Report For Testing To IEC60945
For EMC Only

Echomax Active-X Radar Target Enhancer

5th June 2009

1. Introduction

This report contains all of the relevant documented information following testing carried out on the Echomax Active-X Radar Target Enhancer (RTE), in accordance with IEC60945, Fourth Edition 2002-08, Clause 1, Section C – for EMC only.

All electrical tests were performed at;
Coverise Ltd, Unit 4 Ocivan way, Margate, Kent CT9 4NN
Tel: +44 (0)1843 282930

On behalf of;
Aquamate Products Ltd, Champers Farm, Bardfield End Green, Thaxted Dunmow, Essex CM6 3PX

Tests were carried out between 27th May and 1st June 2009

The Equipment Under Test (EUT) comprised of the Active X RTE and associated terminal connection box. The intended operating voltage for the EUT is 10.8V to 15.6V DC. In all tests the RTE power supply was provided by a 12VDC lead acid battery.

In order to stimulate the RTE during testing an excitation signal was used. This signal was a pulsed carrier at 9.4GHz, having a pulse duration of 500nS and a pulse repetition frequency (PRF) of 1KHz. This signal was transmitted via an X-band horn antenna placed adjacent to the EUT.

All emissions test were carried out with the excitation signal present.
All immunity tests were carried out both with and without the excitation signal being present. The EUT was continually monitored to ensure that it did not self transmit when the excitation signal was not present and that it did not go into saturation when the excitation signal was present. The EUT was monitored using a second X-band horn antenna connected to a spectrum analyser.

With the excitation signal present the spectrum analyser was used to monitor the excitation pulse as amplified by the EUT. This was continually checked to ensure that the pulse amplitude did not change by more than ± 1.0dB of the nominal, indicating that the EUT was not saturated.

With no excitation signal present the spectrum analyser was continually checked to ensure that the EUT did not self transmit.

In all cases the unit has been tested to the specifications listed in IEC60945 and comments on the relative performance are detailed in the results.

Report prepared by:…… **Date:**05/06/09.

Report checked by:…… **Date:**5/6/09.

2. Test Summary

2.1. Table 1 – IEC60945 Test Summary

Clause	Test Description	Result
9.2	Conducted emissions (10KHz – 30MHz)	PASS
9.3	Radiated emissions from enclosure port (150KHz – 2GHz)	PASS
10.3	Immunity to conducted radio frequency disturbance (150KHz – 80MHz)	PASS
10.4	Immunity to Radiated radio frequencies (80MHz – 2GHz)	PASS
10.5	Immunity to fast transients on a.c. power, signal and control lines	N/A
10.6	Immunity to surges on a.c. power lines	N/A
10.7	Immunity to power supply short-term variation	N/A
10.8	Immunity to power supply failure	PASS
10.9	Immunity to electrostatic discharge	PASS

N/A Not applicable – The EUT is except from these tests, please refer to Sections 5.3, 5.4 & 5.5 of this report for details.

2.2. Test Result

Test Result:	Pass

The supplied test sample of the Echomax Active-X Radar Target Enhancer successfully passed the series of tests outlined above. This indicates compliance with the EMC criteria of IEC 609454, Fourth Edition 2002-08.

3. Test Equipment Used

3.1. Table 2 – Conducted Emissions Test Equipment Used

	Conducted Emissions 10KHz to 30MHz			
No.	**Test Equipment**	**Manufacturer**	**Model No.**	**Serial No.**
NAV1307	Anechoic Chamber	MPE	-	SN: C1162-D1
NAV283	EMI Test Receiver	Rohde & Schwarz	ESHS10	SN: 837356010
NAV282	LISN	Rohde & Schwarz	ESH3-Z-5	SN: 8379448/013
NAV1232	PC Running ESXS K1 Software	Reseda	-	SN: 980724SK1747
TJ0133	10dB Transient Limiter	Coverise	-	-
C012	BNC Cable 3m	Coverise	-	-
C013	BNC Cable 3m	Coverise	-	-
-	12V Lead Acid Battery	Halfords	-	-

3.2. Table 3 – Radiated Emissions Test Equipment Used

	Radiated Emissions 150KHz to 2GHz			
No.	**Test Equipment**	**Manufacturer**	**Model No.**	**Serial No.**
NAV1307	Anechoic Chamber	MPE	-	SN: C1162-D1
NAV284	EMI Test Receiver	Rohde & Schwarz	ESVS10	SN: 837948013
NAV283	EMI Test Receiver	Rohde & Schwarz	ESHS10	SN: 837356010
NAV2043	Spectrum Analyser	Rohde & Schwarz	FSP	SN: 100404
NAV1232	PC Running ESXS K1 Software	Reseda	-	SN: 980724SK1747
NAV1338	Loop Antenna	Schaffner-Chase	HLA6120	SN: 1140
NAV1339	Battery Pack	Schaffner-Chase	CBP9720	SN: 1088
NAV1376	Log Periodic / Biconical Antenna	Antenna Research Ltd	LPB-2513A	SN: 1156
NAV2045	Horn Antenna	Rohde & Schwarz	HF906	SN: 100287
C002	N-Type Cable 10m	Teledyne	-	-
C012	N-Type Cable 3m	Teledyne	-	-
-	12V Lead Acid Battery	Halfords	-	-

3.3. Table 4 – Conducted Immunity Test Equipment Used

	Conducted Immunity 150KHz to 80MHz			
No.	**Test Equipment**	**Manufacturer**	**Model No.**	**Serial No.**
NAV1307	Anechoic Chamber	MPE	-	SN: C1162-D1
NAV1309	Signal Generator	IFR	2023B	SN: 203301/052
NAV1308	Spectrum Analyser	Rohde & Schwarz	FSEA20	SN: 826990/004
NAV1401	RF Power Amplifier	IFI	SMX100	SN: C003-0199
NAV1232	PC Running Chase Immunity Software	Reseda	-	SN: 980724SK1747
-	CDN-M2	Coverise	-	-
-	CDN-M1	Coverise	-	-
-	CDN-M1	Coverise	-	-
NAV2040	30dB Attenuator	Spinner	BN 745385	SN: 13960
C001	N-Type Cable 10m	Coverise	-	-
C007	N-Type Cable 5m	Coverise	-	-
-	12V Lead Acid Battery	Halfords	-	-

3.4. Table 5 – Radiated Immunity Test Equipment Used

	Radiated Immunity 30MHz to 2GHz			
No.	**Test Equipment**	**Manufacturer**	**Model No.**	**Serial No.**
NAV1307	Anechoic Chamber	MPE	-	SN: C1162-D1
NAV1309	Signal Generator	IFR	2023B	SN: 203301/052
NAV1401	RF Power Amplifier	IFI	SMX100	SN: C003-0199
-	RF Power Amplifier	IFI	S41-50	SN: J031-0505
NAV1232	PC Running Chase Immunity Software	Reseda	-	SN: 980724SK1747
NAV1376	Log Periodic / Biconical Antenna	Antenna Research Ltd	LPB-2513A	SN: 1156
NAV2045	Horn Antenna	Rohde & Schwarz	HF906	SN: 100287
NAV1334	Field Meter	Chauvin Arnoux	C.A.43	SN: 2548
C002	N-Type Cable 10m	Teledyne	-	-
C010	N-Type Cable 1m	Teledyne	-	-
C012	N-Type Cable 3m	Teledyne	-	-
-	12V Lead Acid Battery	Halfords	-	-

3.5. Table 6 – Electrostatic Discharge Test Equipment Used

	Immunity to Electrostatic Discharge			
No.	**Test Equipment**	**Manufacturer**	**Model No.**	**Serial No.**
NAV1307	Anechoic Chamber	MPE	-	SN: C1162-D1
NAV0279	ESD Tester	Haefely	PSD 25 B	SN: 082 123 IO
-	12V Lead Acid Battery	Halfords	-	-

3.6. Table 7– General Equipment Used for Excitation Signal and Monitoring EUT

	Excitation Signal Generation / EUT monitoring – All Tests			
No.	**Test Equipment**	**Manufacturer**	**Model No.**	**Serial No.**
	Pulse Generator	Lyons Instruments	PG-2E	SN: 5176
NAV2043	Spectrum Analyser	Rohde & Schwarz	FSP	SN: 100404
-	9.4 GHz Signal Source	Coverise Ltd	-	-
-	6dB Attenuator	HP	8473B	SN: 04917
	Microwave Switch	HP	33144A	SN: 04284
	Switch Driver	HP	33190B	SN: 02187
-	Waveguide to Coax Transition	FMI	-	-
-	Waveguide to Coax Transition	FMI	-	-
	PSU	WEIR	460	SN: 731012
	PSU	Navico	PSU1208	SN: KF0540
	Horn Antenna X-Band	Plessy	3102	SN: 0001
	Horn Antenna X-Band	Plessy	3102	SN: 0002

4. Electromagnetic Emissions Tests Results

(Section 9 - EN60945 Edition 4)

4.1. Conducted Emissions

4.1.1. Test Method

Testing was carried out in accordance with IEC60945, clause 9.2.

The EUT was set-up on the ground plane inside the anechoic chamber and connected to the LISN via the supplied length of cable. The EUT was installed on a supplied mount that set the centre point of the RTE to a height of 1.5m above the groundplane. This was required as the RTE could not be laid flat on the ground plane as this would cause it to self oscillate. Additional microwave frequency absorbing tiles were also used to prevent reflections from the chamber walls. The associated terminal box was placed on the groundplane. Power was provided by a 12VDC Lead Acid Battery. Excess cable was laid across the groundplane. During the test the EUT was stimulated by the excitation signal.

With the EMI receiver and software control PC outside the chamber an initial measurement scan was carried out to determine the ambient signal level with the EUT disconnected. A measurement scan was then carried out on the EUT set up as described and the results recorded.

The test layout is shown in figure 1, section 6.1, page 15. Testing was carried out both with and without the excitation signal being present so as to determine the worst case condition.

4.1.2. Equipment Used

Refer to tables 2 & 7.

4.1.3. Results

Plots 1 & 2, section 7.1 pages 18, show the measurement scans within the frequency range 10kHz to 30MHz. All levels are within the limits specified in IEC60945.

The EUT complies with the requirements of IEC60945, Clause 9.2 for Conducted Emissions.

4.2. Radiated Emissions From Enclosure Port

4.2.1. Test Method

Testing was carried out in accordance with IEC60945, clause 9.3, covering the frequency range 150KHz to 2GHz.

For measurements in the band 150KHz to 30MHz a magnetic loop antenna was used in conjunction with a R&S ESHS10 EMI Test Receiver, running under PC control. A correction factor of +51.5dB was included within the transducer factor of the magnetic loop antenna to convert the magnetic field strength to an equivalent electric field strength.

For measurements in the band 30KHz to 1GHz a bi-log antenna was used in conjunction with a R&S ESVS10 EMI Test Receiver, running under PC control.

For measurements in the band 1GHz to 2GHz a horn antenna was used in conjunction with a R&S FPS30 Spectrum Analyser.

All measurements were carried out at a range of 3m, between the EUT and receive antenna.

The EUT was installed on a supplied mount that set the centre point of the RTE to a height of 1.5m inside the anechoic chamber. The associated terminal box was placed on the test table at a height of 0.8m. Additional microwave frequency absorbing tiles were used to prevent reflections from the chamber walls so as to avoid self oscillation of the RTE. Power was provided by a 12VDC battery connected via the supplied lengths of cable. During the test the EUT was stimulated by the excitation signal.

The test layout is shown in figure 2, section 6.2, page 15

Scans were carried out for each face of the EUT so as to establish the worst case configuration. These were repeated with the receiving antenna both horizontally and vertically polarised for measurements in the Band 30MHz to 2GHz.

4.2.2. Equipment Used

Refer to tables 2 & 6.

4.2.3. Results

Plots 3 to 13, section 7.2, pages 19 to 24, show the measurement scans within the frequency ranges 150kHz to 30MHz , 30MHz to 1 GHz and 1GHz to 2GHz.
All levels are within the limits specified in IEC60945.

The EUT complies with the requirements of IEC60945, Clause 9.3, radiated emissions from enclosure port.

5. Immunity to Electromagnetic Environment Test Results

(Section 10 - EN60945 Document)

5.1. Immunity to Conducted Radio Frequency Interference

5.1.1. Test Method

Testing was carried out in accordance with IEC60945, clause 10.3, covering the frequency range 150KHz to 80MHz.

The EUT terminal box and cabling was set-up on an insulating support 0.1m above a reference ground plane. The RTE was installed on a supplied mount that set the centre point of the RTE at a height of 0.7m, above and adjacent to the reference groundplane. This was required as the RTE could not be laid flat on the ground plane as this would cause it to self oscillate.. Additional microwave absorbing tiles were also used to prevent reflections from the chamber walls. Injection of the interfering signal was via a coupling-decoupling network (CDN) connected to the EUT via a 0.3m cable. Power was provided by a 12VDC battery. The level of the induced interference signal was pre-calibrated over the required frequency range prior to the test. During the test the EUT was stimulated by the excitation signal.

Testing was carried out on the power port.
The induced interference was swept over the range 10kHz to 80MHz at a level of 3Vrms, and at spot frequencies of 2MHz, 3MHz, 4MHz, 6.2MHz, 8.2MHz, 12.6MHz, 18.8MHz, 22MHz and 25MHz, at a level of 10Vrms.

During testing on the power port, a spectrum analyser was used to monitor the excitation signal pulse as amplified by the EUT. This was continually checked to ensure that the pulse amplitude did not change by more than ± 1.0dB of the nominal, indicating that the EUT was not saturated.

The test was then repeated without the excitation signal present. The spectrum analyser was continually checked to ensure that the EUT did not self transmit.

In both cases no degradation or self transmissions were observed.

The test layout is shown in Figure 3, section 6.3 page 16.

5.1.2. Equipment Used

Refer to tables 4 & 7.

5.1.3. Results

Plot 14, section 7.1, page 25 shows the induced generator level used for the test over the frequency range 150kHz to 80MHz. Both during and after the above tests the EUT remained in a stable state and operated as intended, thus conforming to the required performance criterion A.

The unit complies with the requirements of EN60945, clause 10.3, immunity to conducted radio frequency interference.

5.2. Immunity to Radiated Radio Frequencies

5.2.1. Test Method

Testing was carried out in accordance with IEC60945, clause 10.4, covering the frequency range 80MHz to 2GHz**.** All measurements were carried out at a range of 3m, between the EUT and generating antenna.

The EUT was installed on a supplied mount that set the centre point of the RTE to a height of 1.5m, inside the anechoic chamber. The associated terminal box was placed on the test table at a height of 0.8m. Additional microwave frequency absorbing tiles were used to prevent reflections from the chamber walls so as to avoid self oscillation of the RTE. Power was provided by a 12VDC battery connected via the supplied lengths of cable. During the testing the EUT was stimulated by the excitation signal.

The test layout is shown in figure 4, section 6.4, page 16.

The EUT was subject to interference radio frequencies with a field strength of 10v/m, swept over the range 80MHz to 2 GHz, with AM modulation of 400Hz at a depth of 80%. Scans were carried out for each quadrant of the EUT so as to establish the worst case configuration. These were repeated with the generating antenna both horizontally and vertically polarised.

During testing a spectrum analyser was used to monitor the excitation signal pulse as amplified by the EUT. This was continually checked to ensure that the pulse amplitude did not change by more than ± 1.0dB of the nominal, indicating that the EUT was not saturated.

The test was then repeated without the excitation signal present. The spectrum analyser was continually checked to ensure that the EUT did not self transmit.

In both cases no degradation or self transmissions were observed.

5.2.2. Equipment Used

Refer to tables 5 & 7.

5.2.3. Results

Plots 16 to 19, section 8.2, pages 26 to 27 show the radiated field strength level used for the test over the frequency ranges 80MHz to 2GHz. Both during and after the above tests the EUT remained in a stable state and operated as intended, thus conforming to the required performance criterion A.

The unit complies with the requirements of EN60945, clause 10.4, immunity to radiated radio frequencies.

5.3. Immunity to Fast Transients on A.C Power, Signal and Control Lines

Note: This test applies to A.C power ports only. The EUT is DC only and is therefore exempt from this test.

5.3.1. Results

The unit is exempt from the requirements of EN60945, clause 10.5, Immunity to fast transients on A.C power, signal and control lines.

5.4. Immunity to Surges on A.C Power Lines

Note: This test applies to A.C power ports only. The EUT is DC only and is therefore exempt from this test.

5.4.1. Results

The unit is exempt from the requirements of EN60945, clause 10.6, immunity to surges on A.C power lines.

5.5. Immunity to Power Supply Short - Term Variation

Note: This test applies to A.C power ports only. The EUT is DC only and is therefore exempt from this test.

5.6. Results

The unit is exempt from the requirements of EN60945, clause 10.7, immunity to power supply short - term variation.

5.7. Immunity to Power Supply Failure

5.7.1. Test Method

Testing was carried out in accordance with IEC60945, clause 10.8. The EUT was initially connected to a 12 VDC battery, a supply interruption was then made for a duration of 60 seconds. The power was then restored and the EUT performance checked for any degradation.

After each test the EUT was stimulated by the excitation signal. A spectrum analyser was used to monitor the excitation signal pulse as amplified by the EUT. This was checked to ensure that the pulse amplitude had not change by more than ± 1.0dB of the nominal.

The test was then repeated without the excitation signal present. The spectrum analyser was checked to ensure that the EUT did not self transmit.

In both cases no degradation or self transmissions were observed.

Note: This product does not contain a microcontroller and therefore would not suffer corruption of operating software or loss of data.

5.7.2. Equipment Used

Refer to table 7.

5.7.3. Results

No loss of performance was observed. The EUT powered down when power was interrupted and reset to the normal power on state when power was restored after 60 seconds, thus conforming to the required performance criterion C.

The unit complies with the requirements of EN60945, clause 10.8, immunity to power supply failure.

5.8. Immunity to Electrostatic Discharge

5.8.1. Test Method

Testing was carried out in accordance with IEC60945, clause 10.9

The EUT terminal box and cabling was set-up on, bit insulated from, a reference ground plane. The RTE was installed on a supplied mount that set the centre point of the RTE at a height of 0.7m, above and adjacent to the reference groundplane. This was required as the RTE could not be laid flat on the ground plane as this would cause it to self oscillate. Additional microwave frequency absorbing tiles were also used to prevent reflections from the chamber walls. Power was provided by a 12VDC battery connected via the supplied lengths of cable. During the test the EUT was stimulated by the excitation signal.

The ESD generator was held perpendicular to the EUT surface and the specified discharges applied to the points of the enclosure surface which are accessible during normal use, and to points on the reference plane.

Both positive and negative air discharges, at 8KV, and contact discharges, at 6KV, were used, with a minimum of 10 discharges at each point. The positions of the test discharges are shown in Figure 6, section 6.6, page 17. Discharges were applied to the reference ground plane at positions on each side of, and 0.1m from, the EUT.

A spectrum analyser was used to monitor the excitation signal pulse as amplified by the EUT, both during and after the test. This was continually checked to ensure that the pulse amplitude did not change by more than ± 1.0dB of the nominal, indicating that the EUT was not saturated and that its performance had not been degraded.

The test also repeated without the excitation signal present. The spectrum analyser was checked to ensure that the EUT did not self transmit.

In both cases no degradation or self transmissions were observed.

5.8.2. Equipment Used

Refer To tables 6 & 7.

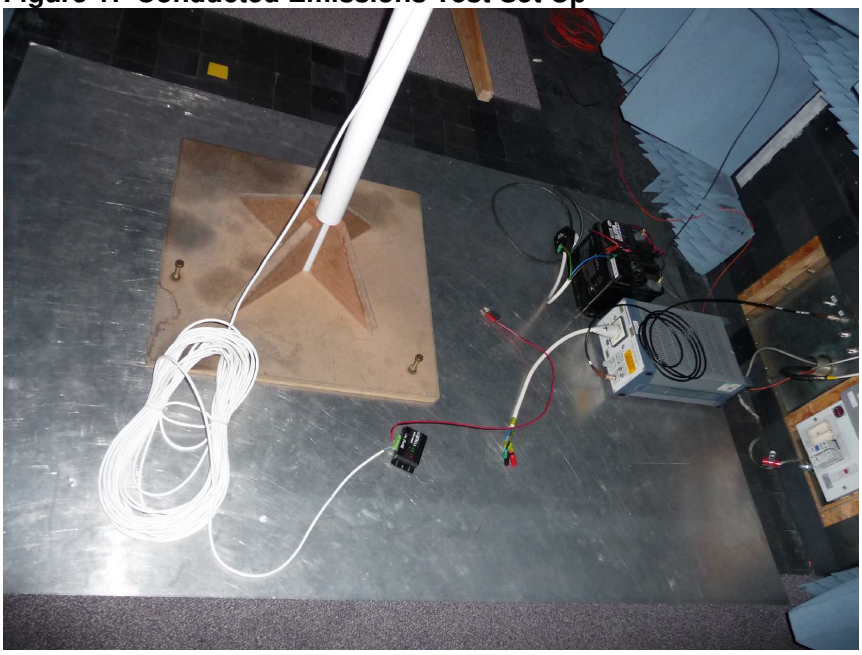
5.8.3. Results

After the test period, the EUT was found to be unaffected by the ESD having been applied, thus the EUT complies with performance criterion B.

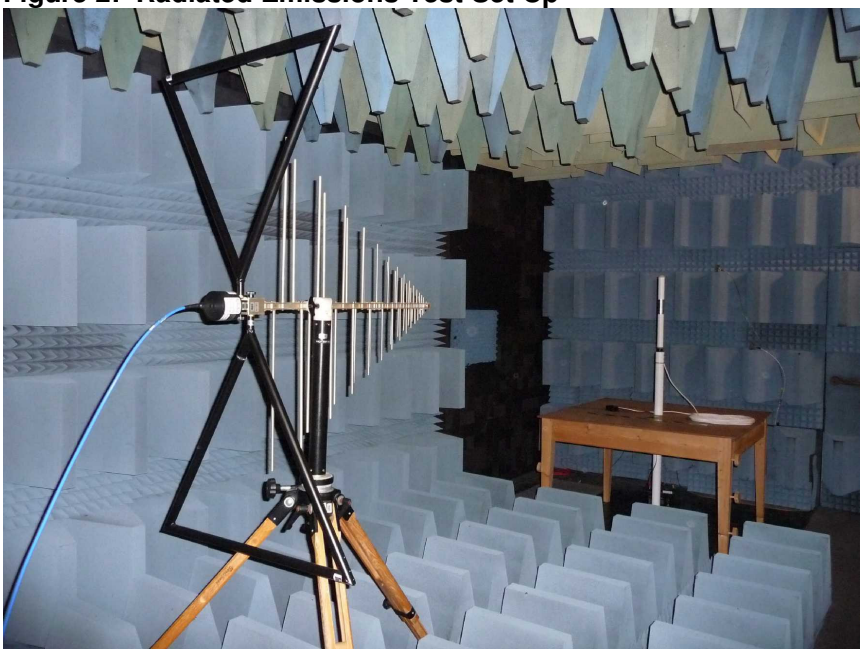
The unit complies with the requirements of EN60945, clause 10.9, immunity to electrostatic discharge.

6. Annex A: Photographs

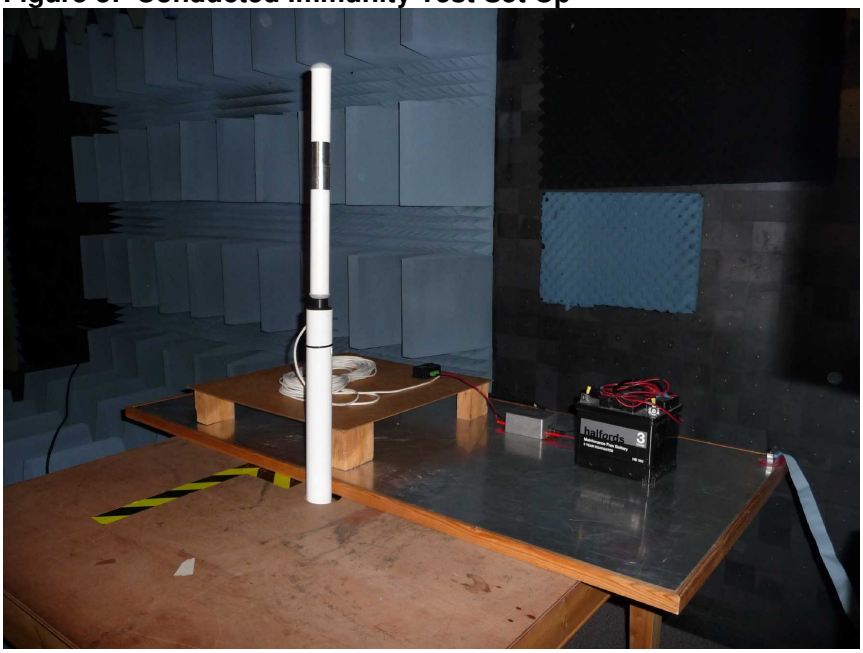
6.1. Figure 1: Conducted Emissions Test Set Up



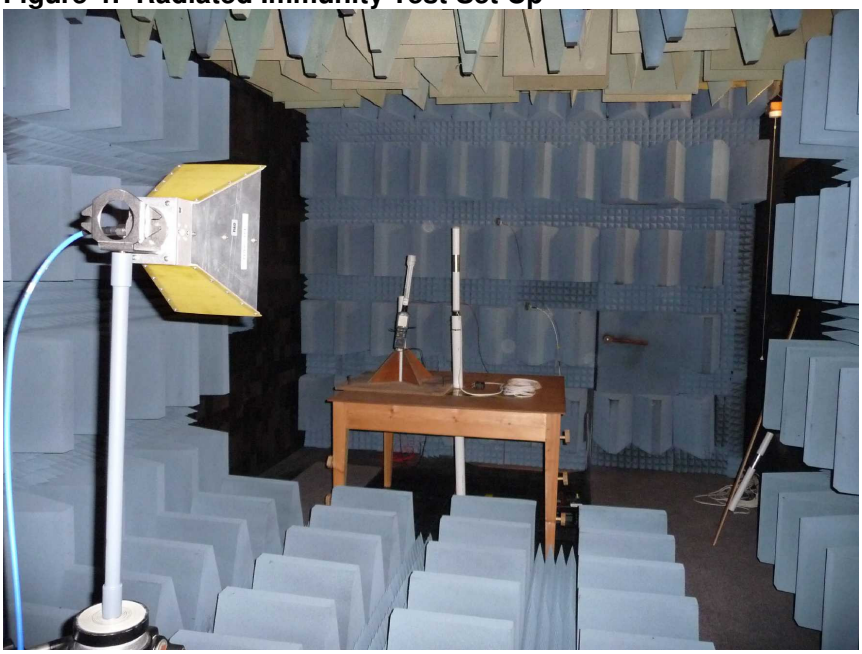
6.2. Figure 2: Radiated Emissions Test Set Up



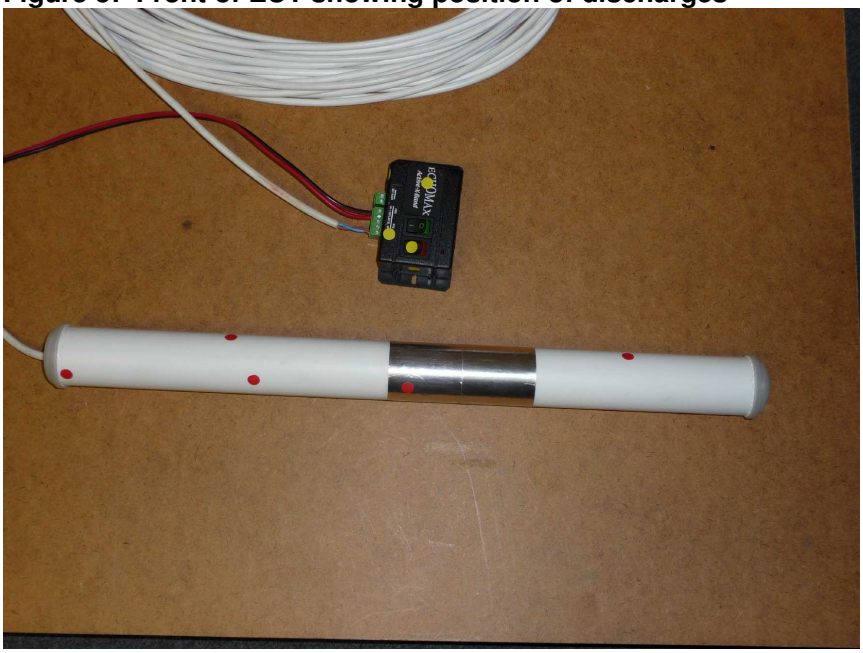
6.3. Figure 3: Conducted Immunity Test Set Up



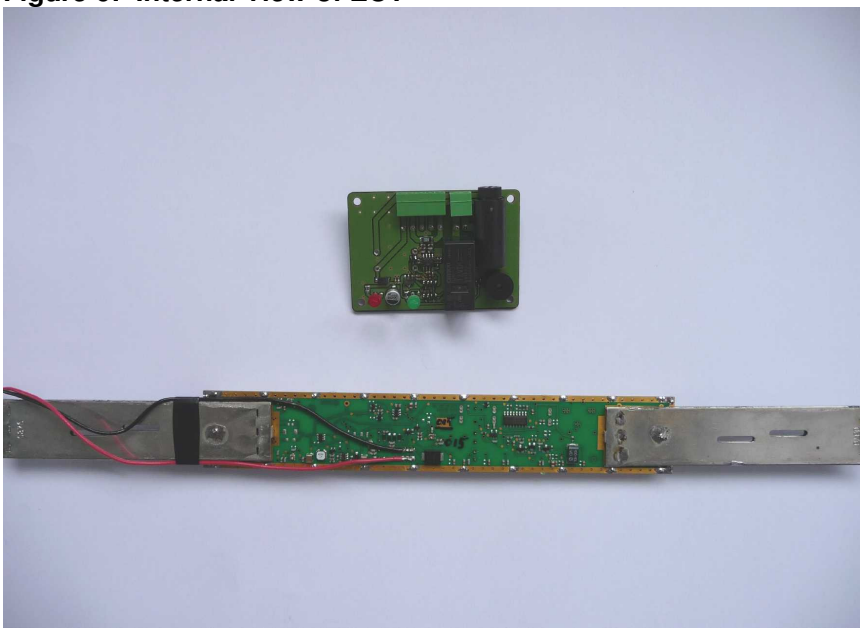
6.4. Figure 4: Radiated Immunity Test Set Up



6.5. Figure 5: Front of EUT showing position of discharges



6.6. Figure 6: Internal View of EUT



7. Annex B: Results of Emission Tests

7.1. Conducted Emissions Plots

7.1.1. Plot 1 : Conducted Emissions (150KHz to 30MHz), RTE STBY Mode

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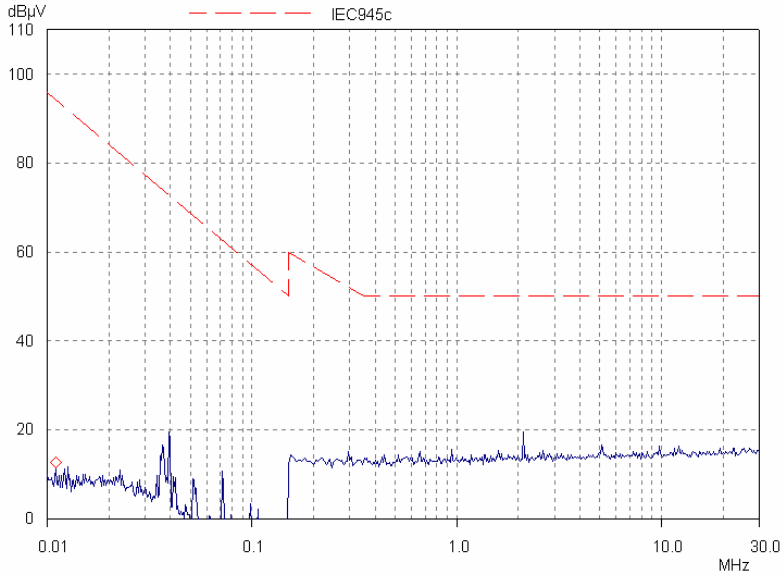
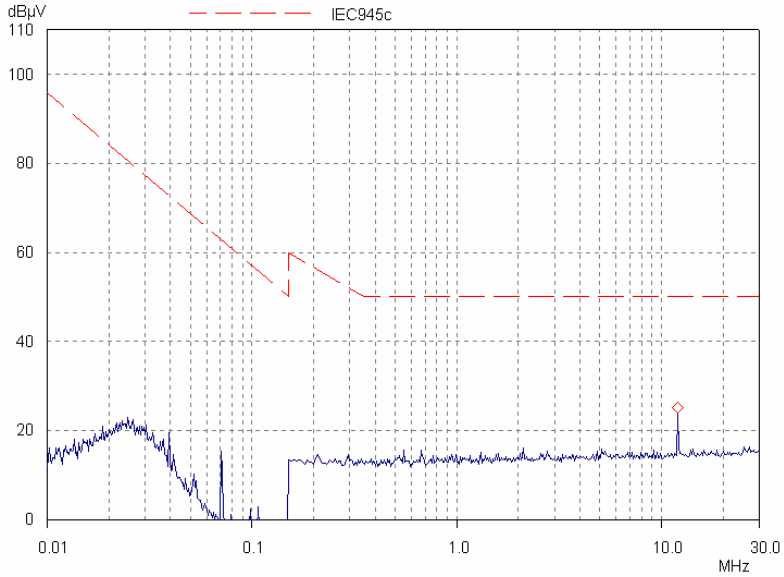


7.1.2. Plot 2: Conducted Emissions (150KHz to 30MHz), RTE On - Interrogated

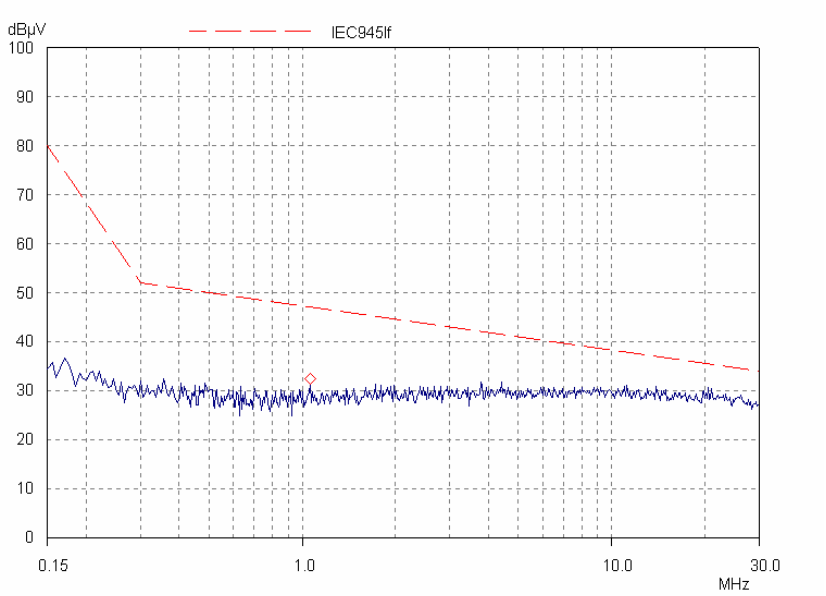
(File: 002_CE.dat)



7.2. Radiated Emission Plots
Radiated Emissions 150KHz to 30MHz

7.2.1. Plot 3: Radiated Emissions (150KHz to 30MHz), EUT Front View, RTE On - Interrogated

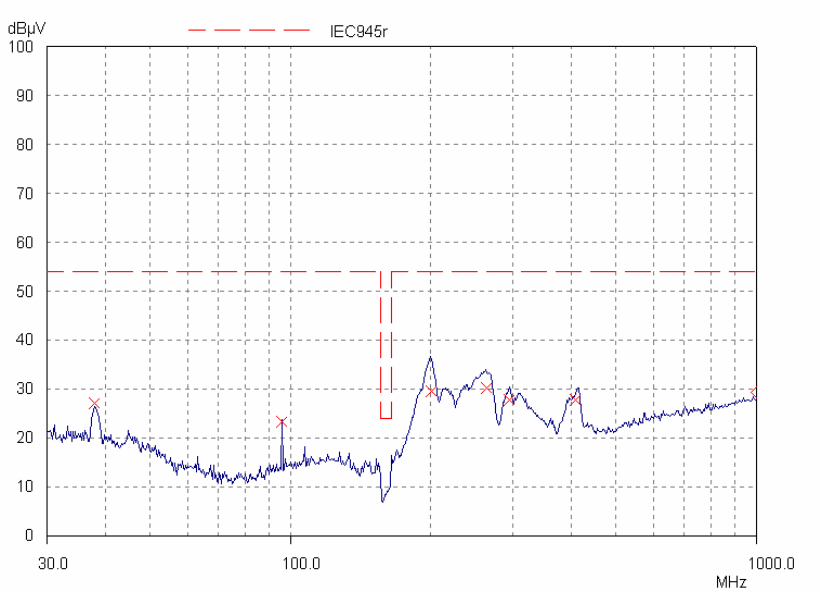
(File: 000_RE.dat)



Radiated Emissions 30MHz to 1GHz
Vertical Polarisation

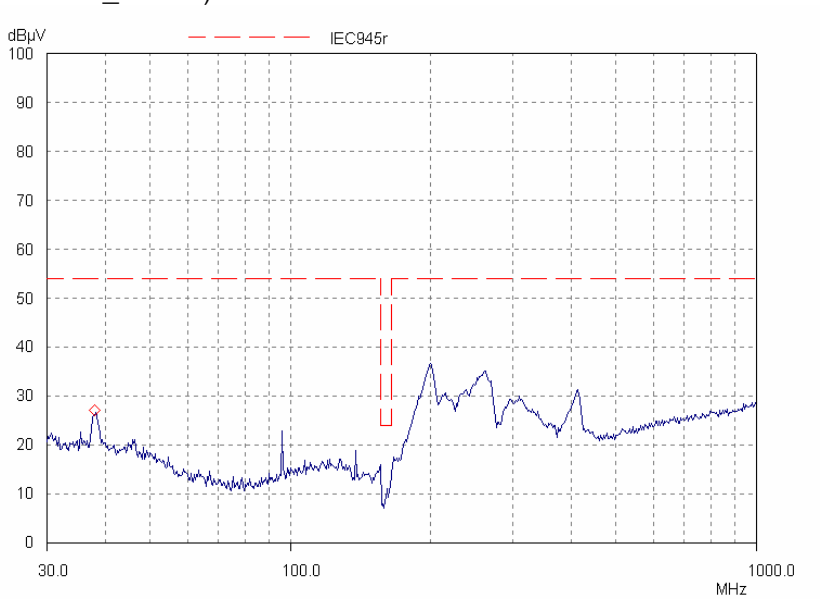
7.2.2. Plot 4: Radiated Emissions, Vertical Polarisation (30MHz to 1GHz), EUT Front View, RTE On - Interrogated – Quasi Peak Measurement

(File: 001_RE.dat)



7.2.3. Plot 5: Radiated Emissions, Vertical Polarisation (30MHz to 1GHz), EUT Left View, RTE On - Interrogated

(File: 002_RE.dat)



7.2.4. Plot 6: Radiated Emissions, Vertical Polarisation (30MHz to 1GHz), EUT Rear View, RTE On - Interrogated

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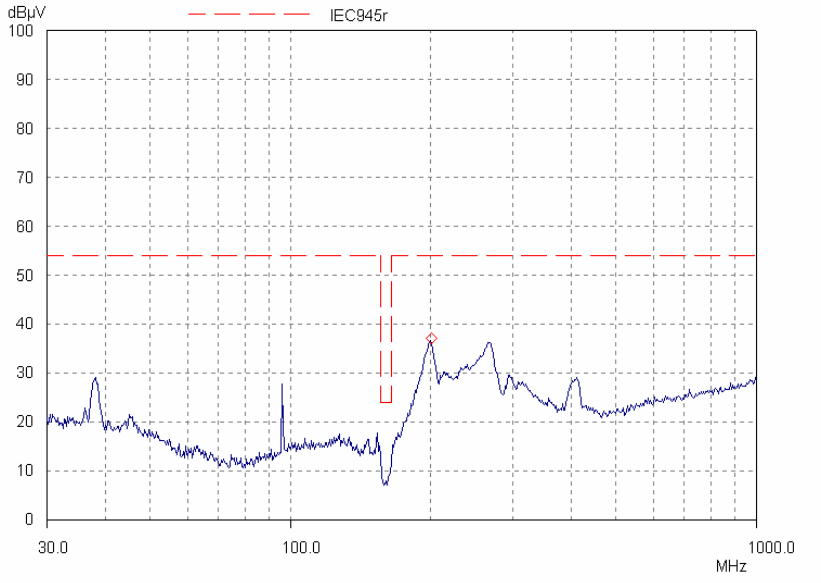

7.2.5. Plot 7: Radiated Emissions, Vertical Polarisation (30MHz to 1GHz), EUT Right View, RTE On - Interrogated

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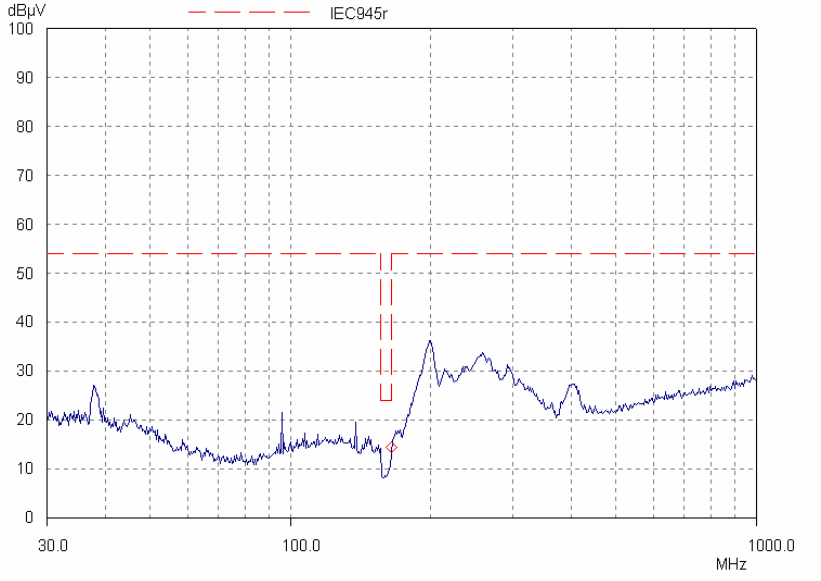
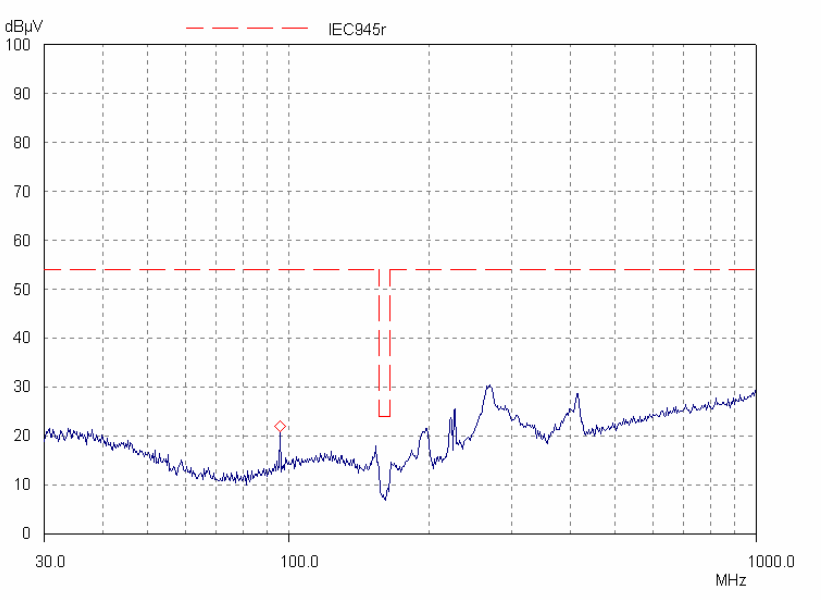


Horizontal Polarisation

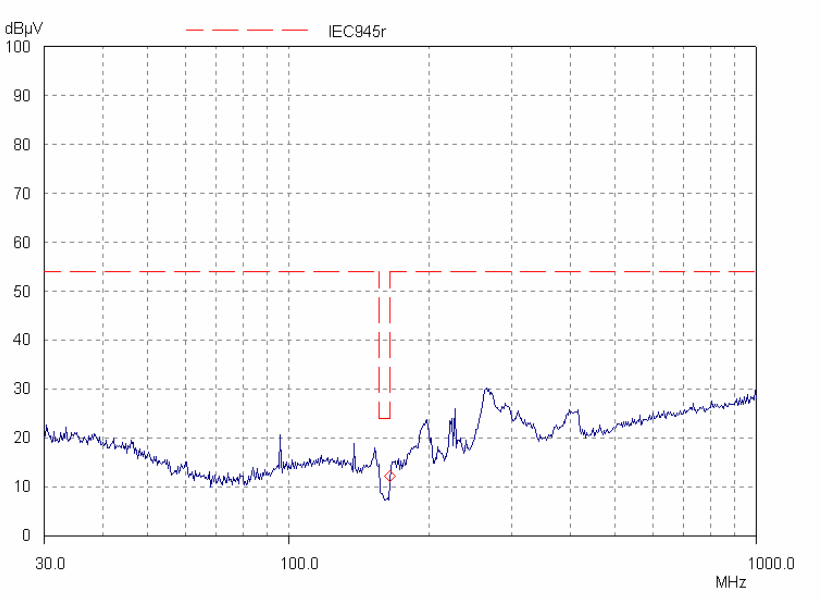
7.2.6. Plot 8: Radiated Emissions, Horizontal Polarisation (30MHz to 1GHz), EUT Front View, RTE On - Interrogated

(File: 005_RE.dat)



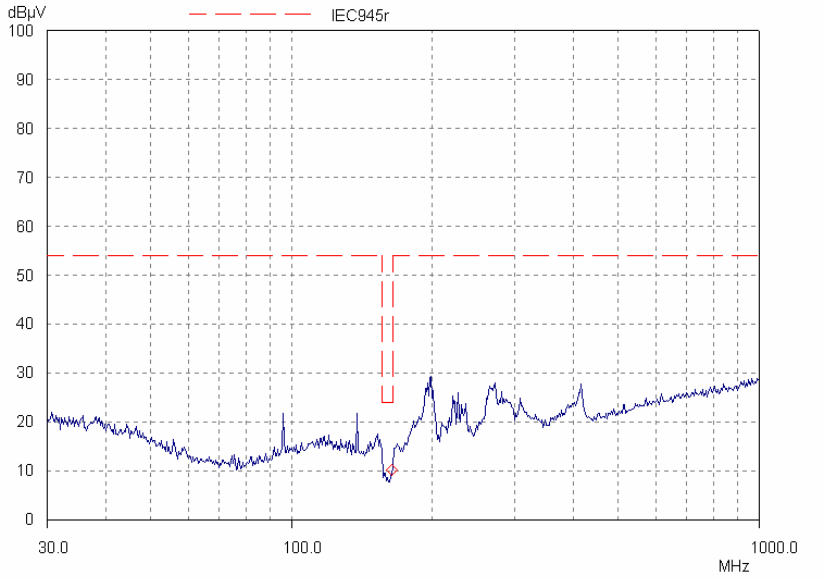
7.2.7. Plot 9: Radiated Emissions, Horizontal Polarisation (30MHz to 1GHz), EUT Left View, RTE On - Interrogated

(File: 006_RE.dat)



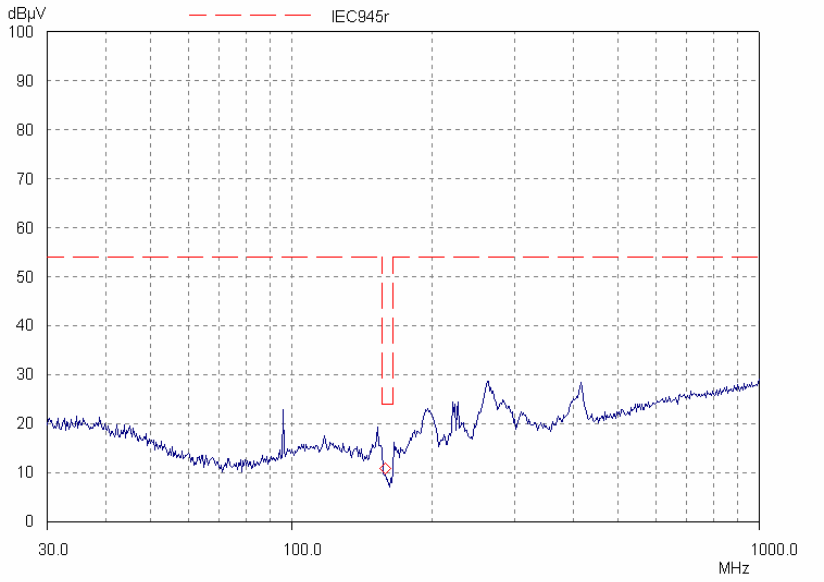
7.2.8. Plot 10: Radiated Emissions, Horizontal Polarisation (30MHz to 1GHz), EUT Rear View, RTE On - Interrogated

(File: 007_RE.dat)



7.2.9. Plot 11: Radiated Emissions, Horizontal Polarisation (30MHz to 1GHz), EUT Right View, RTE On - Interrogated

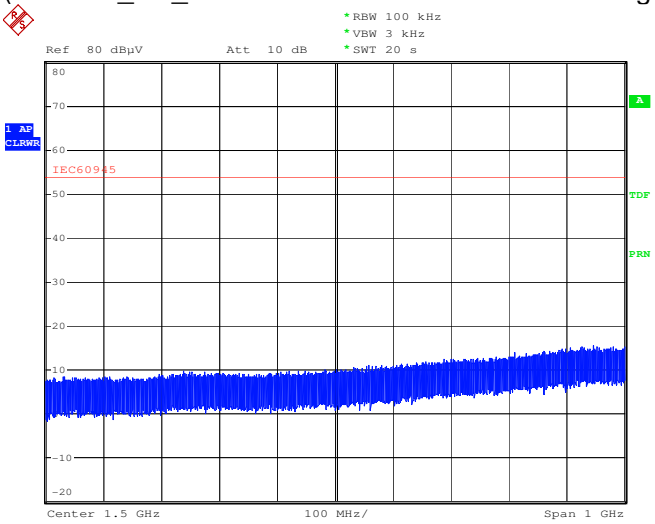
(File: 008_RE.dat)



Radiated Emissions 1GHz to 2GHz
Vertical Polarisation

7.2.10. Plot 12: Radiated Emissions, Vertical Polarisation (1GHz to 2GHz), EUT Front View, RTE On - Interrogated

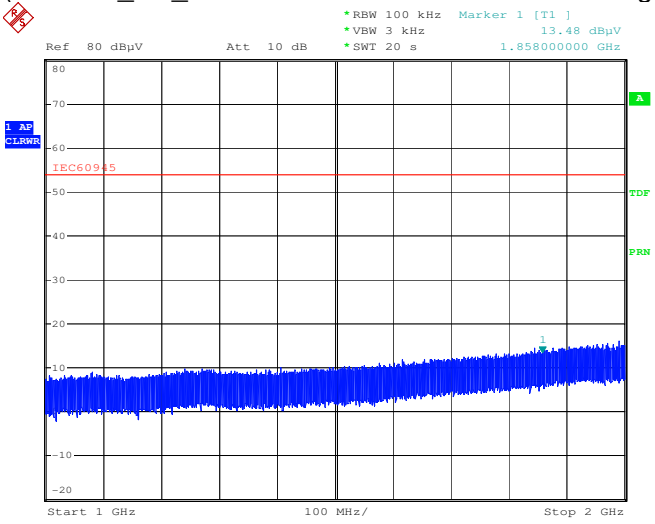
(File: 009_RE_REVP 1-2GHz Front RTE On-Interrogated.WMF)



Horizontal Polarisation

7.2.11. Plot13: Radiated Emissions, Horizontal Polarisation (1GHz to 2GHz), EUT Front View, RTE On – Interrogated

(File: 010_RE_REHP 1-2GHz Front RTE On-Interrogated.WMF)

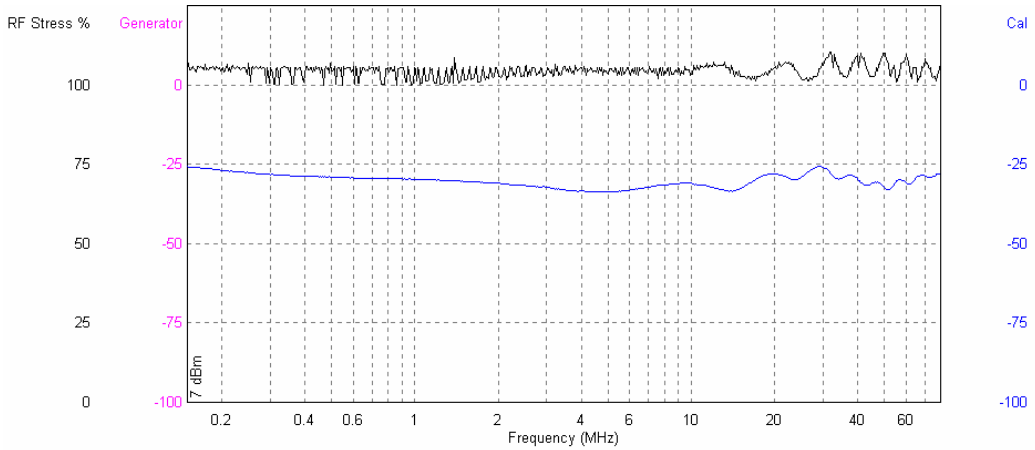


8. Annex C: Results of Immunity Tests

8.1. Conducted Immunity Plot

8.1.1. Plot 14: Generator levels for conducted immunity in the range 150kHz to 80MHz

(File:001_CI.Res)

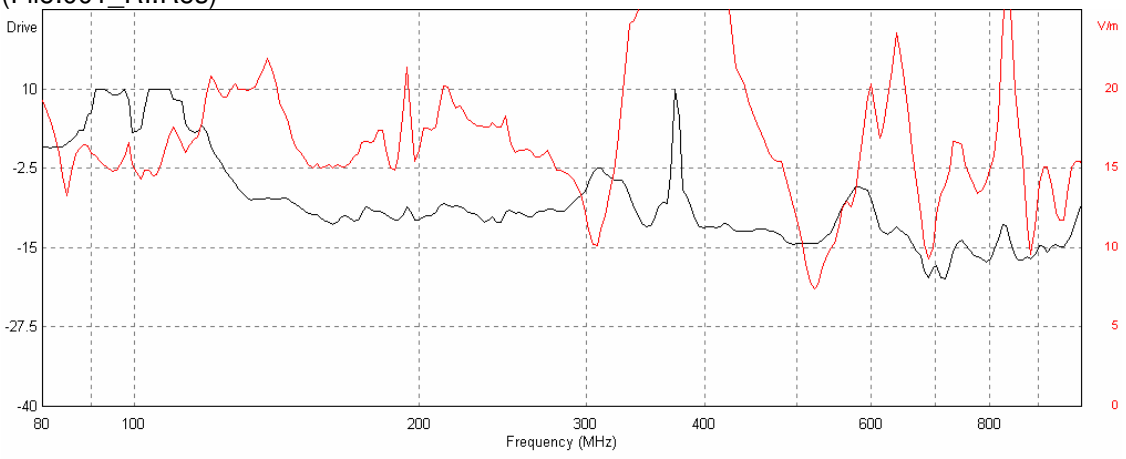


8.2. Radiated Immunity Plots
Radiated Immunity 80MHz to 1GHz

Vertical Polarisation

8.2.1. Plot 16: Scan of field strength from 80MHz to 1GHz, during radiated immunity test with the Antenna vertically polarised

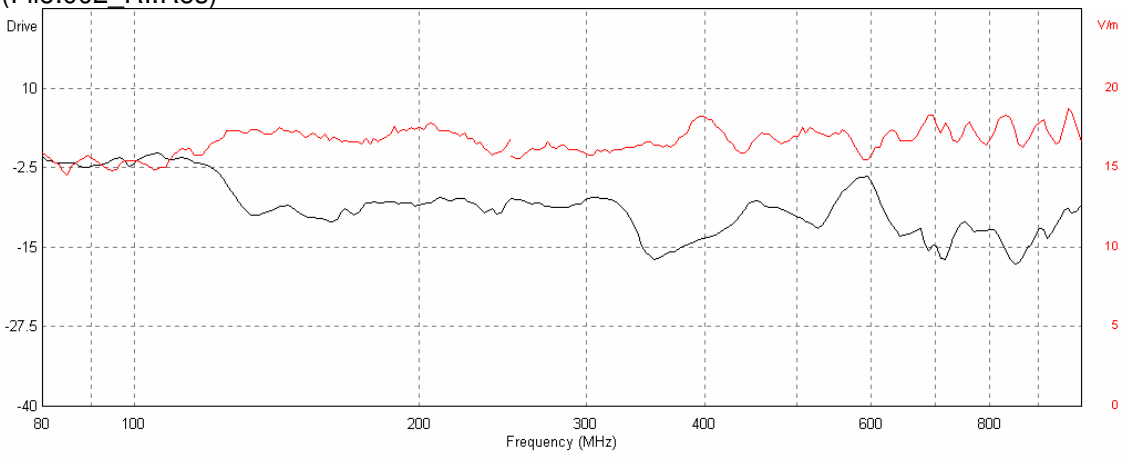
(File:001_RI.Res)



Horizontal Polarisation

8.2.2. Plot 17: Scan of field strength from 80MHz to 1GHz during radiated immunity test with the antenna horizontally polarised

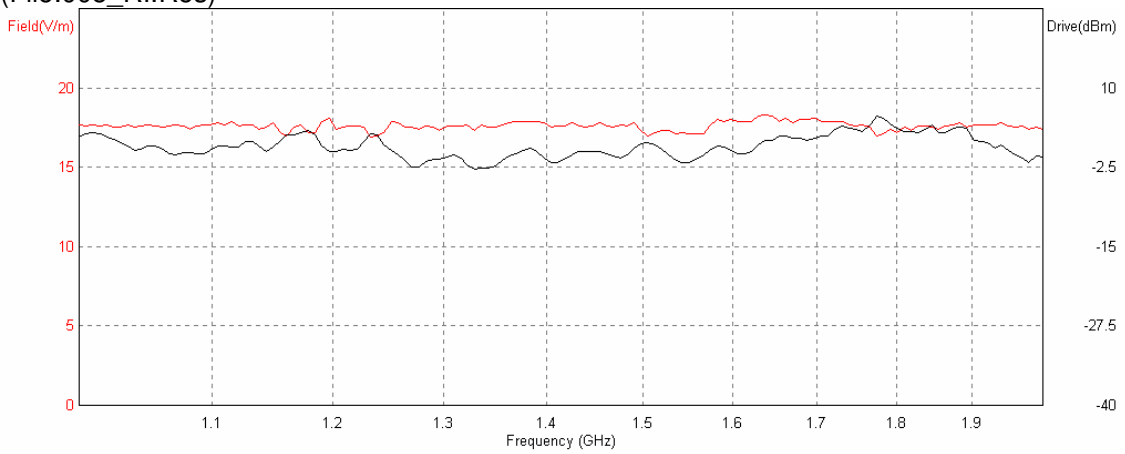
(File:002_RI.Res)



Radiated Immunity 1GHz to 2GHz

Vertical Polarisation

8.2.3. Plot 18: Scan of field strength from 1GHz to 2GHz during radiated immunity test with the antenna vertically polarised
(File:005_RI.Res)



Horizontal Polarisation

8.2.4. Plot 19: Scan of field strength from 1GHz to 2GHz during radiated immunity test with the antenna vertically polarised
(File:006_RI.Res)