

Report on the Radio Testing
For
Third Millennium Systems Ltd
on
PRX60BLE
Report no. TRA-047608-47-07A
2020-04-16

Report Number: TRA-047608-47-07A
Issue: A

REPORT ON THE RADIO TESTING OF A
Third Millennium Systems Ltd
PRX60BLE
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.209

TEST DATE: 2020-02-12 to 2020-02-27

Tested by:

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M Else
D Moncayola
Radio Test Engineer

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Lab Manager

Date: 2020-04-16

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	2020-04-16	Original

2 Summary

TEST REPORT NUMBER:	TRA-047608-47-07A
WORKS ORDER NUMBER:	TRA-047608-02
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):	47CFR15.209
EQUIPMENT UNDER TEST (EUT):	PRX60BLE
FCC IDENTIFIER:	UTJ-PRX60BLE
EUT SERIAL NUMBER:	SAMPLE No: 18
MANUFACTURER/AGENT:	Third Millennium Systems Ltd
ADDRESS:	18/19 Torfaen Business Centre Panteg Way New Inn Pontypool NP4 0LS United Kingdom
CLIENT CONTACT:	Sarah Smith ☎ 01495 751 992 ✉ ssmith@tm-readers.com
ORDER NUMBER:	995445
TEST DATE:	2020-02-12 to 2020-02-27
TESTED BY:	S Garwell M Else D Moncayola Element

2.1 Test Summary

<i>Test Method and Description</i>	<i>Requirement Clause, 47CFR15</i>	<i>Applicable to this equipment</i>	<i>Result / Note</i>
Radiated spurious emissions, below 30 MHz	15.209	<input checked="" type="checkbox"/>	Pass
Radiated spurious emissions	15.209	<input checked="" type="checkbox"/>	Pass
AC power line conducted emissions	15.207	<input checked="" type="checkbox"/>	Pass
Occupied bandwidth	15.215(c)	<input checked="" type="checkbox"/>	Pass
Field strength of fundamental	15.209	<input checked="" type="checkbox"/>	Pass

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

3 Contents

1	Revision Record	3
2	Summary	4
2.1	Test Summary	5
3	Contents	6
4	Introduction	7
5	Test Specifications	8
5.1	Normative References	8
5.2	Deviations from Test Standards	8
6	Glossary of Terms	9
7	Equipment Under Test	10
7.1	EUT Identification	10
7.2	System Equipment	10
7.3	EUT Mode of Operation	10
7.3.1	Transmission	10
7.4	EUT Radio Parameters	10
7.4.1	General	10
7.4.2	Antennas	10
7.5	EUT Description	10
8	Modifications	11
9	EUT Test Setup	11
9.1	Block Diagram	11
9.2	General Set-up Photograph	11
9.3	Measurement software	12
10	General Technical Parameters	13
10.1	Normal Conditions	13
10.2	Varying Test Conditions	13
11	Radiated emissions below 30 MHz	14
11.1	Definitions	14
11.2	Test Parameters	14
11.3	Test Limit	15
11.4	Test Method	15
11.5	Test Set-up Photograph	16
11.6	Test Equipment	16
11.7	Test Results	17
12	Radiated emissions	18
12.1	Definitions	18
12.2	Test Parameters	18
12.3	Test Limit	18
12.4	Test Method	19
12.5	Test Set-up Photograph	20
12.6	Test Equipment	20
12.7	Test Results	21
13	AC power-line conducted emissions	22
13.1	Definition	22
13.2	Test Parameters	22
13.3	Test Limit	22
13.4	Test Method	23
13.5	Test Set-up Photograph	23
13.6	Test Equipment	24
13.7	Test Results	24
14	Occupied Bandwidth	26
14.1	Definition	26
14.2	Test Parameters	26
14.3	Test Limit	26
14.4	Test Method	27
14.5	Test Equipment	27
14.6	Test Results	27
15	Transmitter output power (fundamental radiated emission)	28
15.1	Definition	28
15.2	Test Parameters	28
15.3	Test Limit	28
15.4	Test Method	28
15.5	Test Equipment	29
15.6	Test Results	29
16	Measurement Uncertainty	30

4 Introduction

This report TRA-047608-47-07A presents the results of the Radio testing on a Third Millennium Systems Ltd, PRX60BLE to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Third Millennium Systems Ltd by Element, at the address detailed below.

<input type="checkbox"/>	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	<input checked="" type="checkbox"/>	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.

FCC Site Listing:

Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

ISED Registration Number(s):

Element Skelmersdale	3930B
Element Hull	3483A

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 (nowISED)
ISED	Innovation, Science and Economic Development 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: PRX60BLE
- Serial Number: SAMPLE No: 18
- Model Number: RX3K90B
- Software Revision: AVx90_191231.hex
- Build Level / Revision Number: 100-02406-B

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 transmitter tests was as follows:

The unit was tested in normal operation mode forcing the unit to read a card continuously.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	125 kHz
Modulation type(s):	ASK
Declared output power(s):	Not stated
Warning against use of alternative antennas in user manual (yes/no):	No
Nominal Supply Voltage:	12 Vdc

7.4.2 Antennas

Type:	TM-125 ANTENNA (100-*****)
Frequency range:	Not Stated
Impedance:	Not Stated
Gain:	Not Stated

7.5 EUT Description

The EUT is a dc powered door access control reader with RFID and BTLE. This report covers the 125 kHz RFID radio.

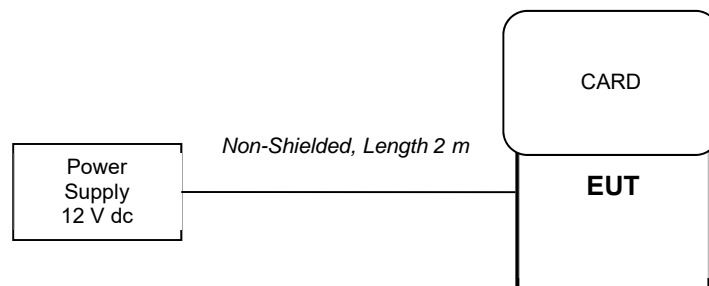
8 Modifications

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 EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied 12 V dc from a power supply.

10.2 Varying Test Conditions

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

	Category	Nominal	Variation
<input checked="" type="checkbox"/>	Power supply	12 Vdc	85 % and 115 %
<input type="checkbox"/>	Battery	New battery	N/A

11 Radiated emissions below 30 MHz

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
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.4
EUT Frequency Measured:	125 kHz
Deviations From Standard:	None
Measurement Distance and Site	3 m
EUT Height:	1 m
Measurement Antenna and Height:	60 cm shielded loop; 1 m
Measurement BW:	9 kHz to 150 kHz: 200 Hz; 150 kHz to 30 MHz: 9 kHz
Measurement Detector:	9 kHz to 90 kHz and 110 kHz to 490 kHz: Average, RMS Other frequencies below 30 MHz: Quasi-peak.

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)
Supply: 12 V dc	12 V dc (as declared)

11.3 Test Limit

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

<i>Frequency, f (kHz)</i>	<i>Field Strength</i>	<i>Measurement Distance (m)</i>
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.

11.4 Test Method

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 360°, 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:

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

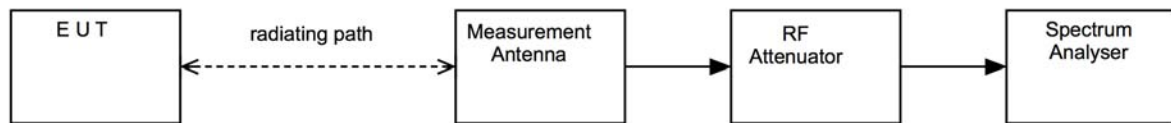
Where,

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);

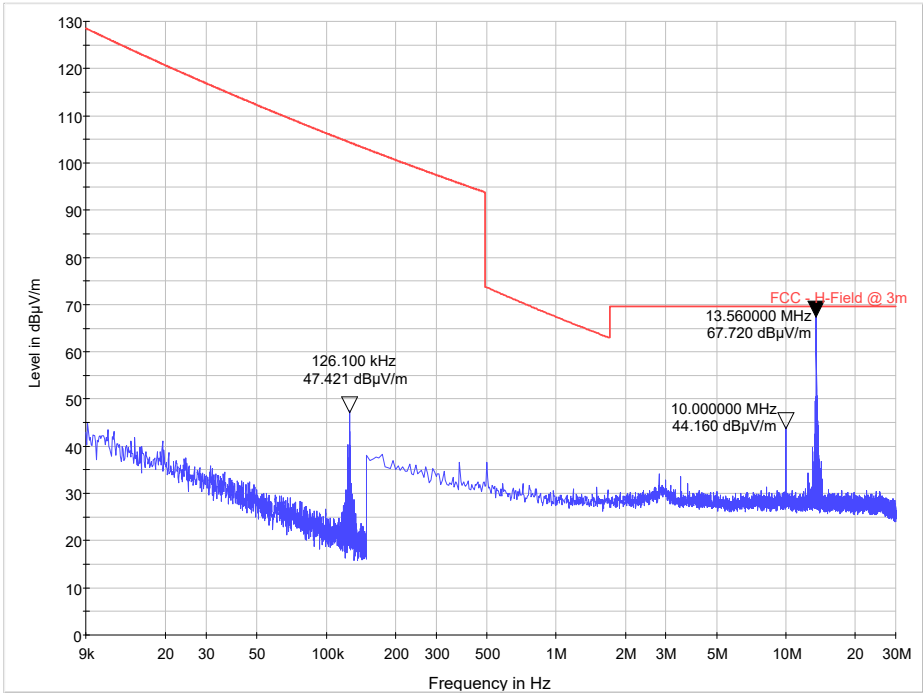
Per FCC 47CFR15.31(f)(2), an extrapolation factor of 40 dB per decade was used for extrapolation from 3 m to 300 m, and from 3 m to 30 m.

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

Figure i Test Setup**11.5 Test Set-up Photograph****11.6 Test Equipment**

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
hfh2	R&S	Loop Antenna	L007	2020-05-15
ATS	Rainford EMC	Radio Chamber - PP	REF940	2021-12-09
ESHS10	R&S	Receiver	U003	2020-10-23

11.7 Test Results



Modulation: ASK; Higher Power setting						
Emission Frequency (MHz)	Receiver Level (dBµV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (µV/m)	Result
No significant emissions within 20 dB to the limit						PASS

12 Radiated emissions

12.1 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.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5
EUT Frequency Measured:	125 kHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 300 MHz: 120 kHz
Measurement Detector:	Quasi-peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 12 V dc	12 V dc

12.3 Test Limit

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 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

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure ii, 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;

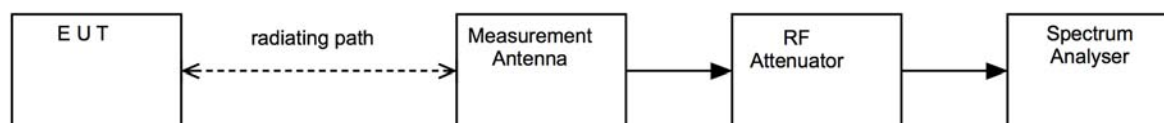
PA is the pre-amplifier gain in dB (where used);

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 is different to limit distance);

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

Figure ii Test Setup



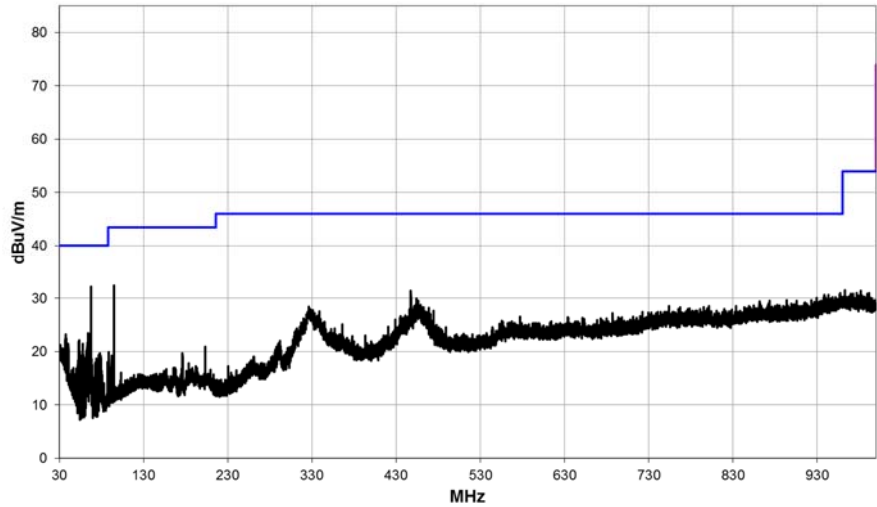
12.5 Test Set-up Photograph



12.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
CBL611/A	Chase	Bilog	U573	2021-09-19
6201-69	Watkins Johnson	PreAmp	U372	2020-02-25
ATS	Rainford EMC	Radio Chamber - PP	REF940	2021-12-09
Emissions R5	Element	Radiated Test Software	REF9000	Cal not required
ESR7	R&S	EMI Receiver	U456	2020-11-25

12.7 Test Results



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)	Comments
67.804	47.2	-16.3	1.86	148.0	3.0	0.0	Vert	QP	0.0	30.9	40.0	-9.1	Pass
94.942	43.6	-12.9	1.0	8.0	3.0	0.0	Vert	QP	0.0	30.7	43.5	-12.8	Pass
454.233	29.1	-2.6	1.0	219.0	3.0	0.0	Vert	QP	0.0	26.5	46.0	-19.5	Pass
327.449	32.3	-6.7	1.38	64.9	3.0	0.0	Vert	QP	0.0	25.6	46.0	-20.4	Pass

13 AC power-line conducted emissions

13.1 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.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Frequency Measured:	125 kHz
EUT Modulation:	ASK
Deviations From Standard:	None
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 12 V dc	As declared

13.3 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.

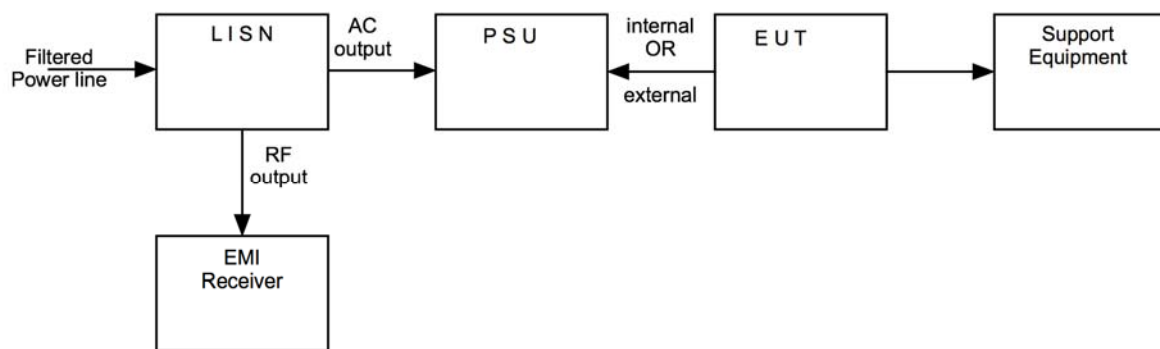
13.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure iii, 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 iii Test Setup



13.5 Test Set-up Photograph

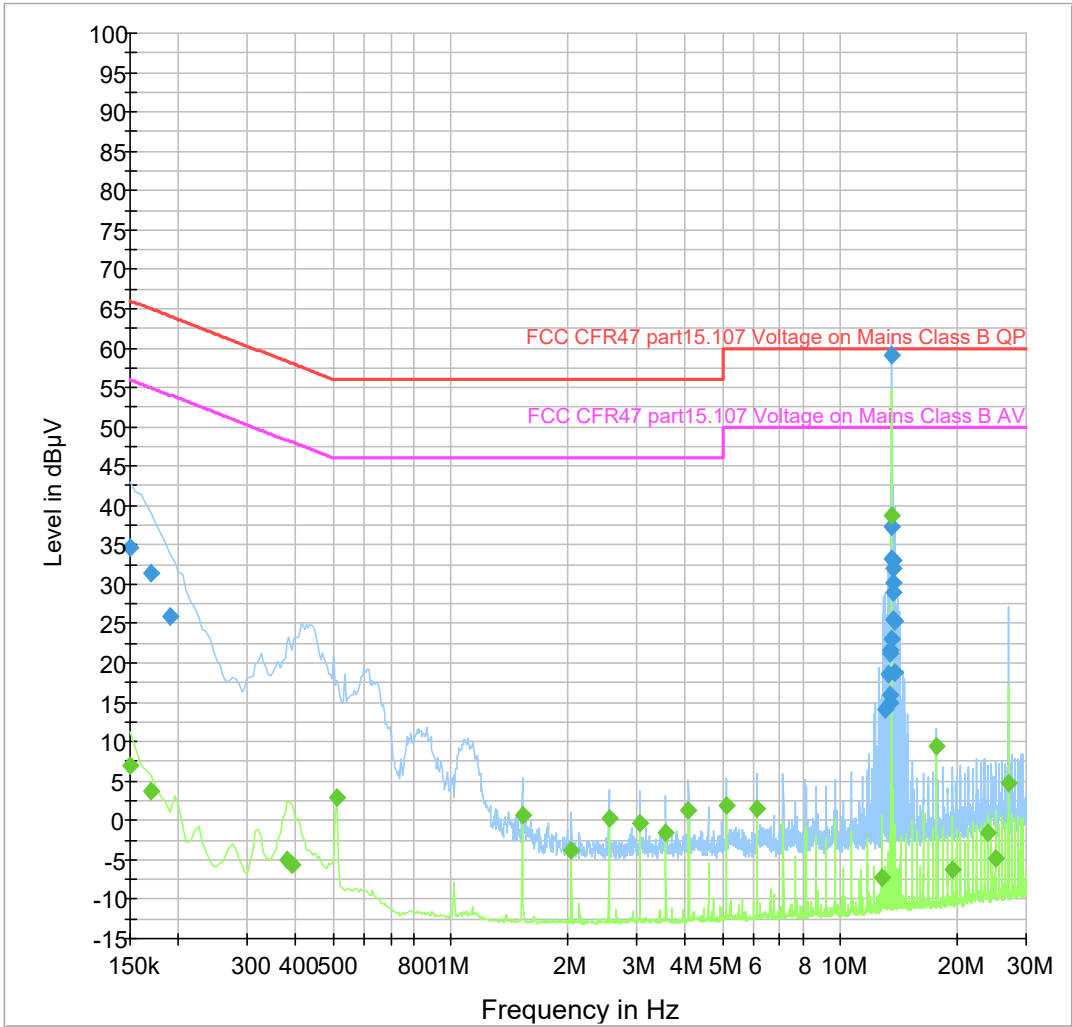


13.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESH3-Z5.831.5	R&S	Lisn	U195	2020-10-04
ESHS10	R&S	Receiver	U003	2020-10-23

13.7 Test Results

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH195 +UH559



AC power-line conducted emissions, Transmit mode									
Frequency (MHz)	QuasiPeak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.150000	34.7	2000.0	10.000	GND	L1	10.0	31.3	66.0	Pass
0.170000	31.4	2000.0	10.000	GND	N	10.0	33.6	65.0	Pass
0.190000	25.9	2000.0	10.000	GND	N	10.0	38.1	64.0	Pass
13.000000	14.1	2000.0	10.000	GND	L1	10.8	45.9	60.0	Pass
13.270000	18.7	2000.0	10.000	GND	L1	10.9	41.3	60.0	Pass
13.360000	14.9	2000.0	10.000	GND	L1	10.9	45.1	60.0	Pass
13.390000	21.2	2000.0	10.000	GND	N	10.8	38.8	60.0	Pass
13.400000	21.5	2000.0	10.000	GND	N	10.8	38.5	60.0	Pass
13.450000	16.0	2000.0	10.000	GND	L1	10.9	44.0	60.0	Pass
13.470000	23.1	2000.0	10.000	GND	L1	10.9	36.9	60.0	Pass
13.520000	33.2	2000.0	10.000	GND	L1	10.9	26.8	60.0	Pass
13.535000	37.3	2000.0	10.000	GND	L1	10.9	22.7	60.0	Pass
13.560000	59.1	2000.0	10.000	GND	N	10.8	0.9	60.0	Pass
13.600000	32.1	2000.0	10.000	GND	N	10.8	27.9	60.0	Pass
13.610000	33.0	2000.0	10.000	GND	L1	10.9	27.0	60.0	Pass
13.620000	28.9	2000.0	10.000	GND	L1	10.9	31.1	60.0	Pass
13.640000	30.1	2000.0	10.000	GND	L1	10.9	29.9	60.0	Pass
13.690000	25.5	2000.0	10.000	GND	N	10.8	34.5	60.0	Pass
13.770000	25.3	2000.0	10.000	GND	N	10.8	34.7	60.0	Pass
13.850000	18.8	2000.0	10.000	GND	L1	10.9	41.2	60.0	Pass

AC power-line conducted emissions, Transmit mode									
Frequency (MHz)	Average (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.150000	7.0	2000.0	10.000	GND	L1	10.0	49.0	56.0	Pass
0.170000	3.7	2000.0	10.000	GND	L1	10.0	51.2	55.0	Pass
0.380000	-5.1	2000.0	10.000	GND	N	10.0	53.4	48.3	Pass
0.390000	-5.7	2000.0	10.000	GND	N	10.0	53.7	48.1	Pass
0.510000	2.9	2000.0	10.000	GND	N	10.0	43.1	46.0	Pass
1.525000	0.7	2000.0	10.000	GND	L1	10.1	45.3	46.0	Pass
2.035000	-3.9	2000.0	10.000	GND	L1	10.1	49.9	46.0	Pass
2.545000	0.2	2000.0	10.000	GND	L1	10.1	45.8	46.0	Pass
3.055000	-0.4	2000.0	10.000	GND	N	10.1	46.4	46.0	Pass
3.565000	-1.7	2000.0	10.000	GND	N	10.2	47.7	46.0	Pass
4.075000	1.3	2000.0	10.000	GND	L1	10.2	44.7	46.0	Pass
5.095000	1.8	2000.0	10.000	GND	N	10.3	48.2	50.0	Pass
6.115000	1.5	2000.0	10.000	GND	L1	10.4	48.5	50.0	Pass
12.730000	-7.3	2000.0	10.000	GND	L1	10.8	57.3	50.0	Pass
13.560000	38.7	2000.0	10.000	GND	N	10.8	11.4	50.0	Pass
17.575000	9.3	2000.0	10.000	GND	L1	11.1	40.7	50.0	Pass
19.355000	-6.2	2000.0	10.000	GND	L1	11.2	56.2	50.0	Pass
23.950000	-1.5	2000.0	10.000	GND	N	11.4	51.5	50.0	Pass
24.960000	-4.7	2000.0	10.000	GND	L1	11.6	54.7	50.0	Pass
27.120000	4.7	2000.0	10.000	GND	L1	11.7	45.3	50.0	Pass

14 Occupied Bandwidth

14.1 Definition

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.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Frequency Measured:	125 kHz
EUT Test Modulations:	ASK
Deviations From Standard:	None
Measurement BW:	500 Hz
Spectrum Analyzer Video BW:	2 KHz
Measurement Span: (requirement 2 to 5 times OBW)	50 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 12 V dc	As declared

14.3 Test Limit

Federal Communications Commission:

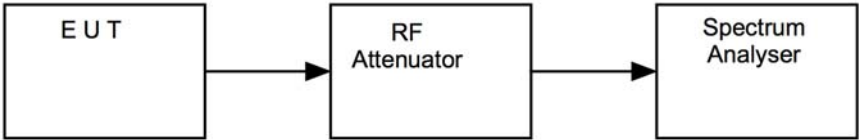
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific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

14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, 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 iv Test Setup

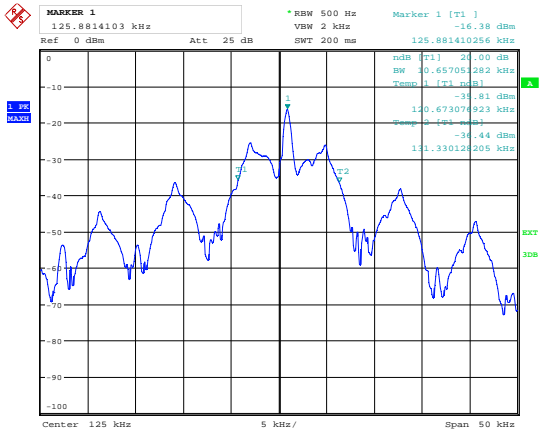


14.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU46	R&S	Spectrum Analyser	REF910	2020-10-17

14.6 Test Results

15.225. Modulation: ASK; Highest Power setting			
Channel Frequency (kHz)	F_L (kHz)	F_H (kHz)	20 dB Bandwidth (kHz)
125	120.673076923	131.330128205	10.657051282



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15 Transmitter output power (fundamental radiated emission)

15.1 Definition

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

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
Test Antenna:	Active 60cm loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
Frequency Measured:	125 kHz
Deviations From Standard:	None
Measurement BW:	200 Hz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	1 KHz
Measurement Detector:	Average

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

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

<i>Frequency, f (kHz)</i>	<i>Field Strength</i>	<i>Measurement Distance (m)</i>
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.

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, 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.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in $\mu\text{V/m}$ at the regulatory distance, using:

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

Where,

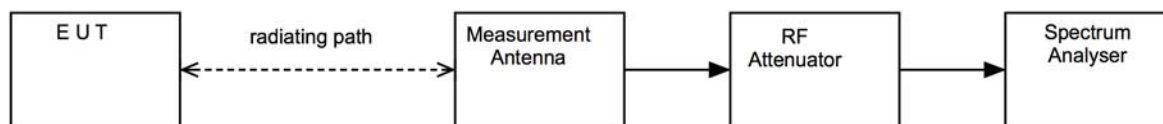
PR is the power recorded on the receiver / spectrum analyzer in $\text{dB}\mu\text{V}$ and includes any cable loss, antenna factor and pre-amplifier gain;

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 extrapolation from 1 m to 300 m and from 3 m to 300 m.

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

Figure v Test Setup



15.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
hfh2	R&S	Loop Antenna	L007	2020-05-15
ATS	Rainford EMC	Radio Chamber - PP	REF940	2021-12-09
ESHS10	R&S	Receiver	U003	2020-10-23

15.6 Test Results

Modulation: ASK; Higher Power Setting						
Channel Frequency (kHz)	Receiver Level (dB $\mu\text{V/m}$)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength ($\mu\text{V/m}$)	Result
125	85.88	1	300	106.20	0.096	PASS
125	59.68	3	300	80.00	0.096	PASS

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 emissions below 30 MHz

Uncertainty in test result (9 kHz to 30 MHz) = **2.3 dB**

[2] Spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**

Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[3] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[4] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[5] Maximum frequency error

Uncertainty in test result (Power Meter) = **0.113 ppm**

Uncertainty in test result (Spectrum Analyser) = **0.265 ppm**