

EMC TEST REPORT



Standard(s):

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

FCC ID:DGFPSDHTP1CX
IC:458A-PSDHTP1CX

Product: 3M™ Connected Safety Headtop Peripheral
Model(s): HTP-1-CX

Company Name:
3M Company

Address:
3M Center, Building 235
St. Paul, MN 55144-1000

Report Number: RE1606003-1
Report Issue Date: April 3, 2019

Report Prepared by:

Signature:
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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.

	Test Description	Requirement – Test	Result	Comments
4.1	15.247(a)(2)/ RSS247,5.2/RSS Gen, 6.6	DTS Bandwidth	pass	
4.2	15.247(b)(3)/ RSS 247, 5.4(d)	Maximum Peak Conducted Output Power	pass	
4.3	Part 15.247(e)/ RSS 247, 5.2(b)	Maximum Power Spectral Density level	pass	
4.4	15.209/RSS Gen, 8.9	Radiated Emissions in restricted band	pass	
4.5	15.247(d)/RSS 247,5.5	Radiated Emissions in non-restricted band	pass	
4.6	15.247(d)(1)/ RSS 247, 5.5	DTS Band-edge Emissions Measurements	pass	
4.7	Part 15.207/RSS-Gen, 8.8	Conducted Emissions	N/A	See note
4.8	Part 15.247(i)/ RSS 102	RF Exposure Compliance	pass	

Note:

Device is Battery operated

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:	3M Active Safety Headtop Peripheral System			
Model(s):	HTP-1-CX			
Serial number:	A064			
Contact:	Chuck Jents			
Phone:	651 737 3133			
3M Division:	Personal Safety			
Modifications and Special Measures:	none			
Frequency Range:	2402.0-2480.0 MHz			
Channel No.:	39			
Modulation Type:	GFSK			
Output Power:	0dBm			
Antenna Type:	Internal PCB Trace Antenna			
Antenna Gain:	1.1dBi			
Test Deviations or Exclusions	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No		
Rated Power:	Voltage:	<input type="checkbox"/> 120VAC	<input type="checkbox"/> 230VAC	<input checked="" type="checkbox"/> 3.0VDC
	Phase:	<input type="checkbox"/> 1ph	<input type="checkbox"/> 3ph	<input checked="" type="checkbox"/> Battery
	Frequency:	<input type="checkbox"/> 50Hz	<input type="checkbox"/> 60Hz	
	Current:			
Test Dates:	01/23-01/25/2019			
Received Date:	01/23/2019			
Received Conditions:	<input type="checkbox"/> Poor	<input checked="" type="checkbox"/> Good		
	<input checked="" type="checkbox"/> Prototype	<input type="checkbox"/> Production		



3.0 EUT Configuration

3.1 System Configuration

No.	Product Type	Manufacturer	Model	Comments
1	Headtop Peripheral	3M	HTP-1-CX	

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
<input checked="" type="checkbox"/>	Table-top only	
<input type="checkbox"/>	Floor-standing only	
<input type="checkbox"/>	Floor-standing or table-top	
<input checked="" type="checkbox"/>	Other	(Head top)

3.5 Primary function(s) of EUT

No.	List of Essential Functions
1	Transferring of various environmental and functional data via Bluetooth radio using 3M Active Safety Messaging Protocol.
2	

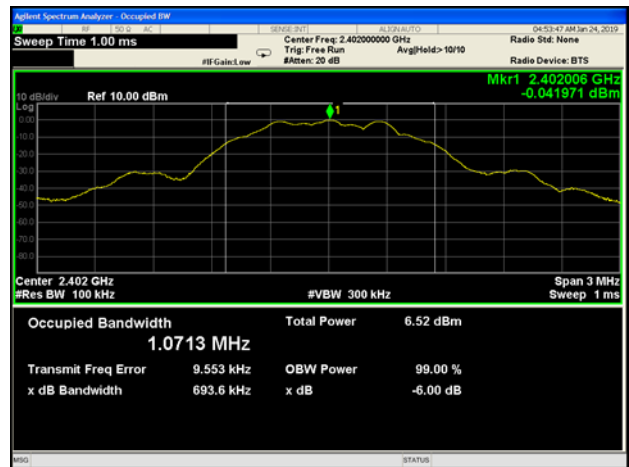
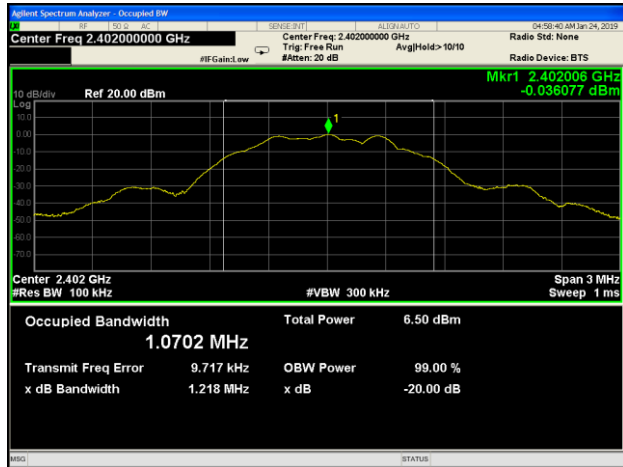
3.6 Exercising of EUT and Interfaces

No.	Mode of Operation
1	Transmitting at lowest, middle and highest channels of operation with unmodulated CW carrier
2	Device programming using Nordic BT Studio software for continues transmission of modulated carrier at maximum rated RF output power and Duty Cycle.

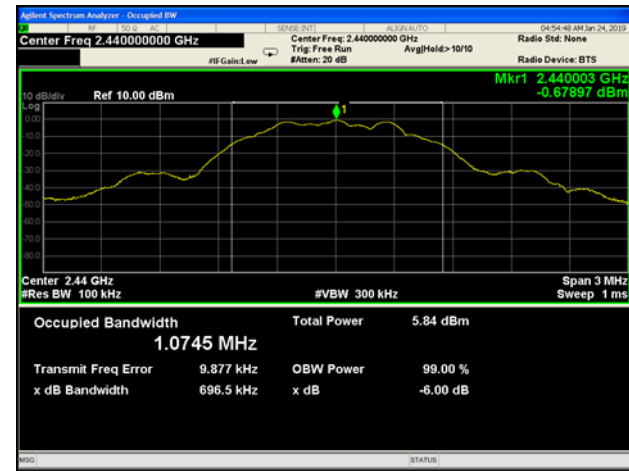
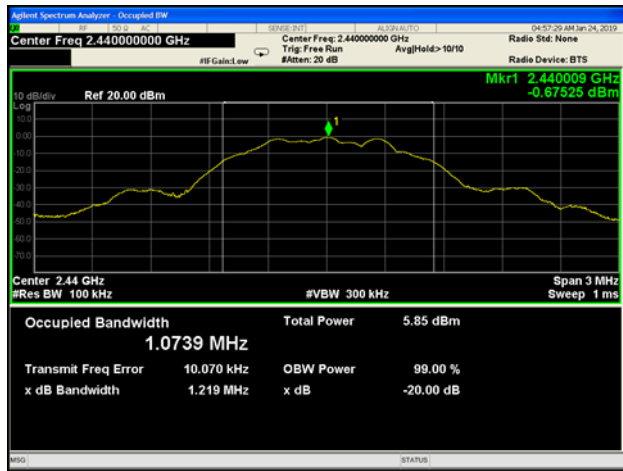
4.0 Test Conditions and Results

4.1	DTS Bandwidth		
	Laboratory Ambient Temperature:	23°C	
	Relative Humidity:	18%	
	Atmospheric Pressure:	836.8 mbars	
Reference Standard(s):	<input checked="" type="checkbox"/> ANSI C63.10:2013 <input checked="" type="checkbox"/> FCC Part 15.247/RSS 247	Measurement Point <input checked="" type="checkbox"/> Conducted <input type="checkbox"/> Radiated	
Frequency Range:	<input checked="" type="checkbox"/> 2402.0-2480.0 MHz	RBW = 100KHz VBW ≥ 3 x RBW	
Nominal Voltage:	<input type="checkbox"/> 120VAC <input checked="" type="checkbox"/> 3.0 VDC		
Test Personnel:	Yuriy Litvinov <i>Yuriy Litvinov</i>	Date: 01/23/2019	

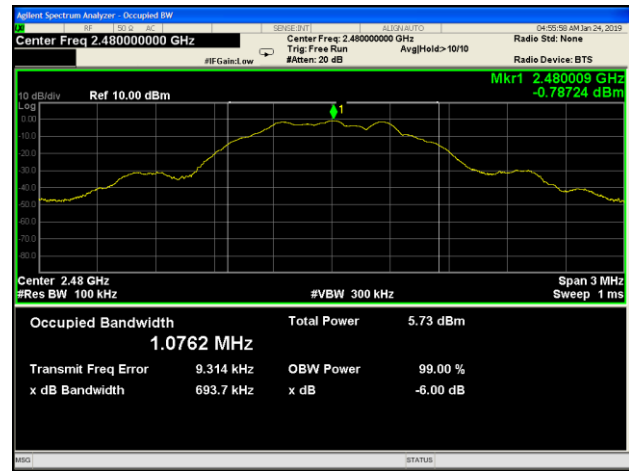
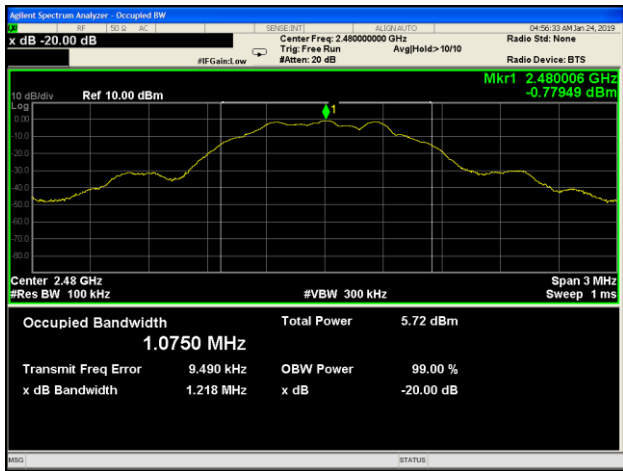
Frequency (MHz)	99% dB Bandwidth (KHz)	20 dB Bandwidth (KHz)	6 dB Bandwidth (KHz)	6dB OBW Limit (KHz)	Results
2402	1070.0	1219.0	693.6	> 500	pass
2440	1075.0	1218.0	696.5	> 500	pass
2480	1075.0	1218.0	693.7	> 500	pass



OBW - Low Channel



OBW - Mid Channel

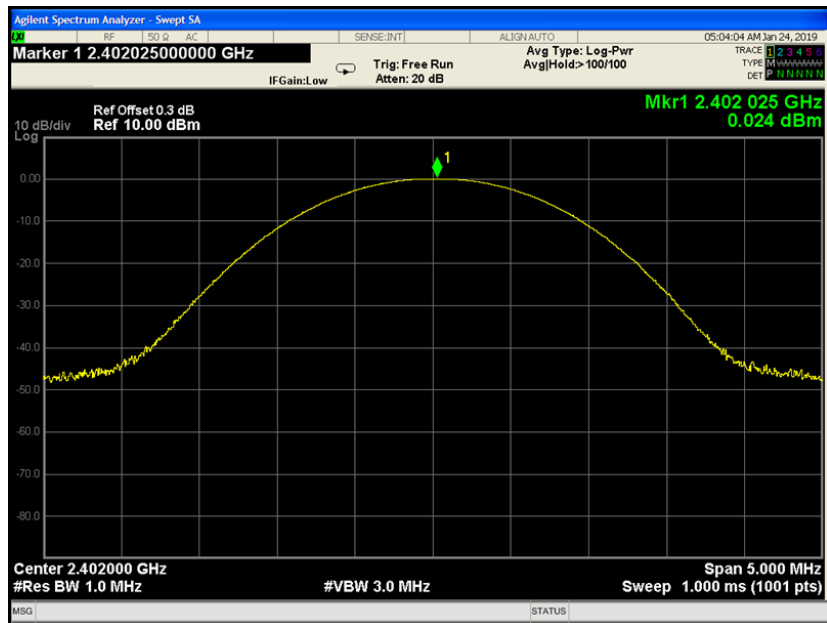


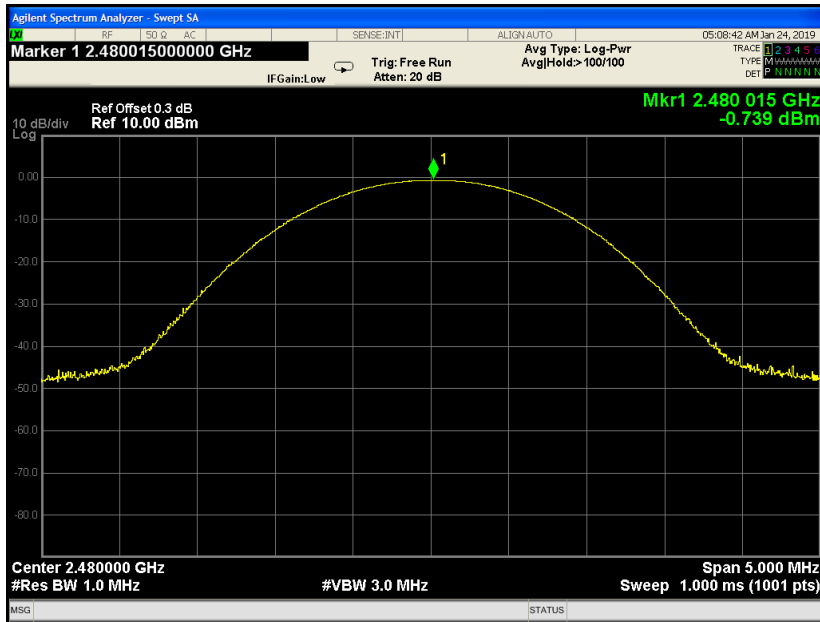
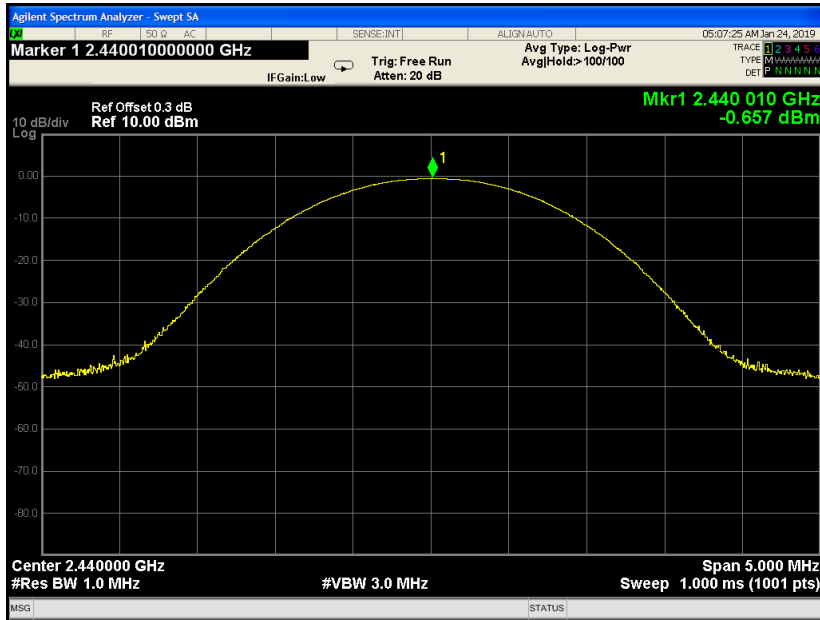
OBW - High Channel



4.2 Maximum Output Power	
Method:	Measurements was performed with CW 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: 23°C
	Relative Humidity: 18%
	Atmospheric Pressure: 836.8 mbars
Reference Standard(s):	<input checked="" type="checkbox"/> ANSI C63.10:2013 <input checked="" type="checkbox"/> FCC Part 15.247/RSS 247 <input type="checkbox"/>
Frequency Range:	<input checked="" type="checkbox"/> 2402.0 – 2480.0 MHz
Antenna Gain:	1.1 dBi
Limit:	30 dBm
Nominal Voltage:	<input type="checkbox"/> 120VAC <input checked="" type="checkbox"/> 3VDC
Test Personnel:	Yuriy Litvinov <i>Yuriy Litvinov</i>
	Measurement Point <input checked="" type="checkbox"/> Conducted <input type="checkbox"/> Radiated at 3 meters
	Maximum Conducted Power: 1.12 dBm
	Date: 01/23/2019

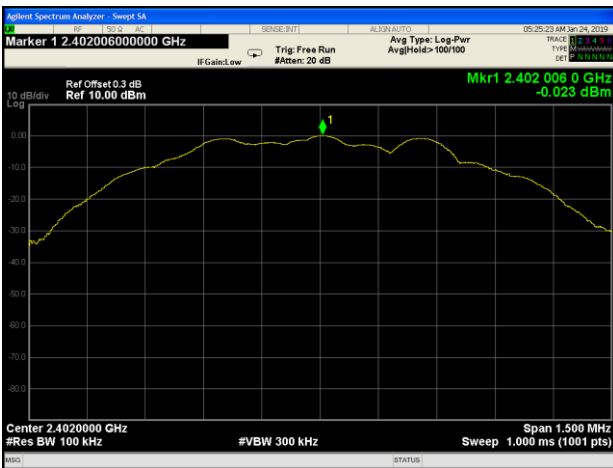
Note:	Conducted Power EIRP (dBm) = Power (dBm) +Antenna Gain (dBi)
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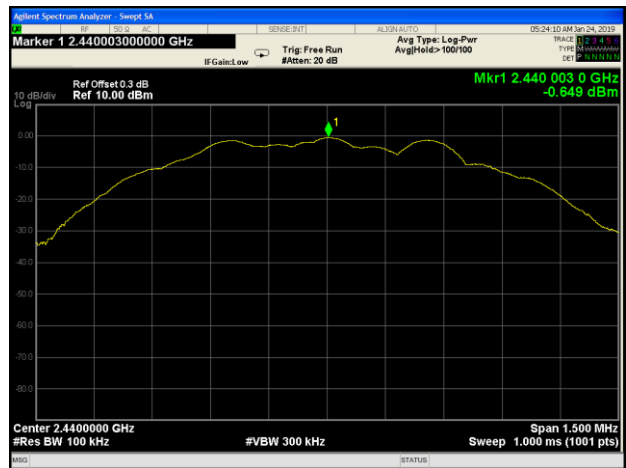




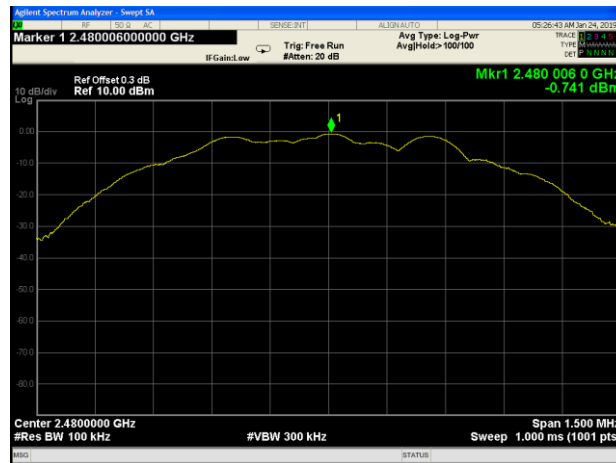
4.3	Maximum Power Spectral Density level		
Method:	Measurements was performed with modulated carrier at the highest power level at which the transmitter is intended to operate. The analyzer offset was adjusted to compensate for the attenuator and other losses.		
	Laboratory Ambient Temperature:	23°C	
	Relative Humidity:	18%	
	Atmospheric Pressure:	836.8 mbars	
Reference Standard(s):	<input checked="" type="checkbox"/> ANSI C63.10:2013 <input checked="" type="checkbox"/> FCC Part 15.247/RSS 247 <input type="checkbox"/>	Measurement Point	
		<input checked="" type="checkbox"/> Conducted <input type="checkbox"/> Radiated at 3 meters	
Frequency Range:	<input checked="" type="checkbox"/> 2402.0 – 2480.0 MHz		PSD Results
PSD Limit:	8 dBm		-0.02 dBm
Nominal Voltage:	<input type="checkbox"/> 120VAC <input checked="" type="checkbox"/> 3VDC		
Test Personnel:	Yuriy Litvinov <i>Yuriy Litvinov</i>		Date: 01/23/2019



PSD Low Channel



PSD Mid Channel



PSD High Channel



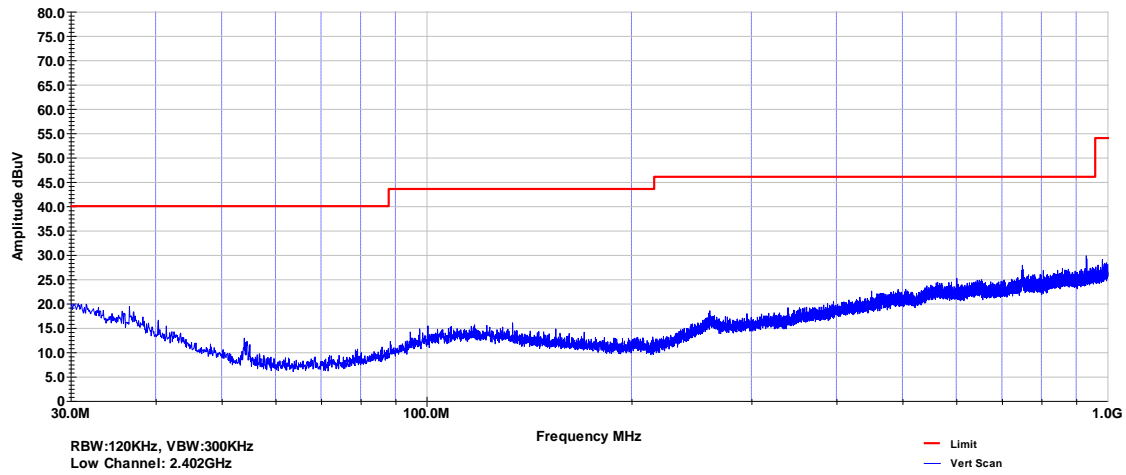
4.4	Radiated Emissions in restricted band				
Method:	Measurements were made in a 3-meter semi-anechoic chamber that complies to CISPR 16/ANSI C63.4. EUT was rotated through three orthogonal axes to determine which attitude (orientation) and arrangement produces the highest emission relative to the limit; 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 were 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: <input checked="" type="checkbox"/>	Laboratory Ambient Temperature:		23°C		
	Relative Humidity:		18%		
	Atmospheric Pressure:		836.8 mbars		
Reference Standard(s):	<input type="checkbox"/> ANSI C63.4:2014:2014		Measurement Distance		
	<input checked="" type="checkbox"/> ANSI C63.10:2013:2013 <input checked="" type="checkbox"/> FCC Part 15.247/RSS-247 <input type="checkbox"/>		<input checked="" type="checkbox"/> 3 Meters <input type="checkbox"/>		
Frequency Range:	<input checked="" type="checkbox"/> 30 MHz to 1 GHz <input checked="" type="checkbox"/> 1 GHz to 26 GHz				
Nominal Voltage:	<input type="checkbox"/> 120VAC <input checked="" type="checkbox"/> 3VDC				
Test Personnel:	Keith Schwartz <i>KS</i>			Date: 01/24/2019	
Limits – 15.109, Class A					
Frequency (MHz)	Limit dB (µV/m)				Results
	Quasi-Peak	Average	Peak	Distance	
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:	<p>For emission in the restricted bands, the limit of 15.209 was used.</p> <p>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.</p> <p>No spurious emissions were detected in the frequency range above 18GHz.</p>



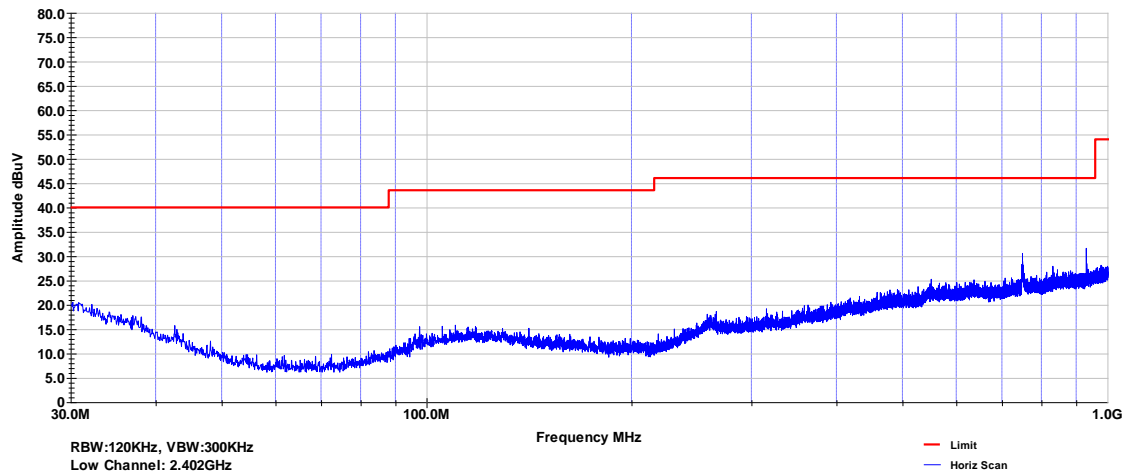
3M Company
Radiated Emissions Prescan
FCC Part 15, Class B, Vertical

Project # - RE1606003
Model # - HTP-1-CX
Serial # - A064
EUT Power - 3.0VDC Lithium Battery



3M Company
Radiated Emissions Prescan
FCC Part 15, Class B, Horizontal

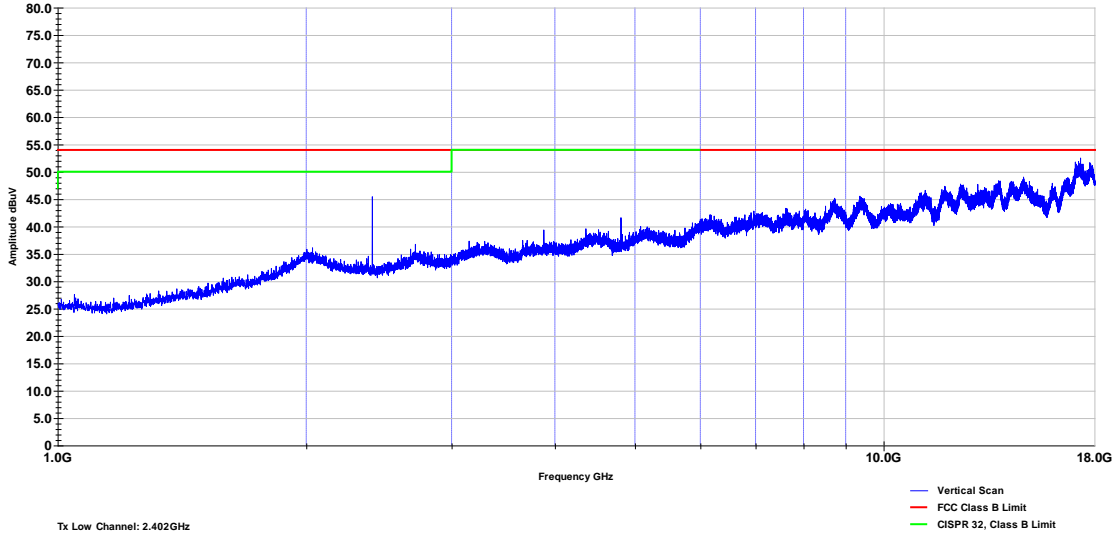
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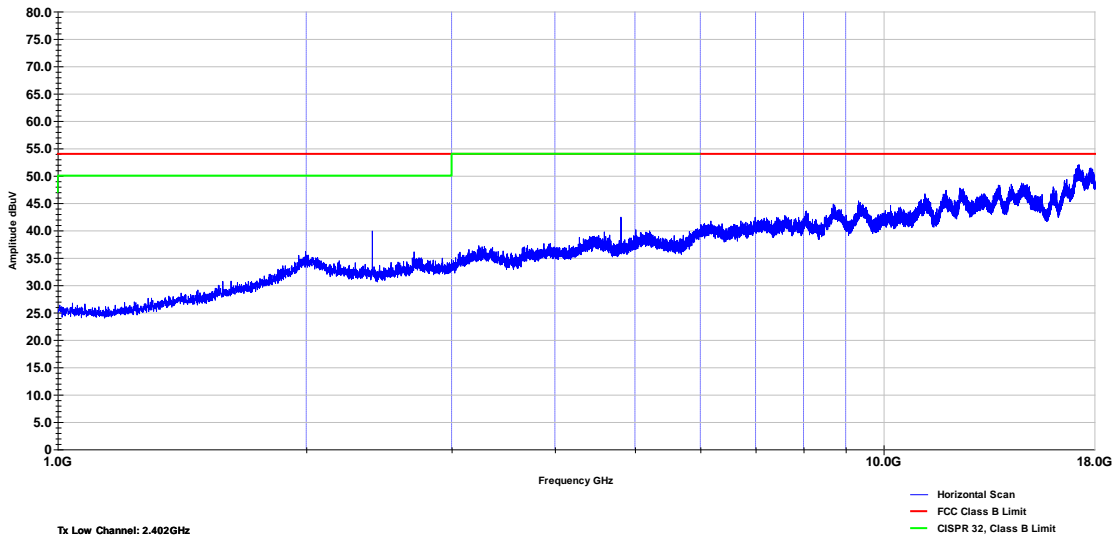
3M Company
Radiated Emissions Prescan
CISPR 32_FCC Part 15 1GHz-18GHz, Vertical

Project # - RE1606003
Model # - HTP-1-CX
Serial # - A064
EUT Power - 3.0VDC Lithium Battery



3M Company
Radiated Emissions Prescan
CISPR 32_FCC Part 15 1GHz-18GHz, Horizontal

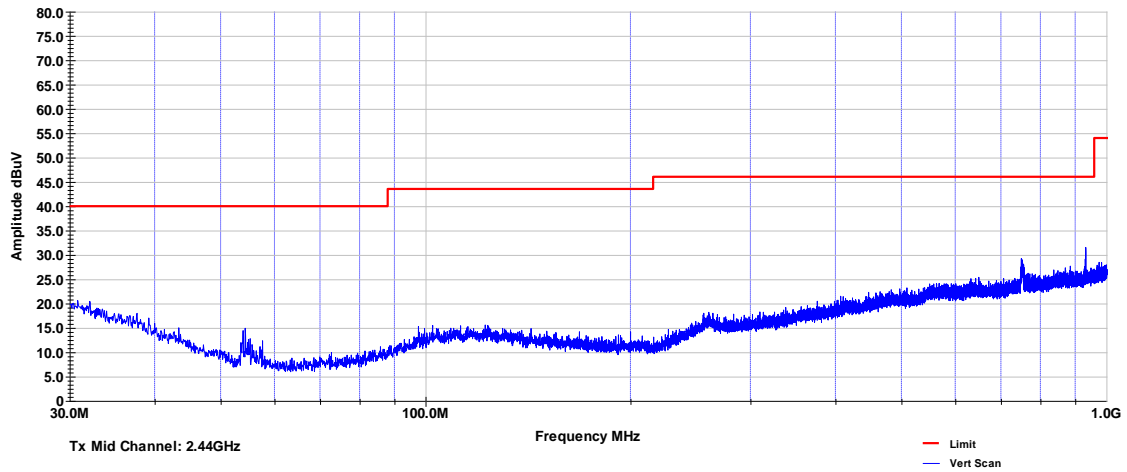
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Model # - HTP-1-CX
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EUT Power - 3.0VDC Lithium Battery





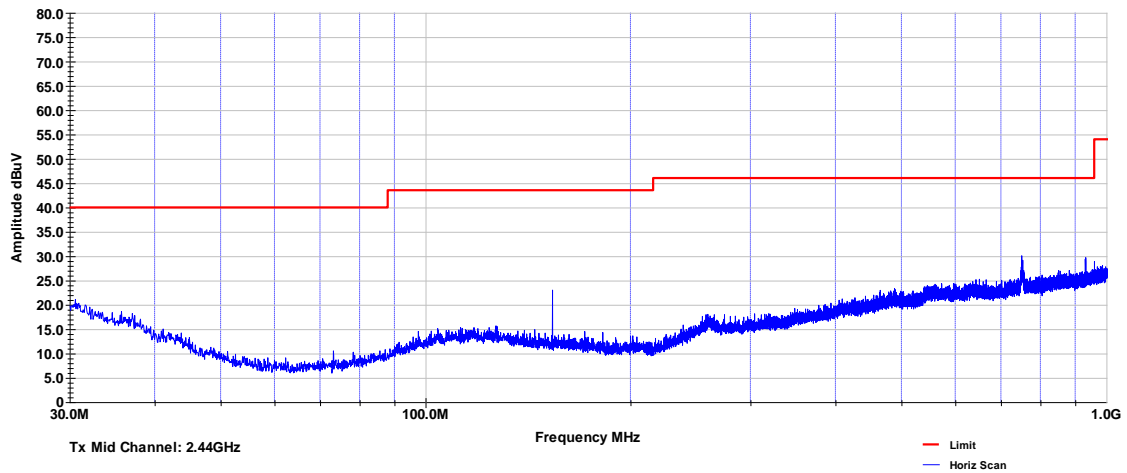
3M Company
Radiated Emissions Prescan
FCC Part 15, Class B, Vertical

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Radiated Emissions Prescan
FCC Part 15, Class B, Horizontal

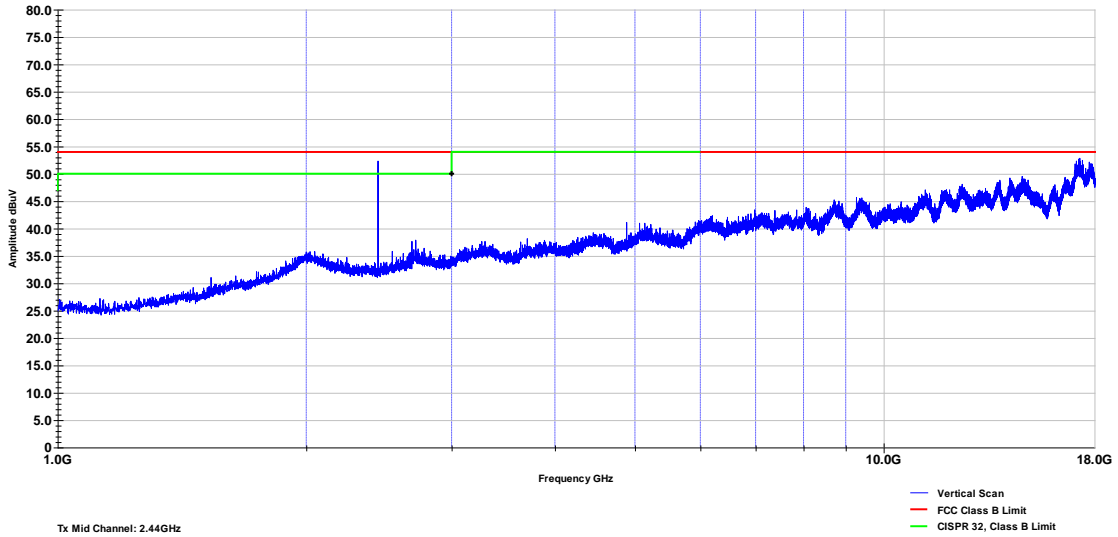
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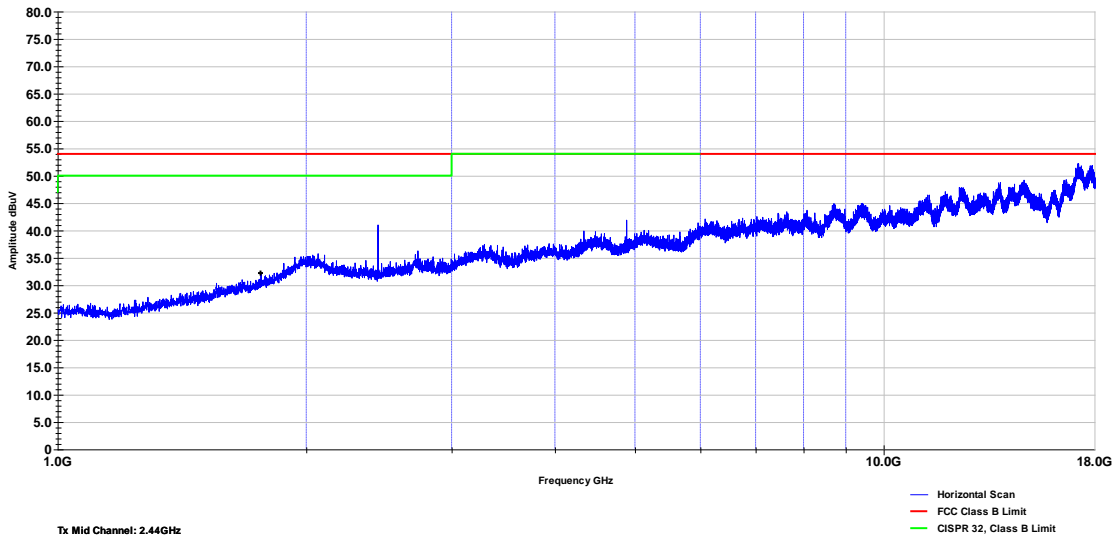
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CISPR 32_FCC Part 15 1GHz-18GHz, Horizontal

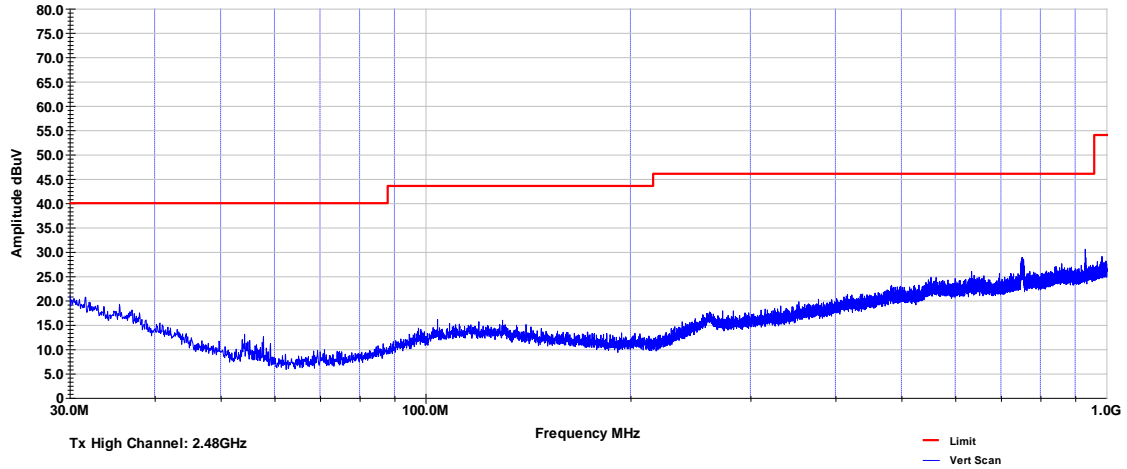
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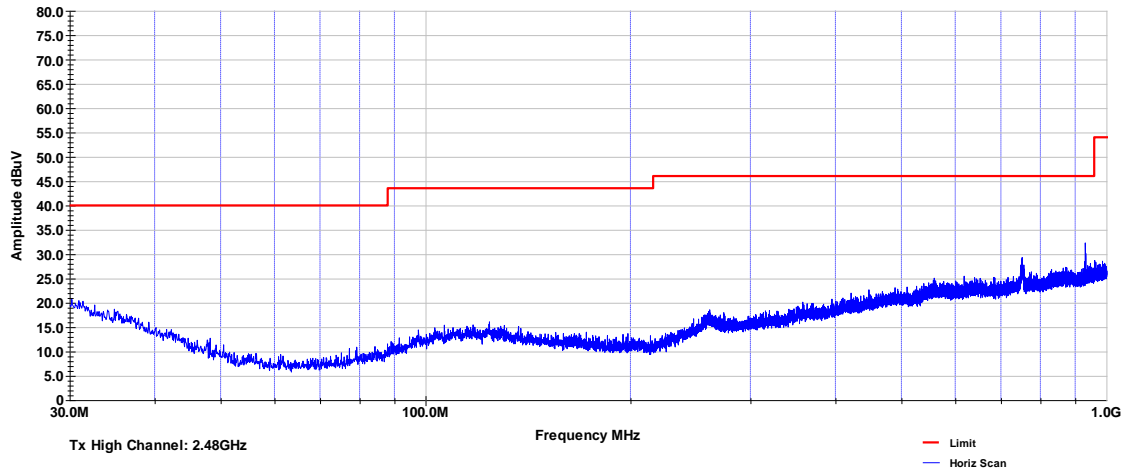
3M Company
Radiated Emissions Prescan
FCC Part 15, Class B, Vertical

Project # - RE1606003
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3M Company
Radiated Emissions Prescan
FCC Part 15, Class B, Horizontal

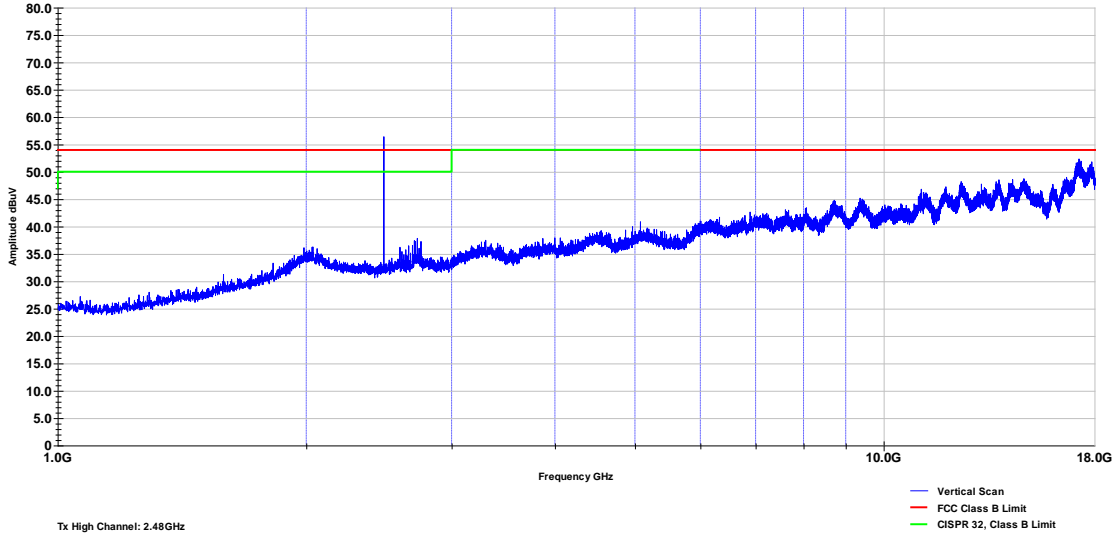
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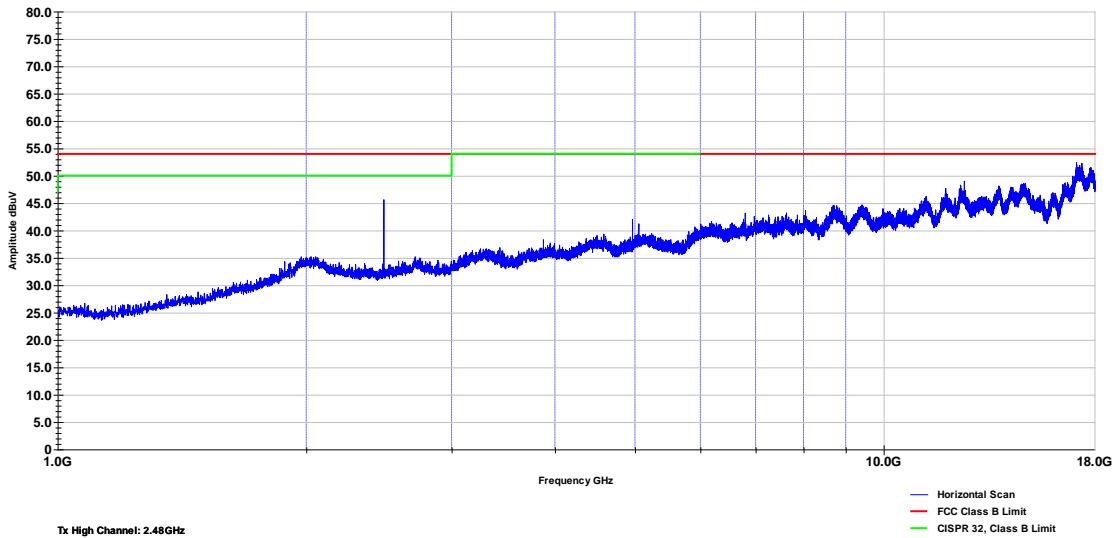
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Frequency (MHz)	Pol.	QP Reading dB μ V/m	Total CF dB	Net at 3 m dB μ V/m	Limit (dB μ V/m)	Margin dB
62.05	H	3.4	10.5	13.9	40	-26.1
153.09	H	3.6	15.1	18.7	43.5	-24.8
746.63	H	4.7	25.6	30.3	46	-15.7
923.74	H	5	26.8	31.8	46	-14.3
Notes:	Net Reading (dB μ V) = Reading (dB μ V)+Antenna CF(dB)+Cable CF(dB) – Amp Gain(dB) Measurements from 30 to 1000 MHz were performed at the Middle Channel as a worst case.					

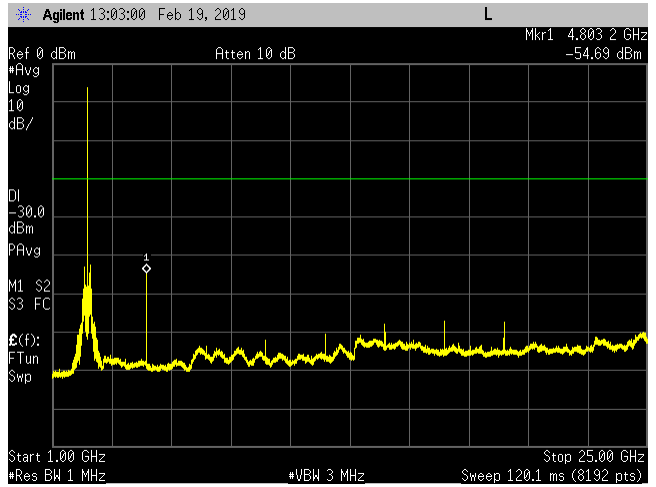
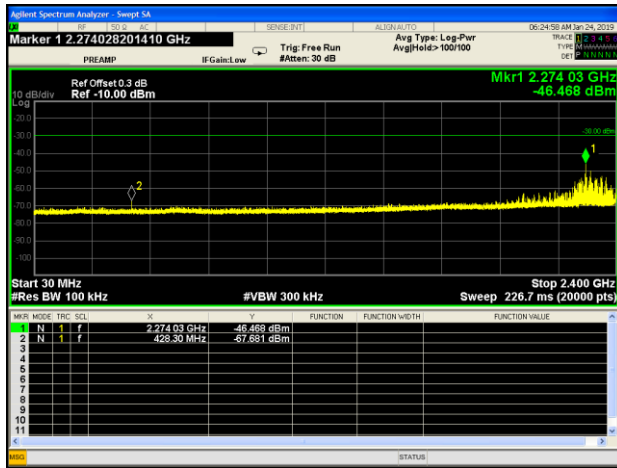
Pol	Frequency (MHz)	Peak dB μ V/m	AVG dB μ V/m	Total CF dB	Net Peak dB μ V/m	Net AVE dB μ V/m	PK Limit dB μ V/m.	AVE Limit dB μ V/m	PK Margin dB μ V/m	AVG Margin dB
H	4804.00	50.40	44.7	-6.29	44.11	38.41	74.00	54.00	-29.89	-15.59
V	4804.00	50.90	44.6	-6.29	44.61	38.31	74.00	54.00	-29.39	-15.69
V	7206.00	42.66	34.4	-3.01	39.65	31.39	74.00	54.00	-34.35	-22.61
H	7206.00	44.50	34.2	-3.01	41.49	31.18	74.00	54.00	-32.51	-22.82
V	9608.00	42.71	33.90	-1.07	41.64	32.83	74.00	54.00	-32.36	-21.17
H	9608.00	41.84	33.50	-1.07	40.77	32.43	74.00	54.00	-33.23	-21.57
Notes:	Net Reading (dB μ V) = Reading (dB μ V)+(Antenna with amp CF(dB)+Cable CF(dB)) Low Channel									

Pol	Frequency (MHz)	Peak dB μ V/m	AVG dB μ V/m	Total CF dB	Net Peak dB μ V/m	Net AVE dB μ V/m	PK Limit dB μ V/m.	AVE Limit dB μ V/m	PK Margin dB μ V/m	AVG Margin dB
H	4880.03	49.61	42.2	-5.39	44.22	36.81	74.00	54.00	-29.78	-17.19
V	4880.03	49.87	44.5	-5.39	44.48	39.10	74.00	54.00	-29.52	-14.90
V	7320.00	46.43	34.7	-3.20	43.23	31.50	74.00	54.00	-30.77	-22.50
H	7320.00	45.61	36.0	-3.20	42.41	32.80	74.00	54.00	-31.59	-21.20
H	9760.00	44.80	35.2	-1.34	43.46	33.86	74.00	54.00	-30.54	-20.14
V	9760.00	45.67	34.1	-1.34	44.33	32.76	74.00	54.00	-29.67	-21.24
Notes:	Net Reading (dB μ V) = Reading (dB μ V)+(Antenna with amp CF(dB)+Cable CF(dB)) Mid Channel									

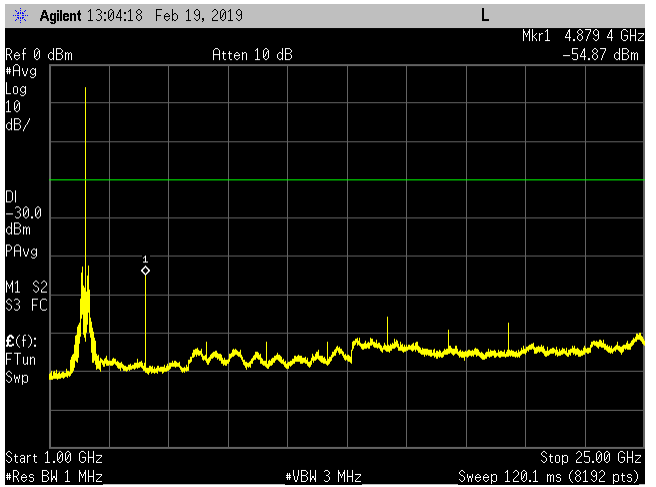
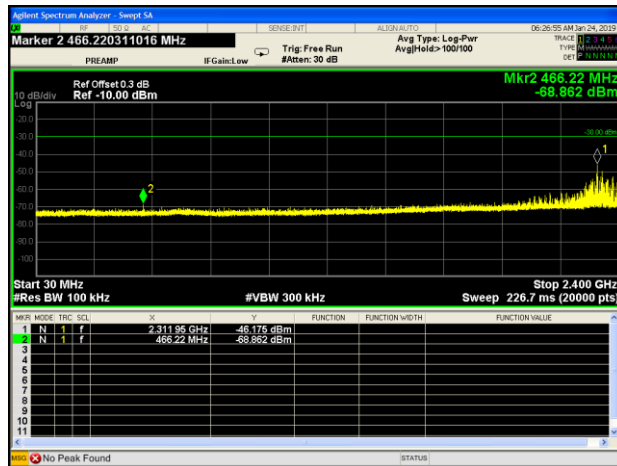
Pol	Frequency (MHz)	Peak dB μ V/m	AVG dB μ V/m	Total CF dB	Net Peak dB μ V/m	Net AVE dB μ V/m	PK Limit dB μ V/m.	AVE Limit dB μ V/m	PK Margin dB μ V/m	AVG Margin dB
V	4960.03	50.01	43.20	-5.16	44.85	38.04	74.00	54.00	-29.15	-15.96
H	4960.03	49.75	41.50	-5.16	44.59	36.34	74.00	54.00	-29.41	-17.66
V	7440.00	43.11	36.20	-2.44	40.67	33.76	74.00	54.00	-33.33	-20.24
H	7440.00	46.59	39.80	-2.44	44.15	37.36	74.00	54.00	-29.85	-16.64
V	9920.00	44.99	34.30	-0.60	44.39	33.70	74.00	54.00	-29.61	-20.30
H	9920.00	44.57	34.30	-0.60	43.97	33.70	74.00	54.00	-30.03	-20.30
Notes:	Net Reading (dB μ V) = Reading (dB μ V)+(Antenna with amp CF(dB)+Cable CF(dB)) High Channel									



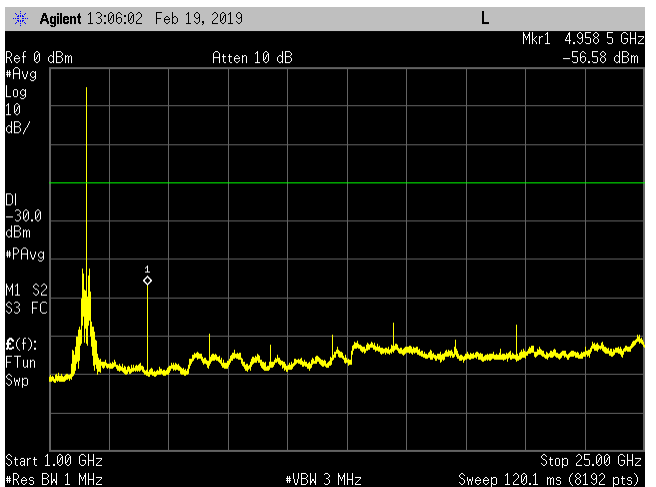
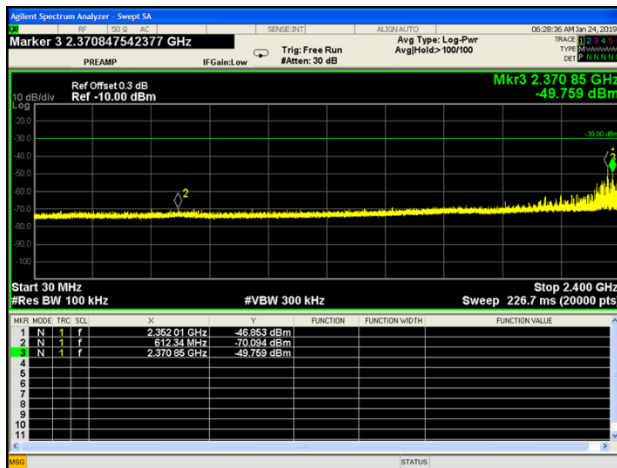
4.5 Radiated Emissions in non-restricted band	
Method:	The measurements were made with transmitter set to transmit continuously low, medium and high channels.
	Laboratory Ambient Temperature: 23°C
	Relative Humidity: 18%
	Atmospheric Pressure: 836.8 mbars
Reference Standard(s):	<input checked="" type="checkbox"/> ANSI C63.10:2013 <input checked="" type="checkbox"/> FCC Part 15.247/RSS 247 <input type="checkbox"/>
Frequency Range:	<input checked="" type="checkbox"/> 2402.0-2480.0 MHz
PSD Level in 100KHz:	<input checked="" type="checkbox"/> -0.02 dBm
Limit:	<input checked="" type="checkbox"/> 30dBc (30dB below PSD)
Nominal Voltage:	<input type="checkbox"/> 120VAC <input checked="" type="checkbox"/> 3VDC
Test Personnel:	Yuriy Litvinov <i>Yuriy Litvinov</i>
	Date: 02/19/2019
Measurement Point	<input checked="" type="checkbox"/> Conducted <input type="checkbox"/> Radiated
	Results
	>46dBc
Note:	



Conducted Spurious - Low Channel



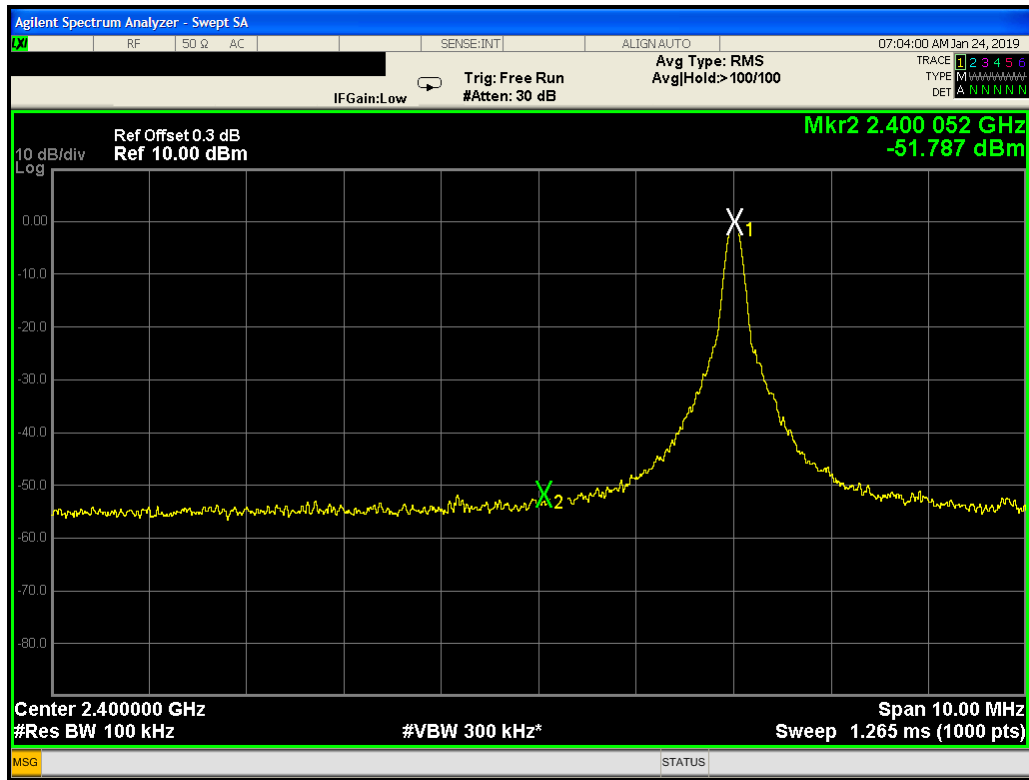
Conducted Spurious - Mid Channel



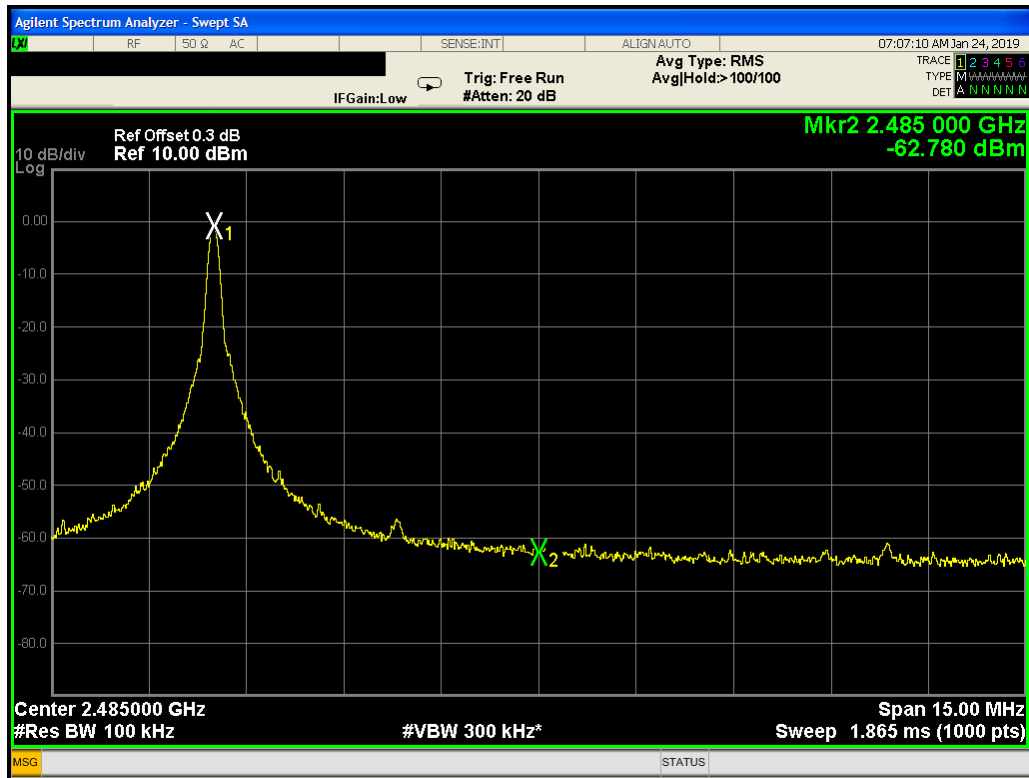
Conducted Spurious - High Channel



4.6		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:	18%	
	Atmospheric Pressure:	836.8 mbars	
Reference Standard(s):	<input checked="" type="checkbox"/> ANSI C63.10:2013 <input checked="" type="checkbox"/> FCC Part 15.247/RSS 247 <input type="checkbox"/>	Measurement Point	<input checked="" type="checkbox"/> Conducted <input type="checkbox"/> Radiated
Frequency Range:	<input checked="" type="checkbox"/> 2402.0-2480.0 MHz	Results	
Limit:	<input checked="" type="checkbox"/> >20dBc	Low Ch., 2402 MHz > 51dBc High Ch., 2480 MHz > 62dBc	
Nominal Voltage:	<input type="checkbox"/> 120VAC <input checked="" type="checkbox"/> 3VDC		
Test Personnel:	Yuriy Litvinov <i>Yuriy Litvinov</i>	Date: 01/23/2019	
Note:	[Redacted]		



Band Edge - Low Channel



Band Edge - High Channel



4.7		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: <input type="checkbox"/>	Laboratory Ambient Temperature:			
	Relative Humidity:			
	Atmospheric Pressure:			
Reference Standard(s):	<input type="checkbox"/> RSS GEN/FCC 15.207		Measurement Point <input type="checkbox"/> Mains <input type="checkbox"/> Telecommunication ports <input type="checkbox"/>	
	<input type="checkbox"/> ANSI C63.4:2014			
	<input type="checkbox"/> ANSI C63.10:2013			
Nominal Voltage:	<input type="checkbox"/> 120VAC <input type="checkbox"/> 230VAC <input type="checkbox"/>			
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:	



4.8 RF Exposure Compliance		
Reference Standard(s):	<input checked="" type="checkbox"/> IEEE Std 1528a <input checked="" type="checkbox"/> RSS 102, Issue 5 <input checked="" type="checkbox"/> KDB 447498 <input type="checkbox"/> KDB [REDACTED]	<input type="checkbox"/> MPE <input type="checkbox"/> SAR Evaluation <input checked="" type="checkbox"/> SAR test Exclusion
Frequency Range:	<input checked="" type="checkbox"/> 2402-2480MHz	
Antenna Separation Distance:	>15cm	
Duty Cycle:	100 %	
Time-Averaged Output power (EIRP):	1.12dBm (1.3mW)	
SAR Test Exclusion Threshold for 100MHz – 6GHz		
FCC	29 mW (<15mm)	
RSS 102, Issue 5	15 mW (<15mm)	



5.0	Test Equipment				
Test Equipment Used					
Description	Manufacturer	Model	Identifier	Last Cal. Date	Check
Biconilog Antenna	Schaffner	CBL6112B	27491	10/20/2018	<input checked="" type="checkbox"/>
Horn Antenna	A.H. Systems	SAS 571	1010	10/20/2018	<input checked="" type="checkbox"/>
Loop Antenna	A.H. Systems	EHA-51B	1213E	10/20/2018	<input type="checkbox"/>
Loop Antenna	EMCO	ALR25M	1011	10/20/2018	<input type="checkbox"/>
Signal Analyzer	Agilent	N9000A	MY53031040	10/20/2018	<input checked="" type="checkbox"/>
EMI Receiver	Agilent	E4448A	1530975	10/20/2018	<input checked="" type="checkbox"/>
LISN	TESEQ	NNB51	1130	10/20/2018	<input type="checkbox"/>
EMF Meter	NARDA	ELT400	1139	10/20/2018	<input type="checkbox"/>
EMF E-field Probe	NARDA	Type 8.3 100KHz-3GHz	K-0014	10/20/2018	<input type="checkbox"/>
EMF H-field Probe	NARDA	Type 12.1 300KHz-30MHz	AP-0004	10/20/2018	<input type="checkbox"/>
Coaxial Cable	Insulated Wire	2803	CBL2039	10/21/2018	<input checked="" type="checkbox"/>
EMC Software	ETS-Lindgren	TILE 7		10/20/2018	<input checked="" type="checkbox"/>
Equipment Calibration Interval:		<input checked="" type="checkbox"/> 12 months <input type="checkbox"/> 24 months			

6.0	Report revision history		
Revision Level	Date	Report Number	Notes
0	04/03/2019	RE1606003-1	Original Issue

Statement 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:	Connected Safety Headtop Peripheral
MODEL NUMBER(S):	HTP-1-CX
TEST REPORT NUMBER:	RE 1606003-1
DATE OF ISSUE:	April 3, 2019

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	47 CFR, 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:



Yuriy Litvinov
Lead EMC Engineer