RF TEST REPORT

Applicant	Copeland Comfort Control LP
FCC ID	2A4JN-1F76U22Z
Product	Thermostat
Brand	Sensi
Model	1F76U-22ZB; 1F76U-22ZW
Report No.	R2409A1311-R1
Issue Date	December 11, 2024

Eurofins TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2023)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Prepared by: Xu Ying *Approved by: Xu Kai*

Eurofins TA Technology (Shanghai) Co., Ltd.

Building 3, No.145, Jintang Rd, Pudong Shanghai, P.R.China
TEL: +86-021-50791141/2/3
FAX: +86-021-50791141/2/3-8000

TABLE OF CONTENT

Summary of Measurement Results

Number	Test Case	Clause in FCC rules	Verdict
1	Unwanted Emissions	15.247(d),15.205,15.209	PASS
2	Conducted Emissions	15.207	PASS
Date of Testing: September 13, 2024 ~ October 9, 2024 Date of Sample Received: September 10, 2024			
Note: PASS: The EUT complies with the essential requirements in the standard. FAIL: The EUT does not comply with the essential requirements in the standard. All indications of Pass/Fail in this report are opinions expressed by Eurofins TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.			

Only Unwanted Emissions and Conducted Emissions is tested for 1F76U-22ZB; 1F76U-22ZW in this report. Other test items refer to the Module report (Report No.: FR342705B, FCC ID: 2AC7Z-ESPH2MINI1, Grant date: 09/04/2023).

1. Test Laboratory

1.1. Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **Eurofins TA Technology (Shanghai) Co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2. Test Facility

FCC (Designation number: CN1179, Test Firm Registration Number: 446626)

Eurofins TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

A2LA (Certificate Number: 3857.01)

Eurofins TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

1.3. Testing Location

Company:	Eurofins TA Technology (Shanghai) Co., Ltd.
Address:	Building 3, No.145, Jintang Rd, Pudong Shanghai, P.R.China
City:	Shanghai
Post code:	201201
Country:	P. R. China
Contact:	Xu Kai
Telephone:	+86-021-50791141/2/3
Fax:	+86-021-50791141/2/3-8000
Website:	https://www.eurofins.com/electrical-and-electronics
E-mail:	Kain.Xu@cpt.eurofinscn.com

2. General Description of Equipment Under Test

2.1. Applicant and Manufacturer Information

Applicant	Copeland Comfort Control LP
Applicant address	8100 West Florissant Ave, St. Louis, United States of America
Manufacturer	Copeland Comfort Control LP
Manufacturer address	8100 West Florissant Ave, St. Louis, United States of America

2.2. General Information

EUT Description	
Model	1F76U-22ZB; 1F76U-22ZW
Lab internal SN	R2409A1311/S01
Hardware Version	0059 5453
Software Version	For Zigbee: MCU: 0170-1740v02_00_for_fcc_combined.hex Zigbee chip: ESP32-H2_RFTest_Bin_5b55c8f_20231010.bin
Power Supply	External power supply
Antenna Type	PCB Antenna
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)
Test Mode	Zigbee
Modulation Type	2.4GHz: O-QPSK
Antenna Gain	3.96 dBi
Directional Gain	NA
additional beamforming gain	NA
Operating Frequency Range(s)	2405 ~ 2480 MHz
Note: The EUT is sent from the applicant to Eurofins TA and the information of the EUT is declared by the applicant.	

3. Applied Standards

According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

Test standards:

FCC CFR47 Part 15C (2023) Radio Frequency Devices

ANSI C63.10-2013

Reference standard:

KDB 558074 D01 15.247 Meas Guidance v05r02

4. Test Configuration

Test Mode

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application.

The radiated emission was measured in the following position: EUT stand-up position (Z axis), lie-down position (X, Y axis). The worst emission was found in stand-up position (Z axis) and the worst case was recorded.

Mode	Channel	Frequency
Zigbee	11	2405MHz
	12	2410MHz
	13	2415MHz
	14	2420MHz
	15	2425MHz
	16	2430MHz
	17	2435MHz
	18	2440MHz
	19	2445MHz
	20	2450MHz
	21	2455MHz
	22	2460MHz
	23	2465MHz
	24	2470MHz
	25	2475MHz
	26	2480MHz

5. Test Case Results

5.1. Unwanted Emission

Ambient Condition

Temperature	Relative humidity	Pressure
15°C ~ 35°C	20% ~ 80%	86 kPa ~ 106 kPa

Method of Measurement

The test set-up was made in accordance to the general provisions of ANSI C63.10.
The Equipment Under Test (EUT) was set up on a non-conductive table in the semi-anechoic chamber. The test was performed at the distance of 3 m between the EUT and the receiving antenna.

The turntable shall be rotated from 0 to 360 degrees for detecting the maximum of radiated spurious signal level. The measurements shall be repeated with orthogonal polarization of the test antenna. The data of cable loss and antenna factor has been calibrated in full testing frequency range before the testing. Sweep the Restricted Band and the emissions less than 20 dB below the permissible value are reported.
The radiated emissions measurements were made in a typical installation configuration.
Sweep the whole frequency band through the range from 9 kHz to the 10th harmonic of the carrier, and the emissions less than 20 dB below the permissible value are reported.

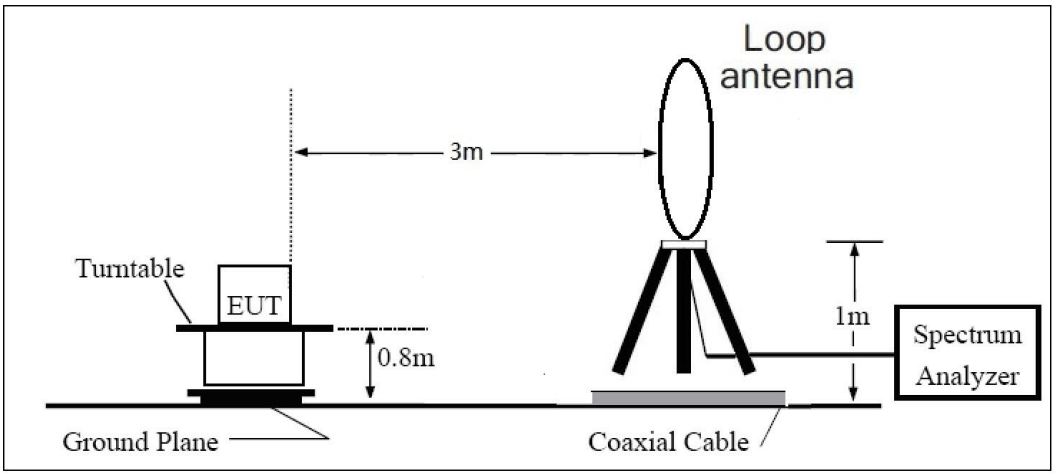
This method refer to ANSI C63.10.
The procedure for peak unwanted emissions measurements above 1000 MHz is as follows:
Set the spectrum analyzer in the following:
9kHz~150 kHz
RBW=200Hz, VBW=1kHz/ Sweep=AUTO
150 kHz~30MHz
RBW=9KHz, VBW=30KHz,/ Sweep=AUTO
Below 1GHz
RBW=100kHz / VBW=300kHz / Sweep=AUTO
a) Peak emission levels are measured by setting the instrument as follows:
Above 1GHz
PEAK: RBW=1MHz VBW=3MHz/ Sweep=AUTO
b) Average emission levels are measured by setting the instrument as follows:
Above 1GHz
AVERAGE: RBW=1MHz / VBW=3MHz / Sweep=AUTO
c) Detector: The measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set

for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
e) Sweep time = auto.
f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of 1 / D, where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
1) If power averaging (rms) mode was used in the preceding step e), then the correction factor is [10 log (1 / D)], where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.
2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is [20 log (1 / D)], where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.
3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

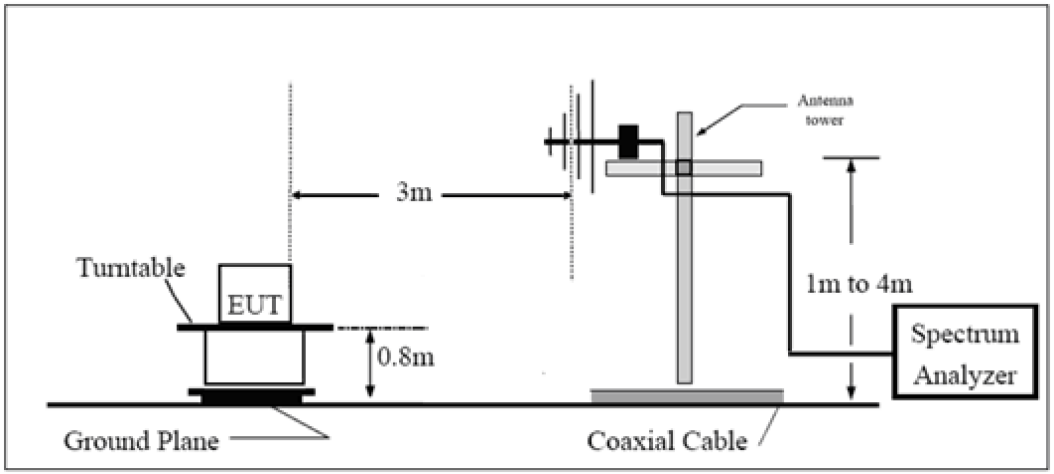
The test is in transmitting mode.

Test Setup

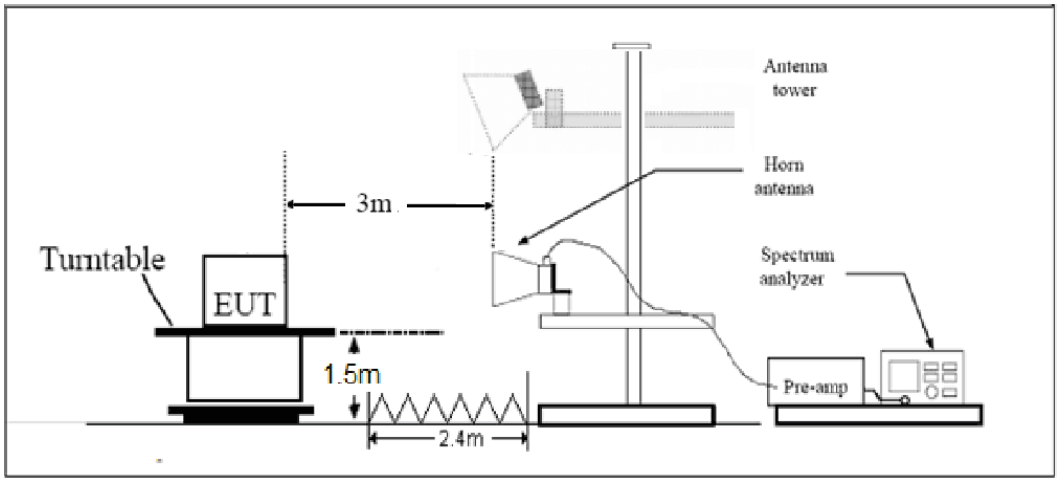
9KHz~ 30MHz



30MHz~ 1GHz



Above 1GHz



Note: Area side:2.4mX3.6m

Limits

Rule Part 15.247(d) specifies that “In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).”

Limit in restricted band

Frequency of emission (MHz)	Field strength(μV/m)	Field strength(dBμV/m)
0.009–0.490	2400/F(kHz)	/
0.490–1.705	24000/F(kHz)	/
1.705–30.0	30	/
30-88	100	40
88-216	150	43.5
216-960	200	46
Above960	500	54

§15.35(b)

There is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.

Peak Limit=74 dBμV/m

Average Limit=54 dBμV/m

Spurious Radiated Emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1] 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

Measurement Uncertainty

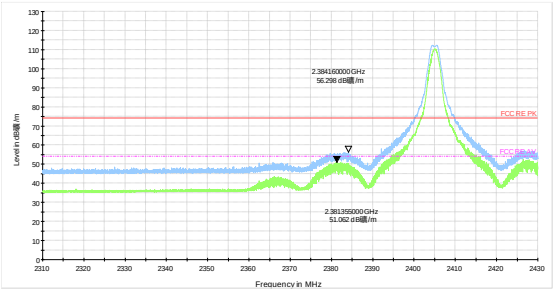
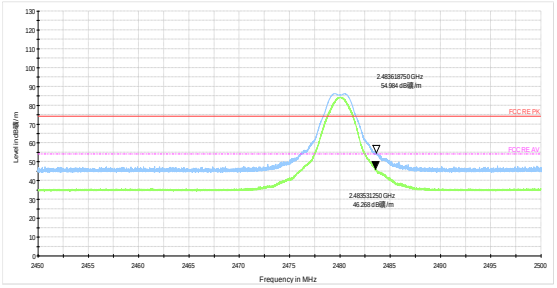
The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 1.96.

Frequency	Uncertainty
9KHz-30MHz	3.55 dB
30MHz-200MHz	4.17 dB
200MHz-1GHz	4.84 dB
1-18GHz	4.35 dB
18-26.5GHz	5.90 dB

Test result

The signal beyond the limit is carrier.

A symbol (dB礦/m) in the test plot below means (dBμV/m)

Zigbee-Channel 11: Peak + Average	Zigbee-Channel 26: Peak + Average
	

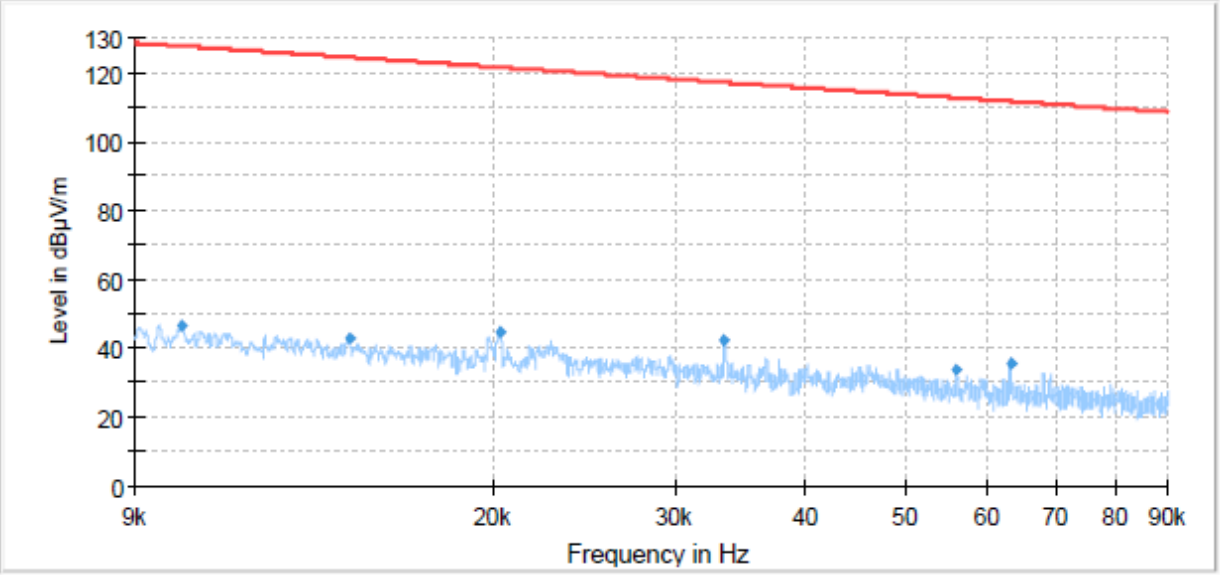
Result of RE

Sweep the whole frequency band through the range from 9kHz to the 10th harmonic of the carrier, the Emissions in the frequency band 18GHz-26.5GHz are more than 20dB below the limit are not reported.

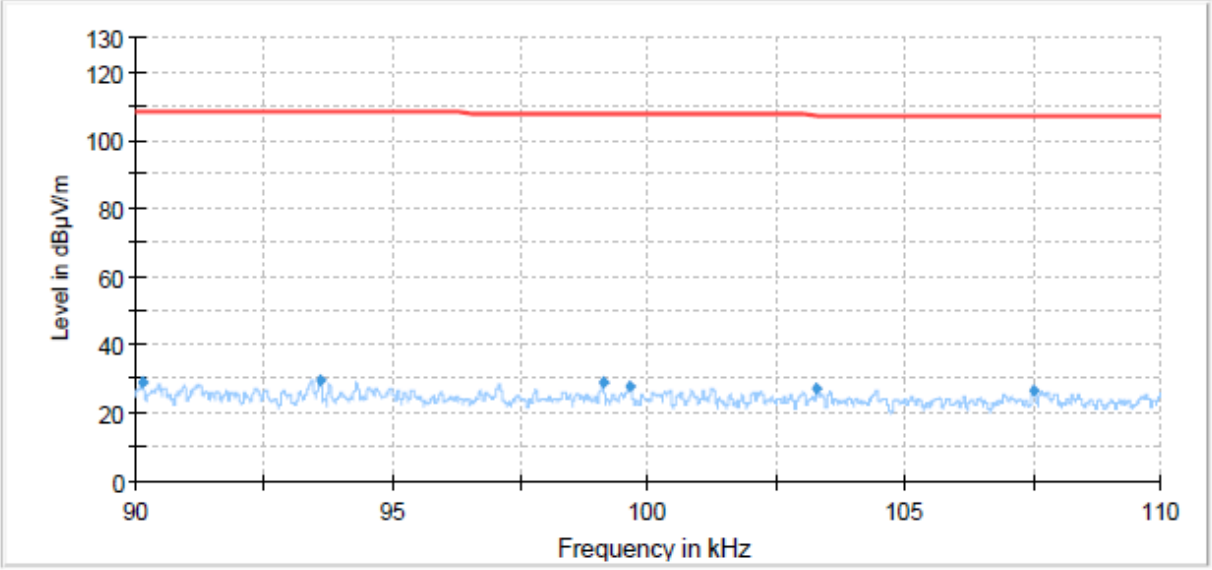
The following graphs display the maximum values of horizontal and vertical by software.
For above 1GHz, Blue trace uses the peak detection, Green trace uses the average detection.

During the test, the Radiates Emission from 9kHz to 1GHz was performed in all modes with all channels, Zigbee, Channel 11 are selected as the worst condition. The test data of the worst-case condition was recorded in this report.

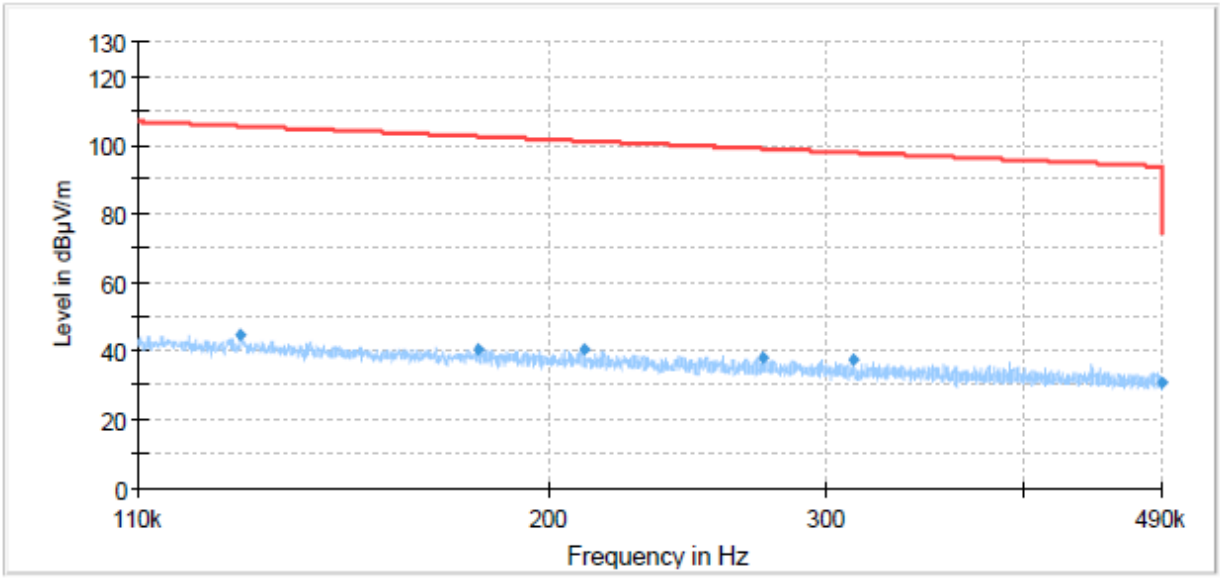
Continuous TX mode:



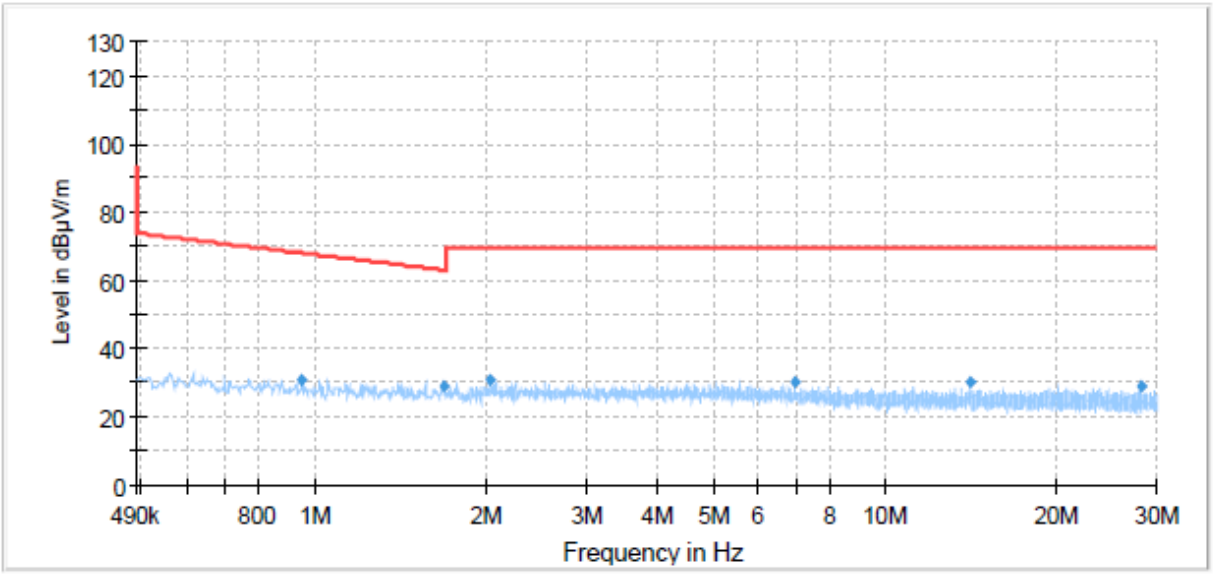
Radiates Emission from 9kHz to 90kHz



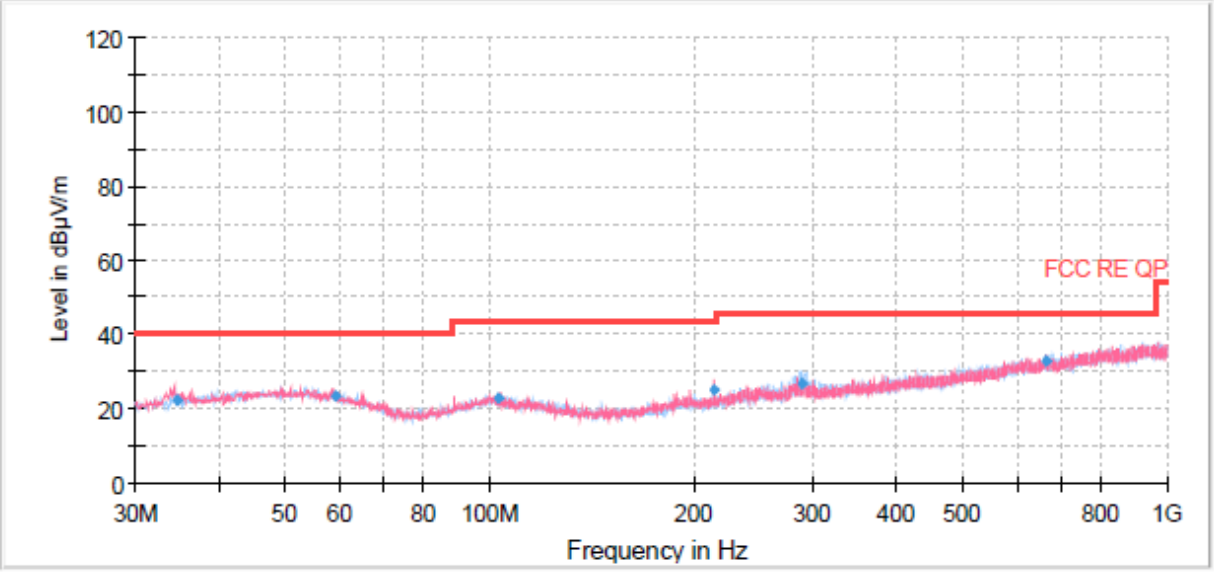
Radiates Emission from 90kHz to 110kHz



Radiates Emission from 110kHz to 490kHz



Radiates Emission from 490kHz to 30MHz



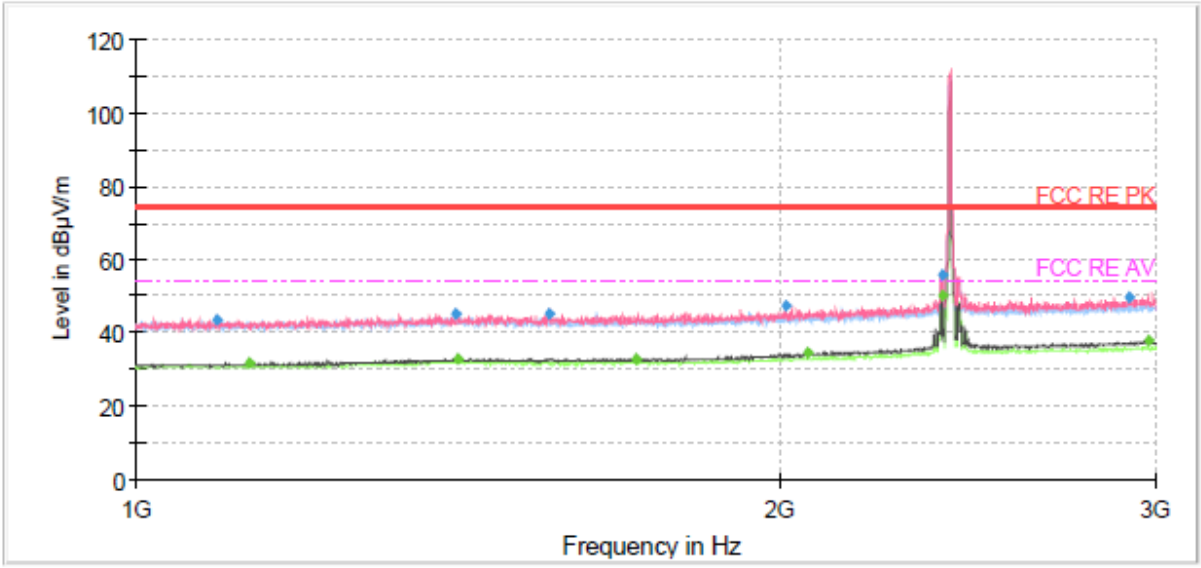
Radiates Emission from 30MHz to 1GHz

Frequency (MHz)	Quasi-Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)
34.47	22.40	40.00	17.60	110.0	V	214.00	18
59.40	23.72	40.00	16.28	207.0	V	313.00	19
103.15	22.83	43.50	20.67	122.0	V	1.00	19
214.56	24.87	43.50	18.63	208.0	V	10.00	18
288.44	26.93	46.00	19.07	110.0	H	270.00	21
661.57	33.10	46.00	12.90	107.0	V	240.00	28

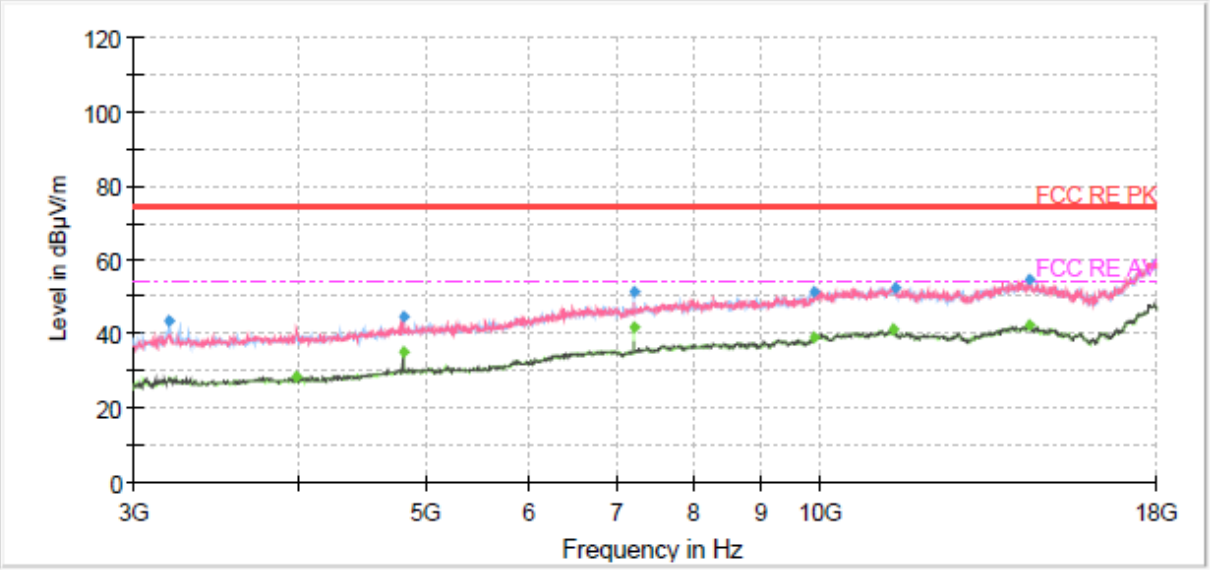
Remark: 1. Correction Factor = Antenna factor + Insertion loss (cable loss + amplifier gain)

2. Margin = Limit – Quasi-Peak

Zigbee CH11



Note: The signal beyond the limit is carrier.
Radiates Emission from 1GHz to 3GHz



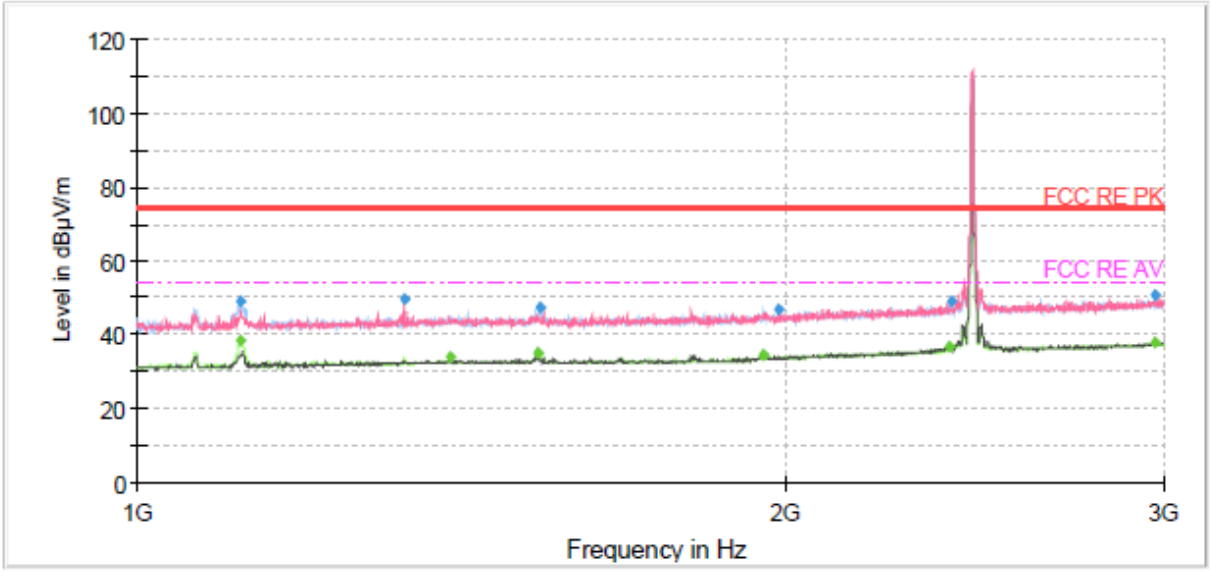
Radiates Emission from 3GHz to 18GHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1091.50	43.76	---	74.00	30.24	500.00	100.0	V	208.00	-5
1128.50	---	31.85	54.00	22.15	500.00	100.0	V	139.00	-5
1412.00	45.28	---	74.00	28.72	500.00	100.0	V	163.00	-3
1416.00	---	33.06	54.00	20.94	500.00	100.0	V	61.00	-3
1559.00	45.27	---	74.00	28.73	500.00	100.0	V	67.00	-3
1715.00	---	33.07	54.00	20.93	500.00	100.0	V	1.00	-2
2013.00	47.49	---	74.00	26.51	500.00	100.0	V	109.00	-1
2063.00	---	34.60	54.00	19.40	500.00	100.0	V	170.00	-1
2383.00	55.81	---	74.00	18.19	500.00	100.0	V	299.00	1
2383.00	---	50.26	54.00	3.74	500.00	100.0	V	299.00	1
2913.50	49.78	---	74.00	24.22	500.00	100.0	V	189.00	2
2977.50	---	38.14	54.00	15.86	500.00	100.0	V	189.00	3

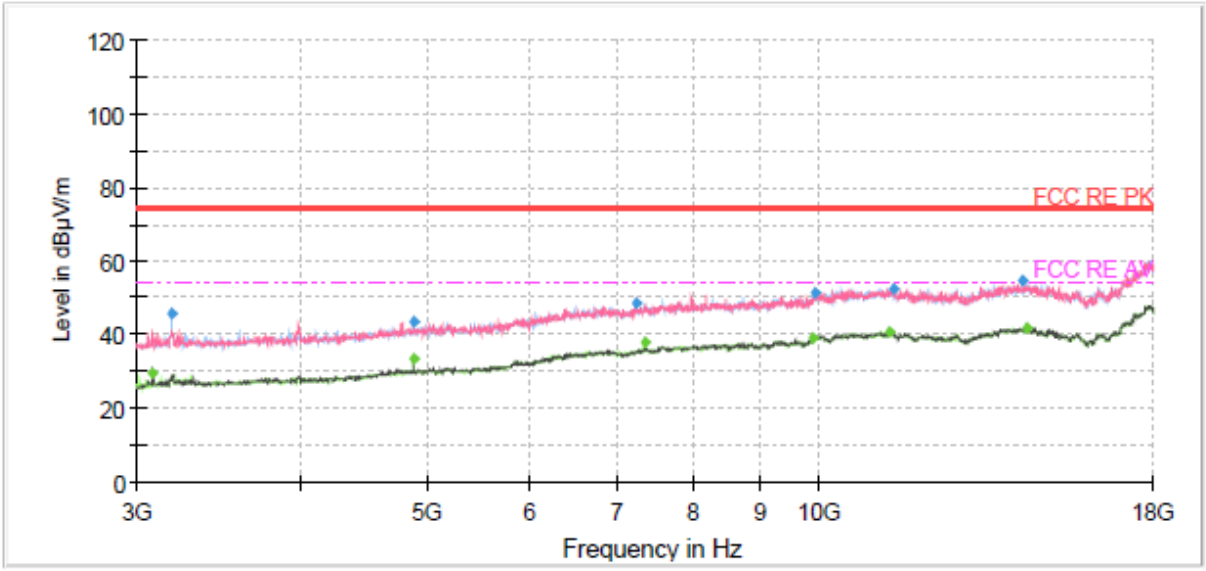
Remark: 1. Correction Factor = Antenna factor + Insertion loss (cable loss + amplifier gain)

2. Margin = Limit –MAX Peak/ Average

Zigbee CH19



Note: The signal beyond the limit is carrier.
Radiates Emission from 1GHz to 3GHz

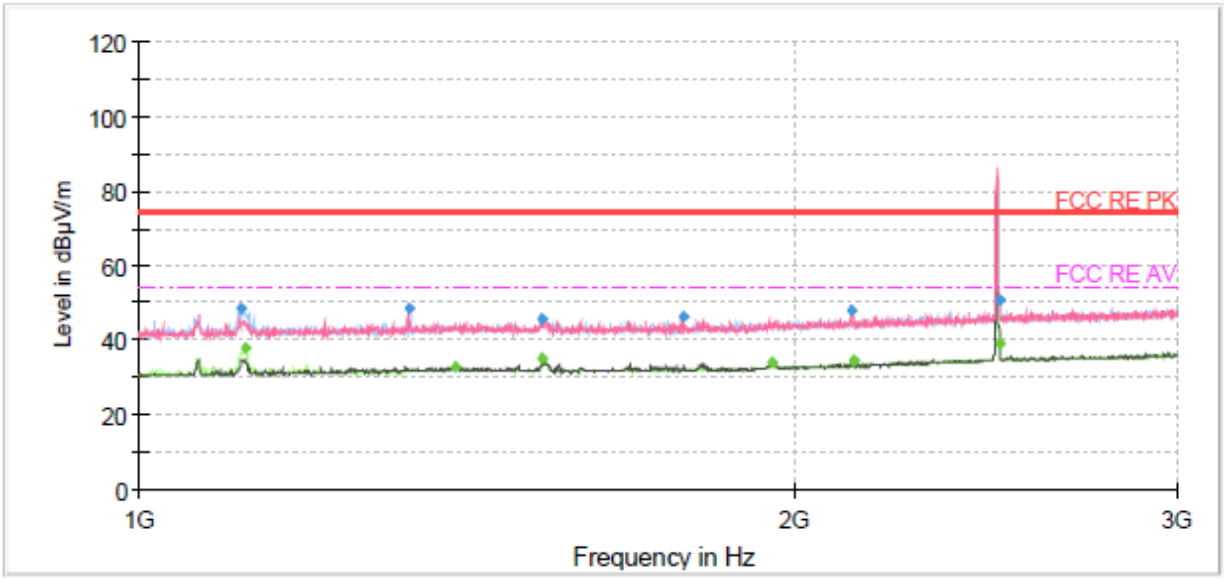


Radiates Emission from 3GHz to 18GHz

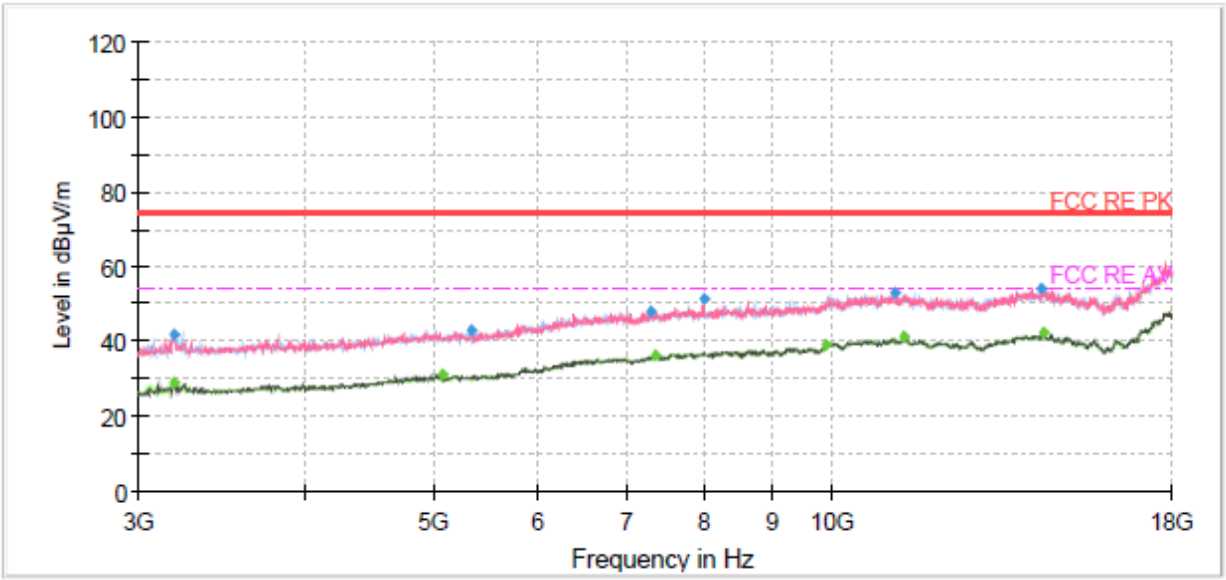
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1116.00	---	38.49	54.00	15.51	500.00	200.0	H	172.00	-5
1116.00	49.03	---	74.00	24.97	500.00	200.0	H	172.00	-5
1330.50	49.71	---	74.00	24.29	500.00	200.0	V	311.00	-4
1397.00	---	33.84	54.00	20.16	500.00	200.0	H	76.00	-3
1536.50	---	35.31	54.00	18.69	500.00	100.0	H	150.00	-3
1540.50	47.37	---	74.00	26.63	500.00	100.0	H	150.00	-3
1955.50	---	34.84	54.00	19.16	500.00	100.0	V	186.00	-1
1986.00	46.64	---	74.00	27.36	500.00	200.0	H	106.00	-1
2382.00	---	36.96	54.00	17.04	500.00	100.0	V	283.00	1
2388.00	49.18	---	74.00	24.82	500.00	200.0	V	286.00	1
2971.00	50.96	---	74.00	23.04	500.00	100.0	V	0.00	3
2973.00	---	38.06	54.00	15.94	500.00	200.0	V	354.00	3

Remark: 1. Correction Factor = Antenna factor + Insertion loss (cable loss + amplifier gain)
2. Margin = Limit –MAX Peak/ Average

Zigbee CH26



Note: The signal beyond the limit is carrier.
Radiates Emission from 1GHz to 3GHz



Radiates Emission from 3GHz to 18GHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1114.00	48.52	---	74.00	25.48	500.00	200.0	H	181.00	-5
1118.00	---	37.95	54.00	16.05	500.00	100.0	H	182.00	-5
1330.50	48.66	---	74.00	25.34	500.00	100.0	H	326.00	-4
1398.50	---	32.89	54.00	21.11	500.00	200.0	V	324.00	-3
1532.00	46.04	---	74.00	27.96	500.00	200.0	V	101.00	-3
1532.50	---	35.35	54.00	18.65	500.00	200.0	V	101.00	-3
1780.50	46.21	---	74.00	27.79	500.00	200.0	V	96.00	-2
1954.00	---	34.21	54.00	19.79	500.00	200.0	V	172.00	-1
2128.50	47.96	---	74.00	26.04	500.00	200.0	V	160.00	0
2129.50	---	34.74	54.00	19.26	500.00	200.0	V	126.00	0
2485.00	50.96	---	74.00	23.04	500.00	100.0	V	290.00	1
2485.50	---	39.01	54.00	14.99	500.00	100.0	V	290.00	1

Remark: 1. Correction Factor = Antenna factor + Insertion loss (cable loss + amplifier gain)

2. Margin = Limit –MAX Peak/ Average

5.2. Conducted Emission

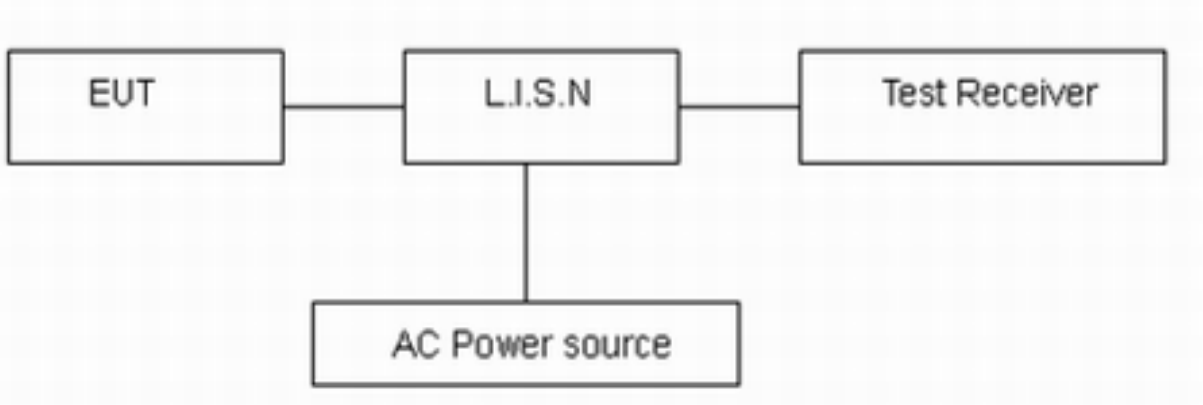
Ambient Condition

Temperature	Relative humidity	Pressure
15°C ~ 35°C	20% ~ 80%	86 kPa ~ 106 kPa

Methods of Measurement

The EUT is placed on a non-metallic table of 80cm height above the horizontal metal reference ground plane. During the test, the EUT was operating in its typical mode. The test method is according to ANSI C63.10-2020. Connect the AC power line of the EUT to the L.I.S.N. Use EMI receiver to detect the average and Quasi-peak value. RBW is set to 9 kHz, VBW is set to 30kHz. The measurement result should include both L line and N line.
The test is in transmitting mode.

Test Setup



Note: AC Power source is used to change the voltage 110V/60Hz.

Limits

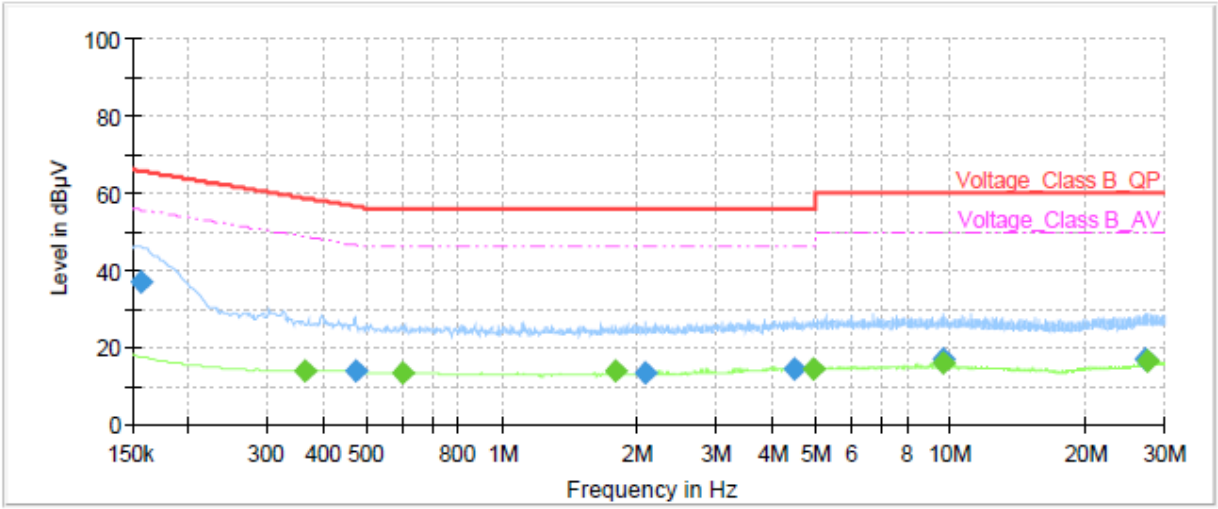
Frequency (MHz)	Conducted Limits(dBμV)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 *	56 to 46*
0.5 - 5	56	46
5 - 30	60	50
*: Decreases with the logarithm of the frequency.		

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 1.96, U= 2.69 dB.

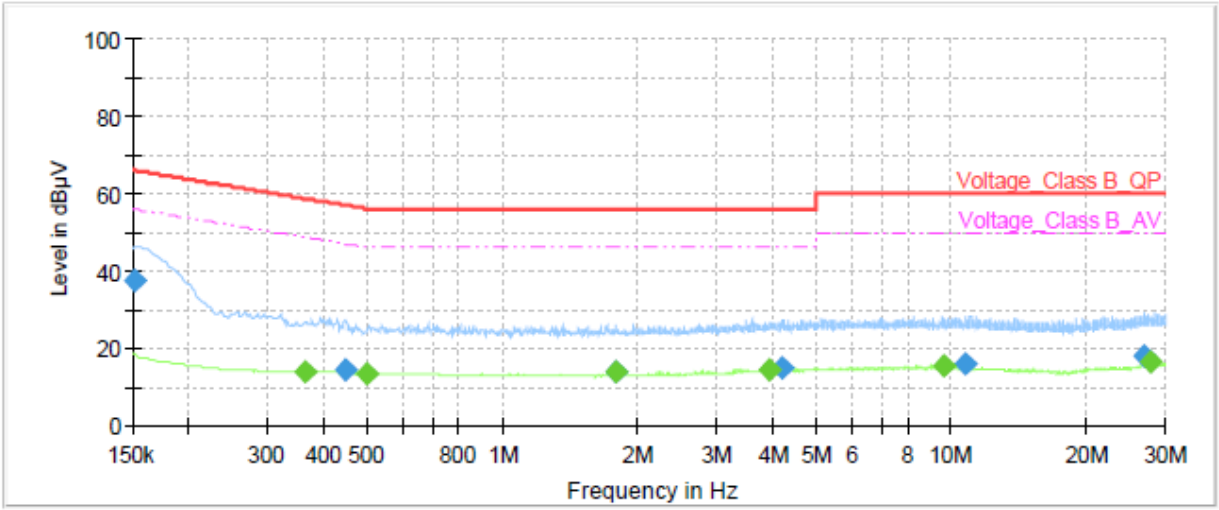
Test Results:

Following plots, Blue trace uses the peak detection and Green trace uses the average detection. During the test, the Conducted Emission was performed in all channels, Zigbee, Channel No.: 11 are selected as the worst condition. The test data of the worst-case condition was recorded in this report.



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.16	36.93	---	65.63	28.70	1000.0	9.000	L1	ON	21.0
0.36	---	13.76	48.69	34.93	1000.0	9.000	L1	ON	21.0
0.47	13.97	---	56.48	42.51	1000.0	9.000	L1	ON	20.9
0.60	---	13.30	46.00	32.70	1000.0	9.000	L1	ON	20.8
1.80	---	13.59	46.00	32.41	1000.0	9.000	L1	ON	19.8
2.09	13.21	---	56.00	42.79	1000.0	9.000	L1	ON	19.7
4.50	14.44	---	56.00	41.56	1000.0	9.000	L1	ON	19.5
4.94	---	14.61	46.00	31.39	1000.0	9.000	L1	ON	19.5
9.60	---	15.65	50.00	34.35	1000.0	9.000	L1	ON	19.6
9.60	17.00	---	60.00	43.00	1000.0	9.000	L1	ON	19.6
27.31	16.71	---	60.00	43.29	1000.0	9.000	L1	ON	19.7
27.40	---	16.17	50.00	33.83	1000.0	9.000	L1	ON	19.7

L line Conducted Emission from 150 kHz to 30 MHz



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.15	37.57	---	65.88	28.31	1000.0	9.000	N	ON	21.0
0.36	---	13.75	48.69	34.94	1000.0	9.000	N	ON	21.0
0.45	14.61	---	56.89	42.28	1000.0	9.000	N	ON	20.9
0.50	---	13.25	46.00	32.75	1000.0	9.000	N	ON	20.9
1.79	13.90	---	56.00	42.10	1000.0	9.000	N	ON	19.8
1.80	---	13.64	46.00	32.36	1000.0	9.000	N	ON	19.8
3.92	---	14.41	46.00	31.59	1000.0	9.000	N	ON	19.5
4.22	14.66	---	56.00	41.34	1000.0	9.000	N	ON	19.5
9.60	---	15.61	50.00	34.39	1000.0	9.000	N	ON	19.6
10.72	15.89	---	60.00	44.11	1000.0	9.000	N	ON	19.6
26.96	18.09	---	60.00	41.91	1000.0	9.000	N	ON	19.8
27.86	---	16.59	50.00	33.41	1000.0	9.000	N	ON	19.8

N line Conducted Emission from 150 kHz to 30 MHz

6. Main Test Instruments

Name of Equipment	Manufacturer	Type/Model	Serial Number	Calibration Date	Expiration Time
Radiated Emission					
EMI Test Receiver	R&S	ESCI3	100948	2024-05-07	2025-05-06
Signal Analyzer	R&S	FSV40	101298	2024-05-07	2025-05-06
Loop Antenna	SCHWARZBECK	FMZB1519	1519-047	2023-04-16	2026-04-15
TRILOG Broadband Antenna	SCHWARZBECK	VULB 9163	01111	2022-10-25	2025-10-24
Horn Antenna	SCHWARZBECK	BBHA 9120D	430	2024-07-18	2027-07-17
Amplifier	MWPA.CN	MWLA-010200G40	YQ2103039B01	2024-05-07	2025-05-06
Horn Antenna	ETS-Lindgren	3160-09	00102643	2021-10-10	2024-10-09
				2024-09-24	2027-09-23
Software	R&S	EMC32	9.26.01	/	/
Conducted Emission					
Artificial main network	R&S	ENV216	102191	2022-12-10	2024-12-09
EMI Test Receiver	R&S	ESR	101667	2024-05-07	2025-05-06
Software	R&S	EMC32	10.35.10	/	/

ANNEX A: The EUT Appearance

The EUT Appearance are submitted separately.

ANNEX B: Test Setup Photos

The Test Setup Photos are submitted separately.

******** END OF REPORT ********