



F2 Labs
16740 Peters Road
Middlefield, Ohio 44062
United States of America
www.f2labs.com

CERTIFICATION TEST REPORT

Manufacturer: Systemic Dizainas UAB
Vikpedes Str. 4
03151 Lithuania

Applicant: Zehnder America
6 Merrill Industrial Drive, Suite 7
Hampton, New Hampshire 03842 USA
United States of America

Product Name: SNS-CO2-RF67-925MHz-MTB

Product Description: Sensor for carbon dioxide

Operating Voltage/Frequency: 120V/60 Hz

Model: Sensor CO2

FCC ID: 2A8X810019109

Testing Commenced: 2022-08-25

Testing Ended: 2022-08-29

Summary of Test Results: **In Compliance**

The EUT complies with the EMC requirements when manufactured identically as the unit tested in this report, including any required modifications and/or manufacturer's statement. Any changes to the design or build of this unit subsequent to this testing may deem it non-compliant.

Standards:

- ❖ FCC Part 15 Subpart C, Section 15.249
- ❖ FCC Part 15 Subpart C, Section 15.215(c) – Additional provisions to the general radiated emission limitations
- ❖ FCC15.207 - Conducted Limits
- ❖ FCC Part 15 Subpart A, Section 15.31(e) – Measurement Standards



Evaluation Conducted by:

Julius Chiller, Senior Wireless Project Engineer

Report Reviewed by:

Ken Littell, Vice President of Operations

F2 Labs
26501 Ridge Road
Damascus, MD 20872
Ph 301.253.4500

F2 Labs
16740 Peters Road
Middlefield, OH 44062
Ph 440.632.5541

F2 Labs
8583 Zionsville Road
Indianapolis, IN 46268
Ph 317.610.0611

This test report may be reproduced in full; partial reproduction only may be made with the written consent of F2 Labs. The results in this report apply only to the equipment tested.



TABLE OF CONTENTS

Section	Title	Page
1	ADMINISTRATIVE INFORMATION	4
2	SUMMARY OF TEST RESULTS/MODIFICATIONS	7
3	TABLE OF MEASURED RESULTS	8
4	ENGINEERING STATEMENT	9
5	EUT INFORMATION AND DATA	10
6	LIST OF MEASUREMENT INSTRUMENTATION	11
7	OCCUPIED BANDWIDTH	12
8	FIELD STRENGTH OF EMISSIONS	15
9	VOLTAGE VARIATIONS	22
10	CONDUCTED EMISSIONS	25
11	PHOTOGRAPHS - TEST SETUPS	30



1 ADMINISTRATIVE INFORMATION

1.1 Measurement Location:

F2 Labs in Middlefield, Ohio. Site description and attenuation data are on file with the FCC's Sampling and Measurement Branch at the FCC Laboratory in Columbia, MD.

1.2 Measurement Procedure:

All measurements were performed according to ANSI C63.10 and recommended FCC procedure of measurement under Section 15.249. A list of the measurement equipment can be found in Section 6.



1.3 Uncertainty Budget:

The uncertainty in EMC measurements arises from several factors which affect the results, some associated with environmental conditions in the measurement room, the test equipment being used, and the measurement techniques adopted.

The measurement uncertainty budgets detailed below are calculated from the test and calibration data and are expressed with a 95% confidence factor using a coverage factor of $k=2$. The Uncertainty for a laboratory is referred to as U_{lab} . For Radiated and Conducted Emissions, the Expanded Uncertainty is compared to the U_{cispr} values to determine if a specific margin is required to deem compliance.

U_{lab}

Measurement Range	Combined Uncertainty	Expanded Uncertainty
Radiated Emissions <1 GHz @ 3m	2.54	5.07dB
Radiated Emissions <1 GHz @ 10m	2.55	5.09dB
Radiated Emissions 1 GHz to 2.7 GHz	1.81	3.62dB
Radiated Emissions 2.7 GHz to 18 GHz	1.55	3.10dB
AC Power Line Conducted Emissions, 150kHz to 30 MHz	1.38	2.76dB
AC Power Line Conducted Emissions, 9kHz to 150kHz	1.66	3.32dB

U_{cispr}

Measurement Range	Expanded Uncertainty
Radiated Emissions <1 GHz @ 3m	5.2dB
Radiated Emissions <1 GHz @ 10m	5.2dB
Radiated Emissions 1 GHz to 2.7 GHz	Under Consideration
Radiated Emissions 2.7 GHz to 18 GHz	Under Consideration
AC Power Line Conducted Emissions, 150kHz to 30 MHz	3.6dB
AC Power Line Conducted Emissions, 9kHz to 150kHz	4.0dB

If U_{lab} is less than or equal to U_{cispr} , then:

- compliance is deemed to occur if no measured disturbance exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance exceeds the disturbance limit.

If U_{lab} is greater than U_{cispr} in table 1, then:

- compliance is deemed to occur if no measured disturbance, increased by $(U_{lab} - U_{cispr})$, exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance, increased by $(U_{lab} - U_{cispr})$, exceeds the disturbance limit.

Note: Only measurements listed in the tables above that relate to tests included in this Test Report are applicable.



1.4 Document History:

Document Number	Description	Issue Date	Approved By
F2P27923-01E	First Issue	2022-10-07	K. Littell



2 SUMMARY OF TEST RESULTS

Test Name	Standard(s)	Results
99% Occupied Bandwidth	CFR 47 Part 15.215(c)	Complies
-20dB Occupied Bandwidth	CFR 47 Part 15.215(c)	Complies
Field Strength of Emissions: Power setting: +10dBm	CFR 47 Part 15.249(a)(d)	Complies
Variation of the Input Power	CFR 47 Part 15.31(e)	Complies
Conducted Emissions	CFR 47 Part 15.207(a)	Complies

Note: Product was operated using an AC to DC power supply, so Voltage Variation testing in 15.31(3)(e) was performed at the nominal voltage, and then the 85% and 115% of that voltage was tested also. The output power was measured to verify how much the power and frequency were affected by the variation of the input power. No shift in frequency or power was measured at either of the varied voltages on any of the channels.

Modifications Made to the Equipment
None



3 TABLE OF MEASURED RESULTS

Test		925 MHz
Quasi-Peak Field Strength of Fundamental: Power setting = -2dBm		89.9dB μ V/m, 31.3 mV/m
Average Limit for Fundamental		93.97dB μ V/m. 50 millivolts/meter
-20dB Occupied Bandwidth		0.206 MHz
99% Occupied Bandwidth (MHz)		0.187 MHz
Voltage Variations	-15%	87.09dBuV/m, 22.6 mV/m
	Nominal	88.45 dBuV/m, 26.4 mV/m
	+15%	88.34dBuV/m, 26.12mV/m

The -20dB bandwidth of the emission shall be contained within the frequency band designated in the rule section under which the equipment is operated.



4 ENGINEERING STATEMENT

This report has been prepared on behalf of Zehnder America to provide documentation for the testing described herein. This equipment has been tested and found to comply with part 15.249 of the FCC Rules using ANSI C63.10 standard. The test results found in this test report relate only to the items tested.



5 EUT INFORMATION AND DATA

5.1 Equipment Under Test:

Product: **SNS-CO2-RF67-925MHz-MTB**

Model: **Sensor CO2**

Serial No.: ZWS22310001

Firmware: CO2SensFW_RF_FCC_US_v0.04.hex

Hardware: V3.0

FCC ID: 2A8X810019109

5.2 Trade Name:

Zehnder America

5.3 Power Supply:

120V/60 Hz

5.4 Applicable Rules:

CFR 47, Part 15.249, subpart C

5.5 Antenna:

Chip Antenna, peak gain -0.7 dB

5.6 Accessories: None

5.7 Test Item Condition:

The equipment to be tested was received in good condition.

5.8 Testing Algorithm:

EUT was set up to transmit a continuously modulated signal at 925 MHz using GFSK modulation with a data rate of 100kbps.

**6 LIST OF MEASUREMENT INSTRUMENTATION**

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shielded Chamber 2014	CL166-E	AlbatrossProjects	B83117-DF435-T261	US140023	2023-08-22
Shielded Chamber 2018	CL251-E-10m	AlbatrossProjects	US170028	B83117-FG639-T261	2023-08-22
Receiver	CL151	Rohde & Schwarz	ESU40	100319	2023-03-31
Receiver	CL204	Rohde & Schwarz	ESR7	101714	2023-03-30
Antenna, Bilog	CL211	Sunol Sciences, Inc.	JB1	A021017	2022-09-28
Active 18" Loop Antenna	CL163-Loop	A.H. Systems, Inc.	EHA-52B	100	2022-09-14
Pre-Amplifier	CL153	Agilent	83006-69007	MY57280115	2022-10-12
Pre-Amplifier	CL136	Hewlett Packard	8447E	1937A01894	2023-03-30
Horn Antenna	CL098	Emco	3115	9809-5580	2023-01-26
Spectrum Analyzer	0204	Hewlett Packard	HP8591A	3149A02546	2023-03-29
Software:	EMC Analyzer 85712D Rev. A.00.01			Date Verified:	2022-08-22 to 2022-08-26
Transient Limiter	0202	Hewlett Packard	11947A	3107A00729	2023-03-29
LISN	CL181	Com-Power	LI-125A	191226	2023-12-01
LISN	CL182	Com-Power	LI-125A	191225	2023-12-01
Temp/Hum. Recorder	CL232	Extech	445814	01	2023-05-19
Temp/Hum. Recorder	CL293	Thermpro	TP50	1	2023-04-15
Temp/Hum. Recorder	CL294	Thermpro	TP50	2	2023-04-15
Software:	Tile Version 3.4.B.3.		Software Verified: 2022-08-25 to 2022-08-29		
Software:	EMC 32, Version 8.53.0		Software Verified: 2022-08-25 to 2022-08-29		
Software:	EMC 32, Version 10.60.20		Software Verified: 2022-08-25 to 2022-08-29		



7 FCC PART 15.215(e), OCCUPIED BANDWIDTH

7.1 Requirements:

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the -20dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

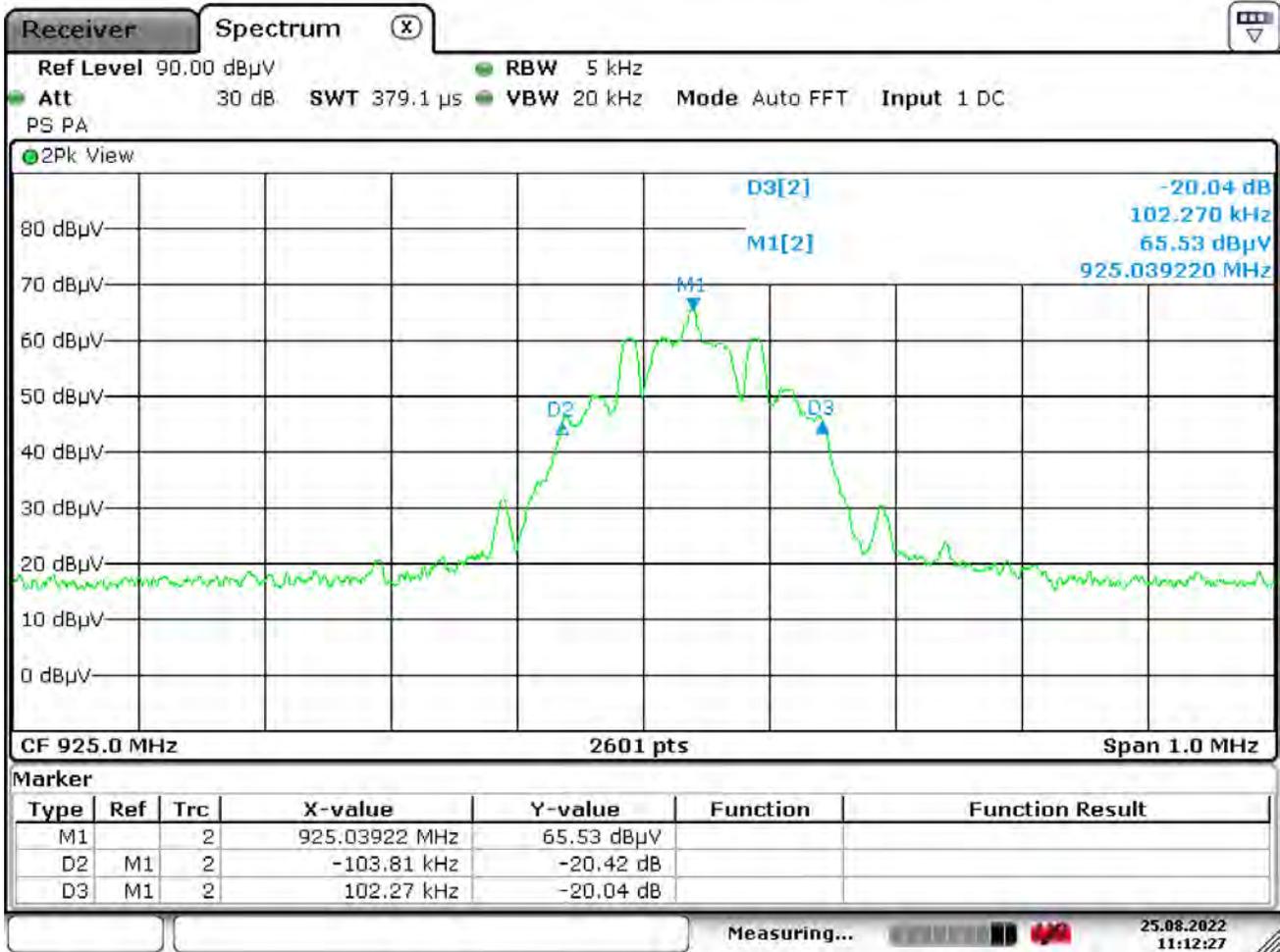
Bandwidth measurements were made at 925 MHz. The bandwidth was measured using the analyzer's marker function.



7.2 Occupied Bandwidth Test Data

Test Date(s):	2022-08-25	Test Engineer(s):	J. Chiller
Standards:	CFR 47 Part 15.215(c)	Air Temperature:	22.9°C
		Relative Humidity:	40%

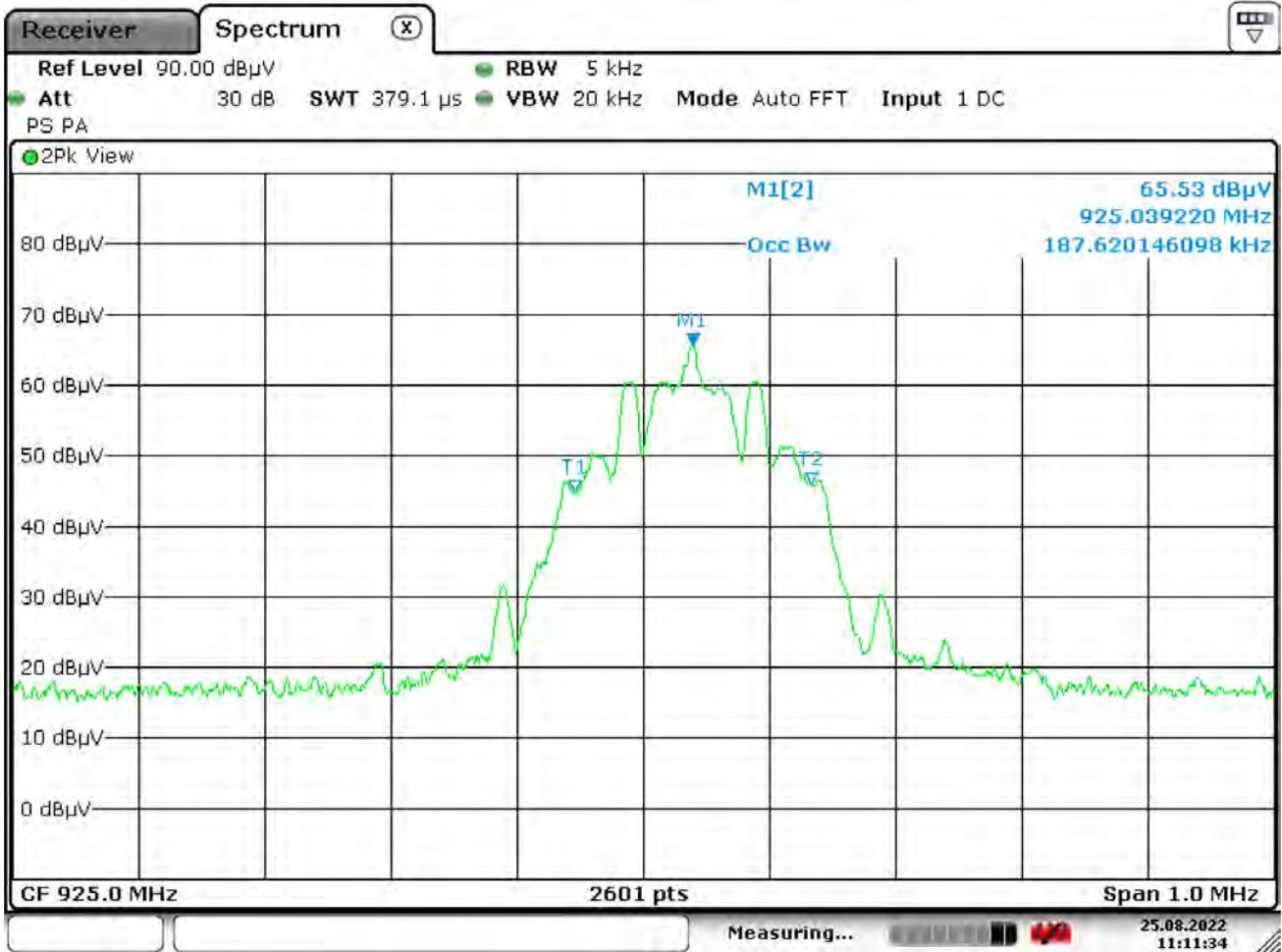
-20dB



Date: 25.AUG.2022 11:12:26



99%



Date: 25.AUG.2022 11:11:33



8 FIELD STRENGTH OF EMISSIONS FROM INTENTIONAL RADIATORS

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency	Field Strength of Fundamental (millivolts/meter)	Field Strength of Harmonics (microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

NOTE: During the pre-scan evaluation, the EUT was rotated in all possible directions to find the maximum emissions. The orthogonal position that showed the highest emissions was used. The antenna was raised between 1 and 4 meters and the EUT turntable was rotated 360 degrees to maximize the emissions.

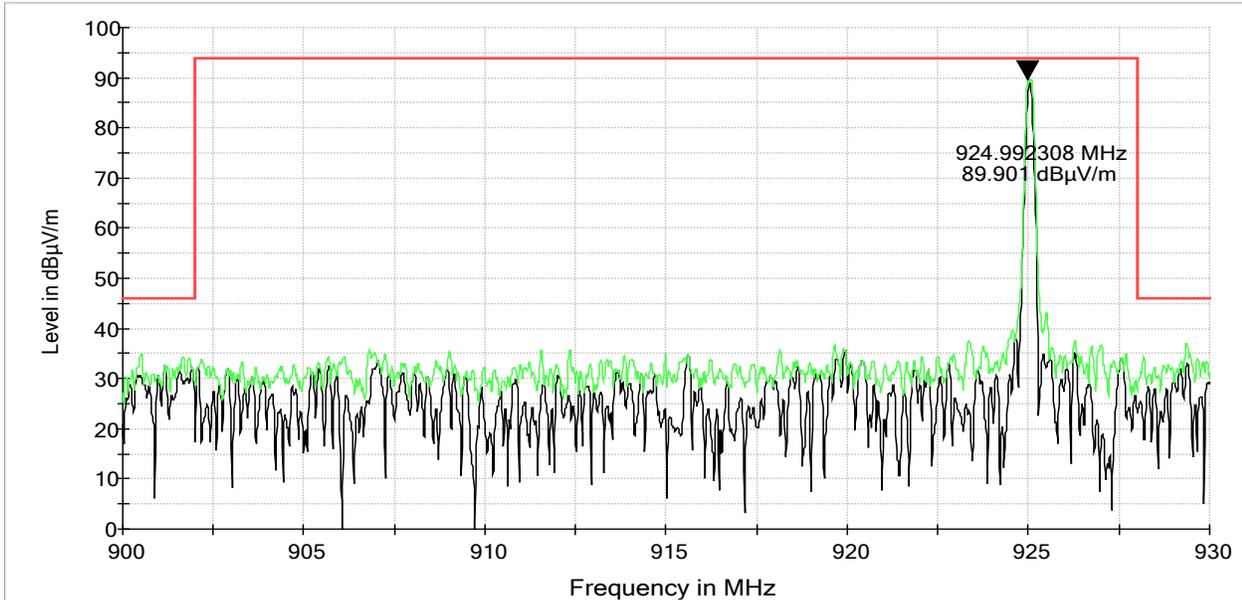
Power setting was set to +10dBm (default).



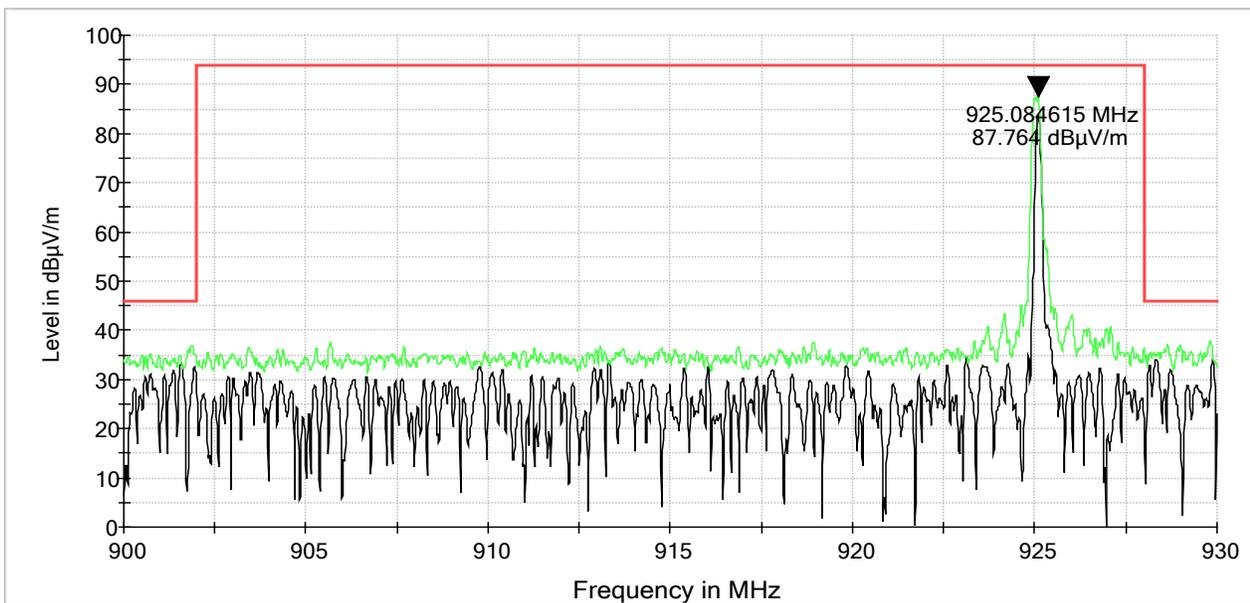
8.1 Test Data - Field Strength of Emissions from Intentional Radiators

Test Date(s):	2022-08-25	Test Engineer(s):	J. Chiller
Standards:	CFR 47 Part 15.249(a)	Air Temperature:	23.1°C
		Relative Humidity:	40%

Band Edges: Vertical



Band Edges: Horizontal

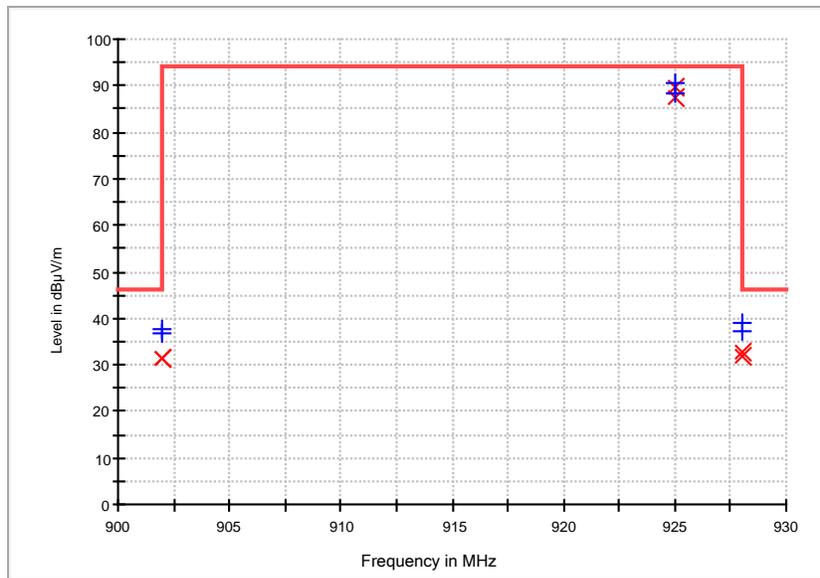




Band Edge and Field Strength of the Fundamentals

QP

Frequency (MHz)	Antenna Polarization	Bandwidth (kHz)	Antenna Height (cm)	Azimuth (deg)	Reading (dB μ V)	Cable Loss & Antenna Factor (dB)	Emission (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
902.00	H	120.00	200.00	126.00	13.8	17.4	31.20	46.0	-14.8
902.00	V	120.00	100.00	308.00	13.8	17.4	31.20	46.0	-14.8
925.00	H	120.00	200.00	126.00	69.7	17.7	87.40	94.0	-6.6
925.00	V	120.00	100.00	308.00	72.2	17.7	89.90	94.0	-4.1
928.00	H	120.00	200.00	126.00	15.1	17.7	32.80	46.0	-13.2
928.00	V	120.00	100.00	308.00	14.2	17.7	31.90	46.0	-14.1





8.2 Test Data – Spurious Emissions

Notes: Plots are peak, max hold pre-scan data included only to determine what frequencies to investigate and measure. During the pre-scan evaluation, the EUT was rotated in all possible directions to find the maximum emissions. The orthogonal position that showed the highest emissions was used. At some frequencies, no emissions from the EUT were measurable over the ambient noise floor. The readings did not change with EUT on and EUT off.

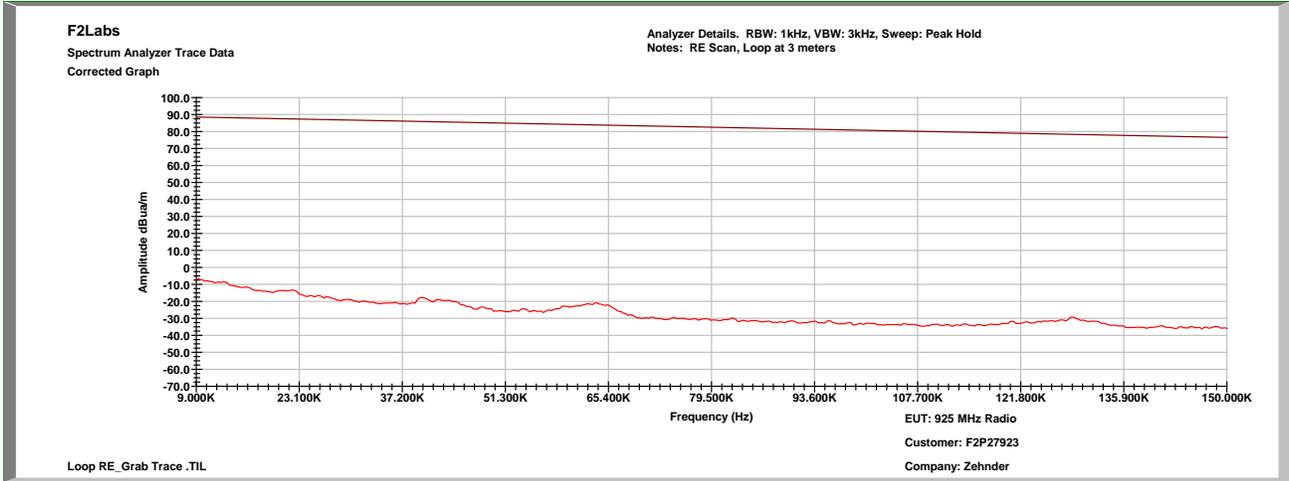
At least 6 of the highest frequencies were measured per ANSI 63.4 in a 3-meter anechoic chamber. Frequencies below 1 GHz were measured using a quasi-peak detector. The antenna was raised between 1 and 4 meters and the EUT turntable was rotated 360 degrees to maximize the emissions. Some of the frequencies did not change with the EUT on or off. At those frequencies, the test distance was shortened to 1 meter and still no emissions from the EUT were visible or over the ambient or limit. Frequencies were scanned from 9kHz to 10 GHz and the highest emissions are listed below.

In the following plots, the black line indicates ambient noise and the red line indicates the measurement with the EUT on. Emissions to be found by the EUT were measured and listed in tables below.

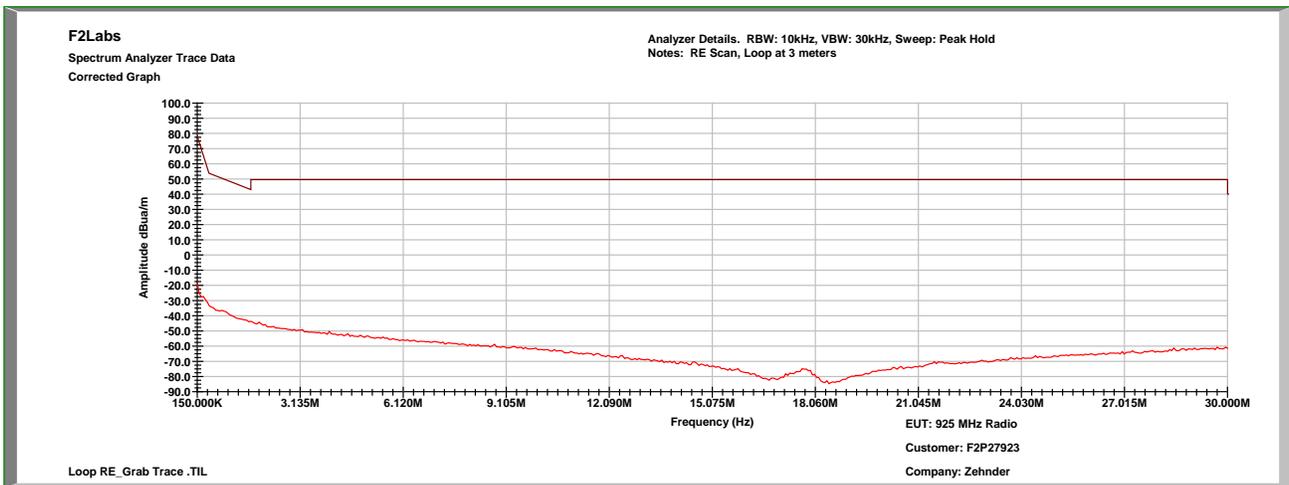


Test Date(s):	2022-08-25	Test Engineer(s):	J. Chiller
Standards:	CFR 47 Part 15.249(d) / Part 15.209	Air Temperature:	23.1°C
		Relative Humidity:	40%

Characterization Scan, 9 kHz to 150 kHz



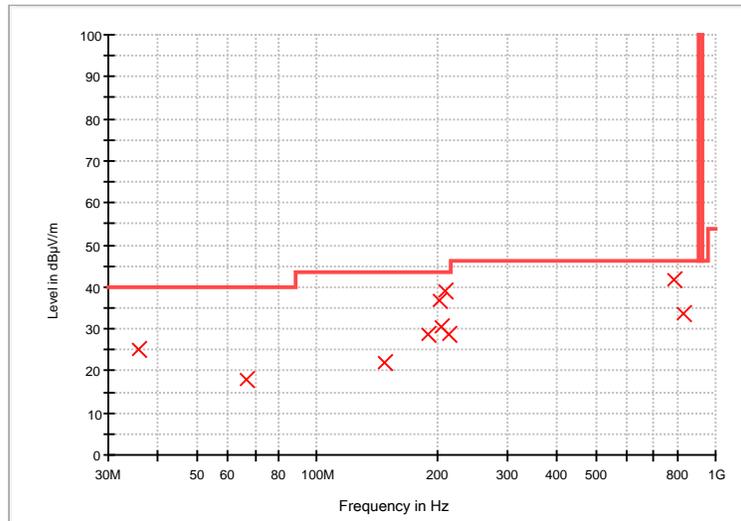
Characterization Scan, 150 kHz to 30 MHz





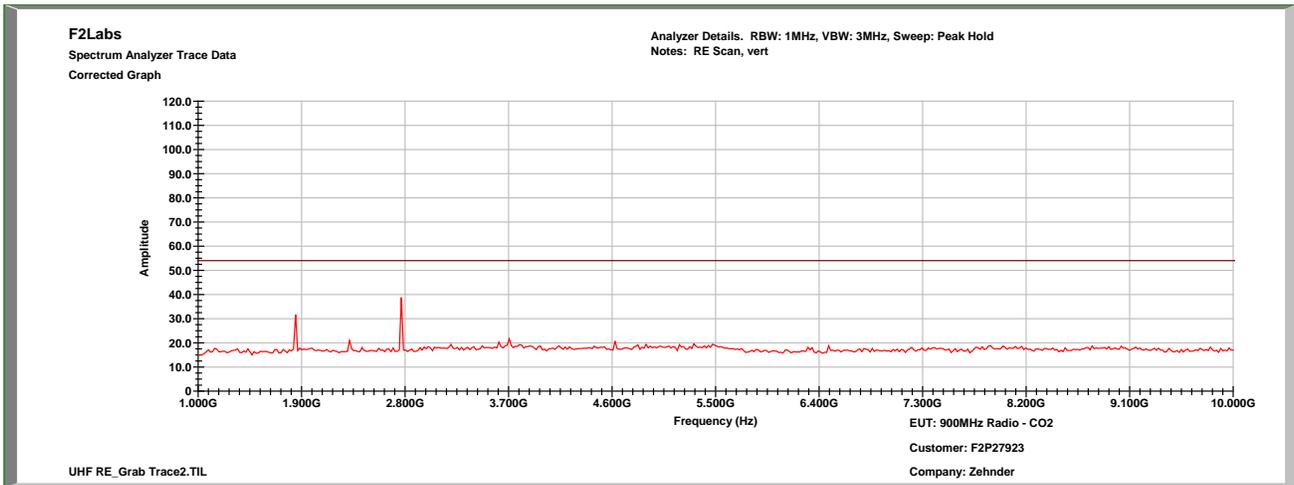
30 MHz to 1000 MHz

Frequency (MHz)	Ant. Pol.	Ant. Height (cm)	Azimuth (degrees)	Reading (dBµV)	Correction Factors (dB)	Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)
35.600000	V	100.00	3.00	17.2	7.9	25.10	40.0	-14.9
66.560000	V	100.00	258.00	19.1	-1.2	17.90	40.0	-22.1
147.520000	V	100.00	35.00	18.5	3.6	22.10	43.5	-21.4
190.800000	V	100.00	238.00	25.5	3.0	28.50	43.5	-15.0
202.000000	H	100.00	341.00	32.5	4.4	36.90	43.5	-6.6
205.360000	V	100.00	157.00	27.5	2.9	30.40	43.5	-13.1
210.200000	H	100.00	0.00	36.5	2.4	38.90	43.5	-4.6
214.680000	V	100.00	227.00	26.1	2.6	28.70	43.5	-14.8
782.120000	H	100.00	346.00	26.0	15.8	41.80	46.0	-4.2
827.280000	H	100.00	0.00	17.1	16.3	33.40	46.0	-12.6

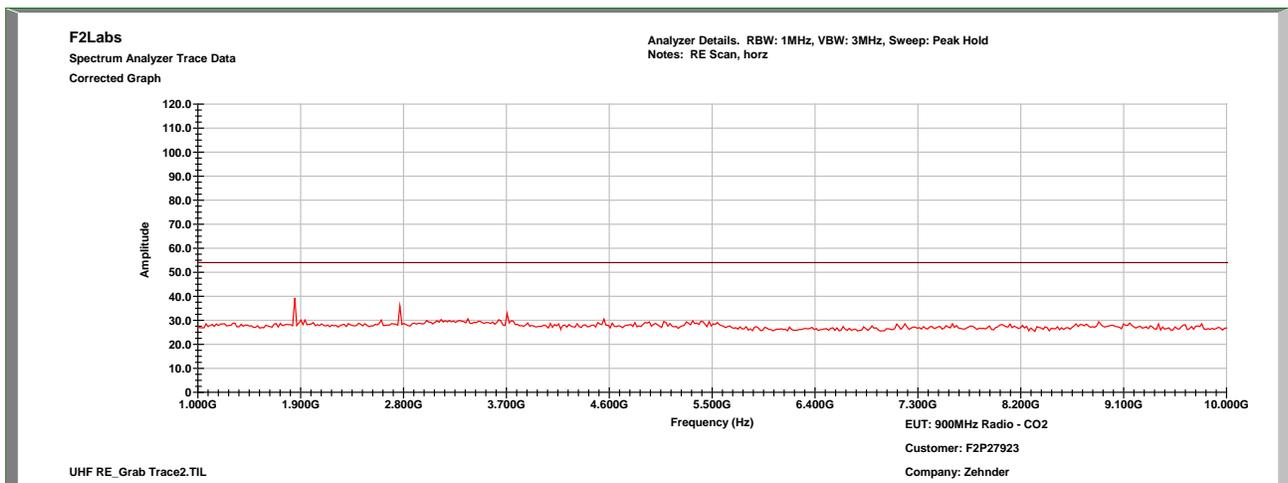




1 GHz to 10 GHz, Vertical



1 GHz to 10 GHz, Horizontal





9 VOLTAGE VARIATIONS

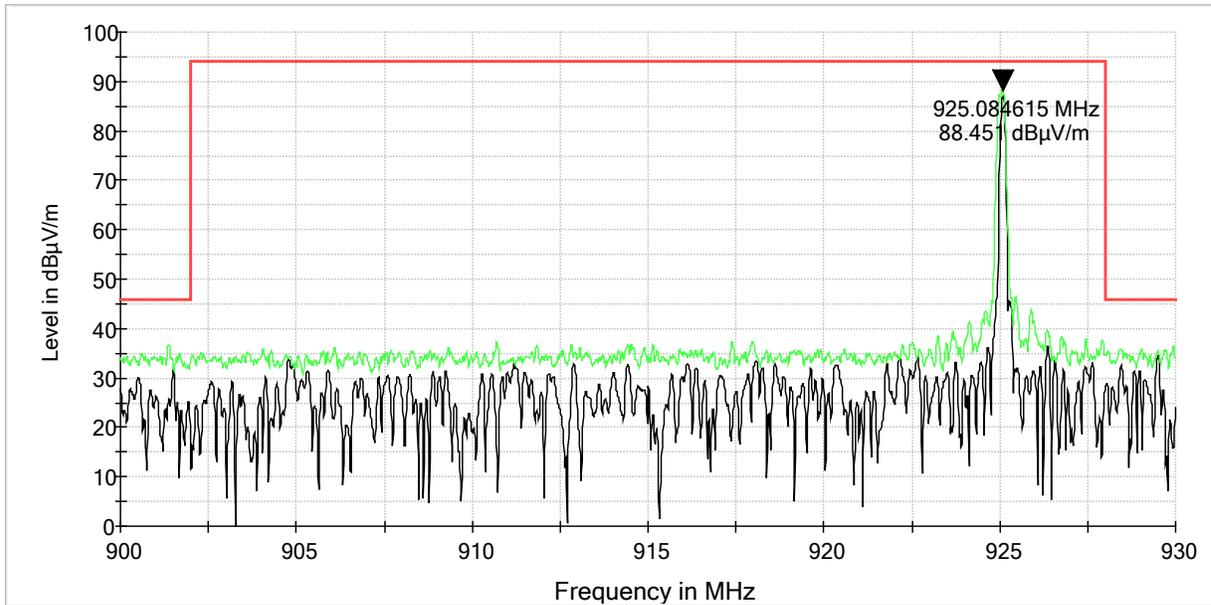
For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery. A nominal voltage of 110VAC was used and then 93VAC and 127VAC were used as the 85% and 115% variations.

RESULTS: The results showed that the fundamental frequency did not move outside the frequency band and the field strength did not increase above the limit during the variations.



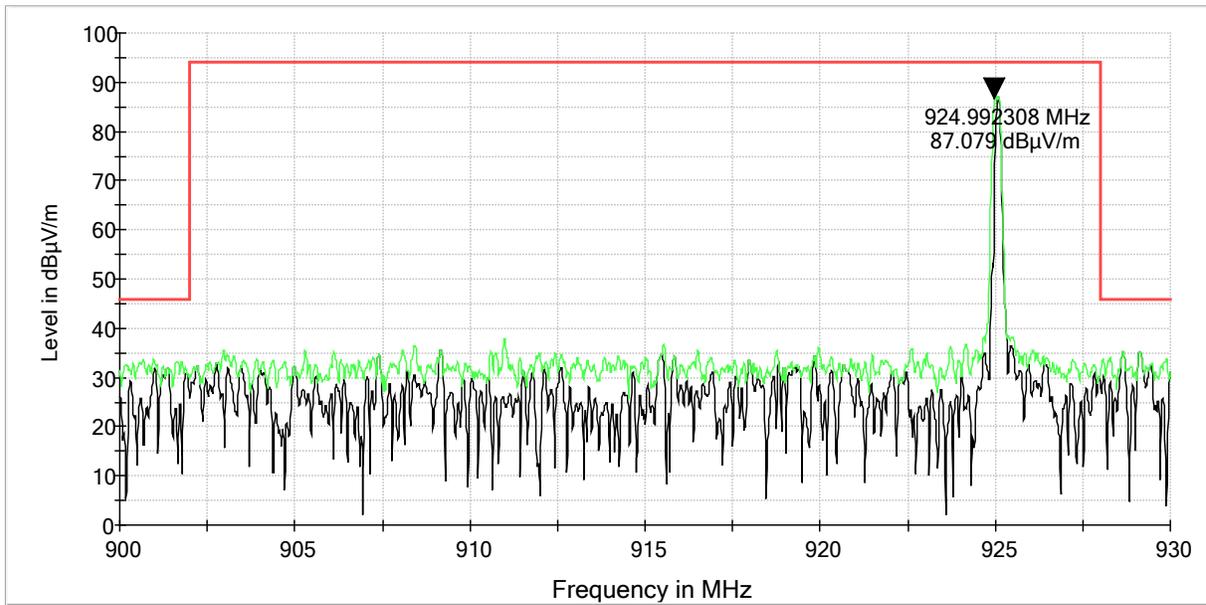
Test Date:	2022-08-25	Test Engineer:	J. Chiller
Rule:	RSS GEN Part 6.11	Air Temperature:	24.1° C
Test Results:	Pass	Relative Humidity:	39%

Nominal @ 110VAC

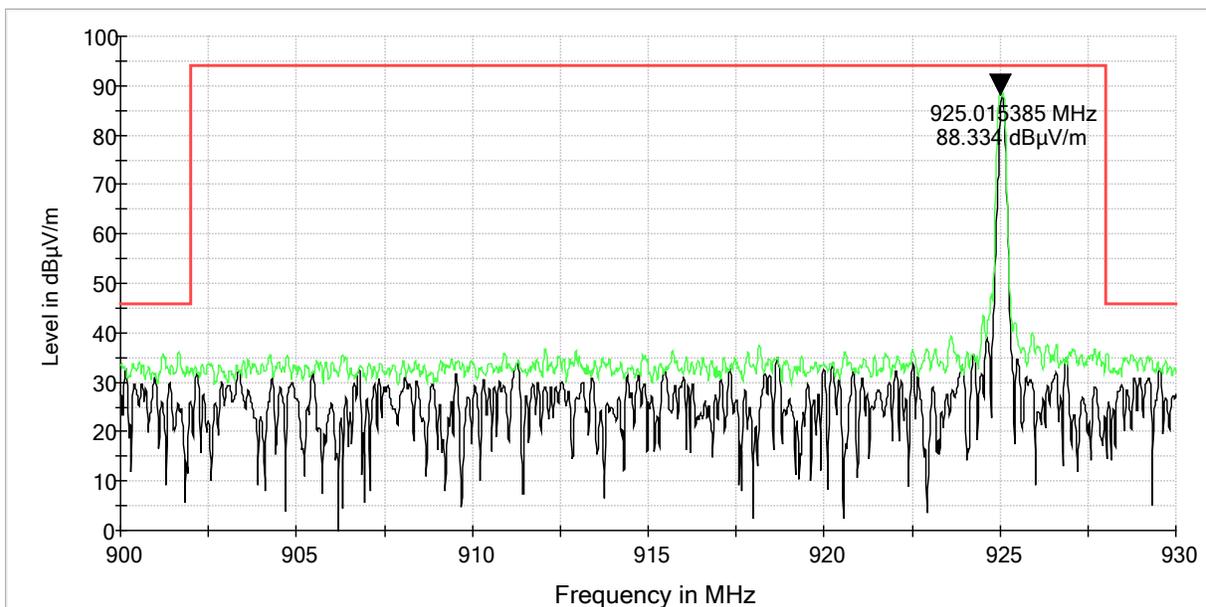




-15% (93.5 VAC)



+15% (126.5 VAC)





10 CONDUCTED EMISSIONS

10.1 Requirements

In accordance with FCC CFR 47 Part 15.207(a), “Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

10.2 Procedure

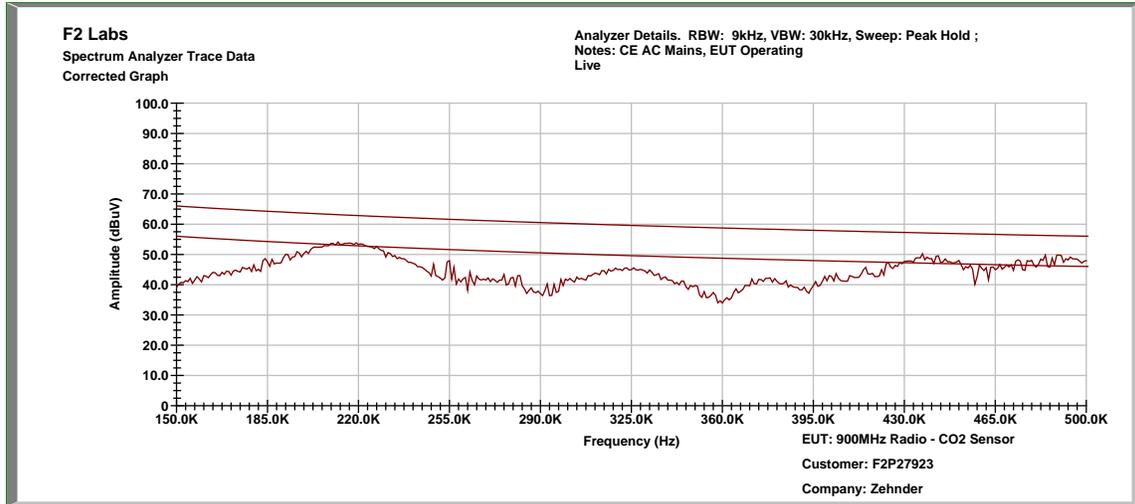
The EUT was placed on a 1.0 x 1.5 meter non-conductive table, 0.8 meter above a horizontal ground plane and 0.4 meter from a vertical ground plane. Power was provided to the EUT through a LISN bonded to a 3 x 2 meter ground plane. The LISN and peripherals were supplied power through a filtered AC power source. The output of the LISN was connected to the input of the receiver via a transient limiter, and emissions in the range 150 kHz to 30 MHz were measured. The measurements were recorded using the quasi-peak and average detectors as directed by the standard, and the resolution bandwidth during testing was 9 kHz. The raw measurements were corrected to allow for attenuation from the LISN, transient limiter and cables.



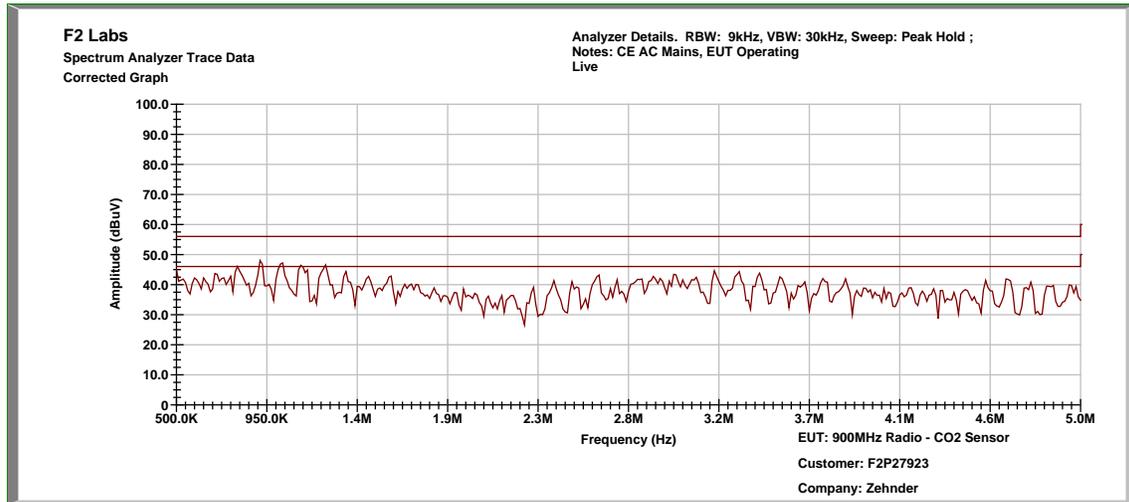
10.3 Conducted Emissions Test Data

Test Date(s):	2022-08-29	Test Engineer:	J. Chiller
Rule:	15.207	Air Temperature:	22.1° C
Test Results:	Complies	Relative Humidity:	37%

Conducted Test – Live: 0.15 MHz to 0.5 MHz

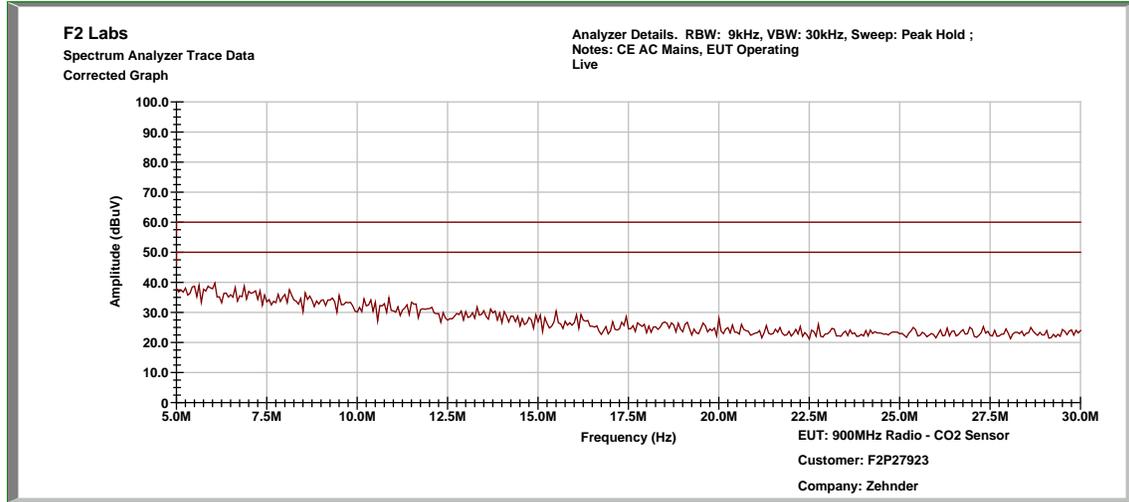


Conducted Test – Live: 0.5 MHz to 5.0 MHz





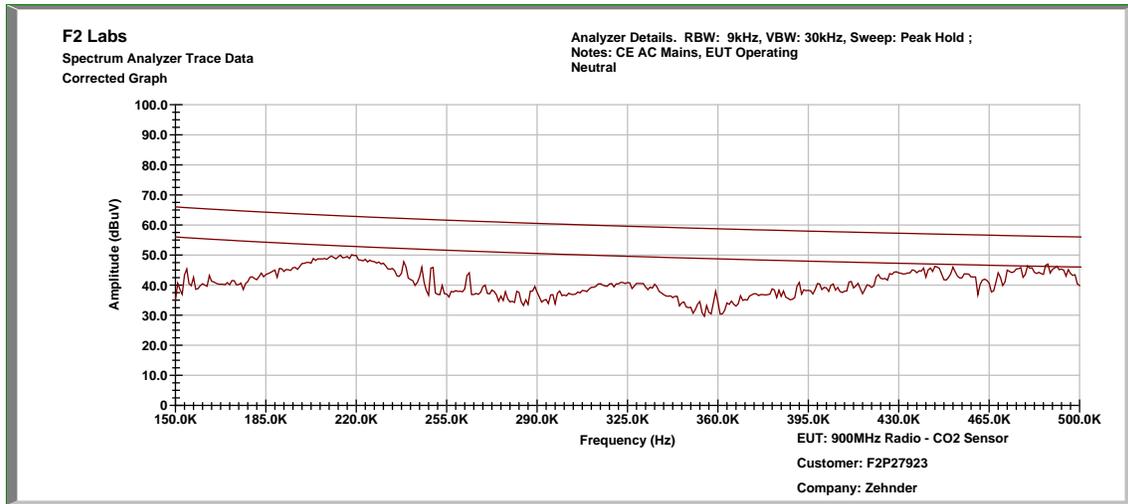
Conducted Test – Live: 5.0 MHz to 30.0 MHz



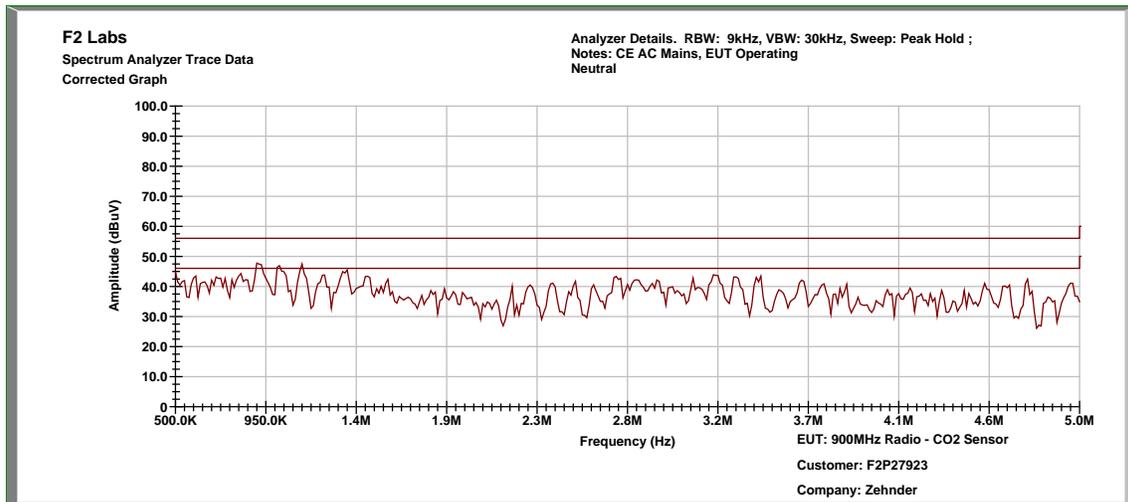
Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Live	0.215	Quasi-Peak	37.13	10.624	47.75	63.01	-15.3
			Average	26.96	10.624	37.58	53.01	-15.4
2	Live	0.227	Quasi-Peak	37.31	10.547	47.86	62.559	-14.7
			Average	26.86	10.547	37.41	52.559	-15.2
3	Live	0.424	Quasi-Peak	30.98	10.29	41.27	57.355	-16.1
			Average	20.30	10.29	30.59	47.355	-16.8
4	Live	0.430	Quasi-Peak	31.29	10.288	41.58	57.236	-15.7
			Average	19.98	10.288	30.27	47.236	-17.0
5	Live	0.437	Quasi-Peak	31.00	10.285	41.29	57.119	-15.8
			Average	18.73	10.285	29.02	47.119	-18.1
6	Live	0.484	Quasi-Peak	30.56	10.266	40.83	56.266	-15.4
			Average	18.95	10.266	29.22	46.266	-17.1
7	Live	0.495	Quasi-Peak	31.10	10.262	41.36	56.084	-14.7
			Average	18.49	10.262	28.75	46.084	-17.3
8	Live	0.815	Quasi-Peak	32.28	10.125	42.41	56.0	-13.6
			Average	22.28	10.125	32.41	46.0	-13.6
9	Live	0.916	Quasi-Peak	31.72	10.137	41.86	56.0	-14.1
			Average	22.51	10.137	32.65	46.0	-13.4
10	Live	1.028	Quasi-Peak	31.52	10.124	41.64	56.0	-14.4
			Average	21.44	10.124	31.56	46.0	-14.4
11	Live	3.177	Quasi-Peak	25.95	10.744	36.69	56.0	-19.3
			Average	16.16	10.744	26.90	46.0	-19.1



Conducted Test – Neutral: 0.15 MHz to 0.5 MHz

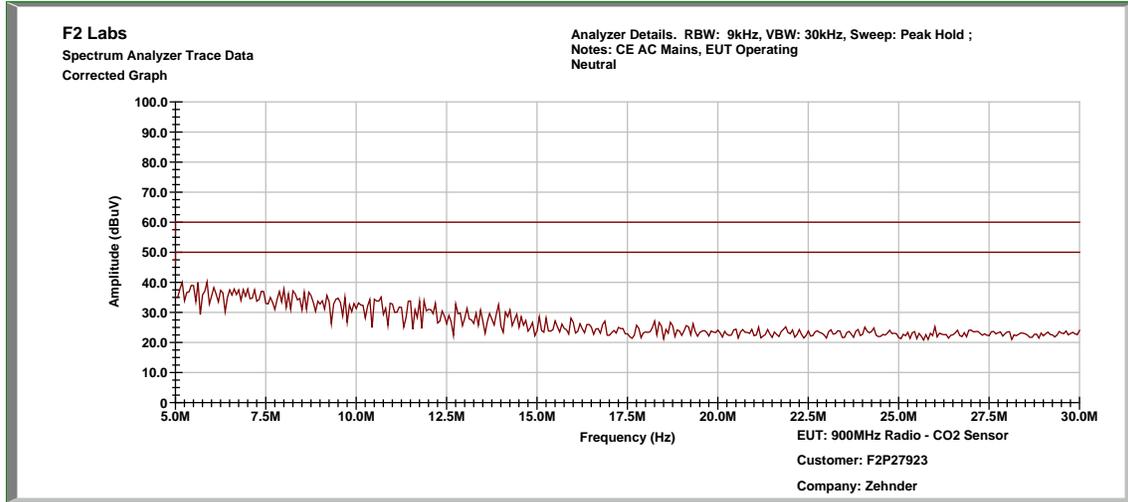


Conducted Test – Neutral: 0.5 MHz to 5.0 MHz





Conducted Test – Neutral: 5.0 MHz to 30.0 MHz

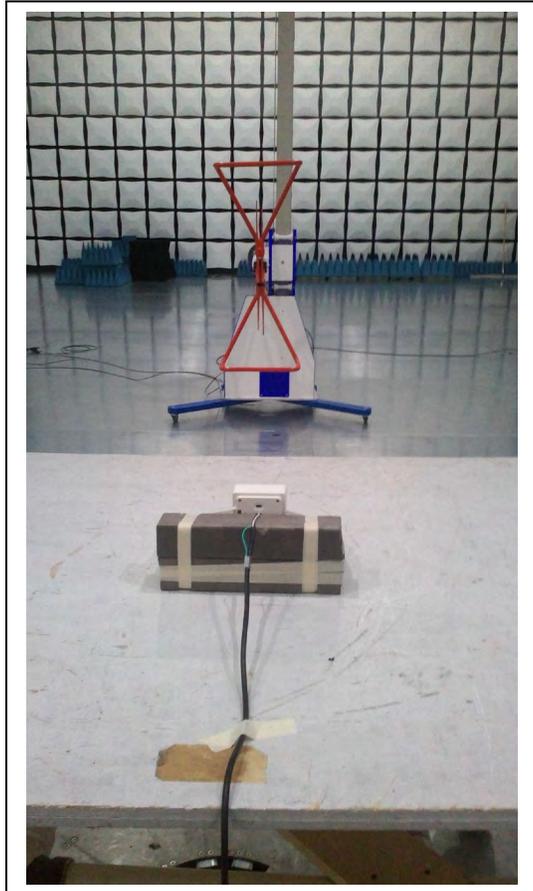


Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Neutral	0.220	Quasi-Peak	35.18	10.467	45.65	62.79	-17.1
			Average	23.79	10.467	34.26	52.79	-18.5
2	Neutral	0.445	Quasi-Peak	30.42	10.097	40.52	56.968	-16.5
			Average	17.03	10.097	27.13	46.968	-19.8
3	Neutral	0.477	Quasi-Peak	30.74	10.081	40.82	56.387	-15.6
			Average	14.32	10.081	24.40	46.387	-22.0
4	Neutral	0.481	Quasi-Peak	31.08	10.079	41.16	56.311	-15.2
			Average	16.19	10.079	26.27	46.311	-20.0
5	Neutral	0.487	Quasi-Peak	30.78	10.076	40.86	56.206	-15.4
			Average	15.83	10.076	25.91	46.206	-20.3
6	Neutral	0.491	Quasi-Peak	31.01	10.074	41.08	56.147	-15.1
			Average	15.99	10.074	26.06	46.147	-20.1
7	Neutral	0.927	Quasi-Peak	25.04	9.995	35.04	56.000	-21.0
			Average	18.7	9.995	28.70	46.000	-17.3
8	Neutral	1.017	Quasi-Peak	32.78	9.981	42.76	56.0	-13.2
			Average	18.79	9.981	28.77	46.0	-17.2
9	Neutral	1.13	Quasi-Peak	31.75	9.985	41.74	56.0	-14.3
			Average	17.29	9.985	27.28	46.0	-18.7
10	Neutral	1.355	Quasi-Peak	29.96	9.994	39.95	56.0	-16.0
			Average	17.08	9.994	27.07	46.0	-18.9
11	Neutral	3.200	Quasi-Peak	28.22	9.976	38.20	56.0	-17.8
			Average	13.2	9.976	23.18	46.0	-22.8



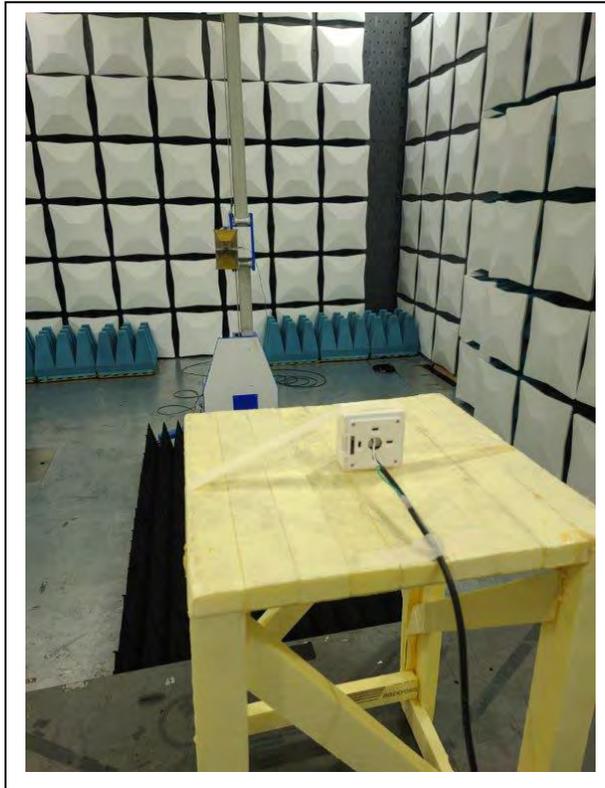
11 PHOTOGRAPHS - TEST SETUPS

OBW, Field Strength, Radiated Spurious Emissions Less Than 1 GHz





Radiated Spurious Emissions Greater than 1 GHz





Loop Antenna





Voltage Variations





Conducted Emissions

