AN RADIO TEST REPORT

FOR

THIRD MILLENNIUM SYSTEMS LTD

ON

RX80 PLUS

DOCUMENT NO.TRA-025998-00-47-00A

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UKAS TESTING
0026

TRaC Wireless Test Report	**:** TRA-025998-00-47-00A
Applicant	**:** Third Millennium Systems Ltd
Apparatus	**:** RX80 Plus
Specification(s)	**:** CFR47 Part 15
Purpose of Test	**:** Certification
FCCID	**: UTJ-RX80PLUS**
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Section 1: Introduction

1.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

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1.2 Tests Requested By

This testing in this report was requested by:

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1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 20th February 2015 and 25th February 2015.

- RX80 Plus

The RX80 Plus is a dual band (126kHz and 13.56MHz) RFID advanced access control reader, and is contained in the following model variants; RX3K80 Plus, RX380 Plus and RX480 Plus.

RX380 Plus is identical to RX3K80 Plus apart from having no keypad. RX480 Plus is identical to RX3K80 Plus apart from having no keypad and a different plastic housing.

Full testing was performed on RX380 Plus, and only radiated and power line tests were performed on RX3K80 Plus.

1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

Test Type	Title 47 of the CFR:	Measurement standard	Result
Spurious Emissions Radiated <1000MHz	Part 15 Subpart (c) 15.209	ANSI C63.10:2009	Pass
Spurious Emissions Radiated >1000MHz	Part 15 Subpart (c) 15.209	ANSI C63.10:2009	N/A
AC Power conducted emissions	Part 15 Subpart (c) 15.207	ANSI C63.10:2009	Pass
Intentional Emission Frequency	Part 15 Subpart (c) 15.209 & 15.225(a)	ANSI C63.10:2009	Pass
Intentional Emission Field Strength	Part 15 Subpart (c) 15.209 & 15.225(a)	ANSI C63.10:2009	Pass
Intentional Emission Band Occupancy	Part 15 Subpart (c) 15.215 (c)	ANSI C63.10:2009	Pass
Frequency Stability	Part 15 Subpart (c) 15.225	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	Part 15 Subpart (b) 15.109	ANSI C63.10:2009	Pass
Antenna Arrangements Integral:	15.203	-	Pass
Antenna Arrangements External Connector	15.204	-	N/A
Restricted Bands	15.205	-	Pass
Maximum Frequency of Search	15.33	-	Pass
Extrapolation Factor	15.31(f)	-	Pass

Abbreviations used in the above table:

CFR : Code of Federal Regulations
REFE : Radiated Electric Field Emissions
ANSI : American National Standards Institution
PLCE : Power Line Conducted Emissions

1.6 Notes Relating To the Assessment

With regard to this assessment, the following points should be noted:

The results contained in this report relate only to the items tested 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.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, “Pass” indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

Temperature	: 17 to 23 °C
Humidity	: 45 to 75 %
Barometric Pressure	: 86 to 106 kPa

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

1.7 Deviations from Test Standards

There were no deviations from the standards tested to.

Section 2: Measurement Uncertainty

2.1 Measurement Uncertainty Values

The following table contains the measurement uncertainties for TRaC Global measurements:

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.

[1] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

Uncertainty in test result (Power Meter) = **1.08dB**
Uncertainty in test result (Spectrum Analyser) = **2.48dB**

[3] Effective Radiated Power

Uncertainty in test result = **4.71dB**

[4] Spurious Emissions

Uncertainty in test result = **4.75dB**

[5] Maximum frequency error

Uncertainty in test result (Frequency Counter) = **0.113ppm**
Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,
Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,
Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[7] Frequency deviation

Uncertainty in test result = **3.2%**

[8] Magnetic Field Emissions

Uncertainty in test result = **2.3dB**

[9] Conducted Spurious

Uncertainty in test result – Up to 8.1GHz = **3.31dB**
Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**
Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**
Uncertainty in test result – Up to 26GHz = **3.14dB**

[10] Channel Bandwidth

Uncertainty in test result = **15.5%**

[11] Amplitude and Time Measurement – Oscilloscope

Uncertainty in overall test level = **2.1dB**,
Uncertainty in time measurement = **0.59%,**
Uncertainty in Amplitude measurement = **0.82%**

[12] Power Line Conduction

Uncertainty in test result = **3.4dB**

[13] Spectrum Mask Measurements

Uncertainty in test result = **2.59% (frequency)**
Uncertainty in test result = **1.32dB (amplitude)**

[14] Adjacent Sub Band Selectivity

Uncertainty in test result = **1.24dB**

[15] Receiver Blocking – Listen Mode, Radiated

Uncertainty in test result = **3.42dB**

[16] Receiver Blocking – Talk Mode, Radiated

Uncertainty in test result = **3.36dB**

[17] Receiver Blocking – Talk Mode, Conducted

Uncertainty in test result = **1.24dB**

[18] Receiver Threshold

Uncertainty in test result = **3.23dB**

[19] Transmission Time Measurement

Uncertainty in test result = **7.98%**

Section 3: Modifications

3.1 Modifications Performed During Assessment

No modifications were performed during the assessment

Section 4: General Test Procedures

4.1 Radiated Test Setup and Procedures

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

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).

For devices with intentional emissions below 30 MHz, a shielded loop antenna is used as the test antenna. It is placed at a 1 meter receive height and appropriate low frequency magnetic field extrapolation to the regulatory limit distance is employed. The EUT is rotated through 360˚in the azimuth.

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˚ 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.

Where regulations allow for direct measurement of field strength, power values measured on the test receiver / analyzer are converted to dBuV/m at the regulatory distance, using:

$$FS = PR + AF + CL - PA + KG + DC - CF \text{ (dBuV/m)}$$

Where:

PR is the power recorded on receiver / spectrum analyzer (dBuV),
AF is the test antenna factor in dB/m,
CL is the cable loss in dB,
PA is the pre-amplifier gain dB (when applicable),
DC is duty correction factor (when applicable) in dB, and
CF is a distance correction (employed only for measurements at alternate distance to limit) in dB.

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

If effective radiated power (ERP) or effective isotropic radiated power (EIRP) is required, it is computed as per ANSI C63.10

$$P = \frac{(Ed)^2}{30G}$$

Where

P is the power, in W
E is the measured peak field strength, in V/m
d is the distance at which the measurement was made, in m
G is the numeric gain of the radiating element

If the gain of the radiating element is not known, then either the effective radiated power (ERP) or the effective isotropic radiated power (EIRP) may be calculated from the measured peak field strength, by using either G = 1.64 or G = 1, respectively.

4.2 AC Powerline Conducted Emissions Test Setup and Procedures

AC Powerline Conducted Emissions from the EUT are checked first by preview scans with Peak and average detectors covering both live and neutral lines. A spectrum analyser is used to determine if any periodic emissions are present. Preview scans are performed in standby or receive mode if the device is subject to these requirements. For transmit mode of operation the device is set to one of the following modes.

- Transmitting operating at full power (single mode device)
- Transmitting at freq / modulation that gives highest output power (multi mode device)
- Transmitter operating in normal TX mode (e.g. FHSS, TDMA etc)

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans.

Battery Power devices are not subject to power line conducted emissions measurements when it is powered solely by its internal battery.

4.3 Antenna Port Conducted Emissions

Antenna port conducted emissions can include, but are not limited to, Carrier power, Power Spectral Density, Occupied bandwidth and spurious emission.

Spurious Emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked to identify frequencies to perform formal measurements on.

Formal measurements are made on frequencies identified from the preview scans and fundamental emission(s). Measurements are made using the correct instrumentation (inc. power meter, receiver, spectrum analyser) that operate with the required detector(s) and bandwidth.

Care is taken to ensure the measurement instrument is not overloaded by the presence of the transmitted signal by use of external attenuation and filtering where required.

Measured levels are corrected for cables, attenuators, and filters. If applicable, for the specific measurement, antenna gain is also taken into account.

4.4 Power Supply Variation

Tests at extreme supply voltages are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

In the case the EUT is designed for operation from a lead-acid battery power source, the extreme test voltages are evaluated between 90% and 130% of the nominal battery voltage declared by the manufacturer.

For float charge applications using gel-cell type batteries, extreme test voltages are evaluated between 85% and 115% of the nominal battery voltage declared.

For all battery operated equipment, worst case intentional and spurious emissions are re-checked employing a new (fully charged) battery.

4.5 Thermal Variation

Tests at extreme temperatures are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

Tests are performed at the upper and lower extremes as required and typically at 10˚ steps between.

Before any temperature measurements are made, the equipment is allowed to reach a thermal balance in the test chamber.

4.6 Time Domain Measurements

Time domain measurements are made for (but not limited to) use in duty cycle correction, to ensure compliance with time restrictions on certain types of devices.

If measurements of a transmitter's on time are required these are performed with a spectrum analyser in the time domain or with an oscilloscope and RF detector. If time on a specific frequency is required (e.g. FHSS timing) the measurement can only be made with a spectrum analyser.

The triggering, timescale and amplitude settings are adjusted according to the signal to be measured on a case by case basis.

For devices with sharp rise/fall times measurements are made between RF reaching full power (T_{on}) and RF dropping to the measurement instrument noise floor (T_{off}). For longer rise times measurements are made for T_{on} and T_{off} at the RF level required by the occupied bandwidth measurement (e.g. 6 dB, 20 dB etc).

Appendix A: Formal Emission Test Results

Abbreviations used in the tables in this appendix:

Spec	: Specification
Mod	: Modification
EUT	: Equipment Under Test
SE	: Support Equipment
L	: Live Power Line
N	: Neutral Power Line
E	: Earth Power Line
Pk	: Peak Detector
QP	: Quasi-Peak Detector
Av	: Average Detector
CDN	: Coupling & decoupling network

ALSR	: Absorber Lined Screened Room
OATS	: Open Area Test Site
ATS	: Alternative Test Site
Ref	: Reference
Freq	: Frequency
MD	: Measurement Distance
SD	: Spec Distance
Pol	: Polarisation
H	: Horizontal Polarisation
V	: Vertical Polarisation

A1 Transmitter Intentional Emission Radiated – 15.209

Test Details: RX3K80 Plus	
Regulation	Part15 Subpart (c) 15.209
Measurement standard	ANSI C63.10:2009
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24°C
Photographs (Appendix F)	1

FREQ. (kHz)	MEASUREMENT DISTANCE Meters	MEASUREMENT Rx. READING (dBµV/m)	EXTRAP. FACTOR (dB)	FIELD STRENGTH (µV/m)
126.10	1	90.10	102.30	0.25
126.10	3	67.80	80.00	0.25
Limit value @ fc		19.21 µV/m @ 300meters		

Notes:
1 Results quoted are extrapolated as indicated
2 Receiver detector @ fc = Average 200Hz bandwidth
3 When battery powered the EUT was powered with new batteries
4 Limit value of 2400/F(kHz) as per 15.209
5 Extrapolation <30 MHz 40dB/decade as per 15.31(f)(2)
6 3 – 300 metre extrapolation 80dB
7 1 – 3 metre extrapolation 22.3dB as measured
8 1 – 300 metre extrapolation 102.3dB (80dB + 22.3dB)

Test Method:
1 As per Radio – Noise Emissions, ANSI C63.10:2009
2 Measuring distances 1m & 3m
3 EUT 0.8 metre above ground plane
4 Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m.
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthogonal planes.
Maximum results recorded

Transmitter Intentional Emission Radiated – 15.209 continued:

Test Details: RX380 Plus	
Regulation	Part15 Subpart (c) 15.209
Measurement standard	ANSI C63.10:2009
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24°C
Photographs (Appendix F)	3

FREQ. (kHz)	MEASUREMENT DISTANCE Meters	MEASUREMENT Rx. READING (dBµV/m)	EXTRAP. FACTOR (dB)	FIELD STRENGTH (µV/m)
126.10	1	93.20	102.90	0.33
126.10	3	70.30	80.00	0.33
Limit value @ fc		19.21 µV/m @ 300meters		
Band occupancy @ -20 dBc		f lower	f higher	
		125.520833 kHz	126.467949 kHz	
		947.115385 Hz		

Notes:
1 Results quoted are extrapolated as indicated
2 Receiver detector @ fc = Average 200Hz bandwidth
3 When battery powered the EUT was powered with new batteries
4 Limit value of 2400/F(kHz) as per 15.209
5 Extrapolation <30 MHz 40dB/decade as per 15.31(f)(2)
6 3 – 300 metre extrapolation 80dB
7 1 – 3 metre extrapolation 22.9dB as measured
8 1 – 300 metre extrapolation 102.9dB (80dB + 22.9dB)

Test Method:
1 As per Radio – Noise Emissions, ANSI C63.10:2009
2 Measuring distances 1m & 3m
3 EUT 0.8 metre above ground plane
4 Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m.
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthogonal planes.
Maximum results recorded

A2 Transmitter Intentional Emission Radiated – 15.225(a)

Test Details: RX3K80 Plus	
Regulation	Part15 Subpart (c) 15.225(a)
Measurement standard	ANSI C63.10:2009
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24°C
Photographs (Appendix F)	1

FREQ. (MHz)	MEASUREMENT DISTANCE (m)	MEASUREMENT Rx. READING (dBµV/m)	EXTRAP. FACTOR (dB)	FIELD STRENGTH (µV/m)
13.56	1	90.30	61.10	28.84
13.56	3	69.20	40.00	28.84

Notes:
1 Results quoted are extrapolated as indicated
2 Receiver detector @ fc = Quasi Peak 10
3 When battery powered the EUT was powered with new batteries
4 Extrapolation <30 MHz 40dB/decade as per 15.31(f)(2)
5 3 – 30 metre extrapolation 40 dB
6 1 – 3 metre extrapolation 21.10dB as measured
7 1 – 30 metre extrapolation 61.10 dB (40dB + 21.10dB)

Test Method
1 As per Radio – Noise Emissions, ANSI C63.10:2009
2 Measuring distances 1m & 3m
3 EUT 0.8 metre above ground plane
4 Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m.
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthogonal planes.
Maximum results recorded

Transmitter Intentional Emission Radiated – 15.225(a) continued:

Test Details: RX380 Plus	
Regulation	Part15 Subpart (c) 15.225(a)
Measurement standard	ANSI C63.10:2009
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24°C
Photographs (Appendix F)	3

FREQ. (MHz)	MEASUREMENT DISTANCE (m)	MEASUREMENT Rx. READING (dBµV/m)	EXTRAP. FACTOR (dB)	FIELD STRENGTH (µV/m)
13.56	1	91.70	61.20	33.50
13.56	3	70.50	40.00	33.50
Limit value @ fc		15848 µV/m @ 30meters		
Band occupancy @ -20 dBc		f lower	f higher	
		13.468013 MHz	13.775705 MHz	
		307.692308 KHz		

Notes:
1 Results quoted are extrapolated as indicated
2 Receiver detector @ fc = Quasi Peak 10
3 When battery powered the EUT was powered with new batteries
4 Extrapolation <30 MHz 40dB/decade as per 15.31(f)(2)
5 3 – 30 metre extrapolation 40dB
6 1 – 3 metre extrapolation 21.20dB as measured
7 1 – 30 metre extrapolation 61.20dB (40dB + 21.20dB)

Test Method
1 As per Radio – Noise Emissions, ANSI C63.10:2009
2 Measuring distances 1m & 3m
3 EUT 0.8 metre above ground plane
4 Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m.
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthogonal planes.
Maximum results recorded

A3 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The radiated electric field emission test applies to all spurious emissions and harmonics emissions. The EUT was set to transmit as required.

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site : [ ] 3m alternative test site : [X]

The effect of the EUT set-up on the measurements is summarised in note (c) below.

Test Details: RX3K80 Plus	
Regulation	Part 15 Subpart (c) Clause 15.209
Measurement standard	ANSI C63.10:2009
Frequency range	9kHz – 1GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	26°C
Photographs (Appendix F)	1

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	30.0	3.9	0.8	19.0	N/A	23.7	15.3	100.0
2.	54.2	27.2	1.0	7.1	N/A	35.3	58.1	100.0
3.	67.8	27.3	1.2	6.2	N/A	34.7	54.2	100.0
4.	352.6	10.2	2.5	14.2	N/A	26.9	22.2	200.0
5.	930.7	-0.5	4.4	23.8	N/A	27.7	24.2	200.0
6.	945.5	-0.5	4.4	24.5	N/A	28.4	26.2	200.0

Radiated Electric Field Emissions Continued:

Test Details: RX380 Plus	
Regulation	Part 15 Subpart (c) Clause 15.209
Measurement standard	ANSI C63.10:2009
Frequency range	9kHz – 1GHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	26°C
Photographs (Appendix F)	3

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	54.3	25.8	0.9	6.3	N/A	33.0	44.8	100.0
2.	61.0	23.9	0.9	5.2	N/A	30.0	31.6	100.0
3.	67.8	17.9	0.9	5.1	N/A	23.9	15.7	100.0
4.	386.5	10.2	2.3	15.3	N/A	27.8	24.5	200.0
5.	413.6	10.2	2.4	16.6	N/A	29.2	28.8	200.0
6.	420.4	10.5	2.4	16.7	N/A	29.6	30.2	200.0
7.	447.5	7.7	2.4	16.3	N/A	26.4	21.0	200.0
8.	467.8	9.7	2.5	16.9	N/A	29.1	28.5	200.0
9.	474.6	10.3	2.5	17.0	N/A	29.8	31.0	200.0
10.	495.0	7.0	2.6	17.4	N/A	27.0	22.4	200.0
11.	501.7	8.7	2.6	17.4	N/A	28.7	27.3	200.0
12.	508.5	8.9	2.6	17.6	N/A	29.1	28.6	200.0
13.	522.0	10.9	2.7	17.6	N/A	31.2	36.1	200.0
14.	528.8	14.5	2.7	17.7	N/A	34.9	55.5	200.0
15.	535.6	11.1	2.7	17.9	N/A	31.7	38.2	200.0
16.	556.0	8.0	2.8	18.7	N/A	29.5	29.7	200.0
17.	583.1	5.3	2.9	18.8	N/A	27.0	22.3	200.0
18.	664.4	4.8	3.1	19.0	N/A	26.9	22.1	200.0
19.	908.5	1.9	3.6	20.8	N/A	26.3	20.7	200.0
20.	935.6	2.3	3.7	21.0	N/A	27.0	22.3	200.0

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10:2009: section 4.5, Table 1 For emissions below 30MHz the cable losses are assumed to be negligible.
2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
3 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
4 For Frequencies below 1 GHz, RBW= 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

Peak	RBW= 1MHz, VBW ≥ RBW
Average	RBW= 1MHz, VBW ≥ RBW

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15 Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits 47 CFR Part 15: Clause 15.209 for all emissions:

Frequency of emission (MHz)	Field strength dBµV/m	Measurement Distance m	Field strength dBµV/m
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation}\,(\text{dB}) = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

(b) The levels may have been rounded for display purposes.

(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels:

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓			
Effect of EUT internal configuration on emission levels	✓			
Effect of Position of EUT cables & samples on emission levels	✓			

(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

A4 Power Line Conducted Emissions

Preview power line conducted emission measurements were performed with a peak detector in a screened room. The effect of the EUT set-up on the measurements is summarised in note (b). Where applicable, the formal measurements of the emissions were performed with a peak, average and/or quasi peak detector.

Test Details: RX3K80 Plus	
Regulation	Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.10:2009
Frequency range	150kHz to 30MHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	2

The worst-case power line conducted emission measurements are listed below:

Results measured using the average detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Emissions were detected within 20dB of the limit						

Results measured using the quasi-peak detector compared to the quasi–peak limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Emissions were detected within 20dB of the limit						

Power Line Conducted Emissions continued:

Test Details: RX380 Plus	
Regulation	Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.10:2009
Frequency range	150kHz to 30MHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	4

The worst-case power line conducted emission measurements are listed below:

Results measured using the average detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Emissions were detected within 20dB of the limit						

Results measured using the quasi-peak detector compared to the quasi–peak limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Emissions were detected within 20dB of the limit						

Specification limits:

Conducted emission limits (47 CFR Part 15: Clause 15.207):

Conducted disturbance at the mains ports

Frequency range MHz	Limits dBμV	
	Quasi-peak	Average
0.15 to 0.5	66 to 56[2]	56 to 46[2]
0.5 to 5	56	46
5 to 30	60	50

Notes:
1. The lower limit shall apply at the transition frequency.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.

Notes:

(a) The levels may have been rounded for display purposes.

(b) The following table summarises the effect of the EUT operating mode and internal configuration on the measured emission levels:

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels		✓		
Effect of EUT internal configuration on emission levels		✓		

(i) Parameter defined by standard and / or single possible, refer to Appendix C
(ii) Parameter defined by client and / or single possible, refer to Appendix C
(iii) Parameter had a negligible effect on emission levels, refer to Appendix C
(iv) Worst case determined by initial measurement, refer to Appendix C

A5 Frequency Stability

Test Details:	
Regulation	Part 15 Subpart (c) Clause 15.225
Measurement standard	ANSI C63.10
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Vnom (Vdc)	Temperature (°C)	Frequency (MHz)	Deviation (kHz)	Limit = ± 0.01% = ±1.3562kHz
12	+24	13.559277	-	-
12	+55	13.559381	0.1040	Pass
12	-20	13.559263	-0.0140	Pass
Voltage (Vdc) 85% - 115%	**Temperature (°C)**	**Frequency (MHz)**	**Deviation (kHz)**	**Limit = ± 0.01% = 1.3562kHz**
10.2	+24	13.559277	0.0000	Pass
13.8	+24	13.559279	0.0020	Pass

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.

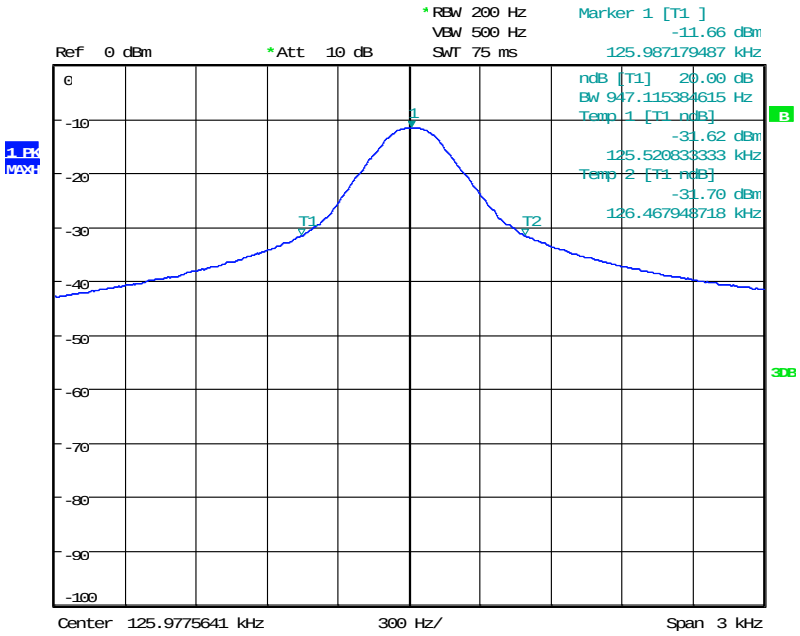
(b) The time and date on the plots do not necessarily equate to the time of the test.

(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

(d) Appendix C details the numbering system used to identify the sample and its modification state.

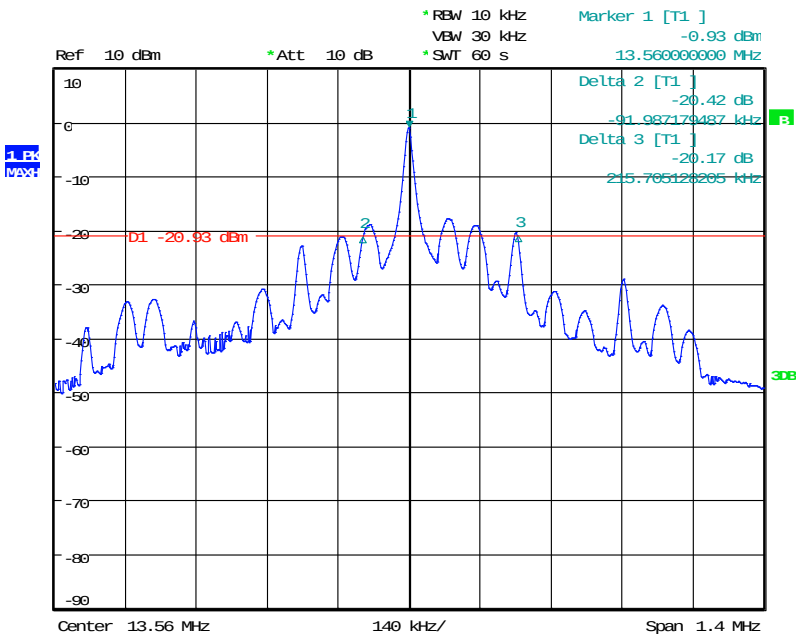
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.

20dB Bandwidth



Date: 20.FEB.2015 13:11:02

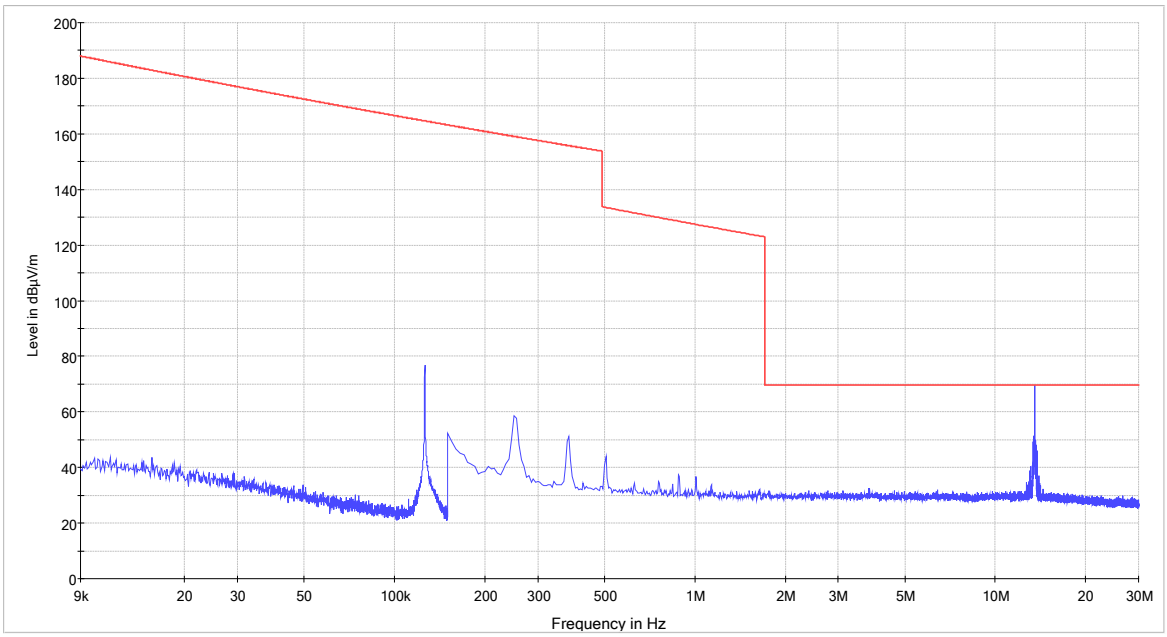
20dB Bandwidth - 126 kHz



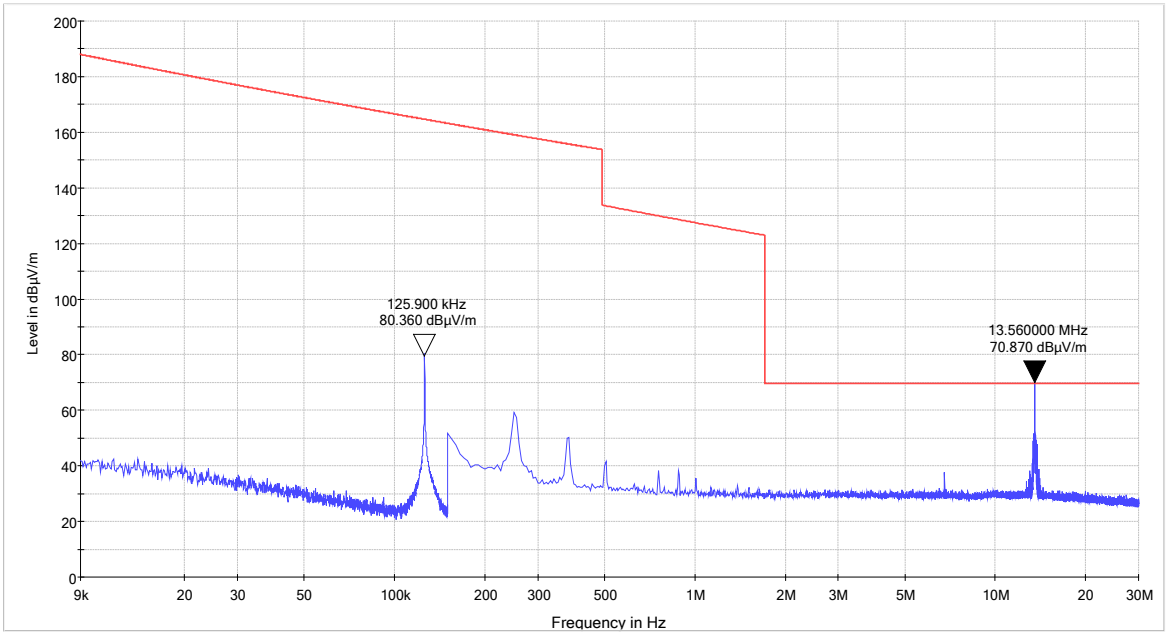
Date: 20.FEB.2015 12:41:10

20dB Bandwidth - 13.56 MHz

Radiated spurious emissions 9 kHz to 30 MHz

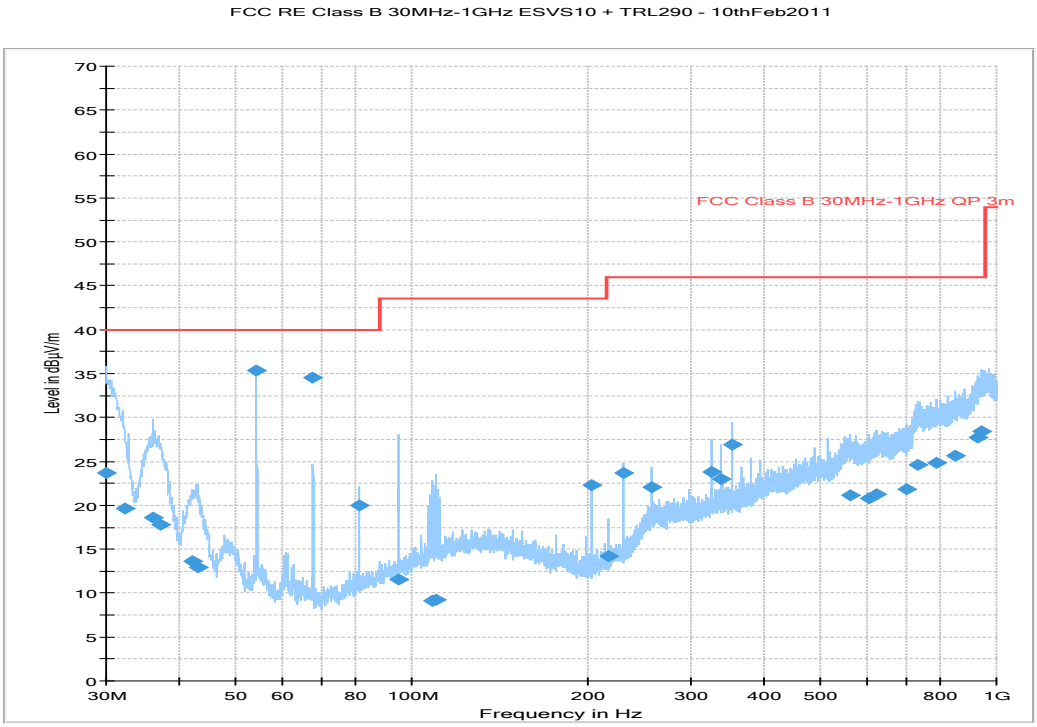


Radiated spurious emissions 9 kHz to 30 MHz – RX3K80 Plus

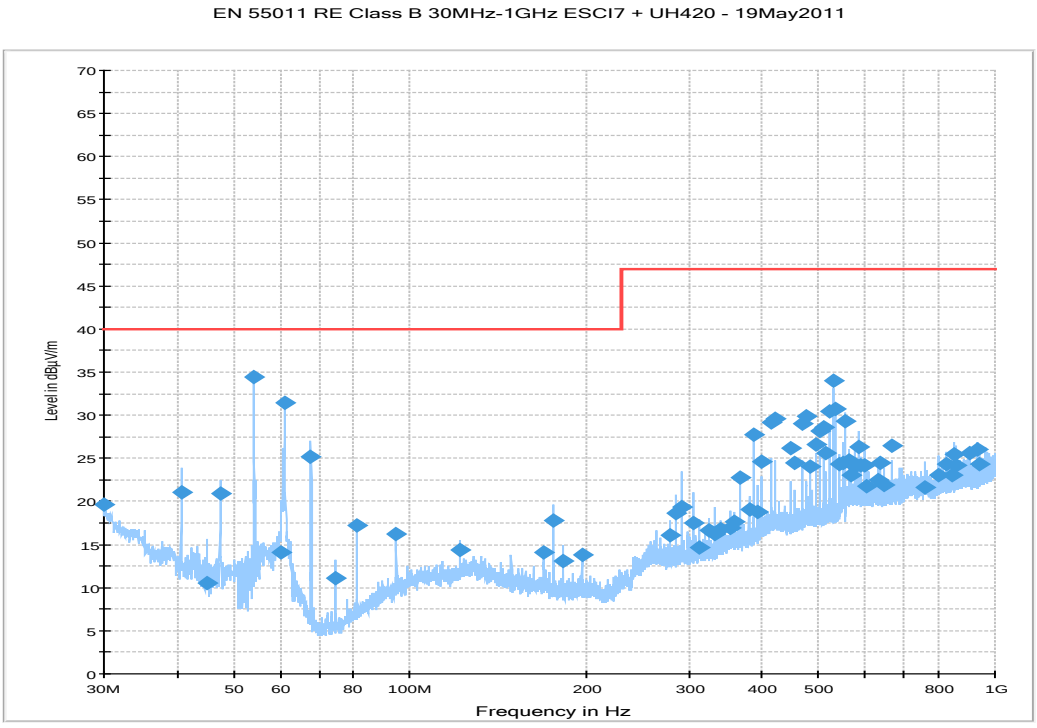


Radiated spurious emissions 9 kHz to 30 MHz – RX380 Plus

Radiated spurious emissions 30 MHz to 1 GHz

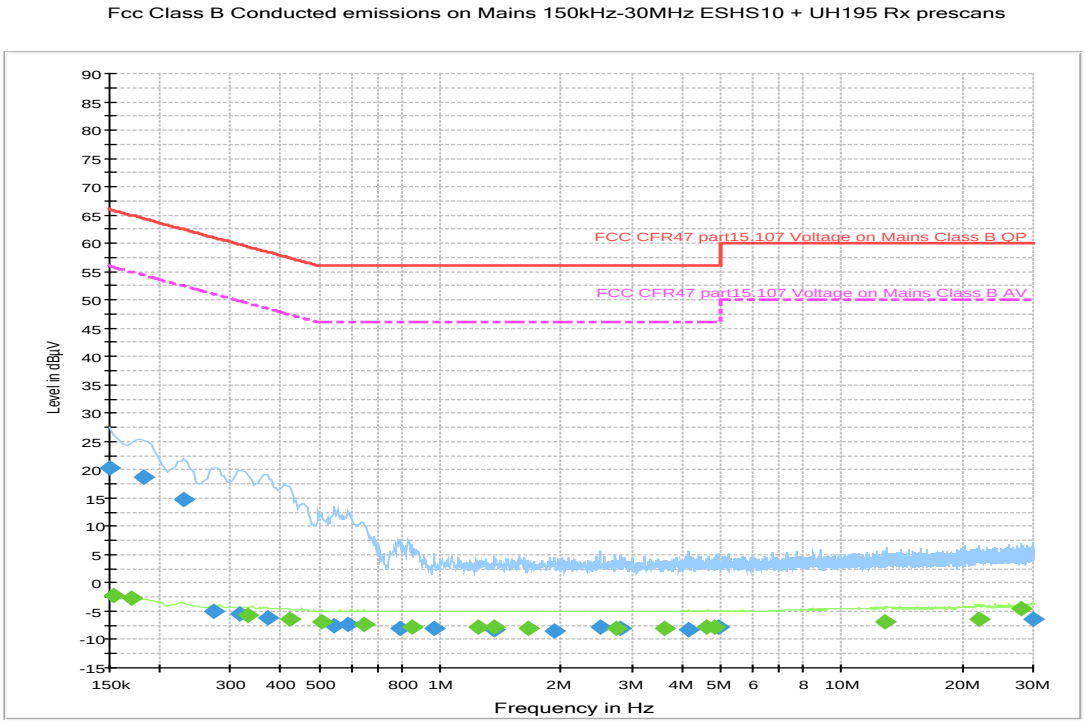


Radiated spurious emissions 30 MHz to 1 GHz – RX3K80 Plus

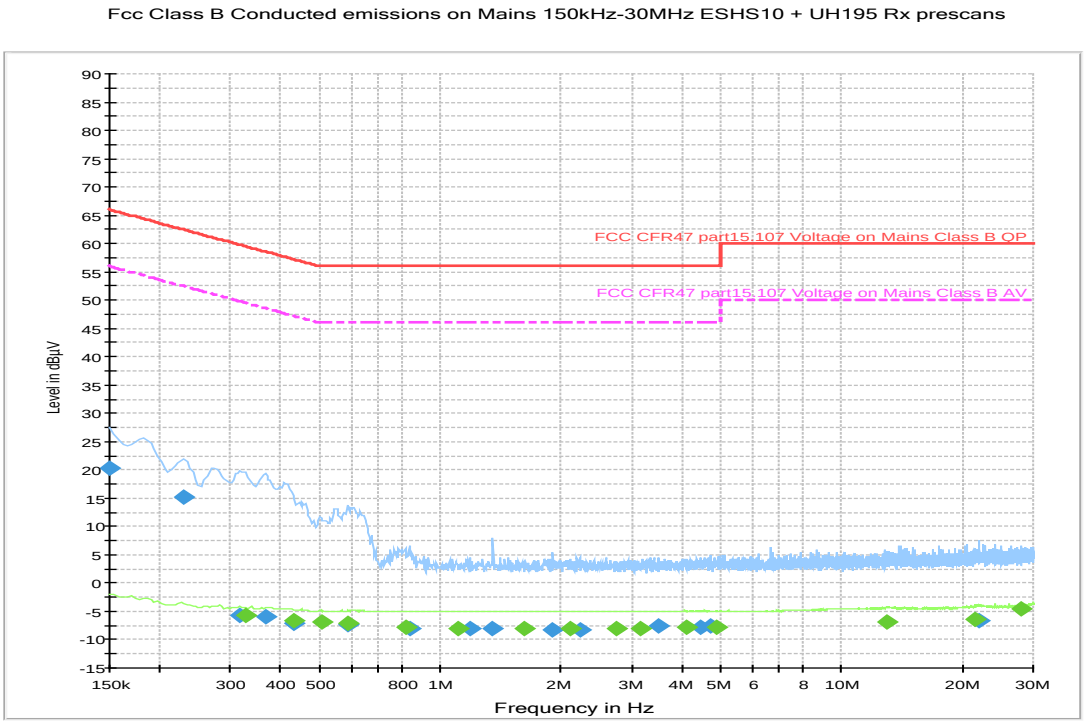


Radiated spurious emissions 30 MHz to 1 GHz - RX380 Plus (Note: limit line is wrong)

AC Powerline Conducted Emissions

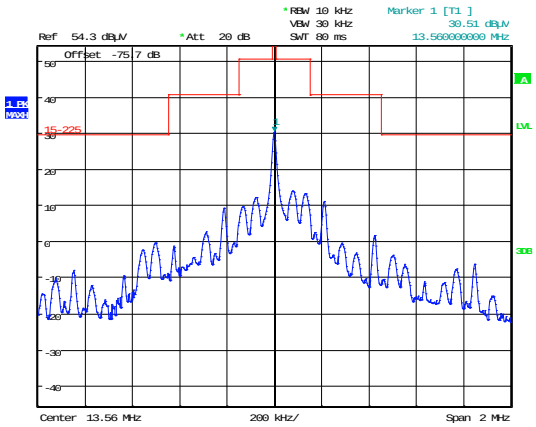


AC Powerline Conducted Emissions – RX3K80 Plus



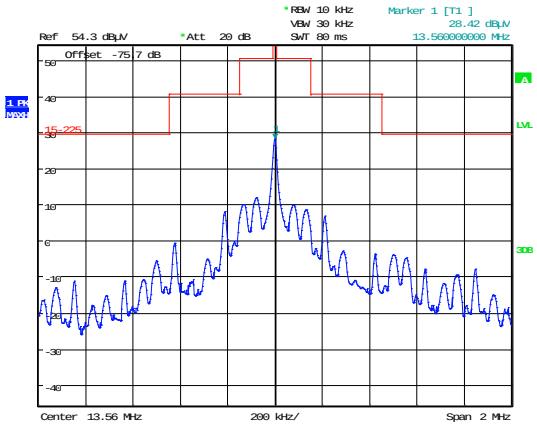
AC Powerline Conducted Emissions – RX380 Plus

Emission Mask



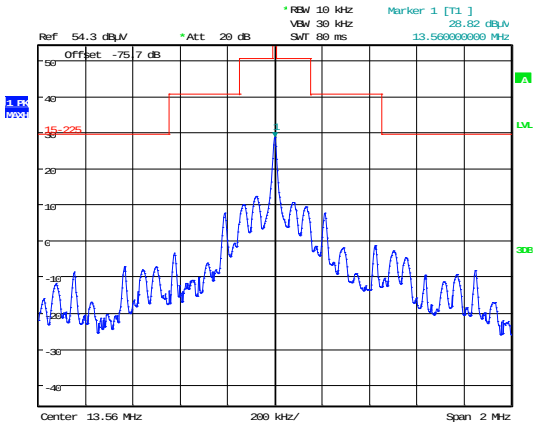
Date: 20.FEB.2015 12:13:36

Tnom Vnom



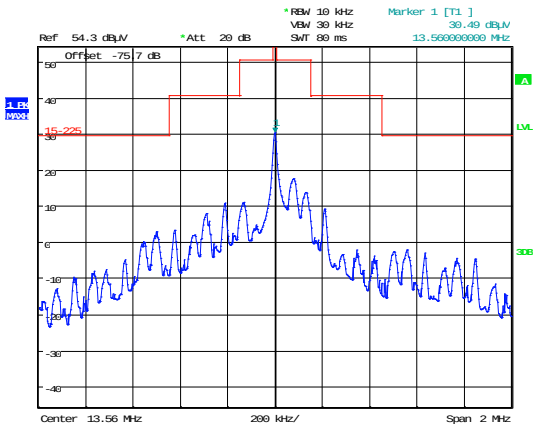
Date: 20.FEB.2015 14:32:04

Tmax Vmin



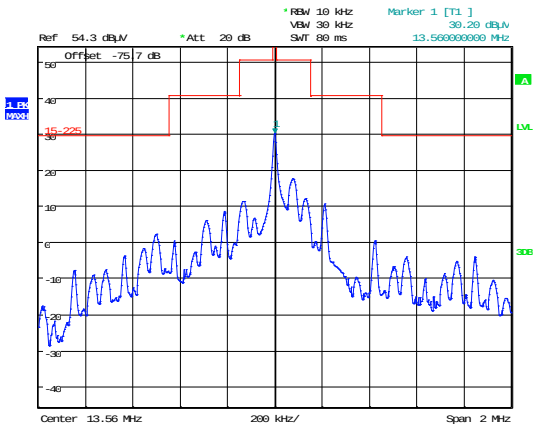
Date: 20.FEB.2015 14:34:57

Tmax Vmax



Date: 23.FEB.2015 10:23:51

Tmin Vmin



Date: 23.FEB.2015 10:26:58

Tmin Vmax

Appendix C: **Additional Test and Sample Details**

This appendix contains details of:

1. The samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to identify the sample and it's modification state:

Sample No: Sxx Mod w

Where:

xx = sample number eg. S01
w = modification number eg. Mod 2

The following terminology is used throughout the test report:

Support Equipment (SE) is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

EUT configuration refers to the internal set-up of the EUT. It may include for example:

Positioning of cards in a chassis.
Setting of any internal switches.
Circuit board jumper settings.
Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as “single possible configuration”.

EUT arrangement refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by TRaC Global upon request.

C1 Test samples

The following samples of the apparatus were submitted by the client for testing:

Sample No.	Description	Identification
S01	RX3K80 Plus	None
S02	RX380 Plus	None

The following samples of apparatus were submitted by the client as host, support or drive equipment (auxiliary equipment):

Sample No.	Description	Identification
None		

The following samples of apparatus were supplied by TRaC Global as support or drive equipment (auxiliary equipment):

Identification	Description
None	

C2 EUT Operating Mode during Testing

During testing, the EUT was exercised as described in the following tables:

Test	Description of Operating Mode:
All tests detailed in this report	EUT is actively transmitting either waiting for a tag to be presented or reading a tag as required.

C3 EUT Configuration Information

The EUT was submitted for testing in one single possible configuration.

C4 List of EUT Ports

The tables below describe the termination of EUT ports:

Sample : S01, S02
Tests : All Tests

Port	Description of Cable Attached	Cable length	Equipment Connected
Power	2 wires	1.2m	Power Supply

C5 Details of Equipment Used

TRaC No	Type	Description	Manufacturer	Last Cal	Period	Cal Due
UH003	ESHS10	Receiver	R&S	03/07/2014	12	03/07/2015
UH004	ESVS10	Receiver	R&S	27/02/2014	12	27/02/2015
UH100	-	PSU	Thandar	Cal in use		
UH195	ESH3-Z5.831.5	Lisn	R&S	21/07/2014	12	21/07/2015
UH281	FSU46	Spectrum Analyser	R&S	26/02/2014	12	26/02/2015
UH387	ATS	Chamber 1	Rainford EMC	04/07/2013	24	04/07/2015
UH403	ESCI 7	Receiver	R&S	20/08/2014	12	20/08/2015
UH420	CBL6112	Bilog	Chase	25/07/2014	24	25/07/2016
L007	hfh2	Loop Antenna	R&S	17/10/2013	24	17/10/2015
L011	-	Temp Chamber	Sharetree	Cal in use		
L290	CBL611/A	Bilog	Chase	02/12/2014	24	02/12/2016
L352	ESVS10	Receiver	R&S	21/03/2014	12	21/03/2015
L426	52 Series II	Temperature Indicator	Fluke	22/05/2014	12	22/05/2015
REF940	ATS	Radio Chamber - PP	Rainford EMC	08/09/2014	24	08/09/2016
REF976	34405a	Multimeter	Agilent	19/05/2014	12	19/05/2015

Appendix D: Additional Information

No additional information is included within this test report.

Appendix E: Calculation of the duty cycle correction factor

Using a spectrum analyser in zero-span mode, centred on the fundamental carrier frequency with a RBW of 1MHz and a video Bandwidth of 1MHz the sweep time was set accordingly to capture the pulse train. The transmit pulse widths and period was measured. A plots of the pulse train is contained in Appendix B of this test report.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulse widths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle was calculated by averaging the sum of the pulse widths over the 100ms width with the highest average value. (The duty cycle is the value of the sum of the pulse widths in one period (or 100ms), divided by the length of the period (or 100ms). The duty cycle correction factor was then expressed in dB and the peak emissions adjusted accordingly to give an average value of the emission.

Correction factor dB = 20 x (Log_{10} Calculated Duty Cycle)

Therefore the calculated duty cycle was determined:

The pulse train period was greater than >100ms and in as shown from the plots in contained in appendix B of this test report.

$$\text{Duty cycle} = \frac{\text{the sum of the highest average value pulse widths over 100ms}}{100\text{ms}}$$

e.g.

$$= \frac{7.459ms}{100ms} = 0.07459$$

0.07459 or 7.459%

Correction factor (dB) = 20 x (Log_{10} 0.07459) = -22.54dB

Duty cycle correction may not be applicable.
Unless duty cycle correction is utilised in the results section of this report this section is included for information only.

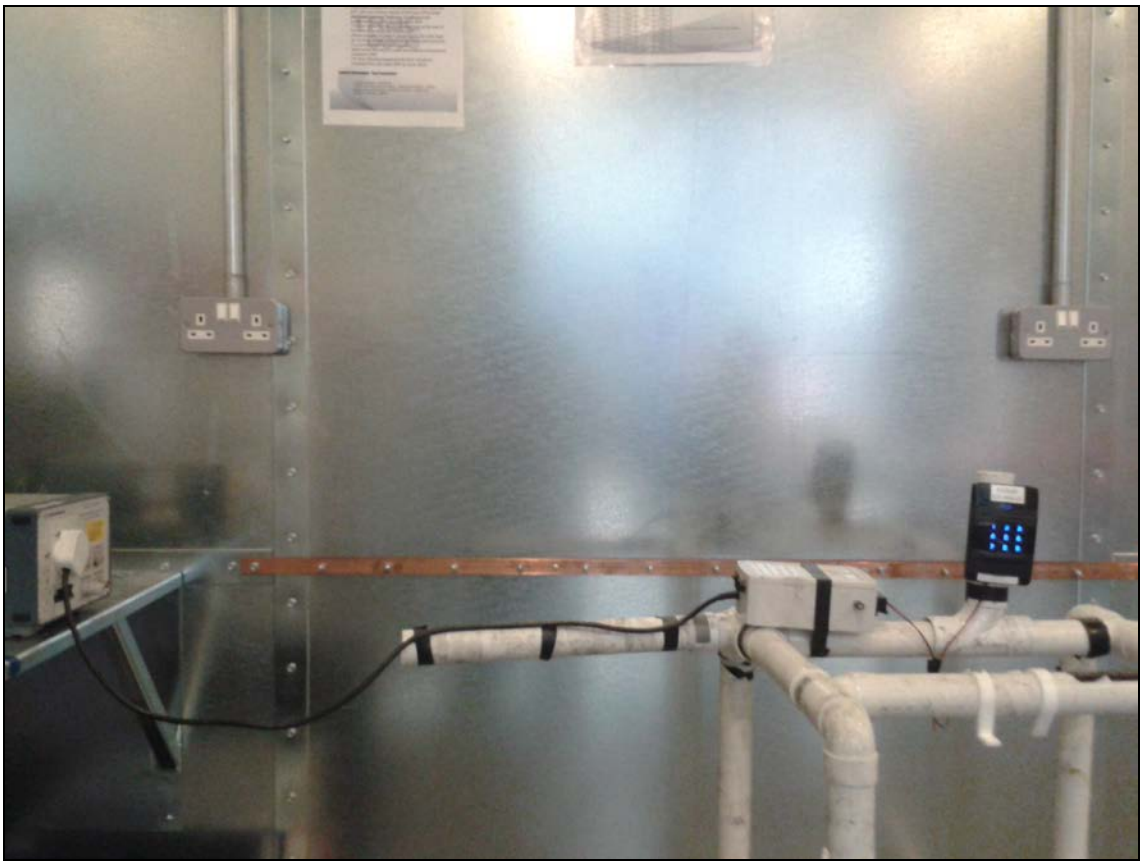
Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated emissions arrangement – RX3K80 Plus
2. Powerline emissions arrangement – RX3K80 Plus
3. Radiated emissions arrangement – RX380 Plus
4. Powerline emissions arrangement – RX380 Plus

Photograph 1

Photograph 2



Photograph 3

Photograph 4

Appendix G: General SAR test reduction and exclusion guidance

KDB 447498

Section 4.3 General SAR test reduction and exclusion guidance

For Standalone SAR exclusion consideration, when the considering 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.

In the frequency range below 100 MHz and test separation distance ≤ 50mm, the SAR Test Exclusion Threshold will be determined as follows

SAR Exclusion Threshold (SARET)
SAR Exclusion Threshold = ([Step 1 + Step2] * Step 3a) * Step 3b

Step 1

$$NT = [(MP/TSD^{A}) * \sqrt{f_{GHz}}]$$

NT	=	Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)
MP	=	Max Power of channel (mW) (inc tune up)
TSD^{A}	=	Min Test separation Distance or 50mm (whichever is lower) = 50
f_{GHz}	=	Transmit frequency (or 100MHz if lower)

We can transpose this formula to allow us to find the maximum power of a channel allowed and compare this to the measured maximum power.

$$MP = [(NT \times TSD^{A}) / \sqrt{f_{GHz}}]$$

For Distances Greater than 50 mm Step 2 applies

Step 2

$$(TSD^{B} - 50mm) * f_{(MHz)}/150$$

Where:

f_{MHz}	=	Transmit frequency
TSD^{B}	=	Min Test separation Distance (mm) = 50

Step 3

3a) The power threshold at the corresponding test separation distance at 100 MHz in step 2) is multiplied by [1 + log(100/f(MHz))] for *test separation distances* > 50 mm and < 200 mm

3b) The power threshold determined by the equation in steps 1 and 2 for 50 mm and 100 MHz is multiplied by ½ for *test separation distances* ≤ 50 mm

$$SARET = (\{ [(NT \times TSD^{A}) / \sqrt{f_{GHz}}] + (TSD^{B} - 50) * [100/150] \} * (1 + Log [100 / F_{MHz}])) * {}^{1}/_{2}$$
$$SARET = (\{ [(3.0 \times 50) / \sqrt{0.1}] + (50 - 50) * [100/150] \} * (1 + Log [100 / F_{MHz})]) * {}^{1}/_{2}$$
$$SARET = (474 * (1 + Log [100 / 13.56)) * {}^{1}/_{2}$$
$$SARET = 442.65 \text{ mW}$$

The calculated output power 1.09×10^{-10}mW (eirp) is less than the SAR Exclusion Threshold of 468mW, at 5mm test separation distance, for general population and uncontrolled exposure.

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

Prediction of MPE limit at a given distance

2.1091 Radio frequency radiation exposure evaluation: Portable devices.

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than 0.98 mW/cm^2 power density limit, as required under FCC rules

Equation from IEEE C95.1

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re-arranged } R = \sqrt{\frac{EIRP}{S4\pi}}$$

Where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Note:

The EIRP value was calculated using the peak E Field measurement.

Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 0.98 mW/cm^2
RX3K80 Plus			
13.56	2.3×10^{-5}	0.98	0.00137
RX380 Plus			
13.56	6.7×10^{-5}	0.98	0.00234

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