

8. Appendix 1

Test setup/arrangement of EUT during open field tests on 05 and 06 November 2014



Details of 3 metre and 30 metre open field test site used on 05 November 2014

GPS coordinates: 51.334017,-1.384317

Temperature: 5°C to 11°C

Relative Humidity: 72% to 99%

Ground conditions: Wet



Aerial view of test site. Red marker indicates test location



Set up for 3 metre measurements



Set up for 30 metre measurements

Measurements at 3 and 30 metres

The test site was free from underground metal objects.

The EUT was powered at its nominal voltage from a single phase supply. A power cable was run across the field to the black box part of the EUT. An RCD was fitted to the power source.

The wire loop part of the EUT was fully extended and taped around the perimeter of the plastic table at a height of 0.8 metres above ground level. The wire loop was connected to the black box via the standard heavy duty cables supplied by the manufacturer. This is representative of the layout in a typical installation. For safety purposes, the black box part of the EUT was placed on plastic trays above the ground level due to very wet ground conditions. All associated EUT cables were random looped and placed next to the black box. It was not possible to suspend the cables vertically from the table as shown in ANSI C63.4-2009 Section 6. This was due to the weight of the cables.

The spectrum analyser used for measurements was located in a vehicle 30 metres from the magnetic loop antenna. Power to the test equipment was from a single phase supply.

The test distance was from the centre of the mag loop antenna to the closest periphery of the EUT. This distance was maintained as the EUT was rotated.

The EUT was rotated through 360 degrees in 60 degree steps at both measurement distances. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to.

Details of 300 metre open field test site used on 06 November 2014

GPS coordinates: 51.331867,-1.381833 (mag loop antenna / lower marker) and 51.334667,-1.381117 (EUT / upper marker)

Temperature: 5°C to 11°C

Relative Humidity: 72% to 99%

Ground conditions: Wet



Aerial view of test site. Red markers indicates test locations



**Set up for 300 metre measurements
(mag loop end, orange in distance is EUT location)**



**Set up for 300 metre measurements
(EUT end facing away from the mag loop antenna)**

Measurements at 300 metres

The test site was free from underground metal objects.

The EUT was powered at its nominal voltage by a portable generator. The generator was located 50 metres from the EUT and surrounded by radio absorbent material. A power cable was run across the field from the generator to the black box part of the EUT. For safety purposes, an RCD was fitted to the generator output.

The wire loop part of the EUT was fully extended and taped around the perimeter of the plastic table at a height of 0.8 metres above ground level. The wire loop was connected to the black box via the standard heavy duty cables supplied by the manufacturer. This is representative of the layout in a typical installation. For safety purposes, the black box part of the EUT was placed on a plastic container above the ground level due to very wet ground conditions. All associated EUT cables were random looped and placed next to the black box. It was not possible to suspend the cables vertically from the table as shown in ANSI C63.4-2009 Section 6. This was due to the weight of the cables.

The spectrum analyser used for measurements was located in a vehicle 30 metres from the magnetic loop antenna. Power to the test equipment was from a single phase agricultural supply.

The test distance was from the centre of the mag loop antenna to the closest periphery of the EUT. This distance was maintained as the EUT was rotated.

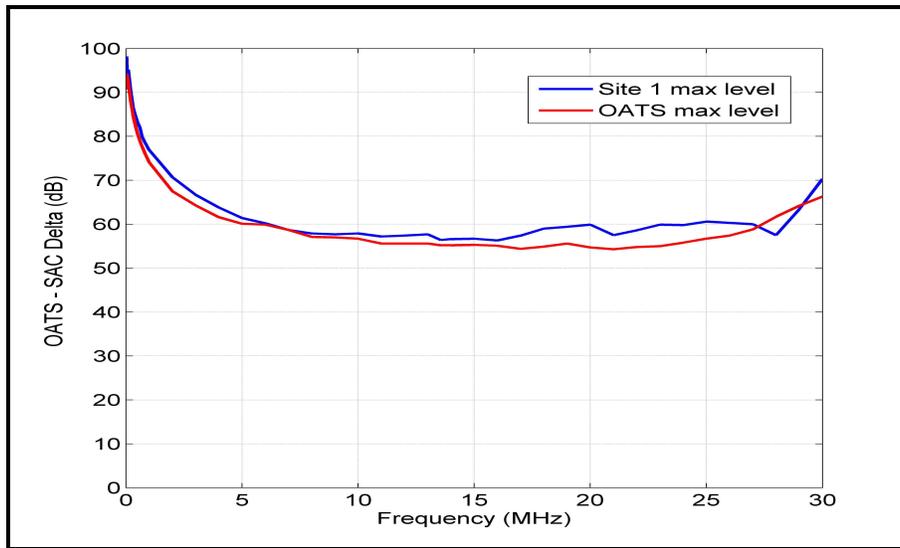
The EUT was rotated through 360 degrees in 60 degree steps at both measurement distances. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to.

Comparison of open field test site with semi-anechoic chamber measurements at 3 metres

Radiated measurements were performed an open field test site (referred to here as 'OATS') and within a 3 metre semi-anechoic chamber (referred to as 'Site 1').

For the signal source, a modified loop antenna was connected to a signal generator at the transmit side. A standard active magnetic loop antenna was connected to a spectrum analyser at the receive side. The signal generator was set to its maximum supported output power and the signal was transmitted to the spectrum analyser via the two antennas and associated RF cables.

A sweep in small frequency increments was performed from 9 kHz to 30 MHz. The sweep was repeatedly performed with both antennas rotated about the axis in various orientations. Received levels for all orientations were recorded and the maximum levels for the open field test site and the semi-anechoic chamber are shown on the graph below. Full data for both tests are archived on the UL VS LTD IT server and available for inspection on request.



The conclusion was that the open field test site compares well with the semi-anechoic chamber at a measurement distance of 3 metres. If anything, the semi-anechoic chamber results are generally slightly higher. This means that if the measurement passes in the semi-anechoic chamber, it will pass with a higher margin on an open field test site.

The magnetic loop antenna used to perform these measurements is the same antenna or same type of antenna used during measurements contained in this test report.

Verification of open field test site and semi-anechoic chamber measurements at 3 metres prior to performing measurements

Two reference units are used for verification of the measurement system before testing commences. Both reference units are door entry systems modified by the manufacturer for test purposes only.

One reference unit transmits a continuous, unmodulated signal at a fixed frequency of 125 kHz when a 12 Volt battery is connected. The output power is fixed and known to be stable.

The second transmits a continuous, unmodulated signal at a fixed frequency of 13.56 MHz when a 12 Volt battery is connected. The output power is fixed and known to be stable.

Both frequencies are commonly used RFID frequencies.

A UL VS LTD internal verification document explains the procedure in detail. A brief description is given below.

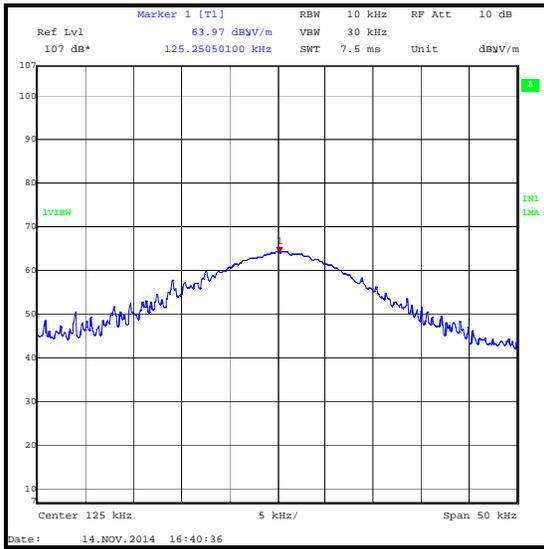
The centre of the magnetic loop antenna is placed exactly 3 metres from the reference unit. The reference unit is placed on a plastic table at a height of 0.8 metres above floor level and the centre of the mag loop antenna is 1 metre above the floor level. The mag loop antenna and reference unit are oriented in certain positions to ensure repeatability.

Each reference unit is connected to a 12 Volt battery and once transmitting, the maximum raw received level at each of the two frequencies is read on the spectrum analyser by using the marker peak function. The measured level has to be within certain levels as specified in the UL VS LTD internal test procedure. The plot of the verification measurement is archived on the UL VS LTD IT server. The peak level of each reference unit is recorded on a spreadsheet which is also archived on the UL VS LTD IT server.

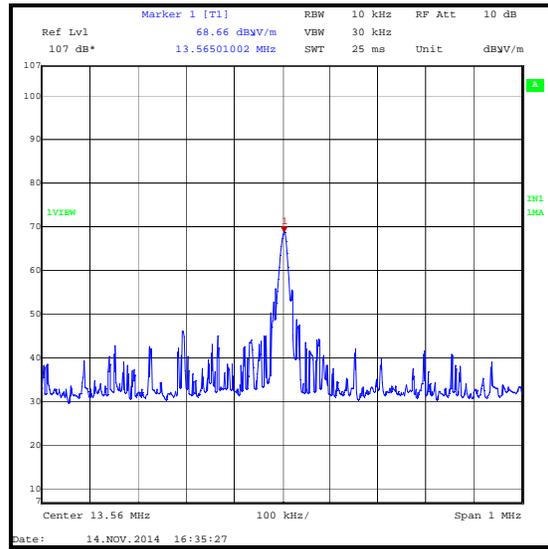
The internal verification procedure and verification plots are available for inspection on request.

Radiated measurements below 30 MHz were performed in a semi-anechoic chamber at a distance of 3 metres.

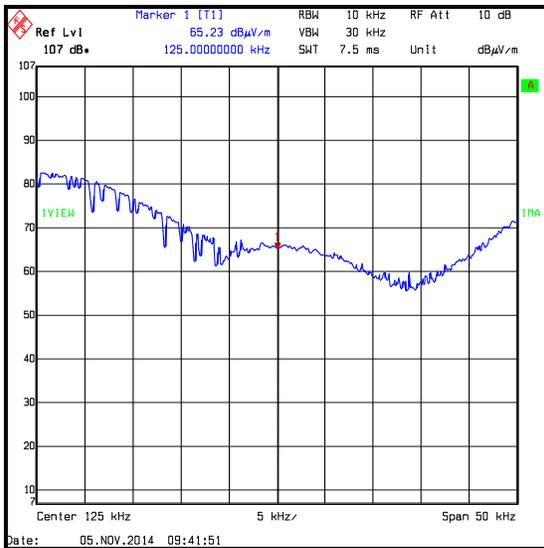
Verification plots of the two reference units at a measurement distance of 3 metres are shown on the following page. Plots were taken on an open field test site (05 November 2014) and in a semi-anechoic chamber (14 November 2014).



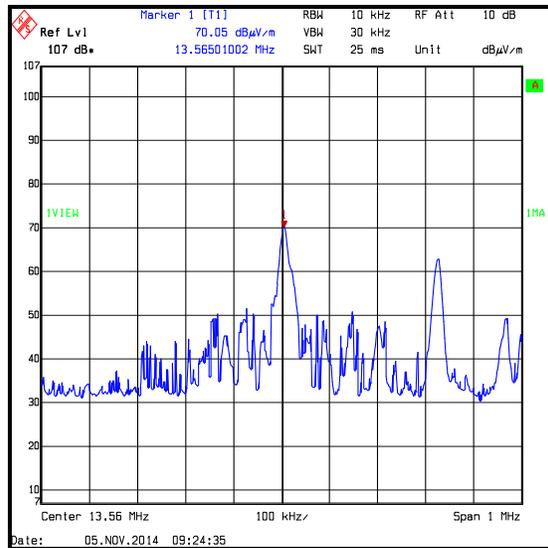
125 kHz reference unit signal at 3 metres in a semi-anechoic chamber on 14 November 2014



13.56 MHz reference unit signal at 3 metres in a semi-anechoic chamber on 14 November 2014



125 kHz reference unit signal at 3 metres on an open field test site on 05 November 2014

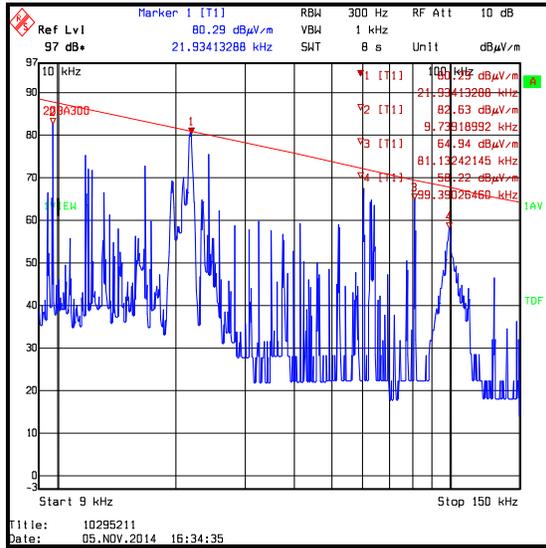


13.56 MHz reference unit signal at 3 metres on an open field test site on 05 November 2014

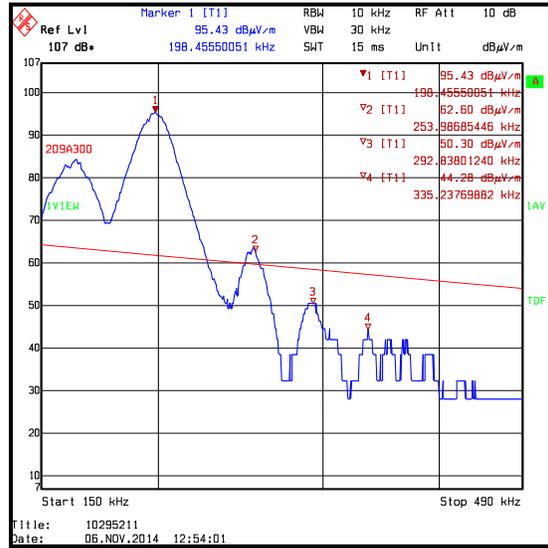
Note(s):

1. The above plots show comparable measurements of reference units on an open field test site and in a semi-anechoic chamber at spot frequencies.

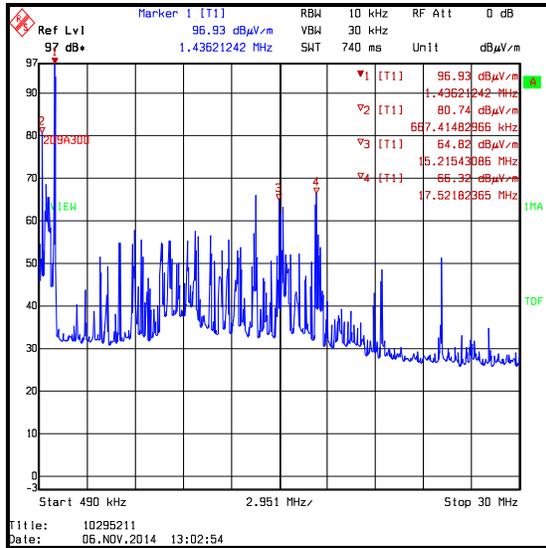
Background scans of the open field test site



**Frequency range: 9 kHz to 150 kHz
Average detector / background scan**



**Frequency range: 150 kHz to 490 kHz
Average detector / background scan**



**Frequency range: 490 kHz to 30 MHz
Peak detector / background scan**

Note(s):

1. The above plots are background scans of the test site. The EUT and generator were turned off when the background scans were performed.

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