

Report on the Radio Testing
For
Dyson Technology Ltd
on
RB03 Dyson 360 VISNAV
Report no. TRA-047957-45-05B
25th May 2021

RF915 7.0



Report Number: TRA-047957-45-05B
Issue: B

REPORT ON THE RADIO TESTING OF A
Dyson Technology Ltd
RB03 Dyson 360 VISNAV
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 2020/06/05 - 2020/12/10

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RF915 7.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	13 th April 2021	Original
B	25 th May 2021	Update after certification check

2 Summary

TEST REPORT NUMBER:	TRA-047957-45-05B
WORKS ORDER NUMBER:	TRA-047957-03
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.
TEST SPECIFICATION:	47CFR15.247
EQUIPMENT UNDER TEST (EUT):	RB03 Dyson 360 VISNAV
FCC IDENTIFIER:	QVHRB03001
EUT SERIAL NUMBER:	not applicable
MANUFACTURER/AGENT:	Dyson Technology Ltd
ADDRESS:	Tetbury Hill Malmesbury Wiltshire SN16 0RP United Kingdom
CLIENT CONTACT:	Neil Taylor ☎ 01666834364 ✉ neil.taylor@dyson.com
ORDER NUMBER:	6000061185
TEST DATE:	2020/06/05 - 2020/12/10
TESTED BY:	D Garvey / A Tosif / A Longley Element

2.1 Test Summary

Test Method and Description		Requirement Clause	Applicable to this equipment	Result / Note
		47CFR15		
Radiated spurious emissions (restricted bands of operation and cabinet radiation)		15.205	☒	PASS
AC power line conducted emissions		15.207	☒	PASS
Occupied bandwidth		15.247(a)(2)	☒	PASS
Conducted carrier power	Peak	15.247(b)(3)	☒	PASS
	Max.		☐	
Conducted / radiated RF power out-of-band		15.247(d)	☒	PASS
Power spectral density, conducted		15.247(e)	☒	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-047957-45-05B presents the results of the Radio testing on a Dyson Technology Ltd, RB03 Dyson 360 VISNAV to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Dyson Technology Ltd by Element, at the address detailed below.

☒	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	☐	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-UK MRA, designation numbers:

UK2007 Hull

UK2020 Skelmersdale

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 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 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

7 Equipment Under Test

7.1 EUT Identification

- Name: RB03 Dyson 360 VISNAV
- Serial Number: not applicable
- Model Number: RB03
- Software Revision: Not Applicable
- Build Level / Revision Number: Not Applicable

7.2 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.

Not Applicable – No support/monitoring equipment required.

7.3 EUT Mode of Operation

The EUT was transmitting continuously with modulation on bottom, middle and top channels, as required.

7.4 EUT Radio Parameters

Frequency of operation:	2402 MHz – 2480 MHz
Modulation type:	GFSK
Nominal Supply Voltage:	5.0 Vdc from internal power supply
Antenna Type:	Integral PCB
Antenna Gain:	5.0 dBi

7.5 EUT Description

The EUT is an autonomous Vacuum Cleaning Robot and Dock that has Bluetooth Low Energy, 2.4 GHz Wi-Fi and 5 GHz Wi-Fi Radios. This test report only covers testing of the Bluetooth Low Energy.

8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

The following diagram shows basic EUT interconnections:



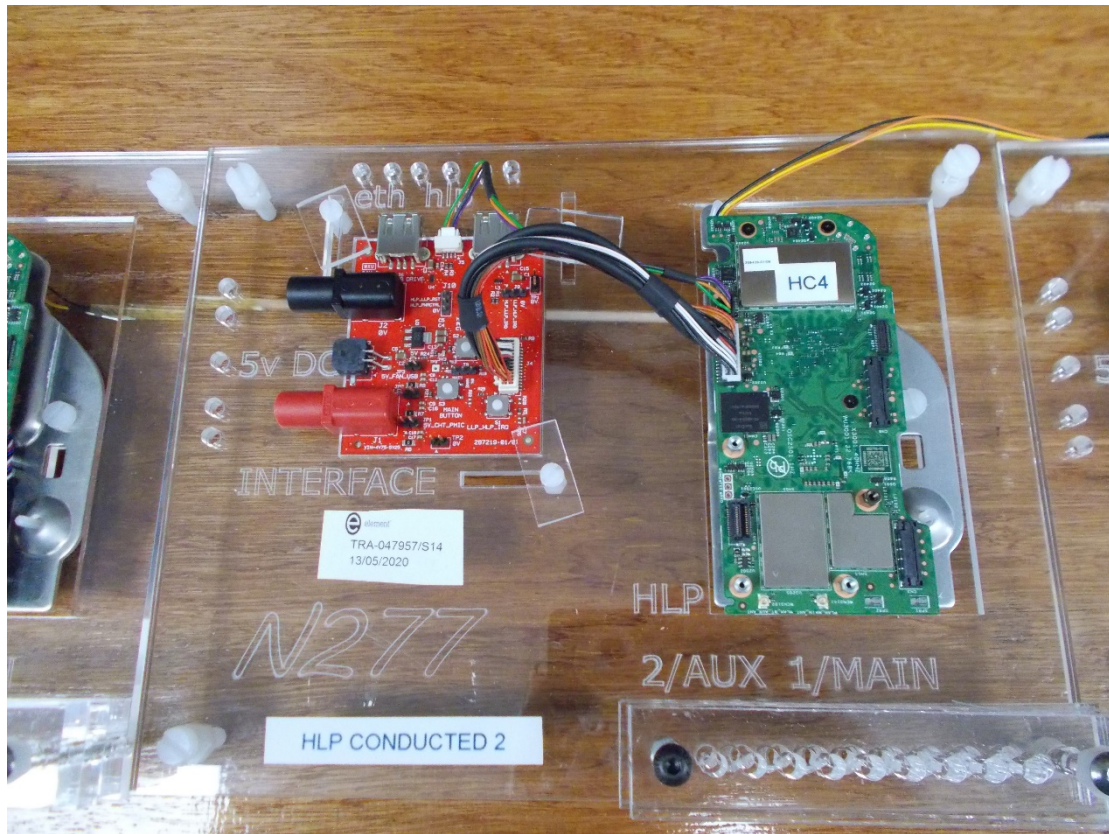
9.2 General Set-up Photograph

The following photographs shows basic EUT radiated set-up:





The following photograph shows the conducted sample:



9.3 Measurement software

Where applicable, the following software was used to perform measurements contained within this report.

Element Emissions R5 (See Note)

Note:

The version of the Element software used is recorded in the results sheets contained within this report.

10 General Technical Parameters

10.1 Normal Conditions

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 5 Vdc from an internal power supply which was powered from a 14.8 Vdc fully charged battery, with charging station connected to 110 Vac, 60 Hz, from the mains. For conducted testing, 5 Vdc was supplied from desktop power supply.

10.2 Varying Test Conditions

There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised band and the manufacturer has declared sufficient frequency stability (refer to section 7.4).

Variation of supply voltage is required to ensure stability of the declared output power. During carrier power testing the following variations were made:

	Category	Nominal	Variation
☐	Mains	110 V ac +/-2 %	85 % and 115 %
☒	Internal Power Supply	5 Vdc	N/A

11 Radiated emissions

11.1 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.

11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 3
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	2 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: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	As declared

11.3 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

11.4 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;

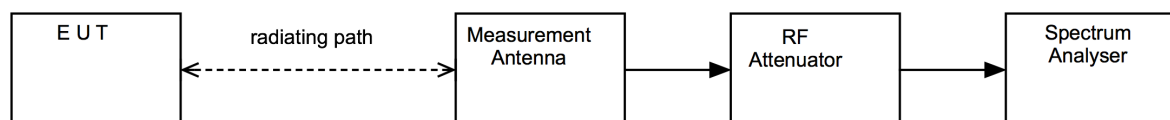
PA is the pre-amplifier gain in dB (where used);

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



11.5 Test Set-up Photograph



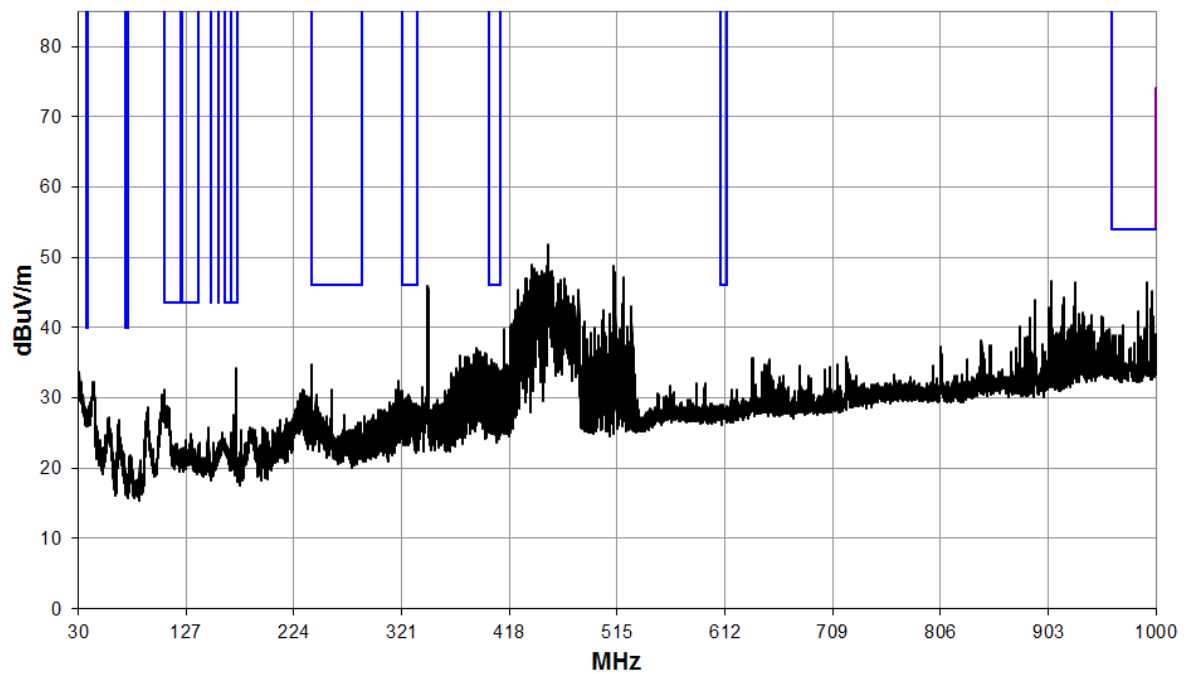
11.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Ferrite Lined Chamber	Rainford	Chamber	REF2259	2022-08-03
EMI Test Receiver	R&S	ESW26	REF2235	2021-08-31
Bilog Antenna	Chase	CBL6111B	REF2218	2021-10-23
Horn Antenna	A Info Inc	LB-10180-NF	REF2241	2022-07-13
LB-90-25-C2-SF	A Info Inc	Horn Antenna	REF2243	2022-07-17
LB-62-25-C-SF	A Info Inc	Horn Antenna	REF2244	2022-07-17
LB-180400-25-C-KF	A Info Inc	Horn Antenna	REF2246	2022-07-28
Emissions R5	Element	Radiated Test Software	REF9000	Cal not required

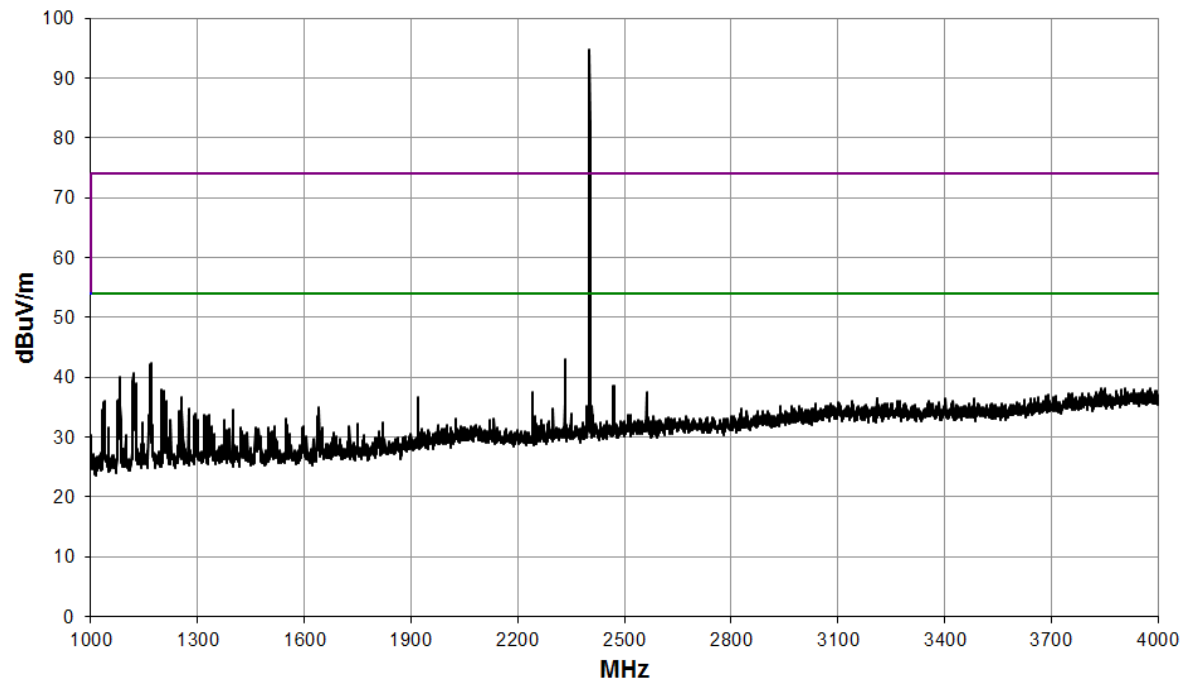
11.7 Test Results

BLE; Power Setting: 4; Channel: 0; Frequency: 2402 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
AV	1169.5	10.7	2.5	24.6	0.0	0.0	0.0	37.8	77.6	500
AV	4803.9	-1.4	5.4	33.3	0.0	0.0	0.0	37.3	73.3	500
Peak emissions are not within 20 dB of the limit.										

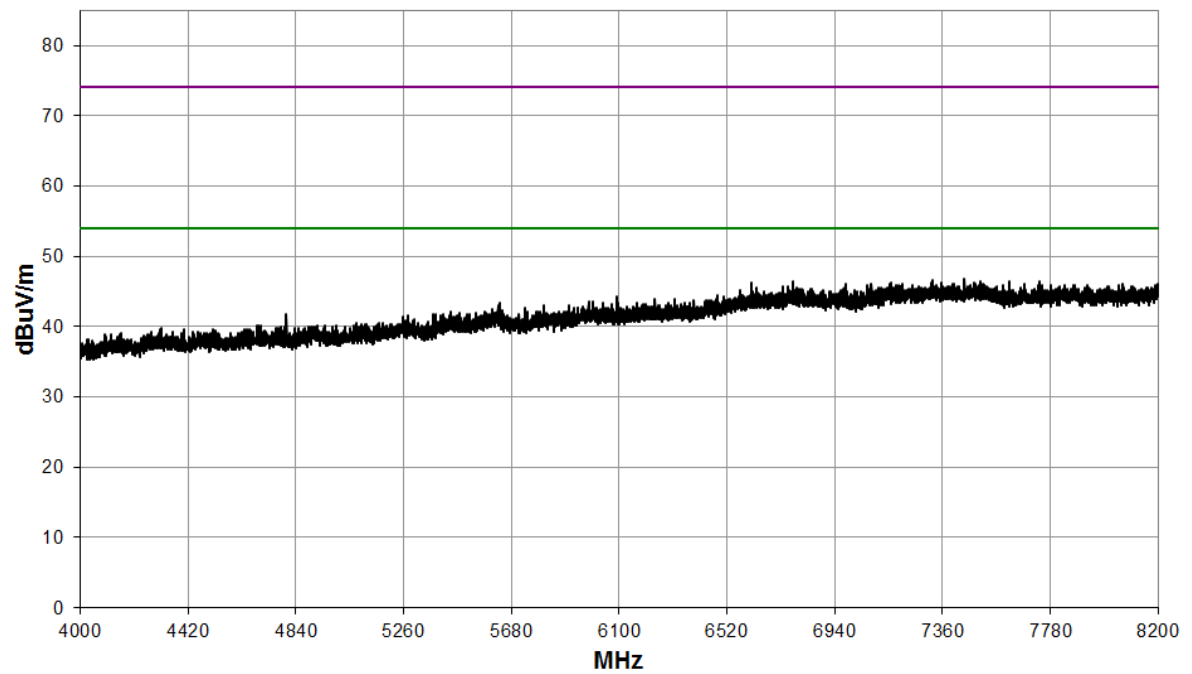
30 MHz to 1 GHz



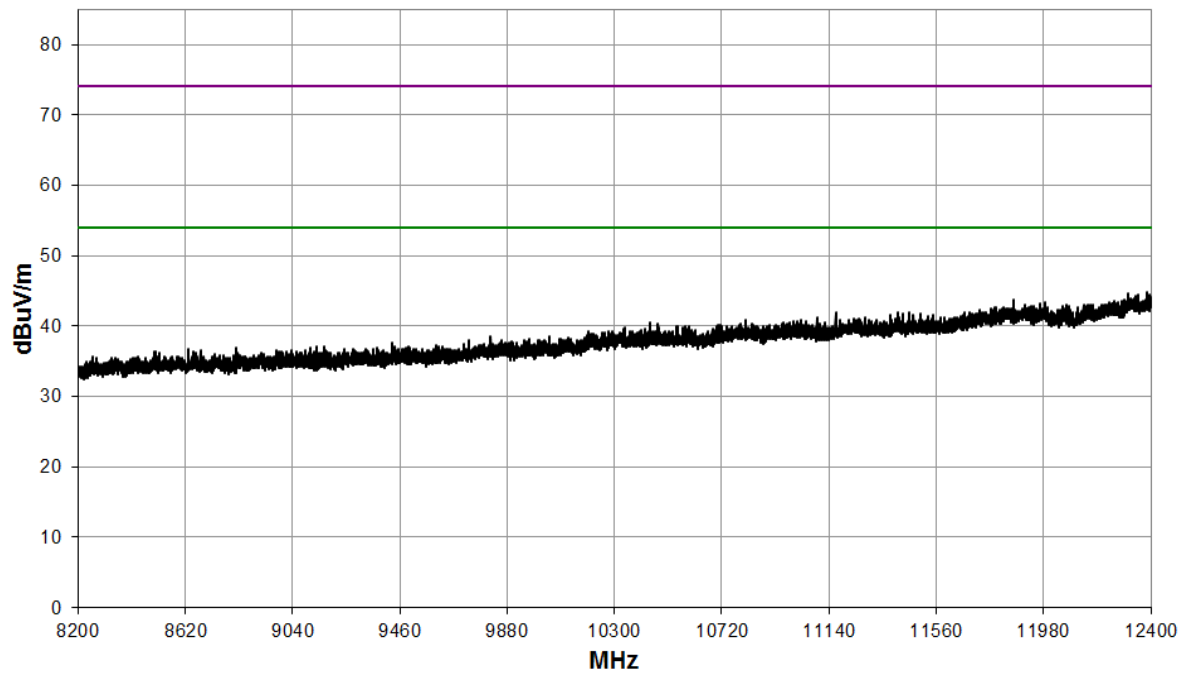
1 GHz to 4 GHz



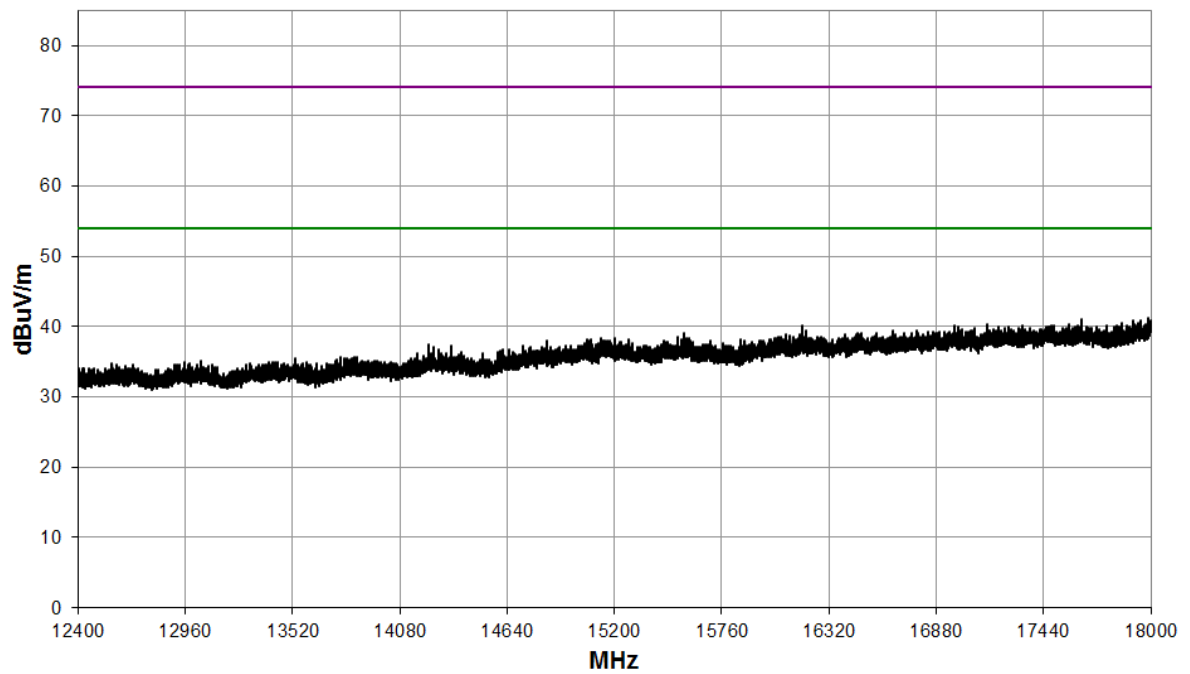
4 GHz to 8.2 GHz



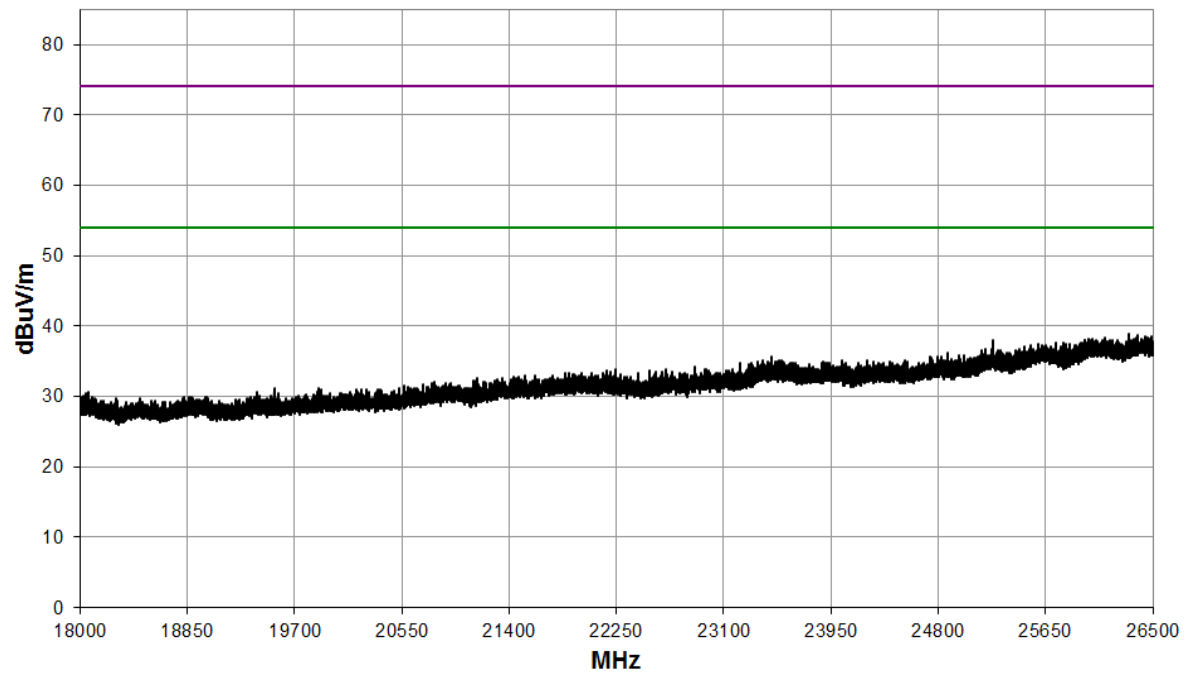
8.2 GHz to 12.4 GHz



12.4 GHz to 18 GHz

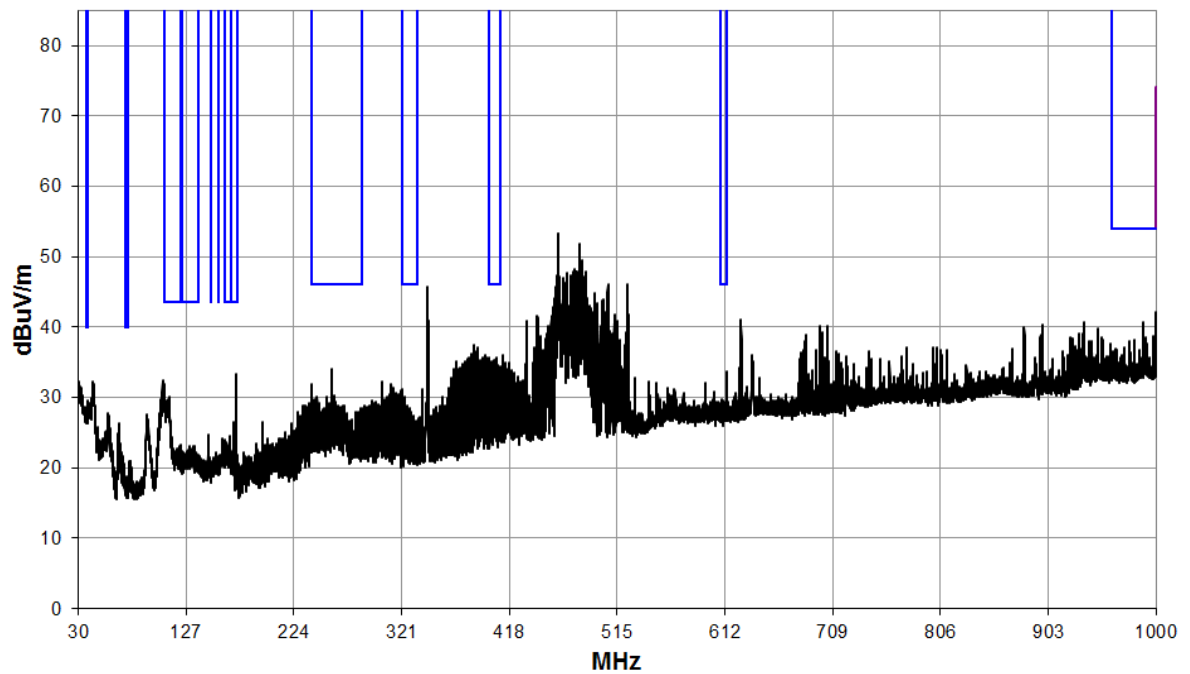


18 GHz to 26.5 GHz

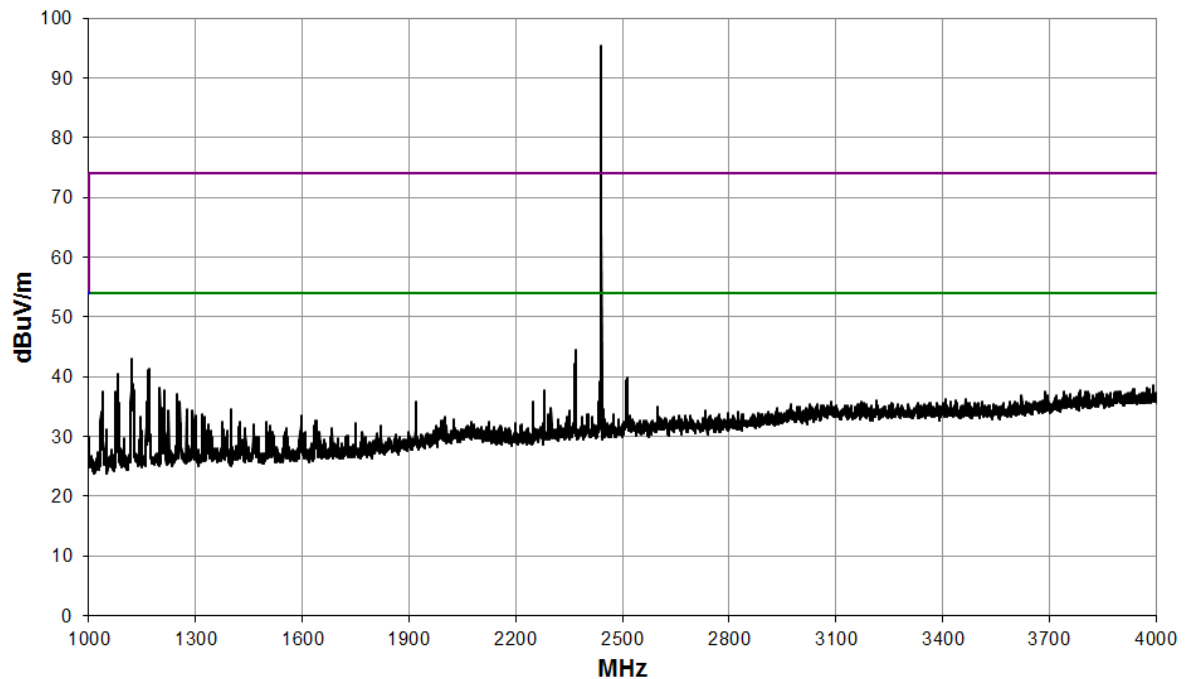


BLE; Power Setting: 4; Channel: 19; Frequency: 2440 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
AV	1169.5	10.7	2.5	24.6	0.0	0.0	0.0	37.8	77.6	500
AV	4879.9	0.9	5.4	33.3	0.0	0.0	0.0	39.6	95.5	500
Peak emissions are not within 20 dB of the limit.										

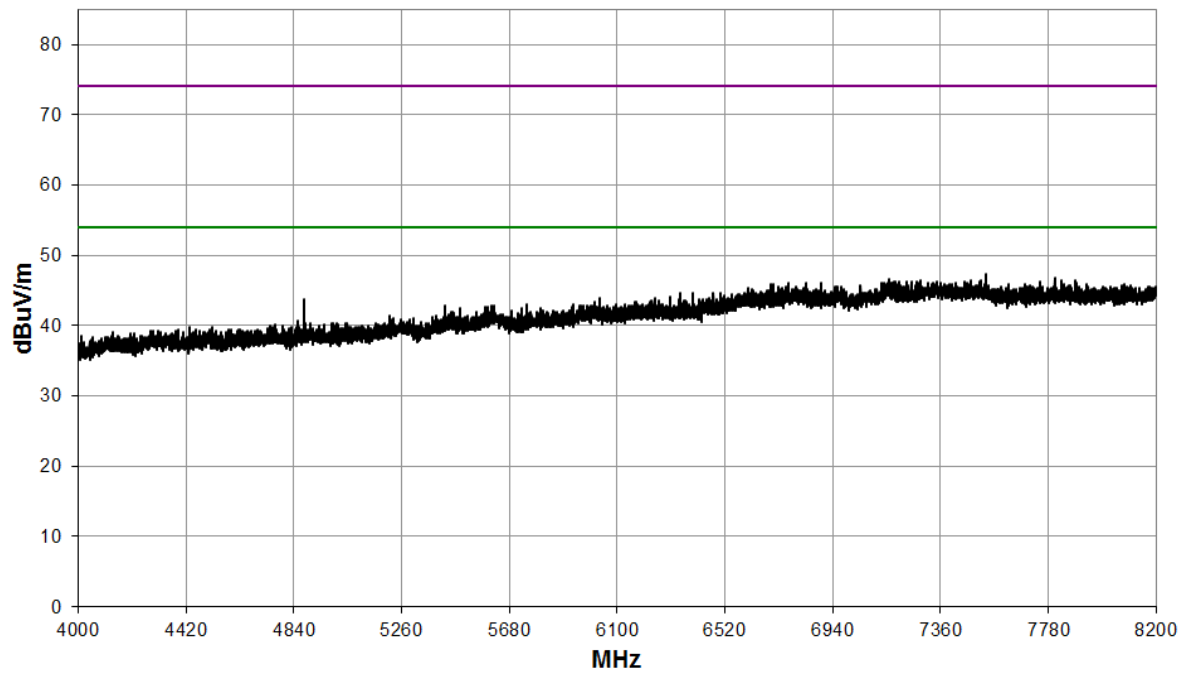
30 MHz to 1 GHz



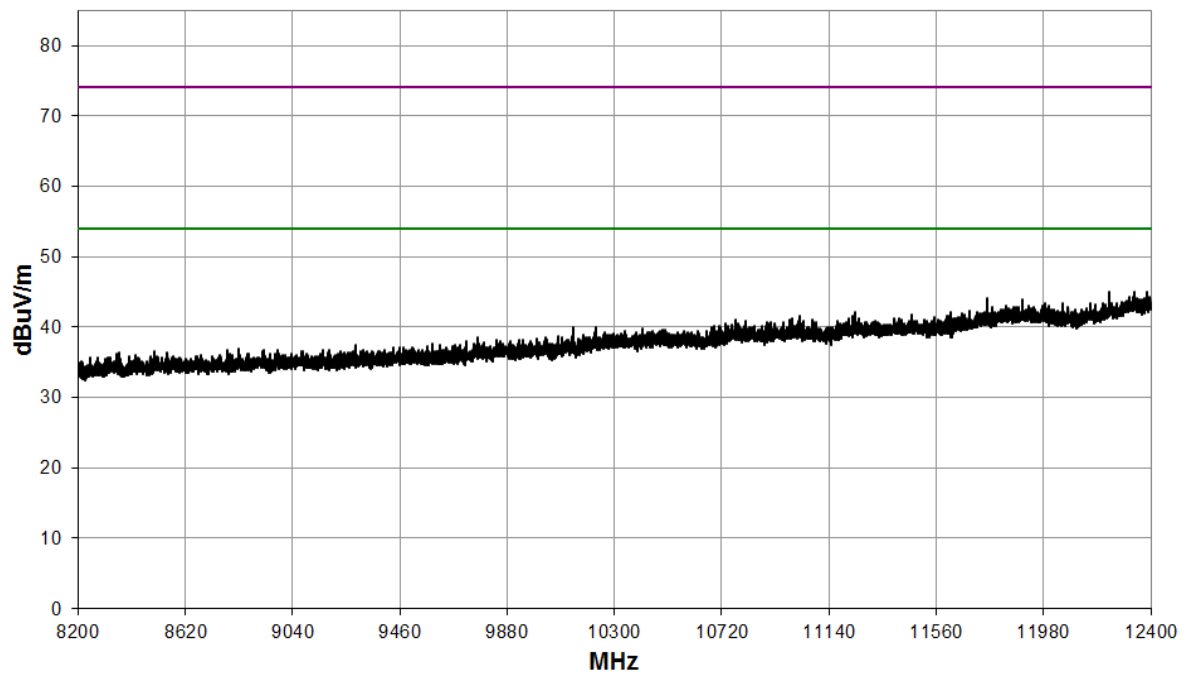
1 GHz to 4 GHz



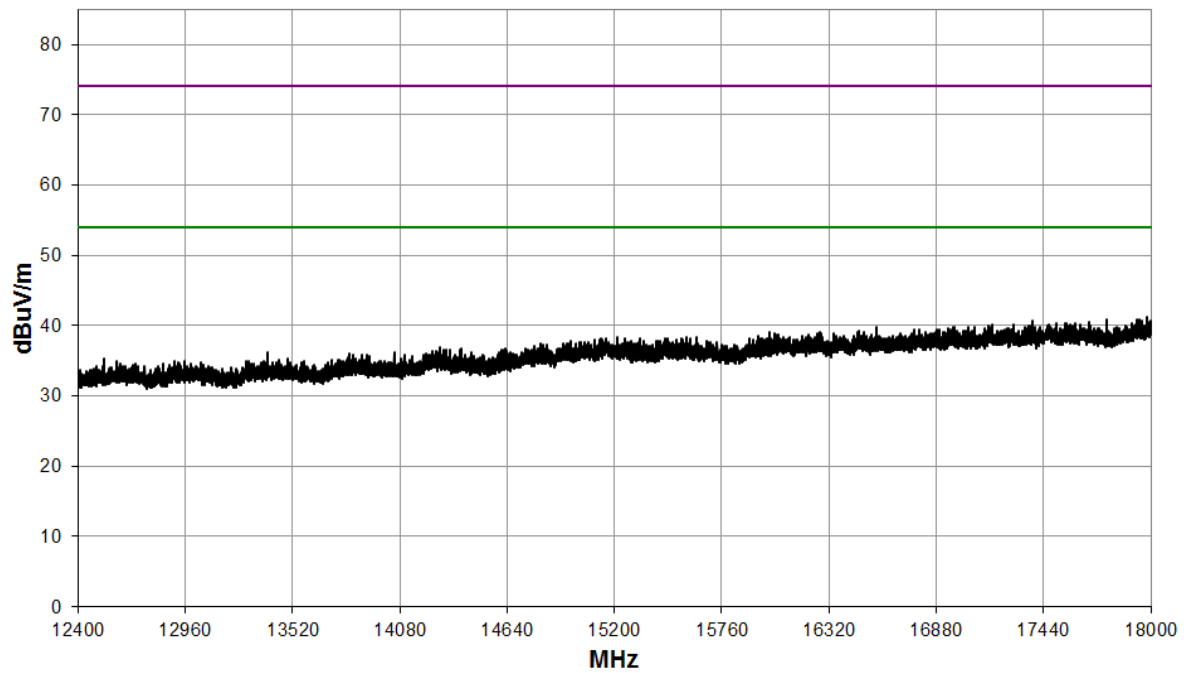
4 GHz to 8.2 GHz



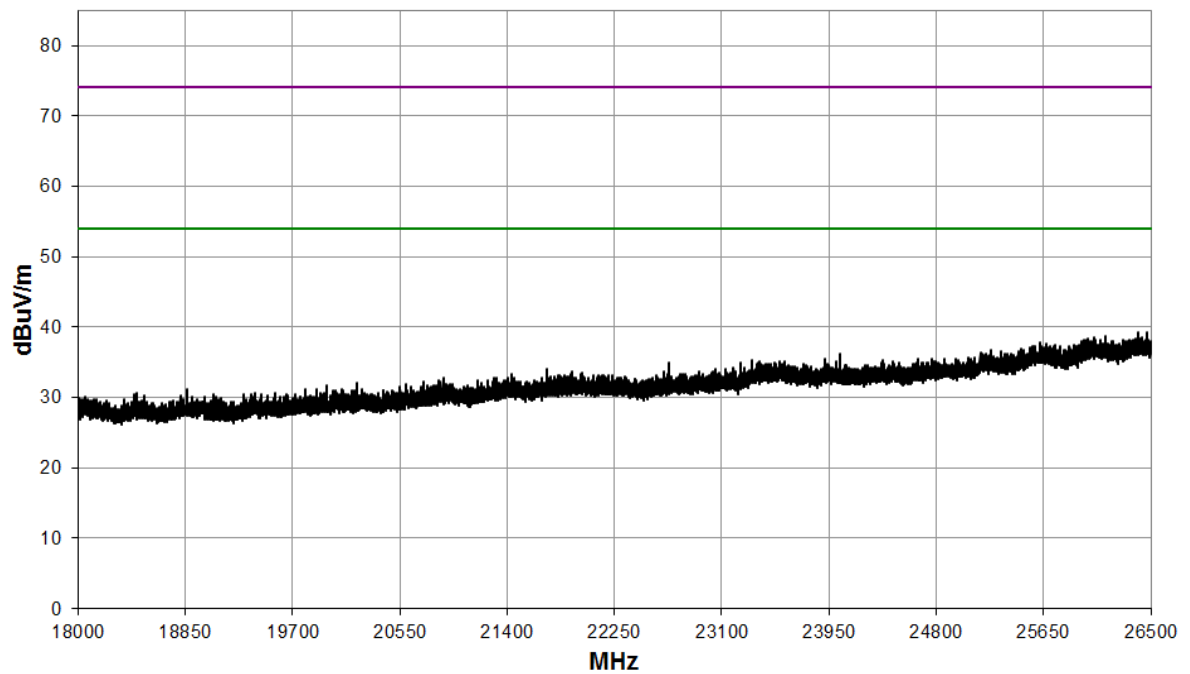
8.2 GHz to 12.4 GHz



12.4 GHz to 18 GHz

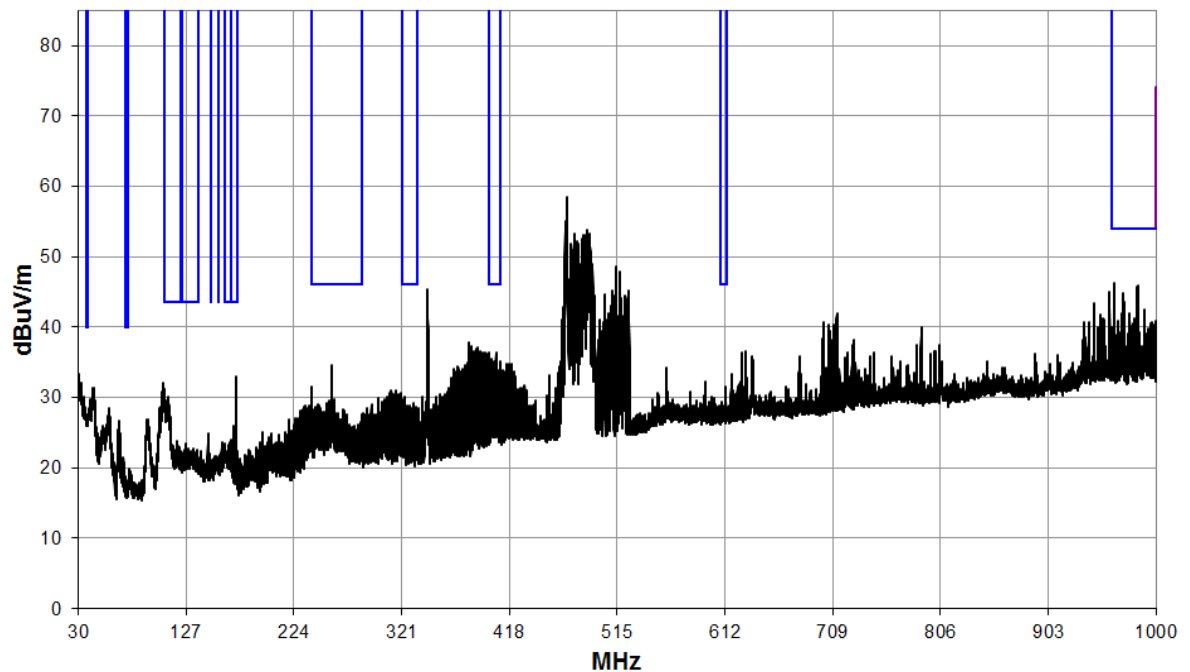


18 GHz to 26.5 GHz

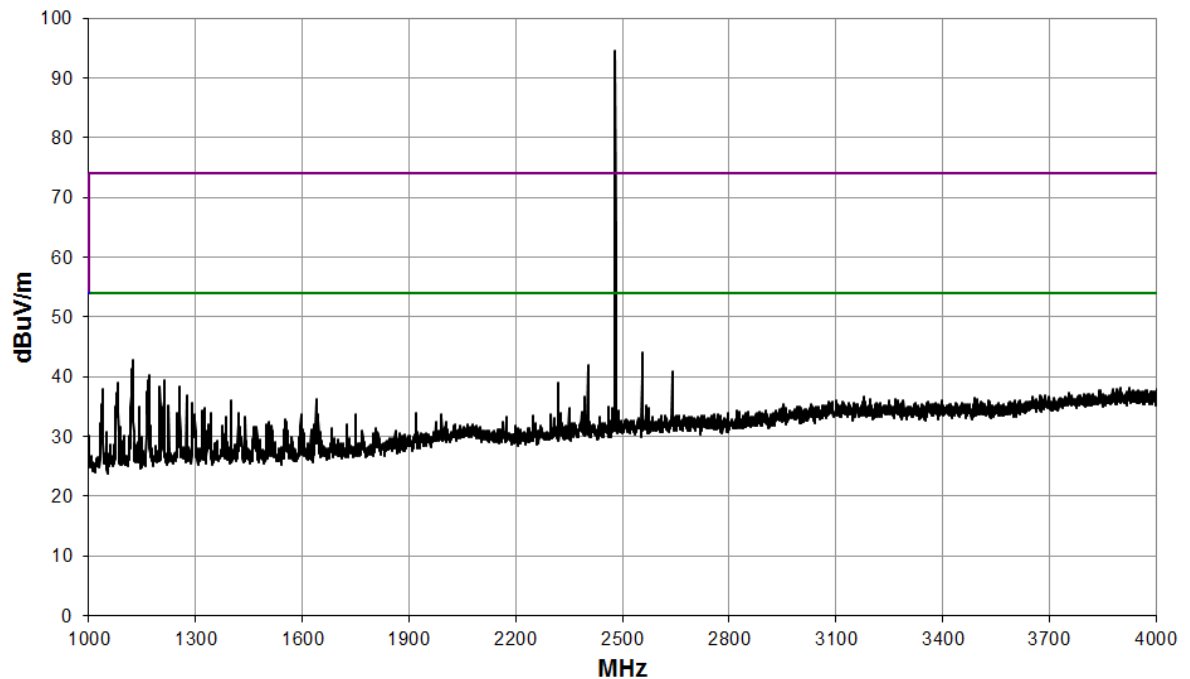


BLE; Power Setting: 4; Channel: 39; Frequency: 2480 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
AV	1169.5	10.7	2.5	24.6	0.0	0.0	0.0	37.8	77.6	500
AV	4959.9	-0.9	5.5	33.3	0.0	0.0	0.0	37.9	78.5	500
Peak emissions are not within 20 dB of the limit.										

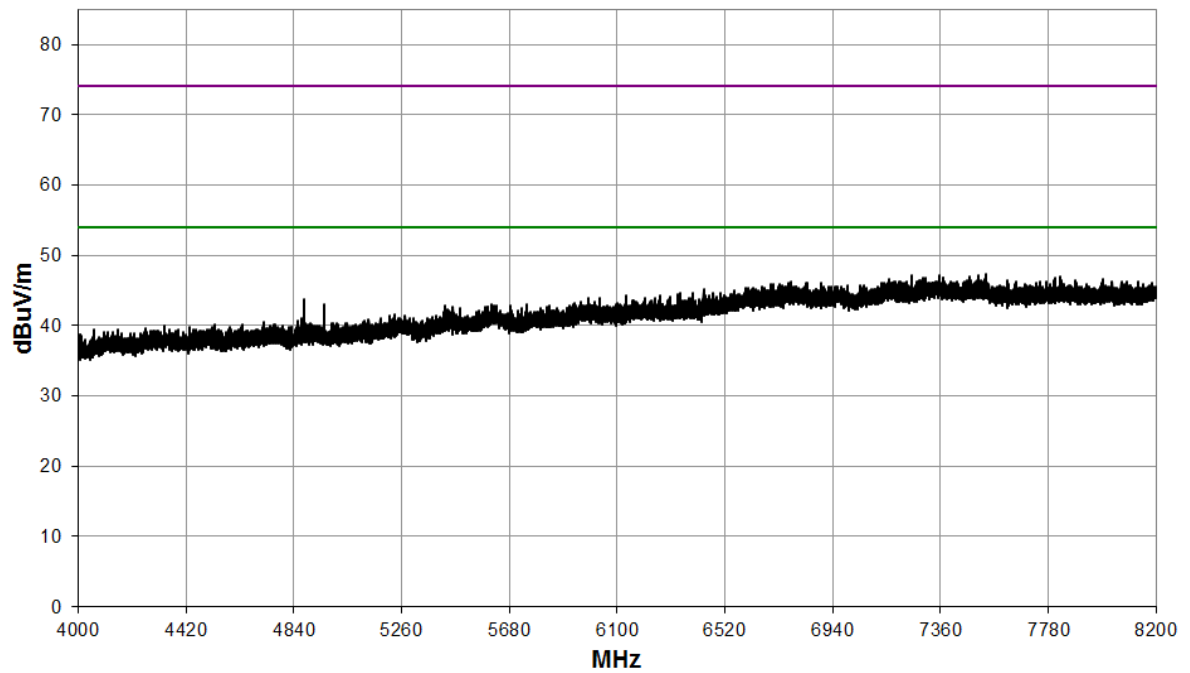
30 MHz to 1 GHz



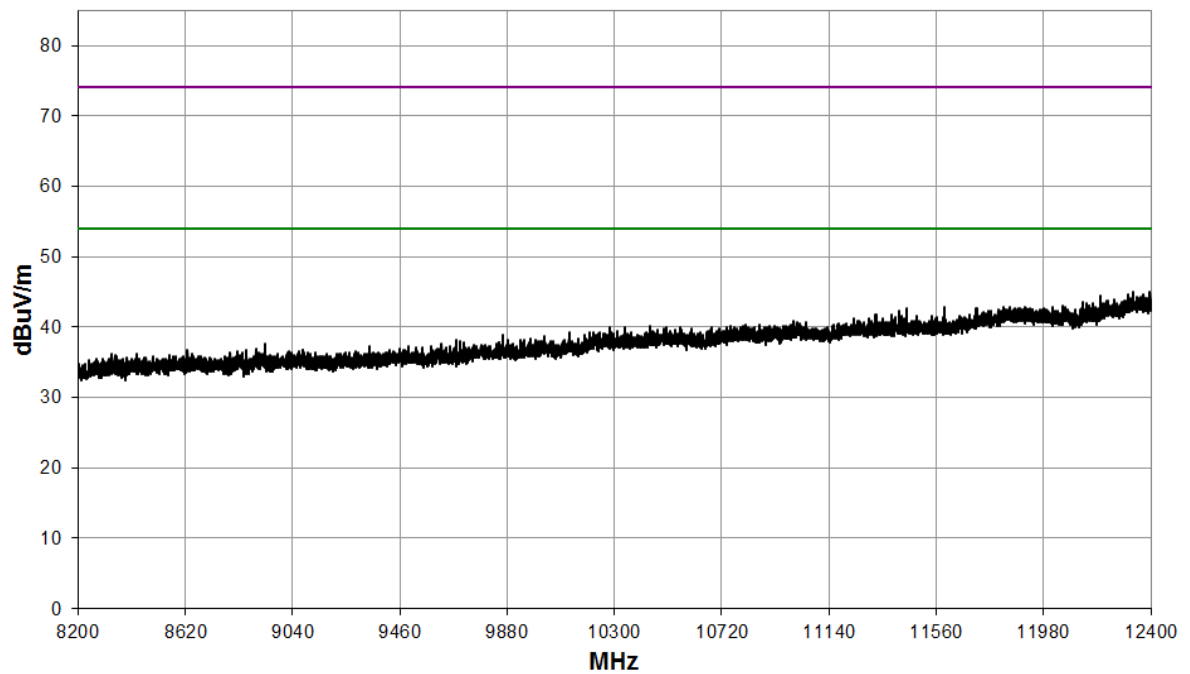
1 GHz to 4 GHz



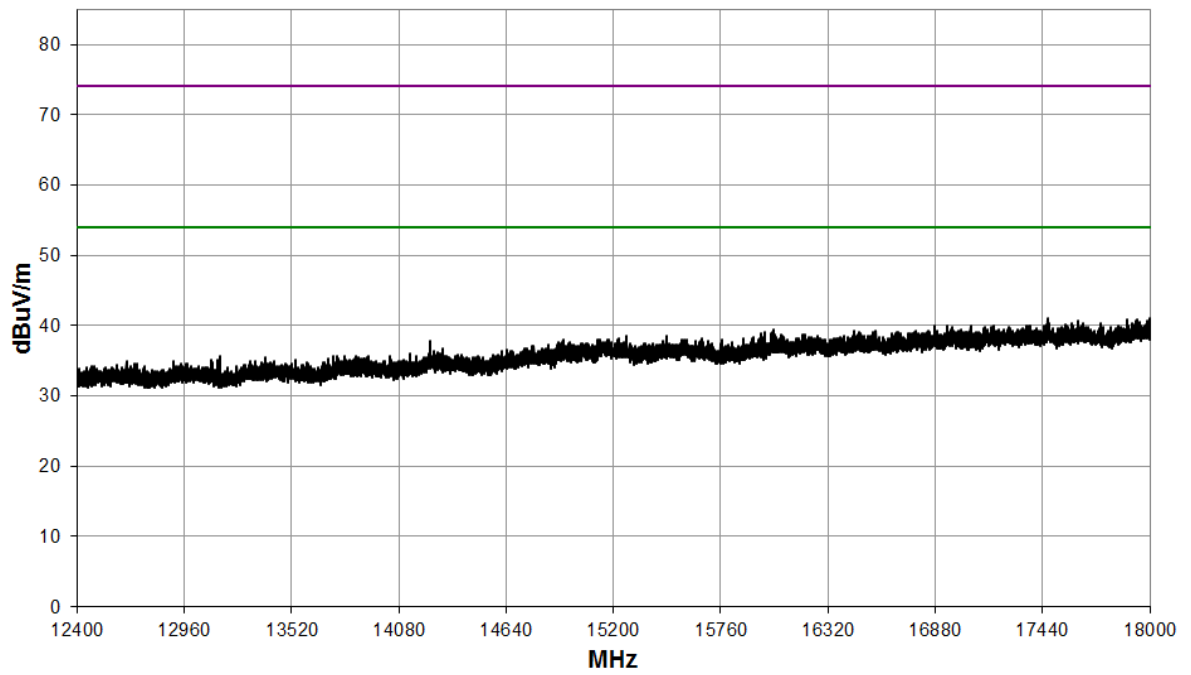
4 GHz to 8.2 GHz



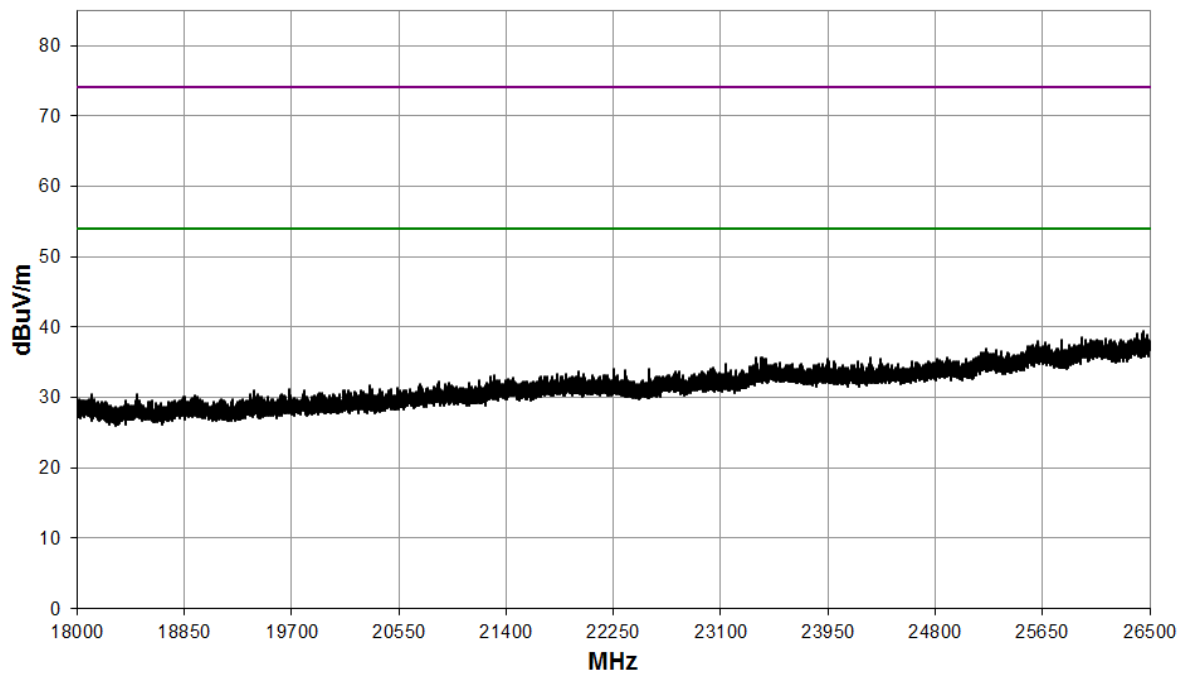
8.2 GHz to 12.4 GHz



12.4 GHz to 18 GHz

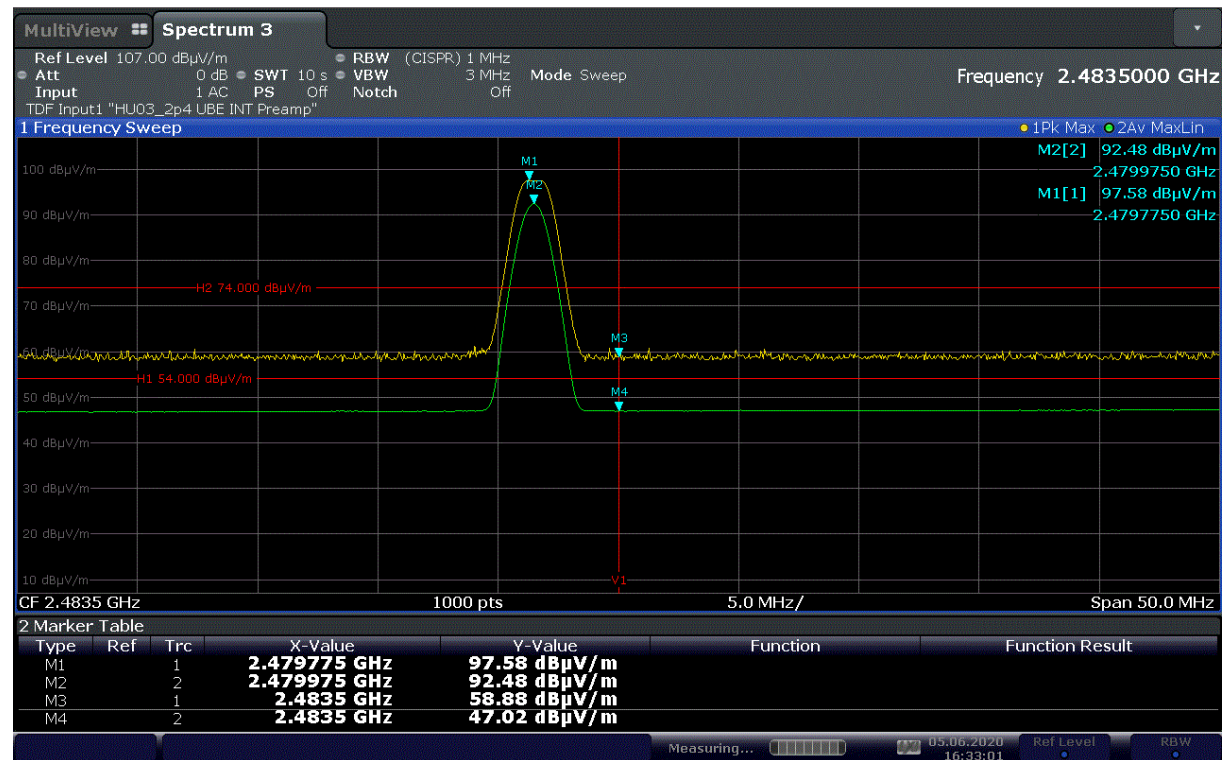


18 GHz to 26.5 GHz



Band Edge

Element



12 AC power-line conducted emissions

12.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Screen Room 2
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels:	2440 MHz
Deviations From Standard:	None
Measurement Detectors:	Quasi-Peak and Average

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 Vac	110 V ac ± 10 % (as declared)

12.3 Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	Conducted limit (dB μ V)	
	Quasi-Peak	Average**
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.

**A linear average detector is required.

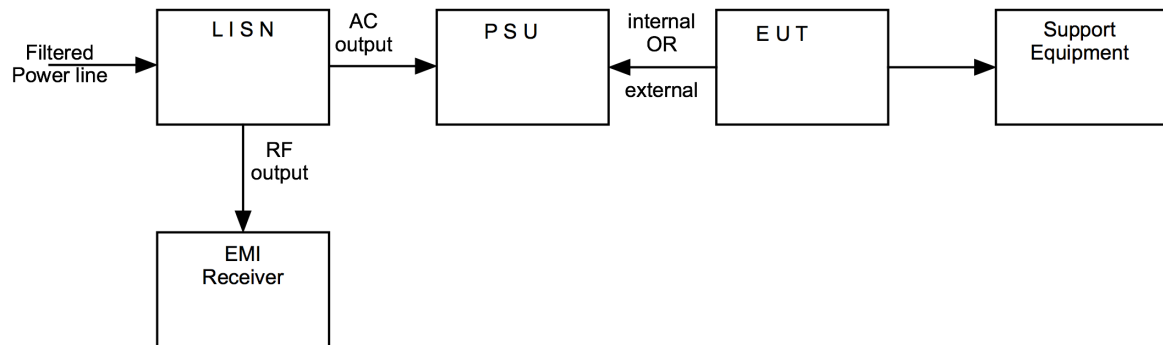
12.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure ii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

Figure ii Test Setup



12.5 Test Set-up Photograph

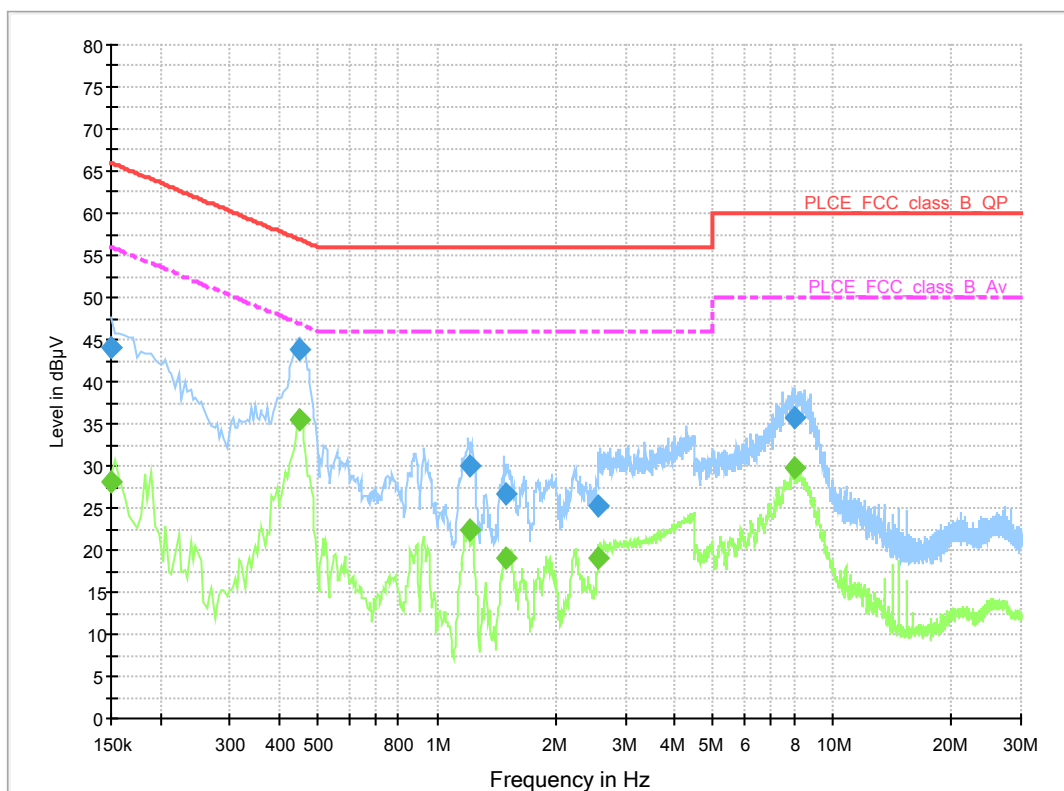


12.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Measuring Receiver	R&S	ESHS10	RFG125	2021-01-22
LISN	R&S	ESH3-Z5	RFG732	2021-05-18
Pulse Limiter	R&S	ESH3-Z2	RFG680	2021-06-09

12.7 Test Results

AC power-line conducted emissions, Transmit mode						
Results measured using the average detector						
Reference Number	Frequency (MHz)	Conductor	Result (dBuV)	Specification Limit (dBuV)	Margin (dB)	Result Summary
1	0.150	L1	28.1	56.0	27.9	PASS
2	0.449	L1	35.5	46.9	11.4	PASS
3	1.209	L1	22.5	46.0	23.6	PASS
4	1.493	L1	19.1	46.0	26.9	PASS
5	2.565	L1	19.0	46.0	27.0	PASS
6	8.001	L1	29.7	50.0	20.3	PASS
Results measured using the quasi-peak detector						
Reference Number	Frequency (MHz)	Conductor	Result (dBuV)	Specification Limit (dBuV)	Margin (dB)	Result Summary
1	0.150	L1	9.7	65.6	21.8	PASS
2	0.449	L1	9.8	62.3	13.1	PASS
3	1.209	L1	9.9	57.0	26.0	PASS
4	1.493	L1	10.0	56.0	29.4	PASS
5	2.565	L1	10.1	56.0	30.7	PASS
6	8.001	L1	11.0	60.0	24.3	PASS



13 Occupied Bandwidth

13.1 Definition

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Laboratory 1
Test Standard and Clause:	FCC: ANSI C63.10-2013, Clause 11.8
EUT Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	2 MHz
EUT Test Modulations:	GFSK
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW:	300 kHz
Measurement Span:	3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	As declared

13.3 Test Limit

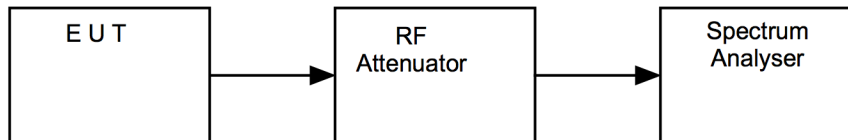
The minimum -6 dB bandwidth shall be at least 500 kHz.

13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the bandwidth of the EUT was measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iii Test Setup

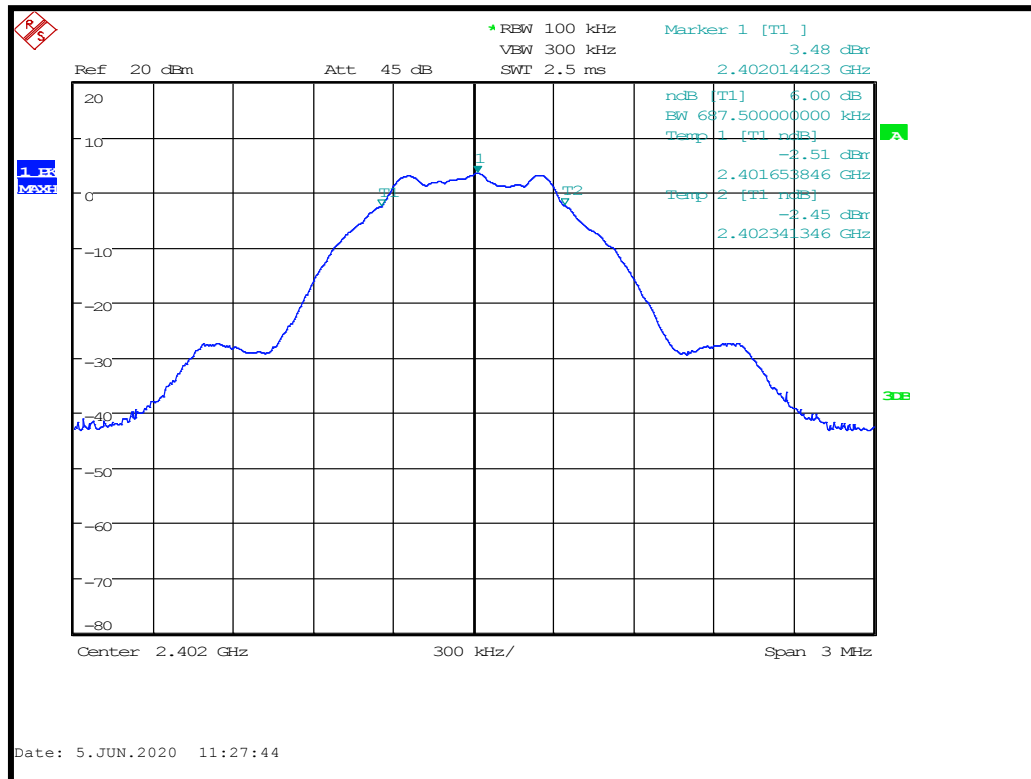


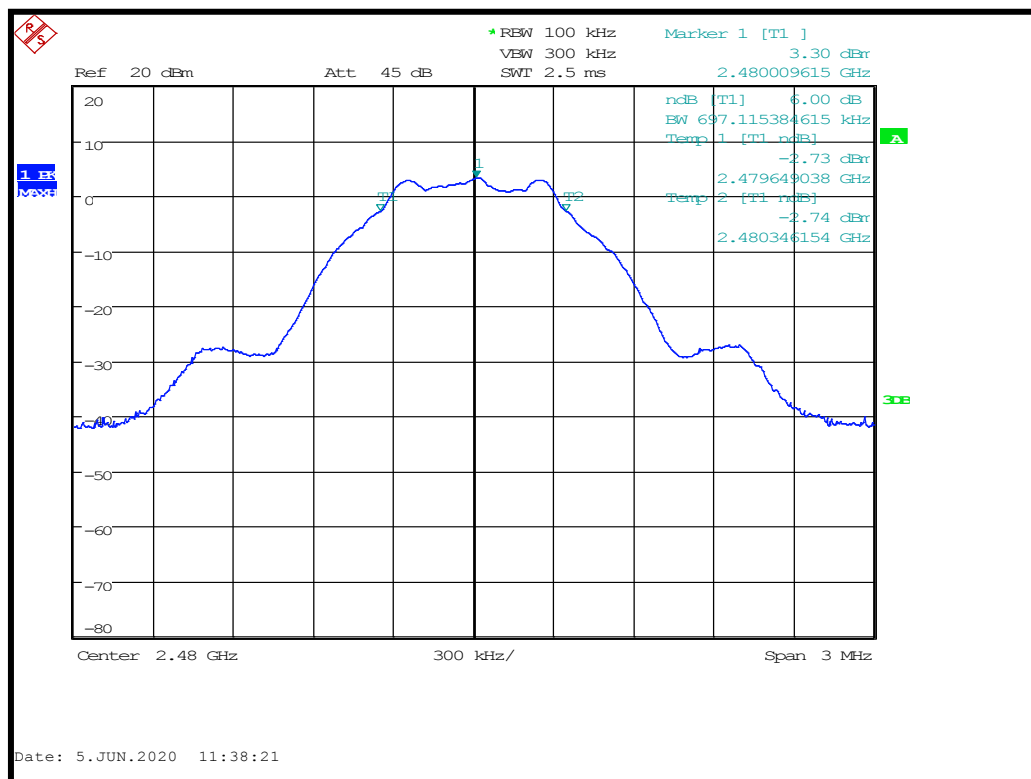
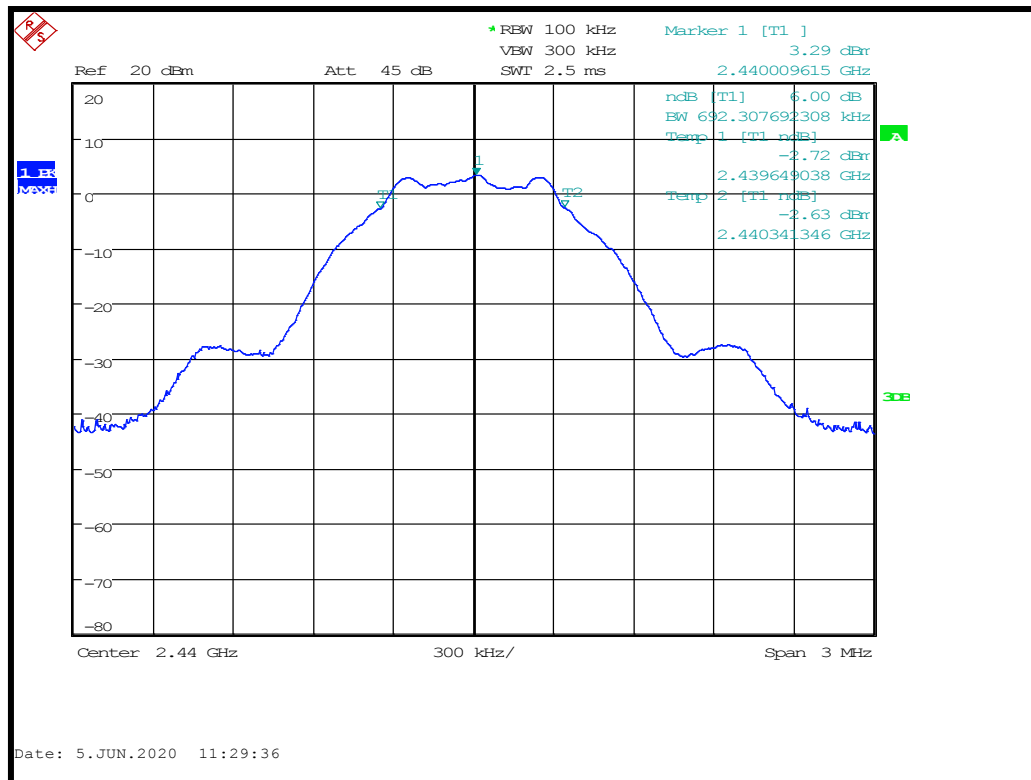
13.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	U405	2021-07-17
LT30-2	Farnell	Power Supply	RFG035	Cal with REF887
34405A	Agilent	Multimeter	REF887	2021-10-21

13.6 Test Results

FCC 15.247. Modulation: GFSK; Data rate: 1 Mbit/s; Power setting: 4				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	6dB Bandwidth (kHz)	Result
2402	2401.653846	2402.341346	687.500000000	PASS
2440	2439.649038	2440.341346	692.307692308	PASS
2480	2479.649038	2480.346154	697.115384615	PASS





14 Maximum peak conducted output power

14.1 Definition

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth.

The maximum conducted output power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

14.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Laboratory 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	2 MHz
Deviations From Standard:	None
Measurement BW:	3 MHz
Spectrum Analyzer Video BW:	10 MHz
Measurement Detector:	Peak
Voltage Extreme Environment Test Range:	Mains Power = 85 % and 115 % of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

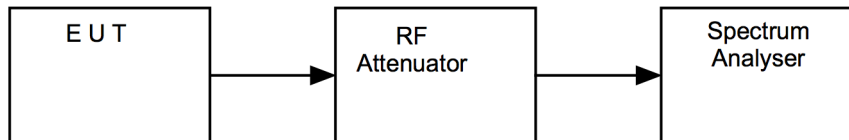
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iv Test Setup

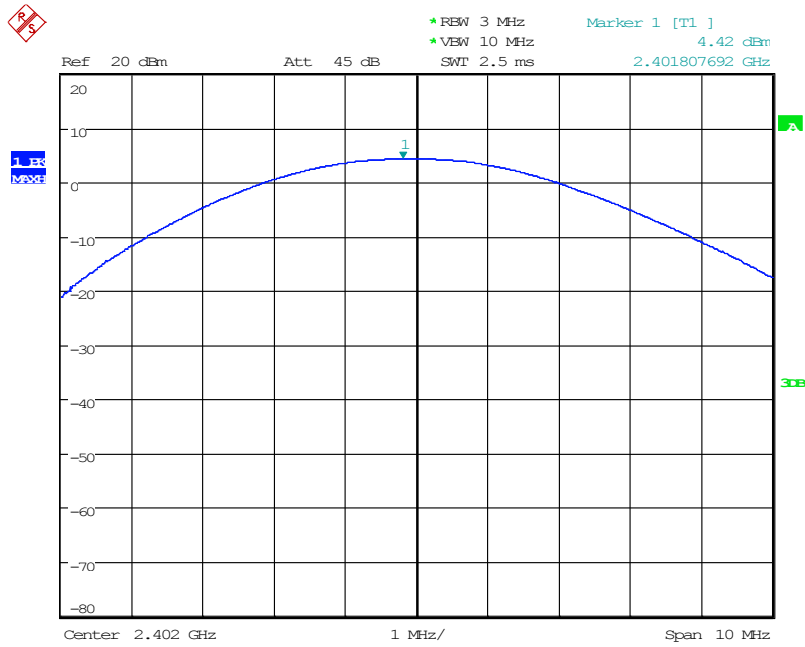


14.5 Test Equipment

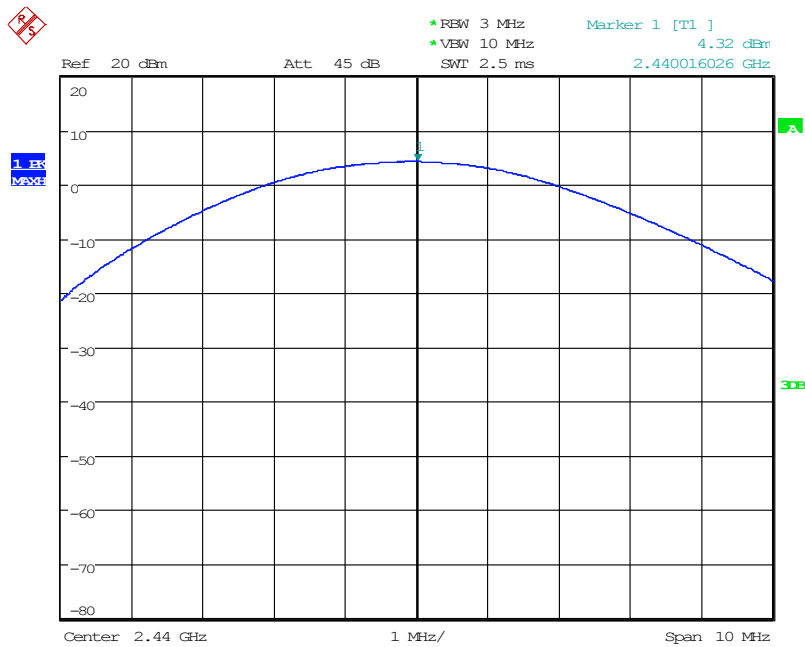
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	U405	2021-07-17
LT30-2	Farnell	Power Supply	RFG035	Cal with REF887
34405A	Agilent	Multimeter	REF887	2021-10-21

14.6 Test Results

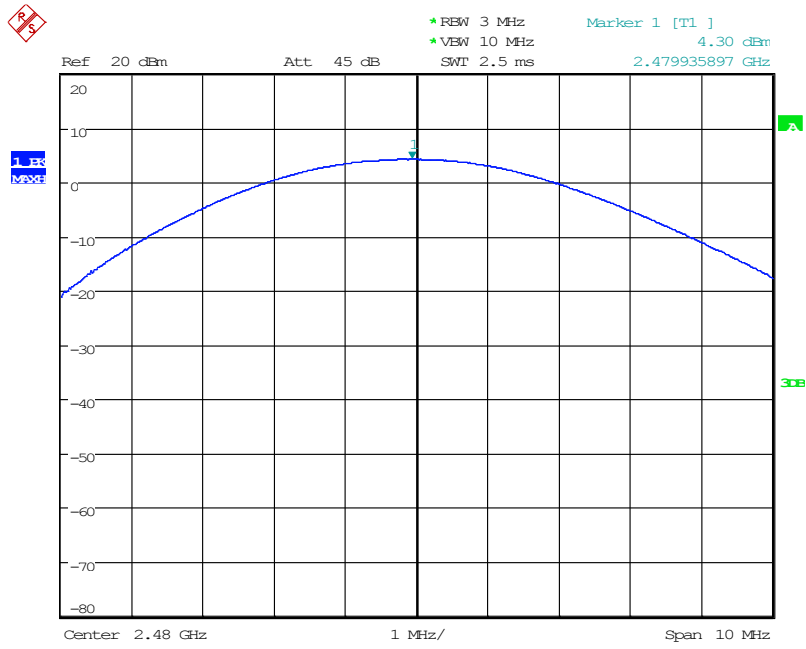
<i>Modulation: GFSK; Data rate: 1 Mbit/s; Power setting: 4</i>				
Channel Frequency (MHz)	Analyzer Level (dBm)	Cable loss (dB)	Power (mW)	Result
2402	4.4	0.8	3.3	PASS
2440	4.3	0.8	3.2	PASS
2480	4.3	0.8	3.2	PASS



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15 Out-of-band and conducted spurious emissions

15.1 Definition

Out-of-band emission.

Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

Spurious emission.

Emission on a frequency or frequencies that 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.

15.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Laboratory 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.11
EUT Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	2 MHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW:	300 kHz
Measurement Detector:	Peak
Measurement Range:	9 kHz to 26.5 GHz

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	As declared

15.3 Test Limit

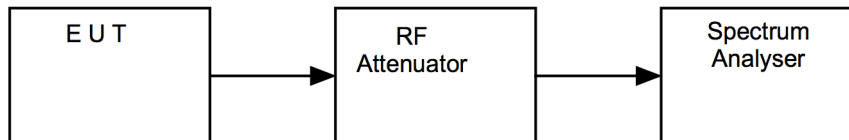
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in FCC 47CFR15.209(a) is not required.

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the emissions from the EUT were measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

Figure v Test Setup

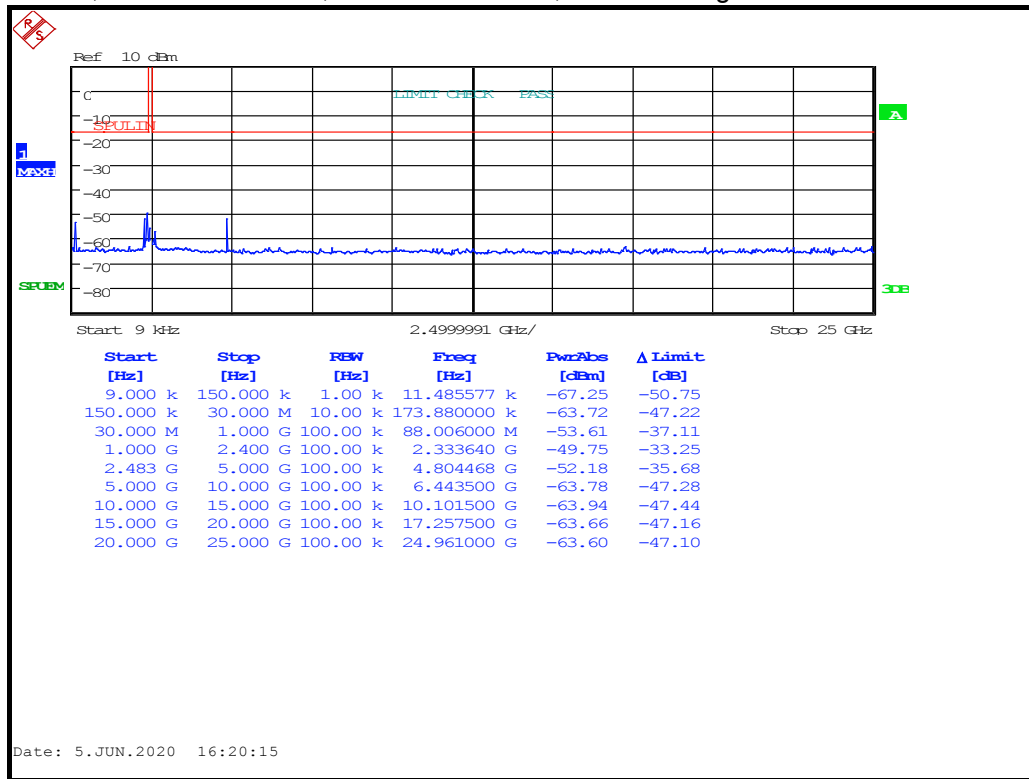


15.5 Test Equipment

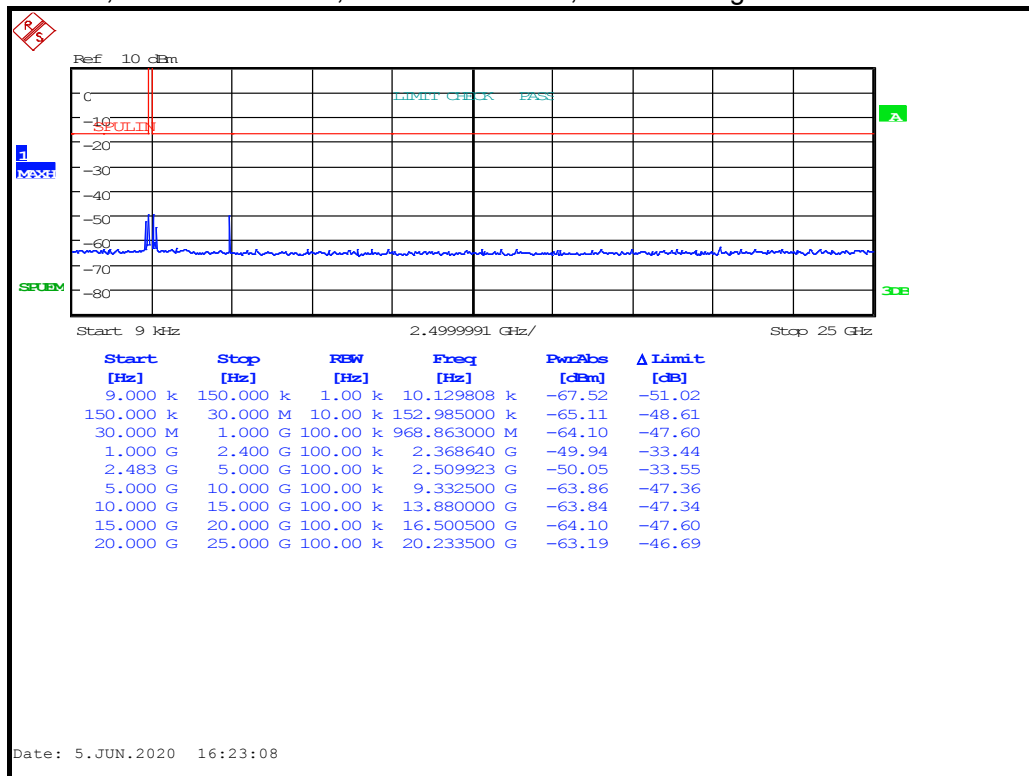
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	U405	2021-07-17
LT30-2	Farnell	Power Supply	RFG035	Cal with REF887
34405A	Agilent	Multimeter	REF887	2021-10-21

15.6 Test Results

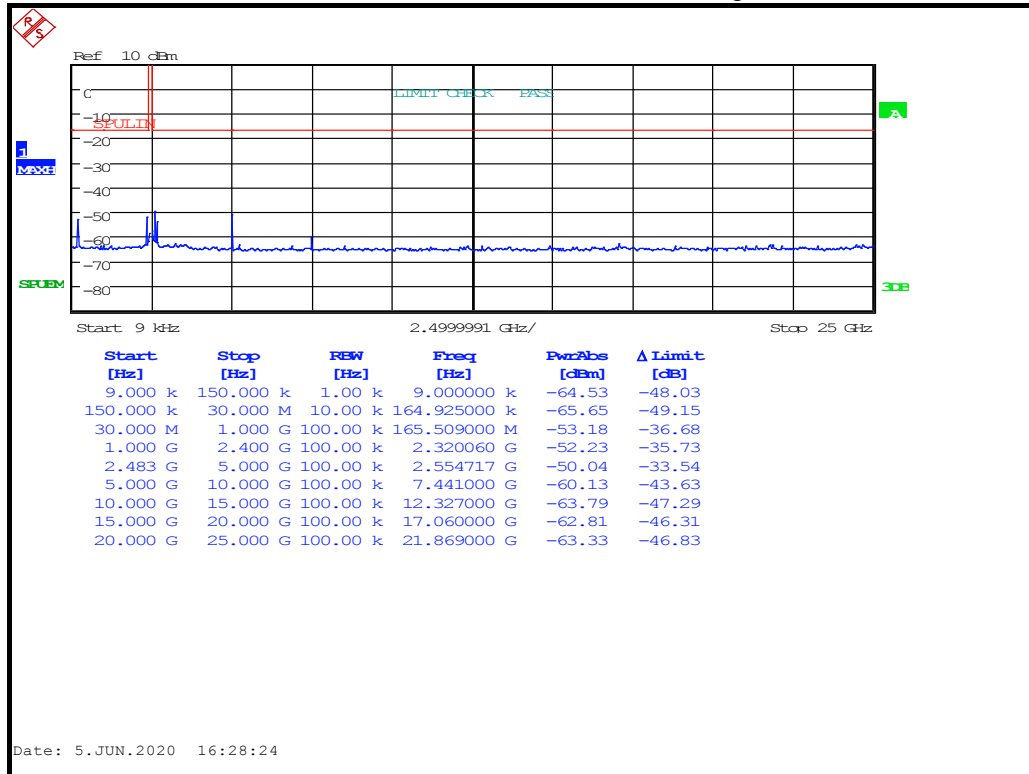
Channel 0; Modulation: GFSK; Data rate: 1 Mbit/s; Power setting: 4



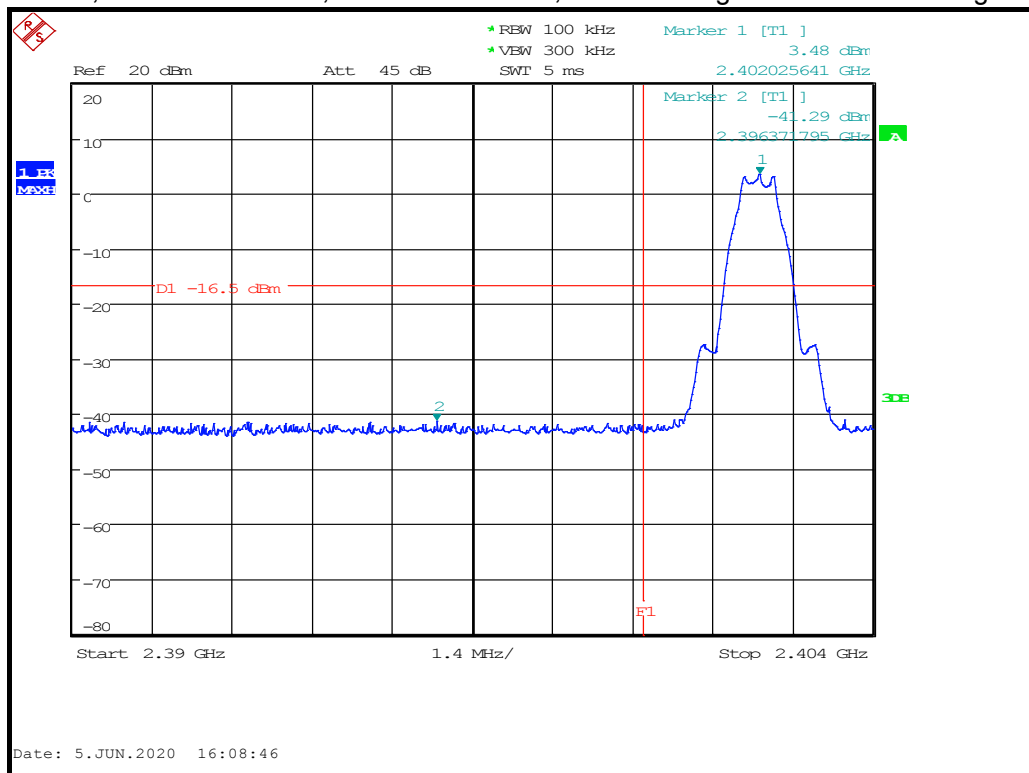
Channel 19; Modulation: GFSK; Data rate: 1 Mbit/s; Power setting: 4



Channel 39; Modulation: GFSK; Data rate: 1 Mbit/s; Power setting: 4



Channel 0; Modulation: GFSK; Data rate: 1 Mbit/s; Power setting: 4 – Lower Band Edge



16 Power spectral density

16.1 Definition

The power per unit bandwidth.

16.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Laboratory 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
EUT Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	2 MHz
Deviations From Standard:	None
Measurement BW:	3 kHz
Spectrum Analyzer Video BW:	10 kHz
Measurement Span:	1.5 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 38 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	As declared

16.3 Test Limit

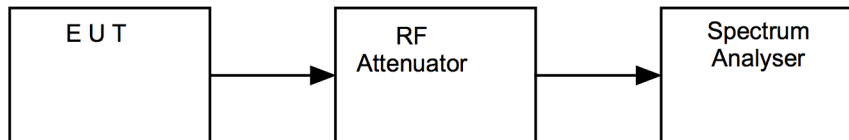
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vi, the peak emission of the EUT was measured on a spectrum analyser, with path losses taken into account.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

Figure vi Test Setup

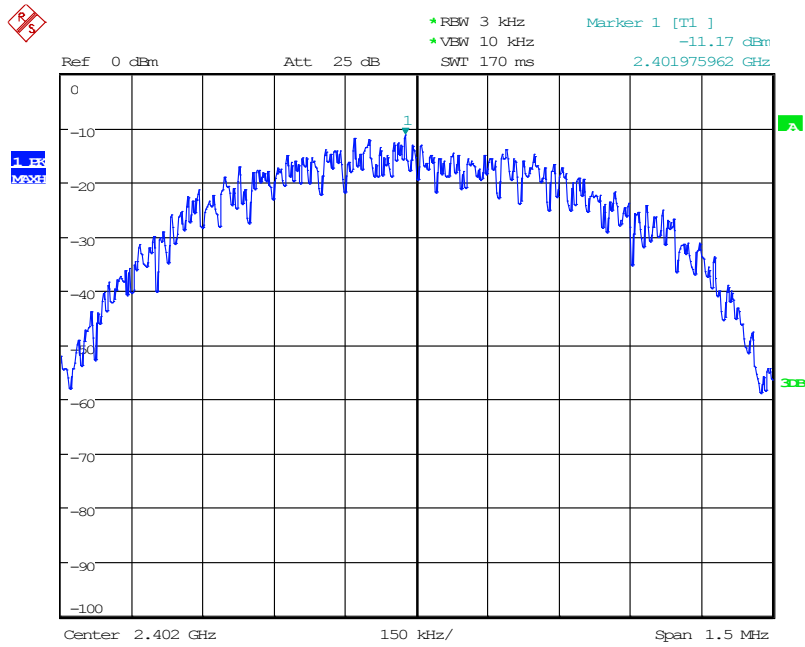


16.5 Test Equipment

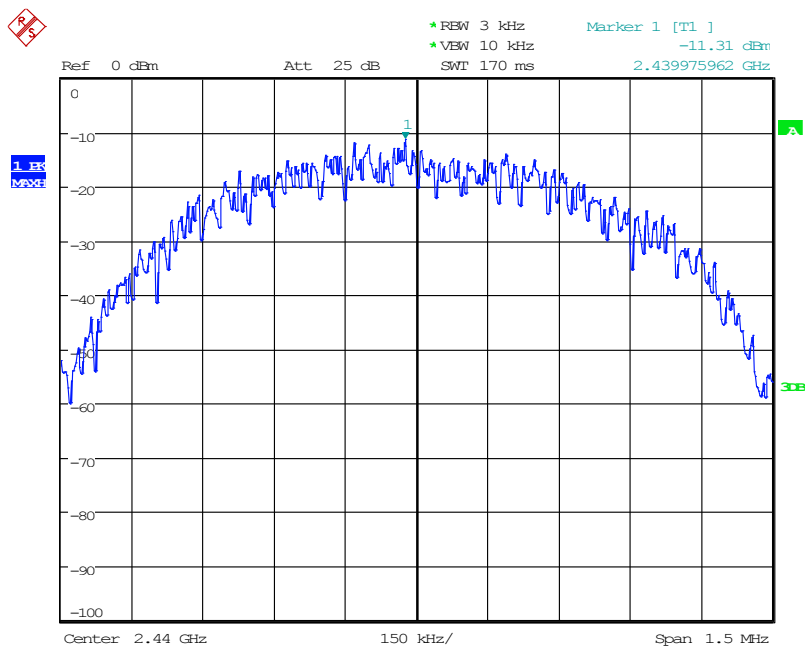
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	U405	2021-07-17
LT30-2	Farnell	Power Supply	RFG035	Cal with REF887
34405A	Agilent	Multimeter	REF887	2021-10-21

16.6 Test Results

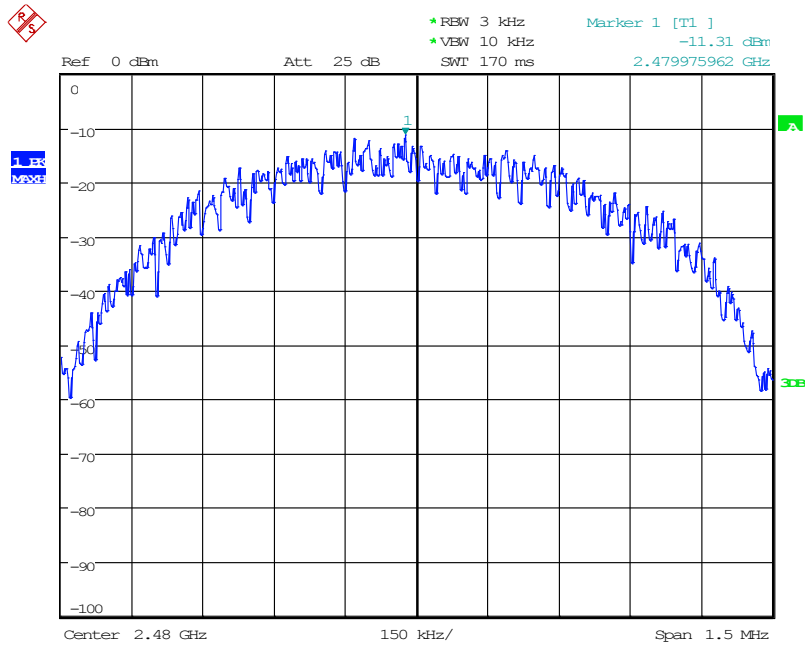
Modulation: GFSK; Data rate: 1 Mbit/s; Power setting: 4				
Channel Frequency (MHz)	Analyzer Level (dBm/3kHz)	Cable loss (dB)	Power (dBm/3kHz)	Result
2402	-11.2	0.8	-10.4	PASS
2440	-11.3	0.8	-10.5	PASS
2480	-11.3	0.8	-10.5	PASS



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17 Measurement Uncertainty

Radio Testing – General Uncertainty Schedule

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence where no required test level exists.

Reference No.	Parameter	Description	Value	Unit
1	Adjacent Channel Power	Uncertainty in test result	Error! Not a valid link.	dB
2	Carrier Power	Uncertainty in test result (Power Meter) Uncertainty in test result (Spectrum Analyser)	0.070 Error! Not a valid link.	dB
3	Effective Radiated Power	Uncertainty in test result	4.71	dB
4	Radiated Spurious Emissions	Uncertainty in test result 30 MHz to 1 GHz 1 GHz to 18 GHz	4.75 4.46	dB
5	Maximum Frequency Error	Uncertainty in test result (CMTA)	113.441	Hz

Reference No.	Parameter	Description	Value	Unit
6	Radiated Emissions, Field Strength OATS 9 kHz – 110 GHz Electric Field	Uncertainty in test result (9 kHz – 30 MHz) Uncertainty in test result (30 MHz – 1 GHz) Uncertainty in test result (1 GHz – 18 GHz) Uncertainty in test result (18 GHz – 26 GHz) Uncertainty in test result (26 GHz – 40 GHz) Uncertainty in test result (40 GHz – 50 GHz) Uncertainty in test result (50 GHz – 75 GHz) Uncertainty in test result (75 GHz – 110 GHz)	2.3 4.75 4.46 3.2 3.3 3.5 3.6 3.6	dB
7	Frequency Deviation	Uncertainty in test result	3.7	%
8	Magnetic Field Emissions	Uncertainty in test result	2.3	dB
9	Conducted Spurious	Uncertainty in test result Up to 26 GHz	0.921	dB
10	Channel Bandwidth	Uncertainty in test result	Error! Not a valid link.	%
11	Spectrum Mask Measurements	Uncertainty in test result (frequency) Uncertainty in test result (amplitude)	2.59 1.32	% dB
12	Adjacent Sub Band Selectivity	Uncertainty in test result	1.24	dB
13	Receiver Blocking – Listen Mode, Radiated	Uncertainty in test result	3.23	dB

Reference No.	Parameter	Description	Value	Unit
14	Receiver Blocking – Talk Mode, Radiated	Uncertainty in test result	3.36	dB
15	Receiver Blocking – Talk Mode, Conducted	Uncertainty in test result	1.24	dB
16	Receiver Threshold	Uncertainty in test result	3.42	dB
17	Transmission Time Measurement	Uncertainty in test result	4.40	%
18	AC power line conducted emissions	Uncertainty in test result	3.42	dB