FCC and ISEDC Test Report

Sepura Ltd
Portable TETRA Handset, Model: SC2124

In accordance with FCC 47 CFR Part 90, FCC 47 CFR Part 2, Industry Canada RSS-119 and ISEDC RSS-GEN

Add value.
Inspire trust.

Prepared for: Sepura Ltd
9000 Cambridge Research Park
Beach Drive, Waterbeach
Cambridge, CB25 9TL
United Kingdom

FCC ID: XX6SC2124 IC: 8739A-SC2124

COMMERCIAL-IN-CONFIDENCE

Document 75944487-02 Issue 01

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Matthew Russell	RF Team Leader	Authorised Signatory	06 January 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 90, FCC 47 CFR Part 2, Industry Canada RSS-119 and ISEDC RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Mehadi Choudhury	06 January 2020	
Testing	Francis Kane	06 January 2020	
Testing	Graeme Lawler	06 January 2020	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

ISEDC Accreditation
12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 90: 2018, FCC 47 CFR Part 2: 2018, Industry Canada RSS-119: Issue 12 (05-2015) and ISEDC RSS-GEN: Issue 5 (04-2018) + A1 (03-2019) for the tests detailed in section 1.3.

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TÜV SÜD
is a trading name of TUV SUD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom

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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	06 January 2020

Table 1

1.2 Introduction

Applicant	Sepura Ltd
Manufacturer	Sepura Ltd
Model Number(s)	SC2124
Serial Number(s)	2PS001845GM55WU, 2PS001845GM55XT and 1PR001909GM18R7
Hardware Version(s)	Pre-production
Software Version(s)	2PS001845GM55WU: 2001 622 08522 2PS001845GM55XT: 1754 006 08522 1PR001909GM18R7: 2001 723 07367
Number of Samples Tested	3
Test Specification/Issue/Date	FCC 47 CFR Part 90: 2018 FCC 47 CFR Part 2: 2018 Industry Canada RSS-119: Issue 12 (05-2015) ISEDC RSS-GEN: Issue 5 (04-2018) + A1 (03-2019)
Order Number Date	PLC-PO011393-1 07-December-2018
Date of Receipt of EUT	01-February-2019, 18-March-2019 and 19-September-2019
Start of Test	26-February-2019
Finish of Test	18-December-2019
Name of Engineer(s)	Mehadi Choudhury, Francis Kane and Graeme Lawler
Related Document(s)	ANSI C63.26: 2015

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 90, FCC 47 CFR Part 2, Industry Canada RSS-119 and ISEDC RSS-GEN is shown below.

Section	Specification Clause				Test Description	Result	Comments/Base Standard
	Part 90	Part 2	RSS-119	RSS-GEN			
Configuration and Mode: TETRA 450 MHz to 470 MHz - Transmit							
2.1	90.205	2.1046	5.4	6.12	Maximum Conducted Output Power	Pass	
2.2	90.209	2.1049	5.5	6.7	Bandwidth Limitations	Pass	
2.3	90.210	2.1051	5.8	6.13	Spurious Emissions at Antenna Terminals	Pass	
2.4	90.210	2.1055	5.3	6.11	Frequency Stability	Pass	
2.5	90.214	-	5.9	-	Transient Frequency Behaviour	Pass	
2.6	90.221	-	5.8.9.1	-	Adjacent Channel Power	Pass	
2.7	90.207	2.1047	5.2	-	Types of Emissions	Pass	
2.8	90.210	2.1051	5.8	6.13	Radiated Spurious Emissions	Pass	
Configuration and Mode: TETRA 403 MHz to 430 MHz -Transmit							
2.1	90.205	2.1046	5.4	6.12	Maximum Conducted Output Power	Pass	
2.2	90.209	2.1049	5.5	6.7	Bandwidth Limitations	Pass	
2.3	90.210	2.1051	5.8	6.13	Spurious Emissions at Antenna Terminals	Pass	
2.4	90.210	2.1055	5.3	6.11	Frequency Stability	Pass	
2.5	90.214	-	5.9	-	Transient Frequency Behaviour	Pass	
2.6	90.221	-	5.8.9.1	-	Adjacent Channel Power	Pass	
2.7	90.207	2.1047	5.2	-	Types of Emissions	Pass	
2.8	90.210	2.1051	5.8	6.13	Radiated Spurious Emissions	Pass	

Table 2

1.4 Application Form

Equipment Description

Technical Description: *(Please provide a brief description of the intended use of the equipment)*	The SC21 hand-portable terminal is a TETRA enabled radio with Bluetooth and Wi-Fi capability
Manufacturer:	Sepura Limited
Model:	SC2124
Part Number:	N/A
Hardware Version:	Pre-Production
Software Version:	2001 716 07367
FCC ID (if applicable)	XX6SC2124
IC ID (if applicable)	8739A-SC2124

Intentional Radiators

Technology	TETRA	TETRA	TETRA	BT Classic	BLE	WLAN
Frequency Band (MHz)	380-430	420-470	380-470	2402-2480	2402-2480	2412-2462 / 2422-2452
Conducted Declared Output Power (dBm)	35	35	35	7.382	7.4	16.5 max
Antenna Gain (dBi)	-1	-1	0	1.3	1.3	1.3
Supported Bandwidth(s) (MHz)	0.025	0.025	0.025	1	2	20 / 40
Modulation Scheme(s)	π/4 DQPSK	π/4 DQPSK	π/4 DQPSK	8PSK, DQPSK, GFSK	GFSK	802.11 b g and n: DSSS CCK BPSK QPSK 16-QAM 64-QAM
ITU Emission Designator	22K0DXW 20K0DXW	22K0DXW 20K0DXW	22K0DXW 20K0DXW	1M01F1D	1M18F1D	19M7G1D 36M8D1D
Bottom Frequency (MHz)	403	403	403	2402	2402	2412 / 2422
Middle Frequency (MHz)	436.5	436.5	436.5	2441	2441	2437
Top Frequency (MHz)	470	470	470	2480	2480	2462 / 2452

Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	2480MHz
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) ☐	

AC Power Source

AC supply frequency:		Hz
Voltage		V
Max current:		A
Single Phase ☐ Three Phase ☐		

DC Power Source

Nominal voltage:	7.4	V
Extreme upper voltage:	7.4	V
Extreme lower voltage:	6.29	V
Max current:	2	A

Battery Power Source

Voltage:	7.4	V
End-point voltage:	6.2	V *(Point at which the battery will terminate)*
Alkaline ☐ Leclanche ☐ Lithium ☒ Nickel Cadmium ☐ Lead Acid* ☐ **(Vehicle regulated)*		
Other ☐ Please detail:		

Charging

Can the EUT transmit whilst being charged	Yes ☒ No ☐

Temperature

Minimum temperature:	-30	°C
Maximum temperature:	+65	°C

Antenna Characteristics

Antenna connector ☐			State impedance		Ohm
Temporary antenna connector ☒			State impedance	50	Ohm
Integral antenna ☒	Type:	Chip	State impedance	1.3	dBI
External antenna ☐	Type:		State impedance		dBI

Ancillaries (if applicable)

Manufacturer:	Model:	Part Number:	Country of Origin:
Sepura	Remote Speaker Microphone	300-00389 300-00733 300-00734 300-01169 300-01982 300-01124 300-01153 300-01123 300-01152	Various
Sepura	Leather Cases	300-01915 300-01916 300-01917	Various
Sepura	Pocket Clips	300-00012 300-00322 300-00323 300-00912 300-01832 300-01923 300-01922	Various
Sepura	Earpieces	300-00580 300-00581 300-00562 300-00563 300-00564 300-01626 300-01628 300-00428 300-00755	Various

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

Name: Chris Beecham
Position held: Conformance Engineer
Date: 14 Oct 2019

1.5 Product Information

1.5.1 Technical Description

The SC21 hand-portable terminal is a TETRA enabled radio with Bluetooth and Wi-Fi capability

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
Model: SC2124: Serial Number: 2PS001845GM55WU			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: SC2124: Serial Number: 2PS001845GM55XT			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: SC2124: Serial Number: 1PR001909GM18R7 (See note)			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3

Note: 1PR001909GM18R7 contained a different software version to other samples as the software was modified by the manufacturer during testing to meet compliance with the transient power requirements.

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: TETRA 450 MHz to 470 MHz - Transmit		
Maximum Conducted Output Power	Mehadi Choudhury and Francis Kane	UKAS
Bandwidth Limitations	Mehadi Choudhury	UKAS
Spurious Emissions at Antenna Terminals	Francis Kane	UKAS
Frequency Stability	Francis Kane	UKAS
Transient Frequency Behaviour	Francis Kane	UKAS
Adjacent Channel Power	Francis Kane	UKAS
Types of Emissions	Francis Kane	UKAS
Radiated Spurious Emissions	Graeme Lawler	UKAS
Configuration and Mode: TETRA 403 MHz to 430 MHz -Transmit		
Maximum Conducted Output Power	Mehadi Choudhury and Francis Kane	UKAS
Bandwidth Limitations	Mehadi Choudhury	UKAS
Spurious Emissions at Antenna Terminals	Francis Kane	UKAS
Frequency Stability	Francis Kane	UKAS
Transient Frequency Behaviour	Francis Kane	UKAS
Adjacent Channel Power	Francis Kane	UKAS
Types of Emissions	Francis Kane	UKAS
Radiated Spurious 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 Maximum Conducted Output Power

2.1.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.205
FCC 47 CFR Part 2, Clause 2.1046
Industry Canada RSS-119, Clause 5.4
ISEDC RSS-GEN, Clause 6.12

2.1.2 Equipment Under Test and Modification State

SC2124, S/N: 2PS001845GM55XT - Modification State 0

2.1.3 Date of Test

16-April-2019

2.1.4 Test Method

The test was applied in accordance with ANSI C63.26, Clause 5.2.4.3.1.

2.1.5 Environmental Conditions

Ambient Temperature	23.2 °C
Relative Humidity	35.3 %

2.1.6 Test Results

TETRA 450 MHz to 470 MHz - Transmit

450.025 MHz		460.025 MHz		469.975 MHz	
Result (dBm)	Result (W)	Result (dBm)	Result (W)	Result (dBm)	Result (W)
33.356	2.166	33.352	2.164	33.421	2.198

Table 5 - ERP

TETRA 403 MHz to 430 MHz -Transmit

406.125 MHz		418.050 MHz		429.975 MHz	
Result (dBm)	Result (W)	Result (dBm)	Result (W)	Result (dBm)	Result (W)
33.170	2.075	33.163	2.072	33.190	2.084

Table 6 - ERP

FCC 47 CFR Part 90, Limit Clause 90.205

Frequency (MHz)	Limit
421 to 430	Refer to 90.279 of the specification

Table 7 - FCC Limits for Maximum ERP

Industry Canada RSS-119, Limit Clause 5.4

The output power shall be within ±1 dB of the manufacturer's rated power listed in the equipment specifications.

Frequency (MHz)	Transmitter Output Power (W)	
	Base/Fixed Equipment	Mobile Equipment
406.1 to 430 and 450 to 470	See SRSP-511 for ERP limit	60

Table 8 - Industry Canada Limits for Transmitter Output Power

2.1.7 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
Attenuator (10dB/250W)	Weinschel	45-10-43	383	12	23-Oct-2019
Multimeter	Fluke	79 Series III	611	12	07-Sep-2019
Hygrometer	Rotronic	I-1000	3220	12	13-Sep-2019
Attenuator (10dB, 150W)	Narda	769-10	3368	12	17-Jul-2020
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	17-Oct-2019
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	22-Oct-2019
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	15-Oct-2019
EXA	Keysight Technologies	N9010B	4968	24	21-Dec-2019
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Cable (18 GHz)	Rosenberger	LU7-071-1000	5099	12	04-Oct-2019
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	06-Oct-2020

Table 9

O/P Mon – Output Monitored using calibrated equipment

2.2 Bandwidth Limitations

2.2.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.209
FCC 47 CFR Part 2, Clause 2.1049
Industry Canada RSS-119, Clause 5.5
ISEDC RSS-GEN, Clause 6.7

2.2.2 Equipment Under Test and Modification State

SC2124, S/N: 2PS001845GM55XT - Modification State 0

2.2.3 Date of Test

16-April-2019

2.2.4 Test Method

The test was performed in accordance with ANSI C63.26, clause 5.4.4.

2.2.5 Environmental Conditions

Ambient Temperature	23.2 °C
Relative Humidity	35.3 %

2.2.6 Test Results

TETRA 450 MHz to 470 MHz - Transmit

450.025 MHz	460.025 MHz	469.975 MHz
Results (kHz)	Results (kHz)	Results (kHz)
21.252	21.085	21.199

Table 10 - Occupied Bandwidth Results

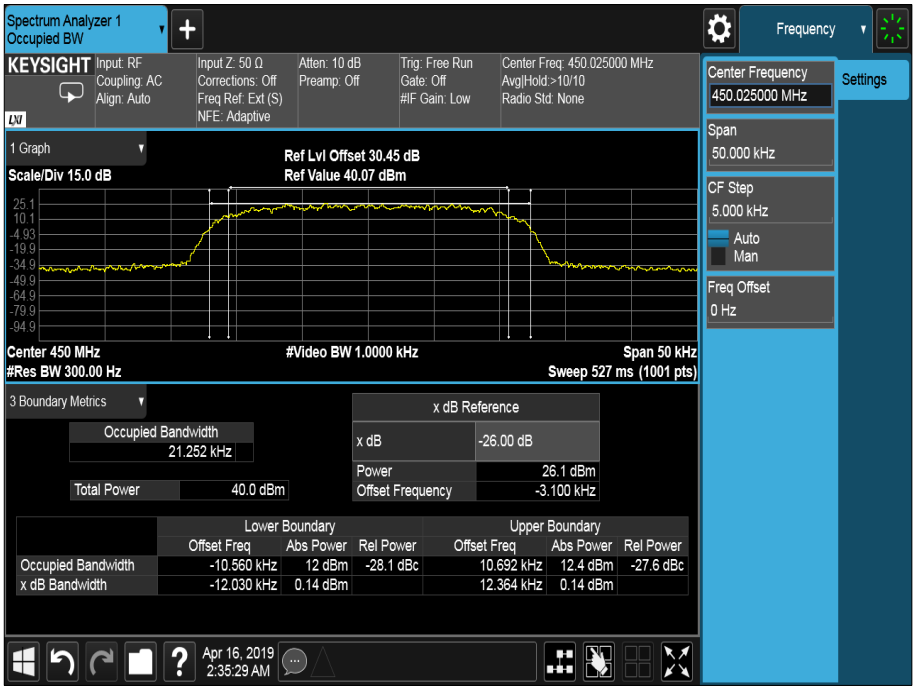

Figure 1 - 450.025 MHz Occupied Bandwidth

Figure 2 - 460.025 MHz Occupied Bandwidth

Figure 3 - 469.975 MHz Occupied Bandwidth

TETRA 403 MHz to 430 MHz -Transmit

406.125 MHz	418.050 MHz	429.975 MHz
Results (kHz)	Results (kHz)	Results (kHz)
21.157	21.121	21.195

Table 11 - Occupied Bandwidth Results

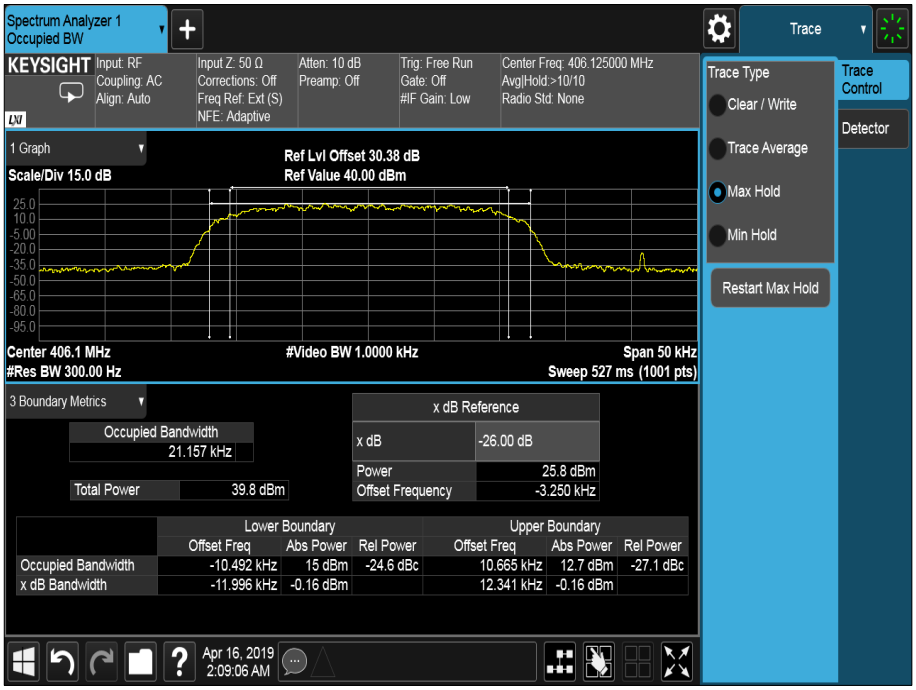

Figure 4 - 406.125 MHz Occupied Bandwidth

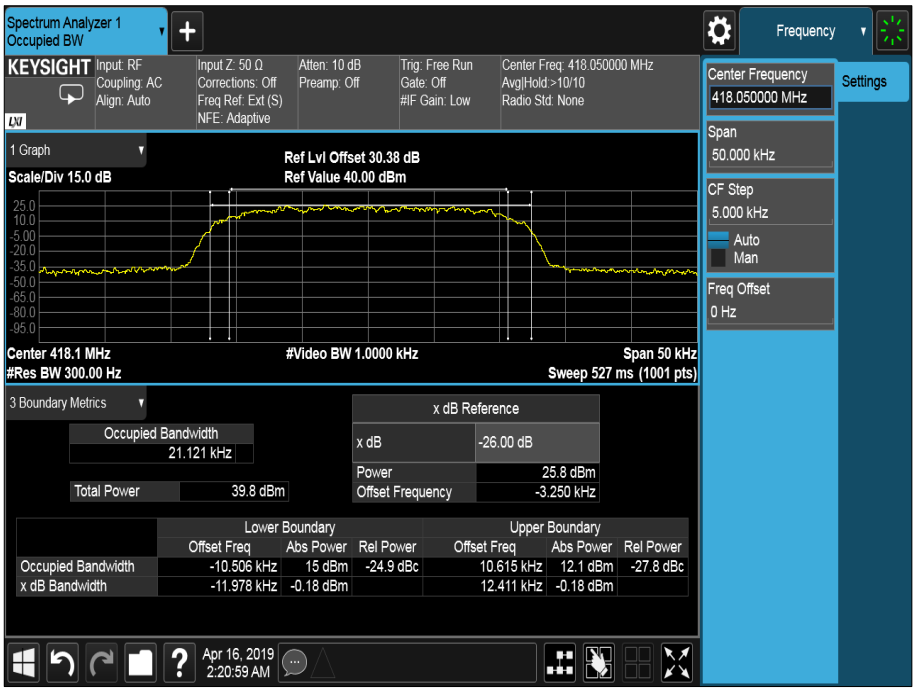

Figure 5 - 418.050 MHz Occupied Bandwidth

Figure 6 - 429.975 MHz Occupied Bandwidth

<u>FCC 47 CFR Part 90, Limit Clause 90.209</u>

Operations using equipment designed to operate with a 25 kHz channel bandwidth may be authorized up to a 22 kHz bandwidth if the equipment meets the Adjacent Channel Power limits of FCC 47 CFR Part 90.221.

<u>Industry Canada RSS-119, Limit Clause 5.5</u>

The maximum permissible occupied bandwidth shall not exceed the authorized bandwidth specified in table 3 of the test specification for the equipment's frequency band as specified below.

< 22 kHz

2.2.7 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
Attenuator (10dB/250W)	Weinschel	45-10-43	383	12	23-Oct-2019
Multimeter	Fluke	79 Series III	611	12	07-Sep-2019
Hygrometer	Rotronic	I-1000	3220	12	13-Sep-2019
Attenuator (10dB, 150W)	Narda	769-10	3368	12	17-Jul-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	15-Oct-2019
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
EXA	Keysight Technologies	N9010B	4968	24	21-Dec-2019
Cable (18 GHz)	Rosenberger	LU7-071-1000	5099	12	04-Oct-2019
Cable (18 GHz)	Rosenberger	LU7-071-2000	5108	12	06-Oct-2020

Table 12

O/P Mon – Output Monitored using Calibrated Equipment

2.3 Spurious Emissions at Antenna Terminals

2.3.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.210
FCC 47 CFR Part 2, Clause 2.1051
Industry Canada RSS-119, Clause 5.8
ISEDC RSS-GEN, Clause 6.13

2.3.2 Equipment Under Test and Modification State

SC2124, S/N: 1PR001909GM18R7 - Modification State 0

2.3.3 Date of Test

12-December-2019 to 16-December-2019

2.3.4 Test Method

This test was performed in accordance with ANSI C63.26, clause 5.7.

For emissions where the frequency is removed less than 250 % of the authorised bandwidth measurements were performed conducted as follows:

The EUT was connected to a spectrum analyser via a cable and attenuator. The path loss between the EUT and analyser was calibrated using a network analyser and entered in to the spectrum analyser as a reference level offset. The reference level for the mask was established with an RBW approximately 2 or 3 times the emission bandwidth. The RBW was then reduced to at least 1% of the emission bandwidth, with a VBW of 3 times RBW.

For emissions where the frequency is removed more than 250 % of the authorised bandwidth measurements were performed conducted as follows:

The EUT was connected to a spectrum analyser via a cable and attenuator. The path loss between the EUT and analyser was calibrated using a network analyser and entered in to the spectrum analyser as a reference level offset. The analyser was configured with a peak detector and max hold trace. For measurements above 1800 MHz, a high pass filter was used. Measurements were also performed radiated as recorded in section 2.7 of this report.

2.3.5 Environmental Conditions

Ambient Temperature	20.9 - 22.8 °C
Relative Humidity	33.7 - 34.2 %

2.3.6 Test Results

TETRA 450 MHz to 470 MHz - Transmit

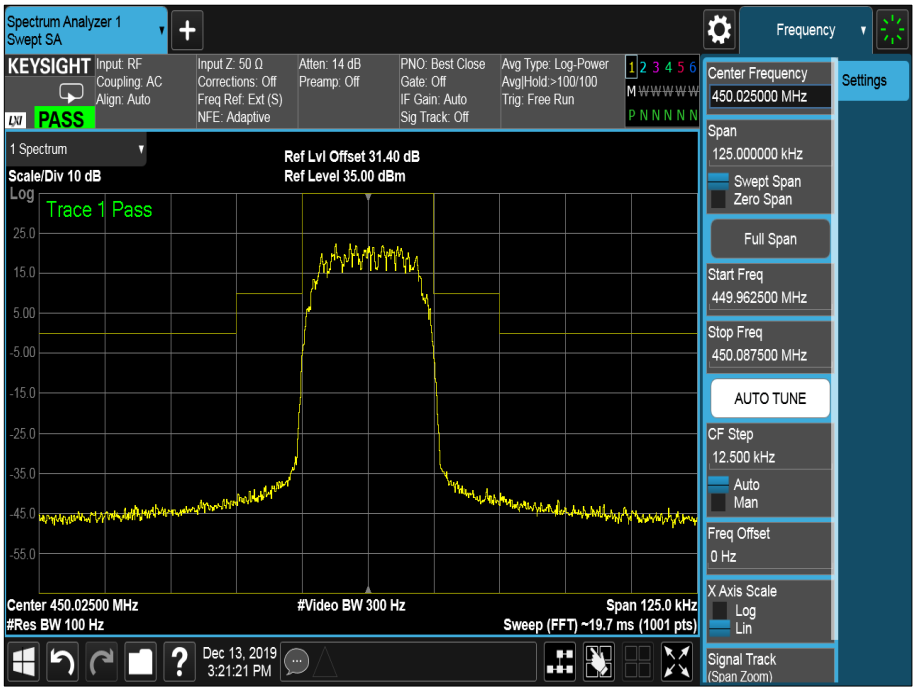

Figure 7 - 450.025 MHz, Transmitter Mask

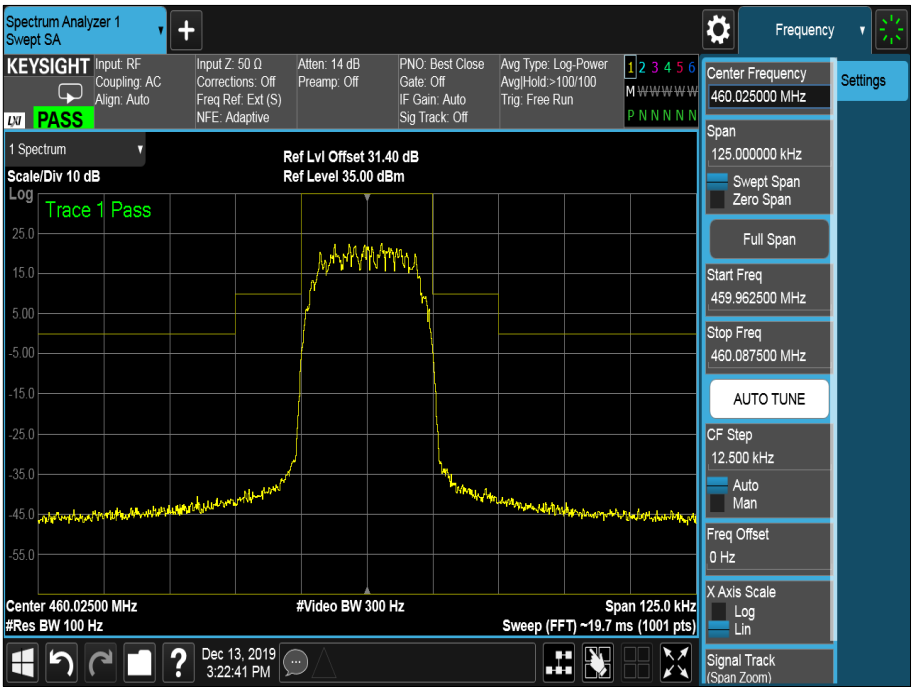

Figure 8 - 460.025 MHz, Transmitter Mask

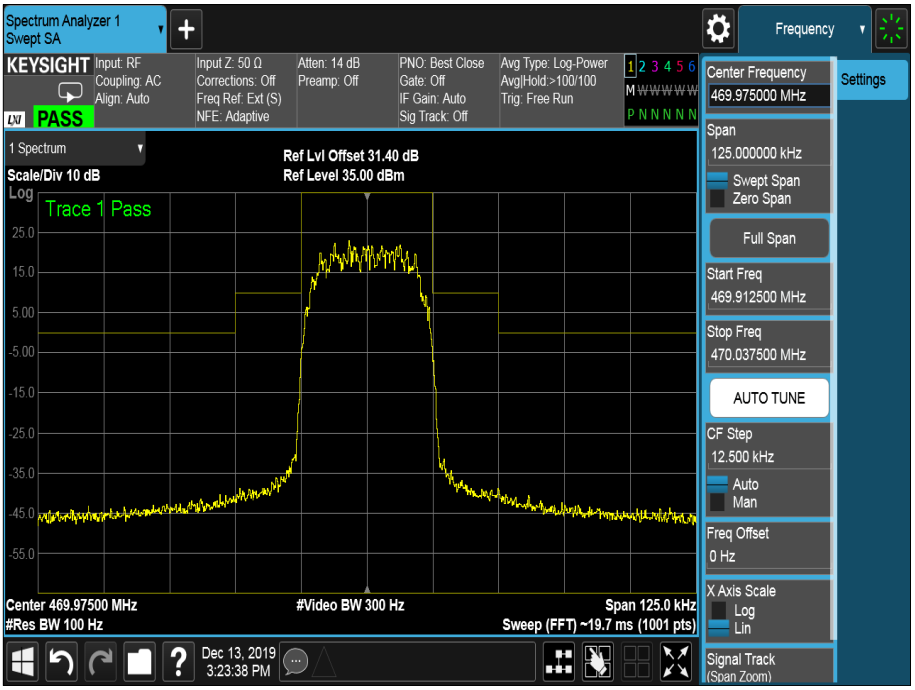

Figure 9 - 469.975 MHz, Transmitter Mask

Figure 10 - 450.025 MHz, 9 kHz to 150 kHz

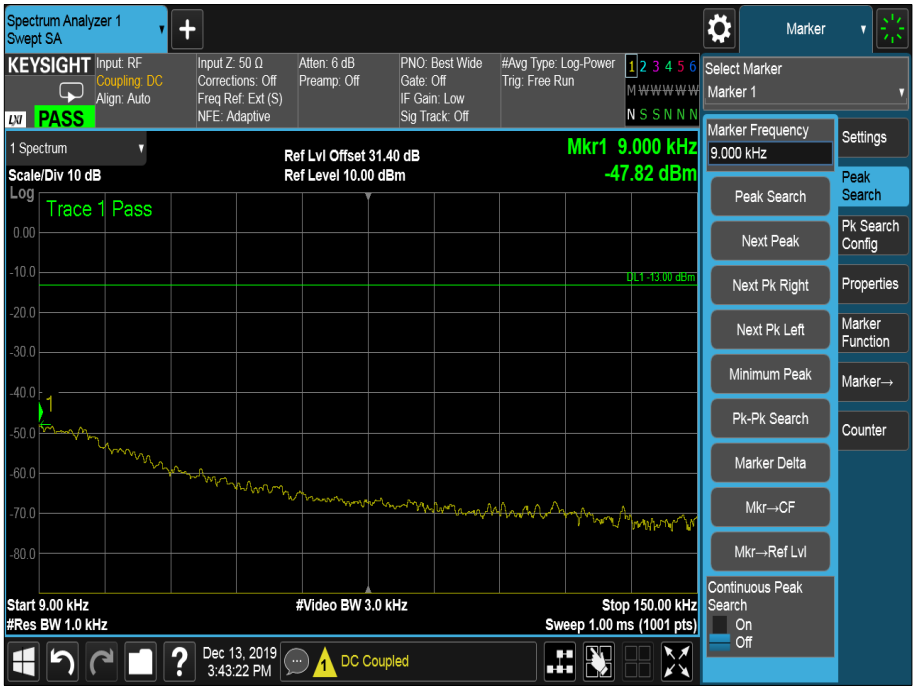

Figure 11 - 460.025 MHz, 9 kHz to 150 kHz

Figure 12 - 469.975 MHz - 9 kHz to 150 kHz

Figure 13 - 450.025 MHz, 150 kHz to 1 MHz

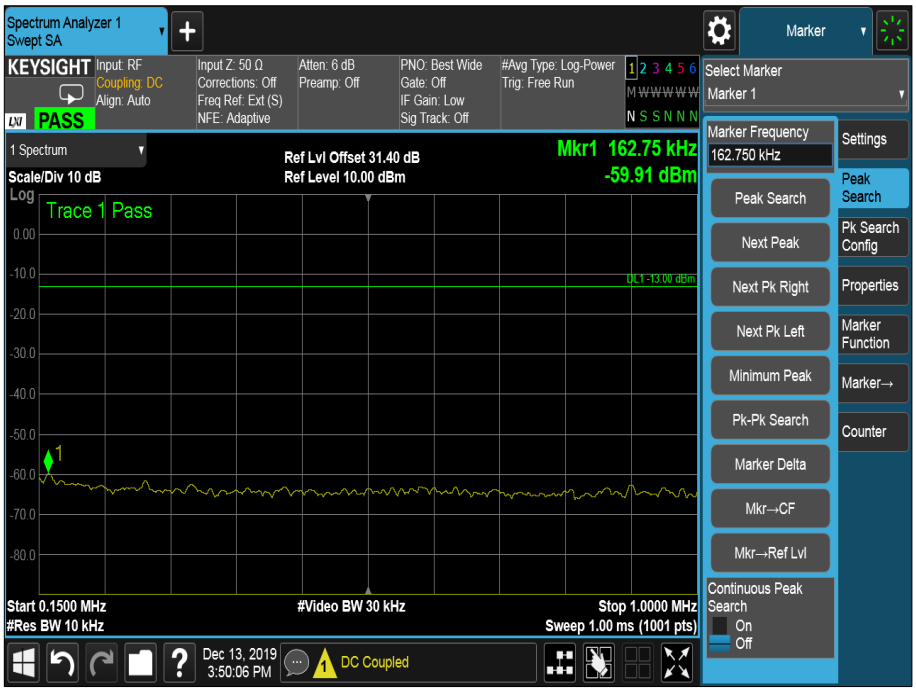

Figure 14 - 460.025 MHz, 150 kHz to 1 MHz

Figure 15 - 469.975 MHz - 150 kHz to 1 MHz

Figure 16 - 450.025 MHz, 1 MHz to 30 MHz

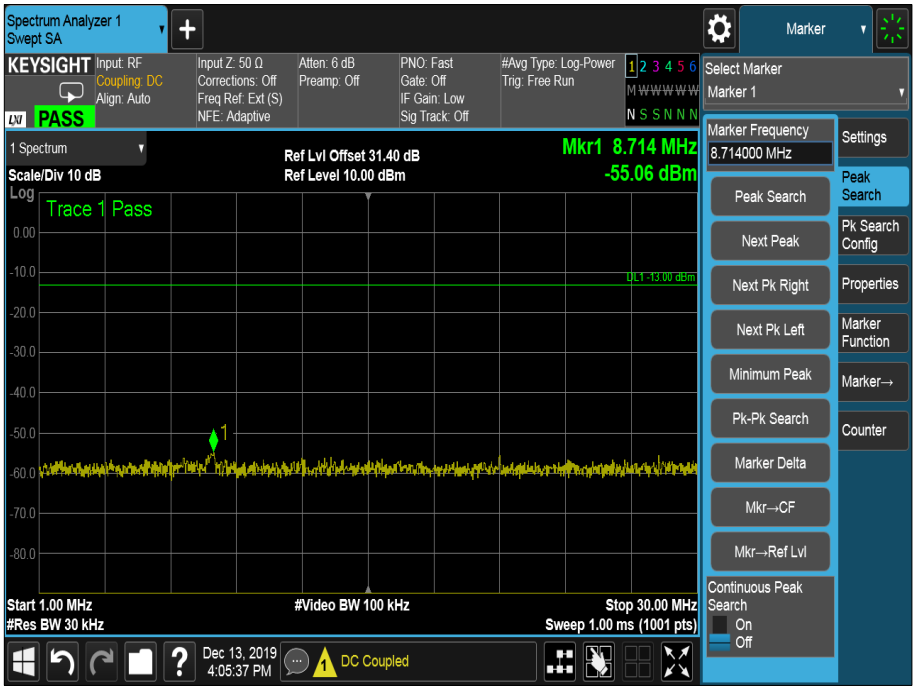

Figure 17 - 460.025 MHz, 1 MHz to 30 MHz

Figure 18 - 469.975 MHz - 1 MHz to 30 MHz

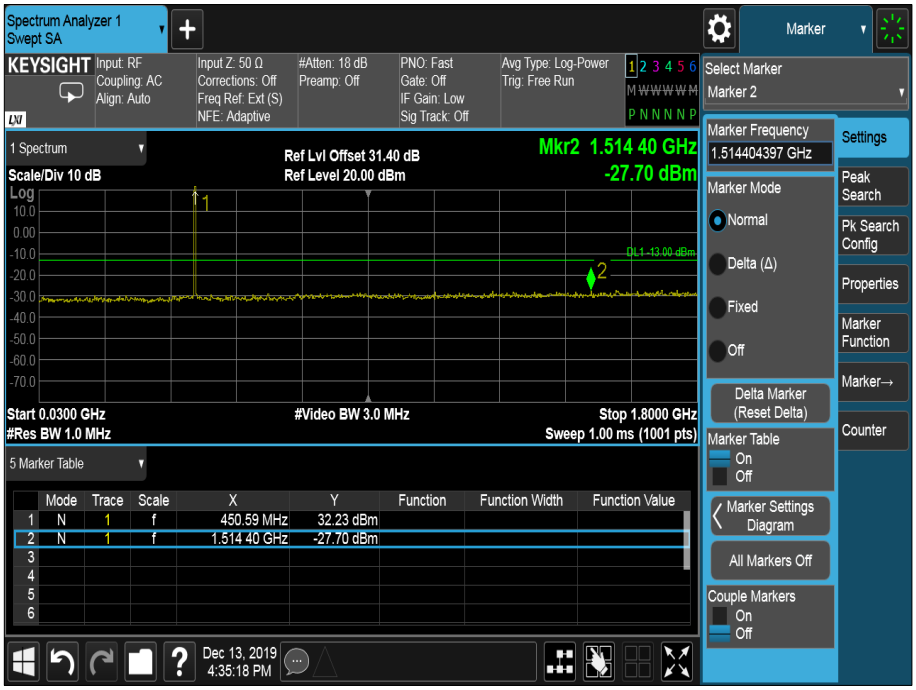

Figure 19 - 450.025 MHz, 30 MHz to 1.8 GHz

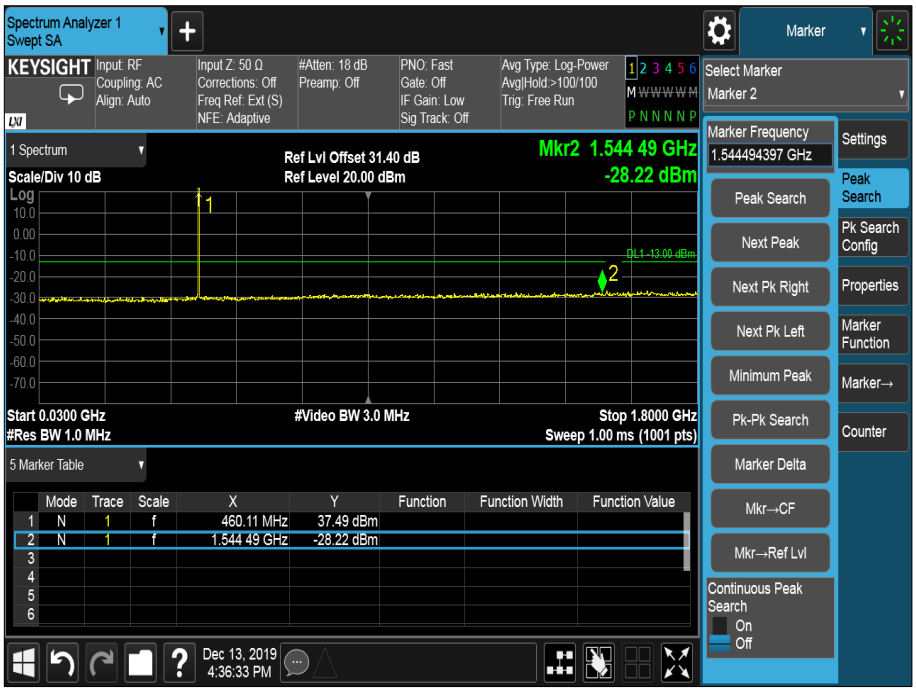

Figure 20 - 460.025 MHz, 30 MHz to 1.8 GHz

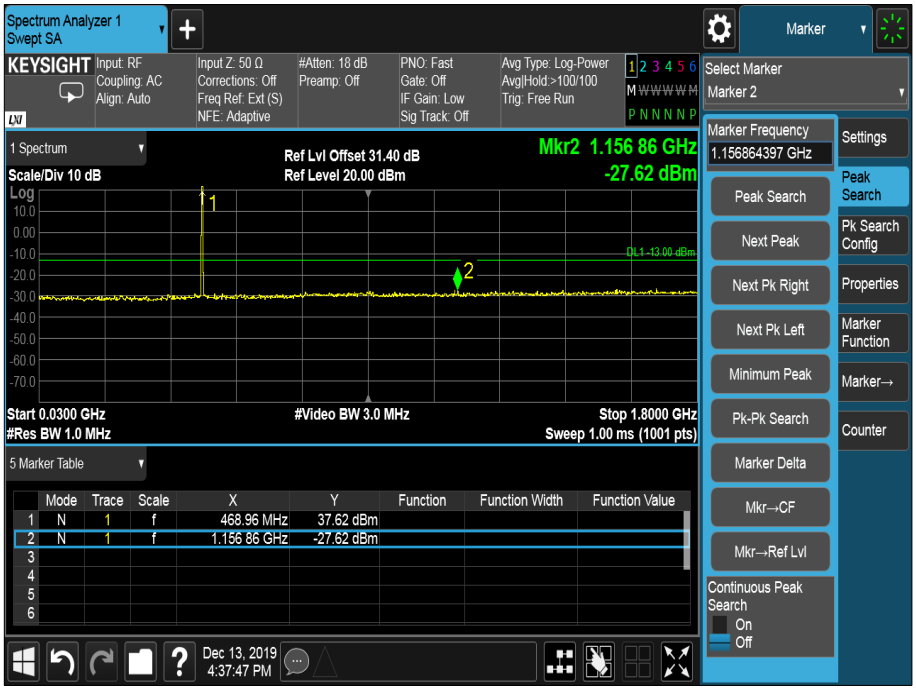

Figure 21 - 469.975 MHz - 30 MHz to 1.8 GHz

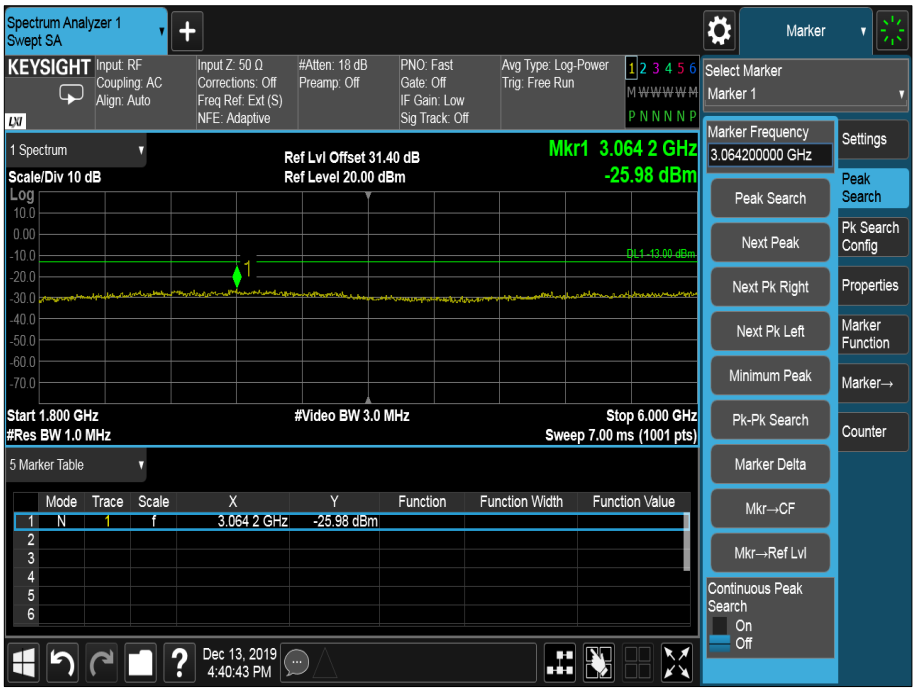

Figure 22 - 450.025 MHz, 1.8 GHz to 6 GHz

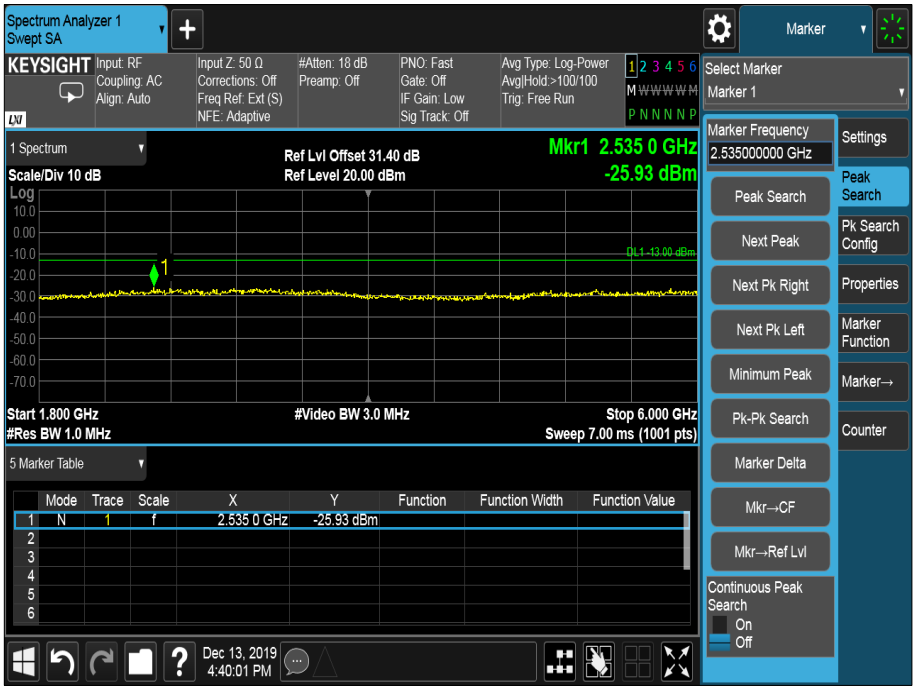

Figure 23 - 460.025 MHz, 1.8 GHz to 6 GHz

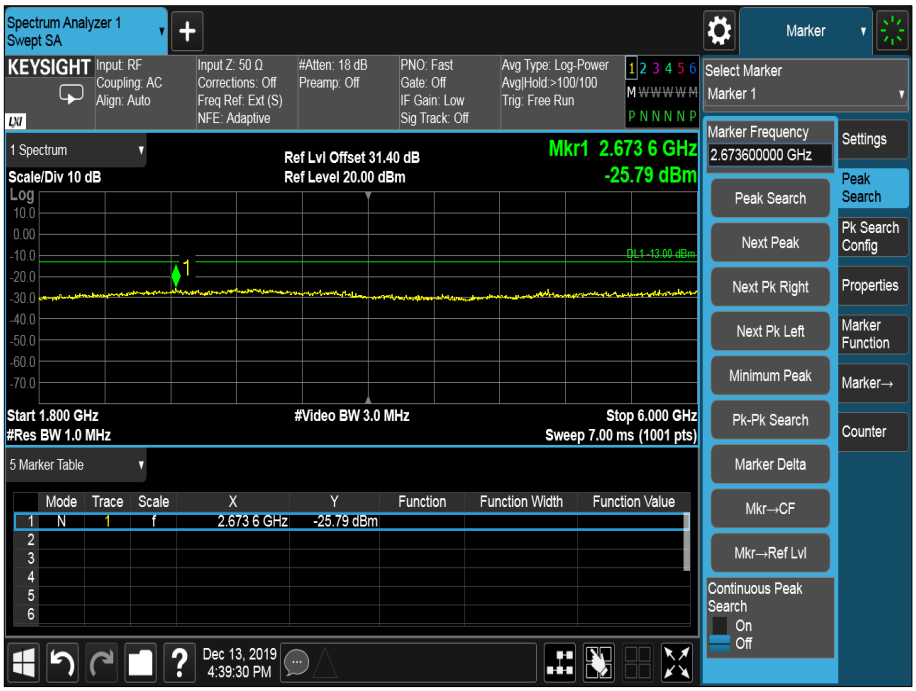

Figure 24 - 469.975 MHz - 1.8 GHz to 6 GHz

TETRA 403 MHz to 430 MHz -Transmit

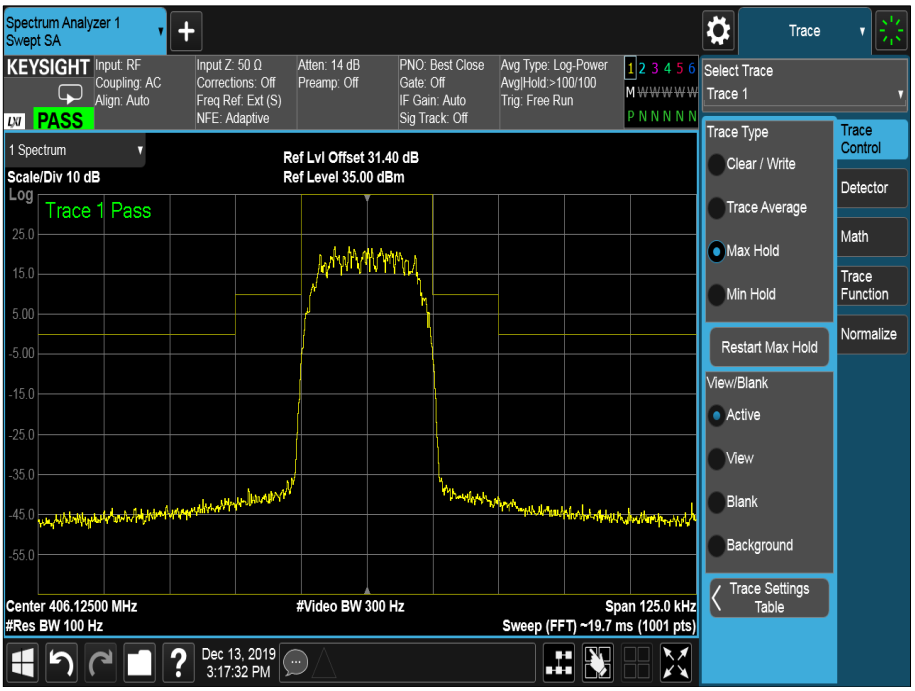

Figure 25 - 406.125 MHz, Transmitter Mask

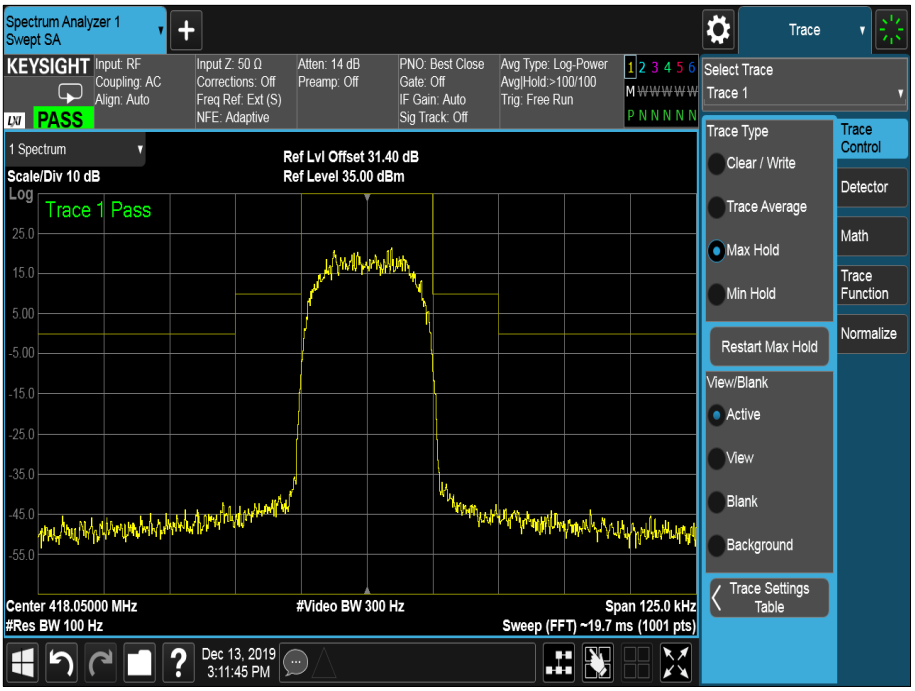

Figure 26 - 418.050 MHz, Transmitter Mask

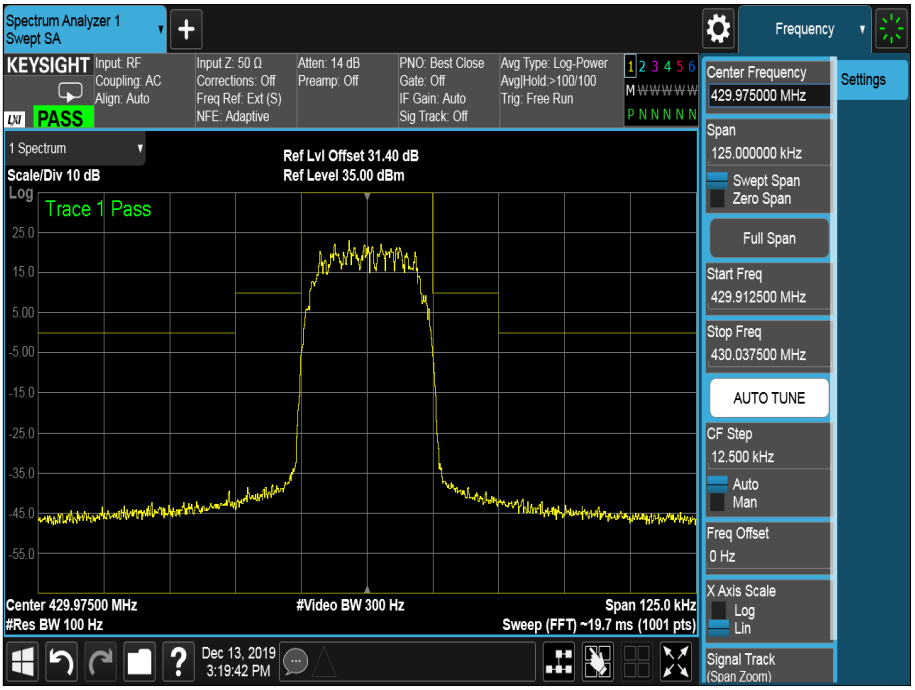

Figure 27 - 429.975 MHz, Transmitter Mask

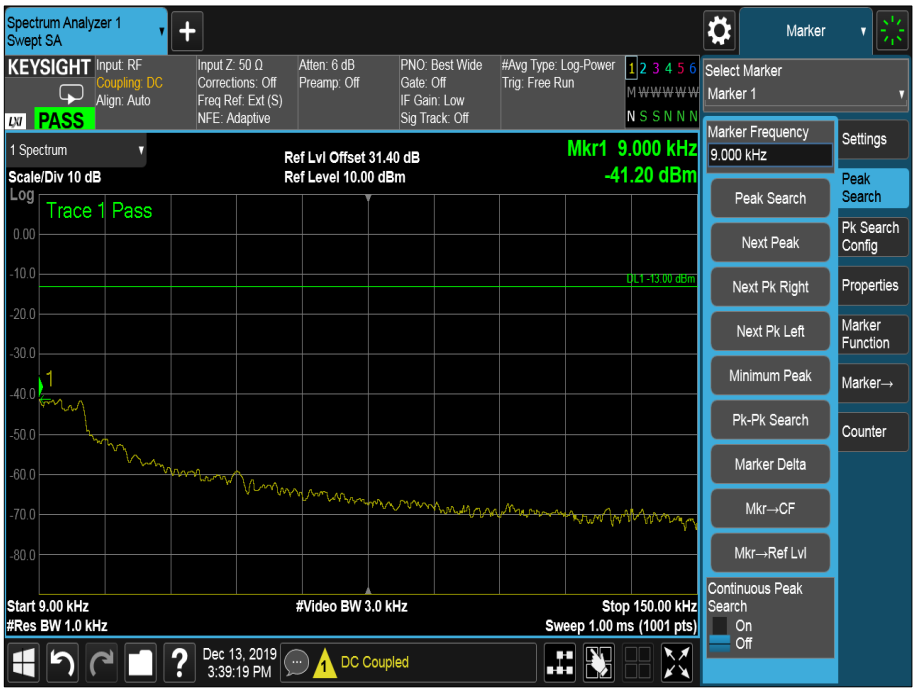

Figure 28 - 406.125 MHz, 9 kHz to 150 kHz

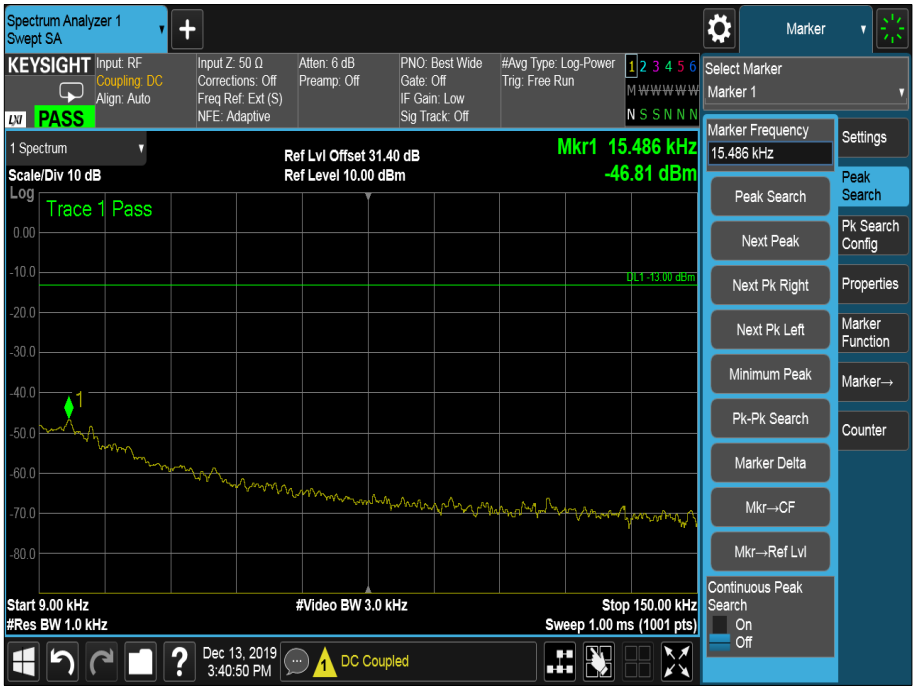

Figure 29 - 418.050 MHz, 9 kHz to 150 kHz

Figure 30 - 429.975 MHz - 9 kHz to 150 kHz

Figure 31 - 406.125 MHz, 150 kHz to 1 MHz

Figure 32 - 418.050 MHz, 150 kHz to 1 MHz

Figure 33 - 429.975 MHz - 150 kHz to 1 MHz

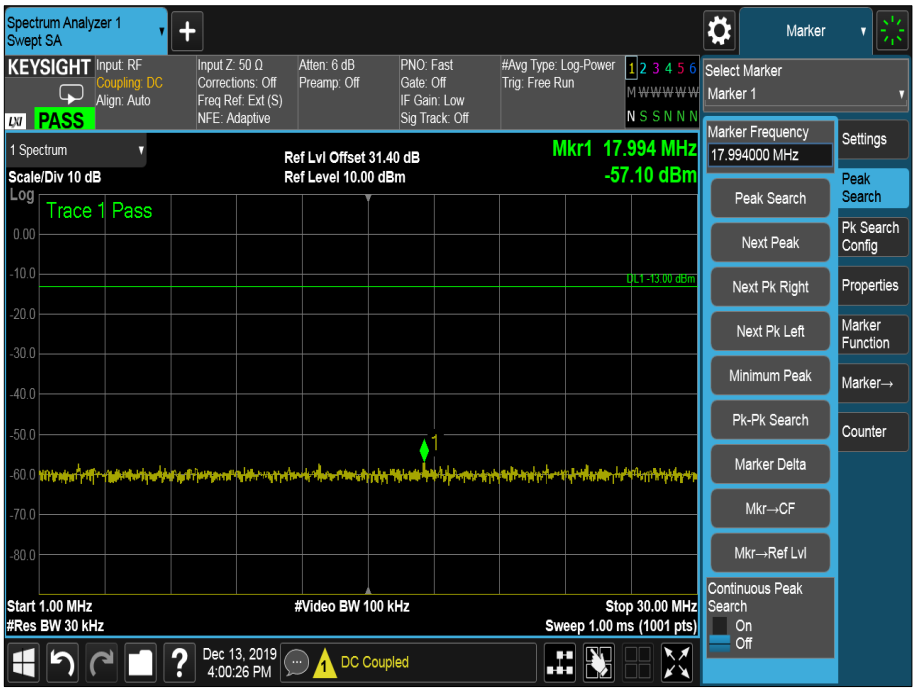

Figure 34 - 406.125 MHz, 1 MHz to 30 MHz

Figure 35 - 418.050 MHz, 1 MHz to 30 MHz

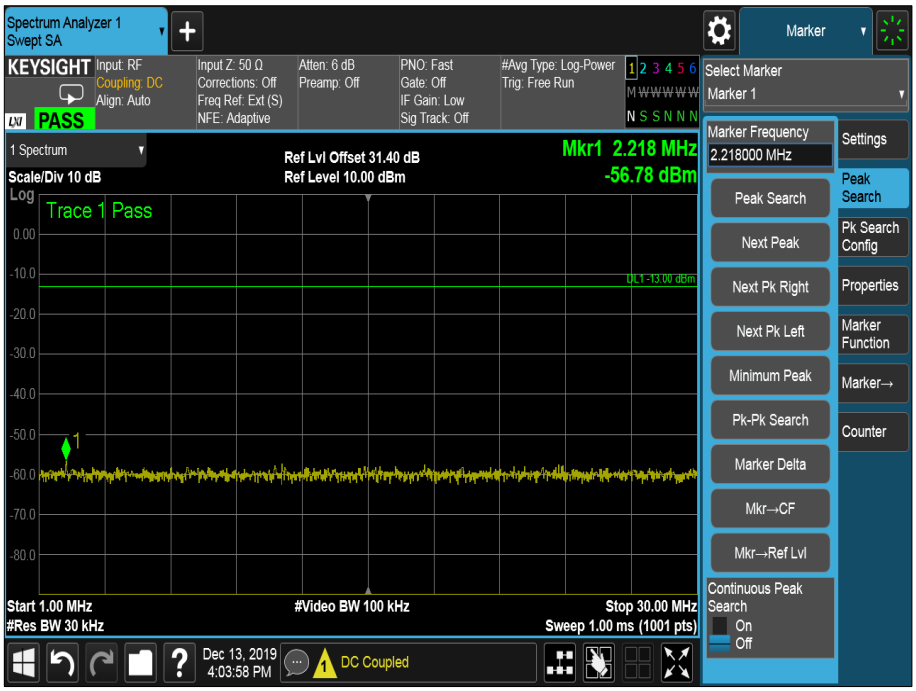

Figure 36 - 429.975 MHz - 1 MHz to 30 MHz

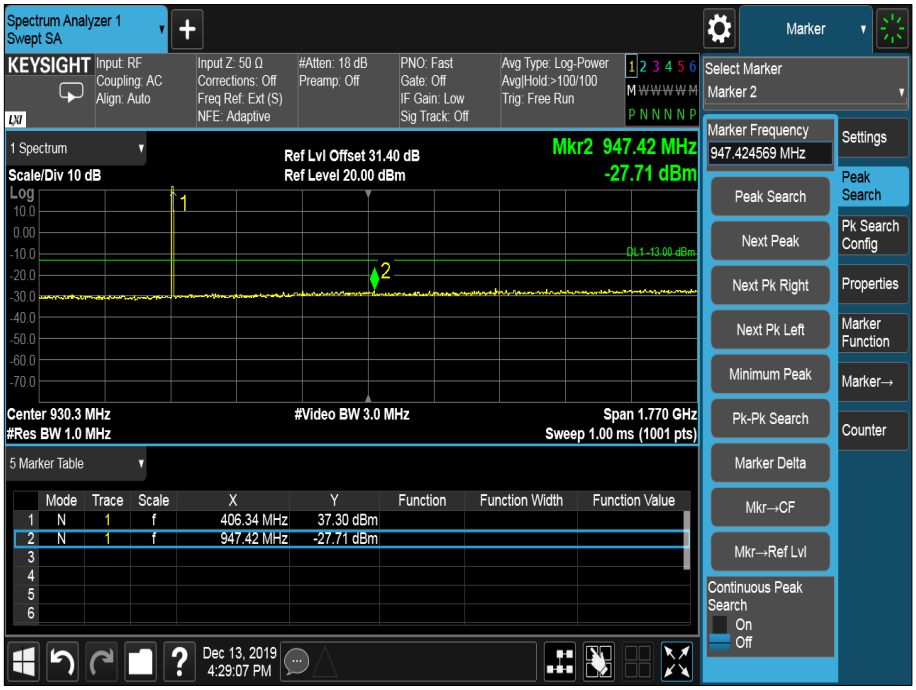

Figure 37 - 406.125 MHz, 30 MHz to 1.8 GHz

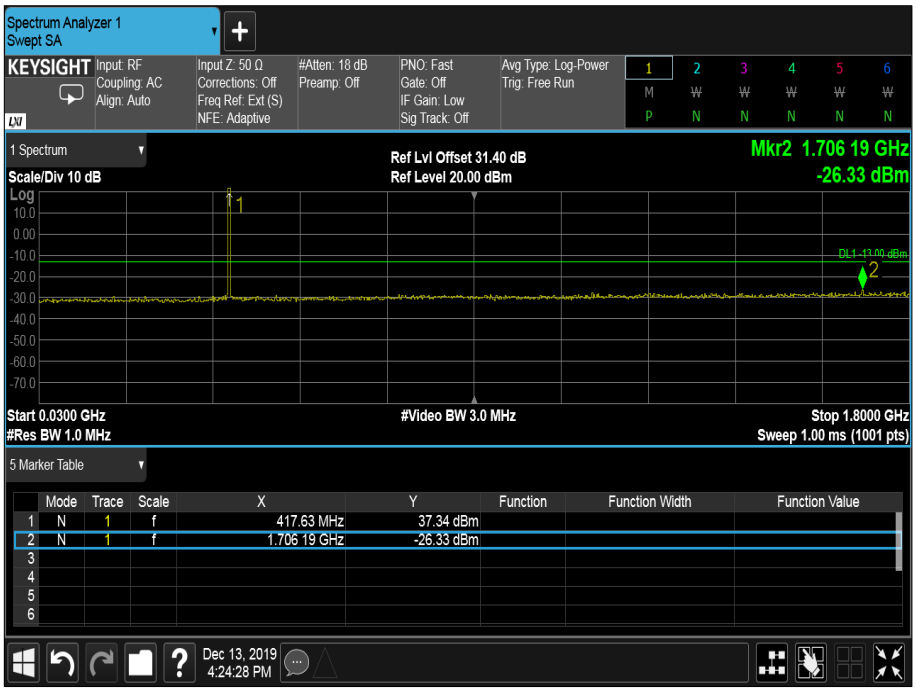

Figure 38 - 418.050 MHz, 30 MHz to 1.8 GHz

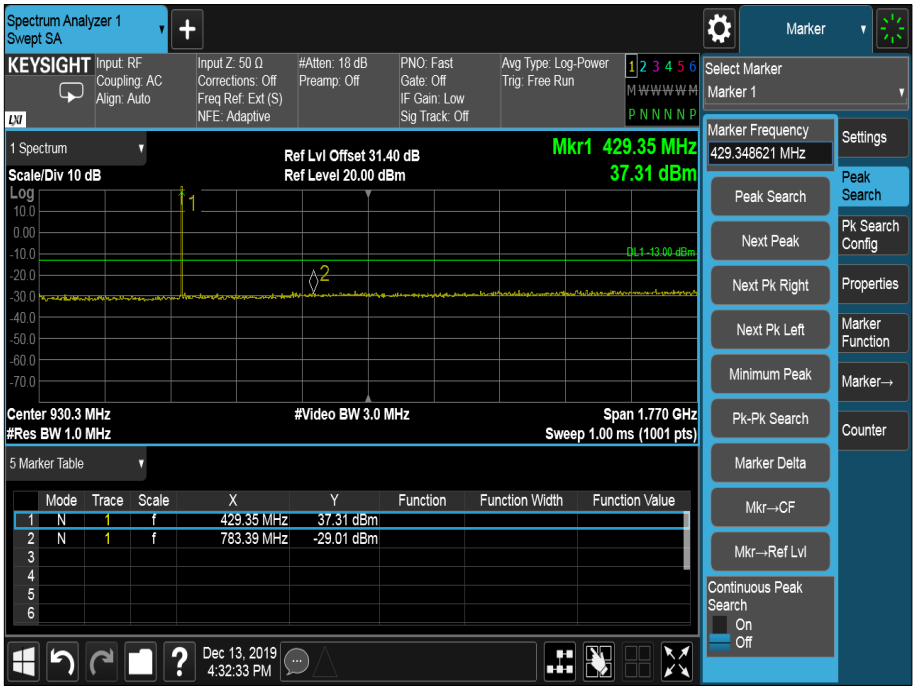

Figure 39 - 429.975 MHz - 30 MHz to 1.8 GHz

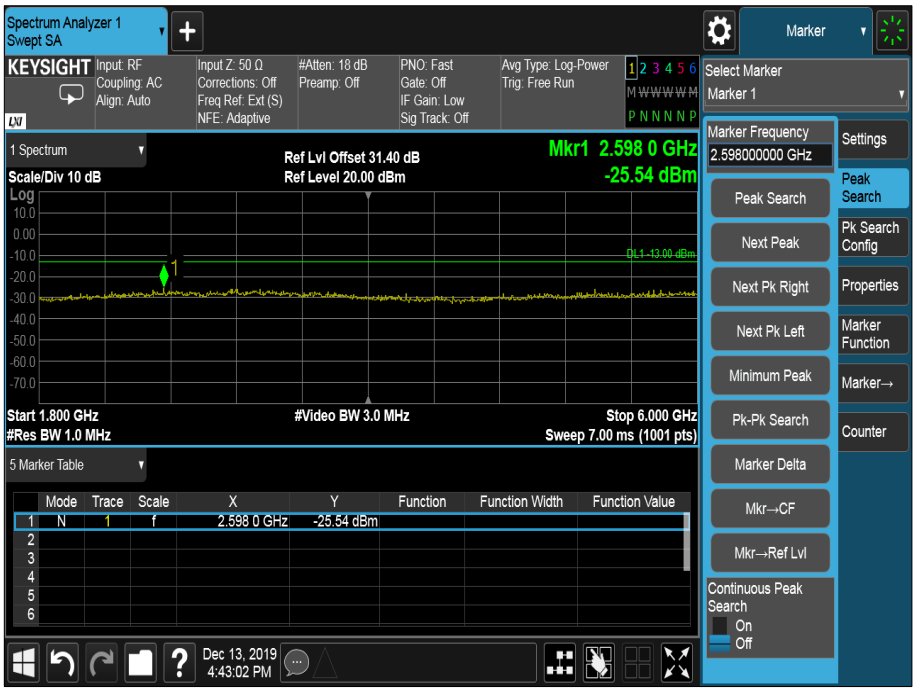

Figure 40 - 406.125 MHz, 1.8 GHz to 6 GHz

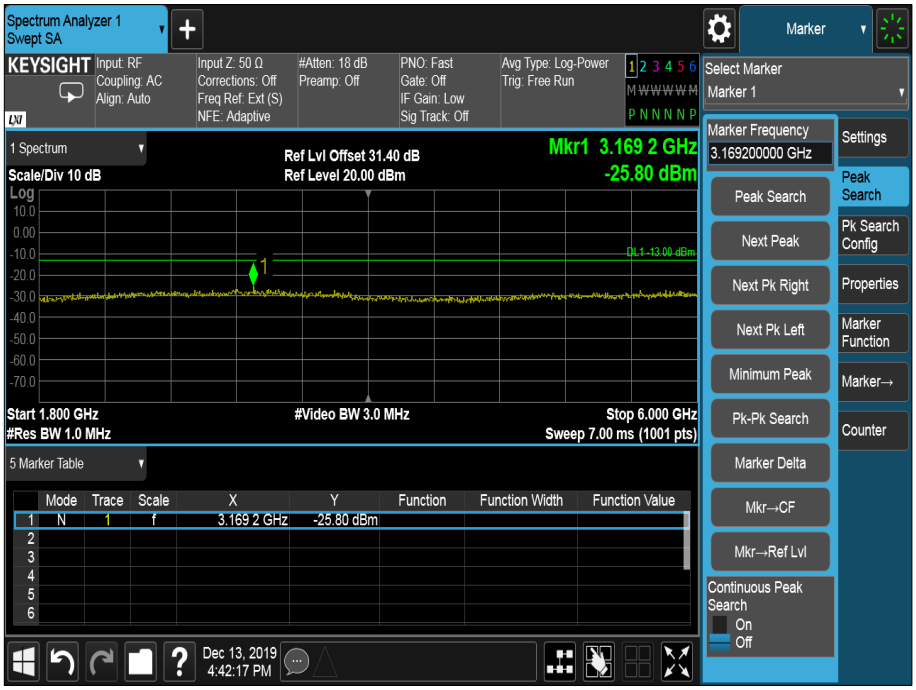

Figure 41 - 418.050 MHz, 1.8 GHz to 6 GHz

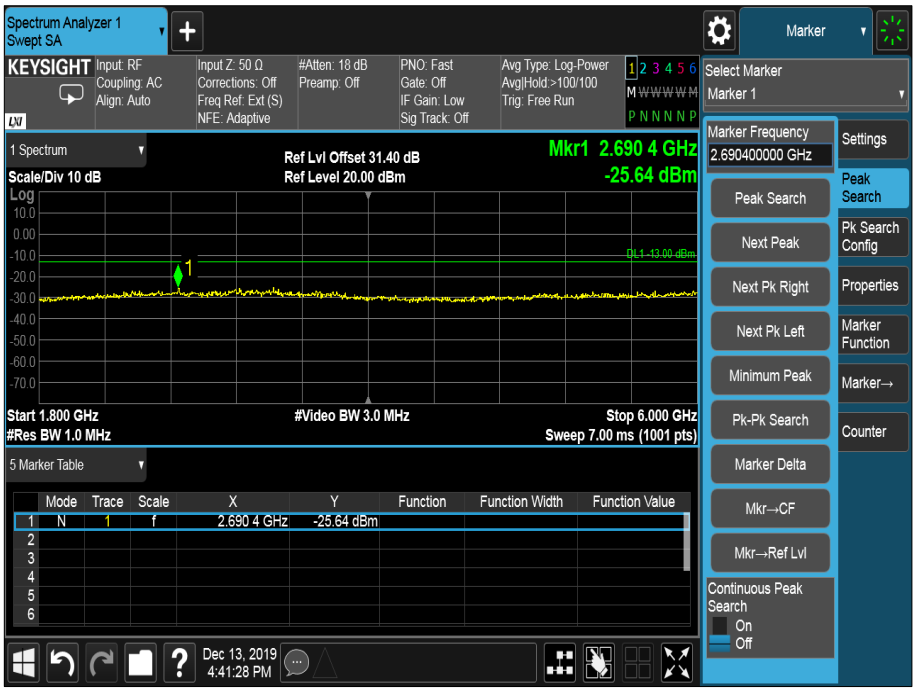

Figure 42 - 429.975 MHz - 1.8 GHz to 6 GHz

FCC 47 CFR Part 90, Limit Clause 90.210

The EUT shall comply with emission mask as per FCC 47 CFR Part 90.210.

Industry Canada RSS-119, Limit Clause 5.8

The EUT shall comply with emission mask as per Industry Canada RSS-119 clause 5.8.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Multimeter	Fluke	75 Mk3	455	12	11-Oct-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre K-Type Cable	Florida Labs	KMS-180SP-39.4-KMS	4520	12	12-Nov-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
High Pass filter	Wainwright	WHKX12-1290-1500-18000-80SS	4961	-	O/P Mon
EXA	Keysight Technologies	N9010B	4968	24	21-Dec-2019
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Electronic Calibration Module	Keysight Technologies	85093C	5188	12	21-May-2020

Table 13

O/P Mon – Output Monitored using calibrated equipment

2.4 Frequency Stability

2.4.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.210
FCC 47 CFR Part 2, Clause 2.1055
Industry Canada RSS-119, Clause 5.3
ISEDC RSS-GEN, Clause 6.11

2.4.2 Equipment Under Test and Modification State

SC2124, S/N: 1PR001909GM18R7 - Modification State 0

2.4.3 Date of Test

12-December-2019 to 16-December-2019

2.4.4 Test Method

This test was performed in accordance with ANSI C63.26, clause 5.6. and the requirements of FCC CFR 47 Part 2.1055 (a)(2), (d)(1).

The EUT was set to transmit on maximum power with an unmodulated carrier on bottom, middle and top channels. The EUT was connected to a spectrum analyser using an external 10 MHz frequency reference. The difference between the frequency of the fundamental and the frequency of the assigned channel in accordance with the manufacturer's documentation was recorded. In accordance with 2.1055, the temperature was varied from -20°C to +50° in 10° steps at nominal voltage and at 20 ˚C for both minimum and maximum voltage extremes.

2.4.5 Environmental Conditions

Ambient Temperature	22.4 - 22.6 °C
Relative Humidity	36.2 - 36.4 %

2.4.6 Test Results

TETRA 450 MHz to 470 MHz - Transmit

Voltage	Frequency Error (ppm)		
	450.025 MHz	460.025 MHz	469.975 MHz
6.2 V DC	0.160	0.163	0.164
7.4 V DC	0.162	0.154	0.157

Table 14 - Frequency Stability Under Voltage Variations

Temperature	Frequency Error (ppm)		
	450.025 MHz	460.025 MHz	469.975 MHz
+50.0 °C	0.173	0.176	0.170
+40.0 °C	0.182	0.176	0.183
+30.0 °C	0.191	0.174	0.179
+20.0 °C	0.187	0.178	0.179
+10.0 °C	0.160	0.165	0.166
0 °C	0.049	0.046	0.045
-10.0 °C	0.033	0.030	0.030
-20.0 °C	0.047	0.048	0.049
-30.0 °C	0.036	0.040	0.040

Table 15 - Frequency Stability Under Temperature Variations

TETRA 403 MHz to 430 MHz -Transmit

Voltage	Frequency Error (ppm)		
	406.125 MHz	418.050 MHz	429.975 MHz
6.2 V DC	0.172	0.165	0.047
7.4 V DC	0.148	0.160	0.163

Table 16 - Frequency Stability Under Voltage Variations

Temperature	Frequency Error (ppm)		
	406.125 MHz	418.050 MHz	429.975 MHz
+50.0 °C	0.199	0.206	0.184
+40.0 °C	0.202	0.199	0.186
+30.0 °C	0.199	0.191	0.188
+20.0 °C	0.177	0.182	0.179
+10.0 °C	0.170	0.170	0.170
0 °C	0.044	0.043	0.044
-10.0 °C	0.034	0.033	0.033
-20.0 °C	0.049	0.049	0.049
-30.0 °C	0.002	0.019	0.002

Table 17 - Frequency Stability Under Temperature Variations

FCC 47 CFR Part 90, Limit Clause 90.213

421-512 MHz: 5 ppm

Industry Canada RSS-199, Limit Clause 5.3

406.1-430 and 450-470 MHz: 5 ppm

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Multimeter	Fluke	75 Mk3	455	12	11-Oct-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Climatic Chamber	TAS	Micro 225	2892	-	O/P Mon
Thermocouple Thermometer	Fluke	51	3174	12	07-Feb-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre K-Type Cable	Florida Labs	KMS-180SP-39.4-KMS	4520	12	12-Nov-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
EXA	Keysight Technologies	N9010B	4968	24	21-Dec-2019
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020

Table 18

O/P Mon – Output Monitored using calibrated equipment

2.5 Transient Frequency Behaviour

2.5.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.214
Industry Canada RSS-119, Clause 5.9

2.5.2 Equipment Under Test and Modification State

SC2124, S/N: 1PR001909GM18R7 - Modification State 0

2.5.3 Date of Test

11-December-2019

2.5.4 Test Method

The Transient frequency behaviour On and Off test was performed on bottom, middle and top frequencies using an unmodulated carrier output from the EUT and measured on a spectrum analyser in accordance with TIA Standard 603 (Referenced in RSS-119 Section 5.9).

The EUT configuration application used to transmit an unmodulated signal was 2.25 kHz higher than the nominal centre frequency of the channel. Therefore, the trace plots recorded were centred on 2.25 kHz higher than the bottom, middle and top nominal centre frequencies.

2.5.5 Environmental Conditions

Ambient Temperature	22.4 - 22.8 °C
Relative Humidity	37.4 - 38.7 %

2.5.6 Test Results

<u>TETRA 450 MHz to 470 MHz - Transmit</u>

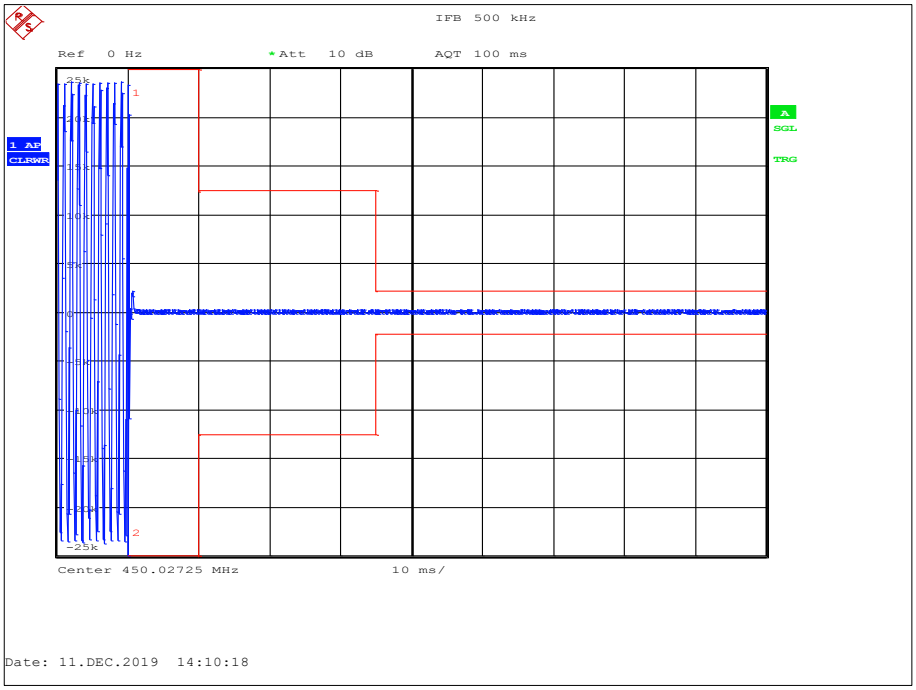

Figure 43 - 450.025 MHz, Switch On Transients

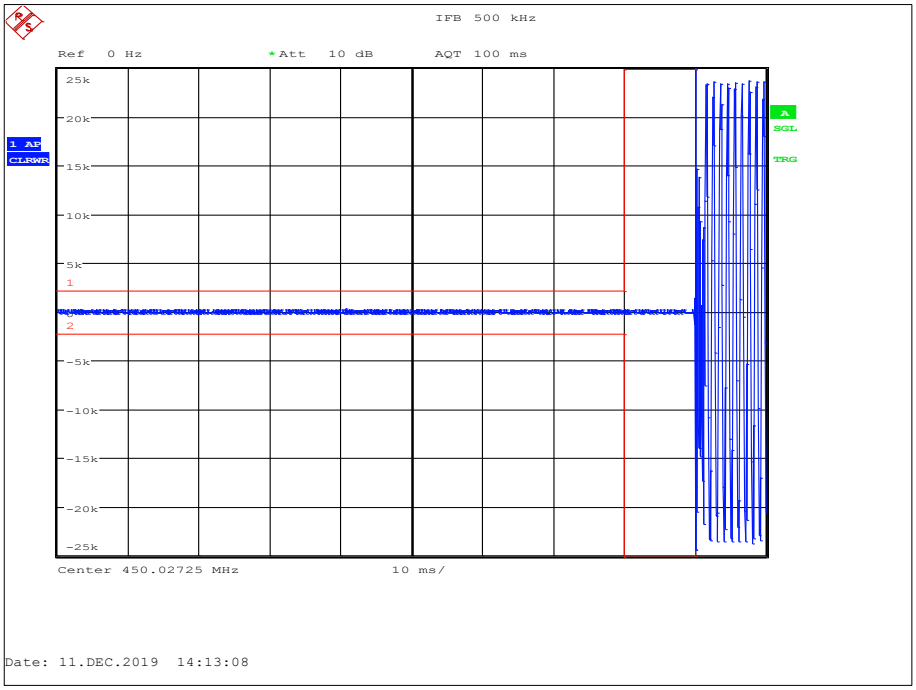

Figure 44- 450.025 MHz, Switch Off Transients

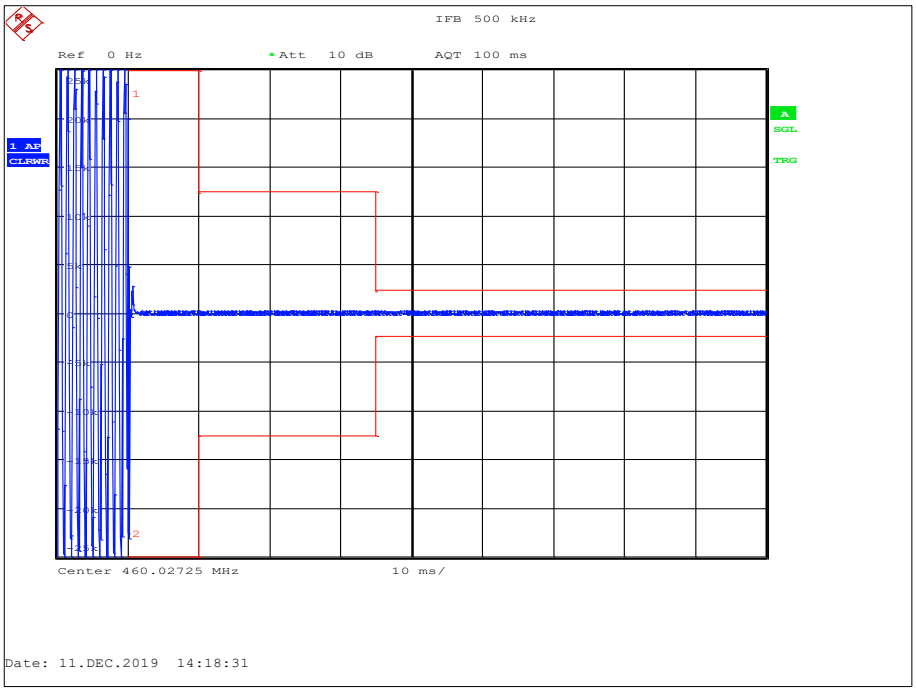

Figure 45 - 460.025 MHz, Switch On Transients

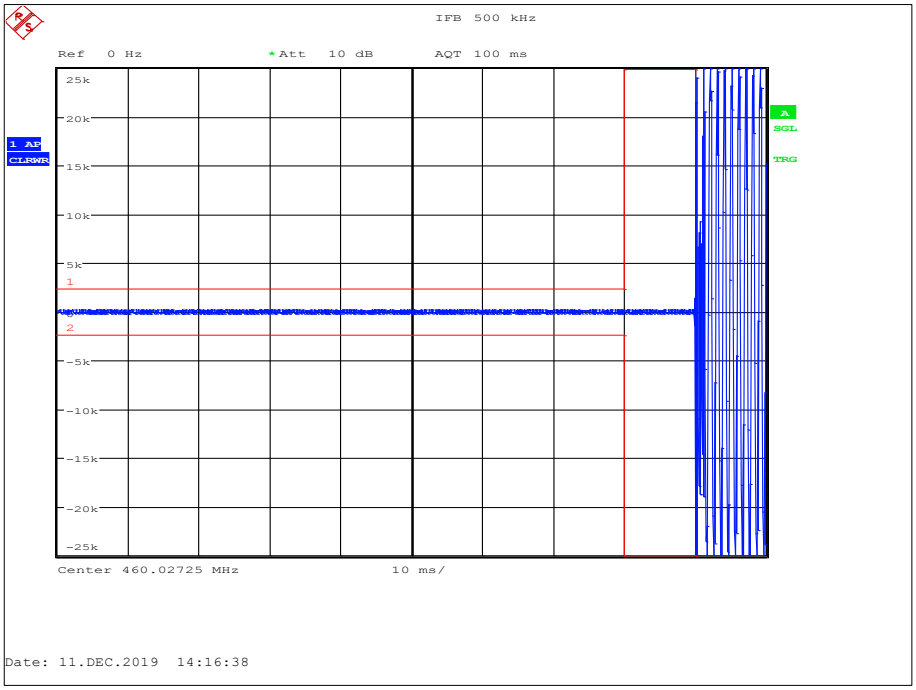

Figure 46- 460.025 MHz, Switch Off Transients

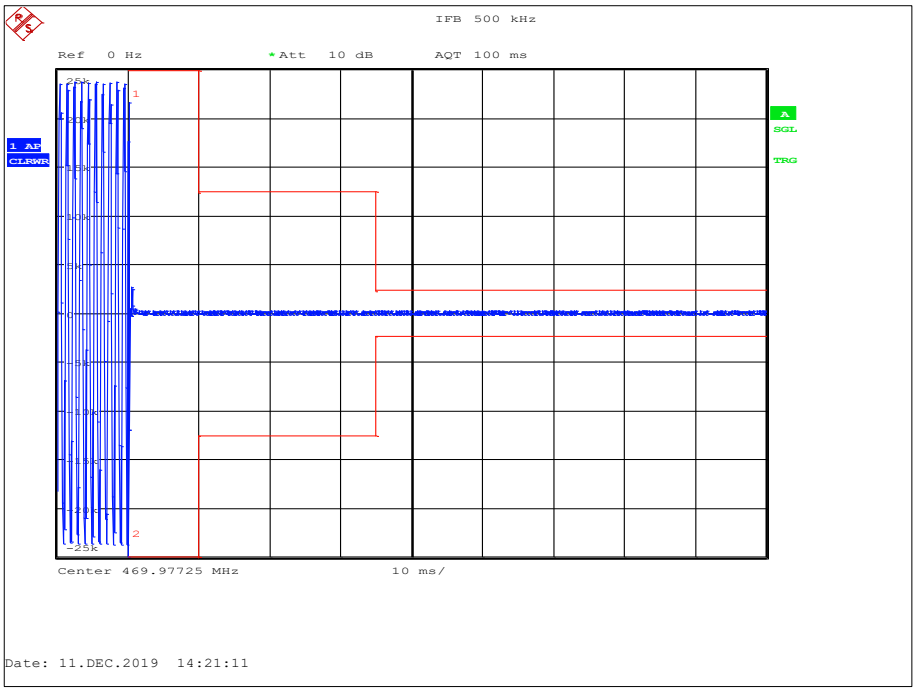

Figure 47 - 469.975 MHz, Switch On Transients

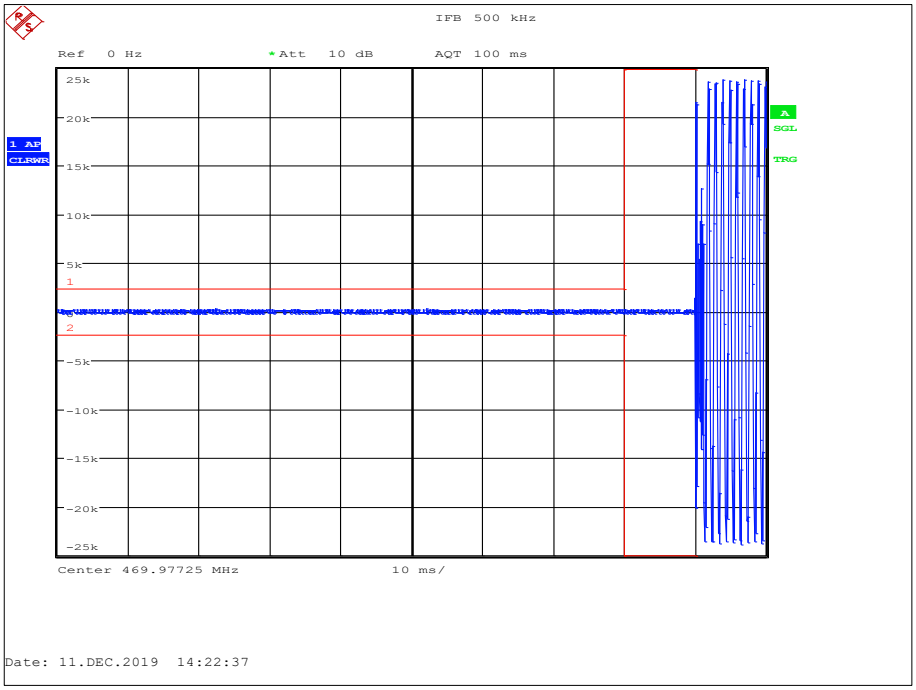

Figure 48- 469.975 MHz, Switch Off Transients

TETRA 403 MHz to 430 MHz -Transmit

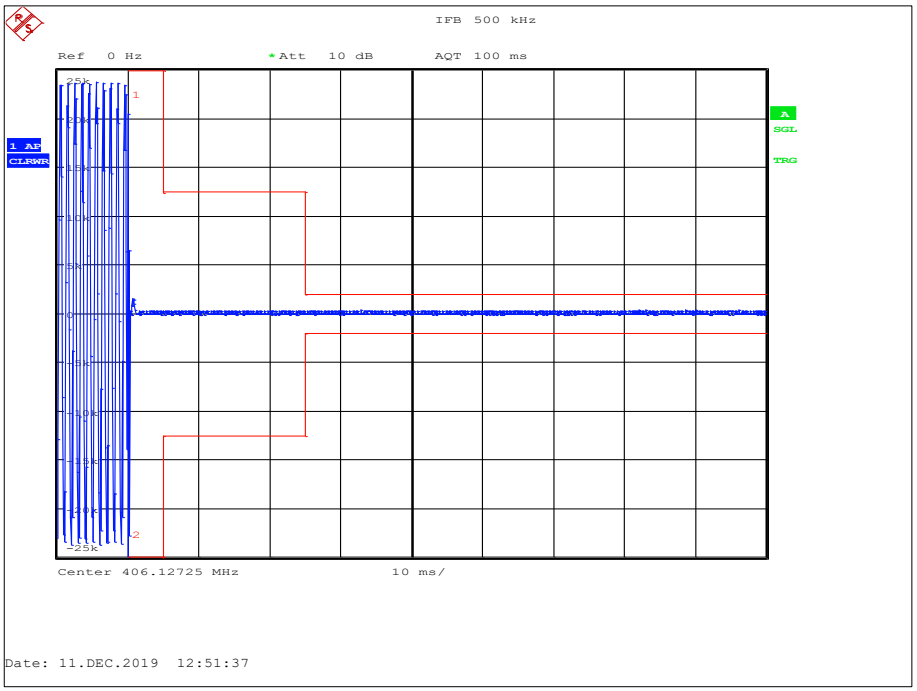

Figure 49 - 406.125 MHz, Switch On Transients

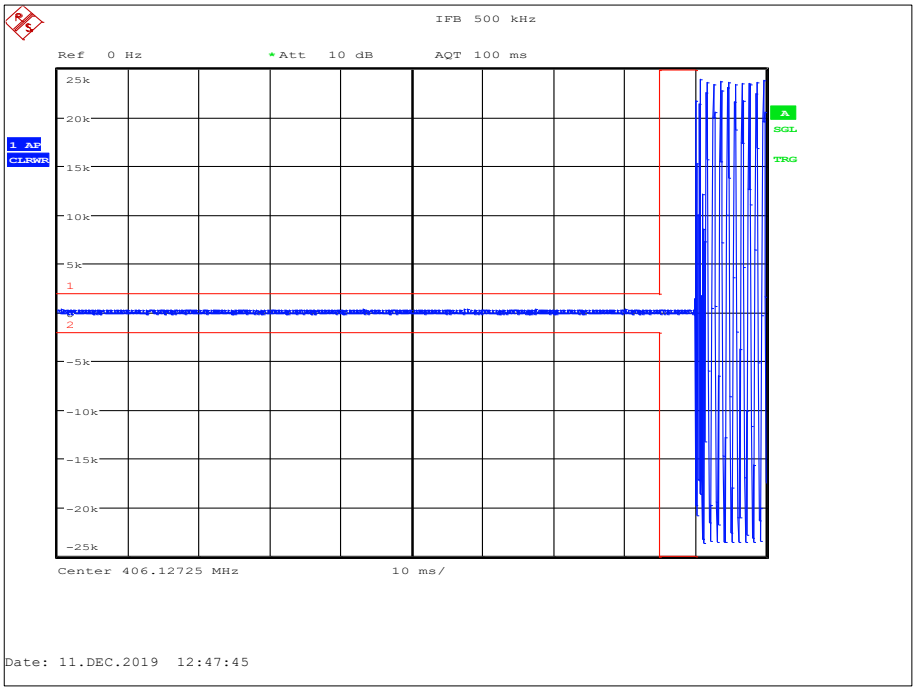

Figure 50- 406.125 MHz, Switch Off Transients

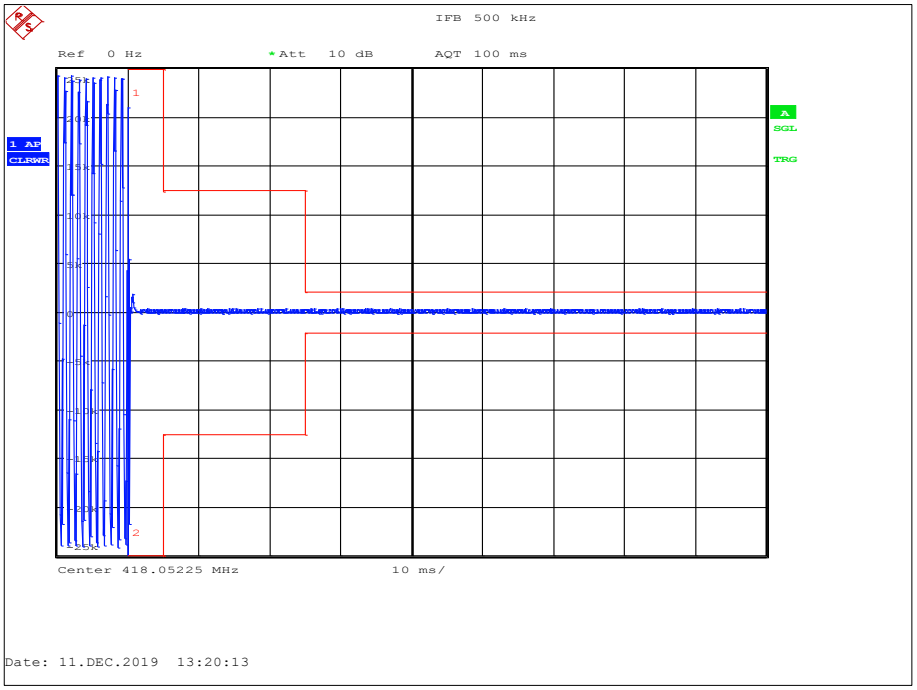

Figure 51 - 418.050 MHz, Switch On Transients

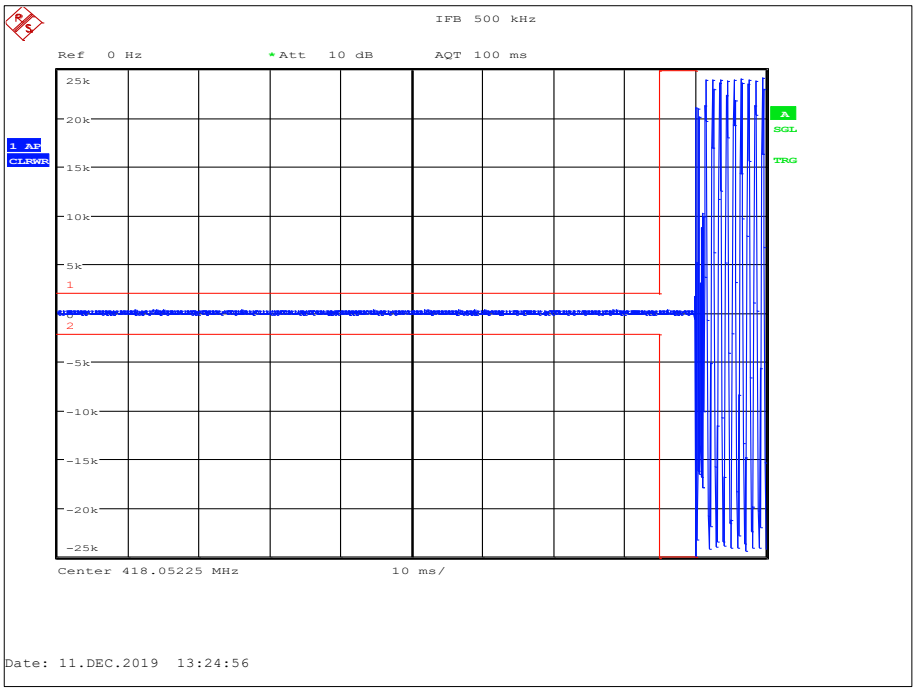

Figure 52- 418.050 MHz, Switch Off Transients

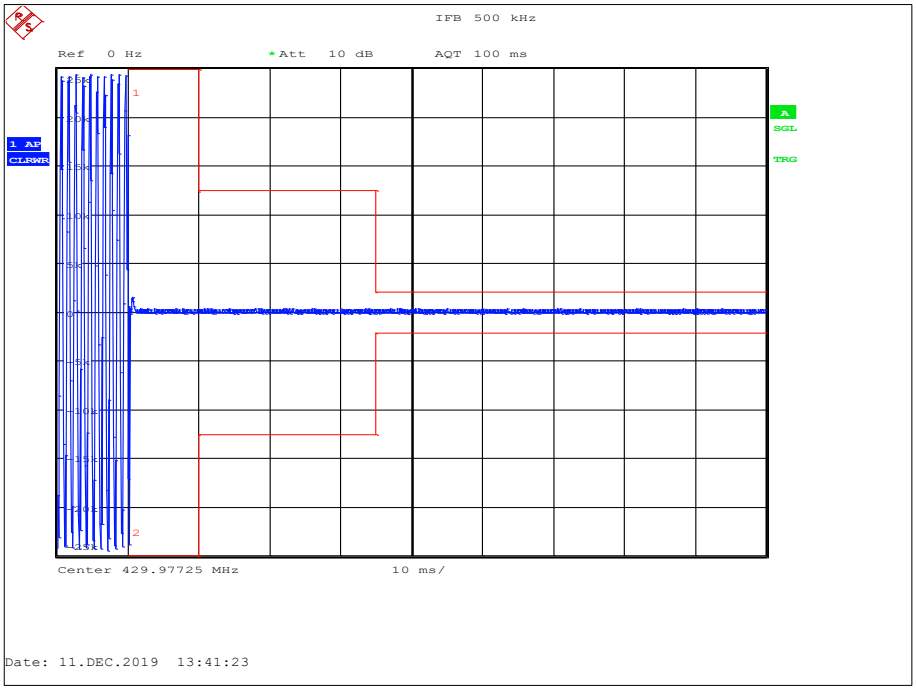

Figure 53 - 429.975 MHz, Switch On Transients

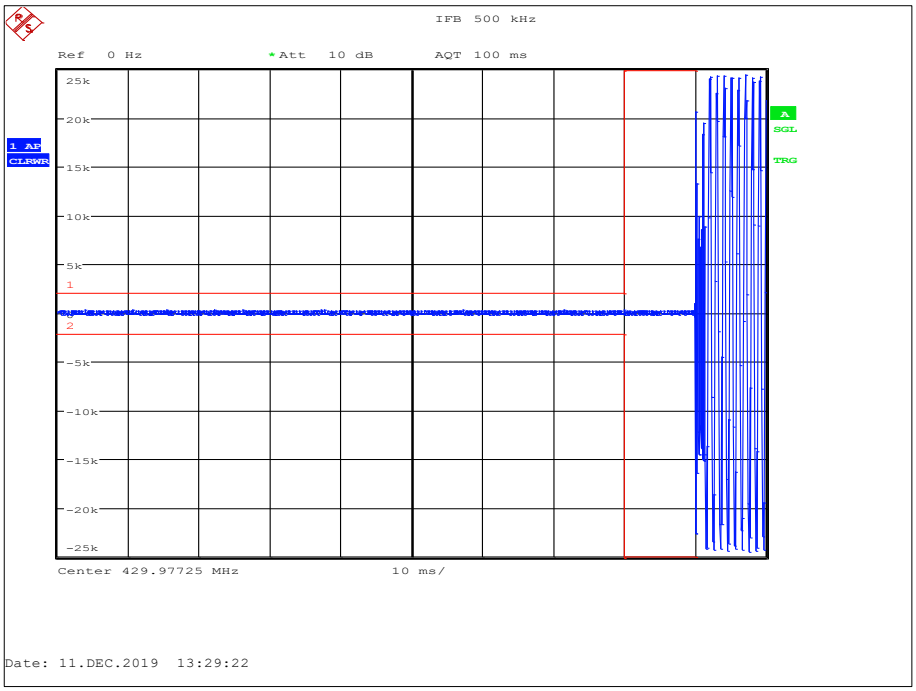

Figure 54- 429.975 MHz, Switch Off Transients

FCC 47 CFR Part 90, Limit Clause 90.214

Time Interval	Maximum Frequency Difference	150 to 174 MHz	421 to 512 MHz
Transient Frequency Behaviour for Equipment Designed to Operate on 25 kHz Channels			
T_1	± 25.0 kHz	5.0 ms	10.0 ms
T_2	± 12.5 kHz	20.0 ms	25.0 ms
T_3	± 25.0 kHz	5.0 ms	10.0 ms
Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz Channels			
T_1	± 12.5 kHz	5.0 ms	10.0 ms
T_2	± 6.25 kHz	20.0 ms	25.0 ms
T_3	± 12.5 kHz	5.0 ms	10.0 ms
Transient Frequency Behaviour for Equipment Designed to Operate on 6.25 kHz Channels			
T_1	± 6.25 kHz	5.0 ms	10.0 ms
T_2	± 3.125 kHz	20.0 ms	25.0 ms
T_3	± 6.25 kHz	5.0 ms	10.0 ms

Table 19 - FCC Limits for Transient Frequency Behaviour

Industry Canada RSS-119, Limit Clause 5.9

Channel Bandwidth (kHz)	Time Intervals	Maximum Frequency Difference (kHz)	Transient Duration Limit (ms)	
			138 to 174 MHz	406.1 to 512 MHz
25	t_1	±25	5	10
	t_2	±12.5	20	25
	t_3	±25	5	10
12.5	t_1	±12.5	5	10
	t_2	±6.25	20	25
	t_3	±12.5	5	10
6.25	t_1	±6.25	5	10
	t_2	±3.125	20	25
	t_3	±6.25	5	10

Table 20 - Industry Canada Limits for Transient Frequency Behaviour

2.5.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Signal Generator	Rohde & Schwarz	SMX	115	12	15-Jul-2020
Multimeter	Fluke	75 Mk3	455	12	11-Oct-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Power Divider	Weinschel	1506A	3345	12	23-Apr-2020
Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	18-Mar-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre K-Type Cable	Florida Labs	KMS-180SP-39.4-KMS	4520	12	12-Nov-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020
Cable (40 GHz)	Rosenberger	LU1-001-2000	5020	-	O/P Mon
Cable (40 GHz)	Rosenberger	LU1-001-2000	5024	-	O/P Mon

Table 21

O/P Mon – Output Monitored using calibrated equipment

2.6 Adjacent Channel Power

2.6.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.221
Industry Canada RSS-119, Clause 5.8.9.1

2.6.2 Equipment Under Test and Modification State

SC2124, S/N: 1PR001909GM18R7 - Modification State 0

2.6.3 Date of Test

16-December-2019

2.6.4 Test Method

The Adjacent Channel Power test was performed conducted on the modulated carrier output from the EUT, measured using a spectrum analyser. The spectrum analyser was set to the transmit frequency, span to 0.2 MHz to measure the 3 x 25kHz adjacent channels below and above the carrier.

The signal was averaged over 200 sweeps, a measurement integration bandwidth of 18 kHz was set and the measurement used the Adjacent Channel Power function of the spectrum analyser.

The traces were recorded.

2.6.5 Environmental Conditions

Ambient Temperature	22.2 - 22.7 °C
Relative Humidity	35.6 - 41.4 %

2.6.6 Test Results

TETRA 450 MHz to 470 MHz - Transmit

Offset (kHz)	Adjacent Channel Power (dBc)		
	450.025 MHz	460.025 MHz	469.975 MHz
-25	-63.4	-63.4	-63.0
+25	-63.5	-63.3	-62.5
-50	-71.7	-72.0	-71.7
+50	-71.8	-72.0	-71.7
-75	-76.3	-77.3	-76.9
+75	-76.3	-77.2	-77.1

Table 22 - Adjacent Channel Power

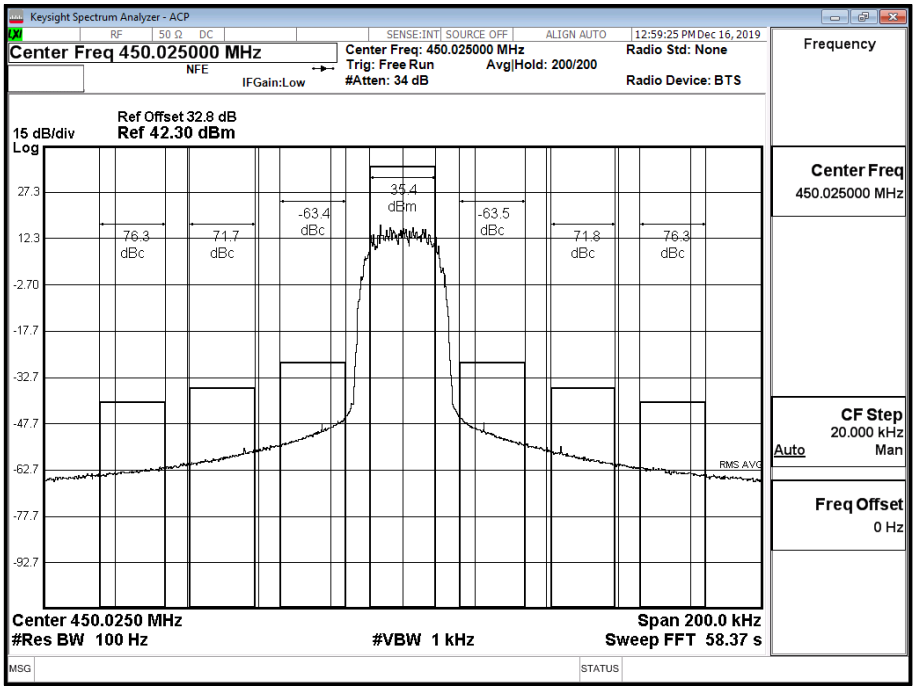

Figure 55 - Adjacent Channel Power - 450.025 MHz

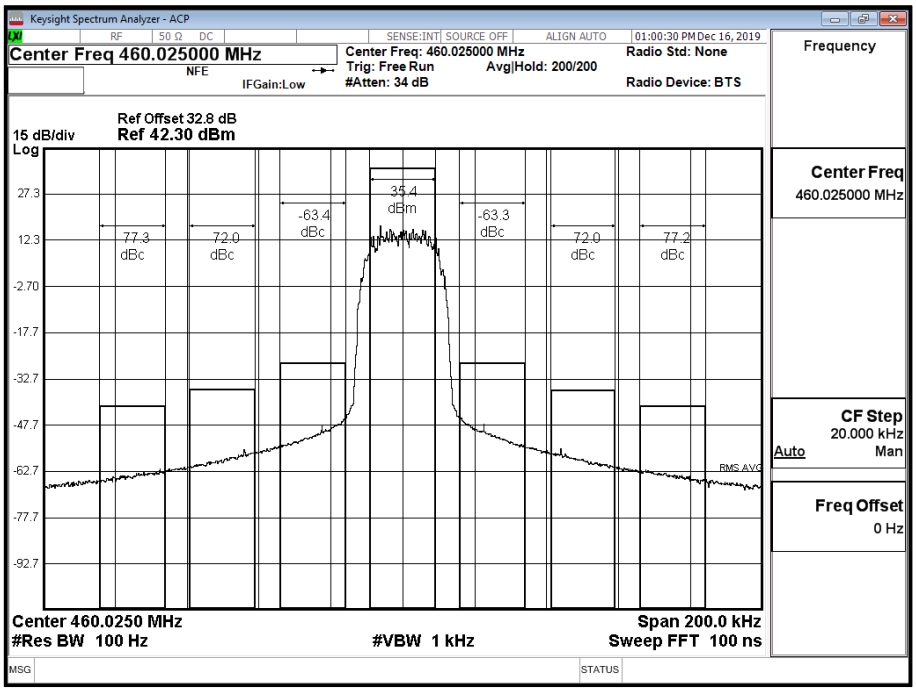

Figure 56 - Adjacent Channel Power - 460.025 MHz

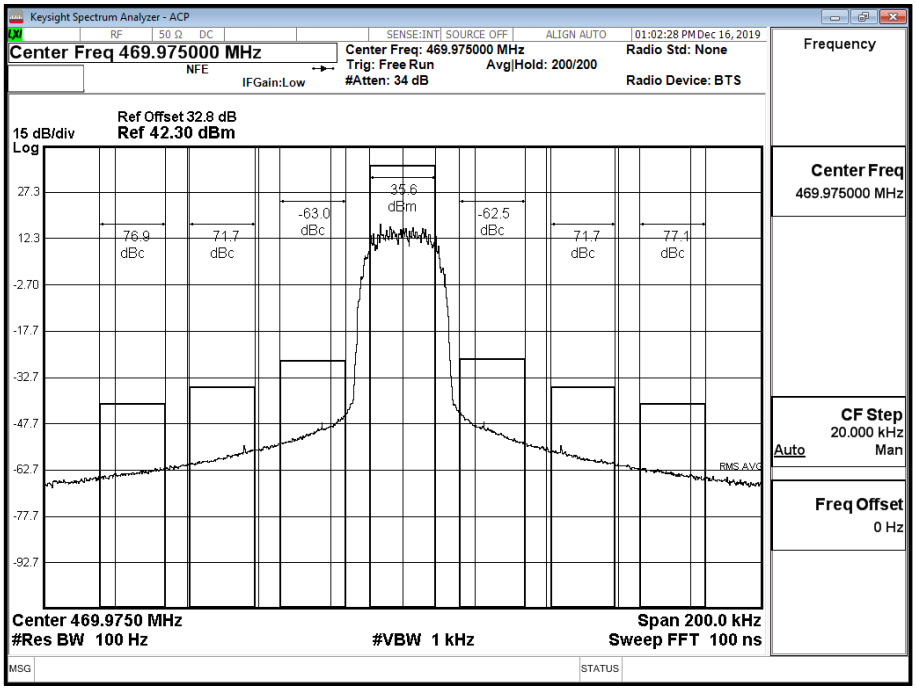

Figure 57 - Adjacent Channel Power - 469.975 MHz

TETRA 403 MHz to 430 MHz -Transmit

Offset (kHz)	Adjacent Channel Power (dBc)		
	406.125 MHz	418.050 MHz	429.975 MHz
-25	-63.4	-64.1	-63.7
+25	-63.5	-64.3	-63.9
-50	-72.0	-72.0	-71.9
+50	-72.0	-72.1	-71.9
-75	-77.2	-77.3	-77.3
+75	-77.2	-77.3	-77.3

Table 23 - Adjacent Channel Power

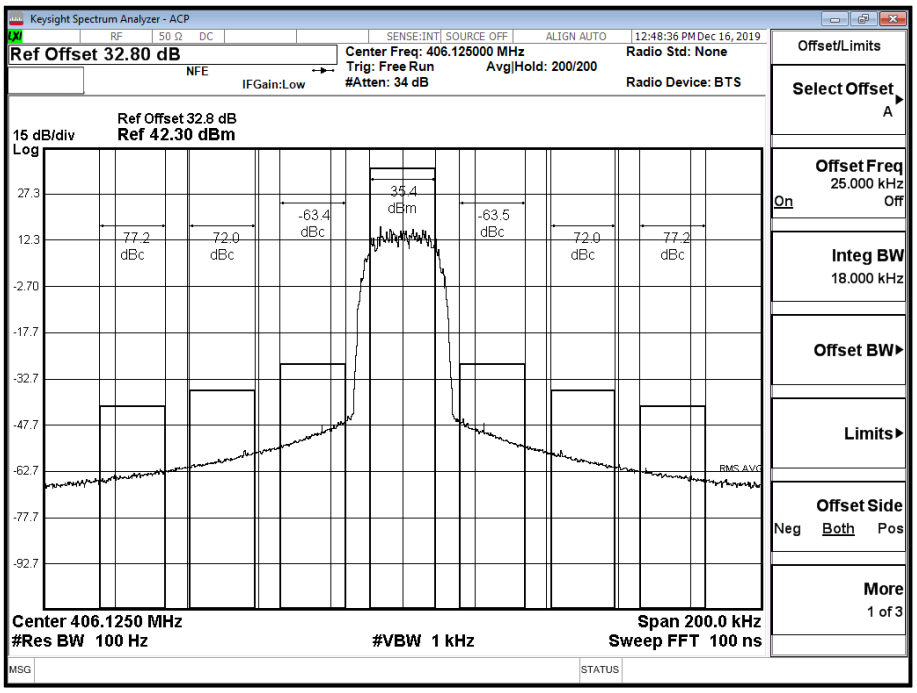

Figure 58 - Adjacent Channel Power - 406.125 MHz

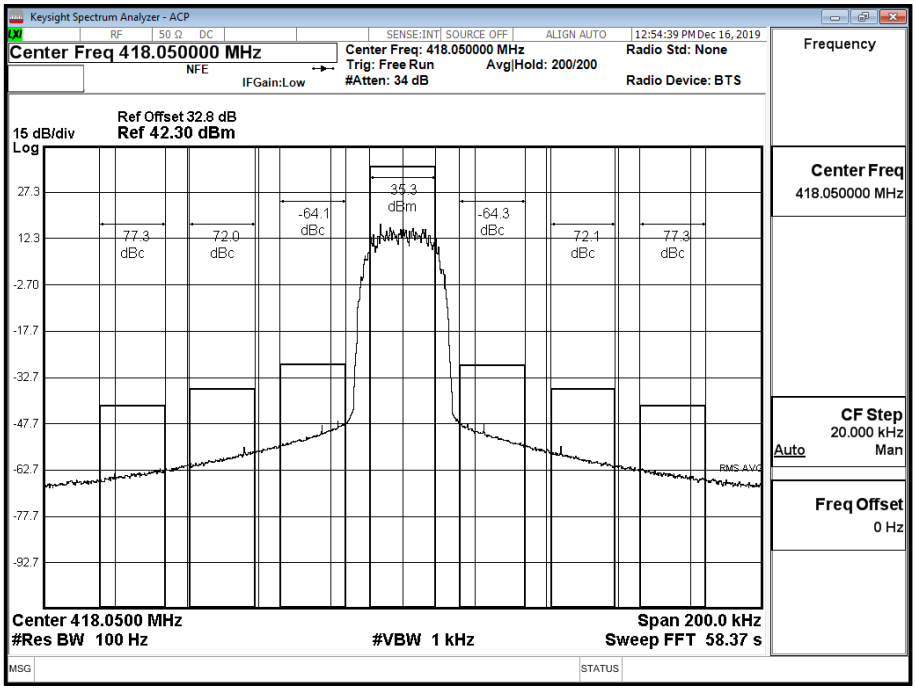

Figure 59 - Adjacent Channel Power - 418.050 MHz

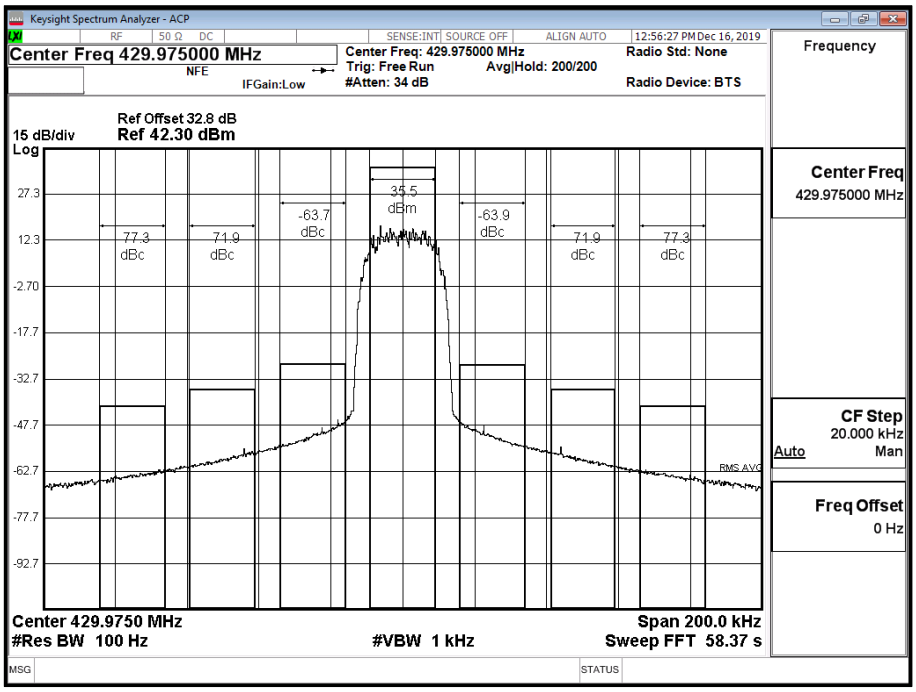

Figure 60 - Adjacent Channel Power - 429.975 MHz

FCC Part 90, Limit Clause 90.221(b)

Frequency Offset	Maximum ACP (dBc) for devices ≤ 1W	Maximum ACP (dBc) for devices > 1W
25 kHz	-55	-60
50 kHz	-70	-70
75 kHz	-70	-70

Table 24 - Adjacent Channel Power Limits

NOTE: In any case, no requirement in excess of -36 dBm shall apply.

Industry Canada RSS-119. Limit Clause 5.8.9.1

The ACP of transmitters operating in the bands 768-776 MHz and 798-806 MHz shall comply with the requirements for various transmitter channel sizes provided in tables 13 to 16 of the specification.

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Multimeter	Fluke	75 Mk3	455	12	11-Oct-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre K-Type Cable	Florida Labs	KMS-180SP-39.4-KMS	4520	12	12-Nov-2020
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	21-Oct-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020

Table 25

O/P Mon – Output Monitored using calibrated equipment

2.7 Types of Emissions

2.7.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.207
FCC 47 CFR Part 2, Clause 2.1047
Industry Canada RSS-119, Clause 5.2

2.7.2 Equipment Under Test and Modification State

SC2124, S/N: 1PR001909GM18R7 - Modification State 0

2.7.3 Date of Test

18-December-2019

2.7.4 Test Method

This test was performed on middle frequency using a modulated carrier output from the EUT and measured on a spectrum analyser. The signal level was referenced to the power test measured in the anechoic chamber and offset in the spectrum analyser. The spectrum analyser was set to the transmit frequency. The burst measurements were made in zero span mode and the frequency spectrum with a span sufficient to show the transmitters response. The signal was maximised and stabilised for >1minute and the marker function of the spectrum analyser was used. The trace plots were recorded.

2.7.5 Environmental Conditions

Ambient Temperature	22.6 - 22.7 °C
Relative Humidity	38.1 - 39.8 %

2.7.6 Test Results

TETRA 450 MHz to 470 MHz - Transmit

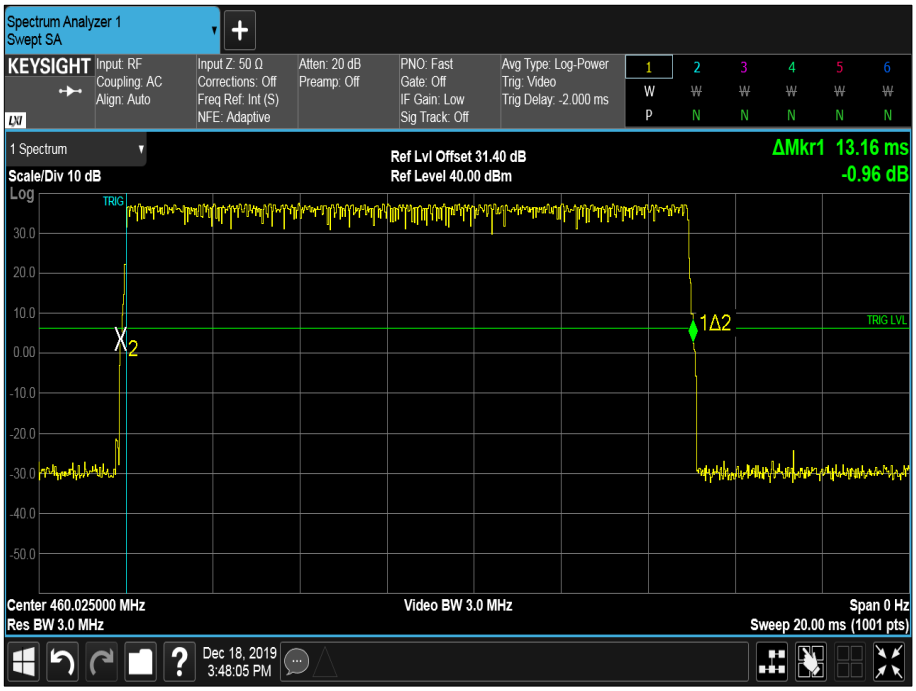

Figure 61 - Burst Length

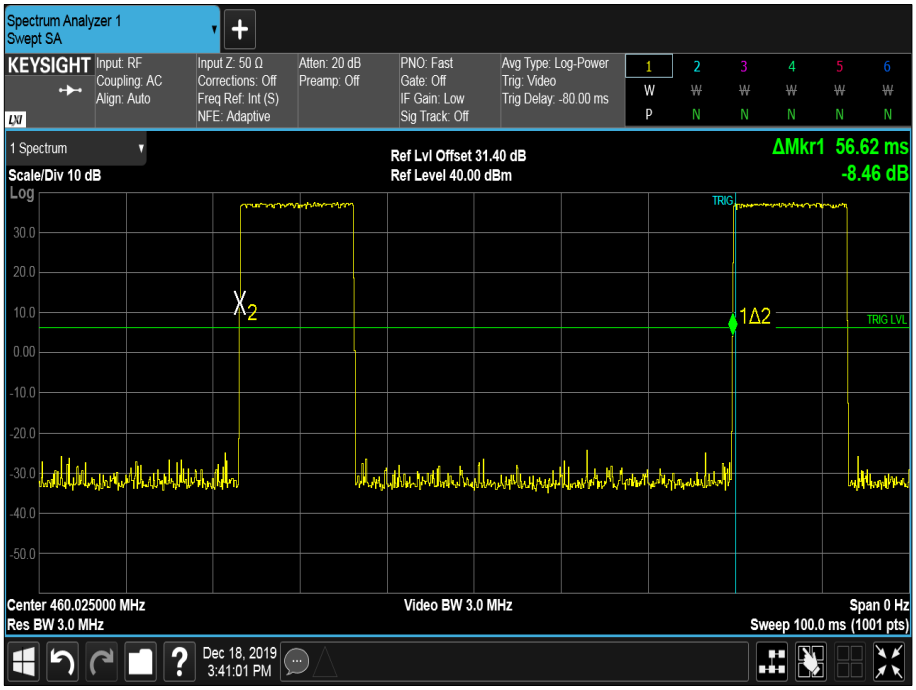

Figure 62 - Burst Period

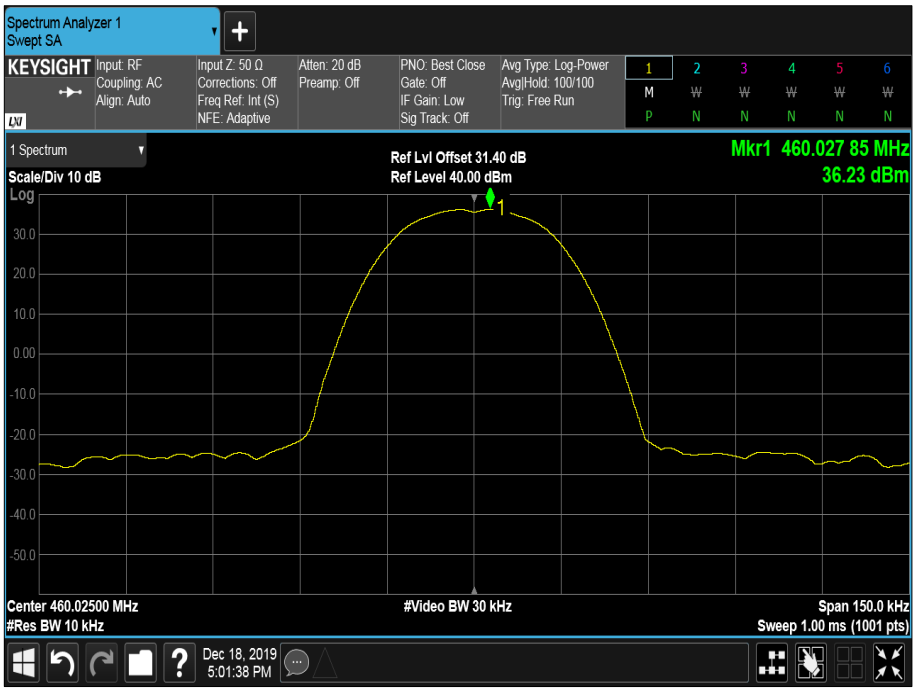

Figure 63 - Frequency Spectrum

TETRA 403 MHz to 430 MHz -Transmit

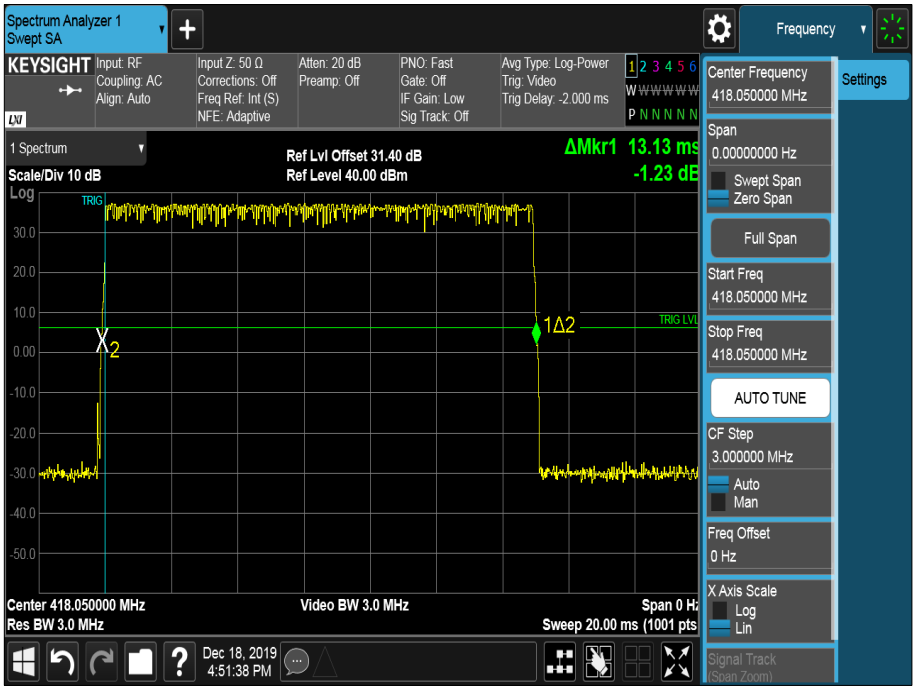

Figure 64 - Burst Length

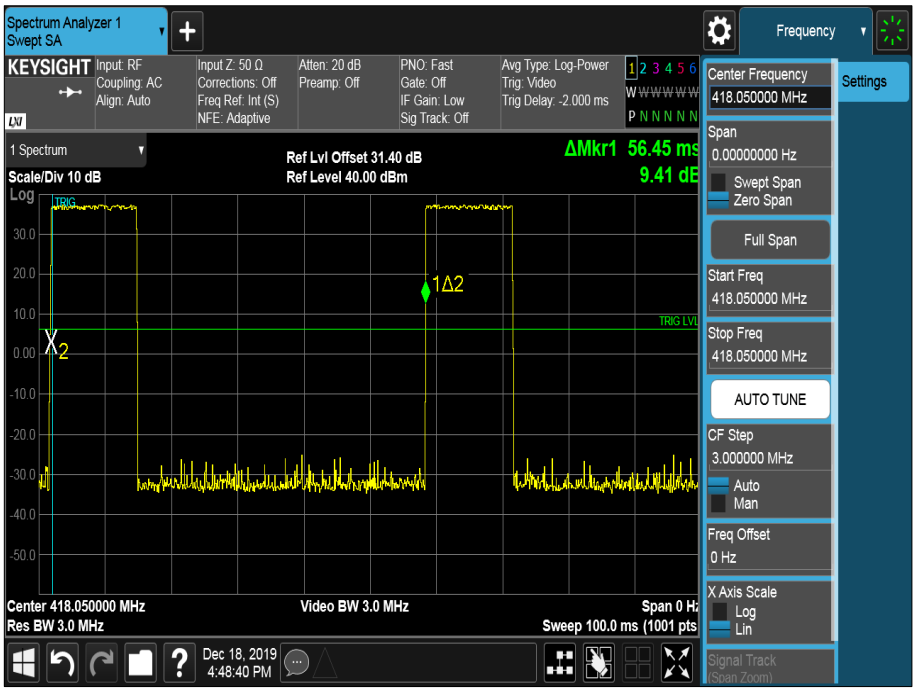

Figure 65 - Burst Period

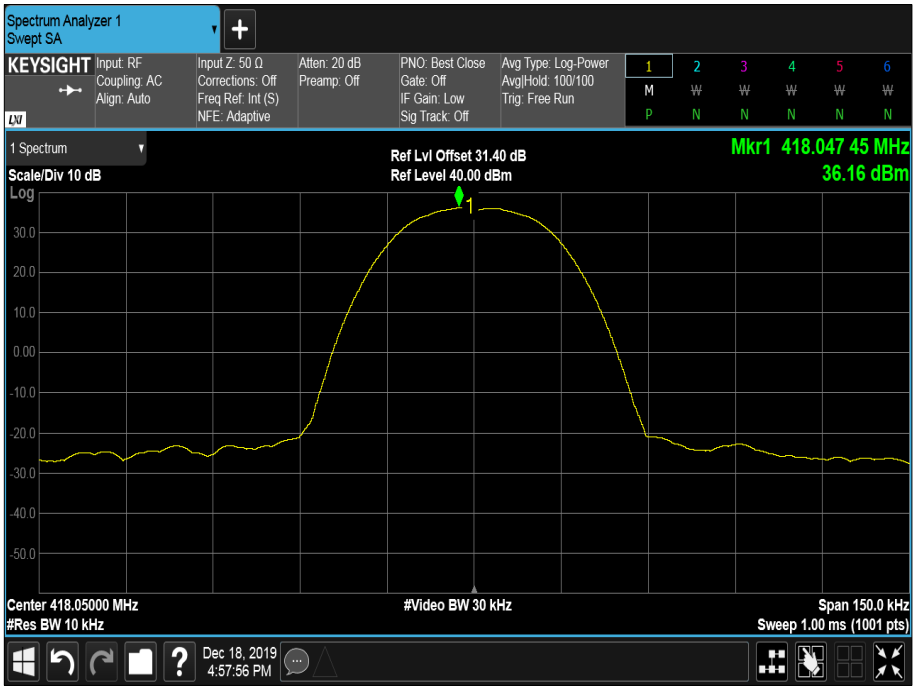

Figure 66 - Frequency Spectrum

FCC 47 CFR Part 90, Limit Clause 90.207

As per FCC Part 90.207 (b) through (n).

FCC 47 CFR Part 2, Limit Clause 2.1047

Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

Equipment which employs modulation limiting. A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

Industry Canada RSS-119, Limit Clause 5.3

Equipment that operates in the bands 768-776 MHz and 798-806 MHz shall use digital modulation. Mobile and portable transmitters that operate in these bands may have analogue modulation capability only as a secondary mode in addition to their primary digital mode. However, mobile and portable transmitters that operate only on the low-power channels as defined in SRSP-511 may employ any type of modulation.

2.7.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Multimeter	Fluke	75 Mk3	455	12	11-Oct-2020
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2020
Hygromer	Rotronic	A1	2138	12	05-Mar-2020
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2020
1 metre K-Type Cable	Florida Labs	KMS-180SP-39.4-KMS	4520	12	12-Nov-2020
Quad Power Supply	Rohde & Schwarz	HMP4040	4955	-	O/P Mon
EXA	Keysight Technologies	N9010B	4968	24	21-Dec-2019
Network Analyser	Keysight Technologies	E5063A	5018	12	20-May-2020

Table 26

O/P Mon – Output Monitored using calibrated equipment

2.8 Radiated Spurious Emissions

2.8.1 Specification Reference

FCC 47 CFR Part 90, Clause 90.210
FCC 47 CFR Part 2, Clause 2.1051
Industry Canada RSS-119, Clause 5.8
ISEDC RSS-GEN, Clause 6.13

2.8.2 Equipment Under Test and Modification State

SC2124, S/N: 2PS001845GM55WU - Modification State 0

2.8.3 Date of Test

26-February-2019 to 27-March-2019

2.8.4 Test Method

Testing was performed in accordance with ANSI C63.26, clause 5.5.

Prescans were performed using the direct field strength method. Any emissions found within 10dB of the specification limit were formally measured using the substitution method.
The limit line on the prescan plots was calculated from equation c) in clause 5.2.7

2.8.5 Environmental Conditions

Ambient Temperature	19.6 - 20.1 °C
Relative Humidity	32.0 - 36.7 %

2.8.6 Test Results

TETRA 450 MHz to 470 MHz - Transmit

Frequency (MHz)	Level (dBm)
*	

Table 27 - 450.025 MHz - Emissions Results

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

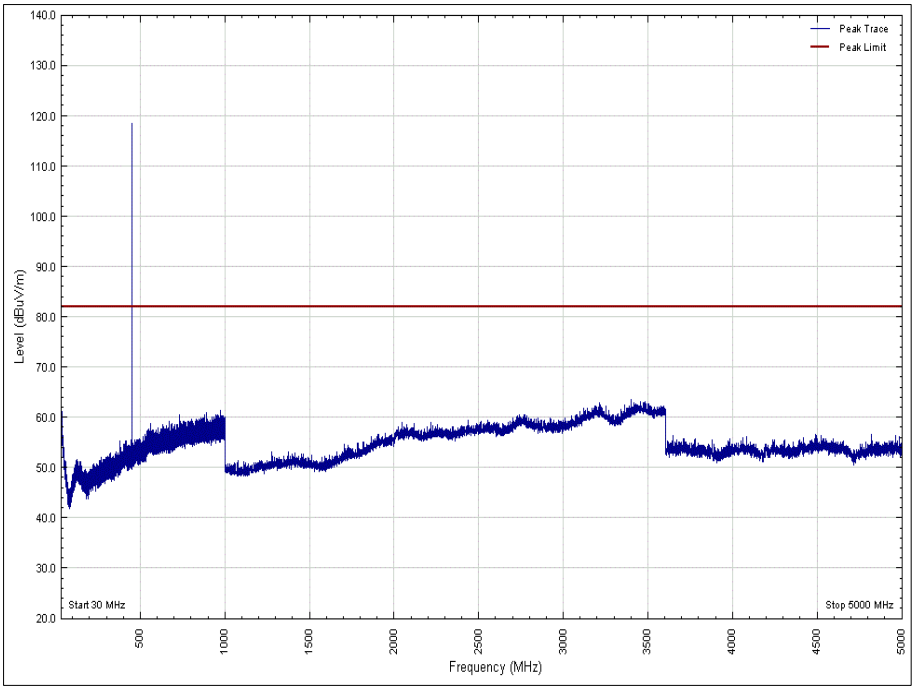

Figure 67 - 450.025 MHz - 30 MHz to 5 GHz - Orientation X – Vertical

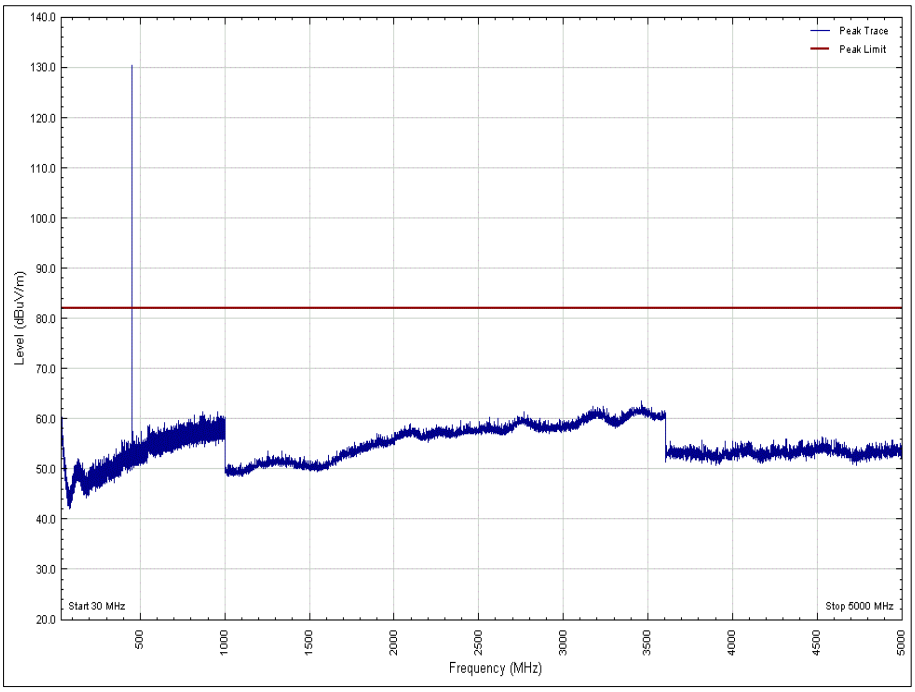

Figure 68 - 450.025 MHz - 30 MHz to 5 GHz - Orientation X - Horizontal

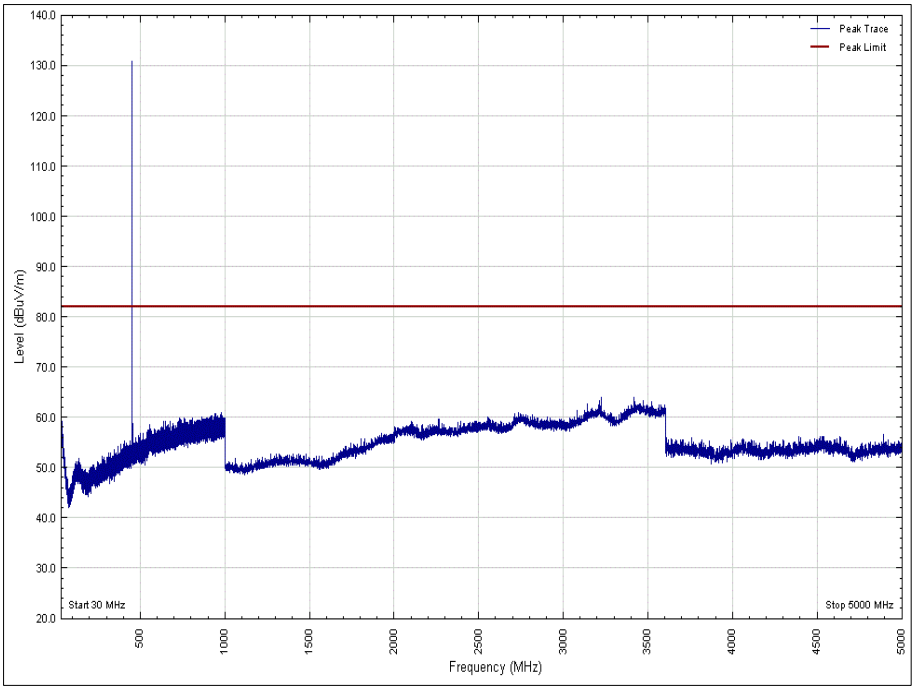

Figure 69 - 450.025 MHz - 30 MHz to 5 GHz - Orientation Y – Vertical

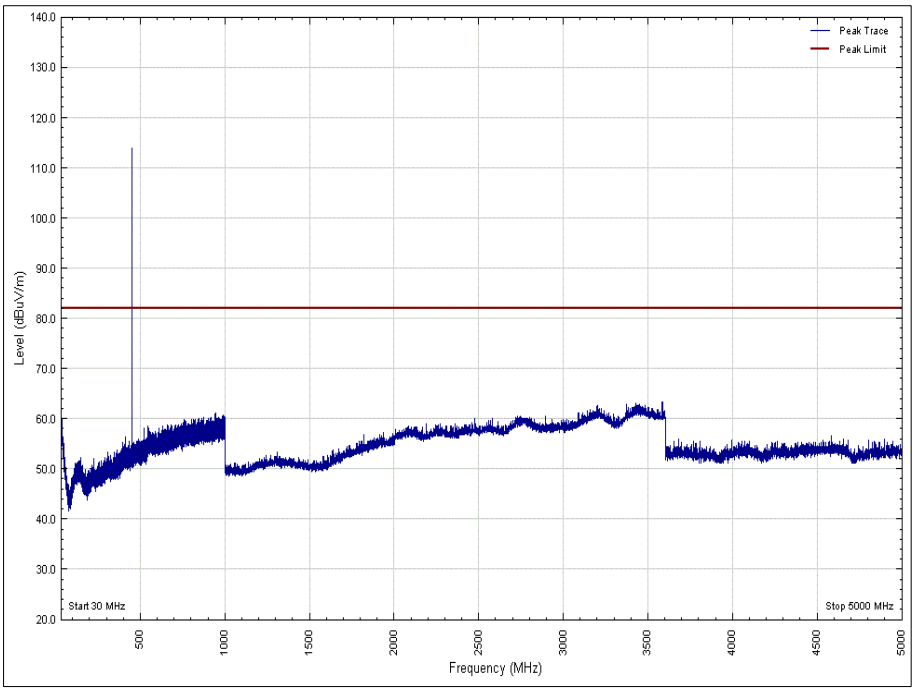

Figure 70 - 450.025 MHz - 30 MHz to 5 GHz - Orientation Y - Horizontal

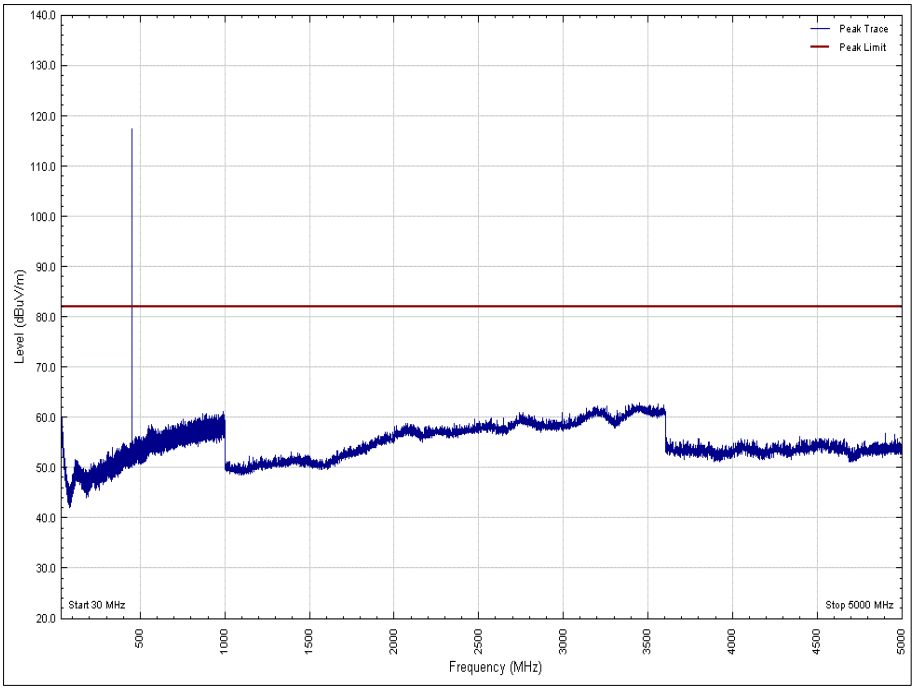

Figure 71 - 450.025 MHz - 30 MHz to 5 GHz - Orientation Z – Vertical

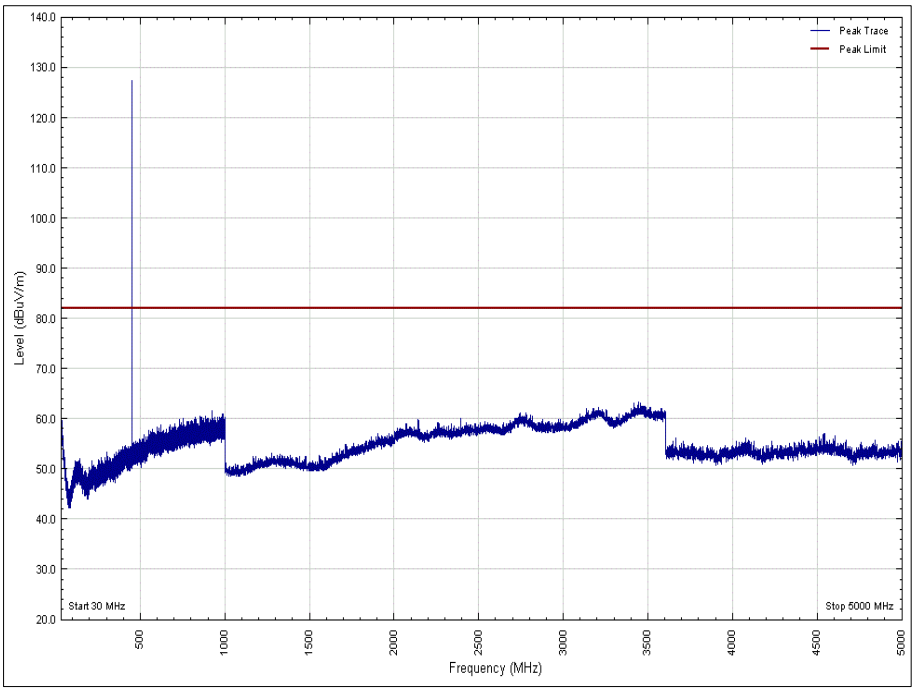

Figure 72 - 450.025 MHz - 30 MHz to 5 GHz - Orientation Z - Horizontal

Frequency (MHz)	Level (dBm)
*	

Table 28 - 460.025 MHz - Emissions Results

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

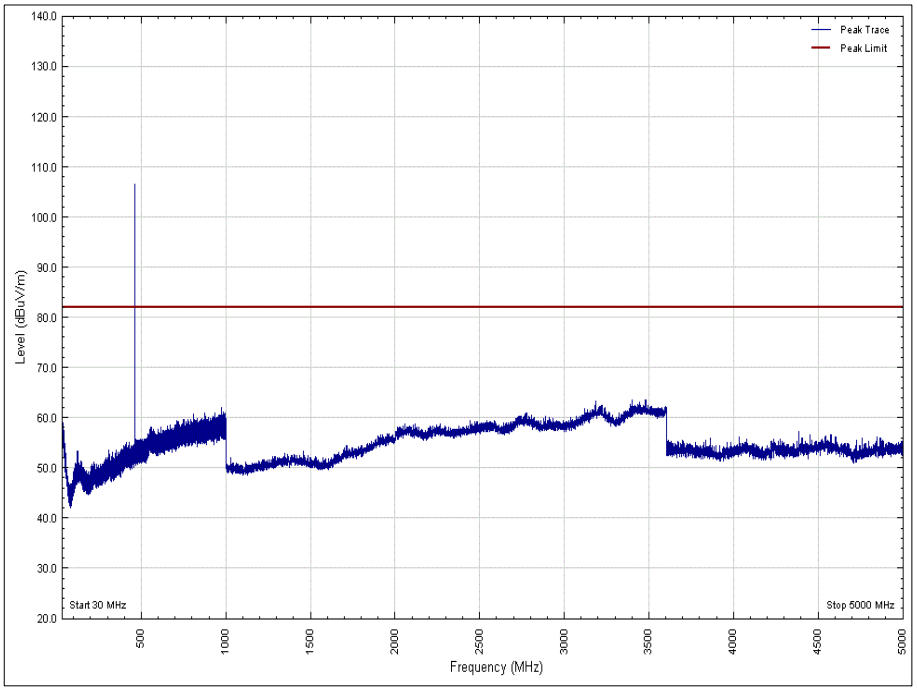

Figure 73 - 460.025 MHz - 30 MHz to 5 GHz - Orientation X - Vertical

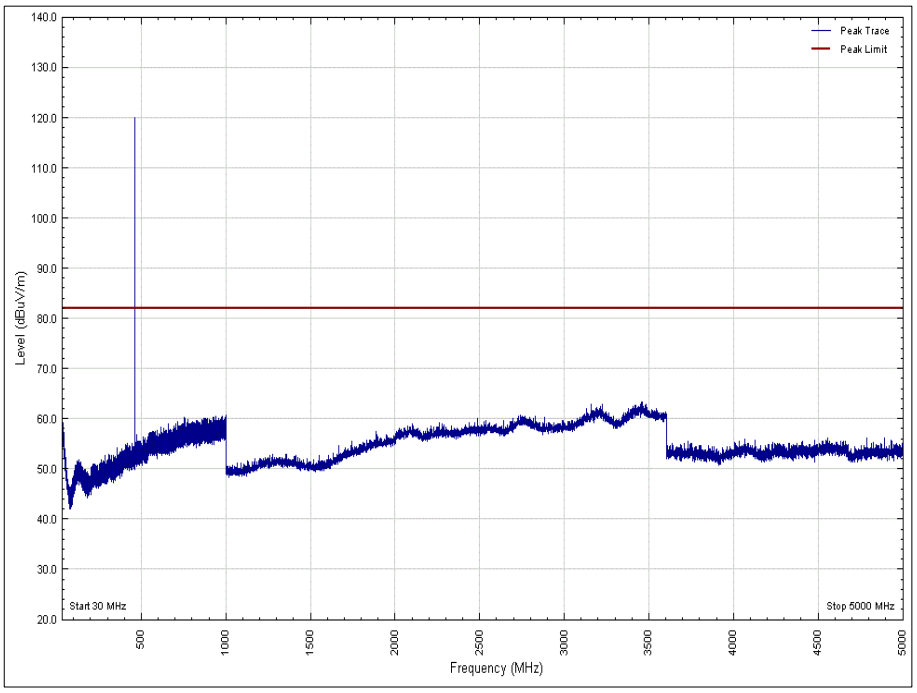

Figure 74 - 460.025 MHz - 30 MHz to 5 GHz - Orientation X - Horizontal

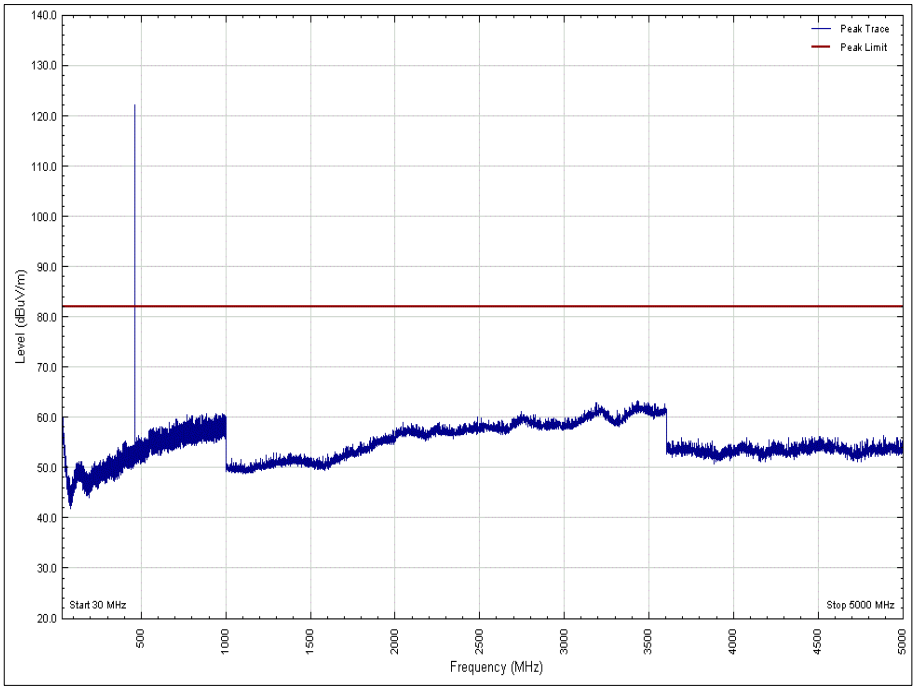

Figure 75 - 460.025 MHz - 30 MHz to 5 GHz - Orientation Y - Vertical

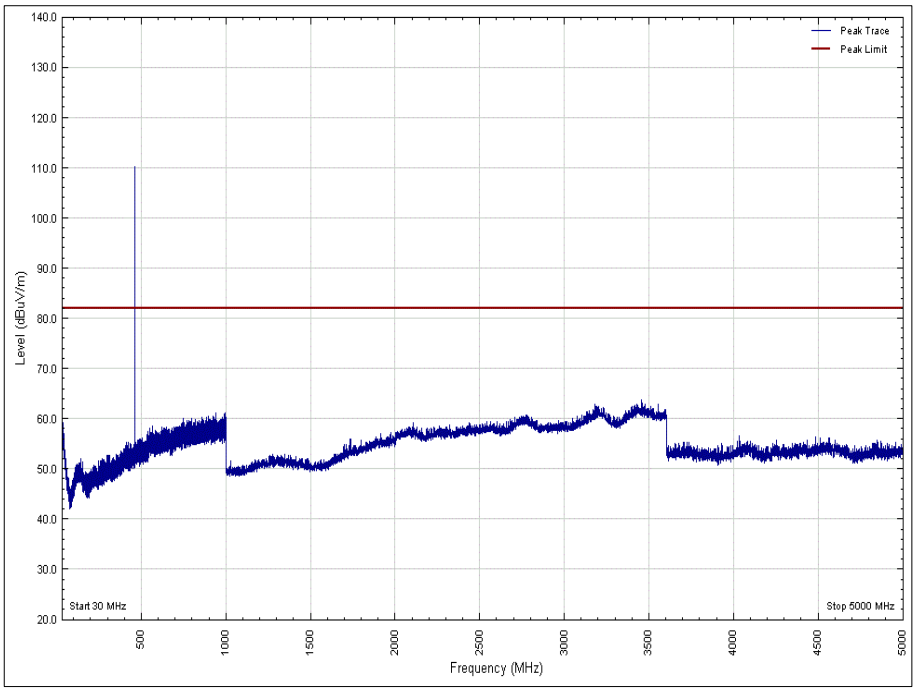

Figure 76 - 460.025 MHz - 30 MHz to 5 GHz - Orientation Y - Horizontal

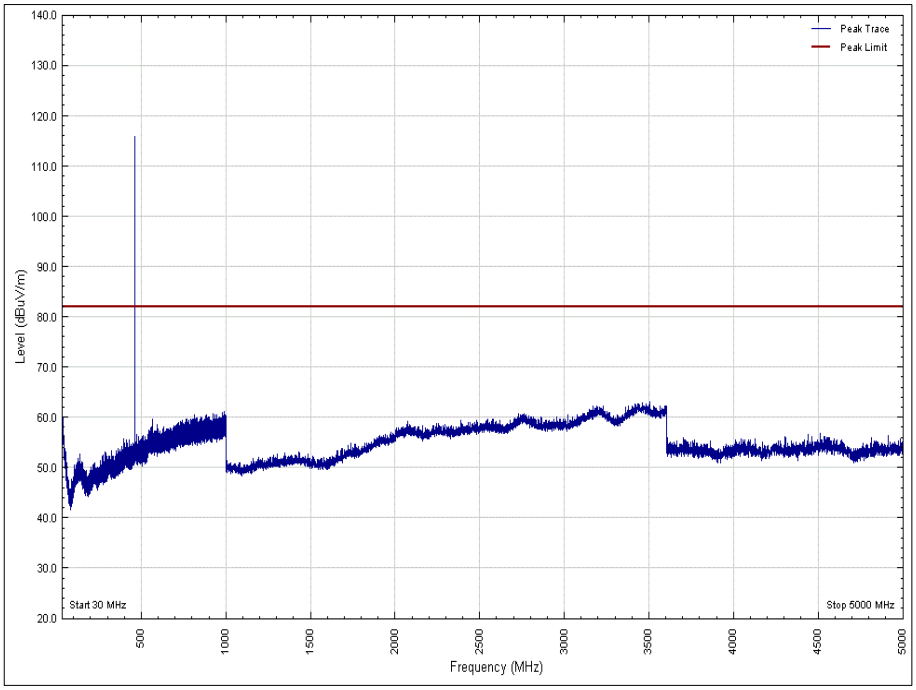

Figure 77 - 460.025 MHz - 30 MHz to 5 GHz - Orientation Z - Vertical

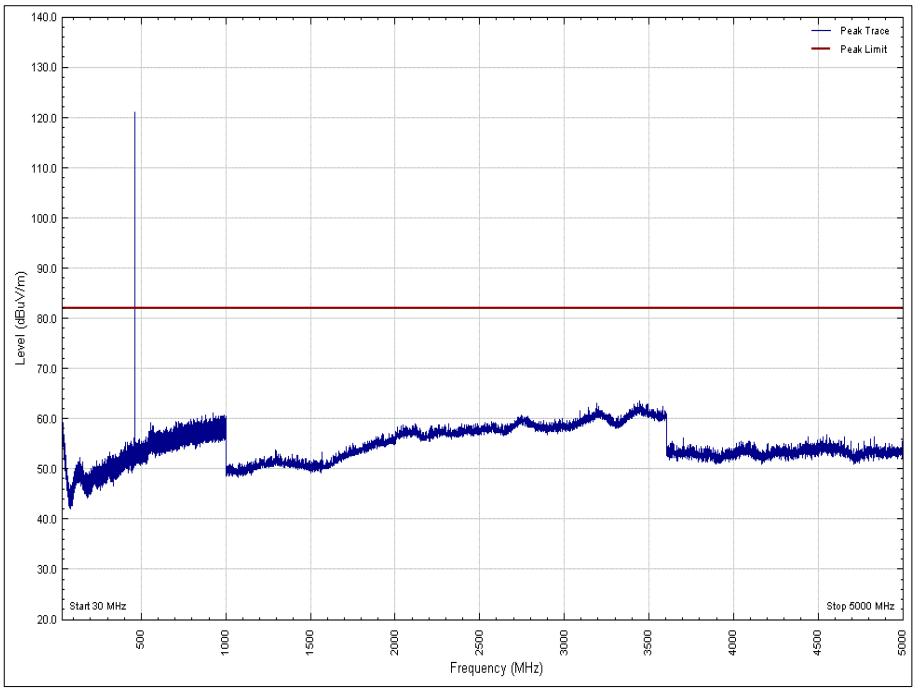

Figure 78 - 460.025 MHz - 30 MHz to 5 GHz - Orientation Z - Horizontal

Frequency (MHz)	Level (dBm)
*	

Table 29 - 460.025 MHz - Emissions Results

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

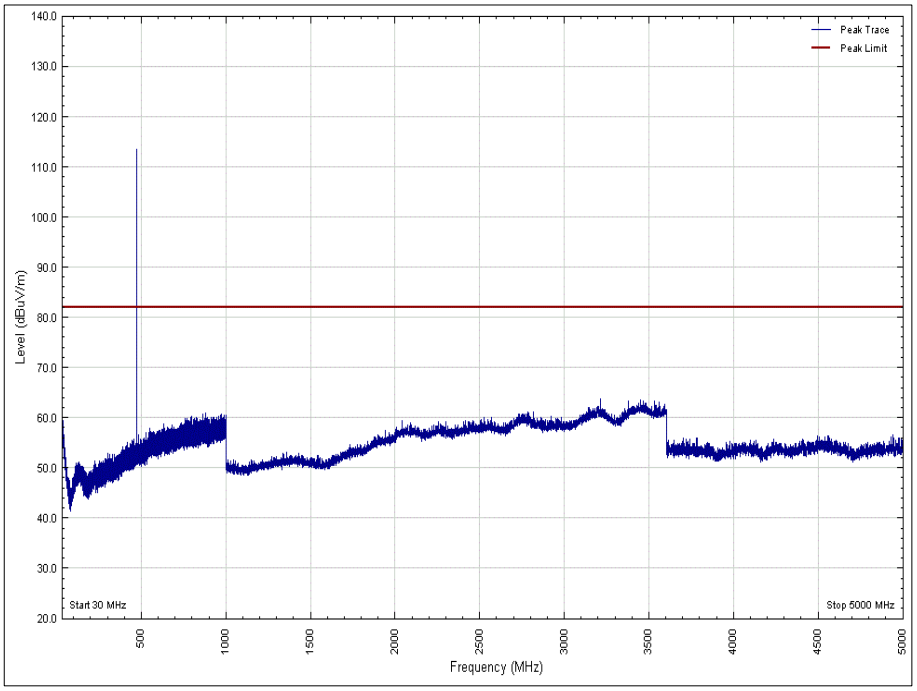

Figure 79 - 469.975 MHz - 30 MHz to 5 GHz - Orientation X - Vertical

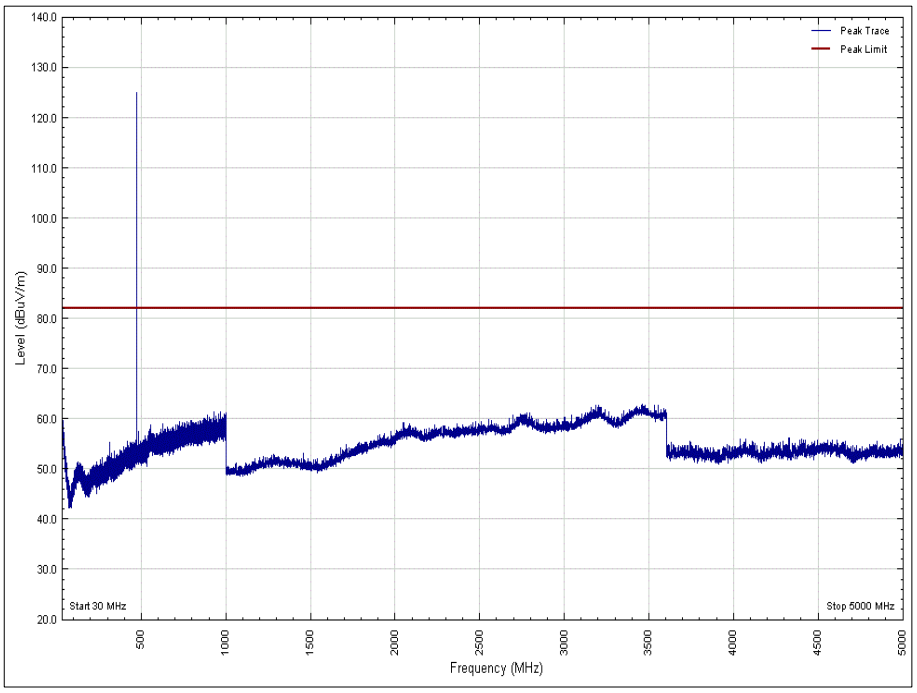

Figure 80 - 469.975 MHz - 30 MHz to 5 GHz - Orientation X - Horizontal

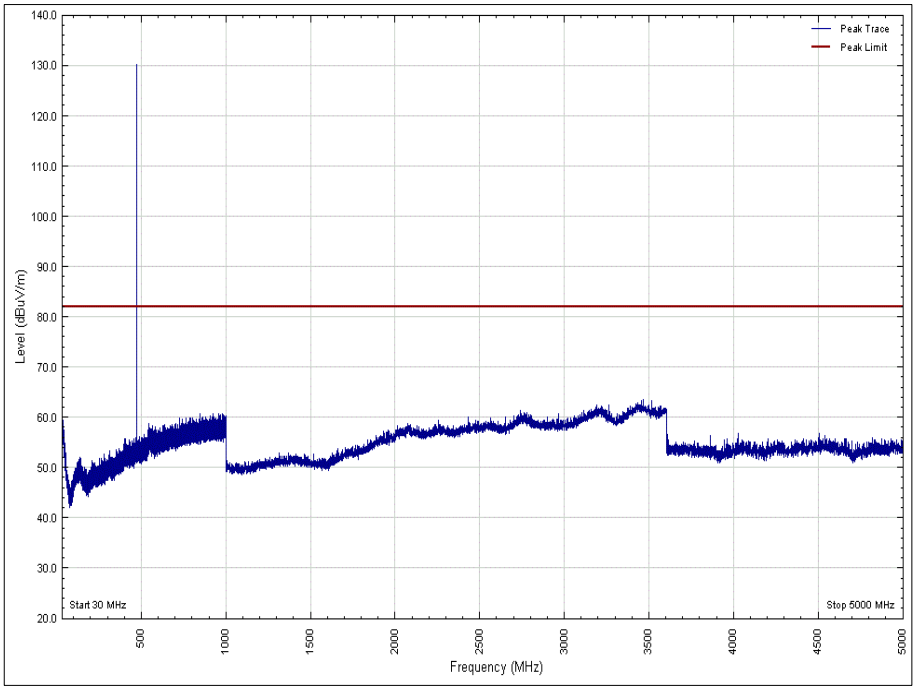

Figure 81 - 469.975 MHz - 30 MHz to 5 GHz - Orientation Y - Vertical

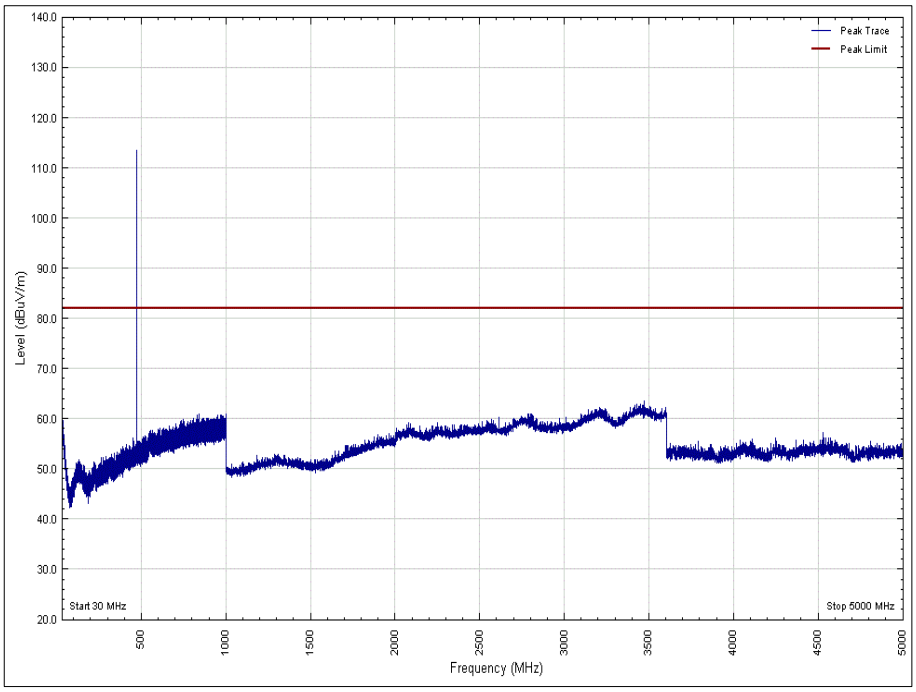

Figure 82 - 469.975 MHz - 30 MHz to 5 GHz - Orientation Y - Horizontal

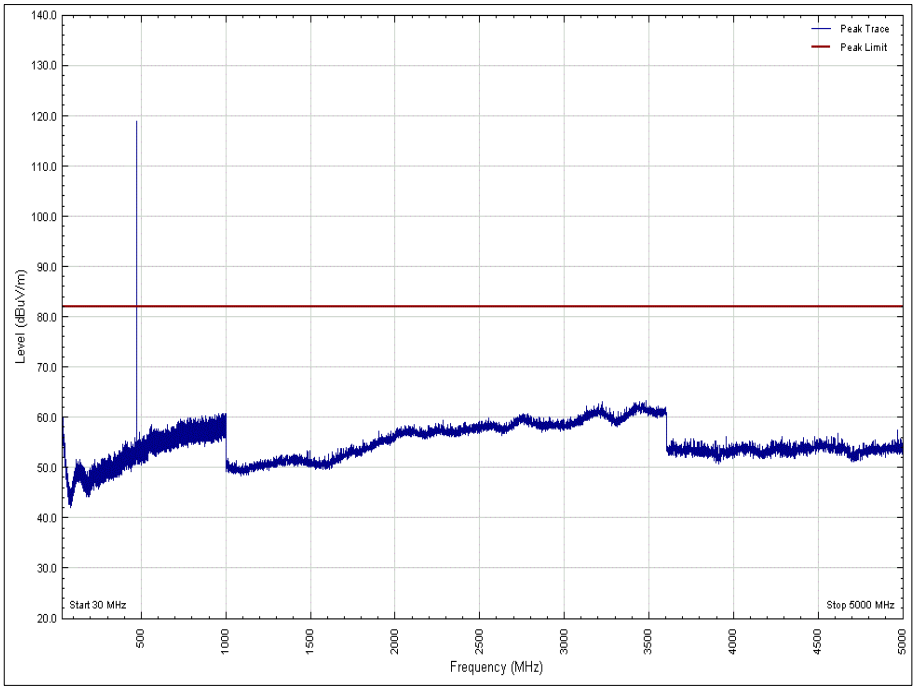

Figure 83 - 469.975 MHz - 30 MHz to 5 GHz - Orientation Z - Vertical

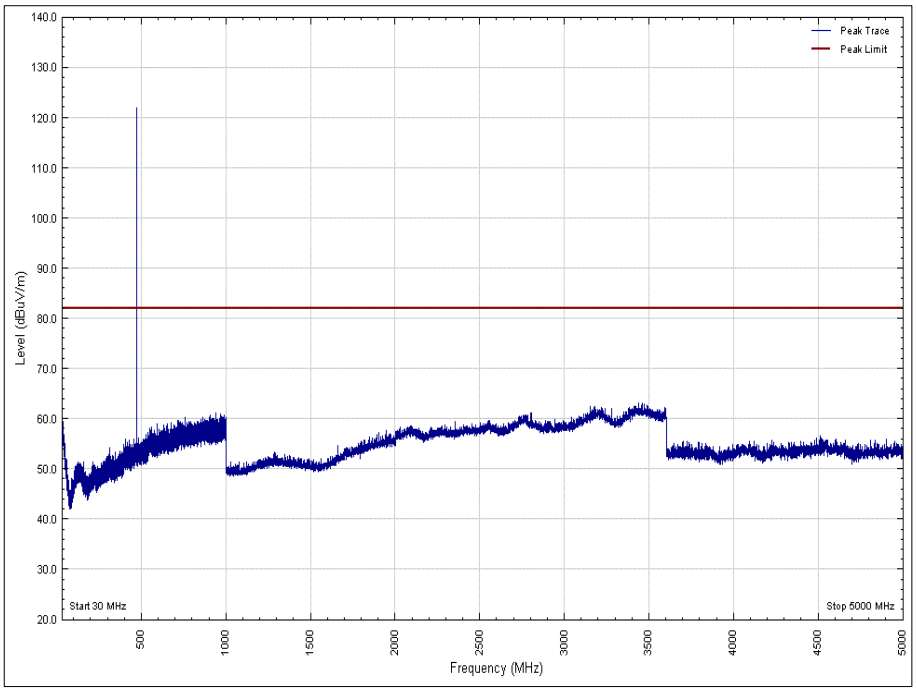

Figure 84 - 469.975 MHz - 30 MHz to 5 GHz - Orientation Z - Horizontal

TETRA 403 MHz to 430 MHz -Transmit

Frequency (MHz)	Level (dBm)
*	

Table 30 - 406.125 MHz - Emissions Results

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

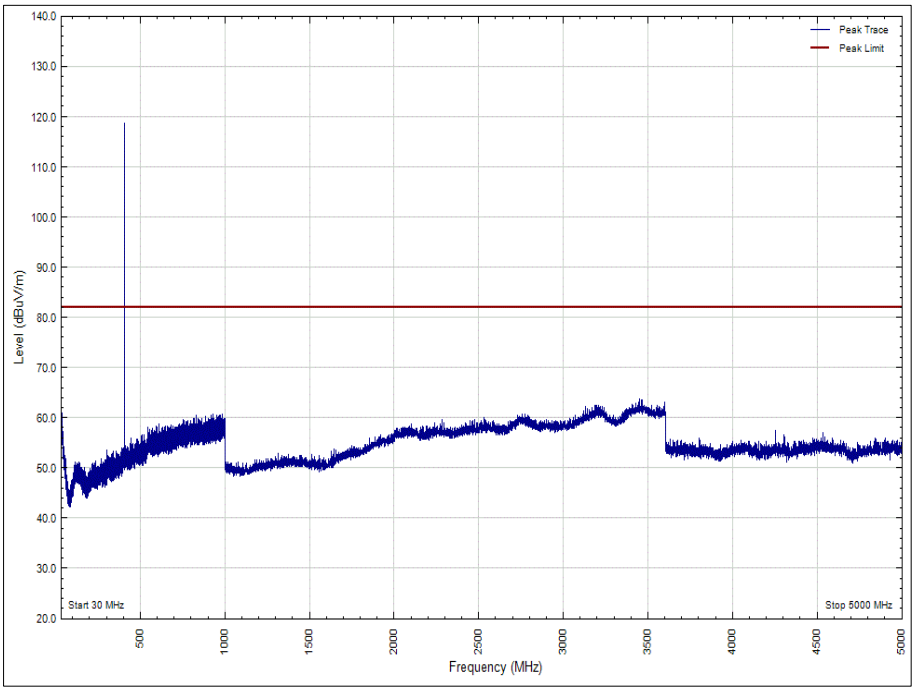

Figure 85 - 406.125 MHz - 30 MHz to 5 GHz - Orientation X – Vertical

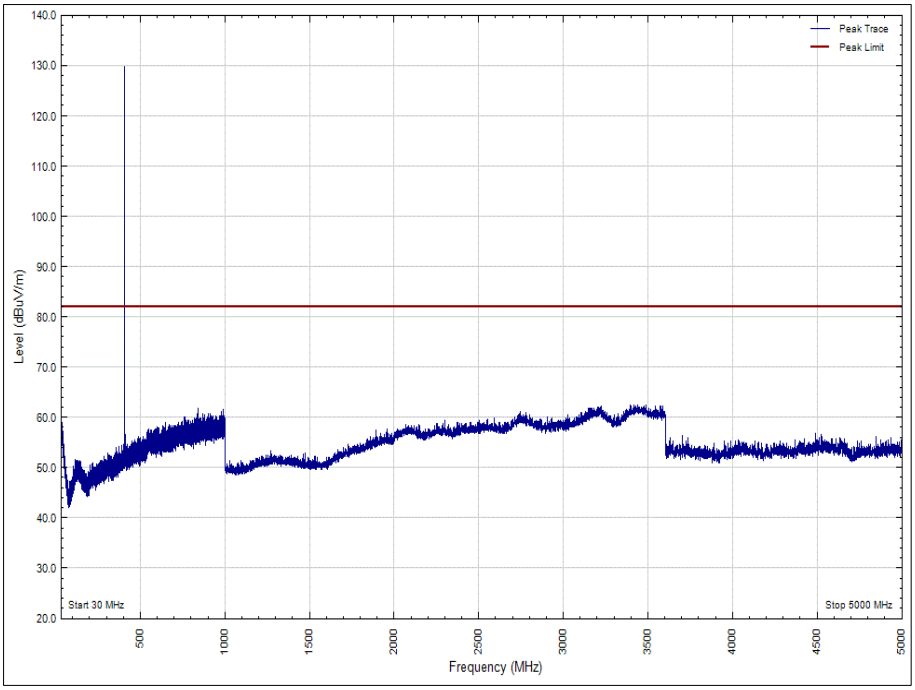

Figure 86 - 406.125 MHz - 30 MHz to 5 GHz - Orientation X – Horizontal

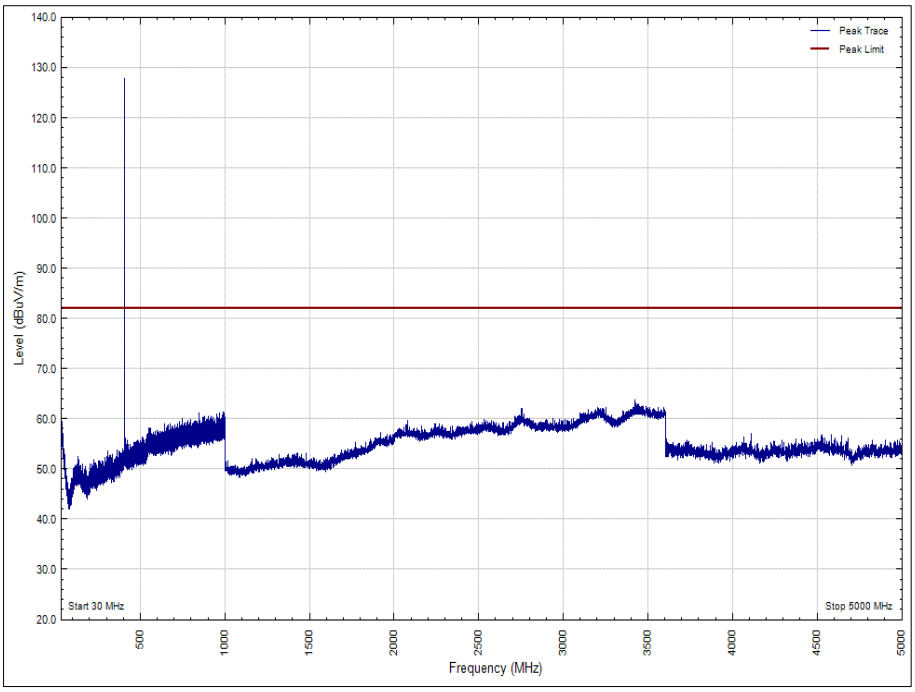

Figure 87 - 406.125 MHz - 30 MHz to 5 GHz - Orientation Y – Vertical

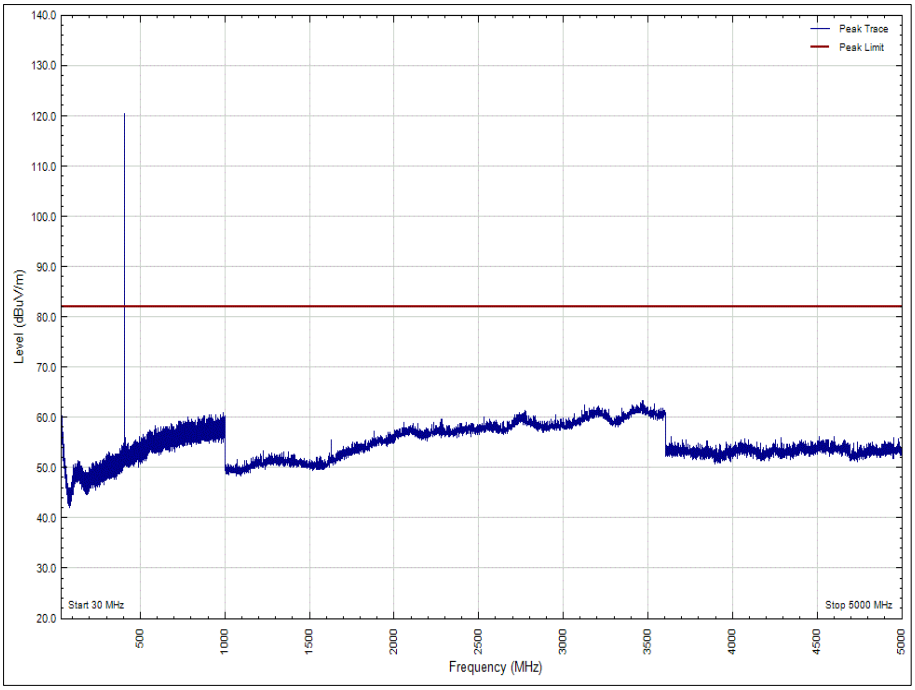

Figure 88 - 406.125 MHz - 30 MHz to 5 GHz - Orientation Y – Horizontal

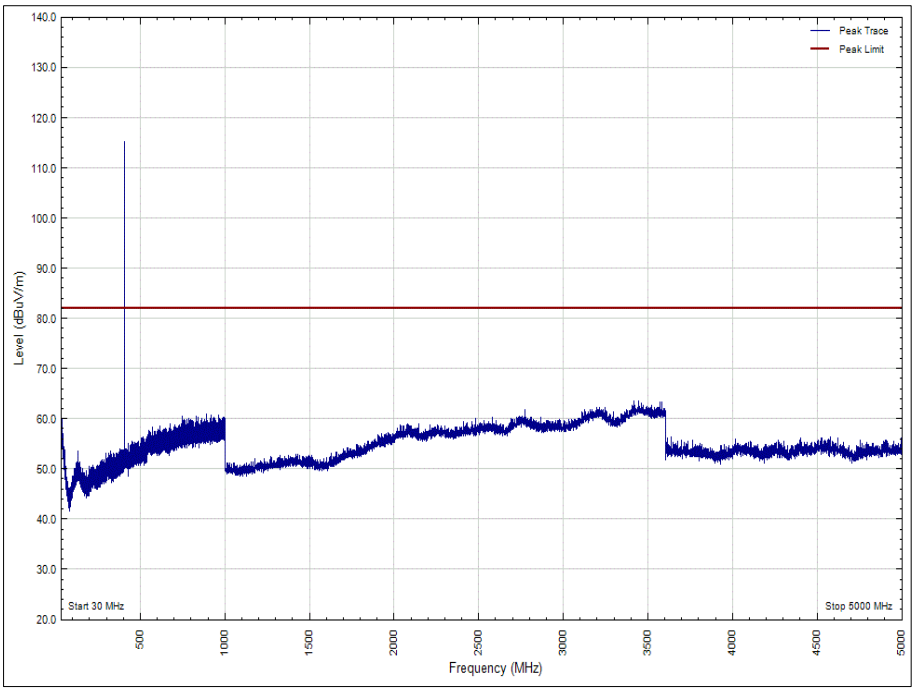

Figure 89 - 406.125 MHz - 30 MHz to 5 GHz - Orientation Z – Vertical

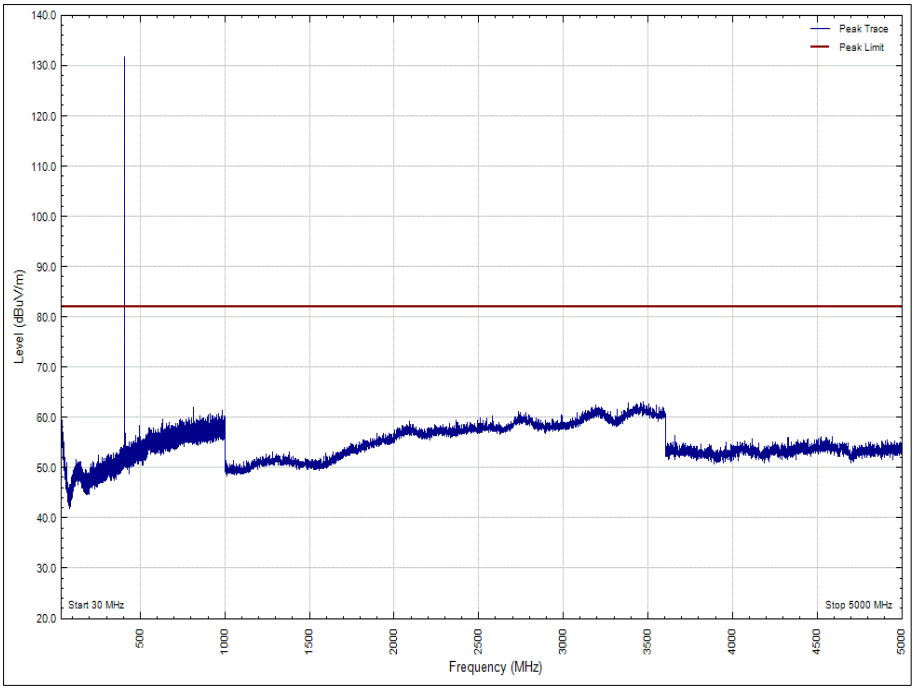

Figure 90 - 406.125 MHz - 30 MHz to 5 GHz - Orientation Z – Horizontal

Frequency (MHz)	Level (dBm)
*	

Table 31 - 418.050 MHz - Emissions Results

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

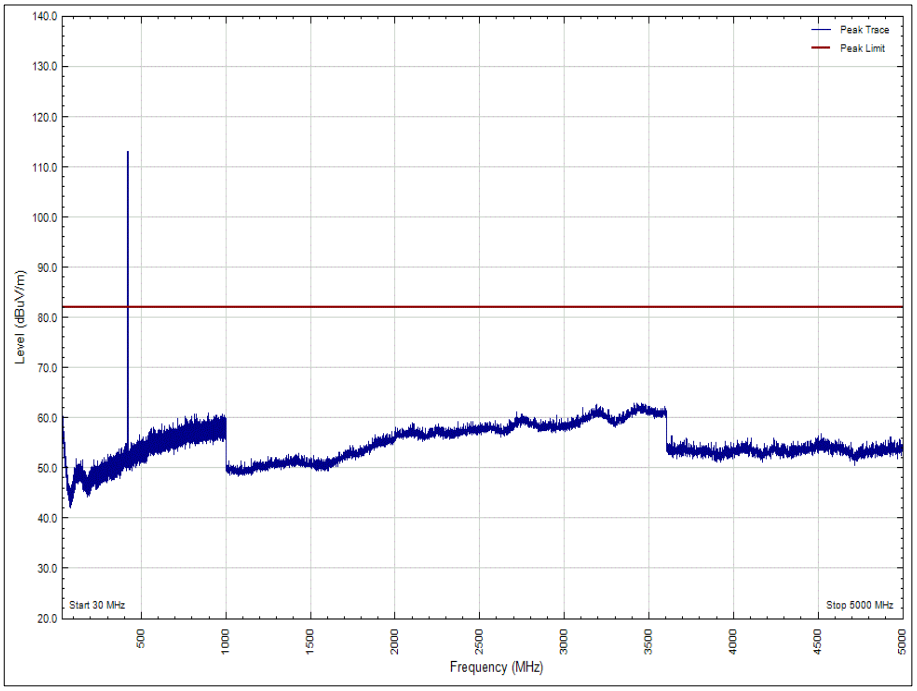

Figure 91 - 418.050 MHz - 30 MHz to 5 GHz - Orientation X - Vertical

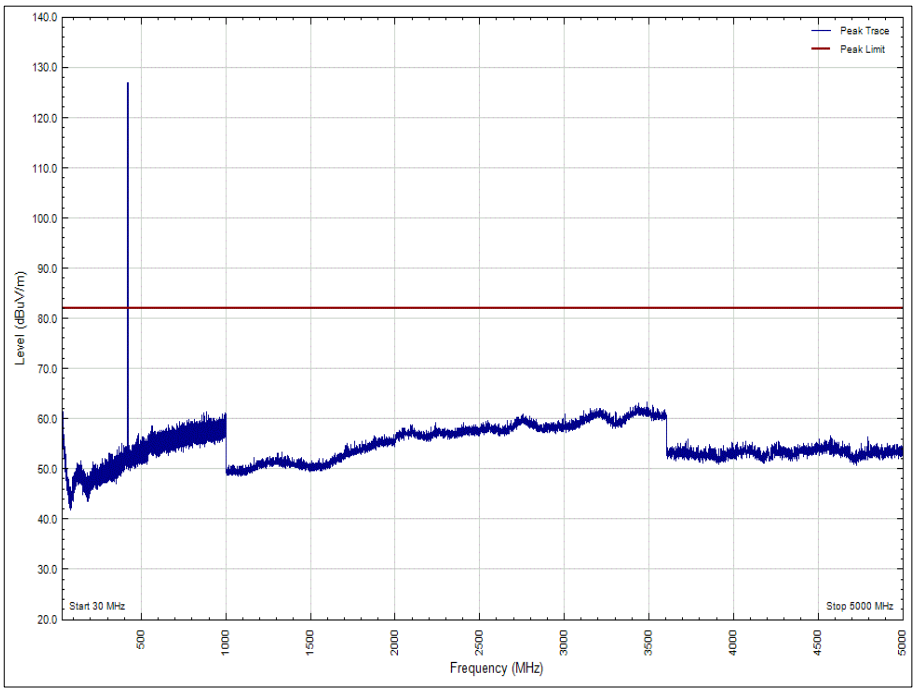

Figure 92 - 418.050 MHz - 30 MHz to 5 GHz - Orientation X - Horizontal

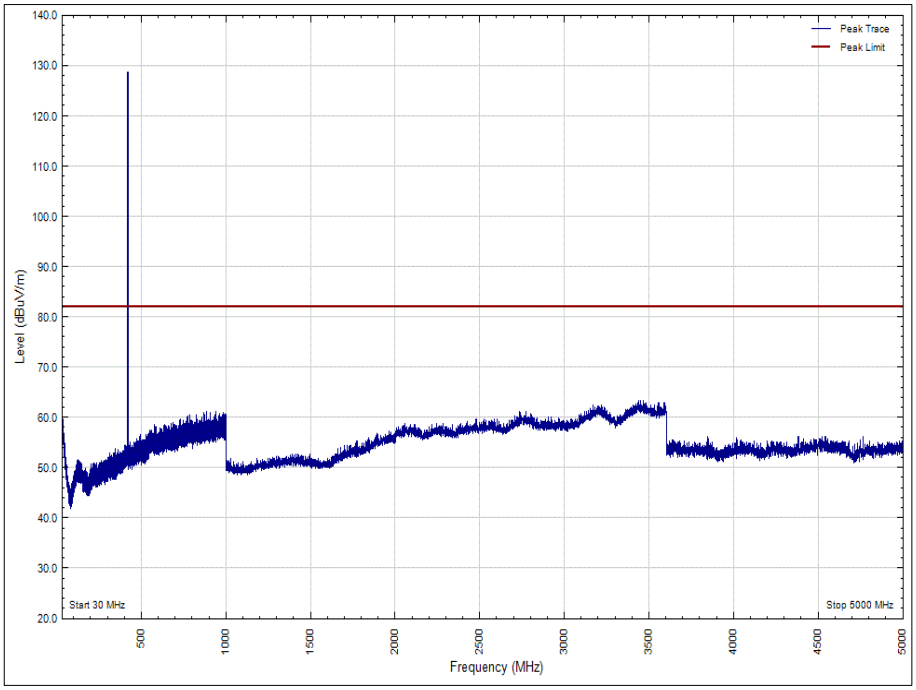

Figure 93 - 418.050 MHz - 30 MHz to 5 GHz - Orientation Y - Vertical

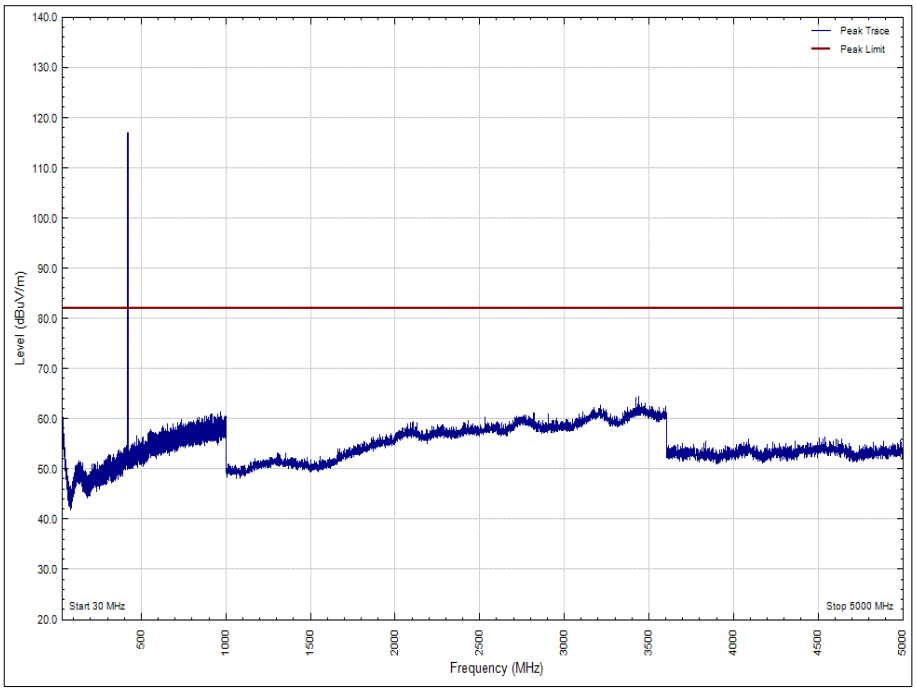

Figure 94 - 418.050 MHz - 30 MHz to 5 GHz - Orientation Y - Horizontal

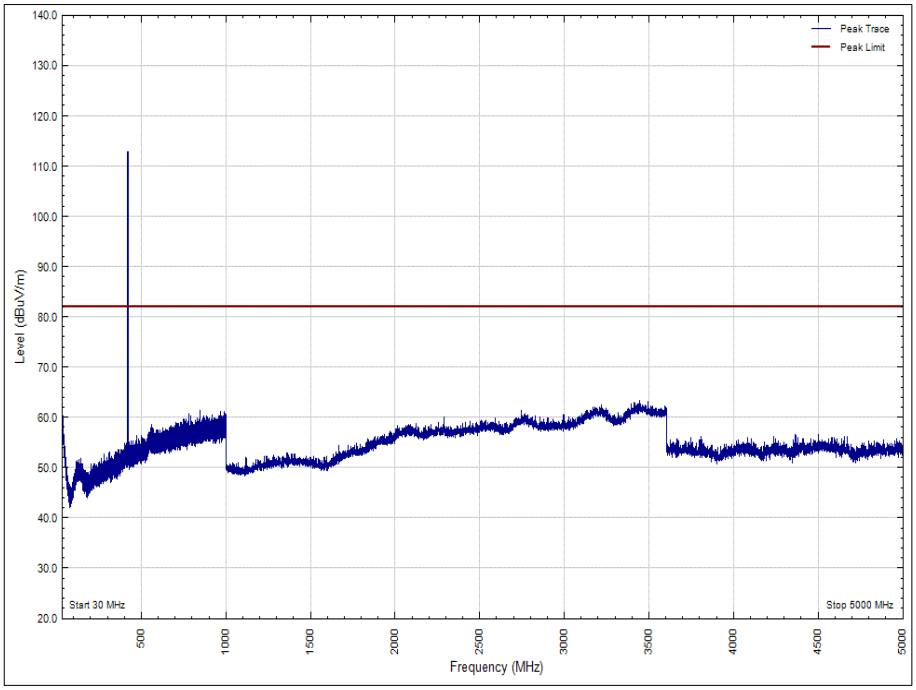

Figure 95 - 418.050 MHz - 30 MHz to 5 GHz - Orientation Z - Vertical

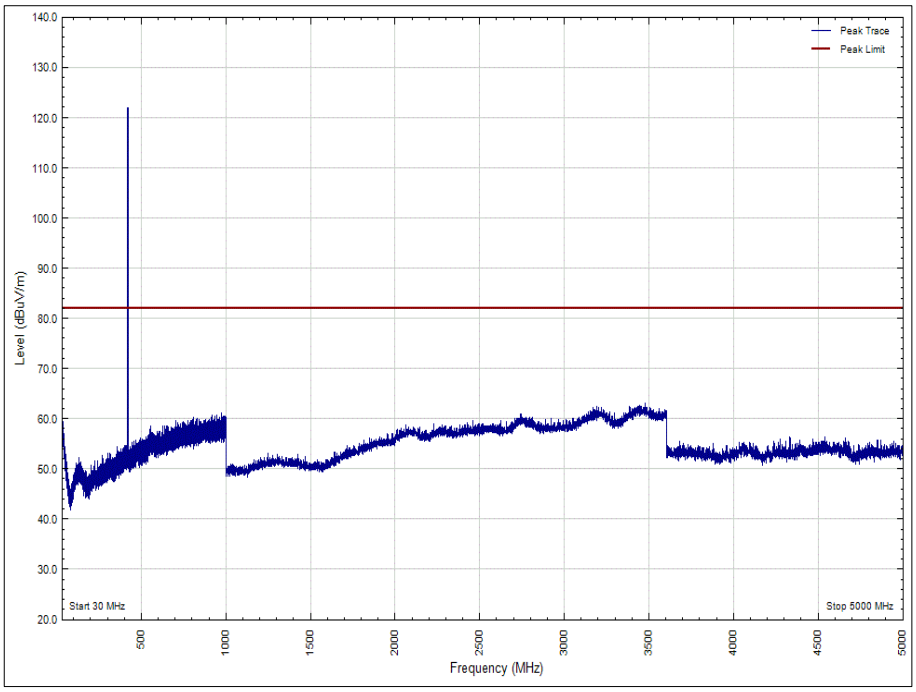

Figure 96 - 418.050 MHz - 30 MHz to 5 GHz - Orientation Z - Horizontal

Frequency (MHz)	Level (dBm)
*	

Table 32 - 418.050 MHz - Emissions Results

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

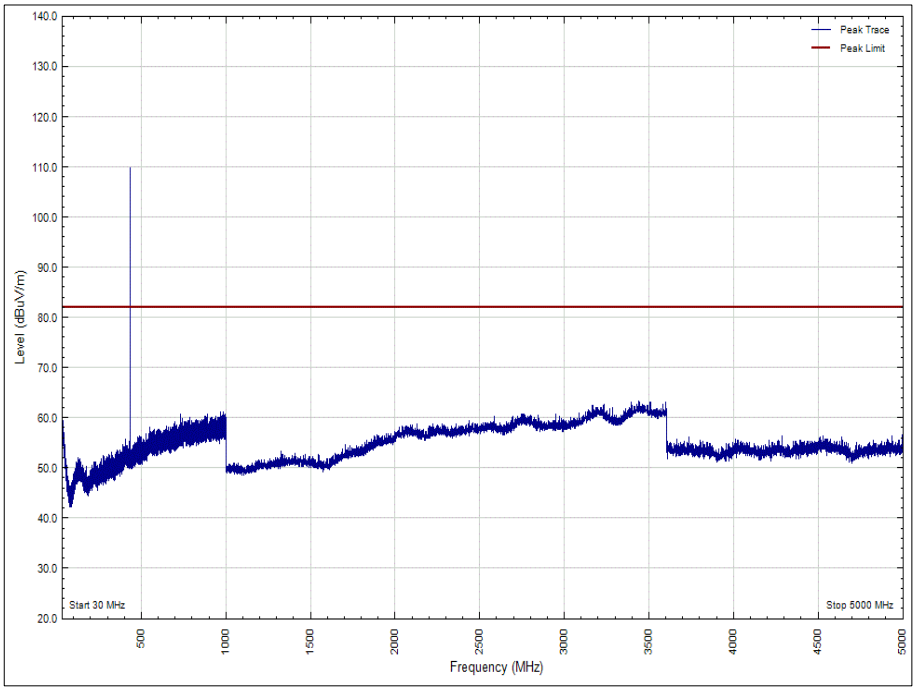

Figure 97 - 429.975 MHz - 30 MHz to 5 GHz - Orientation X - Vertical

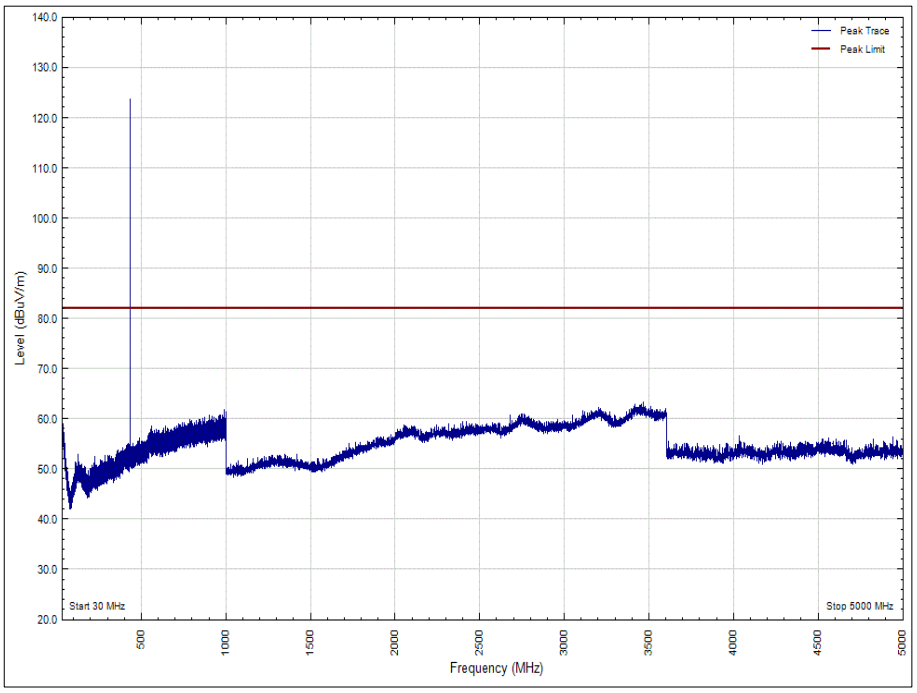

Figure 98 - 429.975 MHz - 30 MHz to 5 GHz - Orientation X - Horizontal

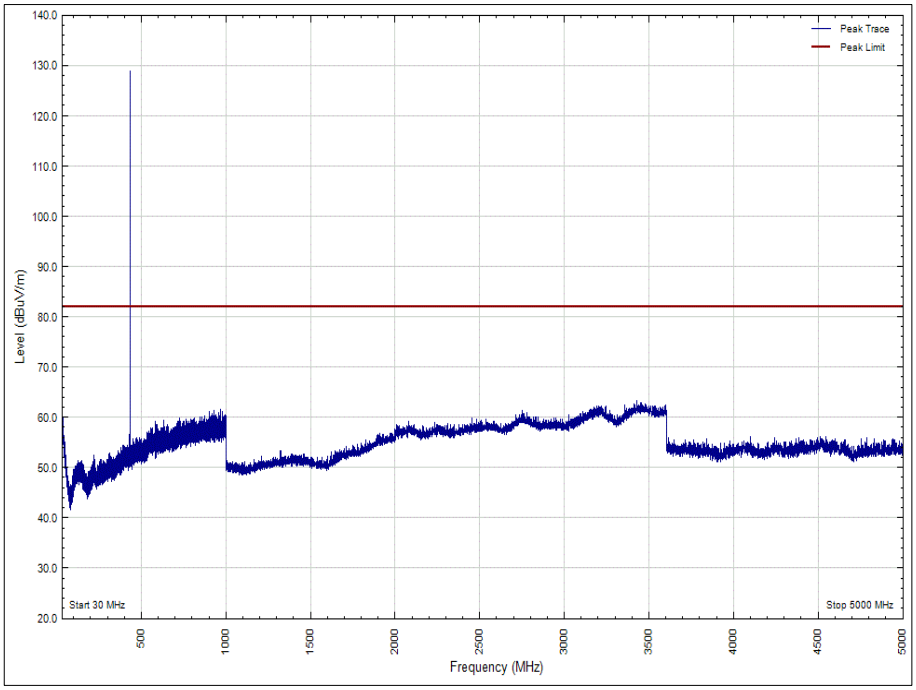

Figure 99 - 429.975 MHz - 30 MHz to 5 GHz - Orientation Y - Vertical

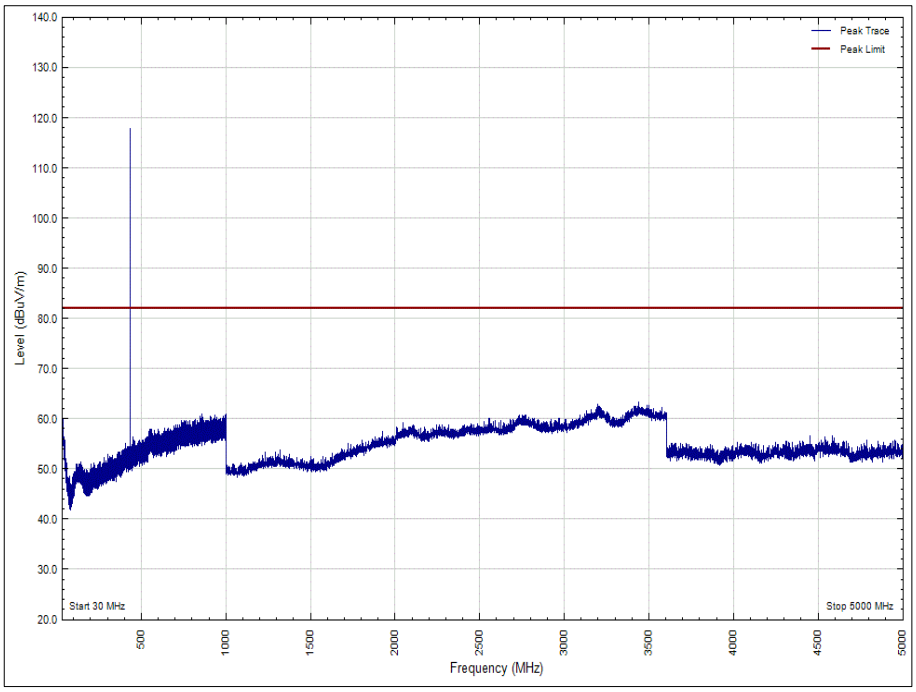

Figure 100 - 429.975 MHz - 30 MHz to 5 GHz - Orientation Y - Horizontal

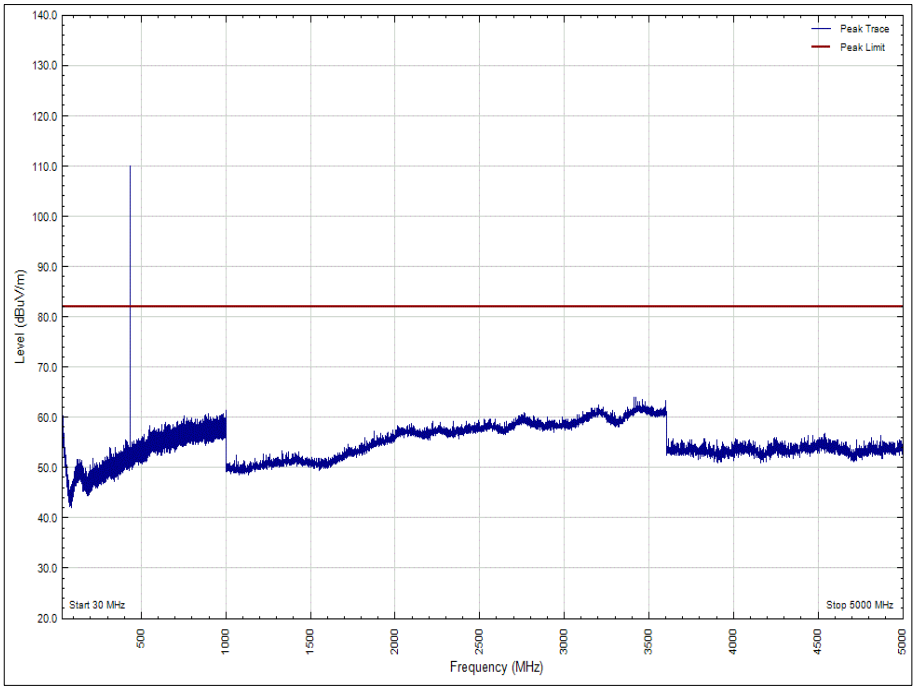

Figure 101 - 429.975 MHz - 30 MHz to 5 GHz - Orientation Z - Vertical

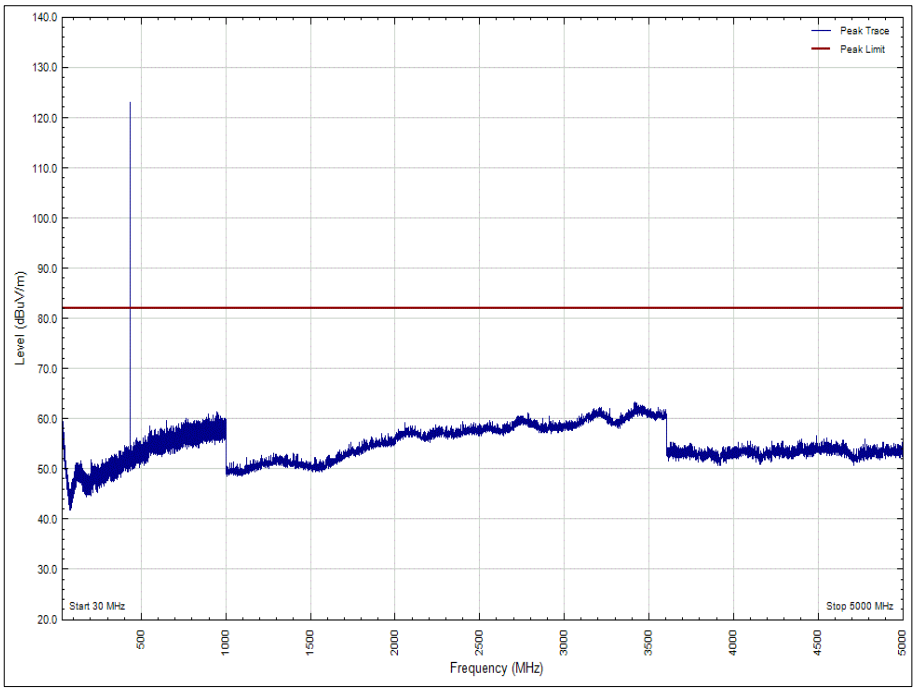

Figure 102 - 429.975 MHz - 30 MHz to 5 GHz - Orientation Z - Horizontal

FCC 47 CFR Part 90, Limit Clause 90.210

The EUT shall comply with emission mask C as per FCC 47 CFR Part 90.210.

Industry Canada RSS-119, Limit Clause 5.8

The EUT shall comply with emission mask C as per Industry Canada RSS-119 clause 5.8.

2.8.7 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
Hygrometer	Rotronic	HYGROPALM 1	2338	12	15-Nov-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 1503 2M 2.92(P)m 2.92(P)m	Rhophase	KPS-1503A-2000-KPS	4293	12	26-Oct-2019
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	26-Apr-2019
Cable (Rx, SMAm-SMAm 0.5m)	Scott Cables	SLSLL18-SMSM-00.50M	4528	6	26-Apr-2019
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	01-Mar-2019
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	05-Mar-2020
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
8m N-Type RF Cable	Teledyne	PR90-088-8MTR	5093	12	04-Oct-2019
8m N-Type RF Cable	Teledyne	PR90-088-8MTR	5095	12	04-Oct-2019
Cable (18 GHz)	Rosenberger	LU7-071-1000	5104	12	05-Oct-2019
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	05-Oct-2019
EmX Emissions Software	TUV SUD	EmX	5125	-	Software
1.5m 40GHz RF Cable	Scott Cables	KPS-1501-2000-KPS	5126	6	26-Apr-2019

Table 33

TU - Traceability Unscheduled

3 Photographs

3.1 Test Setup Photographs

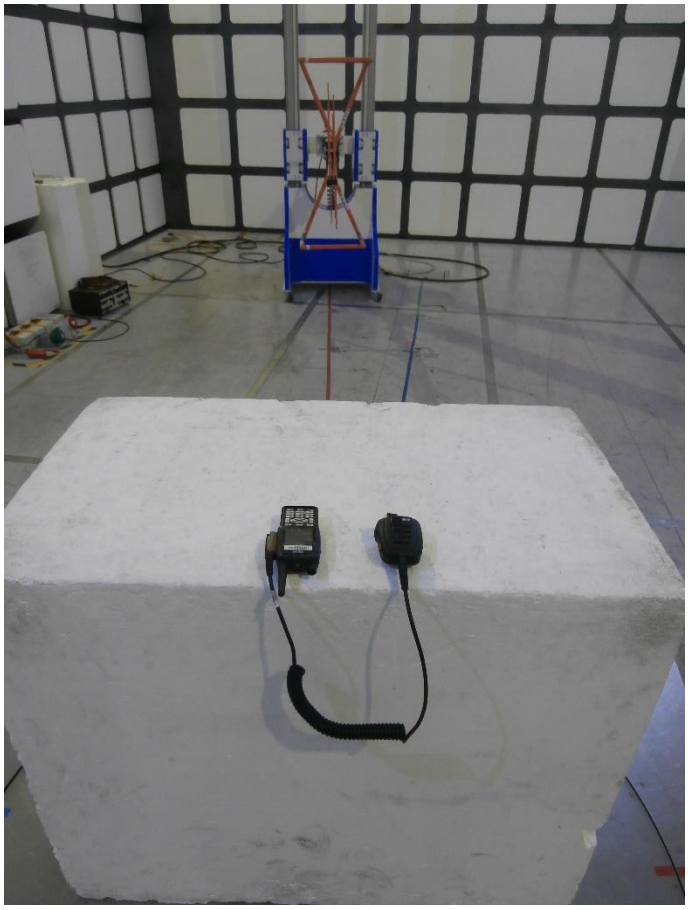

Figure 103 – 30 MHz to 1 GHz, EUT Orientation: X

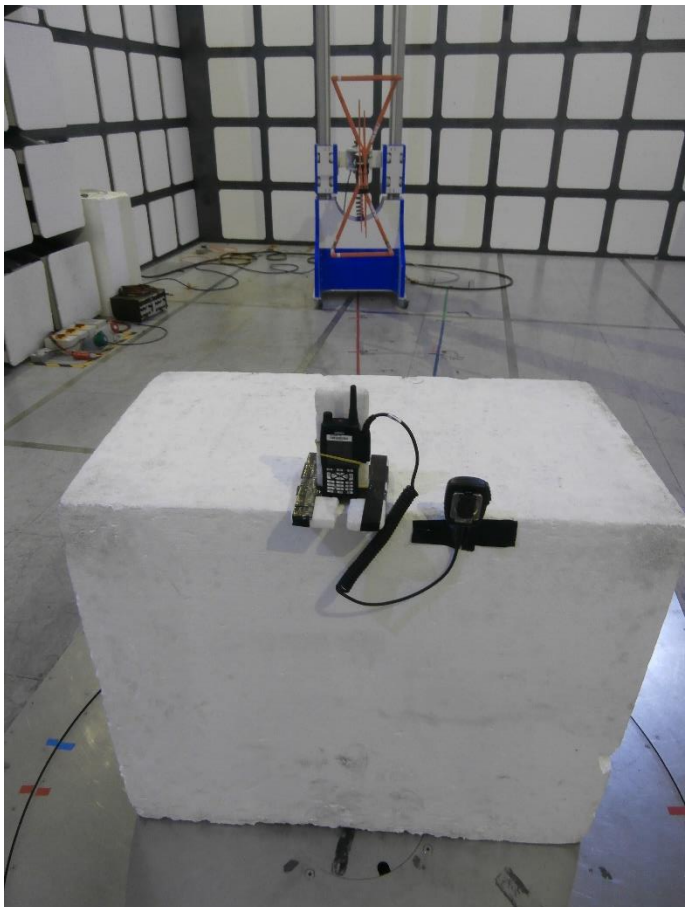

Figure 104 – 30 MHz to 1 GHz, EUT Orientation: Y

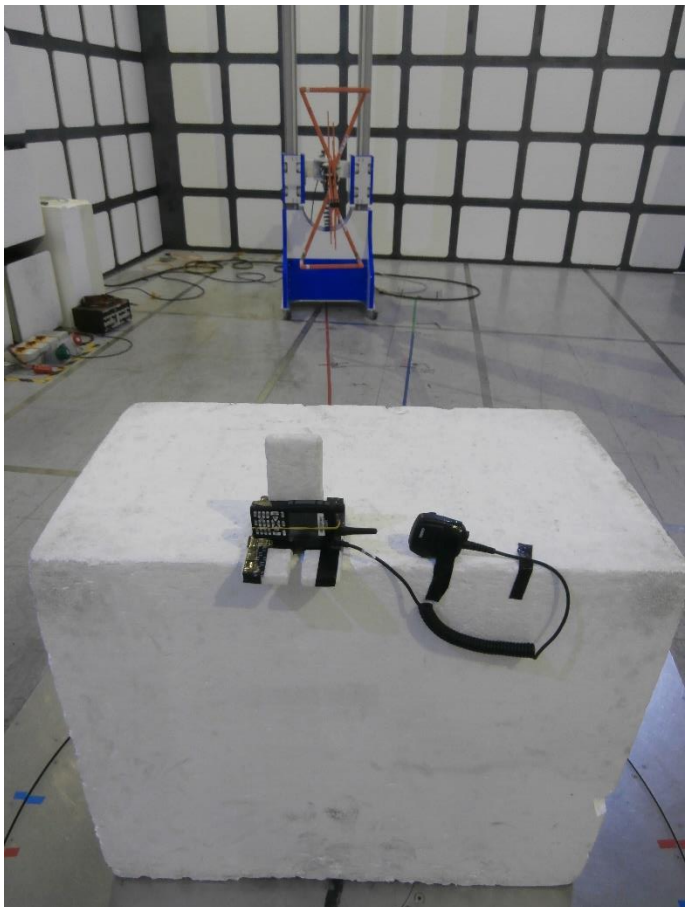

Figure 105 – 30 MHz to 1 GHz, EUT Orientation: Z

Figure 106 – Above 1 GHz, EUT Orientation: X

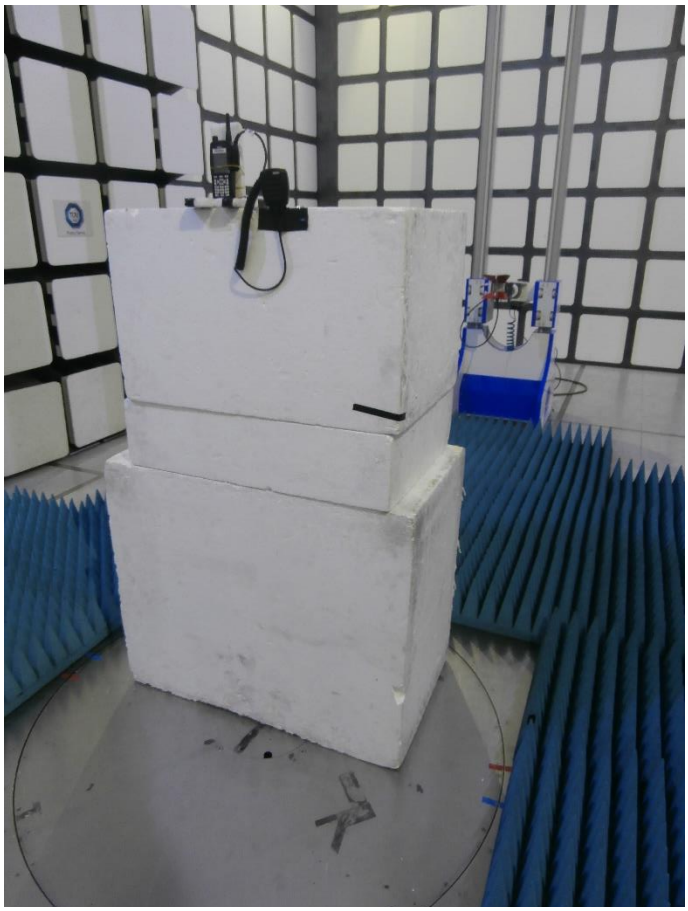

Figure 107 – Above 1 GHz, EUT Orientation: Y

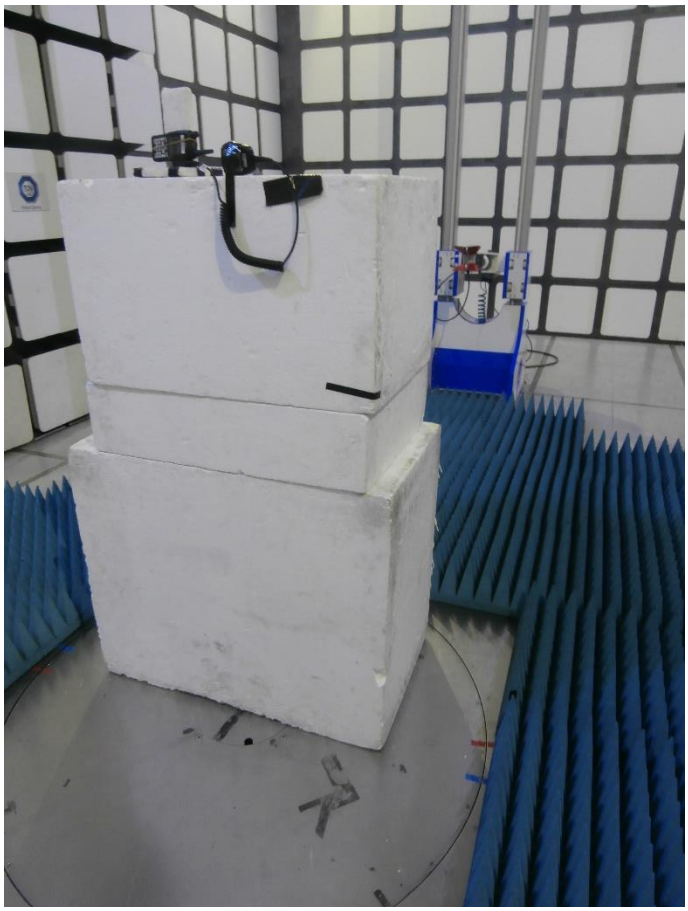

Figure 108 – Above 1 GHz, EUT Orientation: Z

4 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Maximum Conducted Output Power	± 3.2 dB
Bandwidth Limitations	± 58.05 Hz
Spurious Emissions at Antenna Terminals	± 3.45 dB
Frequency Stability	± 11 Hz
Transient Frequency Behaviour	± 0.2 Hz
Types of Emissions	-
Adjacent Channel Power	± 3.0 dB
Radiated Spurious Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 18 GHz: ± 6.3 dB

Table 34

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.