Test Report

FCC ID: N2S-SC42E-235470

FCC Rule Part: 90Y

Report Number: AT72150545-1C0

Manufacturer: Silvus Technologies, Inc.
Model: SC4240E-235470-BB

Test Begin Date: September 16, 2019
Test End Date: October 16, 2019

Report Issue Date: October 22, 2019

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: 2955.09

This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

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This report contains 25 pages

TABLE OF CONTENTS

1 GENERAL 3

1.1 PURPOSE 3
1.2 APPLICANT INFORMATION 3
1.3 PRODUCT DESCRIPTION 3
1.4 TEST METHODOLOGY AND CONSIDERATIONS 3

2 TEST FACILITIES 4

2.1 LOCATION 4
2.2 LABORATORY ACCREDITATIONS/RECOGNITIONS/CERTIFICATIONS 4
2.3 RADIATED EMISSIONS TEST SITE DESCRIPTION 5
2.3.1 Semi-Anechoic Chamber Test Site – Chamber A 5
2.3.2 Semi-Anechoic Chamber Test Site – Chamber B 6

3 APPLICABLE STANDARD REFERENCES 7

4 LIST OF TEST EQUIPMENT 7

5 SUPPORT EQUIPMENT 8

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM 8

7 SUMMARY OF TESTS 9

7.1 26DB BANDWIDTH AND EMISSION MASK – §2.1049 / §90.210(M) 9
7.1.1 Measurement Procedure 9
7.1.2 Measurement Results 9
7.2 FUNDAMENTAL EMISSION OUTPUT POWER – §90.1215(A)(1) 12
7.2.1 Measurement Procedure 12
7.2.2 Measurement Results 12
7.3 POWER SPECTRAL DENSITY (PSD) – §90.1215(A)(2) 13
7.3.1 Measurement Procedure 13
7.3.2 Measurement Results 13
7.4 PEAK EXCURSION – §90.1215(E) 14
7.4.1 Measurement Procedure 14
7.4.2 Measurement Results 14
7.5 MAXIMUM PERMISSIBLE EXPOSURE – §90.1217 / §1.1310 15
7.5.1 Measurement Procedure 15
7.5.2 Results 15
7.6 ANTENNA PORT CONDUCTED SPURIOUS EMISSIONS - §90.210(M) / §2.1051 16
7.6.1 Measurement Procedure 16
7.6.2 Measurement Results 16
7.7 RADIATED SPURIOUS EMISSIONS / CABINET RADIATION - §90.210(M) 18
7.7.1 Measurement Procedure 18
7.7.2 Measurement Results 18
7.7.3 Sample Calculation: 19
7.8 FREQUENCY STABILITY - §90.213(A) / §2.1055 20
7.8.1 Measurement Procedure 20
7.8.2 Measurement Results 20

8 ESTIMATION OF MEASUREMENT UNCERTAINTY 21

9 CONCLUSION 21

APPENDIX A: PLOTS 22

1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 90 Subpart Y of the FCC's Code of Federal Regulations for the tests documented herein.

1.2 Applicant Information

Silvus Technologies, Inc.
10990 Wilshire Blvd., #1500
Los Angeles, CA 90024 USA

1.3 Product Description

The DUT is a 2x2 MIMO radio operating in the licensed 4940-4990MHz band.

Technical Details:

Detail	Description
Frequency Range (MHz)	4945 - 4985
Number of Channels	9
Channel Spacing	5 MHz
Modulation Format	OFDM
Data Rates	100Mbps
Operating Voltage	10.8Vdc Battery
Antenna Type(s) / Gain(s)	Dual-Band Omni Antenna, Half Wave Dipole / 2.5dBi (Southwest Antennas, P/N: 1001-071)

Test Sample Serial Number(s): SC42-32240

Test Sample Condition: The equipment was provided in good condition without any physical damage.

1.4 Test Methodology and Considerations

All modes of operation, including all data rates, were evaluated and the data presented in this report represents the worst case where applicable.

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst-case orientation was the Z-orientation. Antenna ports were terminated through attenuators into 50-Ohm loads.

Power setting during test: Antenna Port 1: 54
Antenna Port 2: 52

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following addresses:

TÜV SÜD America, Inc.
5945 Cabot Pkwy, Suite 100
Alpharetta, GA 30005
Phone: (678) 341-5900

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America, Inc. is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation/A2LA accreditation program and has been issued certificate number 2955.09 in recognition of this accreditation.

Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scopes of accreditation.

The Semi-Anechoic Chamber Test Sites and Conducted Emissions Sites have been fully described, submitted to, and accepted by the FCC, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Designation Accreditation Number:	US1233
ISED Canada Lab Code:	23932
VCCI Member Number:	1831
• VCCI Registration Number	A-0295

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site – Chamber A

The Semi-Anechoic Chamber Test Site consists of a 20’ x 30’ x 18’ shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 5’ in diameter and is located 5’6” from the back wall of the chamber. The chamber is grounded via 1 - 8’ copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted EMCO Model 1060 installed in an all steel frame. The table is remotely operated from inside the control room located 25’ from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3’ x 6’ x 4’ deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4” PVC chase from the turntable to the pit that allows for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

The chamber rear wall is covered with a mixture of Siepel pyramidal absorber. The side walls of the chamber are partially covered with Siepel pyramidal absorber.

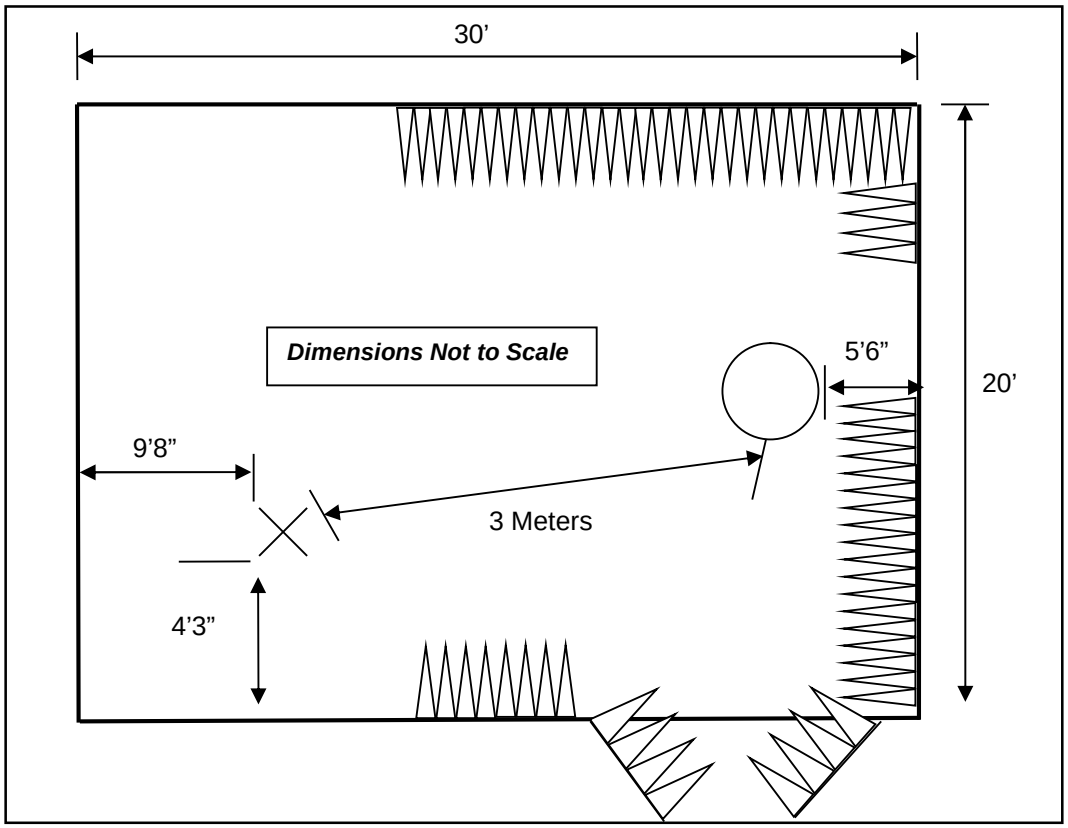


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site – Chamber A

2.3.2 Semi-Anechoic Chamber Test Site – Chamber B

The Semi-Anechoic Chamber Test Site consists of a 20'W x 30'L x 20'H shielded enclosure. The chamber is lined with ETS-Lindgren Ferrite Absorber, model number FT-1500. The ferrite tile 600 mm x 600 mm (2.62 in x 23.62 in) panels and are mounted directly on the inner walls of the chamber shield.

The specular regions of the chamber are lined with additional ETS-Lindgren PS-600 hybrid absorber to extend its frequency range up to 18GHz and beyond.

The turntable is a 2m ETS-Lindgren Model 2170 and installed off the center axis is located 5'6" from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the shield using #8 solid copper wire.

The antenna mast is an EMCO 1060 and is remotely controlled from the control room for both antenna height and polarization.

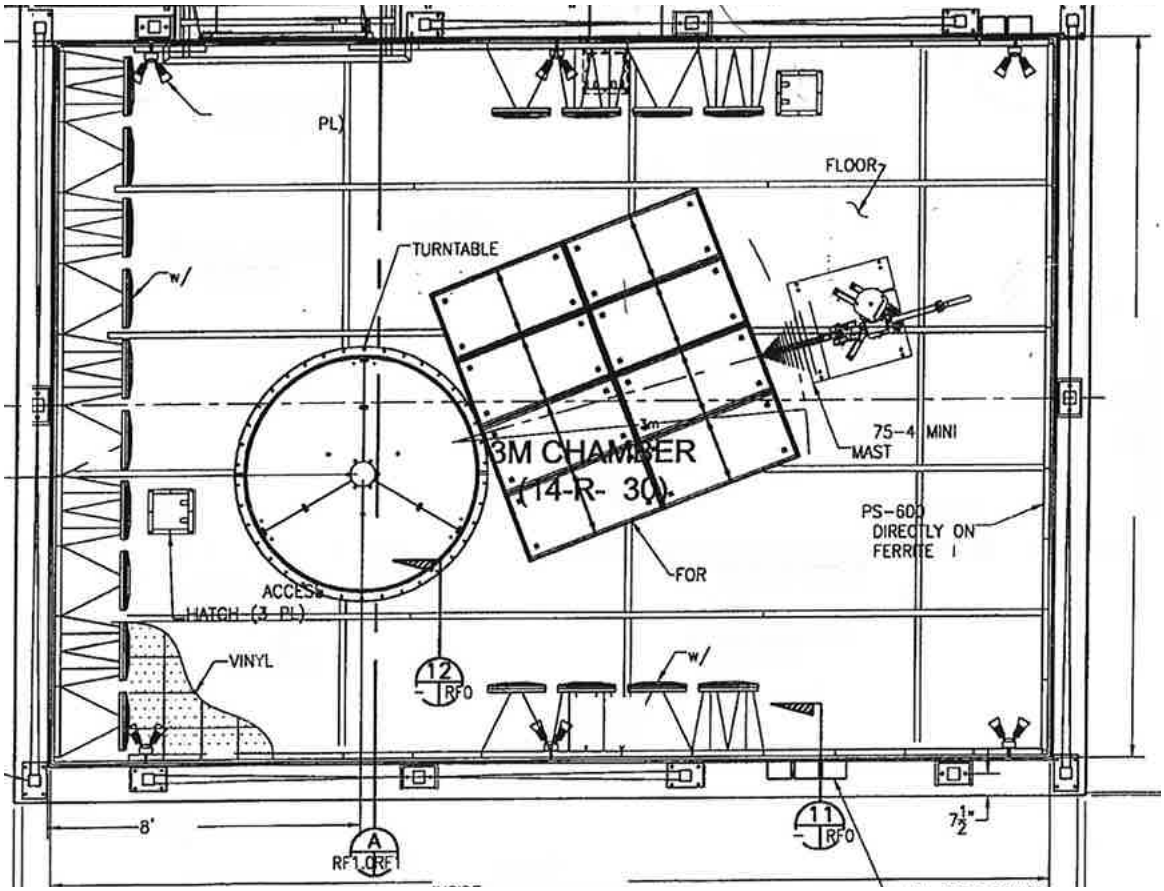


Figure 2.3.2-1: Semi-Anechoic Chamber Test Site – Chamber B

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.26-2015: American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2019
- US Code of Federal Regulations (CFR): Title 47, Chapter I, Subchapter D, Part 90, Subpart Y: Regulations Governing Licensing and Use of Frequencies in the 4940-4990 MHz Band, 2019
- KDB 662911 D01 Multiple Transmitter Output v02r01 - Emissions Testing of Transmitters with Multiple Outputs in the Same Band, October 31, 2013
- KDB 971168 D01 Power Meas License Digital Systems v03r01 - Measurement Guidance for Certification of Licensed Digital Transmitters
- KDB 971168 D02 Misc Rev Approv License Devices v02r01 – Miscellaneous and Basic Review and Approval Items for Transmitting Equipment Used in Licensed Radio Services

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
22	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A00526	07/11/2018	07/11/2020
213	TEC	PA 102	Amplifier	44927	07/22/2019	07/22/2020
329	A.H.Systems	SAS-571	Horn Antenna	721	8/27/2019	8/27/2020
332	Rohde & Schwarz	TS-PR40	40GHz Pre-Amp	100021	03/13/2018	03/13/2020
333	Rohde & Schwarz	3160-10	HF Antenna - 26.5-40GHz	45576	NCR	NCR
335	Suhner	SF-102A	Cable (40GHZ)	882/2A	7/8/2019	7/8/2020
345	Suhner Sucoflex	102A	Cable 42(GHZ)	1077/2A	7/8/2019	7/8/2020
622	Rohde & Schwarz	FSV40 (v3.40)	FSV Signal Analyzer 10Hz to 40GHz	101338	07/30/2018	07/30/2020
651	Rohde & Schwarz	TS-PR26	18GHz to 26.5GHz Pre-Amplifier	100023	07/10/2019	7/10/2020
652	Rohde & Schwarz	3160-09	High Frequency Antenna 18GHz to 26.5GHz	060922-21894	NCR	NCR
694	Thermotron	S-1.2C	Thermotron temperature chamber	19753	NCR	NCR
695	Fluke	51II	Digital Thermometer	76440097	06/05/2019	06/05/2020
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	11/06/2018	11/06/2019
827	(-)	TS8997 Rack Cable Set	TS8997 Rack Cable Set	N/A	05/01/2019	05/01/2020
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	05/01/2019	05/01/2020
853	Teseq	CBL 6112D; 6804.17.A	Bilog Antenna; Attenuator	51616; 20181110A	10/15/2018	10/15/2019

NCR = No Calibration Required
NOTE: All test equipment was used only during active calibration cycles as reported above.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	Battery	Bren-Tronics, Inc.	BT-70716BG	20139
2	Push-To-Talk	Impact	PRSM-HD7-WP	Not Labeled
3	Laptop	Dell	Latitude 3490	18101036450

Table 5-2: Cable Description

Item	Cable Type	Length	Shield	Termination
A	PTT Cable	0.8 m (Coiled)	Yes	EUT – 2
B	AUX / USB	2.8m	Yes	EUT – Unterminated
C	PRI / Ethernet	10m (Extended)	Yes	EUT - 3

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

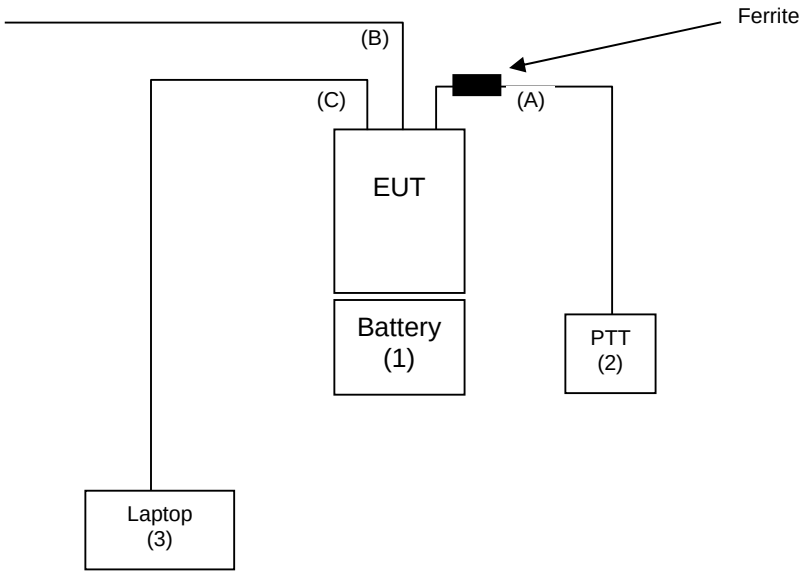


Figure 6-1: Test Setup Block Diagram

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 26dB Bandwidth and Emission Mask – §2.1049 / §90.210(m)

7.1.1 Measurement Procedure

The 26dB bandwidth was measured in accordance with Subclause 5.4.3 of ANSI C63.26. The resolution bandwidth was set from 1% to 5% of the occupied bandwidth and the video bandwidth set to at least 3 times the resolution bandwidth. The trace was set to max hold with a peak detector active. The ndB down function of the spectrum analyzer was utilized to determine the 26 dB bandwidth of the emission.

To show compliance with the emission mask requirements defined in Section 90.210(m), the measurement guidance in KDB 971168 D01 Power Meas License Digital Systems v03r01, Section 6.1. The spectrum analyzer span was set to 150% of the signal bandwidth and the resolution bandwidth was set to a minimum of 1% of the occupied bandwidth. An average detector was applied using a single sweep with the sweep time set to 1ms per sweep point. The resulting trace was compared to the Mask M requirements.

7.1.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.1.2-1: 26dB Bandwidth

Modulation	Frequency (MHz)	26dB Bandwidth (MHz)
OFDM	4945	9.839
	4965	9.857
	4985	9.980

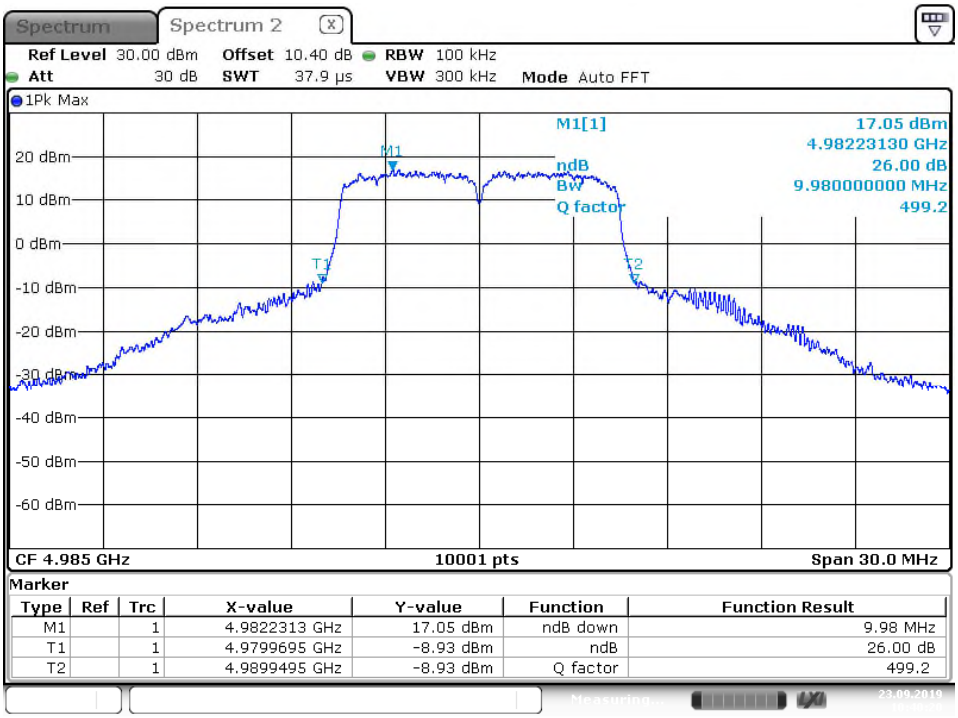


Figure 7.1.2-1: Sample Plot - 26dB BW

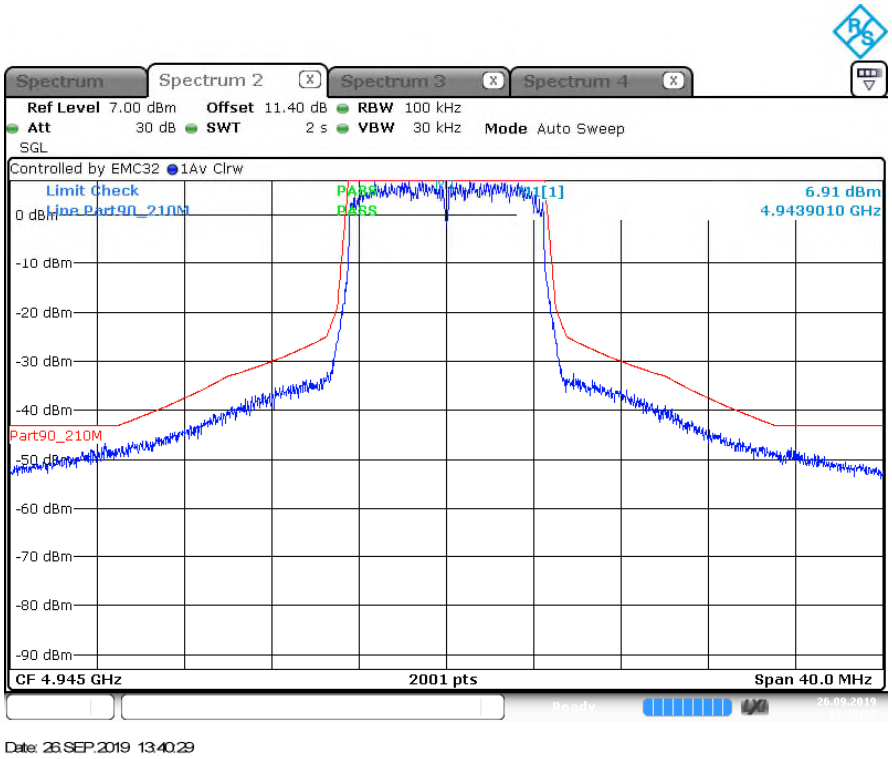


Figure 7.1.2-2: Mask M – Low Channel

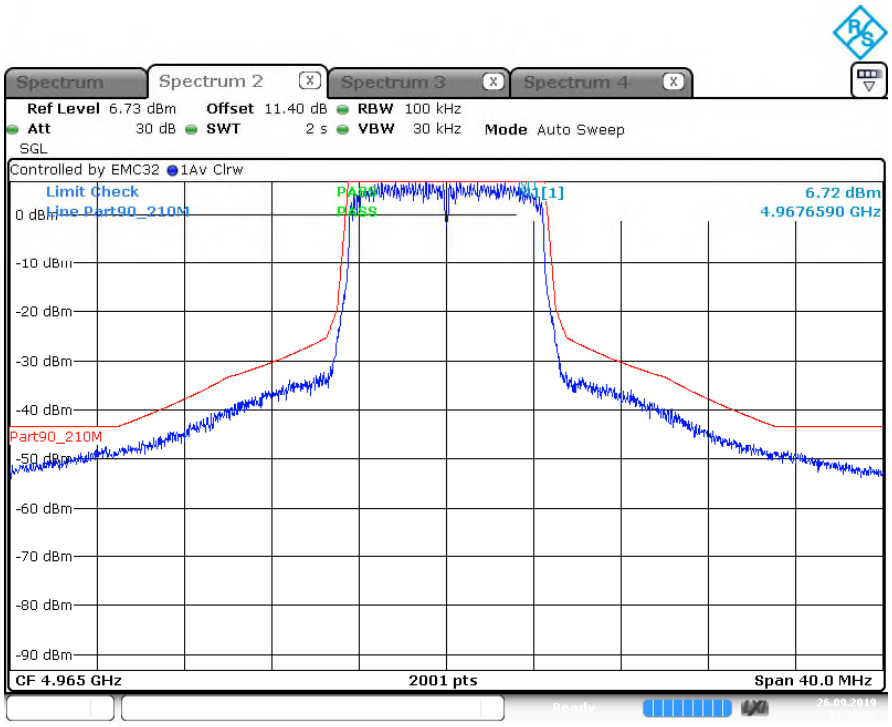


Figure 7.1.2-3: Mask M – Middle Channel

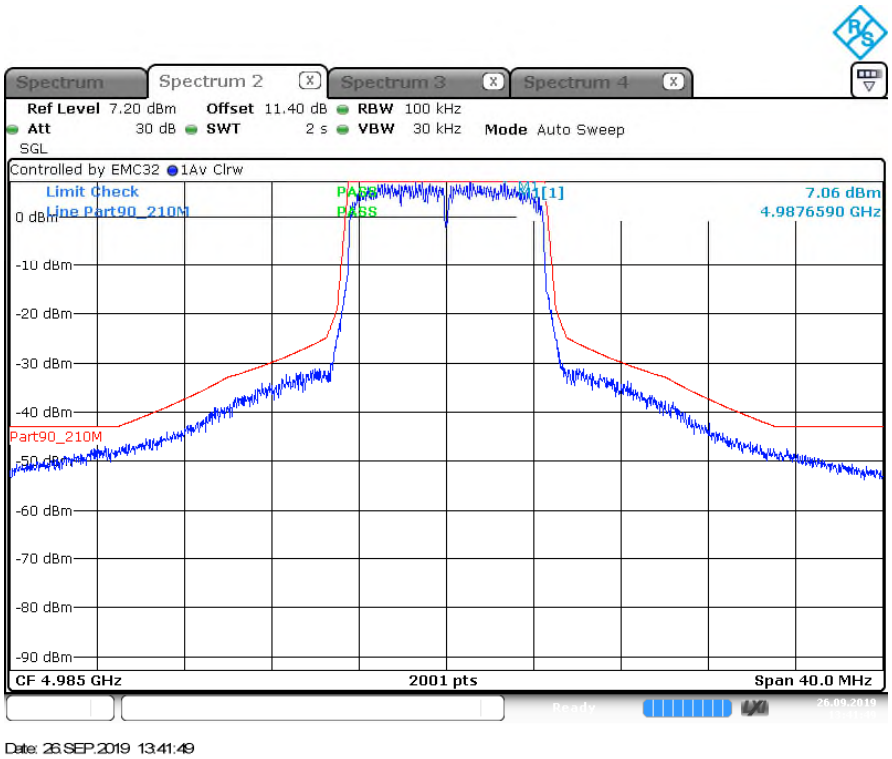


Figure 7.1.2-4: Mask M – High Channel

7.2 Fundamental Emission Output Power – §90.1215(a)(1)

7.2.1 Measurement Procedure

The average conducted output power was measured in accordance with FCC KDB 971168 D01, Section 5.2 utilizing an average power meter followed by duty-cycle correction (if required).

For a 10MHz nominal channel bandwidth operating in the 4940-4990MHz band, the limit is 30dBm.

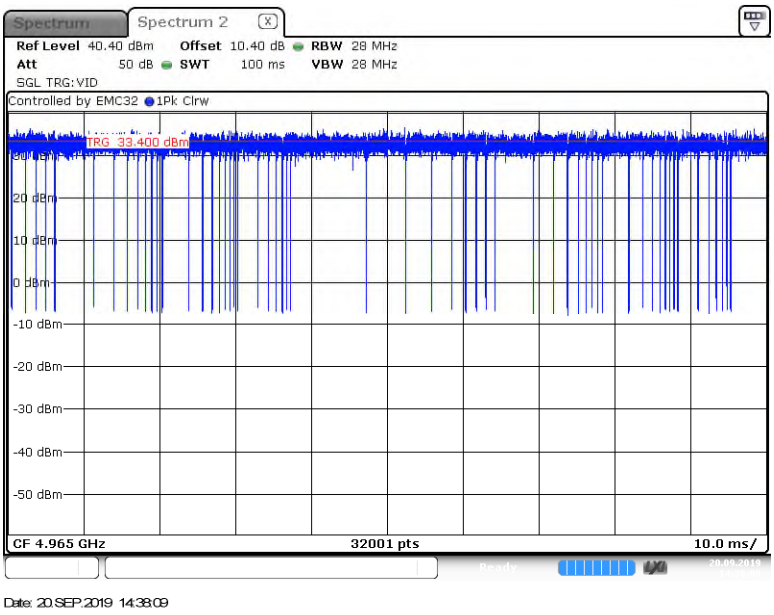
7.2.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.2.2-1: Conducted Output Power

Modulation	Frequency (MHz)	Port 1 Average Power (dBm)	Port 2 Average Power (dBm)	Total Average Power (dBm)
OFDM	4945	26.4	26.5	29.5
	4965	26.6	26.4	29.5
	4985	26.7	26.9	29.8

Measured Duty Cycle: 98.2% (No correction applied)



*Note: Trace data was analyzed using an excel program which found the on time to be 98.2ms and off time to be 1.8ms over the course of the 100ms sweep

Figure 7.2.2-1: Duty Cycle Plot

7.3 Power Spectral Density (PSD) – §90.1215(a)(2)

7.3.1 Measurement Procedure

The Average Power Spectral Density was measured in accordance with FCC KDB 971168 D01, Section 5.4 which references Subclause 5.2.4.5 of ANSI C63.26.

The limit for PSD is 21dBm/MHz

7.3.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.3.2-1: Peak Power Spectral Density

Modulation	Frequency (MHz)	Port 1 PSD (dBm)	Port 2 PSD (dBm)	Total PSD (dBm)
OFDM	4945	17.77	17.95	20.87
	4965	17.97	17.87	20.93
	4985	17.86	18.06	20.97

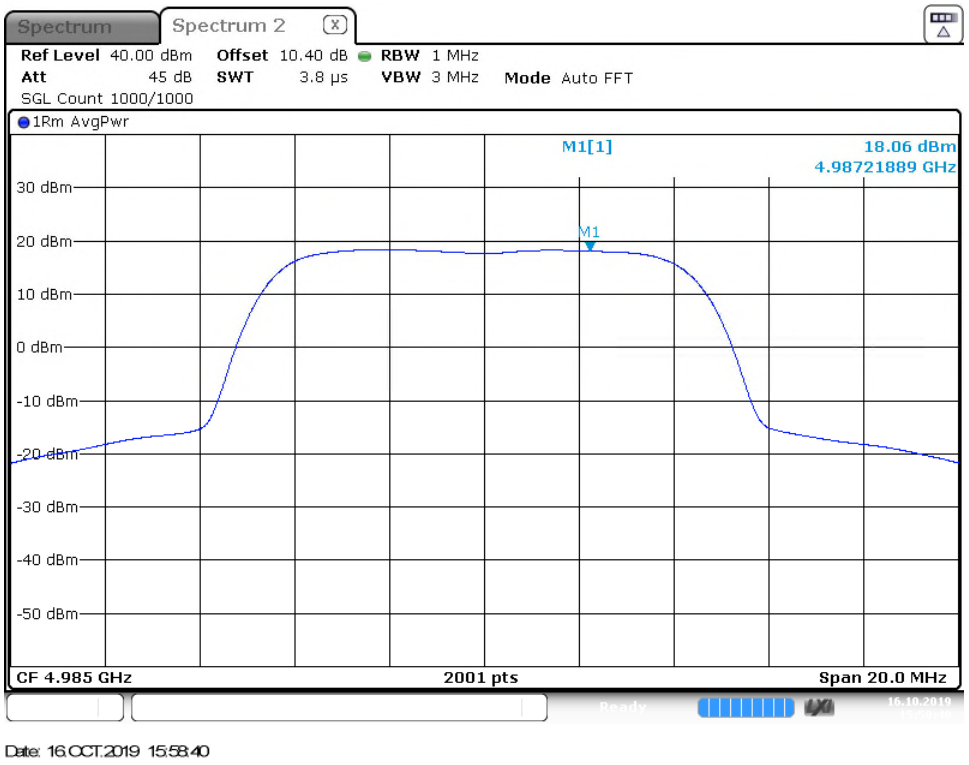


Figure 7.3.2-1: Sample PSD Plot

7.4 Peak Excursion – §90.1215(e)

7.4.1 Measurement Procedure

The Peak-to-Average Power Ratio (PAPR) was measured in accordance with FCC KDB 971168 D01, Section 5.7 which references Subclause 5.2.3.4 of ANSI C63.26 for applying the CCDF function of the spectrum analyzer.

The limit for PAPR is 13dB

7.4.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.4.2-1: Peak-to Average Ratio (Peak Excursion)

Modulation	Frequency (MHz)	Resolution Bandwidth (MHz)	AQT (ms)	Peak Excursion (dB)	Limit (dB)	Margin (dB)
OFDM	4965	10	1	7.71	13	5.29

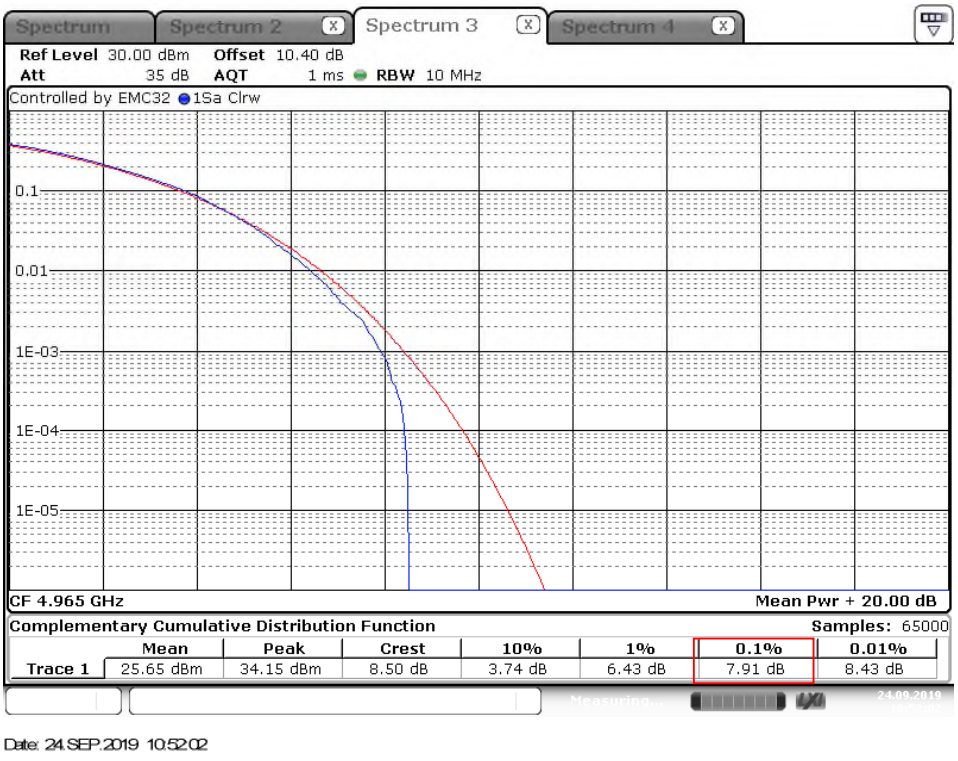


Figure 7.4.2-1: PAPR Plot

7.5 Maximum Permissible Exposure – §90.1217 / §1.1310

7.5.1 Measurement Procedure

Maximum permissible exposure conditions were calculated using the total average power and antenna gains.

The limit for Occupational/Controlled Exposure 5 mW/cm^2
The limit for General Population/Uncontrolled Exposure is 1mW/cm^2

7.5.2 Results

Performed by: Jeremy Pickens

The Power Density (mW/cm^2) is calculated as follows:

$$S = \frac{PG}{4\pi R^2}$$

Where:
S = power density (in appropriate units, e.g. mW/cm2)
P = power input to the antenna (in appropriate units, e.g., mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Table 7.5.2-1: MPE Calculation

Transmit Frequency (MHz)	Radio Power (dBm)	Power Density Limit (mW/cm^2)	Radio Power (mW)	Antenna Gain (dBi)	Antenna Gain (mW eq.)	Distance (cm)	Power Density (mW/cm^2)
4945	30	1.00	1000.00	5.51	3.556	20	0.708

Note: MIMO directional antenna gain was calculated from the equation in KDB 662911 D01:
Directional gain = G_{ANT} + 10 log(N_{ANT}) dBi

7.6 Antenna Port Conducted Spurious Emissions - §90.210(m) / §2.1051

7.6.1 Measurement Procedure

The unwanted emissions at the antenna port were measured in accordance with FCC KDB 971168 D01, Section 6 and Subclause 5.7 of ANSI C63.26.

Limit from §90.210(m): On any frequency removed from the assigned frequency between above 150% of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

Above 1GHz, a resolution bandwidth of 500kHz was used in lieu of 1MHz to provide the dynamic range between the fundamental emission and the noise floor.

7.6.2 Measurement Results

Performed by: Jeremy Pickens

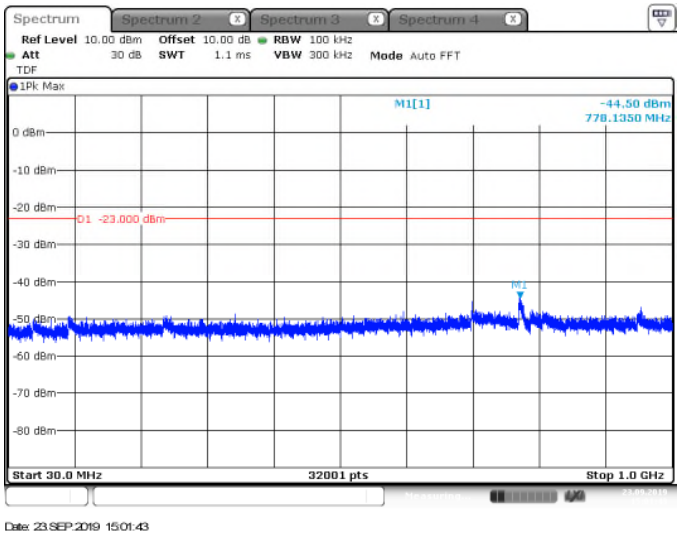


Figure 7.6.2-1: LCH – 30MHz–1GHz

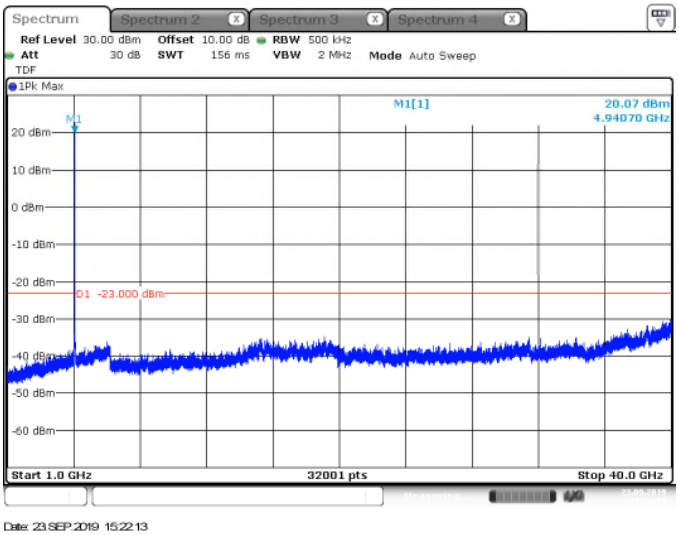


Figure 7.6.2-2: LCH – 1GHz–40GHz

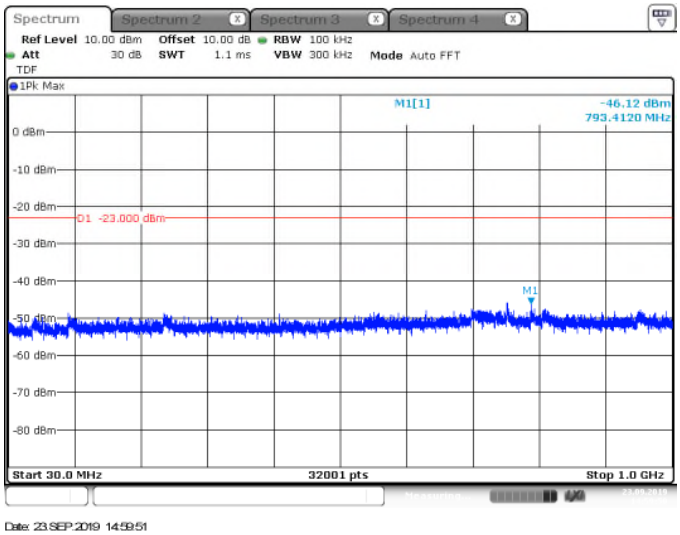


Figure 7.6.2-3: MCH – 30MHz–1GHz

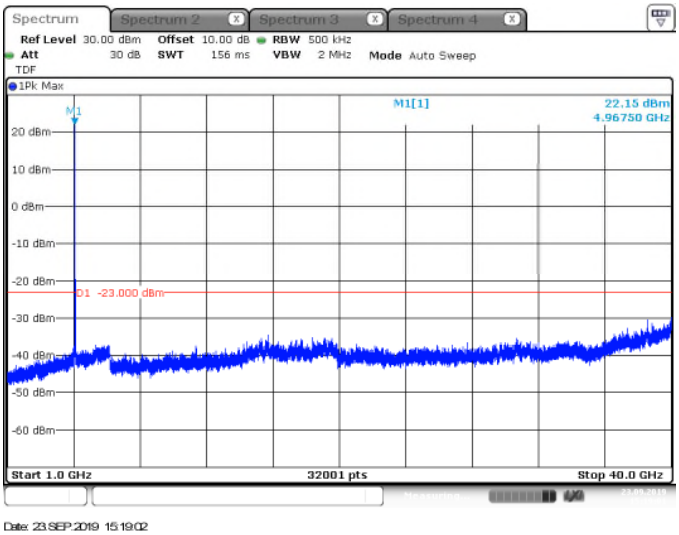


Figure 7.6.2-4: MCH – 1GHz–40GHz

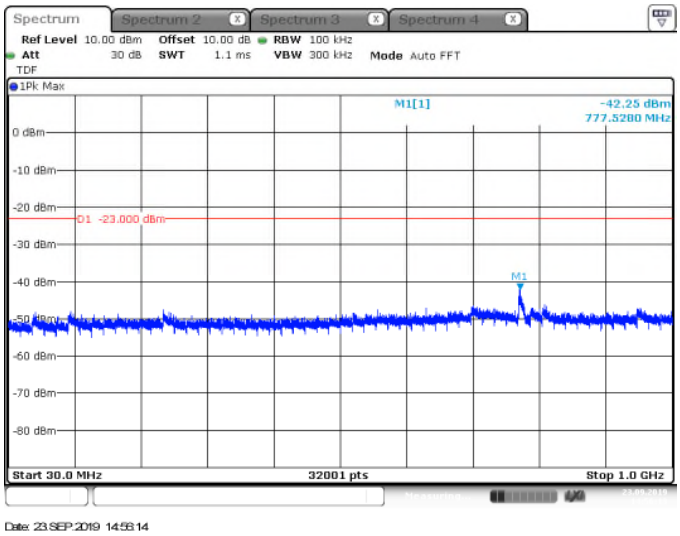


Figure 7.6.2-5: HCH – 30MHz–1GHz

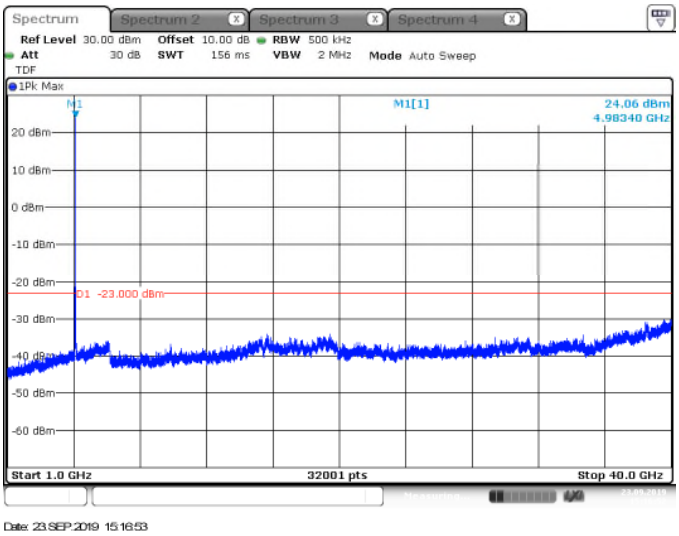


Figure 7.6.2-6: HCH – 1GHz–40GHz

7.7 Radiated Spurious Emissions / Cabinet Radiation - §90.210(m)

7.7.1 Measurement Procedure

The unwanted emissions were measured radiated over the frequency range of 30MHz to 40GHz.

The EUT was rotated through 360° and the receive antenna height was varied from 1 meter to 4 meters so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, RMS measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, RMS measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

Cabinet radiation measurements were recorded with the antenna ports terminated into 50-Ohms through attenuators.

Limit from §90.210(m): On any frequency removed from the assigned frequency between above 150% of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation. The device was configured for 27dBm output power per port, so the applied limit was -23dBm or 72.2dBµV/m at 3 meters.

7.7.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.7.2-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	pk	RMS	(H/V)	(dB)	pk	RMS	pk	RMS	pk	RMS
Low Channel - 4945MHz										
9890	45.70	33.20	H	15.61	--	48.81	--	72.2	--	23.4
9890	46.2	33.1	V	15.61	--	48.71	--	72.2	--	23.5
Mid Channel - 4965MHz										
9930	45.9	33.2	H	15.65	--	48.85	--	72.2	--	23.3
9930	46	33.1	V	15.65	--	48.75	--	72.2	--	23.4
High Channel - 4985MHz										
9970	46.3	33	H	15.69	--	48.69	--	72.2	--	23.5
9970	46	33.1	V	15.69	--	48.79	--	72.2	--	23.4

7.7.3 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

Example Calculation: RMS

Corrected Level: 33.2 + 15.65 - 0 = 48.85dBµV
Margin: 72.2dBµV – 48.85dBµV = 23.3dB

7.8 Frequency Stability - §90.213(a) / §2.1055

7.8.1 Measurement Procedure

The frequency stability was measured in accordance with FCC KDB 971168 D01, Section 9 and Subclause 5.6 of ANSI C63.26.

7.8.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.8.2-1: Frequency Stability Tabulated Data

Nominal Voltage		10.8Vdc	Nominal Frequency (MHz)		4965
Voltage (VDC)	Temperature (°C)	Frequency Low (MHz)	Frequency High (MHz)	Frequency Center (MHz)	Deviation (ppm)
10.8	-30	4960.397	4969.591	4964.994	-1.21
	-20	4960.393	4969.599	4964.996	-0.81
	-10	4960.413	4969.587	4965	0
	0	4960.393	4969.595	4964.994	-1.21
	+10	4960.393	4969.595	4964.994	-1.21
	+20	4960.401	4969.595	4964.998	-0.4
	+30	4960.397	4969.595	4964.996	-0.81
	+40	4960.389	4969.603	4964.996	-0.81
	+50	4960.397	4969.595	4964.996	-0.81
9.18	+20	4960.401	4969.591	4964.996	-0.81
12.42	+20	4960.405	4969.595	4965	0

8 ESTIMATION OF MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) k = 1.96 which provide confidence levels of 95%.

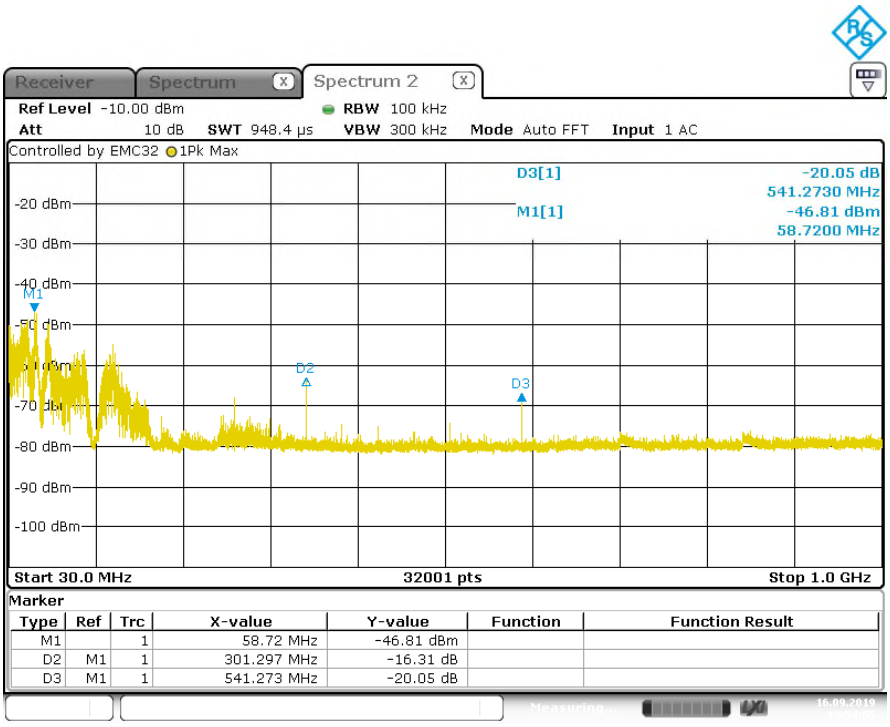
Table 8-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
Occupied Channel Bandwidth	± 0.009 %
RF Conducted Output Power	± 0.349 dB
Power Spectral Density	± 0.372 dB
Antenna Port Conducted Emissions	± 1.264 dB
Radiated Emissions ≤ 1 GHz	± 5.814 dB
Radiated Emissions > 1 GHz	± 4.318 dB
Temperature	± 0.860 °C
Radio Frequency	± 2.832 x 10^{-8}
AC Power Line Conducted Emissions	± 3.360 dB

9 CONCLUSION

In the opinion of TUV SUD the SC4240E-235470-BB, manufactured by Silvus Technologies, Inc. meets the requirements of FCC Part 90Y for the tests documented herein.

Appendix A: Plots



Note: Emissions above the noise floor are from the digital sections of the DUT and not associated with the radio.

Figure A-1: 30MHz-1GHz

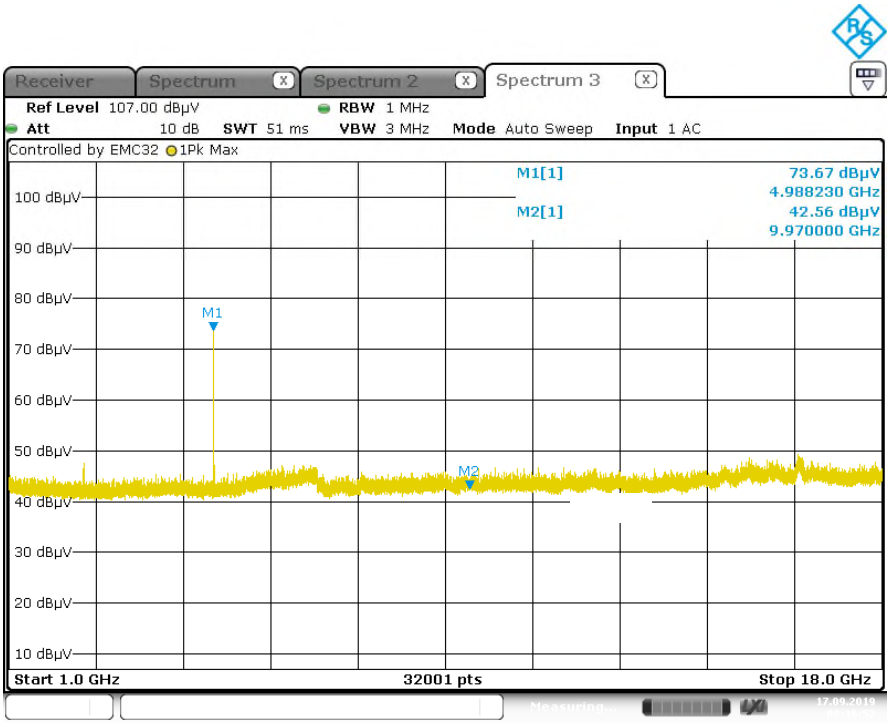


Figure A-2: 1GHz-18GHz

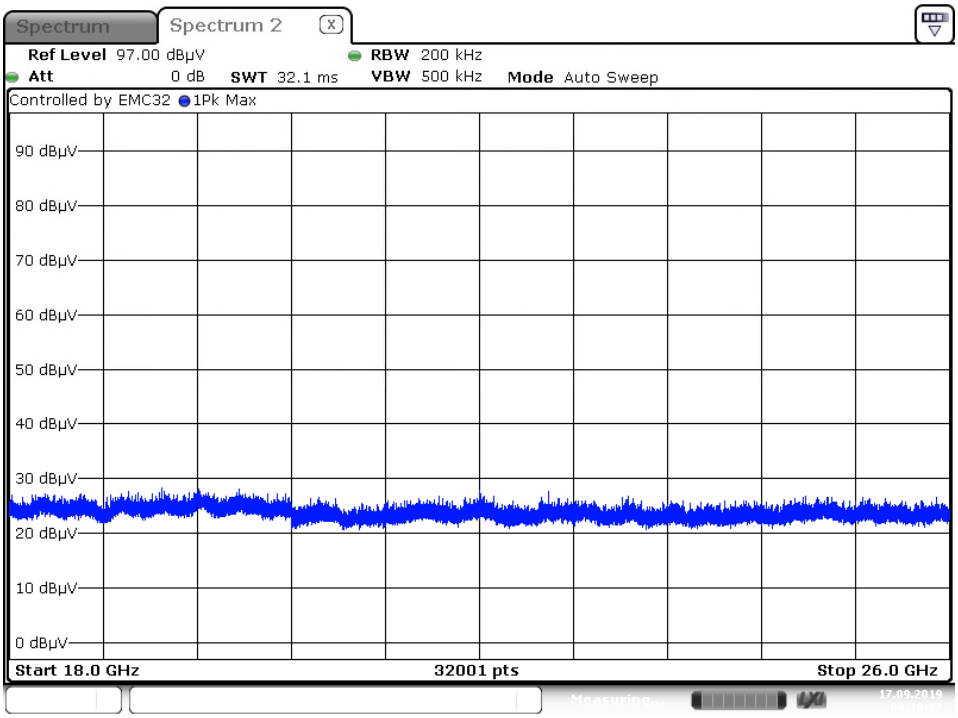


Figure A-3: 18GHz-26GHz

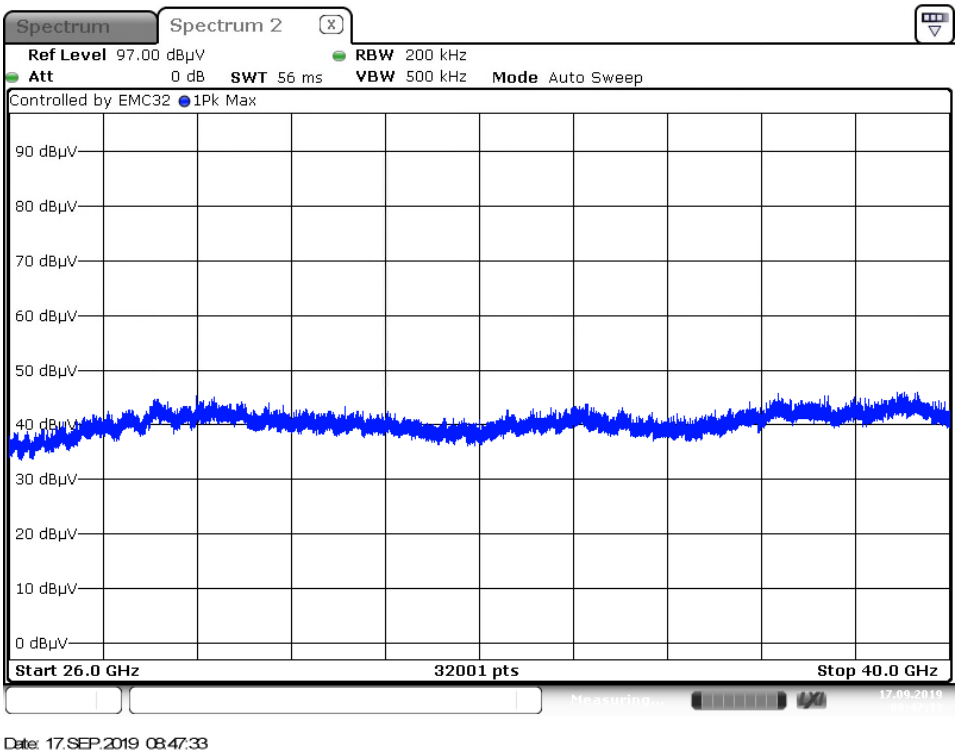


Figure A-4: 26GHz-40GHz

END REPORT