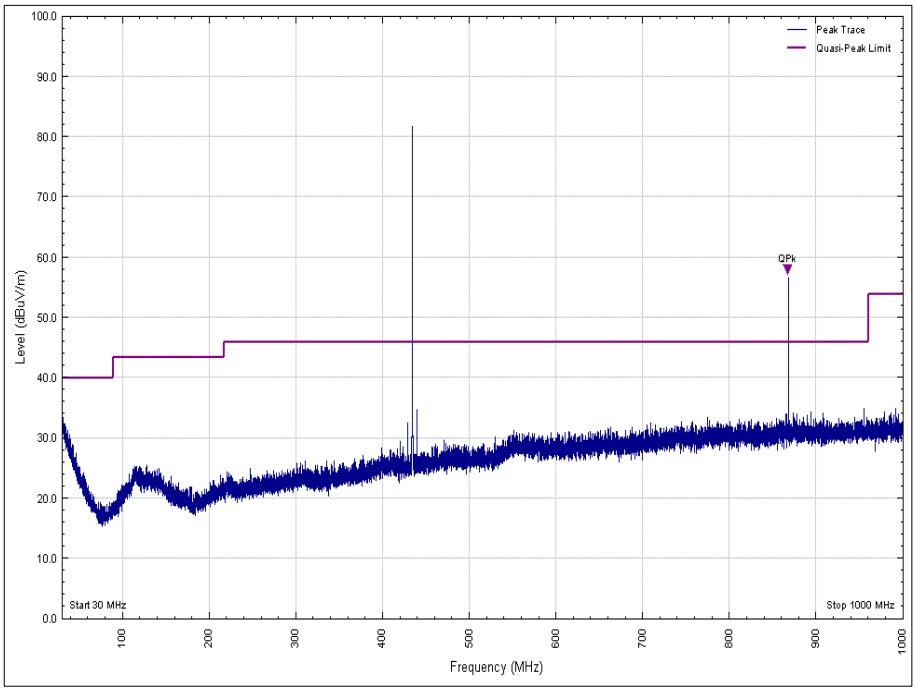

Figure 4 - 30 MHz to 1 GHz, Y Orientation - Horizontal Polarity

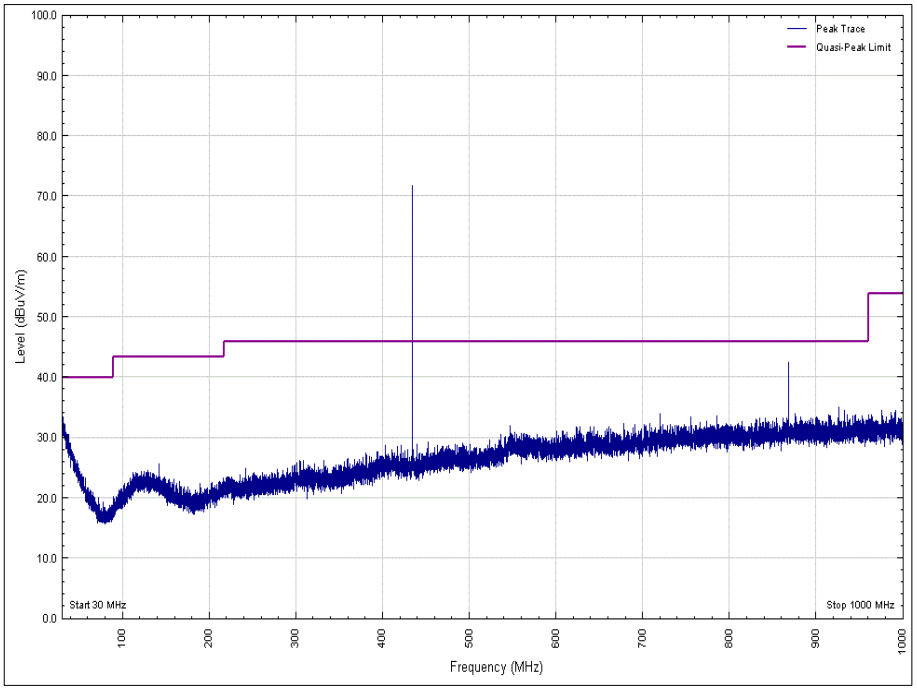

Figure 5 - 30 MHz to 1 GHz, Z Orientation - Vertical Polarity

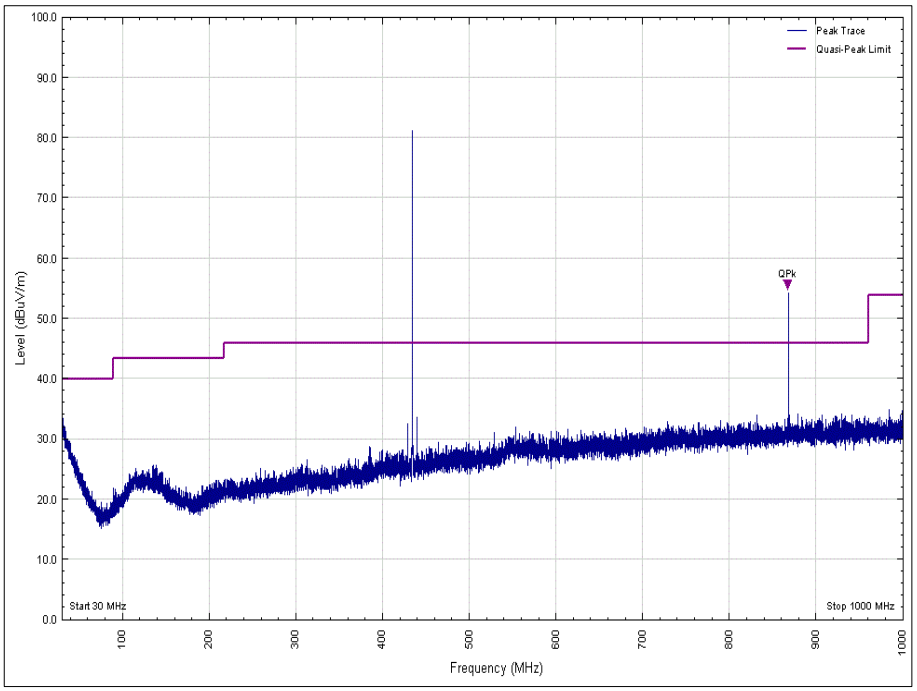

Figure 6 - 30 MHz to 1 GHz, Z Orientation - Horizontal Polarity

Frequency (MHz)	Quasi-Peak Level (dBµV/m) at 3m	Average Level (dBµV/m) at 3m
867.846	56.62	-

Table 8 - Radiated Emissions Results

*No other emissions within 10 dB of the limit were detected.

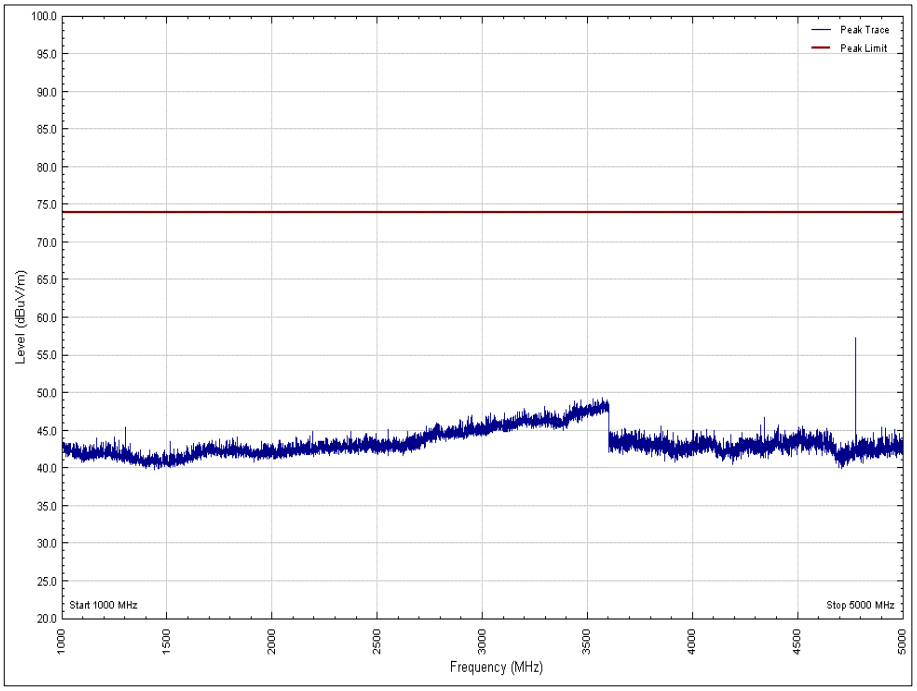

Figure 7 - 1 GHz to 5 GHz, X Orientation - Vertical Polarity - Peak

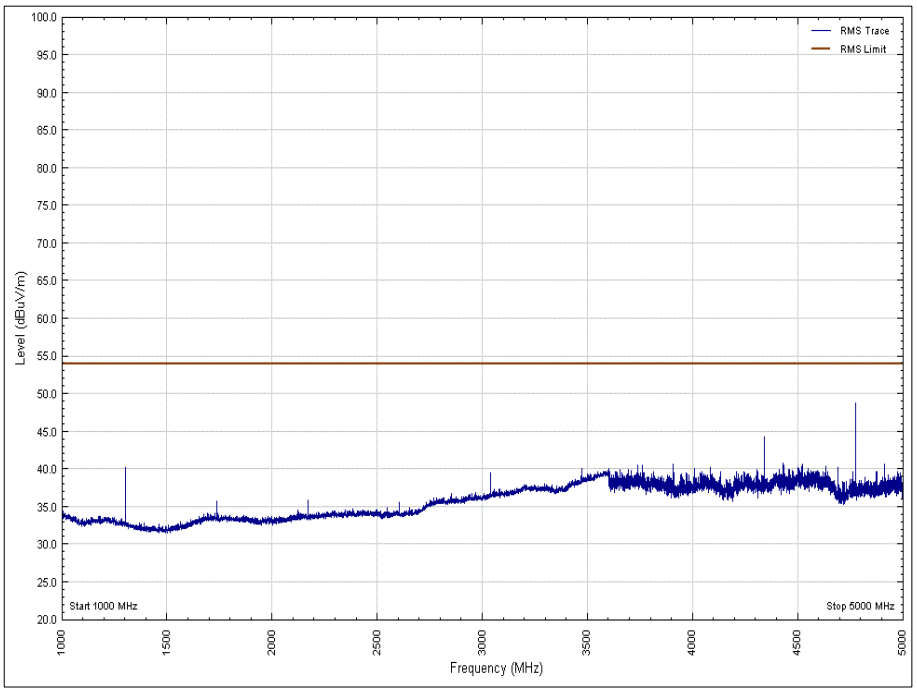

Figure 8 - 1 GHz to 5 GHz, X Orientation - Vertical Polarity - Average

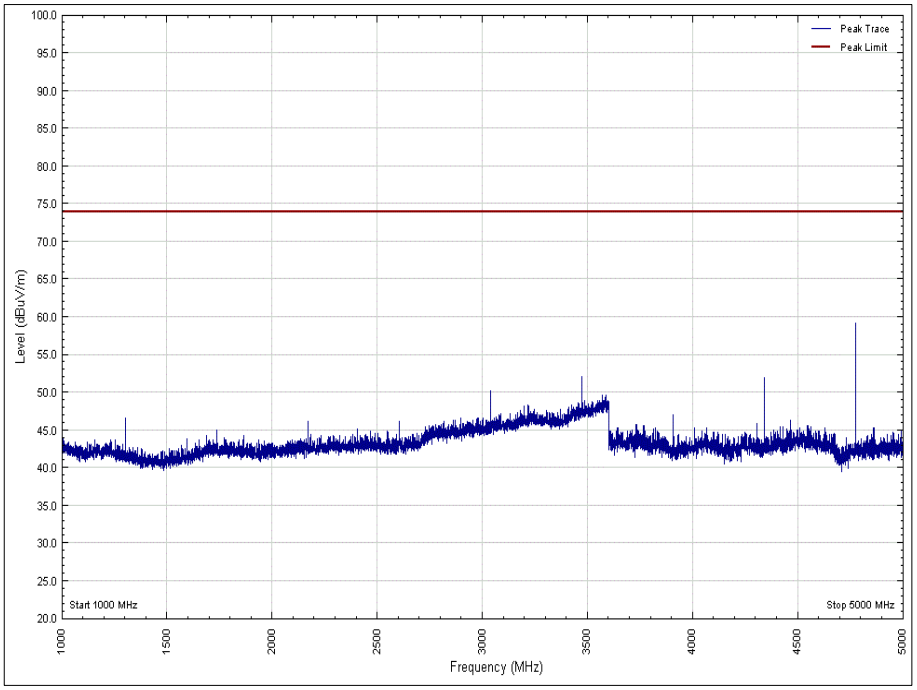

Figure 9 - 1 GHz to 5 GHz, X Orientation - Horizontal Polarity - Peak

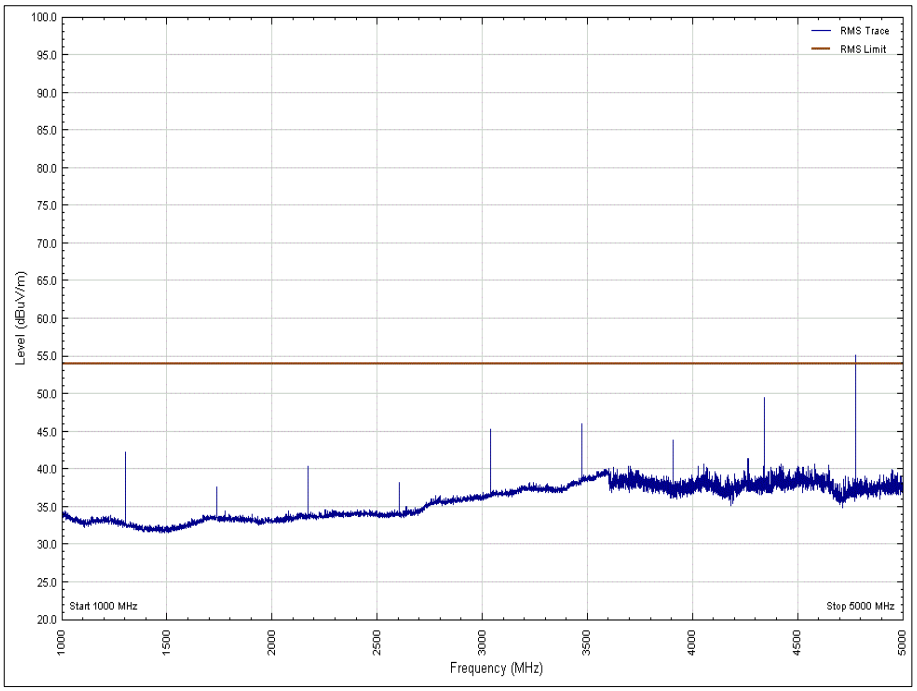

Figure 10 - 1 GHz to 5 GHz, X Orientation - Horizontal Polarity - Average

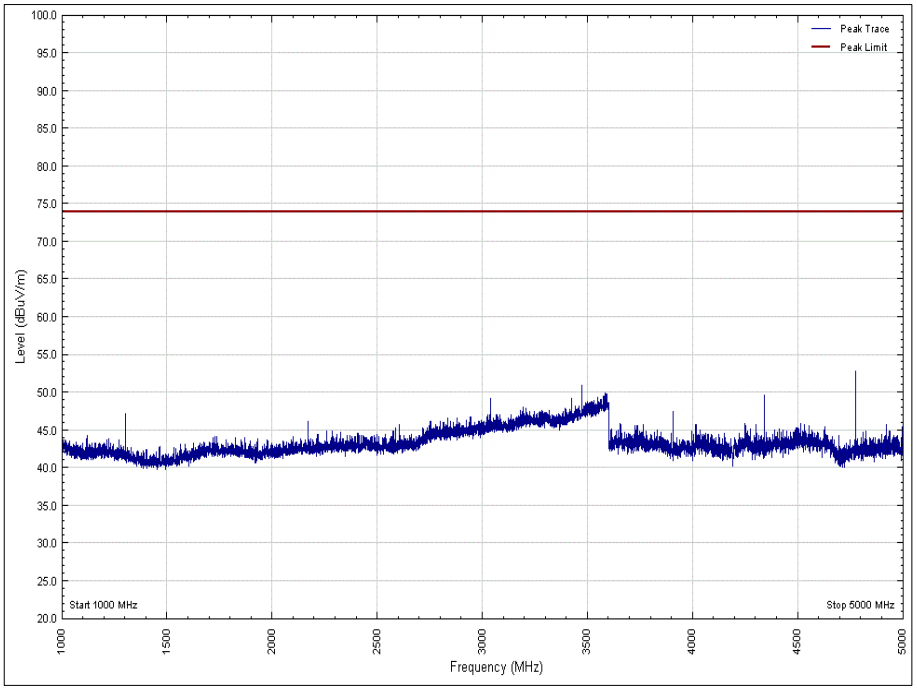

Figure 11 - 1 GHz to 5 GHz, Y Orientation - Vertical Polarity - Peak

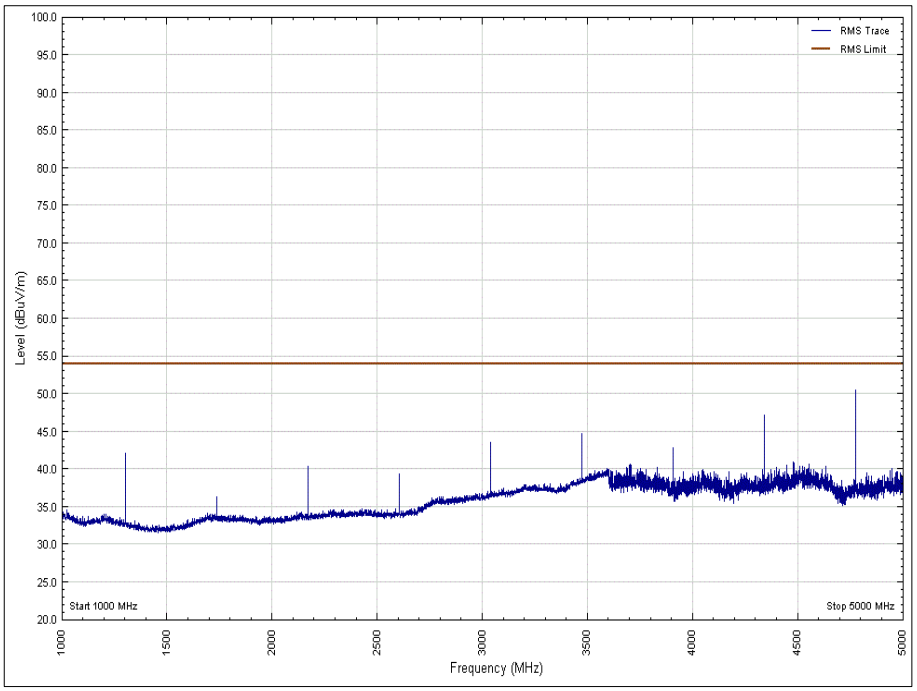

Figure 12 - 1 GHz to 5 GHz, Y Orientation - Vertical Polarity - Average

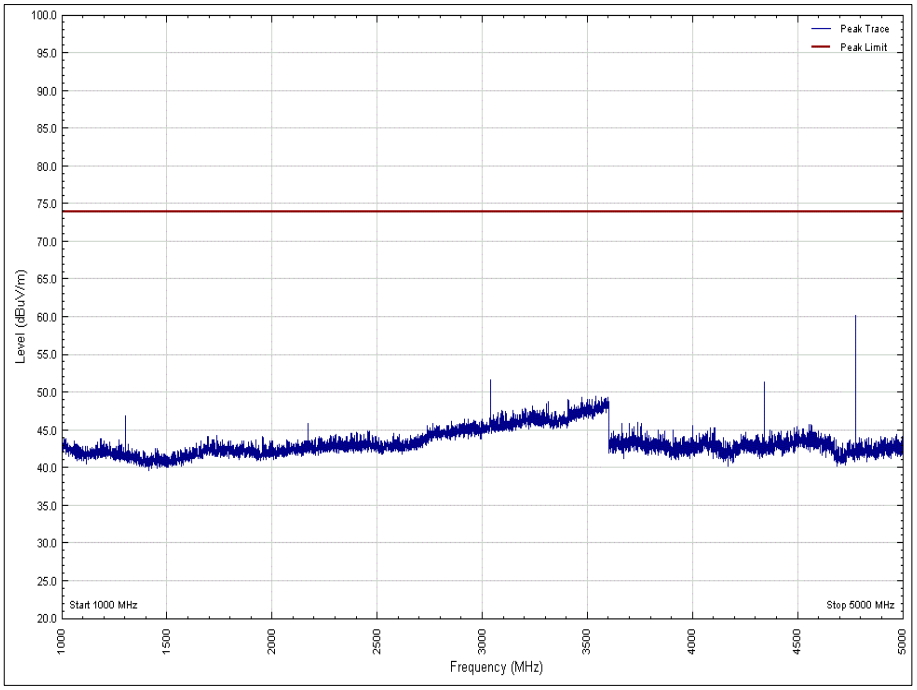

Figure 13 - 1 GHz to 5 GHz, Y Orientation - Horizontal Polarity - Peak

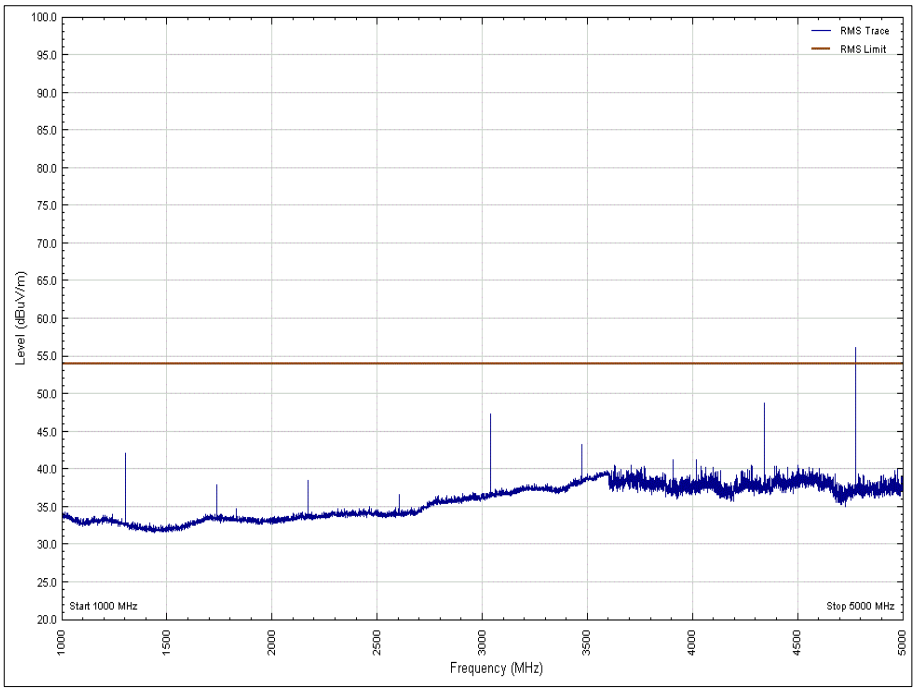

Figure 14 - 1 GHz to 5 GHz, Y Orientation - Horizontal Polarity - Average

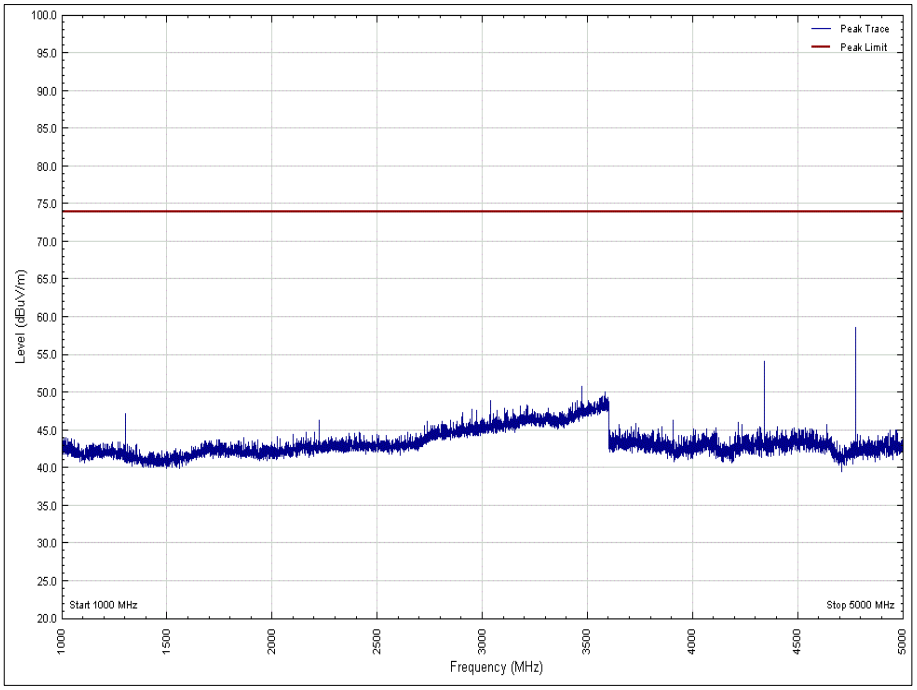

Figure 15 - 1 GHz to 5 GHz, Z Orientation - Vertical Polarity - Peak

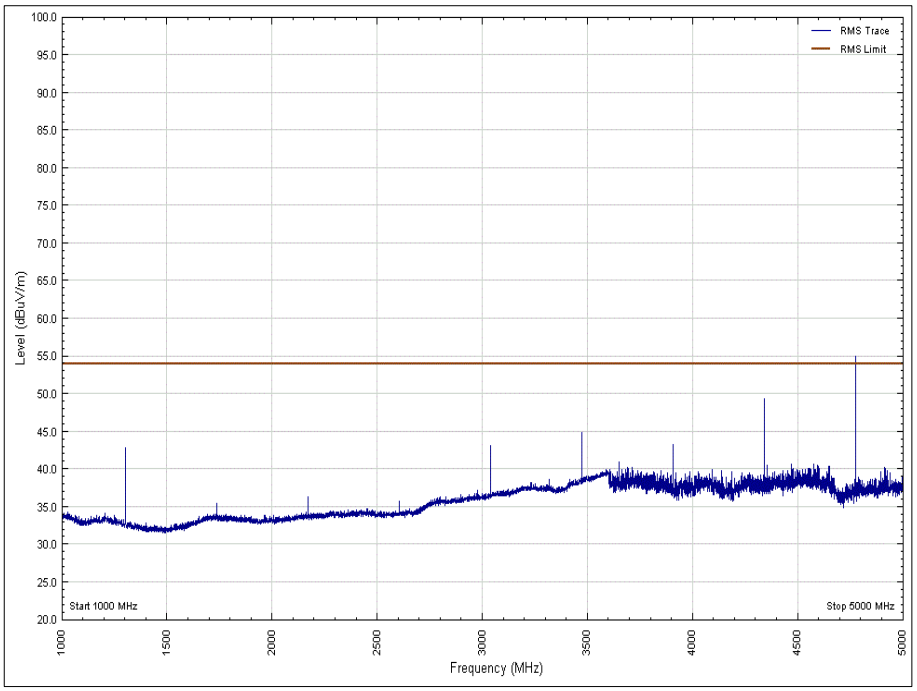

Figure 16 - 1 GHz to 5 GHz, Z Orientation - Vertical Polarity - Average

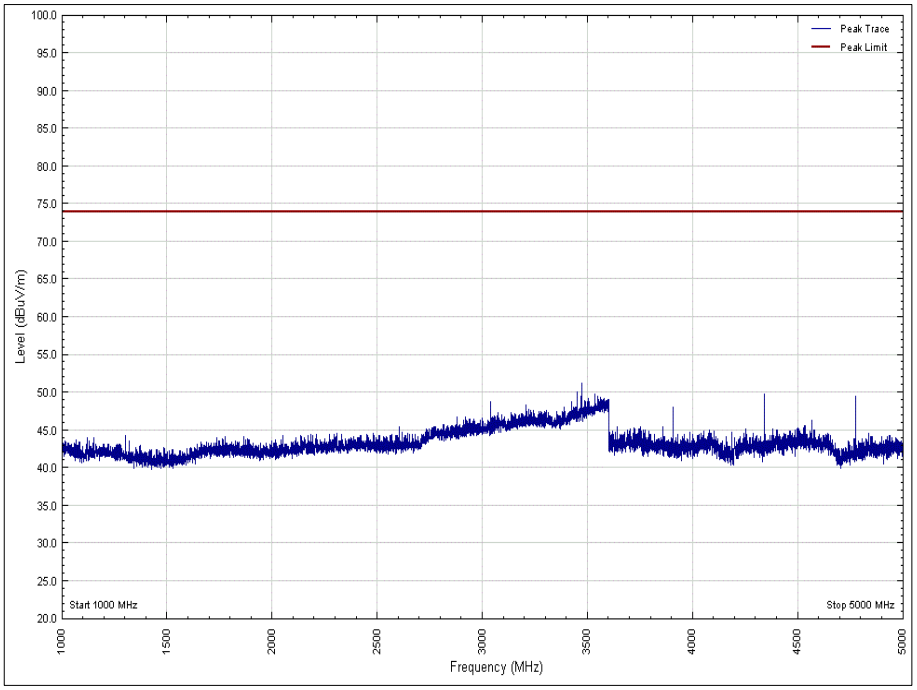

Figure 17 - 1 GHz to 5 GHz, Z Orientation - Horizontal Polarity - Peak

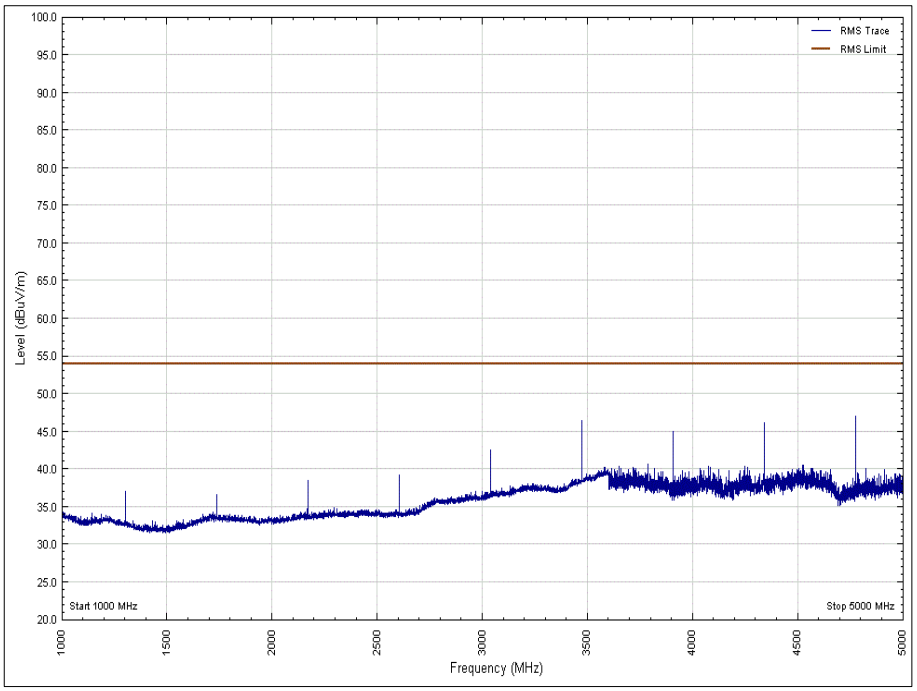

Figure 18 - 1 GHz to 5 GHz, Z Orientation - Horizontal Polarity - Average

FCC 47 CFR Part 15, Limit Clause 15.231 (b)

Fundamental Frequency (MHz)	Field Strength of Fundamental (Microvolts/meter)	Field Strength of Spurious Emissions (Microvolts/meter)
40.66 to 40.70	2250	225
70.00 to 130.00	1250	125
130.00 to 174.00	[1] 1250 to 3750	[1] 125 to 375
174.00 to 260.00	3750	375
260.00 to 470.00	[1] 3750 to 12500	[1] 375 to 1250
Above 470.00	12500	1250

Table 9 - Limit outside Restricted Bands

NOTE: [1] Linear interpolation
The above field strength limits are specified at a distance of 3 meters.

FCC 47 CFR Part 15, Limit Clause 15.205

Restricted Bands of Operation	Peak (dBµV/m)	Average (dBµV/m)
	74	54

Table 10 - Limits within Restricted Bands

433 MHz SRD Transceiver - Channel Reader (external antenna)

Results for the Fundamental Emission

A duty cycle correction factor was made for period operation as follows:

Transmitter On-Time (ms)	Pulse Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
5	100	5	26.02

Table 11 Duty Cycle

Frequency (MHz)	Peak Level (dBµV/m) at 3m	Peak Level (µV/m) at 3m	Duty Cycle Correction Factor (dB)	Average Level (dBµV/m) at 3m	Average Level (µV/m) at 3m
433.925	97.93	78795.24	26.02	71.91	3940

Table 12 - Field Strength of the Fundamental

Field Strength of Emission Results, 30 MHz to 1 GHz

Frequency (MHz)	Quasi-Peak Level (dBµV/m) at 3m	Quasi-Peak Level (µV/m) at 3m
74.009	32.21	40.78
164.861	35.28	58.08
867.840	54.27	517.01

Table 13 - Radiated Emissions Results

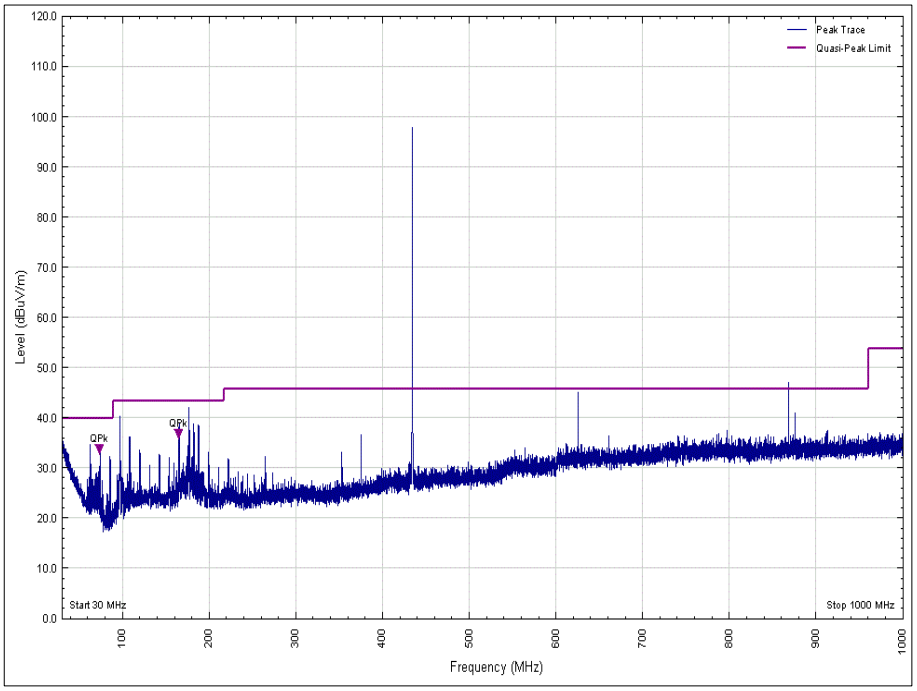

Figure 19 - 30 MHz to 1 GHz - Vertical

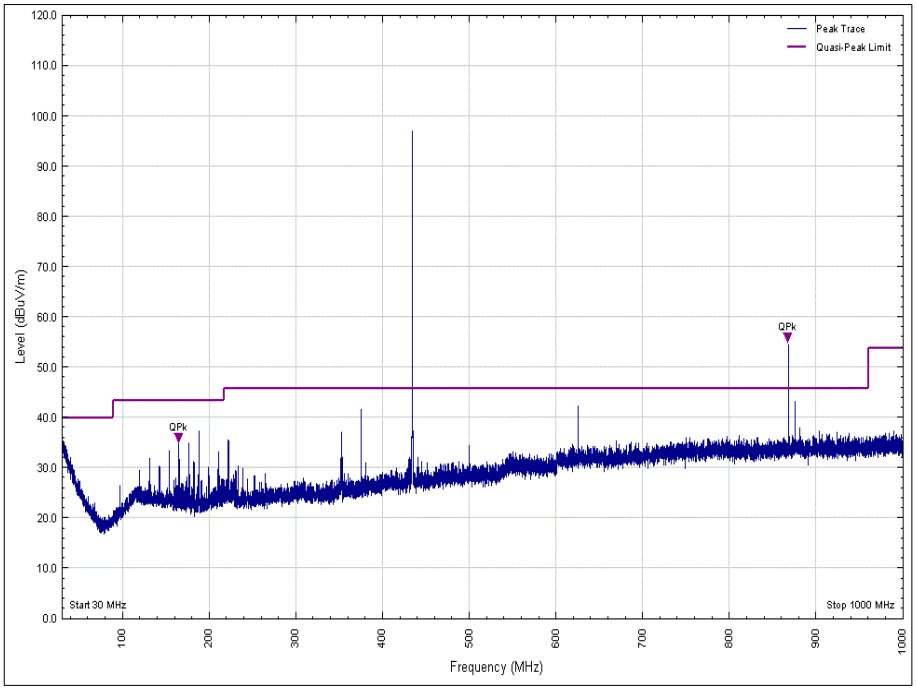

Figure 20 - 30 MHz to 1 GHz - Horizontal

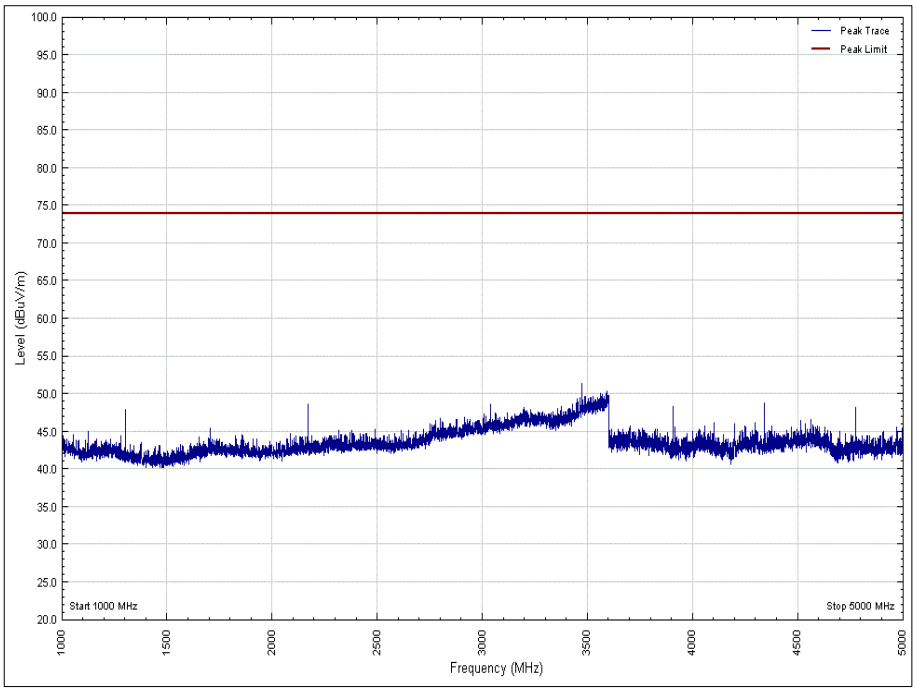

Figure 21 - 1 GHz to 5 GHz - Vertical Peak

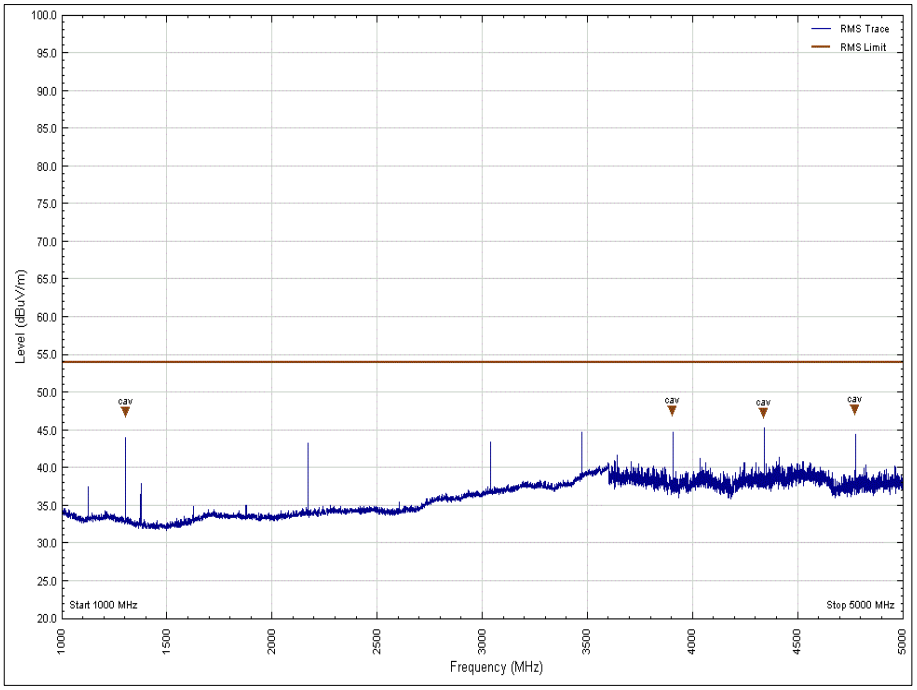

Figure 22 - 1 GHz to 5 GHz - Vertical Average

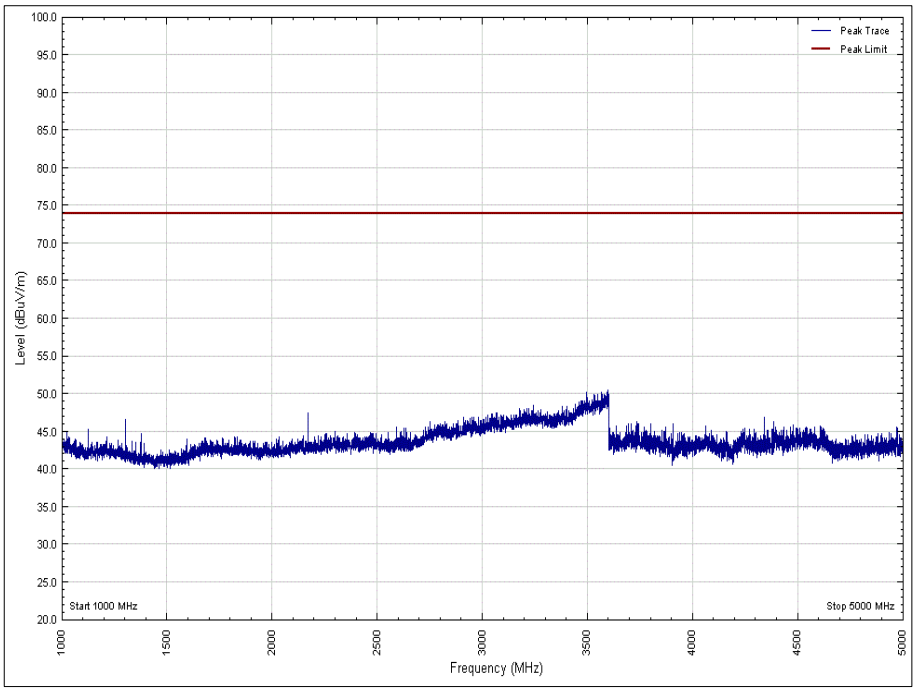

Figure 23 - 1 GHz to 5 GHz - Horizontal Peak

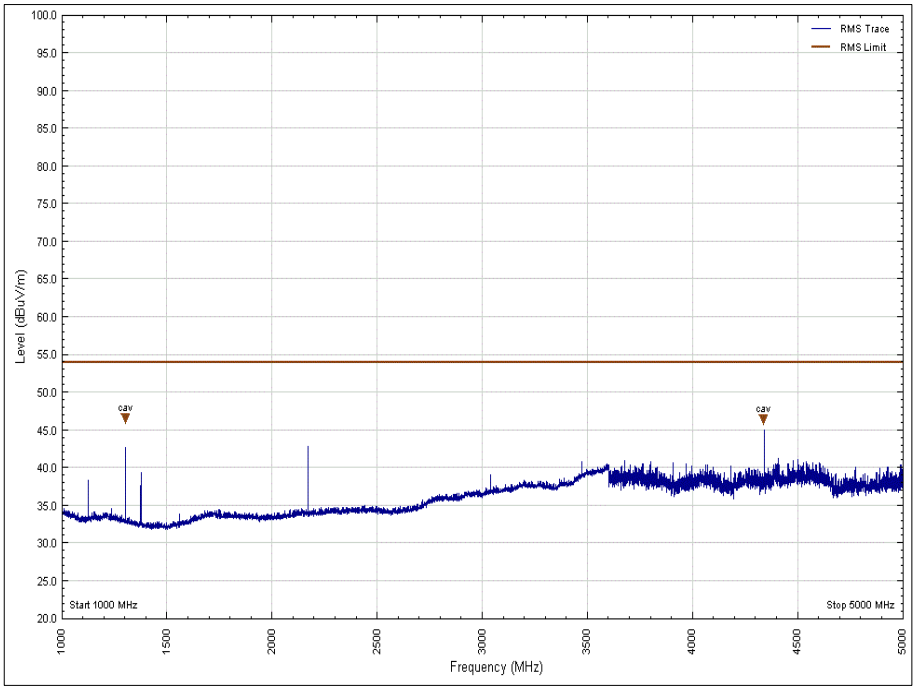

Figure 24 - 1 GHz to 5 GHz - Horizontal Average

FCC 47 CFR Part 15, Limit Clause 15.231 (b)

Fundamental Frequency (MHz)	Field Strength of Fundamental (Microvolts/meter)	Field Strength of Spurious Emissions (Microvolts/meter)
40.66 to 40.70	2250	225
70.00 to 130.00	1250	125
130.00 to 174.00	[1] 1250 to 3750	[1] 125 to 375
174.00 to 260.00	3750	375
260.00 to 470.00	[1] 3750 to 12500	[1] 375 to 1250
Above 470.00	12500	1250

Table 14 - Limit outside Restricted Bands

NOTE: [1] Linear interpolation
The above field strength limits are specified at a distance of 3 meters.

FCC 47 CFR Part 15, Limit Clause 15.205

Restricted Bands of Operation	Peak (dBµV/m)	Average (dBµV/m)
	74	54

Table 15 - Limits within Restricted Bands

2.2.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Hygromer	Rotronic	A1	2677	12	20-Feb-2020
Digital Multimeter	Iso-tech	IDM-101	2895	12	04-Oct-2019
Antenna with permanent attenuator (Bilog)	Chase	CBL6143	2904	24	08-Aug-2019
Comb Generator	Schaffner	RSG1000	3034	-	TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	17-Dec-2019
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	11-Dec-2019
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
4dB Attenuator	Pasternack	PE7047-4	4935	24	28-Nov-2019
8m N-Type RF Cable	Teledyne	PR90-088-8MTR	5093	12	04-Oct-2019
EmX Software	TUV SUD	EmX V.1.4.8.3	5125	-	Software

Table 16

TU – Traceability Unscheduled

2.3 20 dB Bandwidth

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.231 (c)

2.3.2 Equipment Under Test and Modification State

FST433, S/N: Not Serialised (75945973-TSR0051) - Modification State 0

2.3.3 Date of Test

05-August-2019

2.3.4 Test Method

The test was performed in accordance with FCC 47 CFR Part 15, clause 15.231 (c).

2.3.5 Environmental Conditions

Ambient Temperature	23.8 °C
Relative Humidity	61.0 %

2.3.6 Test Results

433 MHz SRD Transceiver - Channel Tag (internal antenna)

Frequency (MHz)	20 dB Bandwidth (Hz)
433.920	103600

Table 17

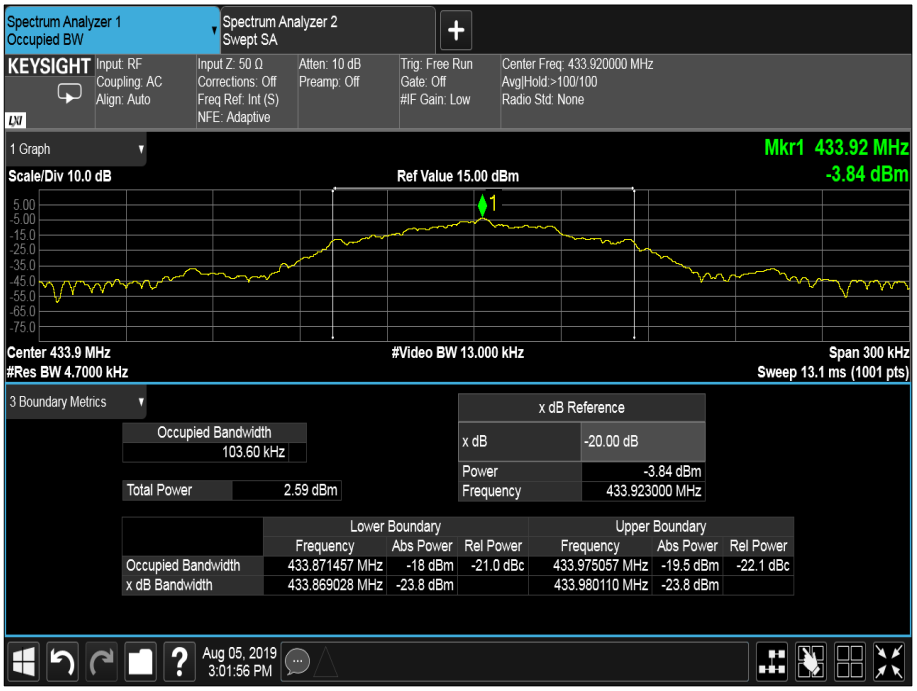

Figure 25

FCC 47 CFR Part 15, Limit Clause 15.231 (c)

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Hygrometer	Rotronic	I-1000	3220	12	13-Sep-2019
EXA	Keysight Technologies	N9010B	4969	24	21-Dec-2019
Cable (18 GHz)	Rosenberger	LU7-071-1000	5100	12	04-Oct-2019
Handheld Digital Multimeter	Fluke	179	5265	12	12-Apr-2020
Attenuator 10dB 2W	Telegartner	J01156A0031	N/S	-	O/P Mon
Programmable power supply Type188 W	Rohde & Schwarz	HMP2020	101828 -FJ	-	O/P Mon

Table 18

O/P Mon – Output Monitored using calibrated equipment

3 Photographs

3.1 Test Setup Photographs

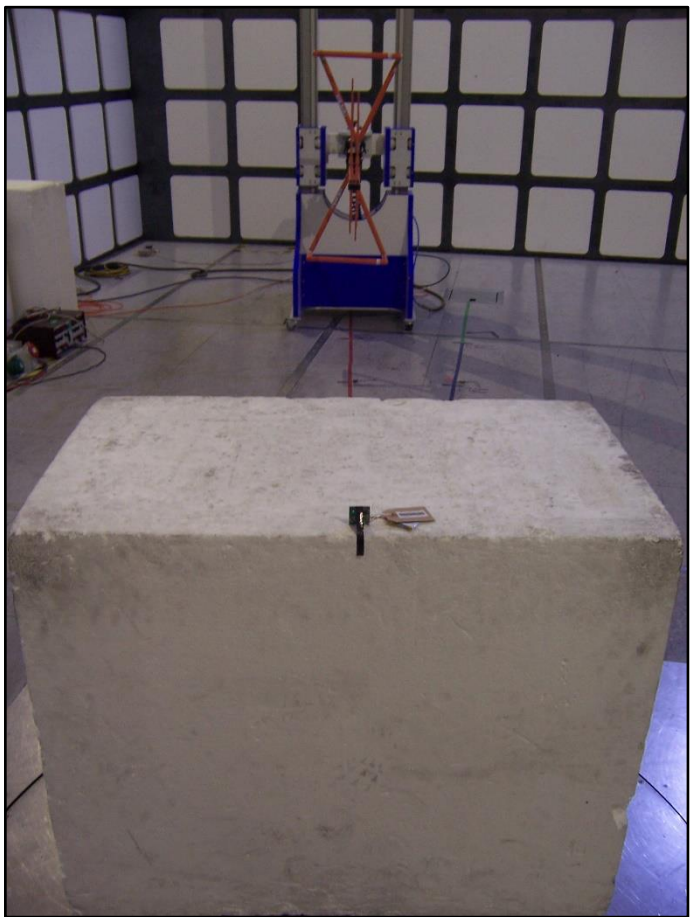

Figure 26 – 30 MHz to 1 GHz (Tag)

Figure 27 – 1 GHz to 5 GHz (Tag)

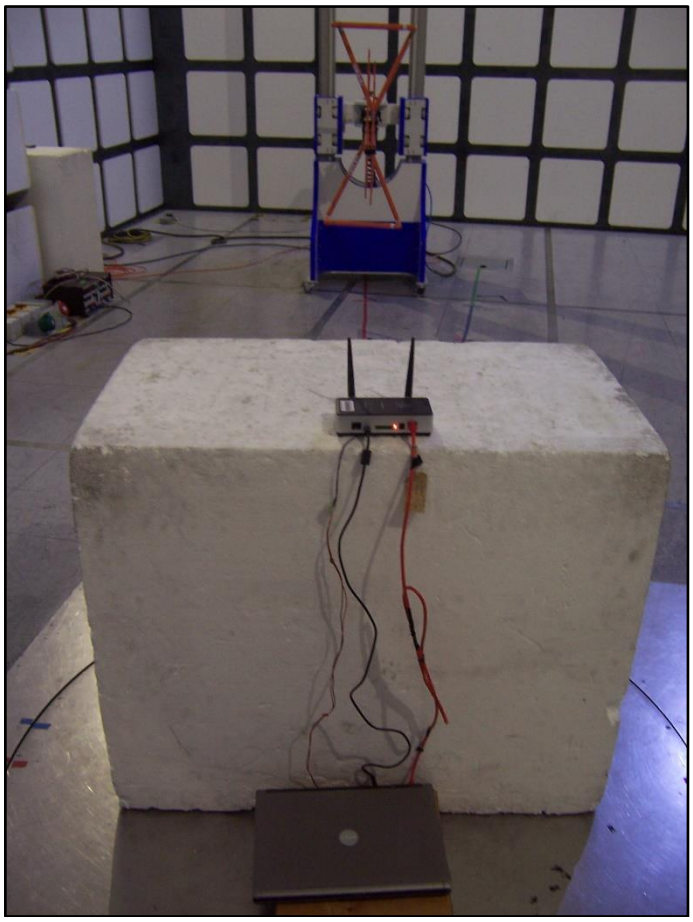

Figure 28 – 30 MHz to 5 GHz (Reader)

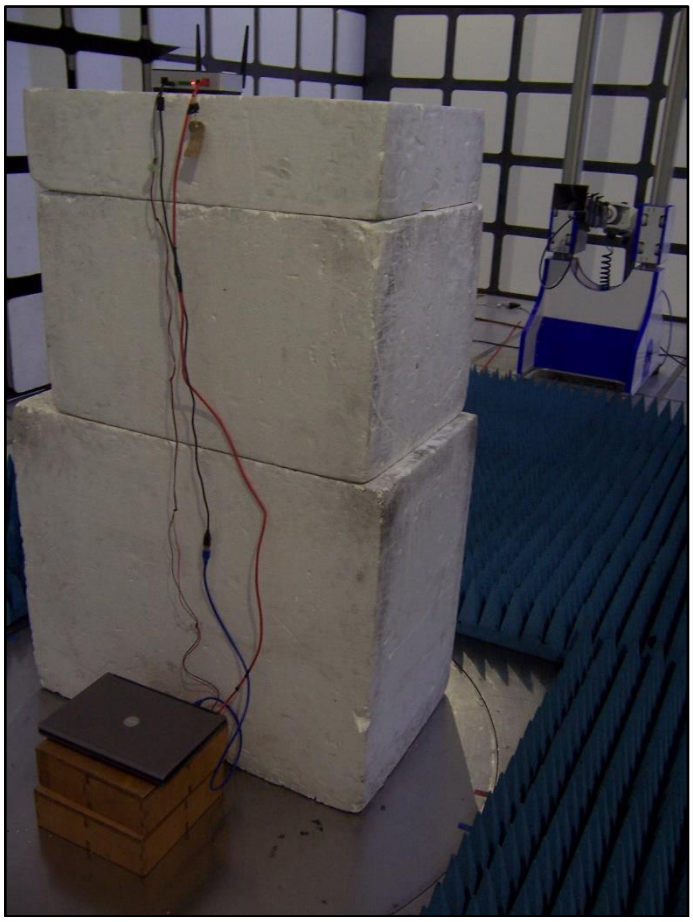

Figure 29 – 1 GHz to 5 GHz (Reader)

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
20 dB Bandwidth	± 16.74 kHz
Field Strength of Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Automatically Activated Transmitter	-

Table 19

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2007, clause 4.4.3 and 4.5.1.