

### **Measurements at 300 metres**

The test site was free from underground metal objects.

The EUT was powered at its nominal voltage from its internal battery. The USB cable was inserted and connected to the AC to DC switching power supply. The AC to DC switching power supply was connected to a single phase supply. A power cable was run across the site to the EUT via the AC to DC switching power supply. An RCD was fitted to the generator being used as a power source. The generator was located 50 metres from the EUT and surrounded by radio absorbent material. For safety purposes, an RCD was fitted to the generator output.

The EUT was placed on a plastic table at a height of 0.8 metres above ground level. All associated cables were arranged according to ANSI C63.4-2014 Section 6.

The spectrum analyser used for measurements was located in a cabin >10 metres from the magnetic loop antenna.

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.

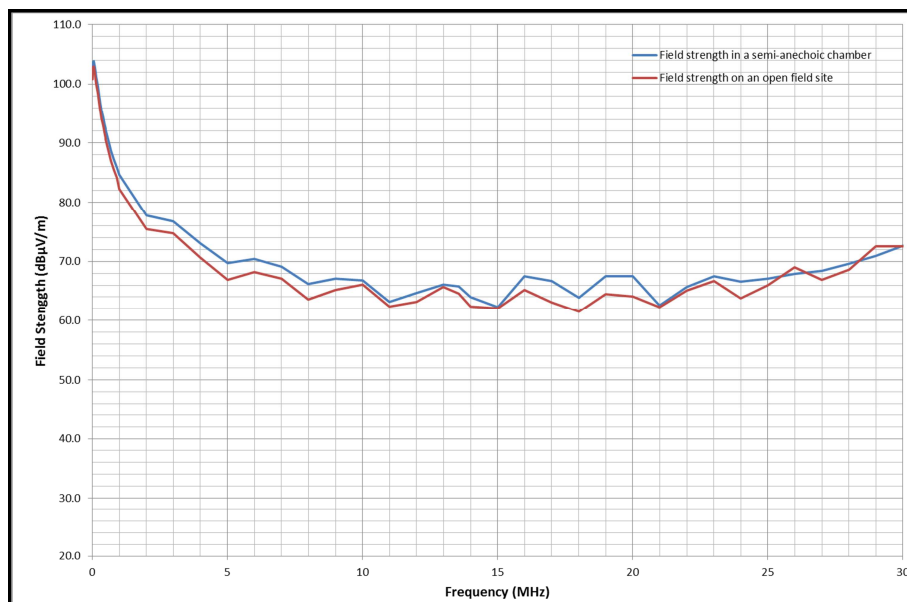
The EUT was rotated through 360 degrees in 60 degree steps. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to.

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

Radiated measurements were performed on an open field test site and within a 3 metre semi-anechoic chamber.

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 vertical 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.

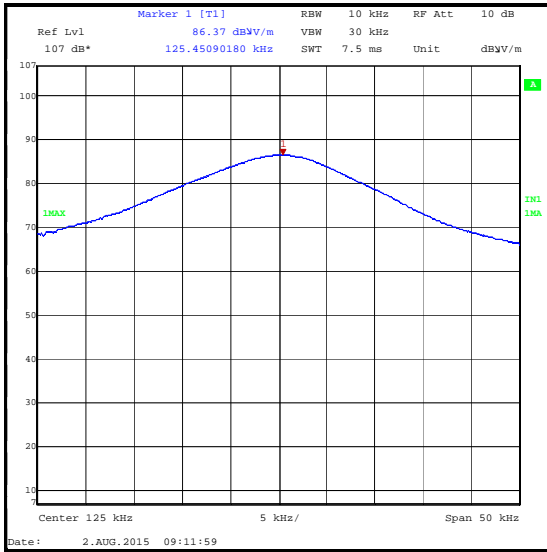
The centre of the magnetic loop antenna is placed exactly 3 metres from the reference unit. The reference unit is placed on a plastic table at a height of 0.8 metres above floor level and the centre of the mag loop antenna is 1 metre above the floor level. The mag loop antenna and reference unit are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

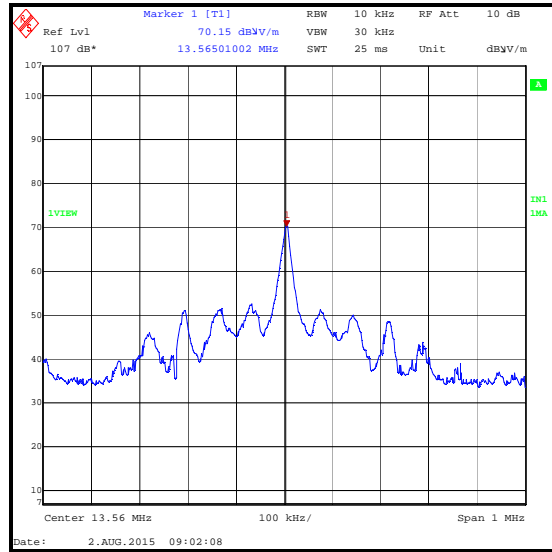
The internal verification procedure and verification plots are available for inspection on request.

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

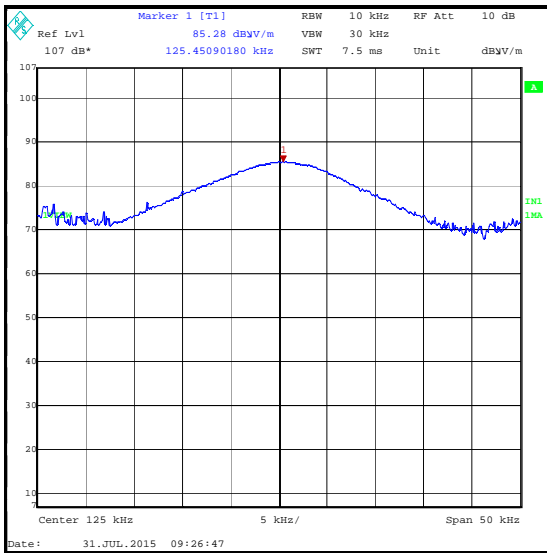
Verification plots of the two reference units at a measurement distance of 3 metres are shown on the following page. Plots were taken on an open field test site (31 July 2015) and in a semi-anechoic chamber (02 August 2015).



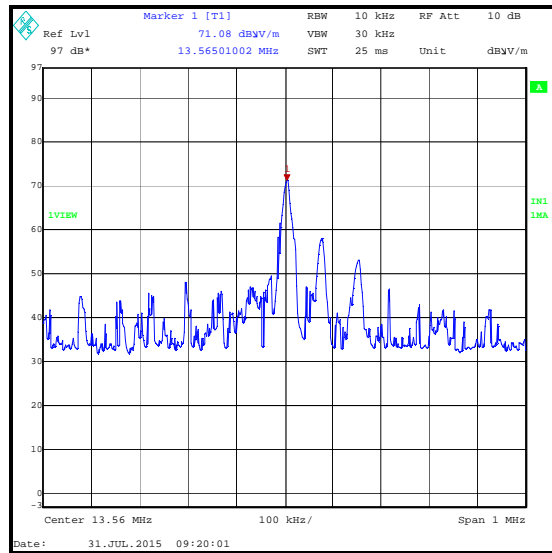
125 kHz reference unit signal at 3 metres in a semi-anechoic chamber on 02 August 2015



13.56 MHz reference unit signal at 3 metres in a semi-anechoic chamber on 02 August 2015



125 kHz reference unit signal at 3 metres on an open field test site on 31 July 2015

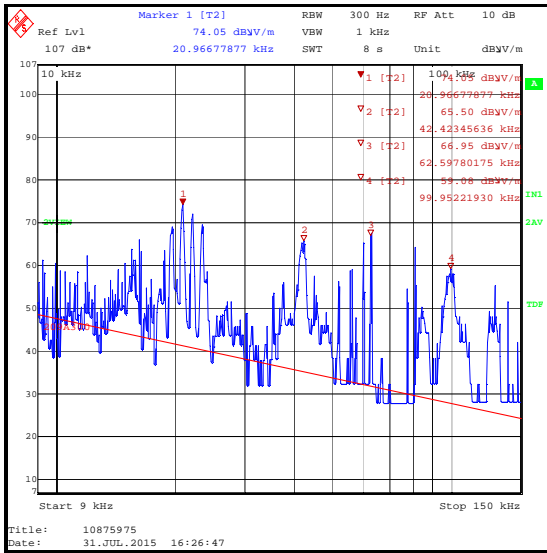


13.56 MHz reference unit signal at 3 metres on an open field test site on 31 July 2015

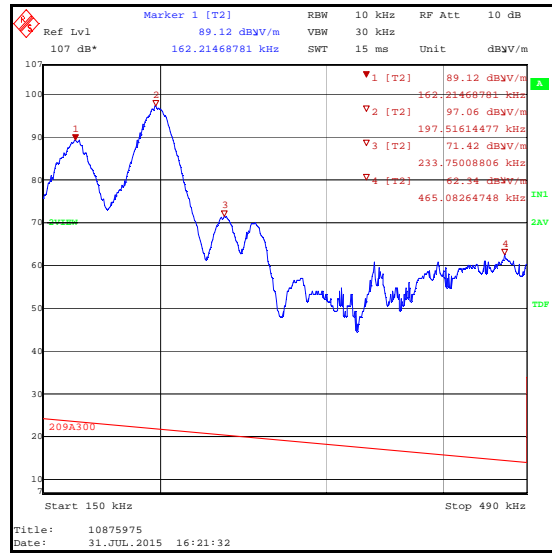
**Note(s):**

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.

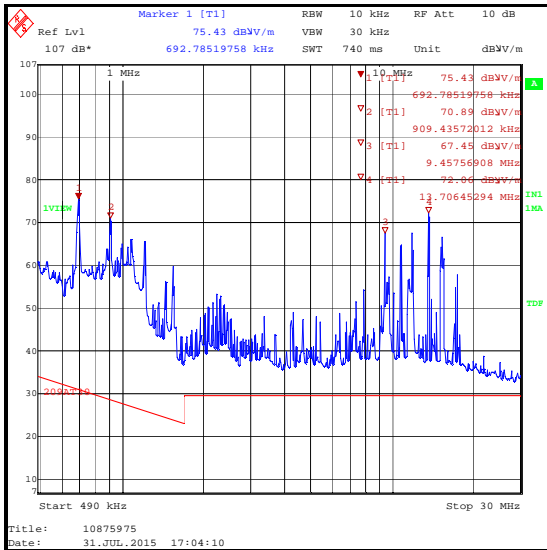
**Background scans of the open field test site**



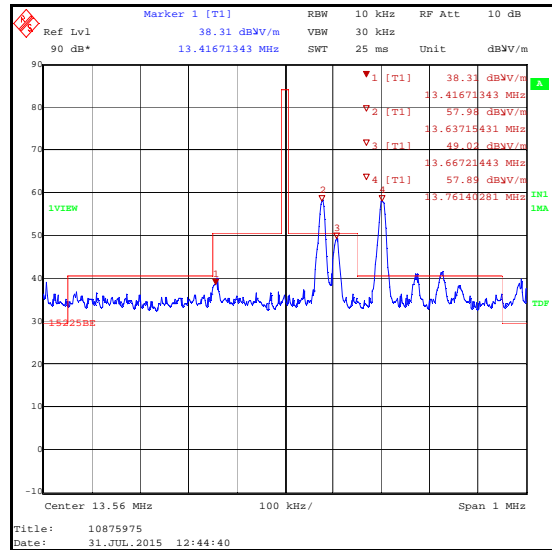
**Frequency range: 9 kHz to 150 kHz  
Average detector / background scan**



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



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



**Frequency range: 13.06 MHz to 14.06 MHz  
/ background scan of the open field test site**

**Note(s):**

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

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