Test Report (pdf copy)

Testing of the Shot Scope Smart Wristband.

13.56MHz operation and containing a BLE module

FCCId: 2AHWR-SS02

For

Shot Scope Technologies Ltd

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Author: .....

Senior Engineer

Checked / Approved .....

E Warren

Principal Engineer

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York EMC Services Ltd
Market Square
University of York
Heslington
York
YO10 5DD
UK

T: +44 (0)1904 324440
F: +44 (0)1904 324434
E: enquiry@yorkemc.co.uk
www.yorkemc.co.uk

Registered in England and Wales
Company Reg No. 6048589
VAT Reg No. 647 2055 41

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1 Introduction

Name and address of laboratory:	York EMC Services Ltd Three Lane Ends Business Centre Methley Road Castleford West Yorkshire WF10 1PN
Name and address of customer:	Shot Scope Technologies Ltd ETTC 3rd Floor Alrick Building The King's Buildings, The University of Edinburgh Edinburgh EH9 3JL UK

The test results contained in this test report relate only to the unit(s) tested.

Equipment under test	Shot Scope Smart Wristband.
Model	SS01
Manufacturer	Shot Scope Technologies Ltd.
PCB number (RFID device)	SSM-MAIN-01 v1.0.
No. tested of each item	One
FCC Grantee Code	**2AHWR**.
FCC ID:	**2AHWR-SS01**
BLE FCCID	**2AHWR-SS02**
BLE modular type	Limited Single Modular
Customer supplied test plan ref.	N/A
Date of receipt of EUT	22nd March 2016
Method of receipt	Brought by customer
Date(s) of test(s)	8th June 2016 and 30th June 2016
Date(s) when EUT was out of laboratory's control	None
Method of disposal	Taken by customer
Personnel witnessing tests	Lewis Allison

2 Test Specification

2.1 Introduction

The Shot Scope Smart Wristband is a Golfing aid designed to predict trajectory of a golf ball. It contains a 13.56MHz RFID device and a Bluetooth Low Energy (BLE) module.

FCCID	**2AHWR-SS02**
Modular type	Limited Single Modular

The purpose of this test report is to demonstrate the radiated spurious emissions and band edge continuing compliance. Radiated emissions were measured between 9kHz and 26GHz. The BLE module was set to output the same power level as the module original testing and certification. All tests were performed with the Bluetooth module transmitting on the following channels:

Low:: 2402MHz

Middle: 2440MHz

High 2480MHz

This test report shall be filed in support of a Class 2 Permissive Change to include the BLE module.

Note: The apparatus also contains a 13.56MHz transmitter which is subject to separate equipment authorisation.

2.2 Relevant standards

FCC Rule Part: 47CFR15.205 – Restricted Bands

And

47CFR15.209 – Radiated Spurious Emissions

The standard ANSIC63.10 was the test standard used.

2.3 Radiated Emission Limits

2.3.1 47CFR15.209 Limits for spurious emissions

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
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

Throughout this test report units of dBμV/m are used.

2.3.2 Detector Type used

According to FCC Rule Part 47CFR15.35(a) for frequencies less than or equal to 1GGz the CISPR quasi-peak detector shall be used.

2.3.2.1 Detector Type used above 1GHz

According to FCC Rule Part 47CFR15.35(b) for any frequencies greater than 1GHz an average detector function shall be used. In addition there is a limit for the **peak value of the emissions 20dB higher than the average detector limits**.

If the maximum peak measurement is lower than the average detector limit, then both limits are complied with.

3 Test Results

3.1 Mains conducted emissions

This test was not applicable. The apparatus cannot transmit while charging.

3.2 Field strength within the band 9kHz to 30MHz

Mode of operation	Description	Mode No.
	BLE module in continuous transmit mode as tabulated below.	1

Test standard	Test description	Class/limit
CFR 47 Part 15C 15..209 ANSI C63.10-2013	Radiated emissions	47CFR15.209 Table.

Wrist band position	Polarity	Channel	Graphical Data Appendix 5.1	Tabulated Data
Side	Parallel	2402	5.1.1	Table 3.2.2
Side	Parallel	2440	5.1.2	Table 3.2.3
Side	Parallel	2480	5.1.3	Table 3.2.4
Side	Perpendicular	2402	5.1.4	No data >20dB from limit
Side	Perpendicular	2440	5.1.5	No data >20dB from limit
Side	Perpendicular	2480	5.1.6	No data >20dB from limit

Table 3.2.1 Summary of measurements in the frequency range 9kHz to 30MHz

Representative measurements were performed in the parallel measurement antenna position as representative worst case and are tabulated below.

Investigations demonstrated that there was no significant difference in the positioning of the apparatus under test. The side orientation was used for all testing.

frequency (MHz)	Rx at 10m	pre-amp(dB)	AF(dB/m)	SD (m)	Extrap (dB)	E field at spec distance	Limit at SD	Margin (dB)
0.009	19	31.1	86	300	-59.1	14.8	48.5	-33.7
0.04	16.7	30.7	73.9	300	-59.1	0.8	35.6	-34.8
0.15	29.8	30.7	62.4	300	-59.1	2.4	24.1	-21.7
0.538	17.8	30.6	51.5	30	-19.1	19.6	33	-13.4
1.97	15.2	30.5	40.8	30	-19.1	6.4	30	-23.6
25	13	30.5	31.7	30	-19.1	-4.9	30	-34.9

Table 3.2.2 Receiving antenna parallel position, receiving antenna at 1m measurement height, 2402MHz Chanel, Quasi-peak detector

frequency (MHz)	Rx at 10m	pre-amp(dB)	AF(dB/m)	SD (m)	Extrap (dB)	E field at spec distance	Limit at SD	Margin (dB)
0.009	16.5	31.1	86	300	-59.1	12.3	48.5	-36.2
0.04	18.1	30.7	73.9	300	-59.1	2.2	35.6	-33.4
0.15	29	30.7	62.4	300	-59.1	1.6	24.1	-22.5
0.538	18.3	30.6	51.5	30	-19.1	20.1	33	-12.9
1.97	15.2	30.5	40.8	30	-19.1	6.4	30	-23.6
25	16.7	30.5	31.7	30	-19.1	-1.2	30	-31.2

Table 3.2.3 Receiving antenna parallel position, receiving antenna at 1m measurement height, 2440MHz, Quasi-peak detector

frequency (MHz)	Rx at 10m	pre-amp(dB)	AF(dB/m)	SD (m)	Extrap (dB)	E field at spec distance	Limit at SD	Margin (dB)
0.009	19	31.1	86	300	-59.1	14.8	48.5	-33.7
0.04	17	30.7	73.9	300	-59.1	1.1	35.6	-34.5
0.15	28	30.7	62.4	300	-59.1	0.6	24.1	-23.5
0.538	18.8	30.6	51.5	30	-19.1	20.6	33	-12.4
1.97	14.8	30.5	40.8	30	-19.1	6	30	-24
25	12.7	30.5	31.7	30	-19.1	-5.2	30	-35.2

Table 3.2.4 Receiving antenna parallel position, receiving antenna at 1m measurement height, 2480MHz, quasi-peak detector

Rx = Test receiver reading (voltage dBμV) at a measurement distance of 10m before the addition of cable loss and antenna factor.

SD = Specification Distance for the measurement, the Measurement distance specified in 47CFR15.209

Result at 10m = Field strength (dBμV/m) at a measurement distance of 10m, calculated as follows:

Field strength (dBμV/m) = Rx (dBμV) -Pre-amp gain (dB)+Antenna factor (dB/m)+Extrapolation(dB)

The above measurements were performed at a test distance of 10m and hence the result at 10m was scaled using the extrapolation factor of **40dB/decade as stated in section 15.31(f)(2).**

For the specified measurement distance of 30m the correction will be:

Correction = 40*log (10/30) = -19dB

For the specified measurement distance of 300m the correction will be:

Correction = 40*log (10/300) = -59.1dB

Modifications	Required for this test	Modification state
	None	0

3.3 Field strengths within the band 30MHz and 1GHz:

Mode of operation	Description	Mode No.
	BLE module in continuous transmit mode as tabulated below.	1

Test standard	Test description	Class/limit
CFR 47 Part 15C 15..209 ANSI C63.10-2013	Radiated emissions	47CFR15.209 Table.

Chamber measurements (scans) were first performed to obtain the radiated frequency data. The worse case frequencies were then measured on an Open Area Test Site (OATS) at a distance of 3 meters.

Wrist band position	Measuring antenna Polarity	Channel	Graphical Data Appendix 5.2	Tabulated Data*
Side	Vertical	2402	5.2.1	Table 3.3.2
Side	Vertical	2440	5.2.2	Table 3.3.3
Side	Vertical	2480	5.2.3	Table 3.3.4
Side	Horizontal	2402	5.2.4	No horizontal peaks detected
Side	Horizontal	2440	5.2.5	No horizontal peaks detected
Side	Horizontal	2480	5.2.6	Table 3.4.4

Table 3.3.1 Summary of measurements in the frequency range 30MHz to 1GHz

*In the frequency range 30MHz to 1GHz, horizontal and vertical measurements are presented in the same table for each channel.

Frequency (MHz)	Polarity (H/V)	Height (m)	Angle (degrees)	E field @ spec distance (dBuV/m)	E field Limit (dBuV/m)	Margin (dB)
48.430	V	1	0	18.7	40.0	-21.3
120.000	V	1	0	20.1	43.5	-23.4
240.000	V	2.7	0	19.3	46.0	-26.7
359.800	v	1	110	17.2	46.0	-28.8
480.000	v	1	150	24.0	46.0	-22.0
860.000	v	1	360	24.0	46.0	-22.0

Table 3.4.2 Open Area test Data 30MHz to 1GHz – lowest channel – 2402MHz

Frequency (MHz)	Polarity (H/V)	Height (m)	Angle (degrees)	E field @ spec distance (dBuV/m)	E field Limit (dBuV/m)	Margin (dB)
48.430	v	1	0	17.6	40.0	-22.4
120.000	v	1	0	14.3	43.5	-29.2
240.000	V	1	138	19.6	46.0	-26.4
359.800	V	1	360	18.0	46.0	-28.0
480.000	V	1	360	23.6	46.0	-22.4
860.000	V	1	360	30.0	46.0	-16.0

Table 3.4.3 Open Area test Data 30MHz to 1GHz – middle channel – 2440MHz

Frequency (MHz)	Polarity (H/V)	Height (m)	Angle (degrees)	E field @ spec distance (dBuV/m)	E field Limit (dBuV/m)	Margin (dB)
48.400	v	1	0	17.6	40.0	-22.4
120.000	v	1	135	20.0	43.5	-23.5
120.000	H	1	0	11.0	43.5	-32.5
240.000	v	1	0	16.0	45.0	-29.0
359.800	v	1	0	18.0	46.0	-28.0
480.000	v	1	170	26.0	46.0	-20.0
860.000	v	1	0	30.1	46.0	-15.9

Table 3.4.4 Open Area test Data 30MHz to 1GHz – highest channel – 2480MHz

Notes:

A quasi-peak detector was used for the above measurements.

Pol = position of receive antenna, below 30MHz perp = loop antenna plane perpendicular to equipment under test.

Above 30MHz, V = Vertical, H = horizontal

These measurements were made at the specified measurement distance of 3m at an Open Area Test Site (OATS), with direct application of the limit and no data extrapolation.

Field strength (dBuV/m) = Receiver voltage reading (dBuV)+Antenna factor (dB/m)+Cable loss (dB)

Modifications	Required for this test	Modification state
	None	0

3.4 Field strengths within the band 1GHz and 18GHz:

Mode of operation	Description	Mode No.
	BLE module in continuous transmit mode as tabulated below.	1

Test standard	Test description	Class/limit
CFR 47 Part 15C 15..209 ANSI C63.10-2013	Radiated emissions	47CFR15.209 Table.

Chamber measurements (scans) were first performed to obtain the radiated frequency data.

Wrist band position	Measuring antenna Polarity	Channel	Graphical Data Appendix 5.3	Tabulated Data
Side	Vertical	2402	5.3.1	Table 3.4.2
Side	Vertical	2440	5.3.2	Table 3.4.2
Side	Vertical	2480	5.3.3	Table 3.4.2
Side	Horizontal	2402	5.3.4	Table 3.4.2
Side	Horizontal	2440	5.3.5	Table 3.4.2
Side	Horizontal	2480	5.3.6	Table 3.4.2

Table 3.4.1 Summary of measurements in the frequency range 1GHz to 18GHz, 2.4GHz band-stop filter in place at the input to the pre-amplifier

Wrist band position	Measuring antenna Polarity	Channel	Graphical Data	Tabulated Data*
Side	Vertical	2480	5.3.7	Table 3.4.2
Side	Horizontal	2480	5.3.8	Table 3.4.2

Table 3.4.2 Summary of measurements in the frequency range 30MHz to 1GHz, 2.4GHz notch filter removed

frequency (MHz)	Rx at 10m	pre-amp(dB)	AF(dB/m)	SD (m)	Extrap (dB)	E field at spec distance	Limit at SD	Margin (dB)
-	-	-	-	-	-	-	-	-

Table 3.4.3

No emissions were detected that were within 20dB of the specification limit when measured in the chamber during initial peak detector scans.

No emissions were detected that were within 20dB of the specification limit when measured in the chamber during initial peak detector scans.

The limit line displayed on the plots is the average detector limit line.

The Peak detector limit is 20dB higher than the average detector limit (not shown on the graphical data.

The detector used was the spectrum analyser peak detector. Since the peak detector measurement was in all cases lower than the average detector limit, then both the average and peak detector limits were complied with.

3.5 Field strengths within the band 18GHz and 26GHz:

Mode of operation	Description	Mode No.
	BLE module in continuous transmit mode as tabulated below.	1

Test standard	Test description	Class/limit
CFR 47 Part 15C 15..209 ANSI C63.10-2013	Radiated emissions	47CFR15.209 Table.

Chamber measurements (scans) were first performed to obtain the radiated frequency data.

Wrist band position	Measuring antenna Polarity	Channel	Graphical Data Appendix 5.4	Tabulated Data
Side	Vertical	2402	5.4.1	Table 3.5.2
Side	Vertical	2440	5.4.2	Table 3.5.2
Side	Vertical	2480	5.4.3	Table 3.5.2
Side	Horizontal	2402	5.4.4	Table 3.5.2
Side	Horizontal	2440	5.4.5	Table 3.5.2
Side	Horizontal	2480	5.4.6	Table 3.5.2

Table 3.5.1 Summary of measurements in the frequency range 18 to 1GHz, 26GHz band-stop filter in place at the input to the pre-amplifier

frequency (MHz)	Rx at 10m	pre-amp(dB)	AF(dB/m)	SD (m)	Extrap (dB)	E field at spec distance	Limit at SD	Margin (dB)
-	-	-	-	-	-	-	-	-

Table 3.5.2

No emissions were detected that were within 20dB of the specification limit when measured in the chamber during initial peak detector scans.

The limit line displayed on the plots is the average detector limit line.

The Peak detector limit is 20dB higher than the average detector limit (not shown on the graphical data.

The detector used was the spectrum analyser peak detector. Since the peak detector measurement was in all cases lower than the average detector limit, then both the average and peak detector limits were complied with.

3.6 Band Edge Compliance Measurements 47CFR15.205 requirement

Measurements were performed to demonstrate restricted band edge requirements

The restricted bands relevant this product are 2310-2390MHz and 2483.5-2500MHz. This is stated in 47CFR15.205 section (a) Table.

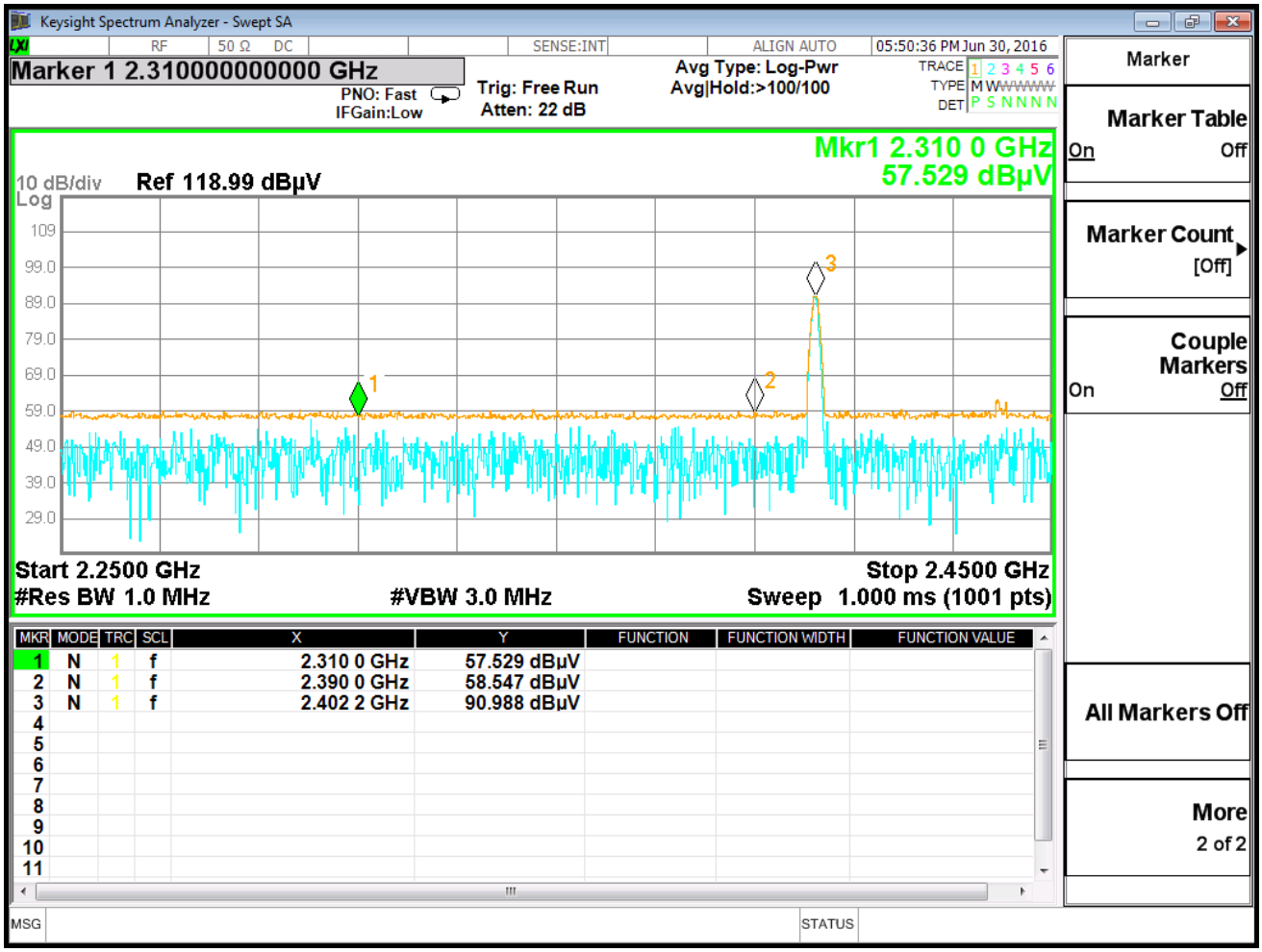
The method used was radiated.at 3m. The test method was as defined in ANSIC63.10-2013 Section 6.10.5. The apparatus was oriented for maximum emission from the carrier.

Note:

The detector used was the spectrum analyser peak detector. The Peak detector limit is 20dB higher than the average detector limit

Since the peak detector measurement was in all cases lower than the average detector limit, then both the average and peak detector limits were complied with.

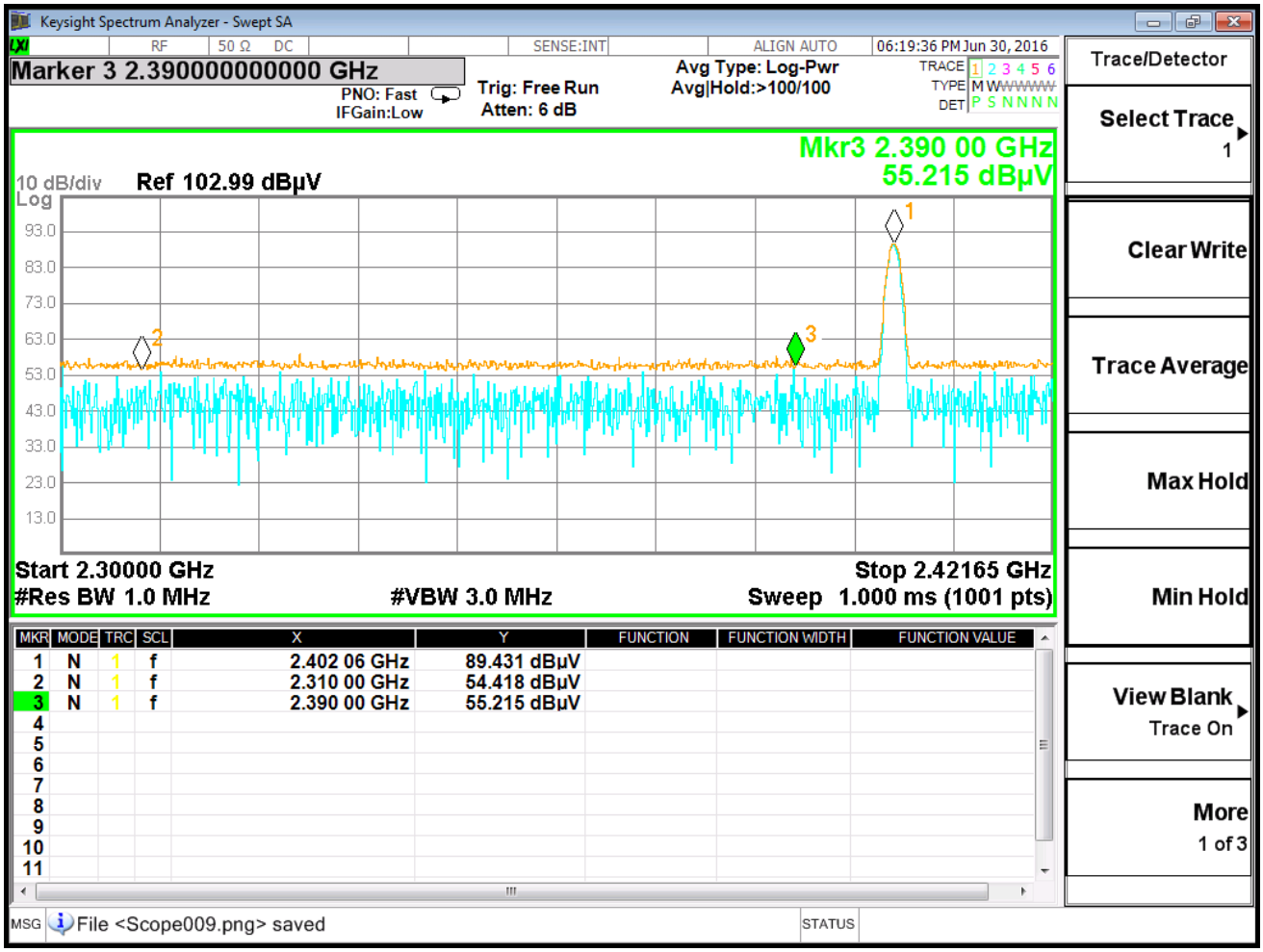
The tabulated data was measured using a peak detector. In all cases the average detector limit was met using peak detector measurements.



3.6.1 Lower restricted band spectrum analyser display showing settings, Horizontal polarity

Frequency (MHz)	Voltage (dBuV)	Preamp gain (dB)	Cable loss (dB)	Antenna Factor (dB)	E field at band edge (dBuV/m)	Spurious emission limit (dBuV/m)
2310	57.5	-51.99	4.8	28.06	38.37	54
2390	59.5	-52.02	5.07	28.26	40.81	54

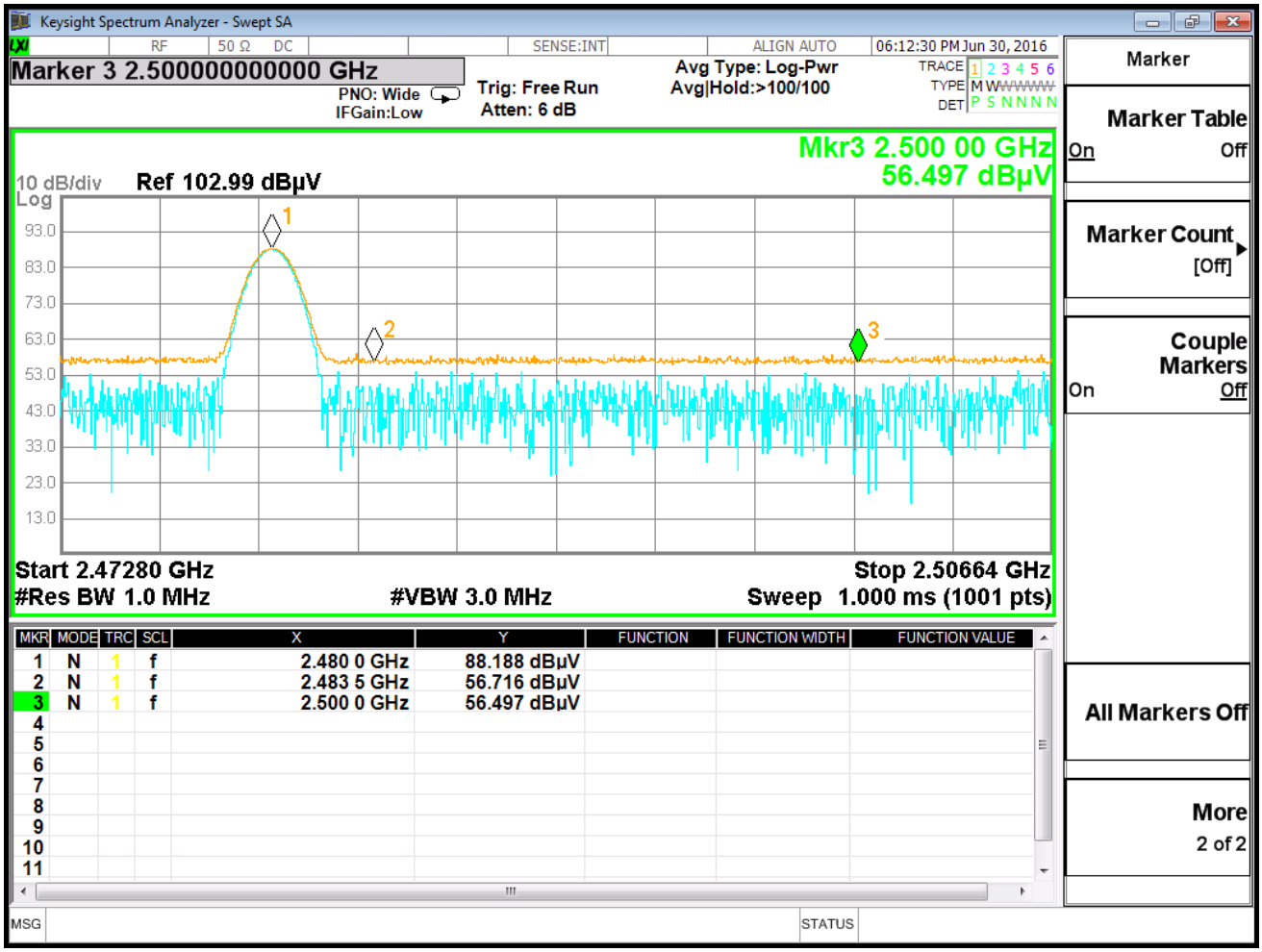
Table 3.6.2 – lower restricted band showing calculation of electric field strength. Horizontal polarity.



3.6.3 Lower restricted band spectrum analyser display showing settings, Vertical polarity

Frequency (MHz)	Voltage (dBuV)	Preamp gain (dB)	Cable loss (dB)	Antenna Factor (dB)	E field at band edge (dBuV/m)	Spurious emission limit (dBuV/m)
2310	54.4	-51.99	4.8	28.06	35.27	54
2390	55.3	-52.02	5.07	28.26	36.61	54

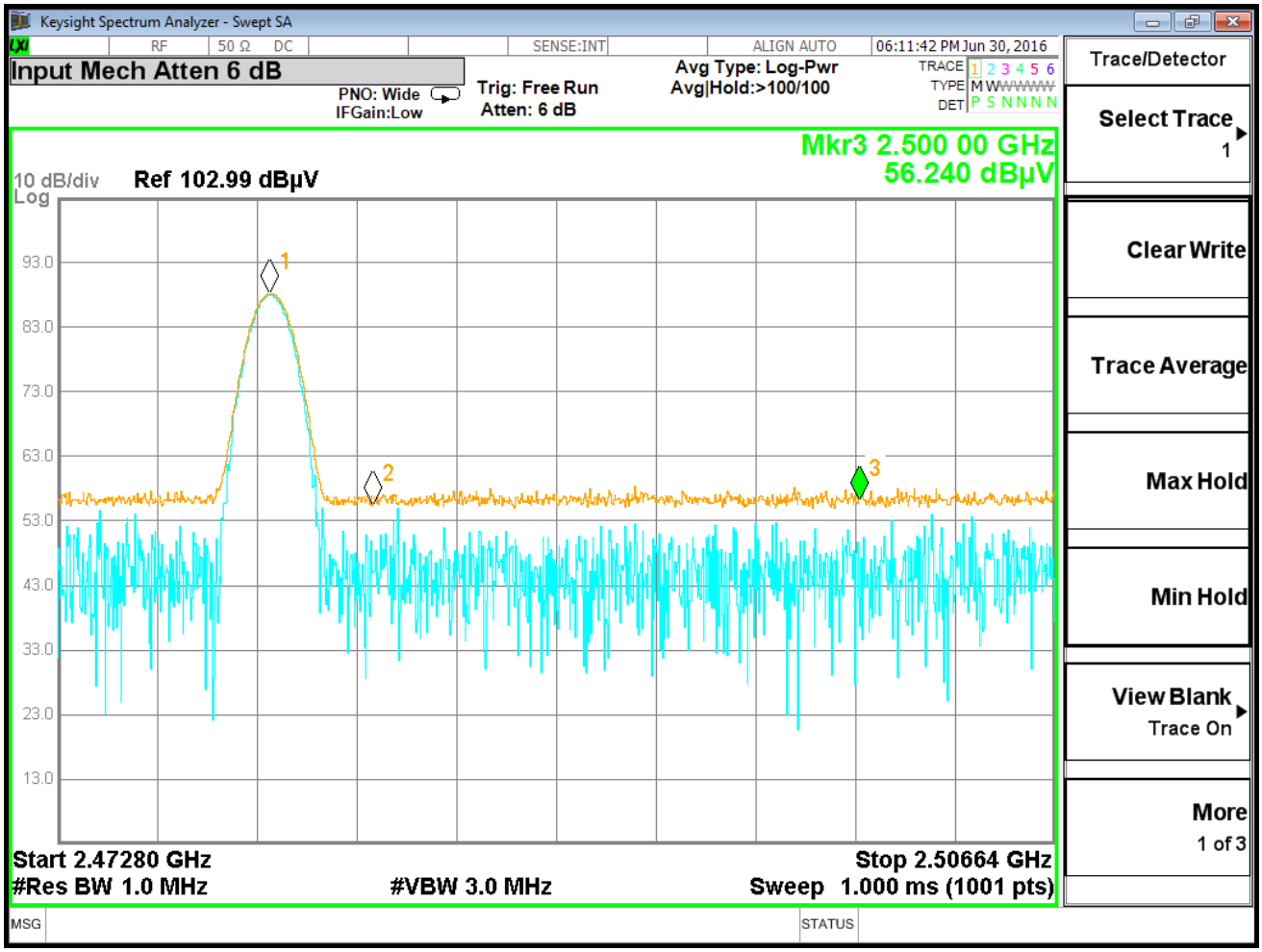
Table 3.6.4 lower restricted band showing calculation of electric field strength. Vertical polarity.



3.6.5 Higher restricted band spectrum analyser display showing settings, Horizontal polarity

Frequency (MHz)	Voltage (dBuV)	Preamp gain (dB)	Cable loss (dB)	Antenna Factor (dB)	E field at band edge (dBuV/m)	Spurious emission limit (dBuV/m)
2483.5	54.4	-52.06	5.07	28.29	35.7	54
2500	55.3	-52.07	5.08	28.29	36.6	54

Table 3.6.5 higher restricted band showing calculation of electric field strength. Horizontal polarity.



3.6.7 Higher restricted band spectrum analyser display showing settings, Horizontal polarity

Frequency (MHz)	Voltage (dBuV)	Preamp gain (dB)	Cable loss (dB)	Antenna Factor (dB)	E field at band edge (dBuV/m)	Spurious emission limit (dBuV/m)
2483.5	54.4	-52.06	5.07	28.29	35.7	54
2500	55.3	-52.07	5.08	28.29	36.6	54

Table 3.6.8 higher restricted band showing calculation of electric field strength. Horizontal polarity.

4 Summary

4.1 Emissions

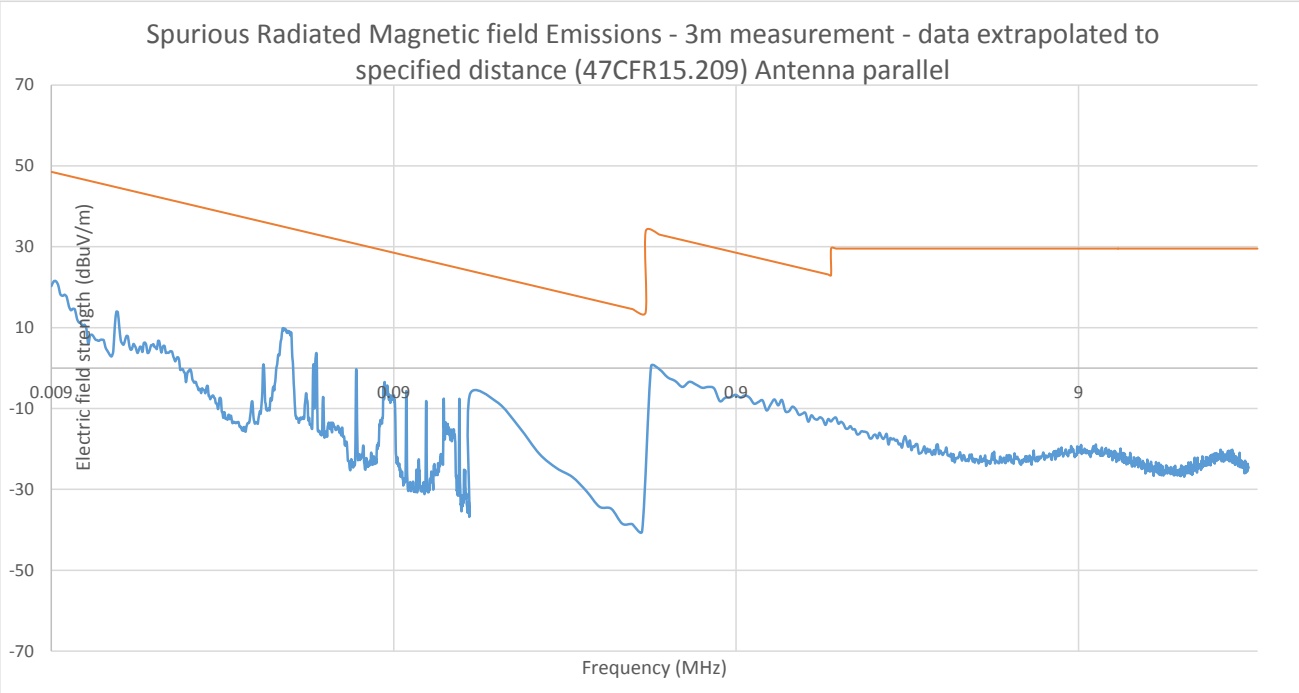
Test Standard	CFR 47 Part 15C:2008 & ANSI C63.10-2013

Relevant Section	Class/limit	Result Summary
47CFR15.209 – radiated emissions	47CFR15.209(a)	Complies
47CFR15.205 – restricted bands	47CFR15.209(a) ANSIC63.10-2013 Section 6.10.5	Complies

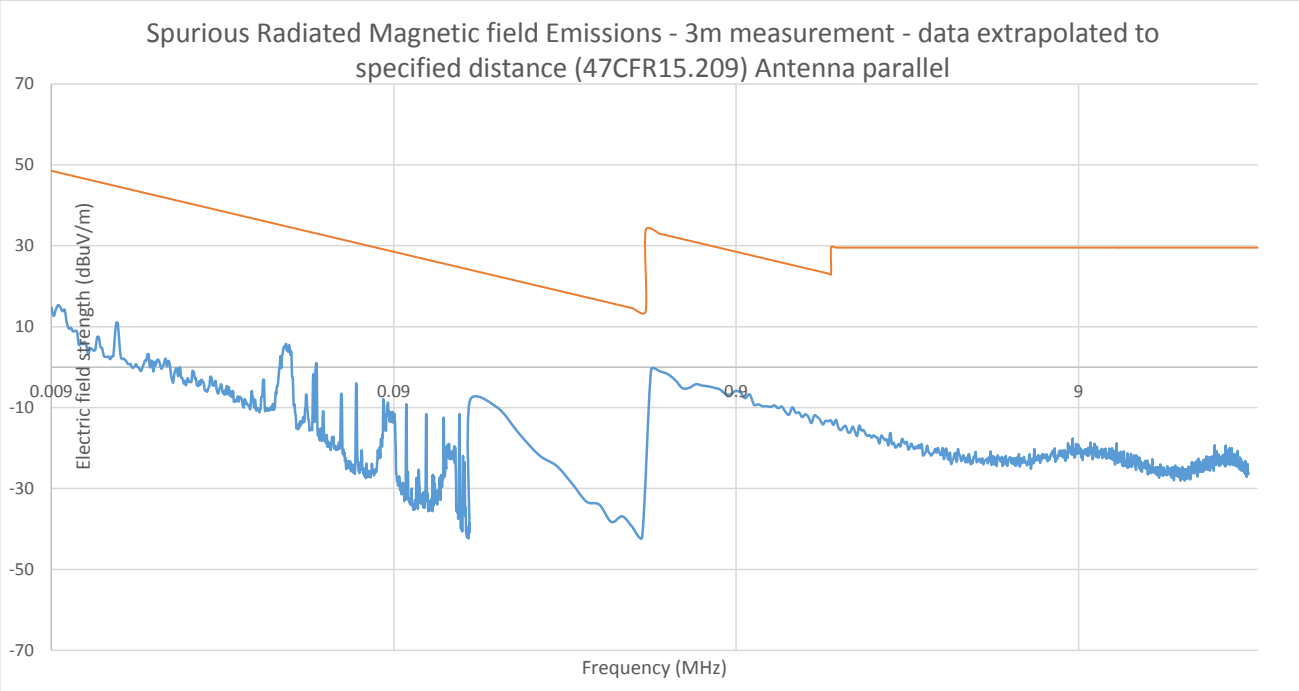
5 Appendices

5.1 Appendix 1 Radiated emission graphical data 9kHz to 30MHz

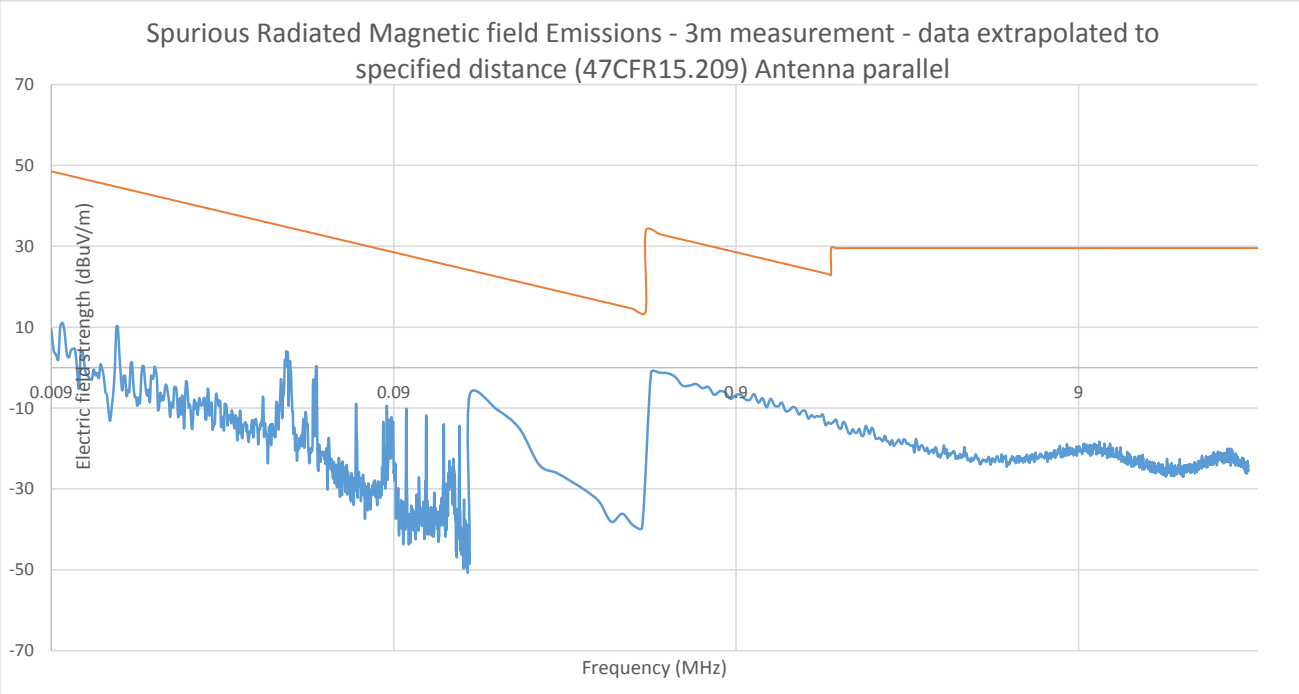
Note: on all plots the limit line shown is the



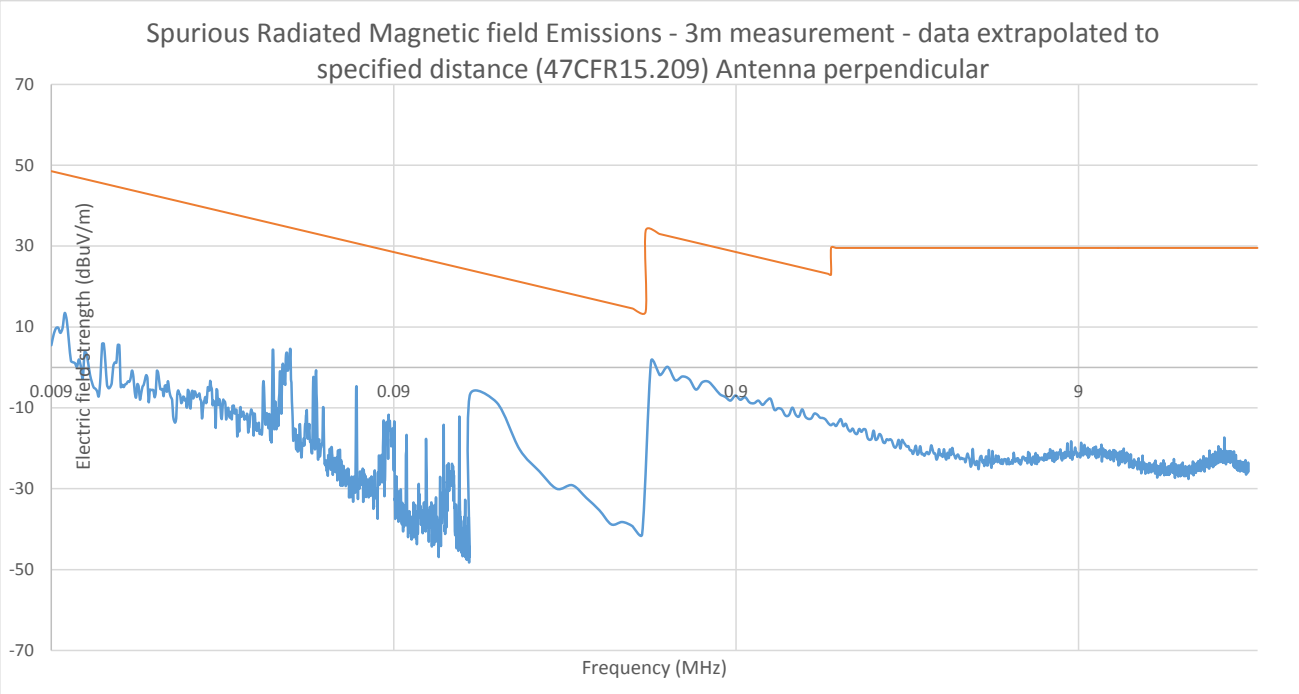
5.1.1 Transmitting on lowest channel: 2402MHz



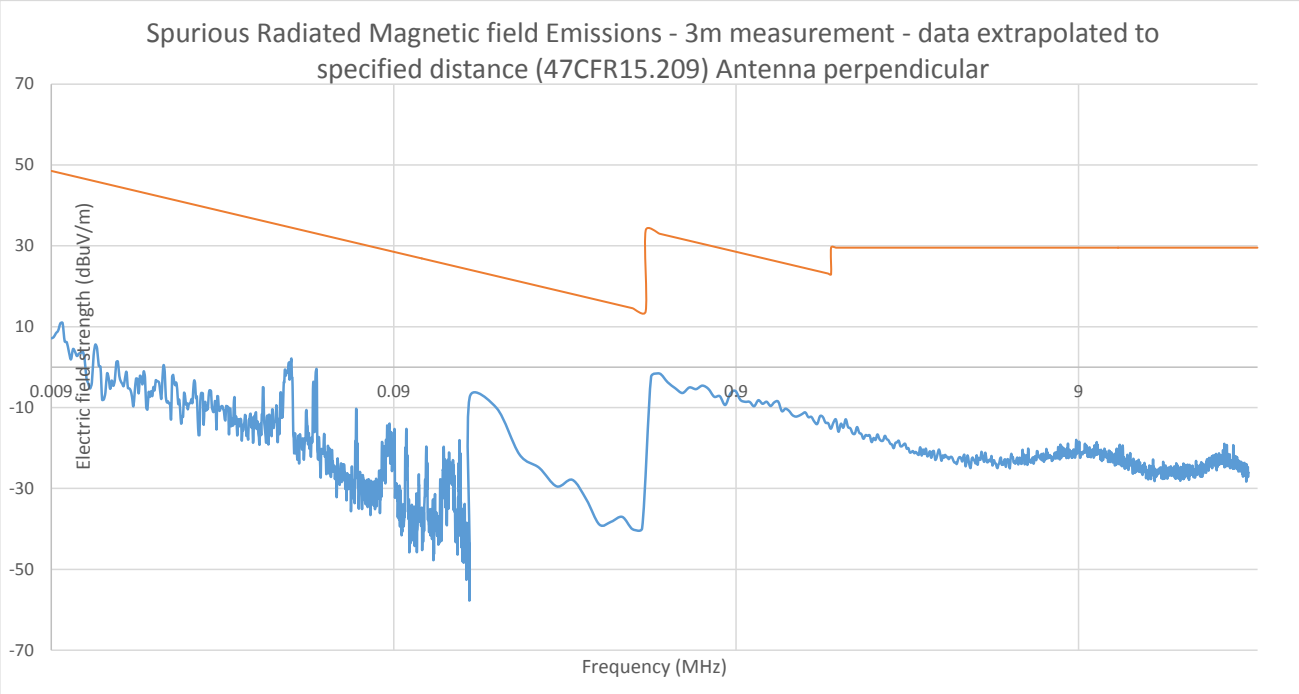
5.1.2 Transmitting on Middle channel: 2440MHz



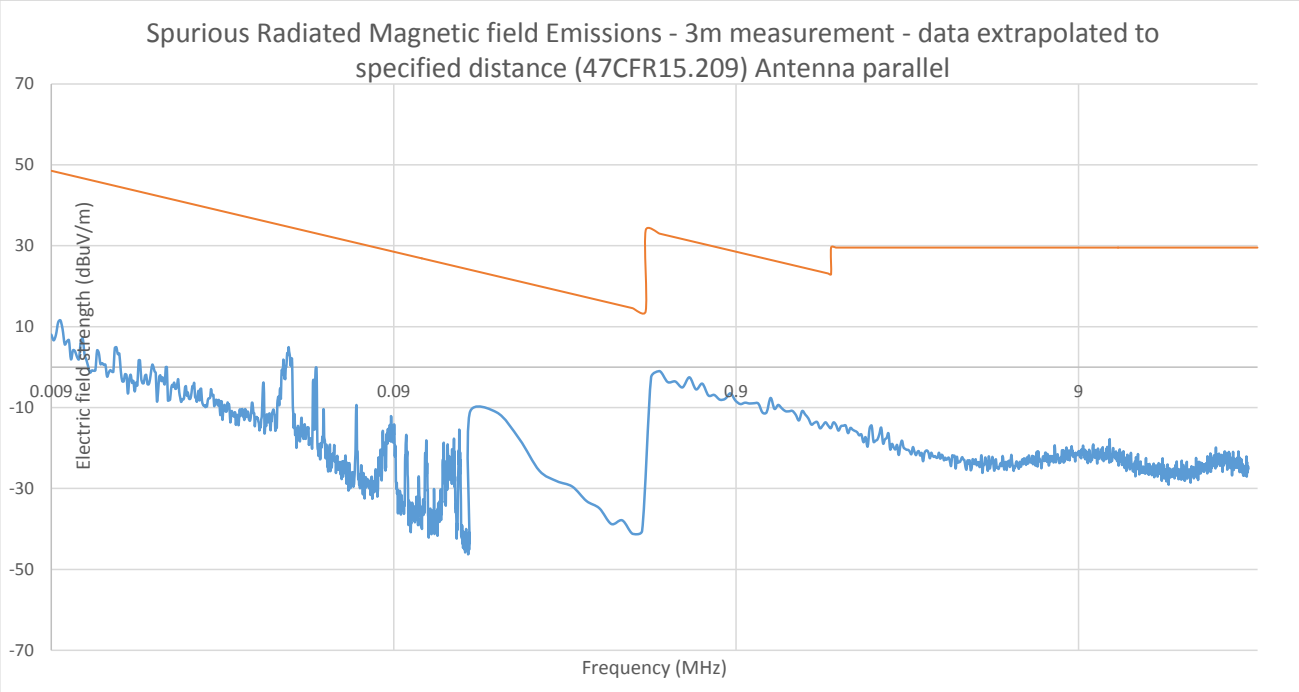
5.1.3 Transmitting on highest channel: 2480MHz



5.1.4 Transmitting on lowest channel: 2402MHz

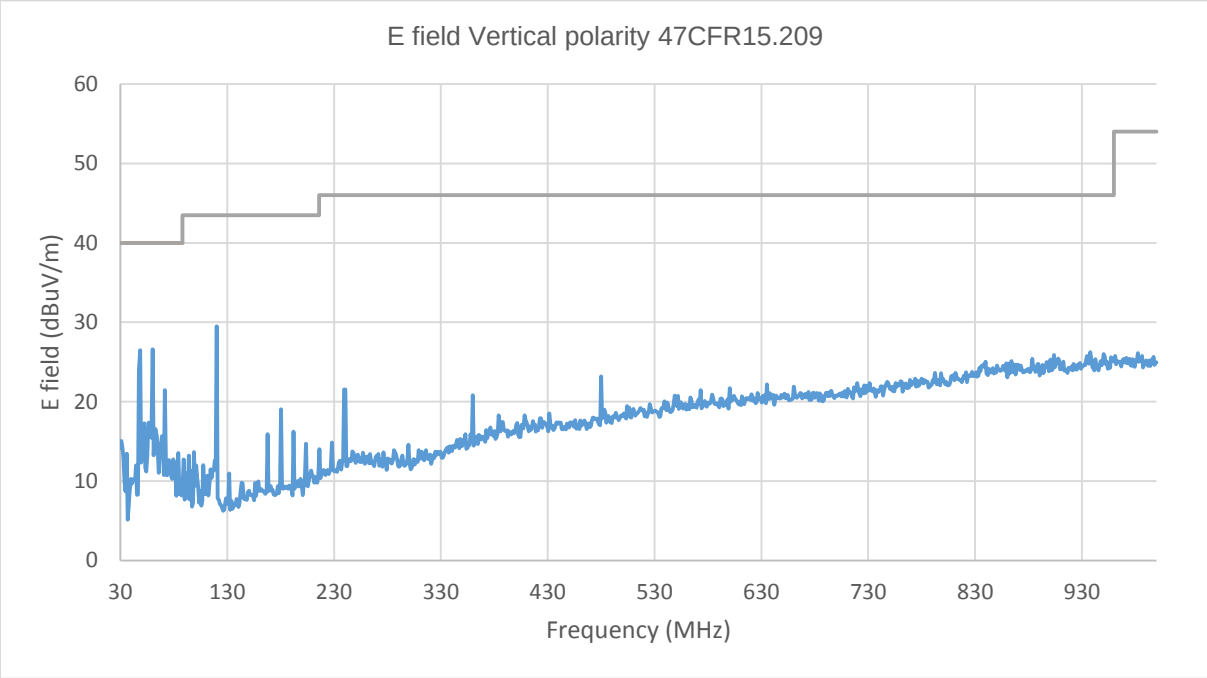


5.1.5 Transmitting on Middle channel: 2440MHz

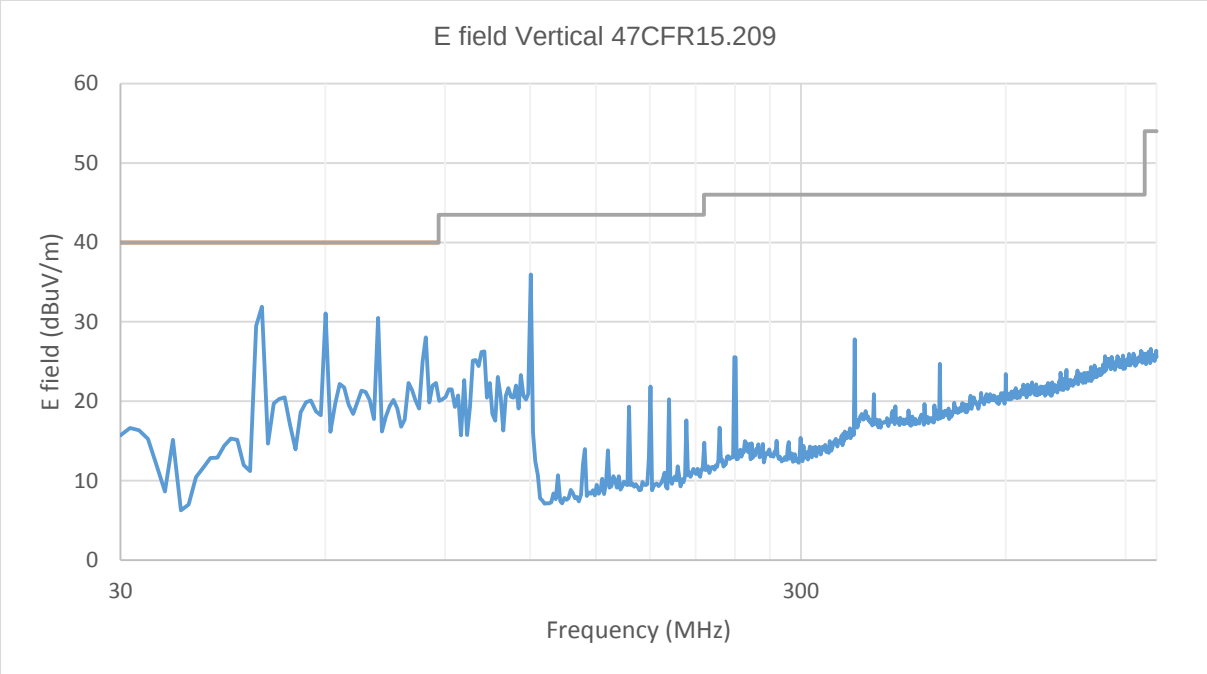


5.1.6 Transmitting on highest channel: 2480MHz

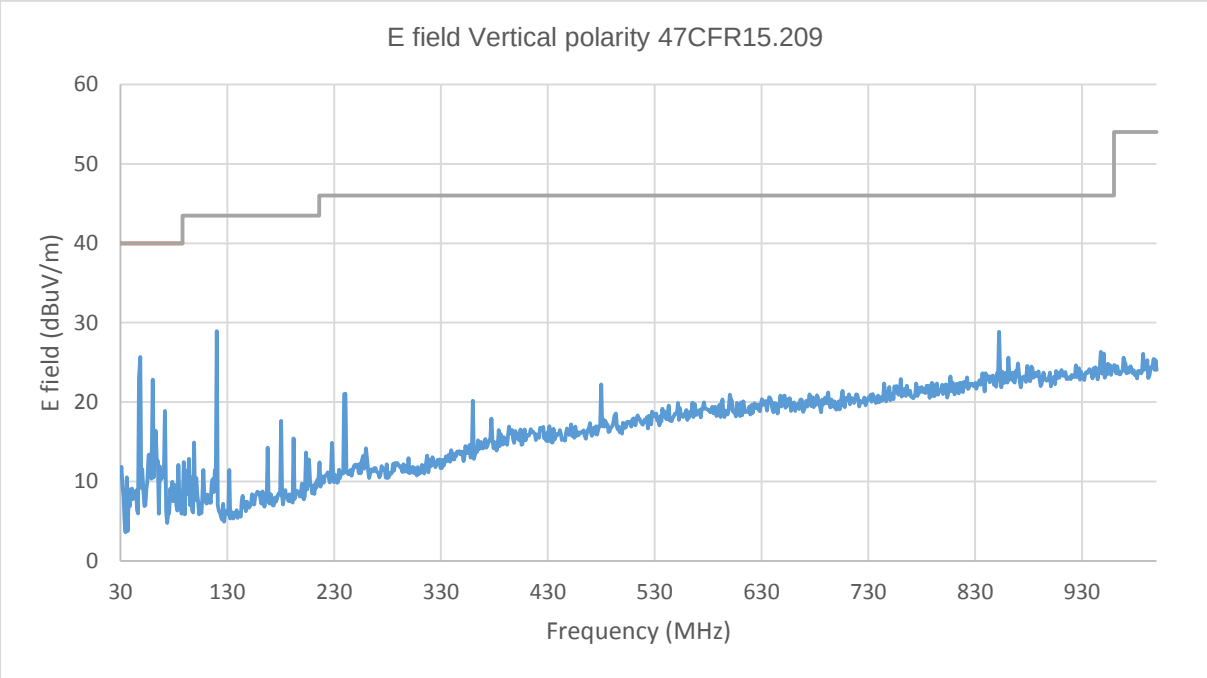
5.2 Appendix 2 Radiated emission graphical data 30MHz to 1000MHz



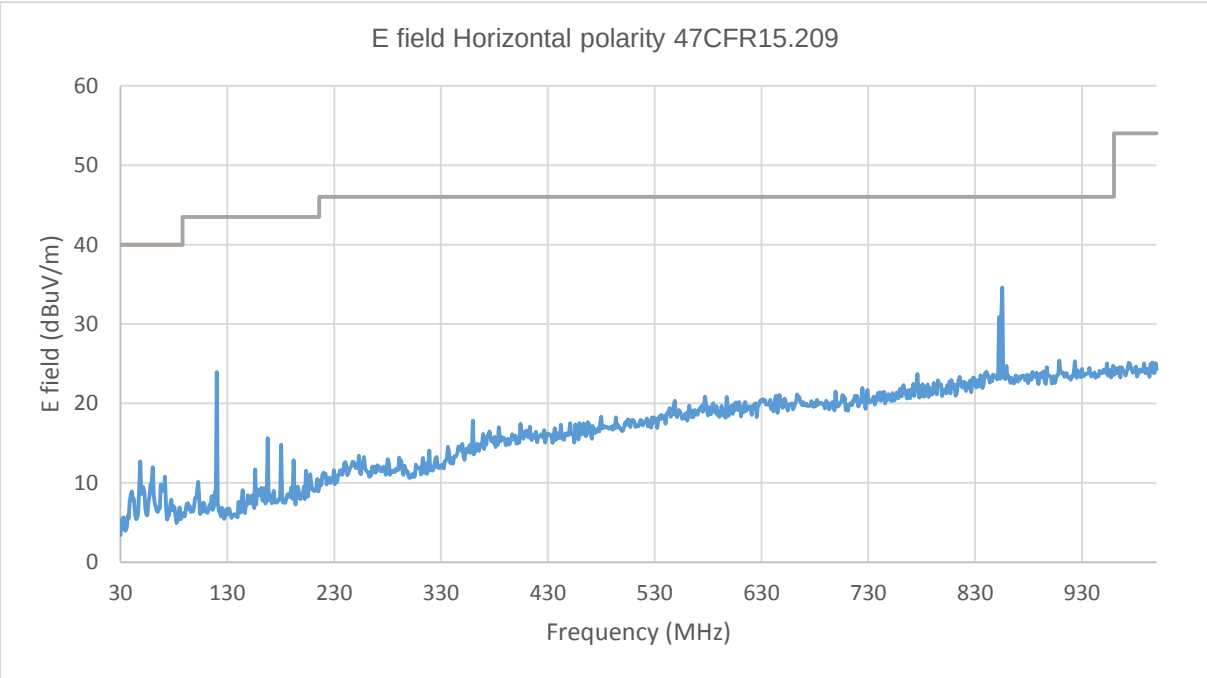
5.2.1 Transmitting on lowest channel: 2402MHz



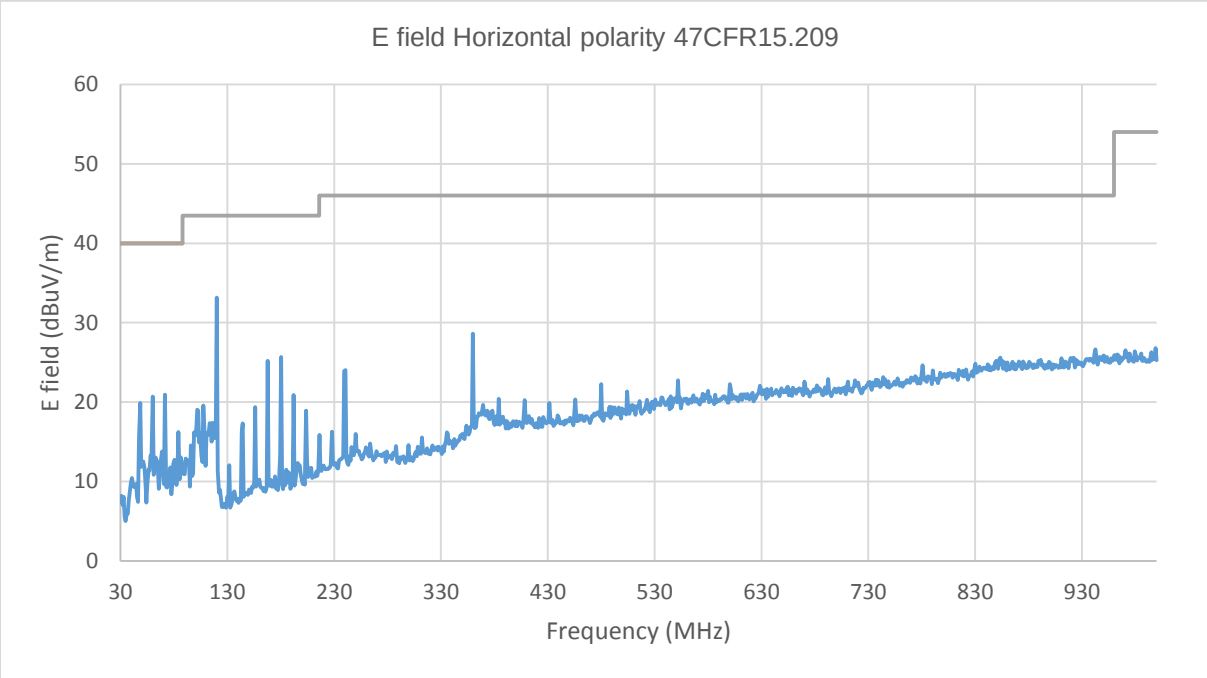
5.2.2 Transmitting on Middle channel: 2440MHz



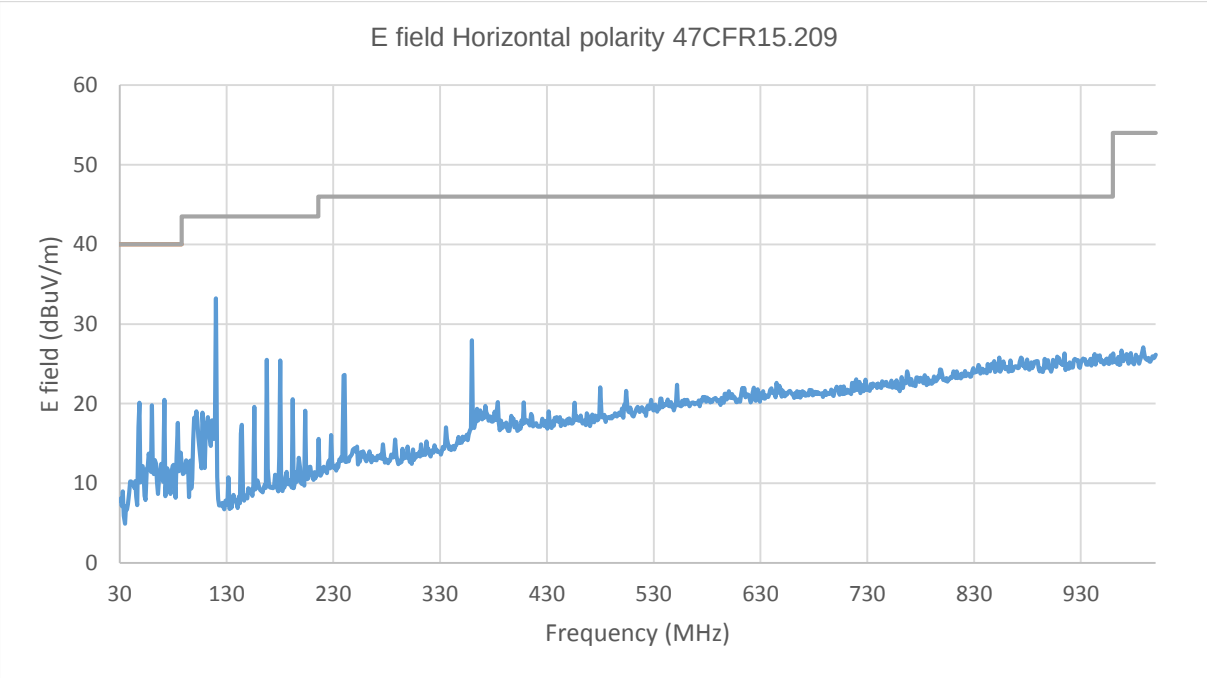
5.2.3 Transmitting on highest channel: 2480MHz



5.2.4 Transmitting on lowest channel: 2402MHz

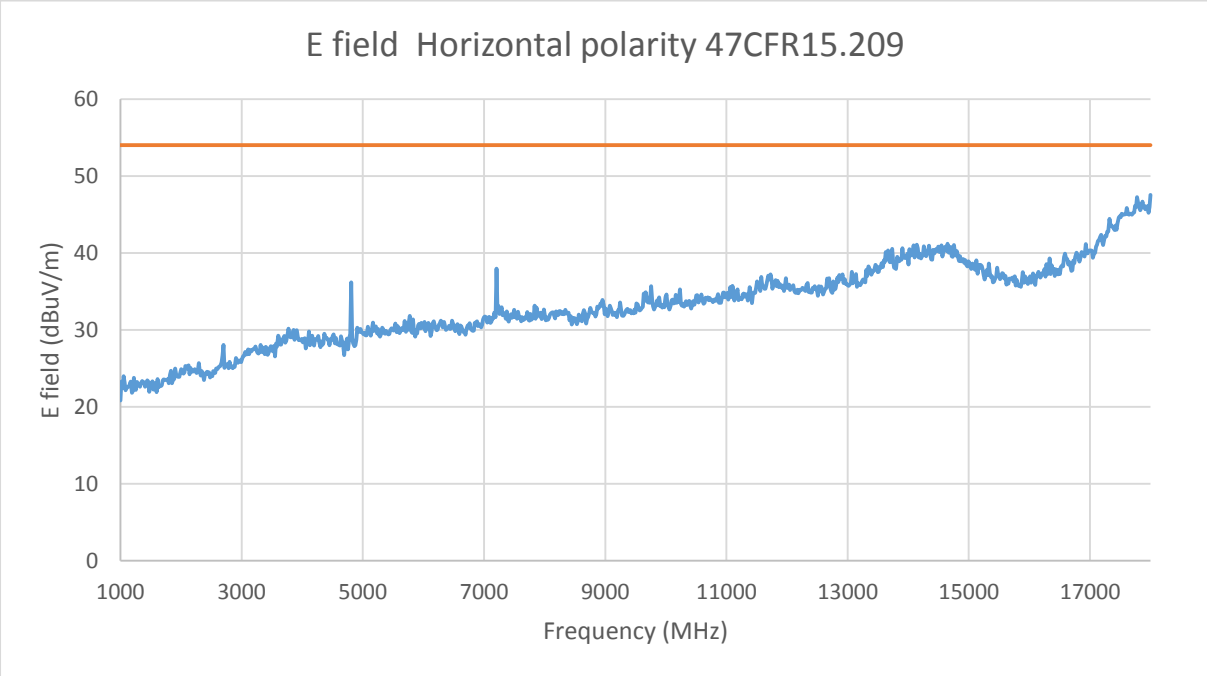


5.2.5 Transmitting on Middle channel: 2440MHz

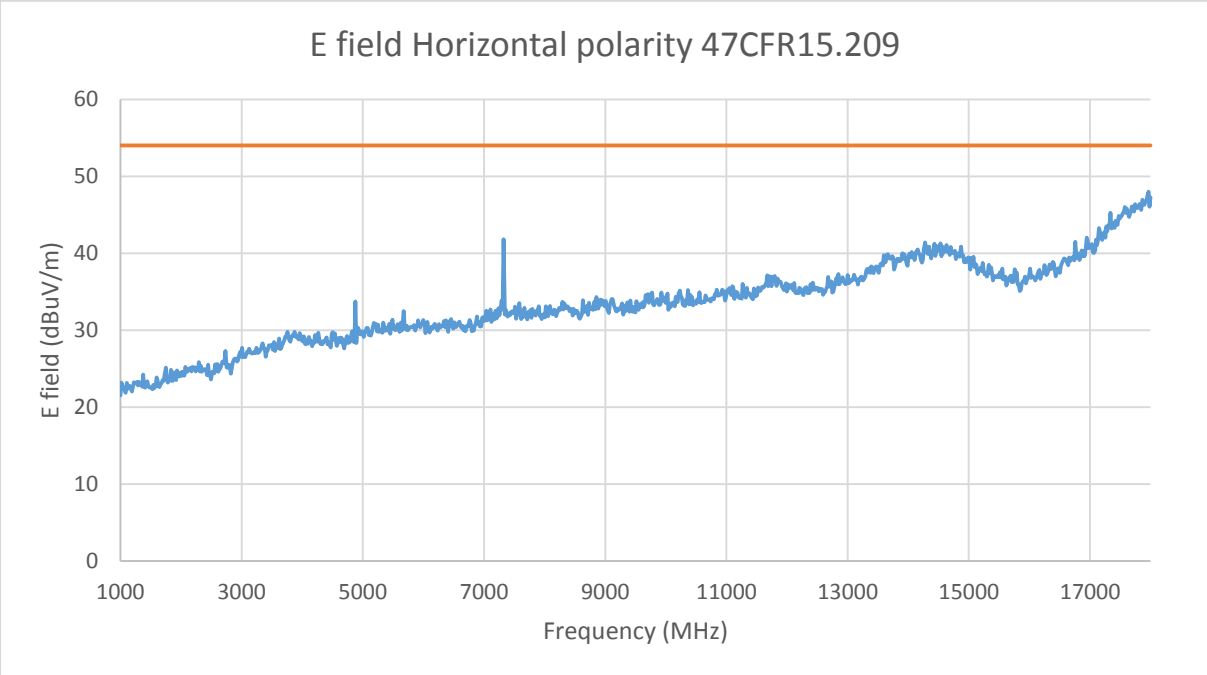


5.2.6 Transmitting on highest channel: 2480MHz

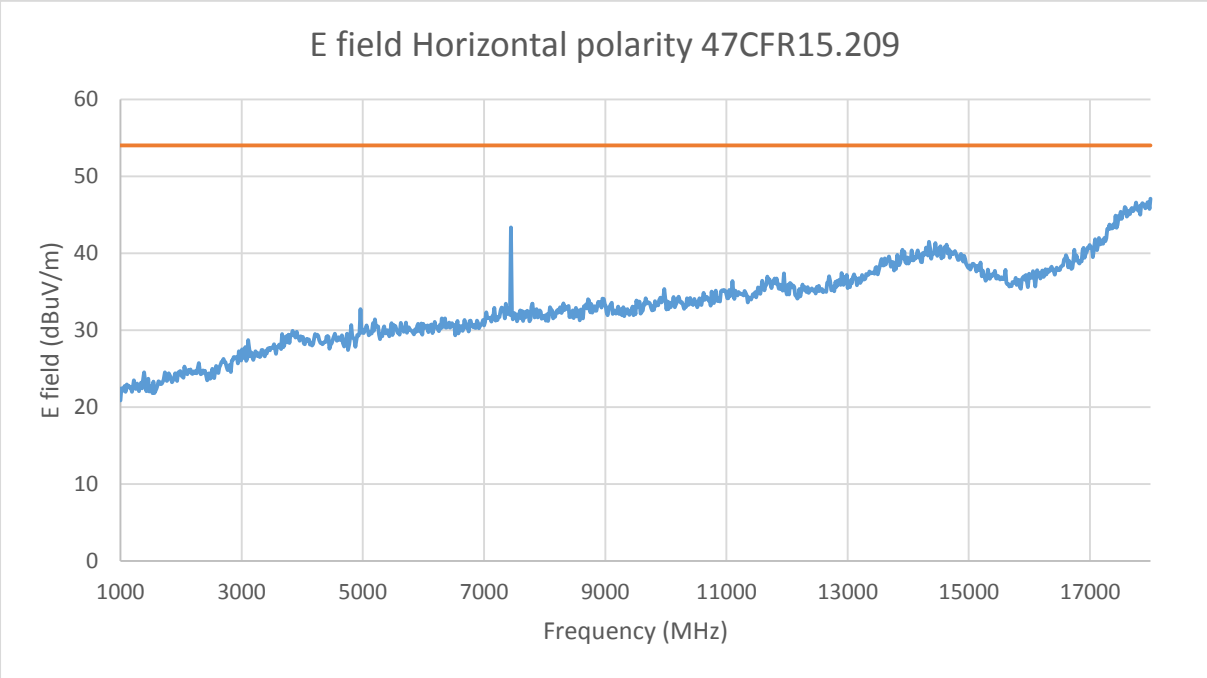
5.3 Appendix 3 Radiated emission graphical data 1GHz to 18GHz…



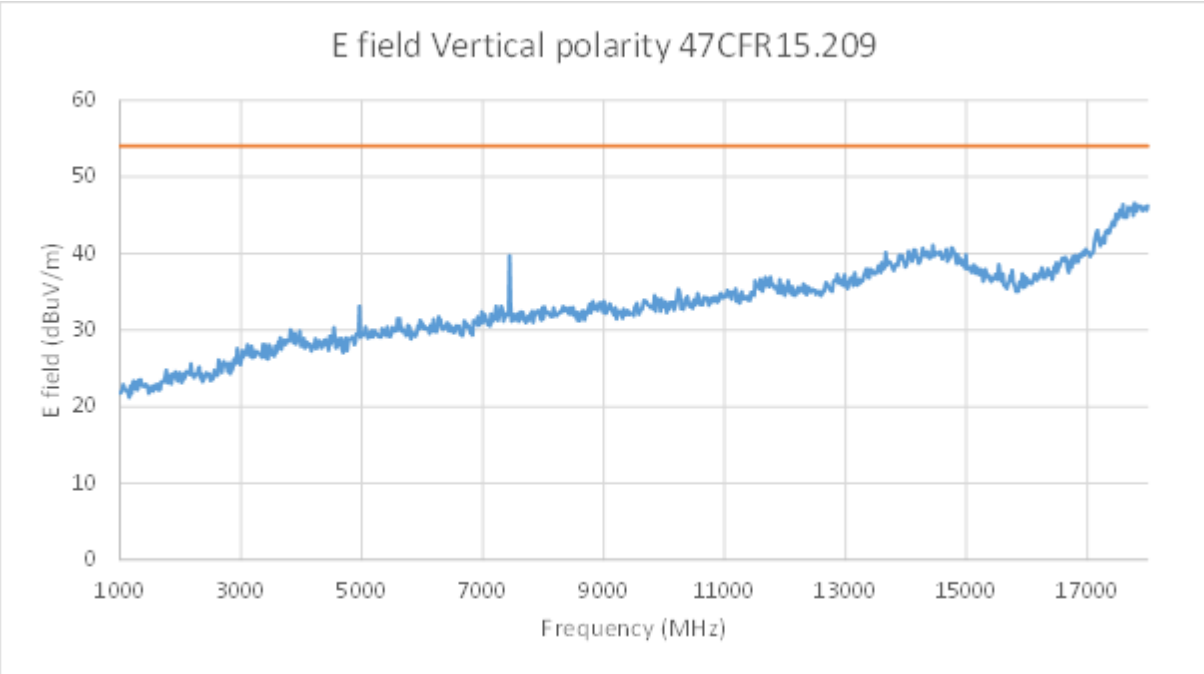
5.3.1 Transmitting on lowest channel: 2402MHz



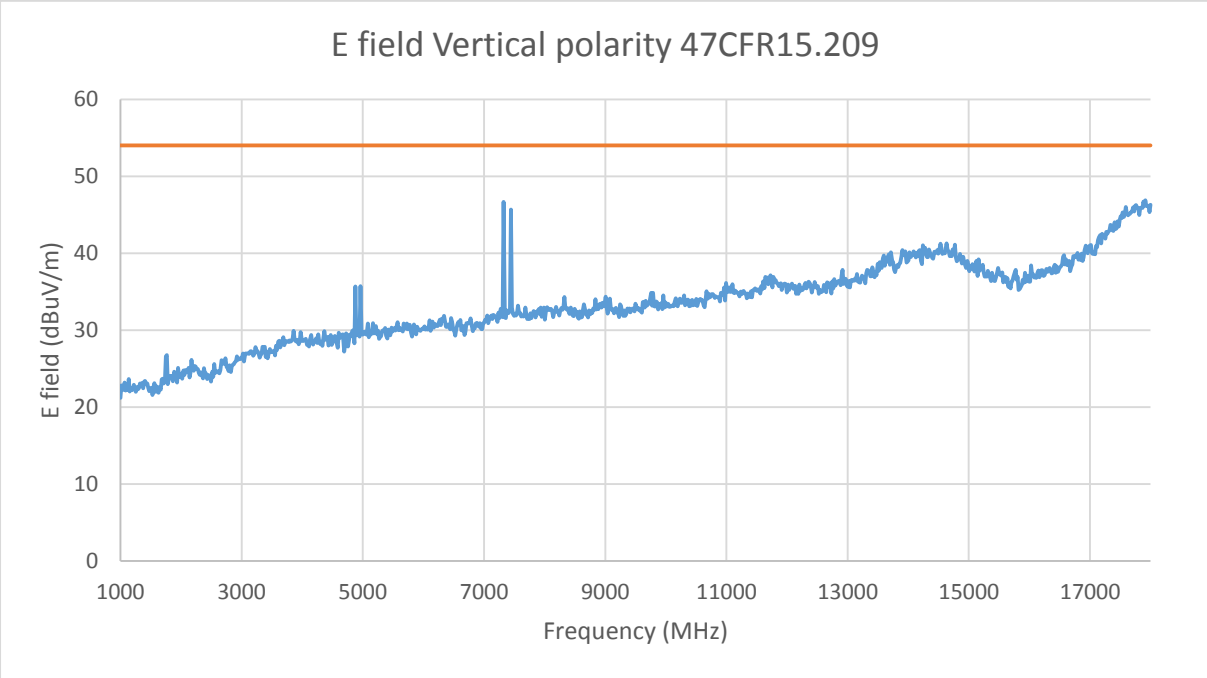
5.3.2 Transmitting on Middle channel: 2440MHz



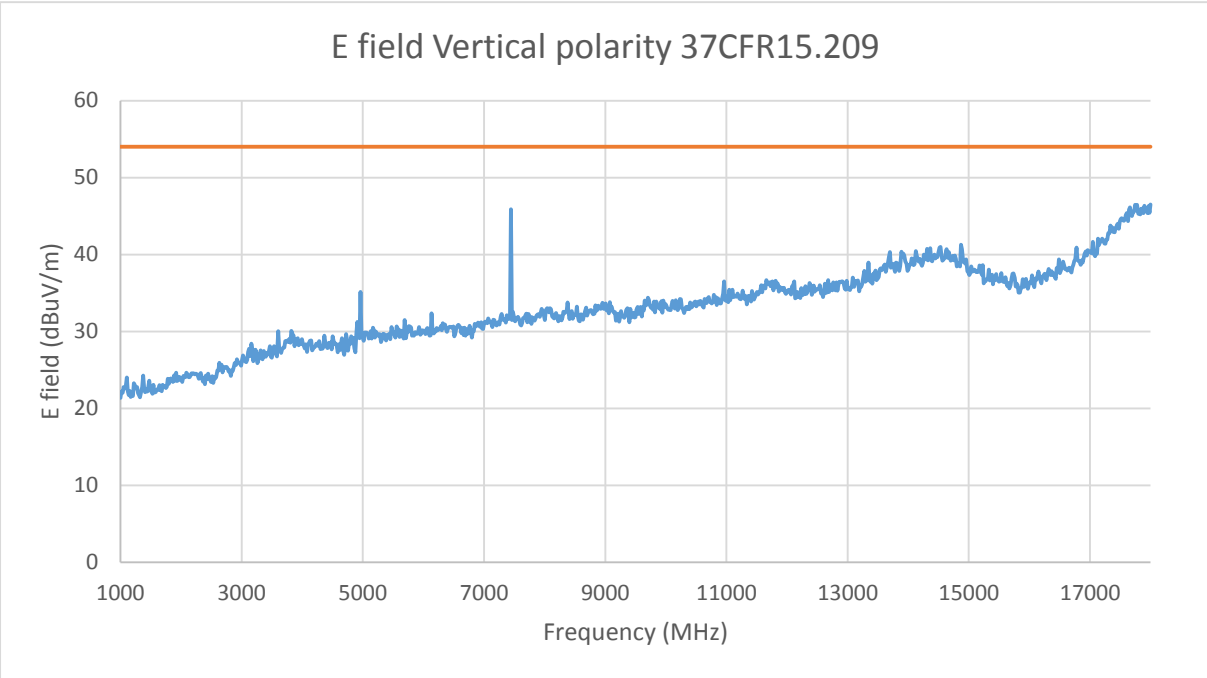
5.3.3 Transmitting on highest channel: 2480MHz



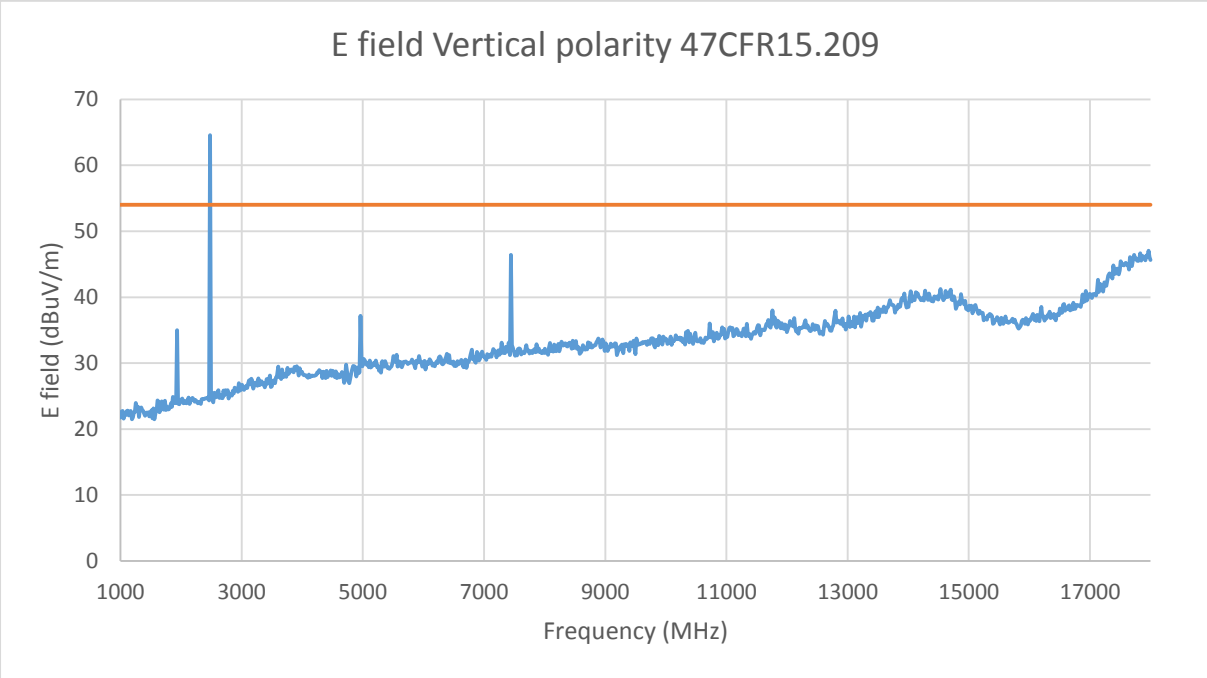
5.3.4 Transmitting on lowest channel: 2402MHz



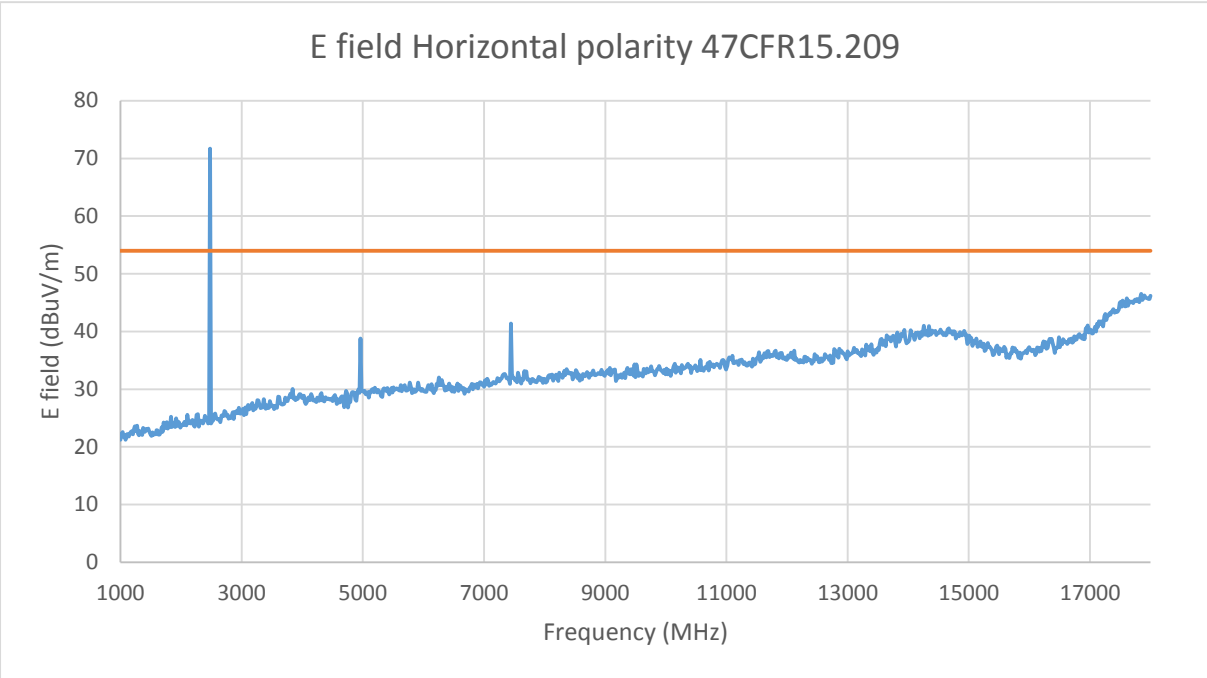
5.3.5 Transmitting on Middle channel: 2440MHz



5.3.6 Transmitting on highest channel: 2480MHz

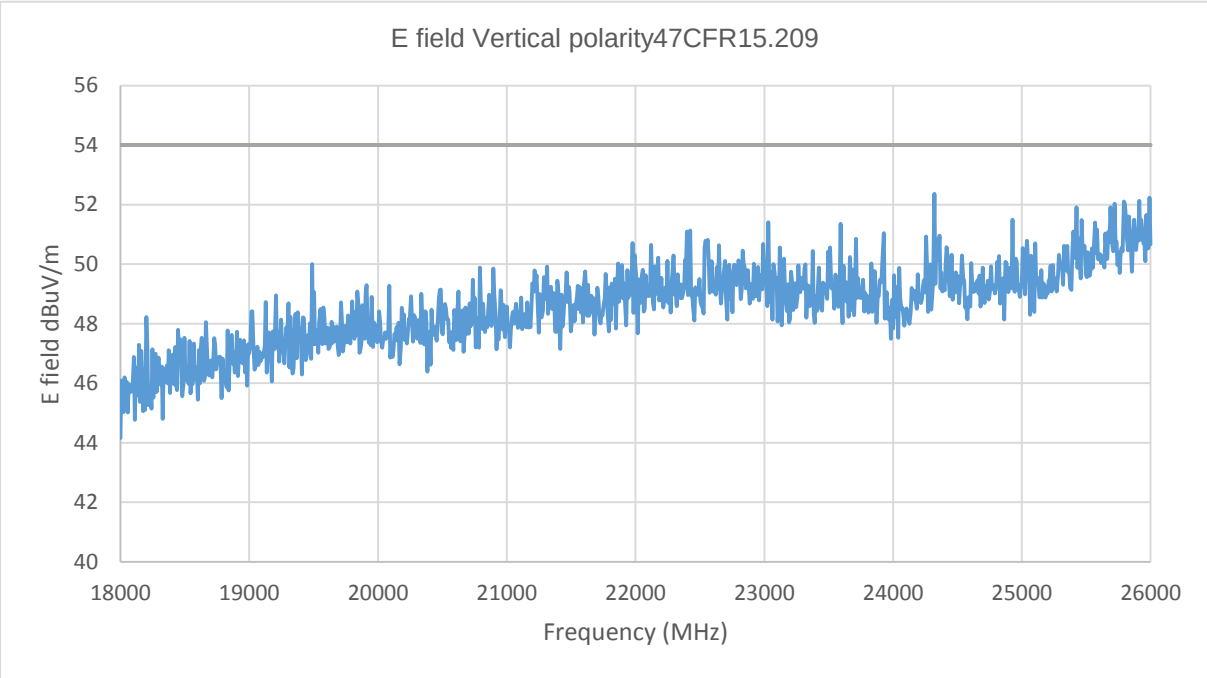


5.3.7 Transmitting on highest channel: 2480MHz 2.4GHz band stop filter removed

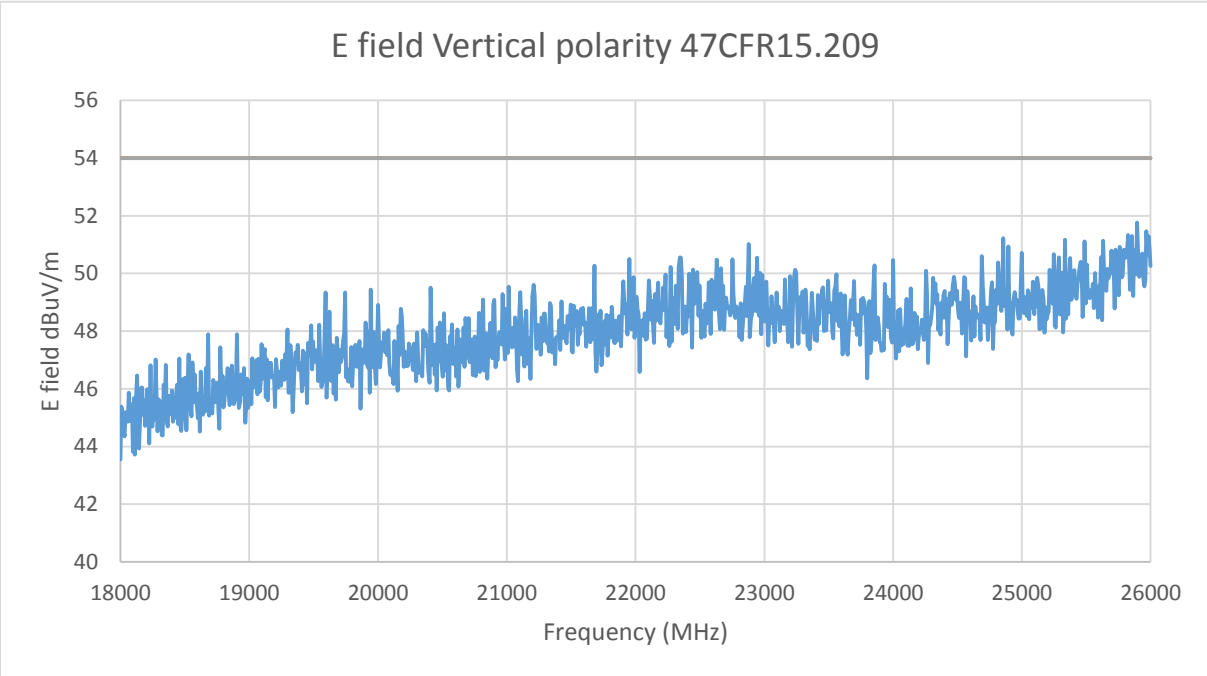


5.3.8 Transmitting on highest channel: 2480MHz 2.4GHz band stop filter removed

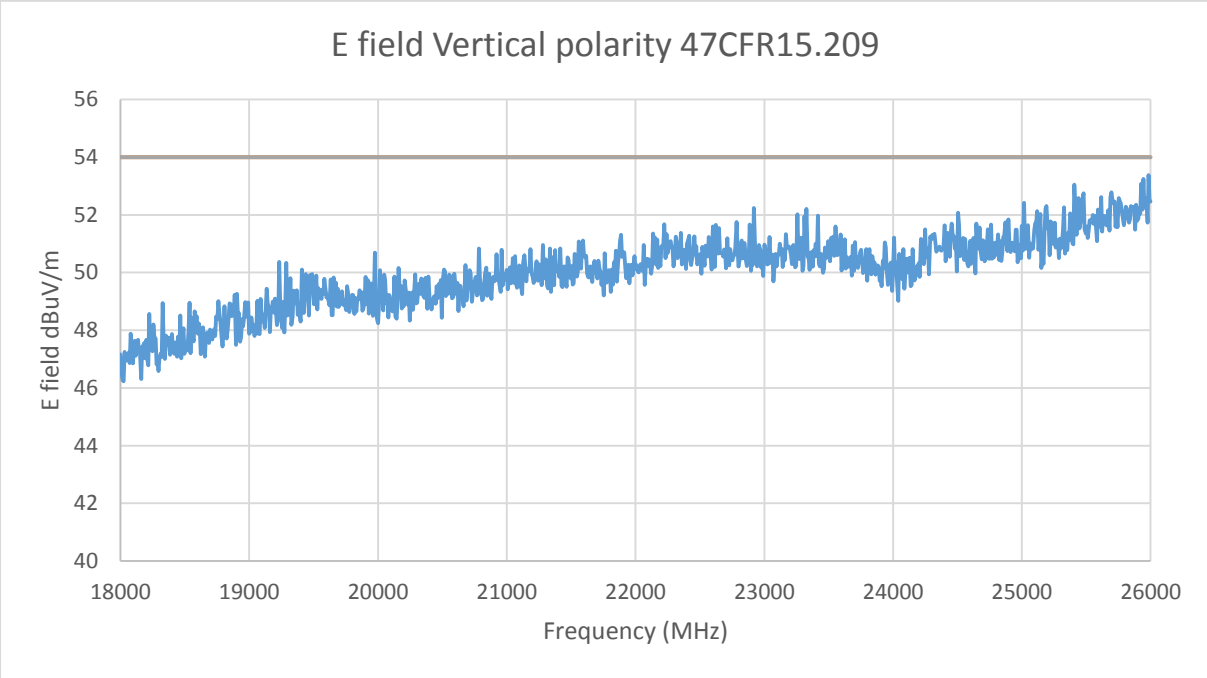
5.4 Appendix 4 Radiated emission graphical data 18GHz to 26GHz



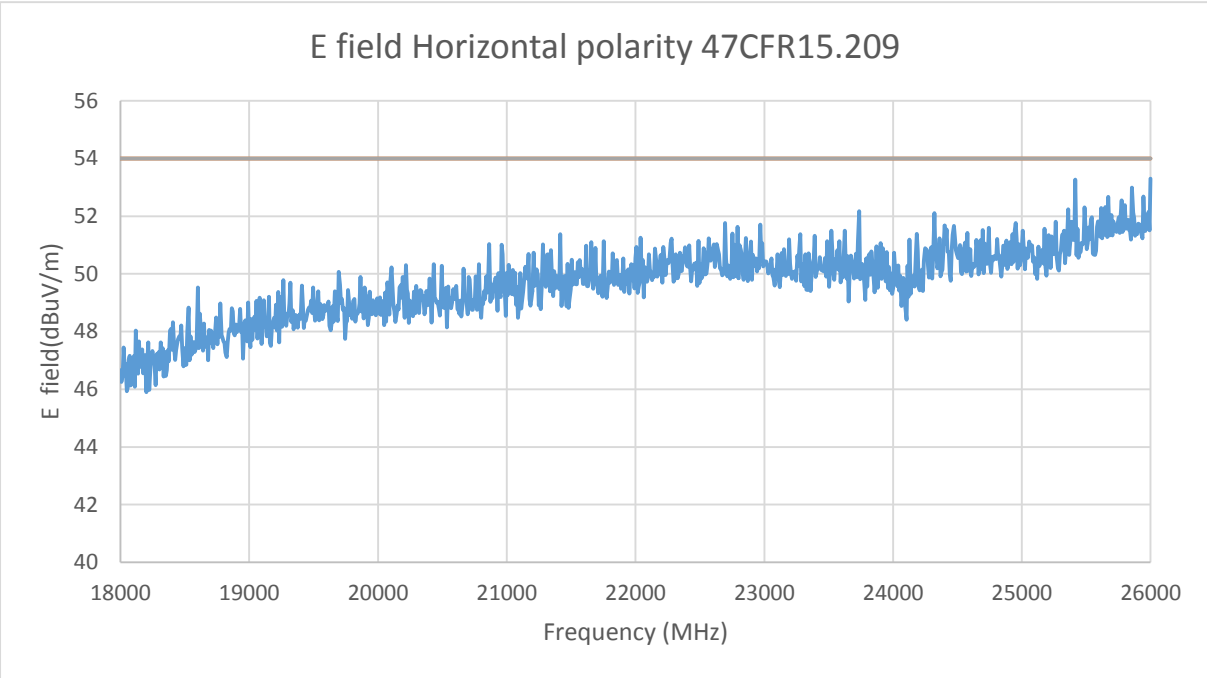
5.4.1 Transmitting on lowest channel: 2402MHz



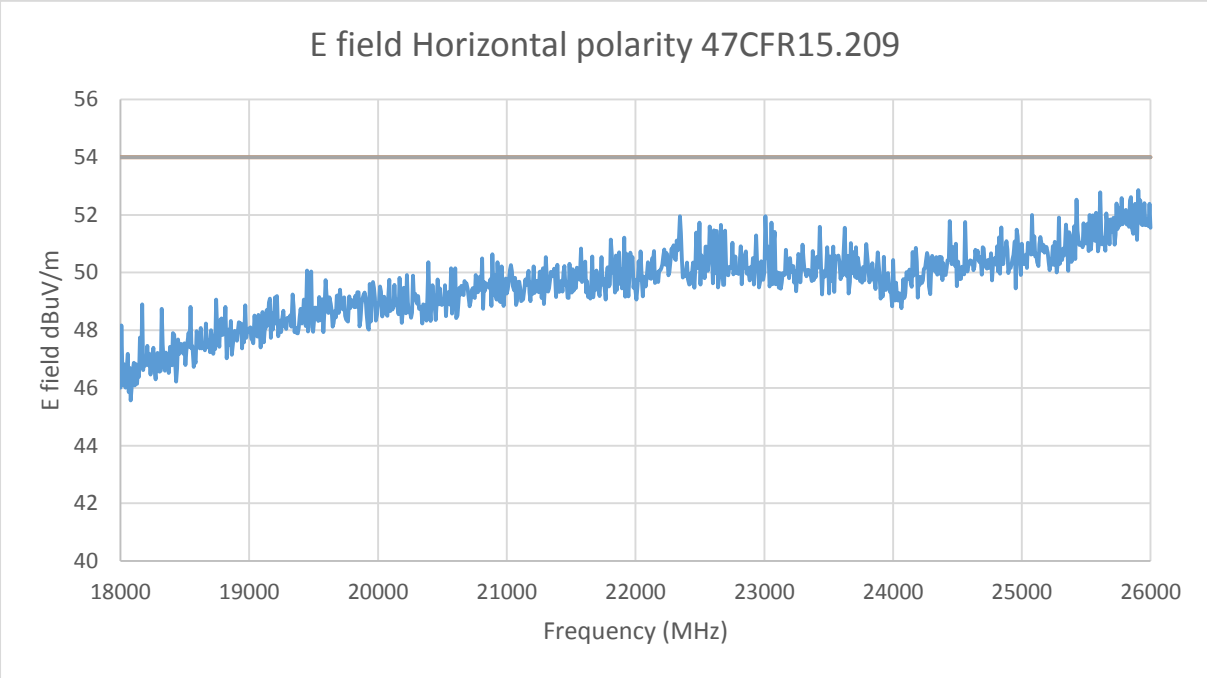
5.4.2 Transmitting on Middle channel: 2440MHz



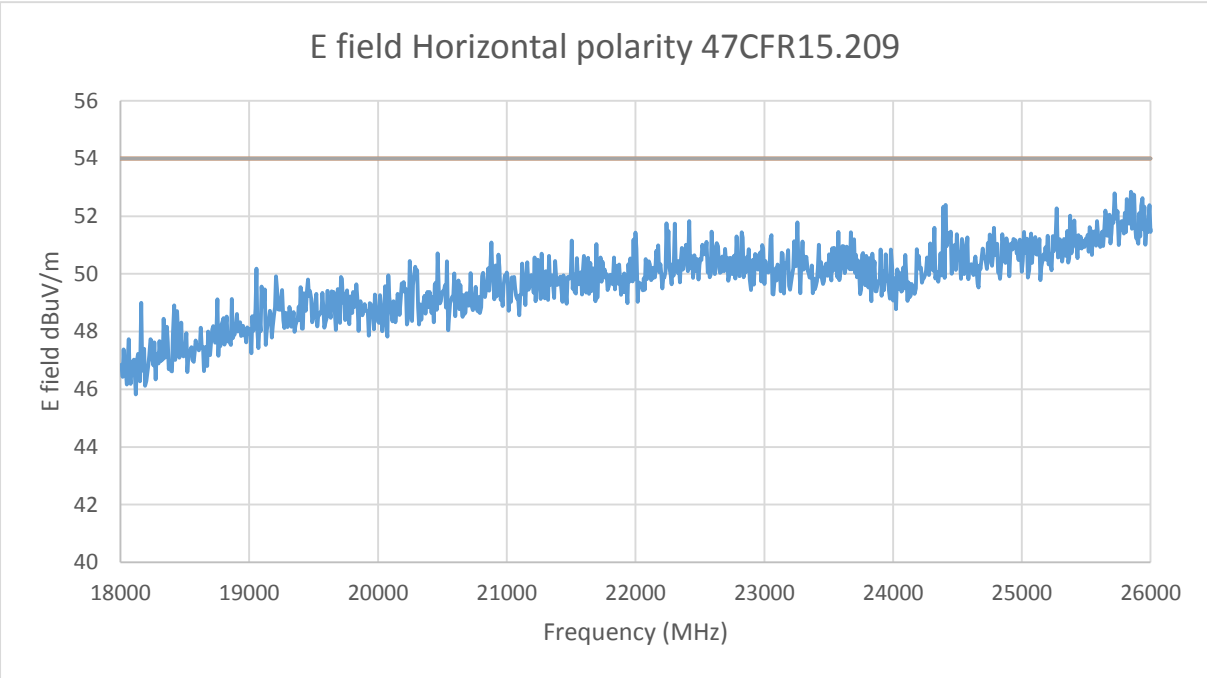
5.4.3 Transmitting on highest channel: 2480MHz



5.4.4 Transmitting on lowest channel: 2402MHz



5.4.5 Transmitting on Middle channel: 2440MHz



5.4.6 Transmitting on highest channel: 2480MHz

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5.5 Appendix 5 Test Set up photographs

Test set up photographs are not included in this test report at the request of the customer.

5.6 Appendix 6 Equipment used

Equipment	York EMC Asset No.	Cal Type	Cal date	Cal Period (Months)
Keysight PXA Spectrum analyser	C0338	UKAS	28th January 2016	12
Screened loop antenna	78128	UKAS	20th March 2014	36
Bilog antenna	78707	UKAS	13th January 2016	12
Horn antenna 1-18GHz	78347	UKAS	23rd December 2013	36
Horn antenna 18-26GHz	C0342	UKAS	26th November 2014	36
Bonn pre-amplifier – for 1-18GHz	YO145	UKAS	24th November 2015	12
HP preamplifier – for 18-26GHz	C0221	UKAS	25th September 2015	12

5.7 Appendix 7 Customers test equipment used

Equipment	Serial number	Cal status
None	N/A	N/A

5.8 Appendix 8 Modification States

Modification state	Modification
0	As supplied by the customer.

5.9 Appendix 9 Test Report History

Issue	Date of issue	Modification details
1	August 31st 2016	Original issue of the test report.
2	**September 23rd 2016**	Second issue of the test report. Updated following TCB review.