Report on the FCC and IC Testing of:

DETNET SOUTH AFRICA (PTY) LTD
Blasting control of electronic detonators, Model: CE4 Commander

In accordance with FCC 47 CFR Part 15 (Simultaneous Transmission)

Prepared for: DETNET SOUTH AFRICA (PTY) LTD
Block 1B, Founders Hill Office Park
Centenary Road
Modderfontein P O Box 10
1645
SOUTH AFRICA

Product Service

Choose certainty.
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FCC ID: 2ARNH-15351660 and 2ARNH-1535166A
IC: 24476-15351660 and 24476-1535166A

COMMERCIAL-IN-CONFIDENCE

Document Number: 75943624-03 | Issue: 02

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Simon Bennett	Chief Engineer	Authorised Signatory	04 February 2019

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service 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 15. 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	Senior Engineer	Testing	04 February 2019

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

Industry Canada Accreditation
IC2932B-1 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with FCC 47 CFR Parts 15: 2017.

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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	21 November 2018
2	To amend the FCC and IC ID's	04 February 2019

Table 1

1.2 Introduction

Applicant	DETNET SOUTH AFRICA (PTY) LTD
Manufacturer	DETNET SOUTH AFRICA (PTY) LTD
Model Number(s)	CE4 Commander
Serial Number(s)	1) CE4 Commander: 1530000B8 2) CE4 Commander: 15300000F
Hardware Version(s)	1) CE4 Commander: V5 2) CE4 Commander: V5A
Software Version(s)	CE4 Commander: 36230C
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Parts 15: 2017
Order Number Date	4500348610 23-August-2018
Date of Receipt of EUT	07-September-2018
Start of Test	19-September-2018
Finish of Test	23-September-2018
Name of Engineer(s)	Graeme Lawler
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 15 is shown below.

Section	Specification Clause	Test Description	Result	Comments/Base Standard
Configuration and Mode: CE4 Commander 1 - CoTX (13.56MHz + 2.4GHz WLAN + 900 MHz)				
2.1	15.247 (d), 15.225 and 15.209	Radiated Spurious Emissions (Simultaneous Transmission)	Pass	
Configuration and Mode: CE4 Commander 2 - CoTX (13.56MHz + 2.4GHz WLAN + 900 MHz)				
2.1	15.247 (d), 15.225 and 15.209	Radiated Spurious Emissions (Simultaneous Transmission)	Pass	

Table 2

1.4 Application Form

CE4 Commander

EQUIPMENT DESCRIPTION	
Model Name/Number	CE4 Commander
Part Number	
Hardware Version	V5
Software Version	36230C
FCC ID (if applicable)	2ARNH-15351660
Industry Canada ID (if applicable)	24476-15351660
Technical Description (Please provide a brief description of the intended use of the equipment)	Free standing blast controller for testing and blasting of electronic detonators.

INTENTIONAL RADIATORS									
Technology	Frequency Band (MHz)	Conducted Declared Output Power (dBm)	Antenna Gain (dBi)	Supported Bandwidth (s) (MHz)	Modulation Scheme(s)	ITU Emission Designator	Test Channels (MHz)		
							Bottom	Middle	Top
WiFi	2400	18	2	2412 – 2457			2412	2434	2457
NFC	13.56	6		13.56				13.56	
RF	900	30	2	902 – 928			902	915	928

UN-INTENTIONAL RADIATOR	
Highest frequency generated or used in the device or on which the device operates or tunes	3177.2MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	32.768kHz
Class A Digital Device (Use in commercial, industrial or business environment) ☒ Class B Digital Device (Use in residential environment only) ☐	

Power Source			
AC	Single Phase	Three Phase	Nominal Voltage
External DC	Nominal Voltage	Maximum Current	
Battery	Nominal Voltage	Battery Operating End Point Voltage	
	3.7	3.3	
Can EUT transmit whilst being charged?	Yes ☐ No ☒		

EXTREME CONDITIONS					
Maximum temperature	+60	°C	Minimum temperature	-30	°C

Ancillaries
Please list all ancillaries which will be used with the device.

ANTENNA CHARACTERISTICS						
☒	Antenna connector			State impedance	50	Ohm
☐	Temporary antenna connector			State impedance		Ohm
☒	Integral antenna	Type	PCB Trace Antenna			
☐	External antenna	Type				

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

Name: H van der Walt

Position held: Quality and Compliance Manager Date: 2018-09-12

EQUIPMENT DESCRIPTION	
Model Name/Number	CE4 Commander
Part Number	
Hardware Version	V5A
Software Version	36230C
FCC ID (if applicable)	2ARNH-15305A
Industry Canada ID (if applicable)	24476-15305A
Technical Description (Please provide a brief description of the intended use of the equipment)	Free standing blast controller for testing and blasting of electronic detonators.

INTENTIONAL RADIATORS									
Technology	Frequency Band (MHz)	Conducted Declared Output Power (dBm)	Antenna Gain (dBi)	Supported Bandwidth (s) (MHz)	Modulation Scheme(s)	ITU Emission Designator	Test Channels (MHz)		
							Bottom	Middle	Top
WiFi	2400	18		2.412 – 2.457GHz			2412	2434	2457
NFC	13.56	6		13.56				13.56	
RF	*900*	27	2.1	907.125 – 913.325 MHz			907.125	910.125	913.325

UN-INTENTIONAL RADIATOR	
Highest frequency generated or used in the device or on which the device operates or tunes	**3177.2 MHz**
Lowest frequency generated or used in the device or on which the device operates or tunes	32.768 kHz
Class A Digital Device (Use in commercial, industrial or business environment) ☒ Class B Digital Device (Use in residential environment only) ☐	

Power Source			
AC	Single Phase	Three Phase	Nominal Voltage
External DC	Nominal Voltage		Maximum Current
Battery	Nominal Voltage		Battery Operating End Point Voltage
	3.7		3.3
Can EUT transmit whilst being charged?			Yes ☐ No ☒

EXTREME CONDITIONS					
Maximum temperature	+60	°C	Minimum temperature	-30	°C

Ancillaries
Please list all ancillaries which will be used with the device.

ANTENNA CHARACTERISTICS						
☒	Antenna connector			State impedance	50	Ohm
☐	Temporary antenna connector			State impedance		Ohm
☒	Integral antenna	Type	PCB Trace Antenna			
☐	External antenna	Type				

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

Name: H van der Walt

Position held: Quality and Compliance Manager Date: 2018-09-12

1.5 Product Information

1.5.1 Technical Description

CE4 Commander - Free standing blast controller for testing and blasting of electronic detonators.

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
CE4 Commander, Serial Number: 1530000B8			
0	As supplied by the customer	Not Applicable	Not Applicable
CE4 Commander, Serial Number: 15300000F			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3

1.8 Test Location

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

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: CE4 Commander 1 - CoTX (13.56MHz + 2.4GHz WLAN + 900 MHz)		
Radiated Spurious Emissions (Simultaneous Transmission)	Graeme Lawler	UKAS
Configuration and Mode: CE4 Commander 2 - CoTX (13.56MHz + 2.4GHz WLAN + 900 MHz)		
Radiated Spurious Emissions (Simultaneous Transmission)	Graeme Lawler	UKAS

Table 4

Office Address:

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

2 Test Details

2.1 Radiated Spurious Emissions (Simultaneous Transmission)

2.1.1 Specification Reference

FCC 47 CFR Parts 15, Clause 15.247 (d), 15.225 (d) and 15.209

2.1.2 Equipment Under Test and Modification State

CE4 Commander, S/N: 1530000B8 - Modification State 0
CE4 Commander, S/N: 15300000F - Modification State 0

2.1.3 Date of Test

19-September-2018 to 23-September-2018

2.1.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.3, 6.5 and 6.6.
For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10 clause 4.1.4.2.3 to characterize the EUT. Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10 clause 4.1.4.2.2.

If emissions were found to be pulsed, final average measurements were taken in accordance with ANSI C63.10 clause 7.5. A peak measurement is performed. A duty cycle correction factor is then determined by the expression duty (dB) = 20log (On Time/ (On Time+ Off Time)). This factor is then subtracted from the peak value to determine the final average value.

The plots shown are the characterization of the EUT. The limits on the plots represent the most stringent case for restricted bands, (74/54 dBuV/m) when compared to 20 dBc outside restricted bands. The limits shown have been used as a threshold to determine where further measurements are necessary. Where results are within 10 dB of the limits shown on the plots, further investigation was carried out and reported in results tables.

The following conversion can be applied to convert from dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

For frequencies > 18 GHz, the measurement distance was reduced to 1 meter and the limit line was increased by 20*LOG(3/1) = 9.54 dB.

2.1.5 Environmental Conditions

Ambient Temperature	20.0 °C
Relative Humidity	44.0 %

2.1.6 Test Results

CE4 Commander 1 - CoTX (13.56MHz + 2.4GHz WLAN + 900 MHz)

The EUT was configured for simultaneous transmission in the following mode of operation:

Technology	Frequency Band (MHz)	Channel Frequency (MHz)
802.11b	2400 MHz to 2483.5 MHz	2437MHz
RFiD	13.11 to 14.01 MHz	13.56 MHz
SRD	902 MHz to 928 MHz	911 MHz

Table 5 - Modes of Operation

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
168.005	38.2	43.5	-5.3	39	1.00	Vertical
173.518	23.4	43.5	-20.1	170	1.00	Vertical
215.960	32.9	43.5	-10.6	18	1.00	Vertical
261.478	35.2	46.0	-10.8	31	1.65	Vertical
263.746	31.2	46.0	-14.8	303	1.00	Vertical
271.047	35.2	46.0	-10.8	42	2.11	Vertical

Table 6 - 30 MHz to 300 MHz Emissions Results

No other emissions were detected within 6 dB of the limit.

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
326.250	29.9	46.0	-16.1	354	1.87	Vertical
960.000	37.7	46.0	-8.3	19	1.00	Horizontal

Table 7 - 300 MHz to 1 GHz Emissions Results

No other emissions were detected within 6 dB of the limit.

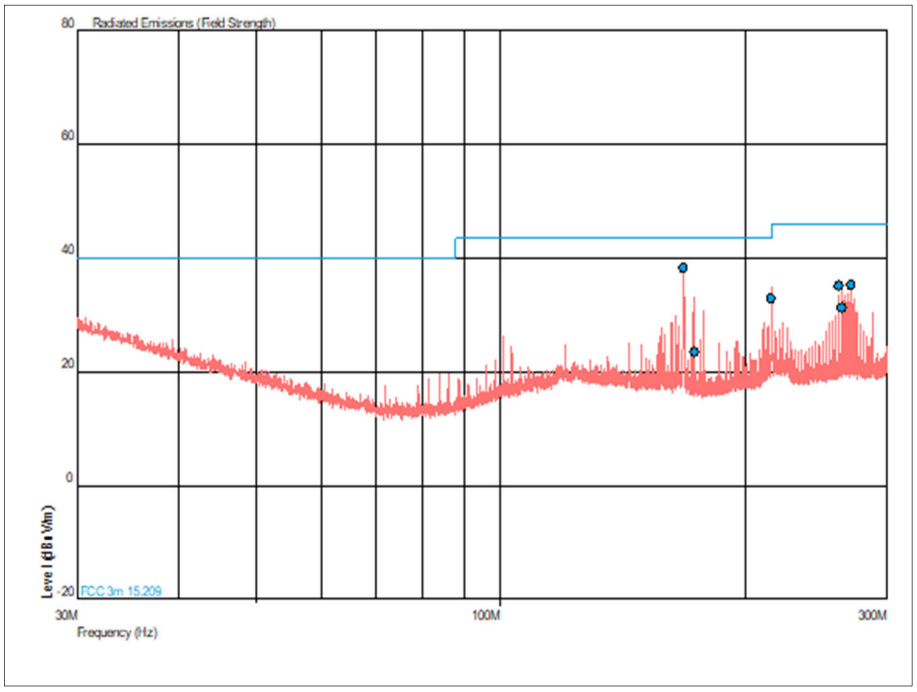

Figure 1 - 30 MHz to 300Hz - Horizontal and Vertical

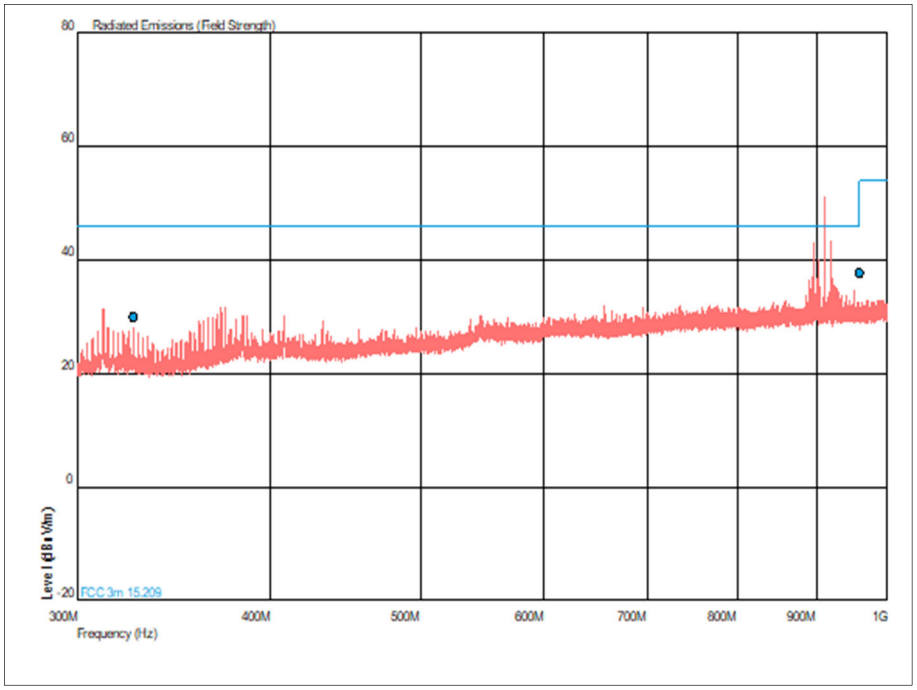

Figure 2 - 300 MHz to 1 GHz - Horizontal and Vertical

Frequency (GHz)	Result (µV/m)		Limit (µV/m)		Margin (µV/m)	
	Peak	Average	Peak	Average	Peak	Average
*						

Table 8 - 1 GHz to 25 GHz Emissions Results

*No emissions were detected within 6 dB of the limit.

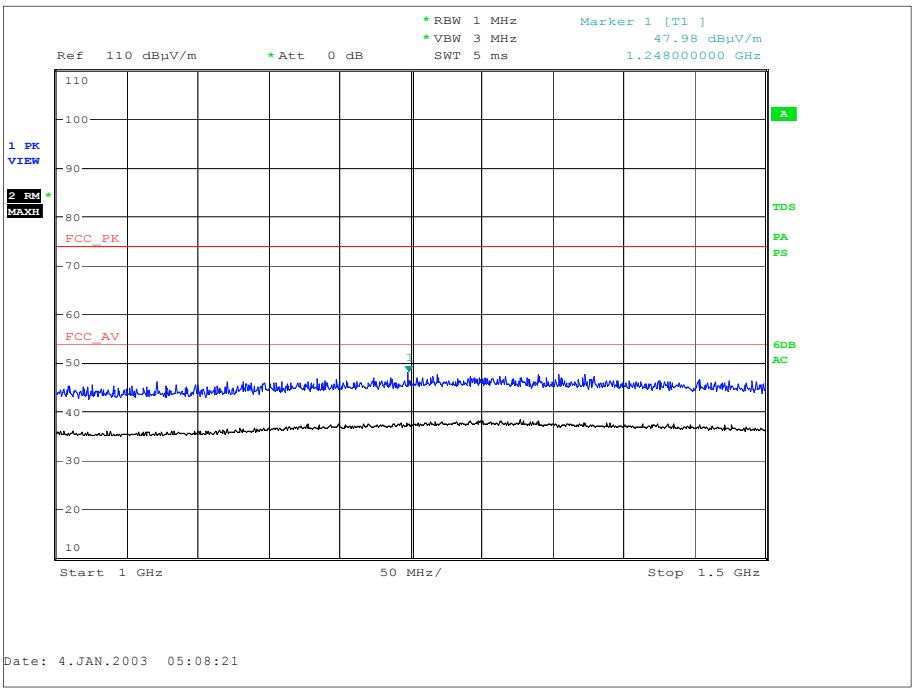

Figure 3 - 1 GHz to 1.5 GHz - Horizontal and Vertical

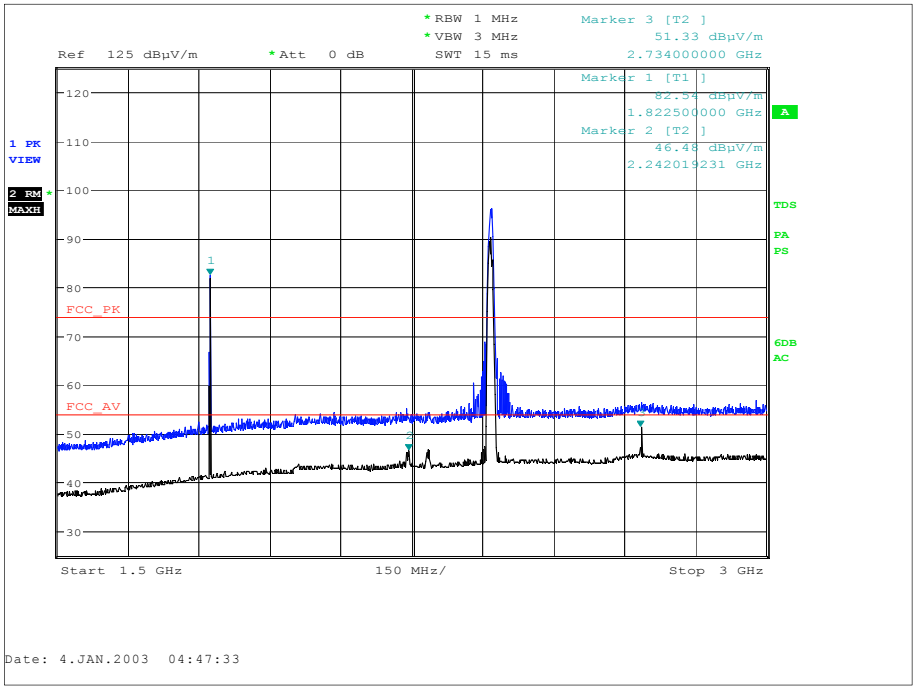

Figure 4 - 1.5 GHz to 3 GHz - Horizontal and Vertical

NOTE: The emission at 1822 MHz does not fall within the restricted band of operation and is therefore not subject to the 74/54 dBµV/m limit, instead it is subject to the -20 dBc as specified in 15.247.

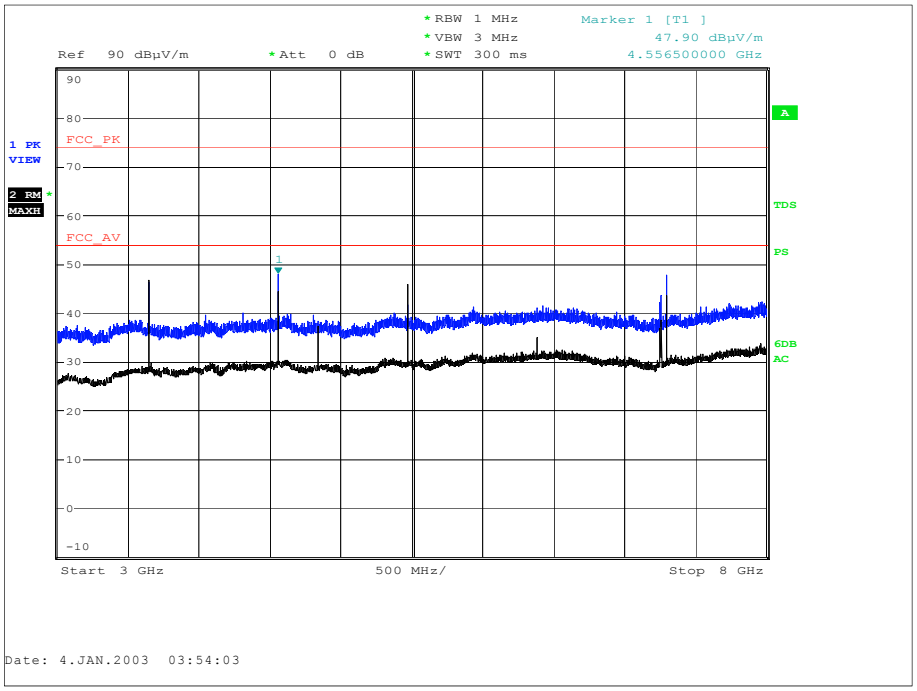

Figure 5 - 3 GHz to 8 GHz - Horizontal and Vertical

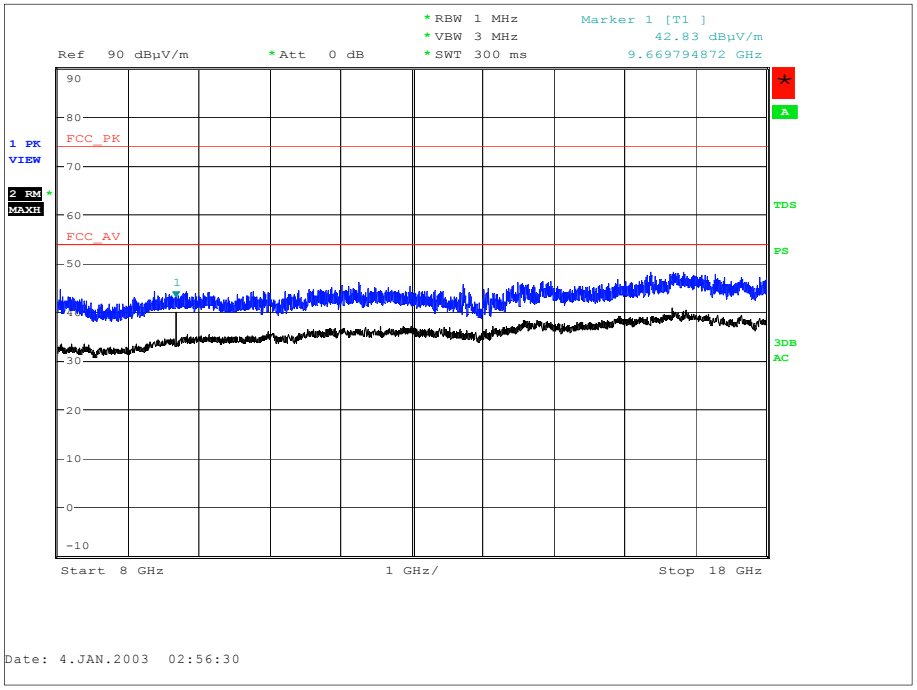

Figure 6 - 8 GHz to 18 GHz - Horizontal and Vertical

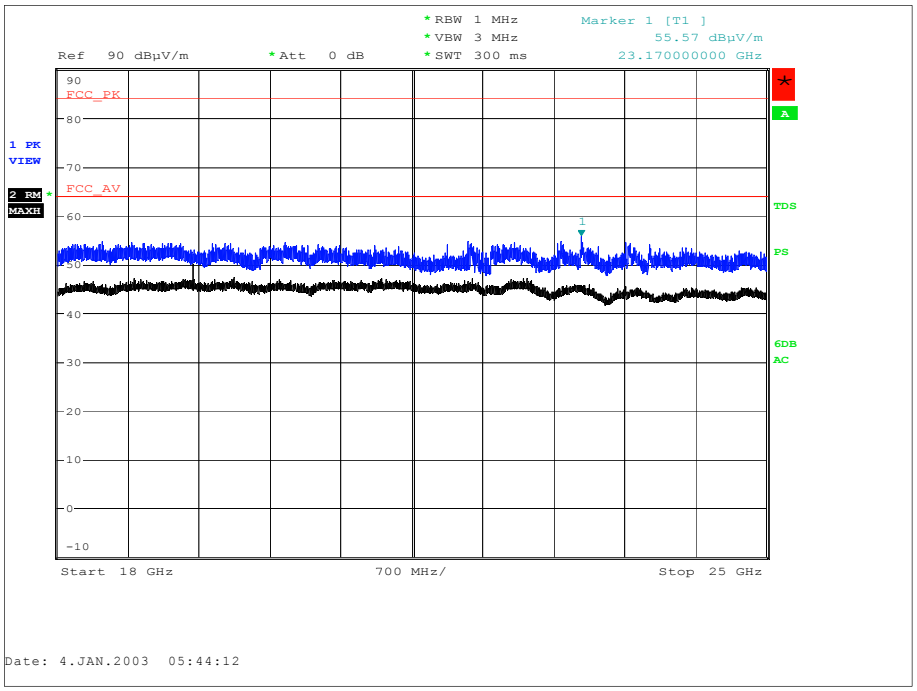

Figure 7 - 18 GHz to 25 GHz - Horizontal and Vertical

FCC 47 CFR Parts 15.247 (d), 15.225 (d) and 15.209

The least stringent limit from the applicable rule parts was used to determine compliance for Radiated Emissions testing of multiple transmission sources.

The least stringent applicable limit was:

Rule Part	Limit
Part 15.247 (d)	-20 dBc
Part 15.209 (Applies within restricted bands of operation listed in 15.205).	30-88 MHz: 40 dBµV/m at 3m 88-216 MHz: 43.5 dBµV/m at 3m 216-916 MHz: 46 dBµV/m at 3m Above 960 MHz: Peak: 74 dBµV/m at 3m, Average 54 dBµV/m at 3m

Table 9 - Limit Table

CE4 Commander 2 - CoTX (13.56MHz + 2.4GHz WLAN + 900 MHz)

The EUT was configured for simultaneous transmission in the following mode of operation:

Technology	Frequency Band (MHz)	Channel Frequency (MHz)
802.11b	2400 MHz to 2483.5 MHz	2437 MHz
SRD	902 MHz to 928 MHz	Hopping on all channels
RFiD	13.11 to 14.01 MHz	13.56 MHz

Table 10 - Modes of Operation

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
172.743	39.4	43.5	-4.1	289	1.00	Vertical
230.660	51.4	46.0	5.4	56	1.00	Vertical
258.118	35.1	46.0	-10.9	258	1.00	Horizontal
260.655	42.1	46.0	-3.9	295	1.87	Vertical
263.072	42.9	46.0	-3.1	5	2.19	Vertical
265.512	38.6	46.0	-7.4	27	1.00	Vertical

Table 11 - 30 MHz to 300 MHz Emissions Results

No other emissions were detected within 6 dB of the limit.

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
324.392	36.2	46.0	-9.8	6	1.00	Vertical
608.000	35.0	46.0	-11.0	36	1.00	Vertical
614.000	35.3	46.0	-10.7	2	3.75	Vertical

Table 12 - 300 MHz to 960 MHz Emissions Results

No other emissions were detected within 6 dB of the limit.

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
971.742	45.5	54.0	-8.5	161	1.00	Vertical
977.000	50.1	54.0	-3.9	242	1.00	Vertical
982.256	49.2	54.0	-4.8	265	1.00	Vertical
983.296	49.9	54.0	-4.1	175	1.00	Vertical
984.449	52.6	54.0	-1.4	173	1.00	Vertical
985.213	49.9	54.0	-4.1	46	1.00	Vertical

Table 13 - 960 MHz to 1000 MHz Emissions Results

No other emissions were detected within 6 dB of the limit.

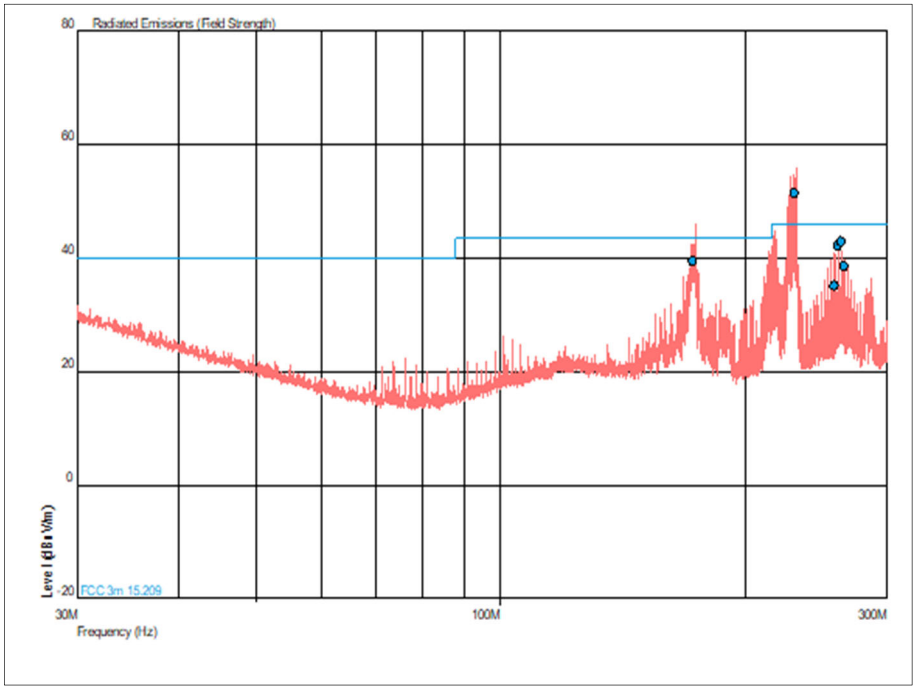

Figure 8 - 30 MHz to 300 MHz - Horizontal and Vertical

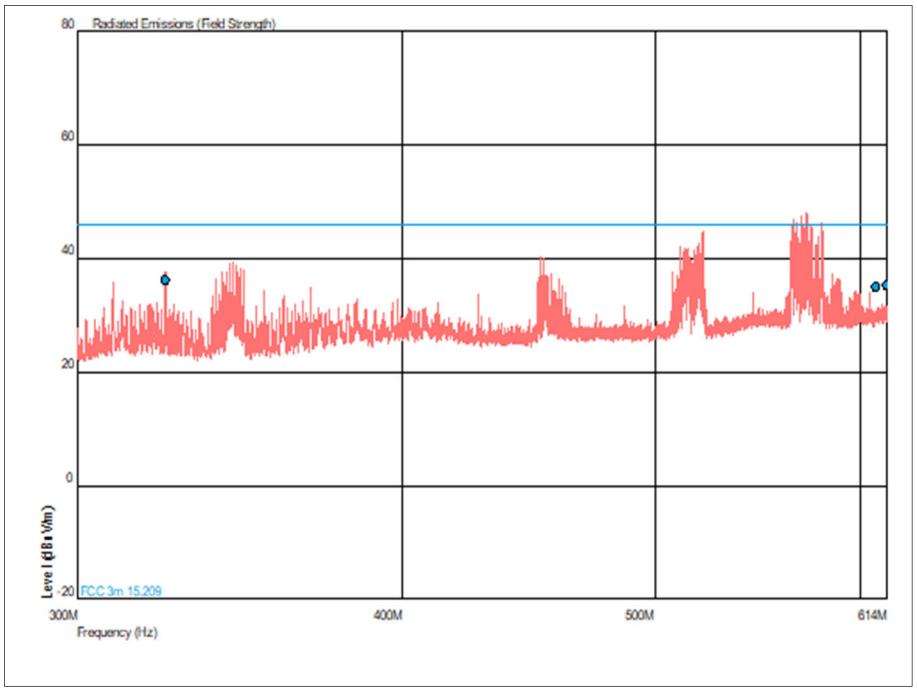

Figure 9 - 300 MHz to 614 MHz - Horizontal and Vertical

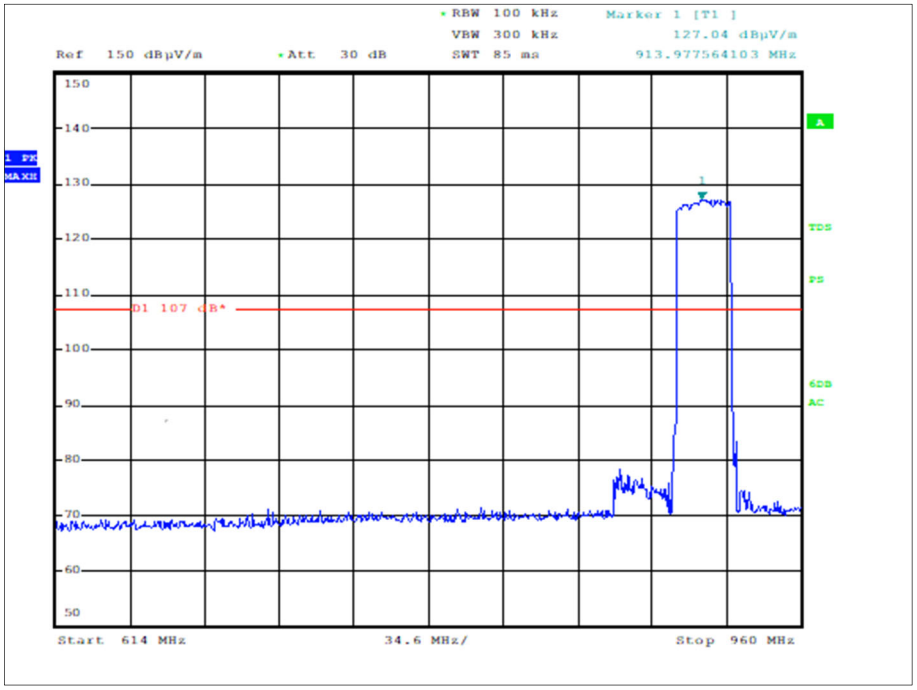

Figure 10 - 614 MHz to 960 MHz - Horizontal and Vertical

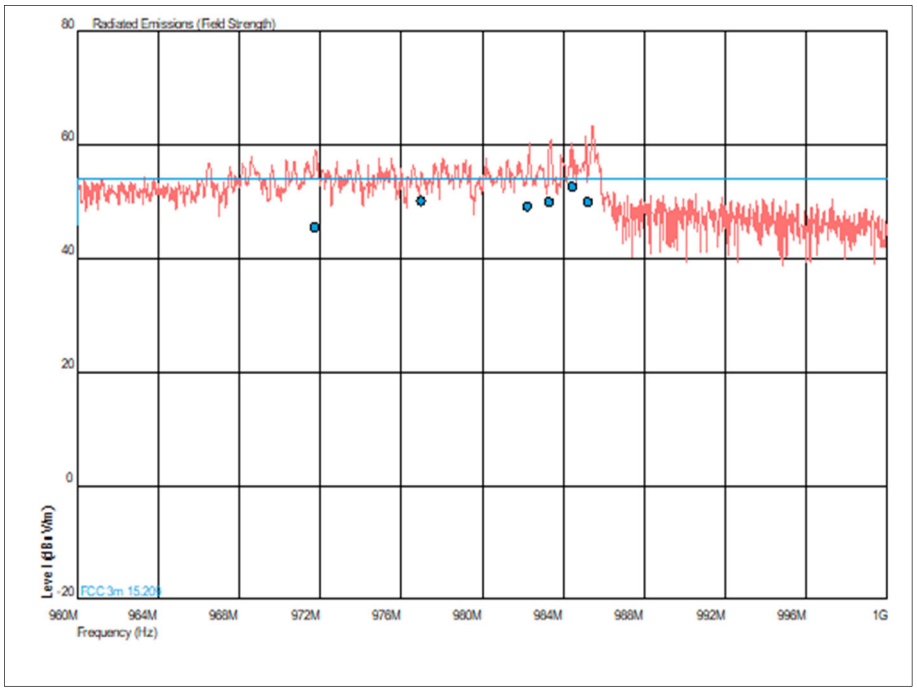

Figure 11 - 960 MHz to 1000 MHz - Horizontal and Vertical

Frequency (GHz)	Result (µV/m)		Limit (µV/m)		Margin (µV/m)	
	Peak	Average	Peak	Average	Peak	Average
1.000001	2679.17	52.24	5000	500	2320	447.76
1.001602	1834.43	291.74	5000	500	3165.57	208.26
1.043205	1330.45	224.90	5000	500	3669.55	275.09
1.080113	1706.08	288.40	5000	500	3293.92	211.60
1.100962	1840.77	266.07	5000	500	3159.23	233.93
1.127403	2162.72	314.77	5000	500	2837.28	185.23
1.159455	2333.46	339.63	5000	500	2666.54	160.37
3.619660	1725.84	5.040	5000	500	3274.16	494.96

Table 14 - 1 GHz to 25 GHz Emissions Results

No other emissions were detected within 6 dB of the limit.

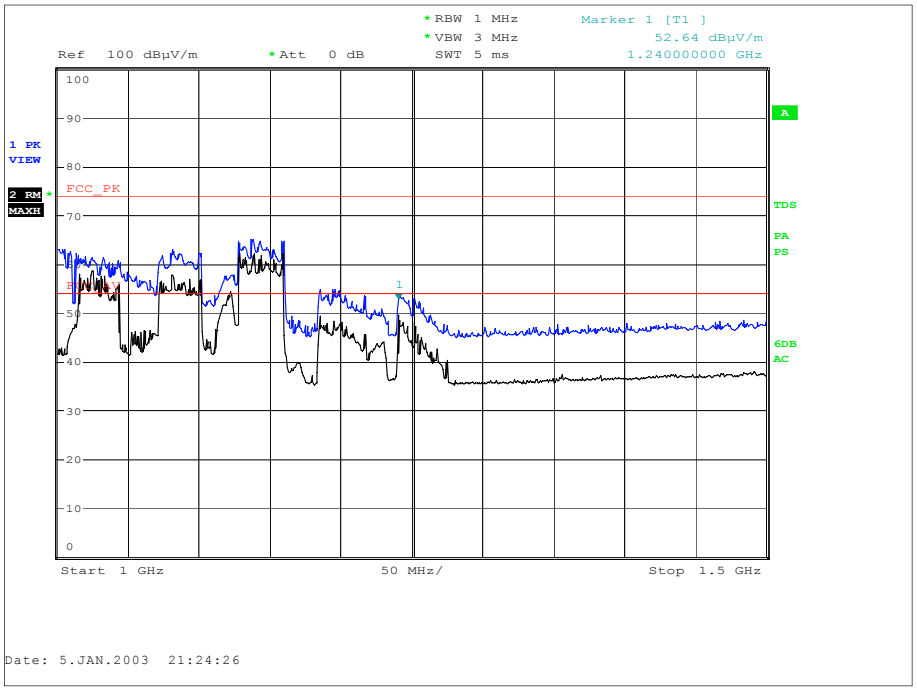

Figure 12 - 1 GHz to 1.5 GHz - Horizontal and Vertical

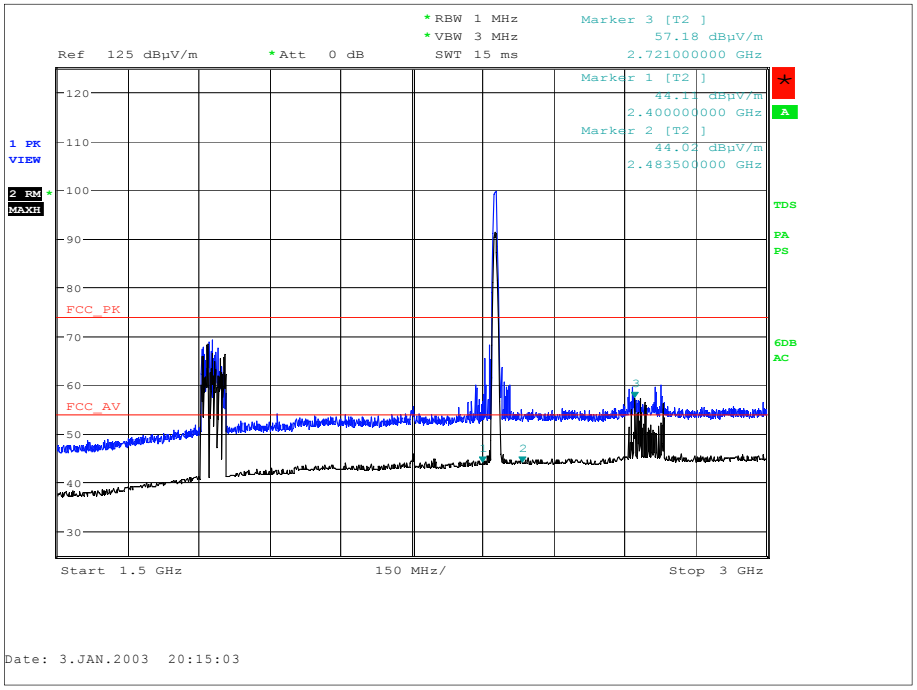

Figure 13 - 1.5 GHz to 3 GHz - Horizontal and Vertical

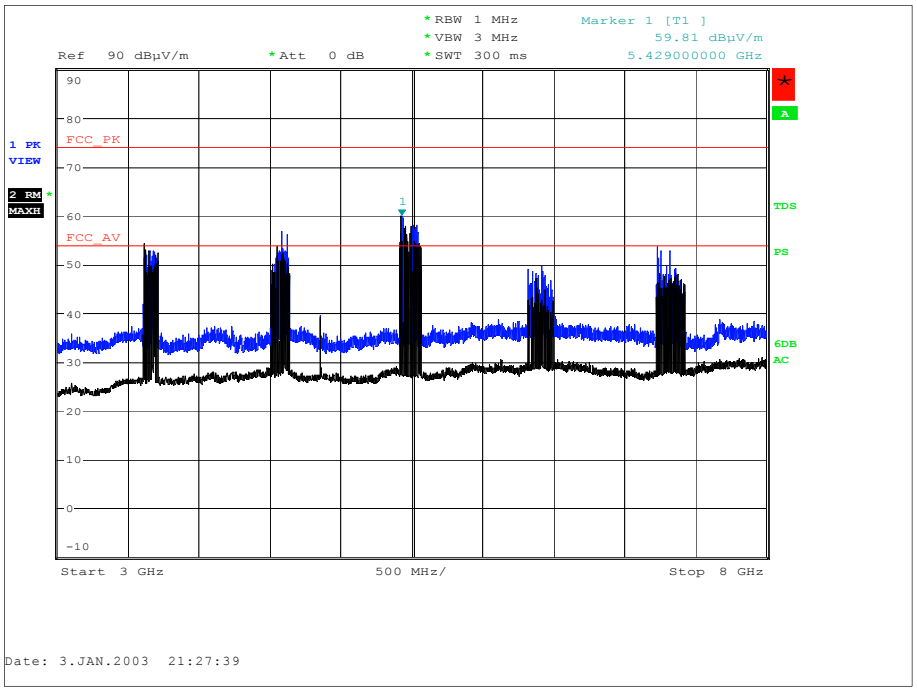

Figure 14 - 3 GHz to 8 GHz - Horizontal and Vertical

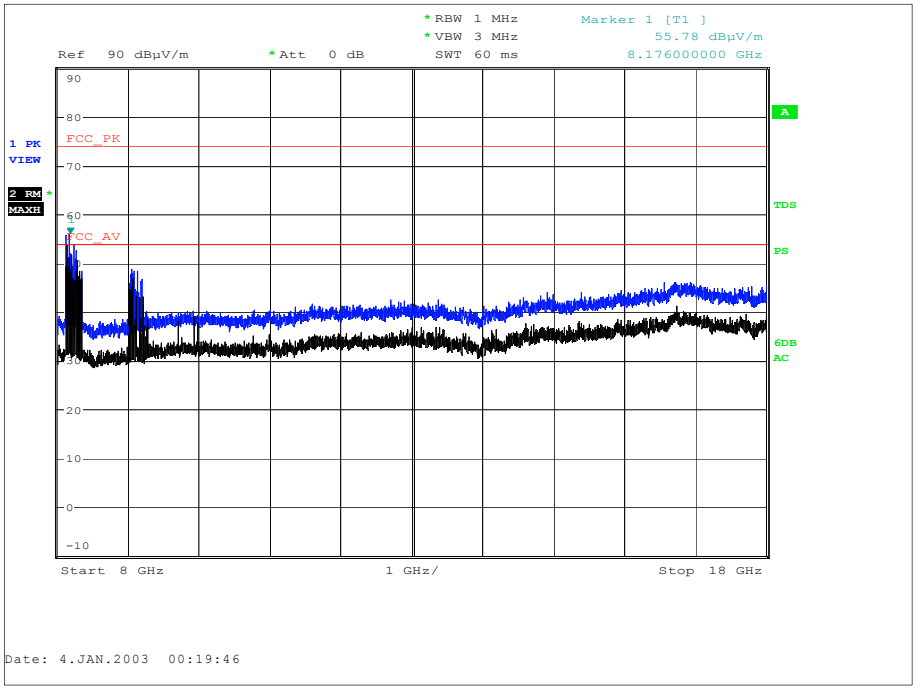

Figure 15 - 8 GHz to 18 GHz - Horizontal and Vertical

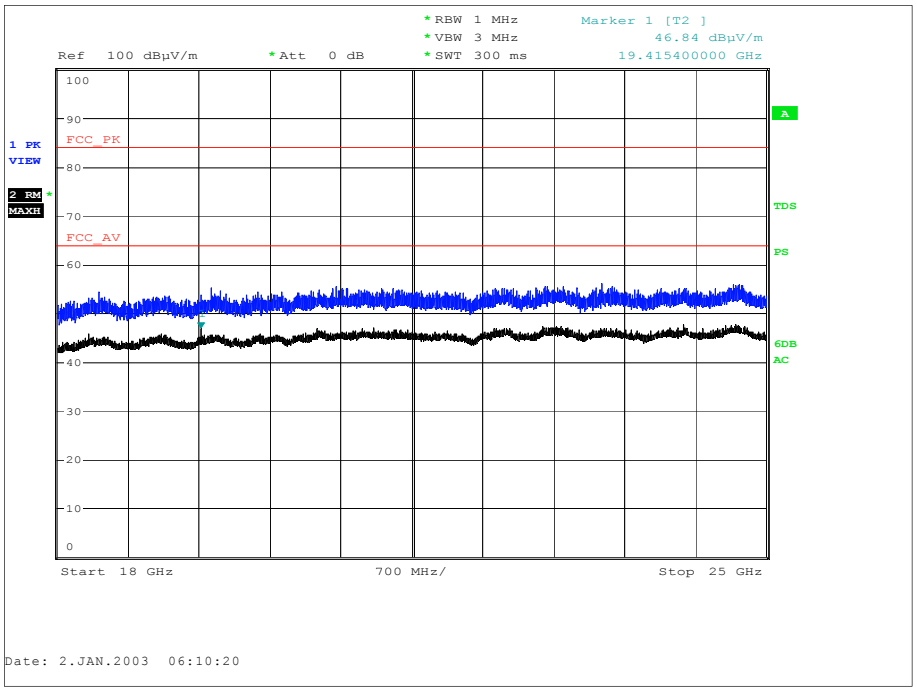

Figure 16 - 18 GHz to 25 GHz - Horizontal and Vertical

FCC 47 CFR Parts 15.247 (d), 15.225 (d) and 15.209

The least stringent limit from the applicable rule parts was used to determine compliance for Radiated Emissions testing of multiple transmission sources.

The least stringent applicable limit was:

Rule Part	Limit
Part 15.247 (d)	-20 dBc
Part 15.209 (Applies within restricted bands of operation listed in 15.205).	30-88 MHz: 40 dBµV/m at 3m 88-216 MHz: 43.5 dBµV/m at 3m 216-916 MHz: 46 dBµV/m at 3m Above 960 MHz: Peak: 74 dBµV/m at 3m, Average 54 dBµV/m at 3m

Table 15 - Limit Table

2.1.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 7.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Signal Generator	Hewlett Packard	ESG4000A	38	12	05-Jun-2019
Antenna 18-40GHz (Double Ridge Guide)	Link Microtek Ltd	AM180HA-K-TU2	230	24	02-May-2020
Turntable Controller	Heinrich Diesel	HD 050	280	-	TU
Antenna with permanent attenuator (Bilog)	Schaffner	CBL6143	287	24	15-May-2020
Filter (Tuneable Bandreject)	K&L Microwave	5TNF-500/1000-N/N	439	-	TU
Pre-Amplifier	Phase One	PS04-0086	1533	12	12-Jan-2019
18GHz - 40GHz Pre-Amplifier	Phase One	PSO4-0087	1534	12	02-Feb-2019
Screened Room (7)	Siemens	S M	1547	36	21-Jan-2021
Low Pass Filter	Mini-Circuits	NLP-300	1636	12	25-Oct-2018
Hygromer	Rotronic	A1	2138	12	21-Feb-2019
Comb Generator	Schaffner	RSG1000	3034	-	TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Nov-2018
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	3916	-	TU
Mast Controller	Maturo Gmbh	NCD	3917	-	TU
1GHz to 8GHz Low Noise Amplifier	Wright Technologies	APS04-0085	4365	12	18-Oct-2018
Suspended Substrate Highpass Filter	Advance Power Components	11SH10-3000/X18000-O/O	4412	12	15-Jun-2019
1 metre K-Type Cable	Florida Labs	KMS-180SP-39.4-KMS	4520	12	13-Feb-2019
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	01-Mar-2019
N to N cable, 4m	Rhophase	2303-002-TUVS	4849	12	18-Dec-2018
N to N cable, 4m	Rhophase	2303-002-TUVS	4850	12	18-Dec-2018
Cable (26.5GHz)	Rosenberger	LU7-133-5000	5019	-	O/P Mon
Cable (18GHz)	Rosenberger	LU7-036-1000	5030	-	O/P Mon

Table 16

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

3 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Radiated Spurious Emissions (Simultaneous Transmission)	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB

Table 17