

## Data Sheet

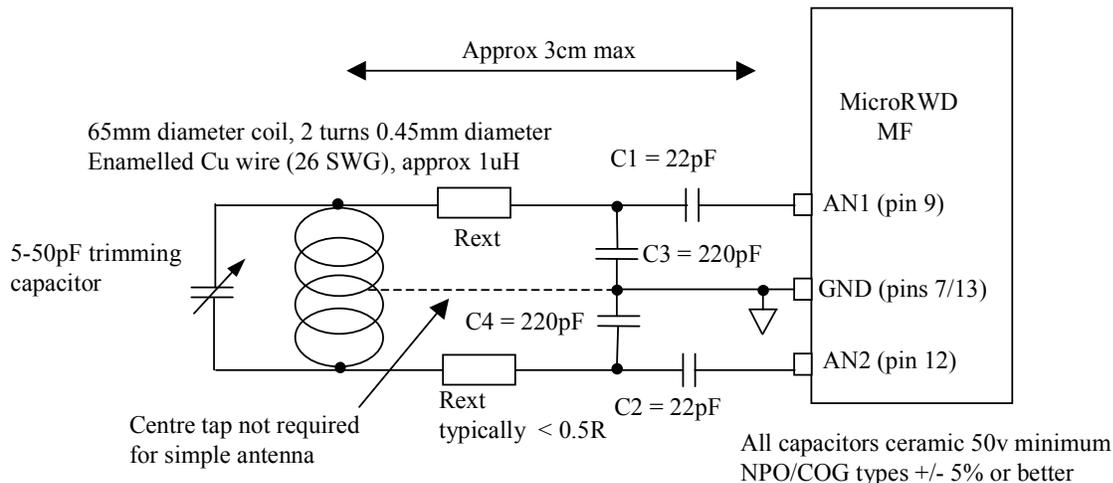
### ANTENNA\_1356.PDF

6 Pages

Last Revised 18/02/08

## Micro RWD MF (Mifare) Antenna Specification

The MicroRWD MF (Mifare) module has been designed to interface to a simple high Q antenna coil of around 1uH inductance together with some capacitor and resistor components. The antenna coil and passive components form the “tuned” RLC (Resistor-Inductor-Capacitor) circuit, which is designed to resonate at the 13.56 MHz carrier frequency and have a Q factor of 35-40. For the 125 kHz family of MicroRWD modules, the low Q antenna (700uH) has a relatively wide tolerance of inductance so the capacitor components are fixed and mounted on the RWD module itself – pins AN1 and AN2 connect to an external antenna coil directly. For the 13.56 MHz MicroRWD modules, the antenna Q is higher and the inductance tolerance is narrow. For this reason the capacitor components are external to the module to allow fine-tuning and adjustment of the LC circuit as shown below. The external resistors are used to limit the antenna current and correct the antenna Q to 35-40 range.



### Directly connected antenna arrangement

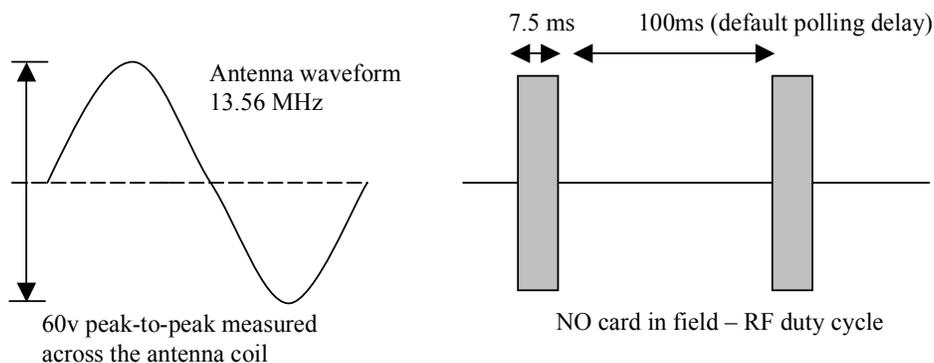
For maximum range and performance the following factors should be considered:

- 1) Maximum range and coupling between transponder and RWD is based on the ratio of their antenna diameters. Very approximately the RWD antenna loop diameter should be 2-3 times the diameter of the transponder coil. The basic method of communication is via magnetic flux linkage (like an air-cored transformer) so the more lines of flux that intersect the transponder coil, the better the overall performance. For ISO card transponders there is little benefit in using an RWD antenna larger than 10cm diameter. Circular antenna coils generally give a more uniform flux distribution

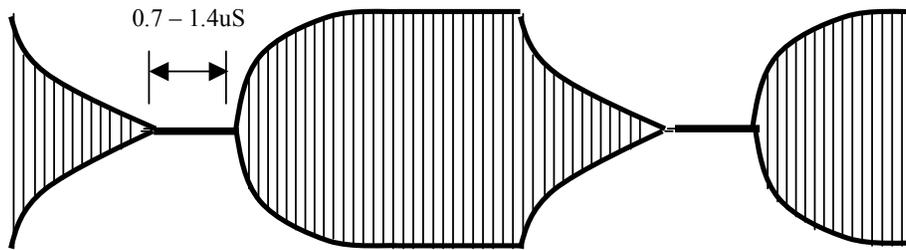
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- 2) The Micro RWD is designed to generate a 13.56 MHz carrier frequency in short bursts of energy with a peak-to-peak voltage of up to 60 volts. This RF field is only turned-on whenever there is card communication and for the remainder of time the RF field is off. This dramatically reduces the average current consumption to around 20ma with short bursts of up to 200ma.
- 3) Generally for 65mm diameter wound antenna or similar sized PCB antenna the range is around 5 cm, larger antenna (10 – 15cm diameter) can achieve up to 10cm range under ideal conditions. Lower burst current can be achieved by adjusting the series resistors in the antenna loop circuit (ensuring Q value is around 35-40).
- 4) Sample antenna supplied are for evaluation only. The characteristics of an antenna for EMC approval will vary according to shape of coil, type of wire, style of winding, bobbin material, spacing between windings or PCB track design and PCB material etc.
- 5) The antenna coil (PCB or wire wound) should be positioned as close to the capacitor components as possible and the coil-capacitor (LC) arrangement should be no more than 3cm from the MicroRWD module for optimum performance. For longer distances a screened twisted-pair antenna cable can be used with an impedance matching transformer, this technique is not described here.
- 6) The position and environment of the antenna in the final applications should be taken into account and a trimming capacitor can be used to adjust the capacitance to fine tune the LC arrangement back to 13.56 MHz resonance. An oscilloscope should be connected **ACROSS** the antenna coil connections. **With NO** transponder card in the field a pulsed 13.56 MHz sine wave will be seen with a peak-to-peak voltage of up to 60 volts. The trimming capacitor should be adjusted to achieve the highest amplitude of sine wave. The antenna resistance should then be checked to ensure the Quality factor is correct. The capacitor and coil inductance values have been carefully chosen for optimum performance so any custom antenna should be designed to be as close to this arrangement as possible.



NOTE THAT OPTIMUM PERFORMANCE (BEST SIGNAL TO NOISE RATIO) IS ACHIEVED WHEN PEAK-TO-PEAK ANTENNA VOLTAGE IS APPROXIMATELY 50 VOLTS.



RWD to transponder communication – pulse pause modulation, ISO14443A timing specification and waveform envelope for ideal Quality factor

- 7) For optimum performance the antenna Q (Quality factor) should not exceed 40. Practically the Quality factor effects the shape of the waveform envelope and if too low or too high then read/write performance (range) will be poor or the system will not work at all.

The formula for calculating  $Q = 2 \cdot \pi \cdot f \cdot L / R_{ant} = 102 / R_{ant}$

where  $f$  = Resonant frequency, 13.56 MHz,  $L$  = Antenna inductance, 1.2 uH

$R_{ant}$  = Overall antenna resistance =  $R_{driver} + R_{ext} + (R_{cu} + R_{rf})$

$R_{driver}$  = Resistance of FET driver (from IC spec)

$R_{cu}$  = Resistance of Copper (coil)

$R_{rf}$  = RF resistive component (eddy current losses etc)

For  $Q = 35$ ,  $R_{ant} = 102 / Q = 102 / 35 = 3 R$

By measurement (and IC spec)  $R_{driver} + (R_{cu} + R_{rf}) = \text{approx } 2R$

Therefore  $R_{ext} = 1R$

- 8) **The Micro RWD has been designed to work at optimum performance with a Quality factor of 35-40 using 1uH inductor and  $R_{ant} < 3 R$ .**

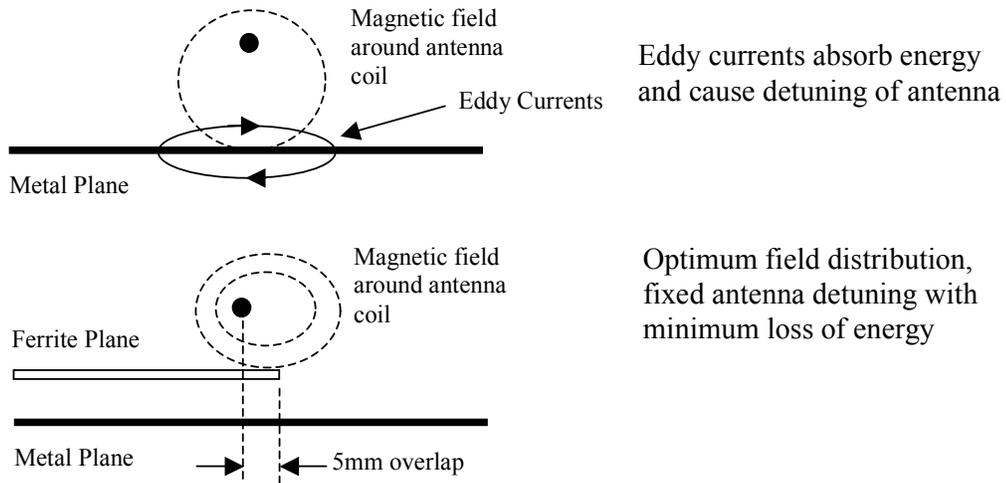
**For practical purposes  $R_{ext}$  will be  $< 1R$  and may be omitted and a thinner gauge of wire used for the coil.**

(Note that  $R_{ext}$  would be shared between two series resistors of value  $R_{ext}/2$ )

- 9) When designing and winding antenna coils, the wire gauge and its DC resistance must be considered to keep close to the design optimum. Significant differences in  $R_{ant}$  will affect EMC and overall performance.

## Ferrite Shielding

When the RWD antenna coil is positioned close to metal objects such as the reader housing or even the PCB ground plane then the RF field induces eddy currents in the metal. This absorbs the RF field energy and has the effect of detuning the antenna (reducing the inductance). Both these factors can very significantly affect the performance of the RWD system. Therefore for operation in metallic environments it may be necessary to shield the antenna with ferrite. This shielding has the effect of concentrating the magnetic field lines close to the ferrite material, which introduces a fixed field component that detunes the antenna system (which can be accounted for in antenna design). Practically, there is a compromise between the shielding effect (reduction of eddy currents) and the concentration of the magnetic field (reduced range), so the ferrite plane should only slightly overlap the antenna coil. The optimum size of the ferrite plane, the distance from the coil and the degree of overlap are very hard to calculate and must be determined practically. Tests have shown that best performance is achieved when the antenna coil and ferrite plane overlap by around 5mm.



## Antenna Design

A useful formula is given below for calculating the approximate number of turns required to achieve a particular inductance.

$$N = (\text{approx}) \sqrt[1.9]{\frac{L}{2 \cdot A \cdot \ln(A/D)}} \quad \text{or} \quad L = 2 \cdot A \cdot \ln(A/D) \cdot N^{1.9}$$

L = Required Inductance (nH) i.e  $H \times 10^{-9}$

A = Antenna Circumference (cm) i.e.  $\pi \times \text{diameter (cm)}$

D = Wire Diameter (cm) e.g 0.0450 cm

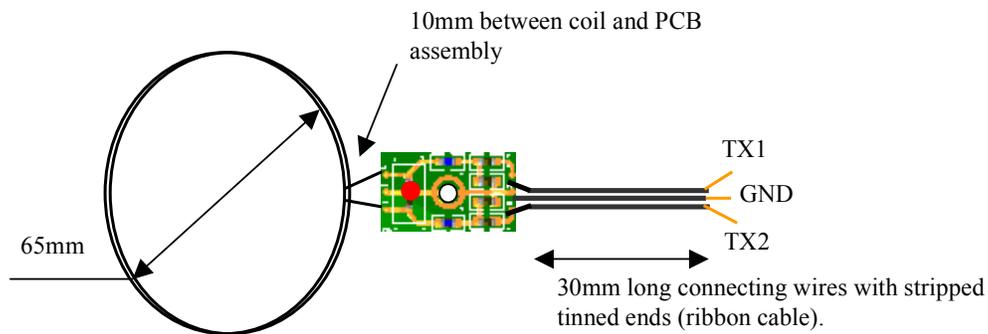
N = Approx number of windings

## Example Antennas

A)

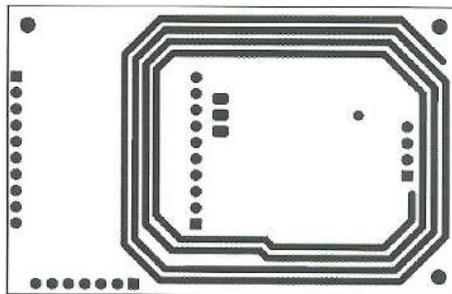
Wire wound coil 0.450mm diameter (26 swg) Enamelled Cu wire.  
Antenna 6.5 cm internal diameter, 2 turns.  
Inductance approx 1.2uH (micro Henry)  
Maximum range: approx 5cm with ISO card transponders  
C1/C2 = 22pF  
C3/C4 = 220pF, Rext = 0R (zero ohm)

### IBT Evaluation kit antenna



Antenna coil 65mm diameter, 2 turns 0.45mm diameter En Cu wire (26 SWG). Wire covered in contact adhesive (“Evo-stik”) or bound in PTFE tape to stiffen coil assembly.

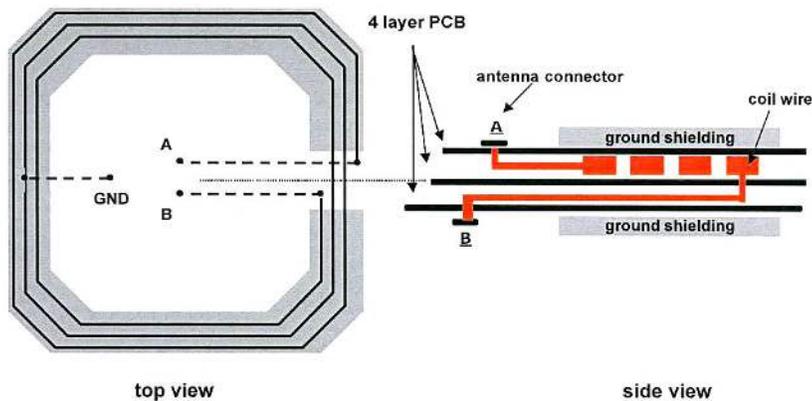
B)



PCB antenna  
Dimensions: 51 x 42 mm  
Track width: 1.27 mm, 35uM Cu thickness  
Distance between 2 turns: 1.75 mm  
Number of turns: 4  
Inductance approx 1.2uH  
Rext = 0.5 R

## Reducing EMC emission

To reduce the EMC emission and transmission of stray harmonic frequencies, the antenna should have partial electrical shielding. This is easiest to implement using a PCB antenna and a 4-layer board. The shielding loops are on the top and bottom layers and cover the antenna track area. **These shielding loops must not be closed.** The shielding must be connected to system ground at one point only. The coil is routed on the first inner layer. The optional centre tap of the coil is connected to ground with a via as shown. The connection of the coil ends to the matching circuit should be routed close together to avoid additional inductance.



**No responsibility is taken for the method of integration or final use of Micro RWD**

More information on the Micro RWD and other products can be found at the Internet web site:

**<http://www.ibtechnology.co.uk>**

Or alternatively contact IB Technology by email at:

**[sales@ibtechnology.co.uk](mailto:sales@ibtechnology.co.uk)**