Wireless Limit Switch

EMC Test Report

Model No.: WBX1A14AAC

Date: 18/11/2014

Report Prepared By: Gulshan

EMC Test Report
For
Wireless Limit Switch

Report Number:	: *EMC-0330-3*	
EUT Nomenclature	: Wireless Limit Switch	
Sample Identification:	: Model No.	- WBX1A14AAC
	: SL No :	- 01
	: Hardware Version	- Rev B- Battery board, Rev C- Switch board
	: Software Version	- Switch PCBA- V1.3, RF PCBA Product firmware- V2.8
Date of Receipt of sample	: 15-11-2014	
Condition of sample on receipt	: Good	
Requester name:	: Kelly Geiseman	
Requester Address:	: Honeywell International Inc 315 E Stephenson St, Plant 1 A2-148, Freeport, IL, USA Zip code 61032-4353	
Testing Laboratory:	: Honeywell Technology Solutions, Bangalore-EMC Lab	
Address:	RMZ ECOWORLD INFRASTRUCTURE PVT. LTD., Survey # 19/2, Devarabisanahalli Village, Varthur Hobli, Bangalore East Taluk, Bangalore – 560103	
Test Dates:	: 17-11-2014 to 18-11-2014	
Applicable Standard:	: FCC Part 15- Subpart C	
Test Results:	: PASS	

Prepared By: Test Engineer Name : Gulshan Kumar. B Signature: Gulshan S. Date : 23/11/14	Reviewed By: Technical Manager Name : Rajesh. N Signature: N. Rajesh Date : 24/11/14
Authorized By: Quality Manager Name : Prasanna Kumar BT Signature: B Prasanna Kumar Date : 24/11/14	Authorized By: Lab Manager Name : Ananth Krishna Signature: Date : 25/11/14

This Report relates to the above mentioned test sample only. Without the approval of Lab manager, this report shall not be reproduced except in full.

TEST SUMMARY					
	Name	**Specification**	**Test Method**	**Pass**	**Fail**
FHSS					
☐	20dB Bandwidth	FCC Part 15.247	DA 00-705	☐	☐
☐	Maximum Peak Output Power	FCC Part 15.247	DA 00-705	☐	☐
☐	Carrier Frequency Separation	FCC Part 15.247	DA 00-705	☐	☐
☐	Number of Hopping Frequencies	FCC Part 15.247	DA 00-705	☐	☐
☐	Band Edge compliance	FCC Part 15.247	DA 00-705	☐	☐
☒	Time of Occupancy (Dwell Time)	FCC Part 15.247	DA 00-705	☒	☐
☐	Spurious RF Conducted Emissions	FCC Part 15.247	DA 00-705	☐	☐
☒	Spurious Radiated Emissions	FCC Part 15.247 and 15.209	DA 00-705	☒	☐
☒	Effective Isotropic Radiated Power	FCC Part 15.247	412172 D01 Determining ERP and EIRP v01	☒	☐
DTS					
☐	DTS 6dB Bandwidth	FCC Part 15.247	KDB 558074	☐	☐
☐	Maximum Peak Output Power	FCC Part 15.247	KDB 558074	☐	☐
☐	Maximum Power Spectral Density	FCC Part 15.247	KDB 558074	☐	☐
☐	Band Edge Conducted Emissions	FCC Part 15.247	KDB 558074	☐	☐
☐	Radiated Spurious Emissions	FCC Part 15.209	KDB 558074	☐	☐

☒ = Test Performed
☐ = Test Not Performed

MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels has been estimated for tests performed on the EUT as specified in CISPR 16-4

The Expanded measurement uncertainty (K=2) is provided below

#	Name	Value
1	20dB & 6dB Occupied Bandwidth	1.4dB
2	Maximum Peak Output Power Level	1.4dB
3	Power Spectral Density	1.4dB
4	Band Edge Conducted Emission	1.4dB
5	Spurious RF Conducted Emission	1.4dB
6	Radiated Spurious Emission < 1GHz	4.9dB
7	Radiated Spurious Emission > 1GHz	6.3dB

1 PRODUCT DETAILS

PRODUCT OPERATION AND INTENDED USE

The product is an Intrinsically safe Limit switch used in Hazardous environment for counting applications. The product registers number of switch presses in a given time and transmits the information to the receiver.

RATINGS AND SYSTEM DETAILS	
Operating Frequency	2405MHz to 2475MHz
Number of Channels	15
Channel Bandwidth (20dB)	3MHz
Transmitted Power	14 dBm
Modulation Type	FHSS
Data Rate	250kbps
Antenna Type	Omni directional
No. of Antenna	1
Antenna Gain	2.0dBi peak
Supply Voltage and Current	7.2VDC (Battery operated)
Dimensions (L x W x H)	8.7 x7.3 x 2.881 (dimensions are in mm)
Environmental Conditions	-40°C to +70°C

TEST CONFIGURATION

Config #	Description
1	Firmware B - Continuous transmission mode, data packets are transmitted continuously. The EUT power level was set to 14 dBm.

OPERATING MODES

Mode #	Description
1	Product was operated in continuous transmit mode in channel 1 - 2405 MHz
2	Product was operated in continuous transmit mode in channel 7 - 2440MHz
3	Product was operated in continuous transmit mode in channel 15 - 2475MHz

INPUT AND OUTPUT CABLES

Port #	Name	Port Type	Cable Length	Cable type Shielded/ Unshielded	Comments
Not Applicable					

*Note :

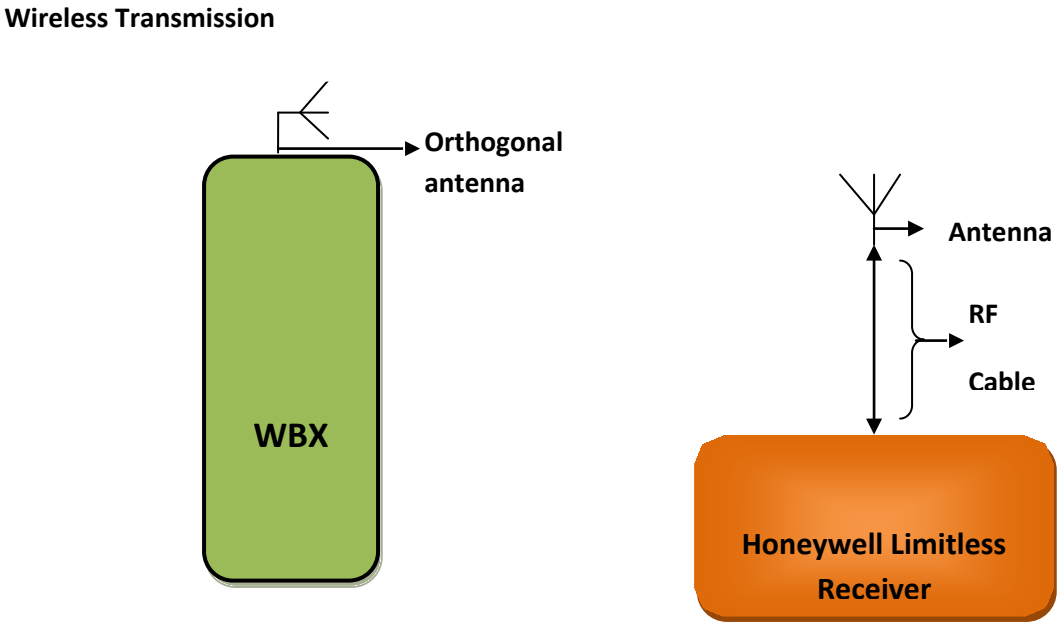
AC	= AC Power Port	DC	= DC Power Port
TP	= Telecommunication Ports (E.g. Ethernet)	DI / DO	= Digital Input / Output
N /E	= Non Electrical	AI / AO	= Analog Input / Output

SUPPORT EQUIPMENTS AND ACCESSORIES USED

#	Item Description	Make	Model	Part No. / Sl. No	Cal Due Date
Not Applicable					

CONNECTION DIAGRAM AND SETUP DIAGRAM

WBX TEST SETUP FOR EMC TESTING



Note: Honeywell Limitless receiver was kept outside the 3m semi anechoic chamber in control room for RE test

Receive antenna was kept inside the chamber which was connected to HLR through RF cable

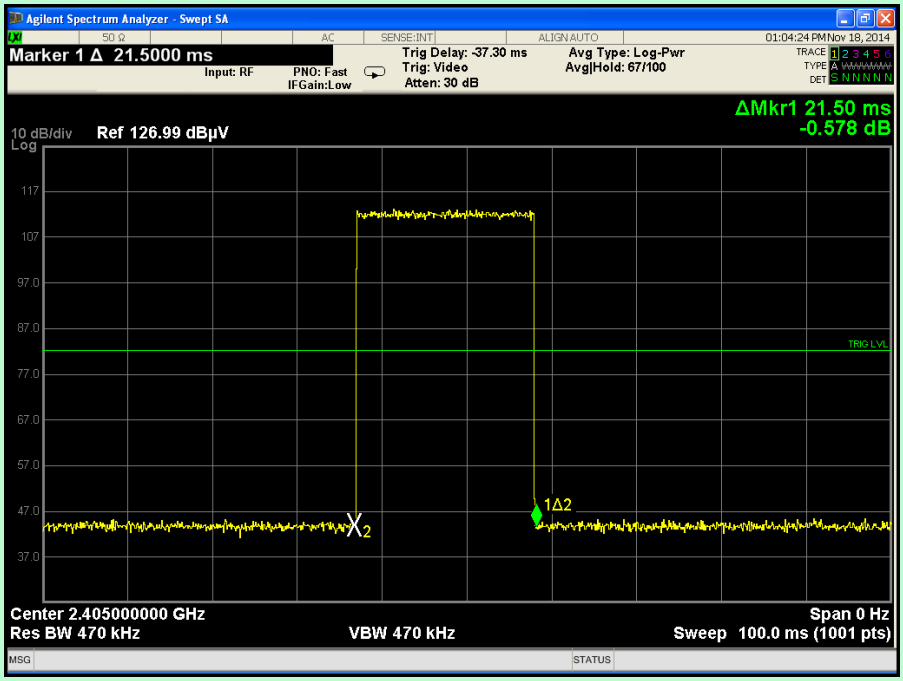
2 Transmitter Tests

2.1 Duty Cycle

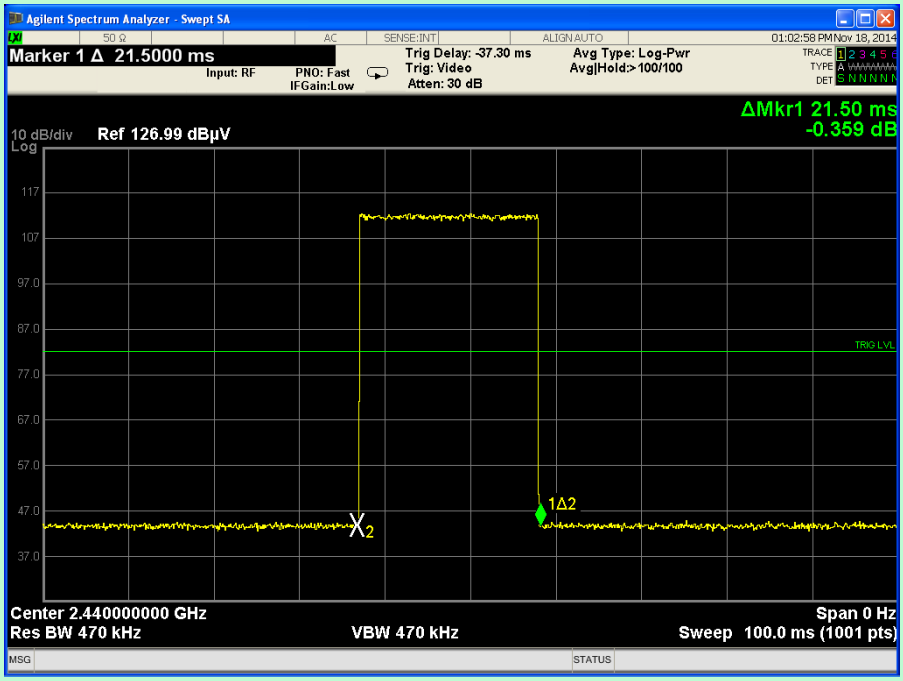
EUT Nomenclature	Wireless Limit Switch	**Test Report No.**	EMC -0330-3
Model No.	WBX1A14AAC	**Serial No.**	01
Test Start Date	17/11/2014	**Temperature (˚C)**	22.4˚C
Test End Date	18/11/2014	**Humidity RH (%)**	51.5%
Tested By	Gulshan Kumar	**Pressure (mbar)**	NA
Input Voltage / Freq	7.2VDC (battery operated)		
Operating Mode	Refer Page 5 Operating Modes Table		
Test configuration	Refer Page 5 Test Configuration Table		
Deviation from Std	NA		
Applicable standard	FCC Part 15.247		
Test Method			
Comment	Nil		
TEST DETAILS			
Method	☒ Conducted ☐ Radiated		
TEST PARAMETERS			
Antenna Height	NA	**Turntable Rotation**	NA
Equipment Class	NA	**Measurement Distance**	NA

TEST EQUIPMENT					
Y/N	**Equipment**	**Make**	**Model**	**Sl. No.**	**Cal Due Date**
Y	EXA Signal Analyzer	Agilent Technologies	N9010A	MY-50420136	08-Dec-14

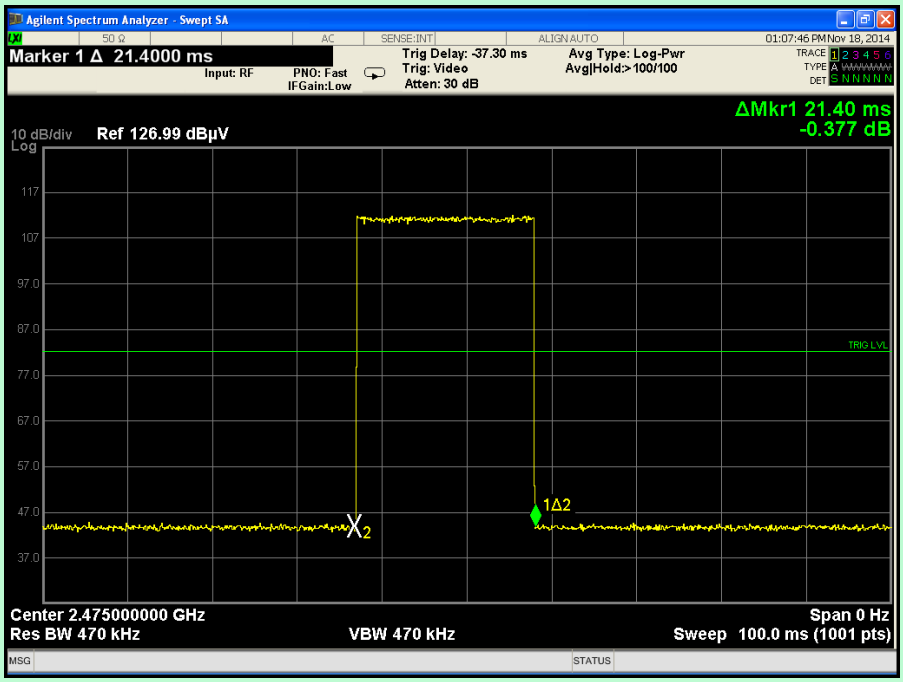
TEST GRAPHS



Channel 1 (2405MHz)



Channel 7 (2440MHz)



Channel 15 (2475MHz)

TEST RESULT				
Channel	**Channel Frequency**	**Measured Duty Cycle**	**No. of bursts**	**Total Duty cycle for 100ms**
#	**MHz**	**ms**	**#**	**ms**
1	2405	21.5	1	21.5
7	2440	21.5	1	21.5
15	2475	21.4	1	21.4

2.1 SPURIOUS RADIATED EMISSIONS

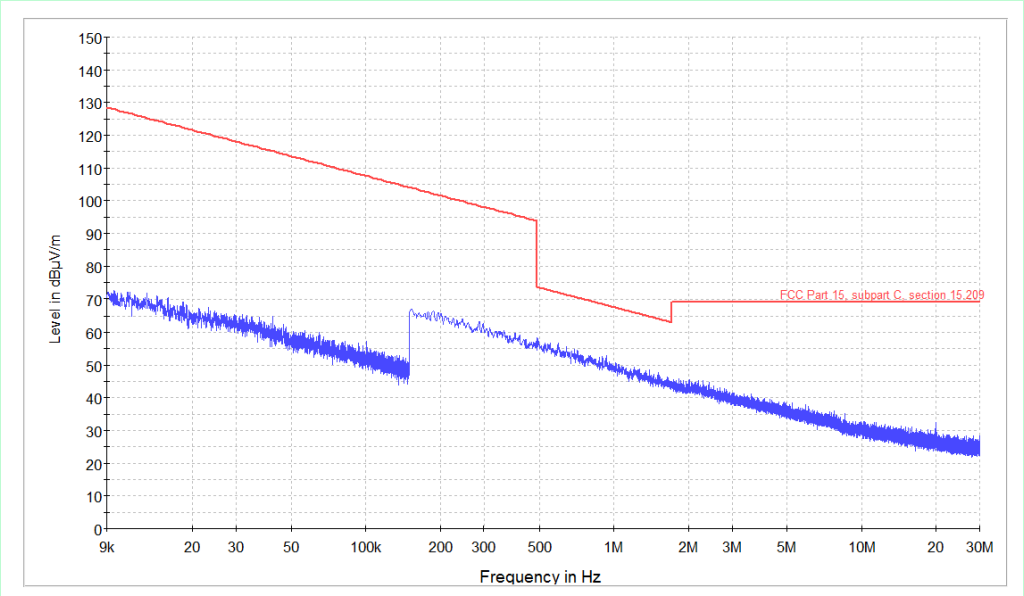
EUT Nomenclature	Wireless Limit Switch	**Test Report No.**	EMC -0330-3
Model No.	WBX1A14AAC	**Serial No.**	01
Test Start Date	17/11/2014	**Temperature (˚C)**	21.1˚C
Test End Date	18/11/2014	**Humidity RH (%)**	51.5%
Tested By	Gulshan Kumar	**Pressure (mbar)**	NA
Input Voltage / Freq	7.2VDC (battery operated)		
Operating Mode	Refer Page 5 Operating Modes Table		
Test configuration	Refer Page 5 Test Configuration Table		
Deviation from Std	NA		
Comment			
TEST FREQUENCY RANGE			
Start Frequency	9KHz	**Stop Frequency**	18GHz
MAXIMUM OPERATING FREQUENCY			
2.4GHz			
TEST PARAMETERS			
Antenna Height	1m to 4m	**Turntable Rotation**	0° to 360°
Applicable standard	FCC Part 15.209	**Test Method**	DA 00-705
Equipment Class	NA	**Measurement Distance**	3m

TEST EQUIPMENT

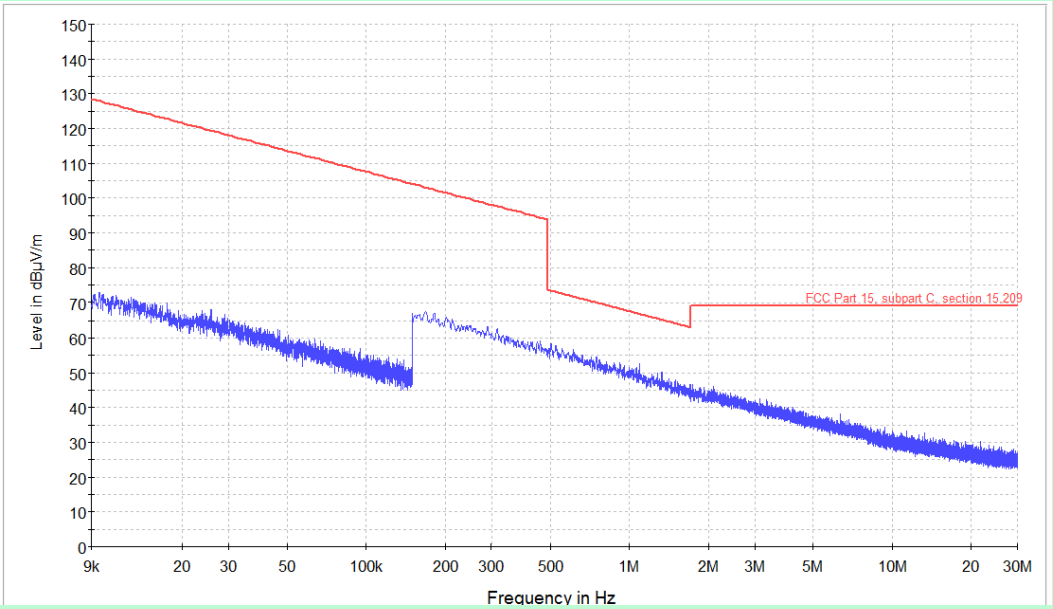
Y/N	Equipment	Make	Model	Sl. No.	Cal Due Date
Y	EMI Test Receiver	R&S	ESU26	100229	20-Mar-2015
Y	3m Semi Anechoic Chamber	ETS Lindgren	DKE 6X7 DBL.DR	1625	31-Dec-2015
Y	Double Ridge Guide Horn Antenna	ETS Lindgren	3117	00119022	04-April-2015
Y	Bilog Antenna	ETS Lindgren	HLP3003C	130524	02-April-2015
Y	Loop Antenna	ETS Lindgren	6507	000103694	01-April-2015
Y	RF cable (9KHz to 1GHz)	COLEMAN	RG214	RE-1A	09-May-2015
Y	RF cable (9KHz to 1GHz)	COLEMAN	RG214	RE-1B	09-May-2015
Y	RF cable (1GHz to 18GHz)	AH Systems	SAC-18G-06	RE-2A	09-May-2015
Y	RF cable (1GHz to 18GHz)	AH Systems	SAC-18G-06	RE-2B	09-May-2015
Y	Signal Conditioning unit	R&S	SCU-18	10178	14-June-2015
Y	High Pass Filter	Micro tronics	BRM50702-01	1	09-May-2015
Y	EMC32 Software	R&S	8.30.0	820-OT101248	NA

Note: Switch ON /OFF the Internal Preamplifier based on carrier level and or noise floor without overloading the receiver

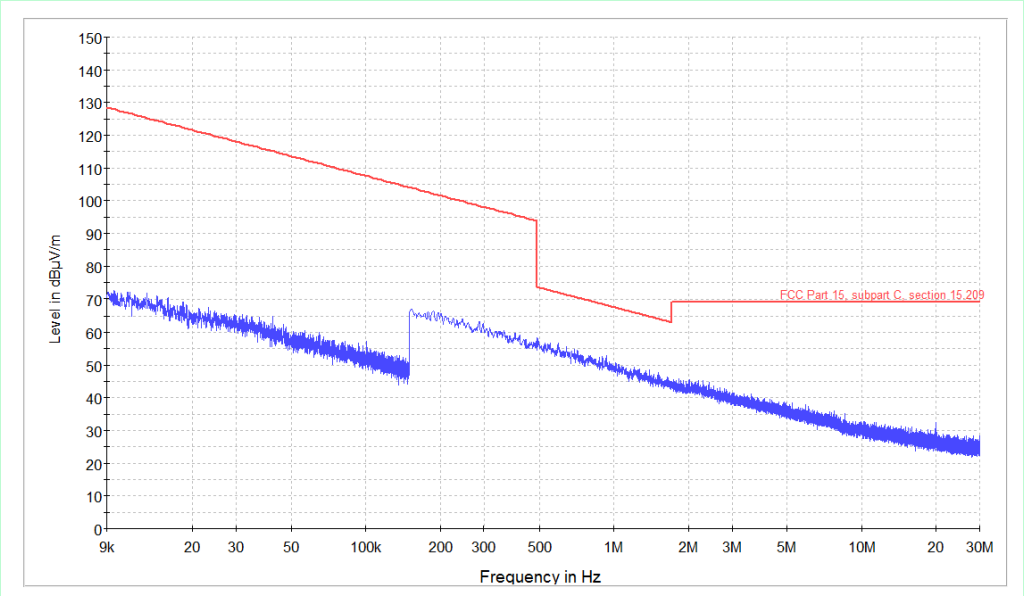
TEST GRAPHS – 9 KHz to 30 MHz



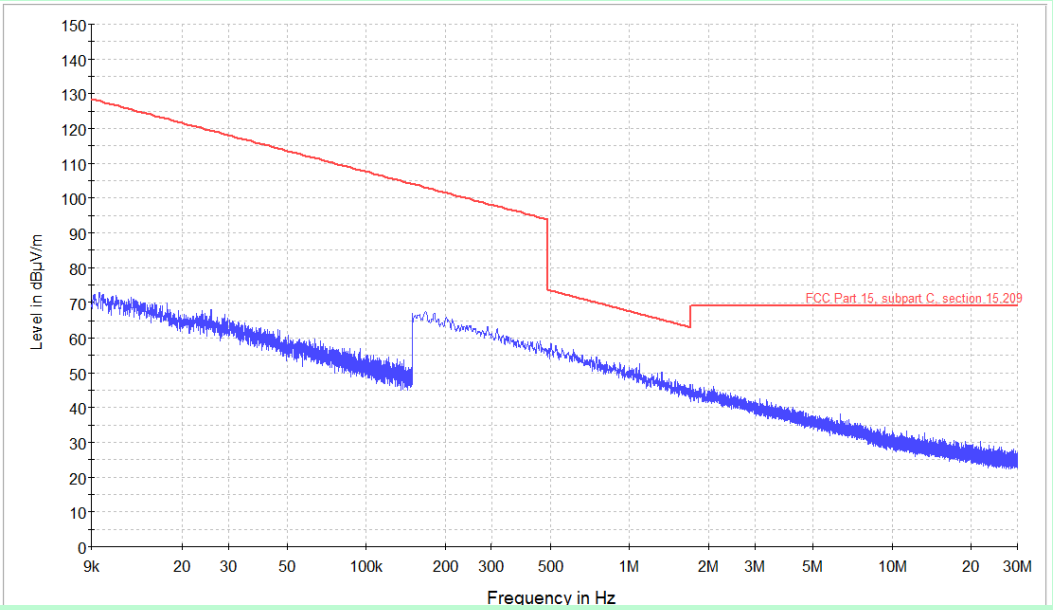
Note : Ch 01-2405MHz Peak Graph - Parallel



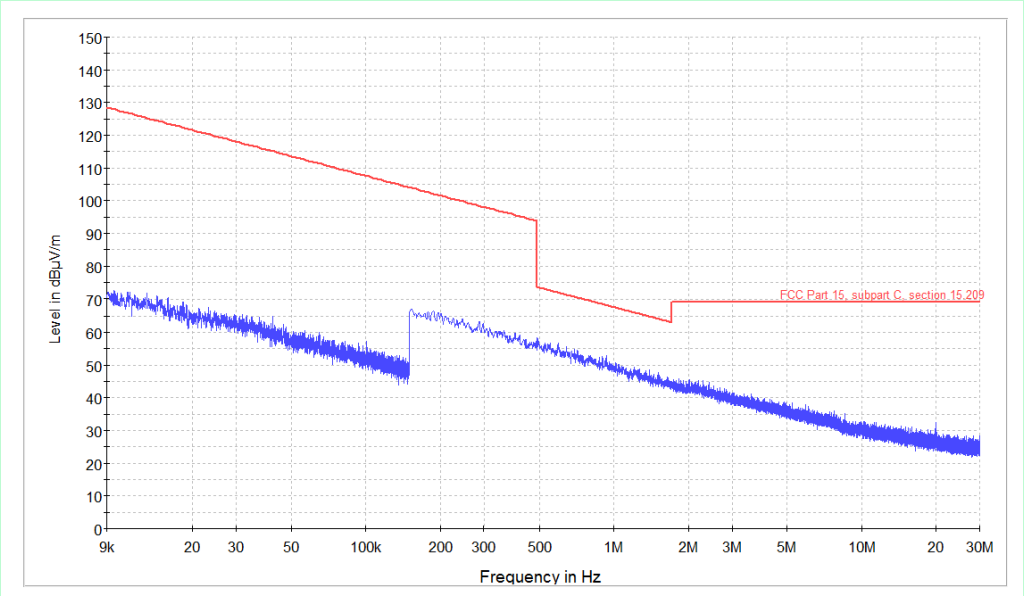
Note : Ch 01-2405MHz Peak Graph - Perpendicular



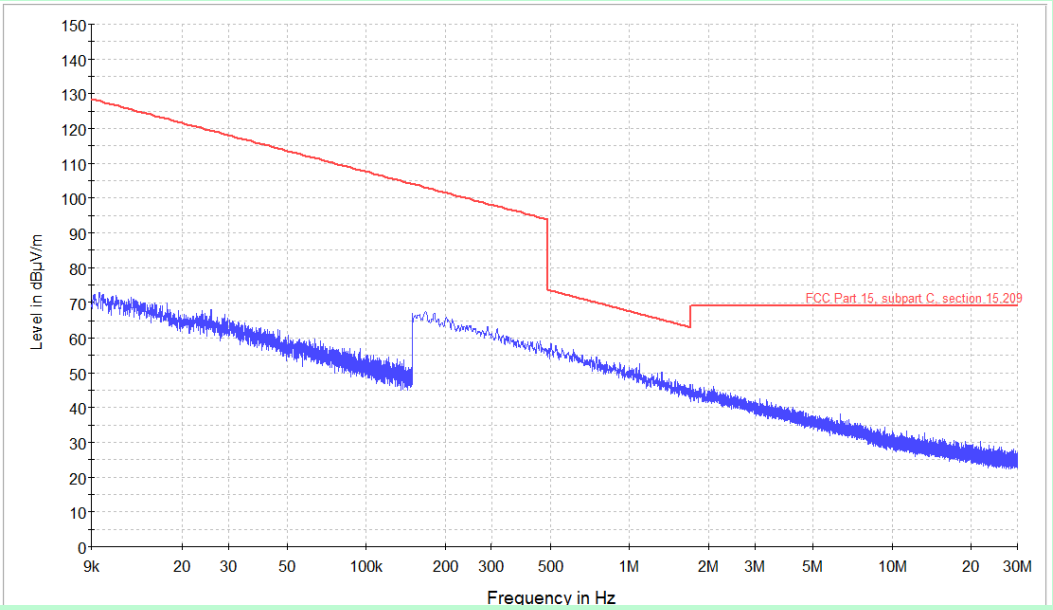
Note : Ch 07- 2440MHz Peak Graph - Parallel



Note : Ch 07-2440MHz Peak Graph - Perpendicular



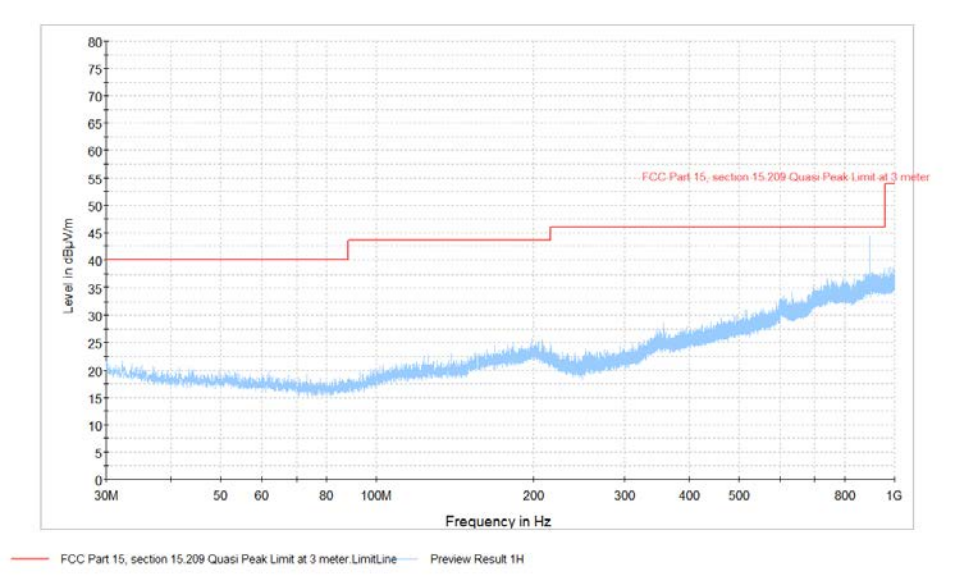
Note : Ch 15-2475MHz Peak Graph - Parallel



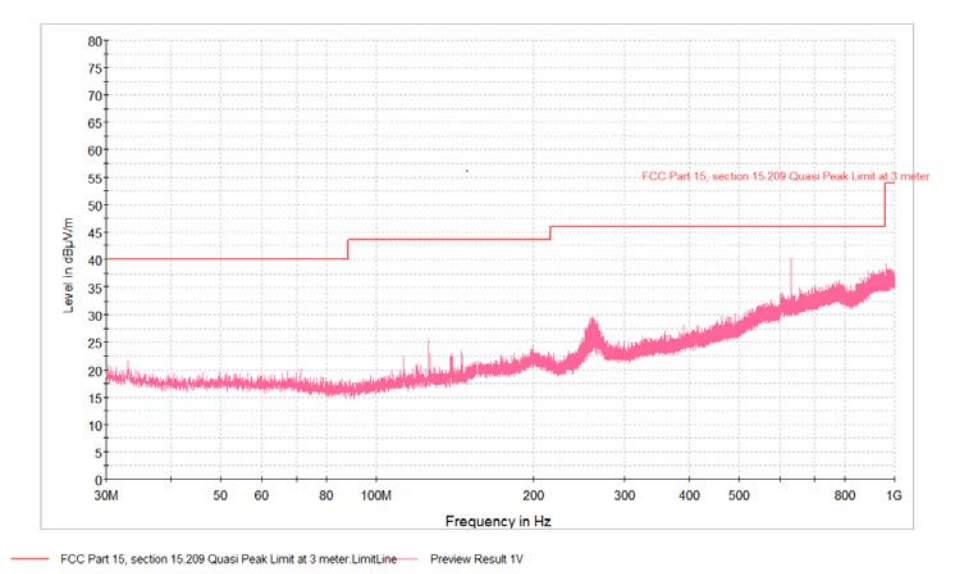
Note : Ch 15 -2475MHz Peak Graph - Perpendicular

TEST RESULT – 9 KHz to 30 MHz									
Channel	Channel Frequency	Measured Spurious	Quasi Peak	Height	Ant Pol	Azimuth	Margin	Limit @ 3m Distance	Results
#	MHz	MHz	dBµV/m	cm	Parallel / Perpendicular	deg	dB	dBµV/m	
1	No Emissions found								
7									
15									

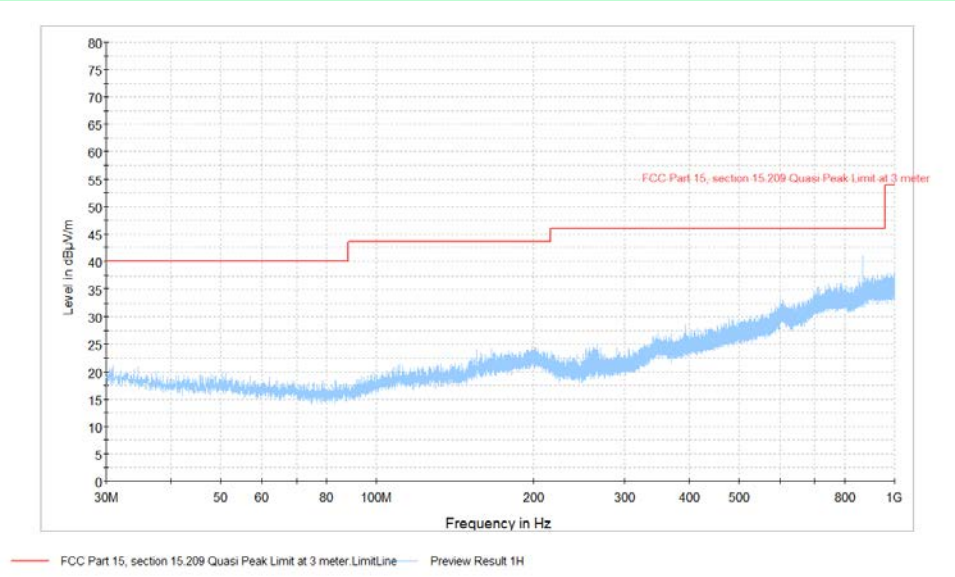
TEST GRAPHS – 30 MHz to 1 GHz



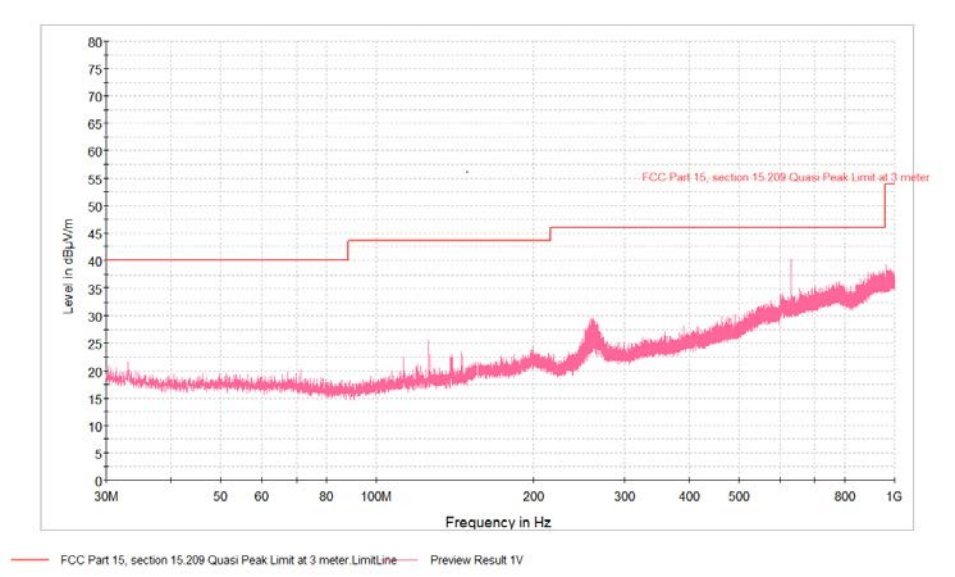
Note : Ch 01 – 2405MHz Peak Graph - Horizontal



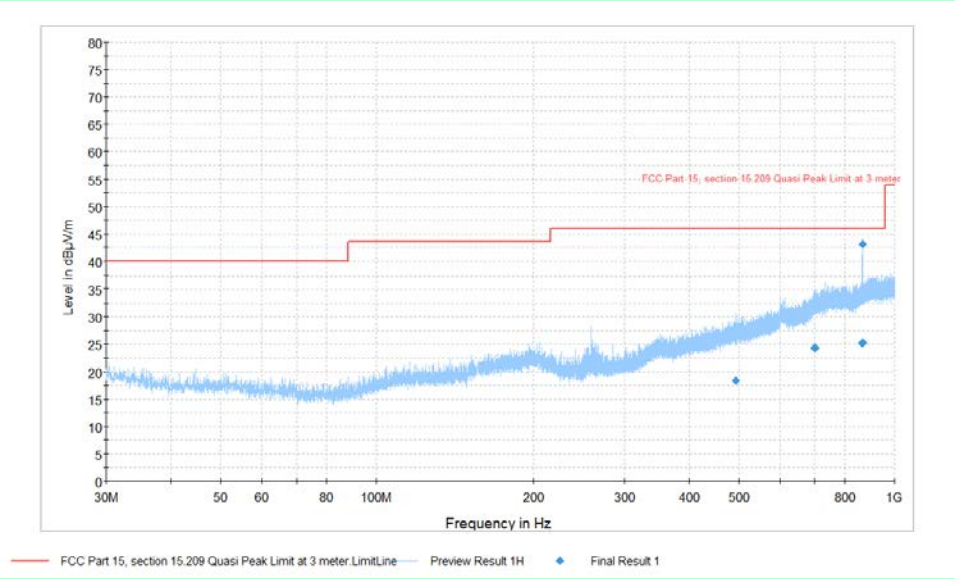
Note : Ch 01 – 2405MHz Peak Graph - Vertical



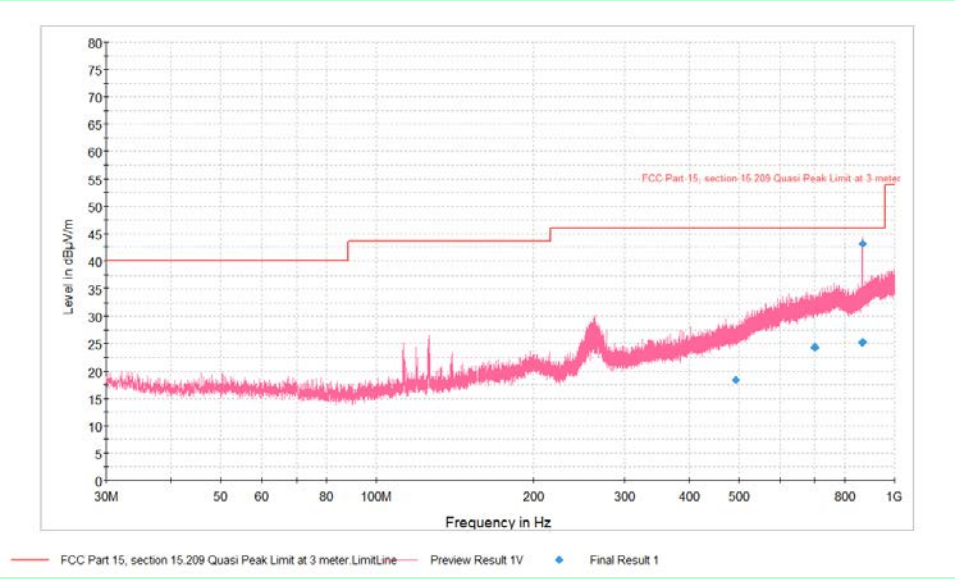
Note : Ch 07 – 2440MHz Peak Graph - Horizontal



Note : Ch 07 – 2440MHz Peak Graph - Vertical



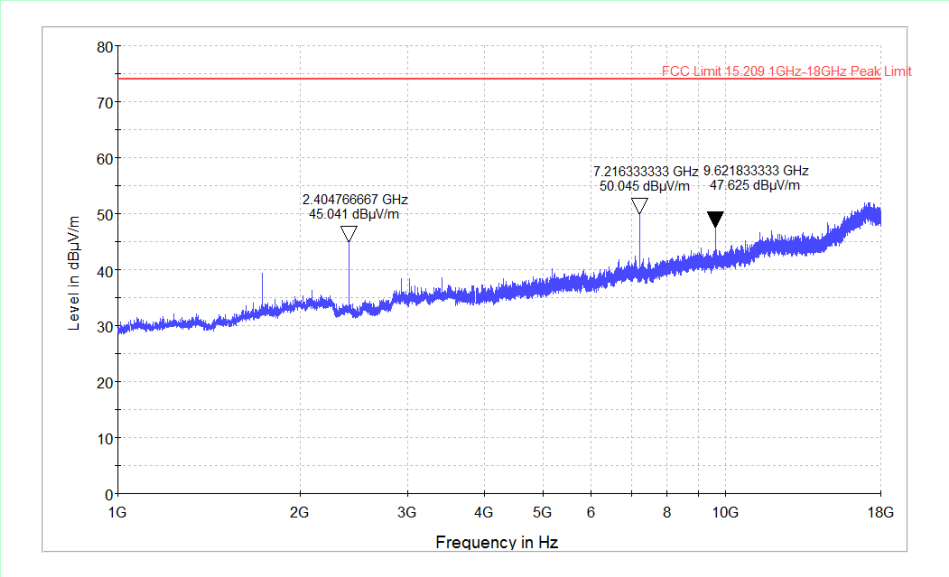
Note : Ch 15 – 2475MHz Peak Graph - Horizontal



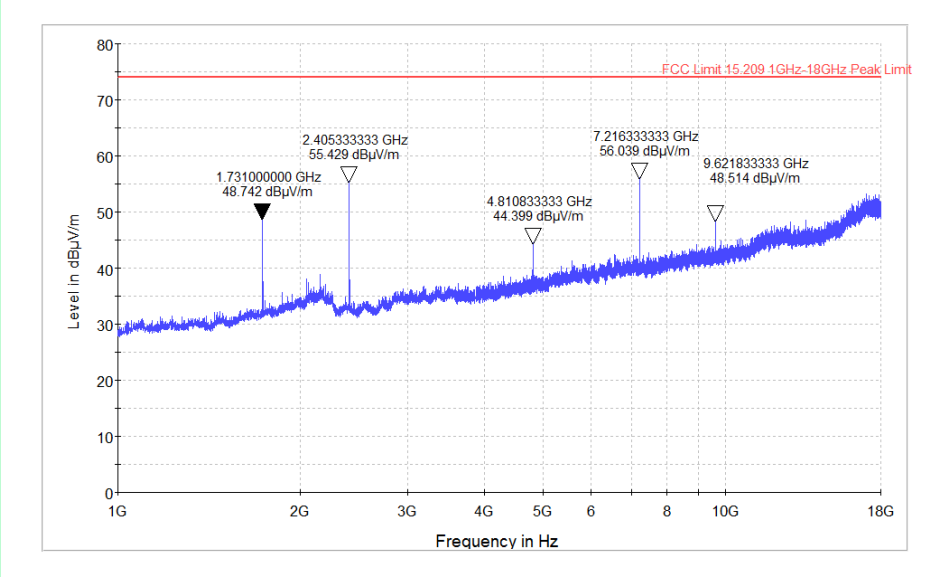
Note : Ch 15 – 2475MHz Peak Graph - Vertical

TEST RESULT – 30 MHz to 1 GHz								
Channel	Frequency	Quasi Peak Readings	Height	Ant Pol	Azimuth	Margin	Limit @ 3m Distance	Results
#	MHz	dBµV/m	cm	H / V	deg	dB	dBµV/m	
CH1	697.34	34.0	300.0	H	180.0	12.0	46.0	PASS
	865.37	35.8	300.0	H	180.0	10.2	46.0	PASS
	896.73	36.7	100.0	H	270.0	9.3	46.0	PASS
	492.53	28.3	300.0	V	90.0	17.7	46.0	PASS
	630.80	32.7	200.0	V	45.0	13.3	46.0	PASS
	866.46	35.2	100.0	V	0.0	10.8	46.0	PASS
	866.49	35.2	100.0	V	90.0	10.8	46.0	PASS
	867.12	35.3	100.0	V	315.0	10.7	46.0	PASS
	867.23	35.2	100.0	V	135.0	10.8	46.0	PASS
	867.56	35.2	100.0	V	45.0	10.8	46.0	PASS
CH7	692.45	33.7	100.0	H	315.0	12.3	46.0	PASS
	704.00	34.3	200.0	H	90.0	11.7	46.0	PASS
	865.61	35.9	100.0	H	135.0	10.1	46.0	PASS
	866.49	40.0	300.0	H	45.0	6.0	46.0	PASS
	866.52	35.9	300.0	H	45.0	10.1	46.0	PASS
	263.46	27.5	100.0	V	45.0	18.5	46.0	PASS
	866.64	35.2	200.0	V	0.0	10.8	46.0	PASS
	866.93	35.2	300.0	V	45.0	10.8	46.0	PASS
	867.06	42.8	200.0	V	270.0	3.2	46.0	PASS
	867.09	35.3	200.0	V	270.0	10.7	46.0	PASS
CH15	700.84	24.4	300.0	H	270.0	21.6	46.0	PASS
	701.56	24.3	300.0	H	90.0	21.7	46.0	PASS
	492.62	18.4	300.0	V	270.0	27.6	46.0	PASS
	865.93	25.2	300.0	V	0.0	20.8	46.0	PASS
	866.10	25.2	200.0	V	45.0	20.8	46.0	PASS
	866.39	25.2	200.0	V	315.0	20.8	46.0	PASS
	866.51	43.1	100.0	V	270.0	2.9	46.0	PASS
	866.68	25.2	100.0	V	90.0	20.8	46.0	PASS
	866.82	25.3	100.0	V	0.0	20.7	46.0	PASS
	866.84	25.3	100.0	V	0.0	20.7	46.0	PASS
NOTE: Quasi Peak Readings (dBuV/m) = Receiver Readings (dBuV) + Antenna Factor (dB/m) + Cable loss (dB)								

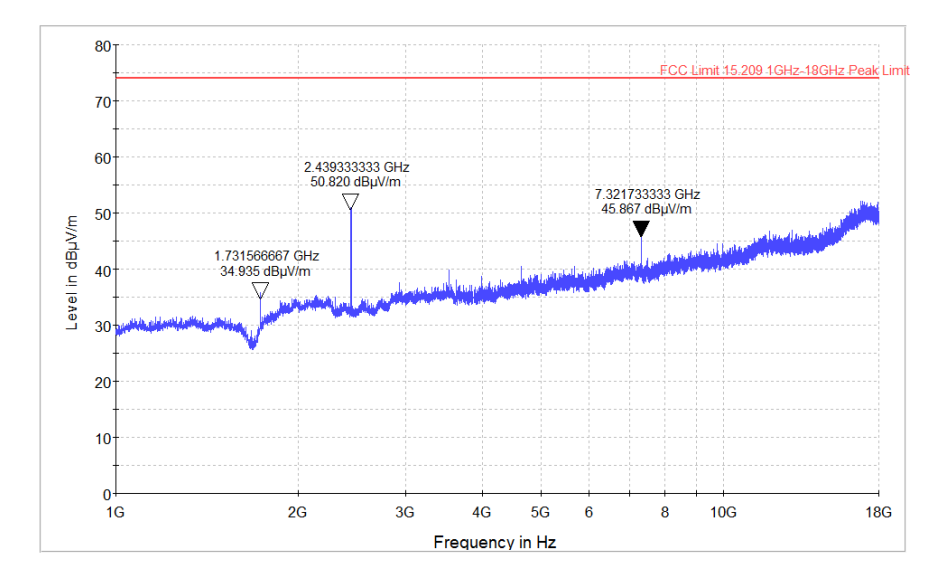
TEST GRAPHS – 1 GHz to 18 GHz



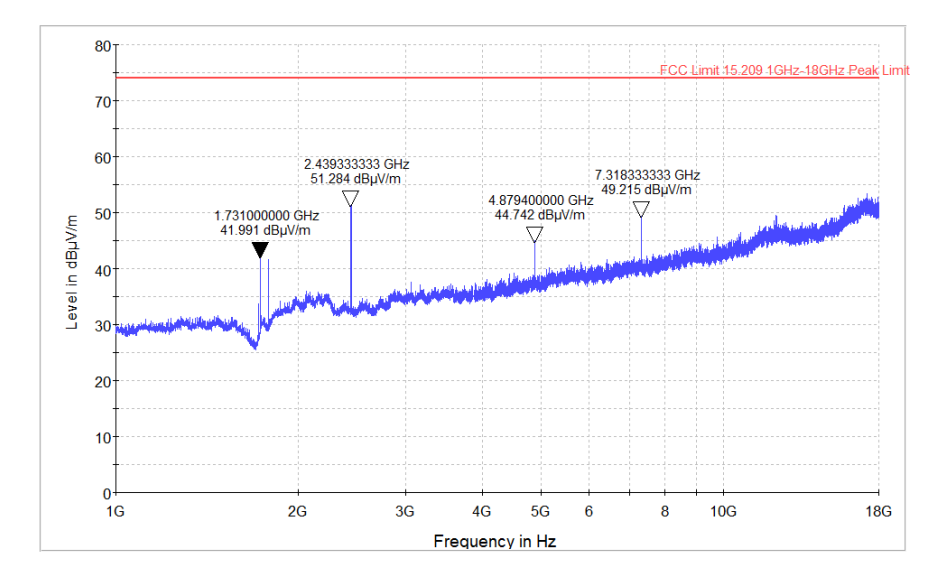
Note : Ch 01 – 2405MHz Peak Graph - Horizontal



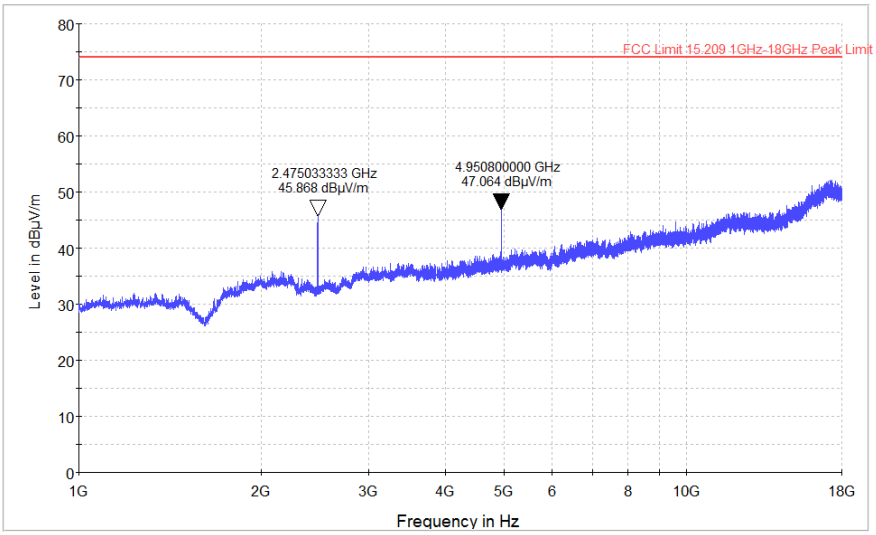
Note : Ch 01 – 2405MHz Peak Graph - Vertical



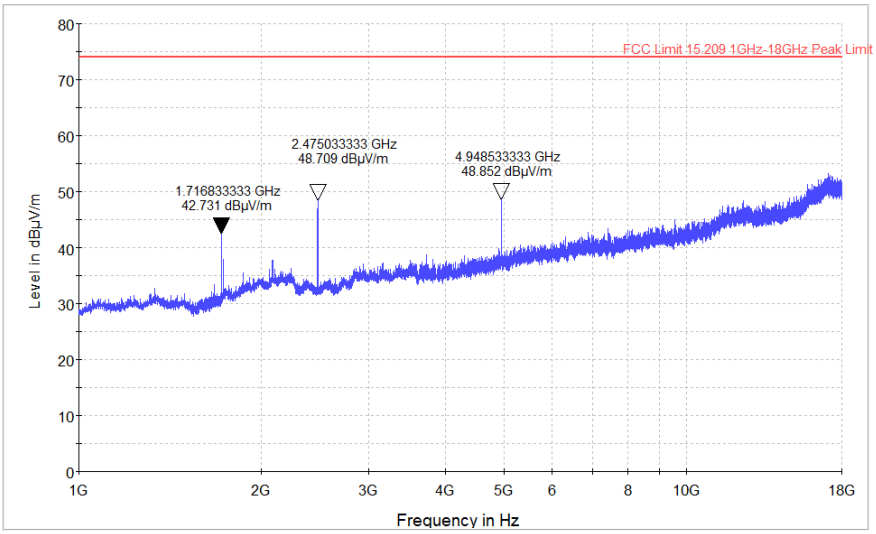
Note : Ch 07 – 2440MHz Peak Graph - Horizontal



Note : Ch 07 – 2440MHz Peak Graph - Vertical



Note : Ch 15 – 2475MHz Peak Graph - Horizontal



Note : Ch 15 – 2475MHz Peak Graph - Vertical

TEST RESULT – 1 GHz to 18 GHz										
Channel	Frequency	Measured Peak	Calculated Average	Height	Ant Pol	Azimuth	Peak Margin	Peak Limit	Average Margin	Average Limit
#	(MHz)	(dBµV/m)	(dBµV/m)	(cm)	H/V	(deg)	(dB)	(dBµV/m)	(dB)	(dBµV/m)
1	2407	45.04	31.06	100	H	245	29.0	74	22.9	54
1	7216	50.05	36.07	100	H	353	24.0	74	17.9	54
1	9621	47.63	33.65	200	H	295	26.4	74	20.4	54
1	1731	48.74	34.76	300	V	63	25.3	74	19.2	54
1	2405	55.42	41.44	200	V	124	18.6	74	12.6	54
1	4810	44.39	30.41	200	V	231	29.6	74	23.6	54
1	7216	56.04	42.06	100	V	339	18.0	74	11.9	54
1	9621	48.51	34.53	100	V	221	25.5	74	19.5	54
7	1731	34.94	20.96	100	H	125	39.1	74	33.0	54
7	2439	50.82	36.84	100	H	289	23.2	74	17.2	54
7	7321	45.87	31.89	300	H	183	28.1	74	22.1	54
7	1731	41.99	28.01	300	V	90	32.0	74	26.0	54
7	2439	51.28	37.30	200	V	331	22.7	74	16.7	54
7	4879	44.74	30.76	200	V	305	29.3	74	23.2	54
7	7318	49.21	35.23	100	V	210	24.8	74	18.8	54
15	2475	45.87	31.89	100	H	212	28.1	74	22.1	54
15	4950	47.06	33.08	300	H	99	26.9	74	20.9	54
15	1716	42.73	28.75	300	V	127	31.3	74	25.3	54
15	2475	48.70	34.72	300	V	20	25.3	74	19.3	54
15	4948	48.85	34.87	200	V	49	25.2	74	19.1	54

Note :

Peak Measured Field Strength –dBuV/m = Receiver Readings (dBuV) + Antenna Factor (dB/m) + Cable loss (dB)+ Notch Filter Insertion loss (dB) – Pre amplifier Gain (dB)

Worst case Duty Cycle = 20msec, Where, 20ms= Max. Pulse ON Time during 100msec

Duty Cycle Correction Factor = 20 log (20 /100) = -13.98 dB

Calculated Average readings = Peak readings in dBuV/m + Duty cycle Correction Factor (dB)

2.1 EFFECTIVE ISOTROPIC RADIATED POWER

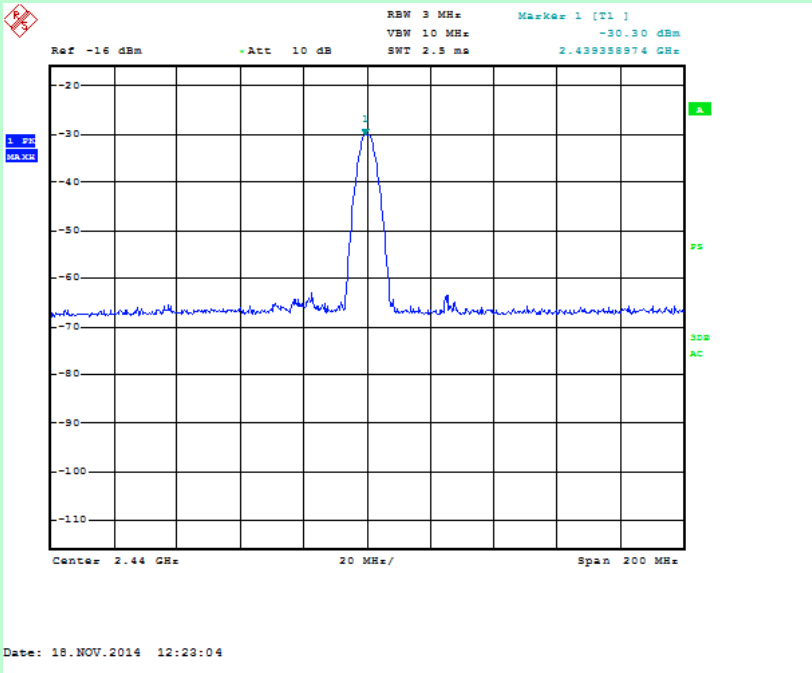
EUT Nomenclature	Wireless Limit Switch	**Test Report No.**	EMC -0330-3
Model No.	WBX1A14AAC	**Serial No.**	01
Test Start Date	17/11/2014	**Temperature (˚C)**	23.1˚
Test End Date	18/11/2014	**Humidity RH (%)**	55%
Tested By	Gulshan Kumar	**Pressure (mbar)**	NR
Input Voltage / Freq	7.2VDC (battery operated)		
Operating Mode	Refer Page 5 for Operating Mode Table		
Test configuration	Refer Page 5 for Test Configuration Table		
Deviation from Std	NA		
Applicable standard	FCC Part 15.247		
Test Method	DA 00-705		
Comment			
TEST DETAILS			
Method	☐ Conducted ☒ Radiated		
TEST PARAMETERS			
Antenna Height	1m to 4m	**Turntable Rotation**	0 to 360°C
Equipment Class	NA	**Measurement Distance**	NA

TEST EQUIPMENT

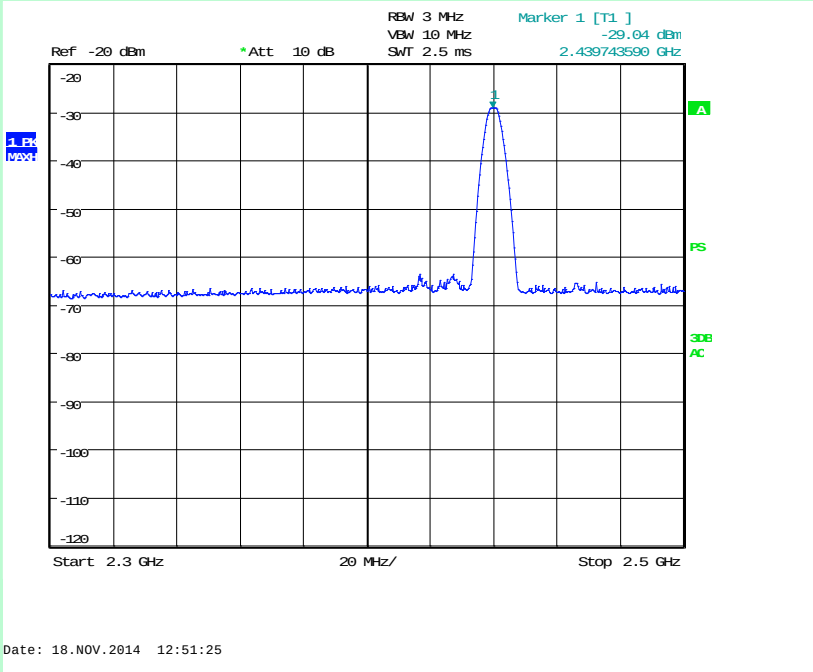
Y/N	Equipment	Make	Model	Sl. No.	Cal Due Date
Y	EMI Test Receiver	R&S	ESU26	100229	20-Mar-2015
Y	3m Semi Anechoic Chamber	ETS Lindgren	DKE 6X7 DBL.DR	1625	31-Dec-2015
Y	Double Ridge Guide Horn Antenna	ETS Lindgren	3117	00119022	04-April-2015
N	Bilog Antenna	ETS Lindgren	HLP3003C	130524	02-April-2015
N	RF cable (9KHz to 1GHz)	COLEMAN	RG214	RE-1A	09-May-2015
N	RF cable (9KHz to 1GHz)	COLEMAN	RG214	RE-1B	09-May-2015
Y	RF cable (1GHz to 18GHz)	AH Systems	SAC-18G-06	RE-2A	09-May-2015
Y	RF cable (1GHz to 18GHz)	AH Systems	SAC-18G-06	RE-2B	09-May-2015
N	Signal Conditioning unit	R&S	SCU-18	10178	14-June-2015
N	High Pass Filter	Micro tronics	BRM50702-01	1	09-May-2015
N	EMC32 Software	R&S	8.30.0	820-OT101248	NA

Note: Switch ON /OFF the Internal Preamplifier based on carrier level and or noise floor without overloading the receiver

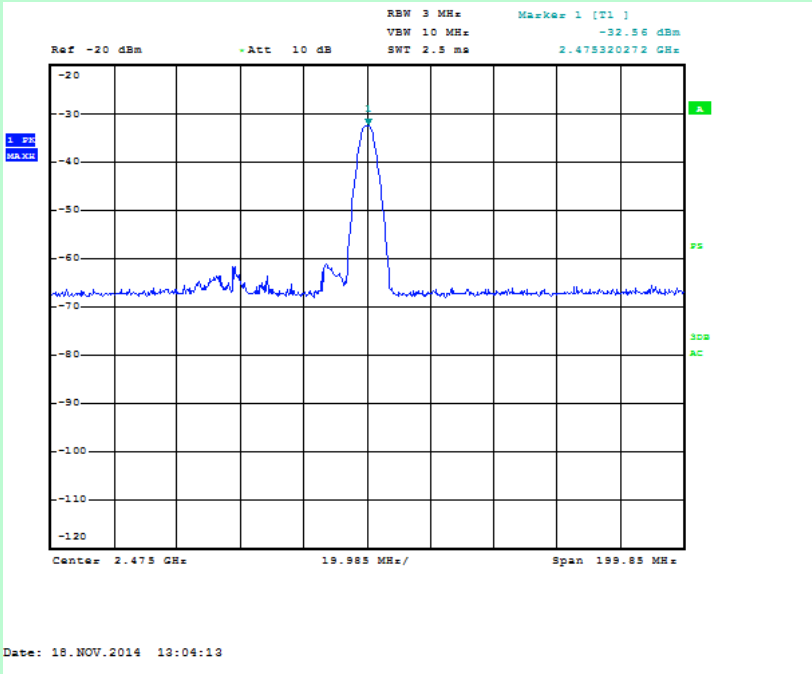
TEST GRAPHS



Channel 1 (2405MHz)



Channel 7 (2440MHz)



Channel 15 (2475MHz)

TEST RESULT

Channel	Channel Frequency	Measured Power Level	Gain of Receive Antenna	Path Loss	Measurement distance	EIRP
#	MHz	dBm	dBi	dB	m	dBm
1	2405	-30.30	5.0	49.66	3	14.36
7	2440	-29.04	5.0	49.79	3	15.75
15	2475	-32.56	5.0	49.93	3	12.37

EIRP = $P_R + L_P$

$$P_R = P_{Meas} - G_R + L_C + L_{Atten} - G_{Amp}$$

$$L_P = 20 \log F + 20 \log D - 27.5$$

where;

EIRP = equivalent (or effective) isotropically radiated power (in same units as PR);
PR = adjusted received power level, in dBW, dBm, or psd;
LP = basic free space propagation path loss, in dB.
$P_{Measured}$ = measured power level, in dBW, dBm or psd;
G_R = gain of the receive (measurement) antenna, in dBi;
L_C = signal loss in the measurement cable, in dB;
L_{Atten} = value of external attenuation (if used), in dB;
G_{Amp} = value of external amplification (if used), in dB.
L_P = basic free space propagation path loss, in dB;
F = center frequency of radiated DUT signal, in MHz;
D = measurement distance, in meters.

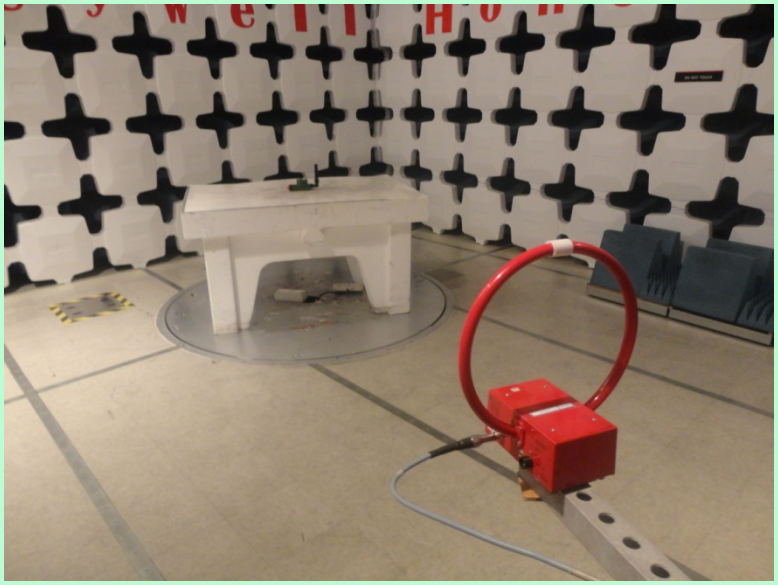
TEST SETUP PHOTOGRAPHS

Refer Annexure-1

Effective Isotropic Radiated Power

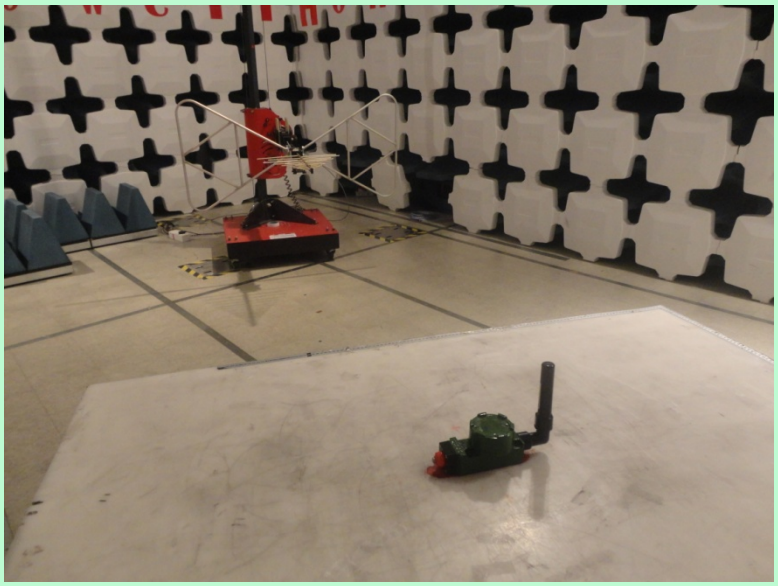
Annexure – 1

RADIATED EMISSION SETUP

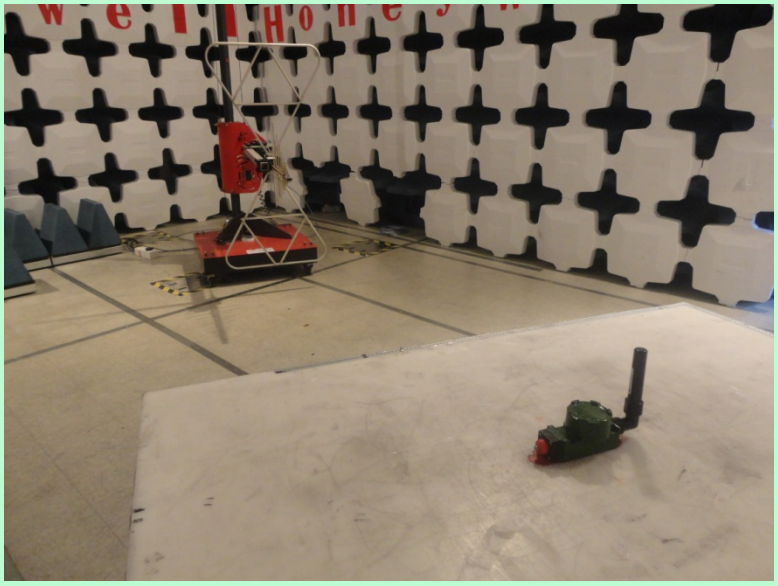


Radiated Emission Setup – 9 KHz to 30 MHz [Parallel]

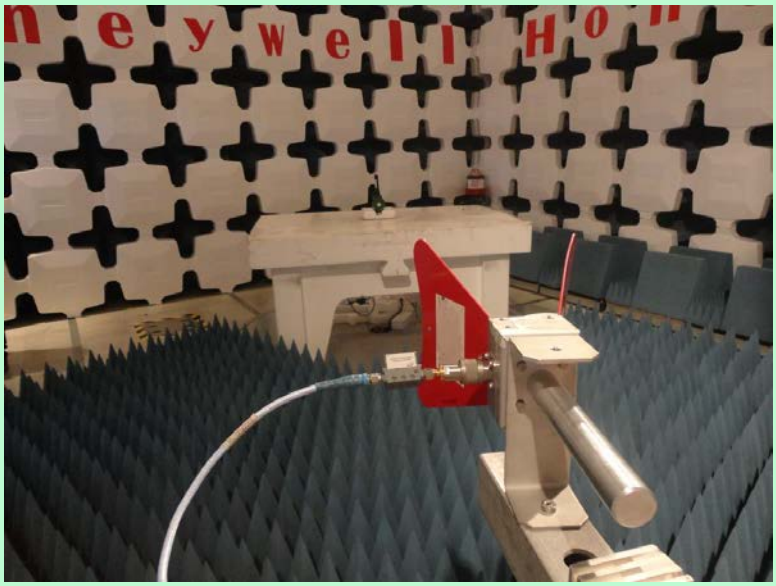
Radiated Emission Setup – 9 KHz to 30 MHz [Perpendicular]



Radiated Emission Setup –30MHz to 1GHz_[Horizontal Polarization]



Radiated Emission Setup –30MHz to 1GHz_[Vertical Polarization]



Radiated Emission Setup –1 GHz to 18GHz_[Horizontal Polarization]

Radiated Emission Setup –1 GHz to 18GHz [Vertical Polarization]

Effective Isotropic Radiated Power Test Setup - [Vertical Polarization]