Report on the Radio Testing

For

Checkit Europe Ltd

on

Wireless ethernet repeater GENII/SRPT/200E

Report no. TRA-060926-02B

18th September 2023

Report Number: TRA-060926-47-02B
Issue: B

REPORT ON THE RADIO TESTING OF A
Checkit Europe Ltd
Wireless ethernet repeater GENII/SRPT/200E
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.249

TEST DATE: 28-06-2023 TO 19-07-2023

Written by:	Digitally signed by Michael Else Date: 2023.09.18 13:24:22 +01'00'	Michael Else Radio Test Engineer
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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

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1 Revision Record

Issue Number	***Issue Date***	***Revision History***
A	7th August 2023	Original
B	18th September 2023	FCC ID Updated, RF Exposure amended.

2 Summary

TEST REPORT NUMBER:	TRA-060926-47-02B
WORKS ORDER NUMBER:	TRA-060926-04
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):	47CFR15.249
EQUIPMENT UNDER TEST (EUT):	Wireless ethernet repeater GENII/SRPT/200E
FCC IDENTIFIER:	2A9Q3CHK00472
EUT SERIAL NUMBER:	E7E789
MANUFACTURER/AGENT:	Checkit Europe Ltd
ADDRESS:	Broers Building 21 JJ Thomson Ave Cambridge CB3 0FA United Kingdom
CLIENT CONTACT:	Stefan Chiforeanu ☎ +44 7490 469064 ✉ stefan.chiforeanu@checkit.net
ORDER NUMBER:	PO-001954
TEST DATE:	28-06-2023 TO 19-07-2023
TESTED BY:	Michael Else Element

2.1 Test Summary

Test Method and Description	***Requirement Clause***	***Applicable to this equipment***	***Result / Note***
	47CFR15		
Radiated spurious emissions	15.249(d)	☒	*Pass*
AC power line conducted emissions	15.207	☒	*Pass*
Occupied bandwidth	15.215(c)	☒	*Pass*
Field strength of fundamental	15.249(a)	☒	*Pass*
Calculation of duty correction	15.35(c)	☐	*N/A*

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-060926-47-02B presents the results of the Radio testing on a Checkit Europe Ltd, Wireless ethernet repeater GENII/SRPT/200E to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Checkit Europe Ltd by Element, at the address(es) 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	☐	Element Surrey Hills Unit 15 B Henley Business Park Pirbright Road Normandy Guildford GU3 2DX UK

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:
The test laboratory is accredited for the above sites under the following US-UK MRA, Designation numbers.

Element Hull	UK2007
Element Skelmersdale	UK2020

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

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: Wireless ethernet repeater GENII/SRPT/200E
- Serial Number: E7E789
- Model Number: GENII/SRPT/200E
- Software Revision: Production
- Build Level / Revision Number: Production

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 Tx tests was as follows…

The EUT was set to Transmit on the indicated frequency when powered on.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	915 MHz
Modulation type(s):	FSK
Occupied channel bandwidth(s):	300 kHz
Declared output power(s):	3 dBm
Nominal Supply Voltage:	110 Vac
Duty cycle:	0.061%

7.4.2 Antennas

Type:	Whip Antenna
Make:	RF Solutions
Model:	FLEXI-M4-868
Gain:	2dBi

7.5 EUT Description

The EUT is a wireless ethernet repeater.

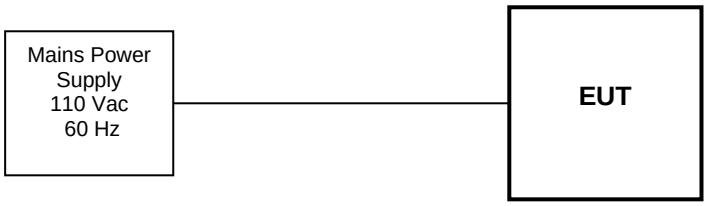
8 Modifications

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 was 110 V ac, 60 Hz, from the mains.

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

Out-of-band emissions
Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

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:	Radio Chamber 03
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	915 MHz
Deviations From Standard:	None
Measurement BW:	9 kHz to 30 MHz: 9 kHz; 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: 25 °C	+15 ºC to +35 ºC (as declared)
Humidity: 55 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 Vac	110 V ac ±10 % (as declared)

11.3 Test Limit, 30 MHz and above

Except for harmonics, out-of-band emissions shall be attenuated by at least 50 dB below the level of the fundamental or to the general field strength limits listed in FCC 47CFR15.209 / RSS-Gen {see table below}, whichever is less stringent.

Harmonics shall be limited to a maximum level of 0.5 mV/m measured at 3 metres.

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

Frequency (MHz)	*Field Strength (µV/m at 3 m)*
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

n.b. per FCC 47CFR15.35(b), peak limit is 20 dB above average.

11.4 Test Method, 30 MHz and above

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:

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

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.

11.5 Test Limit, Below 30 MHz

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for License-Exempt Transmitters at Frequencies Below 30 MHz

Frequency, f (kHz)	*Field Strength*	*Measurement Distance (m)*
9 to 490	2,400 / 377.f (µA/m) 2,400 / f (µV/m)	300
490 to 1,750	24,000 / 377.f (µA/m) 24,000 / f (µV/m)	30
1,750 to 30,000	30 (µV/m)	30

n.b. Devices operated pursuant to §15.225 / RSS-210 A2.6 are exempt from complying with the restricted band requirements for the 13.36–13.41 MHz band only.

11.6 Test Method, Below 30 MHz

With the EUT setup as per section 9 of this report and connected as per Figure i, the EUT fundamental frequency was maximised by rotating the EUT through 360º, in three orthogonal planes, and adjusting the measurement antenna azimuth.

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 9 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 9 kHz and 30 MHz are measured using a calibrated 60cm active loop antenna. 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.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in µV/m at the regulatory distance, using:

$$FS = 10^{(PR - CF) / 20}$$

Where,

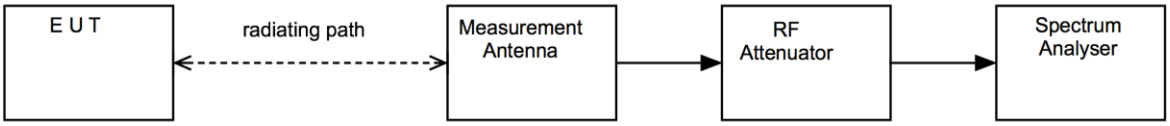
PR is the power recorded on the receiver / spectrum analyzer in dBµV and includes any cable loss, antenna factor and pre-amplifier gain;

CF is the distance extrapolation factor in dB (where measurement distance different to limit distance);

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for measurements at distances closer than specified.

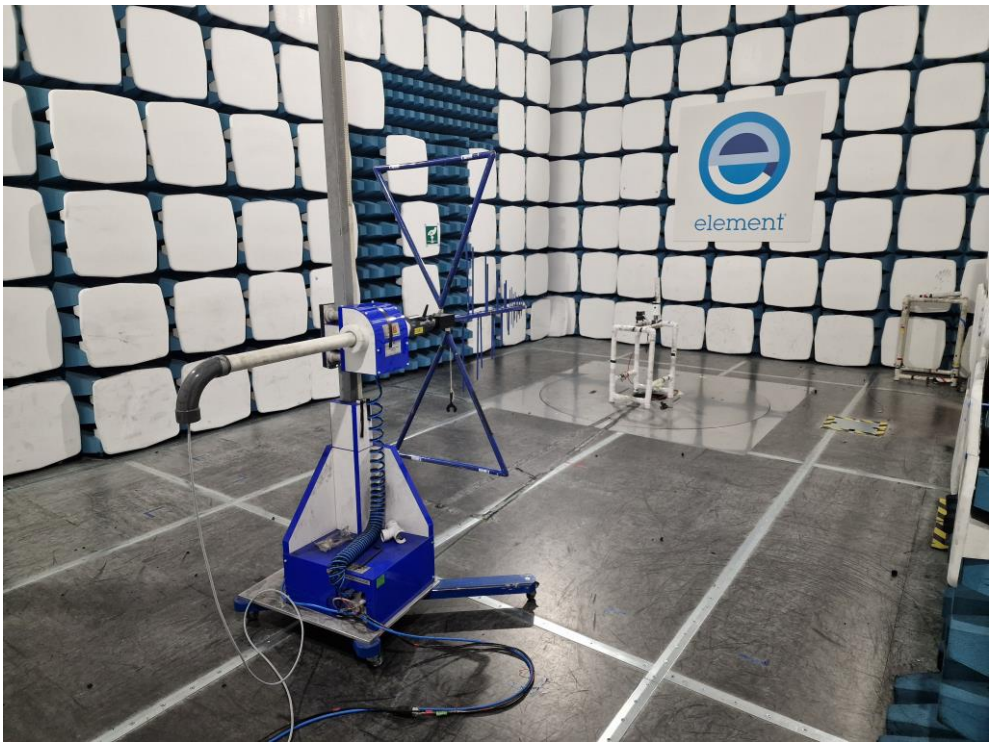
This field strength value is then compared with the regulatory limit.

Figure i Test Setup



11.7 Test Set-up Photograph

9 kHz to 30 MHz



30 MHz TO 1 GHz

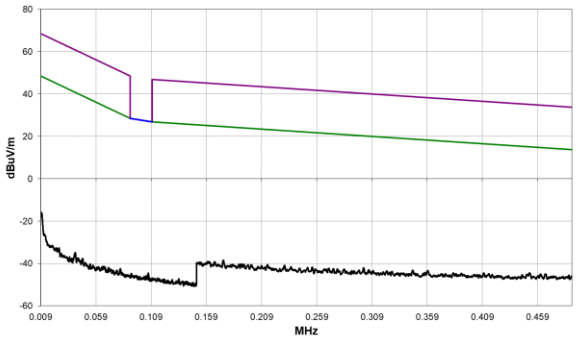
1 GHz to 10 GHz

11.8 Test Equipment

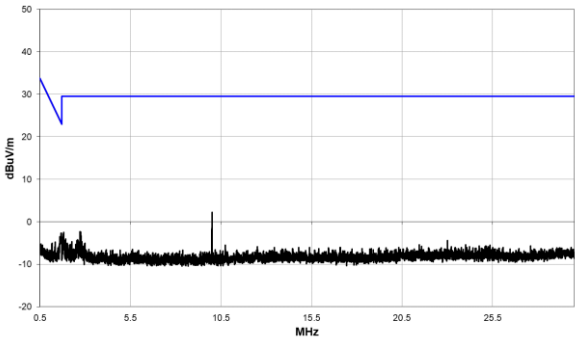
Equipment Description	***Manufacturer***	***Equipment Type***	***Element No***	***Last Cal Calibration***	***Calibration Period***	***Due For Calibration***
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required		
Radio Chamber - PP	Rainford EMC	ATS	REF940	2021-11-06	24	2023-11-06
Spectrum Analyser	R&S	FSU46	REF910	2023-01-10	12	2024-01-10
EMI Receiver	R&S	ESR7	U456	2023-02-06	12	2024-02-06
Bilog	Chase	CBL611/B	U573	2022-10-14	24	2024-10-14
Loop Antenna	R&S	hfh2	L007	2022-09-09	12	2023-09-09
PreAmp	Watkins Johnson	6201-69	U372	2023-03-07	12	2024-03-07
Pre Amp	Agilent	8449B	U457	2023-01-24	12	2024-01-24
1-18GHz Horn	EMCO	3115	L139	2022-07-01	24	2024-07-01

11.9 Test Results

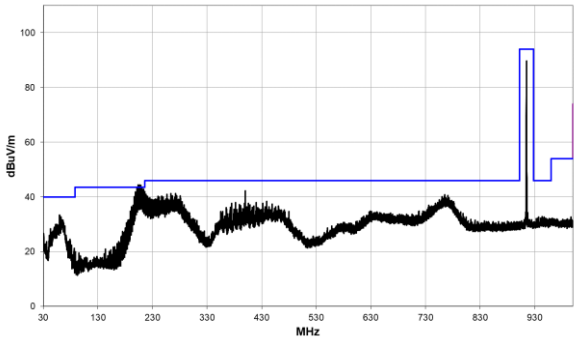
915 MHz; Power: Default



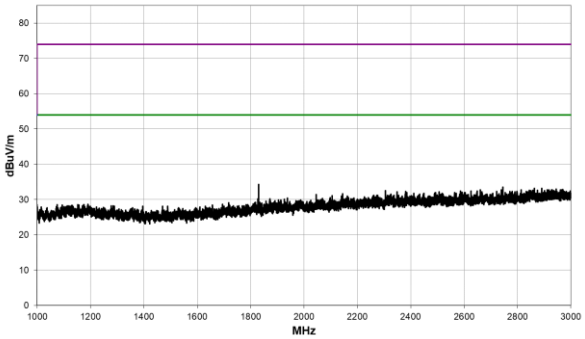
9 kHz to 490 kHz



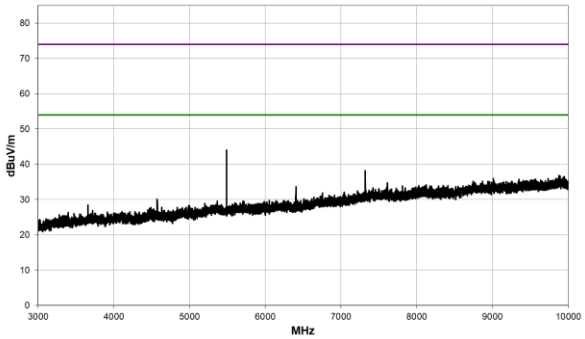
490 kHz to 30 MHz



30 MHz to 1 GHz



1 GHz to 3 GHz



3 GHz to 10 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)
206.208	54.5	-11.9	1.5	248.1	3.0	0.0	Horz	QP	0.0	42.6	43.5	-0.9
203.843	54.2	-11.8	1.5	279.9	3.0	0.0	Horz	QP	0.0	42.4	43.5	-1.1
208.622	53.7	-12.0	1.5	281.1	3.0	0.0	Horz	QP	0.0	41.7	43.5	-1.8
210.982	53.6	-12.0	1.41	265.0	3.0	0.0	Horz	QP	0.0	41.6	43.5	-1.9
201.446	52.8	-11.9	1.5	287.0	3.0	0.0	Horz	QP	0.0	40.9	43.5	-2.6
213.351	52.7	-12.0	1.5	268.1	3.0	0.0	Horz	QP	0.0	40.7	43.5	-2.8
400.014	45.4	-4.2	1.17	215.0	3.0	0.0	Vert	QP	0.0	41.2	46.0	-4.8
766.064	32.8	3.0	1.5	328.0	3.0	0.0	Vert	QP	0.0	35.8	46.0	-10.2
1830.125	48.8	-5.7	1.71	147.1	3.0	0.0	Vert	AV	0.0	43.1	54.0	-10.9
1830.592	46.6	-5.7	1.5	339.0	3.0	0.0	Horz	AV	0.0	40.9	54.0	-13.1
5490.508	43.7	5.3	1.57	333.9	1.0	0.0	Horz	AV	-9.5	39.5	54.0	-14.5
5489.642	38.8	5.3	1.17	17.0	1.0	0.0	Vert	AV	-9.5	34.6	54.0	-19.4
7319.425	34.8	9.2	1.51	303.0	1.0	0.0	Horz	AV	-9.5	34.5	54.0	-19.5

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 Skelmersdale
Test Chamber:	Transient Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	915 MHz
Deviations From Standard:	None
Measurement BW:	150 kHz – 30 MHz: 9kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 19.8 °C	+15 ºC to +35 ºC (as declared)
Humidity: 62 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	(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 (dBµV)***	
	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.

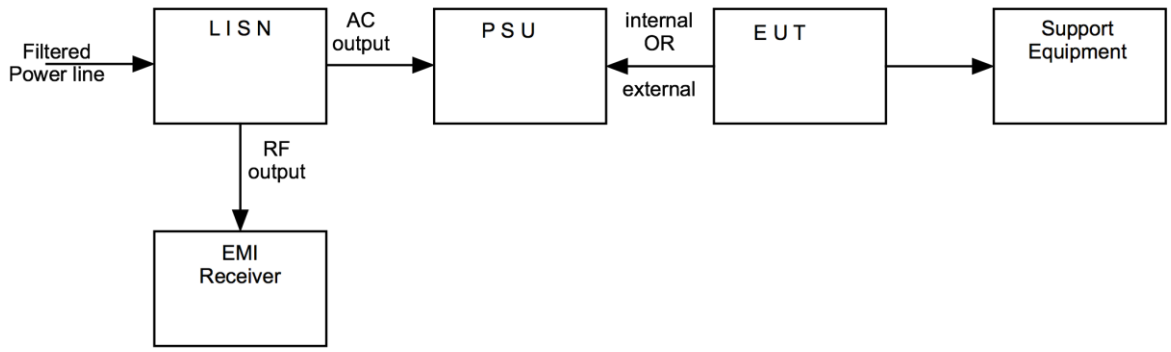
12.4 Test Method

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

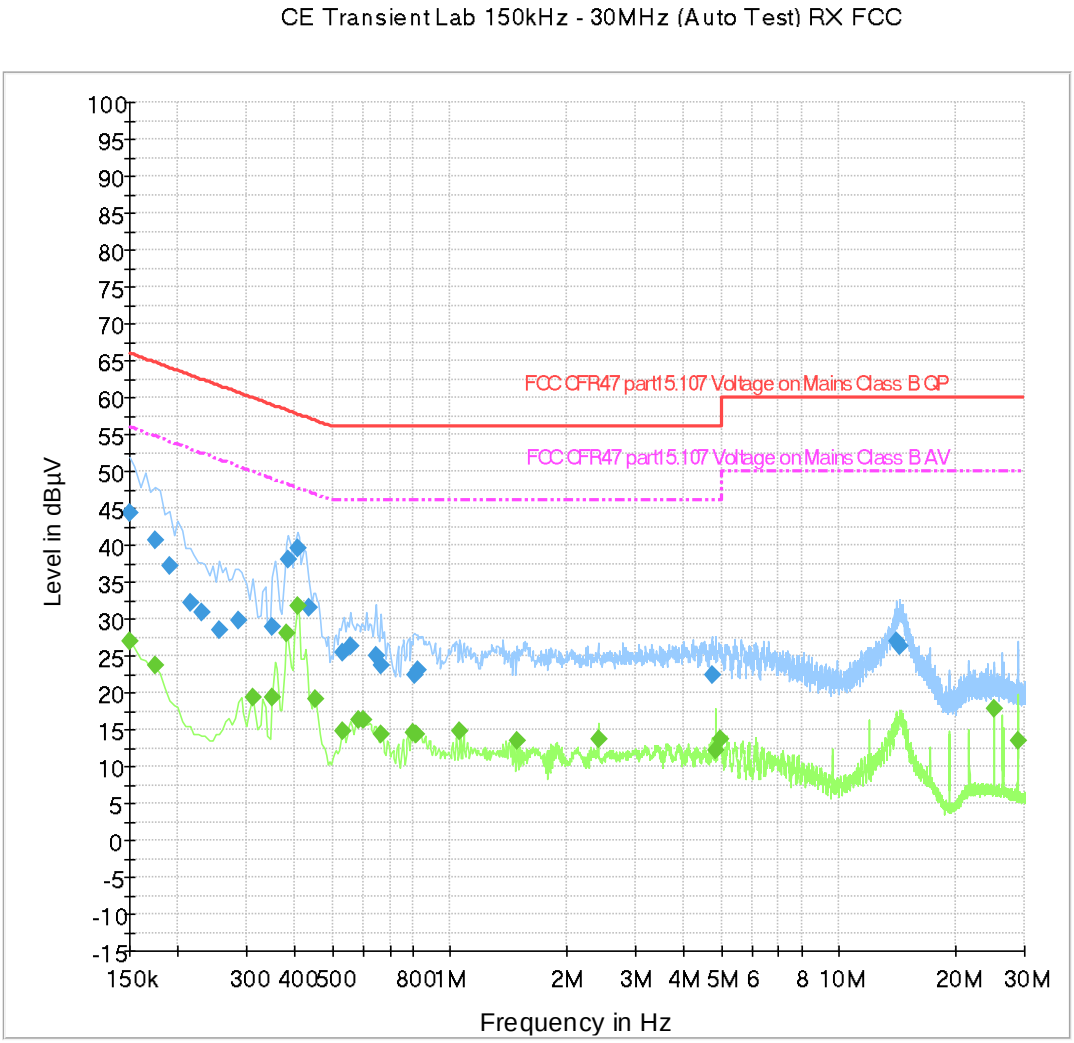


12.5 Test Set-up Photograph

12.6 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Lisn	R&S	ENV216	U396	2023-05-22	12	2024-05-22
Spectrum Analyser	R&S	ESR 7	U727	2023-05-09	12	2024-05-09
Pulse Limiter	R&S	ESH3-Z2	U559	2023-02-01	12	2024-02-01

12.7 Test Results



QuasiPeak Results								
Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	44.4	2000.0	9.000	Off	L1	19.7	21.6	66.0
0.175000	40.7	2000.0	9.000	Off	L1	19.7	24.1	64.7
0.190000	37.2	2000.0	9.000	Off	N	19.6	26.8	64.0
0.215000	32.3	2000.0	9.000	Off	L1	19.7	30.7	63.0
0.230000	30.9	2000.0	9.000	Off	L1	19.7	31.5	62.4
0.255000	28.4	2000.0	9.000	Off	L1	19.7	33.2	61.6
0.285000	29.7	2000.0	9.000	Off	N	19.7	31.0	60.7
0.350000	28.9	2000.0	9.000	Off	L1	19.8	30.0	59.0
0.385000	38.0	2000.0	9.000	Off	N	19.7	20.1	58.2
0.405000	39.5	2000.0	9.000	Off	N	19.7	18.2	57.8
0.435000	31.6	2000.0	9.000	Off	N	19.7	25.5	57.2
0.530000	25.4	2000.0	9.000	Off	N	19.7	30.6	56.0
0.555000	26.3	2000.0	9.000	Off	N	19.7	29.7	56.0
0.645000	25.0	2000.0	9.000	Off	N	19.7	31.0	56.0
0.665000	23.7	2000.0	9.000	Off	N	19.7	32.3	56.0
0.810000	22.4	2000.0	9.000	Off	N	19.8	33.6	56.0
0.825000	23.0	2000.0	9.000	Off	N	19.8	33.0	56.0
4.705000	22.4	2000.0	9.000	Off	N	20.0	33.6	56.0
14.085000	26.9	2000.0	9.000	Off	L1	20.6	33.1	60.0
14.295000	26.3	2000.0	9.000	Off	L1	20.6	33.7	60.0

Average Results								
Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	26.9	2000.0	9.000	Off	L1	19.7	29.1	56.0
0.175000	23.7	2000.0	9.000	Off	L1	19.7	31.0	54.7
0.310000	19.3	2000.0	9.000	Off	N	19.7	30.6	50.0
0.350000	19.3	2000.0	9.000	Off	N	19.7	29.7	49.0
0.380000	28.1	2000.0	9.000	Off	N	19.7	20.2	48.3
0.405000	31.8	2000.0	9.000	Off	N	19.7	16.0	47.8
0.450000	19.2	2000.0	9.000	Off	N	19.7	27.7	46.9
0.530000	14.8	2000.0	9.000	Off	N	19.7	31.2	46.0
0.580000	16.2	2000.0	9.000	Off	N	19.7	29.8	46.0
0.600000	16.4	2000.0	9.000	Off	N	19.7	29.6	46.0
0.665000	14.3	2000.0	9.000	Off	N	19.7	31.7	46.0
0.800000	14.5	2000.0	9.000	Off	N	19.8	31.5	46.0
0.820000	14.5	2000.0	9.000	Off	N	19.8	31.5	46.0
1.060000	14.7	2000.0	9.000	Off	N	19.8	31.3	46.0
1.485000	13.5	2000.0	9.000	Off	N	19.8	32.5	46.0
2.400000	13.7	2000.0	9.000	Off	N	19.8	32.3	46.0
4.800000	12.1	2000.0	9.000	Off	N	20.0	33.9	46.0
4.965000	13.6	2000.0	9.000	Off	N	20.0	32.4	46.0
25.000000	17.9	2000.0	9.000	Off	N	20.9	32.1	50.0
28.775000	13.5	2000.0	9.000	Off	N	20.9	36.5	50.0

13 Occupied Bandwidth

13.1 Definitions

Occupied bandwidth
The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 % of the emitted power. This is also known as the *99 % emission bandwidth*. For transmitters in which there are multiple carriers, contiguous or non-contiguous in frequency, the occupied bandwidth is to be the sum of the occupied bandwidths of the individual carriers.

20 dB bandwidth
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 Skelmersdale
Test Chamber:	Radio Chamber 03
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	915 MHz
EUT Channel Bandwidths:	300 kHz
Deviations From Standard:	None
Measurement BW: (requirement: 1 % to 5 % OBW)	10 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	30 kHz
Measurement Span: (requirement 2 to 5 times OBW)	1 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 47 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	(as declared)

13.3 Test Limit

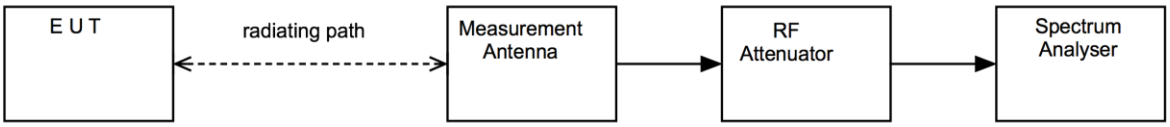
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

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

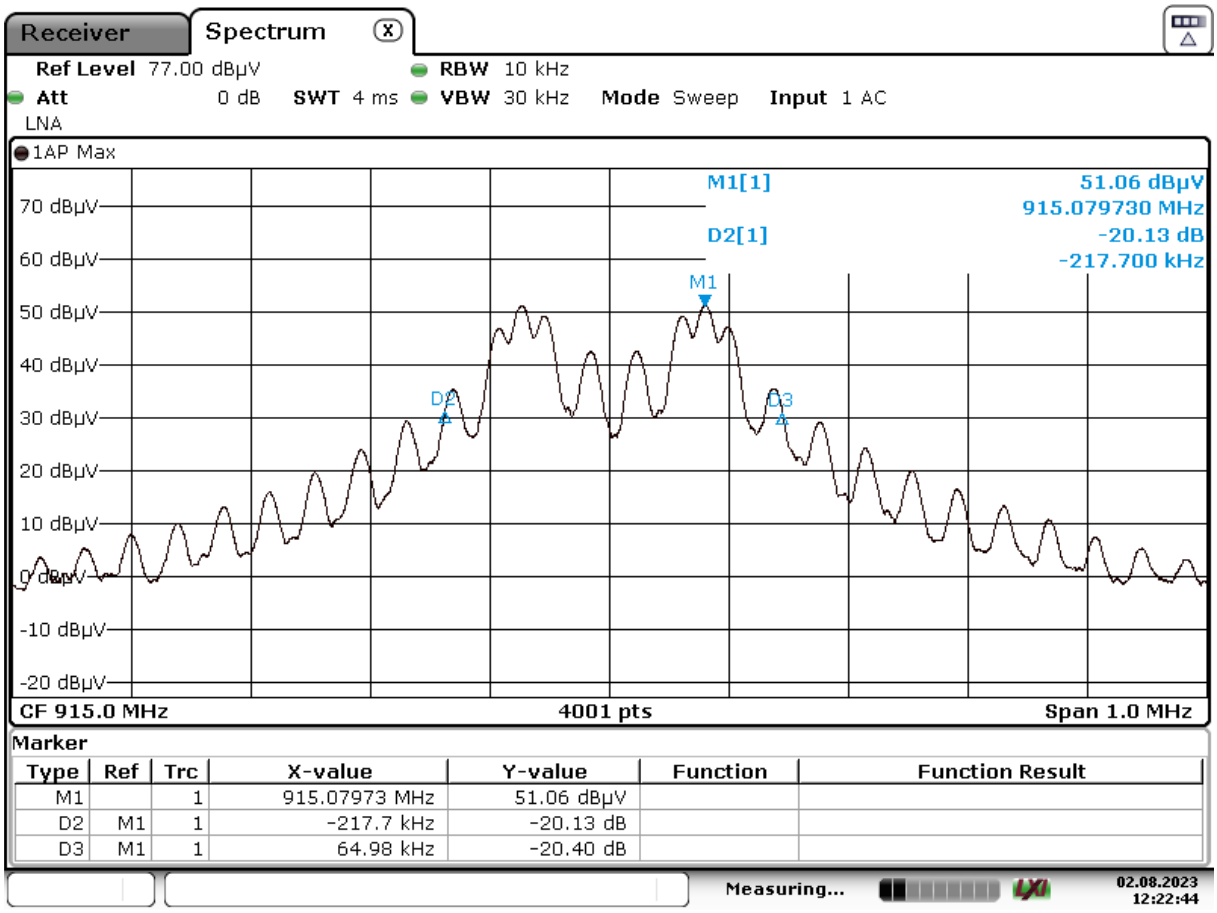


13.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required		
Radio Chamber - PP	Rainford EMC	ATS	REF940	2021-11-06	24	2023-11-06
EMI Receiver	R&S	ESR7	REF910	2023-02-06	12	2024-02-06
Bilog	Chase	CBL611/B	U573	2022-10-14	24	2024-10-14
PreAmp	Watkins Johnson	6201-69	U372	2023-03-07	12	2024-03-07

13.6 Test Results

FCC 15.249. Power setting: Default;				
Channel Frequency (MHz)	**F_L (MHz)**	**F_H (MHz)**	**20dB Bandwidth (kHz)**	**Result**
915 MHz	914.86203	915.14471	282.68	PASS



14 Transmitter output power (fundamental radiated emission)

14.1 Definition

The RF power dissipated in the standard output termination when operating under the rated duty cycle selected by the applicant for approval.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber SK03
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 / 6.6
EUT Channels / Frequencies Measured:	915 MHz
EUT Channel Bandwidths:	300 kHz
Deviations From Standard:	None
Measurement BW:	120 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Detector:	Up to 1 GHz: Quasi-peak Above 1 GHz: Average RMS and 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 ºC to +35 ºC (as declared)
Humidity: 55 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

The field strength measured at 3 metres shall not exceed the limits in the following table:

Field Strength Limits for License-Exempt Transmitters for Any Application

Fundamental frequency (MHz)	*Field strength (mV/m at 3 m)*	*Detector*
902 to 928	50	Quasi-Peak
2400 to 2483.5	50	Average RMS
5725 to 5875	50	Average RMS

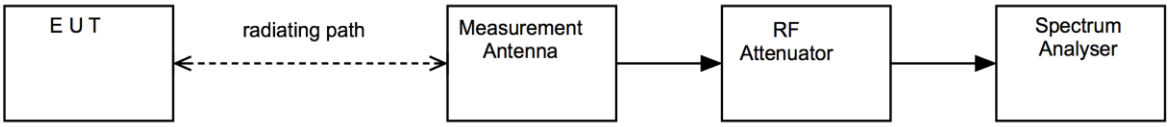
n.b. per FCC 47CFR15.249(e), peak limit is 20 dB above average.

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 Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required		
Radio Chamber - PP	Rainford EMC	ATS	REF940	2021-11-06	24	2023-11-06
EMI Receiver	R&S	ESR7	U456	2023-02-06	12	2024-02-06
PreAmp	Watkins Johnson	6201-69	U372	2023-03-07	12	2024-03-07
Bilog	Chase	CBL611/A	U191	2023-02-22	24	2025-02-22

14.6 Test Results

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 (mV/m)*	*Limit (mV/m)*
QP	915.10	86.00	3.86	30.20	28.70	0.00	0.00	91.36	36.98	50

15 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 connecter) Dare RPR3006W Power Head	MU4001	**0.9 dB**
Carrier Power and PSD - Spectrum Analysers	MU4004	**0.9 dB**
Adjacent Channel Power	MU4002	**1.9 dB**
Transmitter conducted spurious emissions	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**
Spurious Emissions Electric and Magnetic Field		
Radiated Spurious Emissions 30 MHz to 1 GHz	MU4037	**4.7 dB**
Radiated Spurious Emissions 1-18 GHz	MU4032	**4.5 dB**
E Field Emissions 18GHz to 26 GHz	MU4024	**3.2 dB**
E Field Emissions 26GHz to 40 GHz	MU4025	**3.3 dB**
E Field Emissions 40GHz to 50 GHz	MU4026	**3.5 dB**
E Field Emissions 50GHz to 75 GHz	MU4027	**3.6 dB**
E Field Emissions 75GHz to 110 GHz	MU4028	**3.6 dB**
Radiated Magnetic Field Emissions	MU4031	**2.3 dB**
Frequency Measurements		
Frequency Deviation	MU4022	**0.316 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	**679 µs**
DFS Generator - Frequency Error	MU4007	**92 Hz**
DFS Threshold Conducted	MU4008	**1.3 dB**
DFS Threshold Radiated	MU4009	**3.2 dB**

Test/Measurement	Budget Number	MU
Receiver Parameters		
EN300328 Receiver Blocking	MU4010	**1.1 dB**
EN301893 Receiver Blocking	MU4011	**1.1 dB**
EN303340 Adjacent Channel Selectivity	MU4012	**1.1 dB**
EN303340 Overloading	MU4013	**1.1 dB**
EN303340 Receiver Blocking	MU4014	**1.1 dB**
EN303340 Receiver Sensitivity	MU4015	**0.9 dB**
EN303372-1 Image Rejection	MU4016	**1.4 dB**
EN303372-1 Receiver Blocking	MU4017	**1.1 dB**
EN303372-2 Adjacent Channel Selectivity	MU4018	**1.1 dB**
EN303372-2 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**

16 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.

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

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*
915.1	0.3	15.7	Not Required

Maximum conducted output power is taken from the measured value.

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