

RADIO TEST REPORT

FCC TITLE 47 PART 15C

Client: Minelab Electronics Pty Ltd

Address: 2 Second Avenue, Mawson lakes, Adelaide, SA 5095, Australia

Report Number: 0921COD_GPX6000_FCC15Ca

Date of Testing: 30th June to 8th July 2021

File Number: COD210128

Equipment Name: GPX600 Metal Detector

Model Number: GPX6000

FCC ID: Z4C-0039A

Description: Metal Detector (with Revised Bluetooth)

Result: **COMPLIED**

Tested by: Steven Garnham
Test Engineer



Approved by: Colin Gan
Assessment Engineer



Date of Issue: 1st October 2021

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
21 Sep 2021	0921COD_GPX6000_FCC15C	Original report.
01 Oct 2021	0921COD_GPX6000_FCC15Ca	RF Exposure removed to separate document.

2 RESULT SUMMARY

DISCLAIMER: Austest Laboratories makes no claim regarding the consistency of production versions of the EUT. The results in this report apply only to the sample tested, as described in Section 5 of this report.

2.1 FCC 15C Summary

FCC Part 15, Subpart C – Intentional Radiators		Result	Notes
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, no direct or indirect AC mains connection.

3 MODIFICATIONS

No modifications were required to achieve compliance.

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4 REFERENCES

FCC Title 47 Part 15 current as of June 2021
ANSI C63.10: 2013
KDB Publication 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019
Minelab Test Setup plan-GPX6000: GRU-MLE-Bluetooth_Setup-v5

5 EQUIPMENT UNDER TEST (EUT) DESCRIPTION

EUT Name:	GPX6000
EUT Description:	Metal Detector
EUT Model:	GPX6000
EUT Serial Number:	BT PCB-Conducted RF: 40886600120 BT PCB-Radiated RF: 40886600097 Main Assy MTR6-06 S/N: 35636857956 Search Coil MTR6-06: # 75078960953 Battery Pack: #H7190160091
FCC ID:	Z4C-0039A
Power Supply & Rating:	Battery Pack, Nominal – Labelled 7.2V / 5833mAh, Li-ion
Highest Frequency:	2480 MHz
Lowest Frequency:	4 kHz
Frequency Range:	2402 MHz to 2480 MHz
Transmit Power:	4.7mW EIRP (+3.4dBm Peak Conducted at antenna port)
Modulation Technique:	BT: GFSK, DPSK
Number of Channels:	79 Channels
Antenna Specifications:	Maximum gain: 3.3 dBi; Internal Antenna trace size 25.7 x 7.5 mm (based on TI Inverted F PCB antenna)

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6 EUT TEST SETUP AND CONFIGURATION

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

Measurements were performed using both the conducted and radiated method on the supplied samples.

The testing was to evaluate a revised BT PCB used in a previously compliant metal detector unit. The RF BT PCB would normally be mounted within the user interface display unit.

One Bluetooth PCB was supplied modified with an antenna connector for the conducted RF tests and another same type PCB was supplied with only the integral trace antenna for the radiated RF tests.

During testing, each PCB was connected to a User Interface with membrane switches and also to the battery supply via the associated equipment metal detector Pod / Control Box.

Initial radiated measurements were performed with the control PC and interface connected to configure the required operating mode, such as hopping on or off, channel frequency and modulation type. After configuration the associated control PC and interface were removed and final radiated measurements were performed on only the EUT PCB and host battery supply pod.

Control software used was BlueTest3 installed on the manufacturer's supplied laptop.

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

- a. A supplied test HP Elitebook 8447P 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 manufacturer for the BlueTest3 software, constant BT transmission on selected low, middle and high channels was made. Output power indication was set to the maximum +4dBm as per manufacturer's instructions. Frequency hopping mode with both BDR and EDR modulation could also be selected.

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

There were no facilities for charging the battery pack while installed in the EUT. For charging purposes, the battery pack was removed and connected to the supplied charger adapter. All tests were performed using a fully charged battery pack.

The test PC (via AC adapter) 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 without and with modulation (both EDR and BDR); o/p power software setting +4dBm, on Ch0 (2402MHz).
2	Constant BT transmission without and with modulation (both EDR and BDR); o/p power software setting +4dBm on Ch39 (2441MHz).
3	Constant BT transmission without and with modulation (both EDR and BDR); o/p power software setting +4dBm on Ch78 (2480MHz).
4	Constant Frequency Hopping with modulation.

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.

Radiated emissions testing above 1GHz was performed on an Open Area Test Site with pyramidal absorber (FSOATS).

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 and Listings

Austest Laboratories 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.

7.3 Deviations from Standards and/or Accreditations

None.

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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	Calibration (dd/mm/yyyy)	
			Last	Due
72	HP8574B	Spectrum Analyser / EMI Rx	07/11/2019	07/11/2021
74	HP8447x	RF Preamp	07/04/2021	07/04/2023
83	OATS 1	3m/10m Open Area Test Site	16/01/2020	16/01/2022
225	EM6876	Active Loop Antenna	13/01/2020	13/01/2022
320	Chroma 6912	AC Source	Verified	
1132	SAS-200/574	DRG Horn	03/05/2021	03/05/2024
1241	PAM-118A	RF Preamp	20/12/2019	20/12/2021
1242	PAM840A	RF Preamp	17/07/2020	17/07/2022
1385	FSP40	Spectrum Analyser 40GHz	11/10/2019	11/10/2021
1590	Ametek CBL6141B	Bilog Antenna	22/09/2020	22/09/2022
-	Huber + Suhner	Coax Cables	14/01/2020	14/01/2022
-	HP85869C	Test Software	Verified	
-	RS Commander	Data capture software	Verified	

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

8 ANTENNA REQUIREMENT, 15.203

The EUT complied with the requirement of this Section since the EUT antenna, on a normal production unit, was integral and had no external antenna port.

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9 RESTRICTED BANDS OF OPERATION, 15.205

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 FCC section 15.209.

10 CONDUCTED LIMITS (Mains Ports), 15.207

Not applicable as the EUT was only powered from a battery pack. The battery had to be removed from the EUT for recharging.

11 RADIATED SPURIOUS EMISSIONS

11.1 EUT Operating Mode

- Battery voltage Fully Charged.
- Mode 1 – Constant BT transmission with modulation, ch0.
- Mode 2 – Constant BT transmission with modulation, ch39.
- Mode 3 – Constant BT transmission with modulation, ch78.
- 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 in a vertical position.

11.2 Test Method

- Measurements were performed in accordance with ANSI C63.10-2013, KDB 558074 FHSS Meas Guidance.
- The measuring receiver BW settings were:

Frequency Range	Antenna	Measurement	Detector	RBW	VBW
0.15 to 30 MHz	60 cm Loop	Pre-scan Peak	Peak	9 kHz	30 kHz
		Final Quasi-Peak	Quasi-Peak	9 kHz	30 kHz
30 to 1000 MHz	Hybrid (bicon/log)	Pre-scan Peak	Peak	120 kHz	300 kHz
		Final Quasi-Peak	Quasi-Peak	120 kHz	300 kHz
Above 1000 MHz	Double-ridged guide horn	Pre-scan Peak	Peak	1 MHz	3 MHz
		Pre-scan Average	Peak	1 MHz	1 kHz
		Final Peak	Peak	1 MHz	3 MHz
		Final Average	Average Linear	1 MHz	3 MHz

- The EUT was setup on a non-conductive turntable.
- For measurement below 1GHz at a height of 0.8m above the OATS conductive ground plane and at the indicated test distance away from the measuring antenna.

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- e. For measurements above 1GHz at a height of 1.5m above the OATS conductive ground plane with RF absorber placed between the test table and measuring antenna.
- f. 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 were investigated as the EUT antenna can have both vertical and horizontal positions.
 - ii. Bicon/log antenna (30MHz to 1GHz) - Both vertical and horizontal polarizations.
 - iii. Horn antenna (above 1GHz) - Both vertical and horizontal polarizations.
- g. The maximised emission level was measured and the above repeated for all measurement frequencies.
- h. Average level measurements were not made where the peak level did not exceed the average limit.
- i. Linearity of the measuring system was checked, reducing gain when required.
- j. 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. For simplicity, the test data plots have the limit lines adjusted to reflect any different test distance giving a visual indication of the relative margins.

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

11.4.1 Radiated Emissions: 9kHz to 150kHz at 10m distance

Test Date:	2 nd July 2021	Temperature:	22°C
Test Officer:	Steven Garnham	Humidity:	63%
Test Location:	Austest Laboratories (Yarramalong, NSW)		

9kHz to 150kHz measured at 10 meters.

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

The $\lambda/2\pi$ distance in m, *d near field*, shall be determined using equation (1)

$$d \text{ near field} = 47.77 / f \text{ MHz}$$

Where *f MHz* is the frequency of emission being measured in MHz.

In accordance with ANSI C63.10 Clause 6.4.4.1:

Below 4.8MHz used 40dB/decade extrapolation.

Where 4.8MHz calculated as the near field point for 10 meter measurements.

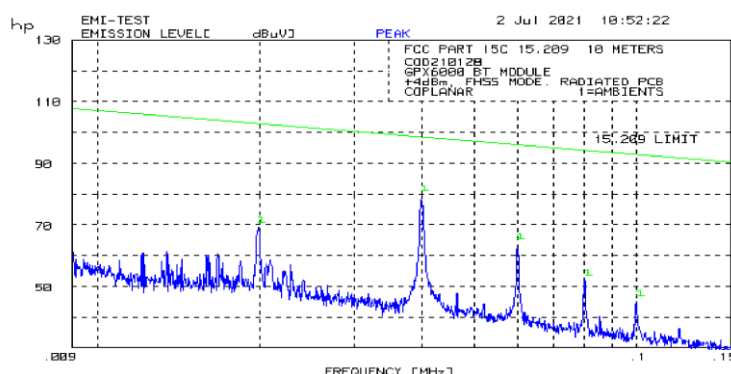
Measurements were performed both on an OATS ground plane and finally also over a non-conductive ground plane as specified in ANSI C63.10:2013, clause 5.2.

Prescan results were used to identify the orientation that produced the highest measured emissions in the three antenna positions, Coaxial, Coplanar and Parallel.

Emission levels were not affected by RF channel selection.

Frequency (MHz)	Channel	Antenna Polarity	Quasi-Peak (dBμV/m)		
			Level	300m Limit	Margin
All measured out of band emissions were greater than 20 dB below the limits specified in section FCC15.209					

Plot with maximum emissions shown at 10 meters:



Maximum Emissions

Note: A Green '1' indicates an ambient emission.

All measured out of band emission levels were below the 15.209 limits and greater than 20 dB below the highest level of the desired in-band power measured within a 100 kHz bandwidth.

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11.4.2 Radiated Emissions: 150kHz to 30MHz at 3m distance

Test Date:	2 nd July 2021	Temperature:	22°C
Test Officer:	Steven Garnham	Humidity:	63%
Test Location:	Austest Laboratories (Yarramalong, NSW)		

150kHz to 30MHz measured at 3 meters.

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

The $\lambda/2\pi$ distance in m, *d near field*, shall be determined using equation (1)

$$d \text{ near field} = 47.77 / f \text{ MHz}$$

Where *f MHz* is the frequency of emission being measured in MHz.

In accordance with ANSI C63.10 Clause 6.4.4.1:

Below 15.9MHz used 40dB/decade extrapolation.

Above 15.9MHz used 20dB/decade extrapolation.

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

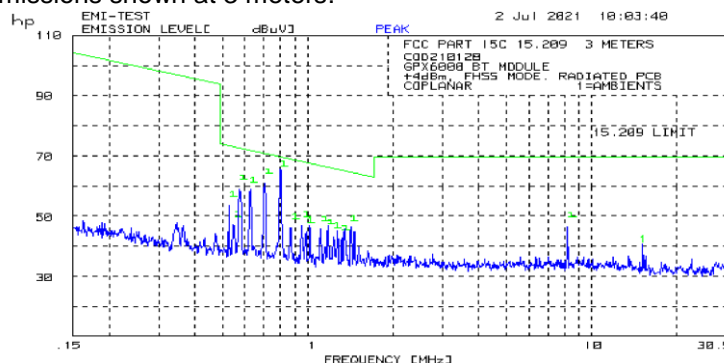
Measurements were performed both on an OATS ground plane and finally also over a non-conductive ground plane as specified in ANSI C63.10:2013, clause 5.2.

Prescan results were used to identify the orientation that produced the highest measured emissions in the three antenna positions, Coaxial, Coplanar and Parallel.

Emission levels were not affected by RF channel selection.

Frequency (MHz)	Channel	Antenna Polarity	Quasi-Peak (dBμV/m)		
			Level	Limit	Margin
All measured out of band emissions were greater than 20 dB below the limits specified in section FCC15.209					

Plot with maximum emissions shown at 3 meters:



Maximum emissions

Note: A Green '1' indicates an ambient emission and was not from the EUT.

All measured out of band emission levels were below the 15.209 limits and greater than 20 dB below the highest level of the desired in-band power measured within a 100 kHz bandwidth.

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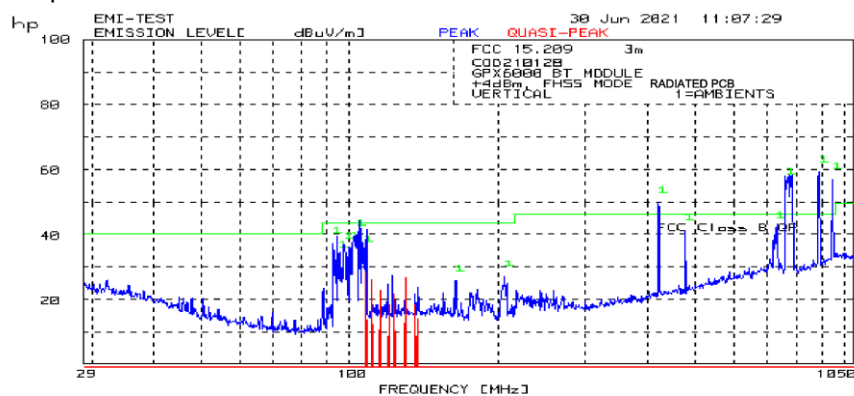
11.4.3 Radiated Emissions: 30MHz to 1000MHz at 3m distance

Test Date:	30 th June 2021	Temperature:	23°C
Test Officer:	Steven Garnham	Humidity:	69%
Test Location:	Austest Laboratories (Yarramalong, NSW)		

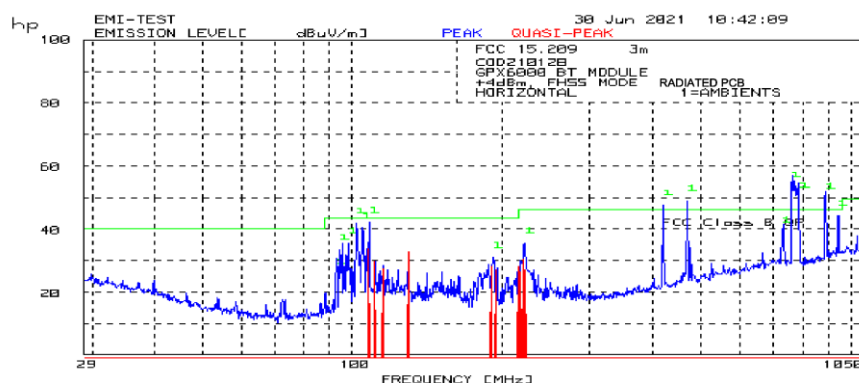
The 6 highest EUT spurious emissions 30 MHz to 1 GHz are tabulated below with reference to the restricted band limits of 15.209:

Frequency MHz	Channel*	Antenna Pol.	QP Level (dB μ V/m)	QP Limit (dB μ V/m)	QP Pass Margin (dB)
107.5	All	Horizontal	33.7	40.0	-9.8
129.0	All	Horizontal	32.6	40.0	-10.9
110.6	All	Horizontal	29.7	40.0	-13.8
107.5	All	Vertical	28.4	40.0	-15.1
189.8	All	Horizontal	28.0	40.0	-15.5
219.9	All	Horizontal	30.5	40.0	-15.5

*Spurious were independent of channel selection.



Radiated Emissions (30MHz to 1000MHz – Vertical)



Radiated Emissions (30MHz to 1000MHz - Horizontal)

Note: A Green '1' indicates an ambient emission and was not from the EUT.

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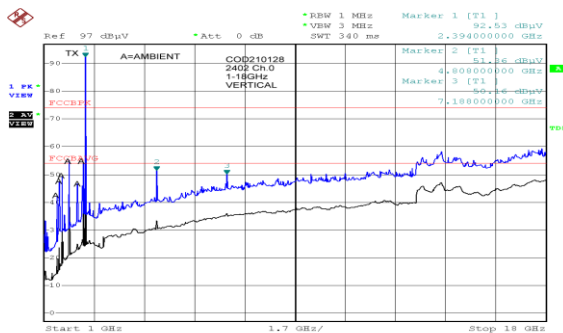


11.4.4 Radiated Emissions: 1 GHz to 18 GHz at 3m distance

The 8 highest EUT spurious emissions above 1 GHz are tabulated below with reference to the restricted band limits of 15.209:

Frequency MHz	Channel Number	Antenna Pol.	Pk Level dB μ V/m	Pk Limit dB μ V/m	Margin dB	Avg Level dB μ V/m	Avg Limit dB μ V/m	Margin dB
4804	0	Vertical	53.1	74.0	>-20	50.5	54.0	*-3.5
7206	0	Vertical	52.6	74.0	>-20	46.3	54.0	-7.7
4804	0	Horizontal	49.4	74.0	>-20	44.9	54.0	-9.1
4882	39	Vertical	51.0	74.0	>-20	47.8	54.0	-6.2
4882	39	Horizontal	51.5	74.0	>-20	47.3	54.0	-6.7
2894.5	78	Vertical	50.7	74.0	>-20	50.6	54.0	*-3.4
4960	78	Vertical	51.6	74.0	>-20	48.6	54.0	-5.4
4960	78	Horizontal	50.2	74.0	>-20	44.3	54.0	-9.7

*Results were within the Laboratory's measurement uncertainty.



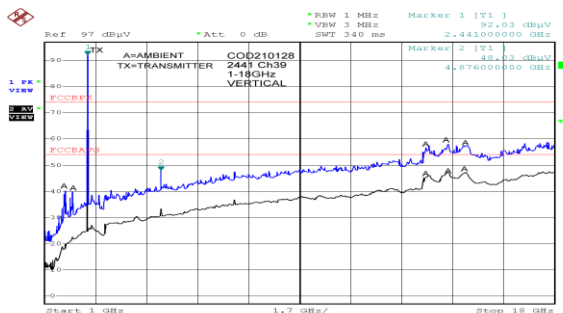
Date: 5.JUL.2021 12:57:18

2402MHz Peak / Avg Vertical Polarisation

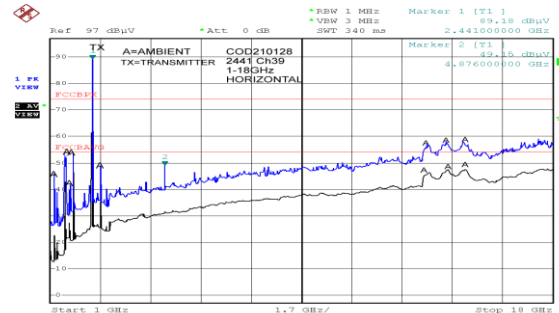


Date: 5.JUL.2021 14:58:00

2402MHz Peak / Avg Horizontal Polarisation



2441MHz Peak / Avg Vertical Polarisation



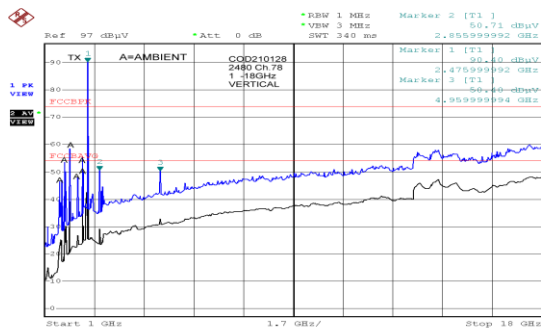
2441MHz Peak / Avg Horizontal Polarisation

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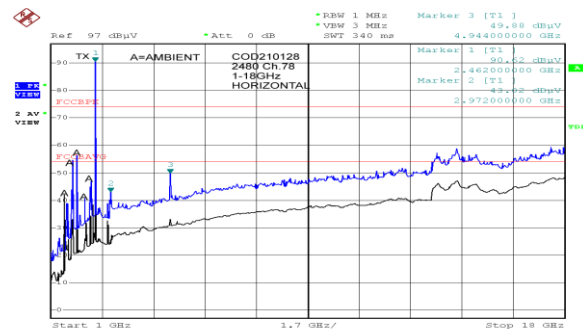
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Date: 5.JUL.2021 13:46:01

2480MHz Peak / Avg Vertical Polarisation



Date: 5.JUL.2021 14:22:13

2480MHz Peak / Avg Horizontal Polarisation

Note: 'A' indicates an ambient emission which was not from the EUT.
Note: 'Tx' indicates an intentional transmitter emission.

11.4.5 Radiated Disturbances: 18GHz to 25GHz at 1m distance

Measured field strength levels performed at a 1 meter distance were extrapolated to a 3 meter distance using the extrapolation factor of 20dB/decade.

All intentional radiation spurious were greater than 20dB below the limits specified in FCC 15.209. Emission levels were not affected by RF channel selection or modulation type.

Frequency MHz	Channel Number	Antenna Pol.	Pk Level dBμV/m	Pk Limit dBμV/m	Margin dB	Avg Level dBμV/m	Avg Limit dBμV/m	Margin dB
				74.0			54.0	
All measured out of band emissions were greater than 20 dB below the limits specified in section FCC15.209								
				74.0			54.0	

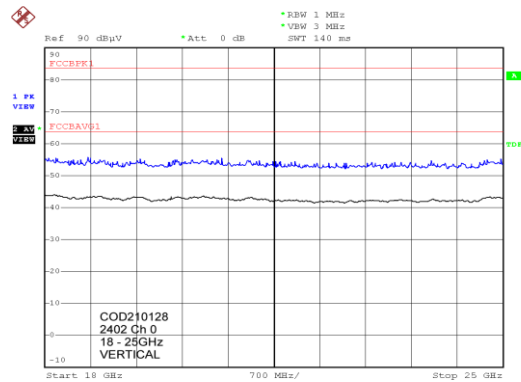
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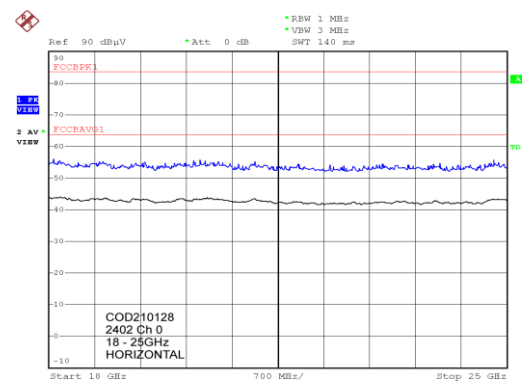


Following plots indicate limits calculated for a 1m distance.



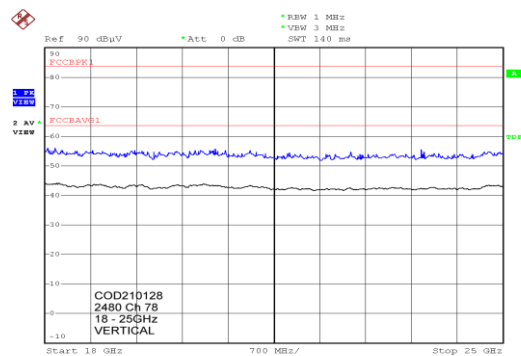
Date: 26.JUL.2021 11:51:14

2402 Ch.0 Peak / Avg Vertical Polarisation



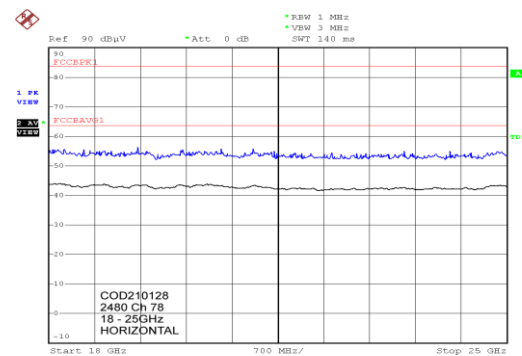
Date: 26.JUL.2021 11:56:46

2402 Ch.0 Peak / Avg Horizontal Polarisation



Date: 26.JUL.2021 12:00:48

2480 Ch.78 Peak / Avg Vertical Polarisation



Date: 26.JUL.2021 11:58:37

2480 Ch.78 Peak / Avg Horizontal Polarisation

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11.5 Band edge measurements

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

All measured disturbances were greater than 10dB below the FCC15.209 average limit, and greater than 20dB below the peak limit.

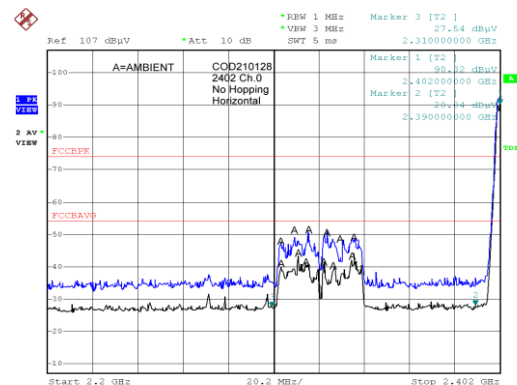
Both hopping and non-hopping modes assessed.

Non-hopping mode using channel 0, constant transmission:



Date: 5.JUL.2021 15:09:46

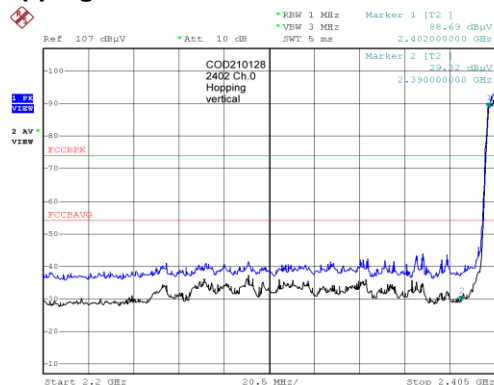
Ch0 – Peak/Avg Vertical Polarisation



Date: 5.JUL.2021 14:43:39

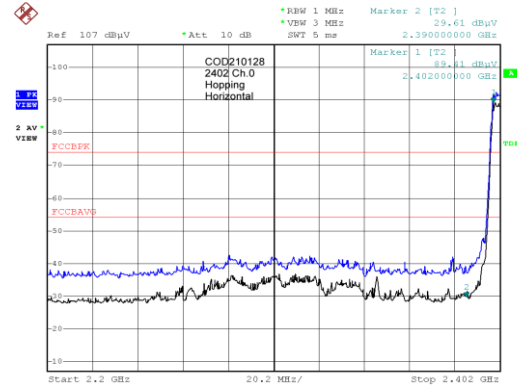
Ch0 – Peak/Avg Horizontal Polarisation

Hopping mode:



Date: 8.JUL.2021 12:19:30

Ch0 – Peak/Avg Vertical Polarisation



Date: 8.JUL.2021 12:08:00

Ch0 – Peak/Avg Horizontal Polarisation

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

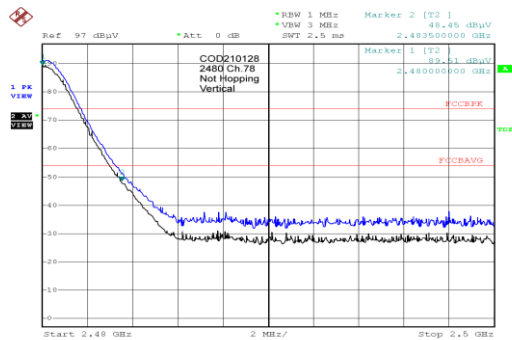
The highest measured Peak disturbance was >20 dB below the FCC15.209 Peak limit.

The highest measured Average disturbance was 3.6 dB below the FCC15.209 Average limit.

Frequency MHz	Channel Number	Antenna Pol.	Pk Level dBμV/m	Pk Limit dBμV/m	Margin dB	Avg Level dBμV/m	Avg Limit dBμV/m	Margin dB
2483.5	Non-Hopping	Vertical	-	74.0	>-20	50.1	54.0	*-3.9
2483.5	Hopping	Vertical	-	74.0	>-20	50.4	54.0	*-3.6
2483.5	Non-Hopping	Horizontal	-	74.0	>-20	48.5	54.0	-5.5
2483.5	Hopping	Horizontal	-	74.0	>-20	48.8	54.0	-5.2

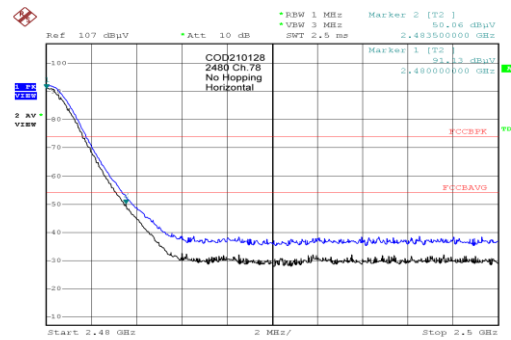
*Results were within the Laboratory's measurement uncertainty.

Non-Hopping mode using channel 78, constant transmission:



Date: 5.JUL.2021 13:26:39

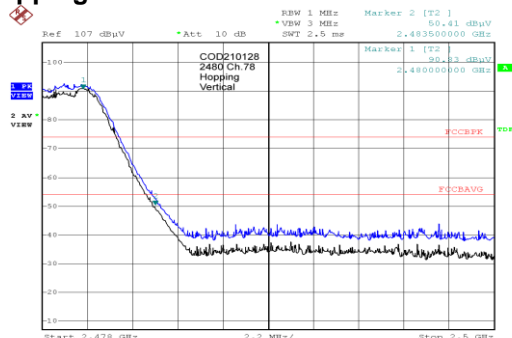
Ch78 – Peak / Avg Vertical Polarisation



Date: 5.JUL.2021 14:16:47

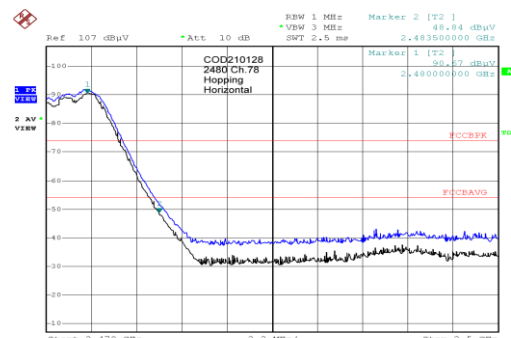
Ch78 –Peak / Avg Horizontal Polarisation

Hopping mode:



Date: 8.JUL.2021 11:37:03

Ch78 - Peak/Avg Vertical Polarisation



Date: 8.JUL.2021 11:52:24

Ch78 - Peak/Avg Horizontal Polarisation

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12 Channel Separation, Hopping Channels and Time of Occupancy

Test Dates:	7 th July 2021 8 th July 2021	Temperature:	22°C 21°C	Humidity:	33% 34%
Test Officer:	Steven Garnham				
Test Location:	Austest Laboratories (Yarramalong)				

12.1 EUT Operating Mode

- Battery voltage – 7.8VDC. Nominal 7.2VDC on label.
- Mode 1 – Constant BT transmission, ch0.
- Mode 2 – Constant BT transmission, ch39.
- Mode 3 – Constant BT transmission, ch78.

12.2 Test Method

Measurements were made using the supplied modified EUT fitted with an RF port connection. An interface board and a laptop were used to control the BT function.

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

12.3 Channel Separation

12.3.1 -20dB Bandwidth – BDR / EDR

Channel / Frequency MHz	Modulation Mode	20dB Bandwidth (MHz)
0 - (2402)	GFSK / 1Mbps	0.852
39 - (2441)	GFSK / 1Mbps	0.852
78 - (2480)	GFSK / 1Mbps	0.858
0 - (2402)	8DPSK / 3Mbps	1.260
39 - (2441)	8DPSK / 3Mbps	1.266
78 - (2480)	8DPSK / 3Mbps	1.266

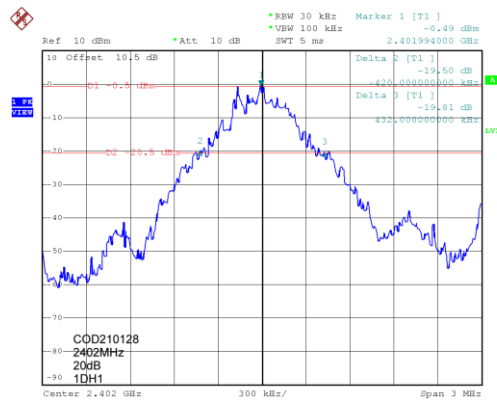
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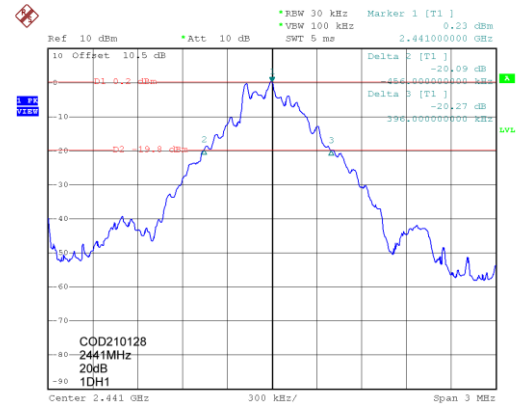


BDR-GFSK 1Mbps



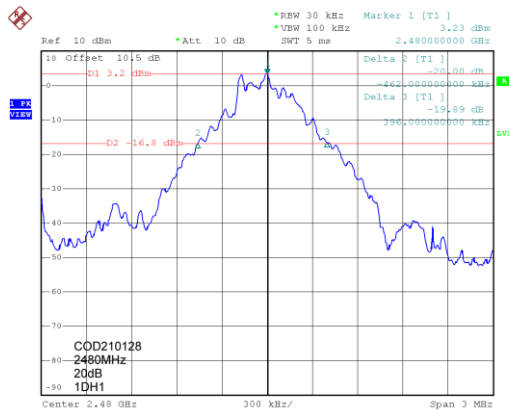
Date: 7.JUL.2021 10:37:44

20dB Bandwidth- Ch0



Date: 7.JUL.2021 11:32:12

20dB Bandwidth- Ch39



Date: 7.JUL.2021 11:35:40

20dB Bandwidth- Ch78

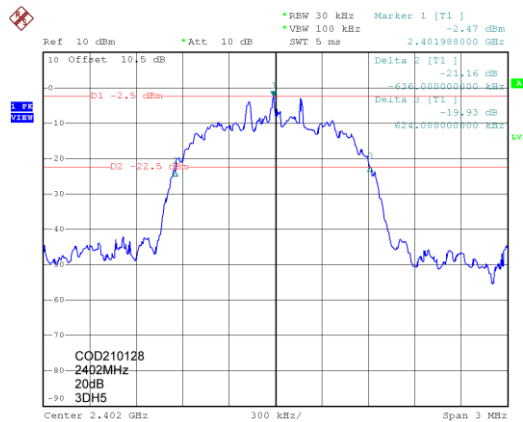
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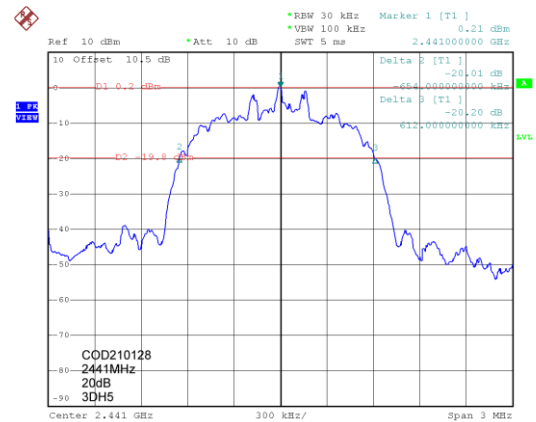
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EDR – 8DPSK 3Mbps

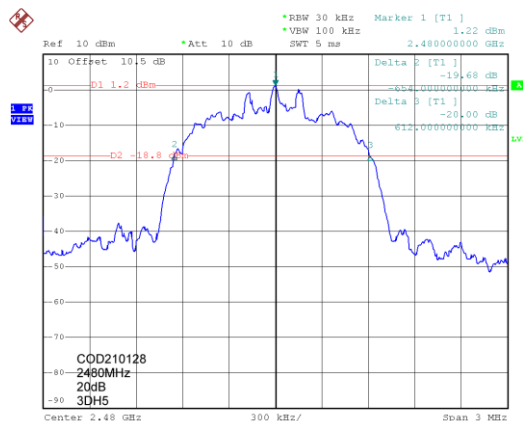


Date: 7.JUL.2021 11:04:26



Date: 7.JUL.2021 11:24:36

20dB Bandwidth – Ch0



Date: 7.JUL.2021 11:45:14

20dB Bandwidth – Ch78

20dB Bandwidth – Ch39

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12.3.2 Channel Separation; BDR, 1DH1

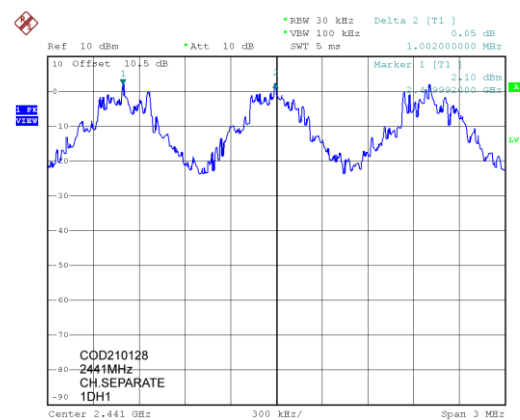
Channel / Frequency MHz	Measured Separation (kHz)	20dB Bandwidth (kHz)	2/3 of 20dB Bandwidth Limit (kHz)
0 - (2402)	1002	852	568
39 - (2441)	1002	852	568
78 - (2480)	1002	858	572

The minimum separation measured was 1.002MHz and therefore complied with the minimum limit of 0.568MHz.



Date: 7.JUL.2021 12:58:35

Channel Spacing – Ch0



Date: 7.JUL.2021 13:05:59

Channel Spacing – Ch39



Date: 7.JUL.2021 13:08:30

Channel Spacing – Ch78

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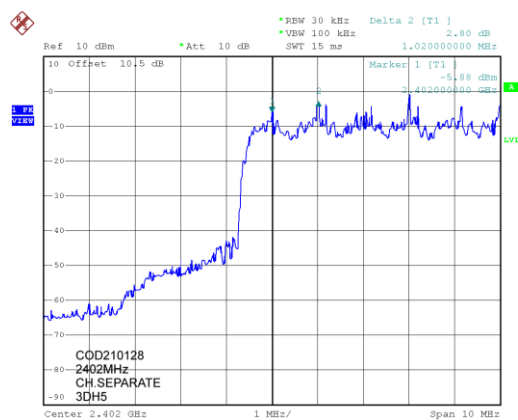
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12.3.3 Channel Separation; EDR, 3DH5

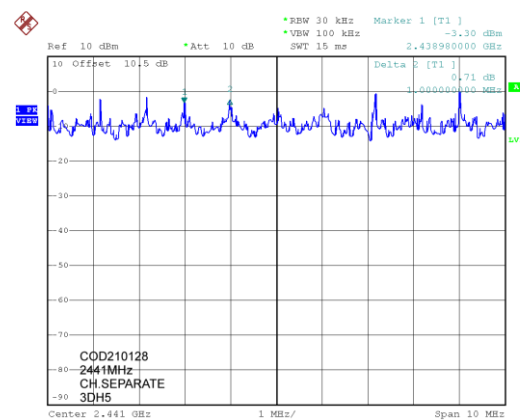
Channel / Frequency MHz	Measured Separation (kHz)	20dB Bandwidth (kHz)	2/3 of 20dB Bandwidth Limit (kHz)
0 - (2402)	1020	1260	840
39 – (2441)	1000	1266	844
78 – (2480)	1000	1266	844

The minimum separation measured was 1.000MHz and therefore complied with the minimum limit of 0.840MHz.



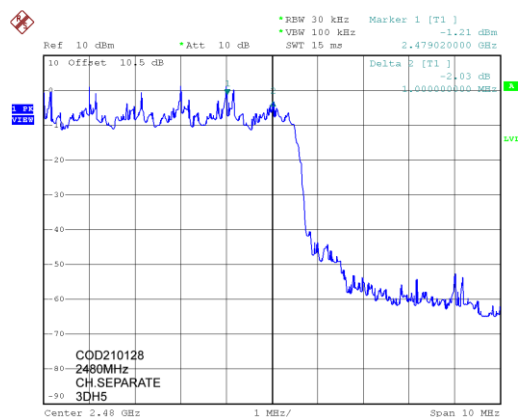
Date: 7.JUL.2021 13:40:25

Channel Spacing – Ch0



Date: 7.JUL.2021 13:42:38

Channel Spacing – Ch39



Date: 7.JUL.2021 13:47:06

Channel Spacing – Ch78

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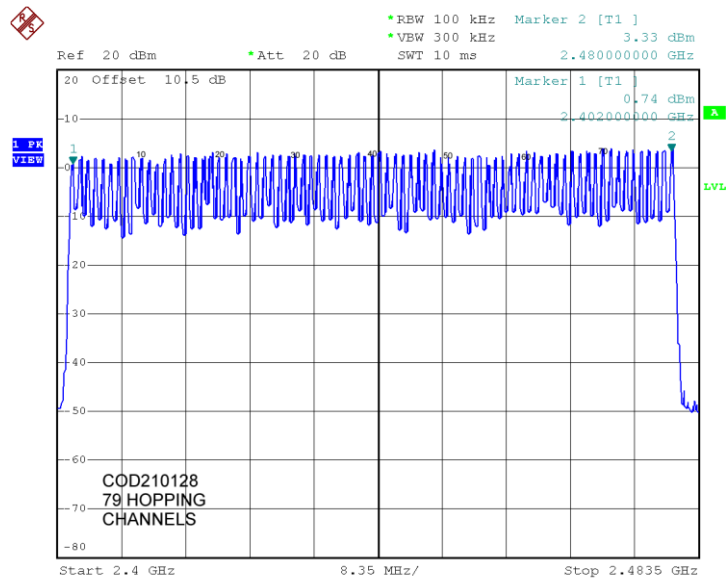
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12.4 Number of Hopping Channels

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



Date: 28.MAY.2021 10:35:52

2400 – 2483.5MHz

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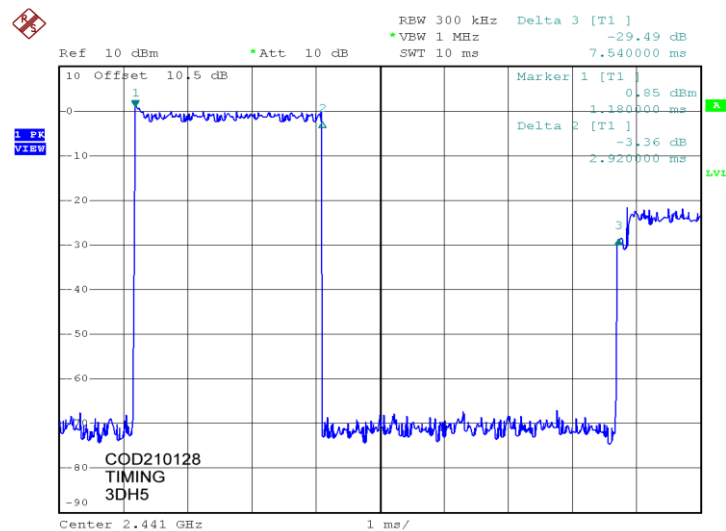


12.5 Time of Occupancy

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.

EDR / 3DH5 mode (longest transmit time):

Limit	0.4 seconds in any 31.6 s.
Tx(ON), ms	2.92
Transmission period, ms	7.54
Channels per hopping sequence	79
Time for one hopping sequence	$7.54 \times 79 = 595.7\text{ms}$
Hops on one channel in 31.6 s	$31.6 / 0.5957 = 53.05$
Average time of Occupancy	$53.05 \times 0.00292 = \mathbf{0.155\text{s per 31.6}}$



Date: 18.AUG.2021 11:03:35

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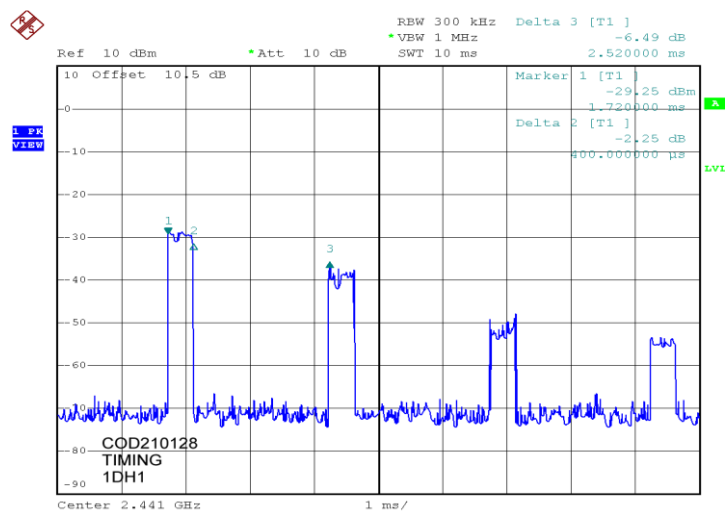
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BDR / 1DH1 mode (shortest transmit time):

Limit	0.4 seconds in any 31.6 s.
Tx(ON) , ms	0.40
Transmission period, ms	2.52
Channels per hopping sequence	79
Time for one hopping sequence	$2.52 \times 79 = 199.1\text{ms}$
Hops on one channel in 31.6 s	$31.6 / 0.1991 = 158.7$
Average time of Occupancy	$158.7 \times 0.0004 = \mathbf{0.063\text{s per 31.6}}$



Date: 18.AUG.2021 11:21:37

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13 PEAK CONDUCTED OUTPUT POWER

Test Date:	7 th July 2021	Temperature:	22°C
Test Officer:	Steven Garnham	Humidity:	33%
Test Location:	Austest Laboratories (Yarramalong)		

13.1 EUT Operating Mode

- Battery voltage – 7.9VDC (Charged battery pack).
- Mode 1 – Constant BT transmission, ch0.
- Mode 2 – Constant BT transmission, ch39.
- Mode 3 – Constant BT transmission, ch78.

13.2 Test Method

Measurements were made using the supplied modified EUT fitted with an RF port connection. An interface board and a laptop were used 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, 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.

13.3 Directional antenna gain

Not applicable as the internal PCB antenna gain was less than 6 dBi.

13.4 Transmit Power – Supply Voltage Variation

The EUT was powered from a fully charged battery pack.

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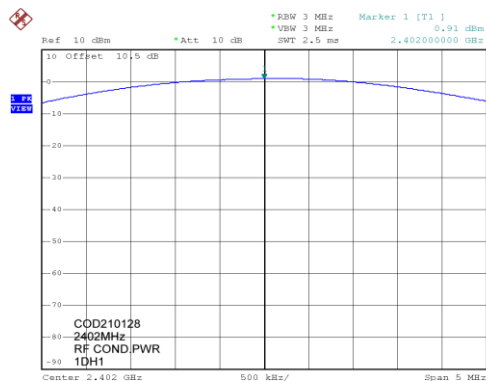


13.5 Test Results

Measurements were performed on the sample with a temporary antenna port by applying the procedure detailed in ANSI C63.10. Measured into 50 Ohms.

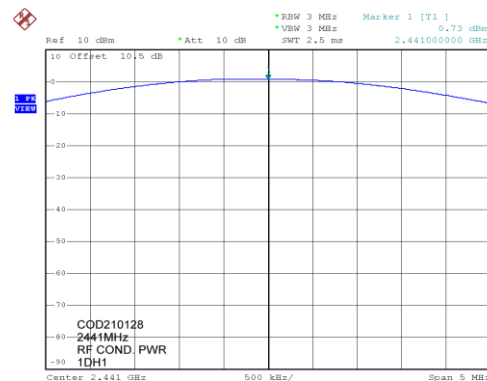
The power was measured directly from the marker results, the cable and attenuator loss used for the conducted measurements were compensated for.

Channel (Modulation)	Peak Conducted Power		Limit W	Margin dB
	dBm	W		
0 (BDR)	+0.91	0.0012	1.000	-29.2
39 (BDR)	+0.73	0.0012	1.000	-29.2
78 (BDR)	+1.78	0.0015	1.000	-28.2
0 (EDR)	+0.32	0.0011	1.000	-29.6
39 (EDR)	+2.46	0.0018	1.000	-27.5
78 (EDR)	+3.41	0.0022	1.000	-24.4



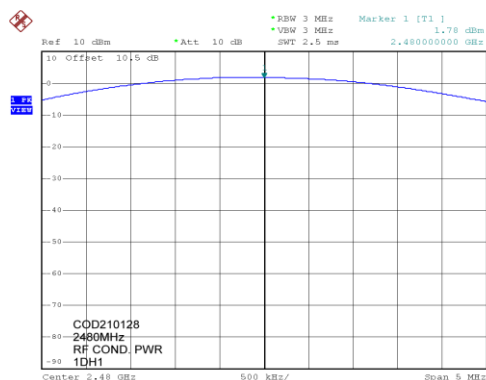
Date: 7.JUL.2021 10:48:59

Peak Conducted Power BDR- Ch0



Date: 7.JUL.2021 11:16:32

Peak Conducted Power BDR - Ch39



Date: 7.JUL.2021 12:02:15

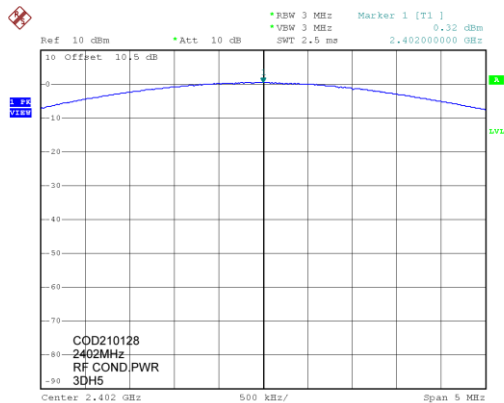
Peak Conducted Power BDR - Ch78

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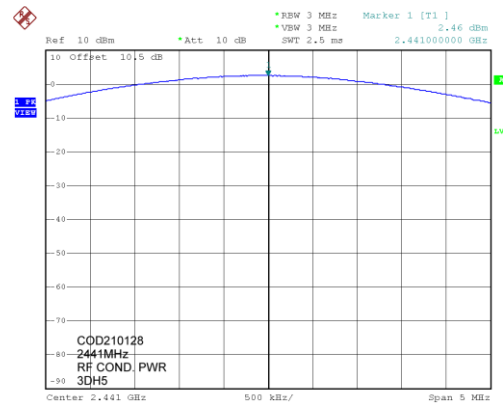
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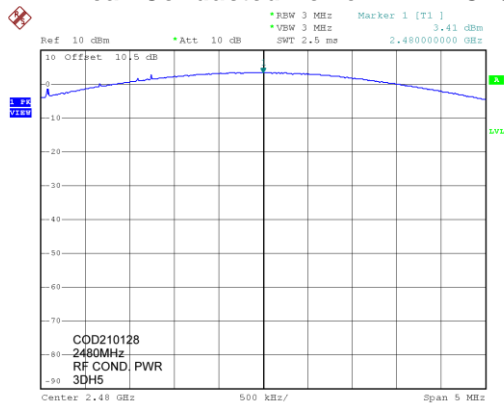


Date: 7.JUL.2021 11:10:02



Date: 7.JUL.2021 11:13:20

Peak Conducted Power EDR – Ch0



Date: 7.JUL.2021 12:05:11

Peak Conducted Power EDR – Ch39

Peak Conducted Power EDR – Ch78

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13.6 Out of band emissions – Section 15.247(d)

Test Date:	7 th July 2021	Temperature:	22°C
	8 th July 2021		21°C
Test Officer:	Steven Garnham	Humidity:	33%
			34%
Test Location:	Austest Laboratories (Yarramalong)		

13.6.1 EUT Operating Mode

- Battery voltage – 7.9VDC.
- Mode 1 – Constant BT transmission, ch0.
- Mode 2 – Constant BT transmission, ch39.
- Mode 3 – Constant BT transmission, ch78.

13.6.2 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.

- Measurements were performed in accordance with ANSI C63.10-2013 and KDB 558074 FHSS Meas Guidance.
- The EUT antenna port was connected directly to a spectrum analyser via a low loss RF cable, and attenuator.
- 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).
- Measurements were made on the low, middle and high channels and highest in-band level recorded.
- The frequency range was swept up to the 10th harmonic to locate the highest out of band emissions.
- Any out of band emissions were measured to ensure they were greater than 20dB below the recorded in band level.
- 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.
- Measurements were repeated for the low, middle and high channel and across all transmit modes.

13.6.3 Test Results

Frequency range: 9kHz to 25000MHz.

Highest in-band reference level at 2441MHz, +3.5dBm (CH39), BDR, (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 -16.5dBm.

Highest measured out of band emission level was at 2527MHz which was 31.5dB below the highest in band -20dB limit.

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Frequency (MHz)	Channel	Peak Level (dBm)	Out of Band Limit (dBm)	Below Limit (dB)
2527	0	-48.0	-16.5	-31.5
2577	39	-51.2	-16.5	-34.7
2577	78	-52.0	-16.5	-35.5

IN BAND REFERENCE LEVEL BDR:



Date: 26.AUG.2021 09:56:21



Date: 26.AUG.2021 09:57:41

In-band - Ch0 - BDR

In-band - Ch39 - BDR



Date: 26.AUG.2021 10:02:46

In-band - Ch78 - BDR

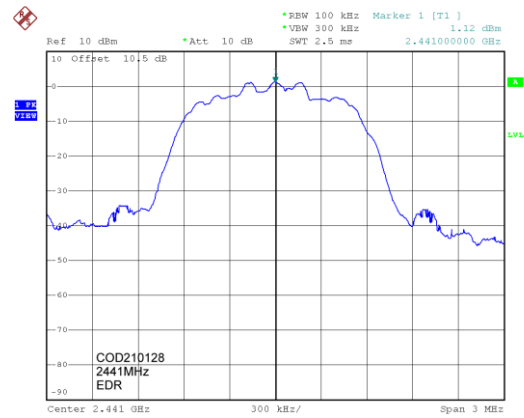
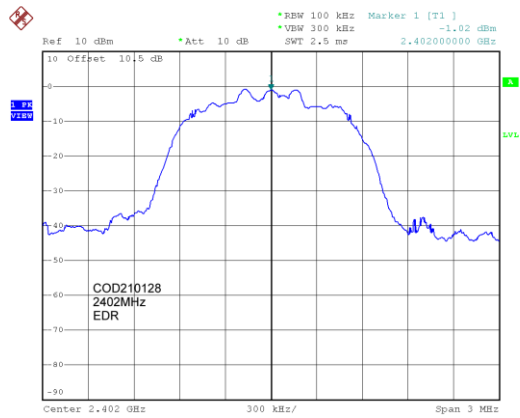
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IN BAND REFERENCE LEVEL EDR:



In-band – Ch0 - EDR



In-band – Ch39 - EDR

In-band – Ch78 - EDR

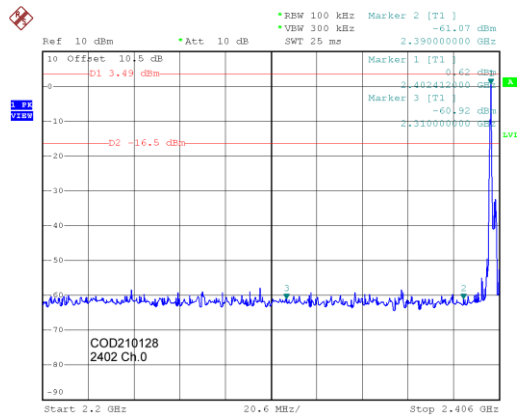
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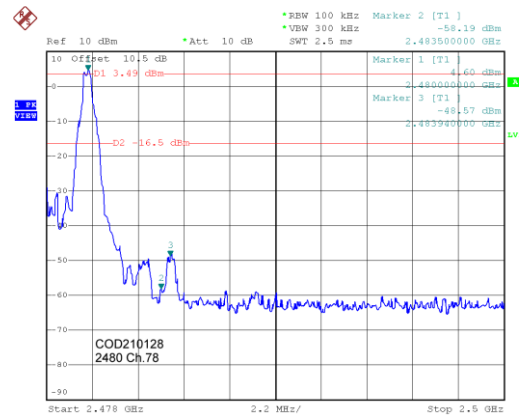
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NON-HOPPING:

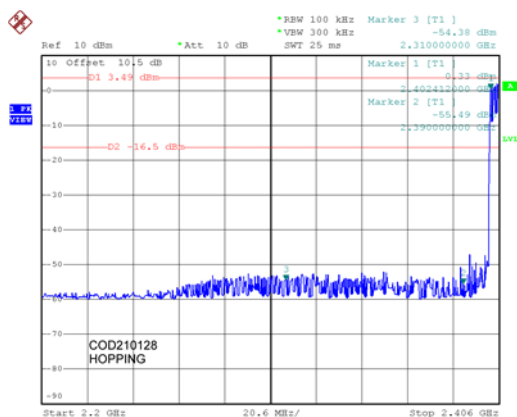


2200MHz to 2400MHz

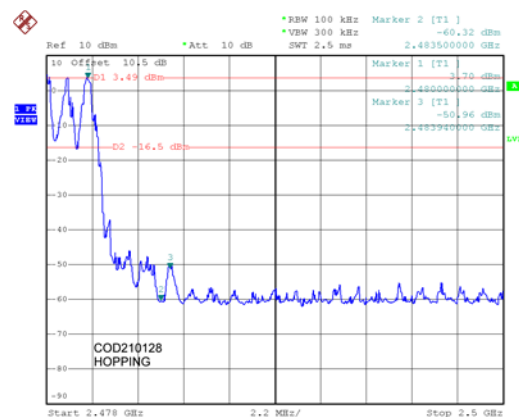


2483.5MHz to 2500MHz

HOPPING:



2200MHz to 2400MHz



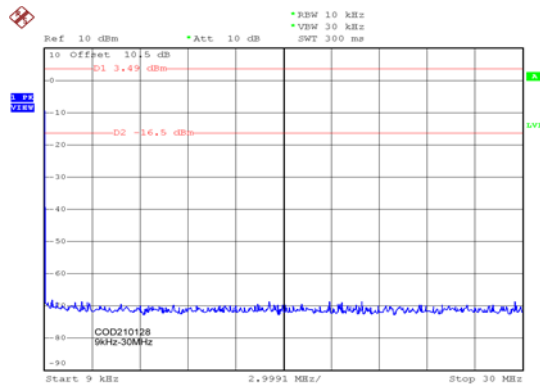
2483.5MHz to 2500MHz

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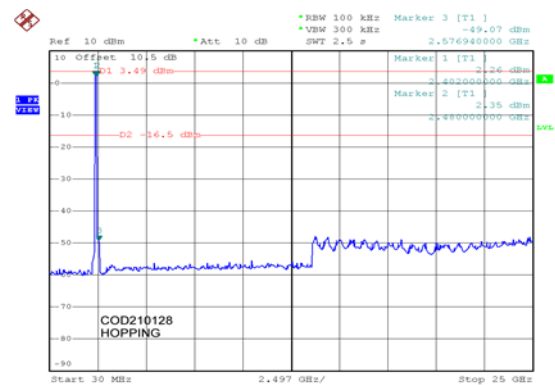
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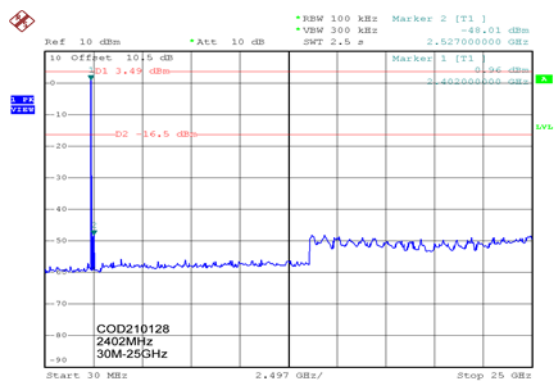




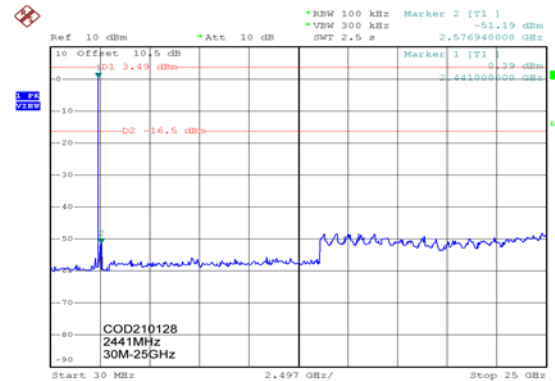
9kHz to 30MHz-Hopping / Non-Hopping



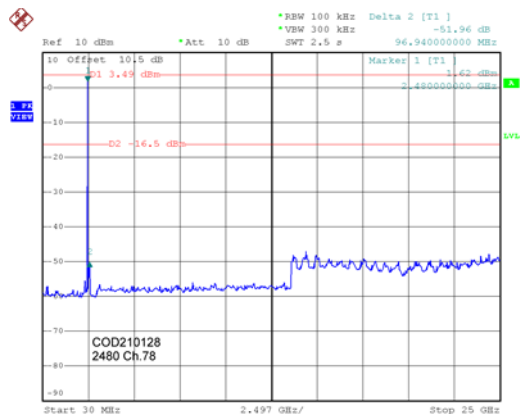
30MHz to 25GHz-Hopping



30MHz to 25GHz-Non-Hopping- Ch 0



30MHz to 25GHz-Non-Hopping- Ch 39



30MHz to 25GHz-Non-Hopping- Ch 78

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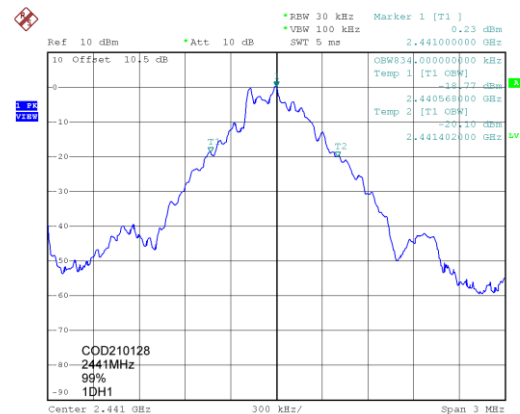


14 FCC Part 2J, Section 2.1049 – 99% Bandwidth

Channel	99% Bandwidth (kHz)
0 (BDR)	858
39 (BDR)	834
78 (BDR)	834
0 (EDR)	1164
39 (EDR)	1164
78 (EDR)	1170



Date: 7.JUL.2021 10:46:13



Date: 7.JUL.2021 11:19:08

99% Bandwidth – BDR – Ch0

99% Bandwidth – BDR – Ch 39



Date: 7.JUL.2021 12:00:07

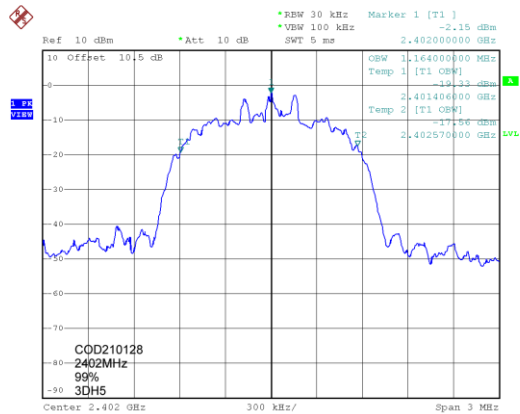
99% Bandwidth – BDR – Ch 78

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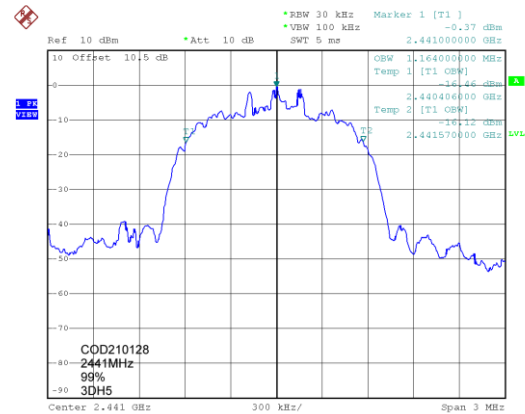
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Date: 7.JUL.2021 11:08:31

99% Bandwidth – EDR – Ch0



Date: 7.JUL.2021 11:22:25

99% Bandwidth – EDR – Ch 39



Date: 7.JUL.2021 11:49:52

99% Bandwidth – EDR – Ch 78

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