Radio Test Report

Domino UK Ltd.

Quality Management Module (QMM)

EPT012462 (made of EPT013186 & EPT013423)

47 CFR Part 15.225 Effective Date 1st October 2014

Test Date: 18th January 2016 to 22nd January 2016
Report Number: 01-8061-5-16 Issue 02
Supersedes report: 01-8061-5-16 Issue 01

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Certificate of Test 8061-5

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of 47 CFR Part 15C. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	Quality Management Module (QMM)
Model Number:	**EPT012462** (made of EPT013186 & EPT013423)
Unique Serial Number:	PXA000051-R03 & PXA000074-R03
Manufacturer:	Domino UK Ltd. Trafalgar Way, Bar Hill Cambridge, Cambridgeshire CB23 8TU
Full measurement results are detailed in Report Number:	01-8061-5-16 Issue 02
Test Standards:	47 CFR Part 15.225 Effective Date 1st October 2015 FCC|DXT: Part 15 Low Power Transceiver, Rx Verified

NOTE:
Certain tests were not performed based upon manufacturer's declarations. For details refer to section 3 of this report.

DEVIATIONS:
Deviations have not 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 Federal 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 the FCC 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: 18th January 2016 to 22nd January 2016

Test Engineer: Ian Rose
Digitally signed by: Ian Rose
DN: CN = Ian Rose email = Ian@rnelectronics.com C = GB O = RN Electronics
Date: 2016.05.19 13:28:35 Z

Approved By:
Radio Approvals Manager
Digitally signed by: Daniel Sims
DN: CN = Daniel Sims C = GB O = RN Electronics Ltd
Date: 2016.05.19 13:13:47 Z

Customer Representative:

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Domino UK Ltd. Trafalgar Way Bar Hill Cambridge Cambridgeshire CB23 8TU	
Manufacturer of EUT	Domino UK Ltd	
Brand name of EUT	Quality Management Module (QMM)	
Model Number of EUT	EPT012462 (made of EPT013186 & EPT013423)	
Serial Number of EUT	PXA000051-R03 & PXA000074-R03	
Date Received	18th January 2016	
Date of Test:	18th January 2016 to 22nd January 2016	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Created	17th February 2016	
Visual Description	The first unit is a rectangular, opaque plastic moulded case housing a printed circuit board. There are two hard wired cables exiting the unit, one to a USB connector and another connecting to the second unit via a 10 way connector. The second unit is housed in a black plastic moulded case. A wooden test fixture was used to hold the two units under test in a fixed position replicating the position as would be fitted inside a host printer	
Main Function	Printer consumables authentication and fluid level sensing	
Information Specification	Height	135/111mm
	Width	110/325mm
	Depth	145/28mm
	Weight	198/409g
	Voltage	4.75-5.25V
	Current	0.35A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Desktop
Choice of model(s) for type tests	Production samples
Antenna details	PCB inductive loop design with 3 turn 60 mm x 50 mm. 1.5mm track 0.5 mm gap.
Antenna port	None
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	27.12 MHz
Lowest Signal generated in EUT	1 MHz
TX Parameters	
Alignment range – transmitter	13.56 MHz +/- 7 kHz
EUT Declared Modulation Parameters	IEC/ISO14443A and B-A=100% ASK B=10% ASK
EUT Declared Power level	230 mW (conducted at output of RF IC)
EUT Declared Signal Bandwidths	14 kHz
EUT Declared Channel Spacing's	Single channel
EUT Declared Duty Cycle	20 ms TX burst from each antenna in turn with all three antennas cycled in 75 ms.
Unmodulated carrier available?	No
Declared frequency stability	+/-30 ppm
RX Parameters	
Alignment range – receiver	13.56 MHz +/- 7 kHz
EUT Declared RX Signal Bandwidth	14 kHz

2.3 Functional description

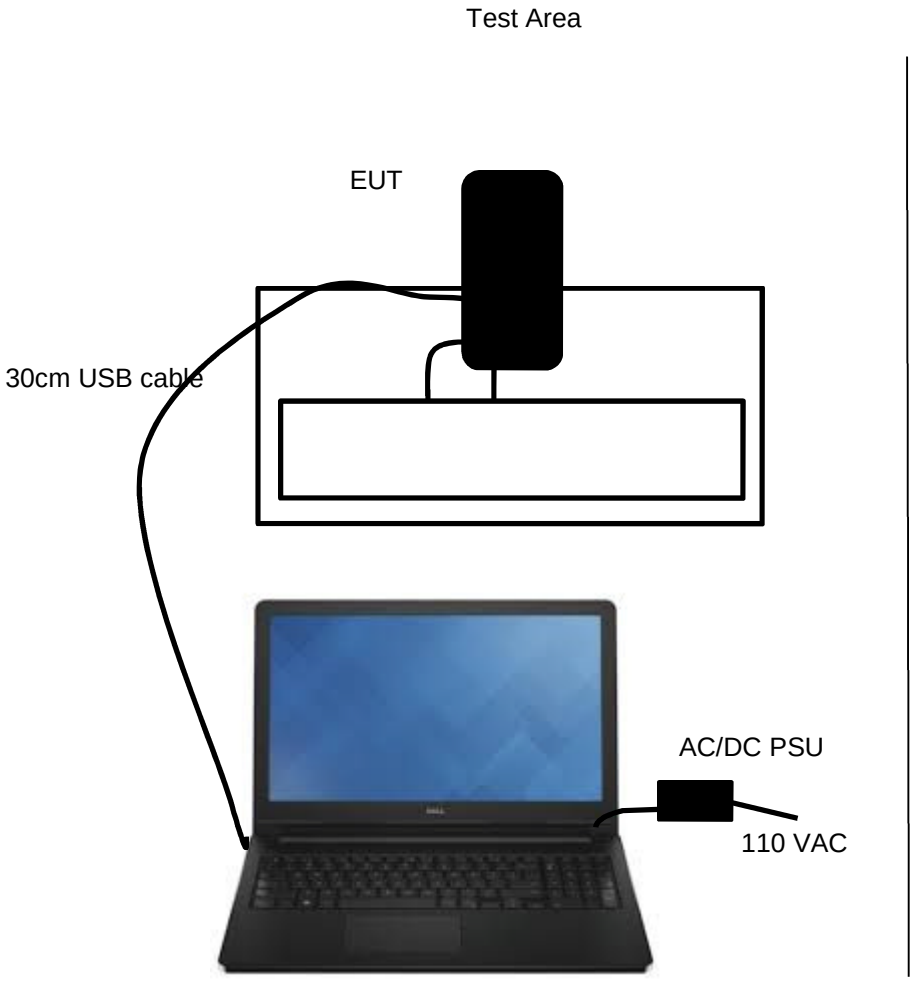
The sub system comprises two modules connected via a cable. The top module houses two RF ID antennas to read (and write) ISO 14443 passive tags on ink and solvent cartridges, a security chip to ensure the top module is a genuine Domino part and indication LEDs. The bottom module houses a single RF ID antenna and two capacitive level sensing arrays for detecting fluid in the printer reservoirs. ISO 14443 type A and type B tags are to be supported by the module. The subsystem is powered via a current-limited USB interface (0.5A, 5V) and designed to conform to the ISO 14443 standards for short range use.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX Normal	EUT cycling round its 3 RFID transmitters in turn every 75 ms	Yes
TX0	INK TX/antenna	Yes
TX1	MAKEUP TX/antenna	Yes
TX2	ITM TX/antenna	Yes

Modes checked with and without tags present in field.

2.5 Emissions configuration



The unit was powered from the USB port of the computer. The unit was configured with engineering menus in software to allow permanent transmit modes of device on a single channel. The ITM, MUP and INK transmitter modes were set using the engineering mode provided within the unit. The transmit modes were 100% continuous with modulation and the power settings for all modes were the default values, this was not programmable during tests. Power was declared by the manufacturer to be 230mW from the RF IC datasheet with modulation ISO14443B being used. Each transmitter had an associated RFID tag supplied with the unit which when scanned reported its information on the laptop software. Tests were performed with and without each of the tags in proximity to their respective transmitters to determine any worst case modes for test. The EUT was provided on a wooden test jig with both parts of the module located in the positions that they would be fitted into the host printer.

2.5.1 Signal leads

Port Name	Cable Type	Connected
USB Power/Comms	30 cm cable, USB A plug	Yes

3 Summary of test results

The Quality Management Module (QMM) EPT012462 was tested for compliance to the following standard(s) :

47 CFR Part 15.225 Effective Date 1st October 2014
FCC|DXT: Part 15 Low Power Transceiver, Rx Verified

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC 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	47 CFR Part 15C Part 15.207	PASSED
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209	PASSED
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15C Part 15.209	PASSED[1]
5. Intentional radiator field strength	47 CFR Part 15C Part 15.225(a)	PASSED
6. Occupied bandwidth	47 CFR Part 15C Part 15.215	PASSED
7. Spectrum mask	47 CFR Part 15C Part 15.225	PASSED
8. Frequency stability	47 CFR Part 15C Part 15.225(e)	PASSED

[1] Spectrum investigated started at a frequency of 30MHz up to a frequency of 1 GHz based on 10 times the highest channel/ signal generated in equipment of 27.12 MHz.

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	47 CFR Part 15C	2014	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2013	American National Standard for Testing Unlicensed Wireless Devices
4.1.3	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

4.2 Deviations

Deviations have not been applied.

4.3 Tests at extremes of temperature & voltage

The following test conditions were used to simulate testing at nominal or extremes.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	5V DC
T minimum	-20 °C	V minimum	4.75V DC
T maximum	50 °C	V maximum	5.25V DC

Extremes of voltage are as declared by the applicant.
Extremes of temperature are as listed in the standard.
The ambient test conditions of humidity and pressure in the laboratory were as follows:
40 %; 102 kPa.

4.4 Test fixtures

In order to measure RF parameters at temperature extremes, the EUT was tested in a temperature controlled chamber as follows:

A test fixture was used for testing.

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.207 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.2 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.207 [Reference 4.1.1 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 10. During the initial scan, mode TX Normal with or without tags was found to be worst case mode of operation.

5.1.3 Test procedure

Tests were made in accordance with FCC Part 15 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

E450, LPE373, E534, E535

See Section 9 for more details

5.1.5 Test results

Temperature of test environment	15°C
Humidity of test environment	46%
Pressure of test environment	102kPa

Band	13.553-13.567 MHz
Power Level	230 mW declared
Channel Spacing	Single Channel
Mod Scheme	ISO14443 B
single channel	13.56 MHz All TX

Plot refs
8061-5 Cond 1 AC Live 150k-30M Average
8061-5 Cond 1 AC Live 150k-30M Quasi-Peak
8061-5 Cond 1 AC Neutral 150k-30M Average
8061-5 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	0.158	69.0	62.7	-2.9	31.4	-24.2
2	0.162	68.6	61.8	-3.6	30.6	-24.8
3	0.204	64.5	57.9	-5.5	42.0	-11.4
4	0.204	63.6	57.7	-5.7	41.6	-11.8
5	0.204	64.7	57.9	-5.5	42.5	-10.9
6	0.216	72.3	60.7	-2.3	35.5	-17.5
7	0.249	67.5	60.6	-1.2	36.9	-14.9
8	0.283	67.8	59.5	-1.2	30.6	-20.1
9	0.337	64.3	55.6	-3.7	30.1	-19.2
10	0.341	66.8	54.3	-4.9	35.3	-13.9
11	0.341	64.5	57.2	-2.0	35.5	-13.7
12	0.351	65.5	56.4	-2.5	23.9	-25.0
13	0.383	62.0	52.5	-5.7	27.5	-20.7
14	0.401	60.4	53.4	-4.4	27.4	-20.4
15	0.433	47.2	42.0	-15.2	17.1	-30.1
16	0.463	58.9	40.9	-15.7	17.3	-29.3
17	0.477	58.9	45.3	-11.1	28.7	-17.7
18	0.506	57.6	46.2	-9.8	20.6	-25.4
19	0.519	52.2	35.9	-20.1	15.0	-31.0
20	0.519	43.8	36.2	-19.8	21.7	-24.3
21	0.585	61.3	49.0	-7.0	12.8	-33.2
22	0.599	50.7	47.4	-8.6	21.9	-24.1
23	0.736	42.8	30.2	-25.8	20.1	-25.9
24	0.736	52.1	27.7	-28.3	12.7	-33.3
25	2.409	25.3	18.8	-37.2	9.2	-36.8
26	13.558	50.5	49.5	-10.5	44.8	-5.2

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	0.155	70.1	62.3	-3.4	31.3	-24.4
2	0.179	64.6	59.3	-5.2	28.6	-25.9
3	0.204	64.0	58.0	-5.4	41.1	-12.3
4	0.250	57.3	51.9	-9.9	31.3	-20.5
5	0.250	57.6	52.0	-9.8	31.2	-20.6
6	0.286	54.2	48.6	-12.0	20.2	-30.4
7	0.340	51.6	45.6	-13.6	30.9	-18.3
8	0.378	47.8	42.5	-15.8	16.4	-31.9
9	0.407	48.1	41.0	-16.7	27.0	-20.7
10	0.408	47.8	41.6	-16.1	26.7	-21.0
11	0.476	44.7	38.7	-17.7	25.9	-20.5
12	0.476	43.8	38.1	-18.3	26.0	-20.4
13	0.476	44.1	38.0	-18.4	26.1	-20.3
14	0.498	41.3	36.6	-19.4	13.5	-32.5
15	0.512	40.8	35.4	-20.6	13.3	-32.7
16	0.541	41.0	35.5	-20.5	24.2	-21.8
17	0.544	41.7	35.6	-20.4	25.8	-20.2
18	0.611	39.8	32.8	-23.2	24.3	-21.7
19	0.679	37.0	31.5	-24.5	25.3	-20.7
20	0.749	40.5	39.0	-17.0	34.1	-11.9
21	1.749	38.6	37.1	-18.9	33.7	-12.3
22	2.248	36.2	34.9	-21.1	30.8	-15.2
23	3.245	35.6	33.6	-22.4	29.6	-16.4
24	13.558	49.6	48.9	-11.1	44.6	-5.4

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

LIMITS:
15.207: as given in the above tables and 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 Radiated emissions 9 - 150 kHz

5.2.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.225(d) [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

The EUT was placed on a 0.8 metre 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 antenna was orientated in both Parallel and Perpendicular polarisations. The EUT was rotated in all three orthogonal planes. The EUT was operated in mode TX Normal with and without tags.

5.2.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Measurements were made in a semi-anechoic chamber (pre-scan) with final measurements on an OATS 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. Tests were performed in Test Site H and OATS.

5.2.4 Test equipment

TMS81 TMS45, E534, E535

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	15°C
Humidity of test environment	34%
Pressure of test environment	102kPa

Band	13.553-13.567 MHz
Power Level	230 mW declared
Channel Spacing	Single Channel
Mod Scheme	ISO14443 B
Single channel	13.56 MHz

Plot refs
8061-5 Rad 1 9-150kHz Para
8061-5 Rad 1 9-150kHz Perp

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

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

n.b. the general limits of 15.209 are as 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: 9kHz - 30MHz ±3.9dB.

5.3 Radiated emissions 150 kHz – 30 MHz

5.3.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.225(d) [Reference 4.1.1 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 antenna was orientated in both Parallel and Perpendicular polarisations. The EUT was rotated in all three orthogonal planes. The EUT was operated in mode TX Normal with and without tags.

5.3.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Measurements were made in a semi-anechoic chamber (pre-scan) with final measurements on an OATS 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. Tests were performed in Test Site H and OATS.

5.3.4 Test equipment

TMS81 TMS45, E534, E535

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	15°C
Humidity of test environment	34%
Pressure of test environment	102kPa

Band	13.553-13.567 MHz
Power Level	230 mW declared
Channel Spacing	Single Channel
Mod Scheme	ISO14443 B
Mid channel	13.56 MHz

Plot refs
8061-5 Rad 1 150k-30MHz Para
8061-5 Rad 1 150k-30MHz Perp

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

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

n.b. the general limits of 15.209 are as 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: 9kHz – 30MHz ±3.9dB.

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.5 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.225(d) [Reference 4.1.1 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 rotated in all three orthogonal planes. The EUT was operated in TX Normal mode with and without tags.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Measurements were made in a semi-anechoic chamber. The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. The equipment and the antenna were rotated 360 degrees to record the worst case emissions. Tests were performed in Test Site H.

5.4.4 Test equipment

LPE364, TMS45, E534, E535

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	16°C
Humidity of test environment	34%
Pressure of test environment	102kPa

Band	13.553-13.567 MHz
Power Level	230 mW declared
Channel Spacing	Single Channel
Mod Scheme	ISO14443 B
Single channel	13.56 MHz

Plot refs
8061-5 Rad 1 VHF Horiz
8061-5 Rad 1 VHF Vert
8061-5 Rad 1 UHF Horiz
8061-5 Rad 1 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	60.695	30.8	27.8	-12.2
2	65.176	38.1	34.6	-5.4
3	65.697	38.1	35.5	-4.5
4	66.693	36.8	33.9	-6.1
5	72.000	30.2	27.1	-12.9
6	167.990	35.9	33.5	-10.0
7	216.937	43.6	41.4	-4.6
8	352.515	38.2	35.4	-10.6
9	379.639	37.0	34.1	-11.9
10	406.755	36.9	33.7	-12.3

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	65.171	30.7	27.1	-12.9
2	102.910	36.1	32.3	-11.2
3	156.122	32.4	28.5	-15.0
4	186.133	30.8	28.1	-15.4
5	216.939	32.1	29.1	-16.9
6	298.290	36.2	32.5	-13.5
7	298.293	35.2	31.3	-14.7
8	298.293	37.2	32.7	-13.3
9	325.406	37.8	32.6	-13.4
10	338.962	34.9	31.3	-14.7
11	352.532	34.8	30.7	-15.3
12	366.088	37.0	34.0	-12.0
13	379.641	38.9	36.7	-9.3
14	399.798	36.7	31.4	-14.6
15	406.758	38.5	36.3	-9.7
16	420.311	37.3	34.5	-11.5
17	431.992	35.7	32.7	-13.3
18	433.874	36.8	33.9	-12.1
19	460.993	37.7	34.8	-11.2
20	527.990	40.0	37.8	-8.2

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

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

n.b. the general limits of 15.209 are as 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 ±5.1dB.

5.5 Intentional radiator field strength

5.5.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.225(a) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.225(a) [Reference 4.1.1 of this report]

5.5.2 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 antenna was orientated in both Parallel and Perpendicular polarisations. The EUT was rotated in all three orthogonal planes. The EUT was operated in TX Normal mode with and without tags.

5.5.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
Measurements were made at Site H & OATS. This site is listed with the FCC.
Both the equipment and the antenna were rotated 360 degrees to record the maximised emission.

5.5.4 Test equipment

E533, E534, E535, TMS81, E285

See Section 9 for more details

5.5.5 Test results

Temperature of test environment 15°C
Humidity of test environment 34%
Pressure of test environment 102kPa

Band	13.553-13.567 MHz
Power Level	230 mW
Channel Spacing	Single Channel
Mod Scheme	ISO14443 B
ITM	13.56 MHz TX2 ITM
MUP	13.56 MHz TX1 MUP
INK	13.56 MHz TX0 INK

	ITM	MUP	INK
Peak Level (dBµV/m) @ 3m	68.50	65.00	64.6
Plot reference	3m field strength	-	-
Antenna Polarisation	Parallel	Parallel	Parallel
EUT Polarisation	Front (pos 1)	back (pos 2)	back (pos 2)

Note: only highest transmitter field strength plotted, but all were maximised and measured in 3 orthogonal EUT positions and two polarisations of measuring antenna.

Analyser plots can be found in Section 6 of this report.

An extrapolation factor of 40dB/decade per ANSI C63.10:2013 clause 6.4 is applied to the 3m results to give the following field strengths at 30m for comparison to the limits:

	ITM	MUP	INK
Peak Level (dBµV/m) @30m	28.50	25.00	24.6

LIMITS:

15.225(a) QP/Peak = the field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 µV/m @ 30m = 84 dBµV/m @ 30m.
15.225(b) QP/Peak = within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m @ 30m = 50.5 dBµV/m @ 30m.
15.225(c) QP/Peak = within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 µV/m @ 30m = 40.5 dBµV/m @ 30m.
15.225(d) QP/Peak = outside of the 13.110-14.010 MHz band shall not exceed the general radiated emissions limits of 15.209.

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: <± 3.9 dB.

5.6 Occupied bandwidth

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.215 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.9 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.215 [Reference 4.1.1 of this report]

5.6.2 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 TX0 and TX1 and TX2 modes with tags.

5.6.3 Test procedure

Tests were performed using Test Site H. Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. RBW was set between 1-5 % of occupied bandwidth, VBW 3 x RBW and span was set to 2-5 x occupied bandwidth. The 20 dB bandwidth was then measured.

5.6.4 Test equipment

E533, E534, E535, TMS81, E285

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 8°C
Humidity of test environment 47%
Pressure of test environment 102kPa

Band	13.553-13.567 MHz
Power Level	230 mW declared
Channel Spacing	Single Channel
Mod Scheme	ISO14443 B
ITM	13.56 MHz TX2 ITM
MUP	13.56 MHz TX1 MUP
INK	13.56 MHz TX0 INK

	ITM	MUP	INK
20dB Bandwidth (kHz)	49.85	48.6	50.65
Plot reference	8061-5 BW TX2 ITM device TAG	8061-5 BW TX1 MAKEUP device TAG	8061-5 BW TX0 INK device TAG

Note: worst case bandwidth was with the RFID tags in the fields of the transmitters.
Analyser plots can be found in section 6 of this report.

LIMITS:
No limits apply however, per 15.215, the 20dB bandwidth of the emission is to remain within the band over expected variations in temperature and supply voltage. It is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimise the possibility of out-of-band operation.

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 %.

5.7 Spectrum mask

5.7.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.225 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.225(a)/(b)/(c)/(d) [Reference 4.1.1 of this report]

5.7.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The EUT was measured at a distance of 3 metres. The EUT and antenna were positioned for maximum field strength and referenced to the field strength measured on the OATS. The EUT was operated in TX0 and TX1 and TX2 modes with and without tags.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Measurements were made at Site H. This site is listed with the FCC. Plots were taken and results were referenced to limits at 30m by using the extrapolation factor of 40dB/decade, per ANSI C63.10 clause 6.4.

5.7.4 Test equipment

E533, E534, E535, TMS81, E285

See Section 9 for more details

5.7.5 Test results

Temperature of test environment 17°C
Humidity of test environment 25%
Pressure of test environment 102kPa

Band	13.553-13.567 MHz
Power Level	230 mW declared
Channel Spacing	Single Channel
Mod Scheme	ISO14443 B
ITM	13.56 MHz TX2 ITM
MUP	13.56 MHz TX1 MUP
INK	13.56 MHz TX0 INK

	ITM	MUP	INK
Nominal, Maximised RF Output / field	28.5 dBuV/m	25 dBuV/m	24.6 dBuV/m
Plot reference NO TAG	J8061-5, 30m mask, TX 2 (ITM) NO TAG	J8061-5, 30m mask, TX 1 (MAKEUP) NO TAG	J8061-5, 30m mask, TX 0 (INK) NO TAG
Plot reference TAG	J8061-5, 30m mask, TX 2 (ITM) TAG	J8061-5, 30m mask, TX 1 (MAKEUP) TAG	J8061-5, 30m mask, TX 0 (INK) TAG

Analyser plots can be found in Section 6 of this report.

LIMITS:

15.225(a) QP/Peak = the field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 µV/m @ 30m = 84 dBµV/m @ 30m.
15.225(b) QP/Peak = within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m @ 30m = 50.5 dBµV/m @ 30m.
15.225(c) QP/Peak = within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 µV/m @ 30m = 40.5 dBµV/m @ 30m.
15.225(d) QP/Peak = outside of the 13.110-14.010 MHz band shall not exceed the general radiated emissions limits of 15.209.

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:
<± 4.1 dB.

5.8 Frequency stability

5.8.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.225(e) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.8 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.225(e) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT's power port was connected to a variable power supply. This allowed the voltage end points to be set as declared by the manufacturer. The EUT was placed in a temperature controlled chamber. The EUT emissions were observed by means of a test fixture. The EUT was operated in TX0 and TX1 and TX2 modes.

5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Temperature stability was achieved at each test level before taking measurements. A frequency count was made on a CW signal. At nominal temperature the EUT supply was varied to the manufacturer stated end points. A frequency counter function on the spectrum analyser was used to monitor the frequency of the carrier. The analyser was set with a suitable span, RBW and VBW to allow for a measurement resolution of 1Hz.
Tests were performed using Test Site A.

5.8.4 Test equipment

E227, E434, E642, TMS38, E623, E541

See Section 9 for more details

5.8.5 Test results

Temperature of test environment	18°C
Humidity of test environment	40%
Pressure of test environment	102kPa

Band	13.553-13.567 MHz
Power Level	230 mW declared
Channel	Single Channel
Mod Scheme	ISO14443 B
ITM	13.56 MHz TX2 ITM
MUP	13.56 MHz TX1 MUP
INK	13.56 MHz TX0 INK

Test conditions		Frequency Reading ITM	Frequency Reading MUP	Frequency Reading INK
-20°C	Volts Nominal (5V)	-0.000040	0.000001	0.000034
-10°C	Volts Nominal (5V)	0.000007	0.000021	0.000046
0°C	Volts Nominal (5V)	0.000020	0.000024	0.000045
10°C	Volts Nominal (5V)	0.000016	0.000016	0.000030
20°C	Volts Minimum (4.75V)	0.000000	0.000002	0.000004
	Volts Nominal (5V)	0.000000	0.000000	0.000000
	Volts Maximum (5.25V)	-0.000001	-0.000002	0.000000
30°C	Volts Nominal (5V)	-0.000010	-0.000002	-0.000004
40°C	Volts Nominal (5V)	-0.000032	0.000004	-0.000007
50°C	Volts Nominal (5V)	-0.000042	0.000033	0.000018
Max Frequency Error per transmitter (Hz)		+20 / -42	+33 / -2	+46 / -7
Max Frequency Error observed (MHz)		-0.000042	0.000033	0.000046

Maximum variation observed was +46 / -42 Hz across all 3 transmitters.

LIMITS:
+/- 0.01%. (+/- 1.356kHz)

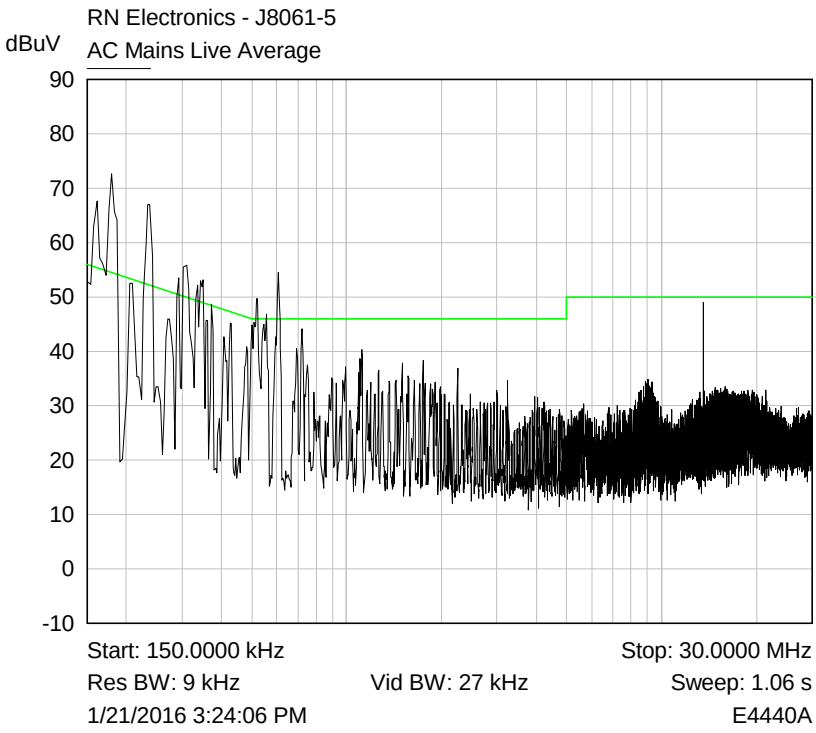
These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 0.7 ppm.

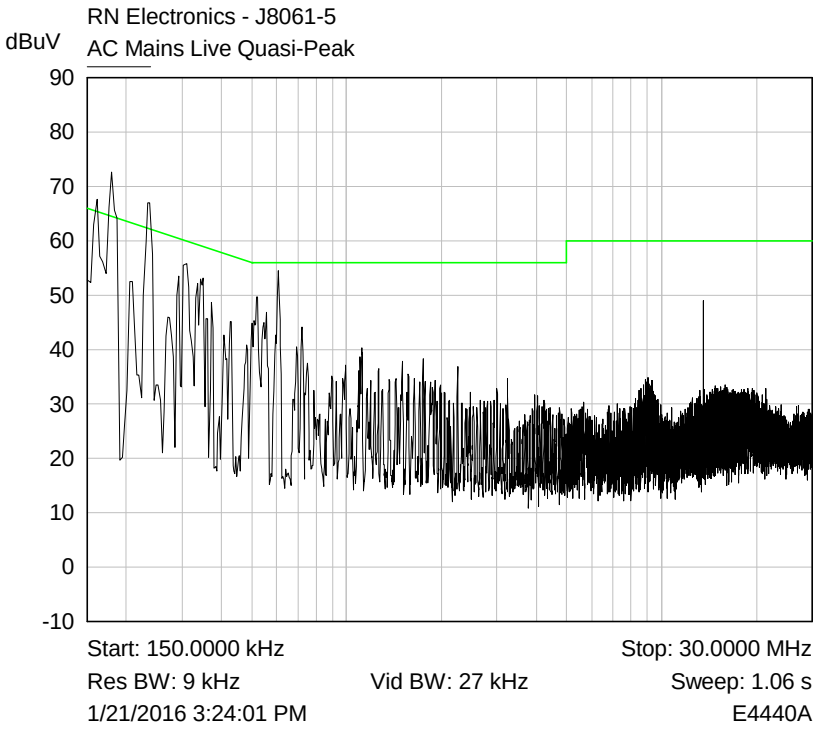
6 Plots/Graphical results

6.1 AC power line conducted emissions

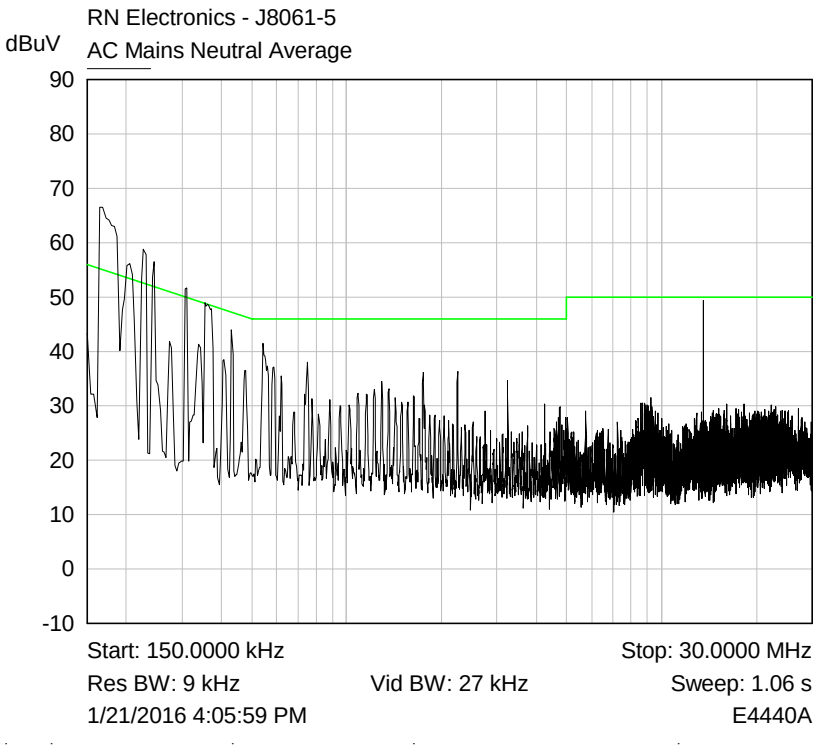
RF Parameters: Band 13.553-13.567 MHz, Power Max, Channel Spacing Single Channel, Modulation ISO14443 B, Channel 13.56 MHz All TX



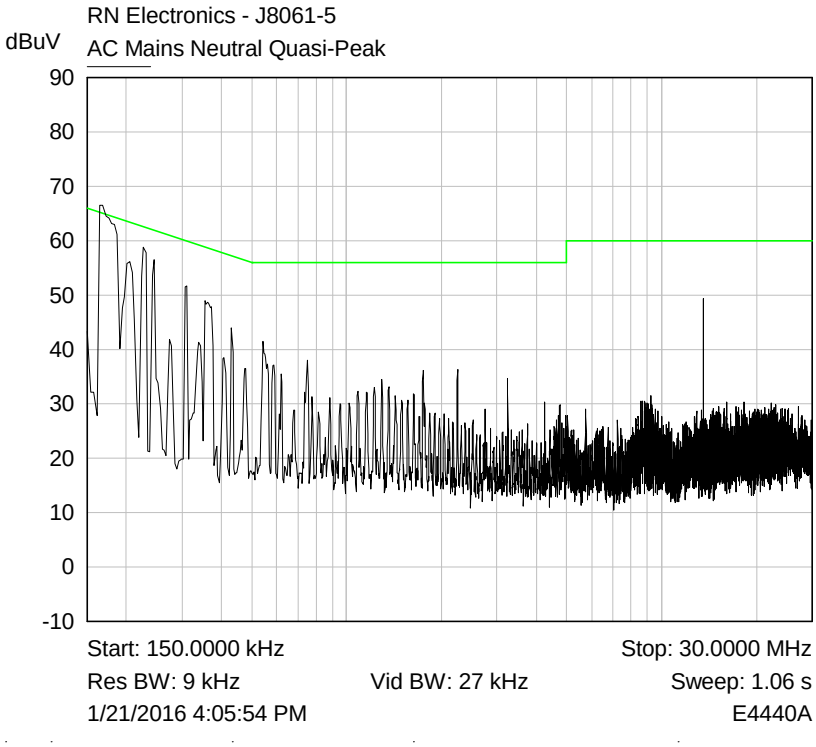
Plot of Live 150k-30MHz Average



Plot of Live 150k-30MHz Quasi-Peak



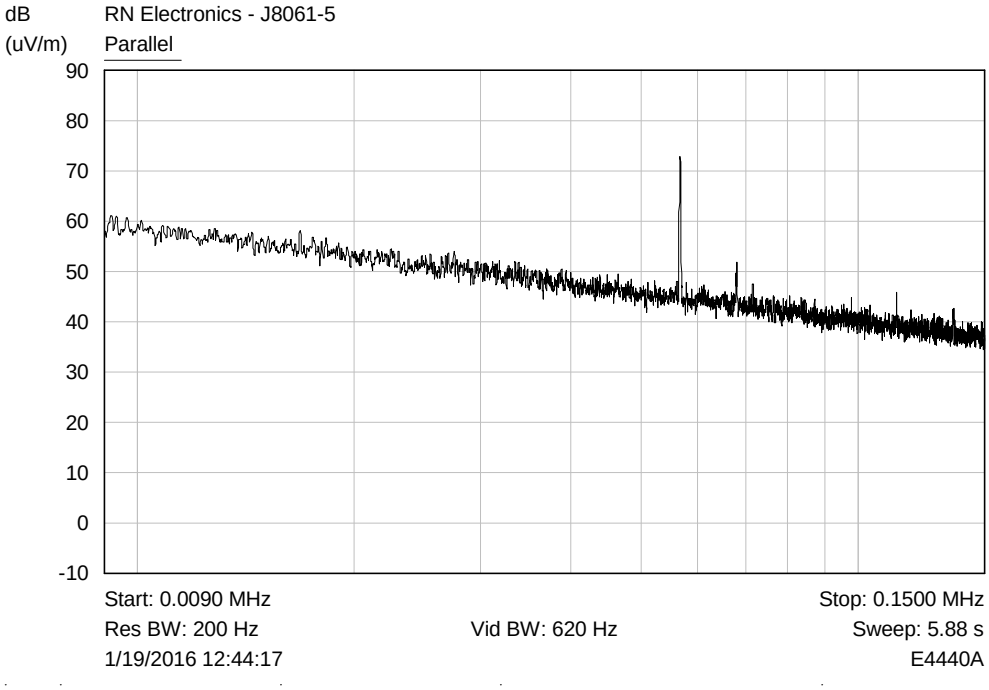
Plot of Neutral 150k-30MHz Average



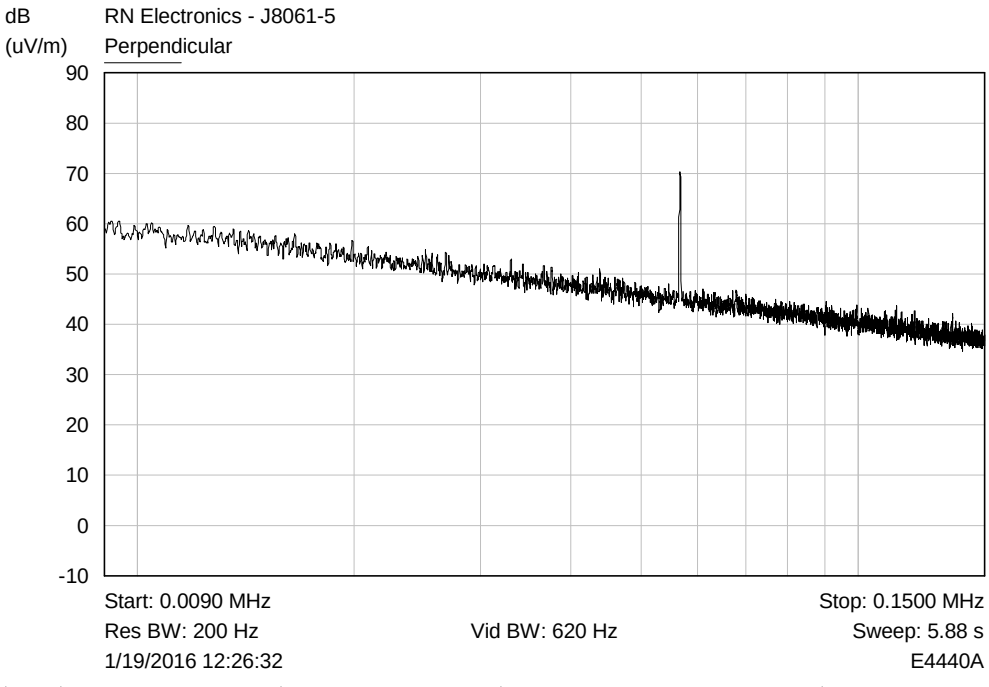
Plot of Neutral150k-30MHz Quasi-Peak

6.2 Radiated emissions 9 - 150 kHz

RF Parameters: Band 13.553-13.567 MHz, Power Max MHz, Channel Spacing Single Channel MHz, Modulation ISO14443 B, Channel 13.56 MHz



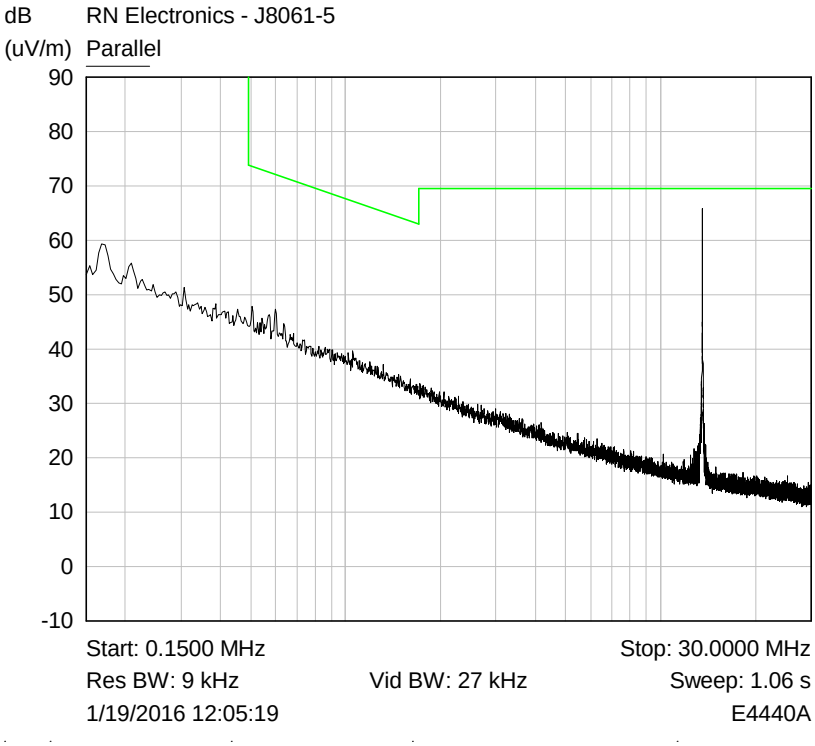
8061-5 Rad 1, 9-150 kHz Parallel



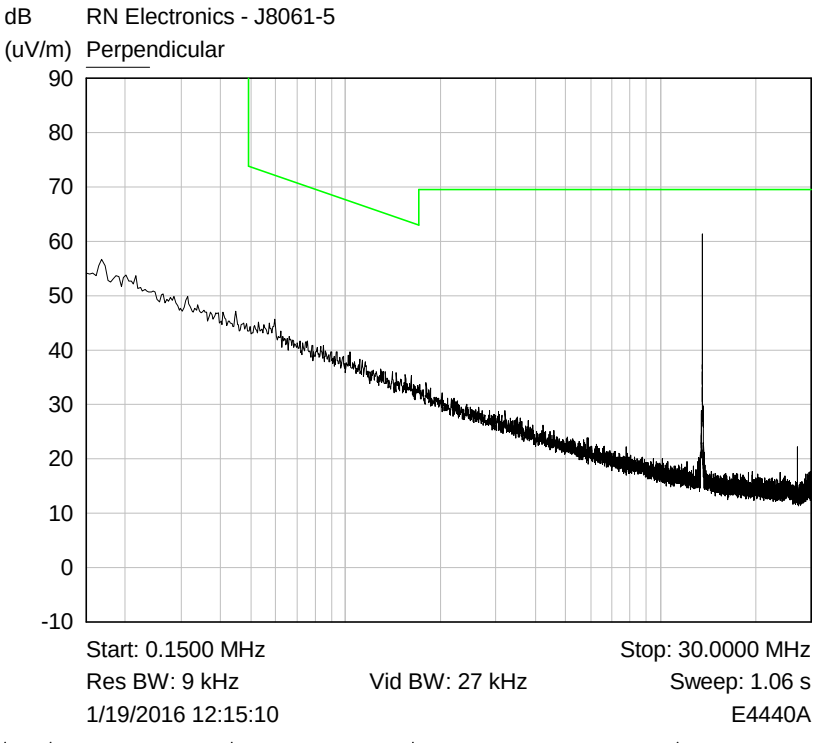
8061-5 Rad 1, 9-150 kHz Perpendicular

6.3 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 13.553-13.567 MHz, Power Max MHz, Channel Spacing Single Channel MHz, Modulation ISO14443 B, Channel 13.56 MHz



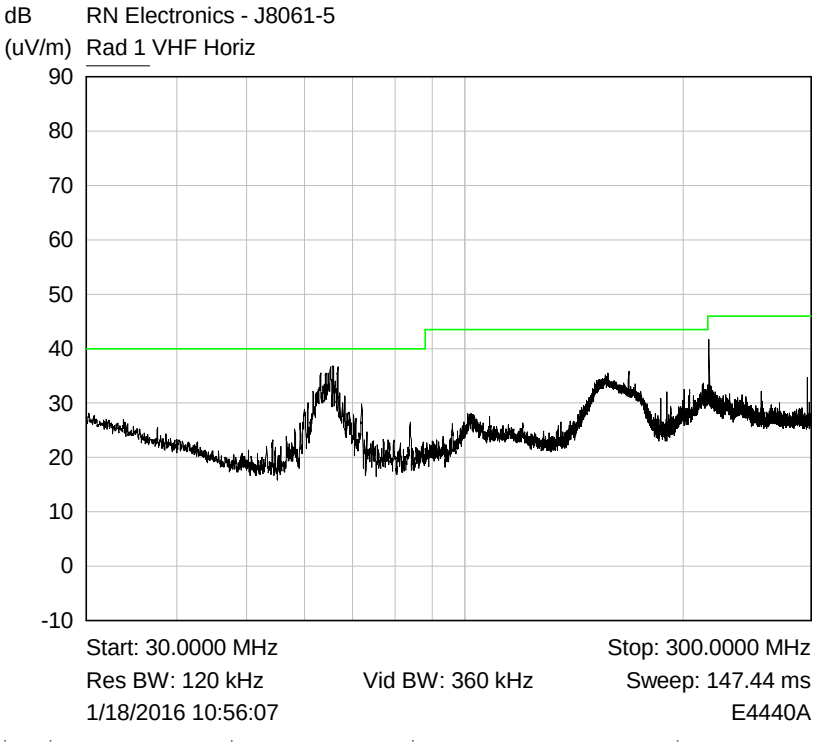
8061-5 Rad 1, 150k-30 MHz Parallel



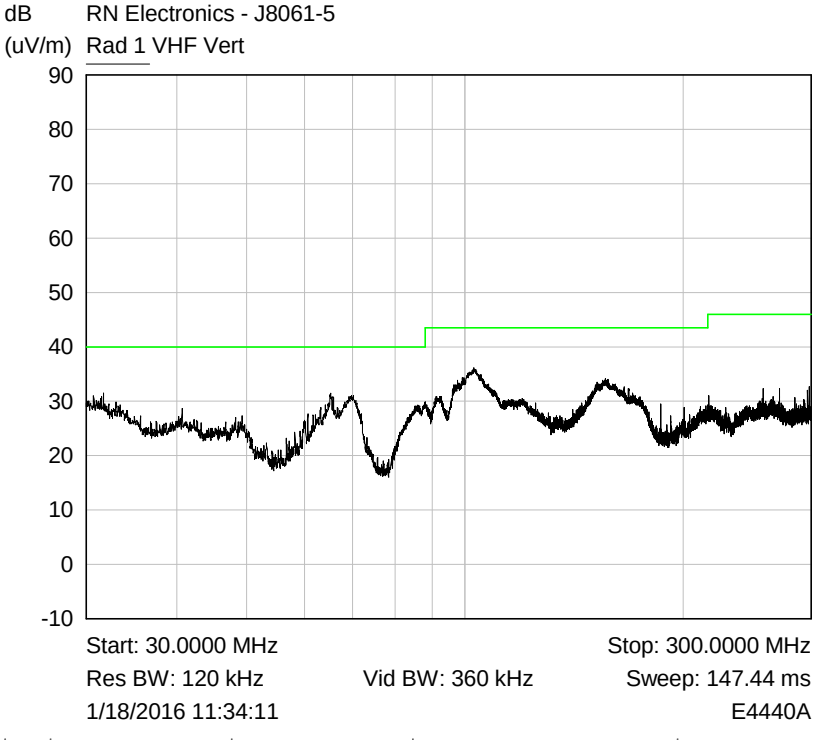
8061-5 Rad 1, 150k-30 MHz Perpendicular

6.4 Radiated emissions 30 MHz -1 GHz

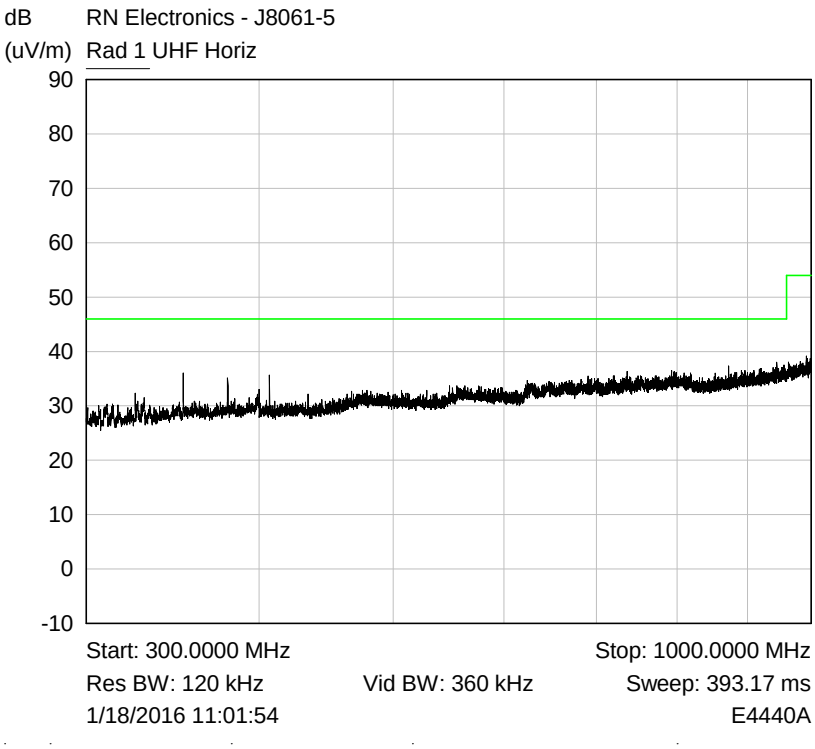
RF Parameters: Band 13.553-13.567 MHz, Power Max MHz, Channel Spacing Single Channel MHz, Modulation ISO14443 B, Channel 13.56 MHz



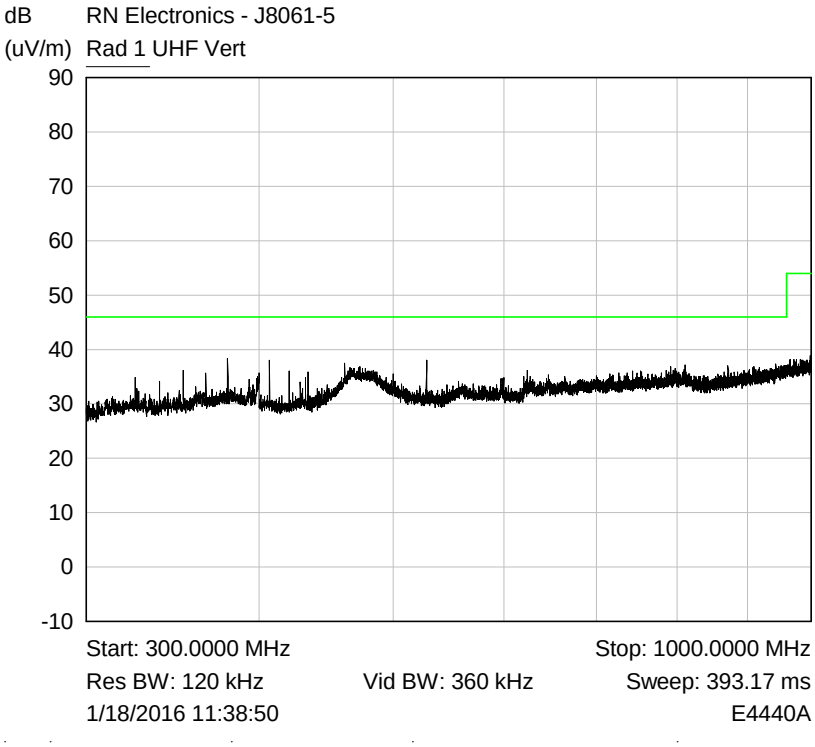
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



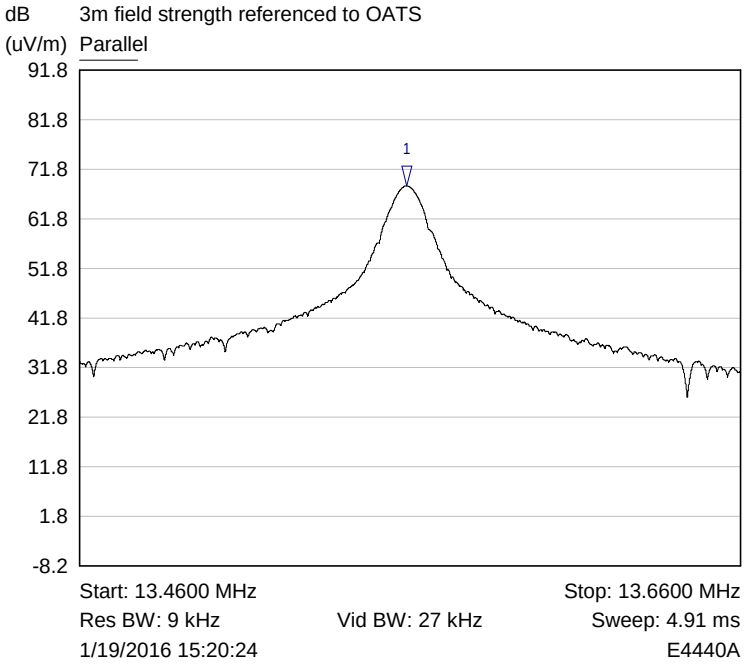
Plot of Peak emissions for UHF Horizontal against the QP limit line.



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

6.5 Intentional radiator field strength

RF Parameters: Band 13.553-13.567 MHz, Power Max, Channel Spacing Single Channel, Modulation ISO14443 B, Channel 13.56 MHz TX2 ITM

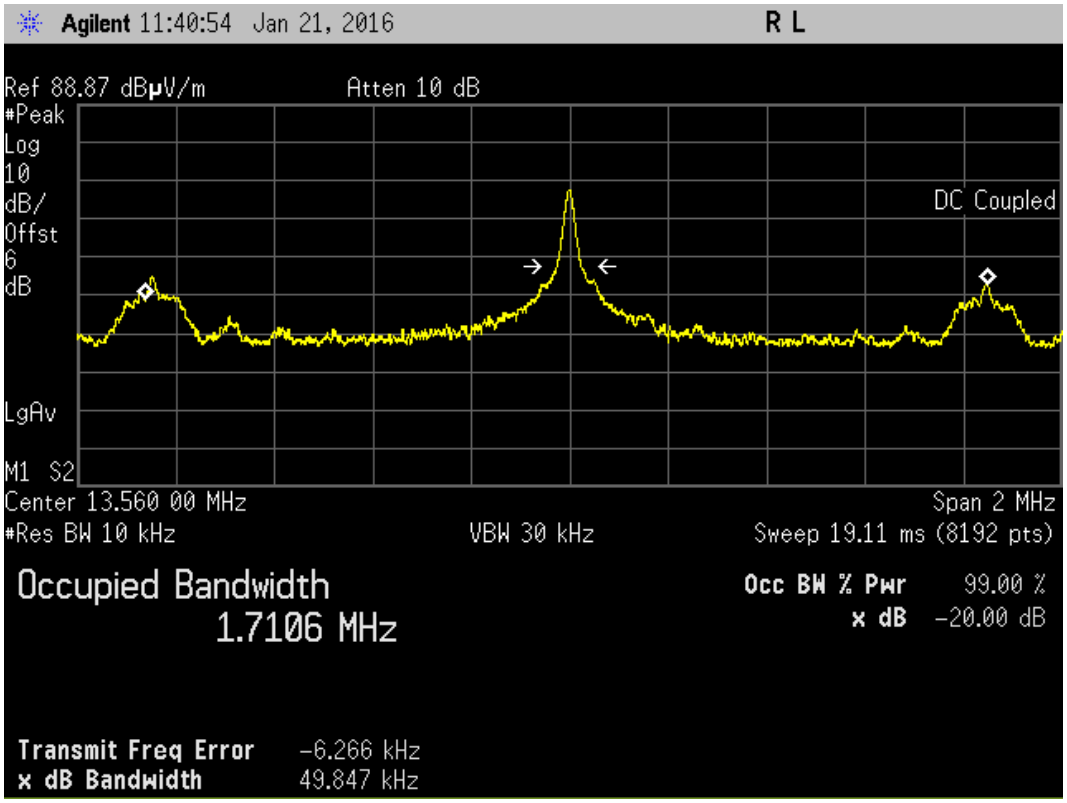


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Parallel	13.5586 MHz	68.48 dB(uV/m)	

Plot of Parallel polarisation and EUT in Front (pos 1) position at 3m

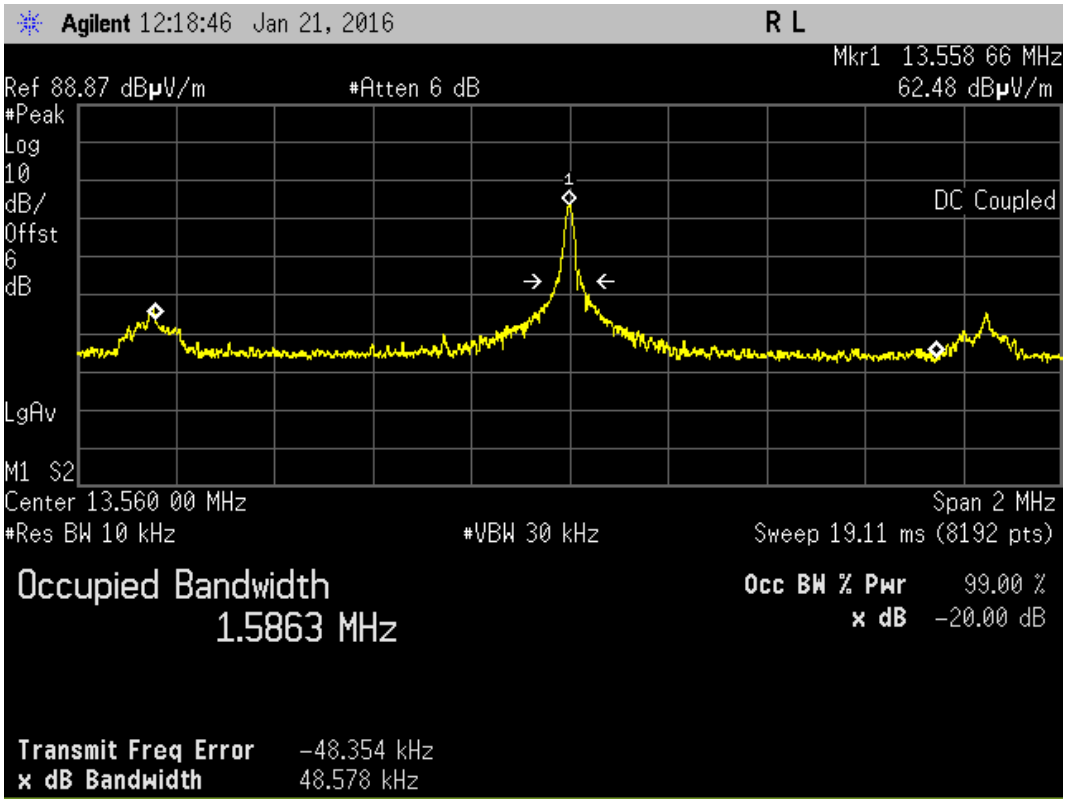
6.6 Occupied bandwidth

RF Parameters: Band 13.553-13.567 MHz, Power Max, Channel Spacing Single Channel MHz, Modulation ISO14443 B, Channel 13.56 MHz TX2 ITM



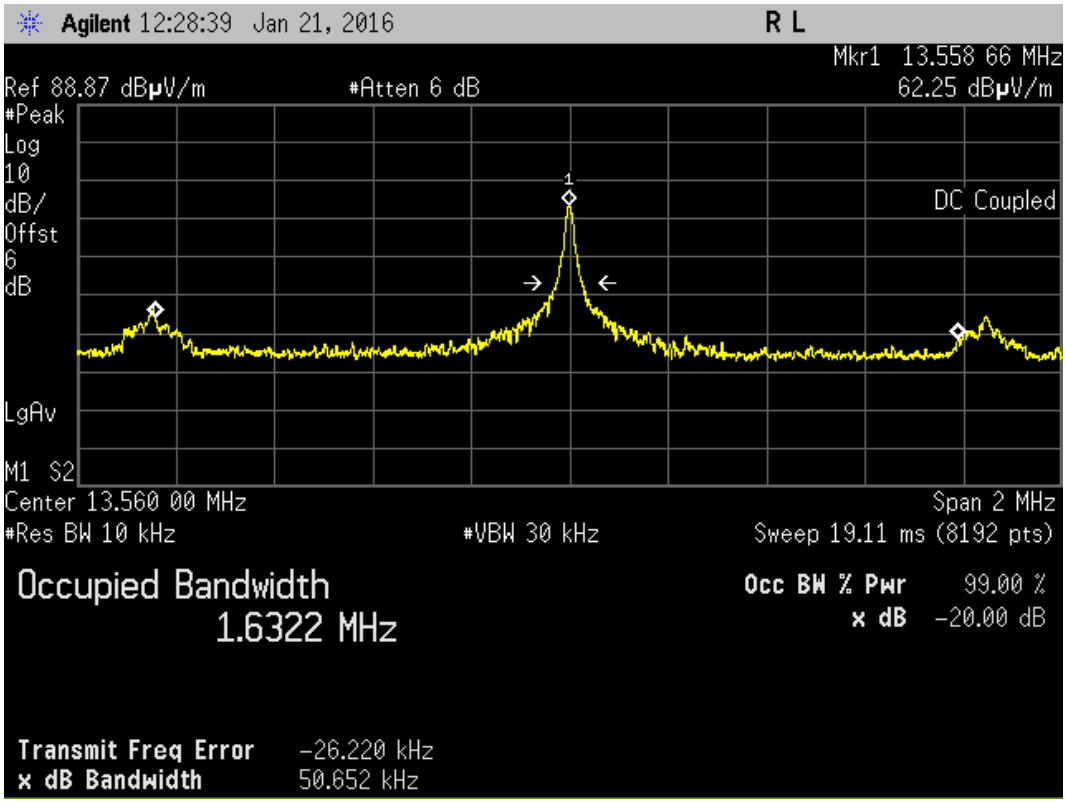
8061-5 BW TX2 ITM device TAG

RF Parameters: Band 13.553-13.567 MHz, Power Max, Channel Spacing Single Channel MHz, Modulation ISO14443 B, Channel 13.56 MHz TX1 MUP



8061-5 BW TX1 MAKEUP device TAG

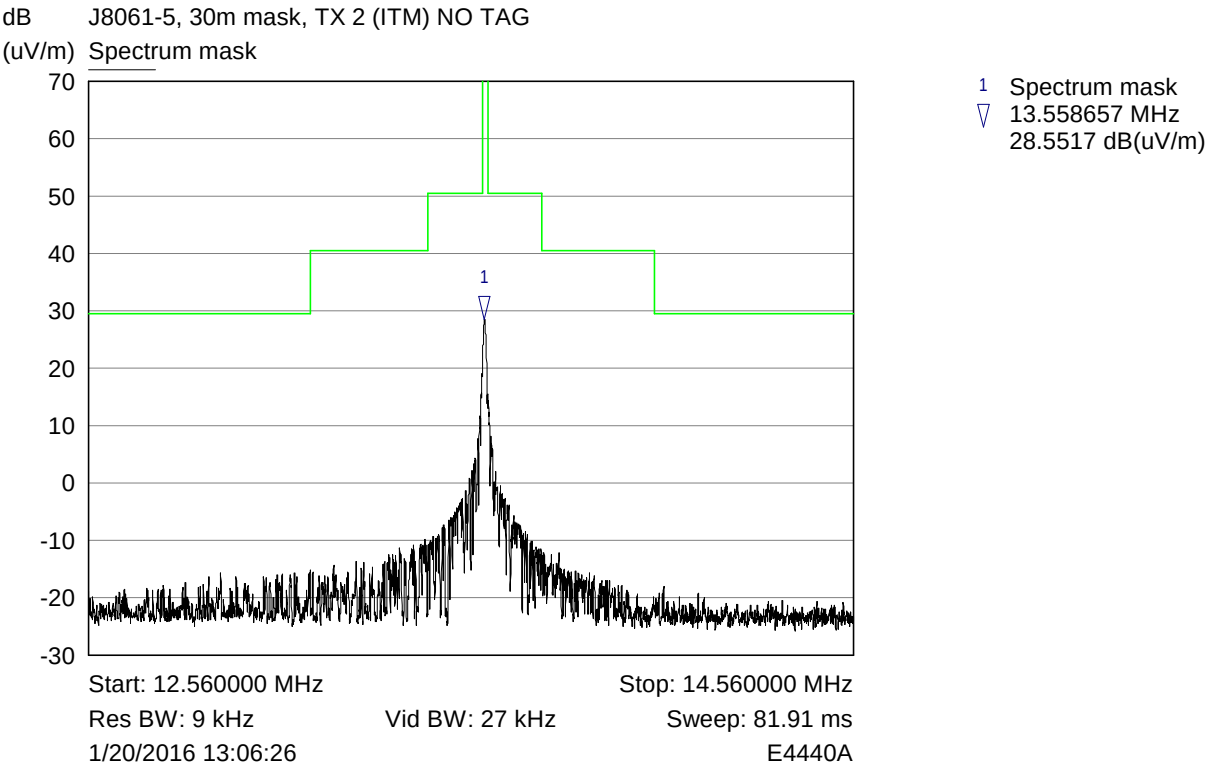
RF Parameters: Band 13.553-13.567 MHz, Power Max, Channel Spacing Single Channel MHz, Modulation ISO14443 B, Channel 13.56 MHz TX0 INK



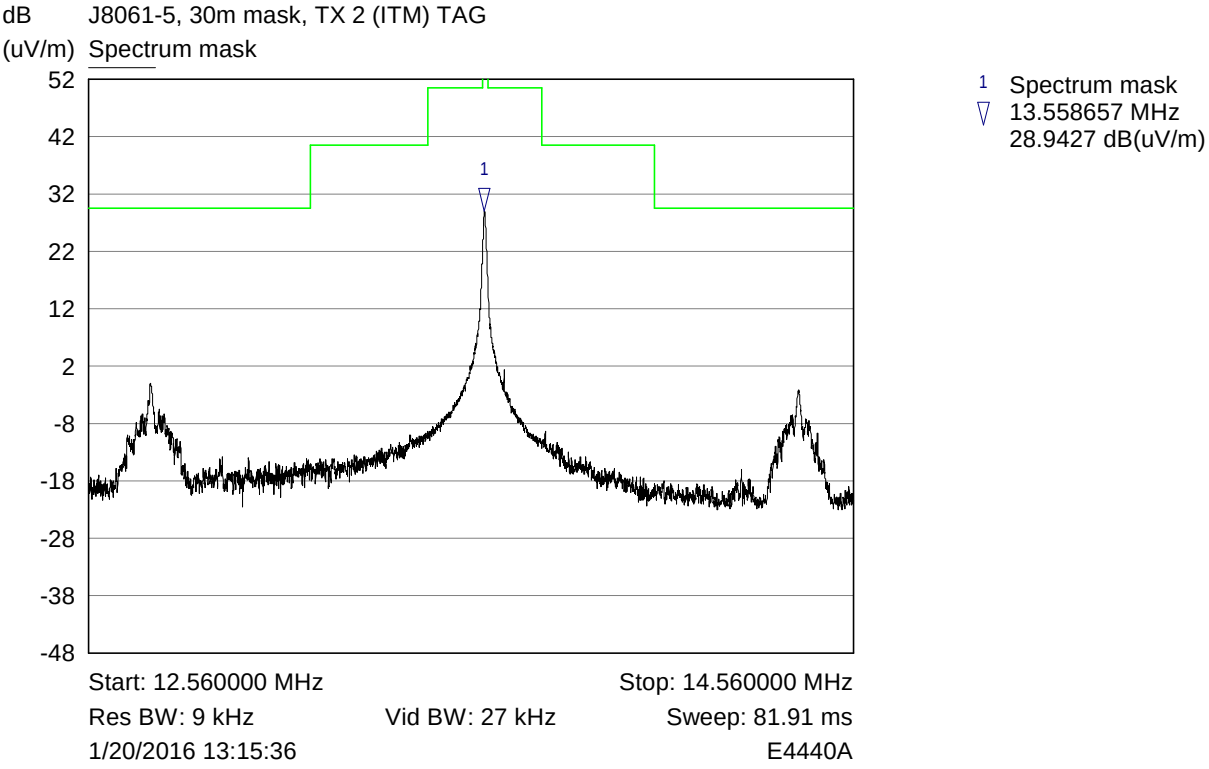
8061-5 BW TX0 INK device TAG

6.7 Spectrum mask

RF Parameters: Band 13.553-13.567 MHz, Power Max, Channel Spacing Single Channel MHz, Modulation ISO14443 B, Channel 13.56 MHz TX2 ITM

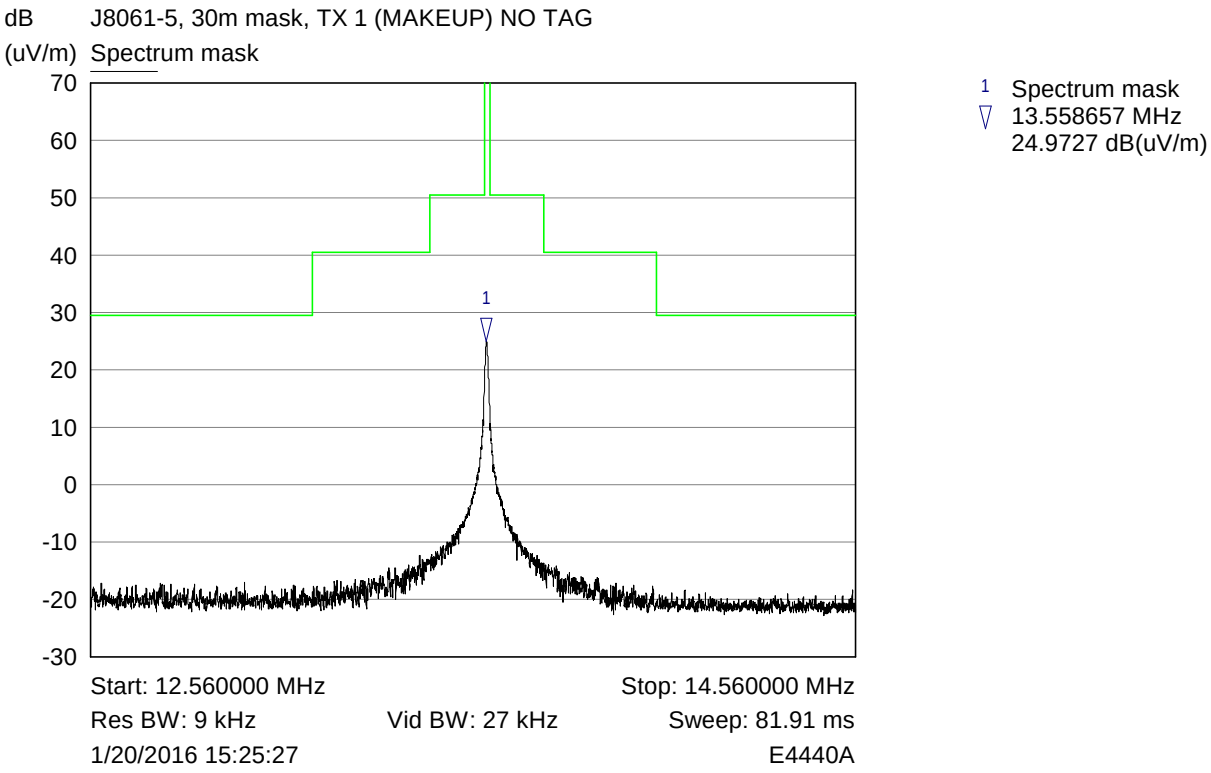


J8061-5, 30m mask, TX 2 (ITM) NO TAG

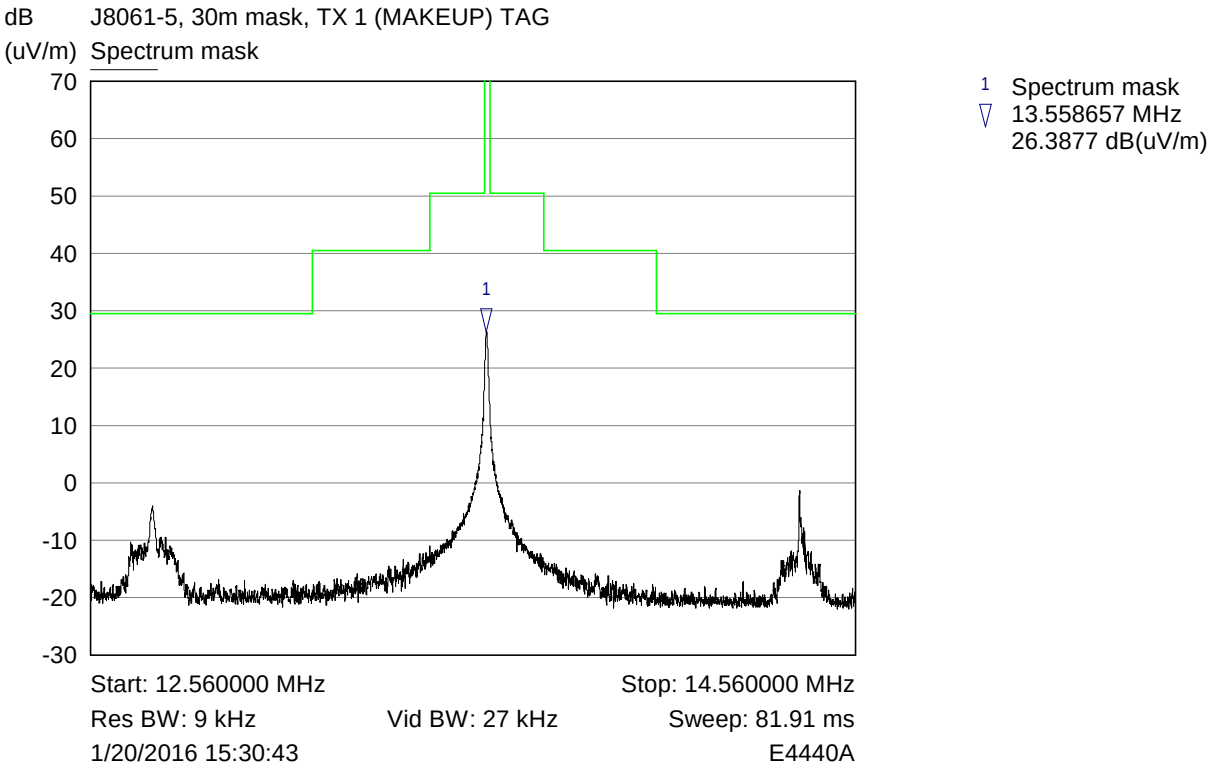


J8061-5, 30m mask, TX 2 (ITM) TAG

RF Parameters: Band 13.553-13.567 MHz, Power Max, Channel Spacing Single Channel MHz, Modulation ISO14443 B, Channel 13.56 MHz TX1 MUP

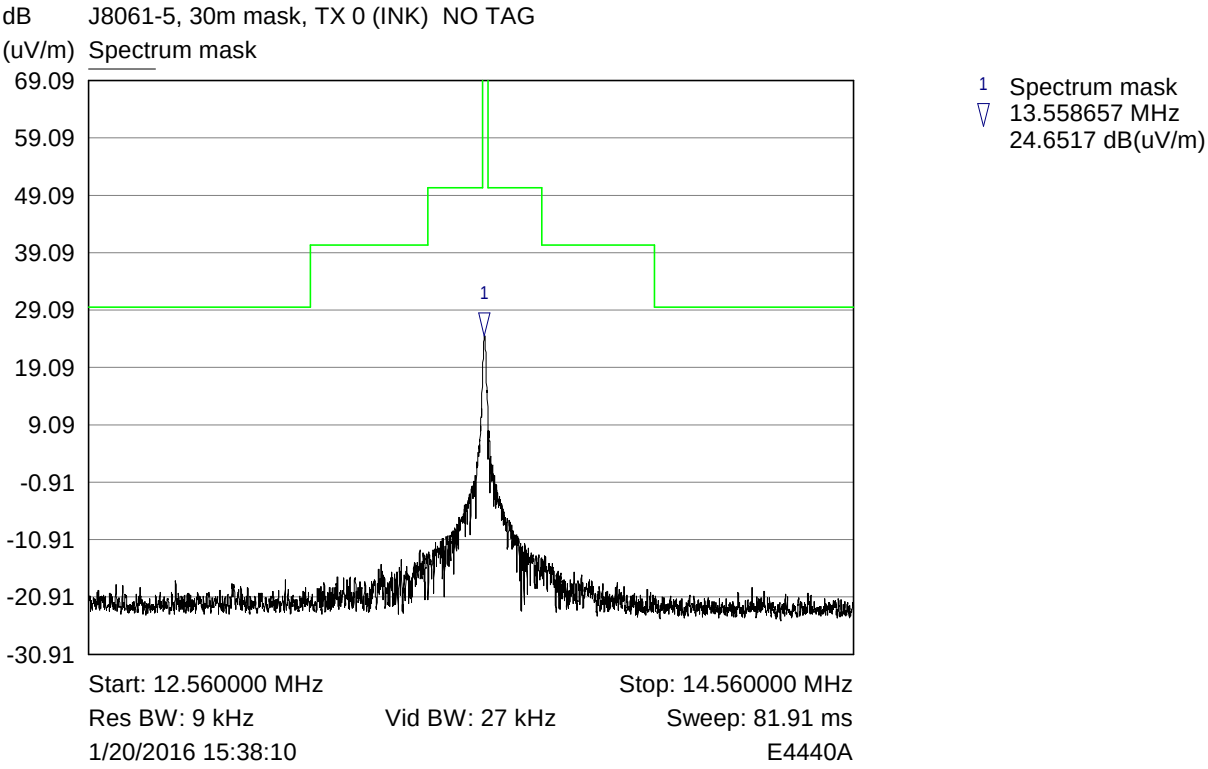


J8061-5, 30m mask, TX 1 (MAKEUP) NO TAG

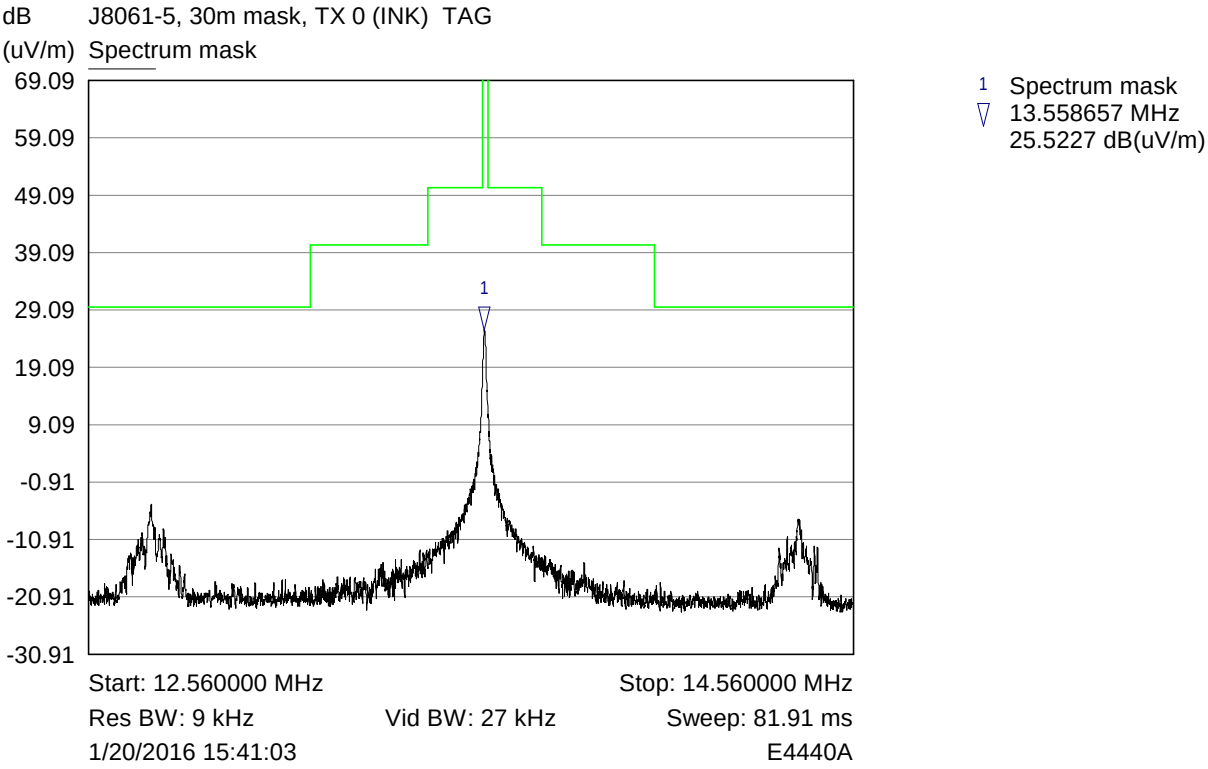


J8061-5, 30m mask, TX 1 (MAKEUP) TAG

RF Parameters: Band 13.553-13.567 MHz, Power Max, Channel Spacing Single Channel MHz, Modulation ISO14443 B, Channel 13.56 MHz TX0 INK



J8061-5, 30m mask, TX 0 (INK) NO TAG



J8061-5, 30m mask, TX 0 (INK) TAG

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:

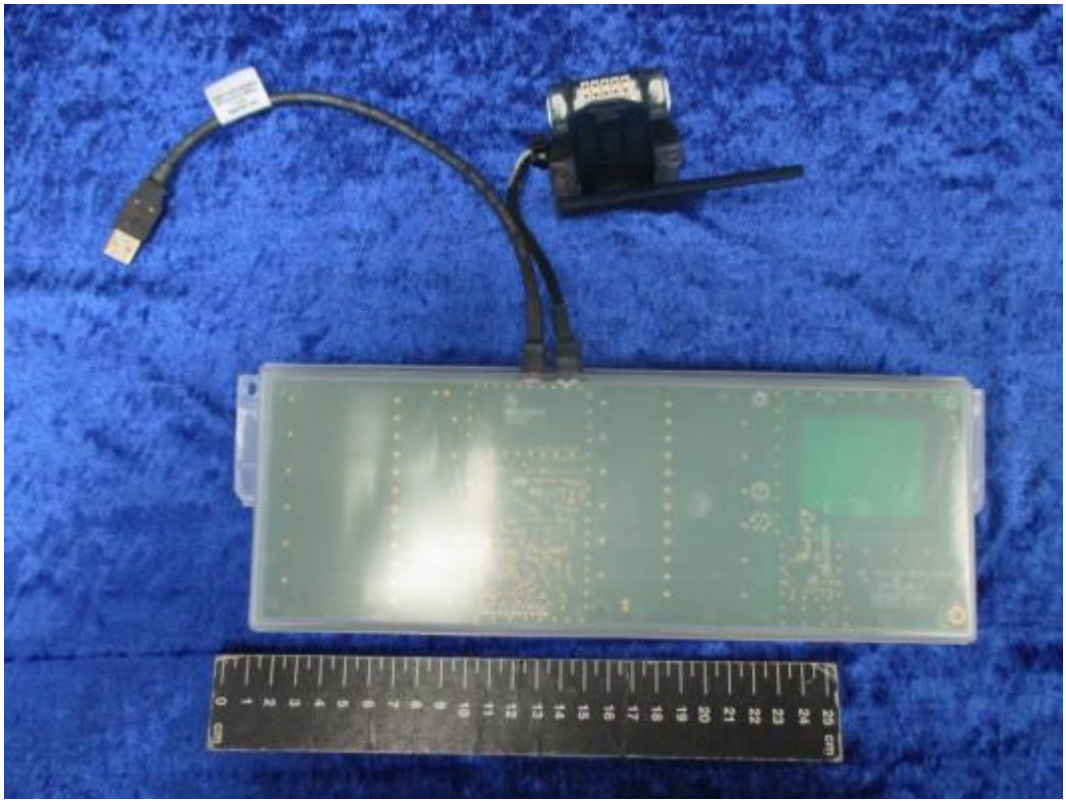
(a) limit of 500 µV/m equates to 20.log (500) = 54 dB µV/m.

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

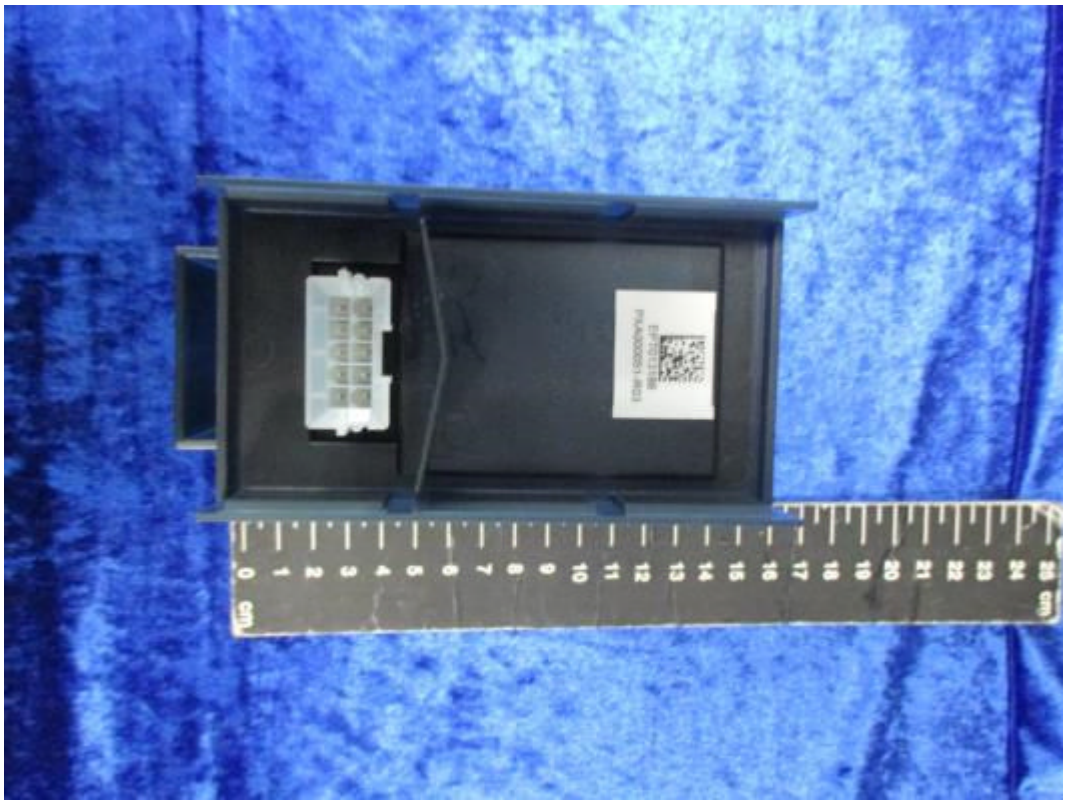
(c) limit of 30 µV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBµV/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

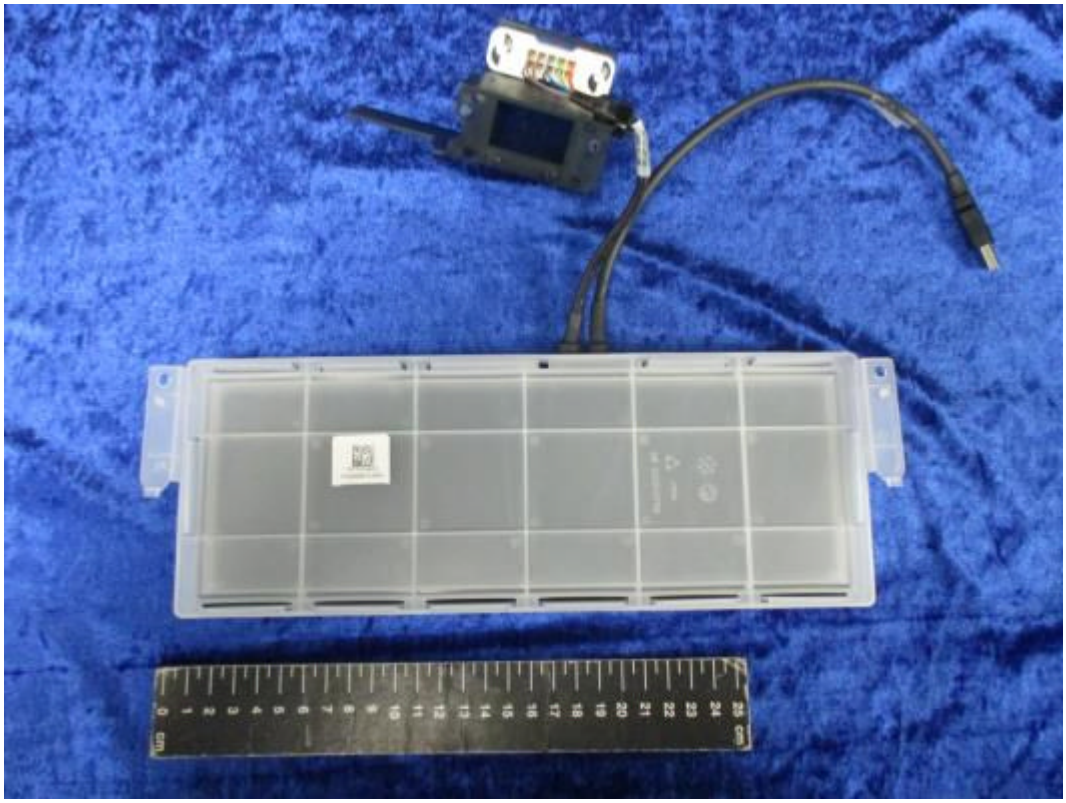
8 Photographs

8.1 EUT Front View

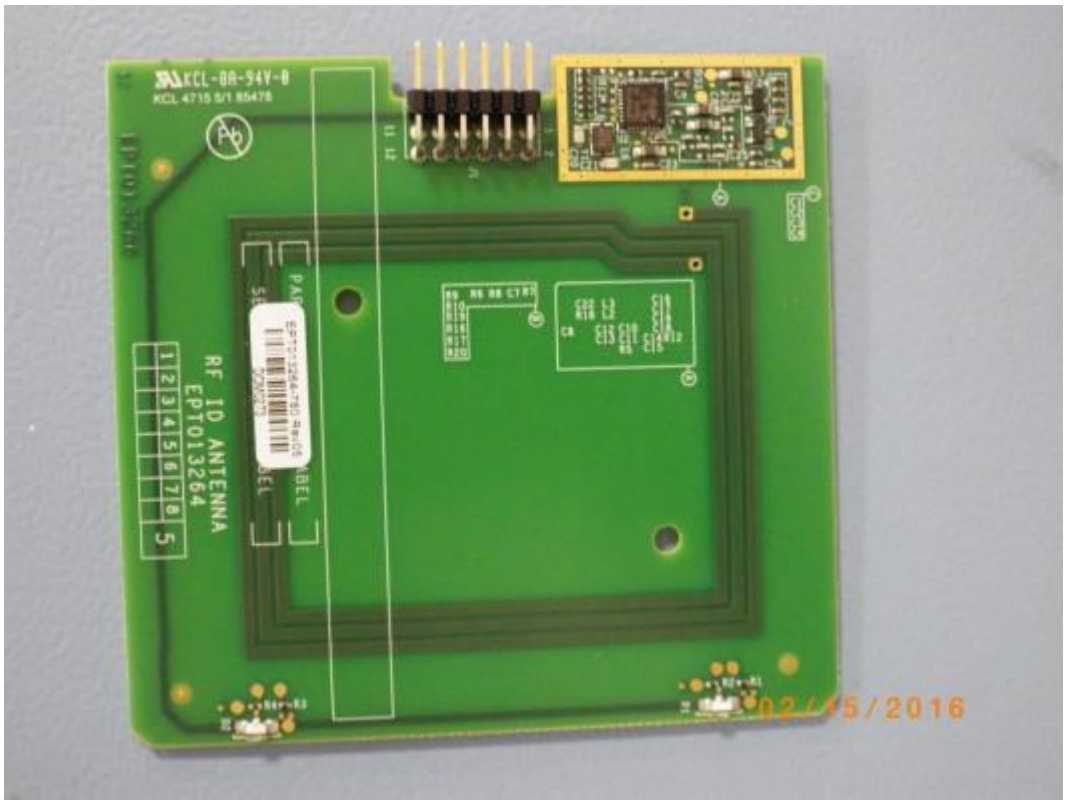


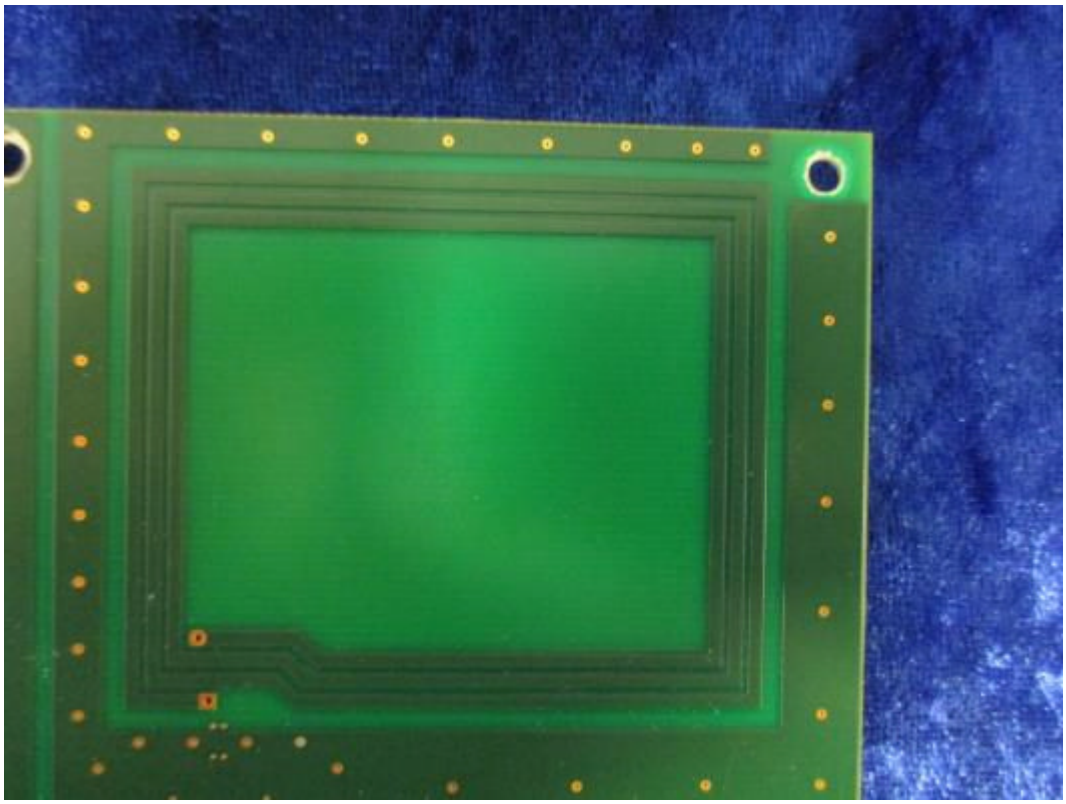
8.2 EUT Reverse Angle





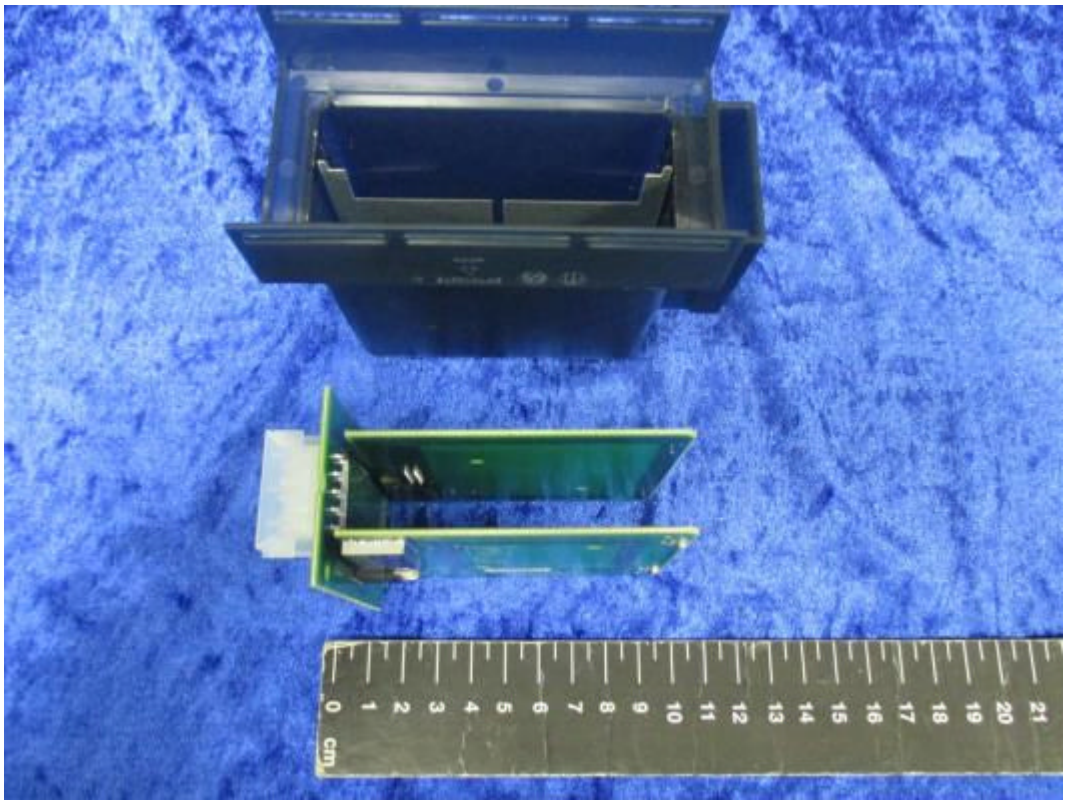
8.3 EUT Antennas

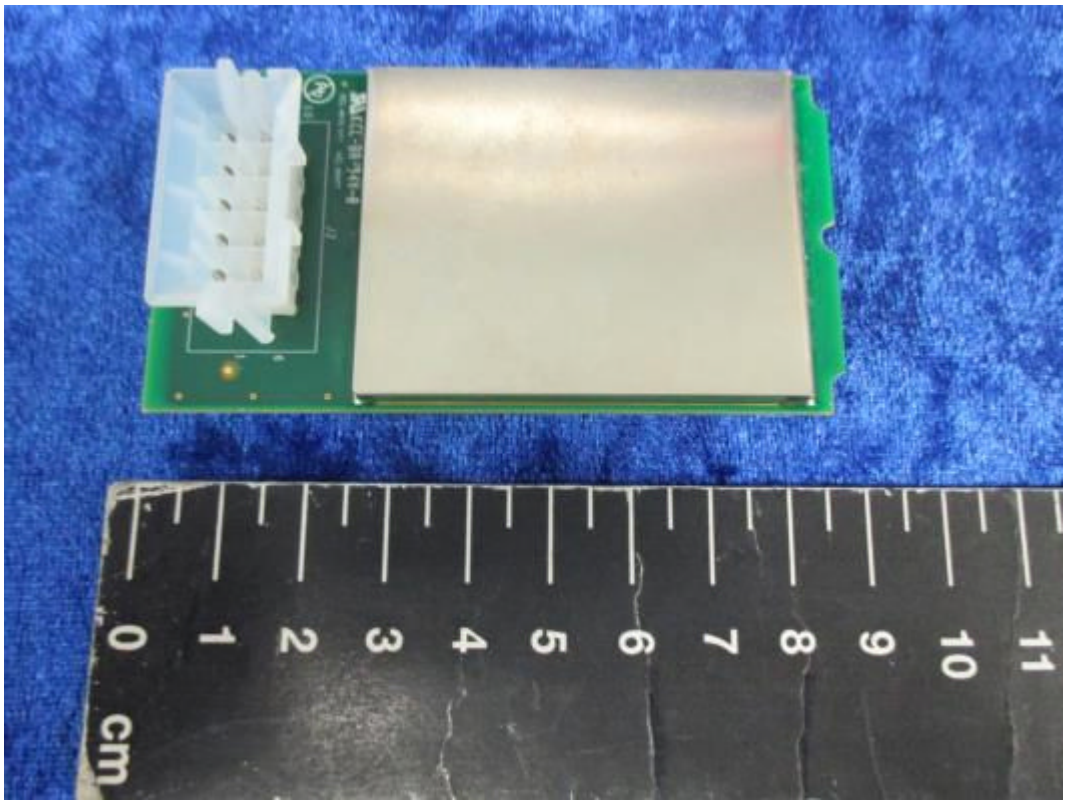


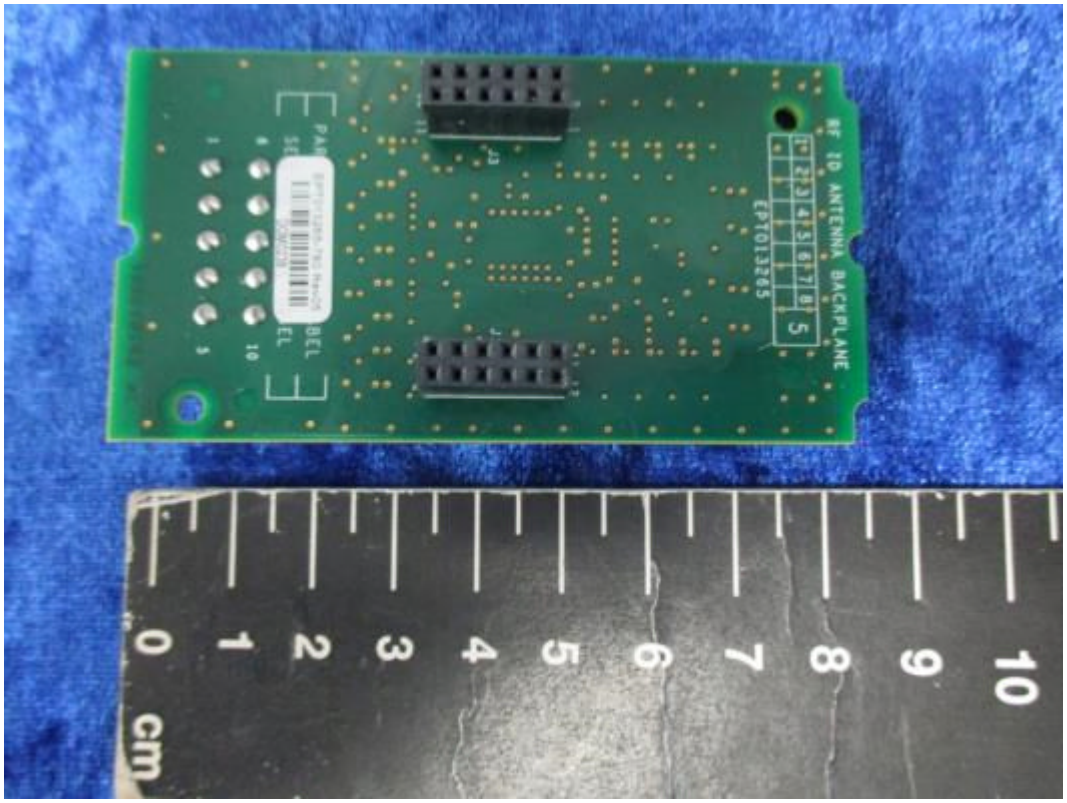


8.4 EUT Display & Controls

8.5 EUT Internal photos



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EPT013205
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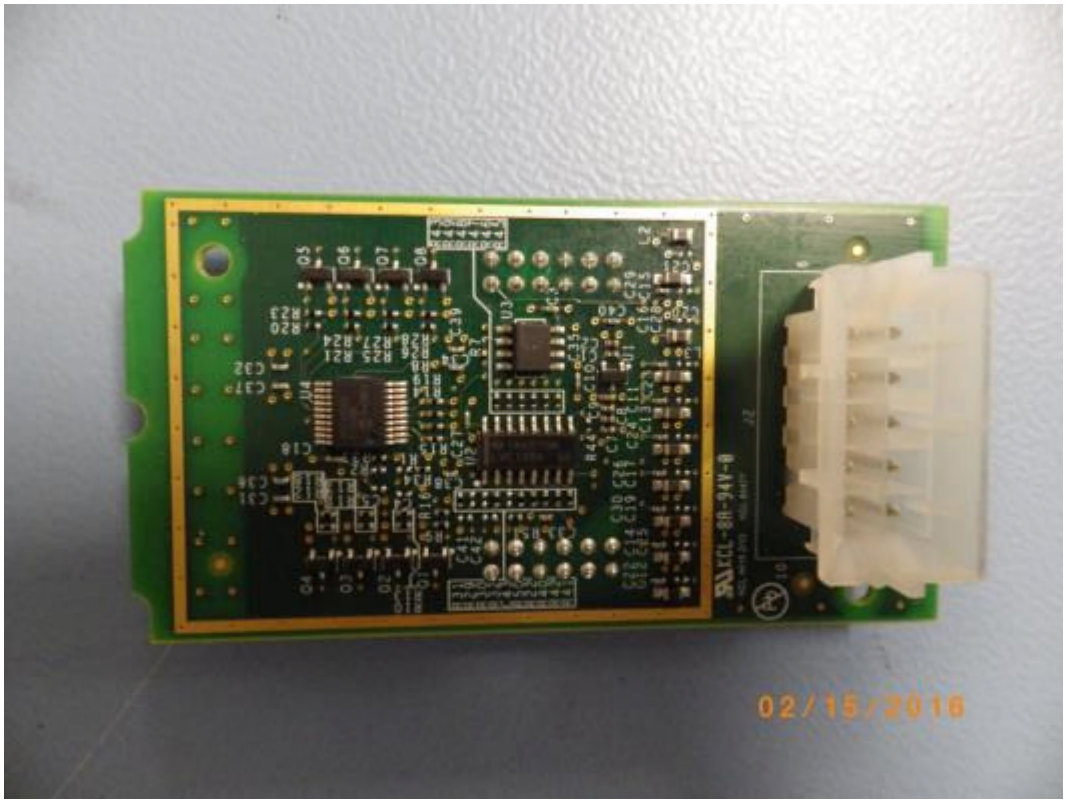
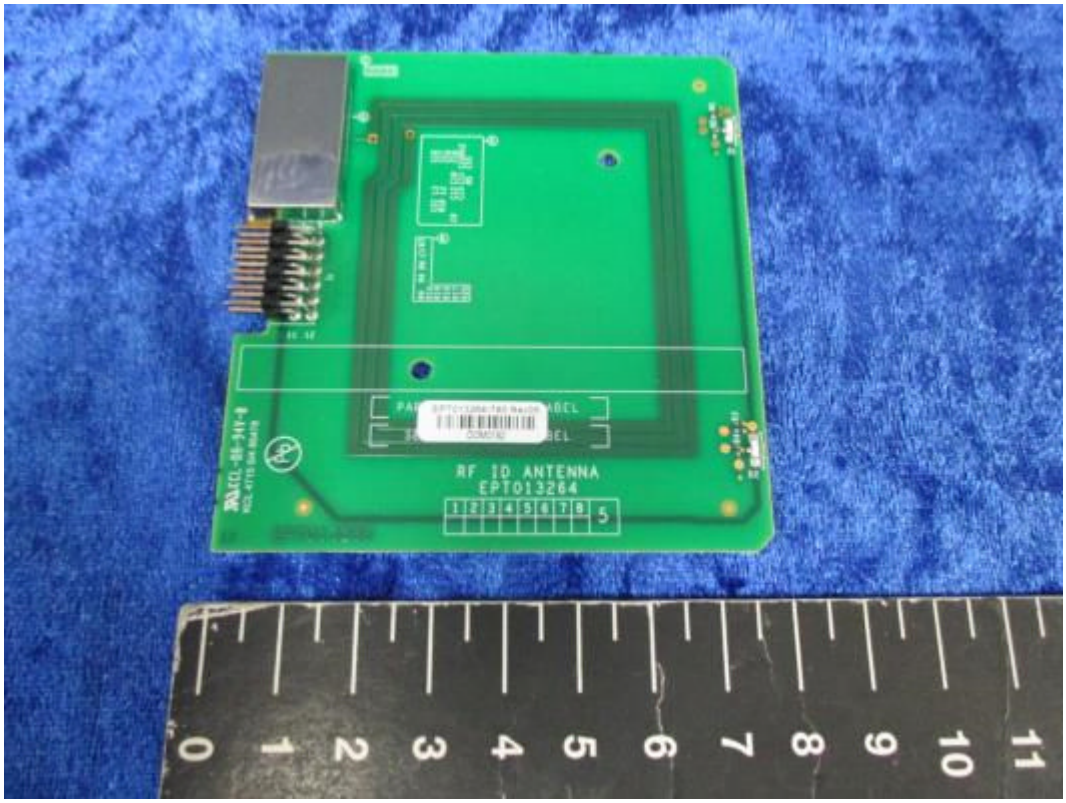
cm


02/15/2016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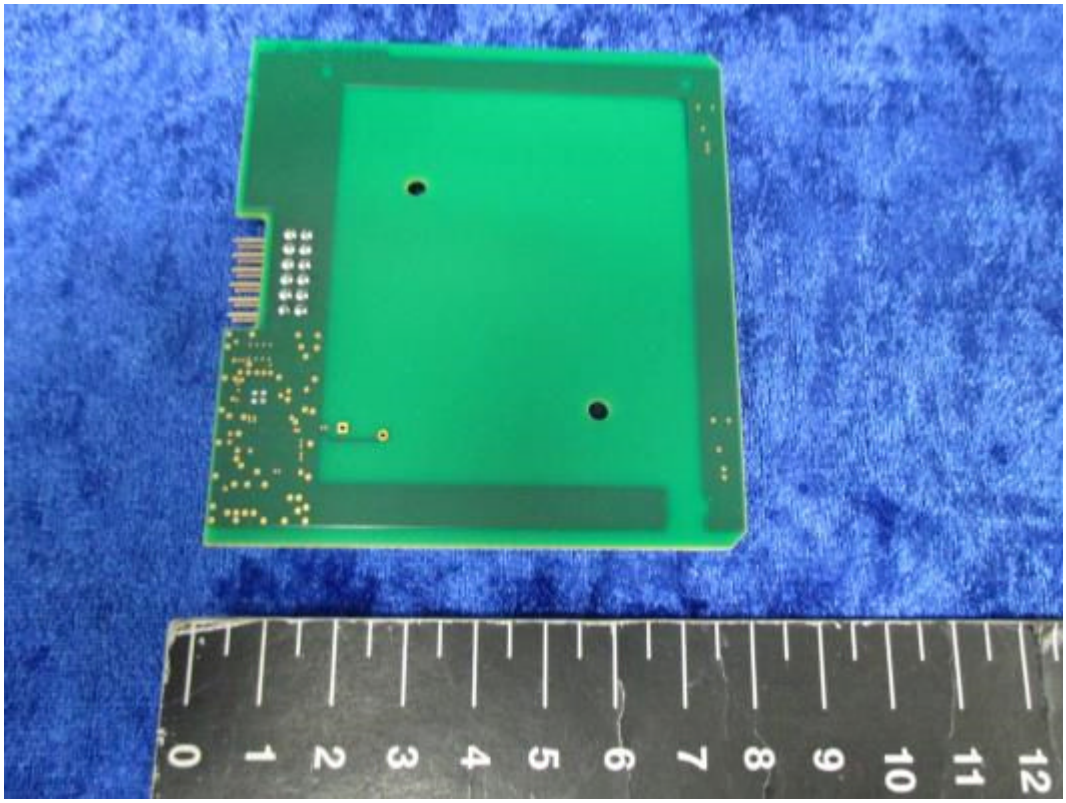

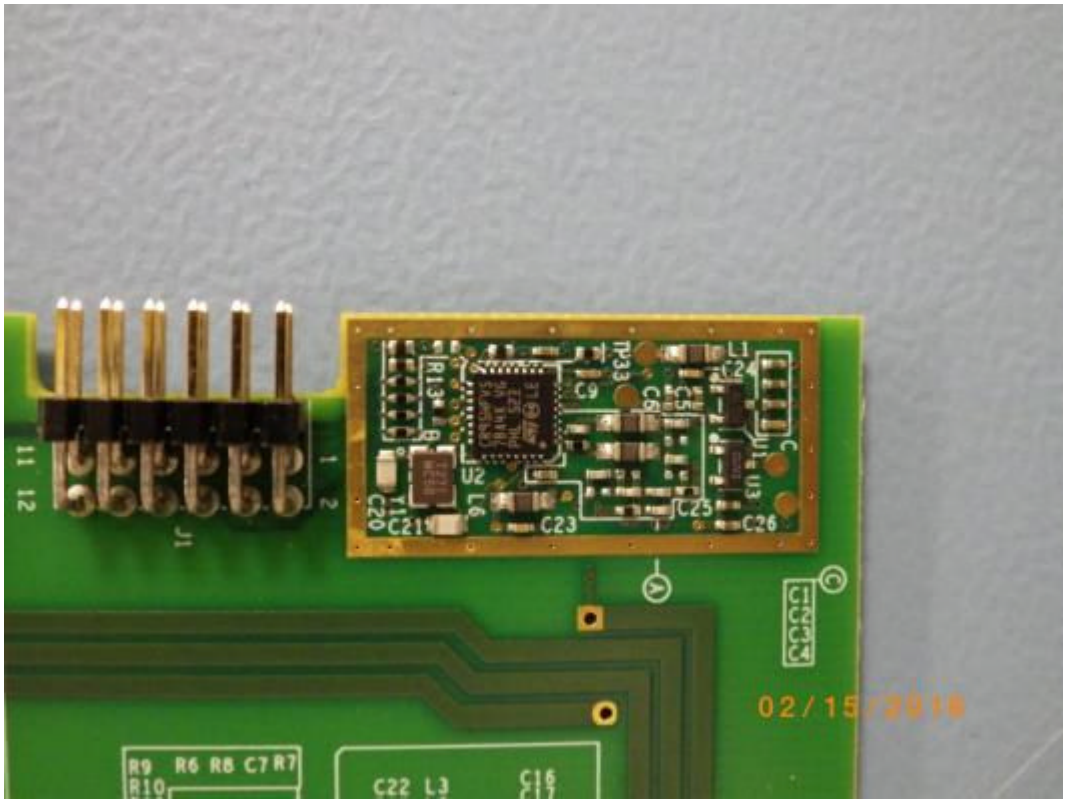

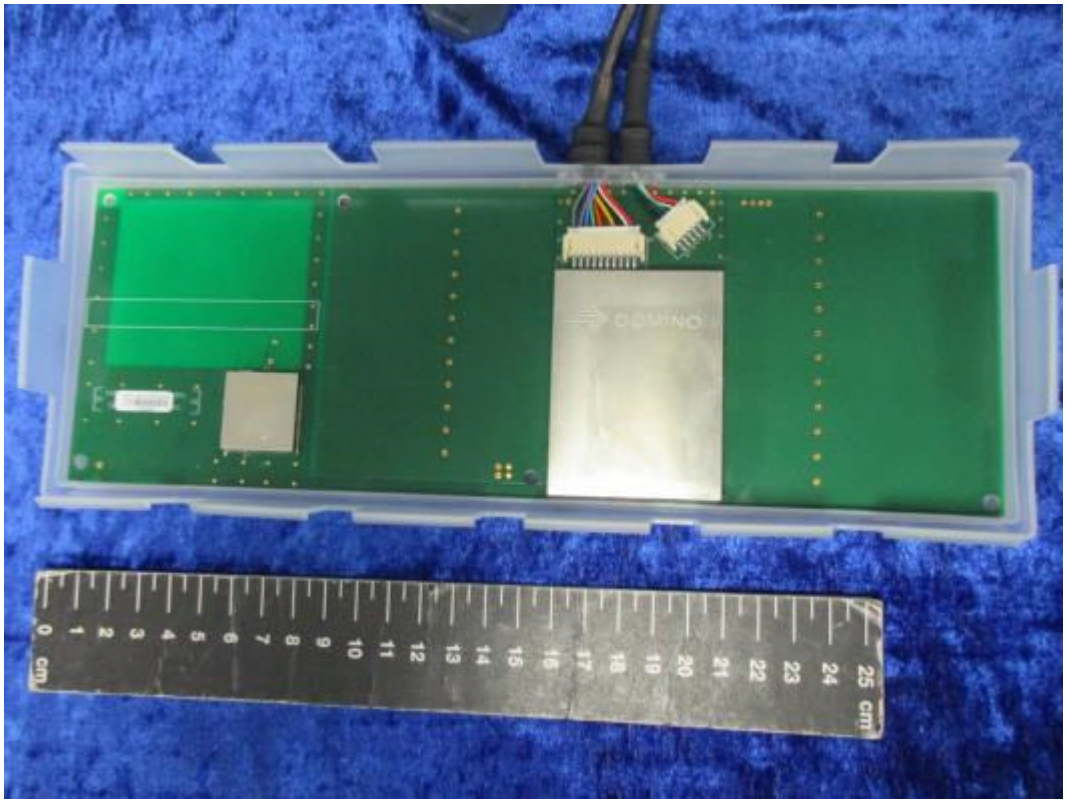

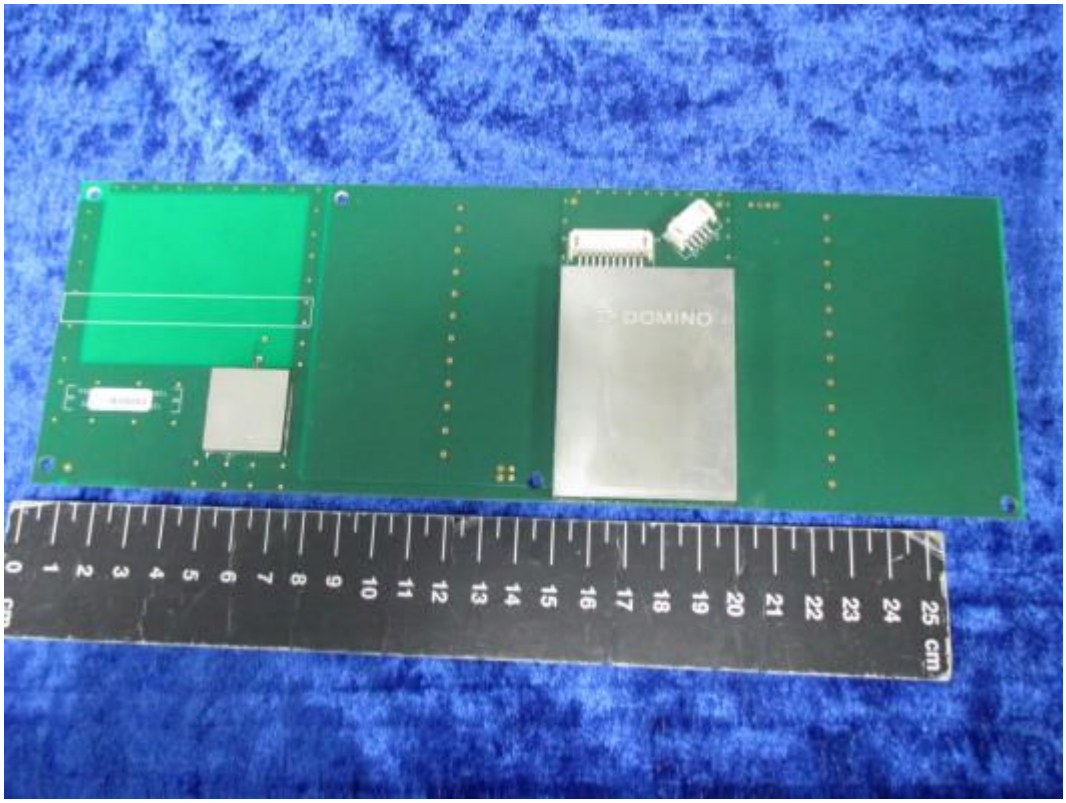
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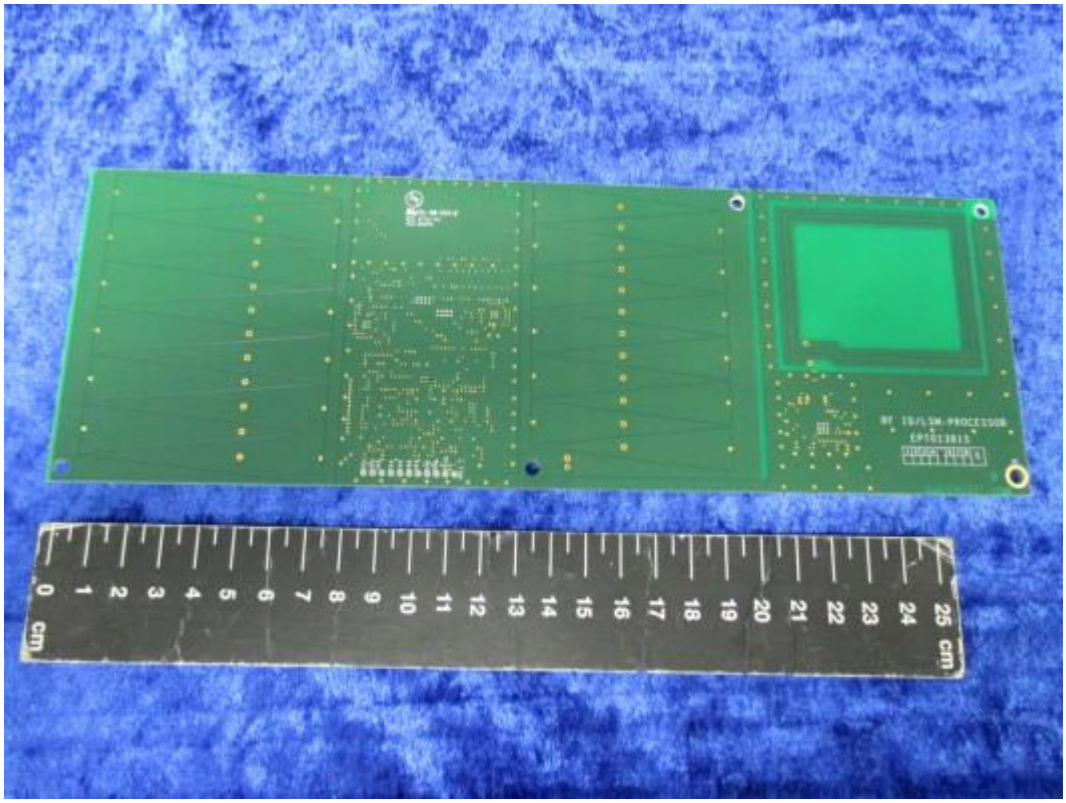
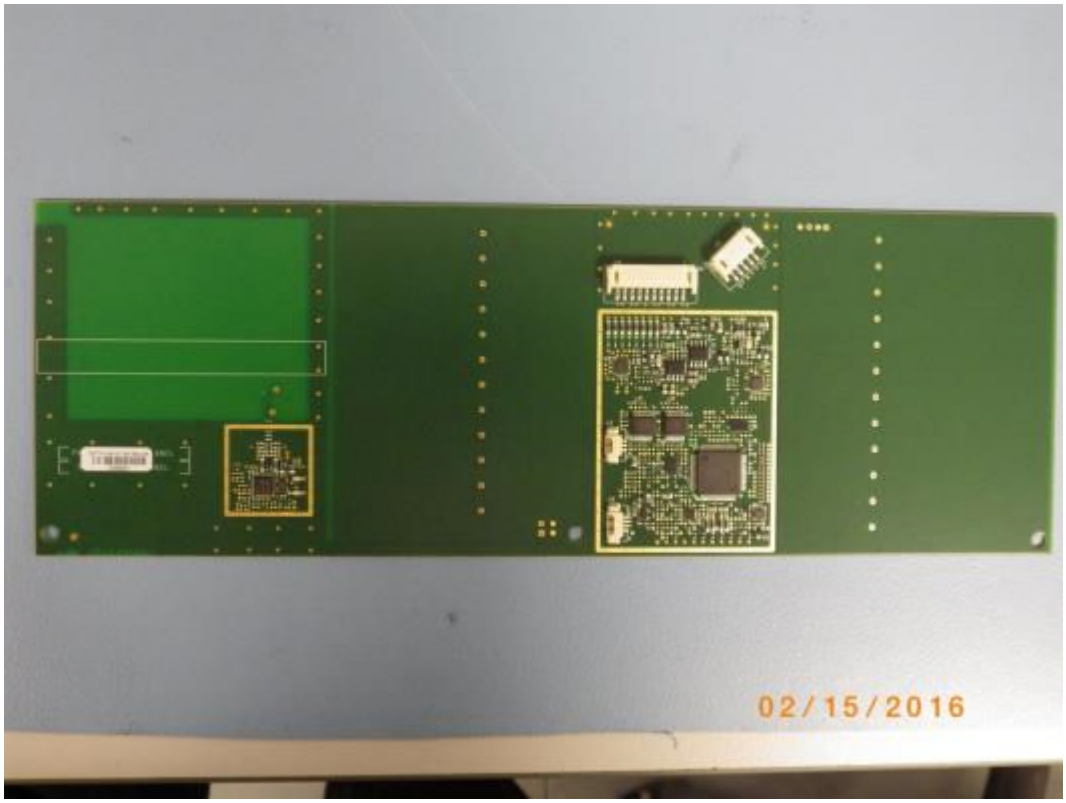
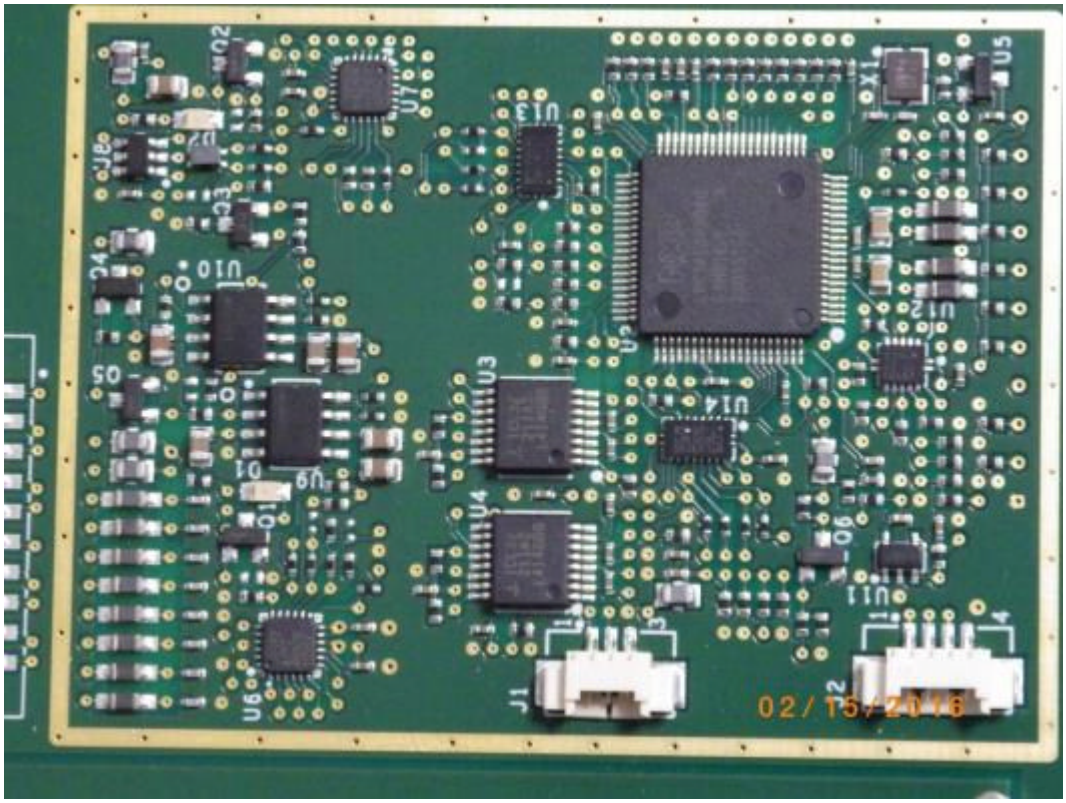
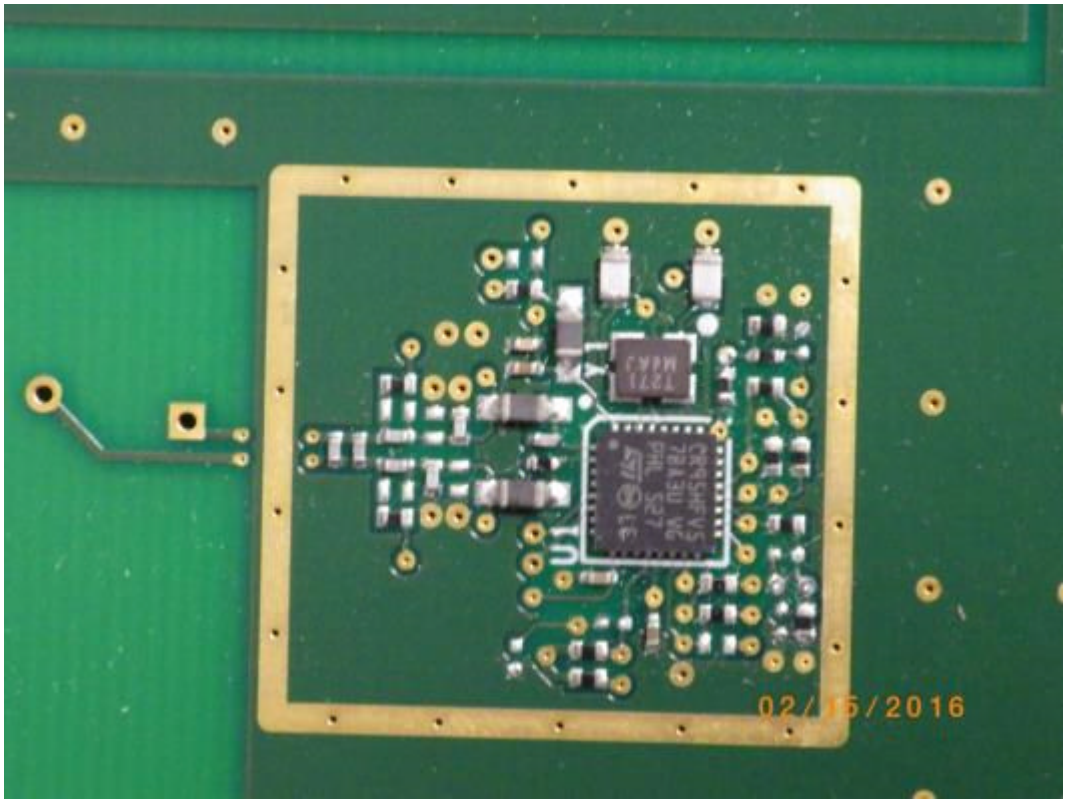






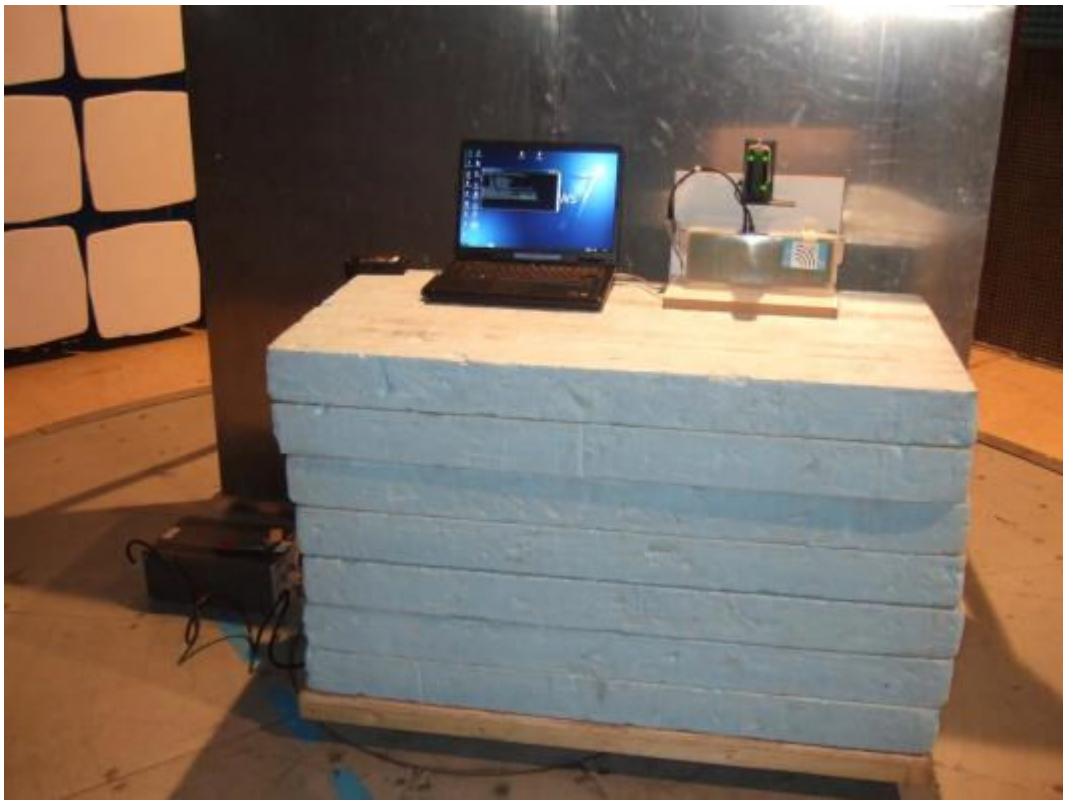

02/15/2016

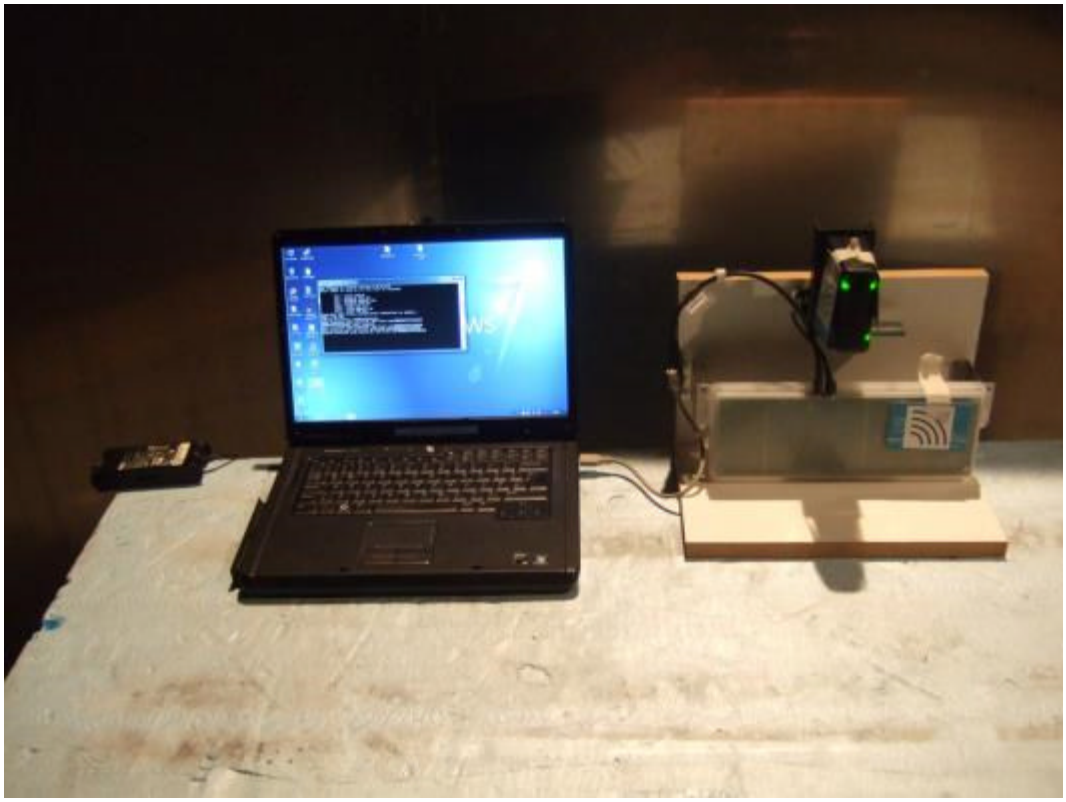
8.6 EUT ID Label

8.7 EUT Chassis

No chassis.

8.8 AC power line conducted emissions





8.9 Radiated emissions 9 kHz – 30 MHz

8.10 Radiated emissions 30 MHz -1 GHz

8.11 Radiated emission diagram

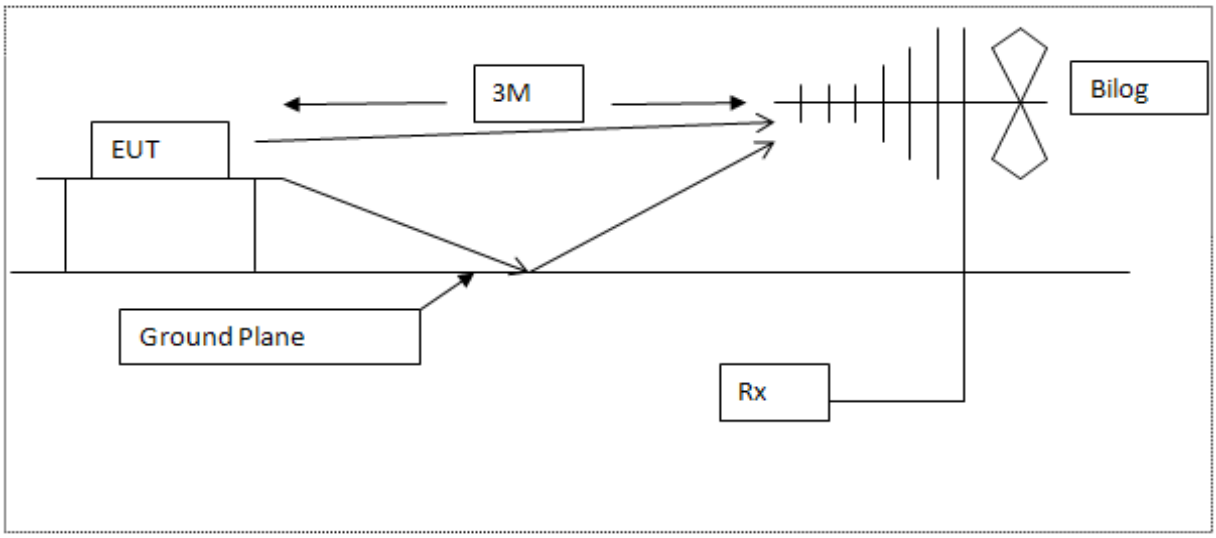


Diagram of the radiated emissions test setup 30 - 1000 MHz

8.12 AC powerline conducted emission diagram

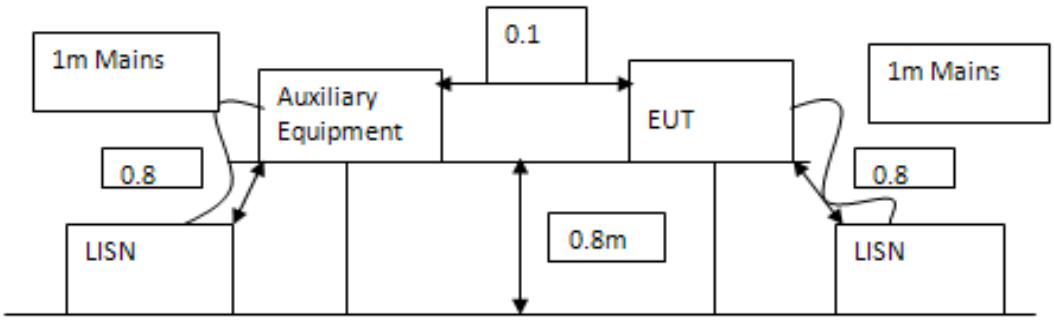


Diagram of the AC conducted emissions test setup

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
E227	6632A	System DC Power Supply	Hewlett Packard	19-Mar-2015	12 months
E285	8546A	EMI Receiver	Hewlett Packard	29-Jul-2015	12 months
E434	G3RUH	10 MHz GPS Oscillator	James Miller	N/A	N/A
E450	LISN 1600	LISN 16A 9 kHz - 30 MHz	Thurlby Thandar Instruments	22-Oct-2015	12 months
E533	N5182A	Signal Generator 6 GHz MXG	Agilent Technologies	26-Feb-2013	36 months
E534	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	26-Feb-2015	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	*26-Jan-2016	12 months
E541	-	Magnetic Loop test fixture	RN Electronics Ltd	N/A	N/A
E623	72-7715	Thermometer	TENMA	07-Mar-2017	12 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Keysight	30-Nov-2015	12 months
LPE364	CBL6112A	30MHz - 2GHz Bilog Antenna	Chase Electronics Ltd	*22-Jan-2016	24 months
LPE373	11947A	Transient Limiter 9kHz - 200MHz	Hewlett Packard	14-Dec-2015	6 months
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	N/A	N/A
TMS45	Model1	Attenuator	Weinschel	07-Jul-2015	12 months
TMS81	6502	Active Loop Antenna	EMCO	27-Apr-2015	24 months

* Equipment was in calibration dates for tests and has been re-calibrated since date of tests.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

No customer supplied equipment.

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
N524	Vostro 1000	DELL Laptop	DELL	J2XPW3J

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

No modifications were made before test by RN Electronics Ltd.

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)
VCCI Registration No. C-2823

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
VCCI Registration No. R-2580

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