Issuing Laboratory:
Intertek Testing Services Hong Kong Limited

Hong Kong Accreditation Service (HKAS) has accredited this laboratory under the Hong Kong Laboratory Accreditation Scheme (HOKLAS) for specific laboratory activities as listed in the HOKLAS directory of accredited laboratories. The results shown in this report were determined by this laboratory in accordance with its terms of accreditation.

HOKLAS 005
TEST

TEST REPORT

Report Number: 14010355HKG-001

Application
for
Original Grant of 47 CFR Part 15 Certification

Triple Program Outdoor Water Timer with Zigbee Module

FCC ID: ML6WT15ZBTRX12

Prepared and Checked by:

Wong Kwok Yeung, Kenneth
Lead Engineer

Approved by:

Chan Chi Hung, Terry
Supervisor
June 6,2014

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GENERAL INFORMATION

Applicant Name:	Orbit Irrigation Product Inc.
Applicant Address:	845N Overland Road, North Salt Lake, Utah 84054 USA
FCC Specification Standard:	FCC Part 15, October 1, 2012 Edition
FCC ID:	ML6WT15ZBTRX12
FCC Model(s):	27396
Type of EUT:	Digital Transmission System
Description of EUT:	Triple Program Outdoor Water Timer with Zigbee Module
Serial Number:	N/A
Sample Receipt Date:	January 09, 2014
Date of Test:	February 07-17, 2014
Report Date:	June 6, 2014
Environmental Conditions:	Temperature: +10 to 40°C Humidity: 10 to 90%

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EXHIBIT 1
SUMMARY OF TEST RESULTS & STATEMENT OF COMPLIANCE

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1.0 Summary of Test Results

Test Items	FCC Part 15 Section	Results	Details see section
Antenna Requirement	15.203	Pass	2.1
Max. Conducted Output Power	15.247(b)(3)&(4)	Pass	4.1
Min. 6dB RF Bandwidth	15.247(a)(2)	Pass	4.2
Max. Power Density	15.247(e)	Pass	4.3
Out of Band Antenna Conducted Emission	15.247(d)	Pass	4.4
Radiated Emission in Restricted Bands and Spurious Emissions	15.247(d), 15.209 & 15.109	Pass	4.6
AC Power Line Conducted Emission	15.207 & 15.107	Pass	4.7

Note: Pursuant to FCC Part 15 Section 15.215(c), the 20dB bandwidth of the emission was contained within the frequency band designated (mentioned as above) which the EUT operated. The effects, if any, from frequency sweeping, frequency hopping, other modulation techniques and frequency stability over expected variations in temperature and supply voltage were considered.

1.1 Statement of Compliance

The equipment under test is found to be complying with the following standards:

FCC Part 15, October 1, 2012 Edition

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EXHIBIT 2
GENERAL DESCRIPTION

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2.0 General Description

2.1 Product Description

The 27396 is a Triple Program Outdoor Water Timer with Zigbee Module. It operates at frequency range of 2405MHz to 2480MHz with 16 channels Zigbee. The Base Unit is power by 120VAC.

The antenna used in the EUT is integral, and the test sample is a prototype.

The circuit description is saved with filename: descri.pdf.

2.2 Test Methodology

Both AC power line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.4 (2009). Preliminary radiated scans and all radiated measurements were performed in Open Area Test Sites. All Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application. Antenna port conducted measurements were performed according to ANSI C63.10 (2009) and KDB Publication No. 558074 D01 v03r01 (09-Arpil-2013).

2.3 Test Facility

The open area test site, AC Power Line conducted measurement facility, and antenna port conducted measurement facility used to collect the radiated data, AC Power Line conducted data, and conductive data are at Roof Top, 2nd Floor, and 5th Floor respectively of Intertek Testing Services Hong Kong Ltd., which is located at Garment Centre, 576 Castle Peak Road, Kowloon, Hong Kong. This test facility and site measurement data have been fully placed on file with the FCC.

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EXHIBIT 3
SYSTEM TEST CONFIGURATION

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3.0 System Test Configuration

3.1 Justification

For radiated emissions testing, the equipment under test (EUT) was setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, all cables (if any) were manipulated to produce worst case emissions.

The EUT was powered by 120VAC.

For the measurements, the EUT was attached to a plastic stand if necessary and placed on the wooden turntable. If the EUT attached to peripherals, they were connected and operational (as typical as possible).

The signal was maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization were varied during the search for maximum signal level. The antenna height was varied from 1 to 4 meters. Radiated emissions were taken at three meters unless the signal level was too low for measurement at that distance. If necessary, a pre-amplifier was used and/or the test was conducted at a closer distance.

For any intentional radiator powered by AC power line, measurements of the radiated signal level of the fundamental frequency component of the emission was performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage.

Radiated emission measurement for transmitter were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Emission that are directly caused by digital circuits in the transmit path and transmitter portion were measured, and the limit are according to FCC Part 15 Section 15.209. Digital circuitry used to control additional functions other than the operation of the transmitter are subject to FCC Part 15 Section 15.109 Limits.

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3.1 Justification – Cont'd

Detector function for radiated emissions was in peak mode. Average readings, when required, were taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings.

Determination of pulse desensitization was made according to *Hewlett Packard Application Note 150-2, Spectrum Analysis... Pulsed RF.* The effective period (Teff) was referred to Exhibit 4.6.3. With the resolution bandwidth 1MHz and spectrum analyzer IF bandwidth 3dB, the pulse desensitization factor was 0dB.

For AC line conducted emission test, the EUT along with its peripherals were placed on a 1.0m(W)x1.5m(L) and 0.8m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane. The EUT was connected to power mains through a line impedance stabilization network (LISN), which provided 50ohm coupling impedance for measuring instrument. The LISN housing, measuring instrument case, reference ground plane, and vertical ground plane were bounded together. The excess power cable between the EUT and the LISN was bundled.

All connecting cables of EUT and peripherals were manipulated to find the maximum emission.

All relevant operation modes have been tested, and the worst case data is included in this report.

3.2 EUT Exercising Software

The EUT exercise program (if any) used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use.

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3.3 Details of EUT and Description of Accessories

Details of EUT:

Not Applicable

Description of Accessories:

There are no special accessories necessary for compliance of this product.

3.4 Measurement Uncertainty

When determining of the test conclusion, the Measurement Uncertainty of test has been considered.

Uncertainty and Compliance - Unless the standard specifically states that measured values are to be extended by the measurement uncertainty in determining compliance, all compliance determinations are based on the actual measured value.

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EXHIBIT 4
TEST RESULTS

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4.0 Test Results

4.1 Maximum Conducted Output Power at Antenna Terminals
The antenna port of the EUT was connected to the input of a spectrum analyzer.

☒ External attenuation and cable loss were compensated for using the OFFSET function of the analyser. The measurement procedure 9.1.1 was used.

☐ The EUT should be configured to transmit continuously (at a minimum duty cycle of 98%) at full power over the measurement duration. The measurement procedure AVG1 was used.

IEEE 802.15.4, Antenna Gain = 0 dBi		
Frequency (MHz)	Output in dBm	Output in mWatt
Low Channel:	2.70	1.86
Middle Channel:	2.05	1.60
High Channel:	1.41	1.38

Cable loss : 0.5 dB External Attenuation : 0 dB

Cable loss, external attenuation: ☒ included in OFFSET function
☐ added to SA raw reading

Base Unit
dBm max. output level = 2.7 dBm

Limits:
☒ 1W (30dBm) for antennas with gains of 6dBi or less

☐ ___W (___dBm) for antennas with gains more than 6dBi

The plots of conducted output power are saved as below.

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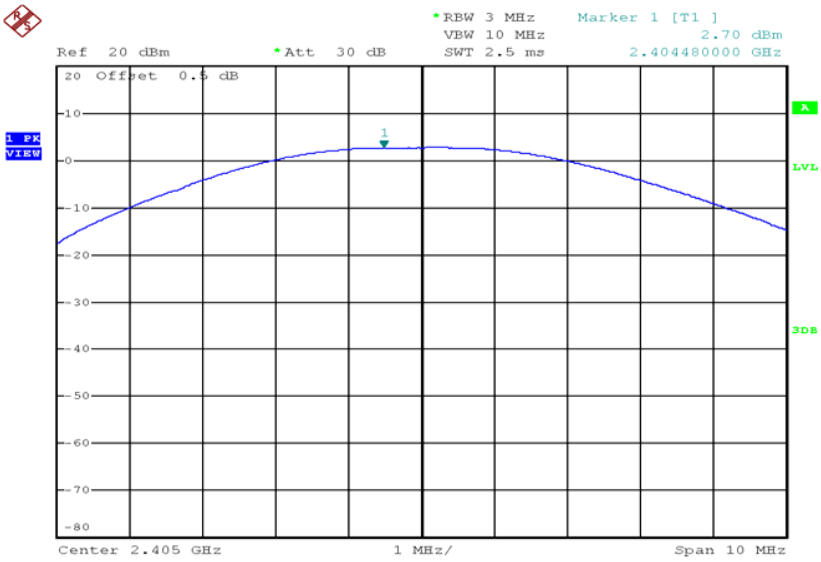
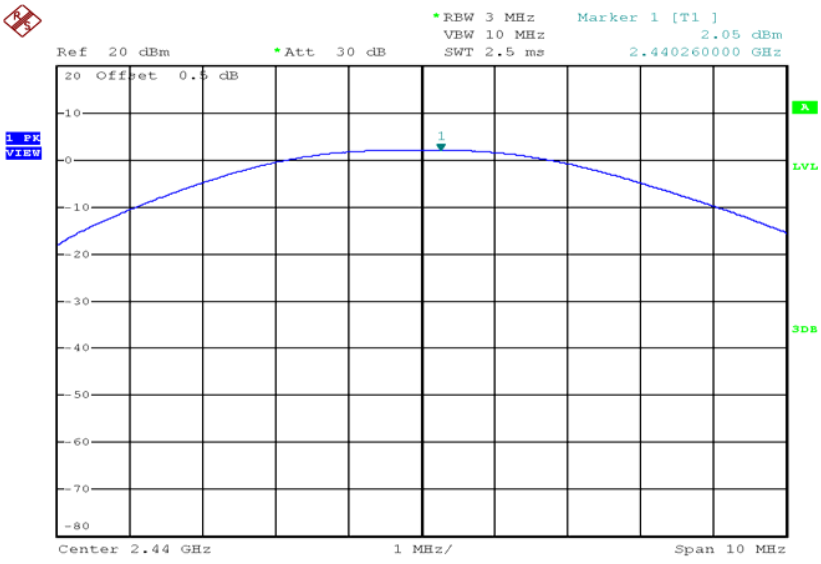
Plots of maximum output power

Lowest channel



Middle channel



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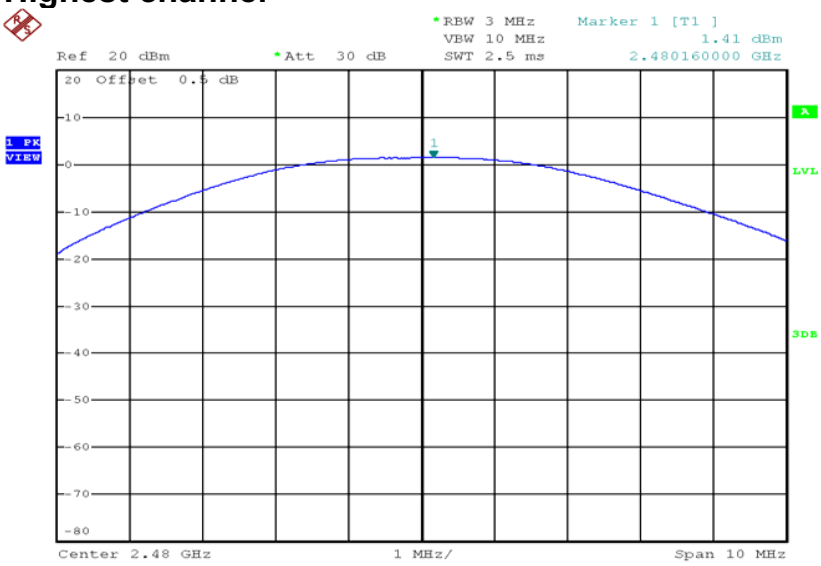
Plots of maximum output power

Highest channel



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4.2 Minimum 6dB RF Bandwidth

The antenna port of the EUT was connected to the input of a spectrum analyzer. The EBW measurement procedure was used. A PEAK output reading was taken, a DISPLAY line was drawn 6dB lower than PEAK level. The 6dB bandwidth was determined from where the channel output spectrum intersected the display line.

IEEE 802.15.4	
Frequency (MHz)	6dB Bandwidth (kHz)
Low Channel: 2405	1620
Middle Channel: 2440	1630
High Channel: 2480	1620

Limits
6 dB bandwidth shall be at least 500kHz

The plots of 6dB RF bandwidth and occupied bandwidth are saved as below.

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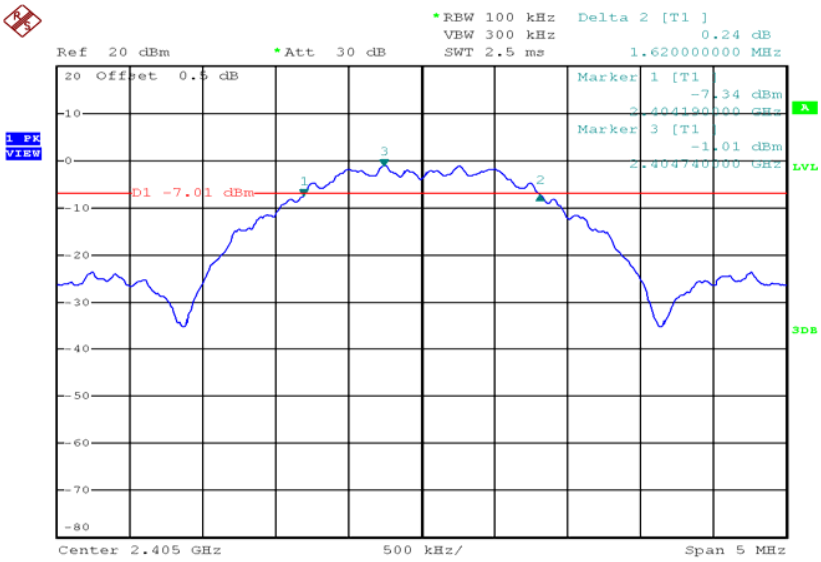
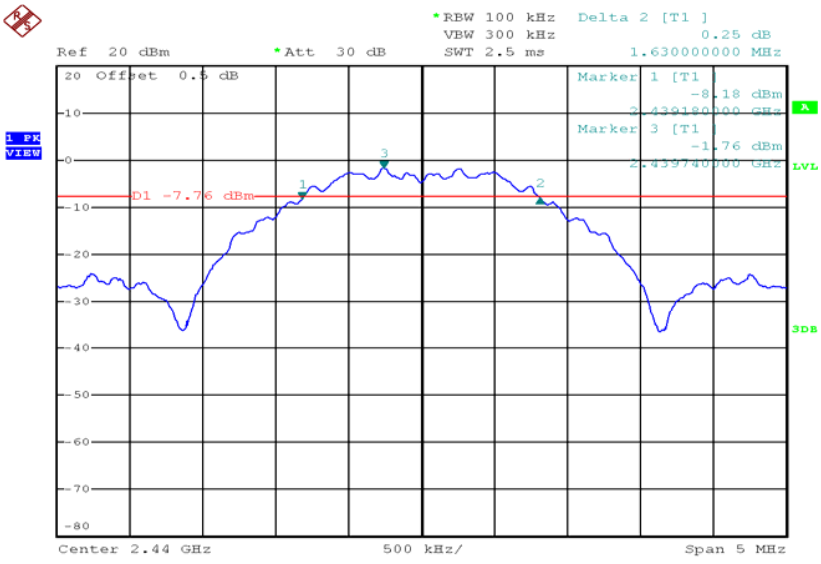
Plots of 6dB RF bandwidth

Lowest Channel



Middle Channel



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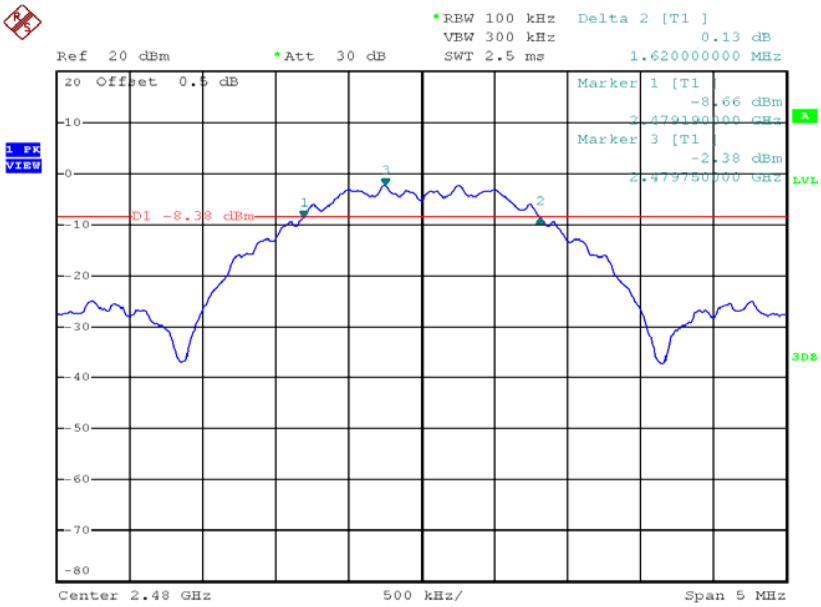
Plots of 6dB RF bandwidth

Highest Channel



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4.3 Maximum Power Spectral Density

Antenna output of the EUT was coupled directly to spectrum analyzer. The measurement procedure PKPSD was used. If an external attenuator and/or cable was used, these losses are compensated for using the OFFSET function of the analyser.

IEEE 802.15.4	
Frequency (MHz)	PSD in 100kHz (dBm)
Low Channel:	-1.07
Middle Channel:	-1.72
High Channel:	-2.36

Cable Loss: 0.5 dB

Limit:
8dBm

The plots of power spectral density are as below.

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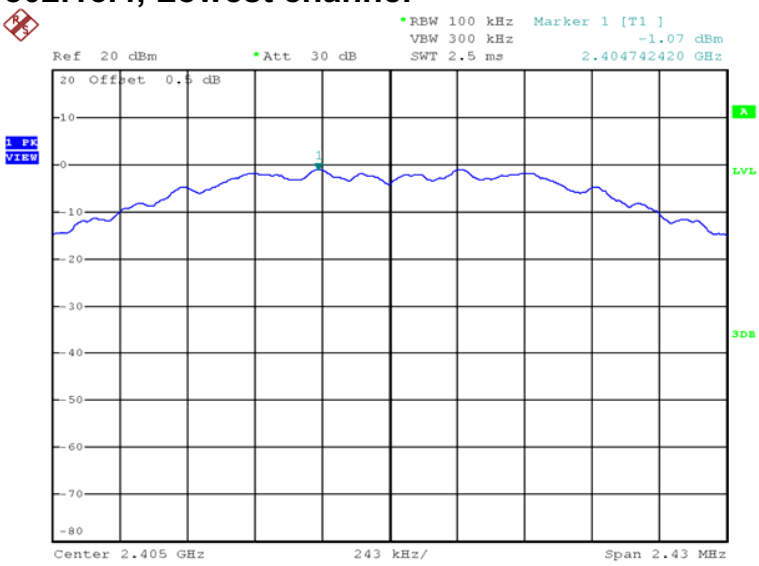
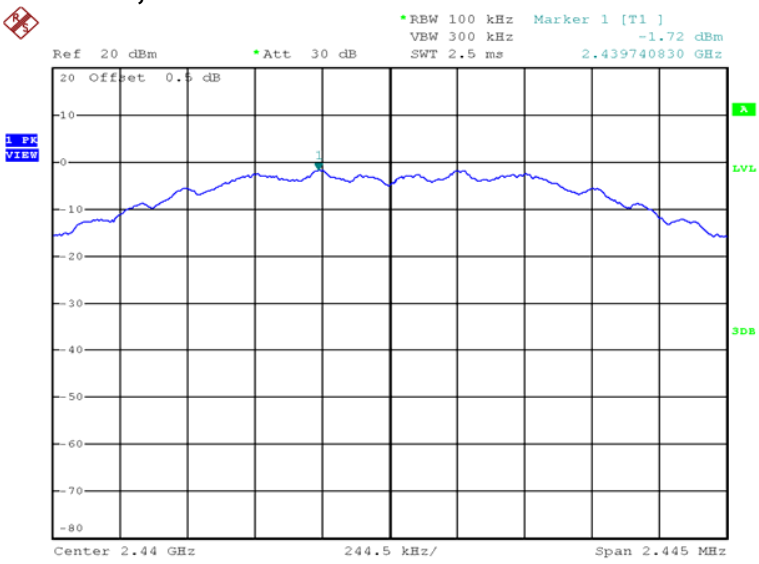
Plots of power spectral density

802.15.4, Lowest channel



802.15.4, Middle channel



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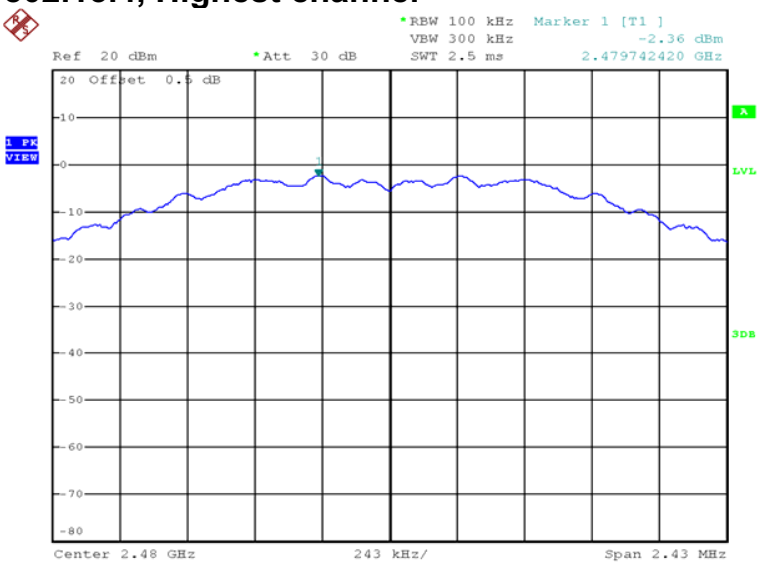
Plots of power spectral density

802.15.4, Highest channel



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4.4 Out of Band Conducted Emissions

RBW was set to 1MHz rather than 100KHz in order to increase the measurement speed.

The display line (in red) shown in the following plots denotes the limit at 20dB below maximum measured in-band peak PSD level in 100KHz bandwidth. The traces in the following plots are measured with 1MHz RBW but not 100KHz in measurement range from 10MHz to 2GHz and 2.8GHz to 25GHz.

The measurement procedures under sections 11 of KDB558074 were used.

Limits:
All spurious emission and up to the tenth harmonic was measured and they were found to be at least 20 dB below the maximum measured in-band peak PSD level.

The plots of out of band conducted emissions and bandedge are as below.

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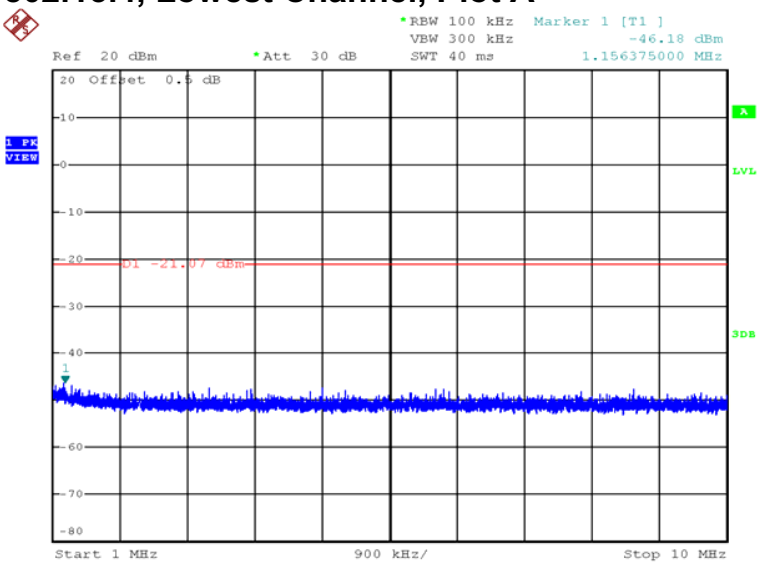
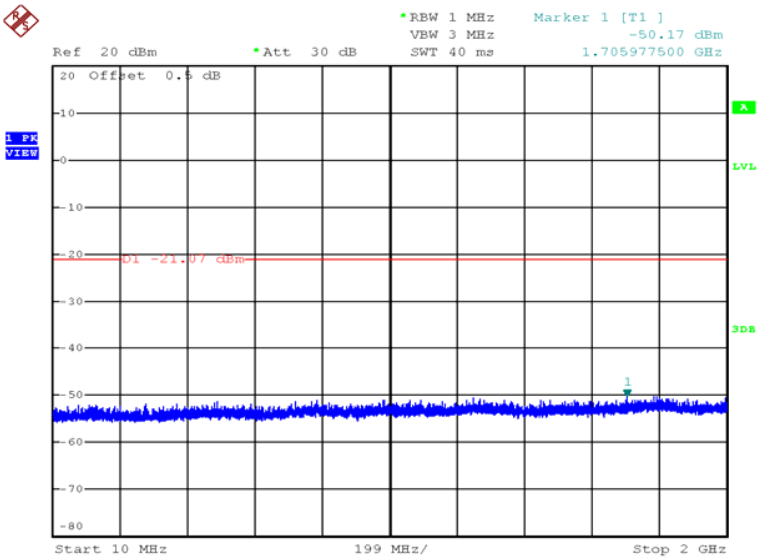
Plots of out of band conducted emissions

802.15.4, Lowest Channel, Plot A



802.15.4, Lowest Channel, Plot B



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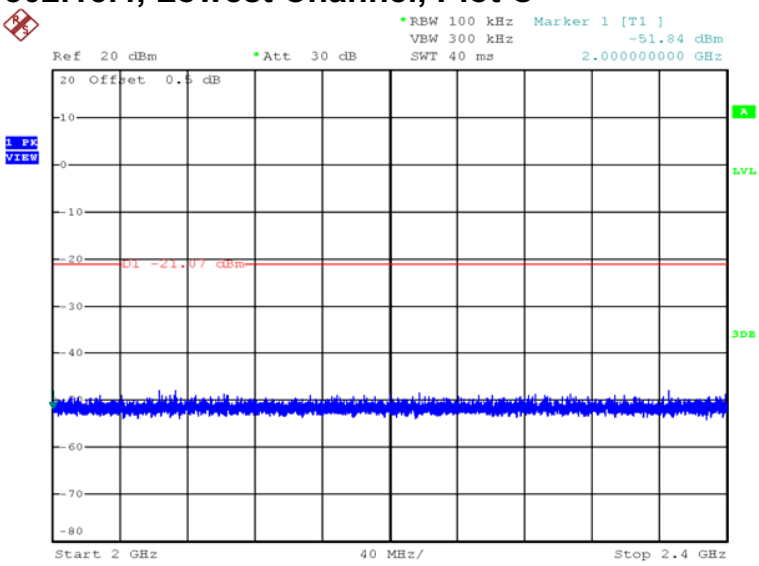
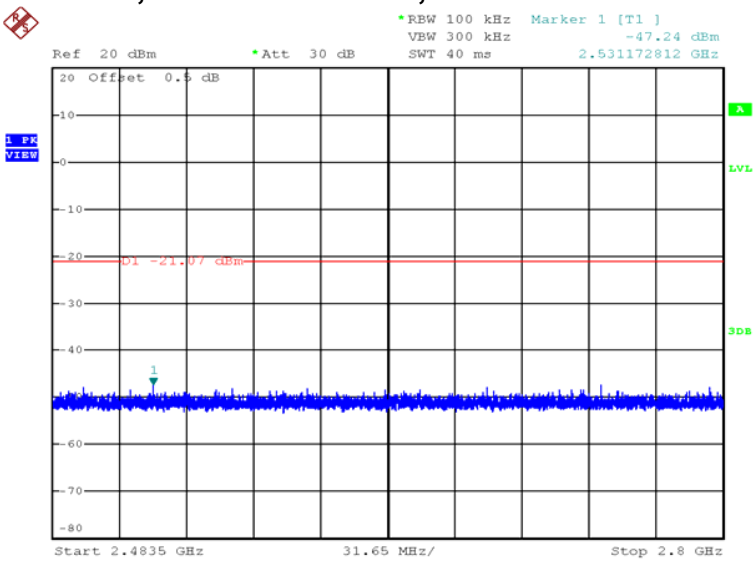
Plots of out of band conducted emissions

802.15.4, Lowest Channel, Plot C



802.15.4, Lowest Channel, Plot D



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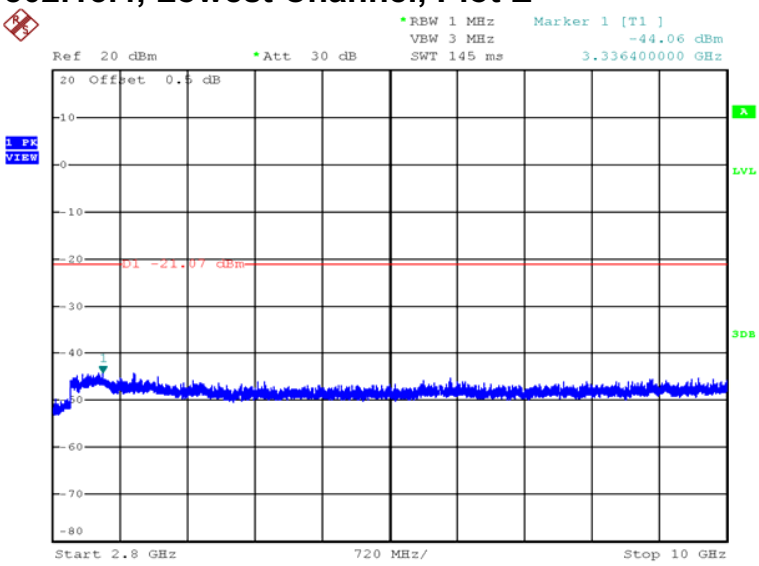
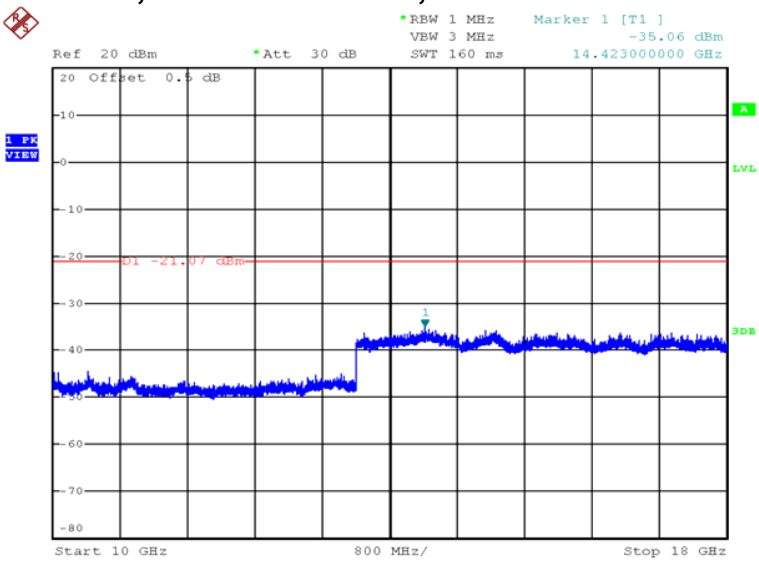
Plots of out of band conducted emissions

802.15.4, Lowest Channel, Plot E



802.15.4, Lowest Channel, Plot F



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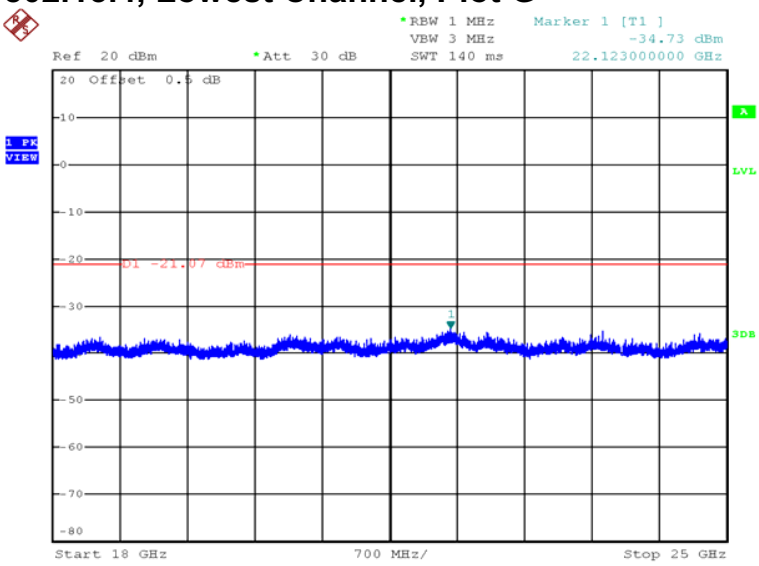
Plots of out of band conducted emissions

802.15.4, Lowest Channel, Plot G



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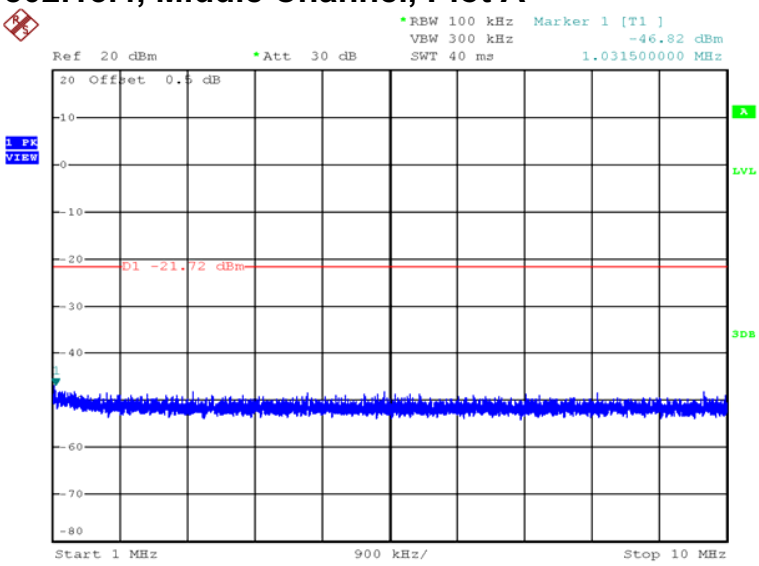
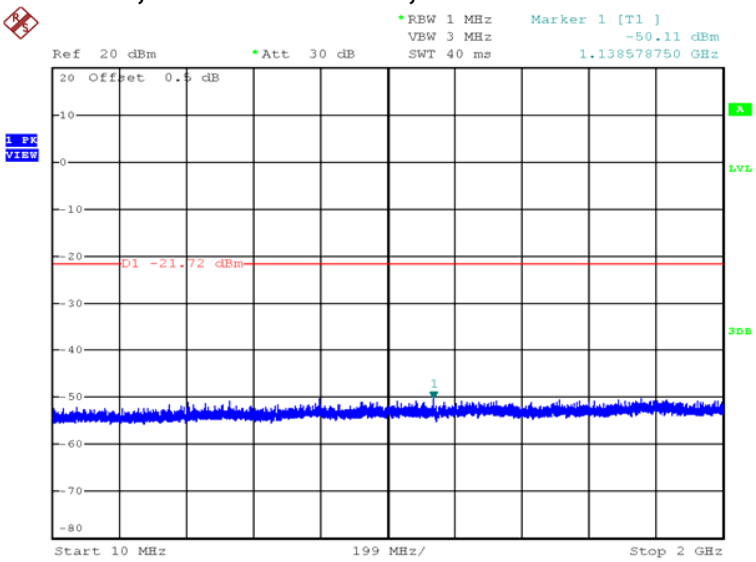
Plots of out of band conducted emissions

802.15.4, Middle Channel, Plot A



802.15.4, Middle Channel, Plot B



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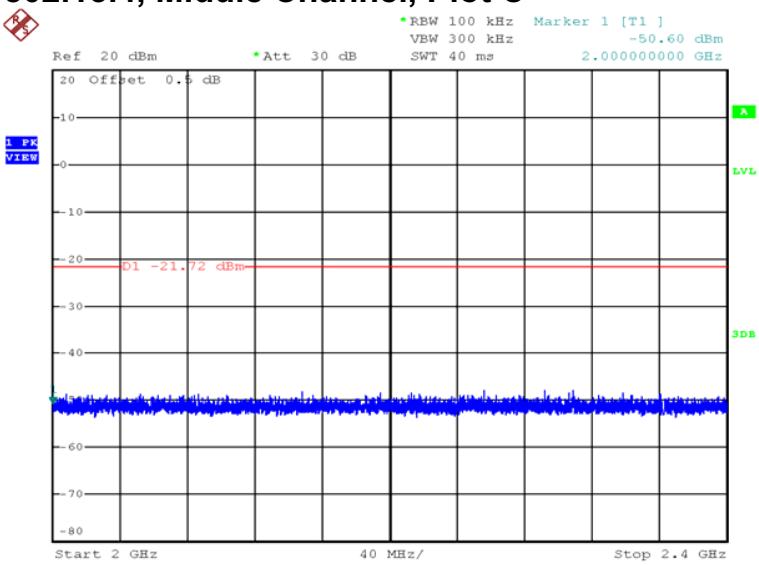
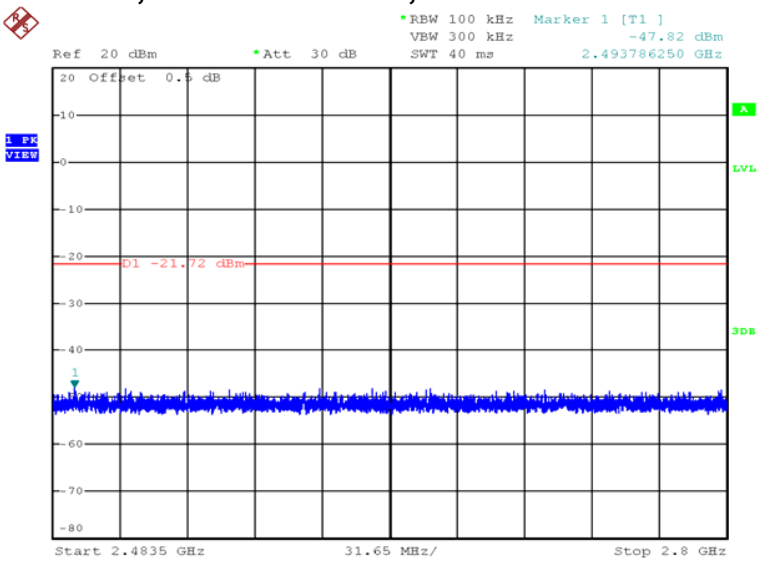
Plots of out of band conducted emissions

802.15.4, Middle Channel, Plot C



802.15.4, Middle Channel, Plot D



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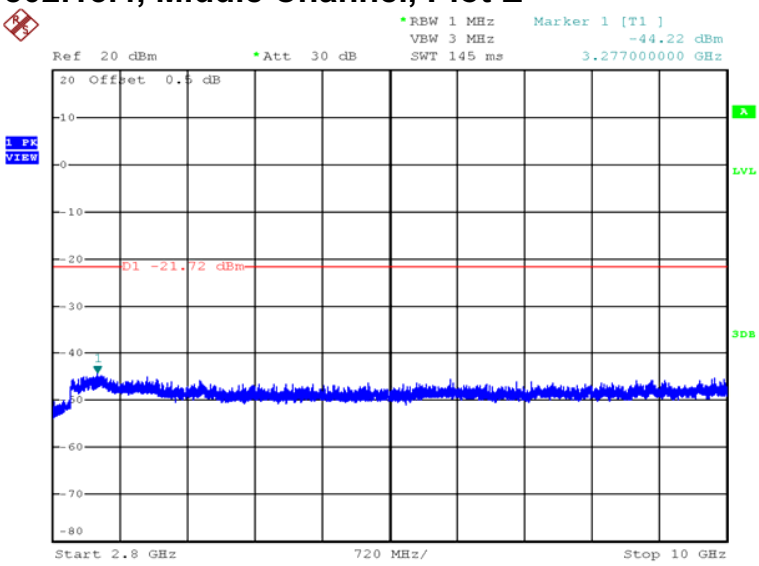
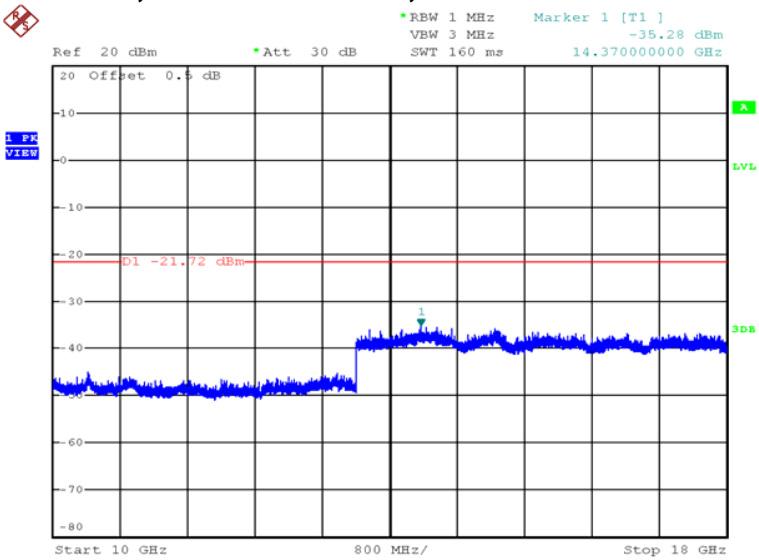
Plots of out of band conducted emissions

802.15.4, Middle Channel, Plot E



802.15.4, Middle Channel, Plot F



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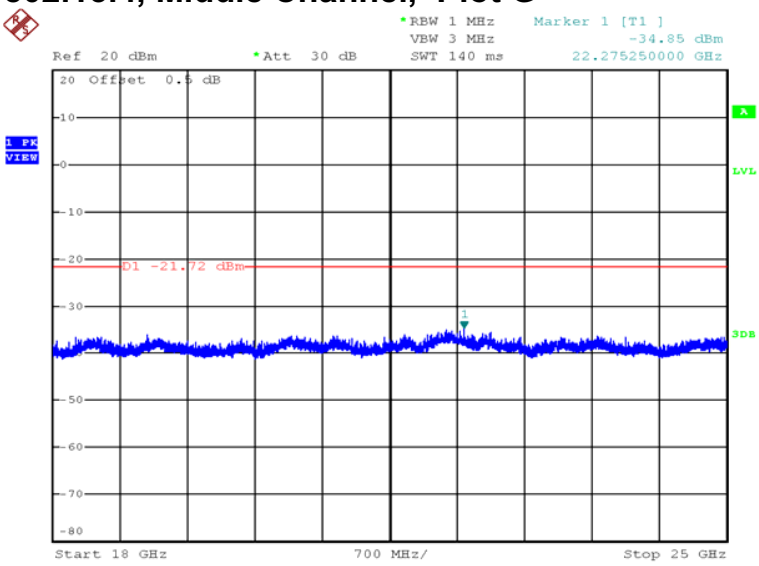
Plots of out of band conducted emissions

802.15.4, Middle Channel, Plot G



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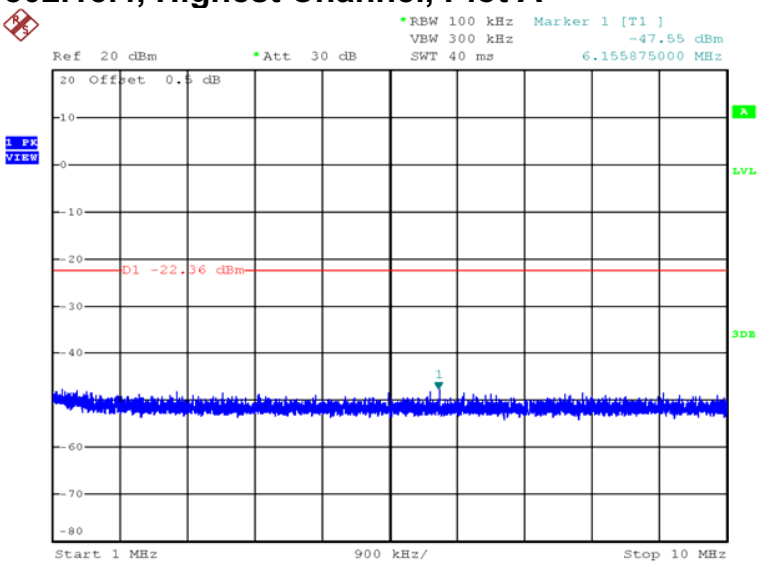
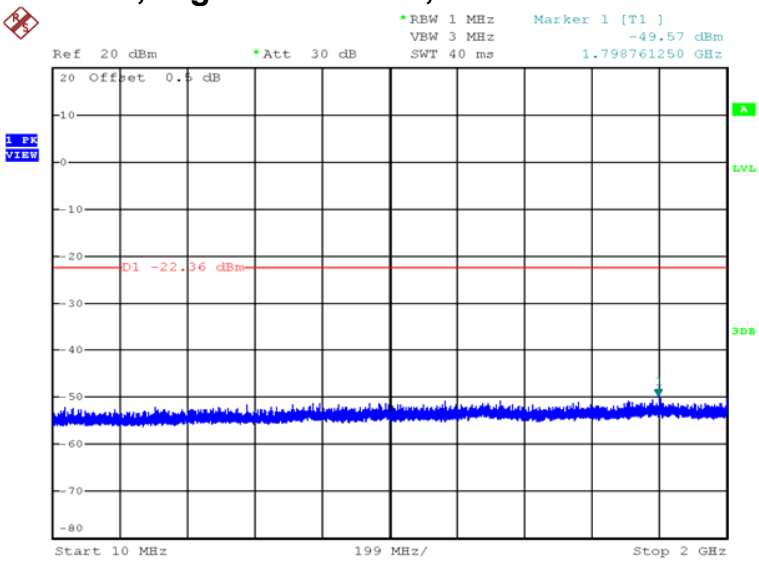
Plots of out of band conducted emissions

802.15.4, Highest Channel, Plot A



802.15.4, Highest Channel, Plot B



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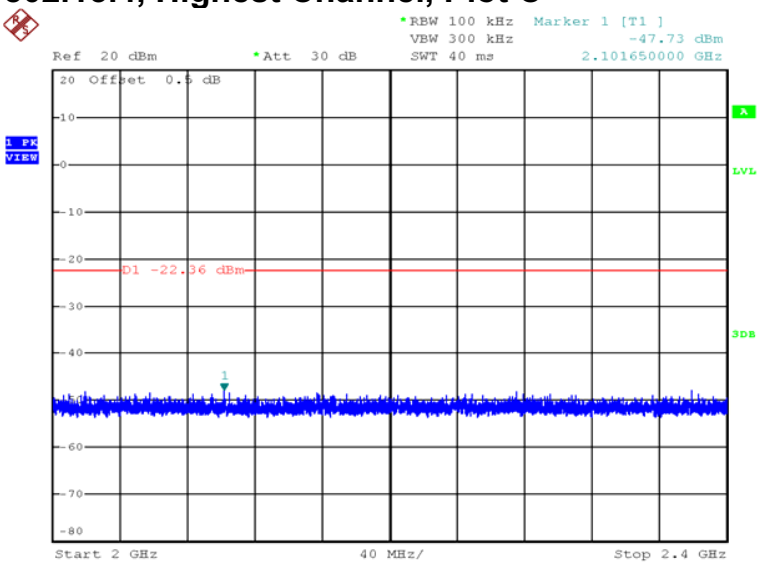
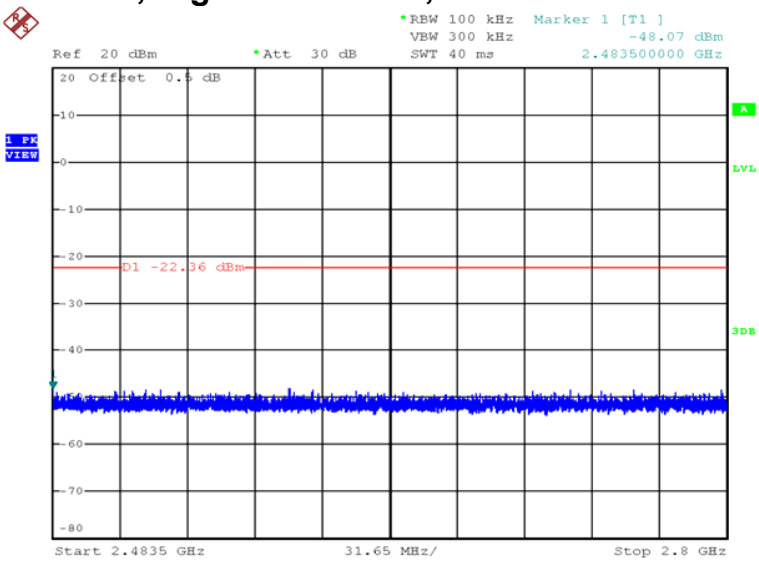
Plots of out of band conducted emissions

802.15.4, Highest Channel, Plot C



802.15.4, Highest Channel, Plot D



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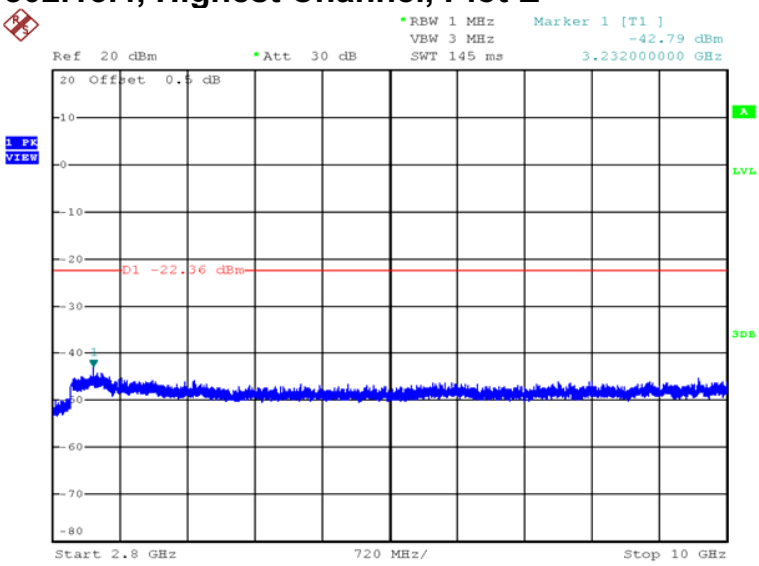
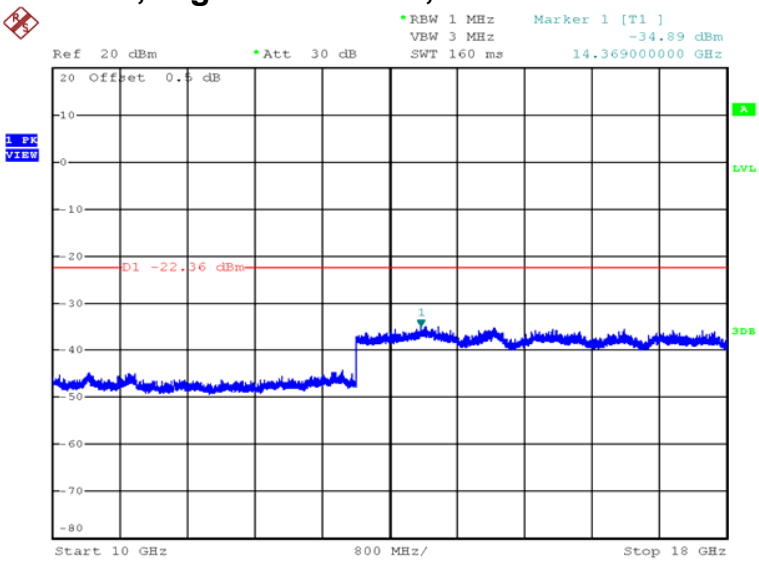
Plots of out of band conducted emissions

802.15.4, Highest Channel, Plot E



802.15.4, Highest Channel, Plot F



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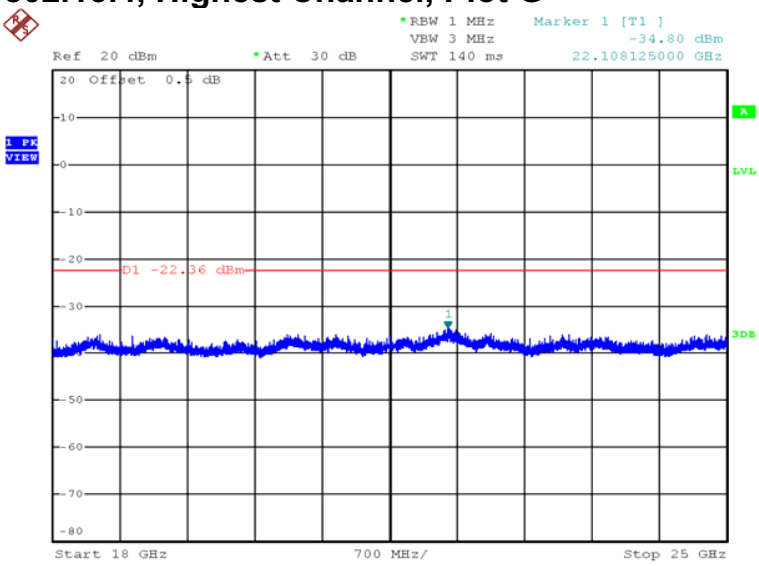
Plots of out of band conducted emissions

802.15.4, Highest Channel, Plot G



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4.5 Field Strength Calculation

The field strength is calculated by adding the reading on the Spectrum Analyzer to the factors associated with preamplifiers (if any), antennas, cables, pulse desensitization and average factors (when specified limit is in average and measurements are made with peak detectors). A sample calculation is included below.

FS = RA + AF + CF - AG + PD + AV

Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB
PD = Pulse Desensitization in dB
AV = Average Factor in -dB

In the radiated emission table which follows, the reading shown on the data table may reflect the preamplifier gain. An example of the calculations, where the reading does not reflect the preamplifier gain, follows:

FS = RA + AF + CF - AG + PD + AV

Example
Assume a receiver reading of 62.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29.0 dB is subtracted. The pulse desensitization factor of the spectrum analyzer is 0.0 dB, and the resultant average factor is -10.0 dB. The net field strength for comparison to the appropriate emission limit is 32.0 dBμV/m. This value in dBμV/m is converted to its corresponding level in μV/m.

RA = 62.0 dBμV
AF = 7.4 dB
CF = 1.6 dB
AG = 29.0 dB
PD = 0.0 dB
AV = -10 dB

FS = 62.0 + 7.4 + 1.6 – 29.0 + 0.0 + (-10.0) = 32.0 dBμV/m

Level in μV/m = Common Antilogarithm [(32.0 dBμV/m)/20] = 39.8 μV/m

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4.6 Transmitter Radiated Emissions in Restricted Bands and Spurious Emissions

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included.

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

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4.6.1 Radiated Emission Configuration Photograph

Worst Case Restricted Band Radiated Emission
at

4810 MHz

The worst case radiated emission configuration photographs are saved with filename: config photos.pdf

4.6.2 Radiated Emission Data

The data in tables 1-4 list the significant emission frequencies, the limit and the margin of compliance.

Judgement -

Passed by 1.5 dB margin compare with average limit

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Mode: TX Lowest Channel

Table 1

Radiated Emission Data

Polari-zation	Frequency	Reading (dBuV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - average (dBuV/m)	Average Limit at 3m (dBuV/m)	Margin (dB)
H	***2390.000***	***54.8***	***33***	***29.4***	***51.2***	***54.0***	***-2.8***
V	***4810.000***	***50.6***	***33***	***34.9***	***52.5***	***54.0***	***-1.5***
H	***12025.000***	***39.7***	***33***	***40.5***	***47.2***	***54.0***	***-6.8***

Remark: Average measurement method is used according to ANSI C63.10.

Polari-zation	Frequency	Reading (dBuV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBuV/m)	Peak Limit at 3m (dBuV/m)	Margin (dB)
H	***2390.000***	***63.8***	***33***	***29.4***	***60.2***	***74.0***	***-13.8***
V	***4810.000***	***59.6***	***33***	***34.9***	***61.5***	***74.0***	***-12.5***
H	***12025.000***	***46.8***	***33***	***40.5***	***54.3***	***74.0***	***-19.7***

Remark: Peak detector is used for the emission measurement.

NOTES:
1. Peak detector is used for the emission measurement.
2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna is used for the emission over 1000MHz.
5. Emission (the row indicated by ***bold italic***) within the restricted band meets the requirement of FCC Part 15 Section 15.205 / RSS-210 Section 2.2.

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Mode: TX Middle Channel

Table 2

Radiated Emission Data

Polari-zation	Frequency	Reading (dBuV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - average (dBuV/m)	Average Limit at 3m (dBuV/m)	Margin (dB)
V	***4880.000***	***49.9***	***33***	***34.9***	***51.8***	***54.0***	***-2.2***
H	***7320.000***	***40.0***	***33***	***37.9***	***44.9***	***54.0***	***-9.1***
H	***12200.000***	***39.8***	***33***	***40.5***	***47.3***	***54.0***	***-6.7***

Remark: Average measurement method is used according to ANSI C63.10.

Polari-zation	Frequency	Reading (dBuV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBuV/m)	Peak Limit at 3m (dBuV/m)	Margin (dB)
V	***4880.000***	***57.4***	***33***	***34.9***	***59.3***	***74.0***	***-14.7***
H	***7320.000***	***49.4***	***33***	***37.9***	***54.3***	***74.0***	***-19.7***
H	***12200.000***	***46.3***	***33***	***40.5***	***53.8***	***74.0***	***-20.2***

Remark: Peak detector is used for the emission measurement.

NOTES:
1. Peak detector is used for the emission measurement.
2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna is used for the emission over 1000MHz.
5. Emission (the row indicated by ***bold italic***) within the restricted band meets the requirement of FCC Part 15 Section 15.205 / RSS-210 Section 2.2.

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Mode: TX Highest Channel

Table 3

Radiated Emission Data

Polari-zation	Frequency	Reading (dBuV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - average (dBuV/m)	Average Limit at 3m (dBuV/m)	Margin (dB)
H	***2483.500***	***54.2***	***33***	***29.4***	***50.6***	***54.0***	***-3.4***
V	***4960.000***	***49.7***	***33***	***34.9***	***51.6***	***54.0***	***-2.4***
H	***7440.000***	***38.9***	***33***	***37.9***	***43.8***	***54.0***	***-10.2***
H	***12400.000***	***39.5***	***33***	***40.5***	***47.0***	***54.0***	***-7.0***

Remark: Average measurement method is used according to ANSI C63.10.

Polari-zation	Frequency	Reading (dBuV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBuV/m)	Peak Limit at 3m (dBuV/m)	Margin (dB)
H	***2483.500***	***62.7***	***33***	***29.4***	***59.1***	***74.0***	***-14.9***
V	***4960.000***	***57.6***	***33***	***34.9***	***59.5***	***74.0***	***-14.5***
H	***7440.000***	***46.6***	***33***	***37.9***	***51.5***	***74.0***	***-22.5***
H	***12400.000***	***45.9***	***33***	***40.5***	***53.4***	***74.0***	***-20.6***

Remark: Peak detector is used for the emission measurement.

NOTES:
1. Peak detector is used for the emission measurement.
2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna is used for the emission over 1000MHz.
5. Emission (the row indicated by ***bold italic***) within the restricted band meets the requirement of FCC Part 15 Section 15.205 / RSS-210 Section 2.2.

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Mode: Transmission mode

Table 4

Radiated Emission Data

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-amp (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Limit at 3m (dBµV/m)	Margin (dB)
V	***38.098***	***40.6***	***16***	***10.0***	***34.6***	***40.0***	***-5.4***
H	***168.500***	***32.9***	***16***	***18.0***	***34.9***	***43.5***	***-8.6***

NOTES: 1. Peak detector is used for the emission measurement.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Emission (the row indicated by ***bold italic***) within the restricted band meets the requirement of FCC Part 15 Section 15.205 / RSS-210 Section 2.2.

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4.6.3 Transmitter Duty Cycle Calculation

Not applicable – No average factor is required.

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4.7 AC Power Line Conducted Emission

☐ Not applicable – EUT is only powered by battery for operation.

☒ EUT connects to AC power line. Emission Data is listed in following pages.

☐ Base Unit connects to AC power line and has transmission. Handset connects to AC power line but has no transmission. Emission Data of Base Unit is listed in following pages.

4.7.1 AC Power Line Conducted Emission Configuration Photograph

Worst Case Line-Conducted Configuration

The worst case line conducted configuration photographs are attached in the Appendix and saved with filename: config photos.pdf

4.7.2 AC Power Line Conducted Emission Data

The plot(s) and data in the following pages list the significant emission frequencies, the limit and the margin of compliance

Passed by more than 20 dB margin

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Worst Case: On mode

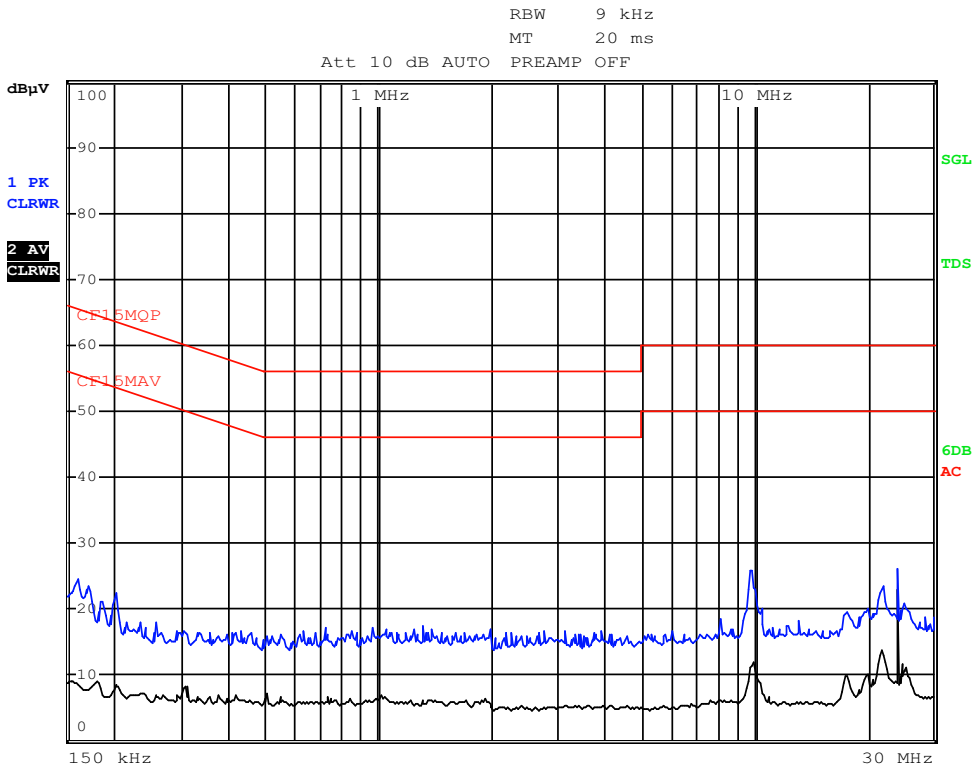

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EXHIBIT 5
EQUIPMENT LIST

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5.0 **Equipment List**

1) Radiated Emissions Test

Equipment	Log Periodic Antenna	EMI Test Receiver	Digital Multimeter
Registration No.	EW-0446	EW-2500	EW-1237
Manufacturer	EMCO	R&S	FLUKE
Model No.	3146	ESCI	179
Calibration Date	Apr. 30, 2013	Mar. 22, 2013	Sep. 02, 2013
Calibration Due Date	Oct. 30, 2014	Feb. 28, 2014	Oct. 01, 2014

Equipment	Biconical Antenna	Double Ridged Guide Antenna (1GHz - 18GHz)	Spectrum Analyzer
Registration No.	EW-0954	EW-1133	EW-2253
Manufacturer	EMCO	EMCO	R&S
Model No.	3104C	3115	FSP40
Calibration Date	Apr. 30, 2013	Oct. 05, 2012	Apr. 24, 2013
Calibration Due Date	Oct. 30, 2014	Apr. 05, 2014	Apr. 24, 2014

Equipment	Broad-Band Horn Antenna with frequency range 14G -40GHz
Registration No.	EW-1679
Manufacturer	SCHWARZBECK
Model No.	BBHA9170
Calibration Date	Apr. 1, 2013
Calibration Due Date	Apr. 1, 2014

2) Conducted Emissions Test

Equipment	EMI Test Receiver	Artificial Mains	Pulse Limiter
Registration No.	EW-2500	EW-0192	EW-0700
Manufacturer	R&S	R&S	R&S
Model No.	ESCI	ESH3-Z5	ESH3-Z2
Calibration Date	Mar. 22, 2013	May 15, 2013	Jan. 15, 2014
Calibration Due Date	Feb. 28, 2014	Apr. 15, 2014	Jul. 15, 2015

3) Conductive Measurement Test

Equipment	Spectrum Analyzer
Registration No.	EW-2253
Manufacturer	R&S
Model No.	FSP40
Calibration Date	Apr. 24, 2013
Calibration Due Date	Apr. 24, 2014

END OF TEST REPORT

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