Report on the Testing of the Synapse Wireless SM220

In accordance with: FCC 47 CFR part 15.247 ISED RSS-247 Issue 3, August 2023

Prepared for: Synapse Wireless

351 SW Electronics Blvd Huntsville 35824 USA



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Jean Charles for the

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Thierry Jean-Charles	Senior Engineer TUV SUD America Inc.	Authorized Signatory	5/24/2024

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

FCC Accreditation Designation Number US1233

FCC Test Site Registration Number 967699

Innovation, Science, and Economic Development Canada Lab Code 23932

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with the standards listed above.





A2LA Cert. No. 2955.09

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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.

Table 1.1-1 - Modification Record

Issue Description of Change		Date of Issue
0	First Issue	05/24/2024

1.2 Introduction

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations Section 15.247 and Innovation Science and Economic Development Canada's Radio Standards Specification RSS-247 for the tests documented herein to support a Class II Permissive Change.

The purpose of this Class II Permissive Change is to add a new antenna to their pre-approved Zigbee SM220 module holding FCC ID: U9O-SM220 / IC ID: 708A4A-SM220

Applicant Jason Gestler

Manufacturer Synapse Wireless

Applicant's Email Address <u>jason.gastler@synapsewireless.com</u>

Model Number(s) SM220

Serial Number(s) NA

Module FCC ID U9O-SM220
Module ISED Certification 7084A-SM220

Number

Hardware Version(s) M-2
Software Version(s) 2.8.2
Number of Samples Tested 1

Test Specification/Issue/Date US Code of Federal Regulation (CFR): Title 47, Part 15,

Subpart C: Radio Frequency Devices, Intentional

Radiators, 2024

ISED Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network

(LE-LAN) Devices, Issue 3, August 2023.

Order Number 72199033

Date of Receipt of EUT 04/09/2024

Start of Test 04/11/2024



Finish of Test

Related Document(s)

04/15/2024

ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Device.

FCC OET KDB 558074 D01 15.247 Meas Guidance v05r02: Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules, April 2, 2019 US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2024. ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 5, Amendment 1 (March 2019), Amendment 2 (February 2021)



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC Part 15.247 and ISED Canada's RSS-247 is shown below.

Table 1.3-1: Test Result Summary

Test Parameter	Test Plan (Yes/No)	Test Result	FCC 47 CFR Rule Part	ISED Canada's RSS	Test Report Page No
Antenna Requirement	Yes	Pass	15.203, 15.204		10
6 dB Bandwidth	No	Not Tested	15.247(a)(2)	RSS-247 5.2(a)	
99% Bandwidth	No	Not Tested		RSS-GEN 6.7	
Avg Output Power	No	Not Tested	15.247(b)(3)	RSS-247 5.4(d)	
Band-Edge Compliance of RF Conducted Emissions	No	Not Tested	15.247(d)	RSS-247 5.5	
RF Conducted Spurious Emissions	No	Not Tested	15.247(d)	RSS-247 5.5	
Radiated Spurious Emissions into Restricted Frequency Bands	Yes	Pass	15.205, 15.209	RSS-GEN 8.9, 8.10	14
Power Spectral Density	No	Not Tested	15.247(e)	RSS-247 5.2(b)	
Power Line Conducted Emissions	Yes	Pass	15.207	RSS-GEN 8.8	11
Duty Cycle	No				



1.4 Product Information

EUT is a 802.15.4 Transceiver Module with SNAP OS.

1.4.1 Technical Description

Table 1.4.1-1 - Wireless Technical Information - Zigbee radio

Detail	Description	
Module FCC ID	U90-SM220	
Module ISED ID	7084A-SM220	
Module Model Name / Number	SM220	
Frequency Range	2405 – 2475 MHz	
Number of Channels	15	
Modulation Format	O-QPSK	
Channel Separation	5 MHz	
Data Rate	2 Mbps	
*Antenna Type / Description:	Low Profile Antenna: Data Alliance AL2W1G1 / 3dBi	

[&]quot;*" – The SM220 module was certified with various types of antennas, details of which are available in the original filing report. This is a new additional antenna adding to the SM220 Zigbee module. Antenna information declared by the customer.

A full description and detailed product specification details are available from the manufacturer.





Figure 1.4.1-1 - Front View of the EUT

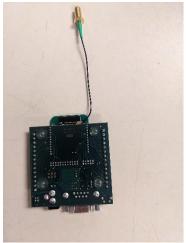


Figure 1.4.1-2 – Rear View of the EUT



Figure 1.4.1-3 – EUT with Antenna and Power Supply



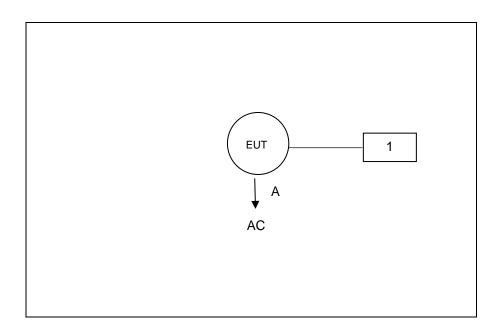


Figure 1.4.1-3 – Test Setup Block Diagram

Table 1.4.1-2 - Cable Descriptions

Item	Cable/Port	Description AC Power Adapter cable - PHIHONG	
А	Power cable	AC Power Adapter cable - PHIHONG	

Table 1.4.1-3 – Support Equipment Descriptions

Item	Make/Model	Description	
1	Low Profile Antenna: Data Alliance AL2W1G1	External Antenna	



1.4.2 Modes of Operation

The purpose of this evaluation is to ensure the compliance of the pre-approved module by adding a new external antenna.

This test report documents the compliance of Zigbee radio module on low, mid, and high channels.

1.4.3 Monitoring of Performance

For radiated emissions, the EUT was evaluated in an orientation of typical use. See test setup photos for more information. The EUT was programmed to generate a continuously modulated signal on each channel evaluated.

Test case	Tested Frequency (MHz)	Module or module/host combination
Radiated spurious emissions	2405, 2440, 2475	Module

Power setting during test: Similar to the pre-approved Module.



1.5 Deviations from the Standard

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

1.6 EUT Modification Record

The table below details modifications made to the EUT during the test program. 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
0	Initial State		

The equipment was tested as provided without any modifications.

1.7 Test Location

TÜV SÜD conducted the following tests at our Alpharetta, GA test laboratory.

Test Name	Name of Engineer(s)	Accreditation
Antenna Requirement	Divya Adusumilli	A2LA
Power Line Conducted Emissions	Divya Adusumilli	A2LA
Radiated Spurious Emissions into Restricted Frequency Bands	Divya Adusumilli	A2LA

Office address: TÜV SÜD America 5945 Cabot Parkway, Suite 100 Alpharetta, GA 30005, USA



2 Test Details

2.1 Antenna Requirement

2.1.1 Specification Reference

FCC Section: 15.203, 15.204

2.1.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.1.3 Date of Test

04/11/2024

2.1.4 Test Method

N/A

2.1.5 Environmental Conditions

N/A

2.1.6 Test Results

The EUT utilizes a Low profile antenna: Data alliance AL2W1G1 with the antenna gain 3 dBi. The antenna is marketed with the product using RSMA connectors which connect to the PCB module via a U.FL. to RSMA cable adapter. The EUT uses unique connectors and therefore meets the requirements of FCC section 15.203.



2.2 Power Line Conducted Emissions

2.2.1 Specification Reference

FCC Section: 15.207

ISED Canada: RSS-Gen 8.8

2.2.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.2.3 Date of Test

04/15/2024

2.2.4 Test Method

ANSI C63.10 section 6 was the guiding documents for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss Margin = Corrected Reading - Applicable Limit

2.2.5 Environmental Conditions

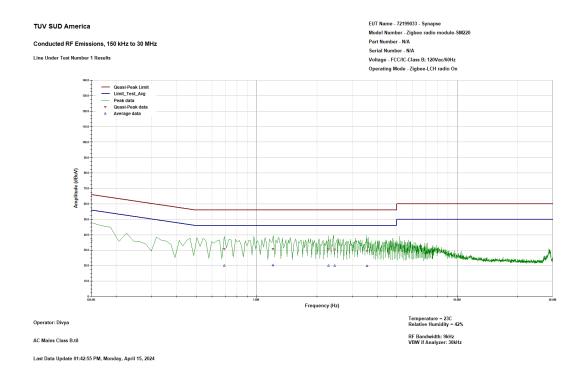
The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature 22.3 °C
Relative Humidity 53.8 %
Atmospheric Pressure 972.2 mbar



2.2.6 Test Results

Figure 2.2.6-1 - Graphical Results - AC Mains Composite Line Plot



Line 1 (AVG)

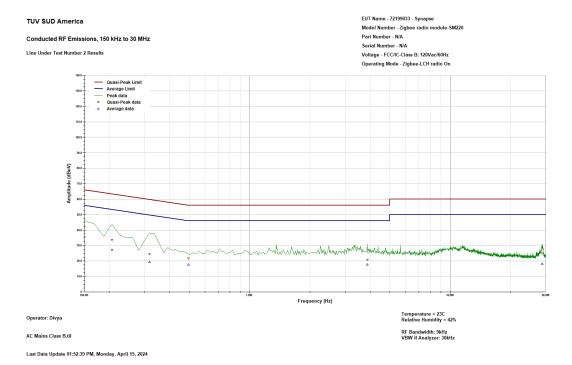
Frequency (MHz)	Avg Limit	Avg Level Corr	Avg Level	Corr Fact.	Avg Margin	Result
0.15	56	36.8	27.1	9.682	-19.2	PASS
0.69	46	20	10.3	9.662	-26	PASS
1.21	46	20.3	10.6	9.693	-25.7	PASS
2.29	46	20	10.2	9.782	-26	PASS
2.45	46	20.1	10.3	9.788	-25.9	PASS
3.56	46	19.8	10	9.78	-26.2	PASS

Line 1 (QP)

Frequency (MHz)	QP Limit	QP Level Corr	QP Level	Corr Fact.	QP Margin	Result
0.15	66	42.2	32.5	9.682	-23.8	PASS
0.69	56	30.9	21.2	9.662	-25.1	PASS
1.21	56	30.8	21.1	9.693	-25.2	PASS
2.29	56	30.6	20.8	9.782	-25.4	PASS
2.45	56	30.4	20.6	9.788	-25.6	PASS
3.56	56	29.5	19.7	9.78	-26.5	PASS



Figure 2.2.6-2 - Graphical Results - AC Mains Composite Neutral Plot



Neutral (AVG)

Frequency (MHz)	Avg Limit	Avg Level Corr	Avg Level	Corr Fact.	Avg Margin	Result		
0.15	56	36.1	26.4	9.675	-19.9	PASS		
0.21	54.4	27.3	17.6	9.669	-27.1	PASS		
0.32	51.2	19.3	9.7	9.657	-31.9	PASS		
0.5	46.1	17.8	8.1	9.63	-28.3	PASS		
3.86	46	17.8	8	9.8	-28.2	PASS		
28.78	50	18.2	8	10.193	-31.8	PASS		

Neutral (QP)

Frequency (MHz)	QP Limit	QP Level Corr	QP Level	Corr Fact.	QP Margin	Result
0.15	66	41.4	31.8	9.675	-24.6	PASS
0.21	64.4	33.6	23.9	9.669	-30.8	PASS
0.32	61.2	24.4	14.8	9.657	-36.8	PASS
0.5	56.1	21.6	11.9	9.63	-34.5	PASS
3.86	56	20.8	11	9.8	-35.2	PASS
28.78	60	24.9	14.7	10.193	-35.1	PASS



2.3 Radiated Spurious Emissions into Restricted Frequency Bands

2.3.1 Specification Reference

FCC Sections: 15.205, 15.209. ISED Canada RSS – Gen 8.9/8.10

2.3.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.3.3 Date of Test

04/11/2024 - 04/15/2024

2.3.4 Test Method

Radiated emissions tests were made over the frequency range of 9 kHz to 26 GHz, 10 times the highest fundamental frequency of 2.4 GHz radio. Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in Section 15.209.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 150 kHz, quasipeak measurements were made using a resolution bandwidth RBW of 300 Hz and a video bandwidth VBW of 1 kHz and frequencies between 150 kHz and 30MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 10 kHz and a video bandwidth VBW of 30 kHz. For frequencies between 30 MHz and 1000 MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 100 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak and average measurements were made with RBW of 1 MHz and VBW of 3 MHz

2.3.5 Environmental Conditions

The EUT was evaluated within the temperature, humidity and pressure range of the EUT as specified by the standard. The laboratory shall have an ambient temperature range of 15°C to 35°C, relative humidity range of 30% to 60% and atmospheric pressure range of 86 kPa to 106 kPa.

Ambient Temperature 22.3 °C
Relative Humidity 53.8 %
Atmospheric Pressure 972.2 mbar



2.3.6 Test Results

Test Summary: EUT was set to transmit mode.

Test Results: Pass

See data below for detailed results.

Table 2.3.6-1: Radiated Spurious Emissions Tabulated Data

Table 2.3.6-1: Radiated Spurious Emissions Tabulated Data										
Frequency	Peak Value	QP/Avg Value	Peak Limit	QP/Avg Limit	Peak Margin	QP/Avg Margin	Antenna Polarity	Peak Limit Results	QP/Avg Limit Results	
MHz	dBµV/m	dBµV/m	dBµV/m	dBµV/m	dB	dB	H/V	Pass/Fail	Pass/Fail	
	Low Channel – 2405 MHz									
2390.05	41.065	31.891	74	54	32.94	22.11	Н	PASS	PASS	
2390.05	41.052	32.018	74	54	32.95	21.98	V	PASS	PASS	
4811.025	38.778	29.137	74	54	35.22	24.86	Н	PASS	PASS	
9622.1	48.808	39.753	74	54	25.19	14.25	Н	PASS	PASS	
4811.025	38.326	28.373	74	54	35.67	25.63	V	PASS	PASS	
9622.1	50.137	41.566	74	54	23.86	12.43	V	PASS	PASS	
12027.45	40.309	31.251	74	54	33.69	22.75	Н	PASS	PASS	
14433.08	42.069	33.161	74	54	31.93	20.84	Н	PASS	PASS	
12025.25	30.341	16.128	74	54	43.66	37.87	V	PASS	PASS	
14430.13	34.319	22.594	74	54	39.68	31.41	V	PASS	PASS	
19240.08	34.965	21.201	74	54	39.03	32.8	Н	PASS	PASS	
19240.23	34.76	21.197	74	54	39.24	32.8	V	PASS	PASS	
				Mid Channe	I – 2440 MHz					
4881.025	39.444	30.56	74	54	34.56	23.44	Н	PASS	PASS	
7321.525	37.061	23.719	74	54	36.94	30.28	Н	PASS	PASS	
9762.1	43.689	33.776	74	54	30.31	20.22	Н	PASS	PASS	
4879.025	41.618	33.356	74	54	32.38	20.64	V	PASS	PASS	
7318.725	39.651	29.255	74	54	34.35	24.75	V	PASS	PASS	
9762.1	46.402	37.385	74	54	27.6	16.61	V	PASS	PASS	
12202.53	42.213	33.623	74	54	31.79	20.38	Н	PASS	PASS	
14631.1	33.326	19.202	74	54	40.67	34.8	Н	PASS	PASS	
12199.78	30.549	16.335	74	54	43.45	37.67	V	PASS	PASS	
17079.85	38.036	22.929	74	54	35.96	31.07	V	PASS	PASS	
19520.15	35.277	21.434	74	54	38.72	32.57	Н	PASS	PASS	
19520.18	34.674	21.432	74	54	39.33	32.57	V	PASS	PASS	
				High Channe	el – 2475 MHz	2				
2483.25	48.59	39.682	74	54	25.41	14.32	Н	PASS	PASS	



2483.25	51.467	42.403	74	54	22.53	11.6	V	PASS	PASS
4949.025	36.409	25.193	74	54	37.59	28.81	Н	PASS	PASS
7423.475	37.42	24.943	74	54	36.58	29.06	Н	PASS	PASS
9898.05	42.835	31.498	74	54	31.17	22.5	Н	PASS	PASS
4951.025	39.504	30.536	74	54	34.5	23.46	V	PASS	PASS
7423.825	40.376	29.952	74	54	33.62	24.05	V	PASS	PASS
9898.05	44.278	34.728	74	54	29.72	19.27	V	PASS	PASS
12377.35	33.753	21.811	74	54	40.25	32.19	Н	PASS	PASS
14847.08	33.629	19.892	74	54	40.37	34.11	Н	PASS	PASS
12372.55	37.513	27.342	74	54	36.49	26.66	V	PASS	PASS
14850.08	33.571	19.898	74	54	40.43	34.1	V	PASS	PASS
19799.75	36.292	21.528	74	54	37.71	32.47	Н	PASS	PASS
19804.08	37.75	23.499	74	54	36.25	30.5	V	PASS	PASS

Note: 1. A duty cycle correction factor of 14.1% was applied to the average measurements. 2. Emissions that fall under restricted frequencies were only evaluated.



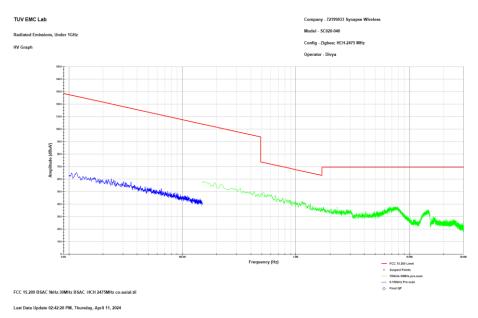


Figure 1: Reference Plot for Radiated Spurious Emissions – 9 kHz – 30 MHz – 2405 MHz – Co-axial Note: Emissions above the noise floor are ambient not associated with the EUT.

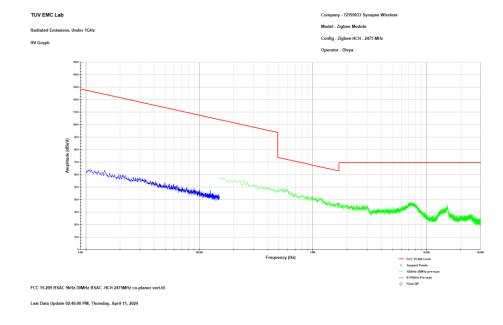


Figure 2: Radiated Spurious Emissions—9 kHz – 30MHz –2405 MHz – Co-planar Vertical Note: Emissions above the noise floor are ambient not associated with the EUT.



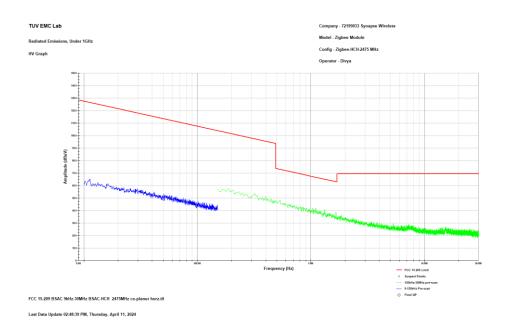


Figure 3: Radiated Spurious Emissions– 9 kHz – 30MHz – 2405 MHz- Co-planar Horizontal Note: Emissions above the noise floor are ambient not associated with the EUT.

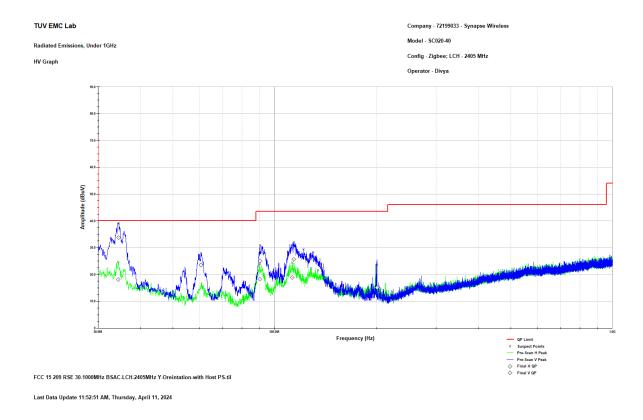


Figure 4: Refrence plot for Radiated Spurious Emissions – 30 MHz – 1 GHz– H/V polarity – 2405 MHz



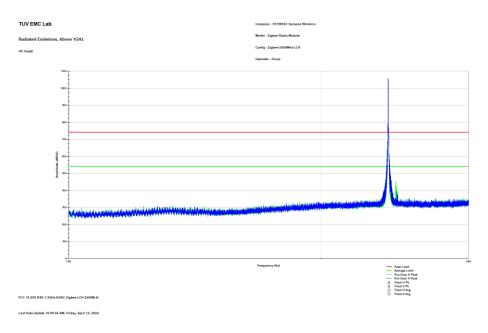


Figure 5: Reference Plot for Radiated Spurious Emissions – 1 – 3 GHz –H/V polarity – 2405 MHz Note: Emission above the limit line is the Fundamental Frequency of Zigbee radio.

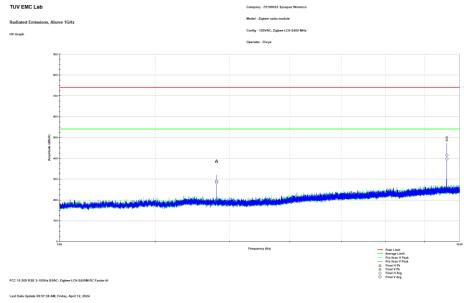


Figure 6: Reference Plot for Radiated Spurious Emissions - 3 - 10 GHz -H/V polarity - 2405 MHz



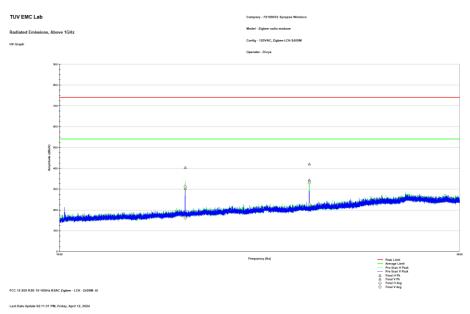


Figure 7: Reference plot for Radiated Spurious Emissions – 10 – 18 GHz– H/V polarity – 2405 MHz

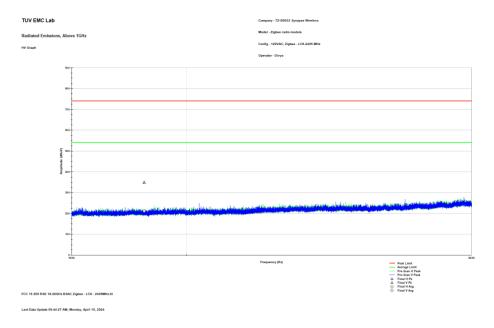


Figure 8: Reference Plot for Radiated Spurious Emissions – 18 – 26 GHz –H/V polarity – 2405 MHz



2.4 Test Equipment Used

Table 2.4-1 - Equipment List

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	06/20/2023	06/20/2024
853	Teseq	CBL6112D	BiLog Antenna	51616	11/01/2022	11/01/2024
884	ETS Lindgren (EMCO)	3117	DOUBLE-RIDGED GUIDE ANTENNA	240106	05/16/2023	05/16/2025
889	Com Power	PAM 103	Pre-amplifier	18020215	10/02/2023	10/02/2024
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	6/22/2023	6/22/2025
882	Rohde & Schwarz	ESW44	ESW44 EMI TEST RECEIVER	101961	06/21/2023	06/21/2024
22	Teledyne Storm Microwave	90-195-456	BSAC Cable	N/A	10/02/2023	10/02/2024
20	Teledyne Storm Microwave	R-90-195-036	BSAC Cable	N/A	07/13/2023	07/13/2024
21	Teledyne Storm Microwave	R-90-195-072	BSAC Cable	N/A	07/13/2023	07/13/2024
334	Rohde & Schwarz	3160-09	HF 18 -26.5 GHz antenna	49404	04/25/2023	04/25/2024
335	Suhner	SF-102A	Cable (40GHZ)	882/2A	06/22/2023	06/22/2024
345	Suhner Sucoflex	102A	Cable 42(GHZ)	1077/2A	06/22/2023	06/22/2024
3010	Rohde & Schwarz	ENV216	Two-Line V-Network	3010	6/21/2023	6/21/2024
871	ACS	n/a	Conducted EMI Cable	871	3/24/2023	3/24/2024
872	HP	E7402A	EMI Receiver	US40240258	6/22/2023	6/22/2024
144	Omega	RH411	Temp / Humidity Meter	H0103373	02/03/2023	02/03/2025

N/A - Not Applicable



3 Diagram of Test Set-ups

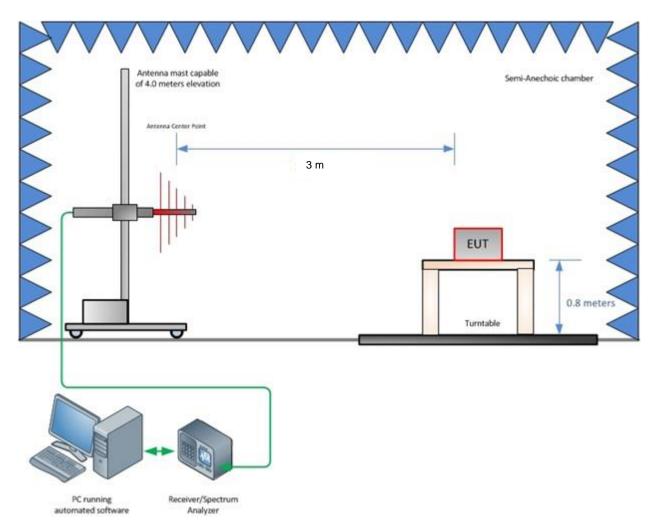


Figure 3-1 – Radiated Emissions Test Setup up to 1 GHz



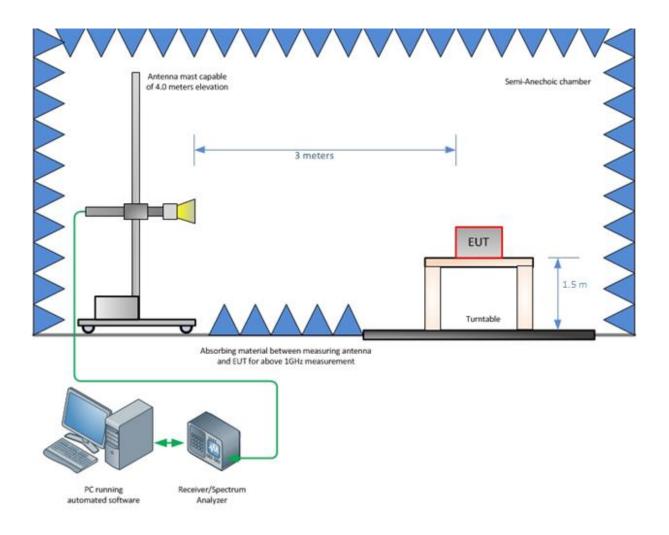


Figure 3-2 - Radiated Emissions Test Setup above 1 GHz



4 Accreditation, Disclaimers and Copyright

TÜV SÜD America Inc.'s reports apply only to the specific sample tested under stated test conditions. It is the manufacturer's responsibility to assure the continued compliance of production units of this model. TÜV SÜD America, Inc. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD America, Inc.'s issued reports.

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

STATEMENT OF MEASUREMENT UNCERTAINTY - Emissions

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 4-1: Estimation of Measurement Uncertainty

Parameter	U _{lab}
Radiated Emissions ≤ 1 GHz	± 5.814 dB
Radiated Emissions > 1 GHz	± 4.318 dB
AC Power Line Conducted Emissions	± 3.360 dB

TEST EQUIPMENT

All measurement instrumentation is traceable to the National Institute of Standards and Technology and is calibrated to meet test method standard requirements and/or manufacturer's specifications.



END REPORT