EMC TEST REPORT

NVLAP Lab Code 200033-0

Standard(s):

47 CFR FCC Part 15.247
RSS 247, Issue 2, 2017

FCC ID: 2AFHL78050019088
IC: 20514-78050019088

Product: 3M Filtrete™ Smart Air Filter
Models: FILTRETE-19088

Company Name:
3M Company

Address:
3M Center, Building 251
St. Paul, MN 55144-1000

Report Number: RE1611023-1
Report Issue Date: November 1, 2017

Report Prepared by:

Signature:
Yuriy Litvinov
Lead EMC Engineer

Tested by:
3M EMC Laboratory
410 E. Fillmore Avenue, Building 76-01-1
St. Paul, Minnesota 55107-1000, USA

TABLE OF CONTENTS

1.0 Test Summary

Based on the results of our investigation, we have concluded the product tested **comply** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

	Standard	Requirement – Test	Result	Comments
4.1	Part 15.207/RSS-Gen	Conducted Emissions	**N/A**	
4.2	Part 15.209/RSS-Gen	Radiated Spurious Emissions	**pass**	
4.3	Part 15.247(b)(3)/ RSS 247, 5.4(d)	Conducted Output Power	**pass**	
4.4	Part 15.247(a)(2)/ RSS247,5.2(a)	6dB Bandwidth	**pass**	
4.5	Part 15.247(d)(1)/ RSS 247, 5.5	Band-edge Compliance	**pass**	
4.6	Part 15.247(e)/ RSS 247, 5.2(b)	Power Spectral Density	**pass**	
	Part 15.247(d)/ RSS 247. 5.5	Spurious Emissions at antenna port	**N/A**	
4.7	Part 15.247(i)/ RSS 102	RF Exposure Compliance	**pass**	

Note:	Device is Battery operated Device doesn't have antenna port. Measurements were performed by radiated method.

1.1 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements. The measurement uncertainty figures were calculated and correspond to a coverage factor of k=2, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Radiated emissions 30MHz to 1000MHz	4.9 dB
Radiated emissions 1GHz to 18GHz	4.6 dB
Conducted emissions 150KHz to 30MHz (AMN)	2.7 dB
Conducted emissions 150KHz to 30MHz (AAN)	1.92 dB

2.0 Equipment Description

2.1	Equipment Under Test			
Description:	Device is used to track and monitor the life of the AC filter with the Filtrete™ Smart application and replace when recommended.			
Model(s):	FILTRETE-19088			
Serial number:	N/A			
Client Contact:	Mike Meis			
Phone:	+1 651 736 0787			
3M Division:	CHIM			
Modifications and Special Measures:	none			
Frequency Range:	2402-2480 MHz			
Channel No.:	12			
Modulation Type:	GFSK			
Output power:	-4.23dBm			
Antenna Type:	Internal PCB Antenna, Gain 1.5 dBi,			
Test Deviations or Exclusions	☐ Yes	☒ No		
Rated Power:	**Voltage:**	☐ 120VAC	☐ 230VAC	☒ 3.6 VDC
	Phase:	☐ 1ph	☐ 3ph	☒ Battery
	Frequency:	☐ 50Hz	☐ 60Hz	
	Current:			
Test Dates:	09/14-10/25/2017			
Received Date:	09/12/2017			
Received Conditions:	☐ Poor	☒ Good		
	☒ Prototype	☐ Production		

3.0 EUT Configuration

3.1 System Configuration

No.	Product Type	Manufacturer	Model	Comments
1	Laptop Computer	HP	Elitebook 840	Support Equipment
2	DC Power Supply	Lambda		Support Equipment
3				

3.2 Input/Output Ports of EUT

No.	Description	Type	Comments
1			
2			

3.3 Cables

No.	Description	Type	Length	Shielding	Comments
1					
2					

3.4 Measurement Arrangements of EUT

	Intended Operational Arrangement(s)	Comments
☒	Table-top only	
☐	Floor-standing only	
☐	Floor-standing or table-top	
☐	Other	

3.5 Primary function(s) of EUT

No.	List of Essential Functions
1	Monitoring the life of the filter
2	

3.6 Exercising of EUT and Interfaces

No.	Mode of Operation
1	Transmitting at lowest, middle and highest channels of operation with un-modulated carrier
2	Device programming using Coolterm utility software for continues transmission of modulated carrier at maximum rated RF output power and Duty Cycle.

4.0 Test Conditions and Results

4.1	**Conducted Emissions Data**
Method:	The AMN was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane. This distance was between the closest points of the AMN and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the AMN. All power was connected to the system through Artificial Mains Network (AMN). Conducted voltage measurements on mains lines were made at the output of the AMN.
	All power was connected to the system through Artificial Mains Network (AMN). All tested telecommunications lines were connected to an Asymmetric Artificial Network (AAN) and conducted voltage measurements on telecommunications lines were made at the output of the ISN. Where an AAN was not appropriate or available measurements were made using a Capacitive Voltage Probe.

Test Verification: ☐	Laboratory Ambient Temperature:	
	Relative Humidity:	
	Atmospheric Pressure:	
Reference Standard:	☐ RSS GEN/FCC 15.207 ☐ ANSI C63.4:2014 ☐ ANSI C63.10:2013	**Measurement Point** ☐ Mains ☐ Telecommunication ports ☐
Nominal Voltage:	☐ 120VAC ☐ 230VAC ☐	
Test Personnel:		**Date:**

Limits - Class A – AC Mains				
Frequency (MHz)	Limit dB (μV)			
	Quasi-Peak	Average	Result	Comments
0.15 to 0.50	79	66	**N/A**	AMN
0.50 to 30	73	60	**N/A**	AMN
Limits - Class B – AC Mains				
0.15 to 0.50	66 to 56	56 to 46	**N/A**	AMN
0.50 to 5	56	46	**N/A**	AMN
5 to 30	60	50	**N/A**	AMN

Modifications:	
Note:	

4.2	**Spurious Radiated Emissions Data**
Method:	Measurements were made in a 3-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.4. EUT was rotated through three orthogonal axes to determine which attitude (orientation) and arrangement produces the highest emission relative to the limit; the attitude and device arrangement that produces the highest emission relative to the limit was used in making final radiated emission measurements. Spurious Radiated emissions measurements ware performed with external preamp and a high pass filter. Final measurements were then performed by rotating the EUT 360° and adjusting the receive antenna height from 1 to 4 m. All frequencies were investigated in both horizontal and vertical antenna polarity, where applicable.

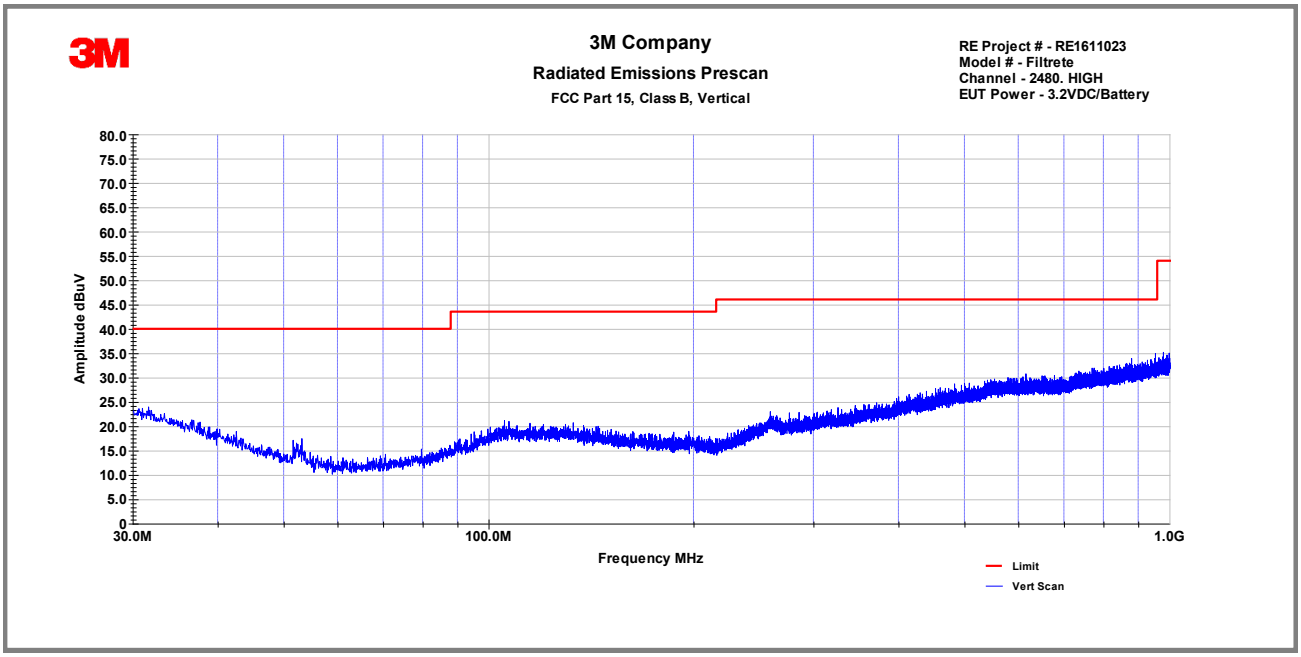
Test Verification: ☒	Laboratory Ambient Temperature:	23°C
	Relative Humidity:	35%
	Atmospheric Pressure:	836.8 mbars
Reference Standard:	☐ ANSI C63.4:2014 ☒ ANSI C63.10:2013 ☒ FCC Part 15.247 ☐	**Measurement Distance** ☒ 3 Meters ☐
Frequency Range:	☒ 30 MHz to 1 GHz ☒ 1 GHz to 26 GHz	
Nominal Voltage:	☐ 120VAC ☐ 230VAC ☒ 3VDC	
Tested By:	Clay Huff C. H	**Date:** 09/15//2017

Limits – 15.109, Class A

Frequency (MHz)	Limit dB (µV/m)				
	Quasi-Peak	Average	Peak	Distance	Results
30 to 88	39			10	**N/A**
88 to 216	43.5			10	**N/A**
216 to 960	46.4			10	**N/A**
Above 960	49.5			10	**N/A**
Limits – 15.109, Class B and 15.209					
0.009-0.490		2400/F(KHz)	300	300	**N/A**
0.490-1.705	24000/F(KHz)		30	30	**N/A**
1.705-30	30		30	30	**N/A**
30 to 88	40			3	**pass**
88 to 216	43.5			3	**pass**
216 to 960	46			3	**pass**
Above 960		54		3	**pass**

Modifications:	
Note:	For emission in the restricted bands, the limit of 15.209 was used. The lower limit applies at the transition frequency. An inverse proportionality factor of 20 dB per decade has been used to normalize the measured data to the specified distance for determining compliance. No spurious emissions were detected in the frequency range above 10GHz.

Frequency (MHz)	Pol.	QP Reading dBµV/m	Total CF dB	Net at 3 m dBµV/m	Limit (dBµV/m)	Margin dB
53.10	V	2.3	11.9	14.2	40.0	-25.8
103.40	V	2.4	16.3	18.7	43.5	-24.8
105.36	V	3.1	16.5	19.6	43.5	-23.9
258.90	V	2.8	18.2	21.0	46.0	-25.0
318.29	V	4.1	19.0	23.1	46.0	-22.9
320.00	V	3.8	19.0	22.8	46.0	-23.2
Notes:	**Net Reading (dBuV) = Reading (dBµV)+Antenna CF(dB)+Cable CF(dB) – Amp Gain(dB)** **Measurements from 30 to 1000 MHz were performed at the Low Channel as a worst case.**					


3M Company
Radiated Emissions Prescan
FCC Part 15, Class B, Vertical
RE Project # - RE1611023
Model # - Filtrete
Channel - 2480. HIGH
EUT Power - 3.2VDC/Battery
Amplitude dBuV
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
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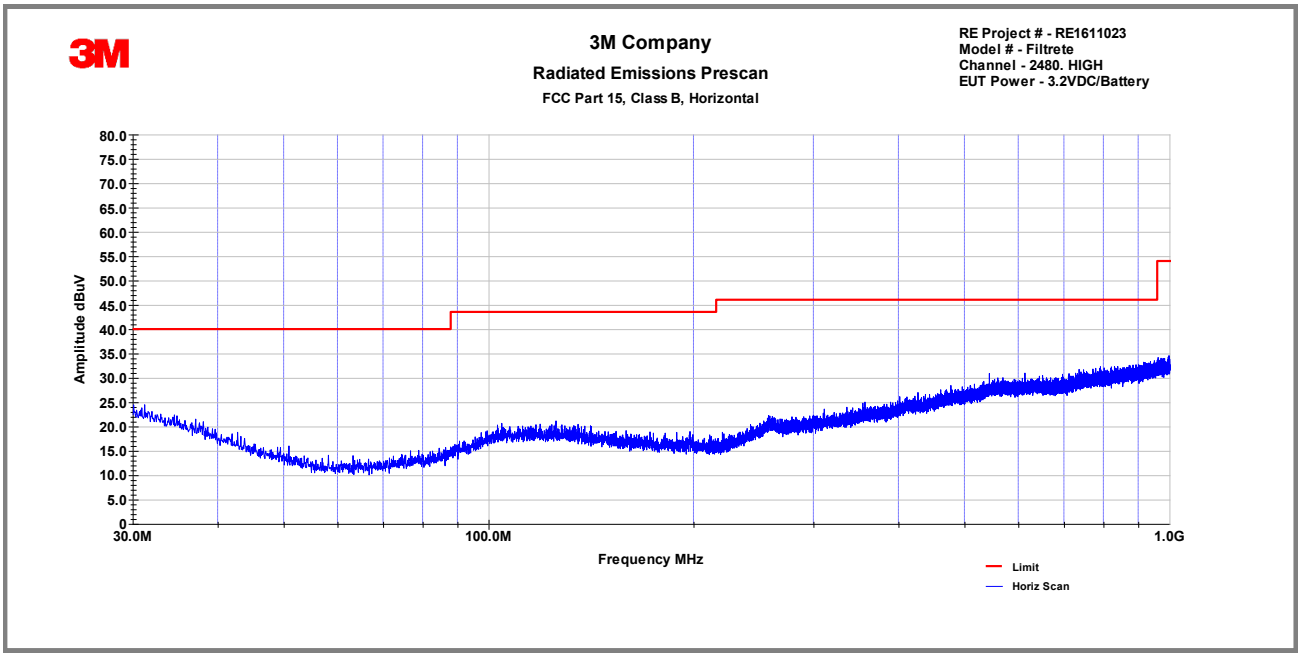
30.0M
100.0M
1.0G
Frequency MHz
Limit
Vert Scan


3M Company
Radiated Emissions Prescan
FCC Part 15, Class B, Horizontal
RE Project # - RE1611023
Model # - Filtrete
Channel - 2480. HIGH
EUT Power - 3.2VDC/Battery
Amplitude dBuV
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0
30.0M
100.0M
1.0G
Frequency MHz
Limit
Horiz Scan

Pol	Frequency (MHz)	Peak dBµV/m	AVG dBµV/m	Total CF dB	Net Peak dBµV/m	Net AVE dBµV/m	PK Limit dBµV/m.	AVE Limit dBµV/m	PK Margin dBµV/m	AVG Margin dB
H	4804.00	53.90	41.70	-4.30	49.60	37.40	74.00	54.00	-24.40	-16.60
V	4804.00	54.10	41.10	-4.30	49.80	36.80	74.00	54.00	-24.20	-17.20
V	7206.00	48.10	40.20	-1.00	47.10	39.20	74.00	54.00	-26.90	-14.80
H	7206.00	48.30	40.40	-1.00	47.30	39.40	74.00	54.00	-26.70	-14.60
V	9608.00	42.00	35.40	1.30	43.30	36.70	74.00	54.00	-30.70	-17.30
H	9608.00	42.20	34.20	1.30	43.50	35.50	74.00	54.00	-30.50	-18.50
Notes		**Net Reading (dBuV) = Reading (dBµV)+(Antenna with amp CF(dB)+Cable CF(dB))**								
		Low Channel. Average readings obtained with the 10Hz VBW								

Pol	Frequency (MHz)	Peak dBµV/m	AVG dBµV/m	Total CF dB	Net Peak dBµV/m	Net AVE dBµV/m	PK Limit dBµV/m.	AVE Limit dBµV/m	PK Margin dBµV/m	AVG Margin dB
H	4880.00	55.80	40.4	-4.30	51.50	36.10	74.00	54.00	-22.50	-17.90
V	4880.00	56.30	40.3	-4.30	52.00	36.00	74.00	54.00	-22.00	-18.00
V	7320.00	48.50	39.7	-1.00	47.50	38.70	74.00	54.00	-26.50	-15.30
H	7320.00	49.50	39.8	-1.00	48.50	38.80	74.00	54.00	-25.50	-15.20
H	9760.00	46.30	38.6	1.30	47.60	39.90	74.00	54.00	-26.40	-14.10
V	9760.00	48.50	38.4	1.30	49.80	39.70	74.00	54.00	-24.20	-14.30
Notes		**Net Reading (dBuV) = Reading (dBµV)+(Antenna with amp CF(dB)+Cable CF(dB))**								
		Mid Channel. Average readings obtained with the 10Hz VBW								

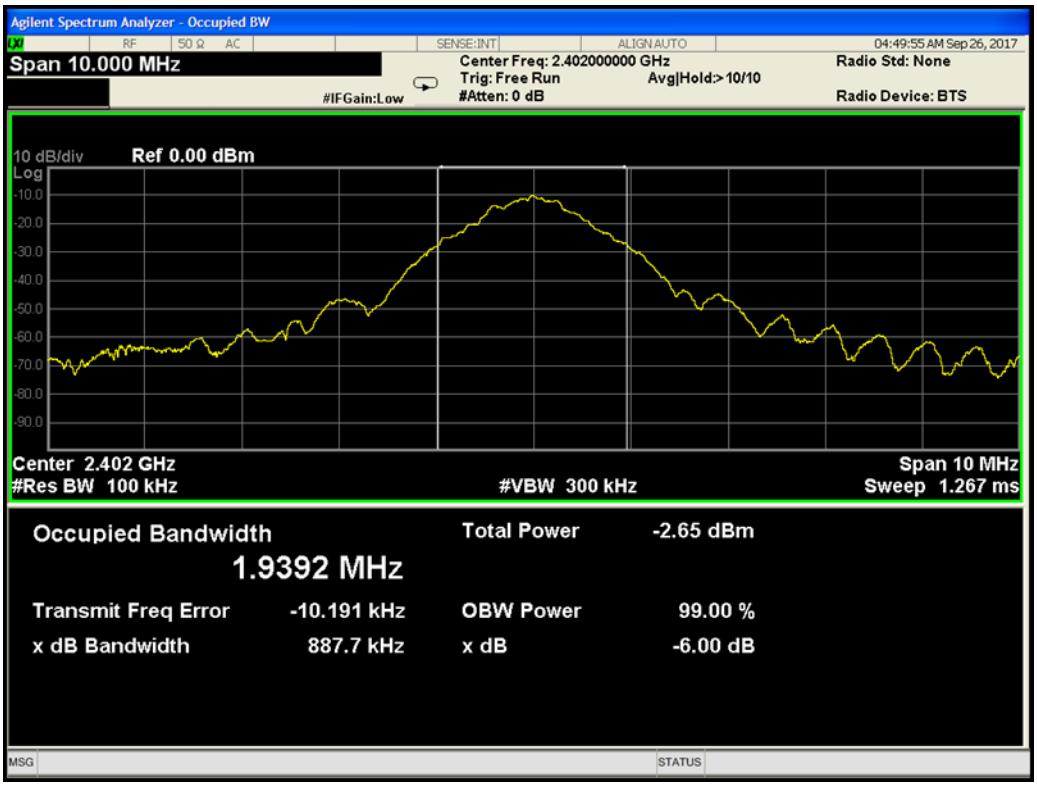
Pol	Frequency (MHz)	Peak dBµV/m	AVG dBµV/m	Total CF dB	Net Peak dBµV/m	Net AVE dBµV/m	PK Limit dBµV/m.	AVE Limit dBµV/m	PK Margin dBµV/m	AVG Margin dB
V	4960.00	53.30	40.20	-4.30	49.00	35.90	74.00	54.00	-25.00	-18.10
H	4960.00	56.30	41.40	-4.30	52.00	37.10	74.00	54.00	-22.00	-16.90
V	7440.00	48.50	40.00	-1.00	47.50	39.00	74.00	54.00	-26.50	-15.00
H	7440.00	48.60	40.20	-1.00	47.60	39.20	74.00	54.00	-26.40	-14.80
V	9920.00	44.30	38.60	1.30	45.60	39.90	74.00	54.00	-28.40	-14.10
H	9920.00	46.30	37.90	1.30	47.60	39.20	74.00	54.00	-26.40	-14.80
Notes		**Net Reading (dBuV) = Reading (dBµV)+(Antenna with amp CF(dB)+Cable CF(dB))**								
		High Channel. Average readings obtained with the 10Hz VBW								

4.3	**Maximum Output Power**	
Method:	Measurements was performed with modulated carrier at the highest power level at which the transmitter is intended to operate. The analyzer offset was adjusted to compensate for the attenuator and other losses.	
	Laboratory Ambient Temperature	21°C
	Relative Humidity	45%
Reference Standard:	☒ ANSI C63.10:2013 ☒ FCC Part 15.247/RSS 247 ☐	**Measurement Point** ☐ Conducted ☒ Radiated at 3 meters
Frequency Range:	☒ 2402 – 2480 MHz	
Antenna Gain:	1.5 dBi	**Maximum Conducted Power:**
Limit:	30 dBm	-4.23 dBm
Nominal Voltage:	☐ 230VAC ☐ 120VAC ☒ 3VDC	
Tested By:	Clay Huff C. H	**Date:** 09/15/2017

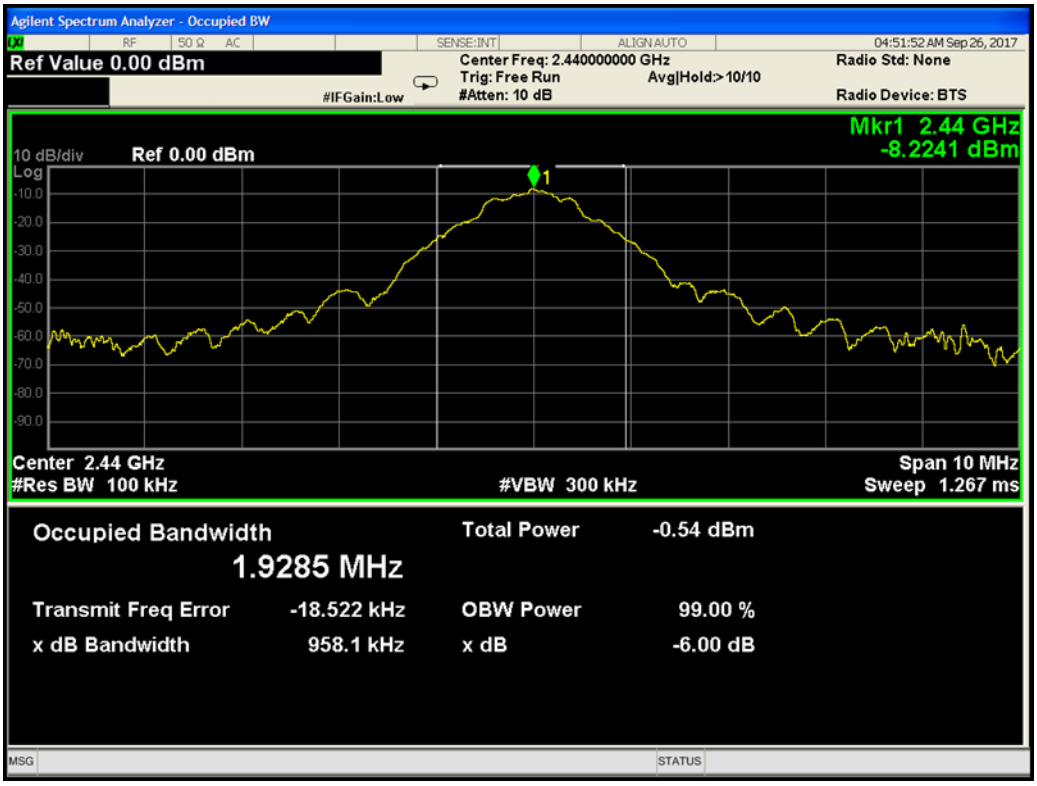
Pol	Frequency (MHz)	Peak dBµV/m	Total CF dB	Net Peak dBµV/m	Net EIRP dBm	Antenna Gain dBi	Conducted Power dBm	Limit dBm	Margin dB	
V	2402.0	56.10	32.30	88.40	-6.83	1.5	-8.33	30	-38.33	
H	2402.0	60.20	32.30	92.50	-2.73	1.5	-4.23	30	-34.23	
H	2440.0	57.20	32.30	89.50	-5.73	1.5	-7.23	30	-37.23	
V	2440.0	57.60	32.30	89.90	-5.33	1.5	-6.83	30	-36.83	
H	2480.0	59.70	32.30	92.00	-3.23	1.5	-4.73	30	-34.73	
V	2480.0	53.10	32.30	85.40	-9.83	1.5	-11.33	30	-41.33	
Notes	Net Peak (dBuV) = Reading (dBµV)+(Antenna CF(dB)+Cable CF(dB))									
	Max EIRP = Net EIRP dBm +Antenna Gain (dBi) = -1.23 dBm(0.75mW)									
	Conducted Power (dBm) = (- EIRP(dBm))-Antenna Gain (dBi) = -2.73-1.5=-4.23 dBi									

4.4	6dB Bandwidth	
	Laboratory Ambient Temperature	21°C
	Relative Humidity	45%
Reference Standard:	☒ ANSI C63.10:2013 ☒ FCC Part 15.247/RSS 247	**Measurement Point** ☐ Conducted ☒ Radiated
Frequency Range:	☒ 2402.0-2480.0 MHz	RBW ≥ 1% of the 20 dB bandwidth VBW ≥ RBW
Nominal Voltage:	☐ 120VAC ☒ 3.0 VDC	
Tested By:	Clay Huff C. H	**Date:** 09/25/2017

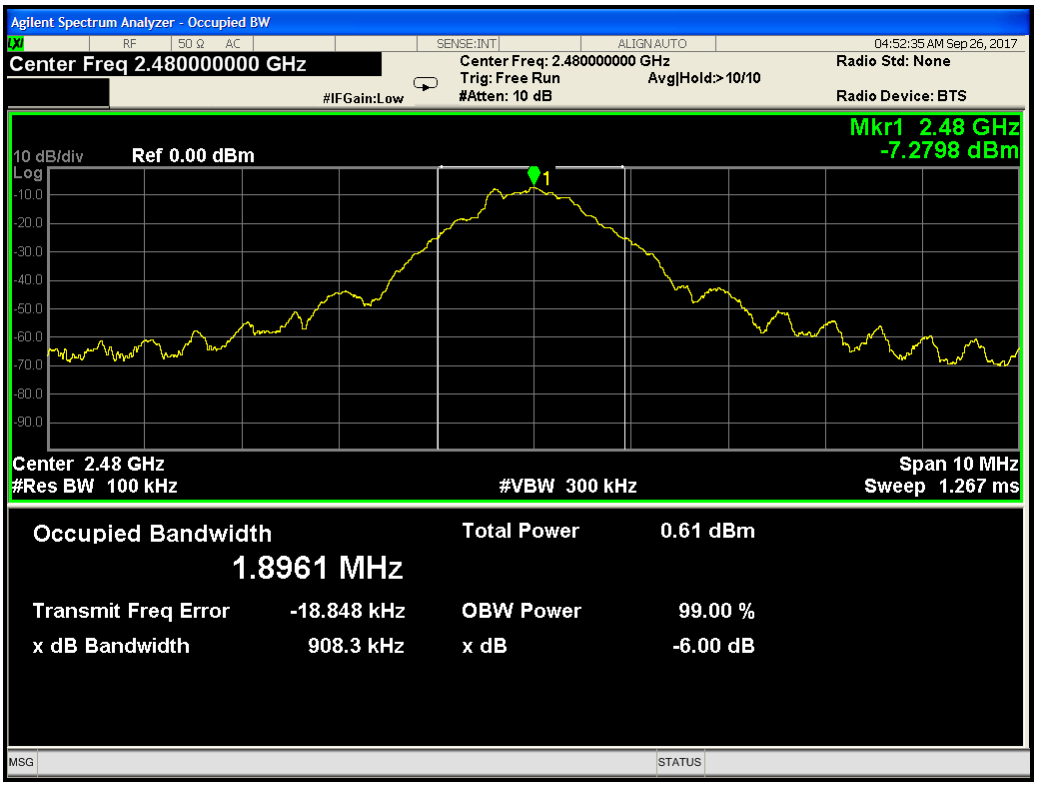
Frequency (MHz)	6 dB Bandwidth (KHz)	99% Bandwidth (KHz)	6dB OBW Limit (KHz)	Results
2402	887.7	1939	**> 500**	**pass**
2440	958.1	1928	**> 500**	**pass**
2480	908.3	1896	**> 500**	**pass**



OBW – Low Channel



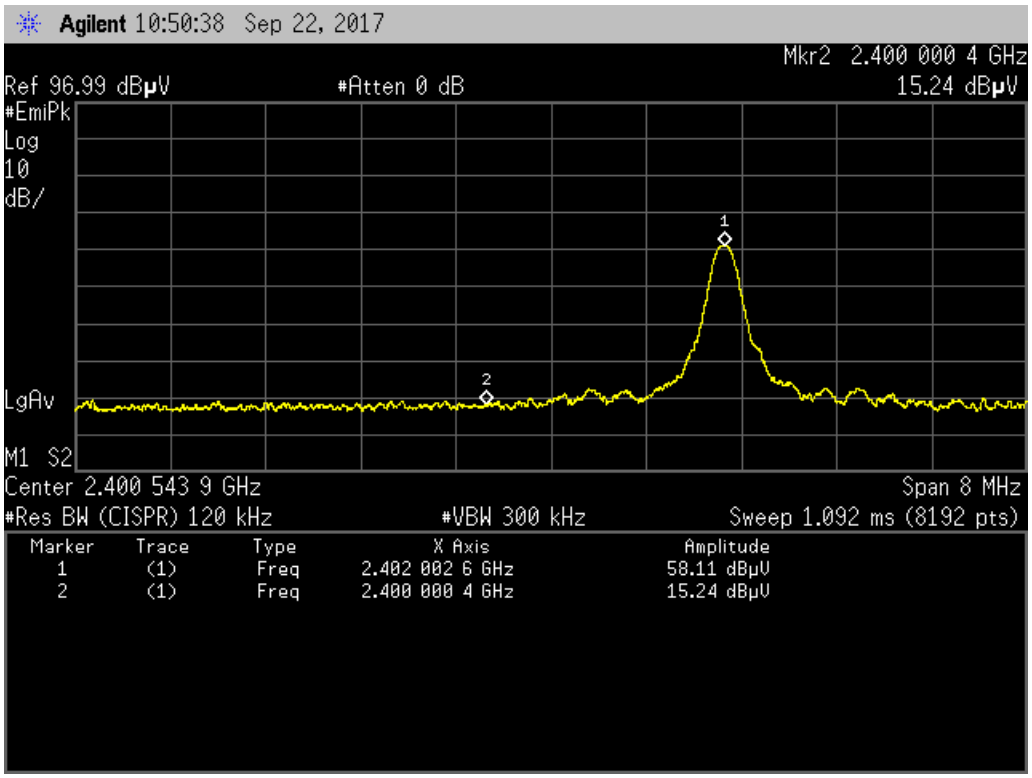
OBW – Mid Channel



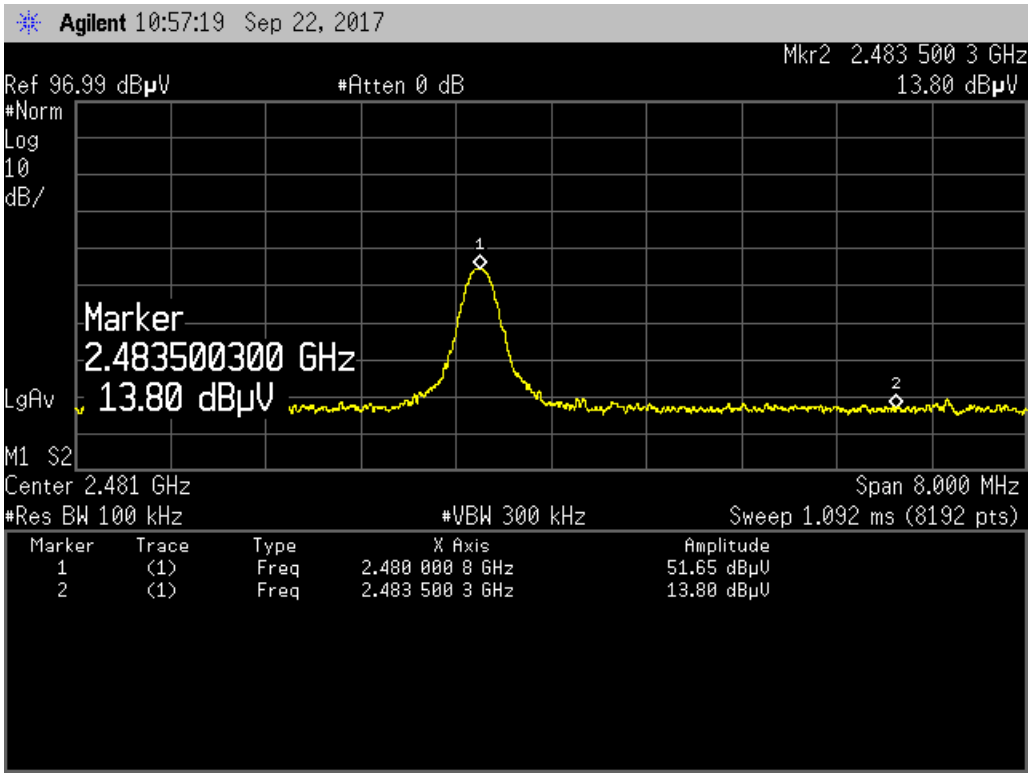
OBW – High Channel

4.5	**Band-Edge Compliance**	
Method:	The measurements were made with transmitter set to transmit continuously with modulated signal at low and high channels.	
	Laboratory Ambient Temperature	23°C
	Relative Humidity	35%
Reference Standard:	☒ ANSI C63.10:2013 ☒ FCC Part 15.247/RSS 247 ☐	**Measurement Point** ☐ Conducted ☒ Radiated
Frequency Range:	☒ 2402.0-2480.0 MHz	
Antenna Gain:	☒ 1.5 dBi	**Results**
Limit	☒ >20dBc	Low Ch, 2402 MHz > 43dBc High Ch, 2480 MHz > 38dBc
Nominal Voltage:	☐ 120VAC ☒ 3VDC	
Tested By:	Clay Huff C. H	**Date:** 09/22/2017

Note:	



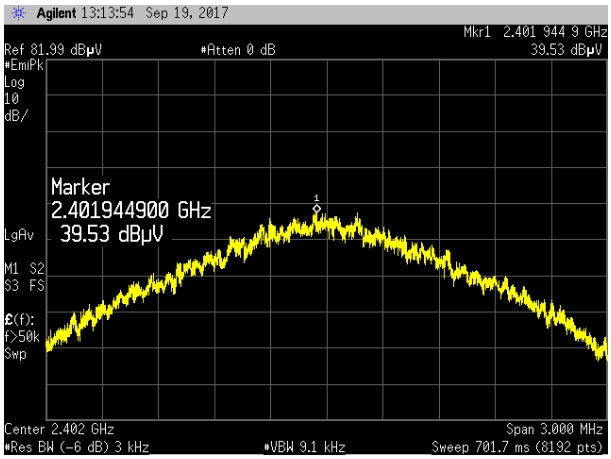
Band Edge - Low Channel

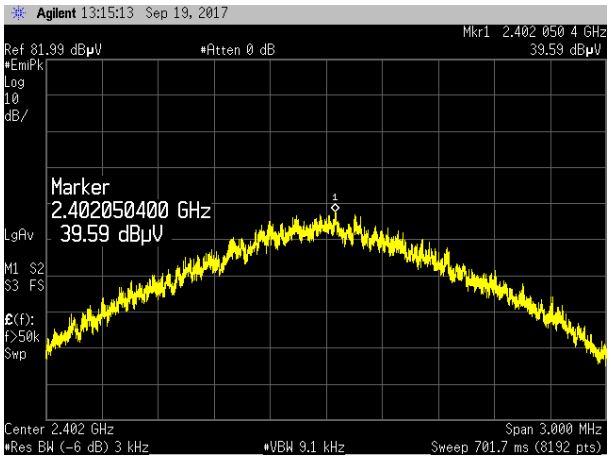


Band Edge - High Channel

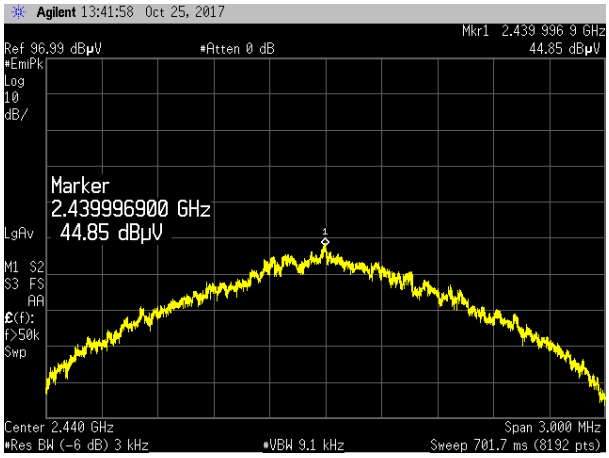
4.6	**Power Spectral Density**	
Method:	Measurements was performed with modulated carrier at the highest power level at which the transmitter is intended to operate. The analyzer offset was adjusted to compensate for the attenuator and other losses.	
	Laboratory Ambient Temperature	21°C
	Relative Humidity	45%
Reference Standard:	☒ ANSI C63.10:2013 ☒ FCC Part 15.247/RSS 247 ☐	**Measurement Point** ☐ Conducted ☒ Radiated at 3 meters
Frequency Range:	☒ 2402 – 2480 MHz	
Antenna Gain:	1.5 dBi	**PSD Results:**
PSD Limit:	8 dBm	-19.58 dBm
Nominal Voltage:	☐ 230VAC ☐ 120VAC ☒ 3VDC	
Tested By:	Clay Huff C. H	**Date:** 09/15/2017

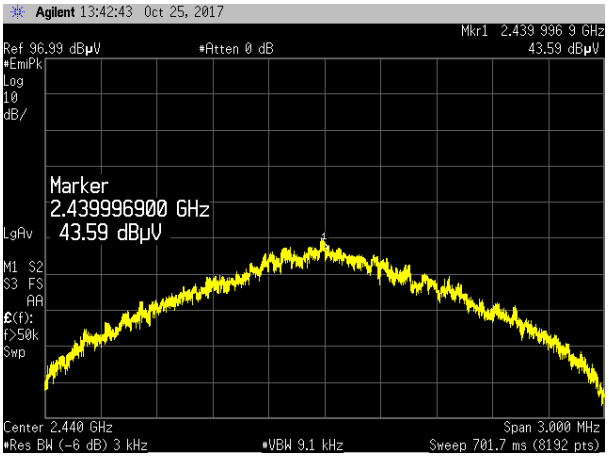
Pol	Frequency (MHz)	Peak dBµV/m	Total CF dB	Net PSD dBµV/m	Net PSD EIRP dBm	Antenna Gain dBi	Corrected PSD dBm	Limit dBm	Margin dB	
H	2402.00	39.53	32.30	71.83	-23.4	1.5	-24.9	8	-32.9	
V	2402.00	39.59	32.30	71.89	-23.33	1.5	-24.83	8	-32.83	
H	2440.00	43.59	32.30	75.89	-19.34	1.5	-20.84	8	-28.84	
V	2440.00	44.85	32.30	77.15	-18.08	1.5	-19.58	8	-27.58	
H	2480.00	41.20	32.30	73.50	-21.73	1.5	-23.23	8	-31.23	
V	2480.00	38.08	32.30	70.38	-24.85	1.5	-26.35	8	-34.35	
Notes	Net PSD(dBuV) = Peak Reading (dBµV)+(Antenna CF(dB)+Cable CF(dB))									
	Corrected PSD (dBm) = (-Net PSD EIRP(dBm)) -Antenna Gain(dBi)									



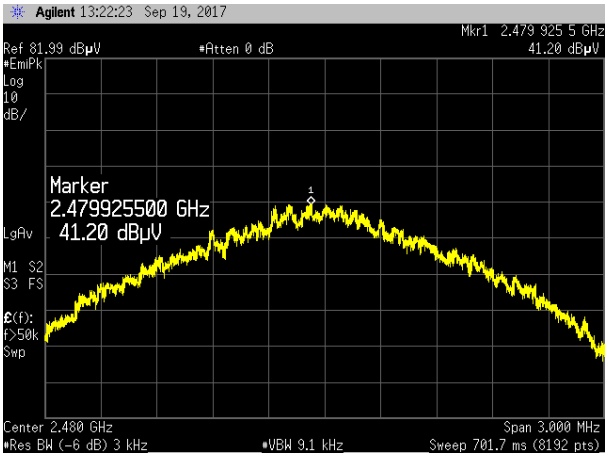


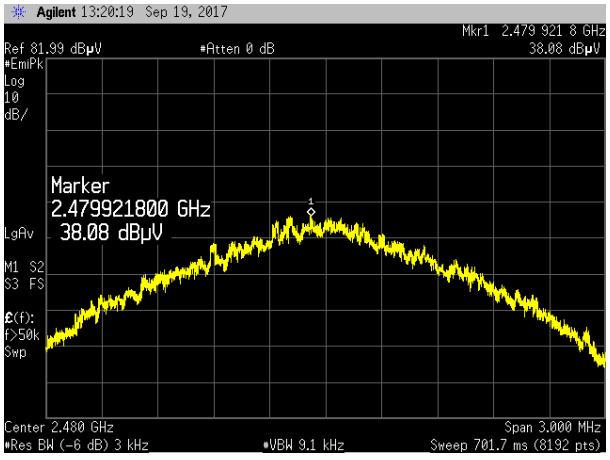
Low Channel – Vertical and Horizontal Polarity





Mid Channel – Vertical and Horizontal Polarity





High Channel – Vertical and Horizontal Polarity

4.7	RF Exposure Compliance	
Reference Standard:	☒ IEEE Std 1528a ☒ RSS 102, Issue 5 ☒ KDB 447498 ☐ KDB	☒ MPE ☐ SAR Evaluation
Frequency Range:	☒ 2402-2480MHz	
Antenna Separation Distance	>20cm	
Duty Cycle	100 %	
Time-Averaged Output power (EIRP)	-4.23dBm (0.38mW)	
SAR Test Exclusion Threshold for 100MHz – 6GHz		
FCC	10 mW (<5mm)	
RSS 102, Issue 5	4 mW (<5mm)	

5.0 Test Equipment

Test Equipment Used

Description	Manufacturer	Model	Identifier	Last Cal. Date	Check
Biconilog Antenna	Schaffner	CBL6112B	27491	10/212017	☒
Horn Antenna with Amp	AH Systems	SAS 571	1010	10/212017	☒
Coaxial Cable	Insulated Wire	2803	CBL2039	10/212017	☒
Loop Antenna	EMCO	ALR25M	1011	10/212017	☐
EMI Receiver	Rohde & Schwarz	ESIB 40	100235	10/212017	☒
EMI Receiver	Agilent	E4448A	1530975	10/212017	☒
LISN	TESEQ	NNB51	1130	10/212017	☐
Harmonic/Flicker Source	Cal. Instruments	C4-5001iX	57162	10/212017	☐
Amplifier	AR	250W1000AM	14354	10/212017	☐
Amplifier	AR	25S1G4A	4003	10/212017	☐
Signal Generator	HP	8656A	2326A05125	10/212017	☐
Signal Generator	Agilent	E8257D	MY45140566	10/212017	☐
Field Probe	AR	FL7006	25019	10/212017	☐
Field Monitor	AR	FM2000	14292	10/212017	☐
AC CDN	Schaffner	M316,	21937	10/212017	☐
AC CDN	TESEQ	M016,	26131	10/212017	☐
Current Injection Coil	A.H. Systems	ICP-200/521	149	10/212017	☐
RF Conducted System	TESEQ	NSG 4070-75	1141	10/212017	☐
ESD Generator	TESEQ	NSG 438	1355	10/212017	☐
EFT/Surge Generator	TESEQ	NSG 3060		10/212017	☐
EMF Meter	NARDA	ELT400	1139	10/212017	☐
EMF E-field Antenna	NARDA	Type 33.0 300M-50G	K-0014	10/212017	☐
EMF H-field Antenna	NARDA	Type 10.2 27M-1G	AP-0004	10/212017	☐
EMC Software	ETS-Lindgren	TILE 7		10/212017	☒
Equipment Calibration Interval		☒ 12 months		☐ 24 months	

6.0 Report revision history

Revision Level	Date	Report Number	Notes
0	11/01/2017	RE1611023-1	Original Issue

Certificate of Conformity

3M EMC Laboratory

Hardgoods Regulatory Engineering
Building 76-01-01
St. Paul, MN 55144-1000, USA

MANUFACTURER'S NAME:	**3M Company**
NAME OF EQUIPMENT:	**Filtrete™ Smart Air Filter**
MODEL NUMBER(S):	**FILTRETE-19088**
TEST REPORT NUMBER:	**RE 1611023-1**
DATE OF ISSUE:	**November 1, 2017**

Referring to the performance criteria and operating mode during the tests specified in this report the equipment complies with the essential requirements herein specified:

47 CFR Part 15 – Subpart C – Intentional Radiator	**FCC Part 15.247**
Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices	**RSS 247, Issue 2, 2017**

Comments:

NVLAP TESTING

NVLAP Lab Code 200033-0

Yuriy Litvinov

Yuriy Litvinov
Lead EMC Engineer