

Report on the Intermodulation Testing

For

Central Connected Home Limited

on

Hive Hub 360

Report no. TRA-034282-02-47-02C

8th December 2017

RF915 4.0

Report Number: TRA-034282-02-47-02C
Issue: C

REPORT ON THE INTERMODULATION TESTING OF A
Central Connected Home Limited
Hive Hub 360
WITH RESPECT TO SPECIFICATION
47CFR PARTS 15, 22, 24
INTERMODULATION EMISSIONS INVESTIGATION

TEST DATE: 25th September-27th September 2017

Written by:

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Radio Test Engineer

Approved by:

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Manager Department-Radio

Date: 8th December 2017

Disclaimers:

- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

RF915 4.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	8th December 2017	Original

2 Summary

TEST REPORT NUMBER:	TRA-034282-02-47-02C
WORKS ORDER NUMBER	TRA-034282-02
PURPOSE OF TEST:	USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J. Canada: Testing of radio apparatus for TAC (technical acceptance certificate) per subsections 4(2) of the Radiocommunication Act and 21(1) of the Radiocommunication Regulations.
TEST SPECIFICATION(S):	Intermodulation emissions investigation using 47CFR Parts 15, 22, 24
EQUIPMENT UNDER TEST (EUT):	Hive Hub 360
FCC IDENTIFIER:	WJHHB450
ISED IDENTIFIER:	21719-HUB450
EUT SERIAL NUMBER:	UFD-637
MANUFACTURER/AGENT:	Central Connected Home Limited
ADDRESS:	Millstream Madenhead Road Windsor, Berkshire SL4 SCO United Kingdom
CLIENT CONTACT:	Darrell Harris ☎ 01223 222150 ✉ darrell.harris@hivehome.com
ORDER NUMBER:	6500467481
TEST DATE:	25th September-27th September 2017
TESTED BY:	Daniel Moncayola S Hodgkinson S Garwell Jack Whitehead Element

2.1 Test Summary

<i>Test Method and Description</i>	<i>Requirement Clause</i>		<i>Applicable to this equipment</i>	<i>Result / Note</i>
	<i>RSS</i>	<i>47CFR</i>		
Intermodulation spurious emissions	Gen, 8.10	Parts 15, 22, 24	<input checked="" type="checkbox"/>	Pass

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

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4 Introduction

This report TRA-034282-02-47-02C presents the results of the Radio testing on a Central Connected Home Limited, Hive Hub 360 .

The testing was carried out for Central Connected Home Limited by Element, at the address detailed below.

<input type="checkbox"/>	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	<input checked="" type="checkbox"/>	Element Skelmersdale Unit 1 Pendle Place Skelmersdale West Lancashire WN8 9PN UK
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This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

IC Registration Number(s):

Element Hull	3483A
Element North West	3930B

The test site requirements of ANSI C63.4-2014 are met up to 1GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

6 Equipment Under Test

6.1 EUT Identification

- Name: Hive Hub 360
- Serial Number: UFD-637
- Model Number: Hub 450
- Software Revision: Not Applicable
- Build Level / Revision Number: Not Applicable

6.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Test laptop (Dell Latitude E6440)
USB Programming cable

6.3 EUT Mode of Operation

6.3.1 Transmission

The mode of operation for transmit tests was as follows:

Radios were set to transmit permanently in various combinations, the spectrum was checked to determine if any intermodulation products were generated due to multiple radios operating simultaneously. The worst case emission plots are shown in this document other combinations different produce not higher intermodulation products shown in this report.

6.4 EUT Description

The EUT is a smart home device with Wi-Fi, Zigbee, Bluetooth, and Z wave connection capabilities. The unit also has a function to detect specific sounds in the environment.

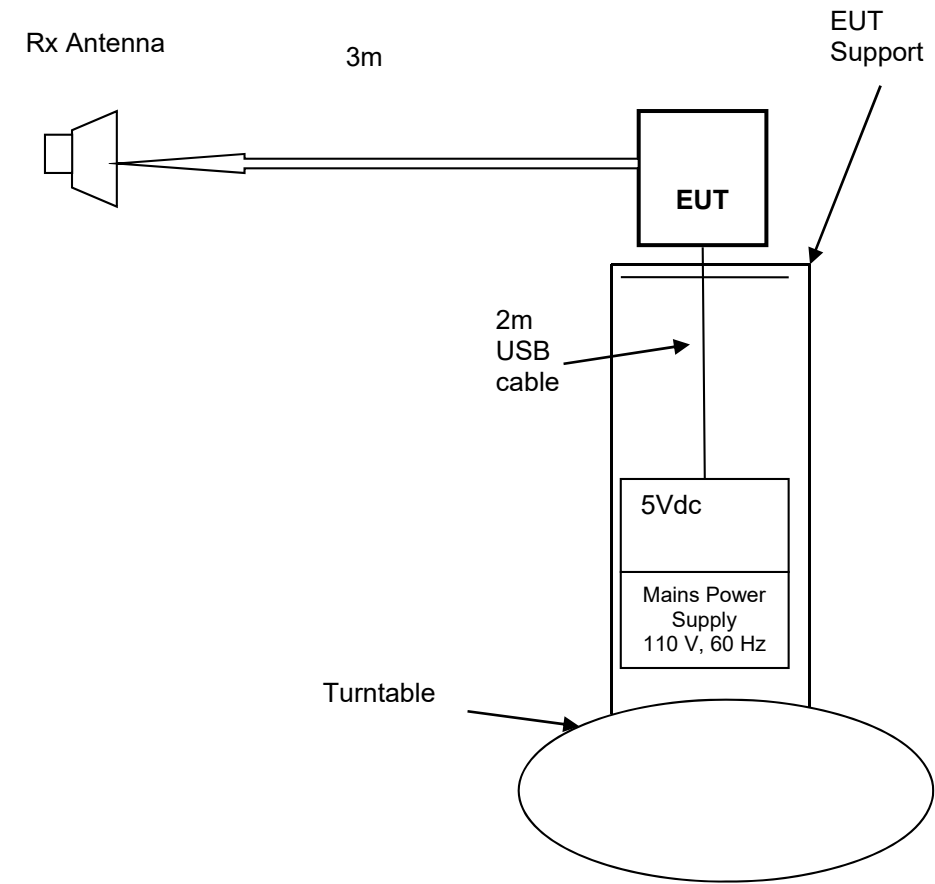
7 Modifications

No modifications were performed during this assessment.

8 EUT Test Setup

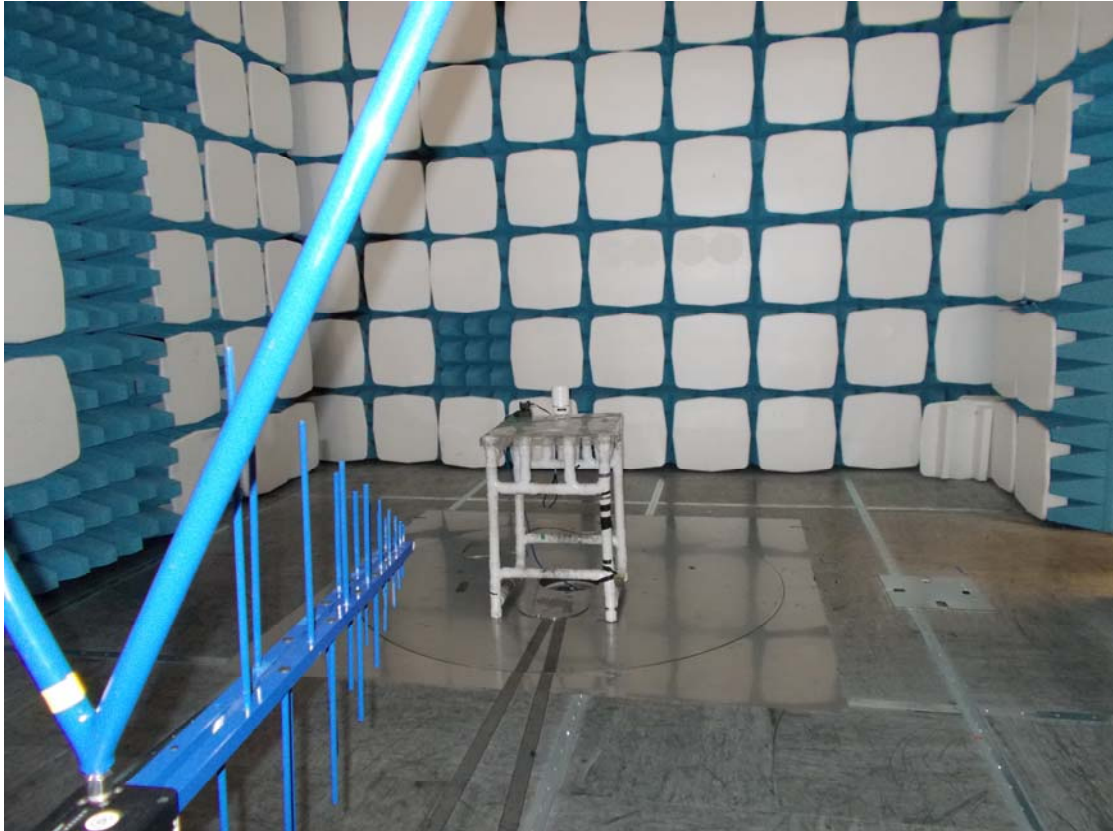
8.1 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



8.2 General Setup Photograph

The following photograph shows basic EUT setup:



9 General Technical Parameters

9.1 *Normal Conditions*

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 110 V ac from the mains

10 Radiated emissions, intermodulation products

10.1 Definitions

Spurious emissions

Emissions on a frequency or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands

A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

Intermodulation products

Emissions of two or more electromagnetic waves transmitted simultaneously through a nonlinear electronic system.

10.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	5 MHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac ± 10 % (as declared)

10.3 Test Limit

Unwanted emissions that fall within the restricted frequency bands shall comply with the limits specified:

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

Frequency (MHz)	Field Strength ($\mu\text{V/m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

10.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360 degrees in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dBμV/m at the regulatory distance, using:

$$FS = PR + CL + AF - PA + DC - CF$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dBμV;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

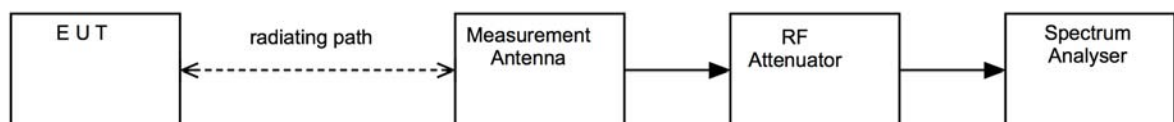
PA is the pre-amplifier gain in dB (where used);

DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

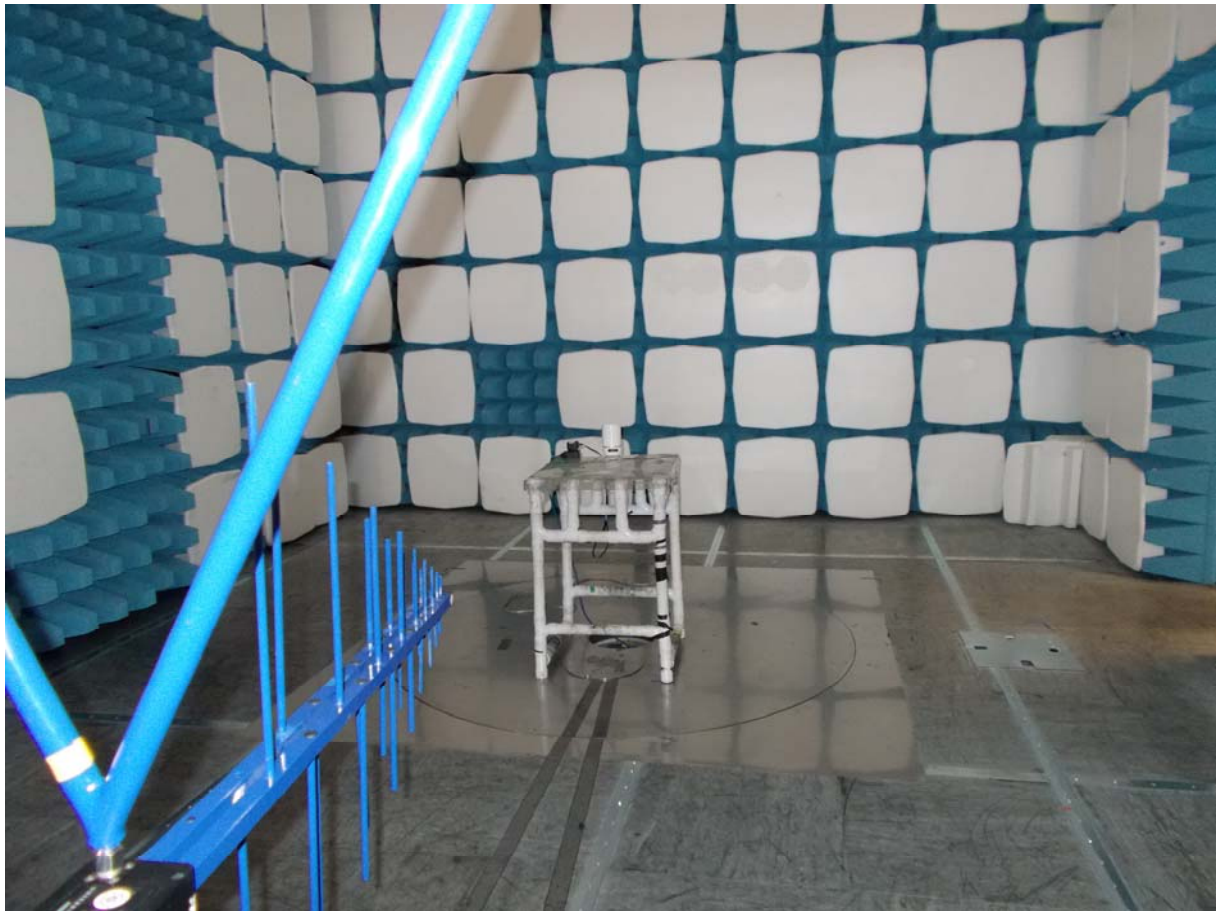
CF is the distance factor in dB (where measurement distance different to limit distance);

This field strength value is then compared with the regulatory limit.

Figure i Test Setup



10.5 Test Set-up Photograph

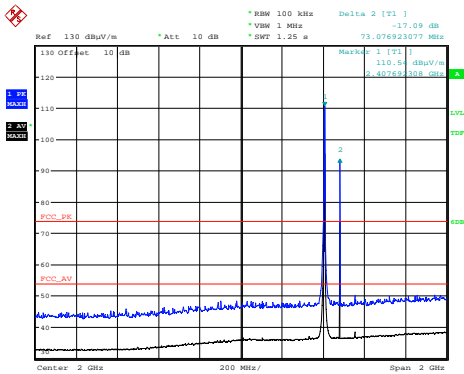
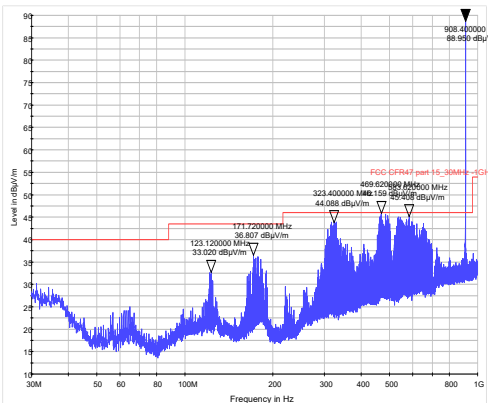


10.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESVS10	R&S	Receiver	L317	22/03/2018
FSU46	R&S	Spectrum Analyser	U281	19/06/2018
CBL611/A	Chase	Bilog	U191	23/02/2019
3115	EMCO	1-18GHz Horn	L138	13/04/2018
8449B	Agilent	Pre Amp	L572	07/02/2018
20240-20	Flann	Horn 18-26GHz (&U330)	L300	07/04/2018

10.7 Test Results

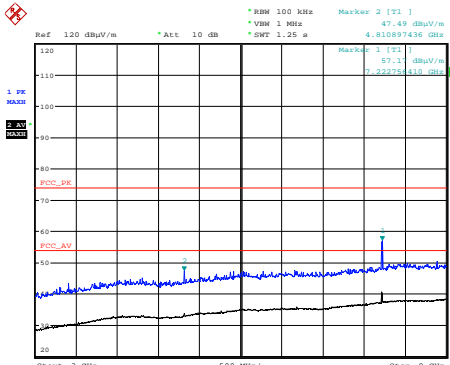
Zig-BEE Bottom – Bluetooth Top – Z-wave



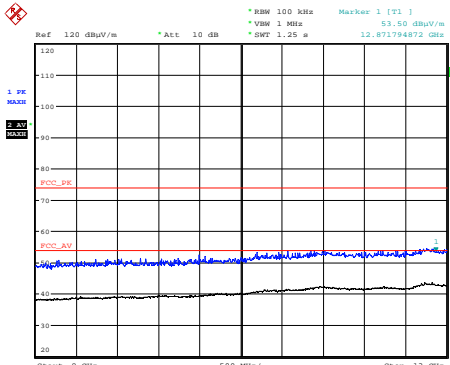
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30 MHz to 1 GHz

1 GHz to 3 GHz



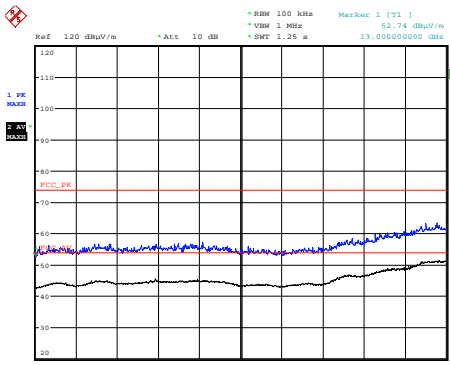
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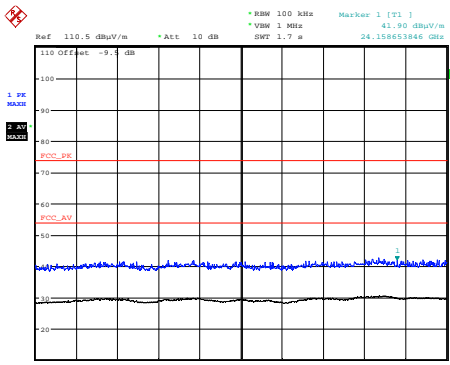
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3 GHz to 8 GHz

8 GHz to 13 GHz



Date: 19.SEP.2017 12:50:25

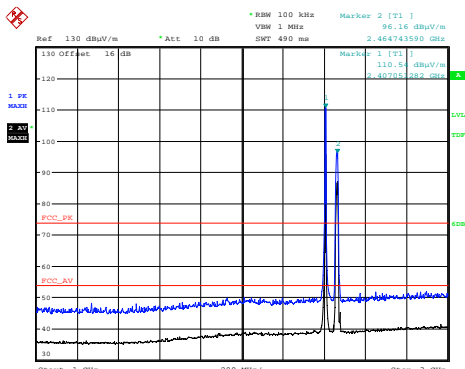
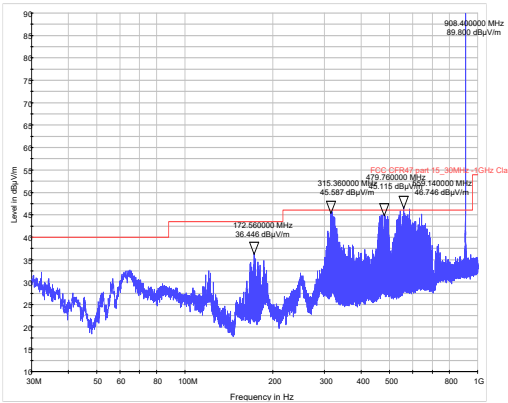


Date: 19.SEP.2017 17:36:48

13 GHz to 18 GHz

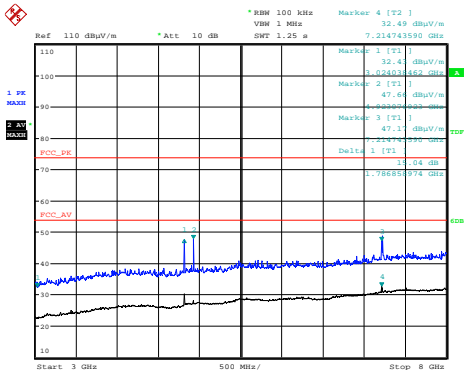
18 GHz to 25 GHz

Zig-BEE Bottom – WIFI Top – Z-wave



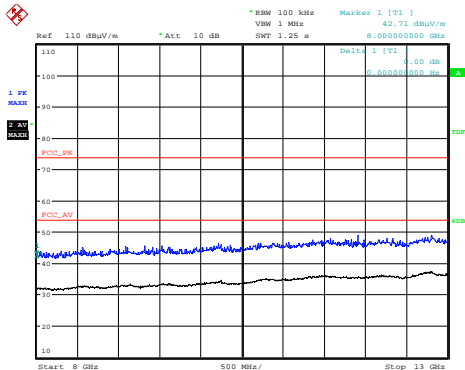
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30 MHz to 1 GHz



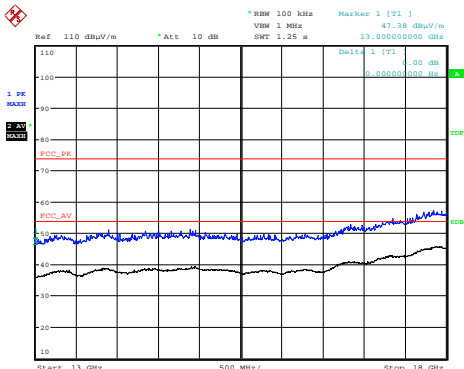
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1 GHz to 3 GHz



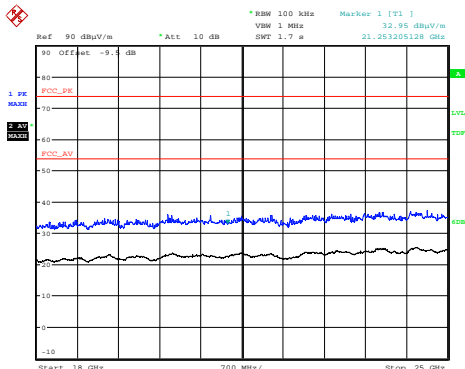
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3 GHz to 8 GHz



Date: 18.SEP.2017 17:11:27

8 GHz to 13 GHz

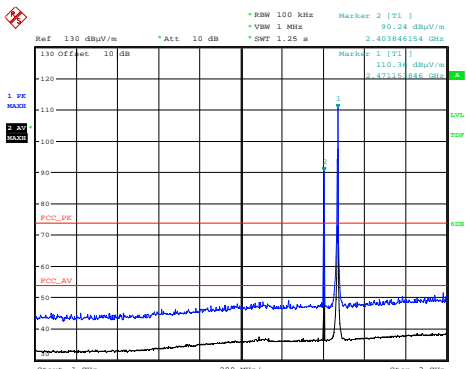
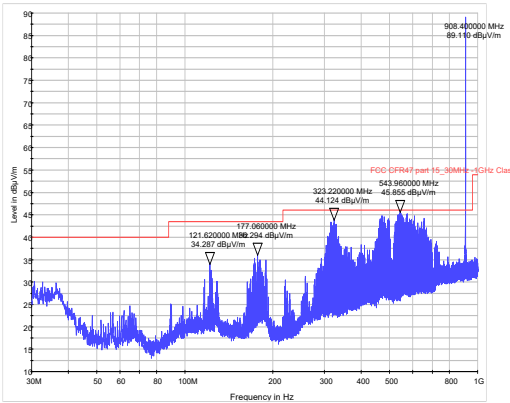


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13 GHz to 18 GHz

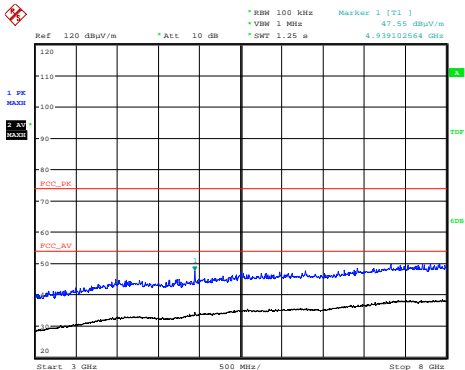
18 GHz to 25 GHz

Zig-BEE Top – Bluetooth Bottom – Z-wave



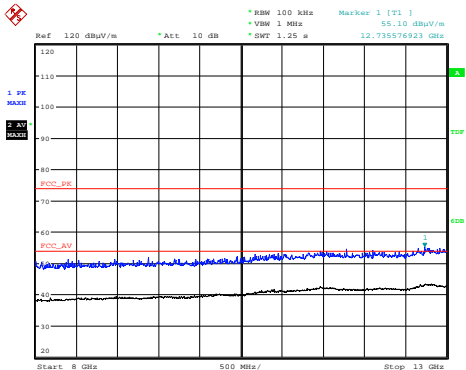
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30 MHz to 1 GHz



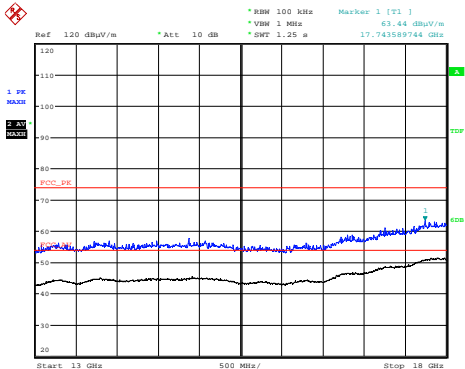
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1 GHz to 3 GHz



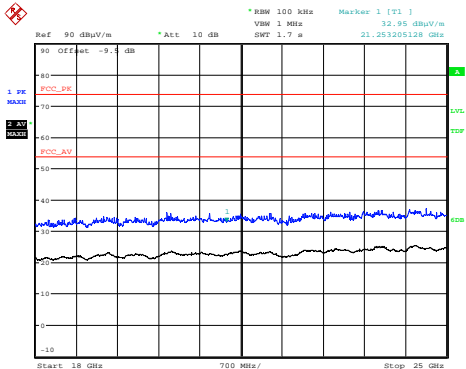
Date: 19_SEP.2017 13:57:42

3 GHz to 8 GHz



Date: 19_SEP.2017 14:02:57

8 GHz to 13 GHz

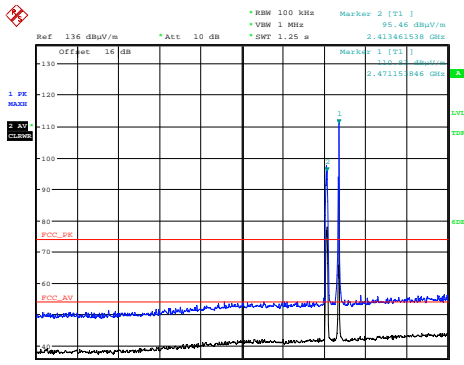
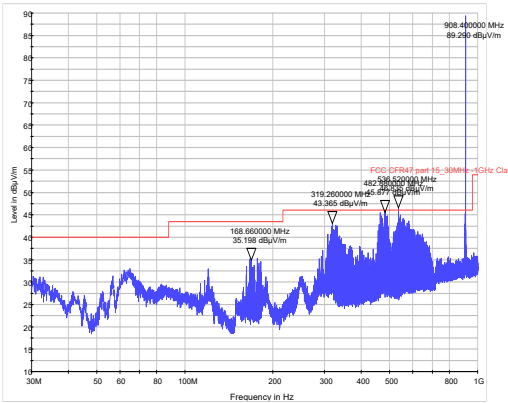


Date: 18_SEP.2017 17:38:14

13 GHz to 18 GHz

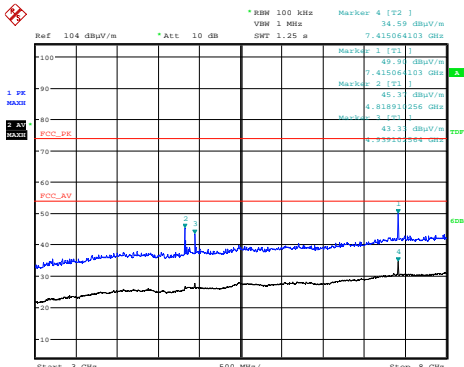
18 GHz to 25 GHz

Zig-BEE Top – WIFI Bottom – Z-wave



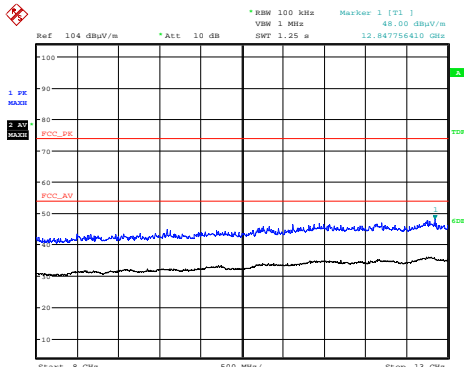
Date: 19.SEP.2017 13:04:19

30 MHz to 1 GHz



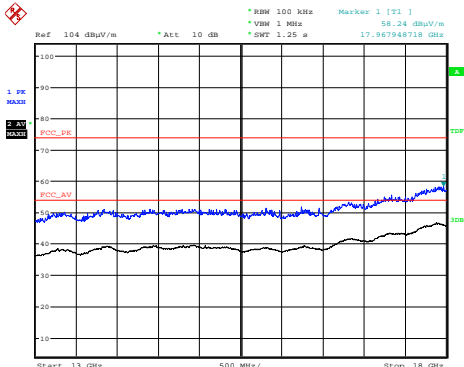
Date: 18.SEP.2017 16:06:06

1 GHz to 3 GHz



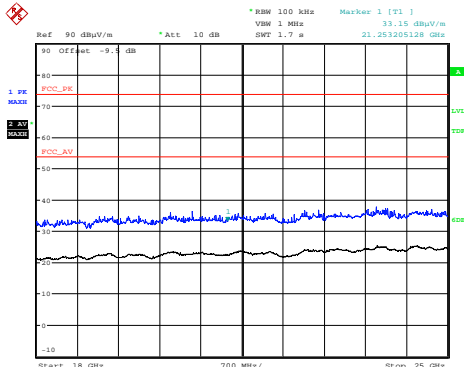
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3 GHz to 8 GHz



Date: 19.SEP.2017 10:28:35

8 GHz to 13 GHz



Date: 18.SEP.2017 17:46:50

13 GHz to 18 GHz

18 GHz to 25 GHz

All emissions on graphs are related to either the Bluetooth classic, WIFI or Z-wave operation and are not intermodulation products.

11 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence:

[1] Radiated spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**

Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**