Radio Test Report

Telensa Limited

Base station

BS4

RSS-247, Issue 2 Feb 2017

↳ RSS-GEN, Issue 4 November 2014

Test Date: 23rd January 2017 to 9th February 2017

Report Number: 02-9314-4-17 Issue 03

Supersedes Report No: 02-9314-4-17 Issue 02

R.N. Electronics Ltd.
Arnolds Court
Arnolds Farm Lane
Mountnessing
Essex
CM13 1UT
U.K.

www.RNelectronics.com

Telephone: +44 (0) 1277 352219
Email: sales@RNelectronics.com

Arnolds Court, Arnolds Farm Lane, Mountnessing, Brentwood Essex, CM13 1UT

Certificate of Test 9314-4

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant part of RSS-247, Issue 2. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	Base station
Model Number:	BS4
Unique Serial Number:	2L0080
Applicant:	Telensa Limited Iconix 3 London Road Pampisford Cambridge, UK CB22 3EG
Proposed IC ID	12199A-BS4AA
Full measurement results are detailed in Report Number:	02-9314-4-17 Issue 03
Test Standards:	RSS-247, Issue 2 Feb 2017 ↳ RSS-GEN, Issue 4 November 2014

NOTE:
Certain tests were not performed based upon manufacturer's declarations. Certain other requirements are subject to manufacturer declaration only and have not been tested/verified. For details refer to section 3 of this report.

DEVIATIONS:
No deviations have been applied.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Radiocommunication Act and Radiocommunication Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to Industry Canada and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Date Of Test:	23rd January 2017 to 9th February 2017
Test Engineer:	Ian Rose Digitally signed by: Ian Rose DN: CN = Ian Rose email = Ian@rnelectronics.com C = GB O = RN Electronics Date: 2017.09.28 13:44:04 Z
Approved By: Technical Manager	Steve Hull Digitally signed by: Steve Hull DN: CN = Steve Hull email = steve@rnelectronics.com C = GB O = RN Electronics Date: 2017.09.28 12:57:08 Z
Customer Representative:	

1 Contents

1 Contents 3
2 Equipment under test (EUT) 4
2.1 Equipment specification 4
2.2 Configurations for testing 5
2.3 Functional description 5
2.4 Modes of operation 6
2.5 Emissions configuration 7
3 Summary of test results 8
4 Specifications 9
4.1 Relevant standards 9
4.2 Deviations 9
5 Tests, methods and results 10
5.1 AC power line conducted emissions 10
5.2 TX Unwanted radiated emissions 9-150 kHz 12
5.3 TX Unwanted radiated emissions 150 kHz-30 MHz 13
5.4 TX Unwanted radiated emissions 30 MHz-1 GHz 15
5.5 TX Unwanted radiated emissions above 1 GHz 18
5.6 Transmitter output power - E.I.R.P 21
5.7 TX Unwanted emissions - Band edge compliance 22
5.8 20dB bandwidth 24
5.9 Transmitter output power conducted - maximum peak 25
5.10 DTSs Transmitter output power conducted - maximum Average 26
5.11 TX unwanted emissions - Antenna port RF conducted emissions 26
5.12 DTSs - TX Duty cycle (Pulsed operation) 26
5.13 DTSs - Power spectral density 26
5.14 FHSs - Number of hop channels 27
5.15 FHSs - Average time of occupancy 29
5.16 FHSs - Carrier Frequency separation 30
6 Plots/Graphical results 31
6.1 AC power line conducted emissions 31
6.2 TX Unwanted radiated emissions 150 kHz-30 MHz 33
6.3 TX Unwanted radiated emissions 30 MHz-1 GHz 34
6.4 TX Unwanted radiated emissions above 1GHz 43
6.5 TX Unwanted emissions - Band edge compliance 52
6.6 20dB / 6dB bandwidth 54
6.7 FHSs - Number of hop channels 56
6.8 FHSs - Average time of occupancy 64
6.9 FHSs - Carrier Frequency separation 65
7 Explanatory Notes 66
7.1 Explanation of Table of Signals Measured 66
7.2 Explanation of limit line calculations for radiated measurements 67
8 Photographs 68
8.1 EUT Front View 68
8.2 EUT Reverse Angle 68
8.3 EUT Antenna Ports 70
8.4 EUT Internal photos 71
8.5 EUT ID Label 77
8.6 AC power line conducted emissions 78
8.7 TX Unwanted radiated emissions 150 kHz-30 MHz 79
8.8 TX Unwanted radiated emissions 30 MHz-1 GHz 80
8.9 TX Unwanted radiated emissions above 1 GHz 81
8.10 Radiated emission diagram 82
Diagram of the radiated emissions test setup 30 - 1000 MHz 82
8.11 AC powerline conducted emission diagram 83
9 Test equipment calibration list 84
10 Auxiliary and peripheral equipment 85
10.1 Customer supplied equipment 85
10.2 RN Electronics supplied equipment 85
11 Condition of the equipment tested 86
11.1 Modifications before test 86
....86
11.2 Modifications during test 86
12 Description of test sites 87
13 Abbreviations and units 88

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Telensa Limited Iconix 3 London Road Pampisford Cambridge UK CB22 3EG	
Manufacturer of EUT	Telensa Limited	
Full Name of EUT	Base station	
Model Number of EUT	BS4	
Serial Number of EUT	2L0080	
Date Received	23rd January 2017	
Date of Test:	23rd January 2017 to 9th February 2017	
Purpose of Test	To demonstrate design compliance with Industry Canada Spectrum Management and Telecommunications requirements for Radio apparatus.	
Date Report Created	15th May 2017	
Main Function	Standalone base station transceiver for street lighting monitoring and control.	
Information Specification	Height	300 mm
	Width	300 mm
	Depth	150 mm
	Weight	5 kg
	Voltage	100-240 V AC
	Current	0.1 A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	On top of a lighting column or post. Typically 10 m above ground.
Choice of model(s) for type tests	Production sample
Antenna details	TX- Shakespeare SKP-794-8-915 8 dBi. RX-Jaybeam 7556910 8 dBi
Antenna port	2 x N type female
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	1980 MHz
Lowest Signal generated in EUT	26 MHz
Hardware Version	05
Software Version	0.8.25
Firmware Version	0.43
Type of Equipment	Transceiver
Technology Type	Custom UNB protocol
Geo-location (yes/no)	Yes
TX Parameters	
Alignment range – transmitter	902-928 MHz
EUT Declared Modulation Parameters	2 level FSK +/-250 Hz
EUT Declared Power level	27.5 dBm to antenna
EUT Declared Signal Bandwidths	1 kHz
EUT Declared Channel Spacing's	25 kHz
EUT Declared Duty Cycle	33% maximum, 10% typical
Unmodulated carrier available?	Yes
Declared frequency stability	1 ppm
RX Parameters	
Alignment range – receiver	902-928 MHz
EUT Declared RX Signal Bandwidth	200 kHz
FHSs Parameters	FHSs Parameters
Maximum No. Of hop channels	59* per subset used
Minimum No. Of hop channels	59
Dwell time per hop channel	395-400 ms

*Note: EUT can use only one subset of any of the 16 subsets (groups) of 59 channels.

2.3 Functional description

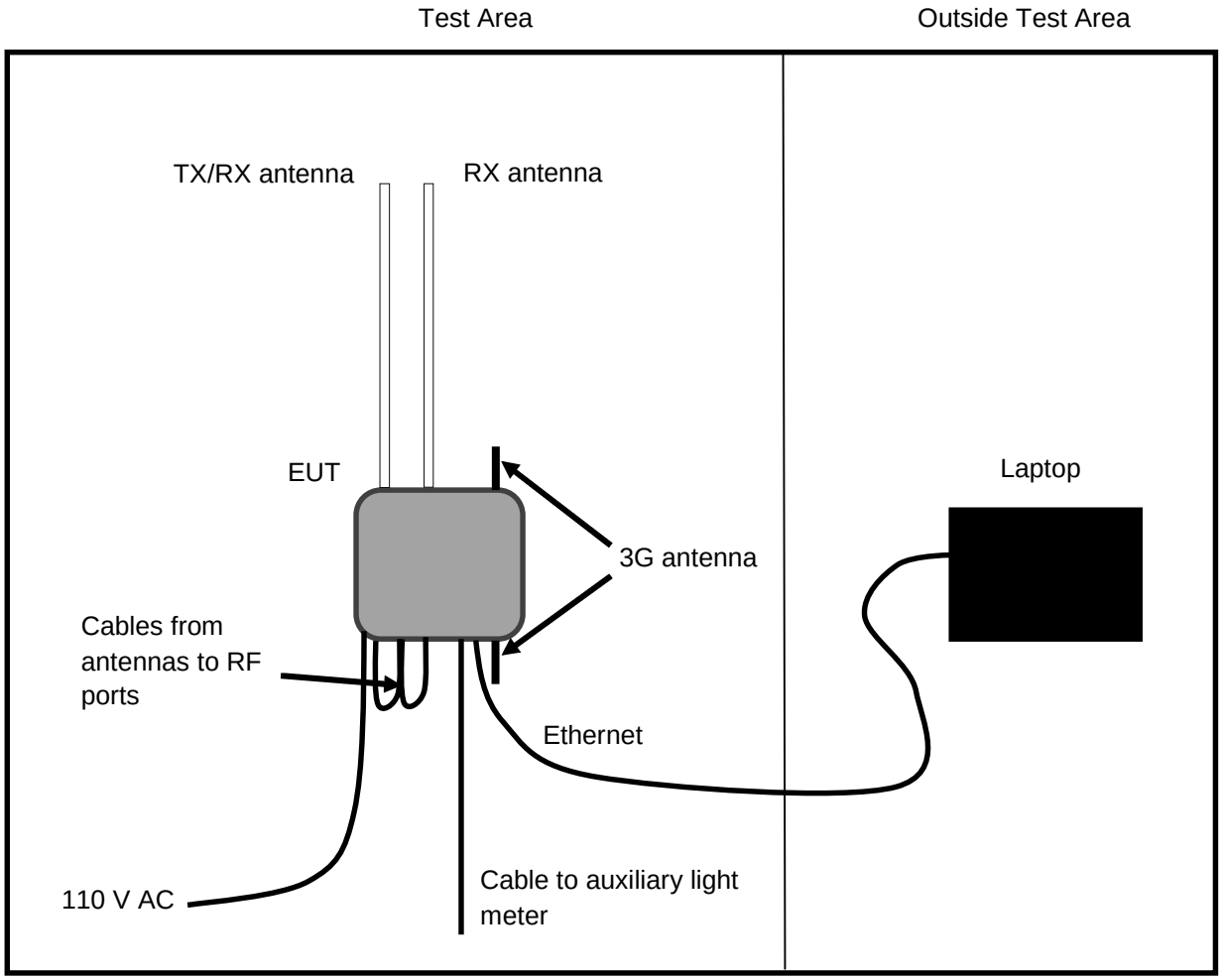
The transceiver operates on a 24 second frame, typically transmitting for one or two 400 ms slots at the start of each frame, receiving for the rest of the frame. The receiver is 200 kHz wide and capable of receiving multiple ultra-narrow band (UNB) simultaneous signals in band through use of FFT techniques. The data backhaul is via one of two 3G modems integral with the device. These have short external "twig" antennas on the case. These modems are operational at the same time as the FHSS transmitter.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX1	902.4 MHz +27.5 dBm FSK 500 bps continuous transmit	Yes
TX2	915.09375 MHz +27.5 dBm FSK 500 bps continuous transmit	Yes
TX3	927.7875 MHz +27.5 dBm FSK 500 bps continuous transmit	Yes
TX4	Hopping +27.5 dBm FSK 500 bps	Yes
RX1	EUT sitting in receive mode at 902.4MHz	No
RX2	EUT sitting in receive mode at 915.09375MHz	No
RX3	EUT sitting in receive mode at 927.7875MHz	No

Note: RX mode tests are covered under RN electronics report 02-9314-2-01 not tested here. TX4 mode was a special engineering mode that configured the EUT to hop on the 59 channels of each subset in turn. i.e. the EUT hopped on all 59 channels of subset A (Pseudo randomly), then moved to subset B and Pseudo randomly hopped on the 59 channels, then Subset C etc. After the 16th subset the cycle re-started at subset A again.

2.5 Emissions configuration



The EUT was powered from the AC mains at 110V 60Hz. The EUT has two main RF ports. One for TX/RX and the second for RX (diversity) only. Each of these ports was connected to an 8 dBi co-linear antenna. An un-terminated cable was connected to the auxiliary light meter connector on the main board and brought outside the EUT. The Ethernet port was connected to a laptop located outside the test chamber. The EUT contains two 3G modems. Both were operating during testing and each was connected to a short, helical antenna on the EUT. The EUT also contained an auxiliary radio that although powered was not configured to be operating during testing as it is for future expansion of the system only. The unit was configured using terminal commands to allow permanent transmit and receive modes of the EUT on the top, middle and bottom channels and hopping across all channels as stated within section 2.4 of this report. The transmit mode was 100% continuous with modulation and the power settings for each channel were as stated below:-

Low Channel (902.4 MHz) = level 27.5 dBm
Mid Channel (915.09375 MHz) only = level 27.5 dBm
High Channel (927.7875 MHz) = level 27.5 dBm

2.5.1 Signal leads

Port Name	Cable Type	Connected
Power	3 core mains	Yes
RX port	Coax to antenna	Yes
TX/RX port	Coax to antenna	Yes
Ethernet	Screened CAT 5E	Yes
Aux light meter	Unscreened multicore	Yes

3 Summary of test results

The Base station, BS4 was tested for compliance to the following standard(s) :

RSS-247, Issue 2 Feb 2017
↳ RSS-GEN, Issue 4 November 2014

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to Industry Canada and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	RSS-GEN, Issue 4 Clause 8.8	PASSED
2. TX Unwanted radiated emissions 9-150kHz	RSS-247, Issue 2 Clause 5.5, RSS-GEN, Issue 4 Clause 6.13	NOT APPLICABLE[1]
3. TX Unwanted radiated emissions 150kHz-30MHz	RSS-247, Issue 2 Clause 5.5, RSS-GEN, Issue 4 Clause 6.13	PASSED
4. TX Unwanted radiated emissions 30MHz-1GHz	RSS-247, Issue 2 Clause 5.5, RSS-GEN, Issue 4 Clause 6.13	PASSED
5. TX Unwanted radiated emissions above 1GHz	RSS-247, Issue 2 Clause 5.5, RSS-GEN, Issue 4 Clause 6.13	PASSED[2]
6. Transmitter output power - E.I.R.P	RSS-247, Issue 2 Clause 5.4	NOT TESTED[3]
7. TX Unwanted emissions - Band edge compliance	RSS-247, Issue 2 Clause 5.5, RSS-GEN, Issue 4 Clause 8.10	PASSED
8. 20dB / 6dB bandwidth	RSS-247, Issue 2 Clause 5.1	PASSED
9. Transmitter output power conducted - maximum peak	RSS-247, Issue 2 Clause 5.4	PASSED
10. DTSs Transmitter output power conducted - maximum Average	RSS-247, Issue 2 Clause 5.4	NOT APPLICABLE[3]
11. TX unwanted emissions - Antenna port RF conducted emissions	RSS-247, Issue 2 Clause 5.5	NOT APPLICABLE[4]
12. DTSs - TX Duty cycle (Pulsed operation)	RSS-GEN, Issue 4 Clause 6.10	NOT APPLICABLE[5]
13. DTSs - Power spectral density	RSS-247, Issue 2 Clause 5.2(b)	NOT APPLICABLE[6]
14. FHSs - Number of hop channels	RSS-247, Issue 2 Clause 5.1(c)	PASSED
15. FHSs - Average time of occupancy	RSS-247, Issue 2 Clause 5.1(c)	PASSED
16. FHSs - Carrier Frequency separation	RSS-247, Issue 2 Clause 5.1(b)	PASSED

[1] Spectrum below 30MHz started at a frequency of 150 kHz up to a frequency of 30MHz based on the lowest signal generated/used within the equipment as declared by the applicant of 26MHz.
[2] Spectrum investigated up to a frequency of 20 GHz based on 10 times the highest channel/ signal generated declared in equipment of 1980 MHz.
[3] The EUT was tested for PK conducted power and known antenna gain was applied. Please refer to section 5.9 within this report for compliance details on E.I.R.P.
[4] The EUT was tested for radiated emissions with its specified antenna in position.
[5] Duty cycle measurements not required. Average time of occupancy measured as EUT is FHSS equipment.
[6] EUT uses FHSS technology and is therefore not applicable to this test.

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	RSS-247, Issue 2	Feb 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
4.1.2	RSS-GEN, Issue 4	November 2014	General Requirements and Information for the Certification of Radio Apparatus
4.1.3	ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
4.1.4	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
4.1.5	KDB 905462 D02	v01r02	COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED-NATIONAL INFORMATION INFRASTRUCTURE DEVICES OPERATING IN THE 5250-5350 MHz AND 5470-5725 MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION

4.2 Deviations

No deviations were applied.

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

Test Requirements: RSS-GEN, Issue 4 Clause 8.8 [Reference 4.1.2 of this report]
Test Method: ANSI C63.10 Clause 6.2 [Reference 4.1.3 of this report]
Limits: RSS-GEN, Issue 4 Clause 8.8 [Reference 4.1.2 of this report]

5.1.2 Configuration of EUT

The EUT was placed on a wooden table 0.8m above the ground plane and connected to a LISN via a 1m mains cable.
Details of the Peripheral and Ancillary Equipment connected for this test is listed in section 11.
The EUT was operated in mode TX4.

5.1.3 Test procedure

Tests were made in accordance with IC RSS-GEN using the measuring equipment noted in the 'Test Equipment' Section. Measurements were made on the live and neutral conductors using both average and quasi-peak detection. At least 6 signals within 20dB and/or all signals within 10dB of the limit were investigated.

Tests were performed in Test Site H.

5.1.4 Test equipment

LPE222, LPE373, ZSW1, E534, E535

See Section 9 for more details

5.1.5 Test results

Temperature of test environment 10°C
Humidity of test environment 38%
Pressure of test environment 102kPa

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Mid channel	915.09375 MHz

Plot refs
9314-4 Cond 1 AC Live 150k-30M Average
9314-4 Cond 1 AC Live 150k-30M Quasi-Peak
9314-4 Cond 1 AC Neutral 150k-30M Average
9314-4 Cond 1 AC Neutral 150k-30M Quasi-Peak

Table of signals measured for Cond 1 AC Live 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.152	52.9	50.9	-15.0	43.8	-12.1
2	0.194	45.9	44.7	-19.2	41.8	-12.1
3	0.240	42.2	41.5	-20.6	37.0	-15.1
4	0.391	35.0	33.8	-24.2	26.8	-21.2
5	0.614	45.6	43.0	-13.0	30.0	-16.0
6	2.470	36.9	33.6	-22.4	26.4	-19.6
7	7.902	30.8	27.2	-32.8	20.7	-29.3

Table of signals measured for Cond 1 AC Neutral 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP Lim (dB)	AV Amp (dBuV)	AV Lim (dB)
1	0.150	52.8	51.8	-14.2	46.1	-9.9
2	0.193	45.9	45.2	-18.7	42.2	-11.7
3	0.242	45.2	44.3	-17.7	40.9	-11.1
4	0.242	45.1	44.4	-17.6	40.9	-11.1
5	0.549	48.6	46.4	-9.6	32.2	-13.8
6	0.591	46.5	45.5	-10.5	38.5	-7.5
7	0.627	47.2	46.2	-9.8	39.0	-7.0
8	1.315	41.3	38.6	-17.4	29.7	-16.3
9	6.631	37.1	33.8	-26.2	27.7	-22.3

No discernible difference was noted in emissions between channels (exploratory measurements); therefore the final measurements are presented for TX mid channel mode only.

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
RSS GEN clause 8.8 Table 3. Given in the above tables / drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:

150kHz to 30MHz ±3.6dB.

5.2 TX Unwanted radiated emissions 9-150 kHz

NOT APPLICABLE: Spectrum below 30MHz started at a frequency of 150 kHz up to a frequency of 30MHz based on the lowest signal generated/used within the equipment as declared by the applicant of 26MHz.

5.3 TX Unwanted radiated emissions 150 kHz-30 MHz

5.3.1 Test methods

Test Requirements:	RSS-247, Issue 2 Clause 5.5 [Reference 4.1.1 of this report], RSS-GEN, Issue 4 Clause 6.13 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.3 of this report]
Limits:	RSS-GEN, Issue 4 Clause 8.9 [Reference 4.1.2 of this report]

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was operated in its normal use position. Radiated Emissions testing was performed whilst powered using the mains power supply. The EUT was operated in TX1, TX2 and TX3 modes.

5.3.3 Test procedure

Tests were made in accordance with RSS-GEN using the measuring equipment listed below.

Measurements were made in a semi-anechoic chamber without a ground plane. The antenna was placed 1m above the ground. The equipment and the antenna were rotated 360 degrees to record the worst case emissions.

No signals were found in this test range within 20dB of the limits.

Tests were performed using Test Site H.

5.3.4 Test equipment

TMS81, TMS45, ZSW1, E534, E535

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	10°C
Humidity of test environment	37%
Pressure of test environment	102kPa

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Low channel	902.4 MHz

Plot refs
9314-4 Rad 1 150k-30MHz Para
9314-4 Rad 1 150k-30MHz Perp

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Mid channel	915.09375 MHz

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
High channel	927.7875 MHz

Note: Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Middle channel plots are shown in this report.

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
RSS-Gen limits as given in the above tables / drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: ±3.9dB

5.4 TX Unwanted radiated emissions 30 MHz-1 GHz

5.4.1 Test methods

Test Requirements:	RSS-247, Issue 2 Clause 5.5 [Reference 4.1.1 of this report], RSS-GEN, Issue 4 Clause 6.13 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.10 Clause 6.5 [Reference 4.1.3 of this report]
Limits:	RSS-GEN, Issue 4 Clause 8.9 [Reference 4.1.2 of this report]

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was operated in its normal use position. Radiated Emissions testing was performed whilst EUT was powered using the mains power supply. The EUT was operated in TX1, TX2 and TX3 modes.

5.4.3 Test procedure

Tests were made in accordance with RSS-247 & RSS-GEN using the measuring equipment listed below.

Measurements were made on a site listed with IC. The equipment was rotated 360 degrees and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions. At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site H.

5.4.4 Test equipment

LPE364, TMS45, ZSW1, E411

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	12°C
Humidity of test environment	35 - 38%
Pressure of test environment	102kPa

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Low channel	902.4 MHz

Plot refs
9314-4 Rad 1 VHF Horiz
9314-4 Rad 1 VHF Vert
9314-4 Rad 1 UHF Horiz
9314-4 Rad 1 UHF Vert

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Mid channel	915.09375 MHz

Plot refs
9314-4 Rad 2 VHF Horiz
9314-4 Rad 2 VHF Vert
9314-4 Rad 2 UHF Horiz
9314-4 Rad 2 UHF Vert

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
High channel	927.7875 MHz

Plot refs
9314-4 Rad 3 VHF Horiz
9314-4 Rad 3 VHF Vert
9314-4 Rad 3 UHF Horiz
9314-4 Rad 3 UHF Vert

Table of signals measured for Rad 1 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	30.967	27.5	21.0	-19.0
2	170.093	32.3	29.5	-14.0
3	249.997	34.7	32.5	-13.5
4	266.400	34.9	30.6	-15.4
5	307.138	34.3	30.6	-15.4
6	349.996	33.7	31.0	-15.0
7	449.994	35.2	31.8	-14.2

Note: all signals in above table are generic and are present regardless of channel setting. See below for specific channel Radio related emissions.

Table of signals measured for Rad 1 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	34.019	36.3	33.0	-7.0
2	35.963	32.3	28.8	-11.2
3	37.908	33.2	29.6	-10.4
4	193.424	31.7	28.6	-14.9
5	249.997	34.3	32.4	-13.6
6	349.996	36.5	34.3	-11.7

Note: all signals in above table are generic and are present regardless of channel setting. See below for specific channel Radio related emissions.

Table of signals measured for Low channel 902.4 MHz Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	451.200	41.5	40.2	-5.8

Table of signals measured for Middle channel 915.09375 MHz Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	457.550	40.8	39.3	-6.7

Table of signals measured for High channel 927.7875 MHz Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	463.890	39.9	38.0	-8.0

Table of signals measured for Low channel 902.4 MHz Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	104.000	35.6	33.7	-9.8
2	451.250	43.2	42.0	-4.0
3	798.400	43.9	41.8	-4.2
4	832.000	46.8	45.0	-1.0

Table of signals measured for Middle channel 915.09375 MHz Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	457.550	42.2	41.1	-4.9
2	837.100	41.5	38.8	-7.2
3	858.000	44.9	42.3	-3.7

Table of signals measured for High channel 927.7875 MHz Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP Lim (dB)
1	463.890	42.8	41.6	-4.4
2	849.790	42.8	40.0	-6.0
3	858.000	43.3	41.1	-4.9

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

LIMITS:
RSS-Gen limits as given in the above tables / drawn on the respective plots.

These results show that the EUT has PASSED this test.
The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:

30MHz - 1000MHz ±6.1dB

5.5 TX Unwanted radiated emissions above 1 GHz

5.5.1 Test methods

Test Requirements:	RSS-247, Issue 2 Clause 5.5 [Reference 4.1.1 of this report], RSS-GEN, Issue 4 Clause 6.13 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.10 Clause 6.6 [Reference 4.1.3 of this report]
Limits:	RSS-GEN, Issue 4 Clause 8.9 [Reference 4.1.2 of this report]

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was operated in its normal use position. Radiated Emissions testing was performed whilst EUT was powered using the mains power supply.

The EUT was operated in TX1, TX2 and TX3 modes.

5.5.3 Test procedure

Tests were made in accordance with RSS-247 & RSS-GEN using the measuring equipment listed below.

Measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. Horn antennas were used at heights where the whole of the EUT was contained within the main beam. The EUT was rotated through 360 degrees to record the worst case emissions. A measurement distance of 3m was used between the test range 1 - 6GHz, 1.2m was used in the test range 6 -18 GHz.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site H.

5.5.4 Test equipment

E429, E478, E534, E535, LPE261, LPE333, TMS78, TMS79

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	14°C
Humidity of test environment	44%
Pressure of test environment	103kPa

Setup Table

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Low channel	902.4 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1804.8	48	-61.5	43.6	-55.9	Upright	Vertical
1804.8	47.9	-61.6	43.8	-55.7	Upright	Horizontal
2707.2	53.1	-20.9	49.8	-4.2	Upright	Vertical
2707.2	51.1	-22.9	47.3	-6.7	Upright	Horizontal
3609.6	53.4	-20.6	49.1	-4.9	Upright	Vertical
10583.0	43.0	-66.5	43	-56.5	Upright	Horizontal

Setup Table

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Mid channel	915.09375 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1050.14	47	-27	38.7	-15.3	Upright	Vertical
1830.1875	48.9	-60.6	45.4	-54.1	Upright	Vertical
1830.1875	45.3	-64.2	39.5	-60	Upright	Horizontal
2745.28125	52.6	-21.4	49.6	-4.4	Upright	Vertical
2745.28125	48.9	-25.1	43.7	-10.3	Upright	Horizontal
3660.375	52.6	-21.4	48.2	-5.8	Upright	Vertical
3660.375	52.7	-21.3	48.4	-5.6	Upright	Horizontal
4575.46875	50	-24	41.7	-12.3	Upright	Vertical
5490.5625	60.3	-49.2	57.9	-41.6	Upright	Vertical
5490.5625	54.1	-55.4	49	-50.5	Upright	Horizontal
10583.0	43.0	-66.5	43	-56.5	Upright	Horizontal

Plots
9314-4 Mid chan 1-3 GHz horiz
9314-4 Mid chan 1-3 GHz vert
9314-4 Mid chan 3-5 GHz horiz
9314-4 Mid chan 3-5 GHz vert
9314-4 Mid chan 5-6 GHz horiz
9314-4 Mid chan 5-6 GHz vert
9314-4 Mid chan 6-7.8 GHz horiz
9314-4 Mid chan 6-7.8 GHz vert
9314-4 Mid chan 7.8-10 GHz horiz
9314-4 Mid chan 7.8-10 GHz vert
9314-4 Mid chan 10-12.5 GHz horiz
9314-4 Mid chan 10-12.5 GHz vert
9314-4 Mid chan 12-15 GHz horiz
9314-4 Mid chan 12-15 GHz vert
9314-4 Mid chan 15-18 GHz horiz
9314-4 Mid chan 15-18 GHz vert
9314-4 Mid chan 18-20 GHz horiz
9314-4 Mid chan 18-20 GHz vert

Setup Table

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
High channel	927.7875 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1855.575	44.9	-64.6	37.6	-61.9	Upright	Vertical
1855.575	44.9	-64.6	37.6	-61.9	Upright	Horizontal
2783.3625	47.8	-26.2	41.2	-12.8	Upright	Vertical
2783.3625	47.8	-26.2	41.2	-12.8	Upright	Horizontal
3711.15	54.2	-19.8	50	-4	Upright	Vertical
3711.15	54.2	-19.8	50.3	-3.7	Upright	Horizontal
4638.9375	47.4	-26.6	35.1	-18.9	Upright	Vertical
4638.9375	51.9	-22.1	44.7	-9.3	Upright	Horizontal
10583.0	43.0	-66.5	43	-56.5	Upright	Horizontal

Peak detector “Max held” Analyser plots against the Average limit line can be found in Section 6 of this report.

Note: Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

LIMITS:
RSS-Gen limits as given in the above tables / drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
1 – 18 GHz ±3.5dB

5.6 Transmitter output power - E.I.R.P

NOT TESTED: The EUT was tested for PK conducted power and known antenna gain was applied. Please refer to section 5.9 within this report for compliance details.

5.7 TX Unwanted emissions - Band edge compliance

5.7.1 Test methods

Test Requirements:	RSS-247, Issue 2 Clause 5.5 [Reference 4.1.1 of this report], RSS-GEN, Issue 4 Clause 8.10 [Reference 4.1.2 of this report]
Test Method:	RSS-GEN, Issue 4 Clause 6.13 [Reference 4.1.2 of this report], ANSI C63.10 Clause 6.10 [Reference 4.1.3 of this report]
Limits:	RSS-GEN, Issue 4 Clause 8.9 & 8.10 [Reference 4.1.2 of this report]

5.7.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres.

The EUT was operated in TX1 and TX3 and TX4 modes.

5.7.3 Test procedure

Tests were made in accordance with RSS-247 & RSS-GEN using the measuring equipment noted below. The emission from the EUT was maximised before taking the plots. Both hopping and non-hopping modes were tested.

Tests were performed using Test Site H.

5.7.4 Test equipment

E328, E411, E624, LPE364, TMS45

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	14°C
Humidity of test environment	42%
Pressure of test environment	103kPa

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Low channel	902.4 MHz
High channel	927.7875 MHz

Restricted Band Edge	Low Channel	High Channel
Peak Level (dBµV/m)	49.3	43.6
Peak Plot reference	9314-4 Low channel upper rest band edge fixed	9314-4 Top channel upper rest band edge fixed
Average Level (dBµV/m)	Peak below average limit	Peak below average limit
Average Plot reference	See peak plot	See peak plot

Authorised Band Edge	Low Channel	High Channel
Authorised Band Edge Plot reference	9314-4 Low channel lower Authorised band edge fixed	9314-4 Top channel upper Authorised band edge fixed

Note: No difference was observed between hopping and non-hopping (fixed) modes of operation for either restricted band edge emissions or authorised band edge emissions.

Analyser plots for the Band Edge Compliance can be found in Section 6 of this report. Additional Restricted band edge plots are also shown in section 6 and radiated emissions sections.

LIMITS:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 3.5 dB

5.8 20dB bandwidth

5.8.1 Test methods

Test Requirements:	RSS-247, Issue 2 Clause 5.1 [Reference 4.1.1 of this report]
Test Method:	RSS-GEN, Issue 4 Clause 6.6 [Reference 4.1.2 of this report], ANSI C63.10 Clause 6.9 [Reference 4.1.3 of this report]
Limits:	RSS-247, Issue 2 Clause 5.1 [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was tested whilst connected to the AC power for maximised emissions. The EUT was operated in TX1, TX2 and TX3 modes.

5.8.3 Test procedure

Tests were made in accordance with RSS-247 & RSS-GEN using the measuring equipment listed below. A 51 Hz RBW, 3x VBW, auto sweep time and max hold settings were used for the 20dB bandwidth.

Tests were performed using Test Site H.

5.8.4 Test equipment

E534, E535, LPE364, TMS45

See Section 9 for more details

5.8.5 Test results

Temperature of test environment	22°C
Humidity of test environment	40%
Pressure of test environment	102kPa

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Low channel	902.4 MHz
Mid channel	915.09375 MHz
High channel	927.7875 MHz

	Low	Mid	High
20 dB Bandwidth (kHz)	1.114	1.126	1.094
Plot reference	9314-4 Low channel OOB	9314-4 Mid channel OOB	9314-4 Top channel OOB

Analyser plots for the 20 dB bandwidth can be found in Section 6 of this report.

LIMITS:
For FHSs in the band 902-928 MHz - The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

5.9 Transmitter output power conducted - maximum peak

5.9.1 Test methods

Test Requirements: RSS-247, Issue 2 Clause 5.4 [Reference 4.1.1 of this report]
Test Method: RSS-GEN, Issue 4 Clause 6.12 [Reference 4.1.2 of this report]
Limits: RSS-247, Issue 2 Clause 5.4 [Reference 4.1.1 of this report]

5.9.2 Configuration of EUT

The EUT was measured on a bench using a power meter connected to the external RF port.

The EUT was set to each mode and (see section 2.4) and highest power levels recorded.

The EUT was operated in TX1, TX2 and TX3 modes for this test.

5.9.3 Test procedure

Tests were made in accordance with RSS-247 using the measuring equipment listed below.

Power meter reading stated is maximum power observed using a Peak power head.
Measurements were made on a test bench in site H.

5.9.4 Test equipment

E313, E611

See Section 9 for more details

5.9.5 Test results

Temperature of test environment	21°C
Humidity of test environment	30%
Pressure of test environment	104kPa

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Low channel	902.4 MHz
Mid channel	915.09375 MHz
High channel	927.7875 MHz

Test conditions	Peak Power (dBm)	Peak Power (dBm)	Peak Power (dBm)
	Low Channel (dBm)	Mid Channel (dBm)	High Channel (dBm)
Maximum TX Power observed (dBm)	27.50	27.70	27.60
Variation in TX Power observed (dB)	-0.50	-0.30	-0.40

EUT is declared to operate with 8dBi antenna gains by the Applicant. The maximum EIRP is therefore calculated as +35.7dBm (3.715 W)

LIMITS:

For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W (+30dBm) and the EIRP shall not exceed 4 watts (+36dBm) when 50 or more hopping channels are used. When less than 50 hopping channels are used the maximum peak conducted output power shall not exceed 0.25 W.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: <± 1.0 dB.

5.10 DTSs Transmitter output power conducted - maximum Average

NOT APPLICABLE: The EUT was tested for PK conducted power and known antenna gain was applied.

5.11 TX unwanted emissions - Antenna port RF conducted emissions

NOT APPLICABLE: The EUT was tested for radiated emissions with its specified antenna in position.

5.12 DTSs - TX Duty cycle (Pulsed operation)

NOT APPLICABLE: Duty cycle measurements not required. Average time of occupancy measured as EUT is FHSS equipment.

5.13 DTSs - Power spectral density

NOT APPLICABLE: EUT uses FHSs technology and is therefore not applicable to this test.

5.14 FHSs - Number of hop channels

5.14.1 Test methods

Test Requirements: RSS-247, Issue 2 Clause 5.1(c) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 7.8.3 [Reference 4.1.3 of this report]
Limits: RSS-247, Issue 2 Clause 5.1(c) [Reference 4.1.1 of this report]

5.14.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. Ambient conditions were monitored. The EUT was operated in TX4 mode for this test.

5.14.3 Test procedure

Tests were made using the measuring equipment noted in the 'Test Equipment' Section at Site H. With the EUT hopping, a suitable span was set on the spectrum analyser to show clearly over a range of plots the number of channels being used by the EUT. The analyser was set to Peak detector and max held and the trace was allowed to stabilise for each plot.

5.14.4 Test equipment

E534, E535, LPE364, TMS45, E412, E306

See Section 9 for more details

5.14.5 Test results

Temperature of test environment	16°C
Humidity of test environment	40-44%
Pressure of test environment	102kPa

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Single channel	Hopping

No of hopping Channels	59
Minimum No. Required number by specification	50
Plot of Hopping Channels 902-903.9 MHz	9314-4 Hopping channels sub band A
Plot of Hopping Channels 903.9-905.4 MHz	9314-4 Hopping channels sub band B
Plot of Hopping Channels 905.4-906.95 MHz	9314-4 Hopping channels sub band C
Plot of Hopping Channels 906.95-908.45 MHz	9314-4 Hopping channels sub band D
Plot of Hopping Channels 908.45-910.475 MHz	9314-4 Hopping channels sub band E
Plot of Hopping Channels 910.475-912 MHz	9314-4 Hopping channels sub band 0
Plot of Hopping Channels 912-913.525 MHz	9314-4 Hopping channels sub band 1
Plot of Hopping Channels 913.525-915.05 MHz	9314-4 Hopping channels sub band 2
Plot of Hopping Channels 915.05-916.575 MHz	9314-4 Hopping channels sub band 3
Plot of Hopping Channels 916.575-918.1 MHz	9314-4 Hopping channels sub band 4

Plot of Hopping Channels 918.1-919.625 MHz	9314-4 Hopping channels sub band 5
Plot of Hopping Channels 919.625-921.725 MHz	9314-4 Hopping channels sub band 6
Plot of Hopping Channels 921.725-923.25 MHz	9314-4 Hopping channels sub band 7
Plot of Hopping Channels 923.25-924.775 MHz	9314-4 Hopping channels sub band 8
Plot of Hopping Channels 924.775-926.3 MHz	9314-4 Hopping channels sub band 9
Plot of Hopping Channels 926.3-928 MHz	9314-4 Hopping channels sub band 10

Note: EUT can use one of any of the 16 subsets (groups) of 59 channels. Each subset has been tested to show the 59 channels in each one.

Analyser plots showing the number of hopping channels can be found in Section 6 of this report.

LIMITS:
For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: <± 1.9 %

5.15 FHSs - Average time of occupancy

5.15.1 Test methods

Test Requirements: RSS-247, Issue 2 Clause 5.1(c) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 7.8.4 [Reference 4.1.3 of this report]
Limits: RSS-247, Issue 2 Clause 5.1(c) [Reference 4.1.1 of this report]

5.15.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. Ambient conditions were monitored. The EUT was operated in TX4 mode for this test.

5.15.3 Test procedure

Tests were made using the measuring equipment listed in the 'Test Equipment' Section. With the EUT hopping, a suitable sweep time was set on the spectrum analyser in zero span mode centred on a hopping channel. Both the TX time period and the repetition time were measured and plotted for comparison to the limits.

Tests were performed in test site H.

5.15.4 Test equipment

E534, E535, LPE364, TMS45

See Section 9 for more details

5.15.5 Test results

Temperature of test environment 12°C
Humidity of test environment 40%
Pressure of test environment 102kPa

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Single channel	Hopping

Measured Dwell time/pulse width (ms)	385.7
Period time (s)	21
Instances of pulse within period time	1
Average time of occupancy (ms)	385.7
Measured Dwell time/pulse width (ms)	9314-4 910.5 MHz TX time
Period time (s)	9314-4 910.5 MHz occupancy

Analyser plots showing pulse width and period /repetition can be found in Section 6 of this report.

LIMITS:
For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 2.57 ms

5.16 FHSs - Carrier Frequency separation

5.16.1 Test methods

Test Requirements: RSS-247, Issue 2 Clause 5.1(b) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 7.8.2 [Reference 4.1.3 of this report]
Limits: RSS-247, Issue 2 Clause 5.1(b) [Reference 4.1.1 of this report]

5.16.2 Configuration of EUT

The EUT was tested in the chamber with the door open and ambient conditions were monitored. The EUT was operated in TX4 mode.

5.16.3 Test procedure

Tests were made using the measuring equipment listed in the 'Test Equipment' Section. With the EUT hopping, a span was set on the spectrum analyser to show two adjacent channel peaks. The analyser was set to Peak detector and a max held trace, the trace was allowed enough sweeps to stabilise.

Tests were performed in test site H.

5.16.4 Test equipment

E534, E535, LPE364, TMS45

See Section 9 for more details

5.16.5 Test results

Temperature of test environment 12°C
Humidity of test environment 40%
Pressure of test environment 102kPa

Band	902-928 MHz
Power Level	27.5 dBm
Channel Spacing	25 kHz
Mod Scheme	FSK
Single channel	Hopping

	Single
Separation (kHz)	25.0214
Plot of Separation (kHz)	9314-4 Carrier frequency separation

Analyser plots for the carrier separation can be found in Section 6 of this report.

LIMITS:
FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater.

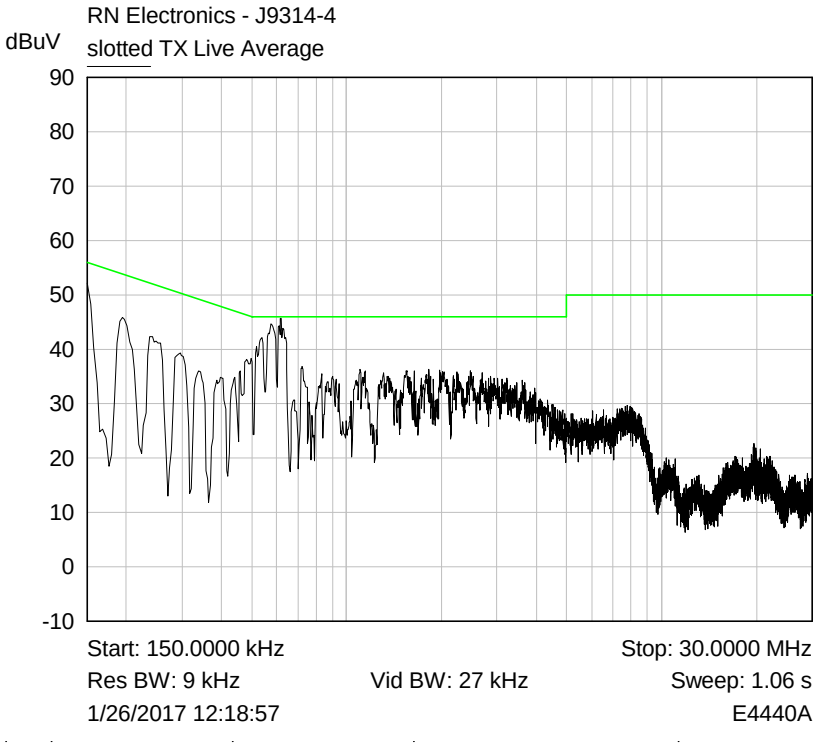
These results show that the EUT has PASSED
this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

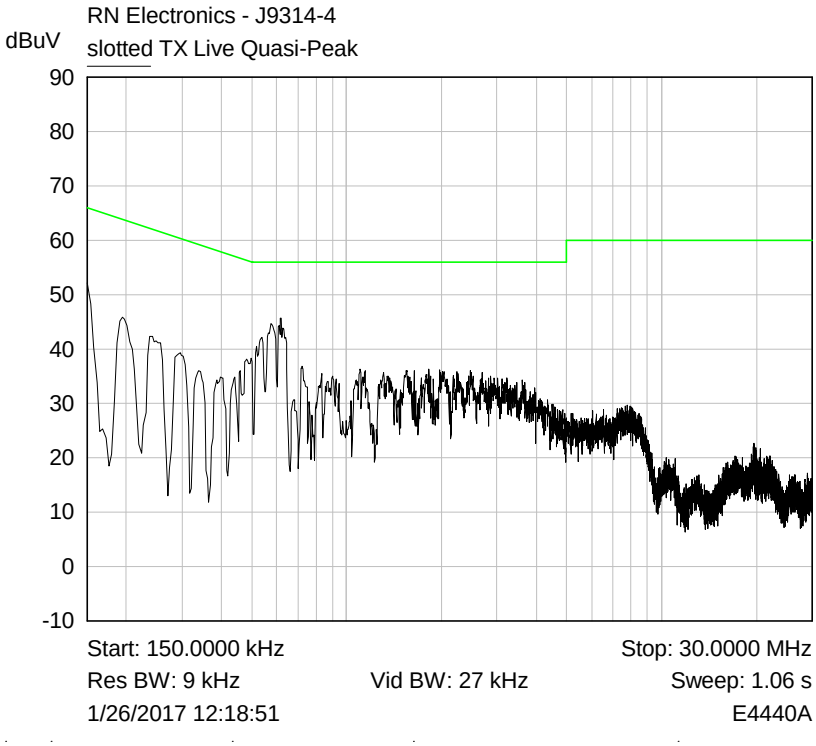
6 Plots/Graphical results

6.1 AC power line conducted emissions

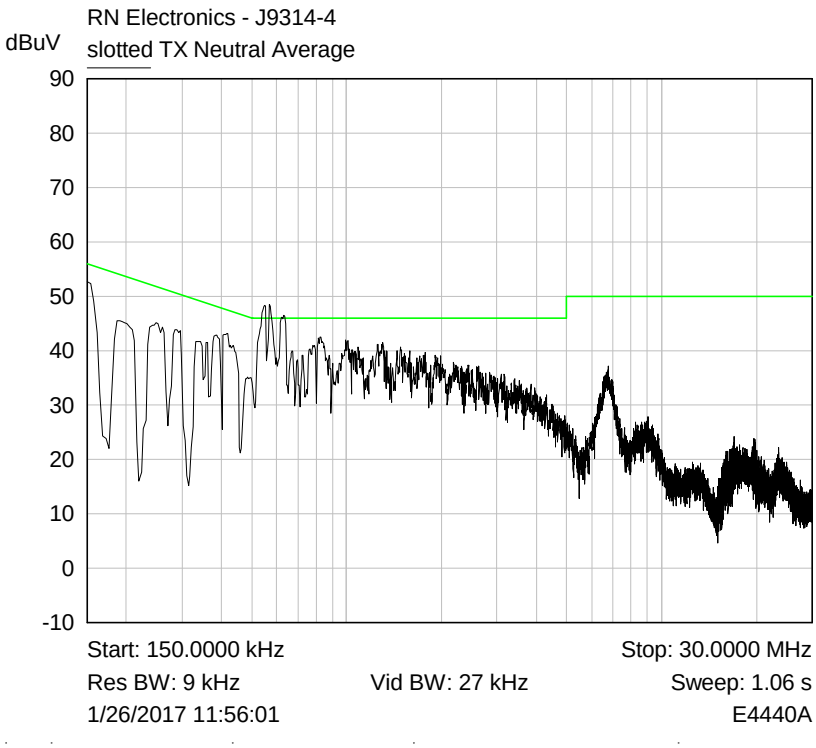
RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 915.09375 MHz



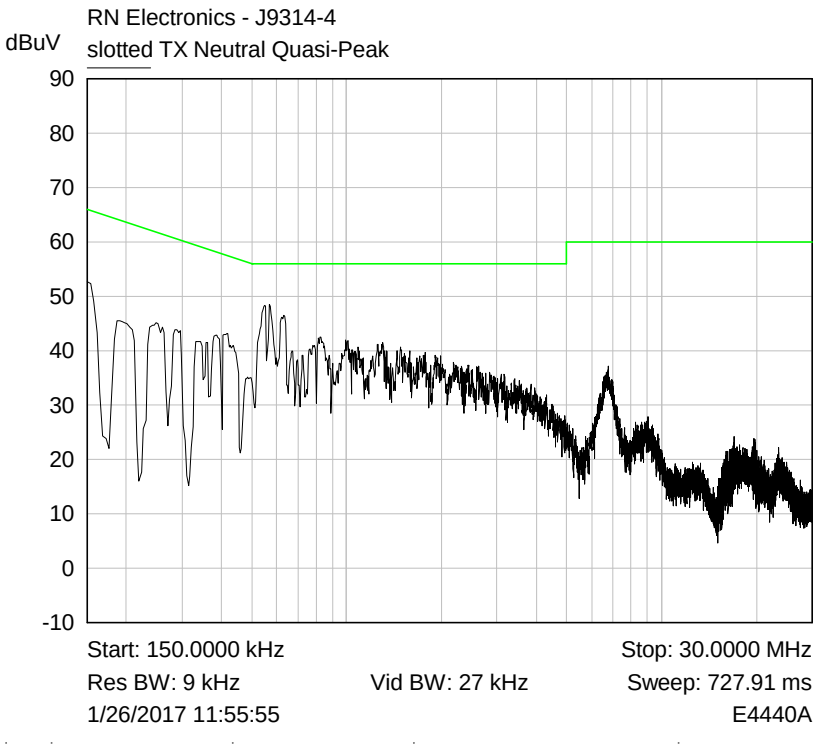
Plot of Live 150k-30M Average



Plot of Live 150k-30M Quasi-Peak



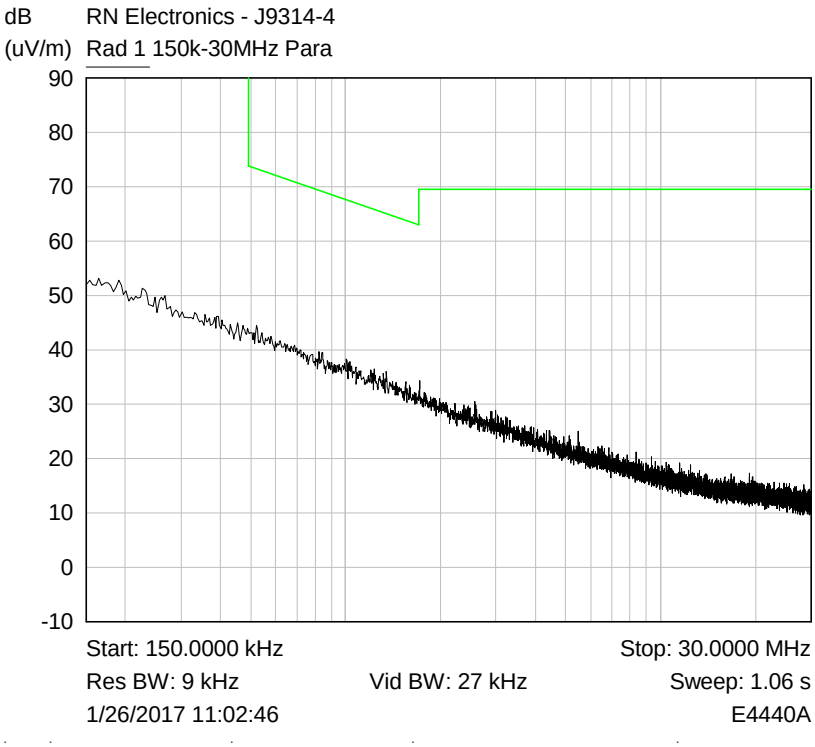
Plot of Neutral 150k-30M Average



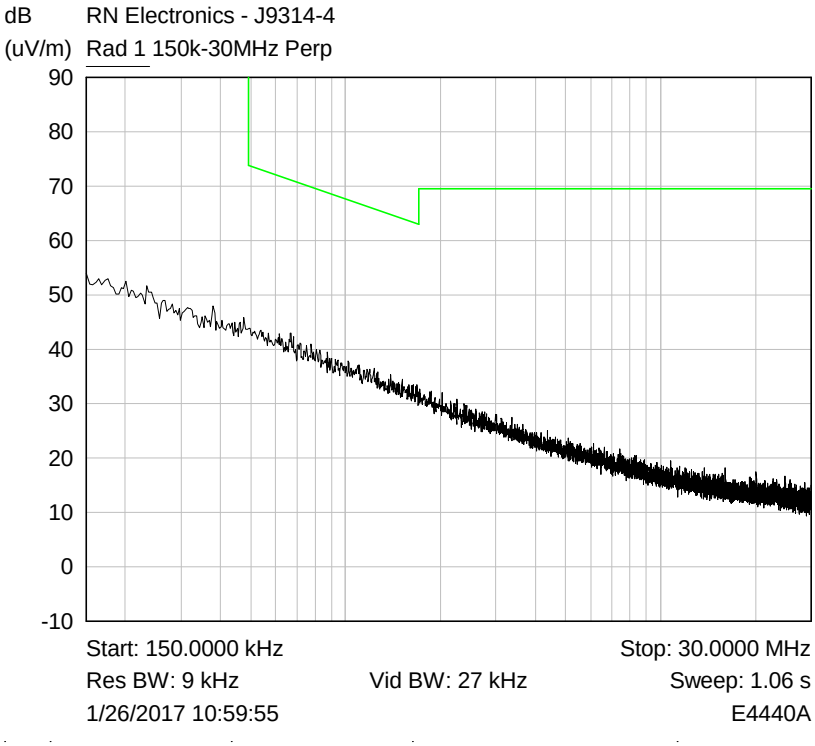
Plot of Neutral 150k-30M Quasi-Peak

6.2 TX Unwanted radiated emissions 150 kHz-30 MHz

RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 902.4 MHz



Plot of 150kHz-30MHz Parallel

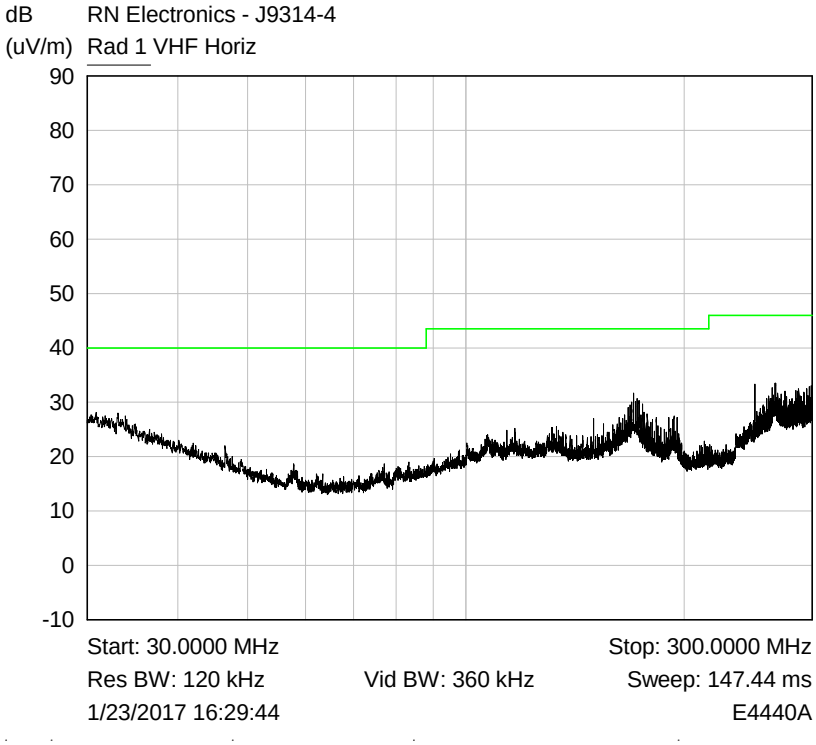


Plot of 150kHz-30MHz Perpendicular

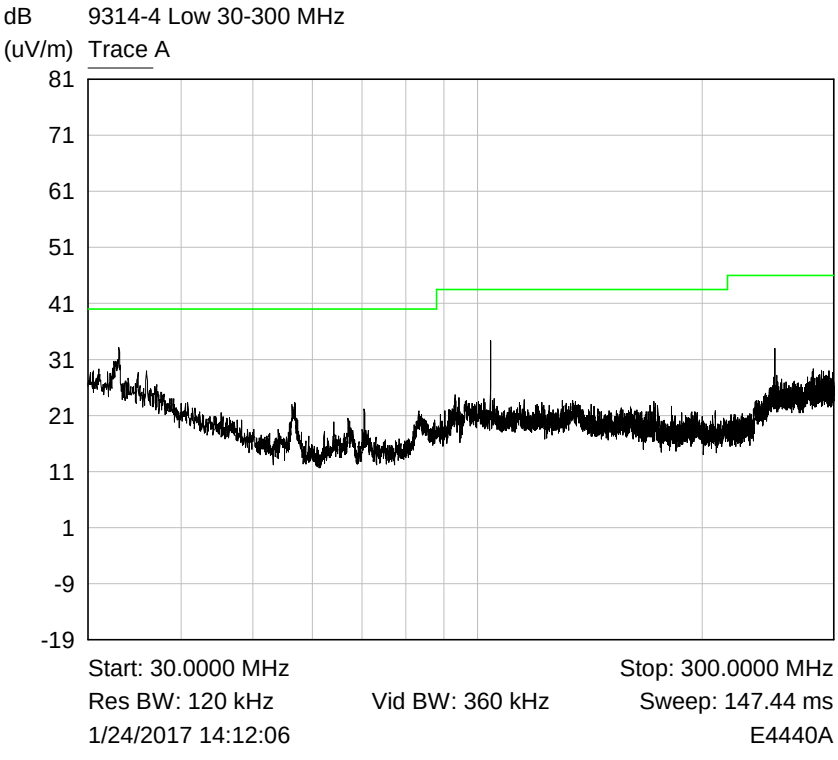
6.3 TX Unwanted radiated emissions 30 MHz-1 GHz

Note: due to differences in emissions between channel settings, plots are shown for Low, Middle and High channels.

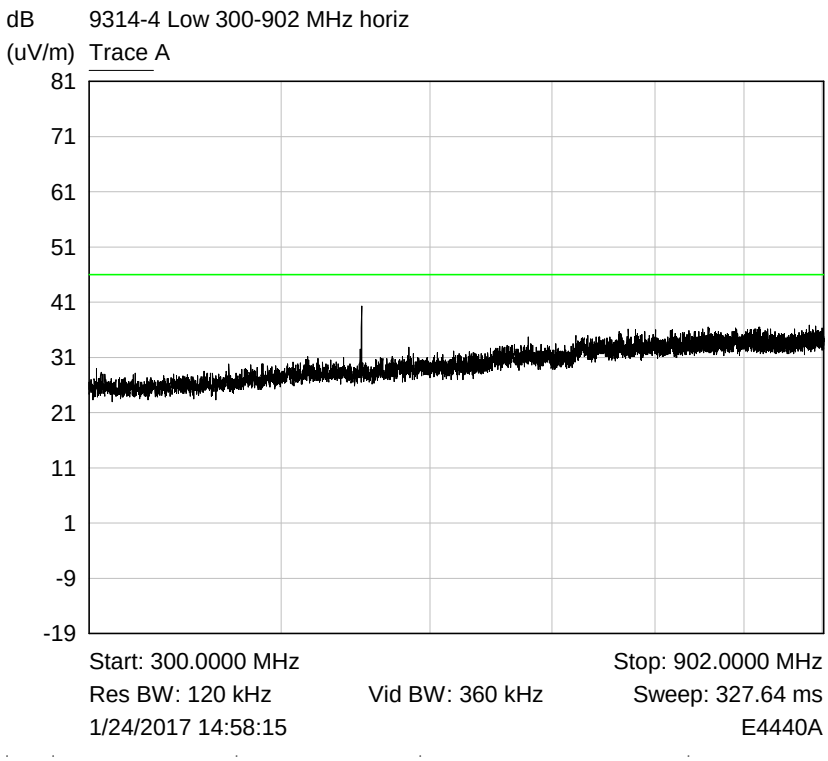
RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 902.4 MHz



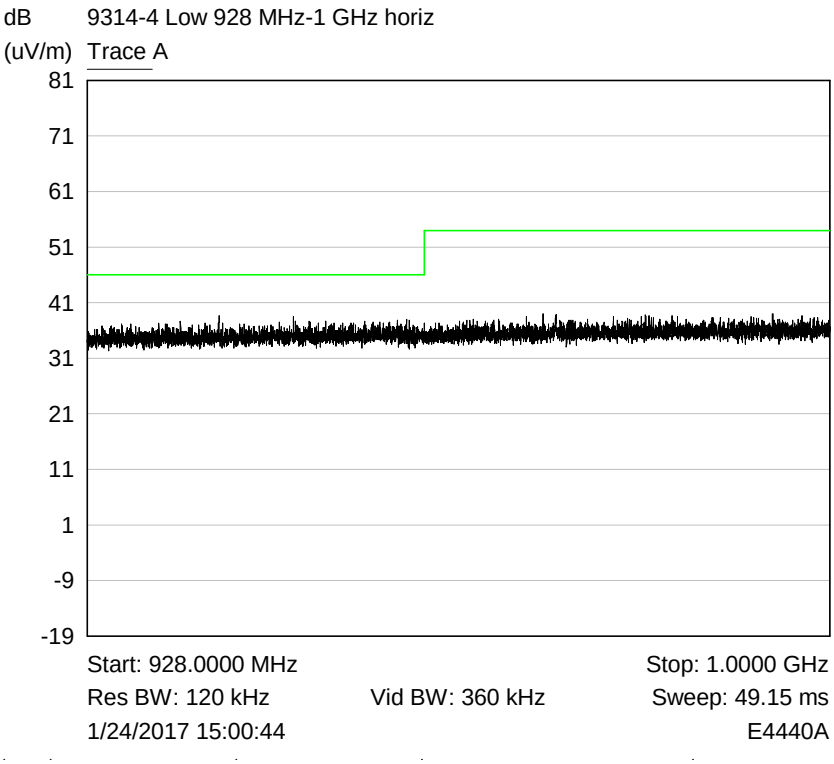
Plot of Peak emissions for VHF Horizontal against the QP limit line.



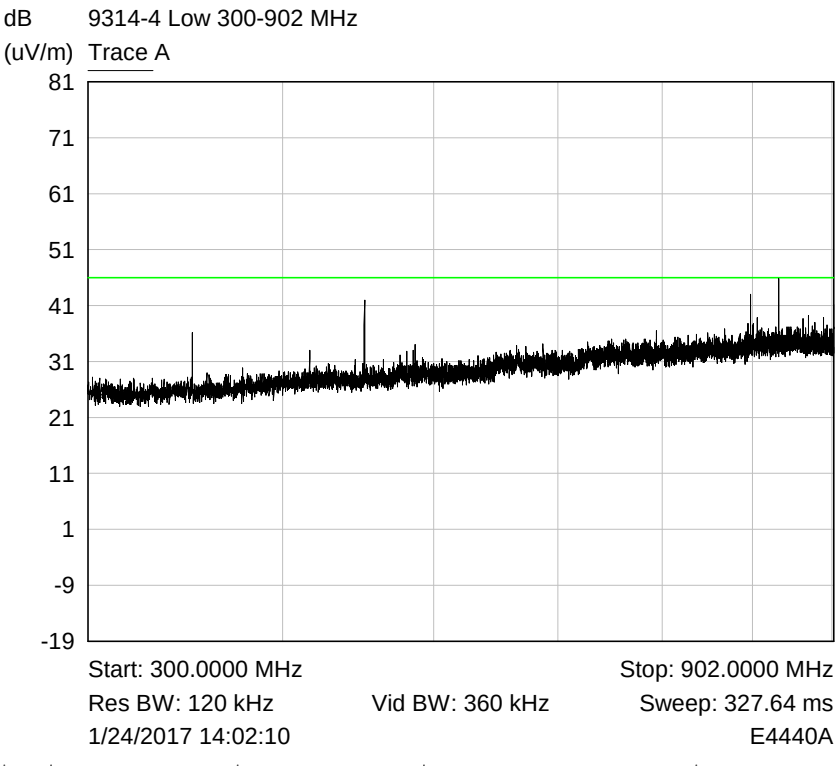
Plot of Peak emissions for VHF Vertical against the QP limit line.



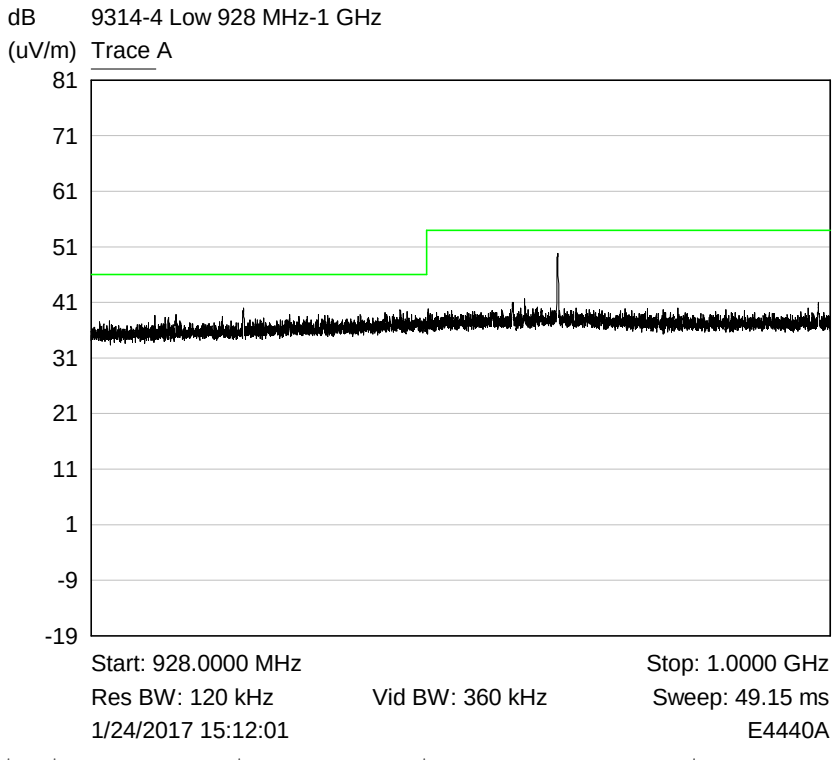
Plot of Peak emissions for 300-902 MHz Horizontal against the QP limit line.



Plot of Peak emissions for 928-1000 MHz Horizontal against the QP limit line.

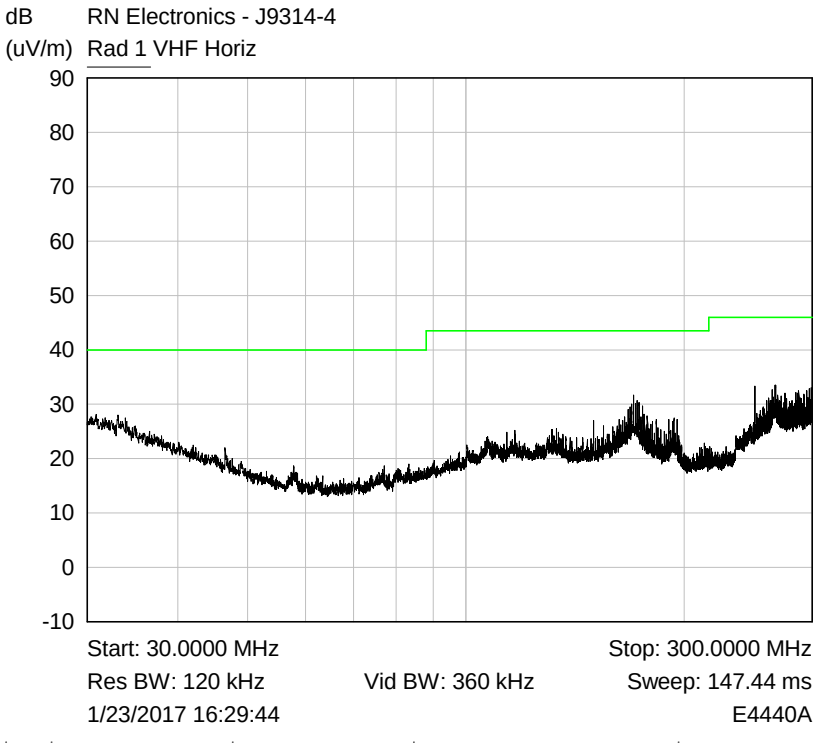


Plot of Peak emissions for 300-902 MHz Vertical against the QP limit line.

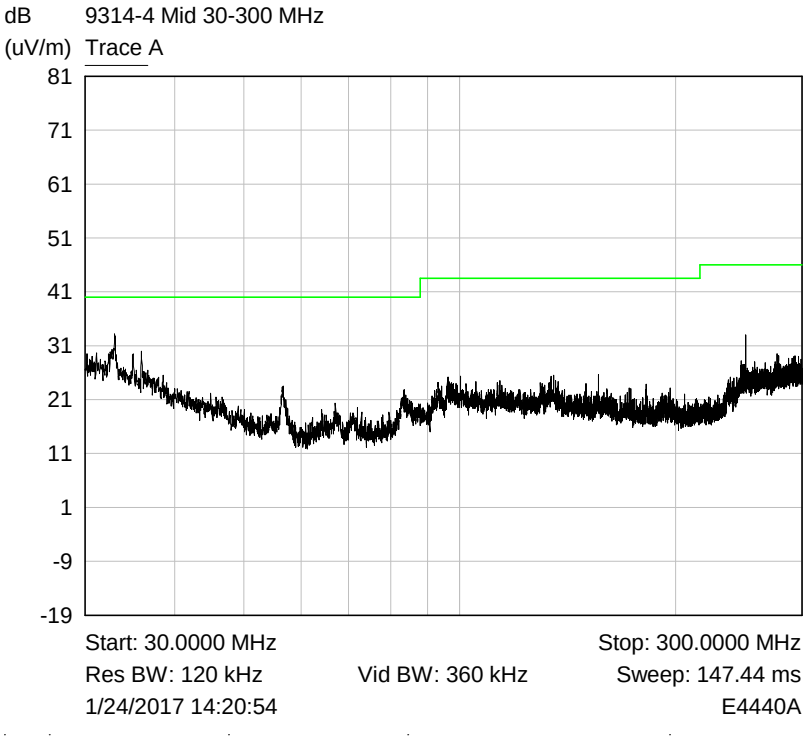


Plot of Peak emissions for 928-1000 MHz Vertical against the QP limit line.

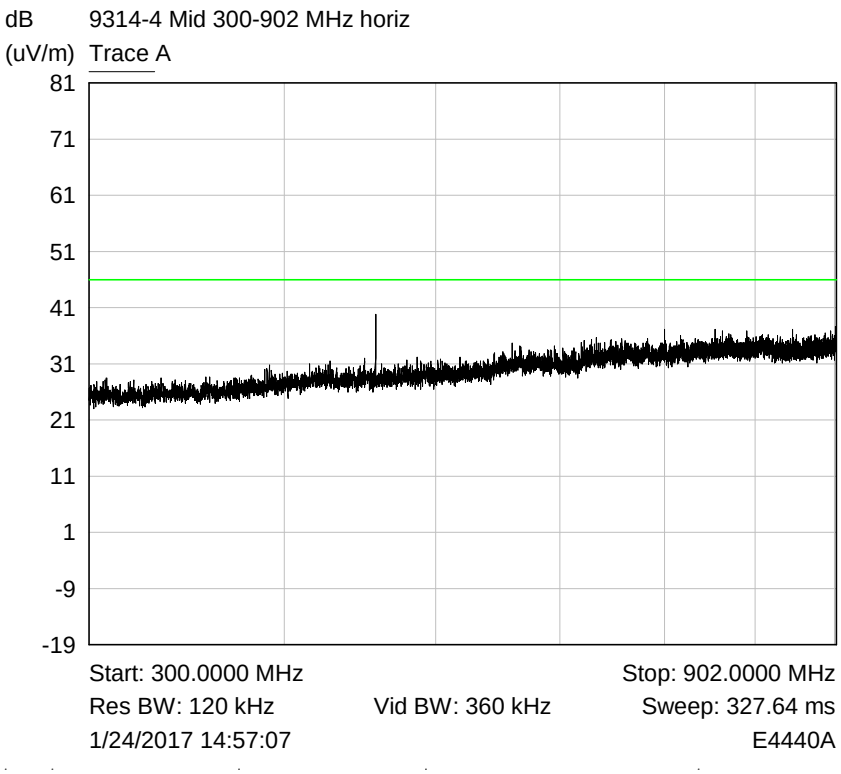
RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 915.09375 MHz



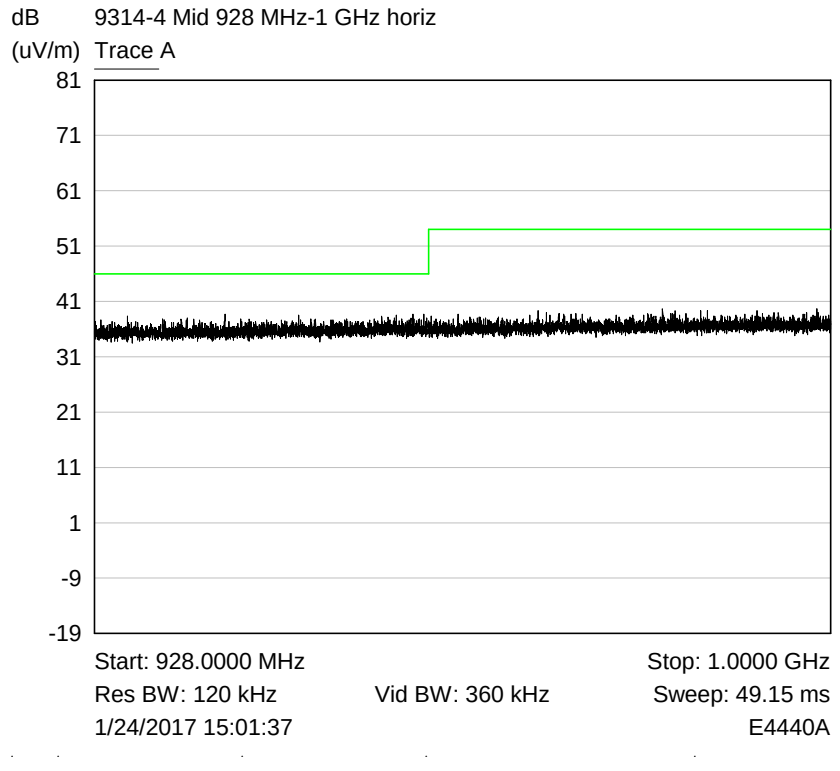
Plot of Peak emissions for VHF Horizontal against the QP limit line.



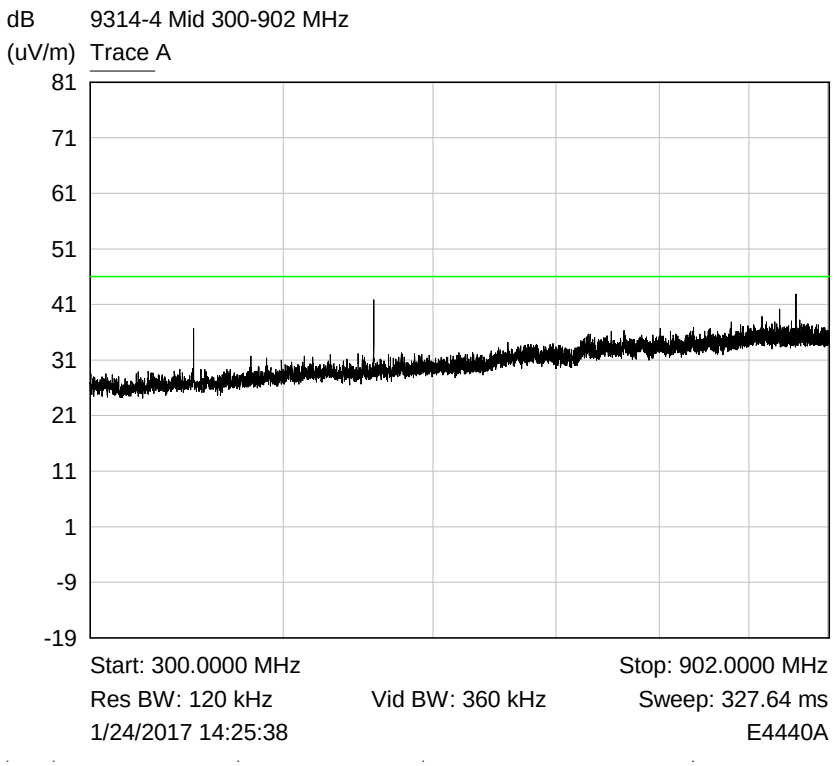
Plot of Peak emissions for VHF Vertical against the QP limit line.



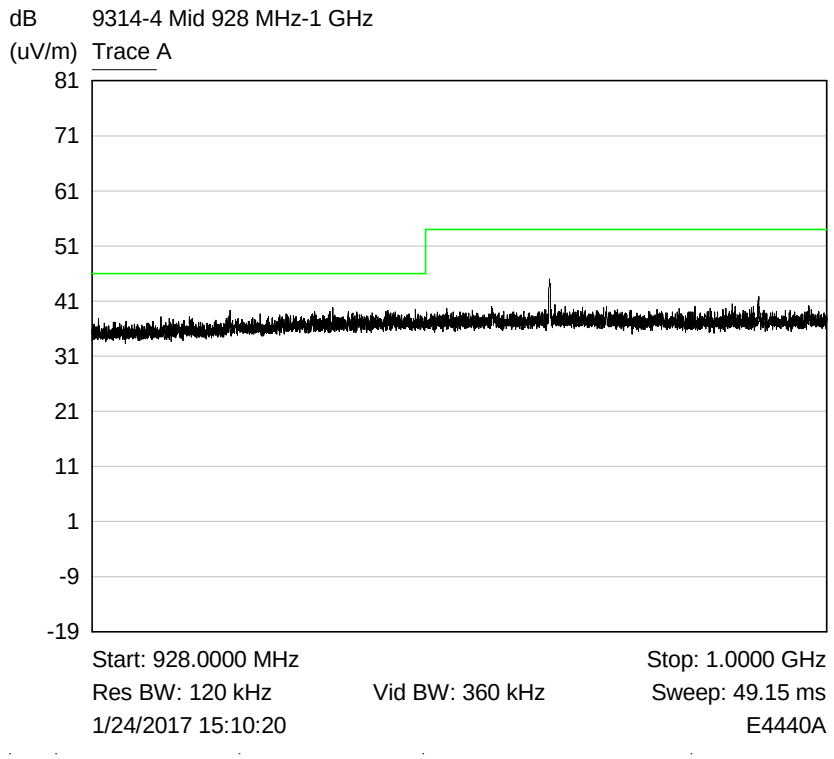
Plot of Peak emissions for 300-902 MHz Horizontal against the QP limit line.



Plot of Peak emissions for 928-1000 MHz Horizontal against the QP limit line.

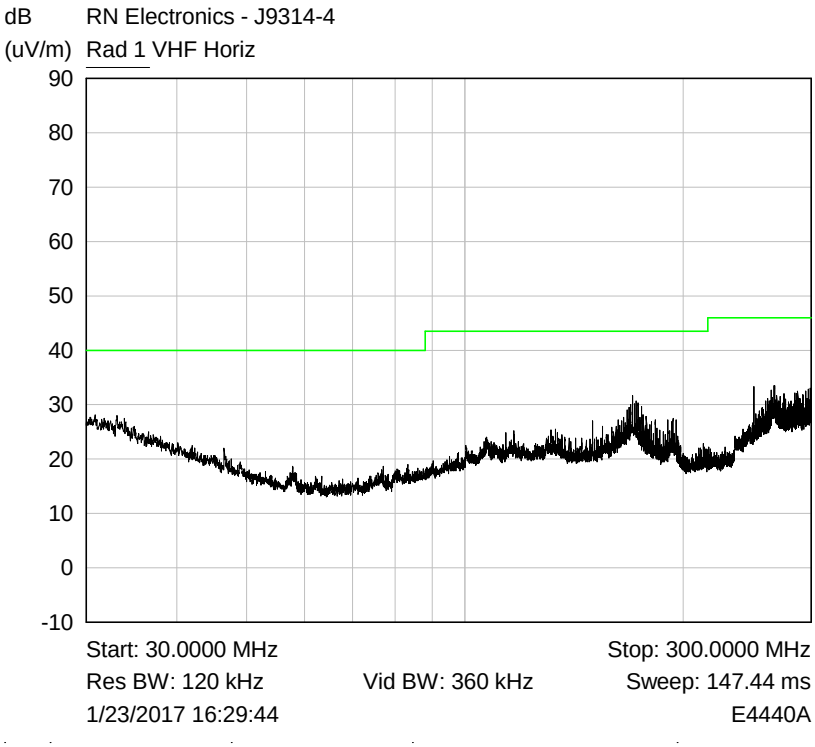


Plot of Peak emissions for 300-902 MHz Vertical against the QP limit line.

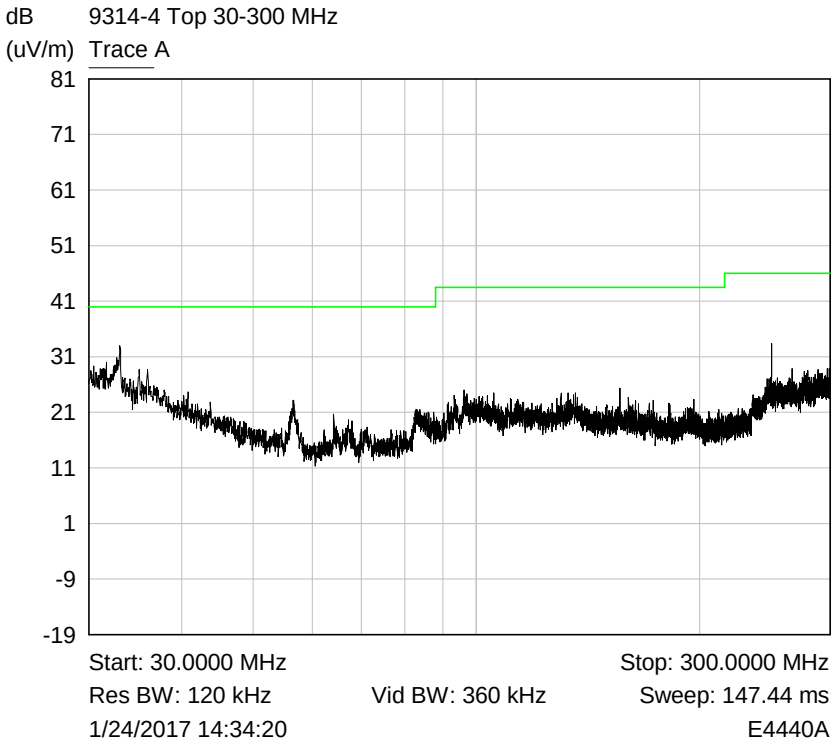


Plot of Peak emissions for 928-1000 MHz Vertical against the QP limit line.

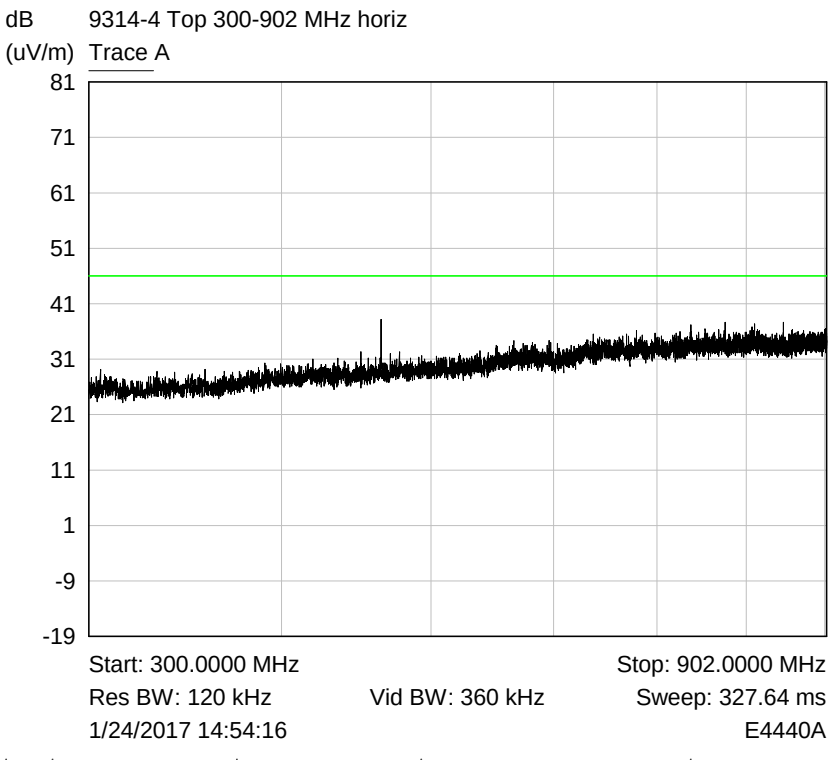
RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 927.7875 MHz



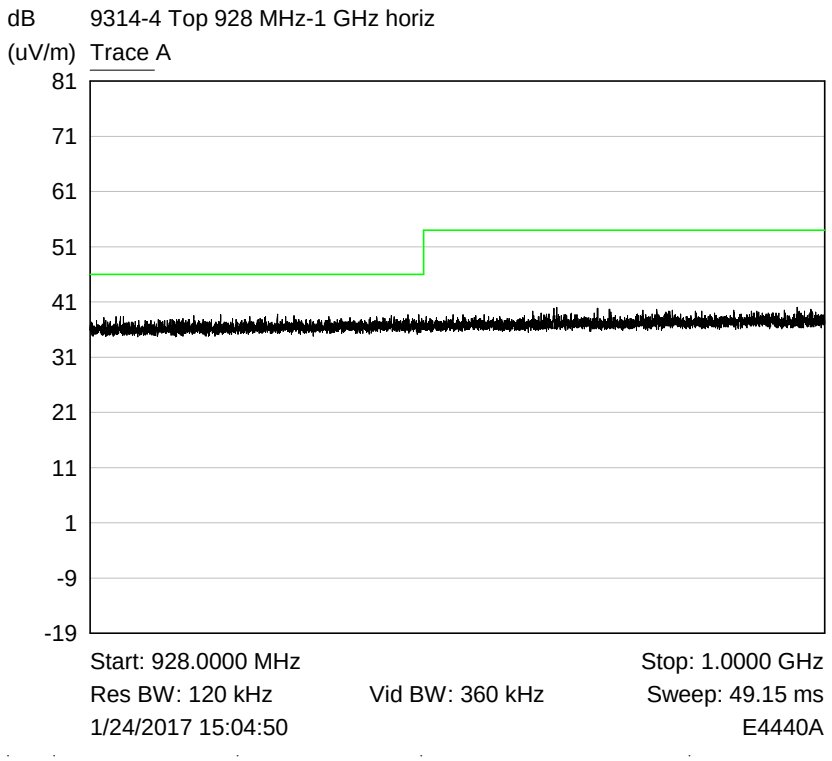
Plot of Peak emissions for VHF Horizontal against the QP limit line.



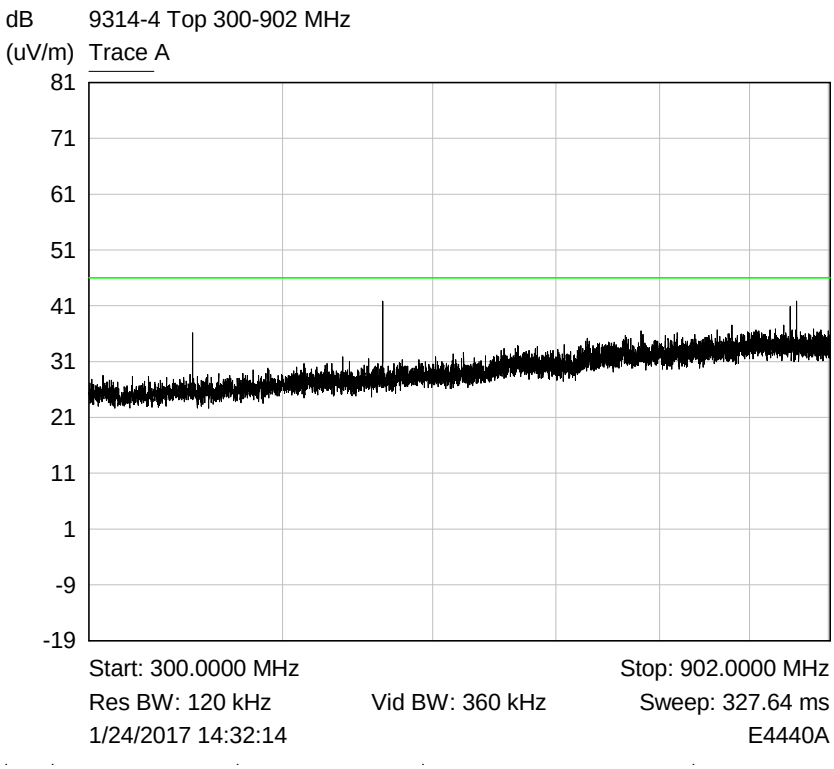
Plot of Peak emissions for VHF Vertical against the QP limit line.



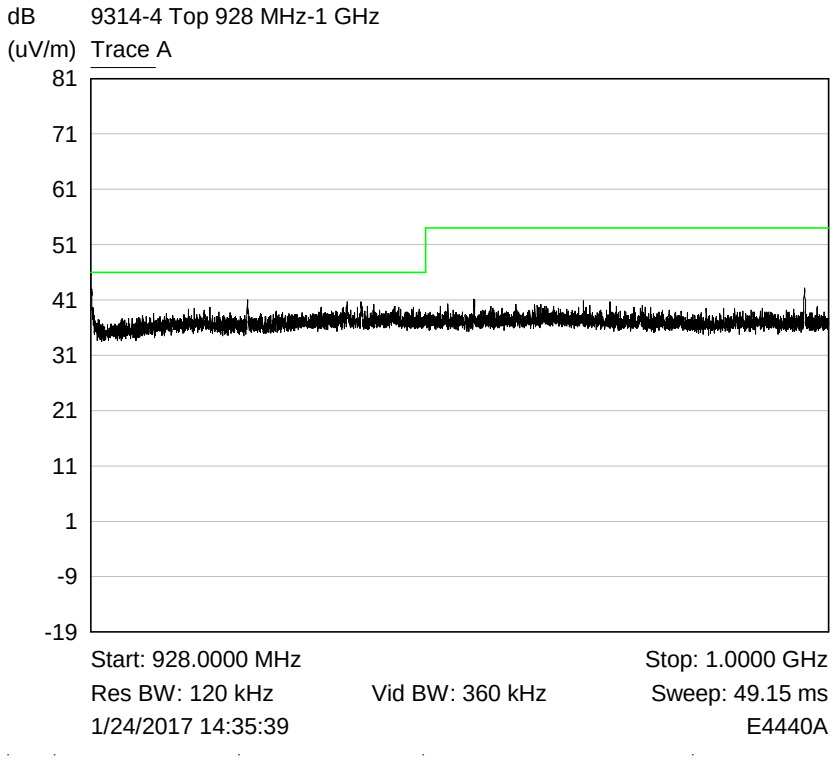
Plot of Peak emissions for 300-902 MHz Horizontal against the QP limit line.



Plot of Peak emissions for 928-1000 MHz Horizontal against the QP limit line.



Plot of Peak emissions for 300-902 MHz Vertical against the QP limit line.

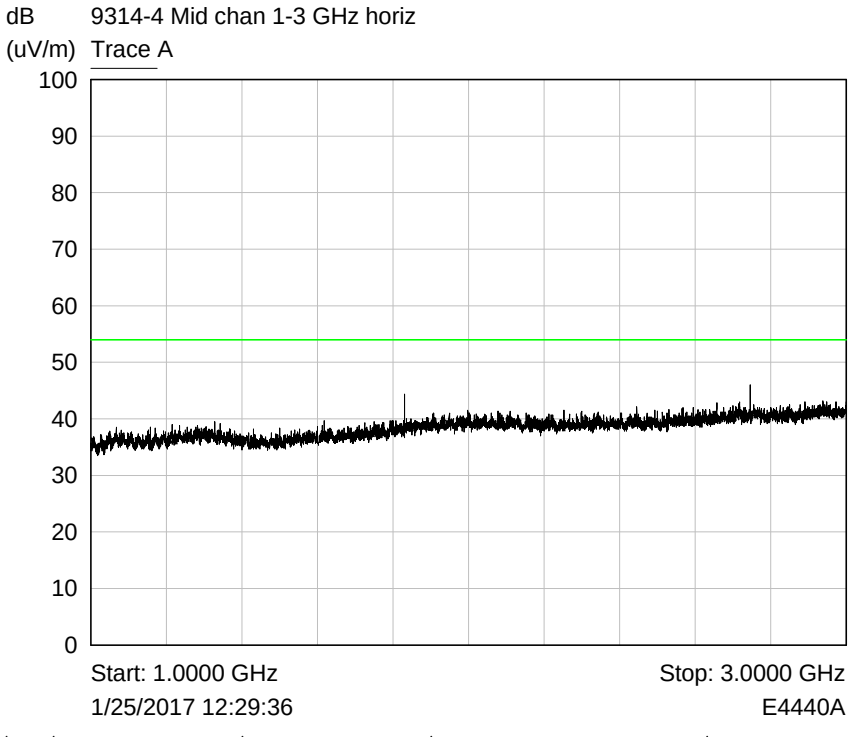


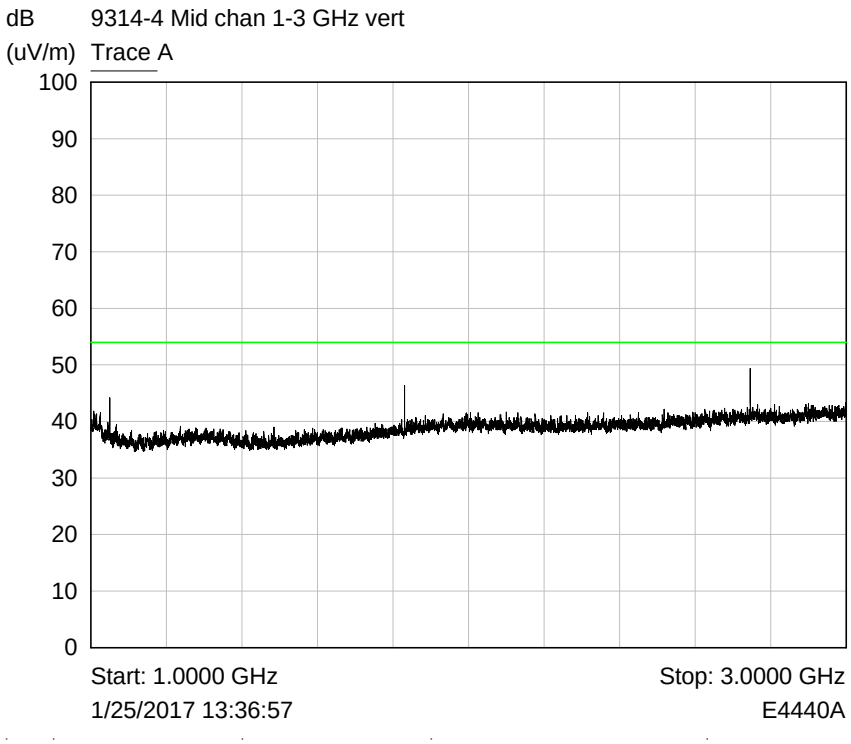
Plot of Peak emissions for 928-1000 MHz Vertical against the QP limit line.

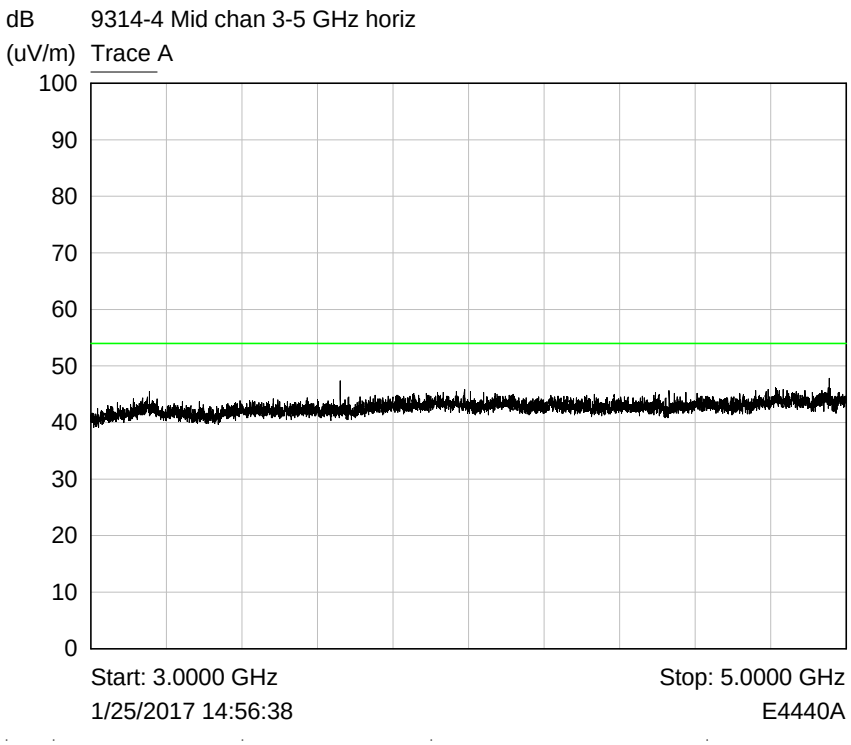
6.4 TX Unwanted radiated emissions above 1GHz

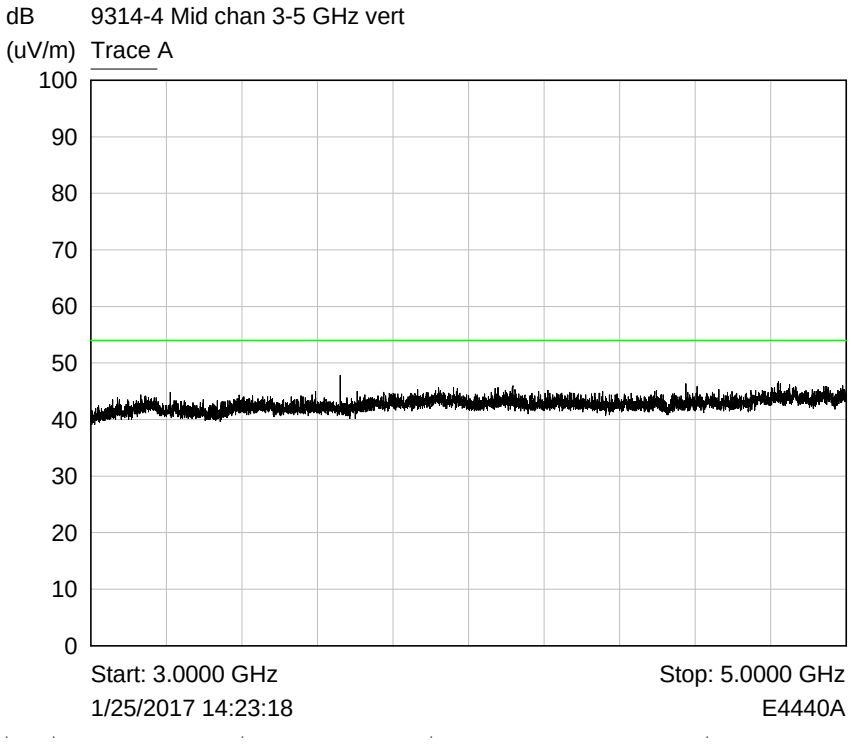
Note: Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only, and only Mid channel plots are shown for this test to minimise report size.

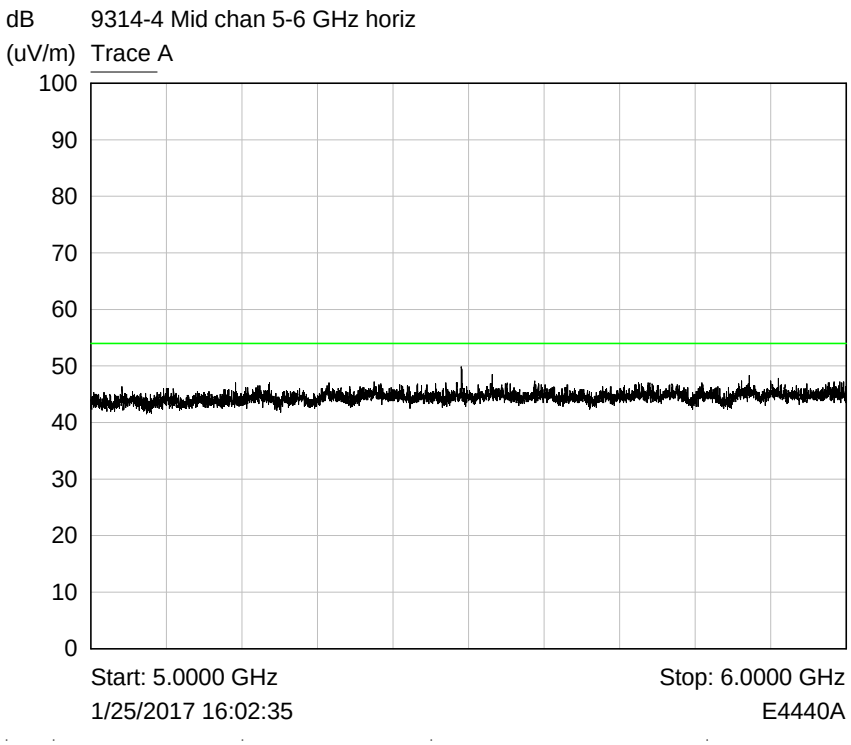
RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 915.09375 MHz

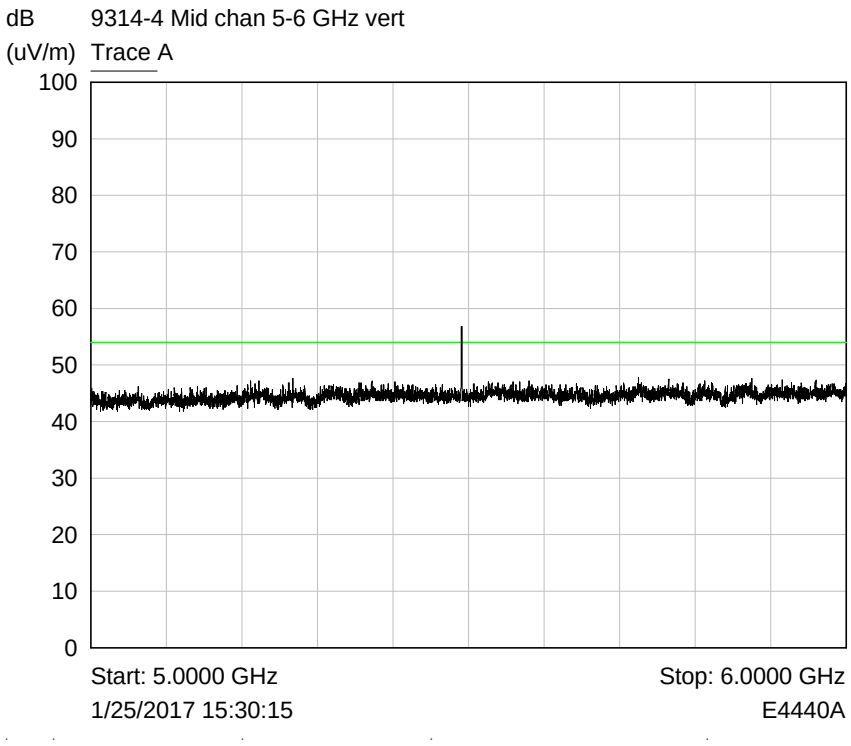


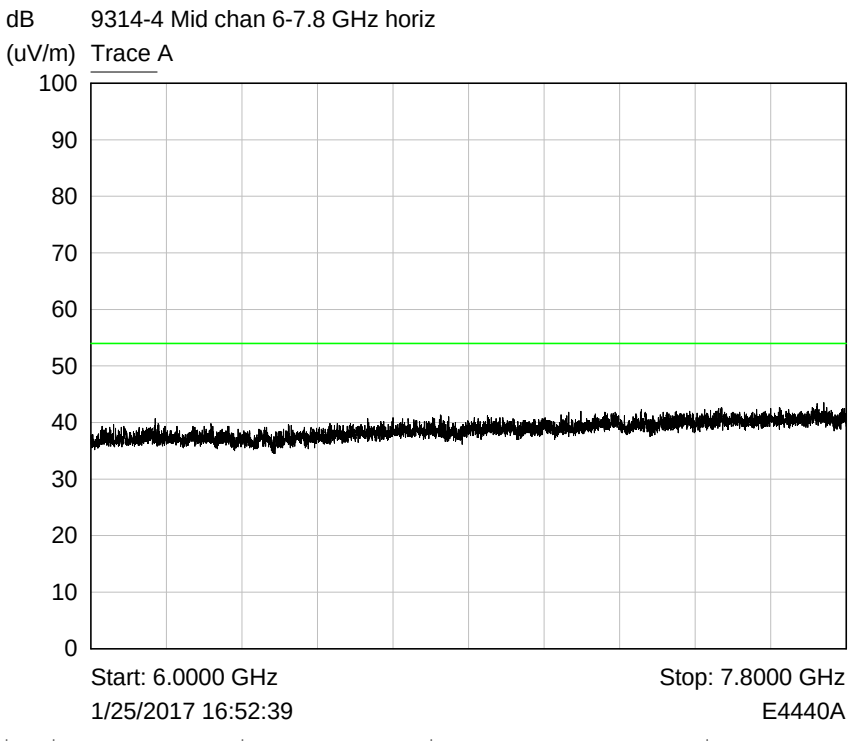


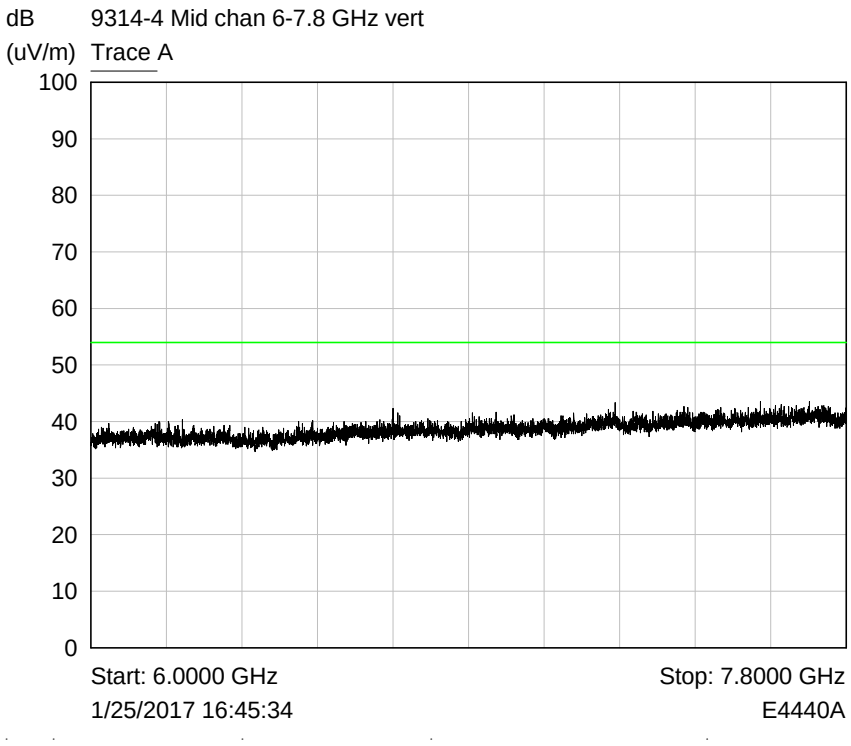


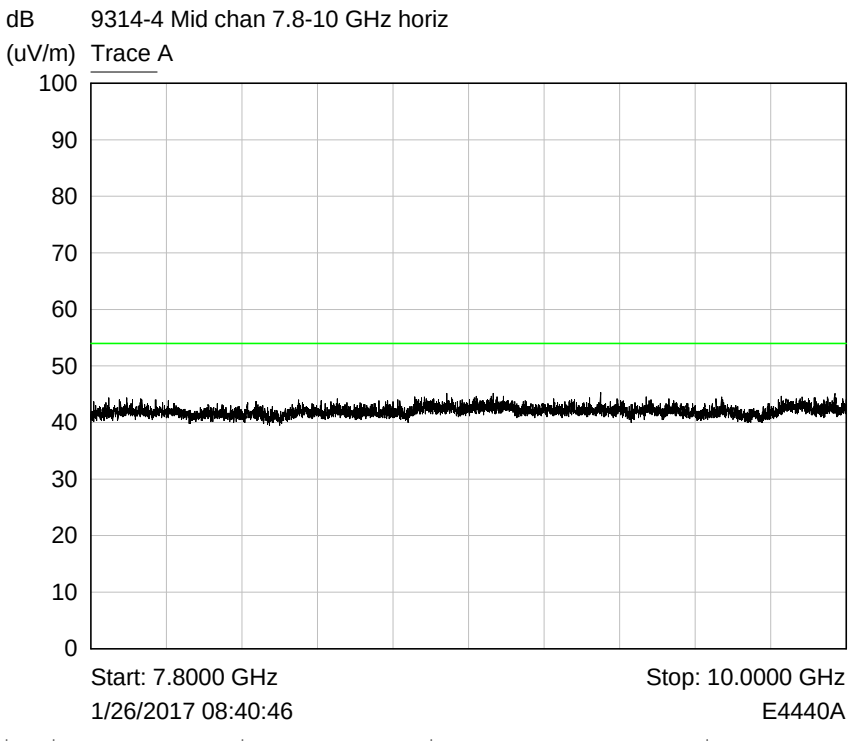


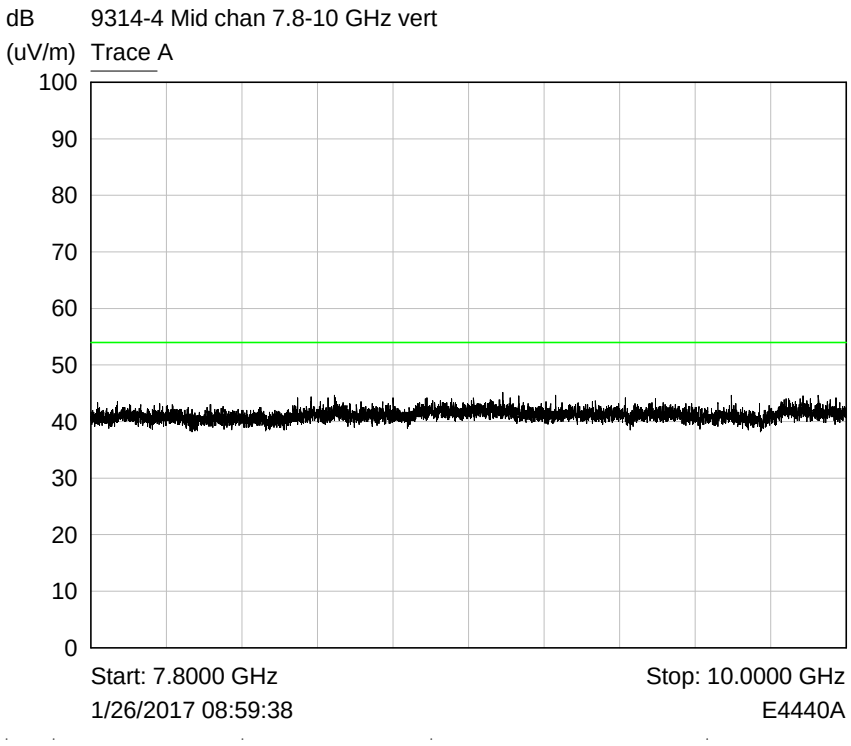


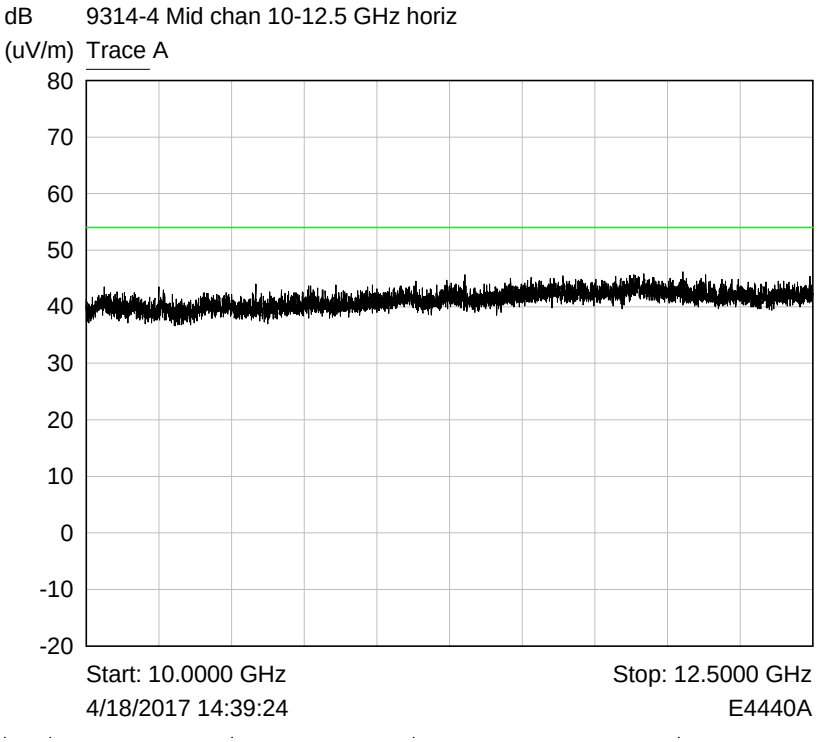


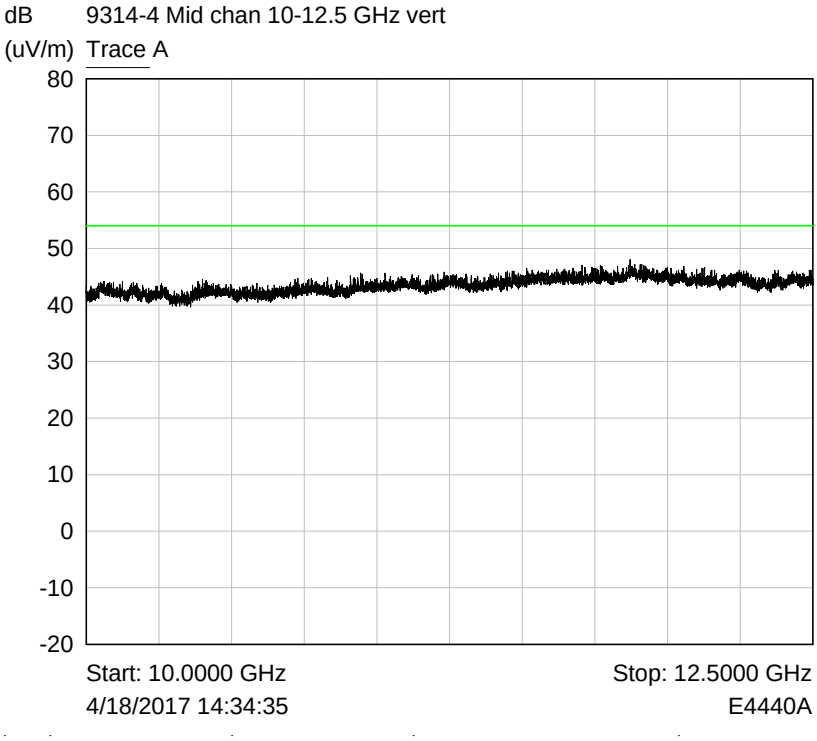


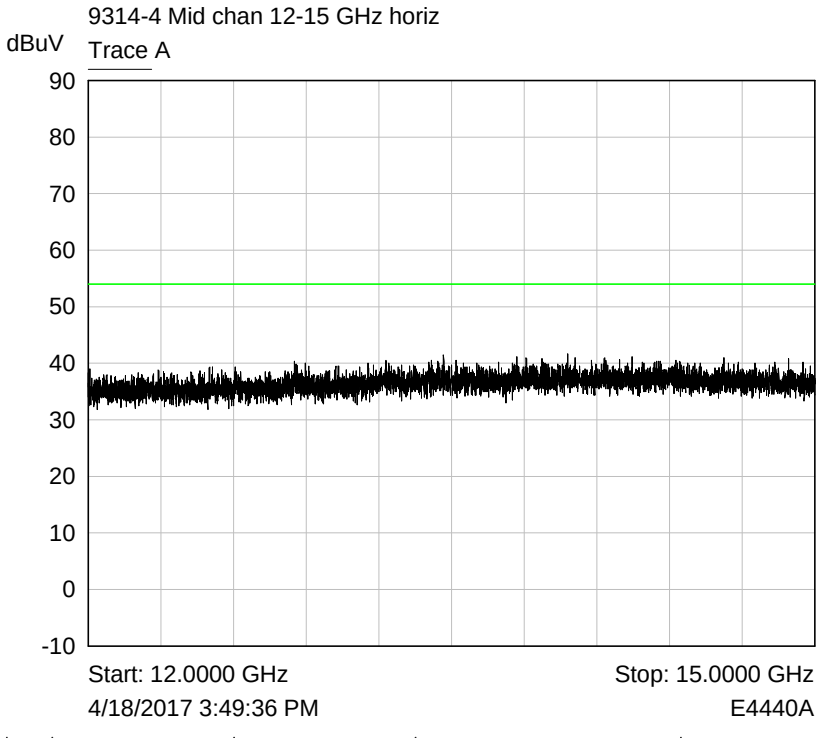


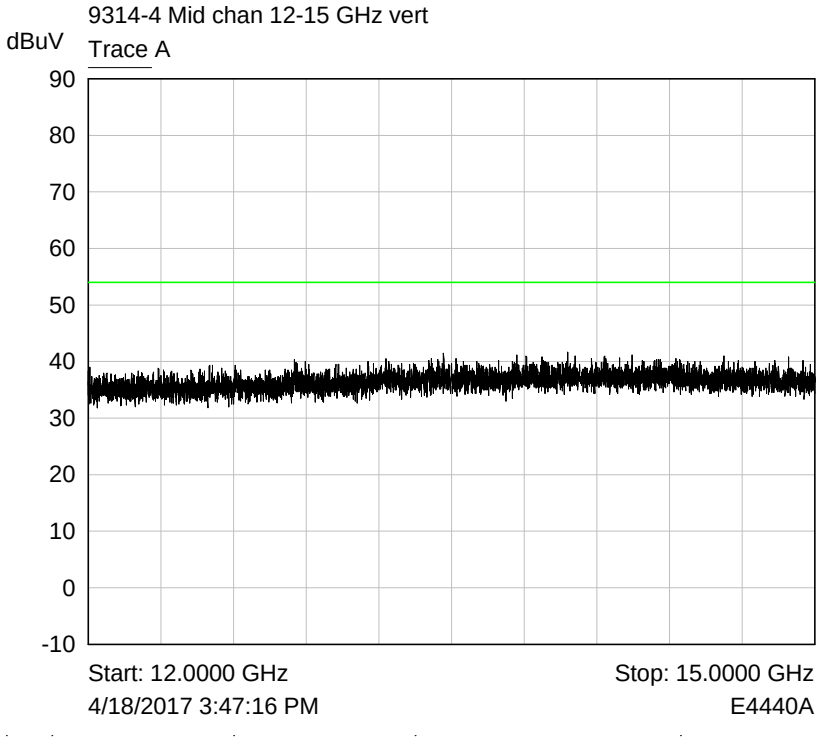


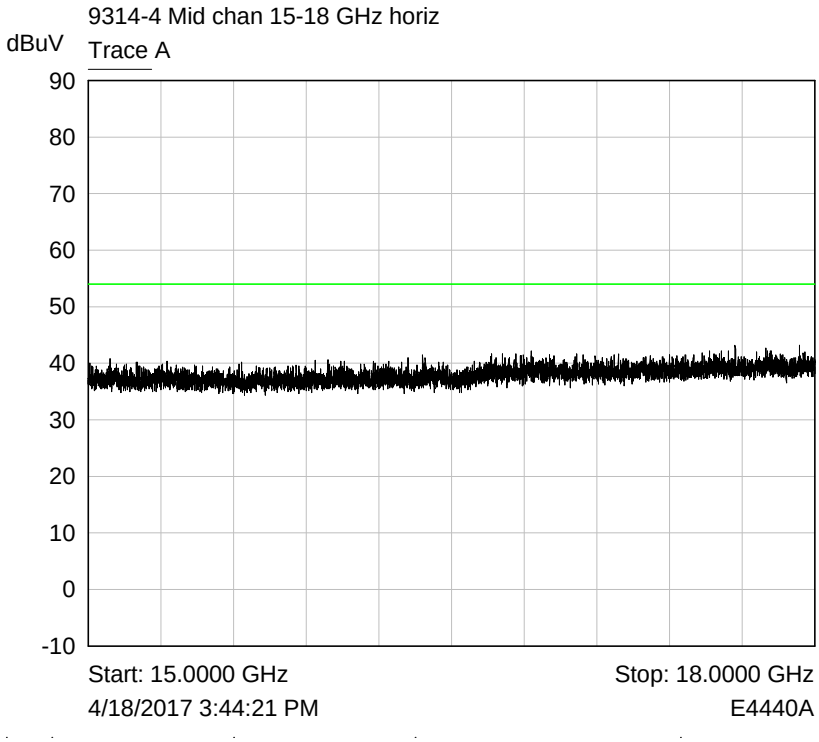


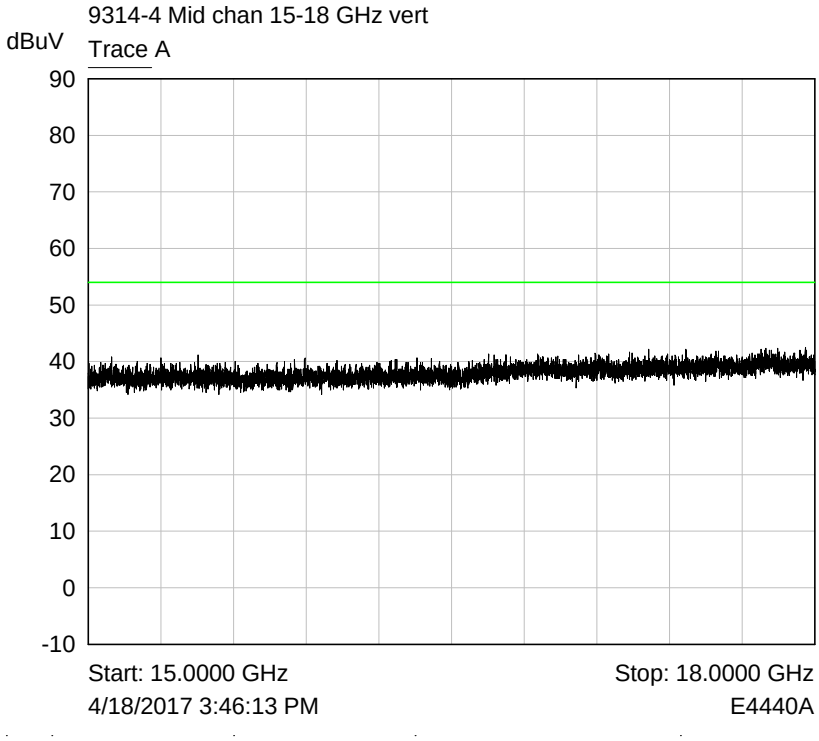


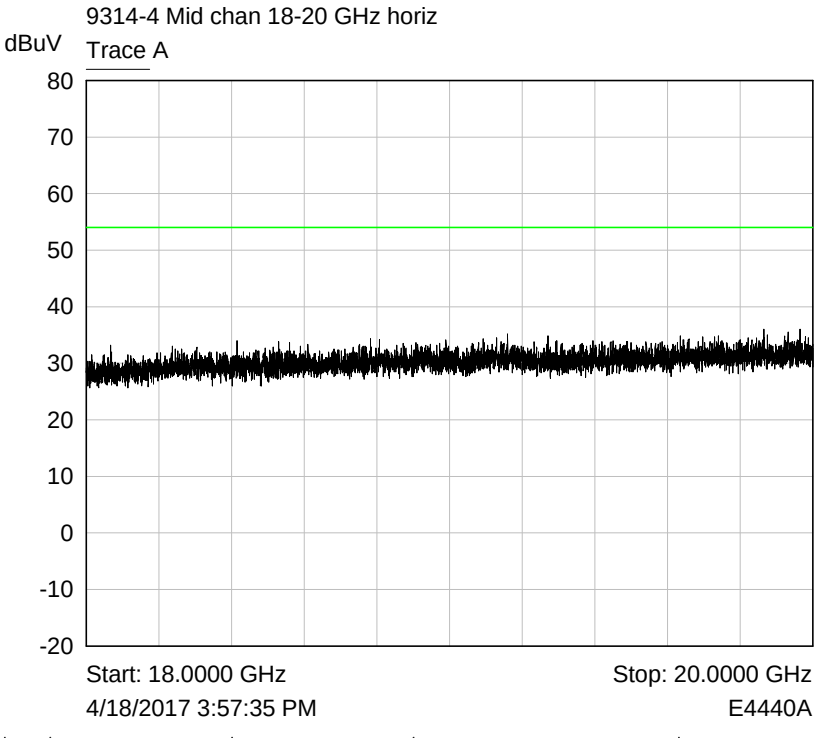


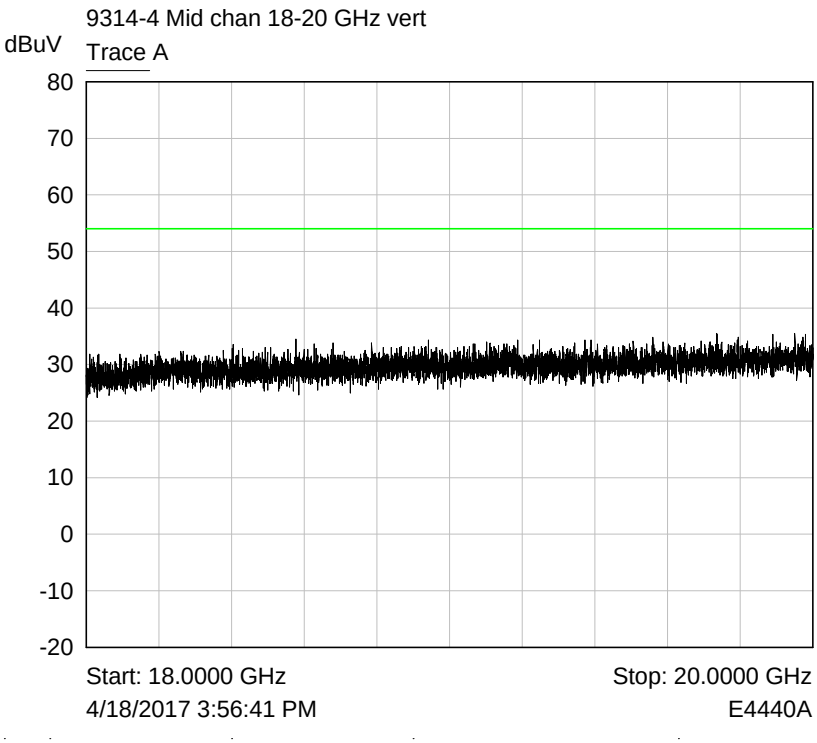






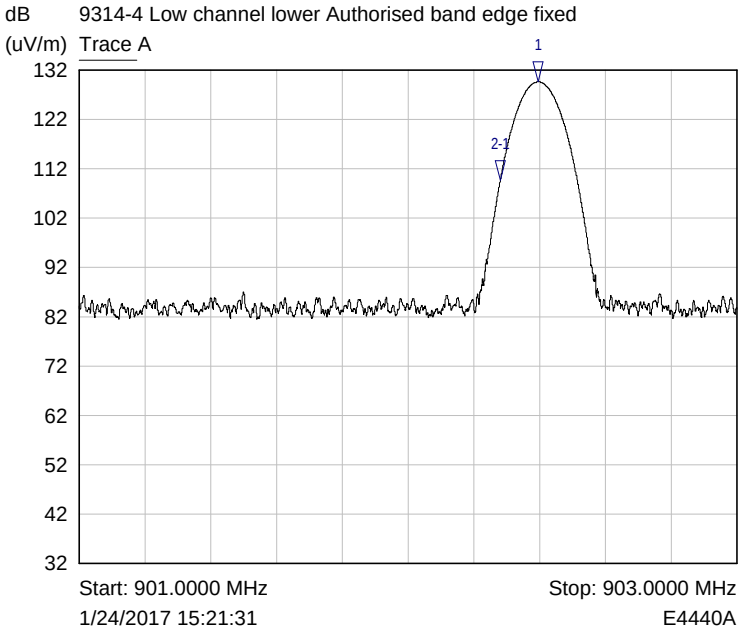






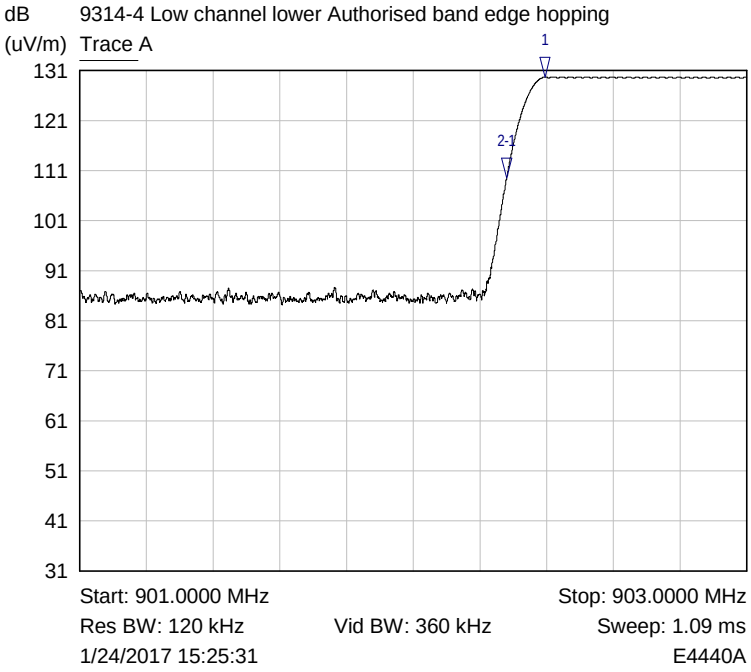
6.5 TX Unwanted emissions - Band edge compliance

RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 902.4 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	902.3942 MHz	129.64 dB(uV/m)	
2-1	Trace A	902.2802 MHz	-19.99 dB	

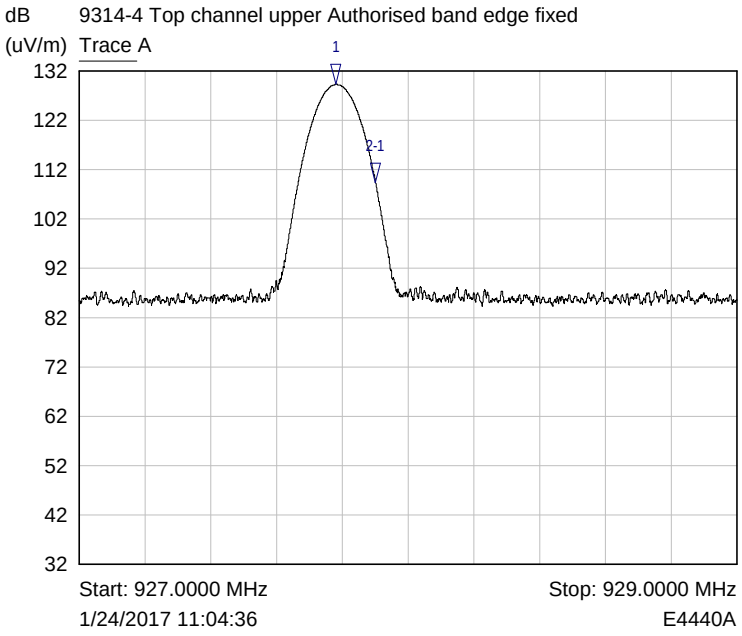
Lower authorised Band Edge Plot non hopping mode



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	902.3942 MHz	129.69 dB(uV/m)	
2-1	Trace A	902.2802 MHz	-20.12 dB	

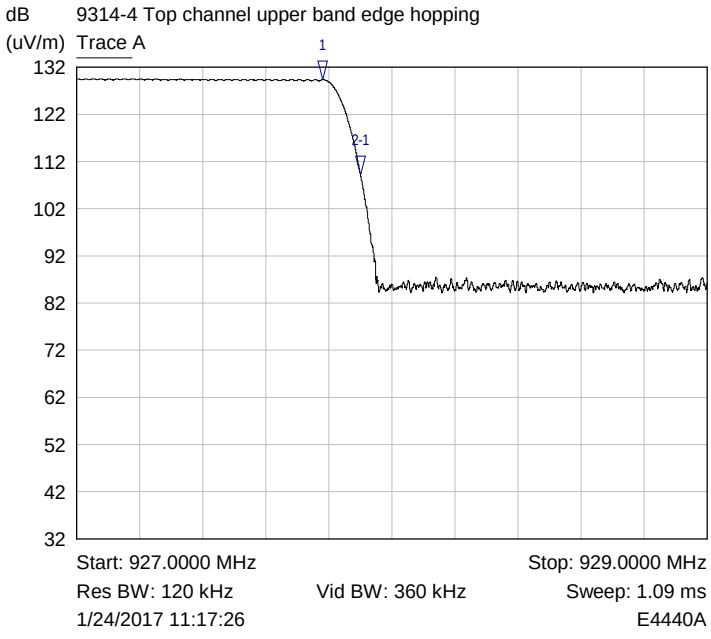
Lower authorised Band Edge Plot hopping mode

RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 927.7875 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	927.7811 MHz	129.27 dB(uV/m)	
2-1 ▽	Trace A	927.9012 MHz	-20.01 dB	

Upper authorised Band Edge Plot non hopping mode

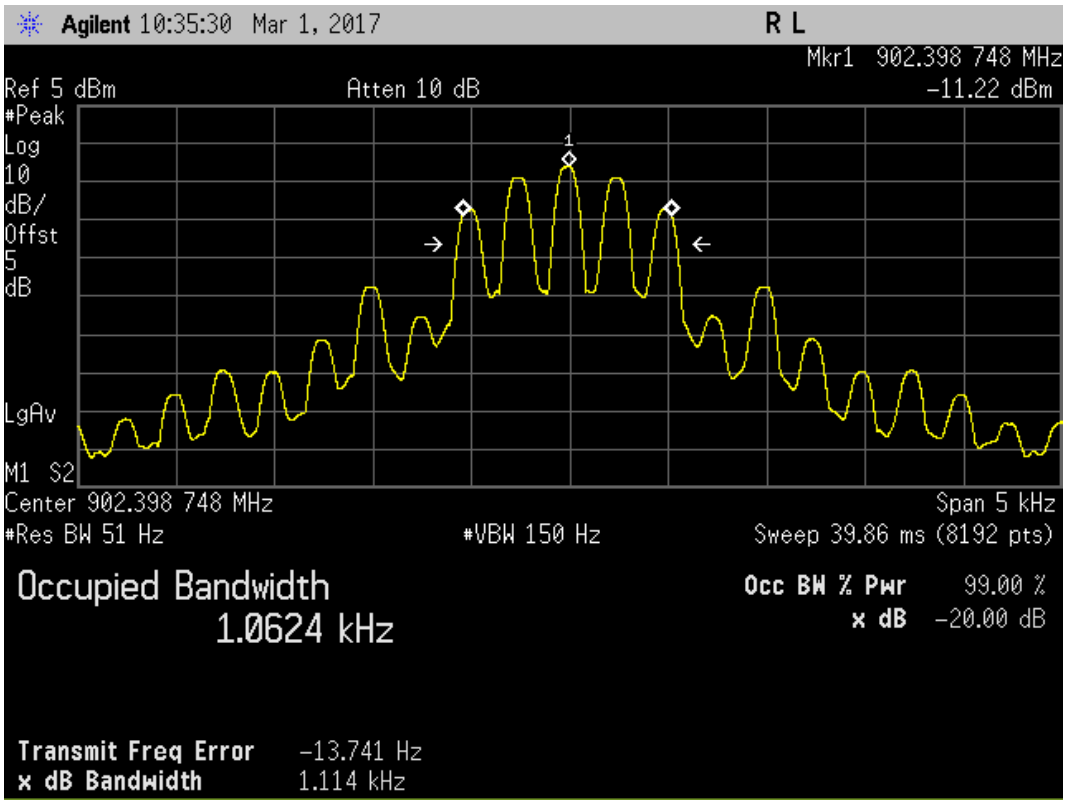


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	927.7811 MHz	129.29 dB(uV/m)	
2-1 ▽	Trace A	927.9003 MHz	-20.06 dB	

Upper authorised Band Edge Plot hopping mode

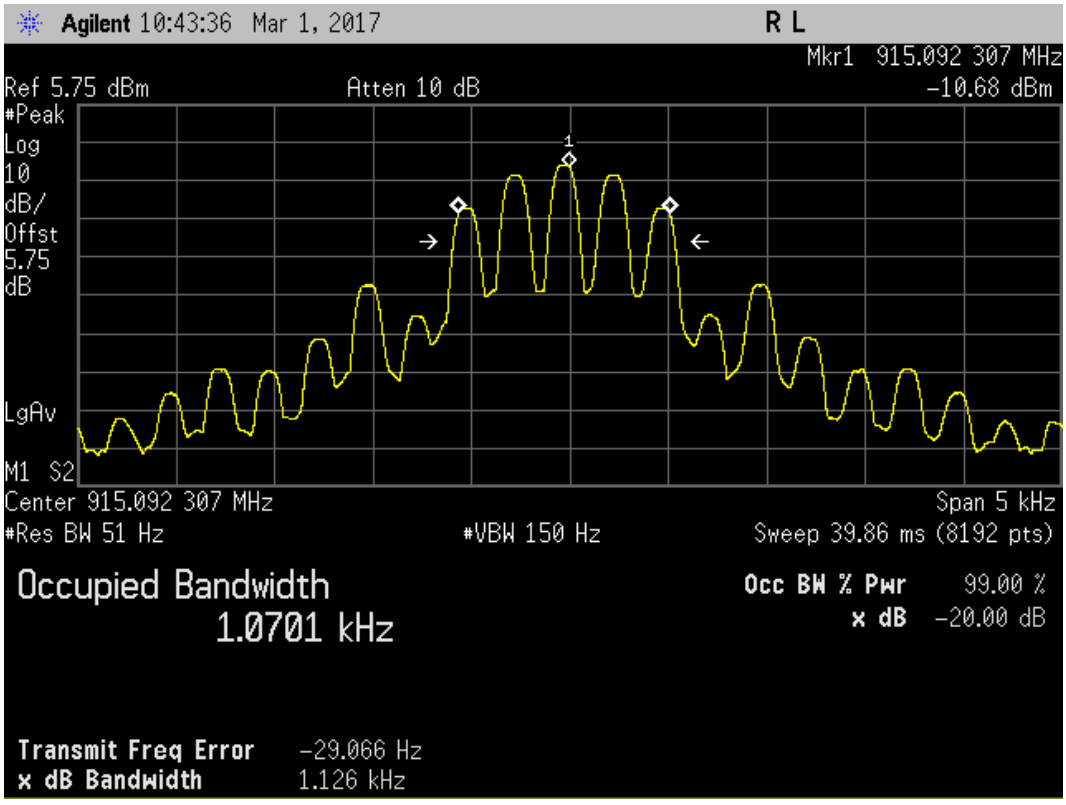
6.6 20dB / 6dB bandwidth

RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 902.4 MHz



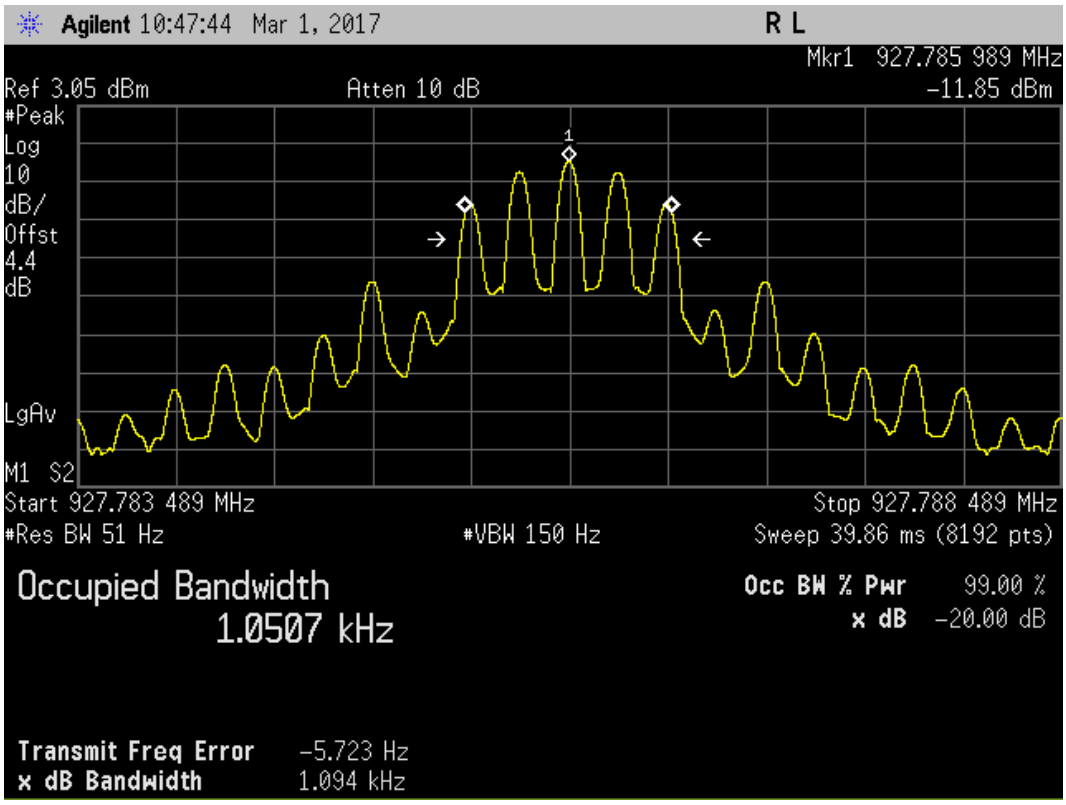
Plot for -20 dB Bandwidth

RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 915.09375 MHz



Plot for -20 dB Bandwidth

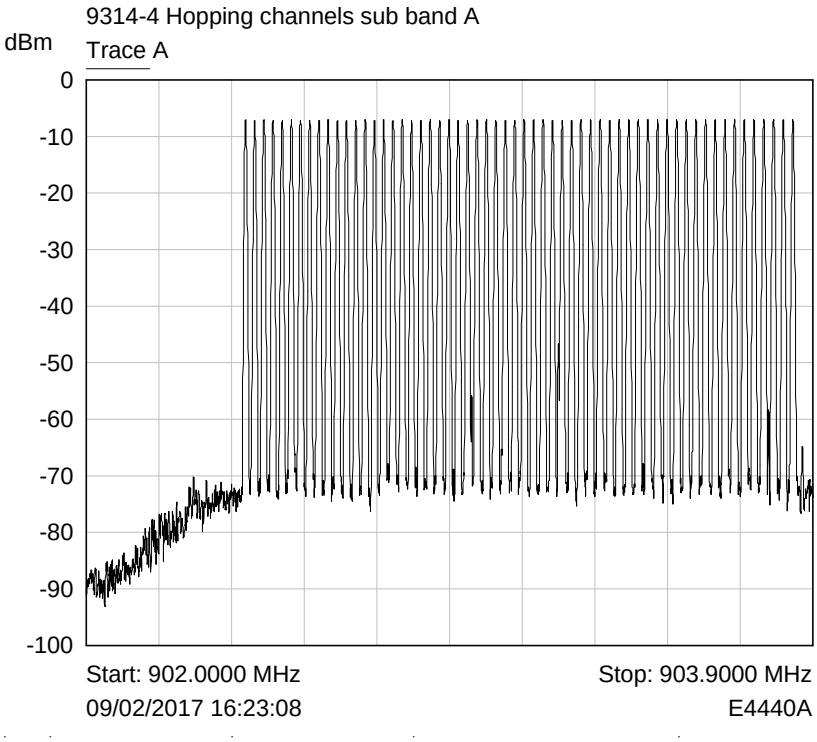
RF Parameters: Band 902-928 MHz, Power 27.8 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel 927.7875 MHz

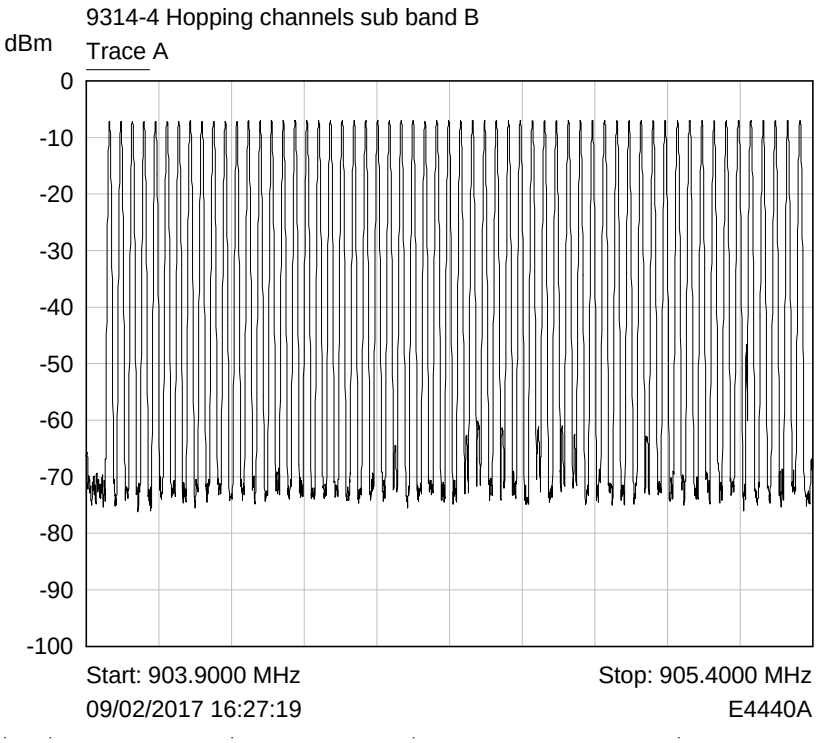


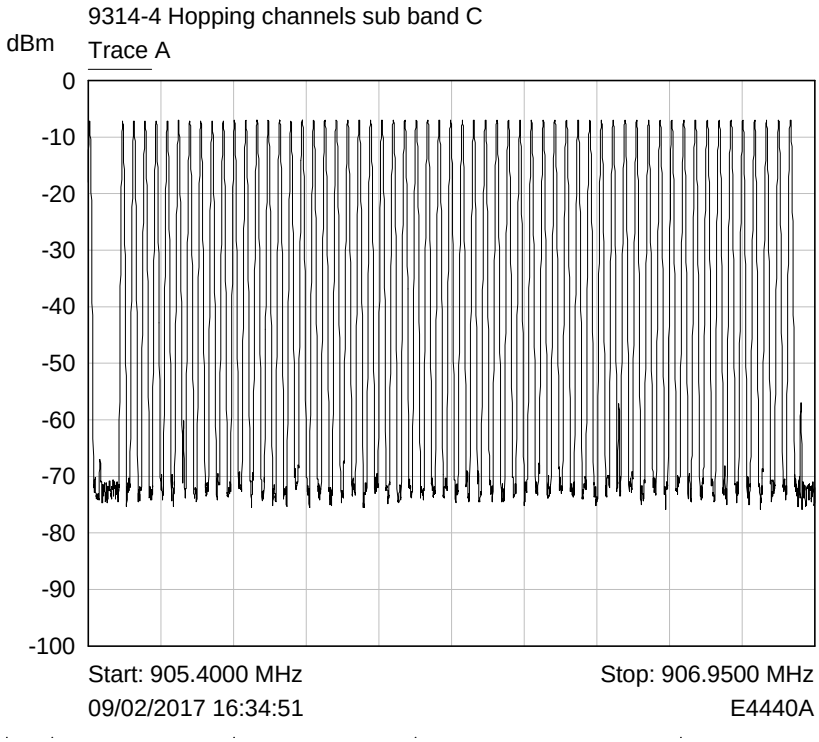
Plot for -20 dB Bandwidth

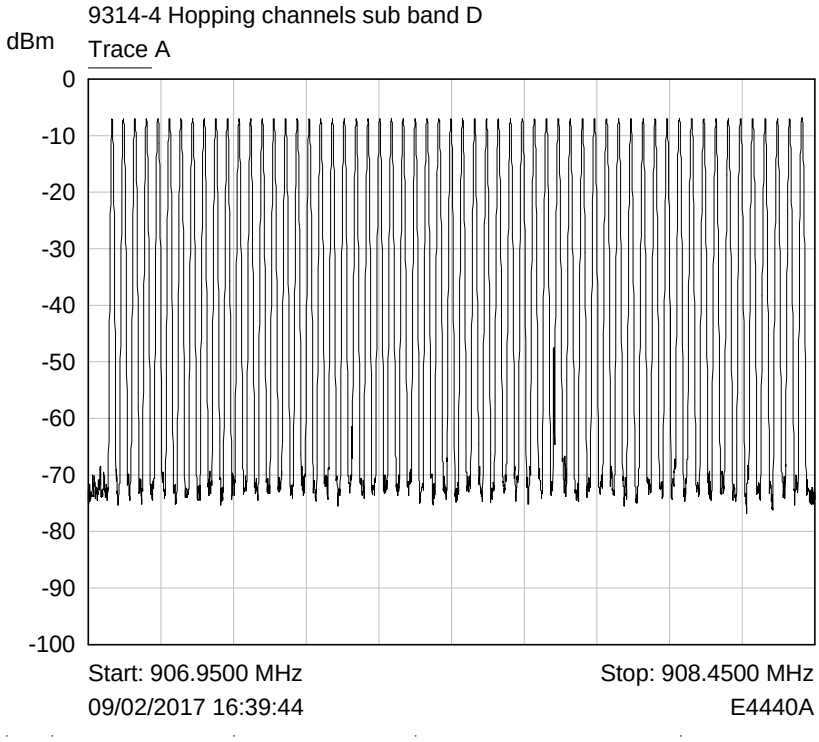
6.7 FHSs - Number of hop channels

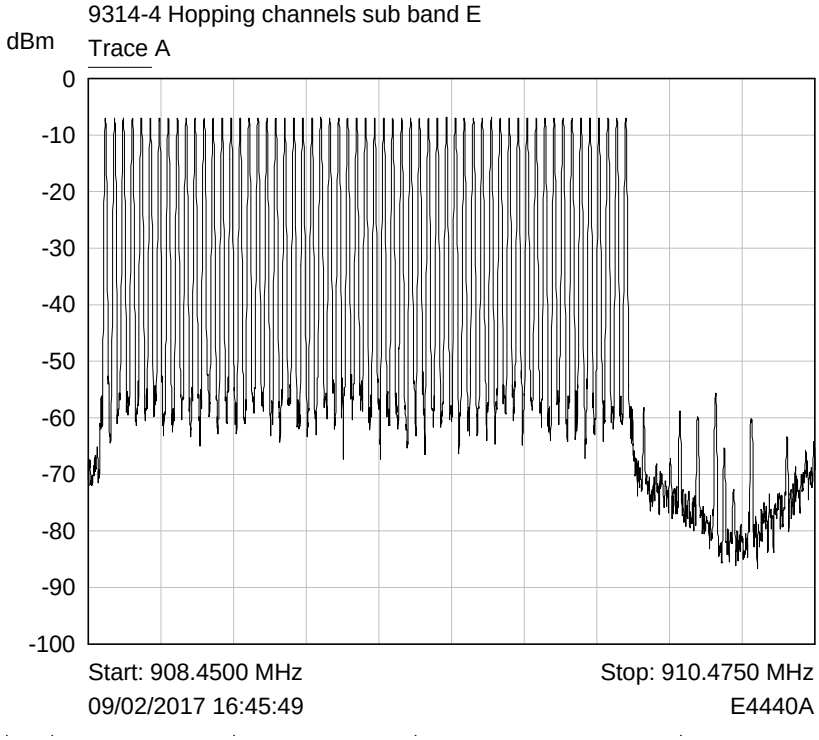
RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel Hopping

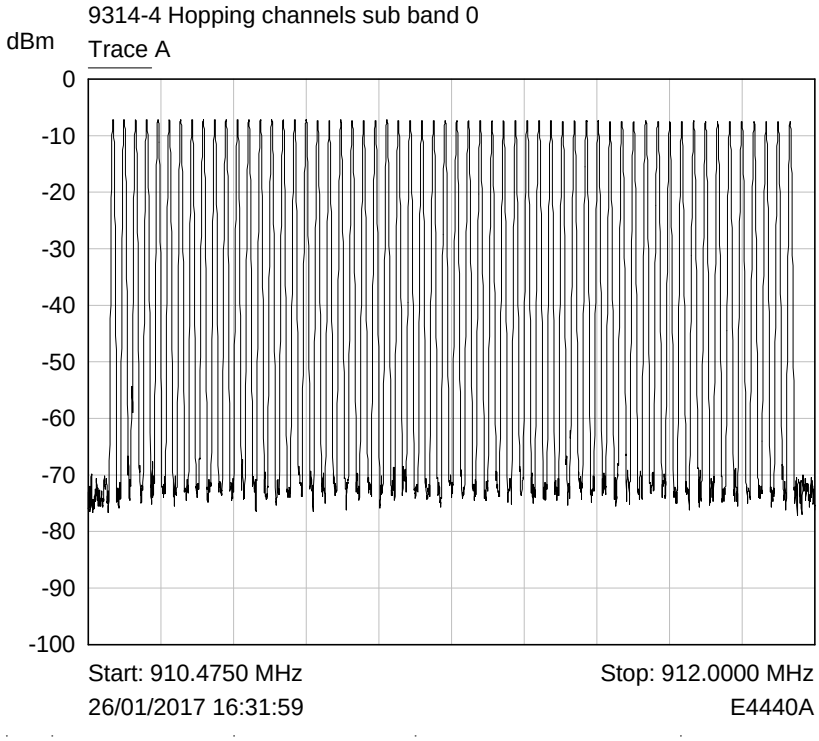


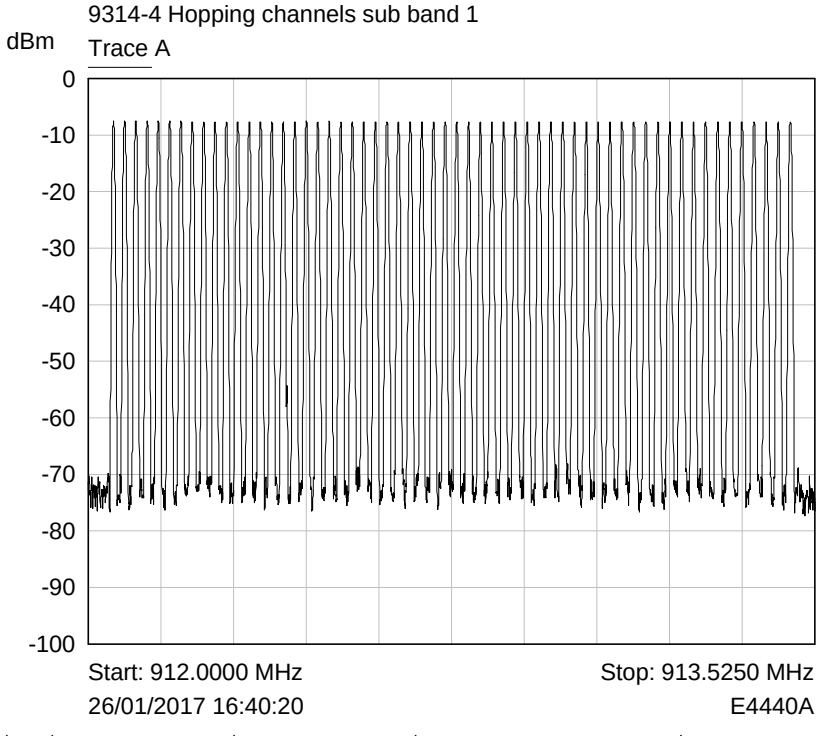


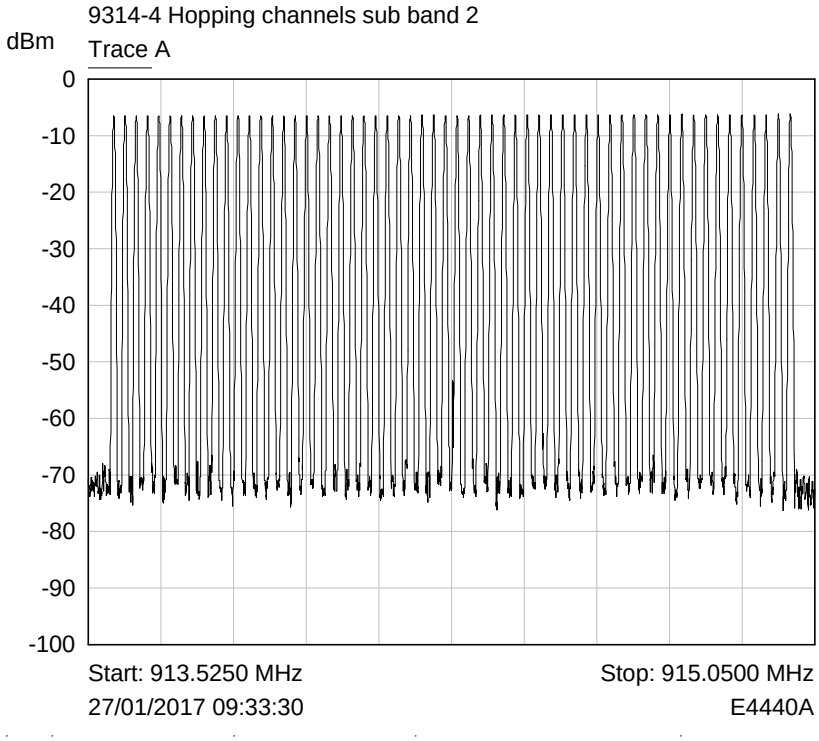


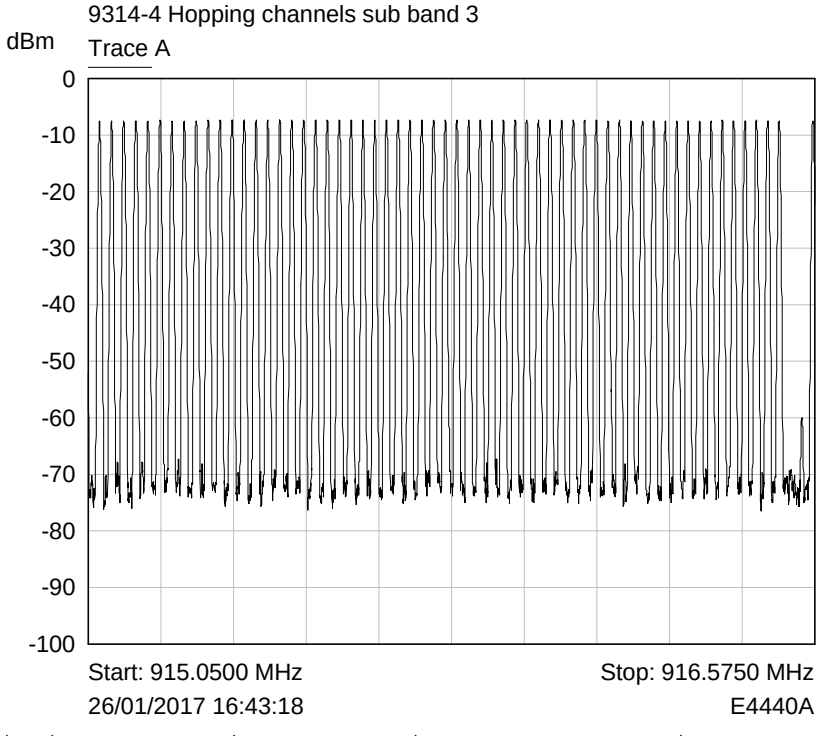


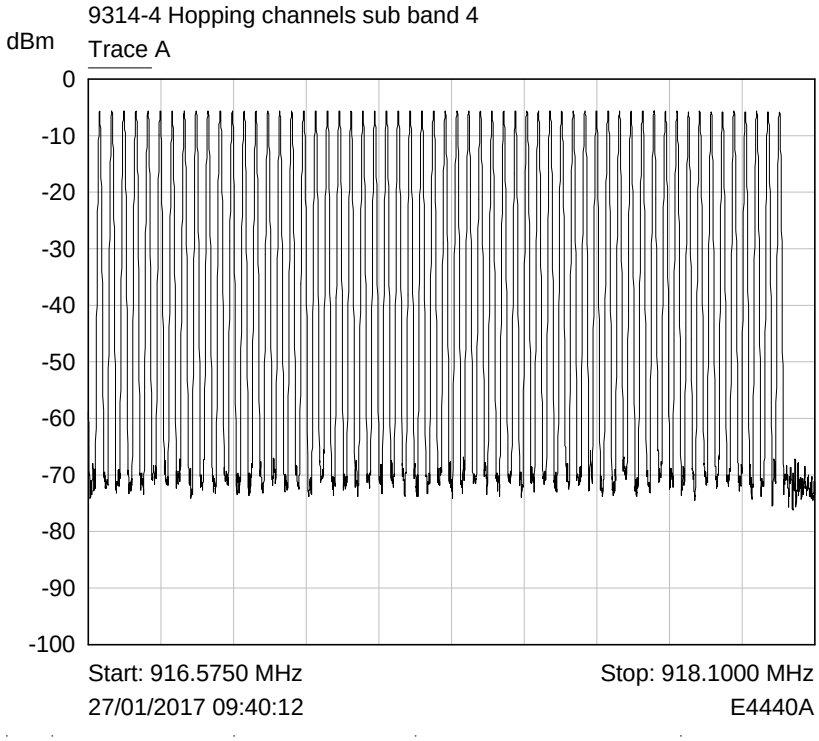


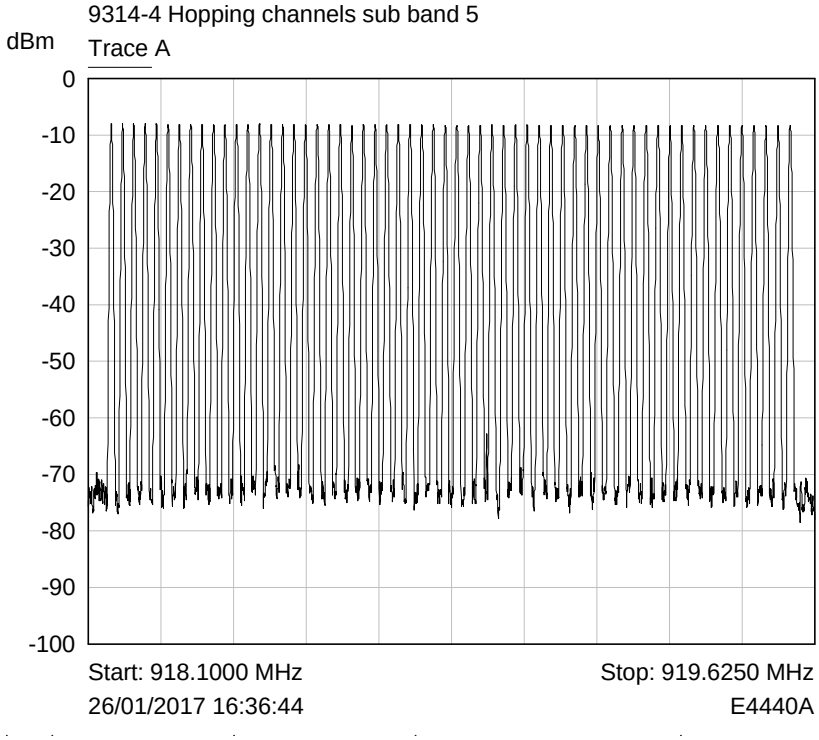


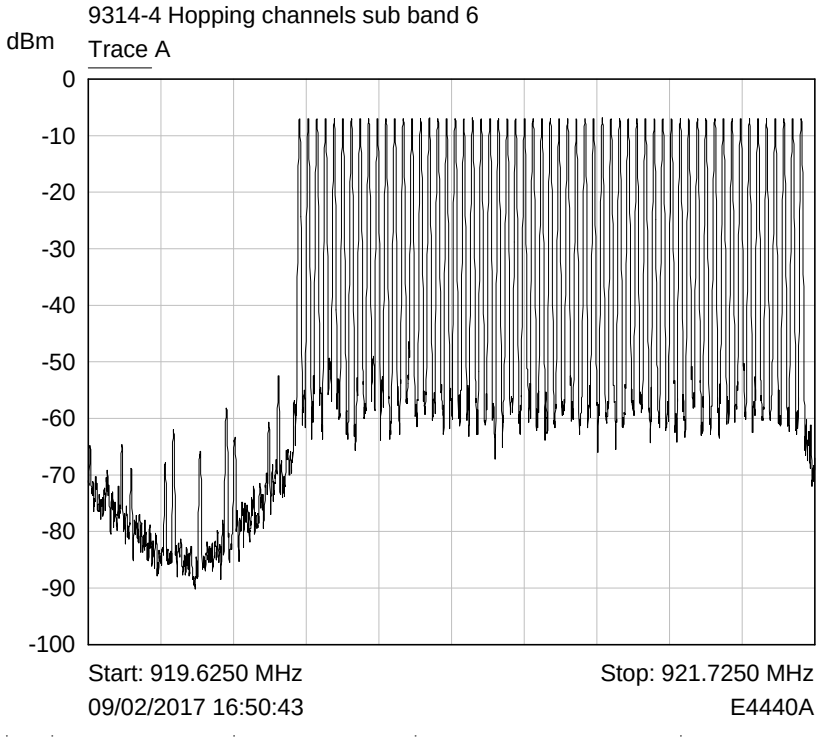


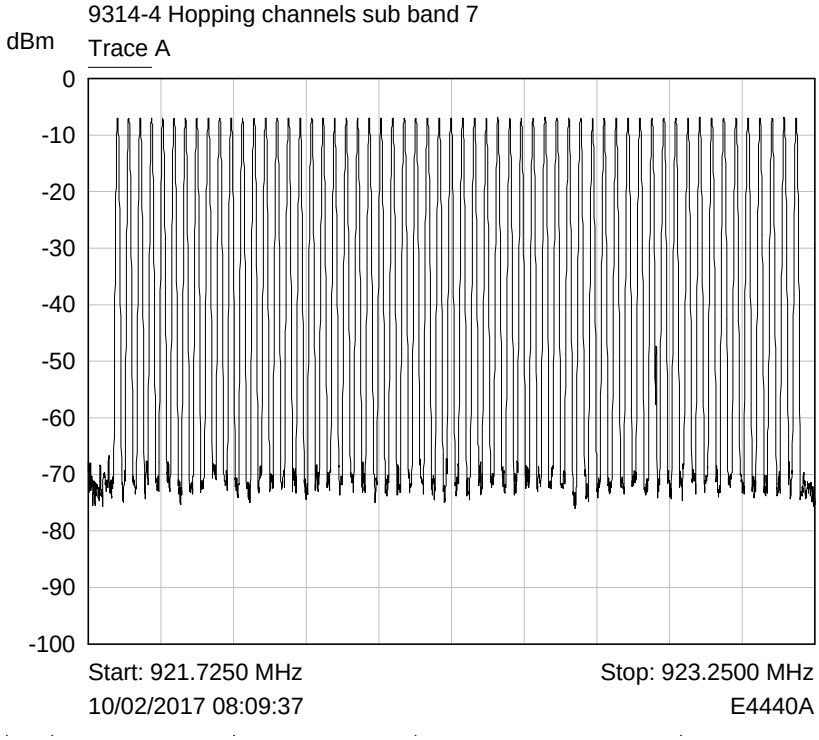


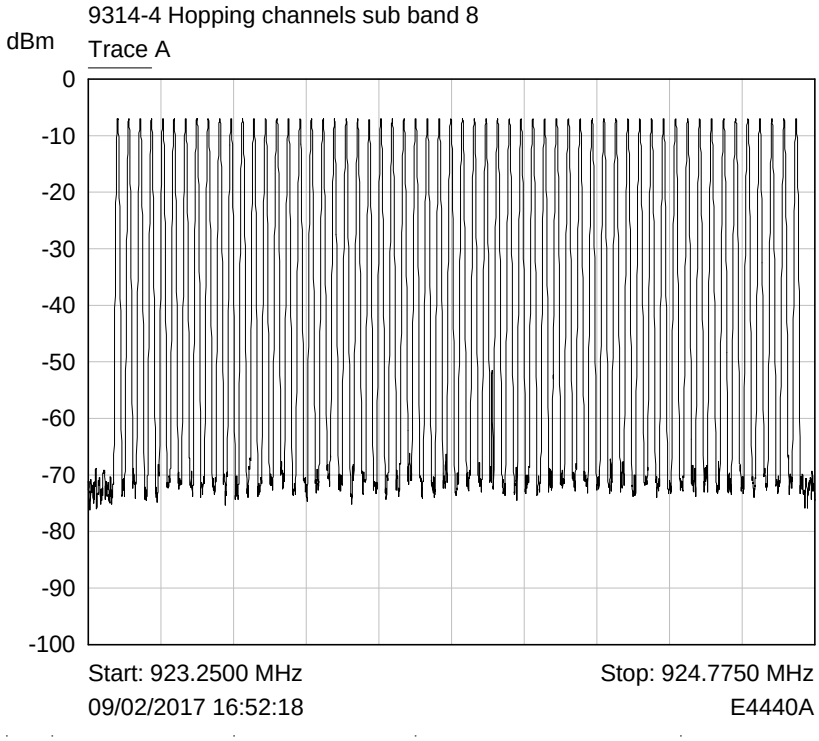


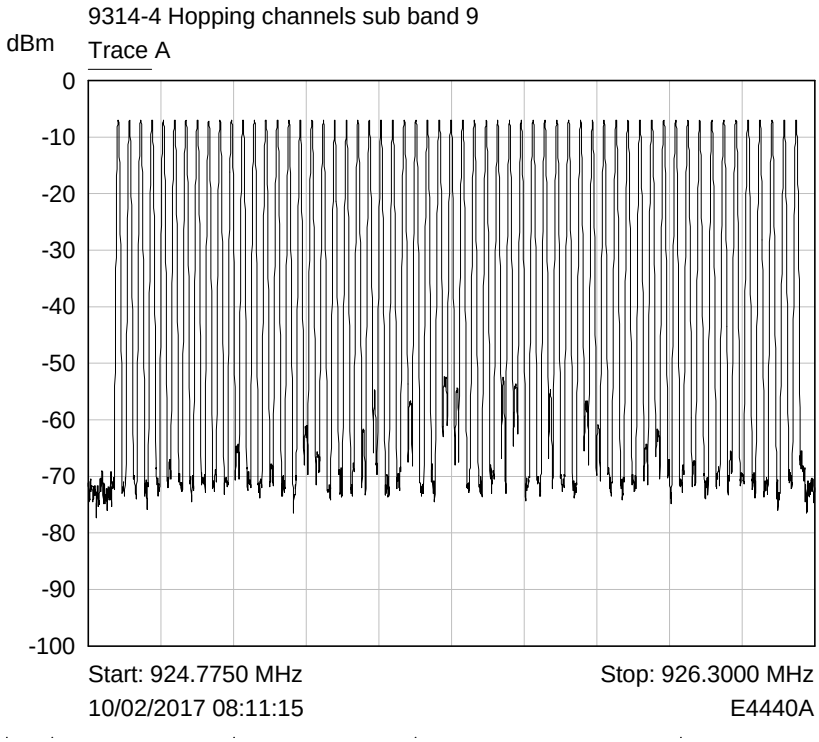


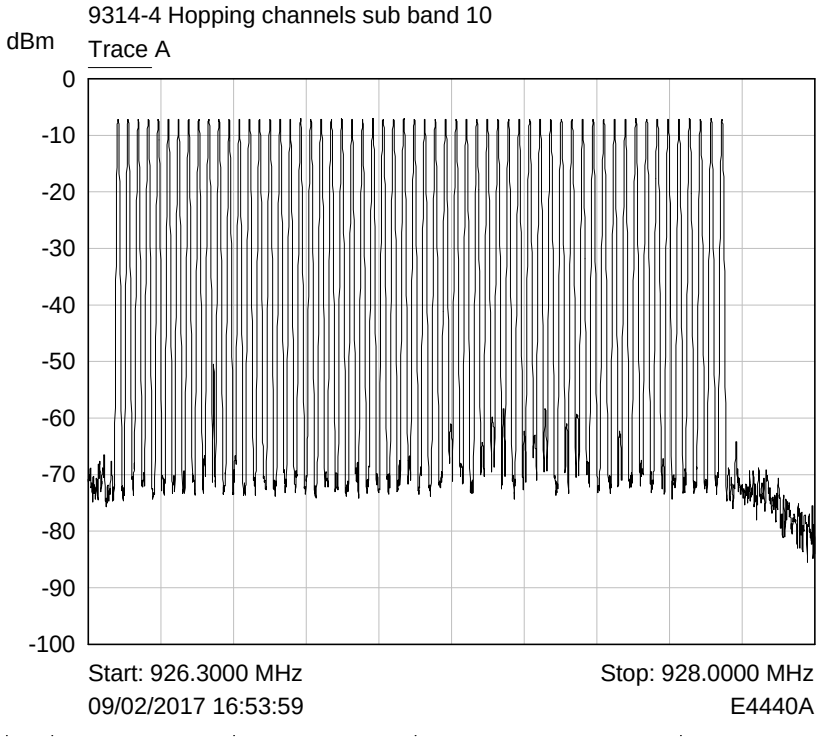






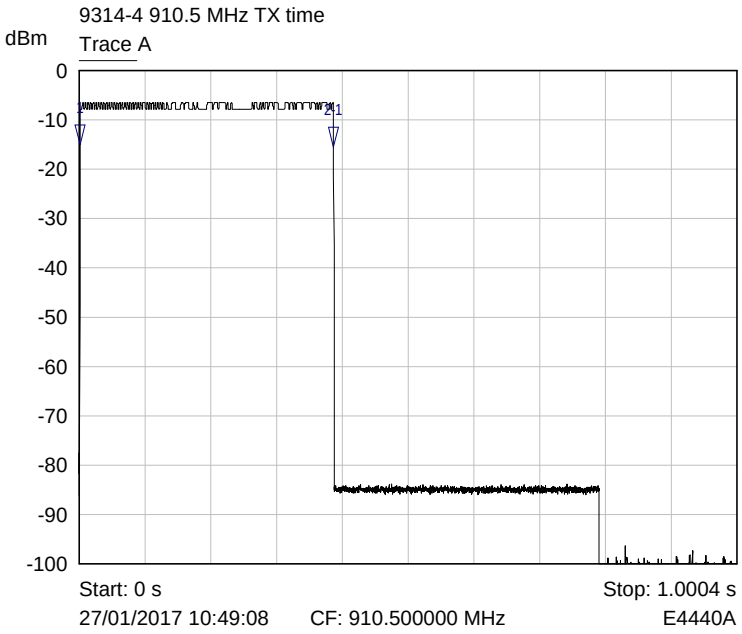






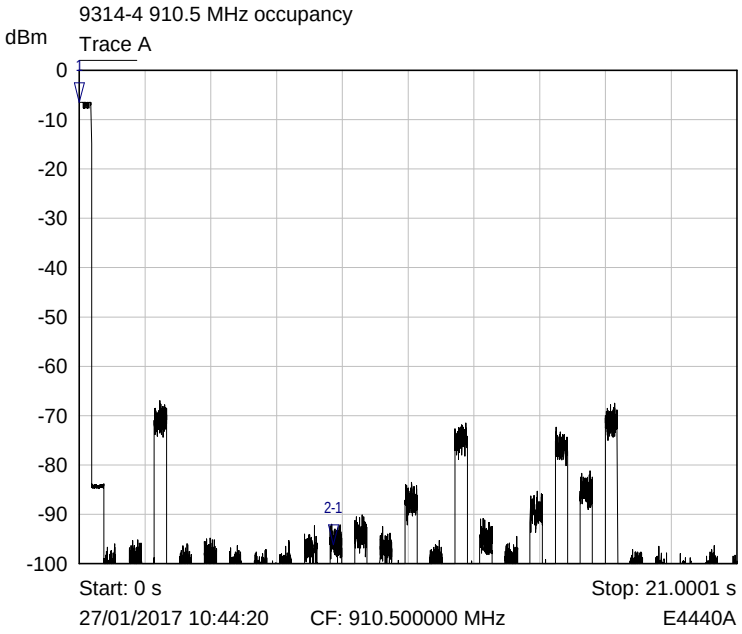
6.8 FHSs - Average time of occupancy

RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK, Channel Hopping



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	1.0992 ms	-15.07 dBm	
2-1 ▽	Trace A	385.6971 ms	-15.54 dBm	

Measured Dwell time/pulse width (ms)

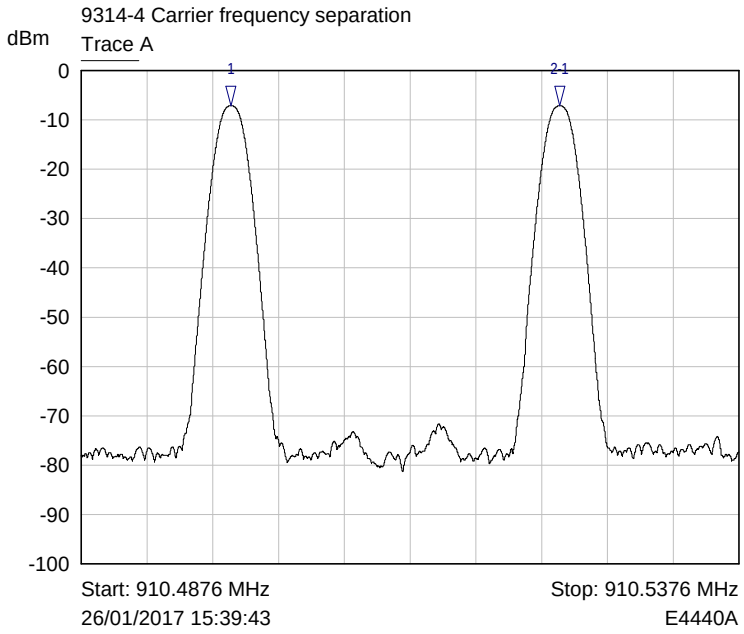


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	0 s	-6.46 dBm	
2-1 ▽	Trace A	8.0990 s	-96.24 dBm	

Period time (s)

6.9 FHSs - Carrier Frequency separation

RF Parameters: Band 902-928 MHz, Power 27.5 dBm, Channel Spacing 25 kHz, Modulation FSK



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	910.4990 MHz	-7.17 dBm	
2-1 ▽	Trace A	25.0214 kHz	-7.18 dBm	

Plot of Separation (kHz)

7 Explanatory Notes

7.1 Explanation of Table of Signals Measured

Measurements are made as required by the standard. These measurements are made and recorded using detectors, either peak, quasi peak or average dependant on the test. A table of results has been given following the relevant plots. This table looks similar to the one illustrated below dependant on the measurements required by the test: -

Signal No.	Freq (MHz)	Peak Amp (dBuV)	Pk – Lim 1 (dB)	QP Amp (dBuV)	QP - Lim1 (dB)	Av Amp (dBuV)	Av - Lim1 (dB)
1	12345	54.9	-10.5	48	-12.6	37.6	-14.4

Column One - Labelled Signal No. is an incremental number that the receiver has given to each signal that has been measured.

Column Two - Labelled Freq (MHz) is the approximate frequency of the signal received.

Column Three - Labelled Peak Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the peak detector.

Column Four - Labelled Pk - Lim1 (dB) is the difference in level from the peak signal given to the active limit line. If this column appears in the table the peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Five - Labelled QP Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the quasi-peak detector.

Column Six - Labelled QP - Lim1 (dB) is the difference in level from the quasi-peak signal given to the active limit line. If this column appears in the table the quasi-peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Seven - Labelled Av Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the average detector.

Column Eight - Labelled Av - Lim1 (dB) is the difference in level from the average signal given to the active limit line. If this column appears in the table the average detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Only signals highlighted in red are deemed to exceed the limit of the detector required.

7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in µV/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dBµV/m referenced to the measuring instrument inputs. RN Electronics calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

(a) limit of 500 µV/m equates to 20.log (500) = 54 dB µV/m.

(b) limit of 300 µV/m at 10m equates to 20.log (300 . 10/3) = 60 dB µV/m at 3m

(c) limit of 30 µV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBµV/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

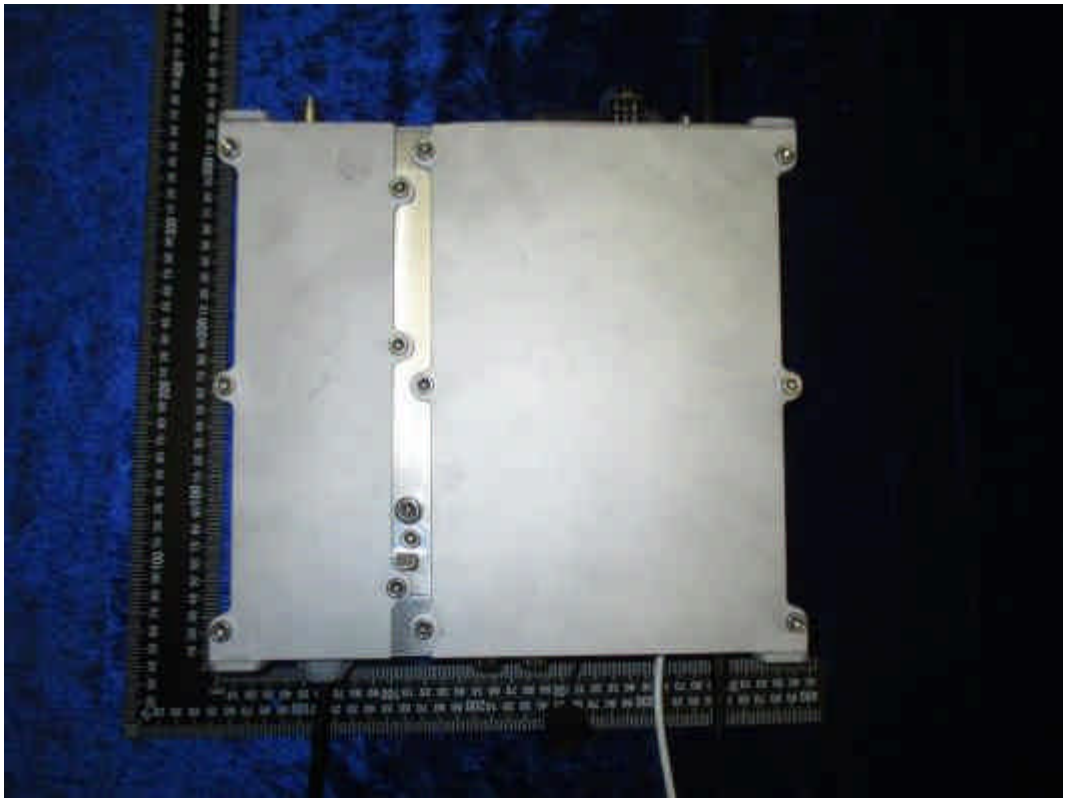
The measurement receiver used for emissions testing, performs the field strength (FS) calculations automatically. The receiver combines the signal amplitude (RA), Antenna Factor (AF) and Cable Loss (CL) factors for the frequency to be measured.

Example calculation: - FS = RA + AF + CL.

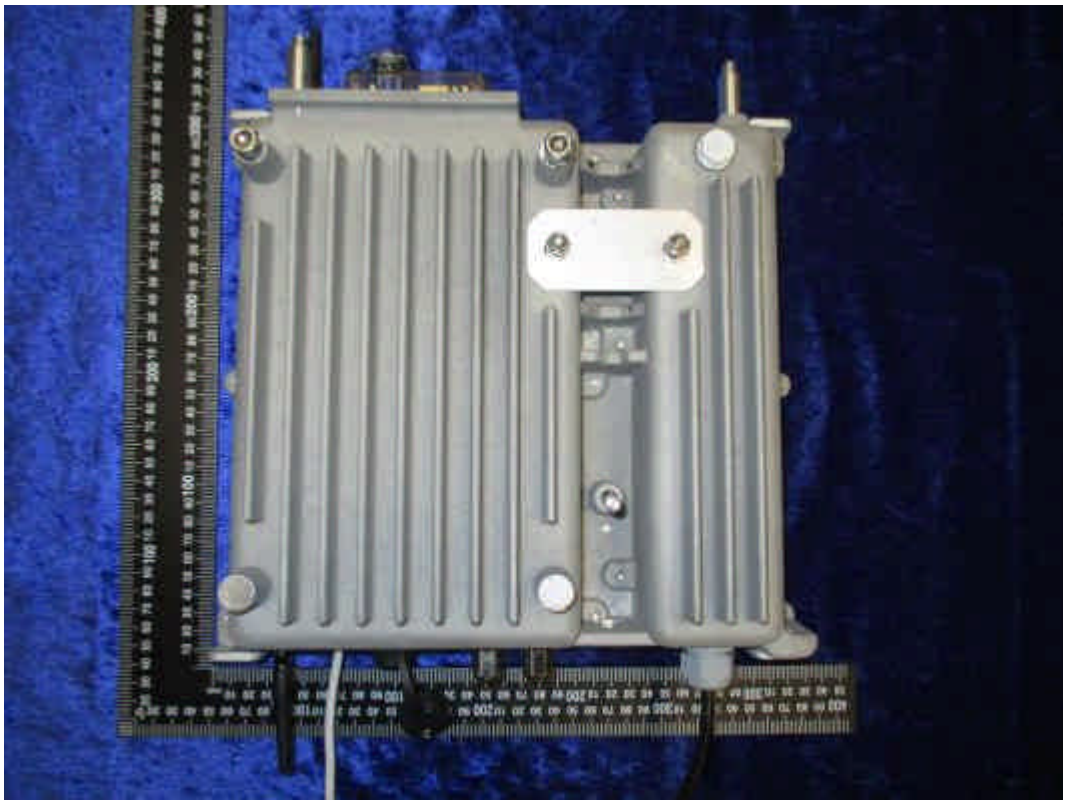
Receiver amplitude (RA)	Antenna factor (3m) (AF)	Cable loss (CL)	Field strength result (3m) (FS)
20dBuV	25 dB	3 dB	48dBuV/m

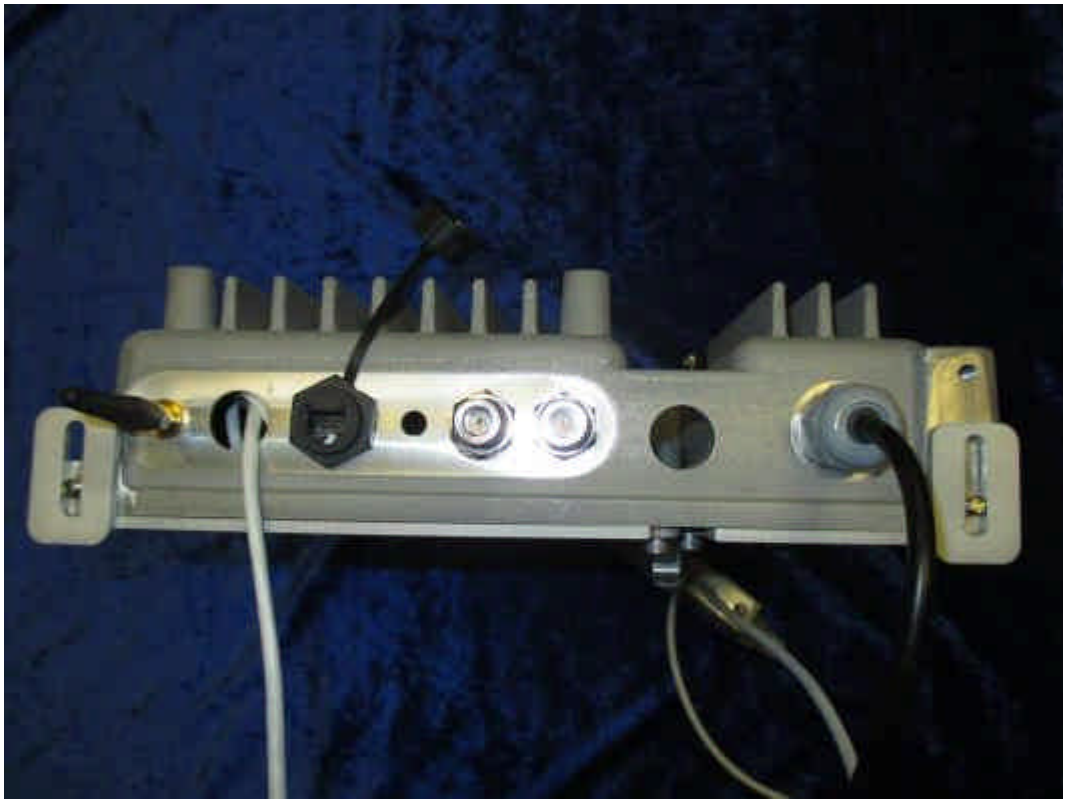
8 Photographs

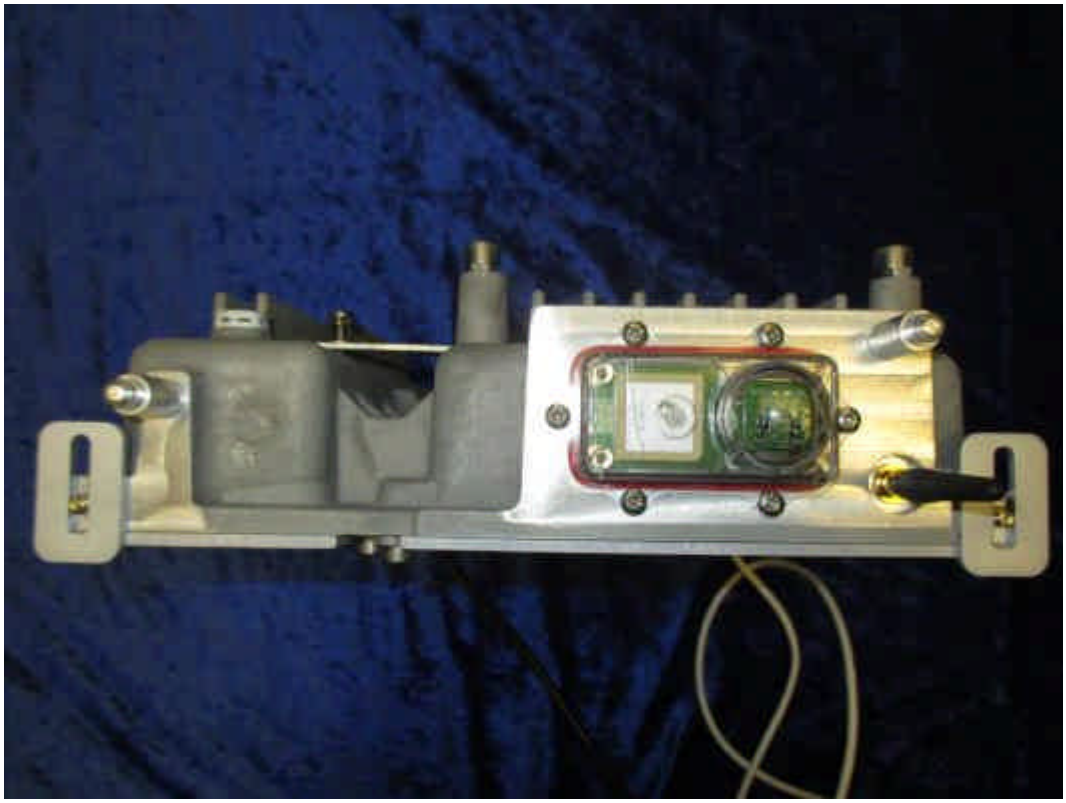
8.1 EUT Front View



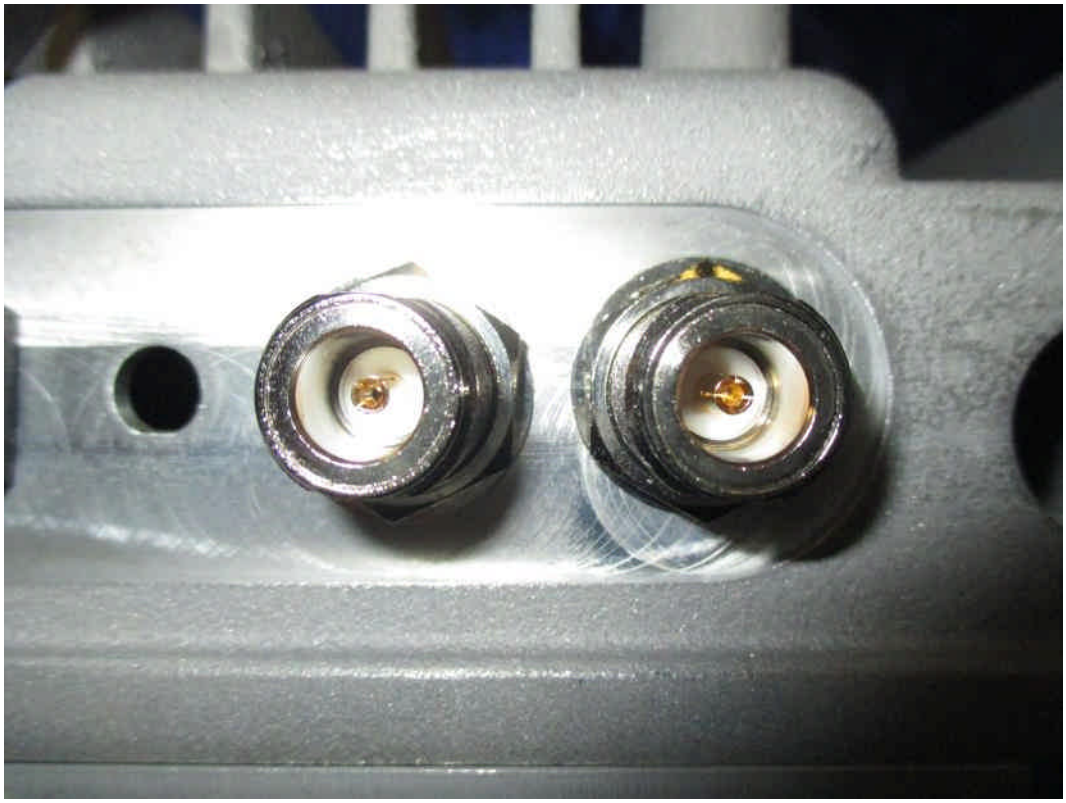
8.2 EUT Reverse Angle

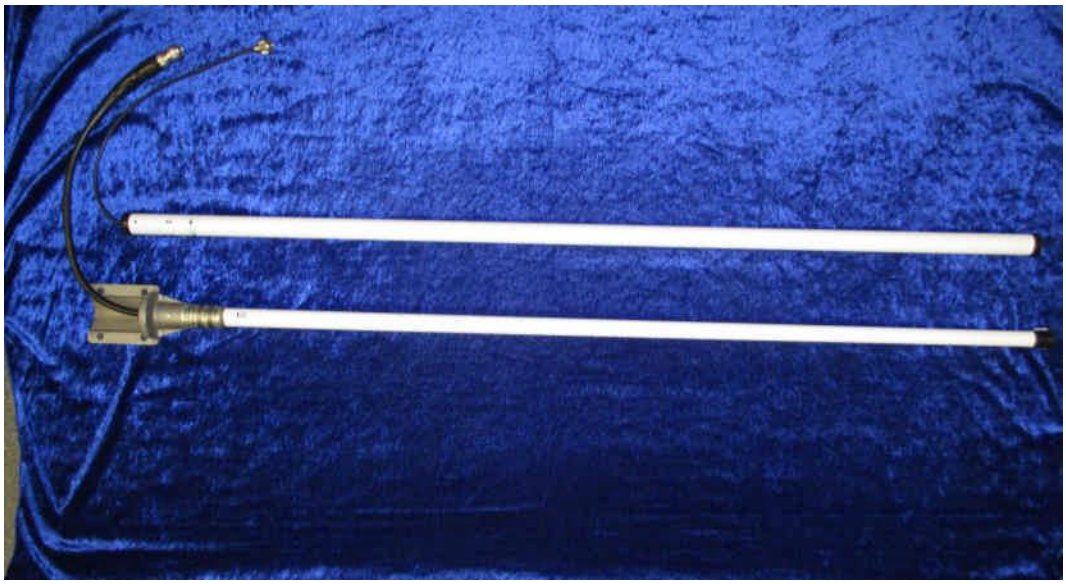






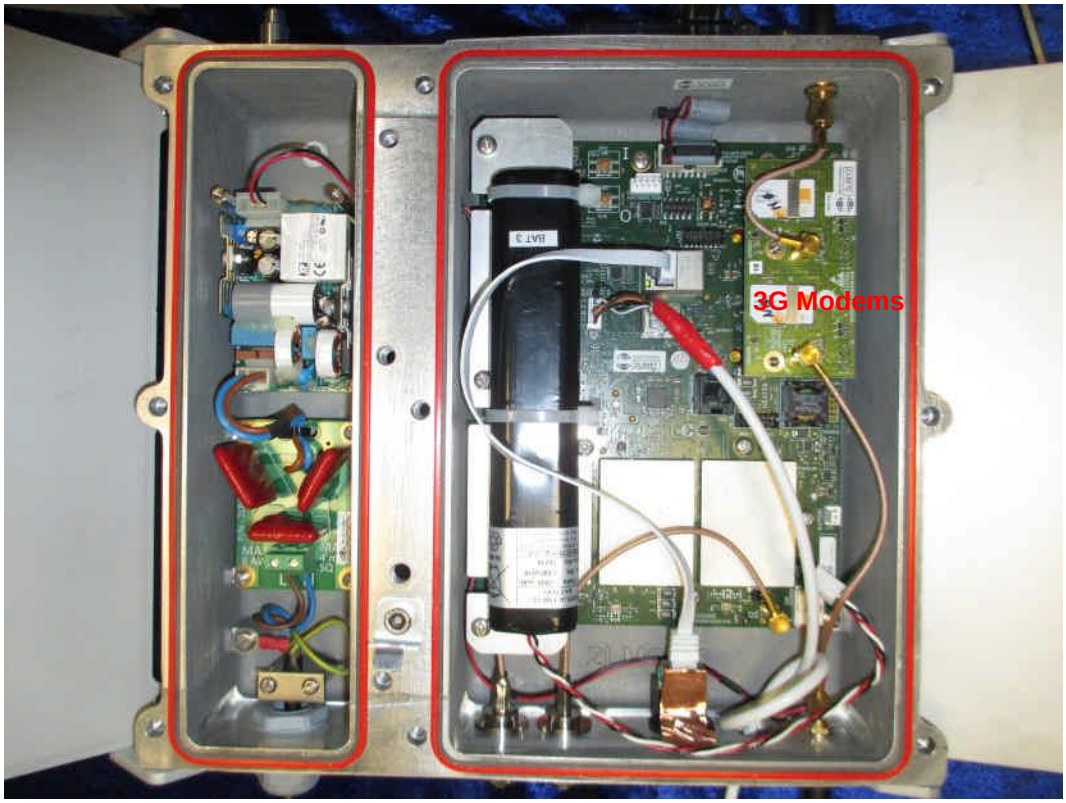
8.3 EUT Antenna Ports

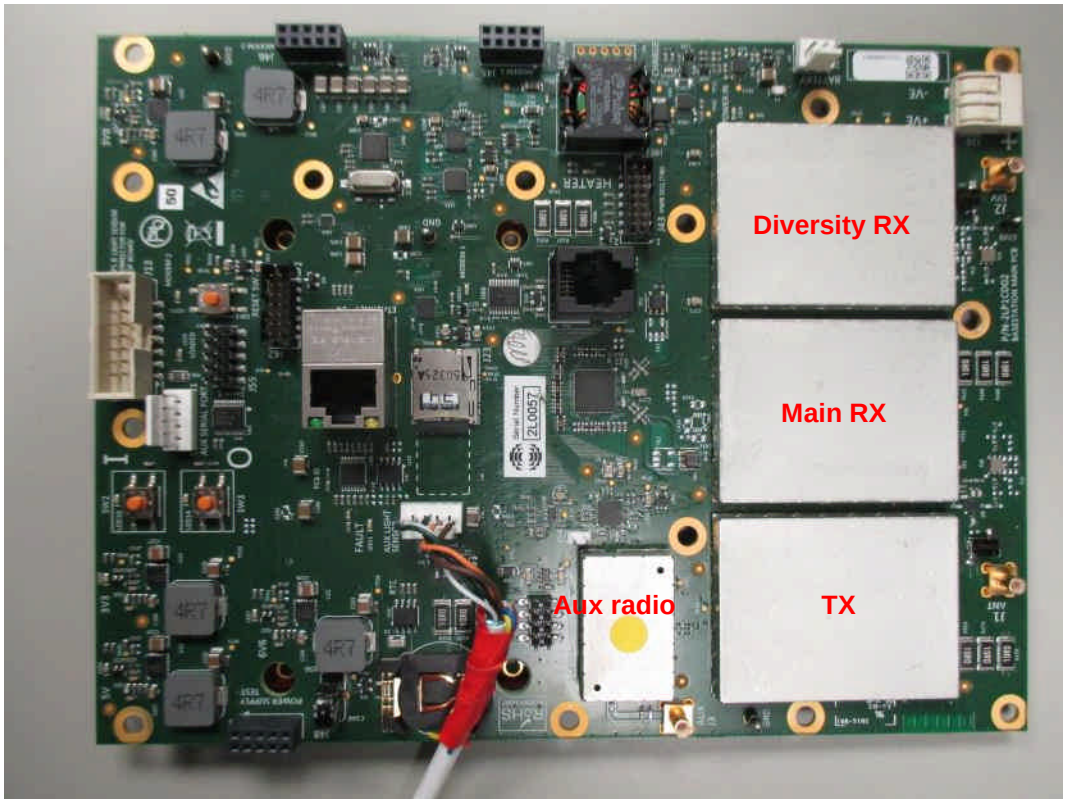


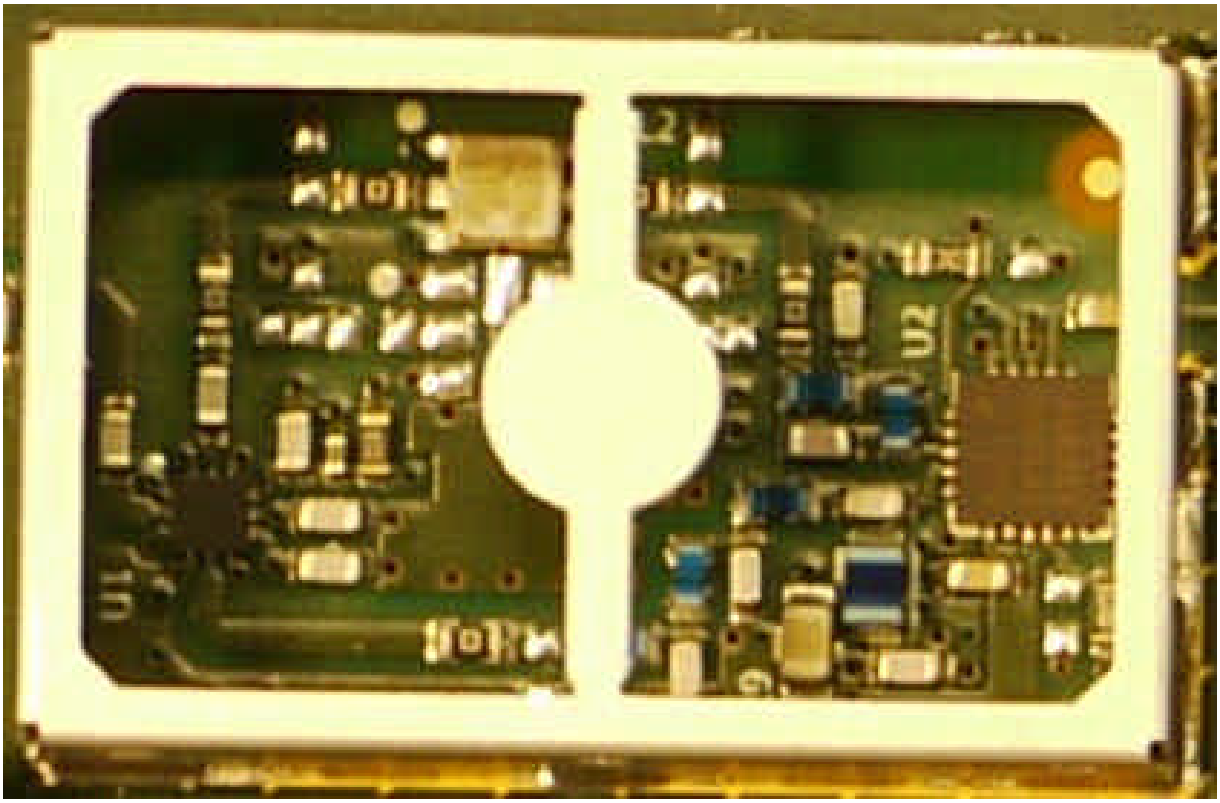


Antennae

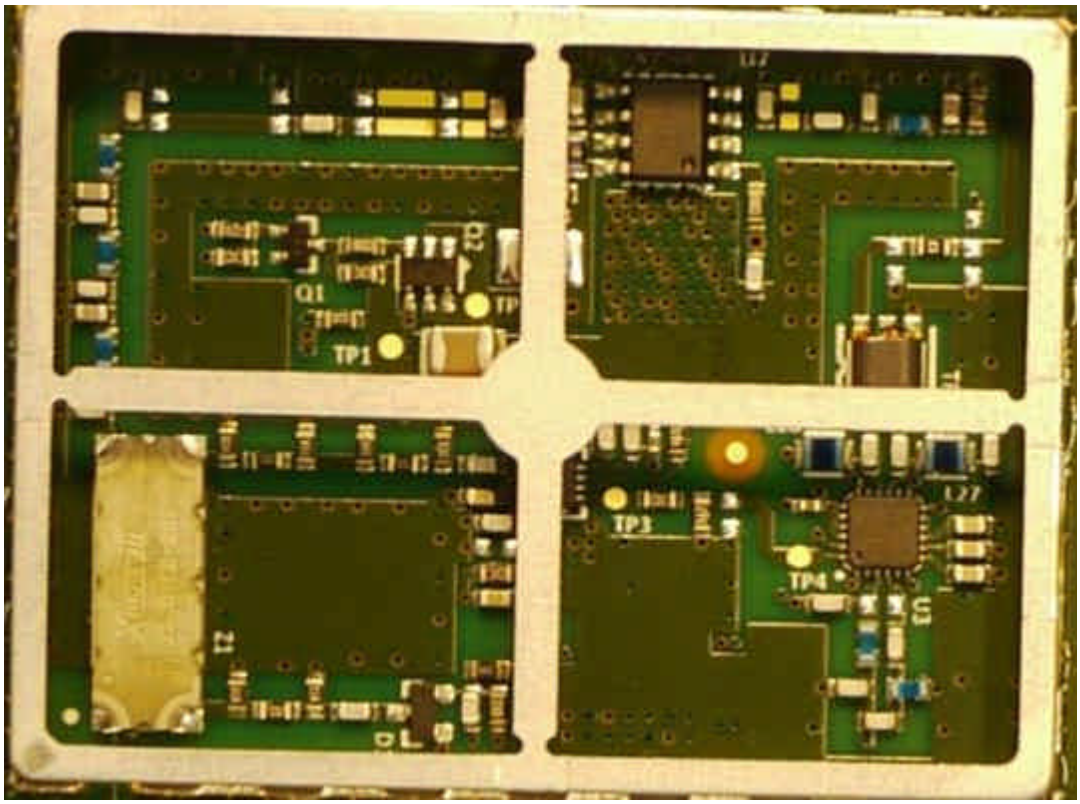
8.4 EUT Internal photos



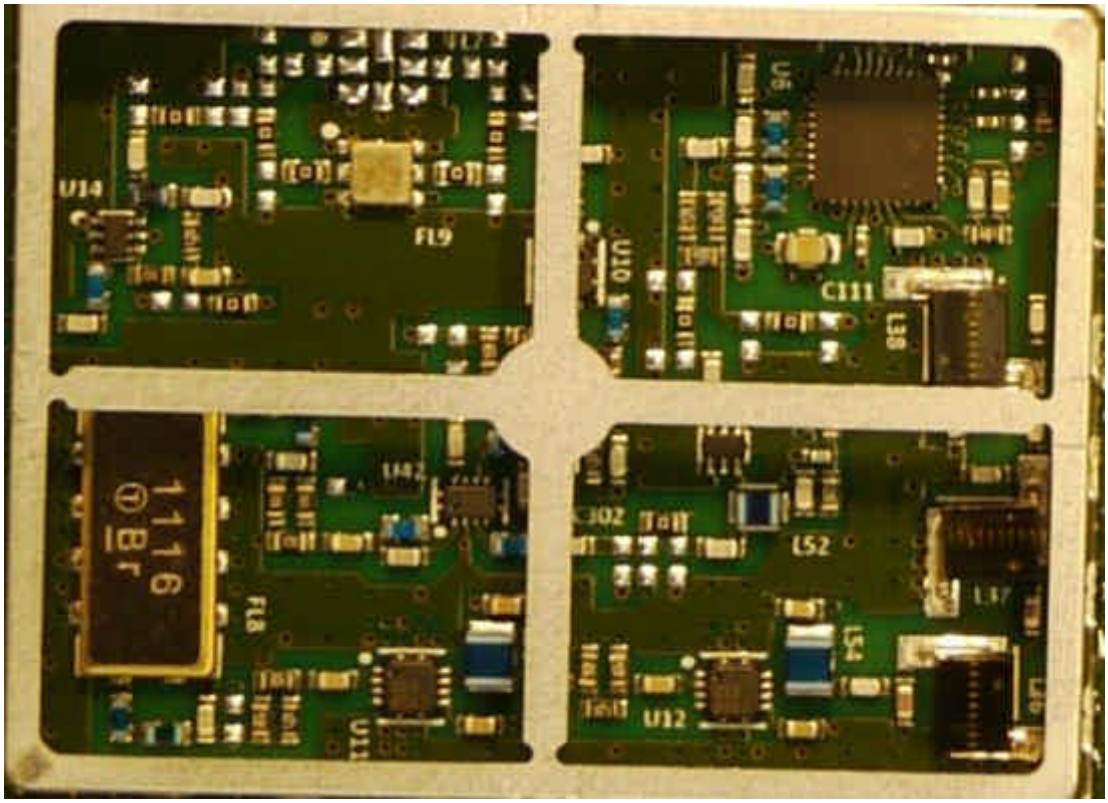




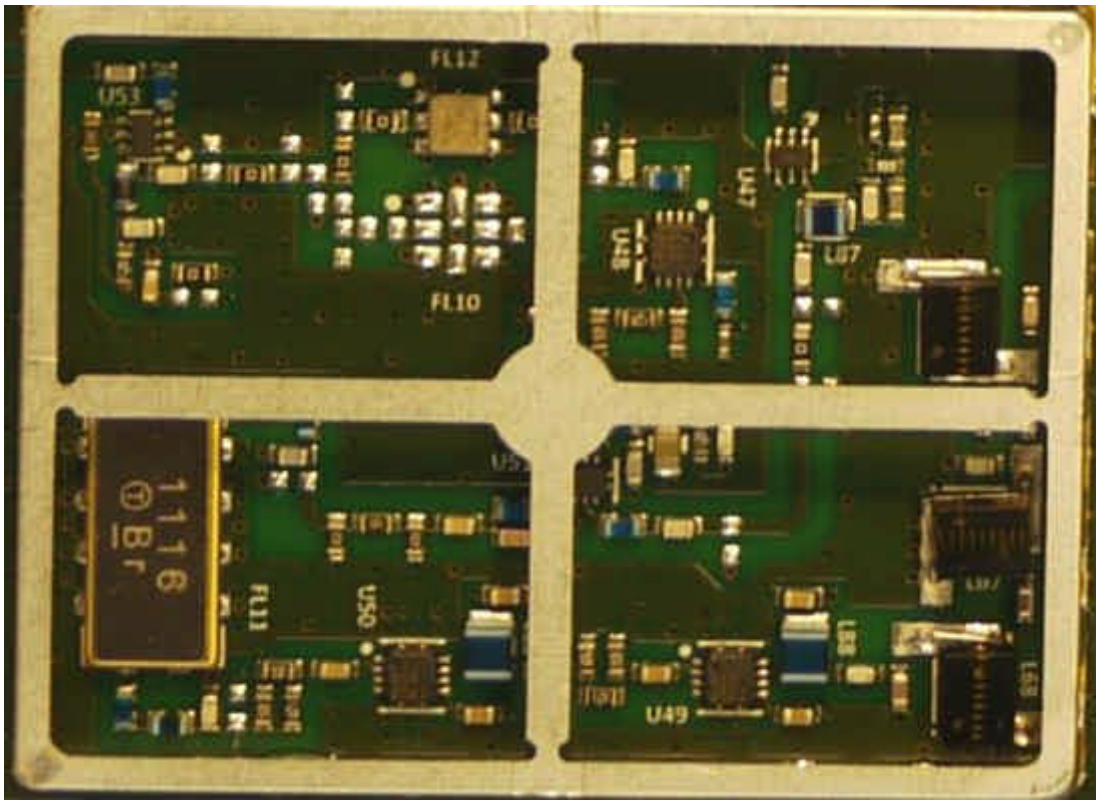
Close-up Aux radio



Close-up TX

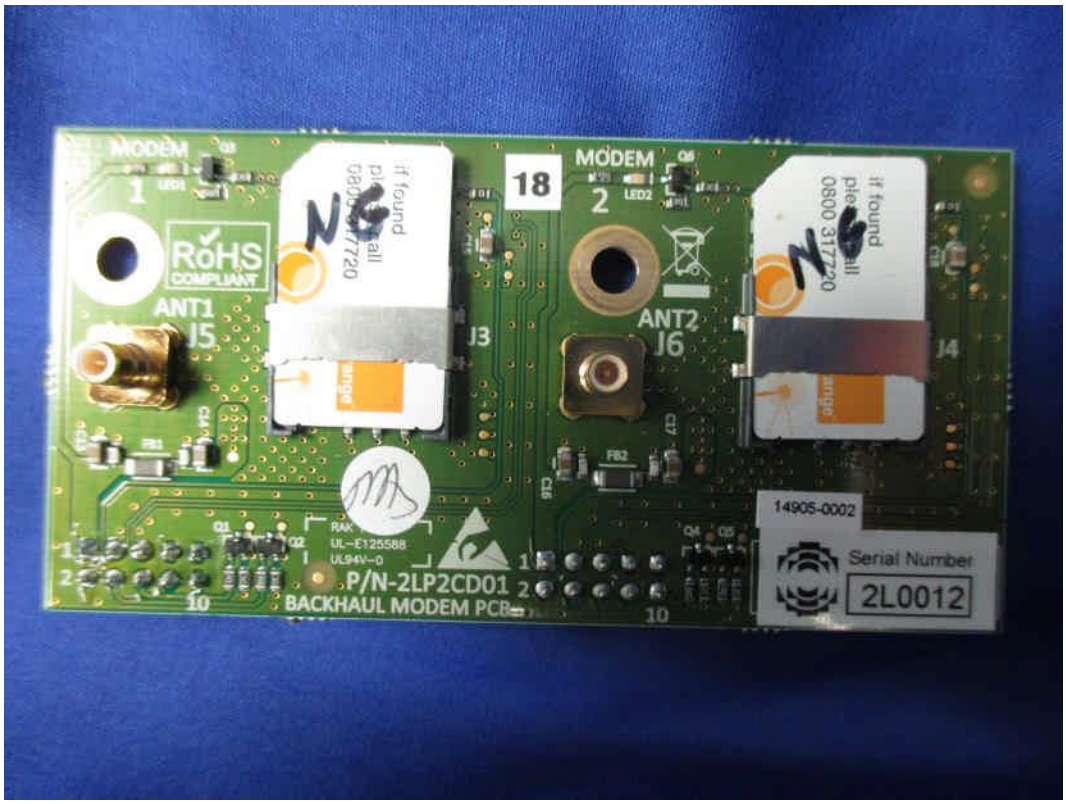


Close-up RX

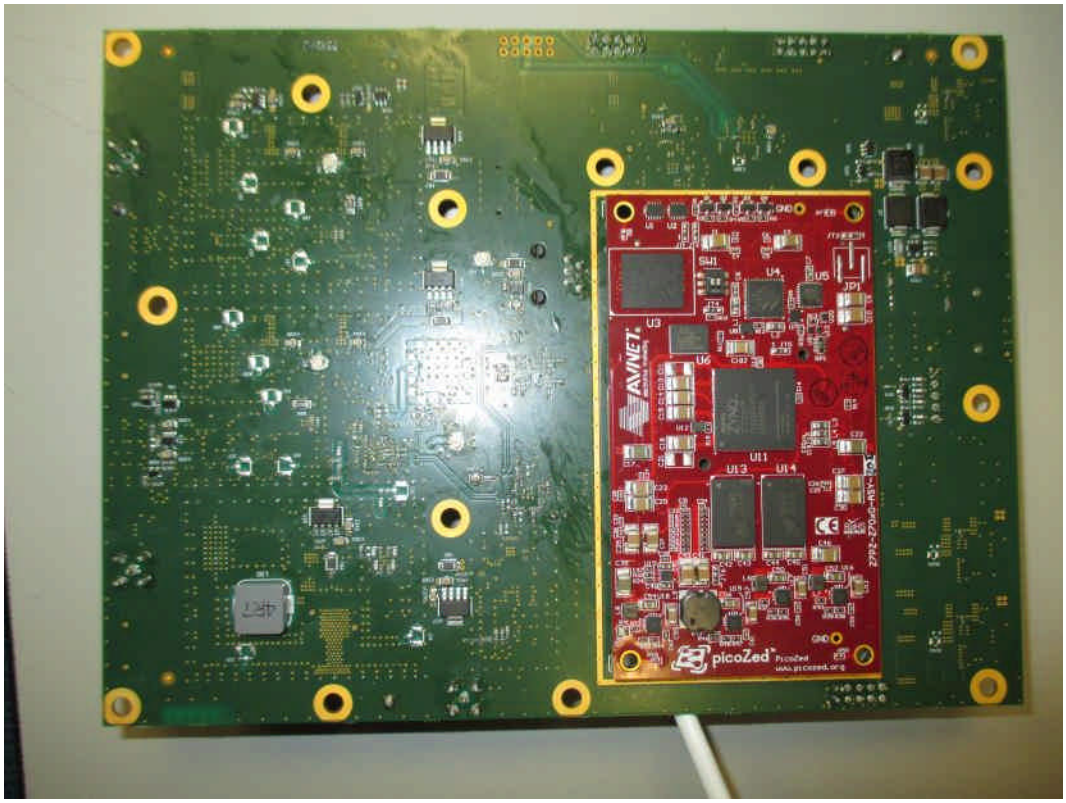


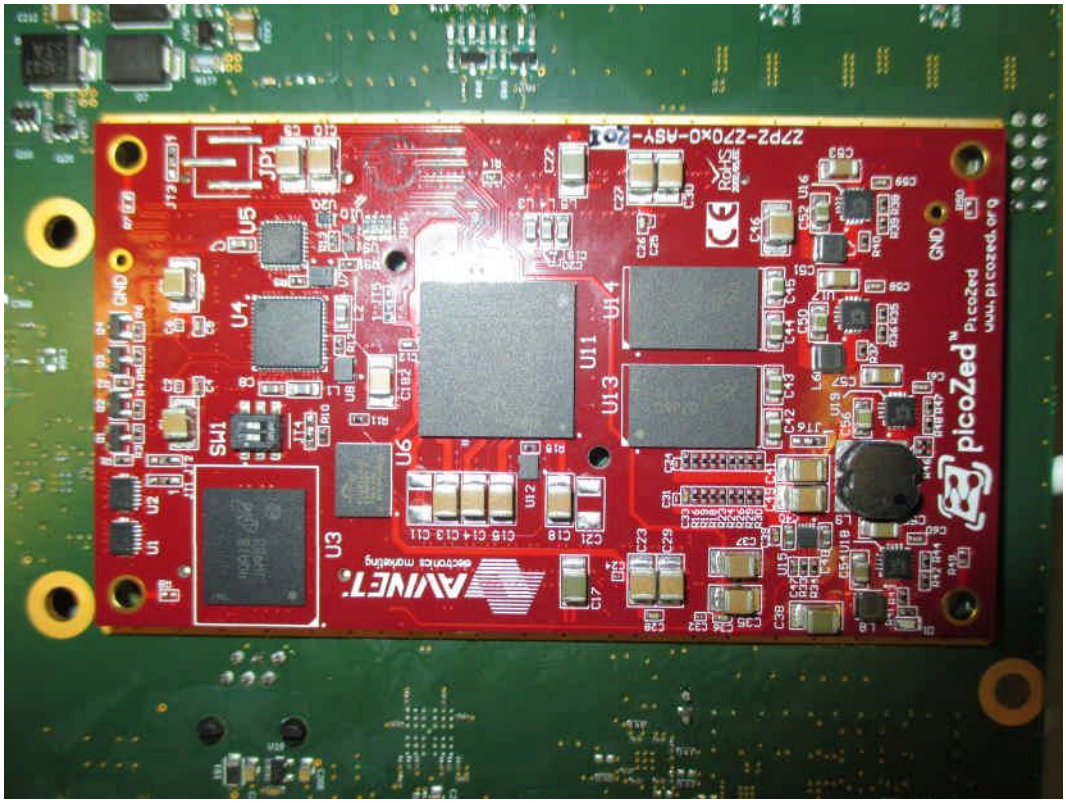
Close-up Diversity RX

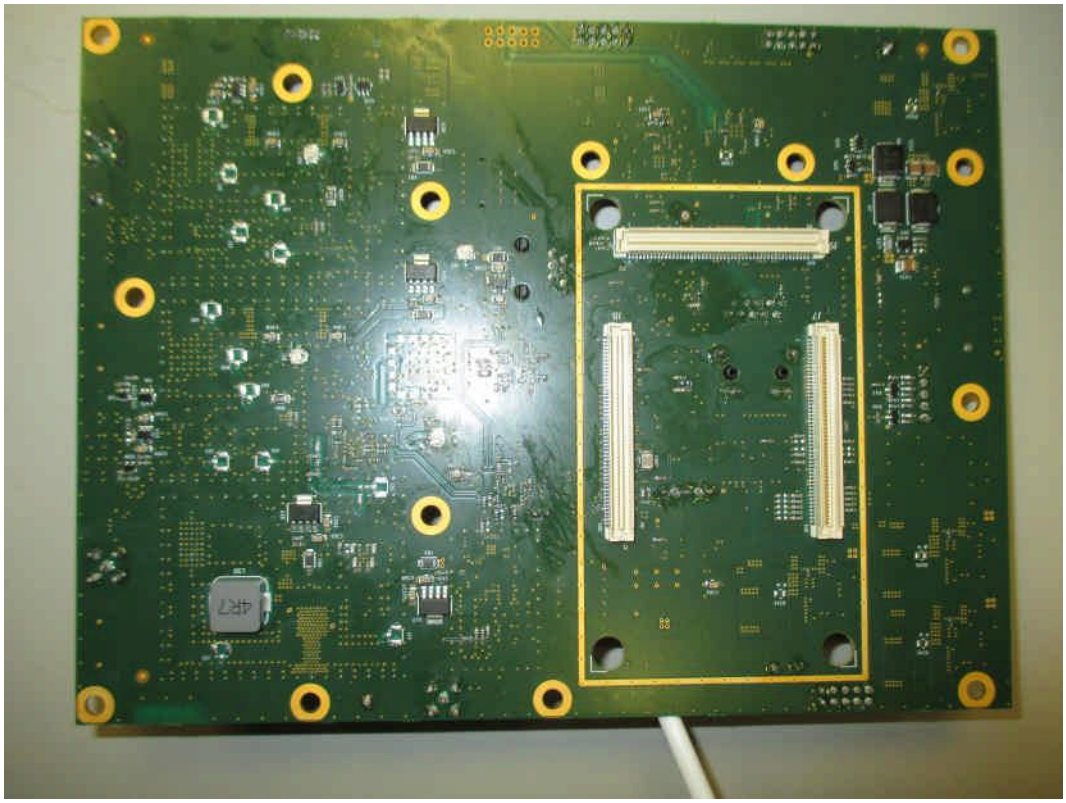
Close up 3G modems underside

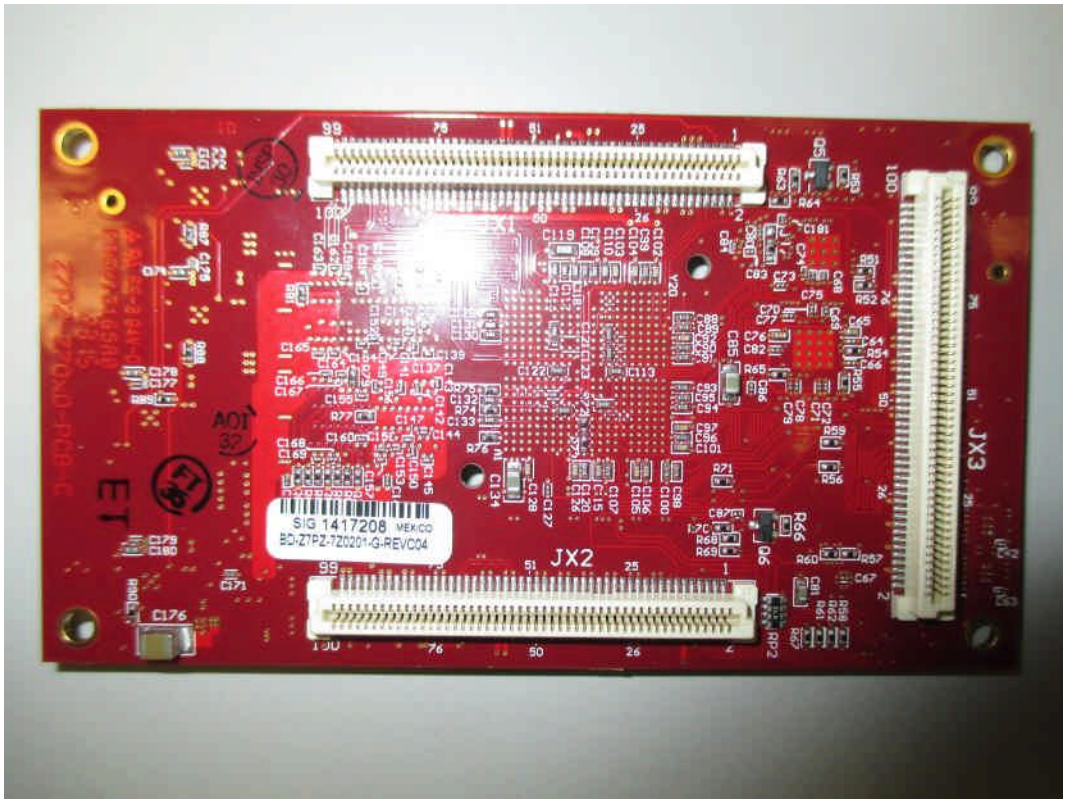


Close up 3G modems topside


picoZed


picoZed
AVNET

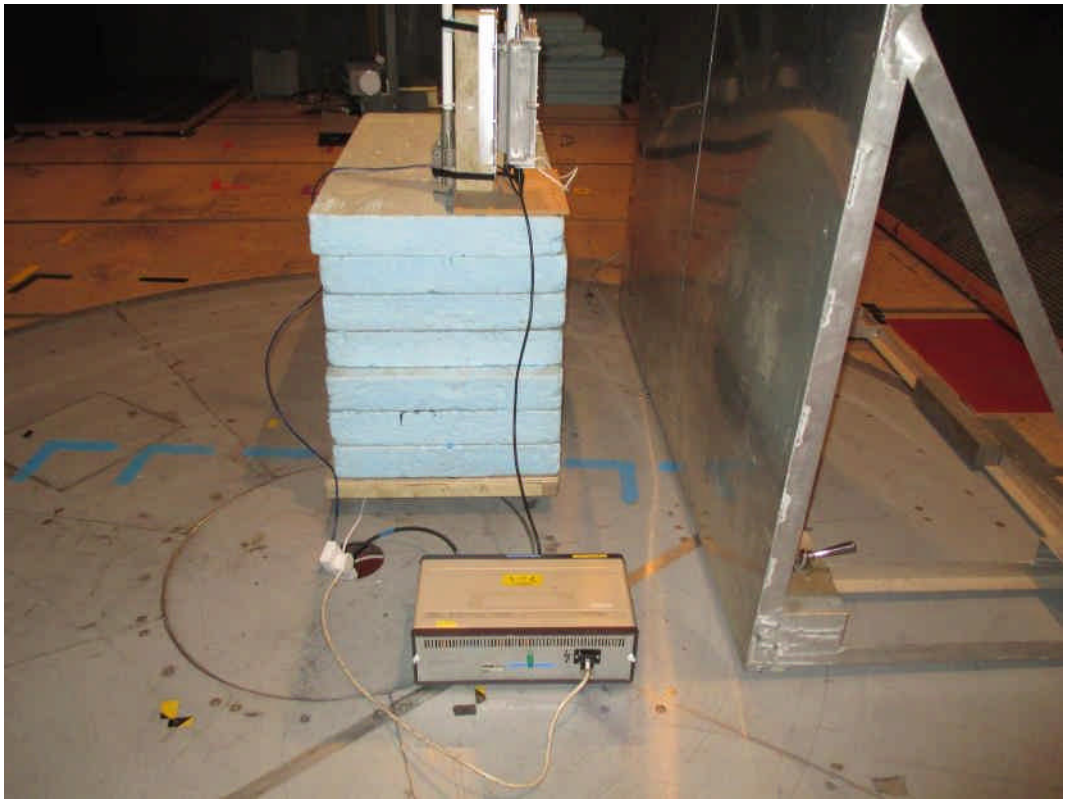




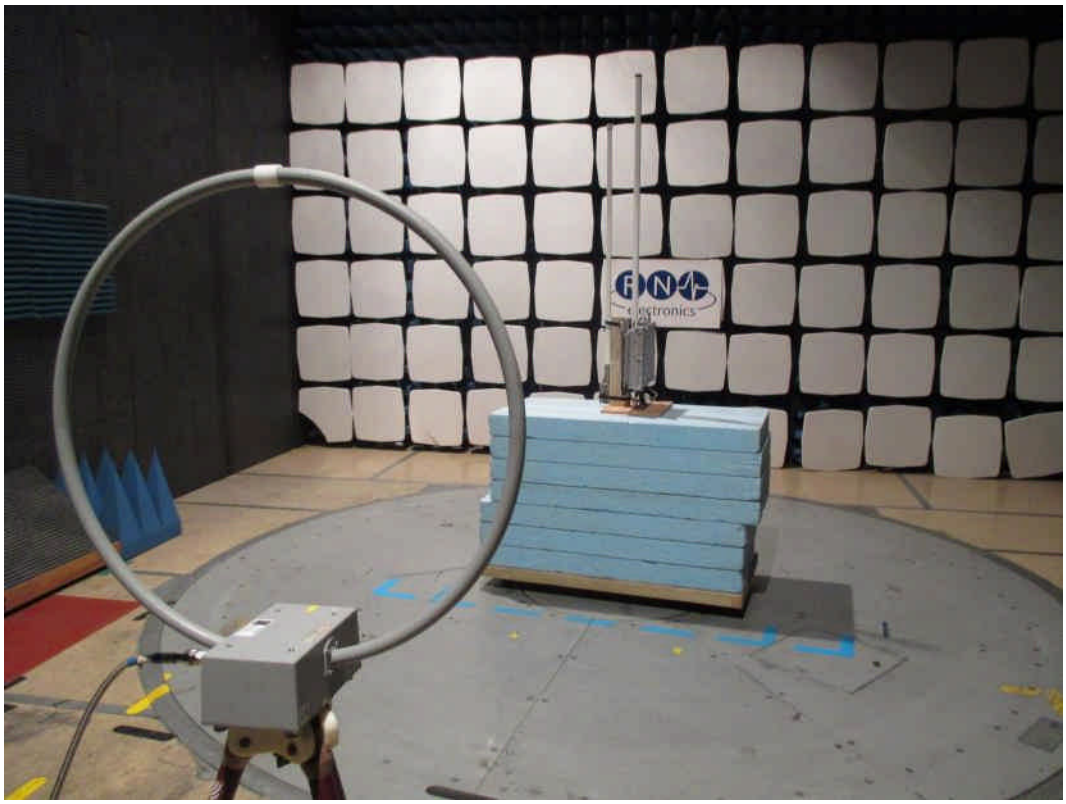
8.5 EUT ID Label

No external labelling provided on unit for test.

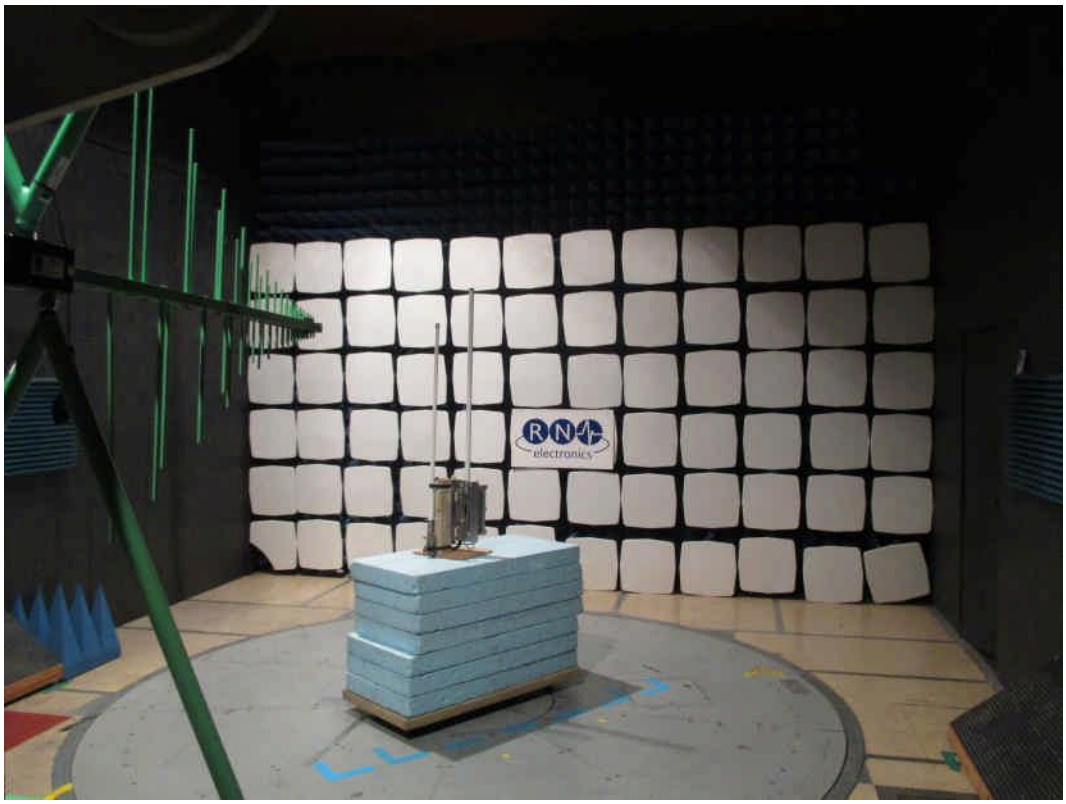
8.6 AC power line conducted emissions



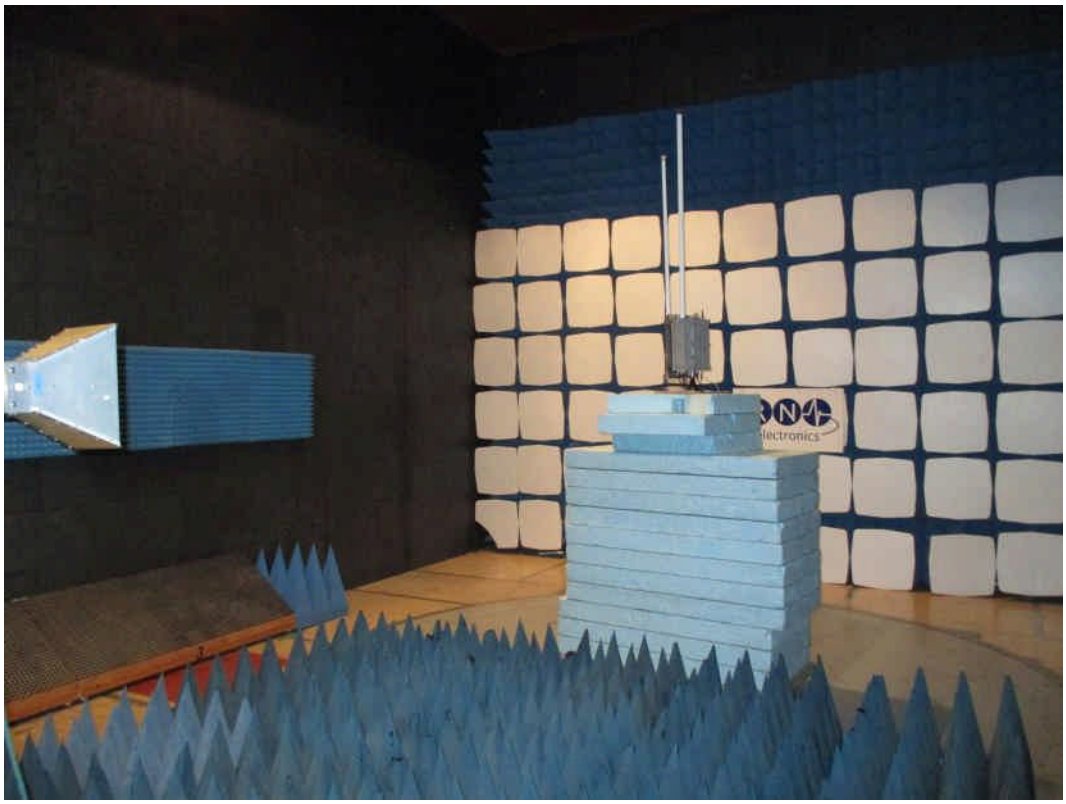
8.7 TX Unwanted radiated emissions 150 kHz-30 MHz



8.8 TX Unwanted radiated emissions 30 MHz-1 GHz



8.9 TX Unwanted radiated emissions above 1 GHz



8.10 Radiated emission diagram

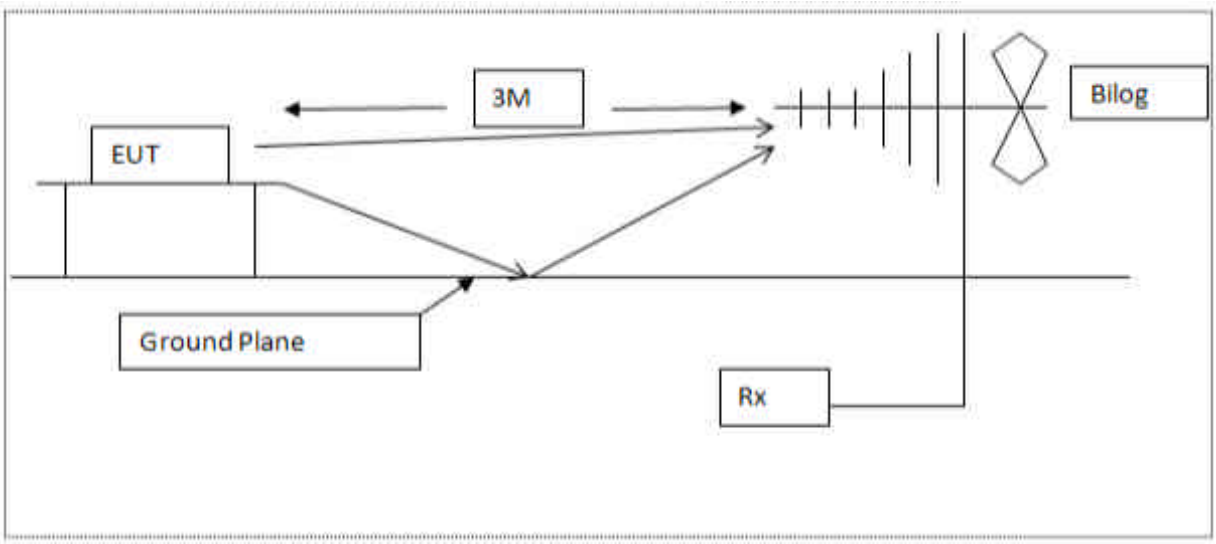


Diagram of the radiated emissions test setup 30 - 1000 MHz

8.11 AC powerline conducted emission diagram

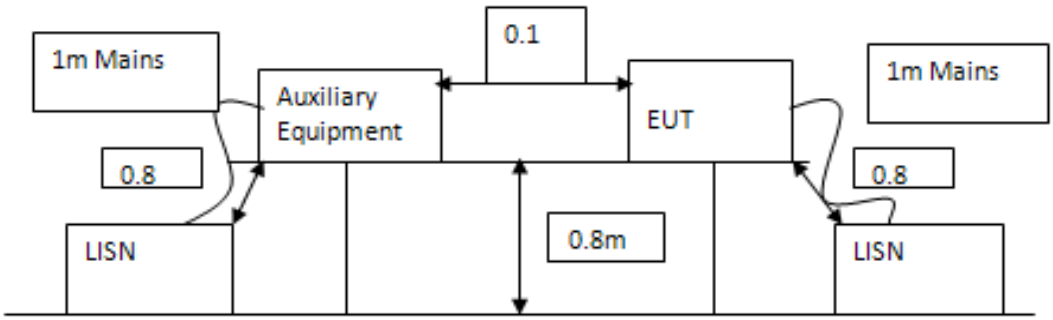


Diagram of the AC conducted emissions test setup

9 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E306	24-40-34	Attenuator 40dB 8.5GHz 50W	Weinschel	09-Jan-2017	12 months
E313	777C	Attenuator 30dB	Narda	17-Jun-2016	12 months
E328	564230-001	Notch Filter 915 MHz	BRF	N/A	N/A
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	06-Jul-2016	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	06-Jul-2016	24 months
E429	-	5 Switch Filter Box 0.91 GHz - 16.3 GHz	RN Electronics	24-Aug-2016	12 months
E478	LQ2992/H	Bandpass Filter 1-3GHz	RACAL-MESL	N/A	N/A
E534	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	18-Jan-2017	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	18-Jan-2017	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	22-Dec-2015	24 months
LPE222	MN2050	Artificial Mains Network	Chase	13-Apr-2016	12 months
LPE261	3115	Horn Antenna 1-18 GHz	EMCO	04-Apr-2016	24 months
LPE333	8449B	Pre-amplifier 1GHz - 26.5GHz	Hewlett Packard	18-Apr-2016	24 months
LPE364	CBL6112A	30MHz - 2GHz Bilog Antenna	Chase Electronics Ltd	22-Jan-2016	24 months
LPE373	11947A	Transient Limiter 9kHz - 200MHz	Hewlett Packard	15-Nov-2016	6 months
TMS78	3160-08	Std Gain Horn Antenna 12.4-18 GHz	ETS Systems	03-Jun-2016	12 months
TMS79	3160-09	Std Gain Horn Antenna 18-26.5 GHz	ETS Systems	03-Jun-2016	12 months
TMS45	Model1	Attenuator 3dB 12.4GHz	Weinschel	02-Sep-2016	12 months
TMS81	6502	Active Loop Antenna	EMCO	27-Apr-2015	24 months
ZSW1	V2.1	Measurement Software Suite	RN Electronics	N/A	N/A

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

There was no customer supplied equipment.

10.2 RN Electronics supplied equipment

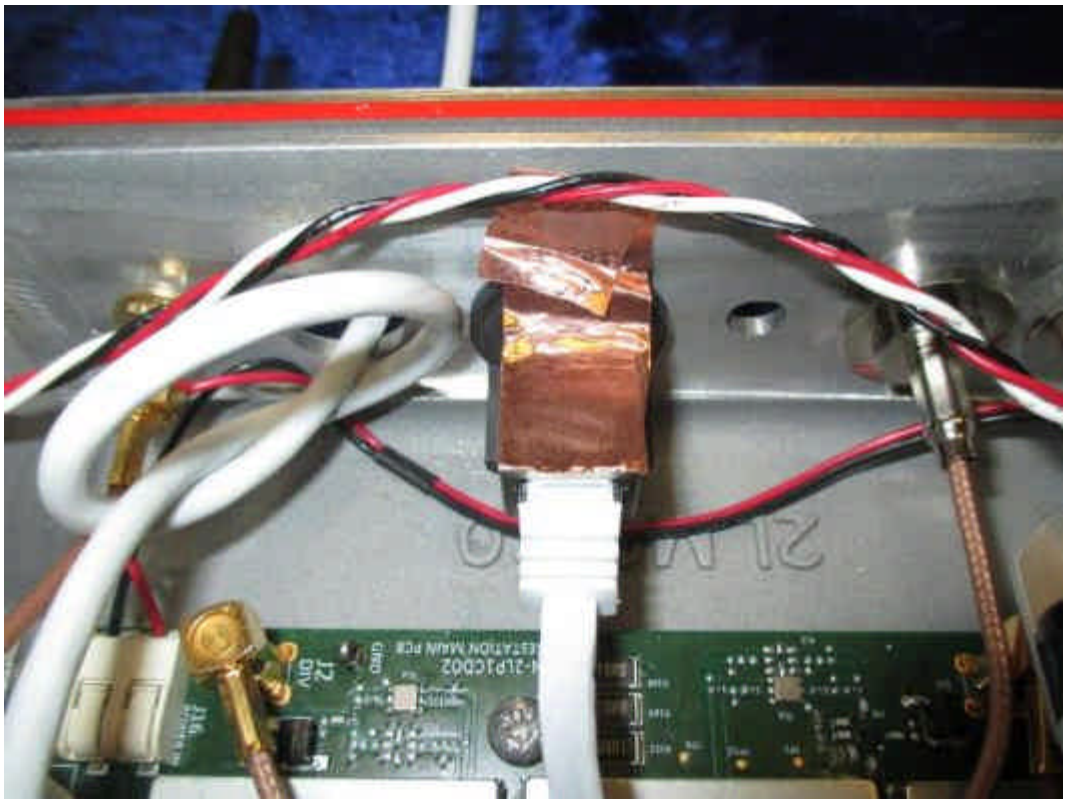
RN No.	Model No.	Description	Manufacturer	Serial No
I218	ZYW	Laptop	Acer	NXV9WEK0014380846B7600

11 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

11.1 Modifications before test

Test	Modification	Time of modification	Photo Reference
TX Rad Em	Ethernet connector bonded to chassis	Before testing	MOD1



11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 Description of test sites

Site A	Radio / Calibration Laboratory and anechoic chamber
Site B	Semi-anechoic chamber
Site B1	Control Room for Site B
Site C	Transient Laboratory
Site D	Screened Room (Conducted Immunity)
Site E	Screened Room (Control Room for Site D)
Site F	Screened Room (Conducted Emissions)
Site G	Screened Room (Control Room for Site H)
Site H	3m Semi-anechoic chamber (indoor OATS) FCC Registration No. 293246 IC Registration No. 5612A-2
Site J	Screened Room
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-anechoic chamber (indoor OATS) FCC Registration No. 293246
Site Q	Fully-anechoic chamber
Site OATS	3m and 10m Open Area Test Site FCC Registration No. 293246 IC Registration No. 5612A-1
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

13 Abbreviations and units

%	Percent
µA/m	microAmps per metre
µV	microVolts
µW	microWatts
AC	Alternating Current
ALSE	Absorber Lined Screened Enclosure
AM	Amplitude Modulation
Amb	Ambient
ATPC	Automatic Transmit Power Control
BER	Bit Error Rate
ºC	Degrees Celsius
C/I	Carrier / Interferer
CEPT	European Conference of Postal and Telecommunications Administrations
COFDM	Coherent OFDM
CS	Channel Spacing
CW	Continuous Wave
dB	deciBels
dBµA/m	deciBels relative to 1µA/m
dBµV	deciBels relative to 1µV
dBc	deciBels relative to Carrier
dBm	deciBels relative to 1mW
DC	Direct Current
DTA	Digital Transmission Analyser
EIRP	Equivalent Isotropic Radiated Power
ERP	Effective Radiated Power
EU	European Union
EUT	Equipment Under Test
FM	Frequency Modulation
FSK	Frequency Shift Keying
g	Grams
GHz	GigaHertz
Hz	Hertz
IF	Intermediate Frequency
kHz	kiloHertz
LBT	Listen Before Talk
LO	Local Oscillator
mA	milliAmps
max	maximum
kPa	Kilopascal
Mbit/s	MegaBits per second
MHz	MegaHertz
mic	Microphone
min	minimum
mm	milliMetres
ms	milliSeconds
mW	milliWatts
NA	Not Applicable
nom	Nominal
nW	nanoWatt
OATS	Open Area Test Site
OFDM	Orthogonal Frequency Division Multiplexing
ppm	Parts per million
PRBS	Pseudo Random Bit Sequence
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
R&TTE	Radio and Telecommunication Terminal Equipment
Ref	Reference
RF	Radio Frequency
RFC	Remote Frequency Control
RSL	Received Signal Level
RTP	Room Temperature and Pressure
RTPC	Remote Transmit Power Control
Rx	Receiver
s	Seconds
SINAD	Signal to Noise And Distortion
Tx	Transmitter
V	Volts