

Report on the Radio Testing
For
Microlise Engineering Limited
on
JCB Livelink 4
Report no. TRA-048544-47-05A
29 January 2021

RF915 7.0



Report Number: TRA-048544-47-05A
Issue: A

REPORT ON THE RADIO TESTING OF A
Microlise Engineering Limited
JCB Livelink 4
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 2020-10-15 to 2020-10-23

Written by:

D Moncayola
Radio Test Engineer

Approved by:

J Charters
Lab Manager

Date: 29 January 2021

Disclaimers:

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

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	29 January 2021	Original

2 Summary

TEST REPORT NUMBER:	TRA-048544-47-05A
WORKS ORDER NUMBER:	TRA-048544-05
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(S):	47CFR15.247
EQUIPMENT UNDER TEST (EUT):	JCB Livelink 4
FCC IDENTIFIER:	TBC
EUT SERIAL NUMBER:	DGG64967
MANUFACTURER/AGENT:	Microlise Engineering Limited
ADDRESS:	Farrington Way Eastwood Nottingham Nottinghamshire NG16 3AG United Kingdom
CLIENT CONTACT:	Craig White ☎ 01773 537000 ✉ craig.white@microlise.com
ORDER NUMBER:	PO804323
TEST DATE:	2020-10-15 to 2020-10-23
TESTED BY:	D Moncayola S Garwell Element

2.1 Test Summary

Test Method and Description		47CFR15	Applicable to this equipment	Result / Note
Radiated spurious emissions (restricted bands of operation and cabinet radiation)		15.205	☒	Pass
AC power line conducted emissions		15.207	☐	Note 1
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
Calculation of duty correction		15.35(c)	☐	Note 2

Notes:

- 1- Battery powered device, it is not going to be connected to the mains.
- 2- Duty $\geq$ 98 %

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-048544-47-05A presents the results of the Radio testing on a Microlise Engineering Limited, JCB Livelink 4 to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Microlise Engineering Limited 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-EU MRA, Designation number UK0009.

IC Registration Number(s):

Element Hull	3483A
Element North West	3930B

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

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

5 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: JCB Livelink 4
- Serial Number: DGG64967
- Model Number: 728/J8518
- Software Revision: V 1
- Build Level / Revision Number: A

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

7.3.1 Transmission

The mode of operation for transmit tests was as follows...

The unit was transmitting permanently modulated carrier on a selected channel with a duty cycle $\geq$ 98%.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	2402 MHz to 2480 MHz
Modulation type(s):	GFSK
Supported Data Rate(s):	1 Mbps only
Occupied channel bandwidth(s):	2 MHz
Channel spacing:	2 MHz
Declared output power(s):	0 dBm
Antenna type(s) and gain(s):	Integral PCB, 0 dBi
Nominal Supply Voltage:	27 Vdc

7.5 EUT Description

The EUT is a tracking device with multiple wireless technologies. This report covers Bluetooth low energy.

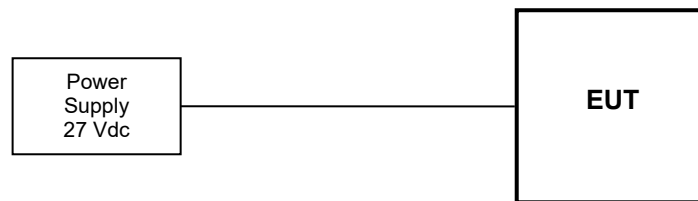
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

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



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



9.3 Measurement software

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

Element Emissions R5 (See Note)
 Element Transmitter Bench Test (See Note)
 ETS Lindgren EMPower V1.0.4.2

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 E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied 27 V dc from the adaptor.

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 %
☒	Battery	New battery	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 Skelmersdale
Test Chamber:	SK03 Radio Chamber
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: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)
Supply: 27 V dc	27 V dc (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:

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

$$\text{Factor} = CL + AF - PA$$

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;

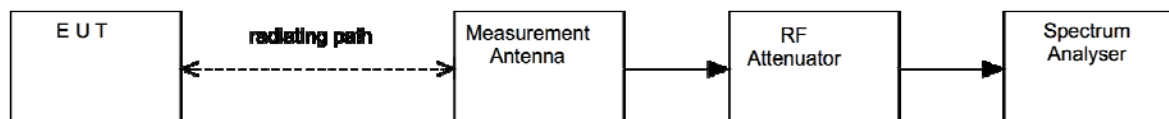
PA is the pre-amplifier gain in dB (where used);

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

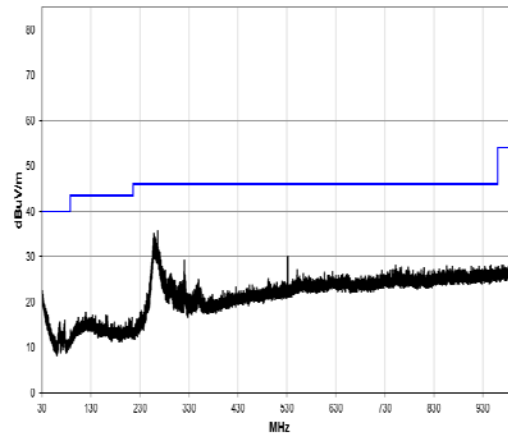
<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU26	REF909	2021-07-09
Bilog	Chase	CBL611/A	U573	2021-09-19
Log Periodic Ant	Chase	UPA6108	L203	2022-06-16
Pre Amp	Watkins Johnson	6201-69	U372	2021-02-26
Pre Amp	Agilent	8449	L572	2021-10-19
1-18GHz Horn	EMCO	3115	L139	2021-07-16
Horn 18-26GHz (&U330)	Flann	20240-20	L300	2022-04-23
Radio Chamber - PP	Rainford EMC	ATS	REF940	2021-12-09

11.7 Test Results

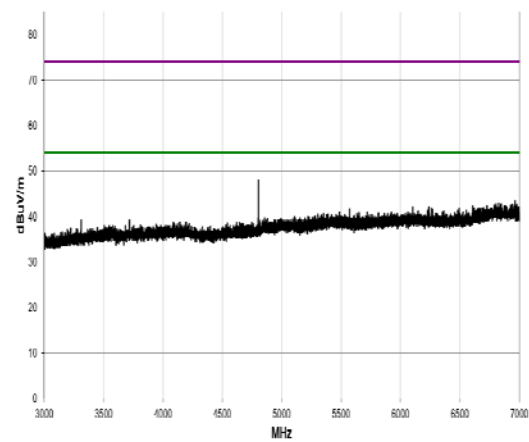
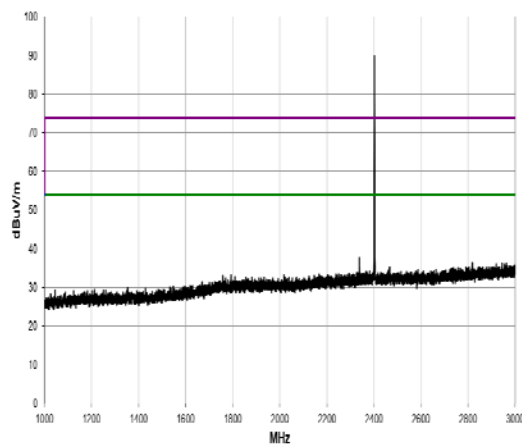
Emissions in common to all modes of operation

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
265.866	35.3	-7.6	1.14	203.0	3.0	0.0	Horz	QP	0.0	27.7	46.0	-18.3
257.848	35.4	-7.7	1.48	236.1	3.0	0.0	Horz	QP	0.0	27.7	46.0	-18.3
531.708	29.0	-1.6	1.0	191.0	3.0	0.0	Horz	QP	0.0	27.4	46.0	-18.6
262.029	34.7	-7.5	1.2	231.1	3.0	0.0	Horz	QP	0.0	27.2	46.0	-18.8

Bottom Channel: 2402 MHz

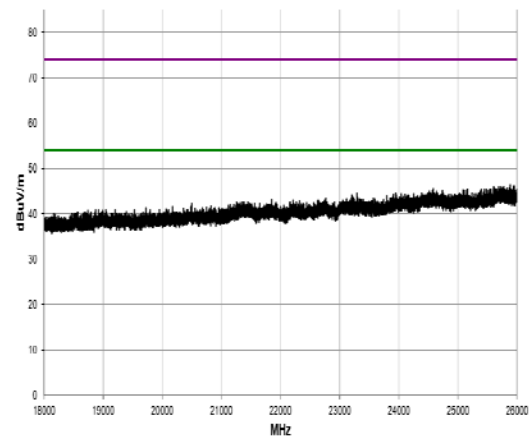
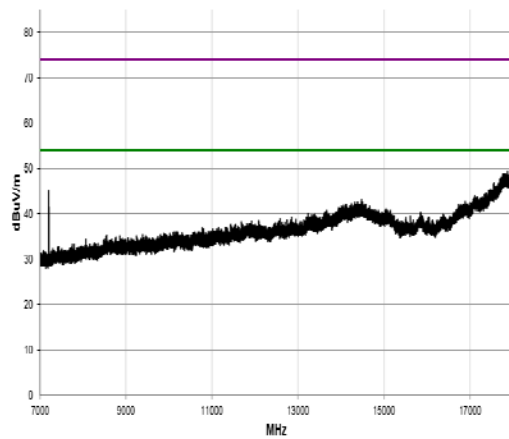


30 MHz to 1 GHz



1 GHz to 3 GHz

3 GHz to 7 GHz

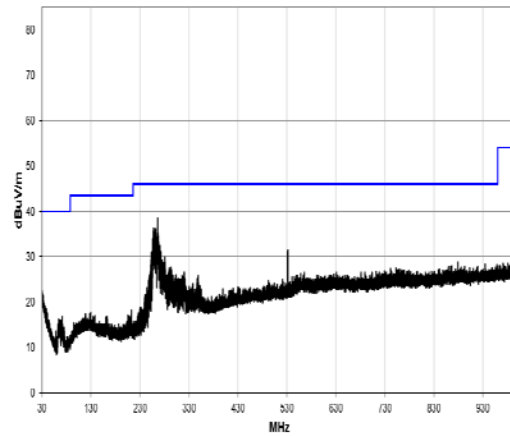


7 GHz to 18 GHz

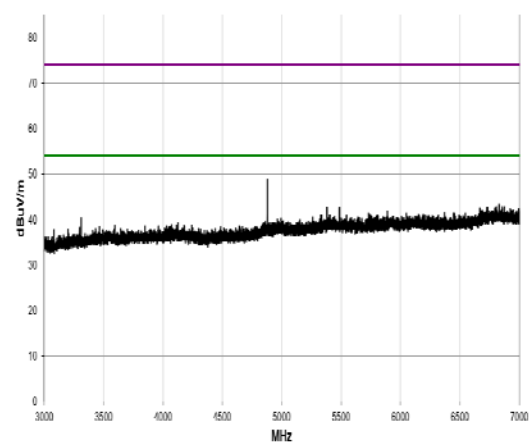
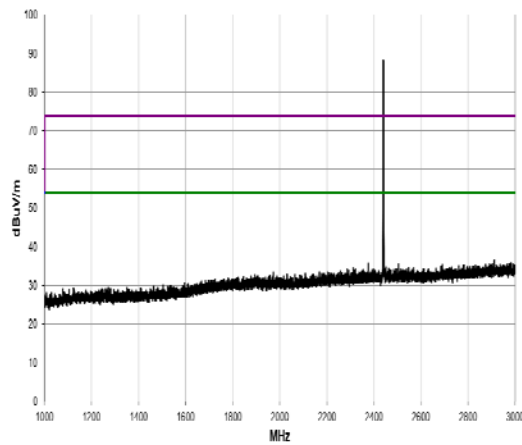
18 GHz to 26 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
4804.058	44.5	3.5	1.46	347.0	3.0	0.0	Horz	AV	0.0	48.0	54.0	-6.0
4804.067	43.1	3.5	1.51	332.0	3.0	0.0	Vert	AV	0.0	46.6	54.0	-7.4
4803.525	52.5	3.5	1.46	347.0	3.0	0.0	Horz	PK	0.0	56.0	74.0	-18.0
4804.408	51.6	3.5	1.51	332.0	3.0	0.0	Vert	PK	0.0	55.1	74.0	-18.9

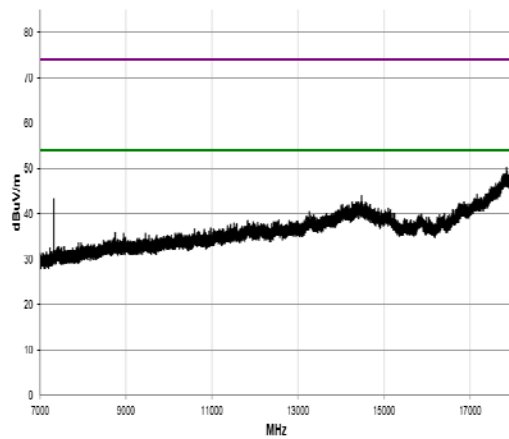
Middle Channel: 2440 MHz



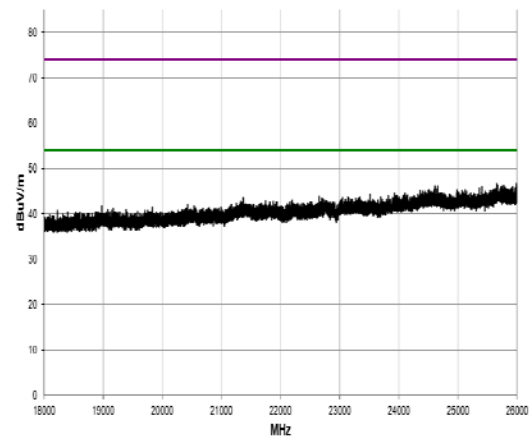
30 MHz to 1 GHz



1 GHz to 3 GHz



3 GHz to 7 GHz

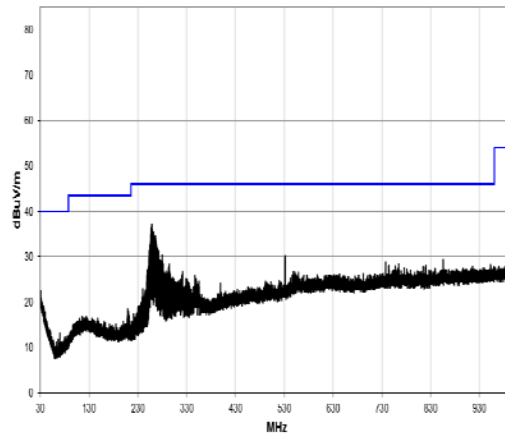


7 GHz to 18 GHz

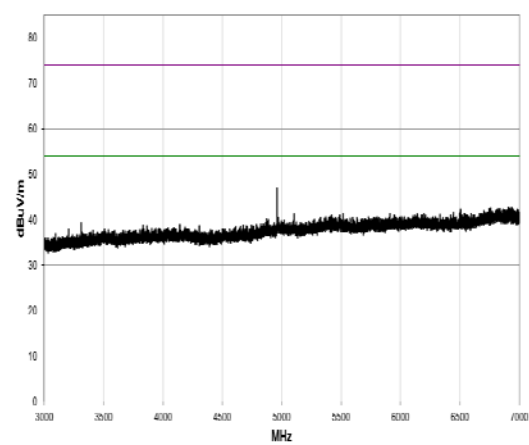
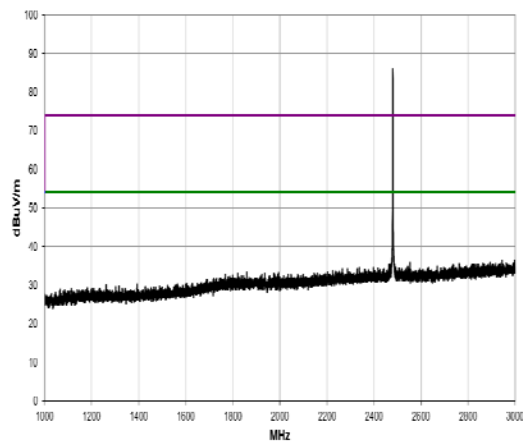
18 GHz to 26 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
4879.992	44.2	3.8	1.56	300.0	3.0	0.0	Horz	AV	0.0	48.0	54.0	-6.0
4880.017	41.5	3.8	1.5	327.1	3.0	0.0	Vert	AV	0.0	45.3	54.0	-8.7
4879.542	52.6	3.8	1.56	300.0	3.0	0.0	Horz	PK	0.0	56.4	74.0	-17.6
4879.458	51.0	3.8	1.5	327.1	3.0	0.0	Vert	PK	0.0	54.8	74.0	-19.2
7320.650	43.9	7.5	1.47	28.9	1.0	0.0	Vert	AV	-9.5	41.9	54.0	-12.1
7320.675	42.8	7.5	1.49	86.0	1.0	0.0	Horz	AV	-9.5	40.8	54.0	-13.2
7319.333	53.1	7.5	1.47	28.9	1.0	0.0	Vert	PK	-9.5	51.1	74.0	-22.9
7320.717	52.3	7.5	1.49	86.0	1.0	0.0	Horz	PK	-9.5	50.3	74.0	-23.7

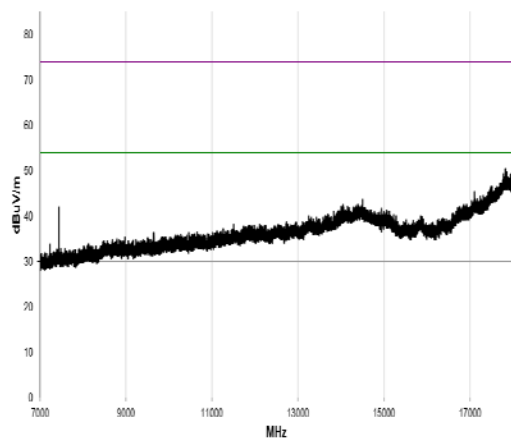
Top Channel: 2480 MHz



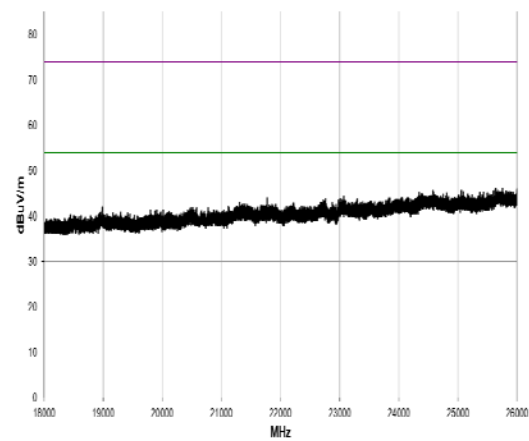
30 MHz to 1 GHz



1 GHz to 3 GHz



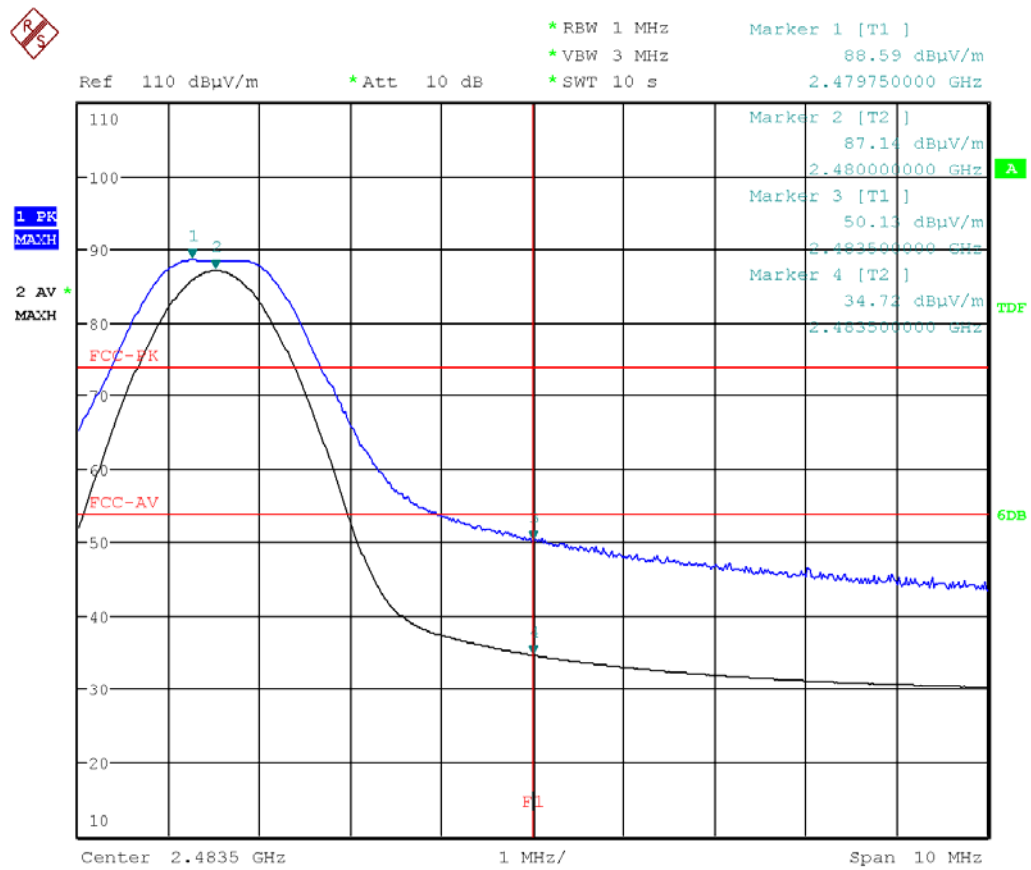
3 GHz to 7 GHz



7 GHz to 18 GHz

18 GHz to 26 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
4960.033	42.0	4.0	1.57	302.0	3.0	0.0	Horz	AV	0.0	46.0	54.0	-8.0
4959.967	36.6	4.0	1.32	319.0	3.0	0.0	Vert	AV	0.0	40.6	54.0	-13.4
4960.400	51.8	4.0	1.57	302.0	3.0	0.0	Horz	PK	0.0	55.8	74.0	-18.2
4960.350	49.6	4.0	1.32	319.0	3.0	0.0	Vert	PK	0.0	53.6	74.0	-20.4
7439.467	44.1	7.6	1.5	28.9	1.0	0.0	Vert	AV	-9.5	42.2	54.0	-11.8
7439.467	42.0	7.6	1.5	87.0	1.0	0.0	Horz	AV	-9.5	40.1	54.0	-13.9
7439.208	53.3	7.6	1.5	28.9	1.0	0.0	Vert	PK	-9.5	51.4	74.0	-22.6
7440.717	51.9	7.6	1.5	87.0	1.0	0.0	Horz	PK	-9.5	50.0	74.0	-24.0



Date: 16.OCT.2020 17:19:59

Upper Radiated Band Edge – Peak / Average

12 Occupied Bandwidth

12.1 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.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.8
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	2 MHz
EUT Test Modulations:	GFSK
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Span: (requirement 2 to 5 times OBW)	3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 27 Vdc	27 V dc (as declared)

12.3 Test Limit

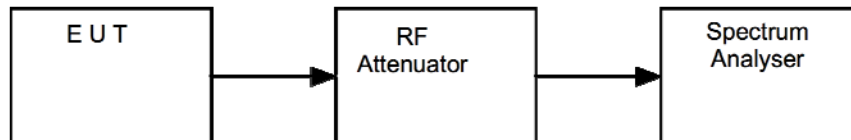
The minimum -6 dB bandwidth shall be at least 500 kHz.

12.4 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



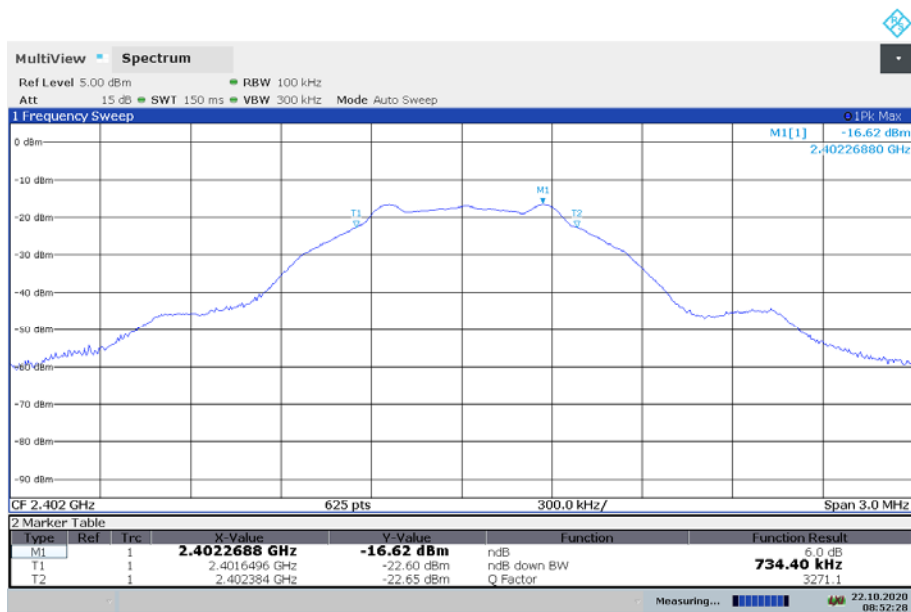
12.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Spectrum Analyser	Rohde & Schwarz	FSW	101805	2021-07-23

* Denotes Serial Number of Hired Spectrum Analyser

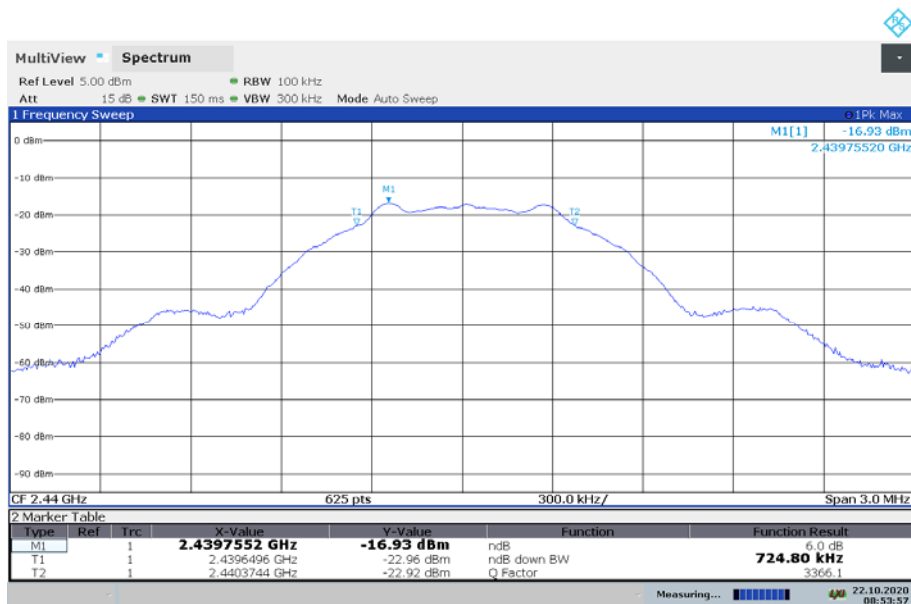
12.6 Test Results

FCC 15.247. Modulation: GFSK; Data rate: 1 MBps; Power setting: 0 dBm				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	6dB Bandwidth (kHz)	Result
2402	2401.48331	2402.5446	1061.29	PASS
2440	2439.47918	2440.55643	1077.25	PASS
2480	2479.48641	2480.54559	1059.18	PASS



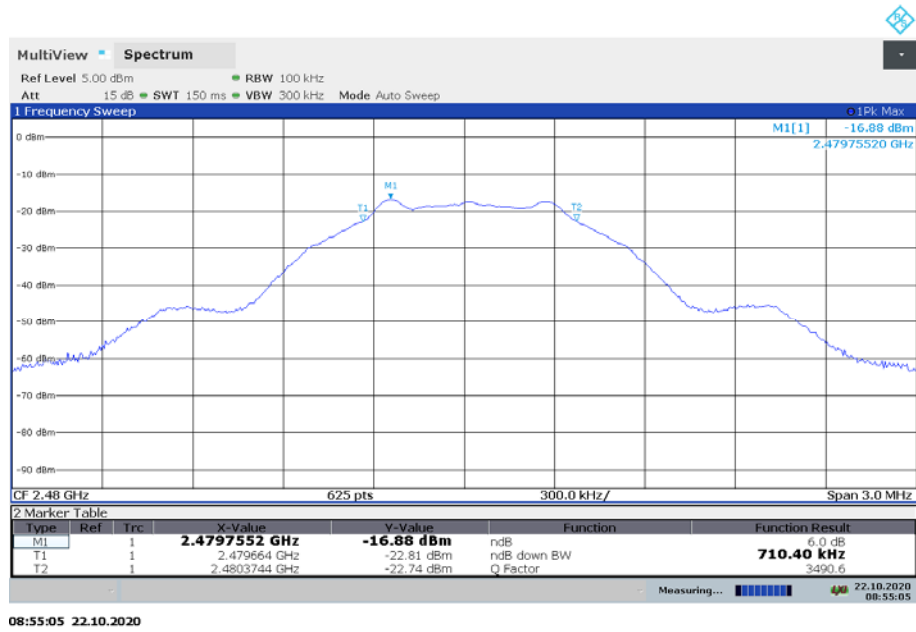
08:52:28 22.10.2020

Bottom



08:53:57 22.10.2020

Middle



Top

13 Maximum peak conducted output power

13.1 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.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	2 MHz
Deviations From Standard:	None
Measurement BW:	2 MHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	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: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)

13.3 Test Limit

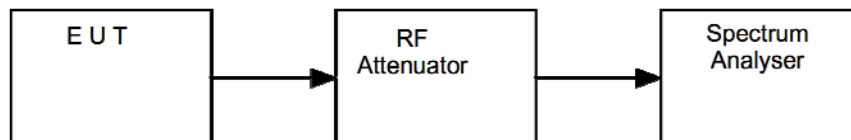
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

13.4 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



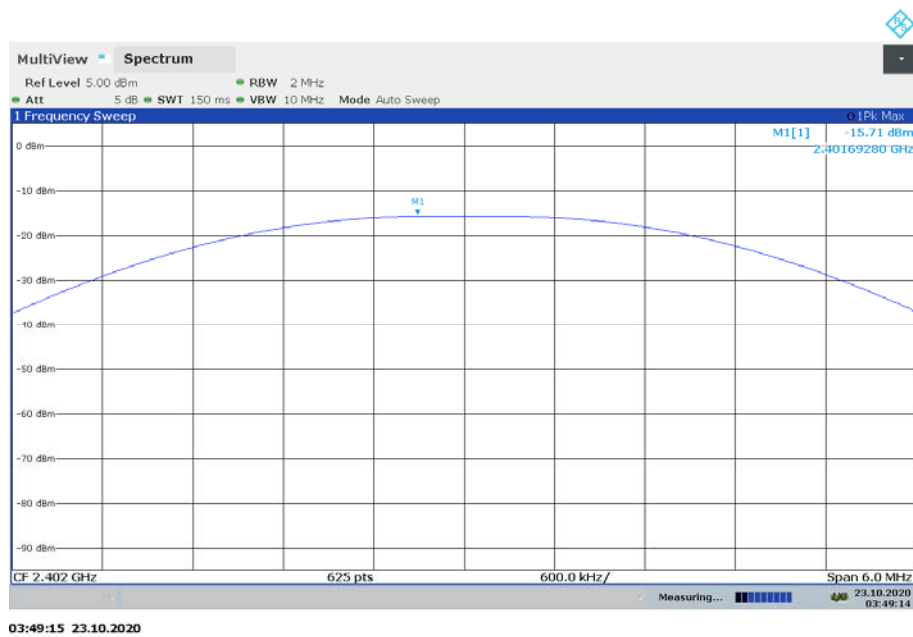
13.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Spectrum Analyser	Rohde & Schwarz	FSW	101805	2021-07-23

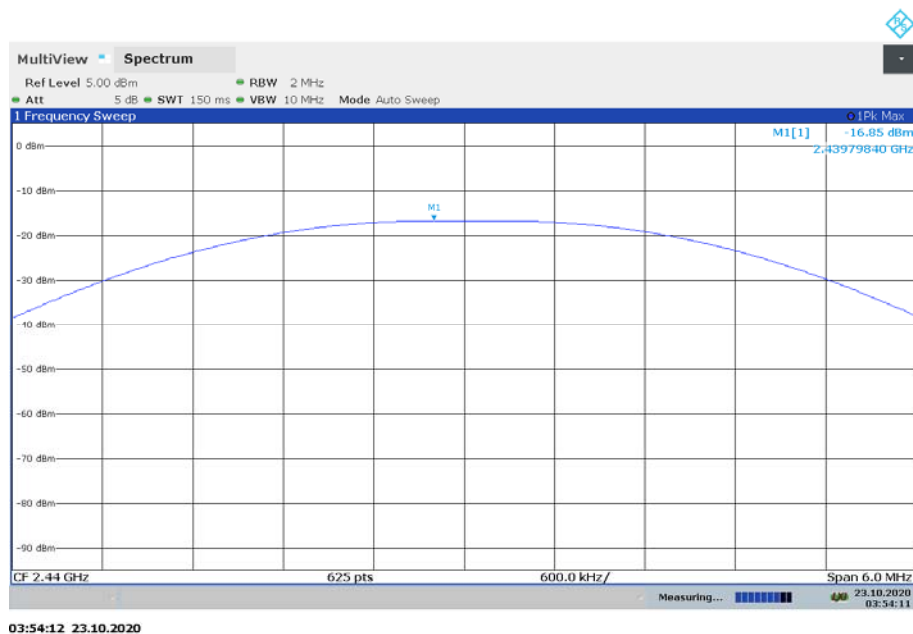
* Denotes Serial Number of Hired Spectrum Analyser

13.6 Test Results

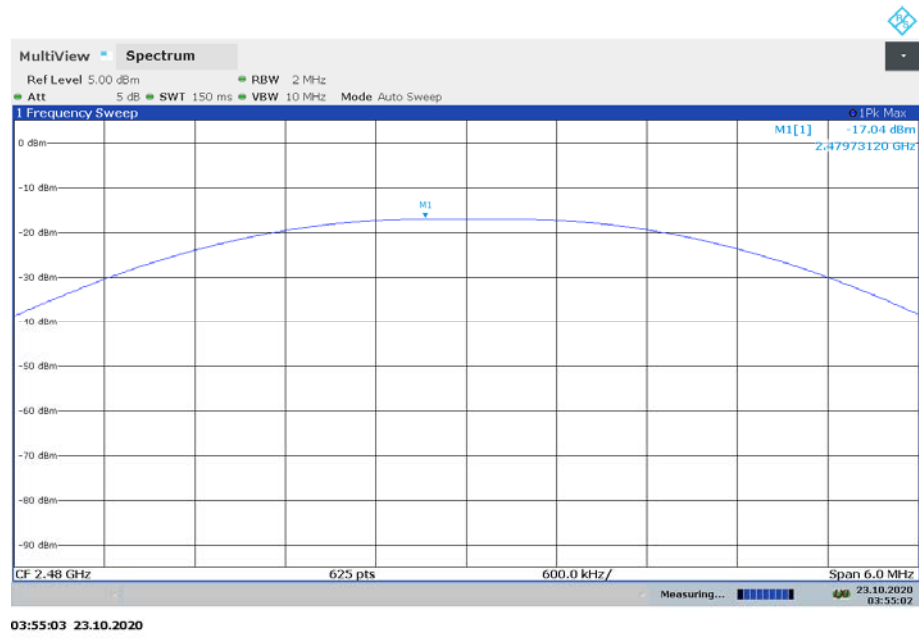
Modulation: GFSK; Data rate: 1 MBps; Power setting: 0 dBm				
Channel Frequency (MHz)	Analyzer Level (dBm)	Cable loss (dB)	Power (mW)	Result
2402.00	-15.71	0.0	0.00003	PASS
2440.00	-16.85	0.0	0.00002	PASS
2480.00	-17.04	0.0	0.00002	PASS



Bottom



Middle



Top

14 Out-of-band and conducted spurious emissions

14.1 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.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.11
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	2 MHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Measurement Detector:	Peak
Measurement Range:	30 MHz to 26.5 GHz

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 27 Vdc	27 Vdc (as declared)

14.3 Test Limit

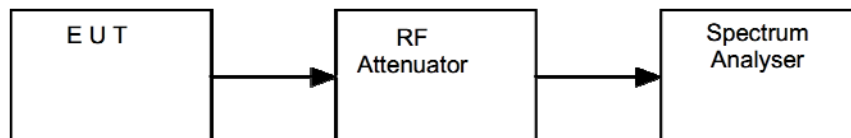
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either 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) / RSS-Gen is not required.

14.4 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

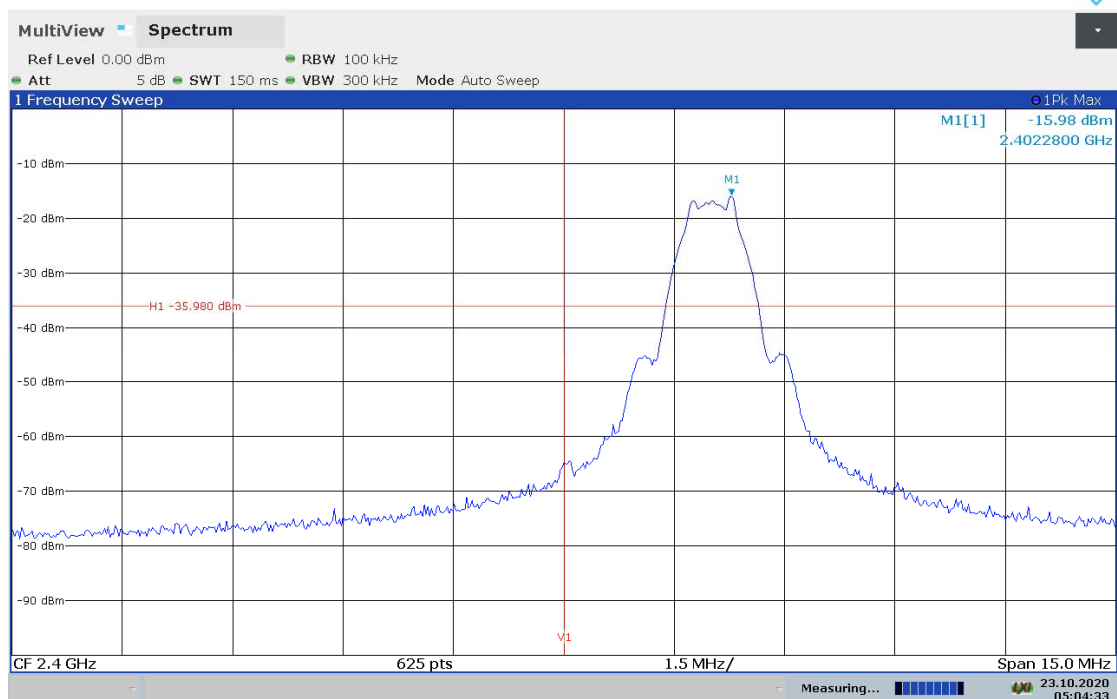
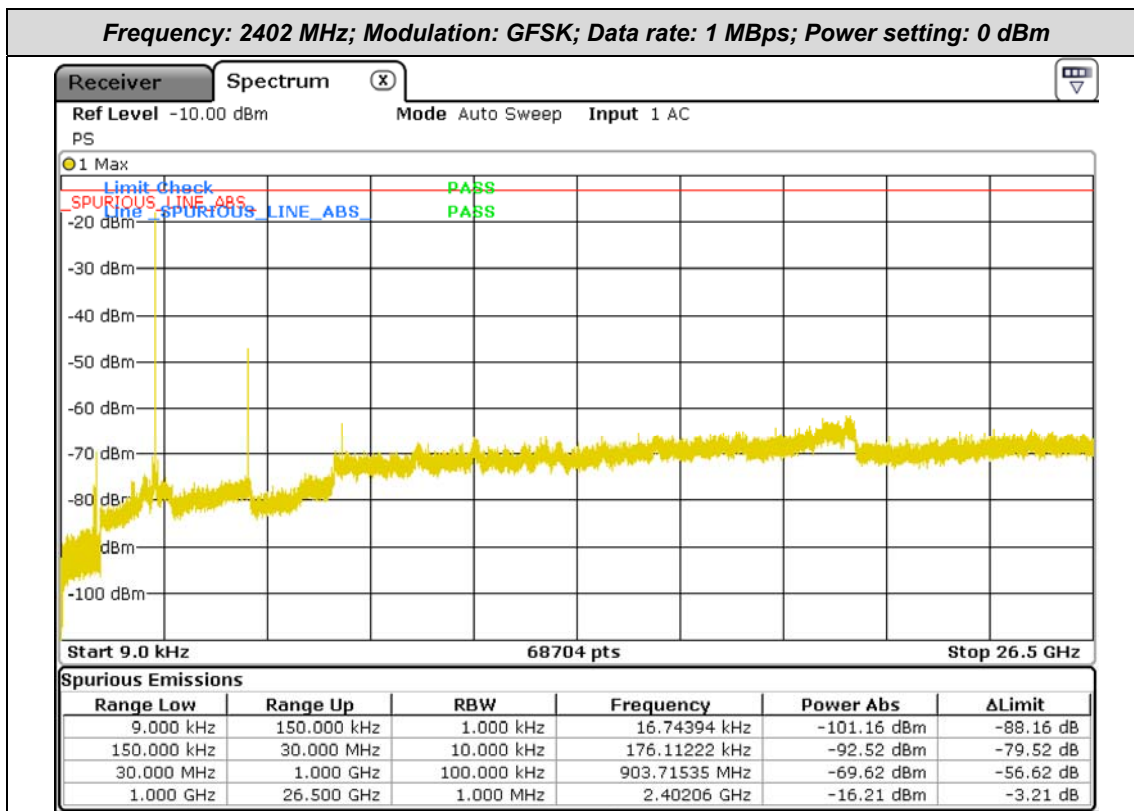


14.5 Test Equipment

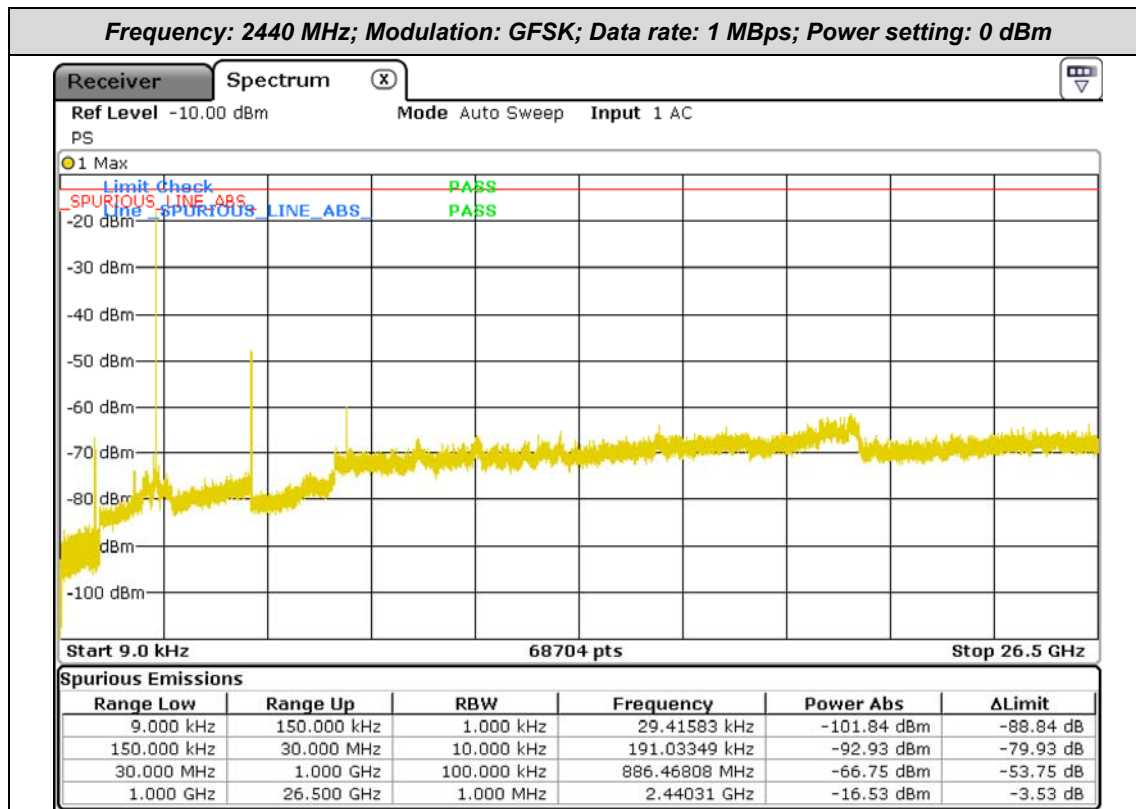
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Spectrum Analyser	Rohde & Schwarz	FSW	101805	2021-07-23

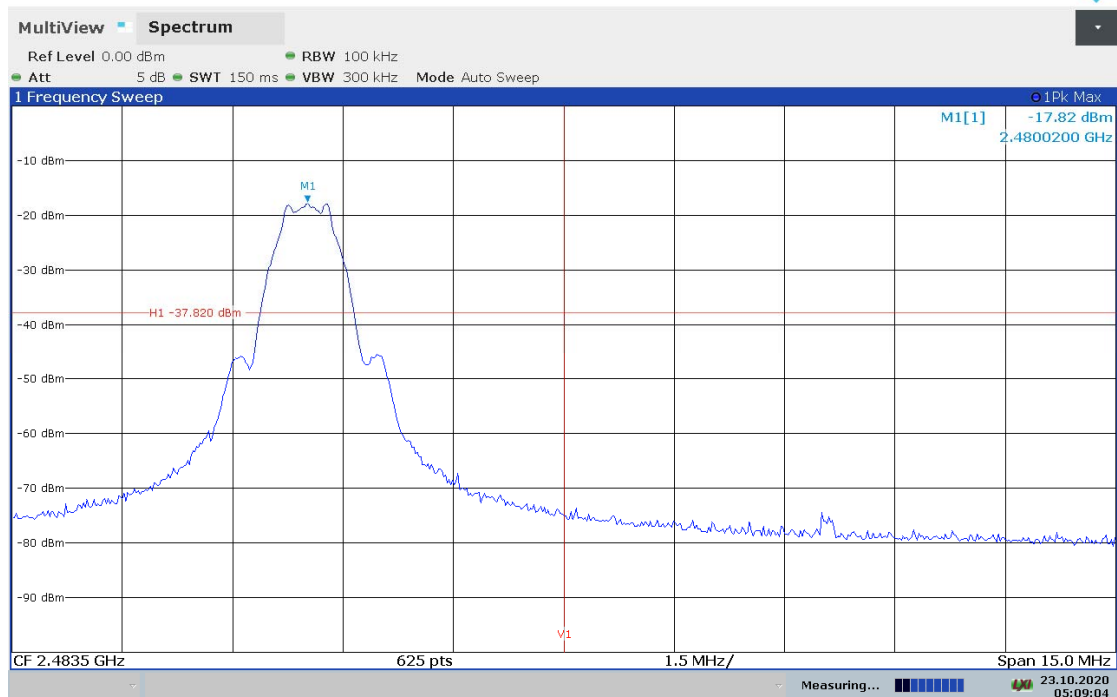
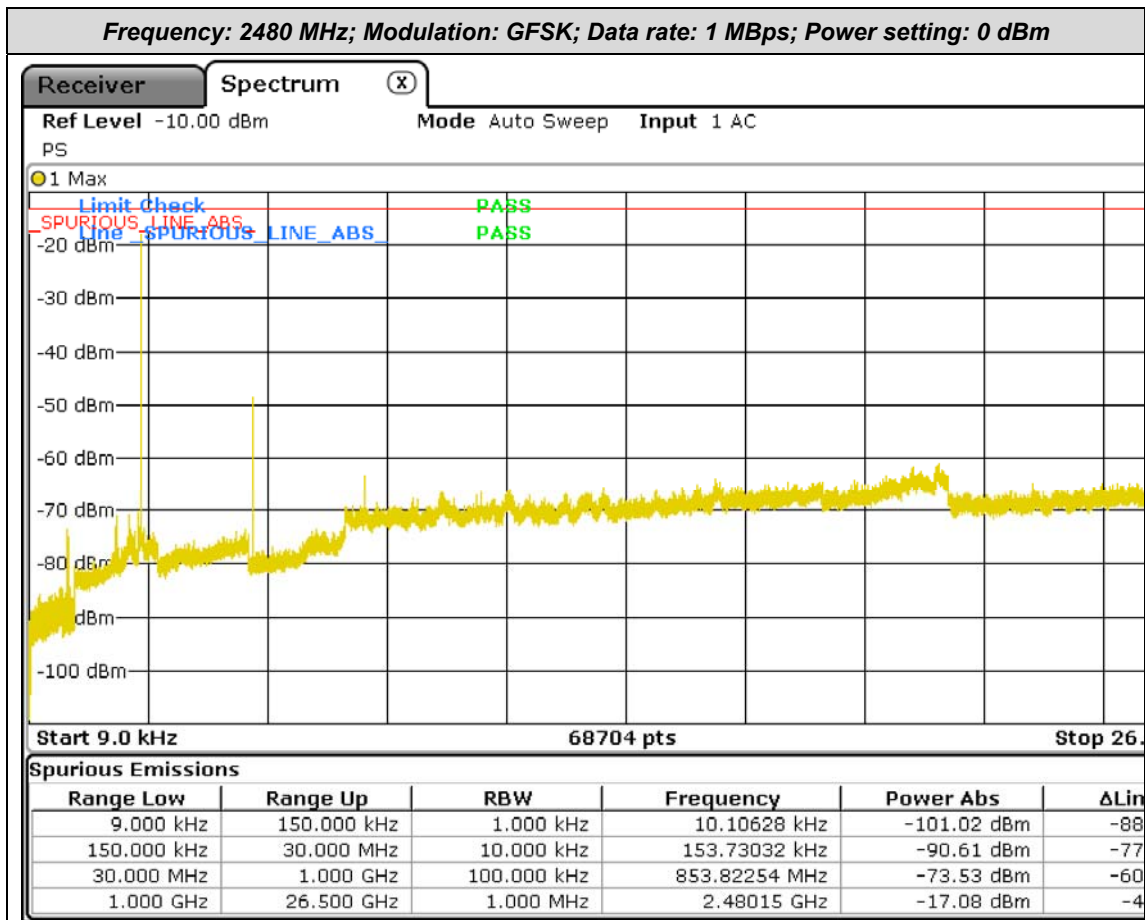
* Denotes Serial Number of Hired Spectrum Analyser

14.6 Test Results



05:04:33 23.10.2020





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15 Power spectral density

15.1 Definition

The power per unit bandwidth.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	2 MHz
Deviations From Standard:	None
Measurement BW:	30 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	100 kHz
Measurement Span: (requirement 1.5 times Channel BW)	1.1 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 27 V dc	27 V dc (as declared)

15.3 Test Limit

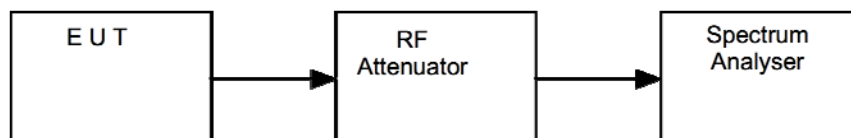
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

15.4 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



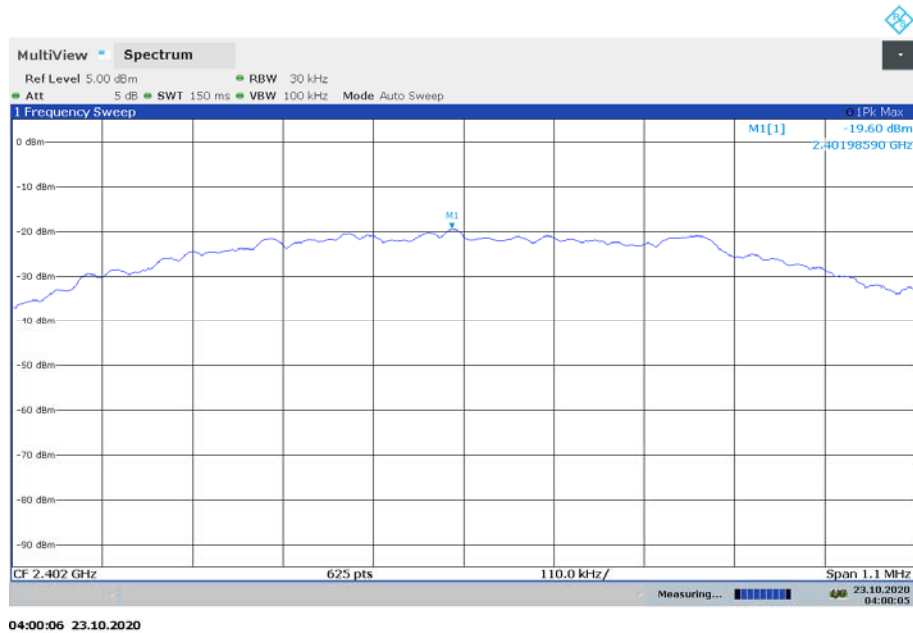
15.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Spectrum Analyser	Rohde & Schwarz	FSW	101805	2021-07-23

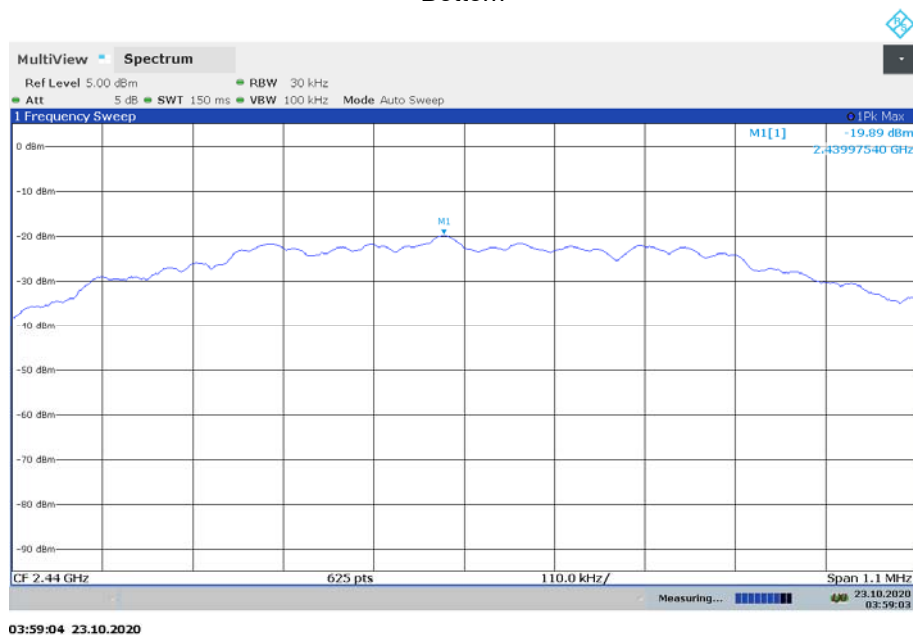
* Denotes Serial Number of Hired Spectrum Analyser

15.6 Test Results

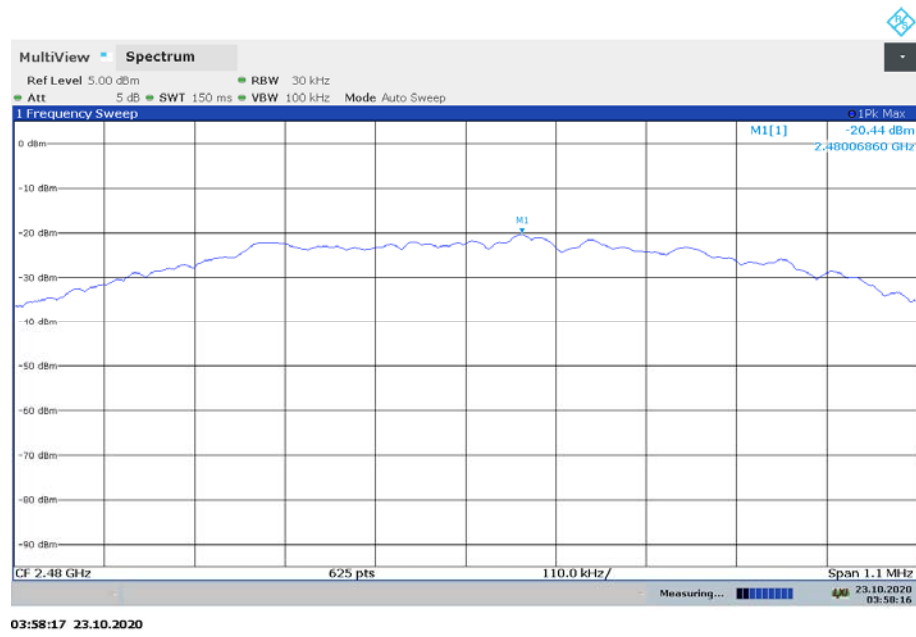
Modulation: GFSK; Data rate: 1 Mbps; Power setting: 0 dBm				
Channel Frequency (MHz)	Analyzer Level (dBm)	Cable loss (dB)	Power (dBm)	Result
2402	-19.60	0	-19.60	PASS
2440	-19.89	0	-19.89	PASS
2480	-20.44	0	-20.44	PASS



Bottom



Middle



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16 Measurement Uncertainty

Calculated Measurement Uncertainties

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

[1] Radiated spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.75 dB**

Uncertainty in test result (1 GHz to 18 GHz) = **4.46 dB**

[2] AC power line conducted emissions

Uncertainty in test result = **3.2 dB**

[3] Occupied bandwidth

Uncertainty in test result = **15.58 %**

[4] Conducted carrier power

Uncertainty in test result (Power Meter) = **0.93 dB**

[5] Conducted RF power out-of-band

Uncertainty in test result – up to 8.1 GHz = **3.31 dB**

Uncertainty in test result – 8.1 GHz to 15.3 GHz = **4.43 dB**

[6] Radiated RF power out-of-band

Uncertainty in test result (30 MHz to 1 GHz) = **4.75 dB**

Uncertainty in test result (1 GHz to 18 GHz) = **4.46 dB**

[7] Power spectral density

Uncertainty in test result (Spectrum Analyser) = **3.11 dB**

[8] ERP / EIRP

Uncertainty in test result (Laboratory) = **4.71 dB**

Uncertainty in test result (Pershore OATS) = **4.26 dB**