

COMPLIANCE TESTING REPORT FCC TITLE 47 PART 15

Client: Minelab Electronics Pty Ltd
Address: 2 Second Avenue, Mawson lakes
Adelaide, SA 5095, Australia
Report Number: 0805COD_Vanquish_FCC15Cc
Date of Testing: 12th June to 2nd August 2019
File Number: COD190401-A

Equipment Name: Vanquish Series Metal Detector
Equipment Model Number: Vanquish 540
Equipment FCC ID: Z4C-0041
Equipment Description: Metal Detector

Result: **COMPLIED**

Tested by: Steven Garnham
Test Engineer



Approved by: Rob Weir
Assessment Engineer



Date of Issue: 14th November 2019

Results appearing herein relate only to the sample(s) tested.
This report is issued errors and omissions exempt and is subject to withdrawal at Austest Laboratories discretion.

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1 REPORT REVISION HISTORY

Date	Report Number	Changes
5 Aug. 19	0805COD_Vanquish_FCC15C	Original report.
23 Oct. 19	0805COD_Vanquish_FCC15Ca	Amendments to address TCB 12 Sep. 2019 email, point 5 (a)-(m) comments.
4 Nov. 19	0805COD_Vanquish_FCC15Cb	Amendments to address TCB 16 Oct. 2019 email.
14 Nov. 19	0805COD_Vanquish_FCC15Cc	Amendments to address TCB 12 Nov. 2019 email.

2 TEST SUMMARY

Austest makes no claim regarding the consistency of production versions of the EUT. The results in this report apply only to the tested EUT described in Section 4 of this report.

FCC Section	Test	Result	Notes
FCC Part 15, Subpart C – Intentional Radiators			
15.203	Antenna Requirement	Complied	-
15.205	Restricted Bands of Operation	Complied	-
15.207	Conducted Limits	N.A.	(i)
15.209	Radiated Emission Limits, General Requirements	Complied	-
15.247	Operation within the Bands 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz	Complied	-
15.247(a)(1)	Channel Separation	Complied	-
15.247(a)(1)(iii)	Number of Hopping Channels	Complied	-
15.247(a)(1)(iii)	Time of Occupancy	Complied	-
15.247(b)(1)	Peak Conducted Output Power	Complied	-
15.247(d)	Out of band emissions	Complied	-
15.247(i)	Maximum Permissible Exposure (MPE)	Complied	-
2.1049	99% Bandwidth	Complied	-

Notes:

- (i) Not applicable as the EUT was only powered by internal batteries.

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3 MODIFICATIONS

No modifications were required to achieve compliance.

4 REFERENCES

FCC Title 47 Part 15 current as of June 2019
ANSI C63.10: 2013
KDB Publication 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019

5 EQUIPMENT UNDER TEST (EUT) DESCRIPTION

EUT Name:	Vanquish Series Metal Detector
EUT Description:	Portable Metal Detector
EUT Model:	Vanquish 540
EUT Serial Number:	Not Supplied
EUT FCC ID:	Z4C-0041
Power Supply & Rating:	Internal battery: 4 x AA NiMh rechargeable, no charging port.
Highest Clock/Operating Frequency:	Highest internal clock frequency: 180MHz; Also with intentional wireless highest possible operating frequency ~2483.5MHz (BT)
Lowest Internal Frequency source	4kHz
Transmit Frequency Range:	2402MHz to 2480MHz
Transmit Power:	+8.1dBm
Modulation Technique:	BT: GFSK
Number of Channels:	79 Channels
Wireless Module	CSR8670C – Bluetooth v4+EDR (Qualcomm APTX LL)
Antenna Specifications:	PCB Track Inverted F Antenna, 3.3 dBi gain

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6 EUT TEST SETUP AND CONFIGURATION

Refer to the photographs in APPENDIX D – EUT TEST SETUP PHOTOGRAPHS for the EUT test setup and physical configuration.

The following cables and auxiliary equipment as supplied by the client were used:

Connection / Port	Connecting Cable	Source / Load
Headphones	Attached to Headphones	Supplied headphones

For measurements made at the output of the transmitter (under FCC Title 47 section 15.247), the client supplied a modified sample fitted with an SMA RF connector and a ribbon cable from the internal BT module to the interface board.

Control software was BlueTest3 installed on the client’s supplied laptop.

To enable control of the BT transmission, the EUT was connected to the following items:

- a. A supplied test HP laptop PC with HP power adaptor.
- b. Interface board, DEV-PC-1.
- c. Ethernet to USB adaptor, CSR USB-SP1, 1324 Converter.
- d. Using instructions provided by the client for the BlueTest3 software, constant BT transmission on selected low, middle and high channels was made. Output power was set to 0dBm as per manufacturer’s instructions. Frequency hopping mode with modulation could also be selected.

The EUT was operated within its allowed temperature and humidity range.

There were no facilities for charging the four AA batteries while installed in the EUT. For charging purposes, the batteries were removed and fitted into the supplied charger adaptor which would be powered from any USB adaptor.

The test PC (via AC adaptor) was connected to the 115VAC 60Hz mains supply, provided by the AC source.

There was no mains connection to the EUT.

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6.1 EUT Operating Modes

Mode No.	Operating Mode Description
1	Constant BT transmission with modulation; o/p power setting 0dBm, on Ch0 (2402MHz).
2	Constant BT transmission with modulation, o/p power setting 0dBm on Ch39 (2441MHz).
3	Constant BT transmission with modulation; o/p power setting 0dBm on Ch78 (2480MHz).
4	Constant Frequency Hopping with modulation

Both BDR and EDR modulation types investigated, worst case modes for each test determined and reported.

7 TEST SPECIFICATIONS

7.1 Test Facility

Testing was performed at Austest Laboratories, 46 Glenola Farm Lane, Yarramalong, NSW 2259, Australia.

Radiated emission testing below 1GHz and was performed at an Open Area Test Site (OATS) at Yarramalong, where some ambient signals may exceed the limit. The possibility of missing an emission during testing is removed by performing pre-scans in a shielded enclosure prior to the final OATS measurements.

For testing below 30MHz, measurements were performed over the normal OATS ground plane and also over a non-conductive ground plane as per ANSI C63.10, clause 5.2.

7.2 Accreditations & Listings

Austest Laboratories (NSW)'s Yarramalong and Castle Hill test facilities are accredited with the FCC under the ACMA-FCC APEC-TEL MRA. Designation Number AU0003 / Registration number 520620

Austest Laboratories (NSW)'s Castle Hill and Yarramalong test facilities are accredited by A2LA. The tests reported herein have been performed in accordance with its terms of accreditation.

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7.3 Deviations from Standards and/or Accreditations

None.

7.4 Measurement Uncertainties

The following uncertainties are for a 95% level of confidence, based on a coverage factor, k=2.

Test	Measurement Uncertainty
RF Frequency	± 5 part in 10^{10}
RF power conducted	± 1.3 dB
RF power radiated <1GHz	± 4.5 dB
RF power radiated >1GHz	± 4.9 dB

7.5 Test Equipment

ID	Brand/Model	Description	Last calibrated	Calibration due
72	HP8574B	Spectrum Analyser / EMI Rx	28/07/2017	28/07/2019
83	OATS 1	3m/10m Open Area Test Site	27/07/2017	27/07/2019
297	EM6912	Bicon Antenna	18/08/2017	18/08/2019
298	EM 6950	Log Antenna	17/08/2017	17/08/2019
320	Chroma 6912	AC Source	Verified	
530	Com-Power SAS/571	DRG Horn	17/08/2017	17/08/2020
1241	Com-Power	PAM-118A	17/08/2018	17/08/2020
1385	FSP40	Spectrum Analyser 40GHz	16/08/2017	16/08/2019
-	Huber + Suhner	Coax Cables	30/11/2017	30/11/2019
-	HP85869C	Test Software	Verified	
-	RS Commander	Data capture software	Verified	

All test equipment was checked and performance verified prior to testing.

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8 FCC Part 15C, Section 15.203 – ANTENNA REQUIREMENT

The EUT complied with the requirement of this Section since the EUT antenna was integral and had no external antenna port.

9 FCC Part 15C, Section 15.205 – RESTRICTED BANDS OF OPERATION

The EUT complied with the requirements of this Section since it did not operate within the listed Restricted Bands of Operation. Out of band emissions falling within the Restricted Bands of Operation were found to be below limits specified in section 15.209.

10 FCC Part 15C, Section 15.207 - CONDUCTED LIMITS

Not applicable as the EUT was only powered from qty 4 AA batteries. The batteries had to be removed from the EUT for recharging.

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11 FCC Part 15C, Section 15.209 - RADIATED EMISSION LIMITS, GENERAL REQUIREMENTS

Test Dates:	12/06/2019 20/06/2019 27/06/2019	Temperature:	21°C 24°C 22 °C
Test Officer:	Steven Garnham	Humidity:	66% 33% 58%
Test Location:	Austest Laboratories (Yarramalong)		

11.1 EUT Operating Mode

- a. Battery voltage – 5.2VDC.
- b. Mode 1 – Constant BT transmission with modulation, ch0.
- c. Mode 2 – Constant BT transmission with modulation, ch39.
- d. Mode 3 – Constant BT transmission with modulation, ch78.
- e. Frequency Hopping with modulation.

Preliminary measurements were made to determine the orientation of the EUT that would generate the highest emission levels. Final measurement was made with the EUT positioned vertically using the supplied PVC pipe stand which simulated a normal user orientation.

11.2 Test Method

- a. Measurements were performed in accordance with ANSI C63.10-2013, KDB 558074 FHSS Meas Guidance.
- b. The measuring receiver BW settings were set to:
 - i. 9kHz (150kHz to 30MHz) EMI Receiver BW.
 - ii. 120kHz (30MHz to 1GHz) EMI Receiver BW.
 - iii. 1MHz (above 1GHz) RBW, 1MHz or more VBW, using a Spectrum Analyser for Peak measurements.
 - iv. 1MHz (above 1GHz) RBW, 1 kHz VBW with linear detection, using a Spectrum Analyser for Average measurements.
- c. The EUT was setup on a non-conductive turntable. For measurement below 1GHz, 0.8m above the OATS conductive ground plane and at the indicated test distance away from the measuring antenna.
- d. For measurements above 1GHz, 1.5m above the OATS conductive ground plane with RF absorber placed between the test table and measuring antenna.
- e. To maximise emissions, the EUT was rotated through 360° and the measuring antenna height adjusted between 1m to 4m in the following antenna orientations:
 - i. Loop antenna (9kHz to 30MHz) – Coaxial, coplanar orientations and also horizontal (parallel to ground) orientations investigated as the EUT antenna can have both vertical and horizontal positions.

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- ii. Biconical and Log-Periodic antennas (30MHz to 1GHz) - Both vertical and horizontal polarizations.
- iii. Horn antenna (above 1GHz) - Both vertical and horizontal polarizations.
- f. The maximised emission was measured and the above repeated for all measurement frequencies.
- g. Average level measurements were not made where the peak level did not exceed the average limit.
- h. Linearity of the measuring system was checked, reducing gain when required.
- i. Test distances: Where the actual test distance used was different to that specified, then the test data results shown in any tables were extrapolated to the required distance using the formula specified within ANSI C63.10:2013.

Video Bandwidth calculation:

Spurious emissions performed with highest duty cycle setting. In this mode T_{ON} was 2.8875ms giving a minimum VBW = 1/ T_{ON} = 346 Hz. Measurements made with VBW = 1 kHz.

11.3 Sample Calculation Example

The final radiated emission levels were obtained from the measurement equipment software which automatically applied all the stored calibration factors. The calibration / correction factors were applied as follows:

$$E = V + AF + L_{cbl} - G_{pre}$$

Where:

- E = Radiated Electric Field Strength in dBμV/m at the specified distance.
- V = EMI Receiver measured signal input voltage in dBμV.
- AF = Antenna Factor of the measuring antenna in dB/m.
- L_{cbl} = Total cable insertion loss in dB.
- G_{pre} = Preamplifier gain in dB.

Frequency (MHz)	Receiver Level, V (dBμV)	AF (dB/m)	Lcbl (dB)	Gpre (dB)	Corrected Level, E (dBμV/m)
100.0	40.0	12.0	2.9	22.5	32.4

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11.4 Test Results

The 6 highest EUT spurious emissions below 1GHz are tabulated below:

Frequency MHz	Channel	Antenna Pol.	QP Level @ 3m (dBµV/m)	QP Limit @ 3m (dBµV/m)	QP Pass Margin (dB)
295.1	All	Vertical	40.0	46.0	6.0
299.3	All	Vertical	38.8	46.0	7.2
303.7	All	Horizontal	38.6	46.0	7.4
291.9	All	Vertical	38.3	46.0	7.7
303.7	All	Vertical	37.5	46.0	8.5
299.3	All	Horizontal	37.4	46.0	8.6

The 6 highest EUT spurious emissions above 1GHz are tabulated below:

Frequency MHz	Channel Number	Antenna Pol.	Pk Level dBµV/m	Pk Limit dBµV/m	Below Limit dB	Avg Level dBµV/m	Avg Limit dBµV/m	Below Limit dB
4882	39	Horizontal	62.1	74.0	11.9	35.0	54.0	19.0
4804	0	Horizontal	60.9	74.0	13.1	33.0	54.0	21.0
4804	0	Vertical	59.5	74.0	14.5	37.0	54.0	17.0
4882	39	Vertical	58.1	74.0	15.9	38.0	54.0	16.0
4960	78	Horizontal	58.0	74.0	16.0	34.0	54.0	20.0
4960	78	Vertical	57.2	74.0	16.8	35.0	54.0	19.0

It should be noted that band edge measurements within the restricted bands (Section 11.4.1) were done with a 100kHz RBW instead of the expected 1MHz RBW in the absence of any significant EUT emissions. Since there are no significant EUT emissions using a 100kHz RBW, there will not be any significant EUT emissions using a 1MHz RBW either.

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11.4.1 Band edge measurements

Restricted band 2310 to 2390MHz, Radiated at 3m.

All measured disturbances were greater than 10dB below the 15.209 average limit, and greater than 20dB below the 15.209 peak limit.

Both hopping and not hopping modes assessed.

Not hopping mode using channel 0, constant transmission:



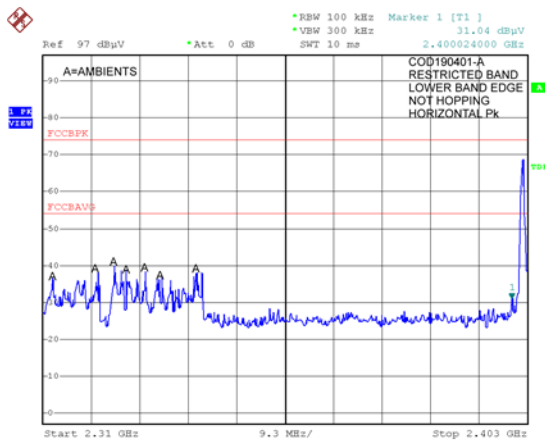
Date: 26.JUL.2019 13:14:55

Ch0 – Peak Vertical Polarisation



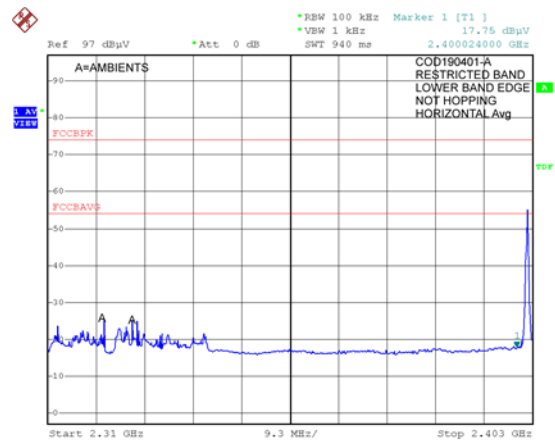
Date: 26.JUL.2019 13:08:40

Ch0 – Avg Vertical Polarisation



Date: 26.JUL.2019 13:12:34

Ch0 – Peak Horizontal Polarisation



Date: 26.JUL.2019 13:10:44

Ch0 – Avg Horizontal Polarisation

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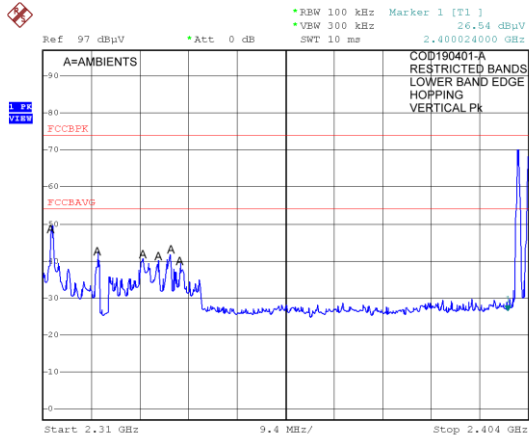
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Restricted band 2310 to 2390MHz, Radiated at 3m.

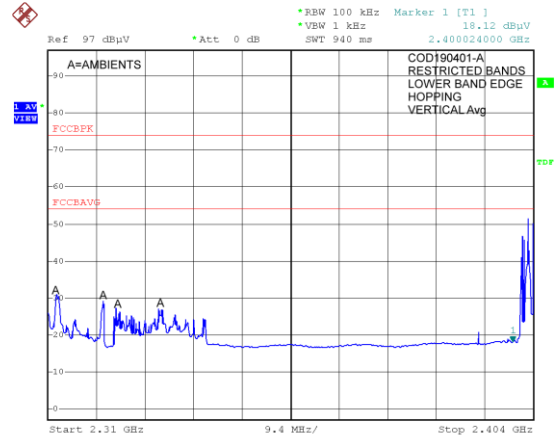
All measured disturbances were greater than 10dB below the 15.209 average limit, and greater than 20dB below the 15.209 peak limit.

Hopping mode:



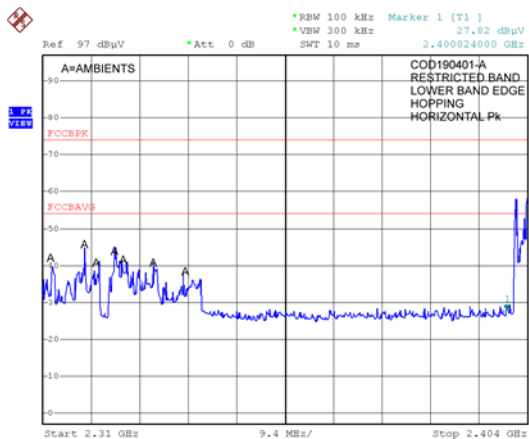
Date: 26.JUL.2019 13:18:38

Ch0 – Peak Vertical Polarisation



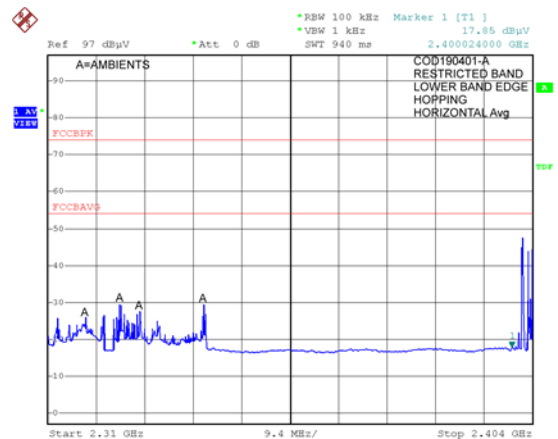
Date: 26.JUL.2019 13:20:32

Ch0 – Avg Vertical Polarisation



Date: 26.JUL.2019 13:23:32

Ch0 – Peak Horizontal Polarisation



Date: 26.JUL.2019 13:22:15

Ch0 – Avg Horizontal Polarisation

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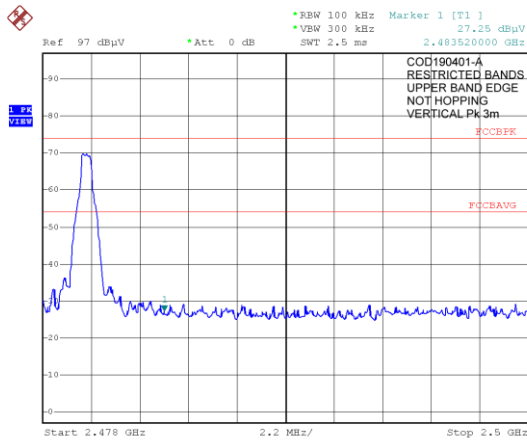


Restricted band 2483.5 to 2500MHz, Radiated at 3m.

All measured disturbances were greater than 10dB below the 15.209 average limit, and greater than 20dB below the 15.209 peak limit.

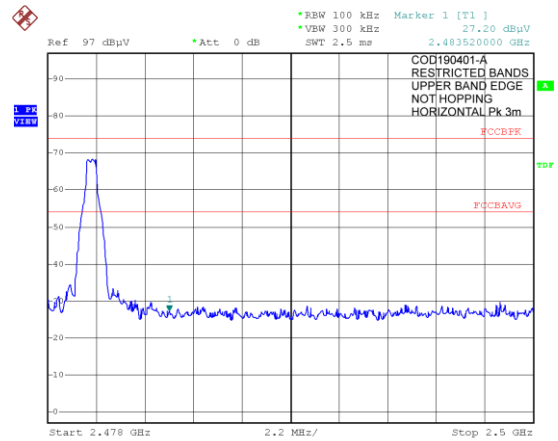
Both hopping and not hopping modes assessed.

Not hopping mode using channel 78, constant transmission:



Date: 26.JUL.2019 13:37:50

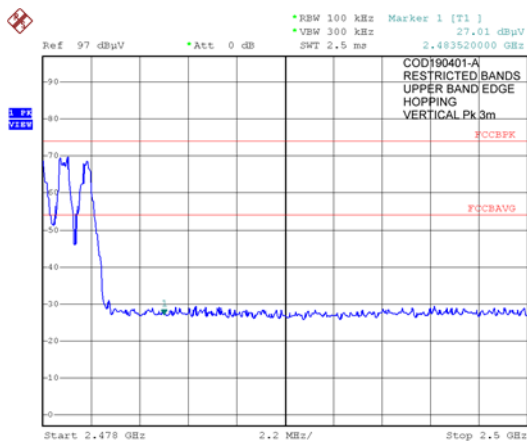
Ch78 – Peak Vertical Polarisation



Date: 26.JUL.2019 13:30:48

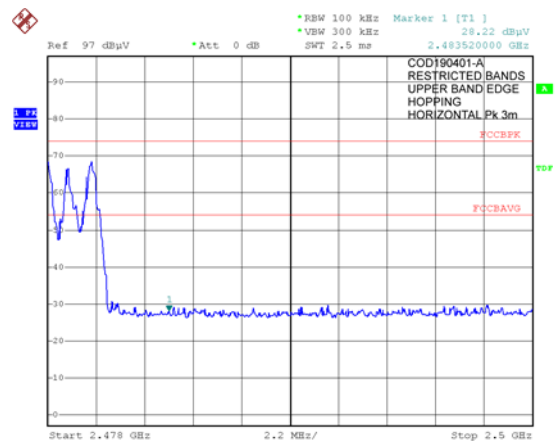
Ch78 – Peak Horizontal Polarisation

Hopping mode:



Date: 26.JUL.2019 13:35:41

Ch78 – Peak Vertical Polarisation



Date: 26.JUL.2019 13:32:58

Ch78 – Peak Horizontal Polarisation

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11.4.2 Radiated Disturbances: 9kHz to 30 MHz

Measurements were performed both on an OATS ground plane and also over a non-conductive ground plane as specified in ANSI C63.10:2013, clause 5.2. There was no measurable difference in EUT emissions between the different setups. Prescan results showed that there was no measurable difference between the three antenna positions, Coaxial, Coplanar and Parallel. Plots with maximum emissions shown.

9 kHz to 150 kHz measured at 10 meters.

150 kHz to 30 MHz measured at 3 meters.

Measured data extrapolated to distances defined by limits (300m for 9-490 kHz and 30m for 490kHz-30MHz).

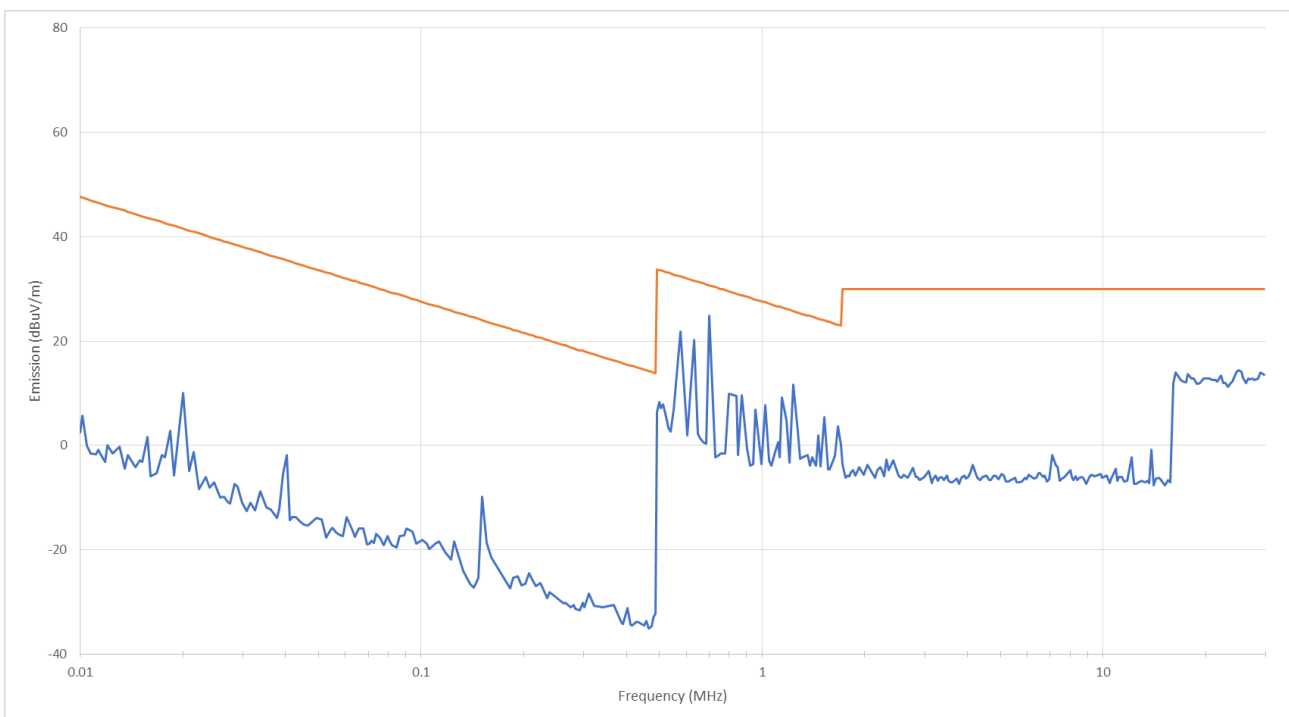
In accordance with ANSI C63.10 Clause 6.4.4.1:

Below 15.9 MHz used 40 dB/decade extrapolation.

Above 15.9 MHz used 20 dB/decade extrapolation.

Where 15.9 MHz calculated as the near field point for 3 meter measurements.

All intentional radiation was greater than 20dB below the limits specified in section 15.209. Emission levels were not affected by RF channel selection.



Maximum Emissions

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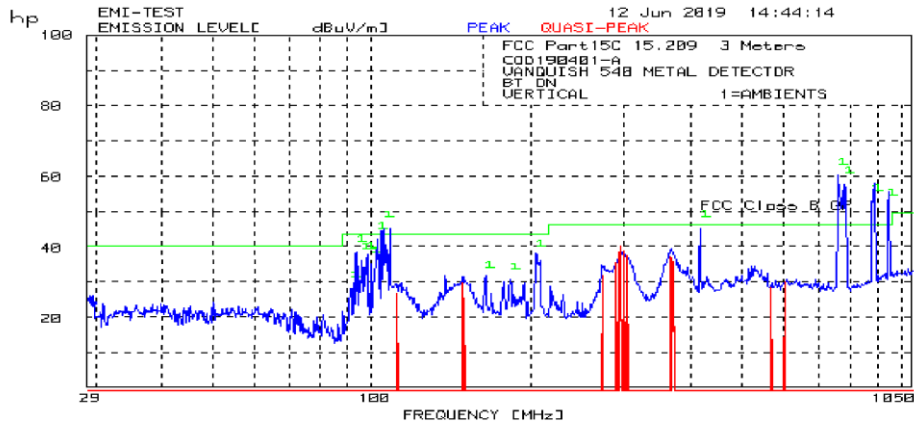
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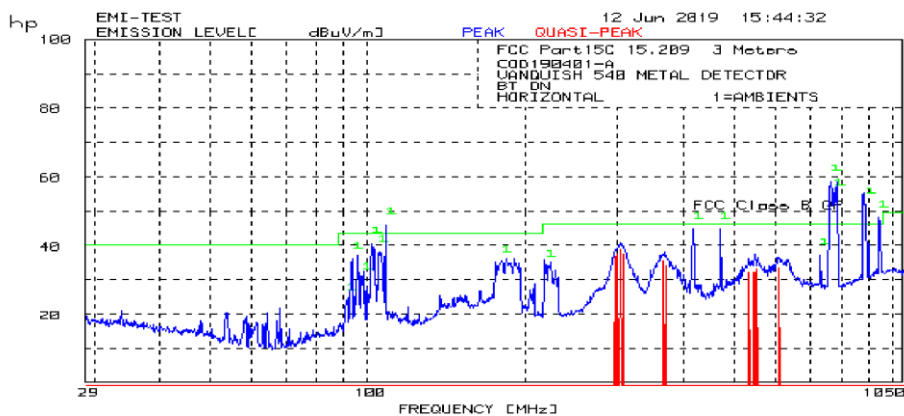
11.4.3 Radiated Disturbances: 30MHz to 1000MHz at 3m distance

The 6 highest EUT spurious emissions below 1GHz are tabulated below:

Frequency MHz	Channel	Antenna Pol.	QP Level @ 3m (dBµV/m)	QP Limit @ 3m (dBµV/m)	QP Pass Margin (dB)
295.1	All	Vertical	40.0	46.0	6.0
299.3	All	Vertical	38.8	46.0	7.2
303.7	All	Horizontal	38.6	46.0	7.4
291.9	All	Vertical	38.3	46.0	7.7
303.7	All	Vertical	37.5	46.0	8.5
299.3	All	Horizontal	37.4	46.0	8.6



Radiated Emissions (30MHz to 1000MHz – Vertical)



Radiated Emissions (30MHz to 1000MHz - Horizontal)

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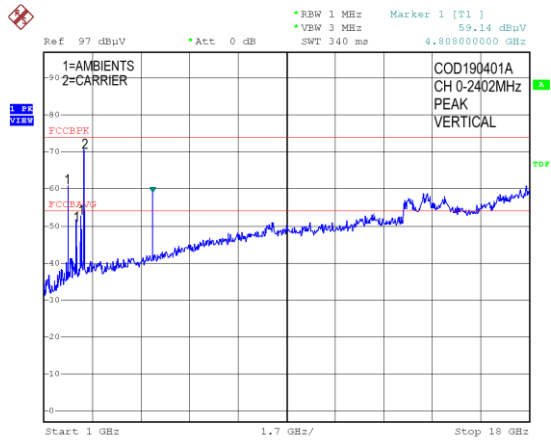
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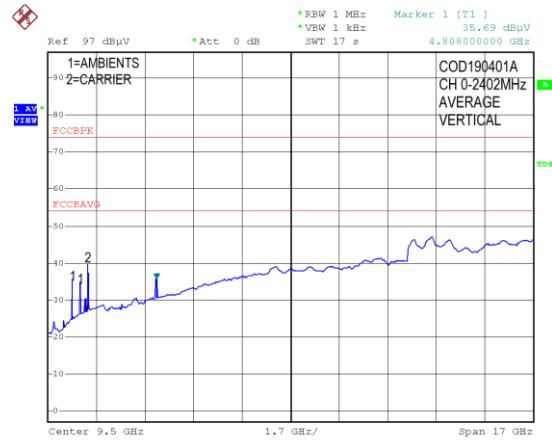
11.4.4 Radiated Disturbances: 1000MHz to 18000MHz at 3m distance

All intentional radiation spurious were greater than 10dB below the limits specified in section 15.209.



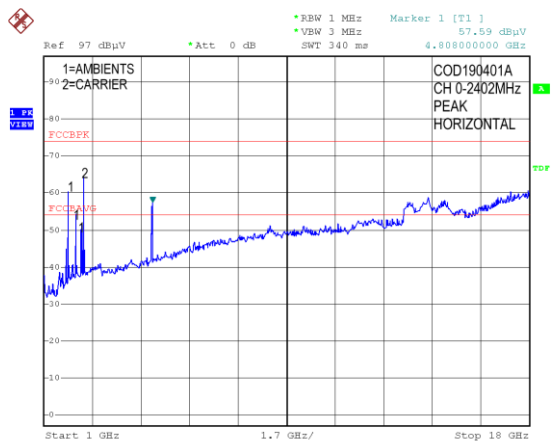
Date: 1.JUL.2019 11:32:37

Ch0 – Peak Vertical Polarisation



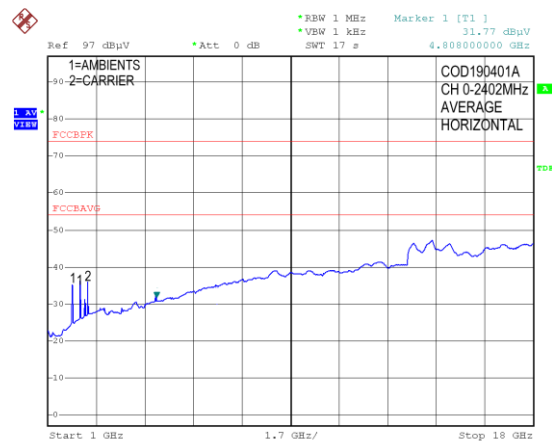
Date: 1.JUL.2019 11:36:40

Ch0 – Average Vertical Polarisation



Date: 1.JUL.2019 11:44:35

Ch0 – Peak Horizontal Polarisation



Date: 1.JUL.2019 11:42:32

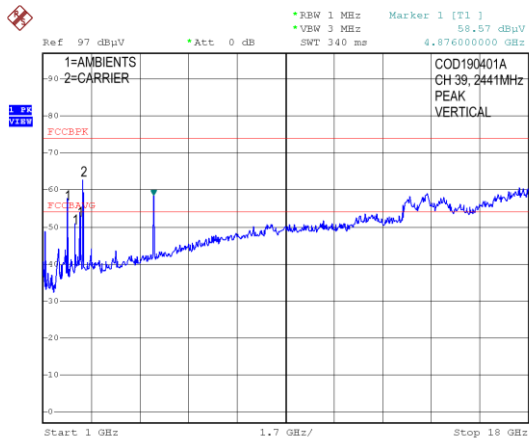
Ch0 – Average Horizontal Polarisation

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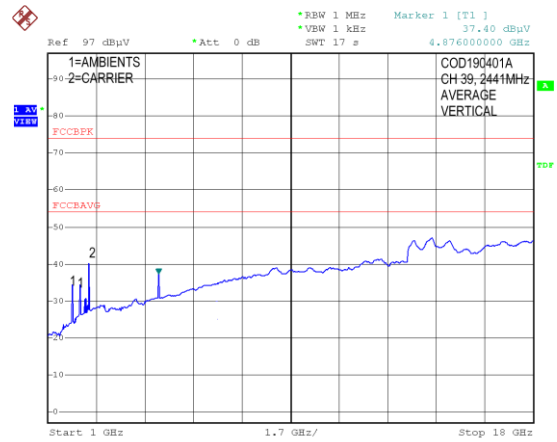
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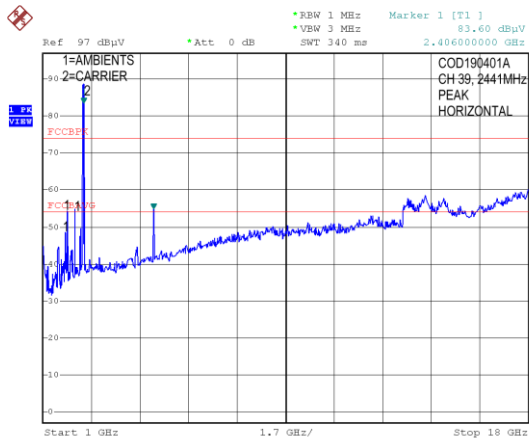
Date: 1.JUL.2019 11:28:25

Ch39 – Peak Vertical Polarisation



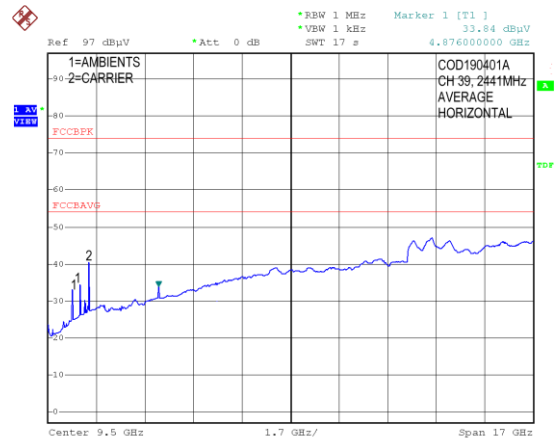
Date: 1.JUL.2019 11:24:05

Ch39 – Average Vertical Polarisation



Date: 1.JUL.2019 11:09:11

Ch39 – Peak Horizontal Polarisation



Date: 1.JUL.2019 11:22:00

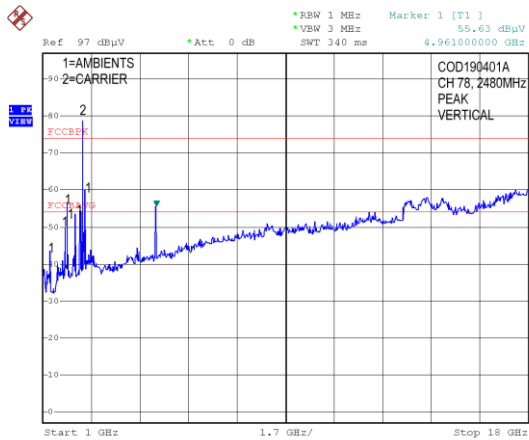
Ch39 – Average Horizontal Polarisation

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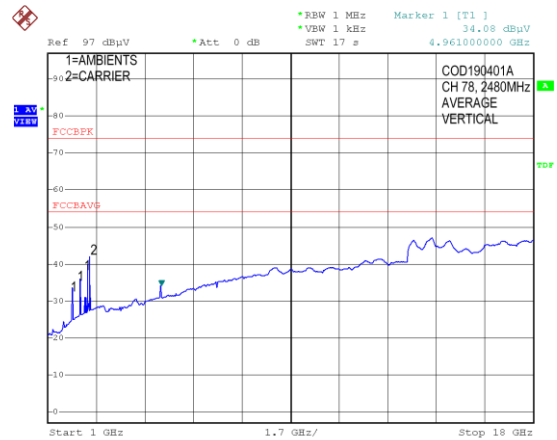
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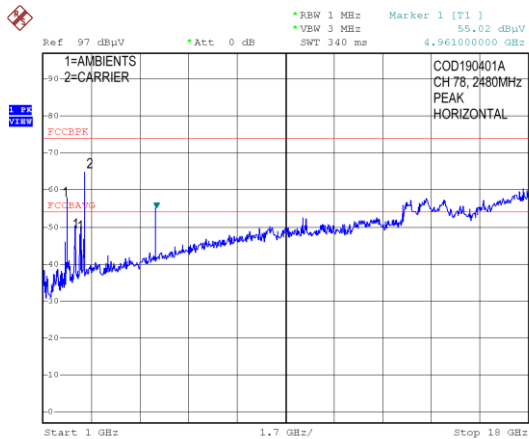
Date: 1.JUL.2019 12:04:47

Ch78 – Peak Vertical Polarisation



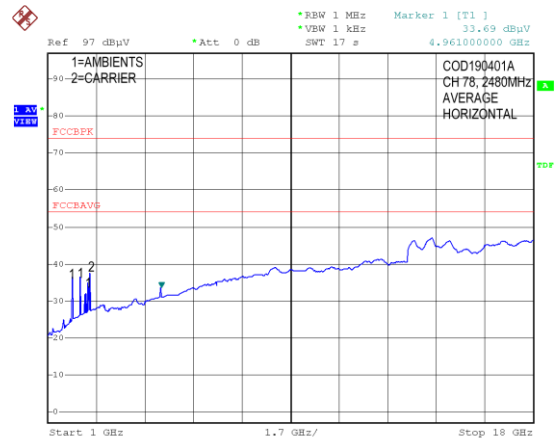
Date: 1.JUL.2019 12:06:24

Ch78 – Average Vertical Polarisation



Date: 1.JUL.2019 11:58:14

Ch78 – Peak Horizontal Polarisation



Date: 1.JUL.2019 12:00:24

Ch78 – Average Horizontal Polarisation

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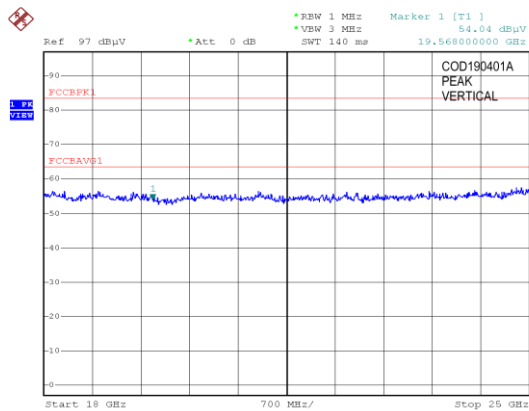


11.4.5 Radiated Disturbances: 18000MHz to 25000MHz at 1m distance

Measured field strength levels performed at a 1 metre distance were extrapolated to a 3 meter distance using the extrapolation factor of 20dB/decade as specified in section 15.31(f)(1).

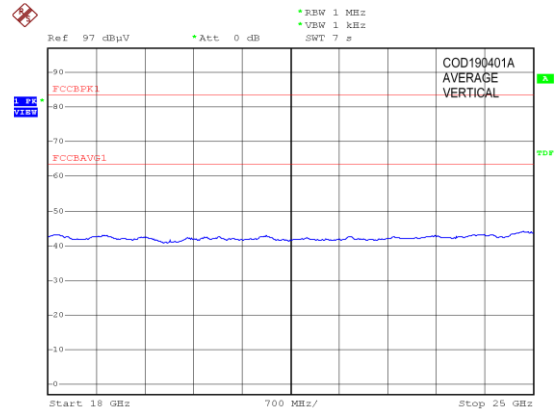
All intentional radiation spurious were greater than 10dB below the limits specified in section 15.209. Emission levels were not affected by RF channel selection.

Following plots indicate limits calculated for a 1m distance.



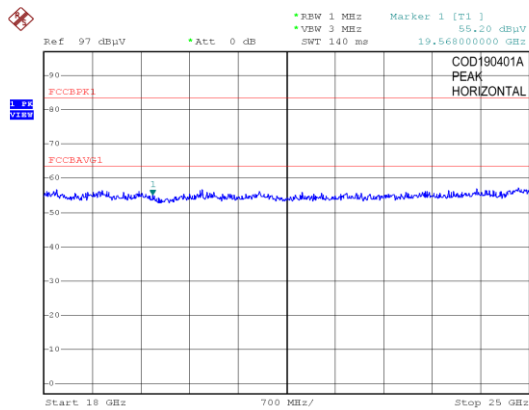
Date: 27.JUN.2019 16:14:44

Peak Vertical Polarisation



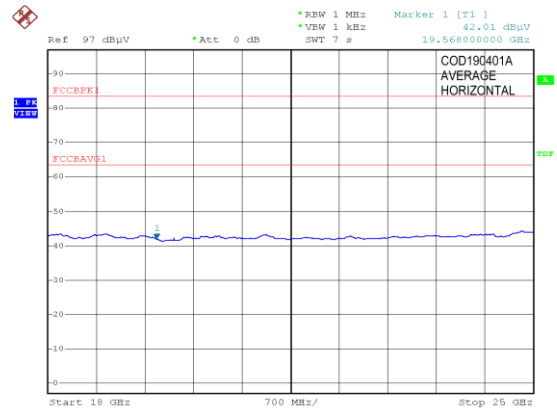
Date: 27.JUN.2019 16:04:49

Average Vertical Polarisation



Date: 27.JUN.2019 16:17:16

Peak Horizontal Polarisation



Date: 27.JUN.2019 16:19:14

Average Horizontal Polarisation

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12 FCC Part 15C, Section 15.247 – OPERATION WITHIN THE BANDS 902-928MHz, 2400-2483.5MHz, AND 5725-5850MHz

12.1 Section 15.247(a)

Test Date:	26 th June 2019	Temperature:	21°C
Test Officer:	Steven Garnham	Humidity:	65%
Test Location:	Austest Laboratories (Yarramalong)		

12.1.1 EUT Operating Mode

- a. Battery voltage – 5.2VDC.
- b. Mode 1 – Constant BT transmission, ch0.
- c. Mode 2 – Constant BT transmission, ch39.
- d. Mode 3 – Constant BT transmission, ch78.

12.1.2 Test Method

Measurements were made using the supplied modified EUT fitted with an external antenna port and an interface board with laptop to control the BT function.

- a. Measurements were performed in accordance with ANSI C63.10-2013 and KDB 558074 FHSS Measurement Guidance.
- b. The EUT antenna port was connected to a spectrum analyser via a low loss RF cable, and attenuator (as necessary).
- c. Spectrum analyser RBW 30kHz RBW, VBW 100kHz.
- d. Peak level was marked and the -20dB (lower and upper) frequencies noted.
- e. Measurements were repeated for the low, middle and high channels across all transmit modes.

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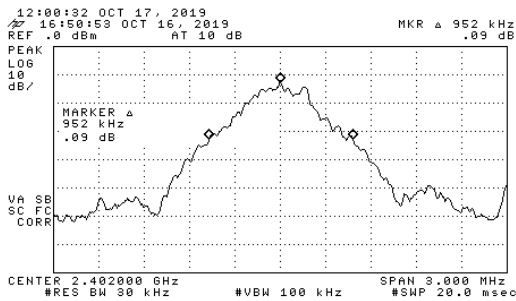
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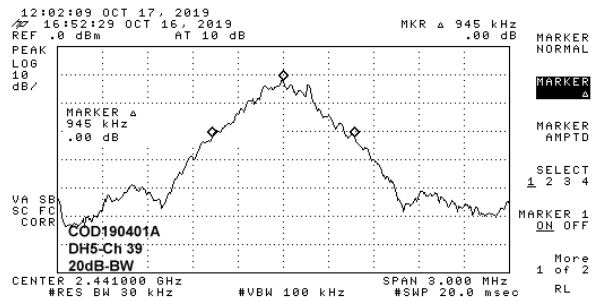
12.2 Channel Separation - Section 15.247(a)(1)

12.2.1 20 dB Bandwidth - EDR

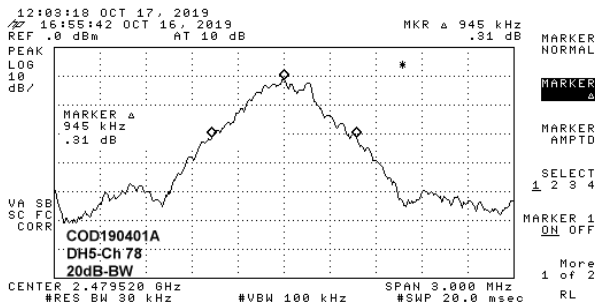
Channel	20dB Bandwidth (kHz)	Channel Separation limit (kHz)
0	952	635
39	945	630
78	945	630



20dB Bandwidth – Ch0



20dB Bandwidth – Ch39



20dB Bandwidth – Ch78

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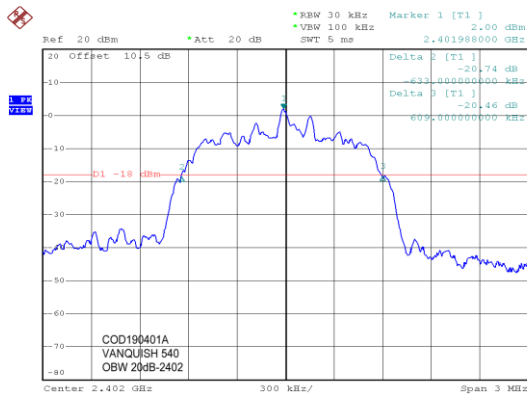
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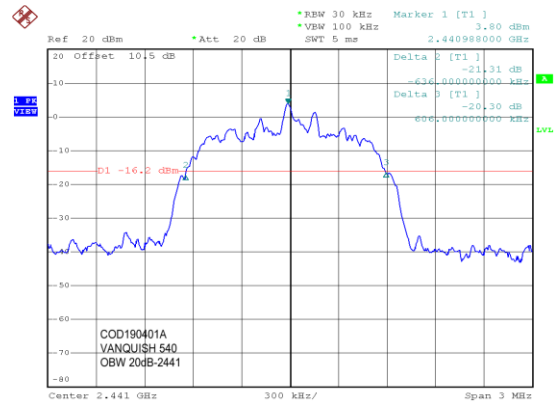
12.2.2 20 dB Bandwidth - BDR

Channel	20dB Bandwidth (kHz)	Channel Separation limit (kHz)
0	1242	828
39	1242	828
78	1236	824



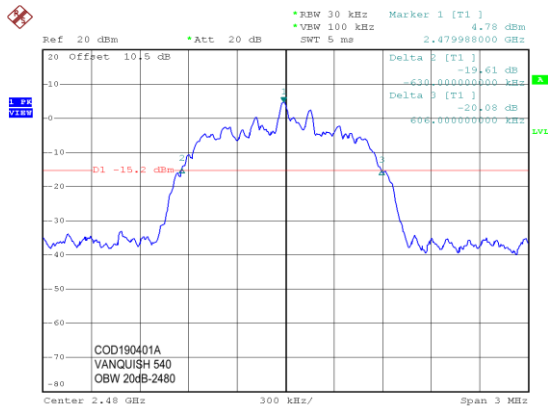
Date: 26.JUN.2019 13:40:08

20dB Bandwidth – Ch0



Date: 26.JUN.2019 13:46:37

20dB Bandwidth – Ch39



Date: 26.JUN.2019 13:36:47

20dB Bandwidth – Ch78

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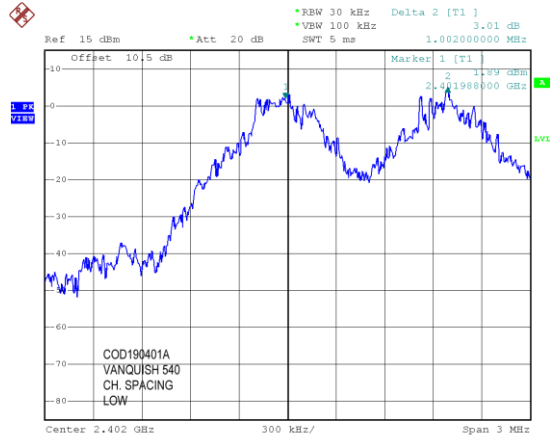
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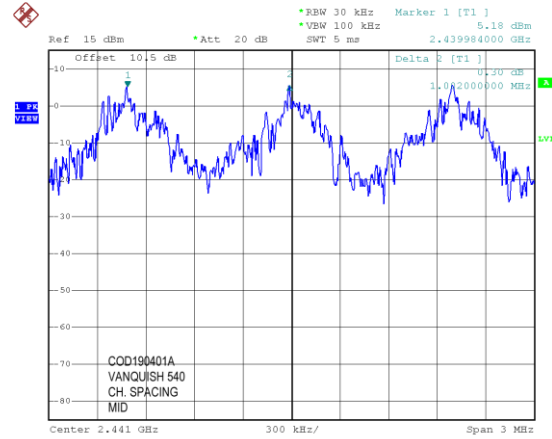


12.2.3 Channel Separation

The minimum separation measured was 1.002 MHz and complied with the minimum limit of 0.828 MHz.

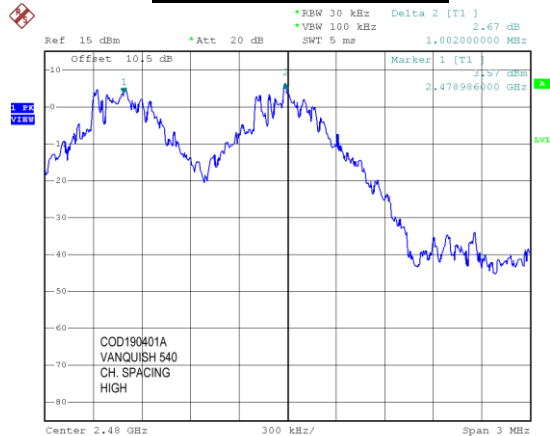


Date: 26.JUN.2019 11:58:58



Date: 26.JUN.2019 11:55:32

Channel Spacing – Ch0



Date: 26.JUN.2019 12:04:43

Channel Spacing – Ch39

Channel Spacing – Ch78

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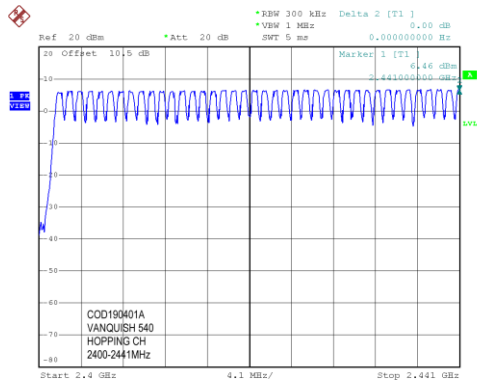
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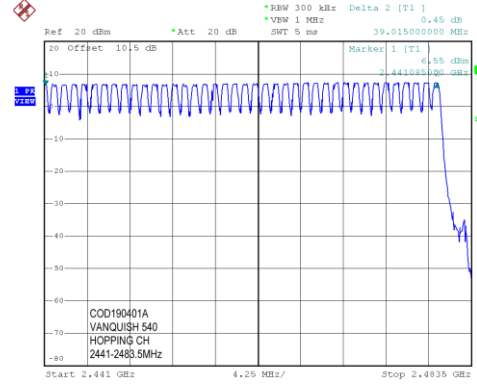
12.3 Number of Hopping Channels - Section 15.247(a)(1)(iii)

A total of 79 channels were used, the limit was >15.



Date: 26.JUN.2019 12:12:25

2400 – 2441MHz



Date: 26.JUN.2019 12:19:25

2441 – 2483.5MHz

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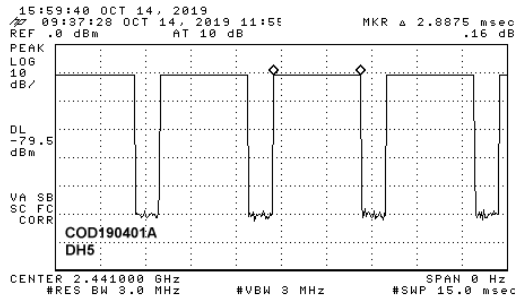


12.4 Time of Occupancy - Section 15.247(a)(1)(iii)

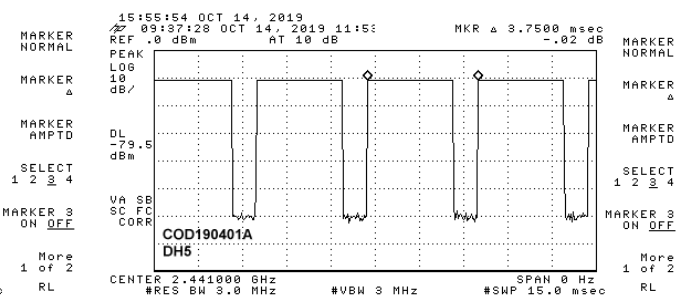
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

DH5 mode (longest transmit time):

Limit	0.4 seconds in any 31.6 s.
Tx(ON)	2.8875 ms
Transmission period	3.75 ms
Channels per hopping sequence	79
Time for one hopping sequence	3.75ms x 79 = 296.25 ms
Hops on one channel in 31.6 s	31.6/0.29625 = 106.667
Average time of Occupancy	106.667 x 0.0028875 = 0.308 s per 31.6 s



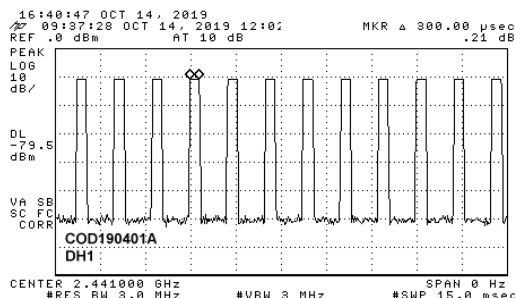
Tx(ON)



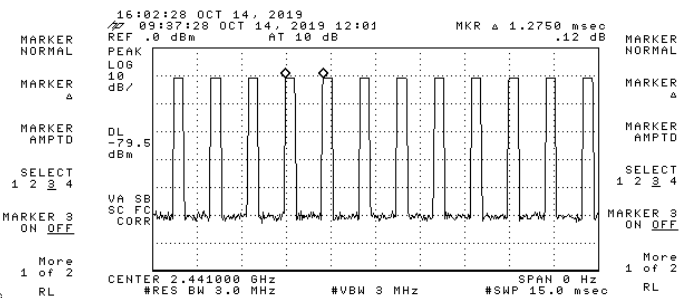
Transmission period

DH1 mode (shortest transmit time):

Limit	0.4 seconds in any 31.6 s.
Tx(ON)	0.3 ms
Transmission period	1.275 ms
Channels per hopping sequence	79
Time for one hopping sequence	1.275ms x 79 = 100.725 ms
Hops on one channel in 31.6 s	31.6/0.100725 = 313.725
Average time of Occupancy	313.725 x 0.0003 = 0.094 s per 31.6 s



Tx(ON)



Transmission period

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12.5 Peak Conducted Output Power – Section 15.247(b)(1)

Test Date:	26 th June 2019	Temperature:	21°C
Test Officer:	Steven Garnham	Humidity:	65%
Test Location:	Austest Laboratories (Yarramalong)		

12.5.1 EUT Operating Mode

- Battery voltage – 5.2VDC.
- Mode 1 – Constant BT transmission, ch0.
- Mode 2 – Constant BT transmission, ch39.
- Mode 3 – Constant BT transmission, ch78.

12.5.2 Test Method

Measurements were made using the supplied modified EUT fitted with an external antenna port and an interface board with laptop to control the BT function.

- Measurements were performed in accordance with ANSI C63.10-2013 and KDB 558074 FHSS Meas Guidance.
- The EUT antenna port was connected to a spectrum analyser via a low loss RF cable, and attenuator (as necessary).
- Spectrum analyser RBW 3MHz RBW, VBW 3MHz.
- Readings were corrected to account for attenuator loss.
- The maximum reading was recorded.
- Measurements were repeated for the low, middle and high channels and across all transmit modes.

12.5.3 Directional antenna gain

Not applicable as the gain was less than 6 dBi.

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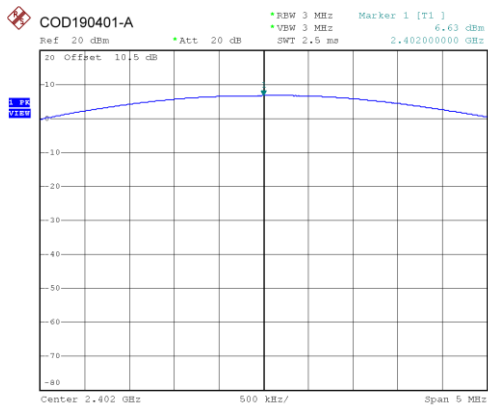
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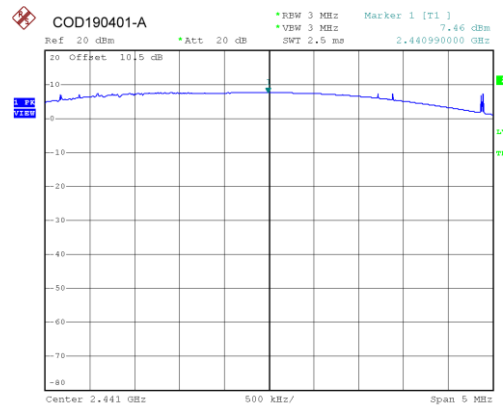
12.5.4 Test Results, (this data from conducted measurements into 50 Ohms)

Channel	Output Power		Limit		Below Limit
	dBm	mW	dBm	W	dB
0	+6.65	4.62	30.0	1.0	23.35
39	+7.46	5.57	30.0	1.0	22.54
78	+8.10	6.46	30.0	1.0	21.90



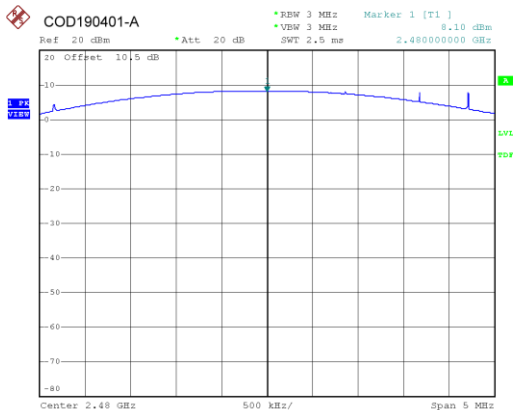
Date: 2.AUG.2019 10:58:11

Conducted Power – Ch0



Date: 2.AUG.2019 11:01:00

Conducted Power – Ch39



Date: 2.AUG.2019 11:03:09

Conducted Power – Ch78

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12.5.5 Transmit Power – Supply Voltage Variation

The EUT was powered from quantity four, internal AA NiMh batteries.

For battery powered equipment, Section 15.31 (e) required that the equipment tests shall be performed using a new battery.

The EUT was tested using charged NiMh batteries with the total measured supply being 5.28vdc.

12.6 Out of band emissions – Section 15.247(d)

Test Date:	2 nd August 2019	Temperature:	23°C
Test Officer:	Steven Garnham	Humidity:	43%
Test Location:	Austest Laboratories (Yarra)		

12.6.1 EUT Operating Mode

- a. Battery voltage – 5.3VDC.
- b. Mode 1 – Constant BT transmission, ch0.
- c. Mode 2 – Constant BT transmission, ch39.
- d. Mode 3 – Constant BT transmission, ch78.

12.6.2 Test Method

Measurements were made using the supplied modified EUT fitted with an external antenna port and an interface board with laptop to control the BT function.

- a. Measurements were performed in accordance with ANSI C63.10-2013 and KDB 558074 FHSS Meas Guidance.
- b. The EUT antenna port was connected directly to a spectrum analyser via a low loss RF cable, and attenuator.
- c. Spectrum analyser RBW 100kHz, VBW to 100kHz or more. (At frequencies below 30MHz the RBW was set lower to reduce influence of the spectrum analysers zero point).
- d. Measurements were made on the low, middle and high channels and highest in-band level recorded.
- e. The frequency range was swept up to the 10th harmonic to locate the highest out of band emissions.
- f. Any out of band emissions were measured to ensure they were are greater than 20dB below the recorded in band level.
- g. Any emissions that fall within the restricted bands specified in section 15.205 shall also meet the radiated emission limits specified in section 15.209.
- h. Measurements were repeated for the low, middle and high channel and across all transmit modes.

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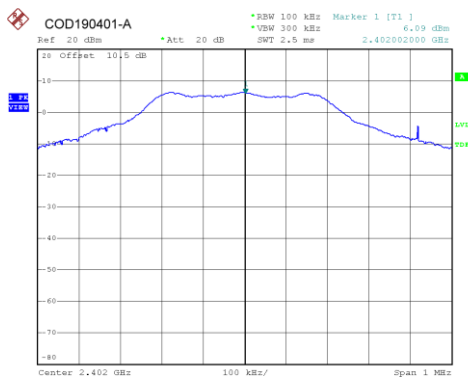
12.6.3 Test Results

Frequency range: 9kHz to 25000MHz.
 Highest in-band level at 2480.0MHz, +7.7dBm (CH78), (RBW=100kHz / VBW=300kHz).

Measurement of peak conducted output power was used to determine compliance with section 15.247 (2)(b)(1). Therefore, the out of band emission limit was 20dB below the in-band level, or -12.3dBm.

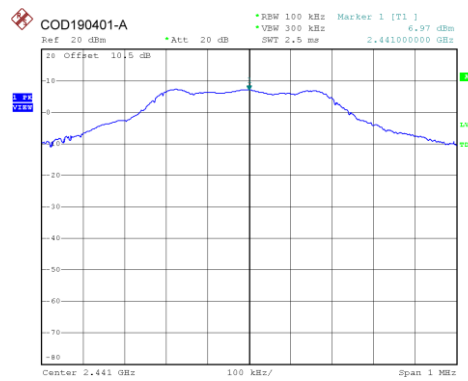
Highest measured out of band emission level was at 2400MHz which was 24.5dB below the highest in band level.

Frequency (MHz)	Channel	Peak Level (dBm)	Out of Band Limit (dBm)	Below Limit (dB)
2400	0	-36.8	-12.3	24.5
2497	78	-48.9	-12.3	36.6



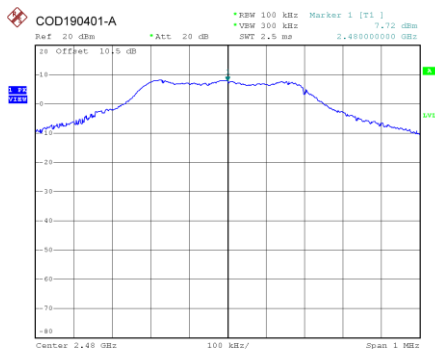
Date: 2.AUG.2019 11:24:19

In-band – Ch0



Date: 2.AUG.2019 11:29:10

In-band – Ch39



Date: 2.AUG.2019 13:35:57

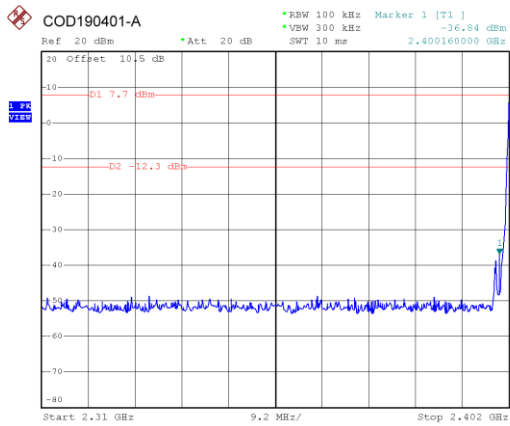
In-band – Ch78

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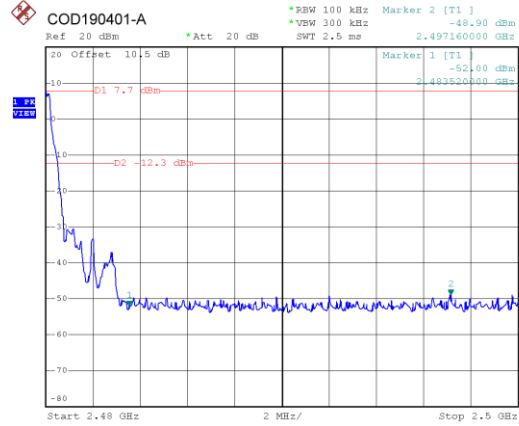
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Date: 2.AUG.2019 12:17:25

2310MHz to 2400MHz

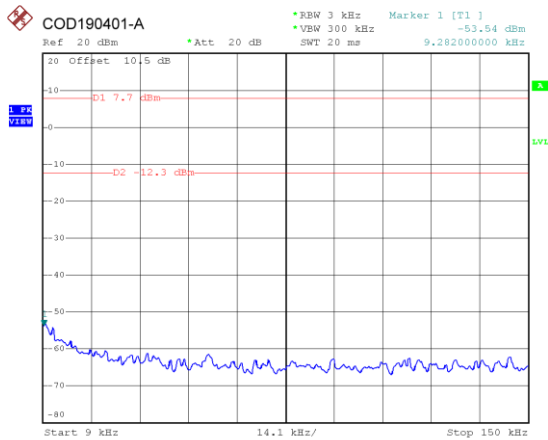


Date: 2.AUG.2019 12:26:01

2483.5MHz to 2500MHz

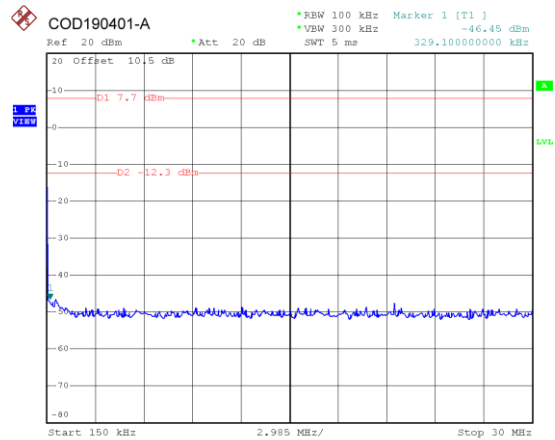
Note:

Conducted emission method for the following graphs: Using the spectrum analyser maxhold function measurements were made and recorded with the transceiver transmitting on the low, middle and high channels separately. Each graph shows the combined emissions.



Date: 2.AUG.2019 12:35:04

9kHz to 150kHz



Date: 2.AUG.2019 12:31:26

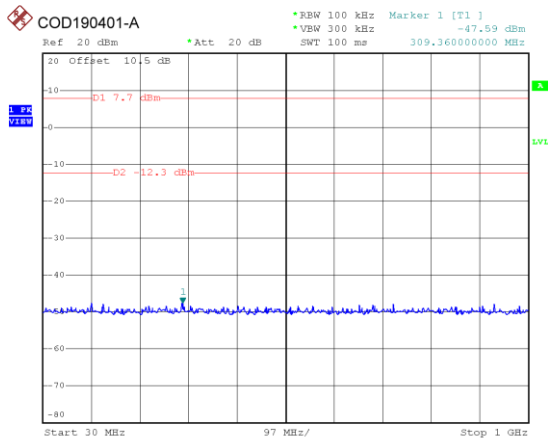
150kHz to 30MHz

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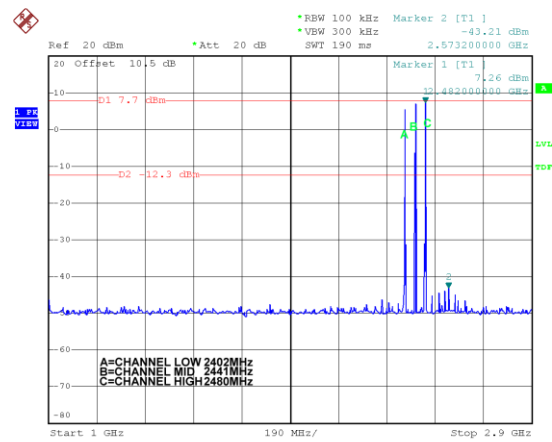
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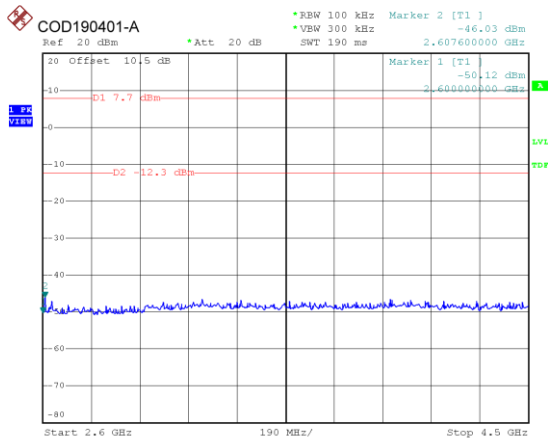
Date: 2.AUG.2019 12:13:07

30MHz to 1000MHz



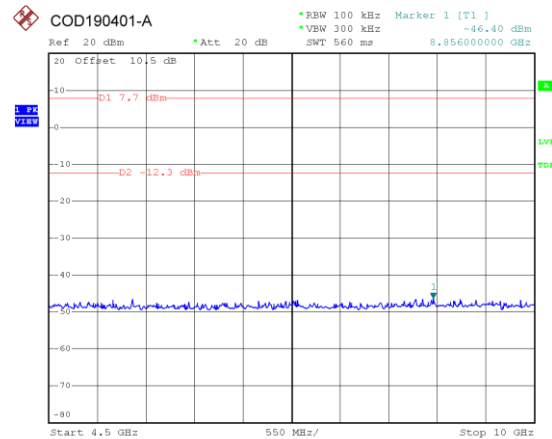
Date: 2.AUG.2019 11:43:33

1000MHz to 2900MHz



Date: 2.AUG.2019 11:52:48

2600MHz to 4500MHz



Date: 2.AUG.2019 12:02:28

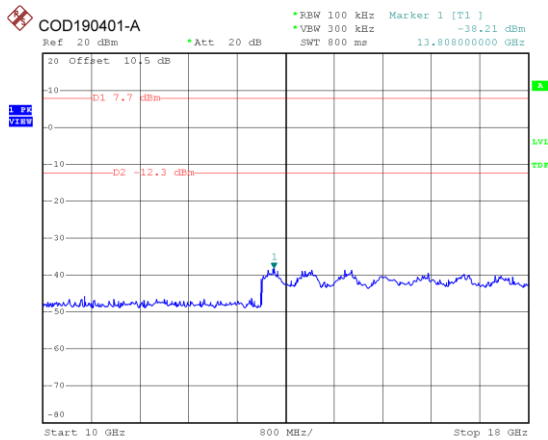
4500MHz to 10000MHz

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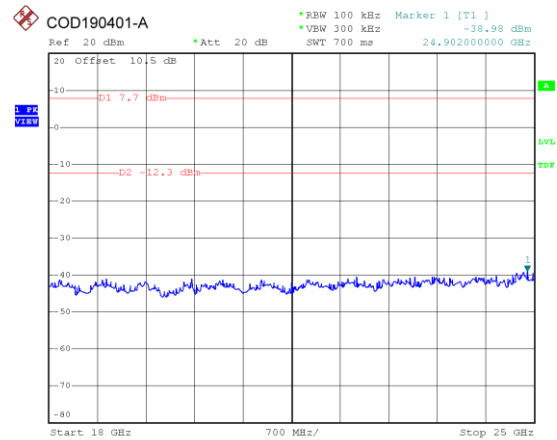
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Date: 2.AUG.2019 12:05:51

10000MHz to 18000MHz



Date: 2.AUG.2019 12:09:05

18000MHz to 25000MHz

12.7 Maximum Permissible Exposure (MPE) – Section 15.247(i)

The device was considered portable equipment as the transceiver could be used within 20 cm. The following SAR exclusion calculation was applied:

$$\left[\frac{(Max. power, mW)}{(min. separation, mm)} \right] \times [\sqrt{f_{GHz}}] \leq 3.0 \text{ (for 1g SAR) and } \leq 7.5 \text{ (for 10g extremity SAR)}$$

As measured the maximum power was 7 mW, and therefore:

$$\left[\frac{(7 mW)}{(5 mm)} \right] \times [\sqrt{(2.48)}] = 2.2$$

The Vanquish Bluetooth transceiver complied with the maximum permissible exposure requirements at any separation distance without further measurement.

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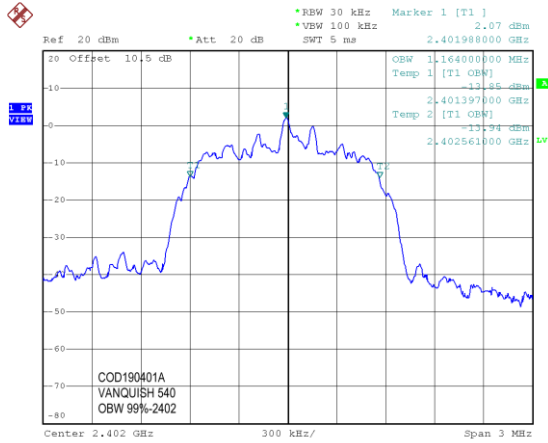
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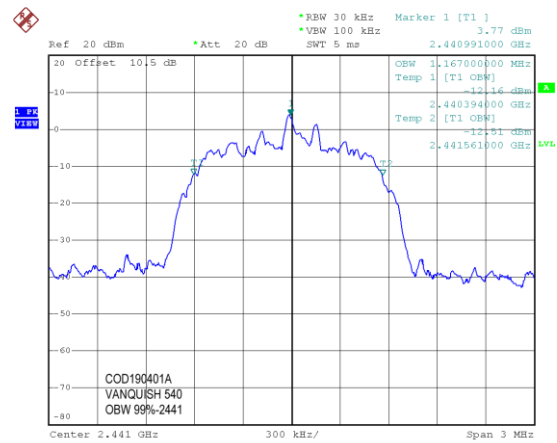
13 FCC Part 2J, Section 2.1049 – 99% Bandwidth

Channel	99% Bandwidth (kHz)
0	1164
39	1167
78	1173



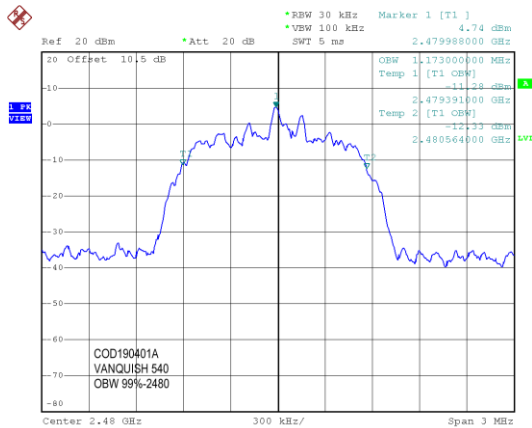
Date: 26.JUN.2019 13:52:15

99% Bandwidth – Ch0



Date: 26.JUN.2019 13:54:44

99% Bandwidth – Ch39



Date: 26.JUN.2019 13:57:14

99% Bandwidth – Ch78

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