AN4409
Application note

Using the same antenna for M24LRXXE-R and M24SRXX-Y Dual Interface EEPROM families

Introduction

The purpose of this document is to explain why the different tuning capacitance allows customers to use the same 13.56 MHz antenna design for M24LRXXE-R ISO15693 and M24SRXX-Y ISO14443 Dynamic NFC/RFID tag IC families. This document clarifies also the reference value of the tuning capacitance for M24LRXXE-R and M24SRXX-Y antenna design.

Table 1 lists the products concerned by this application note.

Table 1. Applicable products

Type	Applicable products
NFC/RFID Tag ICs	M24LR, M24SR series

1 Antenna tuning frequency and performance

M24LRXXE-R and M24SRXX-Y ICs are passive RFID memories powered by the RF magnetic field generated by the reader. Tag to reader communication is achieved by mean of M24SRXX-R and M24SRXX-Y impedance modulation mechanism, called load modulation or backscattering.

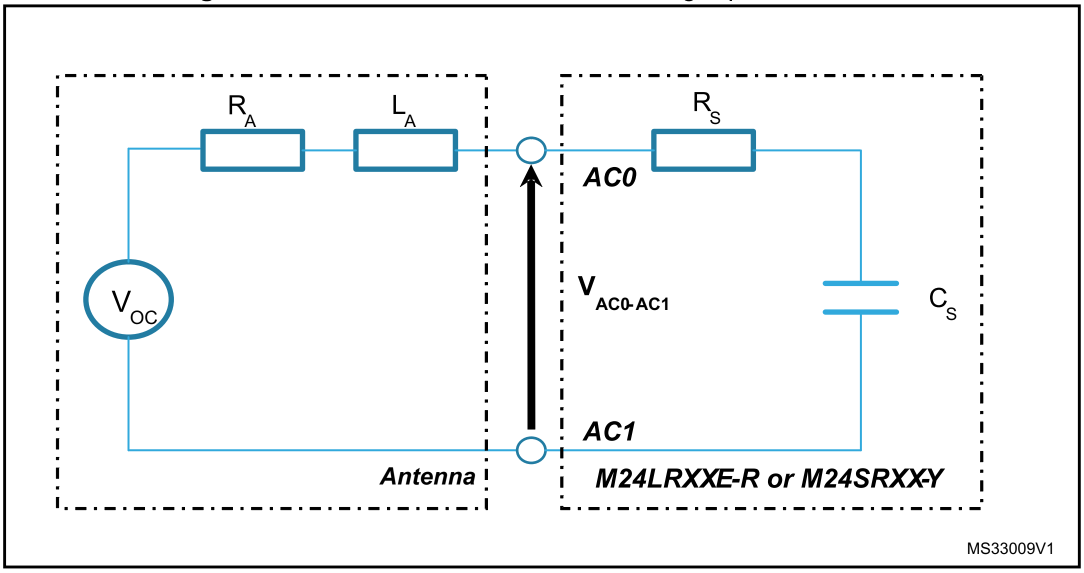
Maximizing the tag operating distance requires maximizing the powering distance but also the tag to reader link. To achieve these requirements, STMicroelectronics recommends a tuning frequency:

- 13.56MHz and 14MHz for RFID tags based on M24LRXXE-R family,
- 14MHz and 14.4MHz for RFID tags based on M24SRXX-R family.

2 Tuning capacitance dependency for using the same antenna design

Figure 1 here after shows the equivalent circuit of an M24LRXXE-R or an M24SRXX-R mounted on a loop antenna in the presence of a sinusoidal magnetic field.

Figure 1. M24LRXXE-R or M24SRXX-R tag equivalent Circuit



V_{OC} represents the open circuit voltage available from the antenna. It depends on the magnetic field strength, the antenna size and number of turns.

The tag antenna impedance is given by $Z_A = R_A + j.L_A.\omega$, where L_A is the antenna inductance.

The M24LRXXE-R or M24SRXX-Y impedance is given by ZS = RS + j.1/$_{CS.\ \omega}$ where R_S represents the power consumption of the chip, and C_S represents the serial equivalent tuning capacitance.

The tuning frequency of the tag described in *Figure 1* is defined by the following *Equation 1*:

Equation 1

$$f_{tun} = \frac{1}{2\Pi\sqrt{L_A \cdot C_S}}$$

Let's consider now, the tuning frequency of an M24LRXXE-R based tag (F_{tun_M24LR}) and the tuning frequency of an M24SRXX-Y based tag (F_{tun_M24SR}) when using the same antenna. They are respectively given by *Equation 2* and *Equation 3*:

Equation 2

$$f_{tunf_{M24LR}} = \frac{1}{2\pi\sqrt{L_A \cdot C_{S_{M24LR}}}}$$

Equation 3

$$f_{tun_{M24SR}} = \frac{1}{2\pi\sqrt{L_A \cdot C_{S_{M24SR}}}}$$

Dividing *Equation 2* by *Equation 3* leads to:

Equation 4

$$\frac{f_{tun_{M24LR}}}{f_{tun_{M24SR}}} = \frac{2\pi\sqrt{L_A \cdot C_{S_{M24SR}}}}{2\pi\sqrt{L_A \cdot C_{S_{M24LR}}}} = \sqrt{\frac{C_{S_{M24SR}}}{C_{S_{M24LR}}}}$$

or, after simplification, to *Equation 5*:

Equation 5

$$\frac{C_{S_{M24SR}}}{C_{S_{M24LR}}} = \left(\frac{f_{tun_{M24LR}}}{f_{tun_{M24SR}}}\right)^2$$

Respecting the tuning frequencies defined in section 1) leads to the following relationship:

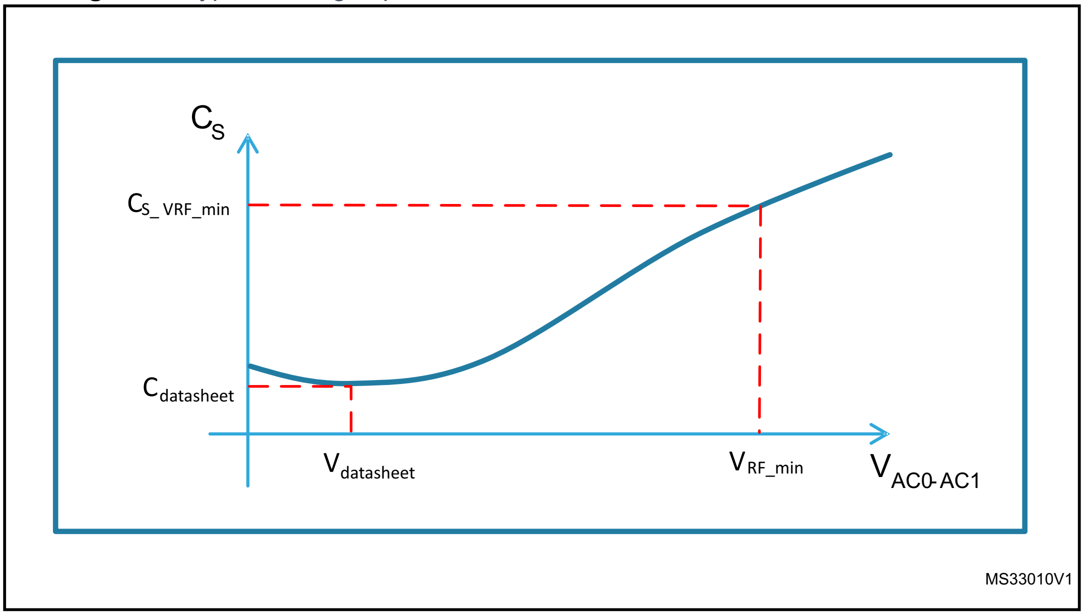
$$\frac{C_{S_{M24SR}}}{C_{S_{M24LR}}} = \left(\frac{13.8MHz}{14.2MHz}\right)^2 \cong 0.94$$

The M24SRXX-Y and M24LRXXE-R internal tuning capacitance has been designed following this rule offering to customers a simple way to use the M24LRXXE-R or M24SRXX-Y Dual Interface EEPROMs in their application without changing their antenna design.

3 Tuning capacitance specification vs tuning reference value

Figure 2 shows the serial equivalent tuning capacitance typical variation of either the M24LRXXE-R or M24SRXX-Y according to the $V_{AC0\text{-}AC1}$ RF input voltage:

Figure 2. Typical tuning capacitance variation of M24LRXXE-R and M24SRXX-Y



V_{RF_min} corresponds to the minimum RF voltage between AC0 and AC1 RF inputs of the RFID memory chips. The corresponding tuning capacitance $C_{S\_VRF\_min}$ must be taken as reference for antenna design: in other words, customers have to design antennas which inductance satisfies the following relationship, showed by *Equation 6*:

Equation 6

$$f_{tun_{M24SR}} = \frac{1}{2\pi\sqrt{L_A \cdot C_{S_{VRF_{min}}}}} \rightarrow L_A = \frac{1}{C_{S_{VRF_{min}}} \cdot \omega^2}$$

Vdatasheet corresponds to the voltage level used for better correlation with measurements in production.

Table 2 here after summarizes the M24LRXXE-R and M24SRXX-Y tuning parameters

Table 2. Tuning parameters for M24LRXXE-R and M24SRXX-R

	M24LRXXE-R	M24SRXX-R
Antenna tuning frequency	13.56MHz-14MHz	14MHz-14.4MHz
$C_{datasheet}$	27.5pF	25pF
$C_{S\_VRF\_min}$	29pF	27.3pF

For more information about the target tuning capacitance for antenna design, please refer to the application note AN3942 “M24LR series internal capacitance considerations for antenna tuning” that discusses this point in details for the M24LR series.

4 Revision history

Table 3. Document revision history

Date	Revision	Changes
19-Dec-2013	1	Initial release.