RS128 Antenna Design report

Revision History

Date	Revision	Description	Author
Sept 2022	1	First Release	CY

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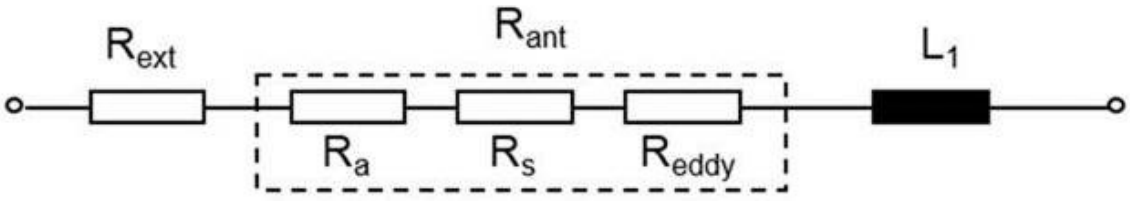
I. Introduction

This document aims to describe the NFC antenna used for RS128 and provide the estimated antenna gain based on ARIB STD-T60, Chapter 5.8.

NFC antenna gain of our magnetic antenna is based on a short Hertzian dipole, and is theoretically (if no losses) Gd=1.76dBi. (S372ff., Antennenbuch, Karl Rothammel, Y21BK, 9.Auflage, Stuttgart 1988)

However, in real applications we cannot assume to be lossless. Especially in NFC the losses are tremendous, so the antenna efficiency of NFC antennas is (intentionally) really bad. Let us check the losses (or Q), which can be seen like this:



Reddy: Eddy current losses due to metallic environment -> should normally be as small as possible, but cannot be avoided sometimes

Rs: Ohmic losses -> normally in the range of some 100mOhm

Ra: radiation losses = really small; typically in the range of some 10 µOhm or even less

Rext: external damping resistor to control the overall Q

If Reddy is negligible, the external damping resistor must be in the range of 1...4 Ohm, to meet the NFC- or ISO-requirements to guarantee the required communication bandwidth.

That means the antenna gain is much lower, since the internal losses are much higher than the radiation losses. Only a very small amount of energy is radiated into far field

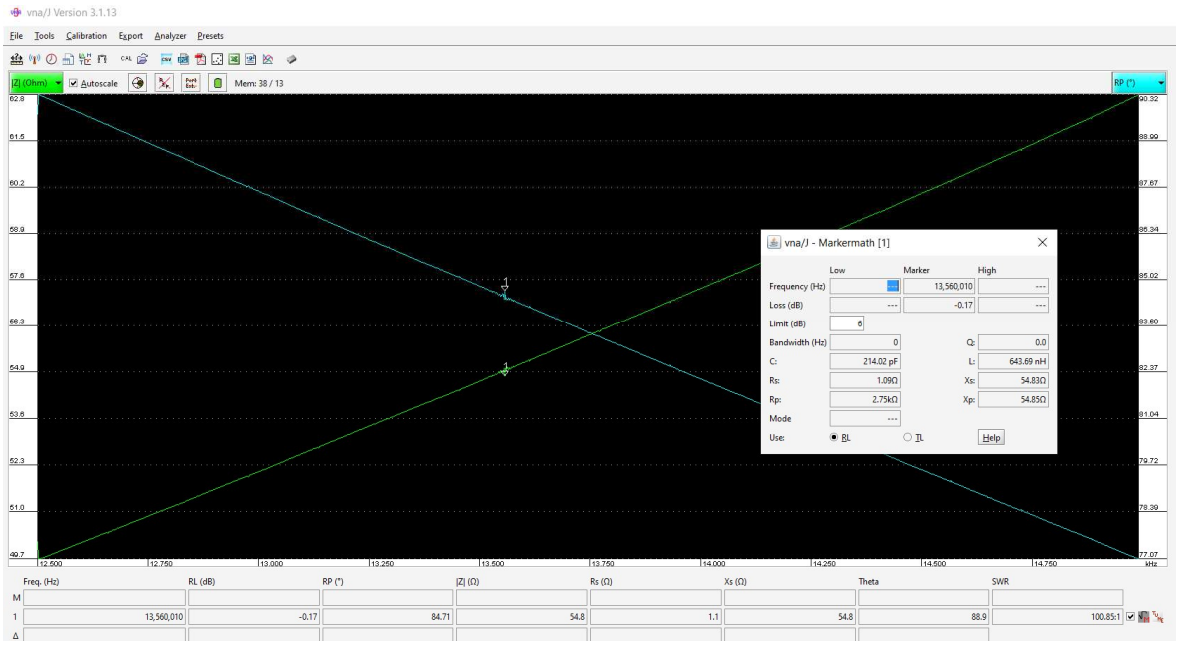
II. Antenna dimension

The design of NFC antenna is based on NXP Semiconductor.

Please refer to [NFC Antenna Design Tool | Antenna Design Hub | NXP Semiconductors]

For RS128, the NFC antenna is a single loop antenna routed on a 2-layer pcb as shown above. The dimension is 168.4mm x 100.4mm with trace width of 3mm.

At 13.56MHz, the measurements are as shown below:



III. Antenna Gain estimation

Antenna Gain calculation is according to ARIB STD-T60, Chapter 5.8.

Using the dimension of the designed NFC antenna and measured antenna resistance, we can estimate the intended antenna Gain = -43dbi

Item	Symbol	Unit	Value	Comment / Formula
Carrier Frequency	f	Hz	1.356E+07	nfc carrier frequency 13.56MHz
Square measure	S	m2	1.691E-02	Antenna dimension 168.4mm x 100.4mm
Numbers of turns of Antenna Coil	N		1	One loop antenna turn
Wavelength	λ	m	22.124	per formula
Radiation Resistance	Rr	Ω	3.719E-05	per formula
Antenna Resistance	Ra_total	Ω	1.1	Measured using miniVNA PRO
Radiation Efficiency	η	dB	-44.710	per formula
Directional Gain (dBi)	Gd	dBi	1.760	Theoretical value about infinitesimal magnetic dipole antenna
Intended Antenna Gain (dBi)	Gi	dBi	-42.950	$G_i = \eta + G_d$

Input value
Calculated value

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