

RADIO TEST REPORT

FCC ID: 2ADAJWH51RF

Product : Freezer Sensor

Trade Mark : N/A

Model Name : WH51RF

Family Model : N/A

Report No. : S24013003901001

Prepared for

Nielsen-Kellerman

21 Creek Circle, Boothwyn, PA19061, USA

Prepared by

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TEST RESULT CERTIFICATION**Applicant's name** : Nielsen-Kellerman

Address : 21 Creek Circle, Boothwyn, PA19061, USA

Manufacturer's Name : Shenzhen Fine Offset Electronics Co., Ltd.

Address : A, 4/F, Bldg.C, Dist.A, Minzhu Jiujiu Ind. City, Xihuan Rd., Shajing St., Baoan Dist. Shenzhen, Guangdong, China

Product description

Product name : Freezer Sensor

Model and/or type reference : WH51RF

Family Model : N/A

Rating(s) : DC1.5V*2 AA from battery

Standards : FCC Part15.249

Test procedure ANSI C63.10-2013

This device described above has been tested by NTEK, and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

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Test Sample Number..... : S240130039001

Date of Test :

Date (s) of performance of tests : 31 Jan. 2024 ~ 01 Mar. 2024

Date of Issue : 01 Mar. 2024

Test Result..... : **Pass**

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1. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards:

FCC Part15, Subpart C (15.249)			
Standard Section	Test Item	Judgment	Remark
15.207	Conducted Emission	N/A	
15.203	Antenna Requirement	Pass	
15.249 15.209	Radiated Spurious Emission	Pass	
15.249(2)	Frequency Tolerance	N/A	
15.249(a)	Fundamental Measurement	Pass	
15.205	Band Edge Emission	Pass	
15.215	Occupied Bandwidth	Pass	

1.1 TEST FACILITY

Shenzhen NTEK Testing Technology Co., Ltd
 Add. : 1&5/F, Building C, 1&2/F, Building E, Fenda Science Park, Sanwei Community,
 Hangcheng Street, Baoan District, Shenzhen ,Guangdong, China
 FCC FRN Registration No.:463705; FCC FRN Designation Number: CN1184
 IC Registration No.:9270A-1
 CNAS Registration No.:L5516

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement $y \pm U$, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately **95 %**.

No.	Item	Uncertainty
1	Conducted Emission Test	$\pm 1.38\text{dB}$
2	RF power,conducted	$\pm 0.16\text{dB}$
3	Spurious emissions,conducted	$\pm 0.21\text{dB}$
4	All emissions,radiated(<1G)	$\pm 4.68\text{dB}$
5	All emissions,radiated(>1G)	$\pm 4.89\text{dB}$
6	Temperature	$\pm 0.5^{\circ}\text{C}$
7	Humidity	$\pm 2\%$
8	Occupied bandwidth	$\pm 4.7\%$
9	All emissions, radiated(9KHz~30MHz)	$\pm 6\text{dB}$

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

Equipment	Freezer Sensor	
Trade Mark	N/A	
Model Name	WH51RF	
Family Model	N/A	
Model Difference	N/A	
Product Description	The EUT is a Freezer Sensor	
	Operation Frequency:	915MHz
	Modulation Type:	FSK
	Antenna Designation:	Spring antenna
	Antenna Gain(Peak)	-2.1dBi
	Based on the application, features, or specification exhibited in User's Manual. More details of EUT technical specification, please refer to the User's Manual.	
Channel List	Please refer to the Note 2.	
Adapter	N/A	
Battery	DC1.5V*2 AA Battery	
Hardware version	WHP0289A1V01	
Firmware version	N/A	
Software version	WN30WN31WN32_GPL813P01A_0x000F857F.hdb	

Note:

1. For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

2.

Channel	Frequency(MHz)
01	915

3.

Table for Filed Antenna

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)	NOTE
1	N/A	N/A	Spring antenna	N/A	-2.1	Antenna

2.2 DESCRIPTION OF TEST MODES

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

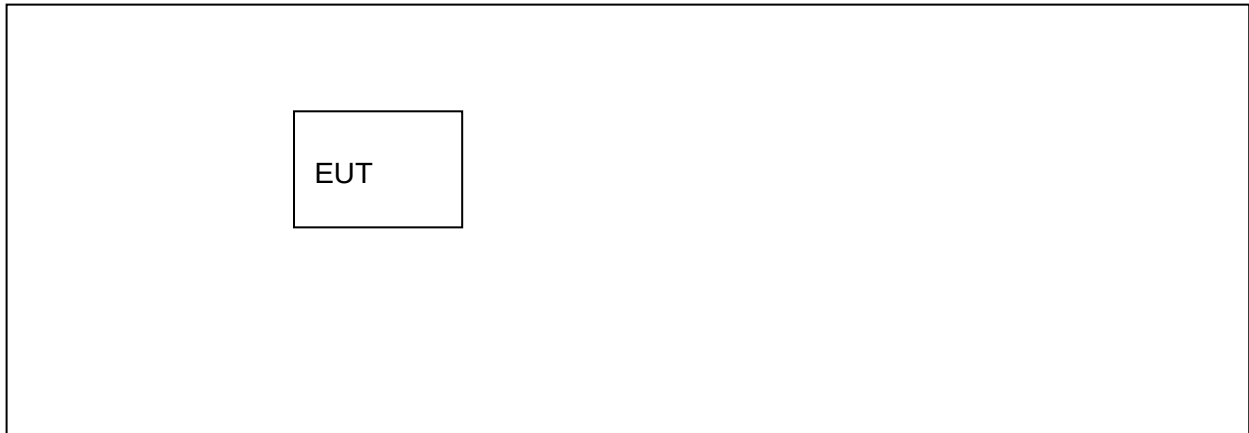
Pretest Mode	Description
Mode 1	CH01
Mode 2	Normal link

For Radiated Spurious Emission	
Pretest Mode	Description
Mode 1	CH01

For Conducted Emission	
Final Test Mode	Description
Mode 1	CH01
Mode 2	Normal link

2.3 BLOCK DIGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED

Radiated Spurious Emission Test



2.4 DESCRIPTION OF SUPPORT UNITS (CONDUCTED MODE)

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note

Item	Cable Type	Shielded Type	Ferrite Core	Length	Note

Note:

- (1) The support equipment was authorized by Declaration of Confirmation.
- (2) For detachable type I/O cable should be specified the length in cm in 『Length』 column.

2.5 EQUIPMENTS LIST FOR ALL TEST ITEMS

Radiation Test equipment

	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	Spectrum Analyzer	Agilent	E4407B	MY45108040	2023.03.27	2024.03.26	1 year
2	Spectrum Analyzer	Agilent	N9020A	MY49100060	2023.05.29	2024.05.28	1 year
3	Spectrum Analyzer	R&S	FSV40	101417	2023.03.27	2024.03.26	1 year
4	Test Receiver	R&S	ESPI7	101318	2023.03.27	2024.03.26	1 year
5	Bilog Antenna	TESEQ	CBL6111D	31216	2023.03.27	2024.03.26	1 year
6	50Ω Coaxial Switch	Anritsu	MP59B	6200983705	2023.05.06	2026.05.05	3 year
7	Horn Antenna	EM	EM-AH-10180	2011071402	2023.03.27	2024.03.26	1 year
8	Broadband Horn Antenna	SCHWARZBECK	BBHA 9170	803	2023.05.29	2024.05.28	1 year
9	Amplifier	EMC	EMC051835SE	980246	2023.05.29	2024.05.28	1 year
10	Active Loop Antenna	SCHWARZBECK	FMZB 1519B	055	2023.05.29	2024.05.28	1 year
11	Power Meter	DARE	RPR3006W	15100041SN084	2023.05.29	2024.05.28	1 year
12	Test Cable (9KHz-30MHz)	N/A	R-01	N/A	2023.05.06	2026.05.05	3 year
13	Test Cable (30MHz-1GHz)	N/A	R-02	N/A	2023.05.06	2026.05.05	3 year
14	High Test Cable(1G-40G Hz)	N/A	R-03	N/A	2022.06.17	2025.06.16	3 year
15	High Test Cable(1G-40G Hz)	N/A	R-04	N/A	2022.06.17	2025.06.16	3 year
16	Filter	TRILTHIC	2400MHz	29	2023.05.29	2024.05.28	3 year
17	temporary antenna connector (Note)	NTS	R001	N/A	N/A	N/A	N/A

Note:

We will use the temporary antenna connector (soldered on the PCB board) When conducted test
And this temporary antenna connector is listed within the instrument list

Conduction Test equipment

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	Test Receiver	R&S	ESCI	101160	2023.03.27	2024.03.26	1 year
2	LISN	R&S	ENV216	101313	2023.03.27	2024.03.26	1 year
3	LISN	SCHWARZBECK	NNLK 8129	8129245	2023.03.27	2024.03.26	1 year
4	50Ω Coaxial Switch	ANRITSU CORP	MP59B	6200983704	2023.05.06	2026.05.05	3 year
5	Test Cable (9KHz-30MHz)	N/A	C01	N/A	2023.05.06	2026.05.05	3 year
6	Test Cable (9KHz-30MHz)	N/A	C02	N/A	2023.05.06	2026.05.05	3 year
7	Test Cable (9KHz-30MHz)	N/A	C03	N/A	2023.05.06	2026.05.05	3 year

Note: Each piece of equipment is scheduled for calibration once a year except the Test Cable which is scheduled for calibration every 3 years.

3. ANTENNA REQUIREMENT

3.1 STANDARD REQUIREMENT

15.203 requirement: For intentional device, according to 15.203: an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

3.2 EUT ANTENNA

The EUT antenna is Spring Antenna (Gain: -2.1dBi). It comply with the standard requirement.

3.3 CONDUCTED EMISSION MEASUREMENT

3.3.1 POWER LINE CONDUCTED EMISSION Limits (Frequency Range 150KHz-30MHz)

FREQUENCY (MHz)	Class B (dBuV)		Standard
	Quasi-peak	Average	
0.15 -0.5	66 - 56 *	56 - 46 *	CISPR
0.50 -5.0	56.00	46.00	CISPR
5.0 -30.0	60.00	50.00	CISPR

Note:

- (1) The tighter limit applies at the band edges.
- (2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

The following table is the setting of the receiver

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

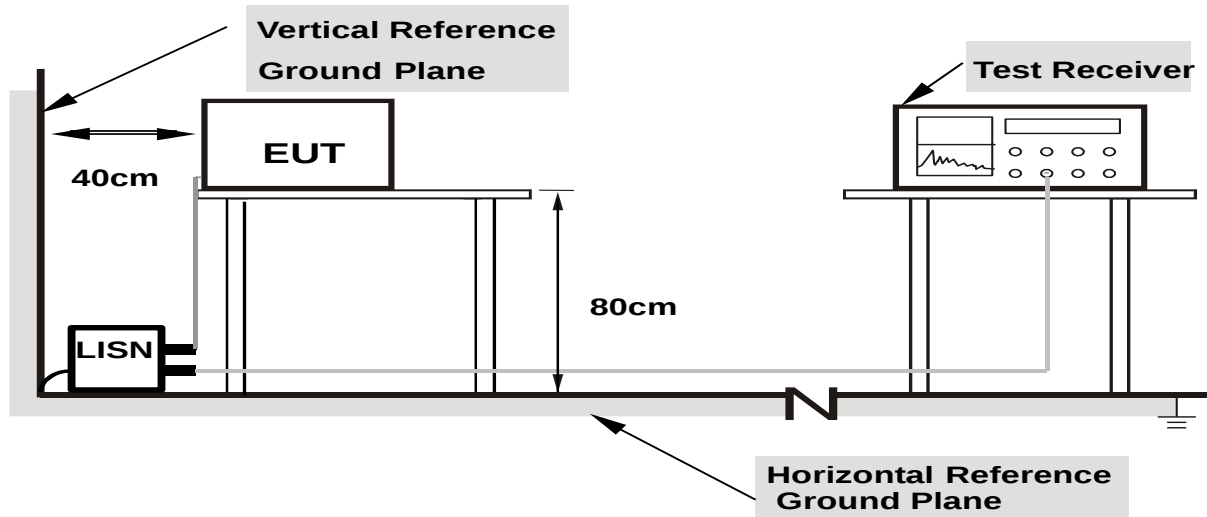
3.3.2 TEST PROCEDURE

- The EUT was placed 0.4 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
- I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
- LISN at least 80 cm from nearest part of EUT chassis.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

3.3.3 DEVIATION FROM TEST STANDARD

No deviation

3.3.4 TEST SETUP



Note: 1.Support units were connected to second LISN.

2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

3.2.5 TEST RESULT

EUT :	Freezer Sensor	Model Name. :	WH51RF
Temperature :	25 °C	Relative Humidity :	55%
Pressure :	1010hPa	Phase :	N/A
Test Voltage :	N/A	Test Mode :	N/A

Note: Product is battery powered so Not Applicable.

3.4 RADIATED EMISSION MEASUREMENT

3.4.1 Radiated Emission Limits (FCC 15.209)

Frequencies (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
Frequency (MHz)	Limit (dBuV)	
30~88	40	3
88~216	43.5	3
216~960	46	3
960 -10000	54.00	3
*902 - 928	94.00	3

Note:

- (1) The tighter limit applies at the band edges.
- (2) Emission level (dBuV/m)=20log Emission level (uV/m).
- (3) *Note: This is the limit for the fundamental frequency.

LIMITS OF RADIATED EMISSION MEASUREMENT (FCC 15.249)

Frequency of Emission (MHz)	Field Strength of fundamental ((millivolts /meter)	Field Strength of Harmonics (microvolts/meter)
902-928	50	500

Notes:

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

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (emission in restricted band)	1MHz / 1MHz for Peak

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RB 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RB 120kHz for QP

3.4.2 TEST PROCEDURE

- The measuring distance of at 3 m shall be used for measurements at frequency up to 1GHz. For frequencies above 1GHz, any suitable measuring distance may be used.
- The EUT was placed on the top of a rotating table 0.8 m for below 1GHz and 1.5m for above 1GHz the ground at a 3 meter. The table was rotated 360 degrees to determine the position of the highest radiation.
- The height of the equipment or of the substitution antenna shall be 0.8 m for below 1GHz and 1.5m for above 1GHz; the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
- If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

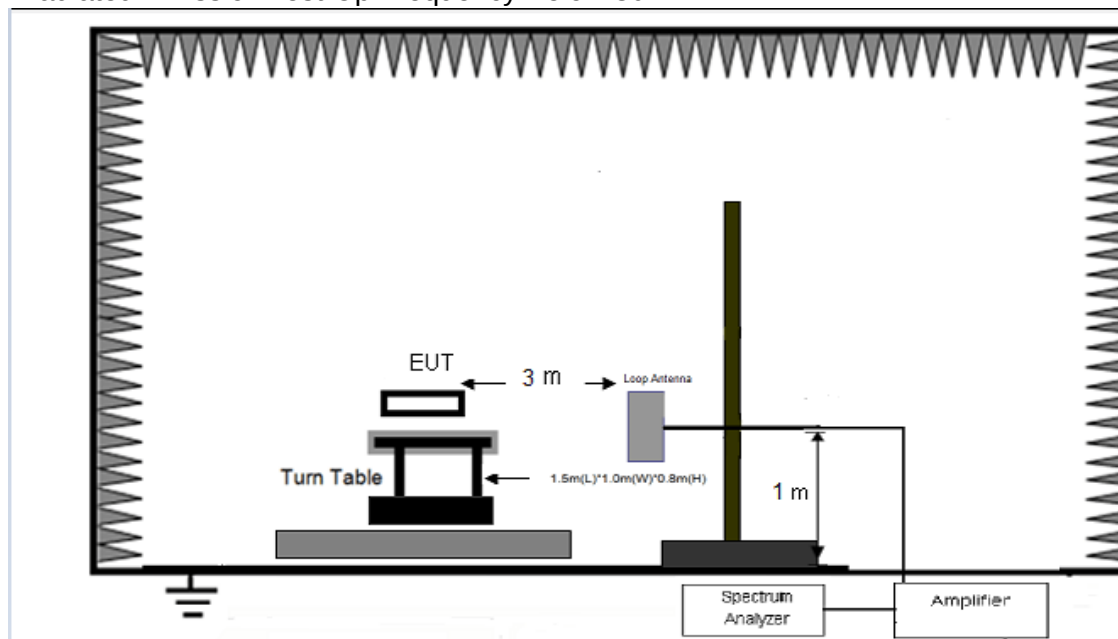
Note:

Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported

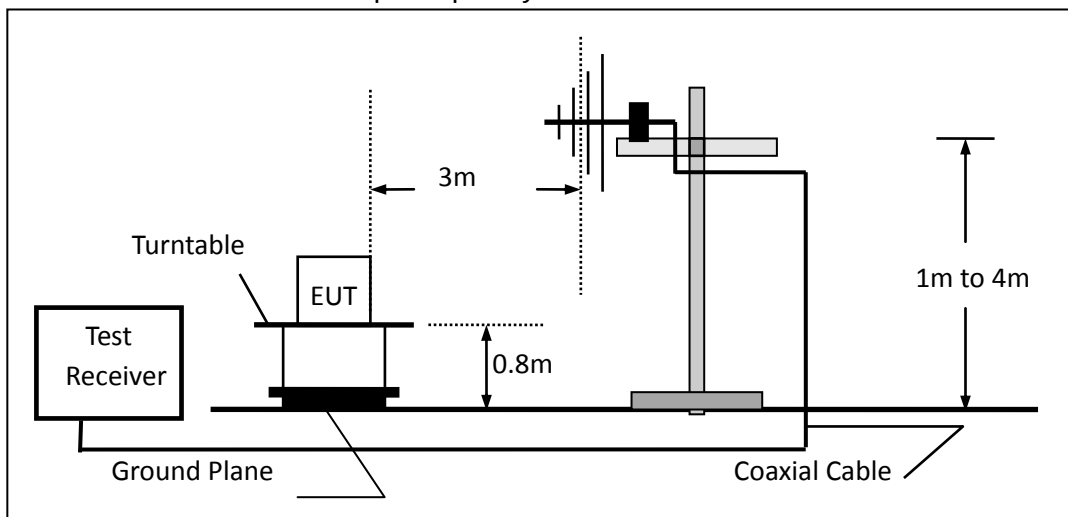
3.4.3 DEVIATION FROM TEST STANDARD

No deviation

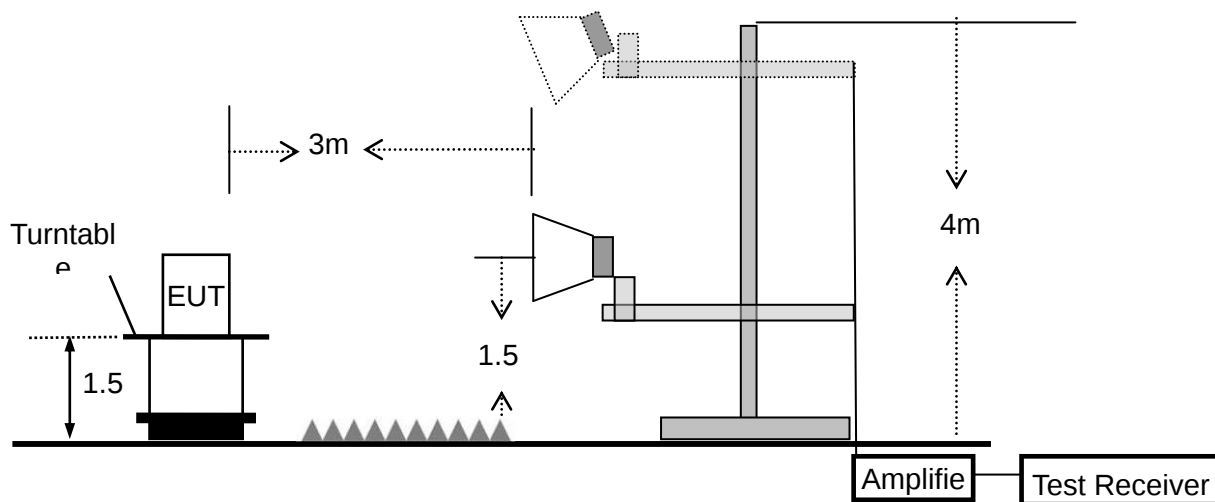
(A) Radiated Emission Test-Up Frequency Below 30MHz



(B) Radiated Emission Test-Up Frequency 30MHz~1GHz



(C) Radiated Emission Test-Up Frequency Above 1GHz



3.4.4 TEST RESULTS (BELOW 30MHz)

EUT :	Freezer Sensor	Model Name. :	WH51RF
Temperature :	20 °C	Relative Humidity :	48%
Pressure :	1010 hPa	Test Voltage :	DC 3V
Test Mode :	TX	Polarization :	--

Freq.	Reading	Limit	Margin	State
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	P/F
--	--	--	--	PASS
--	--	--	--	PASS

Note:

The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

Remark :1. Emission level in dBuV/m= $20 \log (\mu\text{V/m})$

2. Measurement was performed at an antenna to the closed point of EUT distance of meters.

3. For Frequency 9kHz~30MHz:

Distance extrapolation factor = $40 \log (\text{Specific distance/ test distance})(\text{dB})$;

Limit line=Specific limits(dBuV) + distance extrapolation factor.

For Frequency above 30MHz:

Distance extrapolation factor = $20 \log (\text{Specific distance/ test distance})(\text{dB})$;

Limit line=Specific limits(dBuV) + distance extrapolation factor.

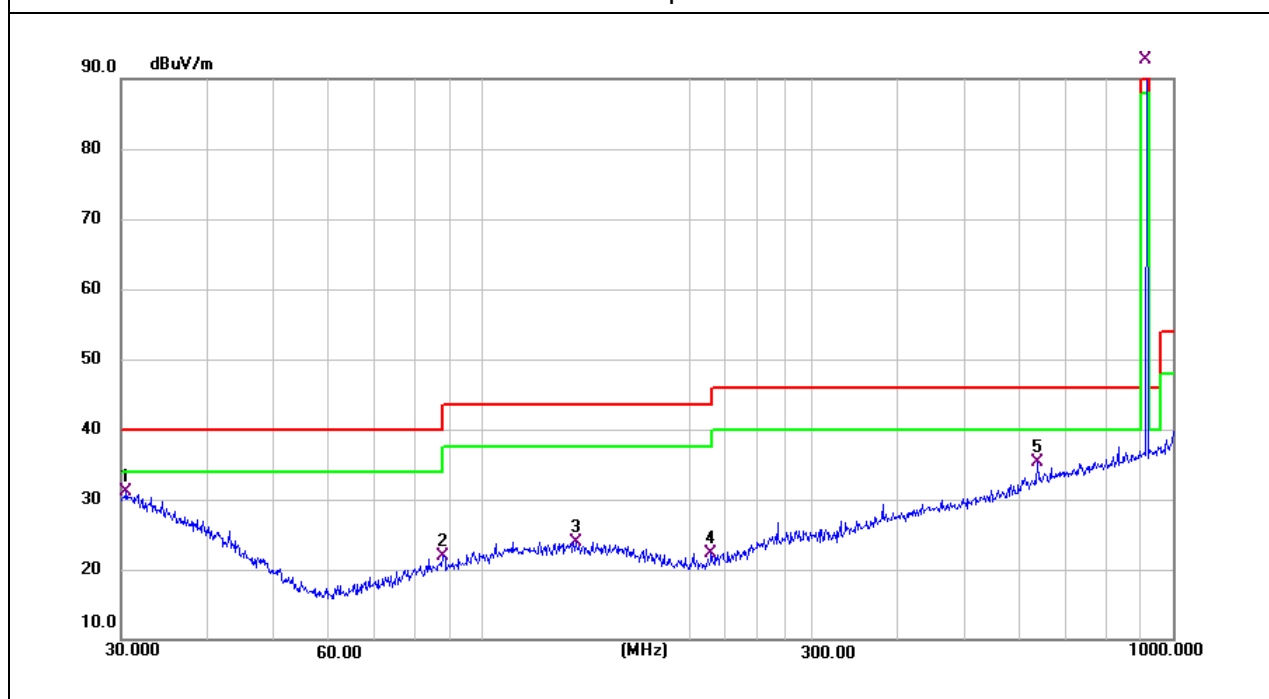
3.4.5 TEST RESULTS (BELOW 1000 MHz)

EUT :	Freezer Sensor	Model Name :	WH51RF
Temperature :	25 °C	Relative Humidity :	51%
Pressure :	1010 hPa	Test Voltage :	DC 3V
Test Mode :	Mode 1	Polarization :	Vertical

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
30.5306	4.97	26.12	31.09	40.00	-8.91	QP
87.7248	5.49	16.34	21.83	40.00	-18.17	QP
136.4598	5.33	18.64	23.97	43.50	-19.53	QP
214.5143	5.74	16.62	22.36	43.50	-21.14	QP
636.1340	8.42	26.85	35.27	46.00	-10.73	QP
915.0000	62.07	30.77	92.84	94.00	-1.16	QP

Remark:

1. Factor = Antenna Factor + Cable Loss – Pre-amplifier.

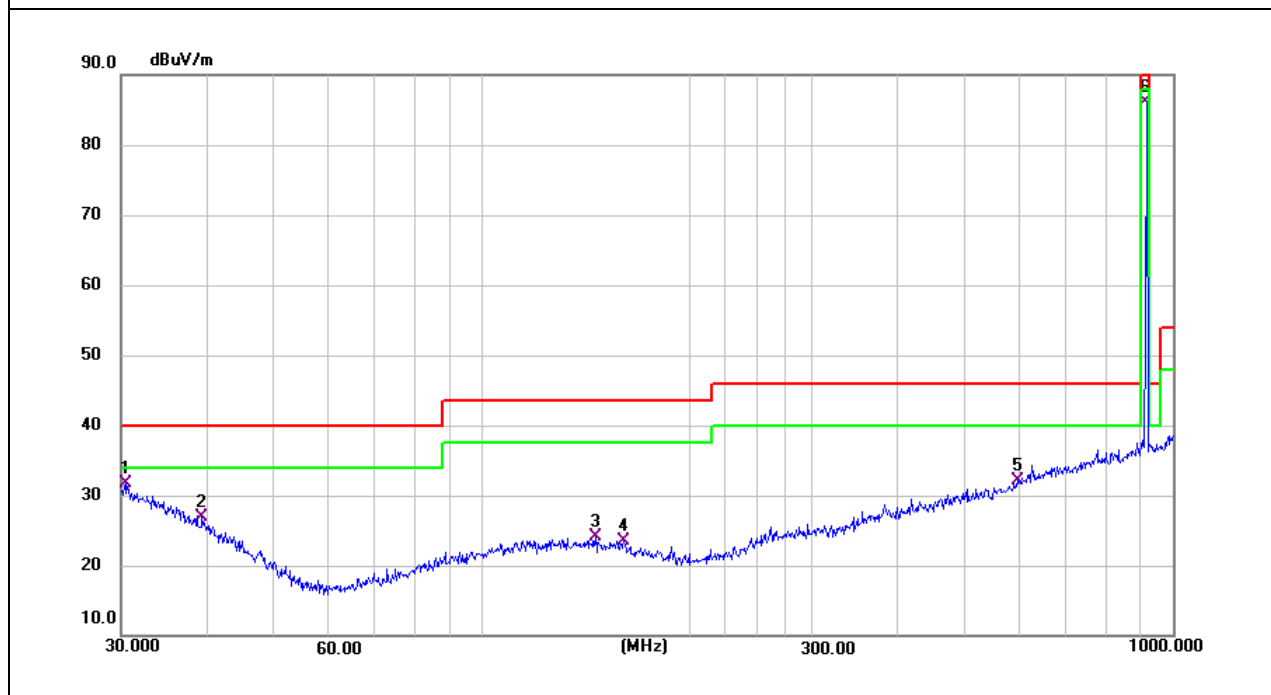


EUT :	Freezer Sensor	Model Name :	WH51RF
Temperature :	25 °C	Relative Humidity :	51%
Pressure :	1010 hPa	Test Voltage :	DC 3V
Test Mode :	Mode 1	Polarization :	Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
30.4237	5.60	26.18	31.78	40.00	-8.22	QP
39.2991	5.67	21.33	27.00	40.00	-13.00	QP
145.8611	5.56	18.47	24.03	43.50	-19.47	QP
160.3456	5.69	17.90	23.59	43.50	-19.91	QP
595.1329	5.91	26.22	32.13	46.00	-13.87	QP
915.0000	55.27	30.77	86.04	94.00	-7.96	QP

Remark:

1. Factor = Antenna Factor + Cable Loss – Pre-amplifier.



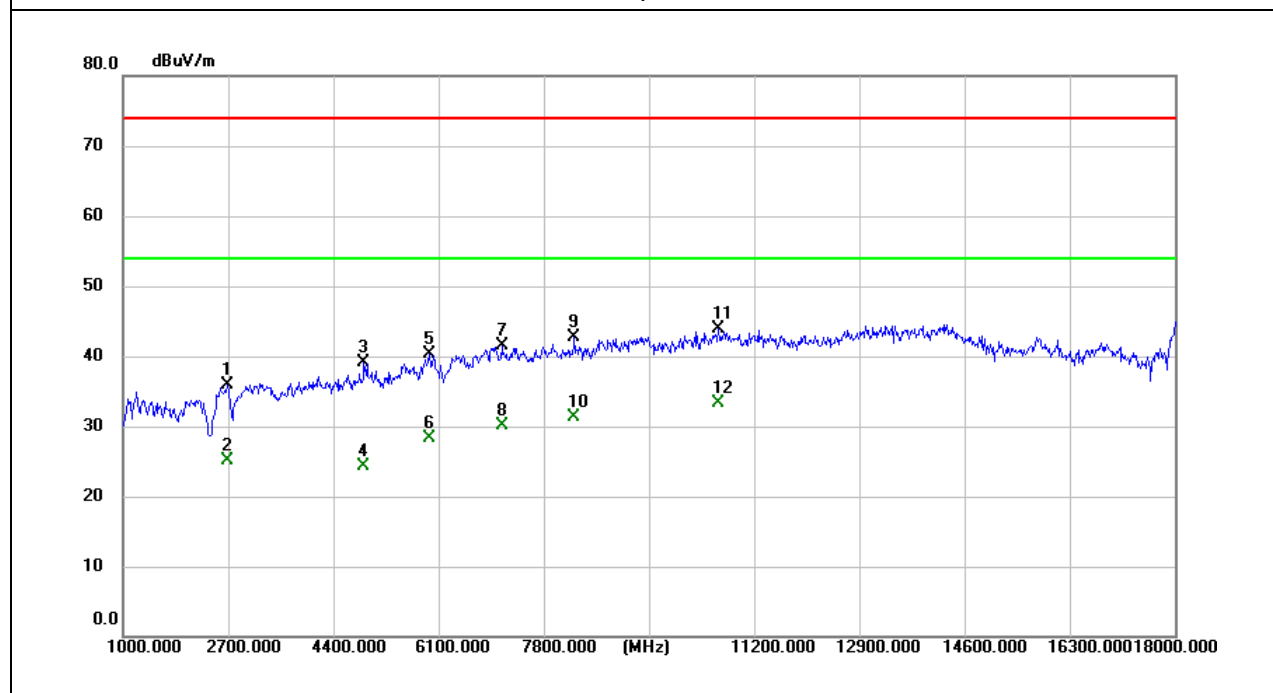
3.4.6 TEST RESULTS (ABOVE 1000 MHZ)

EUT :	Freezer Sensor	Model Name :	WH51RF
Temperature :	25 °C	Relative Humidity :	51%
Pressure :	1010 hPa	Test Voltage :	DC 3V
Test Mode :	Mode 1	Polarization :	Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
2683.000	53.19	-17.33	35.86	74.00	-38.14	peak
2683.000	42.53	-17.33	25.20	54.00	-28.80	AVG
4893.000	52.29	-13.18	39.11	74.00	-34.89	peak
4893.000	37.48	-13.18	24.30	54.00	-29.70	AVG
5947.000	51.79	-11.45	40.34	74.00	-33.66	peak
5947.000	39.70	-11.45	28.25	54.00	-25.75	AVG
7120.000	50.14	-8.63	41.51	74.00	-32.49	peak
7120.000	38.65	-8.63	30.02	54.00	-23.98	AVG
8293.000	50.17	-7.37	42.80	74.00	-31.20	peak
8293.000	38.62	-7.37	31.25	54.00	-22.75	AVG
10622.000	47.63	-3.68	43.95	74.00	-30.05	peak
10622.000	37.04	-3.68	33.36	54.00	-20.64	AVG

Remark:

Factor = Antenna Factor + Cable Loss – Pre-amplifier.

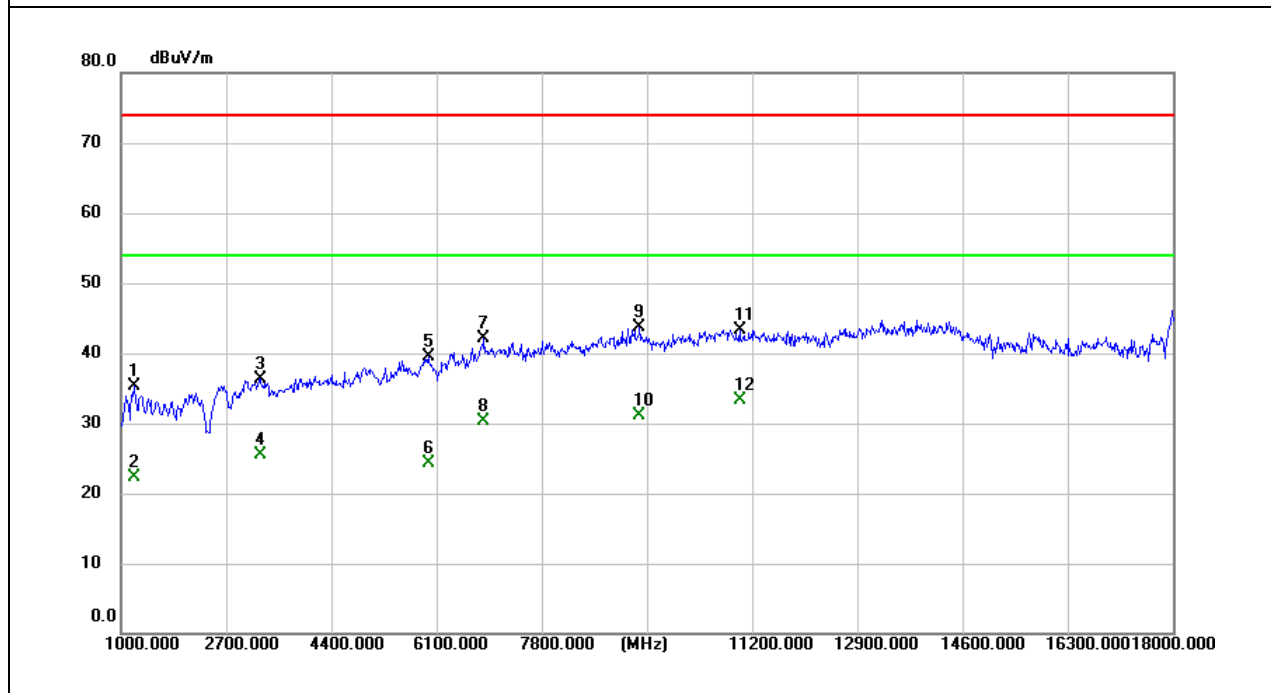


EUT :	Freezer Sensor	Model Name :	WN34BL
Temperature :	25 °C	Relative Humidity :	51%
Pressure :	1010 hPa	Test Voltage :	DC 3V
Test Mode :	Mode 1	Polarization :	Vertical

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1204.000	58.58	-23.30	35.28	74.00	-38.72	peak
1204.000	45.60	-23.30	22.30	54.00	-31.70	AVG
3244.000	51.83	-15.43	36.40	74.00	-37.60	peak
3244.000	41.03	-15.43	25.60	54.00	-28.40	AVG
5964.000	50.93	-11.42	39.51	74.00	-34.49	peak
5964.000	35.72	-11.42	24.30	54.00	-29.70	AVG
6865.000	51.35	-9.34	42.01	74.00	-31.99	peak
6865.000	39.59	-9.34	30.25	54.00	-23.75	AVG
9381.000	49.18	-5.38	43.80	74.00	-30.20	peak
9381.000	36.58	-5.38	31.20	54.00	-22.80	AVG
10996.000	46.66	-3.35	43.31	74.00	-30.69	peak
10996.000	36.65	-3.35	33.30	54.00	-20.70	AVG

Remark:

Factor = Antenna Factor + Cable Loss – Pre-amplifier.



Note:

1) EUT Pre-scan X/Y/Z orientation, only worst case is presented in the report(X orientation).

2) Since the PEAK test results are below the AV limit, according to 15.31, the amplitude of

spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

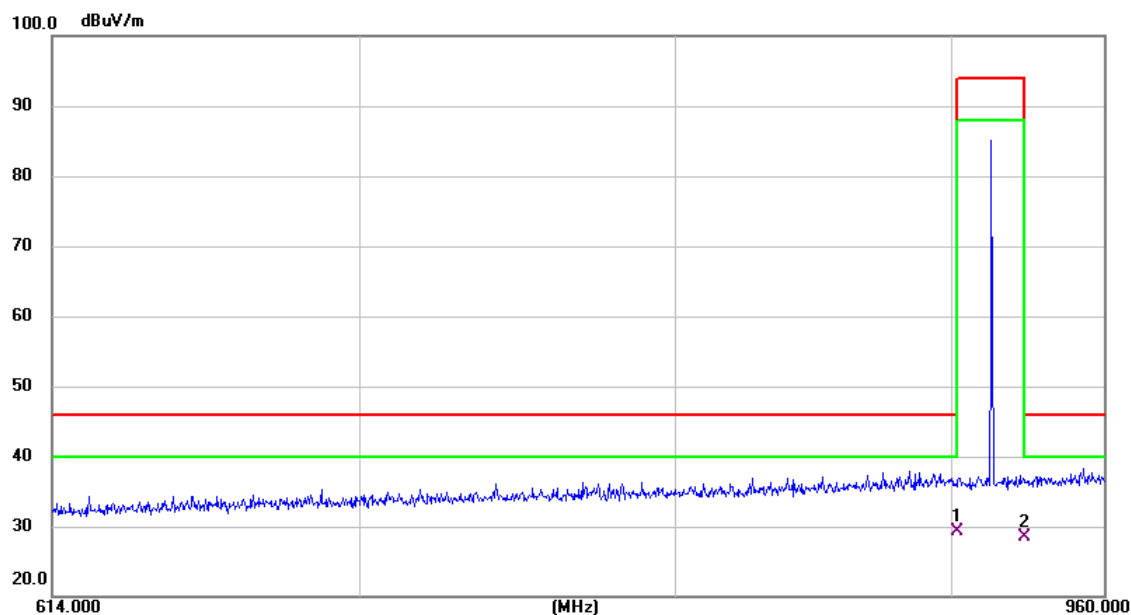
3.4.7 TEST RESULTS (RESTRICTED BANDS REQUIREMENTS)

EUT :	Freezer Sensor	Model Name :	WH51RF
Temperature :	25 °C	Relative Humidity :	51%
Pressure :	1010 hPa	Test Voltage :	DC 3V
Test Mode :	TX-915MHz	Polarization :	Horizontal

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
902.0000	-1.33	30.63	29.30	46.00	-16.70	
928.0000	-2.37	30.93	28.56	46.00	-17.44	QP

Remark:

Factor = Antenna Factor + Cable Loss – Pre-amplifier.

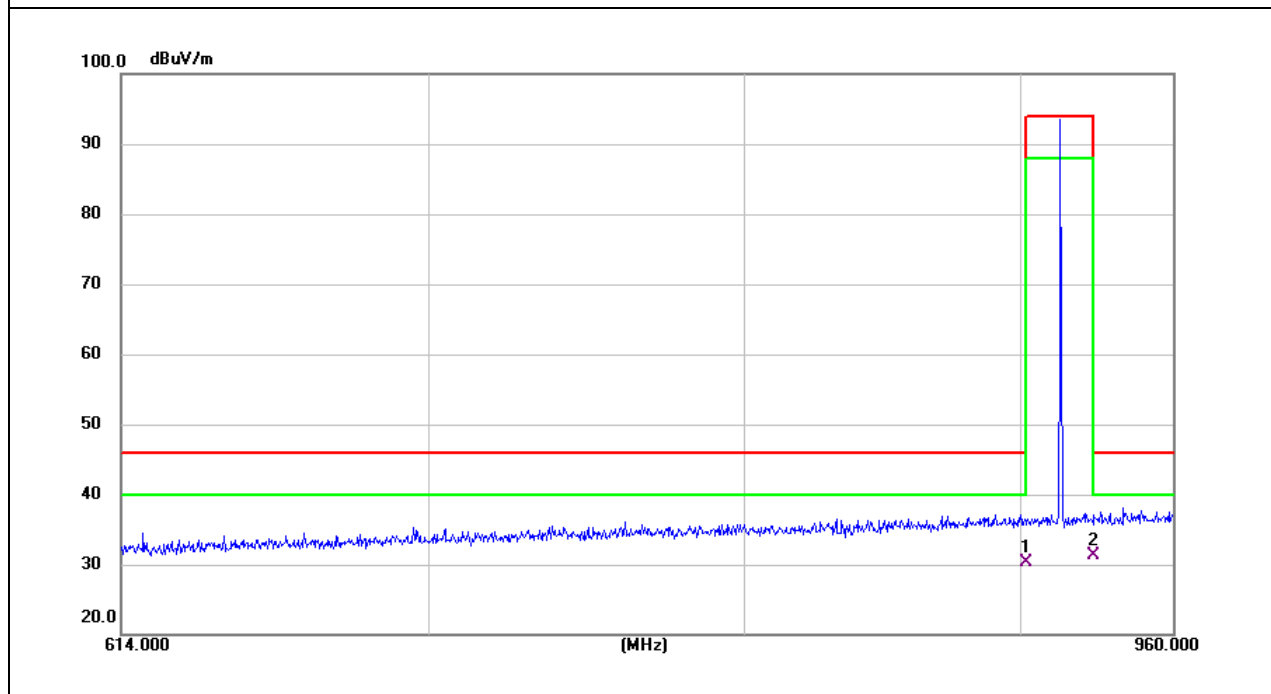


EUT :	Freezer Sensor	Model Name :	WH51RF
Temperature :	25 °C	Relative Humidity :	51%
Pressure :	1010 hPa	Test Voltage :	DC 3V
Test Mode :	TX-915MHz	Polarization :	Vertical

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
902.0000	-0.38	30.63	30.25	46.00	-15.75	QP
928.0000	0.37	30.93	31.30	46.00	-14.70	QP

Remark:

Factor = Antenna Factor + Cable Loss – Pre-amplifier.



4. BANDWIDTH TEST

4.1 TEST PROCEDURE

- a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below,
- b. Spectrum Setting : The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value., Sweep time = Auto.

4.2 DEVIATION FROM STANDARD

No deviation.

4.3 TEST SETUP

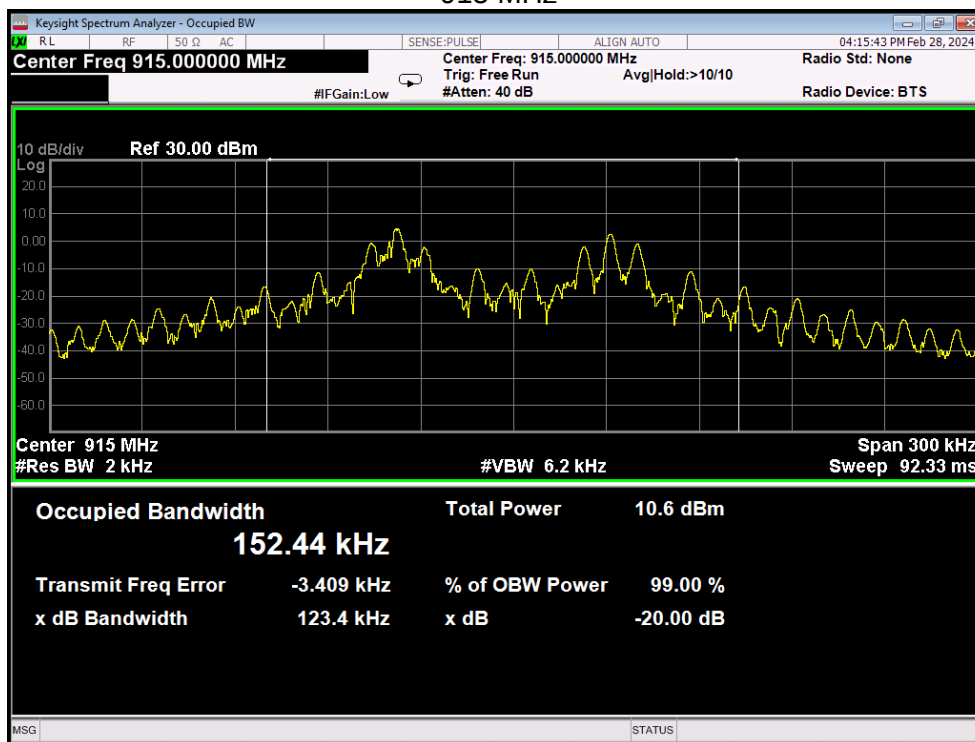


6. TEST RESULTS

EUT :	Freezer Sensor	Model Name :	WH51RF
Temperature :	26 °C	Relative Humidity :	53%
Pressure :	1020 hPa	Test Power :	DC 3V
Test Mode :	Mode 1		

Test Channel	Frequency (MHz)	20 dBc Bandwidth (MHz)
CH01	915	0.1234

915 MHz



END OF REPORT