

Report on the Radio Testing
For
Extronics LTD
on
iTAG X40
Report no. TRA-063664-47-00C
2024-11-14

RF915 14



0026

Report Number: TRA-063664-47-00C
Issue: C

REPORT ON THE RADIO TESTING OF AN
Extronics LTD
iTAG X40
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 2024-07-30 to 2024-08-06

Tested by: M Else

Written by:

M Else
Radio Test Engineer

Approved by:

J Charters
Lab Manager

Date: 2024-11-14

Disclaimers:

RF915 14

- [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	2024-10-02	Original
B	2024-10-09	Appendix A, Declaration of similarity removed
C	2024-11-01	Updated for Certification amendments

2 Summary

TEST REPORT NUMBER:	TRA-063664-47-00C
WORKS ORDER NUMBER:	TRA-063664-01
PURPOSE OF TEST:	Testing of radio frequency equipment per the relevant authorisation requirements of chapter of CFR (code of federal regulations) Part 2, subpart J & ISSED Canada RSS-Gen
TEST SPECIFICATION:	47CFR15.247
EQUIPMENT UNDER TEST (EUT):	iTAG X40
FCC IDENTIFIER:	2AIZEEXTRFID00005
EUT SERIAL NUMBER:	PCB13 / PCB14 / PCB15
MANUFACTURER/AGENT:	Extronics LTD
ADDRESS:	Extronics Ltd, 1 Dalton Way, Midpoint 18, Midpoint 18 Middlewich Cheshire CW10 0HU United Kingdom
CLIENT CONTACT:	Julian Poyner ☎ +441606 539 636 ✉ Julian.Poyner@extronics.com
ORDER NUMBER:	PO0028964
TEST DATE:	2024-07-30 to 2024-08-06
TESTED BY:	M Else Element

2.1 Test Summary

Test Method and Description		Requirement Clause FCC 47 CFR	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
6 dB bandwidth		15.247 (a) (2)	☒	Pass
Occupied bandwidth (99% bandwidth)		N/A	☒	Pass
Conducted output power	Peak	15.247 (b) (3)	☒	Pass
	Maximum		☒	
Undesirable / unwanted emissions		15.247 (d)	☒	Pass
Power spectral density		15.247 (e)	☒	Pass
Pulsed operation correction		15.35 (c)	☐	N/A

Specific Note:

1. The EUT has a rechargeable battery, but as per client's declaration, it doesn't transmit while charging.

General 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).

General notes

The decision rule for compliance is not inherent within this specification and compliance is based on the customer requesting a simple acceptance rule based on understanding and acceptance of Elements Measurement Uncertainty values.

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4 Introduction

This report TRA-063664-47-00C presents the results of the Radio testing on a Extronics LTD, iTAG X40 to specification FCC Title 47 CFR 15 Radio Frequency Devices.

The testing was carried out for Extronics LTD by Element, at the address detailed below.

☒	Element Skelmersdale Unit 1 Pendle Place Skelmersdale West Lancashire WN8 9PN UK	☐	Element Surrey Hills Unit 15 B Henley Business Park Pirbright Road Normandy Guildford GU3 2DX 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 ISO/IEC 17025:2017 accredited 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:

The test laboratory is accredited for the above sites under the US-UK MRA,

Designation number(s):

Element Surrey Hills	UK2027
Element Skelmersdale	UK2020

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: iTAG X40
- Serial Number: PCB13 / PCB14 / PCB15
- Model Number: X40
- 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 set to transmit a modulated signal on the required Frequency.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	2400 MHz to 2480 MHz
Modulation type(s):	GFSK
Occupied channel bandwidth(s):	794.2 kHz / 789.2 kHz / 794.2 kHz
Channel spacing:	2 MHz
Nominal Supply Voltage:	3.7 V Lithium Ion Re-chargeable battery
Duty cycle:	100%

7.4.2 Antennas

Type:	F Type PCB Antenna
Frequency range:	2400 MHz to 2480 MHz
Gain:	1.7 dBi
Mounting:	PCB

7.5 EUT Description

The EUT is a personnel location tag.

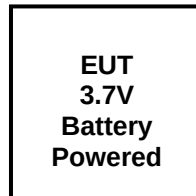
8 Modifications

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:

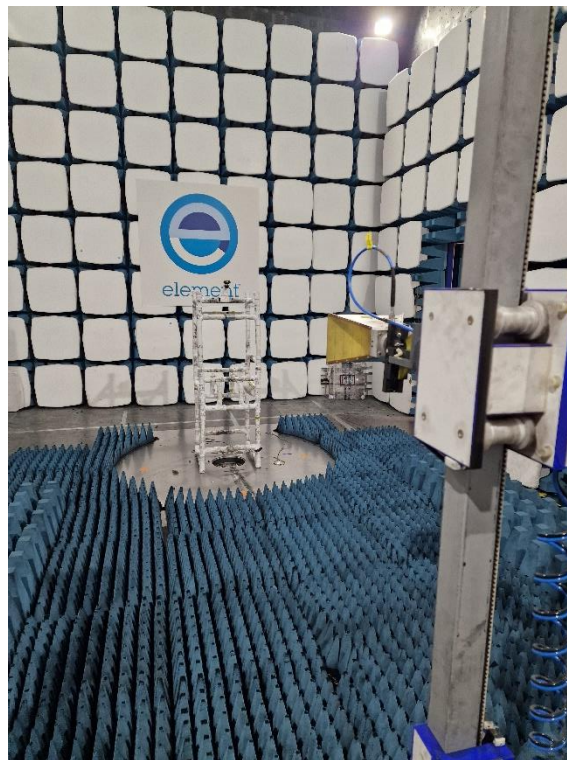


9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



30 MHz to 1 GHz



1 GHz to 26.5 GHz

9.3 *Measurement software*

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

Element Emissions R5

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 3.7 VDC from Lithium batteries.

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.

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 VAC +/-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:	Chamber REF940
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Frequencies Measured:	2402 MHz, 2440 MHz & 2480 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: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (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

<i>Frequency (MHz)</i>	<i>Field Strength (μV/m at 3 m)</i>	<i>Field Strength (dBμV/m at 3 m)</i>
30 to 88	100	40.0
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

On frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function. On frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit.

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:

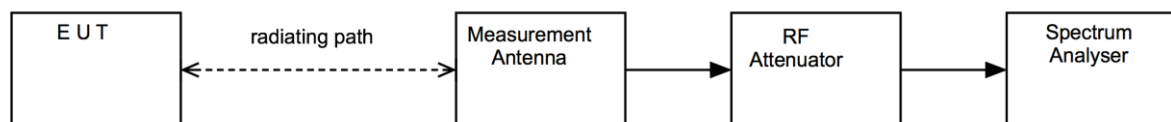
$$FS = PR + CL + AF - PA + DC - CF$$

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

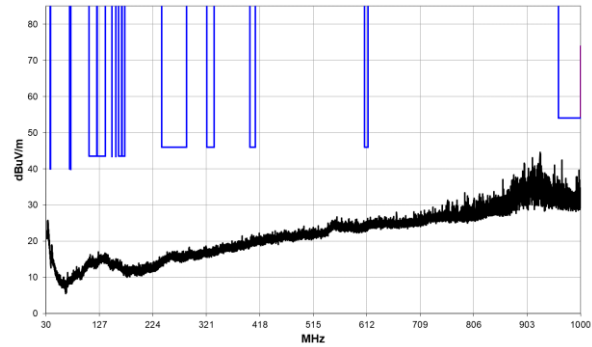


11.5 Test Equipment

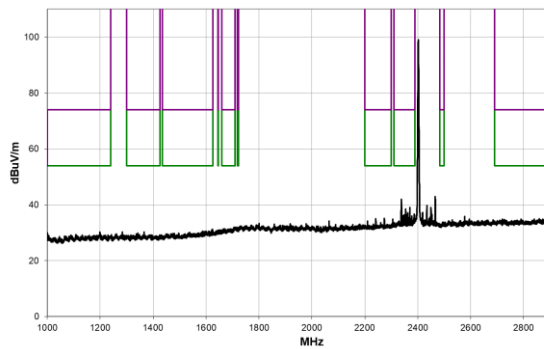
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Emissions R5	Element	Radiated Test Software	REF9000	Cal Not Required
ATS	Rainford EMC	Radio Chamber - PP	REF940	2026-01-29
ESR7	R&S	EMI Receiver	U456	2025-03-08
CBL611/B	Chase	Bilog	U573	2024-10-14
6201-69	Watkins Johnson	PreAmp	U372	2025-03-15
FSU50	R&S	Spectrum Analyser	U544	2024-11-28
3115	EMCO	1-18GHz Horn	U223	2026-01-17
8449B	Agilent	Pre Amp	L572	2024-10-30
SN 4478	BSC	2.4G Band Stop Filter	U543	2025-02-15
AFH-07000	Atlantic Microwave	High Pass Filter	U558	2025-02-15
PAM-840A	Com-Power	Pre-Amp (18 - 40 GHz)	REF2390	2024-10-02
LB-180400-25-C-KF	A Info Inc	Horn Antenna	REF2246	2024-09-23

11.6 Test Results

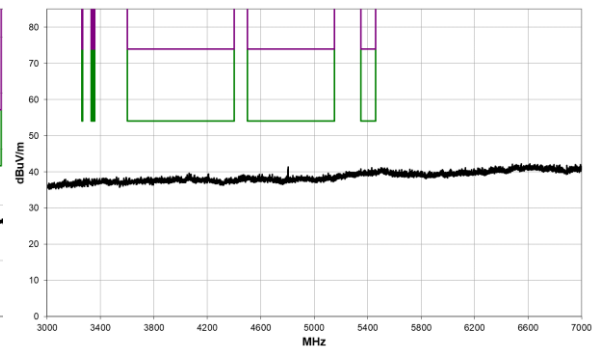
Frequency: 2402 MHz; Power Setting: +8 dBm;



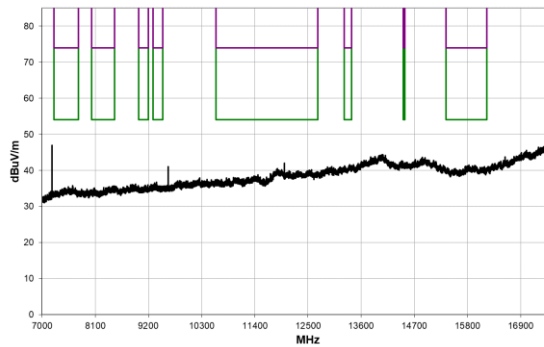
30 MHz to 1 GHz



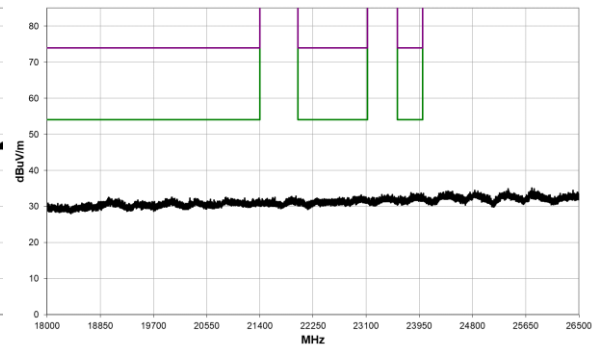
1 GHz to 3 GHz



3 GHz to 7 GHz



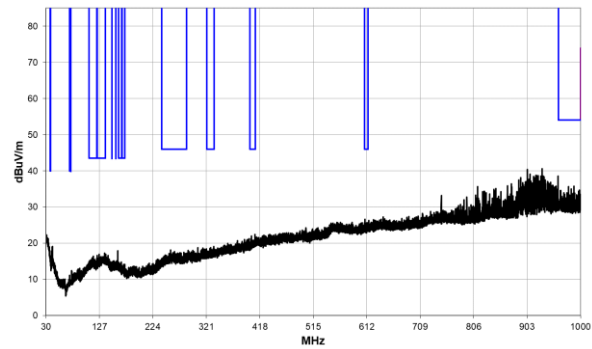
7 GHz to 18 GHz



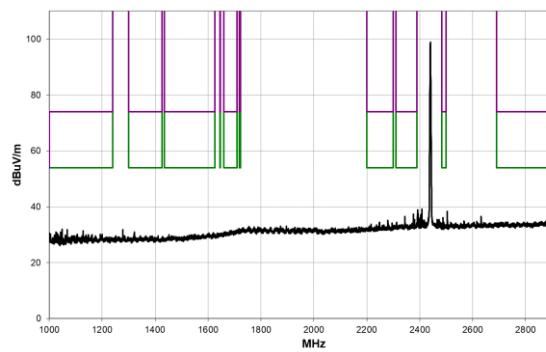
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	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)
2369.808	59.6	-4.1	2.37	343.1	3.0	0.0	Horz	PK	0.0	55.5	74.0	-18.5
2369.883	38.1	-4.1	2.37	343.1	3.0	0.0	Horz	AV	0.0	34.0	54.0	-20.0

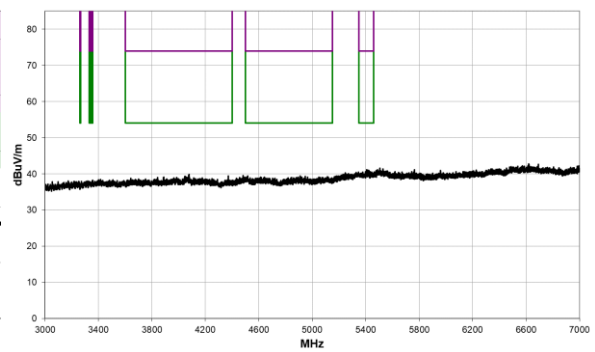
Frequency: 2440 MHz; Power Setting: +8 dBm;



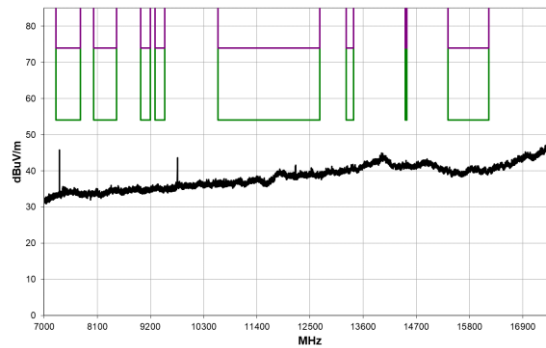
30 MHz to 1 GHz



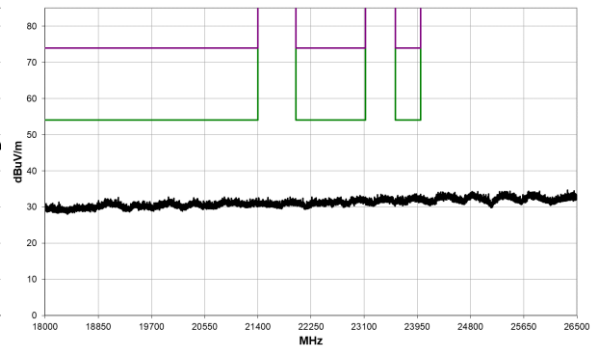
1 GHz to 3 GHz



3 GHz to 7 GHz



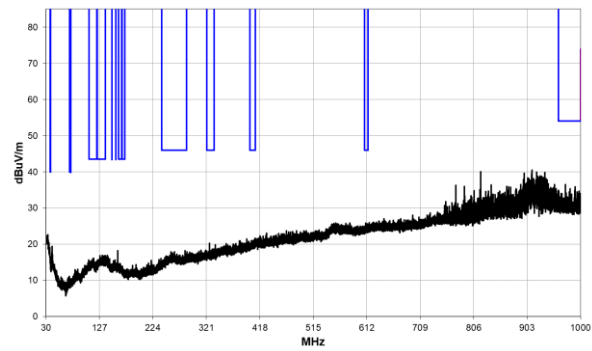
7 GHz to 18 GHz



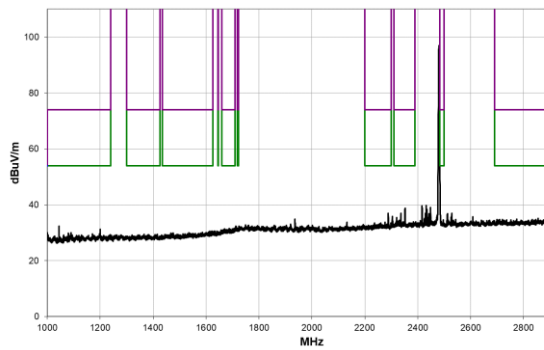
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	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)
7319.383	45.1	7.9	1.52	337.9	1.0	0.0	Horz	AV	-9.5	43.5	54.0	-10.5
7319.442	44.6	7.9	1.5	162.1	1.0	0.0	Vert	AV	-9.5	43.0	54.0	-11.0
12201.550	36.0	11.6	1.48	311.0	1.0	0.0	Horz	AV	-9.5	38.1	54.0	-15.9
12199.020	35.3	11.6	1.5	39.0	1.0	0.0	Vert	AV	-9.5	37.4	54.0	-16.6
7319.292	54.1	7.9	1.52	337.9	1.0	0.0	Horz	PK	-9.5	52.5	74.0	-21.5
7319.600	53.6	7.9	1.5	162.1	1.0	0.0	Vert	PK	-9.5	52.0	74.0	-22.0
12201.580	49.1	11.6	1.48	311.0	1.0	0.0	Horz	PK	-9.5	51.2	74.0	-22.8
12201.320	48.6	11.6	1.5	39.0	1.0	0.0	Vert	PK	-9.5	50.7	74.0	-23.3

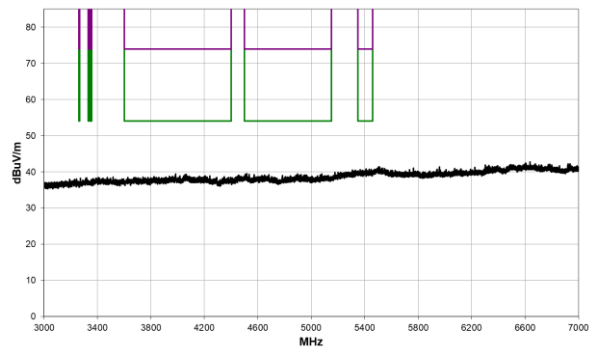
Frequency: 2480 MHz; Power Setting: +8 dBm;



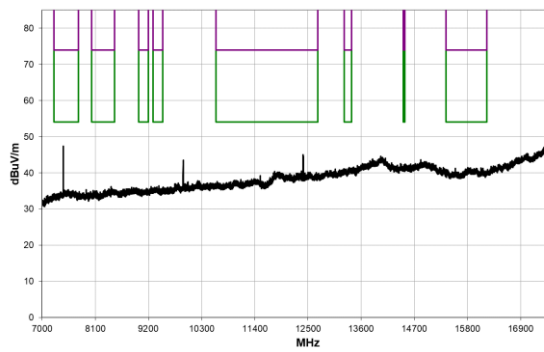
30 MHz to 1 GHz



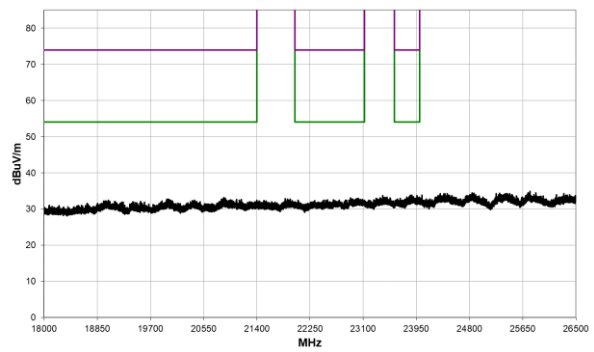
1 GHz to 3 GHz



3 GHz to 7 GHz



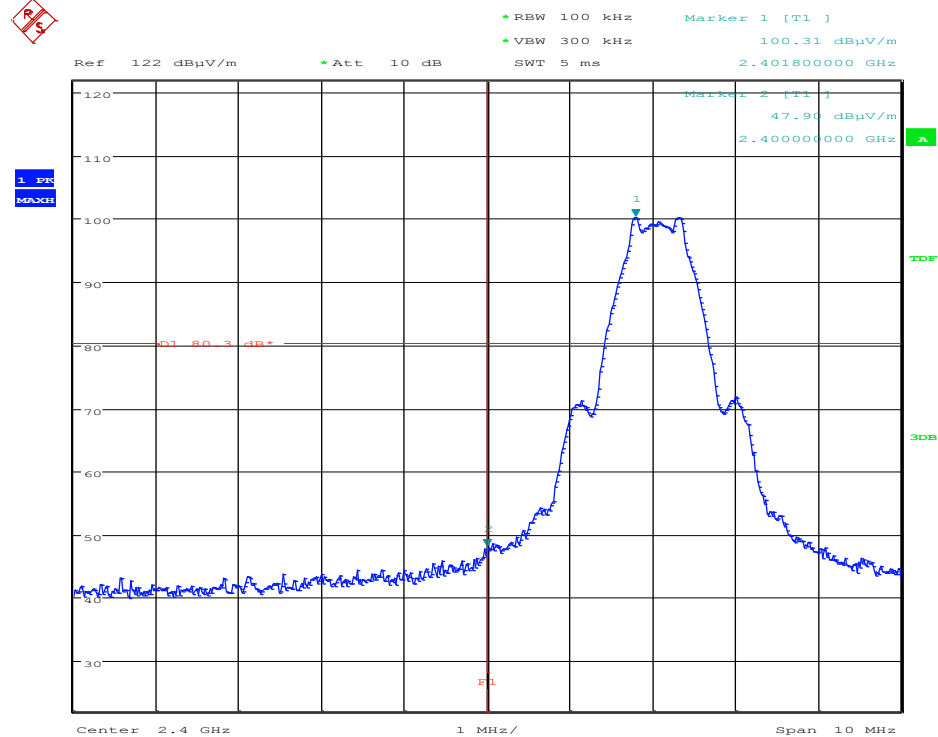
7 GHz to 18 GHz



18 GHz to 26.5 GHz

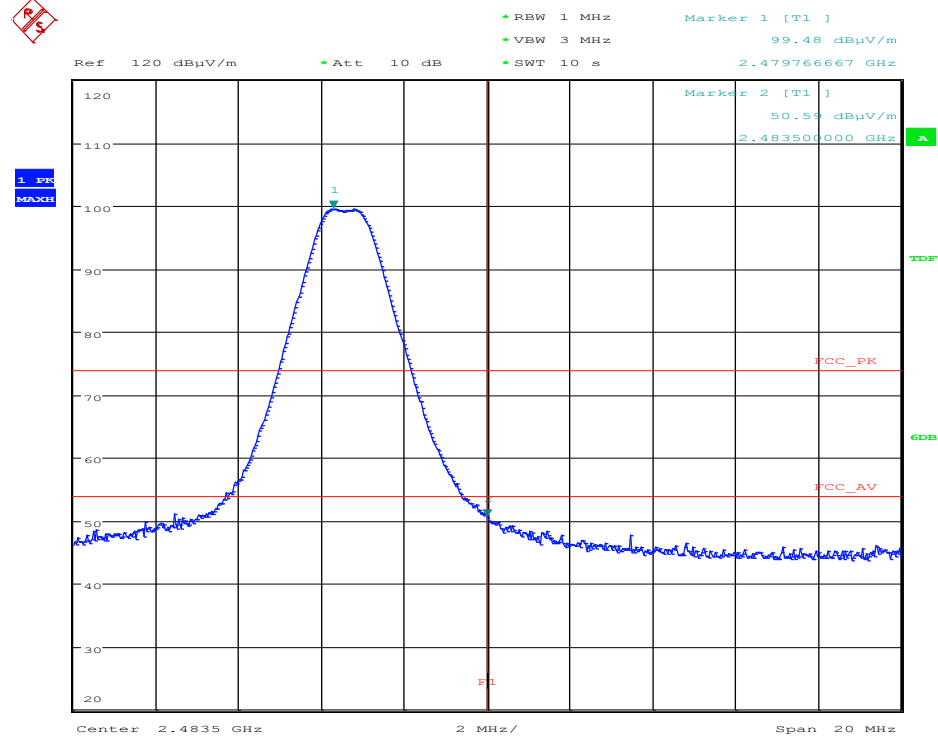
Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
7439.400	46.1	8.0	2.01	25.0	1.0	0.0	Vert	AV	-9.5	44.6	54.0	-9.4
7439.475	44.3	8.0	1.5	237.0	1.0	0.0	Horz	AV	-9.5	42.8	54.0	-11.2
12399.020	37.9	12.6	1.77	309.9	1.0	0.0	Horz	AV	-9.5	41.0	54.0	-13.0
12398.990	34.2	12.6	1.5	345.1	1.0	0.0	Vert	AV	-9.5	37.3	54.0	-16.7
7439.300	54.8	8.0	2.01	25.0	1.0	0.0	Vert	PK	-9.5	53.3	74.0	-20.7
12398.980	50.1	12.6	1.77	309.9	1.0	0.0	Horz	PK	-9.5	53.2	74.0	-20.8
7439.383	53.3	8.0	1.5	237.0	1.0	0.0	Horz	PK	-9.5	51.8	74.0	-22.2
12401.480	47.5	12.6	1.5	345.1	1.0	0.0	Vert	PK	-9.5	50.6	74.0	-23.4

Lower Radiated Band Edge



Date: 30.JUL.2024 10:38:23

Upper Radiated Band Edge



Date: 2.AUG.2024 08:34:21

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.

The 99% emission bandwidth is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	REF940
Test Standard and Clause:	6 dB Bandwidth: ANSI C63.10-2013, Clause 11.8
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	2 MHz
EUT Test Modulations:	GFSK
Deviations From Standard:	None
Measurement BW: (IC requirement: 1% to 5% OBW; FCC requirement: 100 kHz)	IC: 50 kHz FCC: 100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Span: (requirement 2 to 5 times OBW)	5 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 56 % RH	20 % RH to 75 % RH (as declared)

12.3 Test Limit

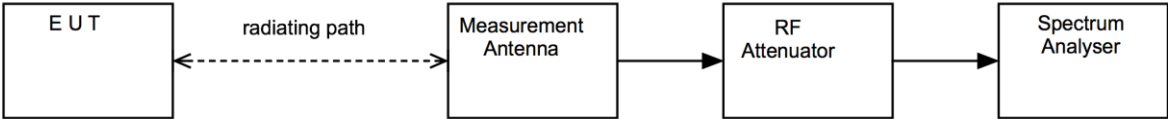
The minimum -6 dB bandwidth shall be at least 500 kHz.

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



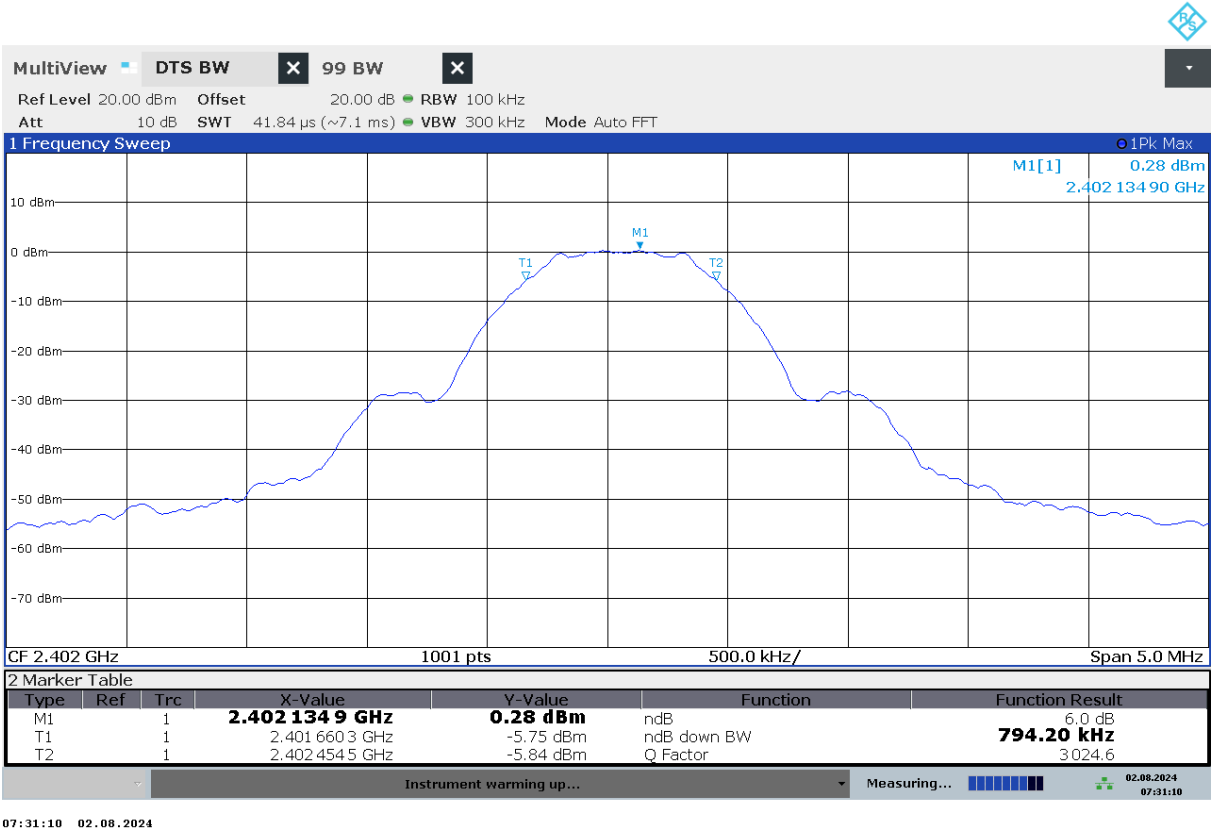
12.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSW 43	R&S	Spectrum Analyser	U728	2025-06-12

12.6 Test Results

Bandwidth Type: 6 dB; Modulation: GFSK; Power setting: +8dB				
Frequency (MHz)	F _L (MHz)	F _H (MHz)	Bandwidth (kHz)	Result
2402	2401.6603	2402.4545	794.2	PASS
2440	2439.6603	2440.4496	789.3	PASS
2480	2479.6703	2480.4645	794.2	PASS

Bottom Channel, 2402 MHz

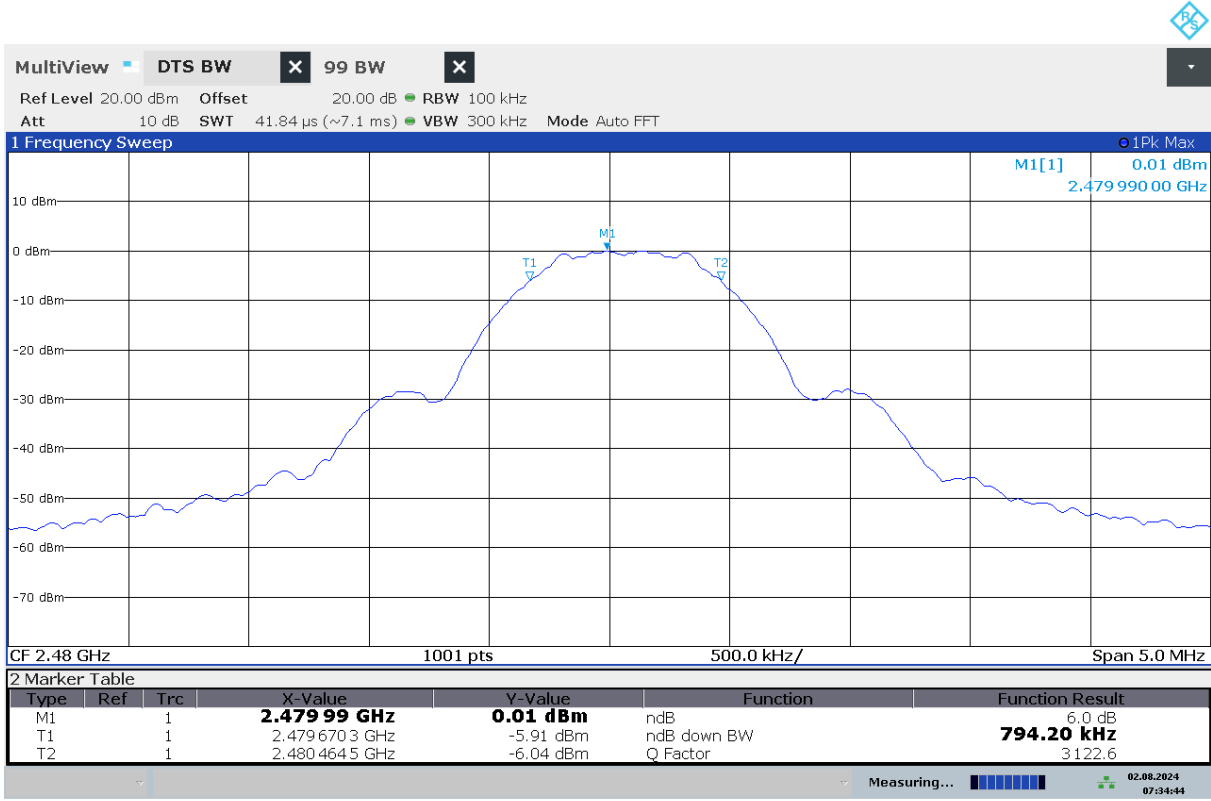


Middle Channel, 2440 MHz



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Top Channel, 2480 MHz



07:34:44 02.08.2024

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.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	REF940
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
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: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 58 % RH	20 % RH to 75 % RH (as declared)

13.3 Test Limit

FCC:

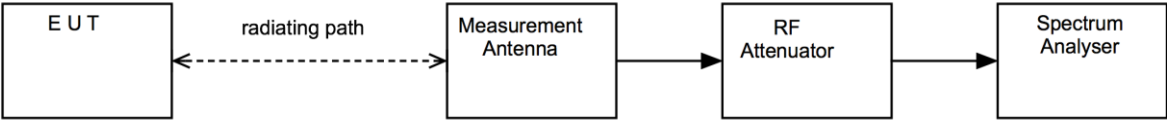
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

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
Emissions R5	Element	Radiated Test Software	REF9000	Cal Not Required
ATS	Rainford EMC	Radio Chamber - PP	REF940	2026-01-29
FSU50	R&S	Spectrum Analyser	U544	2024-11-28
3115	EMCO	1-18GHz Horn	U223	2026-01-17
8449B	Agilent	Pre Amp	L572	2024-10-30

13.6 Test Results

FCC:

The following formula was used to convert field strength (E) in volts/metre to conducted output power in watts:

$$\text{Conducted Output Power} = (E \times d)^2 / (30 \times G)$$

Where,

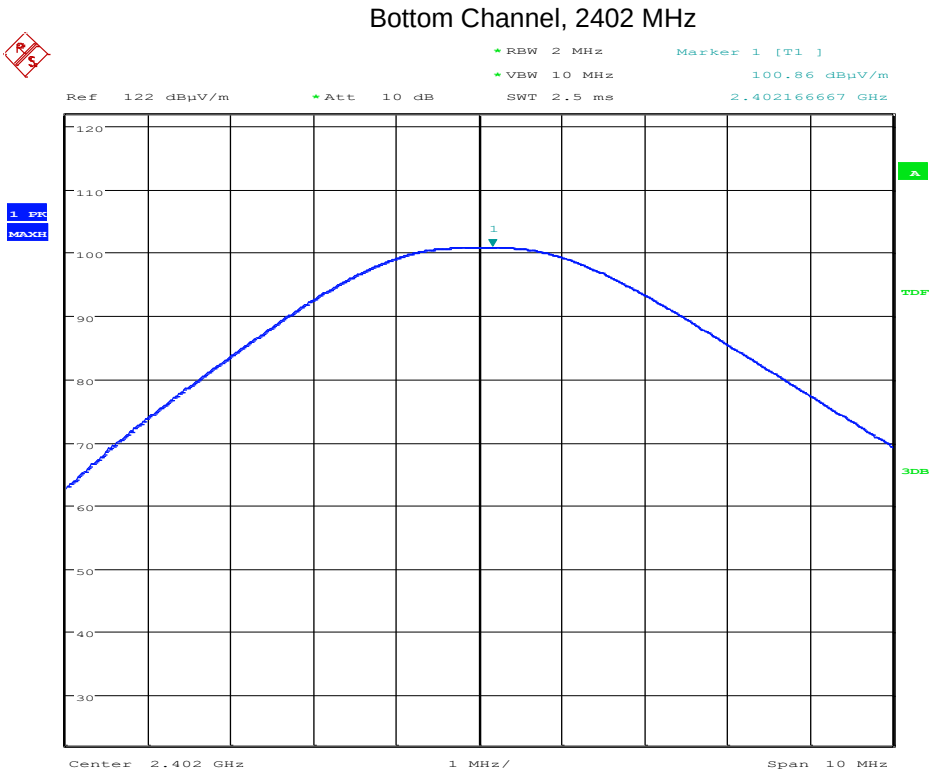
E is the electric field strength in V/m

d is the measurement distance in meters (m)

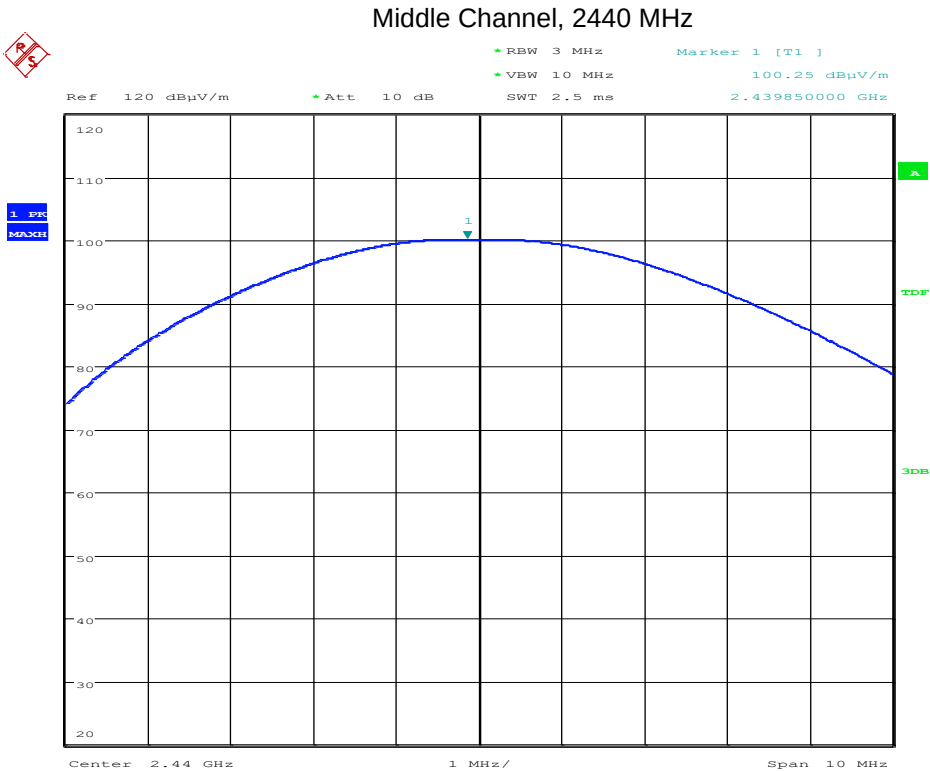
G is the antenna numerical gain referenced to isotropic gain

Modulation: GFSK; Power setting: +8dBm						
Frequency (MHz)	Peak Field Strength (dBμV/m)*	Peak Field Strength (V/m)	Distance (m)	Antenna Numerical Gain	Maximum peak conducted output power (W)	Result
2402	100.86	0.110407862	3	1.48	0.00247	PASS
2440	100.25	0.102920053	3	1.48	0.00215	PASS
2480	99.543	0.094874609	3	1.48	0.00183	PASS

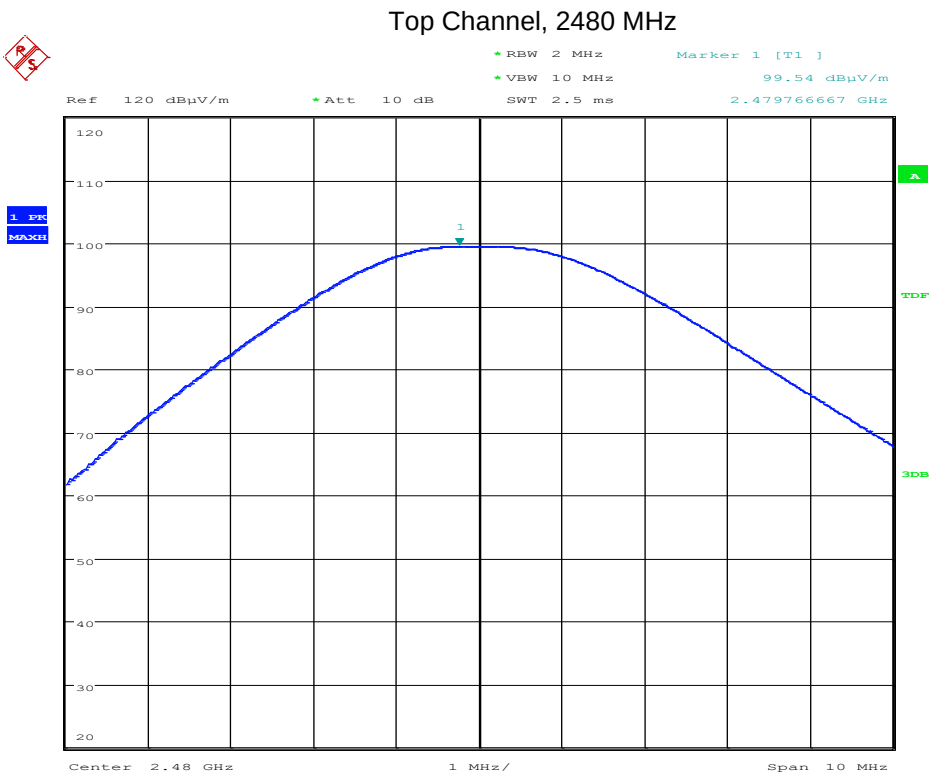
*Radiated measurement



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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:	REF940
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.11
EUT Channels / 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: (requirement at least 3x RBW)	300 kHz
Measurement Detector:	Peak
Measurement Range:	30 MHz to 26.5 GHz

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 58 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

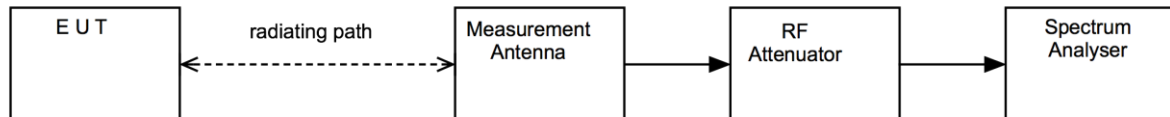
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either 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
Emissions R5	Element	Radiated Test Software	REF9000	Cal Not Required
ATS	Rainford EMC	Radio Chamber - PP	REF940	2026-01-29
ESR7	R&S	EMI Receiver	U456	2025-03-08
CBL611/B	Chase	Bilog	U573	2024-10-14
6201-69	Watkins Johnson	PreAmp	U372	2025-03-15
FSU50	R&S	Spectrum Analyser	U544	2024-11-28
3115	EMCO	1-18GHz Horn	U223	2026-01-17
8449B	Agilent	Pre Amp	L572	2024-10-30
SN 4478	BSC	2.4G Band Stop Filter	U543	2025-02-15
AFH-07000	Atlantic Microwave	High Pass Filter	U558	2025-02-15
PAM-840A	Com-Power	Pre-Amp (18 - 40 GHz)	REF2390	2024-10-02
LB-180400-25-C-KF	A Info Inc	Horn Antenna	REF2246	2024-09-23

14.6 Test Results

Modulation: GFSK; Frequency 2402 MHz						
Emission Frequency (MHz)	Peak Field Strength (dBμV/m)	Distance (m)	Power (dBm)	Limit (dBm)	Margin (dB)	Result
No Significant Emissions See Plots in Section 11						PASS

Modulation: GFSK; Frequency 2440 MHz						
Emission Frequency (MHz)	Peak Field Strength (dBμV/m)	Distance (m)	Power (dBm)	Limit (dBm)	Margin (dB)	Result
No Significant Emissions See Plots in Section 11						PASS

Modulation: GFSK; Frequency 2480 MHz						
Emission Frequency (MHz)	Peak Field Strength (dBμV/m)	Distance (m)	Power (dBm)	Limit (dBm)	Margin (dB)	Result
No Significant Emissions See Plots in Section 11						PASS

15 Power spectral density

15.1 Definition

The power per unit bandwidth.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	REF 940
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
EUT Channels / 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: (requirement at least 3x RBW)	300 kHz
Measurement Span: (requirement 1.5 times DTS BW)	1191.3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 57 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

For equipment operating in the bands 902 - 928 MHz and 2400 - 2483.5 MHz 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.

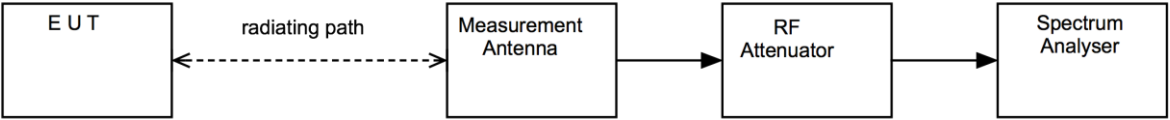
For equipment operating in the band 5725 - 5850 MHz the output power spectral density shall not exceed 30 dBm in any 500 kHz band

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per the test set-up diagram below, 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.

Test Set-up Diagram



15.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Emissions R5	Element	Radiated Test Software	REF9000	Cal Not Required
ATS	Rainford EMC	Radio Chamber - PP	REF940	2026-01-29
FSU50	R&S	Spectrum Analyser	U544	2024-11-28
3115	EMCO	1-18GHz Horn	U223	2026-01-17
8449B	Agilent	Pre Amp	L572	2024-10-30

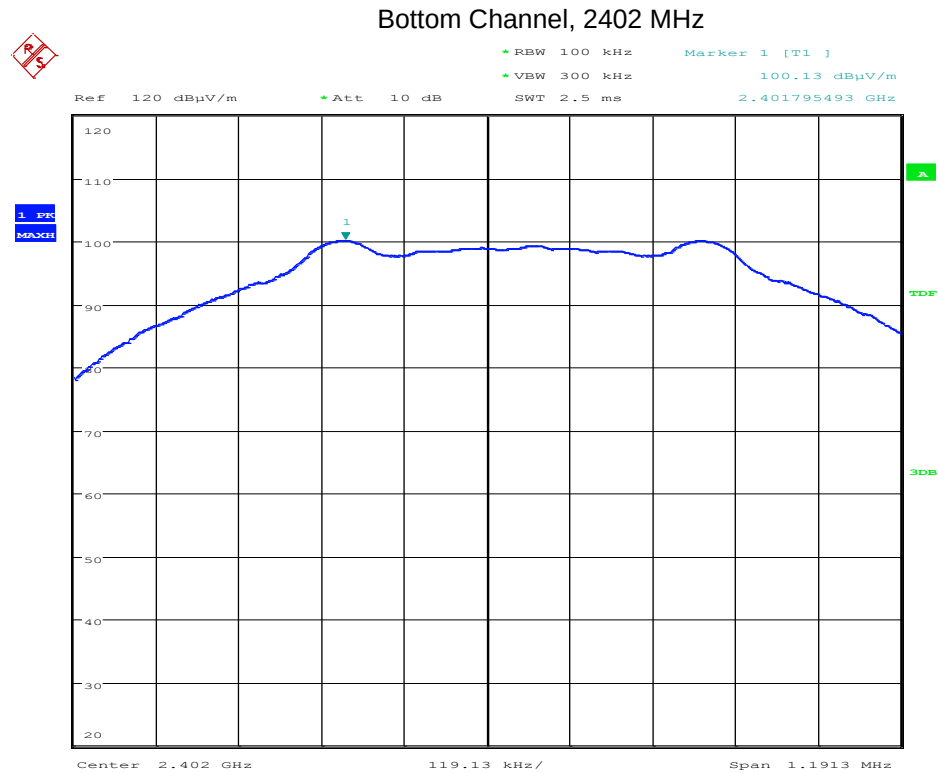
15.6 Test Results

The following formula may be used to convert field strength (FS) in volts/metre to transmitter output power (TP) in watts:

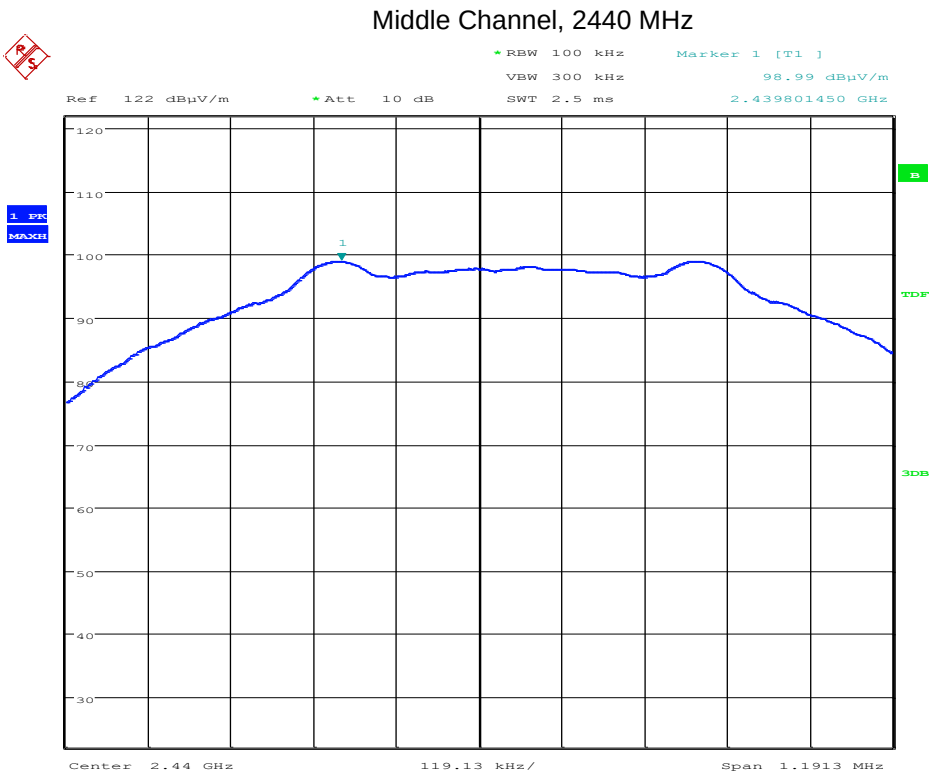
$$TP = (FS \times D)^2 / (30 \times G)$$

where D is the distance in metres between the two antennas and G is the antenna numerical gain referenced to isotropic gain.

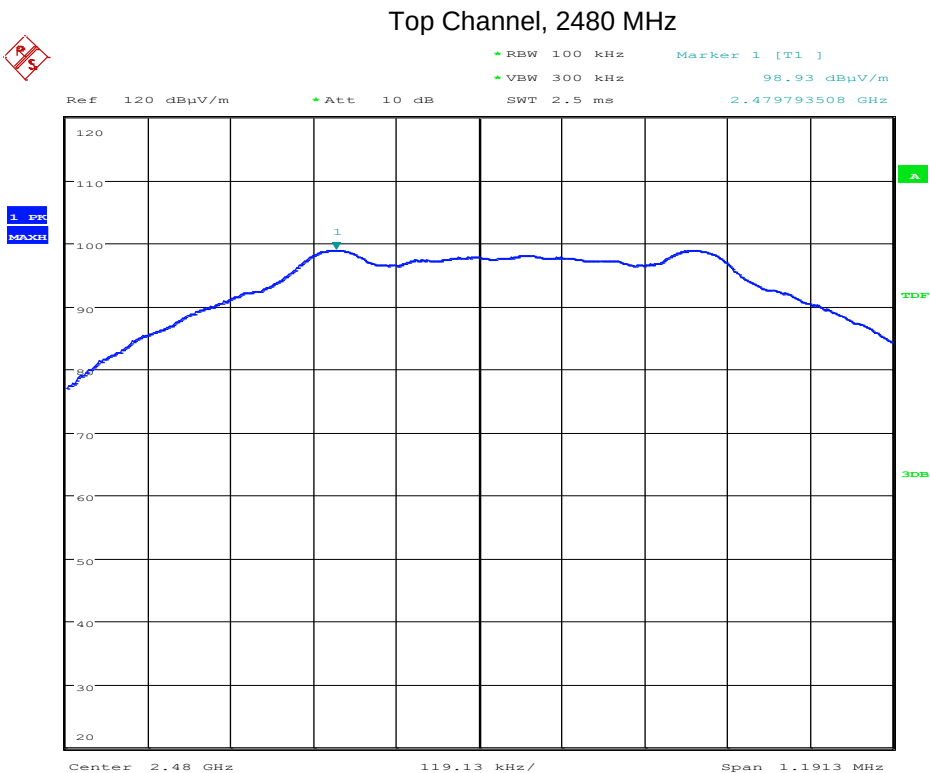
Modulation: GFSK; Power setting: +8dBm					
Channel Frequency (MHz)	Peak Field Strength (dBµV/m)	Distance (m)	Antenna Gain (dBi)	Max. Power (dBm)	Result
2402	100.13	3.00	1.70	3.20	Pass
2440	98.99	3.00	1.70	2.06	Pass
2480	98.93	3.00	1.70	2.00	Pass



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16 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.

Test/Measurement	Budget Number	MU
Conducted RF Power, Power Spectral Density, Adjacent Channel Power and Spurious emissions		
Absolute RF power (via antenna connector) Sampling Power Meter to 8 GHz	MU4001	0.9 dB
Carrier Power and PSD - Spectrum Analysers	MU4004	1.7 dB
Adjacent Channel Power	MU4002	1.9 dB
Transmitter conducted spurious emissions (Including emissions due to intermodulation)	MU4041	0.9 dB
Conducted power and spurious emissions 40 GHz to 50 GHz	MU4042	2.4 dB
Conducted power and spurious emissions 50 GHz to 75 GHz	MU4043	2.5 dB
Conducted power and spurious emissions 75 GHz to 110 GHz	MU4044	2.4 dB
Radiated RF Power and Spurious emissions ERP and EIRP		
Effective Radiated Power Reverb Chamber	MU4020	3.7 dB
Effective Radiated Power	MU4021	4.7 dB
TRP Emissions 30 MHz to 1 GHz using CBL6111 or CBL6112 Bilog Antenna	MU4046	5.3 dB
TRP Emissions 1 GHz to 18 GHz using HL050 Log Periodic Antenna	MU4047	5.1 dB
TRP Emissions 18 GHz to 26.5 GHz using Standard Gain Horn	MU4048	2.7 dB
TRP Emissions 26.5 GHz to 40 GHz using Standard Gain Horn	MU4049	2.7 dB
In-band (3450-3980 MHz) TRP using CATR_ASH_B2	MU4051	4.1 dB
Cellular Radiated Spurious Emissions in a SAC 30 MHz to 180 MHz	MU4052	6.3 dB
Cellular Radiated Spurious Emissions in a SAC 180 MHz to 18 GHz	MU4052	3.6 dB
Cellular Radiated Spurious Emissions in a FAR 30 MHz to 180 MHz	MU4052	5.4 dB
Cellular Radiated Spurious Emissions in a FAR 180 MHz to 18 GHz	MU4052	3.0 dB
Spurious Emissions Electric and Magnetic Field		
Radiated Spurious Emissions 30 MHz to 1 GHz (Including emissions due to intermodulation)	MU4037	4.7 dB
Radiated Spurious Emissions 1-18 GHz (Including emissions due to intermodulation)	MU4032	4.5 dB
E Field Emissions 18 GHz to 26 GHz	MU4024	3.2 dB
E Field Emissions 26 GHz to 40 GHz	MU4025	3.3 dB
E Field Emissions 40 GHz to 50 GHz	MU4026	3.5 dB
E Field Emissions 50 GHz to 75 GHz	MU4027	3.6 dB
E Field Emissions 75 GHz to 110 GHz	MU4028	3.6 dB
Radiated Magnetic Field Emissions	MU4031	2.3 dB

Test/Measurement	Budget Number	MU
Frequency Measurements		
Frequency Deviation	MU4022	3.7 kHz
Frequency error using CMTA test set	MU4023	113.441 Hz
Frequency error using GPS locked frequency source	MU4045	0.0413 ppm
Bandwidth/Spectral Mask Measurements		
Channel Bandwidth	MU4005	3.87%
Transmitter Mask Amplitude	MU4039	1.3 dB
Transmitter Mask Frequency	MU4040	2.59%
Time Domain Measurements		
Transmission Time	MU4038	4.40%
Dynamic Frequency Selection (DFS) Parameters		
DFS Analyser - Measurement Time	MU4006	678.984 µs
DFS Generator - Frequency Error	MU4007	91.650 Hz
DFS Threshold Conducted	MU4008	1.3 dB
DFS Threshold Radiated	MU4009	3.2 dB
Receiver Parameters		
EN 300 328 Receiver Blocking	MU4010	1.1 dB
EN 301 893 Receiver Blocking	MU4011	1.1 dB
EN 303 340 Adjacent Channel Selectivity	MU4012	1.1 dB
EN 303 340 Overloading	MU4013	1.1 dB
EN 303 340 Receiver Blocking	MU4014	1.1 dB
EN 303 340 Receiver Sensitivity	MU4015	0.9 dB
EN 303 372-1 Image Rejection	MU4016	1.4 dB
EN 303 372-1 Receiver Blocking	MU4017	1.1 dB
EN 303 372-2 Adjacent Channel Selectivity	MU4018	1.1 dB
EN 303 372-2 Dynamic Range	MU4019	0.9 dB
Receiver Blocking Talk Mode Conducted	MU4033	1.2 dB
Receiver Blocking Talk Mode- radiated	MU4034	3.4 dB
Rx Blocking, listen mode, blocking level	MU4035	3.2 dB
Rx Blocking, listen mode, radiated Threshold Measurement	MU4036	3.4 dB
Adjacent Sub Band Selectivity	MU4003	4.2 dB

Test/Measurement	Budget Number	MU
Rohde & Schwarz TS8997		
Carrier frequency	MU4050	5.2 ppm
RF Output Power	MU4050	1.0 dB
Peak Power	MU4050	0.8 dB
Power Spectral Density	MU4050	1.0 dB
Occupied Channel Bandwidth	MU4050	2.08 %
Transmitter unwanted emissions in-band	MU4050	0.9 dB
Transmitter unwanted emissions in the spurious domain 30 MHz to 1 GHz	MU4050	0.6 dB
Transmitter unwanted emissions in the spurious domain 1 GHz to 12.75 GHz	MU4050	1.8 dB
Receiver Spurious emission 30 MHz to 1 GHz	MU4050	0.6 dB
Receiver Spurious emission 1 GHz to 12.75 GHz	MU4050	1.8 dB
Duty Cycle	MU4050	0.02 %
Tx Sequence	MU4050	0.02 %
Tx Gap	MU4050	0.02 %
Medium Utilisation	MU4050	0.1 %
Accumulated Transmit Time	MU4050	0.01 %
Minimum Frequency Occupation Time	MU4050	0.01 %
Hopping Frequency Separation	MU4050	0.6 %
Receiver blocking (for bit streams)	MU4050	3.0 dB
Channel Access Mechanism / Adaptivity / DFS / Contention Based Protocol	MU4050	1.8 dB

17 RF Exposure

General SAR test reduction & exclusion guidance

KDB 447498

Section 4.3 General SAR test reduction and exclusion guidance

For Standalone SAR exclusion consideration, when SAR Exclusion Threshold requirement in KDB 447498 is satisfied, standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

The SAR Test Exclusion Threshold for frequencies in the range 100 MHz to 6 GHz, and for test separation distance of ≤ 50 mm, is determined as follows.

$$\text{SAR Exclusion Threshold (SARET)} = (\text{NT} \times \text{TSD}_A) / \sqrt{f_{\text{GHz}}}$$

Where,

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)

TSD_A = Minimum Test separation distance or 50 mm (whichever is lower)

f_{GHz} = Transmit frequency in GHz

Channel Frequency (MHz)	Maximum Conducted Power (mW)	SAR Exclusion Threshold at 5 mm (mW)	SAR Evaluation
2402	2.5	9.7	Not Required
2440	2.1	9.6	Not Required
2480	1.8	9.5	Not Required

Therefore standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.