

SmartAC.com, Inc.

TEST REPORT

Model:

SMFIL1A2

REPORT NUMBER

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Radio Spectrum TEST REPORT

Applicant:	SmartAC.com, Inc. 5302 Egbert Street, Houston, TX 77007, United States
Product:	Sensor
Model No.:	SMFIL1A2
Brand Name:	smartAC.com
FCC ID:	2AVMLSMFIL2
Test Method/ Standard:	47 CFR FCC Part 15.249 & ANSI C63.10 2013
Test By:	Intertek Testing Services Taiwan Ltd., Hsinchu Laboratory No. 11, Lane 275, Ko-Nan 1 Street, Chia-Tung Li, Shiang-Shan District, Hsinchu City, Taiwan



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Revision History

Report No.	Issue Date	Revision Summary
220800296THC-001	Sep. 21, 2022	The differences is add accessory connector, after engineer judgment radiated (30MHz~1GHz) emission test was considered necessary, this data based on report No.: 220800294THC-001. Same as RF modular, the other test data based on Report No.: 200700311TWN-001.

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Summary of Tests

Test	Reference	Results
20dB Bandwidth/Occupied Bandwidth test	15.215(c)	Pass
Radiated Emission test	15.249(c), 15.209	Pass
Emission on the Band Edge	15.249(d)	Pass
Conducted Emission of AC Power	15.207	N/A
Antenna Requirement	15.203	Pass

Note: Please note that the test results with statement of conformity, the decision rules which are based on: Safety Testing: the specification, standard or IEC Guide 115.

Other Testing: the specification, standard and not taking into account the measurement uncertainty.

1. General Information

1.1 Identification of the EUT

Product:	Sensor
Model No.:	SMFIL1A2
Operating Frequency:	2407 MHz ~ 2477 MHz
Channel Number:	8 channels
Frequency of Each Channel:	2407MHz, 2408MHz, 2414MHz, 2425MHz, 2435MHz, 2460MHz, 2469 MHz, 2477MHz
Access scheme:	GFSK
Rated Power:	DC 3V from battery
Power Cord:	N/A
Sample receiving date:	1. 2020/07/23 2. 2022/08/29
Sample condition:	Workable
Test Date(s):	1. 2020/07/31 ~ 2020/08/10 2. 2022/09/13

1.2 Antenna description

Antenna Gain	: 1.3 dBi
Antenna Type	: PIFA antenna
Connector Type	: Fixed

1.3 Peripherals equipment

Peripherals	Model No.	Serial No.	Data cable
DC Power Supply	TP-1603C	N/A	N/A
Battery	LFB-AA-GRP-FR6	N/A	N/A

2. Test specifications

2.1 Test standard

The EUT was performed according to the procedures in FCC Part 15 Subpart C Paragraph 15.249 for non-spread spectrum devices.

The test of radiated measurements according to FCC Part15 Section 15.33(a) had been conducted and the field strength of this frequency band were all meet limit requirement, thus we evaluate the EUT pass the specified test.

2.2 Operation mode

Power on and press button to select different frequency and modulation.

The signal is maximized through rotation and placement in the three orthogonal axes.



X axis



Y axis



Z axis

After verifying three axes, we found the maximum electromagnetic field was occurred at X axis. The final test data was executed under this configuration.

3. 20dB Bandwidth & Occupied Bandwidth test

3.1 Operating environment

Temperature:	27	°C
Relative Humidity:	54	%

3.2 Test setup & procedure

The 20dB Bandwidth & Occupied Bandwidth was measured using a 50 ohm spectrum analyzer with the resolutions bandwidth set at 100 kHz, the video bandwidth \geq RBW, and the SPAN may equal to approximately 2 to 3 times the 20dB bandwidth. The test was performed at 3 channels (lowest, middle and highest channel). The maximum 20dB modulation bandwidth is in the following Table.

3.3 Measured data of modulated bandwidth test results

Single TX

Mode	Channel	Frequency (MHz)	20dB Bandwidth (MHz)
GFSK	Low	2407	0.793
	Mid	2435	0.844
	High	2477	1.008

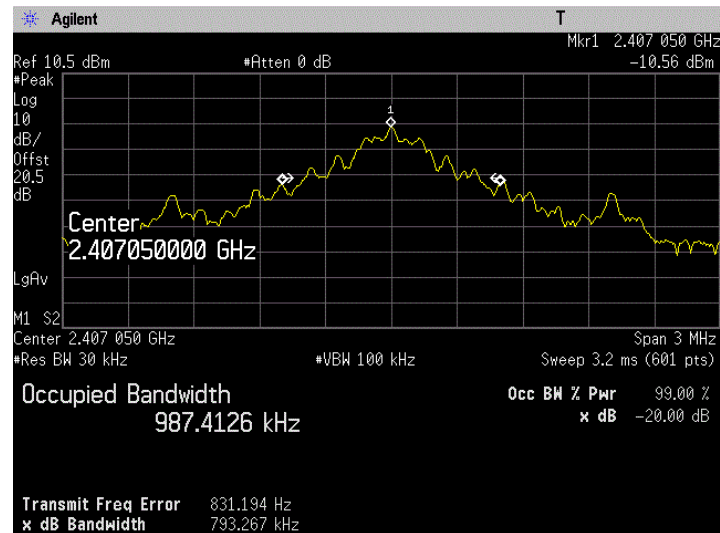
Please see the plot below.

Single TX

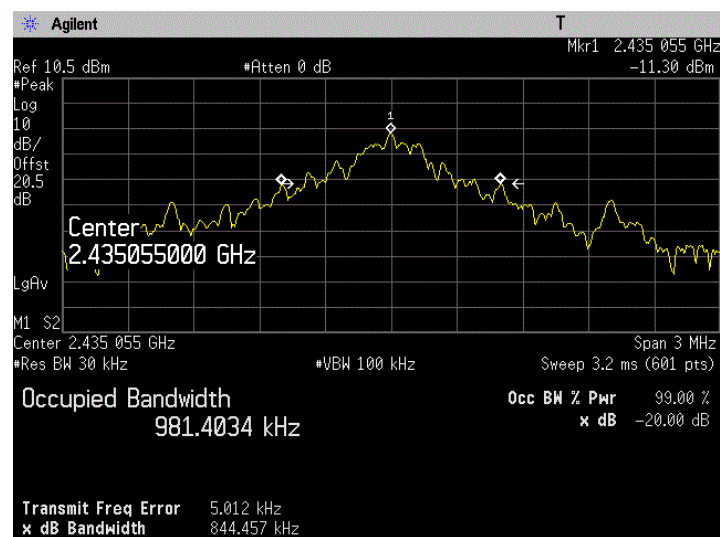
Mode	Channel	Frequency (MHz)	Occupied Channel Bandwidth (MHz)
GFSK	Low	2407	0.987
	Mid	2435	0.981
	High	2477	1.019

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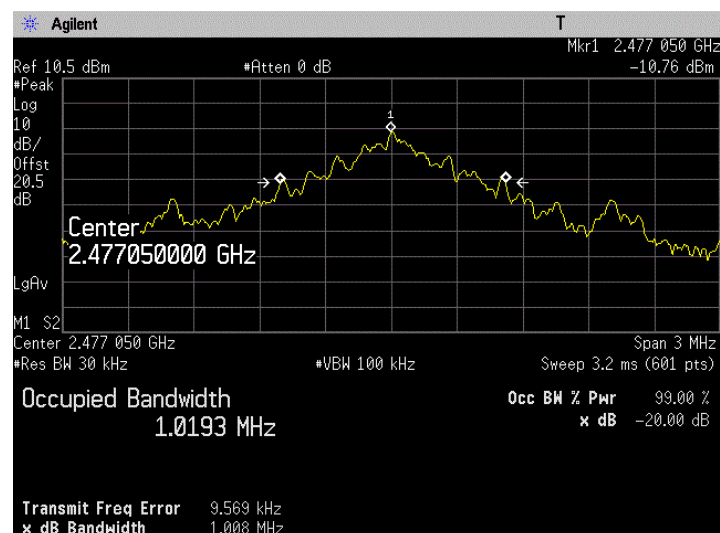
Occupied Channel Bandwidth & 20dB Bandwidth @ Ch Low mode



Occupied Channel Bandwidth & 20dB Bandwidth @ Ch Mid mode



Occupied Channel Bandwidth & 20dB Bandwidth @ Ch High mode



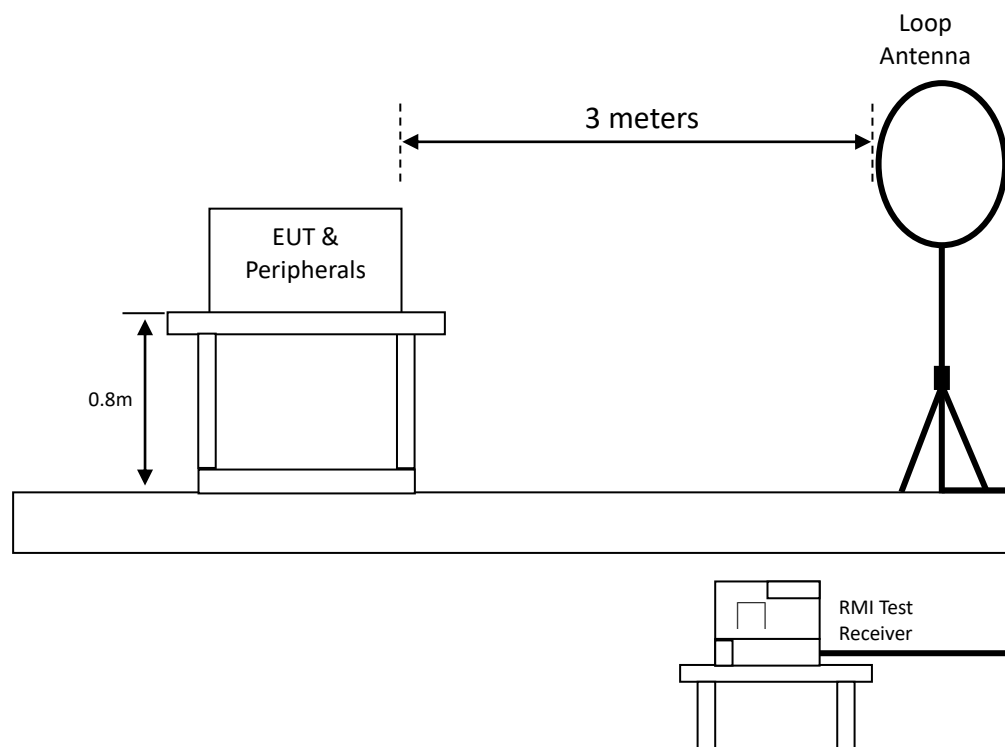
4. Radiated emission test FCC 15.249 (C)

4.1 Operating environment

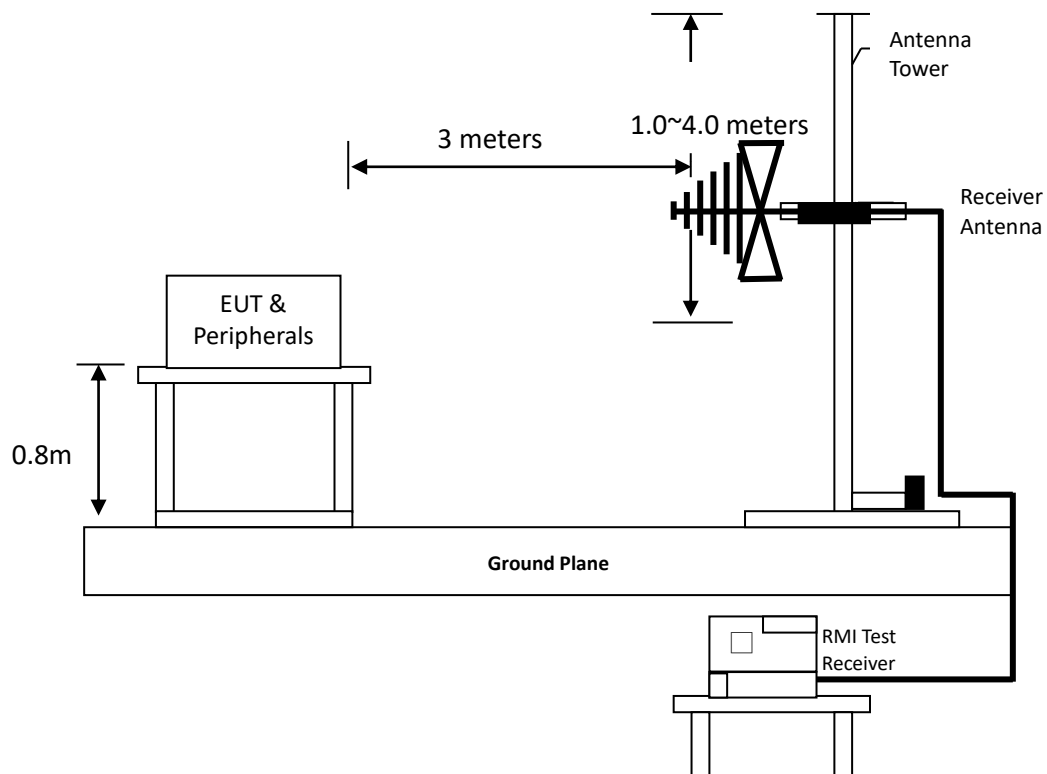
Temperature:	26	°C
Relative Humidity:	59	%

4.2 Test setup & procedure

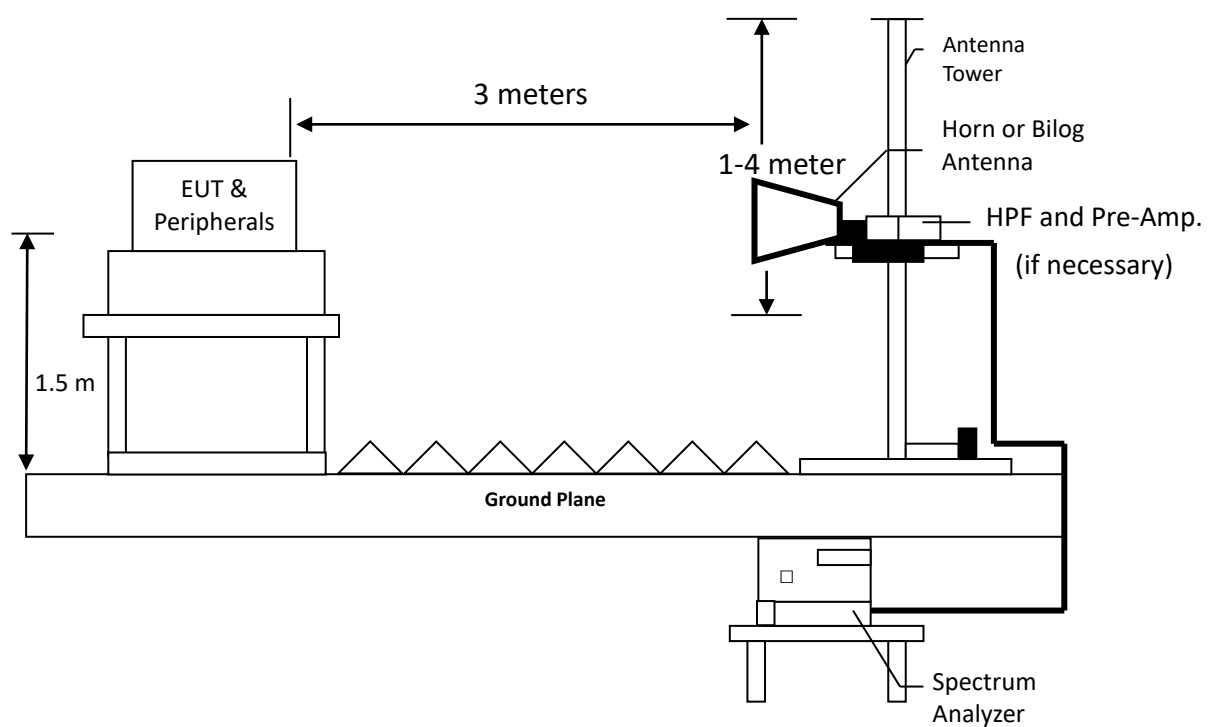
Radiated emission from 9kHz to 30MHz uses Loop Antenna:



Radiated emission below 1GHz using Bilog Antenna



Radiated emission above 1GHz using Horn Antenna



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Radiated emissions were investigated cover the frequency range from 30MHz to 1000MHz using a receiver RBW of 120kHz record QP reading, and the frequency over 1GHz using a spectrum analyzer RBW of 1MHz and 10Hz VBW record Average reading. (15.209 paragraph), the Peak reading (1 MHz RBW/ 3 MHz VBW) recorded also on the report.

The EUT for testing is arranged on a turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meters and down to 1 meter.

The measurement for radiated emission will be done at the distance of three meters unless the signal level is too low to measure at that distance. In the case of the reading under noise floor, a pre-amplifier is used and/or the test is conducted at a closer distance. And then all readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

4.3 Emission limit

4.3.1 Fundamental and harmonics emission limits

Frequency (MHz)	Field Strength of Fundamental		Field Strength of Harmonics	
	(mV/m@3m)	(dBuV/m@3m)	(uV/m@3m)	(dBuV/m@3m)
2400-2483.5	50	94	500	54

4.3.2 General radiated emission limits

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 paragraph 15.209, whichever is the lesser attenuation.

Frequency MHz	15.209 Limits (dB μ V/m@3m)
30-88	40
88-216	43.5
216-960	46
Above 960	54

Remark:

1. In the above table, the tighter limit applies at the band edges.
2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

4.4 Radiated spurious emission test data

4.4.1 Measurement results: frequency range from 9 kHz to 30 MHz

The emissions are more than 20 dB below the limit, the value has no need to be reported.

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4.4.2 Measurement results: frequencies equal to or less than 1 GHz

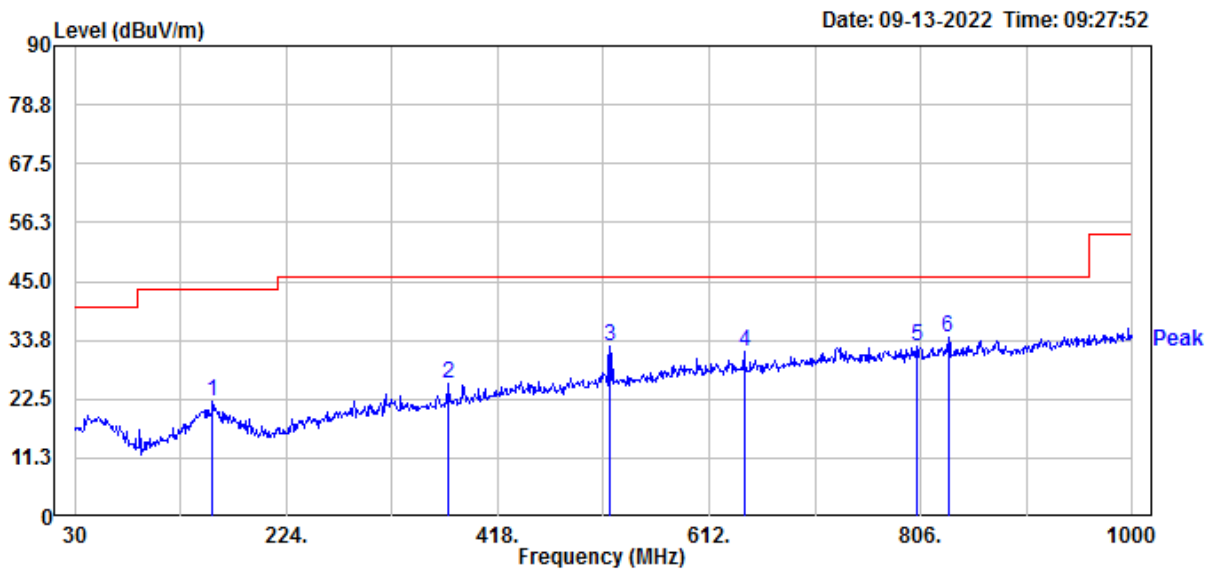
The test was performed continuously transmitting mode. The worst case occurred at TX middle channel.

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Worst case: TX middle channel

Ant. Pol. (H/V)	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Vertical	156.10	QP	20.58	1.48	22.06	43.50	-21.44
Vertical	372.41	QP	23.61	1.79	25.40	46.00	-20.60
Vertical	520.82	QP	27.02	5.49	32.51	46.00	-13.49
Vertical	644.01	QP	29.68	1.86	31.54	46.00	-14.46
Vertical	802.12	QP	32.08	0.66	32.74	46.00	-13.26
Vertical	831.22	QP	32.53	1.65	34.18	46.00	-11.82

Remark: Corr. Factor = Antenna Factor + Cable Loss

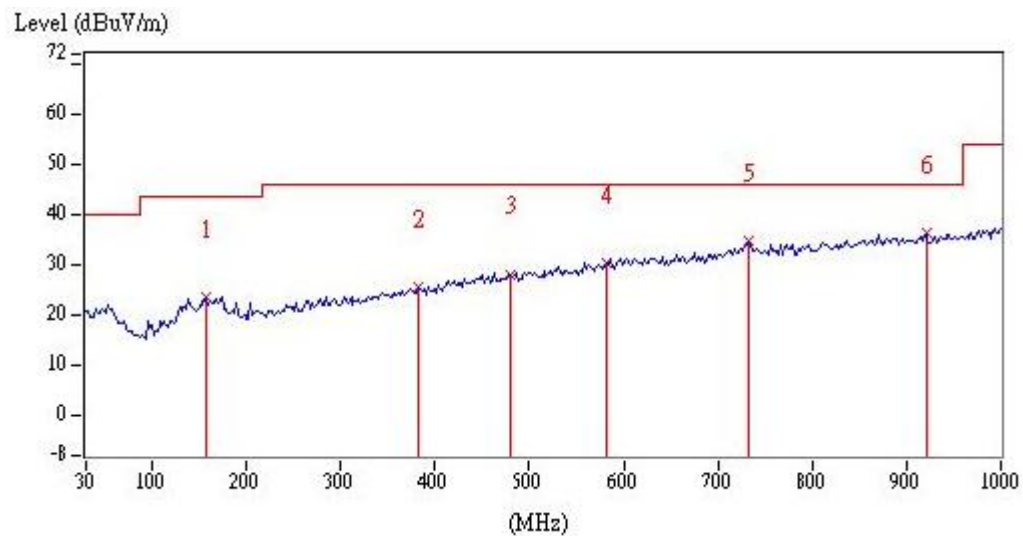


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EUT: SMFIL1A2
Worst case: TX middle channel

Ant. Pol. (H/V)	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Horizontal	139.61	QP	19.79	1.36	21.15	43.50	-22.35
Horizontal	290.93	QP	21.41	0.66	22.07	46.00	-23.93
Horizontal	489.78	QP	26.32	7.24	33.56	46.00	-12.44
Horizontal	513.06	QP	26.90	10.58	37.48	46.00	-8.52
Horizontal	729.37	QP	31.06	1.64	32.70	46.00	-13.30
Horizontal	903.00	QP	33.20	5.67	38.87	46.00	-7.13

Remark: Corr. Factor = Antenna Factor + Cable Loss



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4.4.3 Measurement results: frequency above 1GHz

EUT: SMFIL1A2

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Ch_Low	4814	PK	V	6.95	44.63	51.58	74	-22.42
	7221	PK	V	13.69	43.39	57.08	74	-16.92
	7221	AV	V	---	---	36.00	54	-18.00
	4814	PK	H	6.95	44.61	51.56	74	-22.44
	7221	PK	H	13.69	43.04	56.73	74	-17.27
	7221	AV	H	---	---	35.65	54	-18.35
Ch_Mid	4870	PK	V	7.09	45.31	52.40	74	-21.60
	7305	PK	V	14.00	45.30	59.30	74	-14.70
	7305	AV	V	---	---	38.22	54	-15.78
	4870	PK	H	7.09	47.21	54.30	74	-19.70
	4870	AV	H	---	---	33.22	54	-20.78
	7305	PK	H	14.00	42.85	56.85	74	-17.15
	7305	AV	H	---	---	35.77	54	-18.23
Ch_High	4954	PK	V	7.32	47.86	55.18	74	-18.82
	4954	AV	V	---	---	34.10	54	-19.90
	7431	PK	V	14.47	41.08	55.56	74	-18.44
	7431	AV	V	---	---	34.48	54	-19.52
	4954	PK	H	7.32	48.22	55.54	74	-18.46
	4954	AV	H	---	---	34.46	54	-19.54
	7431	PK	H	14.47	41.99	56.46	74	-17.54
	7431	AV	H	---	---	35.38	54	-18.62

Remark: Correction Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Pre_Amplifier Gain

Note: AV Corrected Reading = PK Corrected Reading + Duty cycle correction factor(-21.08)

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4.4.4 Measurement results: Fundamental

EUT: SMFIL1A2

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Ch low	2407	PK	V	34.59	56.19	85.11	114.00	-28.89
	2407	AV	V	--	--	64.03	94.00	-29.97
	2407	PK	H	34.59	64.04	88.06	114.00	-25.94
	2407	AV	H	--	--	66.98	94.00	-27.02
Ch mid	2435	PK	V	34.74	57.26	84.08	114.00	-29.92
	2435	AV	V	--	--	63.00	94.00	-31.00
	2435	PK	H	34.74	64.40	88.45	114.00	-25.55
	2435	AV	H	--	--	67.37	94.00	-26.63
Ch high	2477	PK	V	34.89	56.37	83.21	114.00	-30.79
	2477	AV	V	--	--	62.13	94.00	-31.87
	2477	PK	H	34.89	62.83	88.39	114.00	-25.61
	2477	AV	H	--	--	67.31	94.00	-26.69

Remark: Correction Factor = Antenna Factor + Cable Loss

Note: AV Corrected Reading = PK Corrected Reading + Duty cycle correction factor(-21.08)

5. Radiated emission on the band edge FCC 15.249(d)

5.1 Operating environment

Temperature:	29	°C
Relative Humidity:	57	%

5.2 Radiated emission on the band edge test data

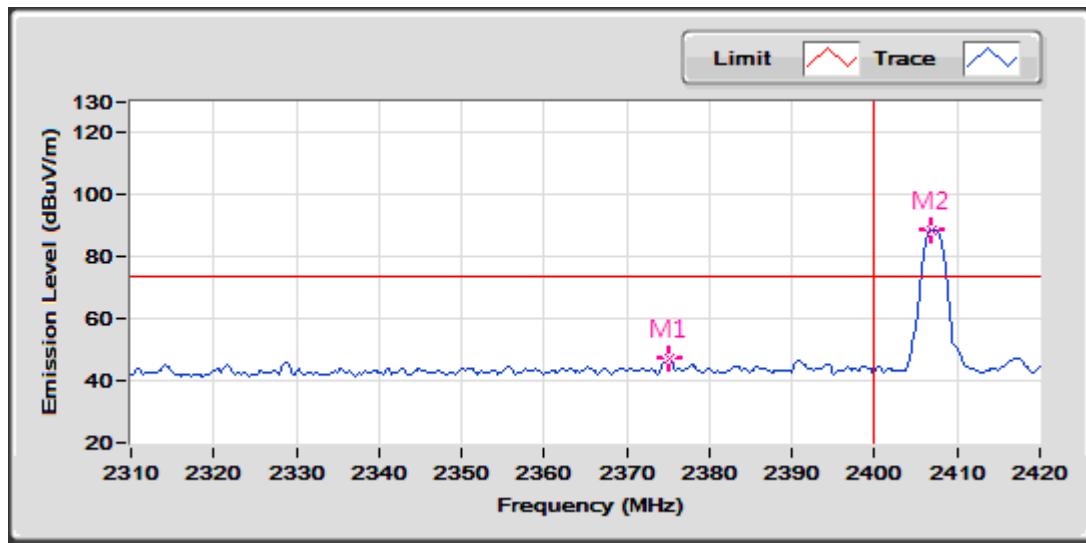
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)	Restricted band (MHz)
GFSK	2375.12	PK	H	34.45	12.49	46.94	74	-27.06	≤2400
	2375.12	AV	H	---	---	25.86	54	-28.14	
	2493.22	PK	H	34.96	11.80	46.76	74	-27.24	≥2483.5
	2493.22	AV	H	---	---	25.68	54	-28.32	

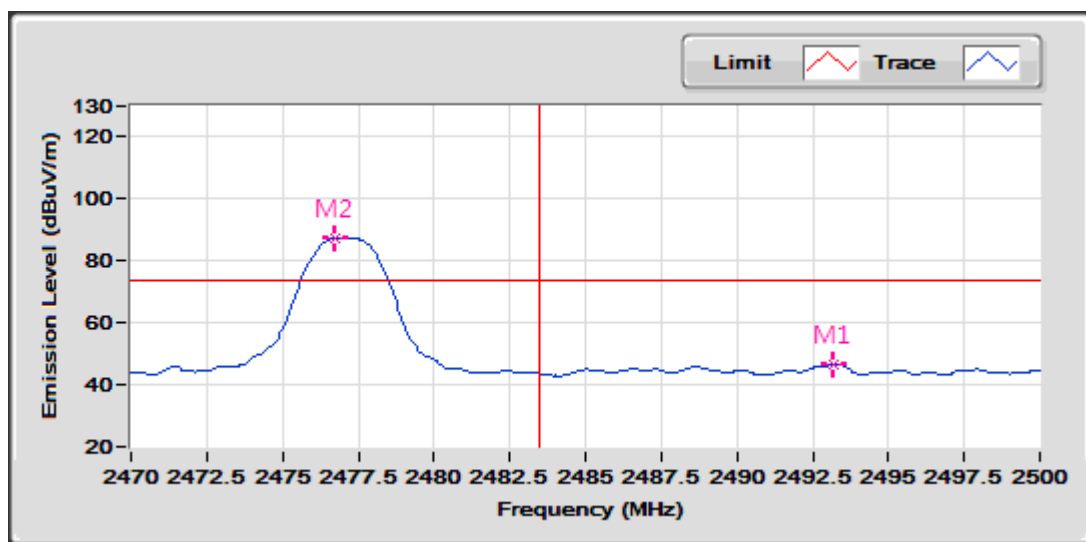
Remark: Correction Factor = Antenna Factor + Cable Loss

Note: AV Corrected Reading = PK Corrected Reading + Duty cycle correction factor(-21.08)

Restricted Band Bandedge @ 2.4G Mode Ch low PK



Restricted Band Bandedge @ 2.4G Mode Ch high PK



6. AC Power Line Conducted Emission

Since the EUT is not connected to AC source, therefore, the test can be waived.

Appendix A: Test equipment list

Test Equipment	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
EMI Test Receiver	R&S	ESR-7	101232	2020/01/18	2021/01/16
EMI Test Receiver	R&S	ESR7	101822	2022/08/09	2023/08/08
EMI Test Receiver	R&S	ESU40	100381	2020/05/29	2021/05/28
Spectrum Analyzer	R&S	FSP30	100137	2019/08/29	2020/08/27
Signal Analyzer	Agilent	N9030A	MY51380492	2019/08/21	2020/08/19
WiMAX PSA Spectrum Analyzer	Agilent	E4440A	MY46186191	2020/05/08	2021/05/07
Active Loop Antenna	SCHWARZBECK MESS-ELEKTRONIC	FMZB1519	1519-067	2020/04/13	2021/04/12
Broadband Antenna	SHWARZBECK	VULB 9168	9168-172	2020/06/02	2021/06/01
Broadband Antenna	SHWARZBECK	VULB 9168	9168-172	2022/01/20	2023/01/19
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170159	2017/09/04	2020/09/02
Horn Antenna	SHWARZBECK	BBHA 9120 D	9120D-456	2020/01/20	2021/01/18
Power Meter	Anritsu	ML2495A	0844001	2019/10/23	2020/10/21
Power Sensor	Anritsu	MA2411B	0738452	2019/10/23	2020/10/21
Pre-Amplifier	SCHWARZBECK	BBV9718	9718-004	2019/10/16	2020/10/14
Pre-Amplifier	EMCI	EMC184045SE	980512	2020/06/01	2021/05/31
966-2(A) Cable	SUHNER	SMA / EX 100	N/A	2019/08/19	2020/08/17
966-2(A) Cable	SUHNER	SMA / EX 100	N/A	2022/03/04	2023/03/03
966-2(B) Cable	SUHNER	SUCOFLEX 104P	CB0005	2019/08/19	2020/08/17
966-2(B) Cable	SUHNER	SUCOFLEX 104P	CB0005	2022/03/04	2023/03/03

Test Equipment	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
RF Cable	EMCI	EMC102-KM-KM-2000	170225	2020/07/13	2021/07/12
RF Cable	SUHNER	SUCOFLEX 102	N/A	2020/04/15	2021/04/14
RF Cable	SUHNER	SUCOFLEX 102	CB0006	2020/04/30	2021/04/29
Hight Pass Filter	Reactel	7HS-3G/18G-S11	N/A	2020/05/27	2021/05/26
966-2_3m Semi-Anechoic Chamber	966_2	CEM-966_2	N/A	2020/02/22	2021/02/20
966-2_3m Semi-Anechoic Chamber	966_2	CEM-966_2	N/A	2022/01/14	2023/01/13

Appendix B: Measurement Uncertainty

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level using a coverage factor of $k=2$.

Item	Uncertainty
Vertically polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.16 dB
Horizontally polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.02 dB
Vertically polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	4.29 dB
Horizontally polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	4.29 dB
Vertically polarized Radiated disturbances from 18GHz~26.5GHz in a semi-anechoic chamber at a distance of 1m	2.45 dB
Horizontally polarized Radiated disturbances from 18GHz~26.5GHz in a semi-anechoic chamber at a distance of 1m	2.45 dB
Radiated disturbances from 9kHz~30MHz in a semi-anechoic chamber at a distance of 3m	3.32 dB
Emission on the Band Edge Test	4.29 dB
20dB Bandwidth	7.69 %
Minimum 6 dB Bandwidth	7.69 %