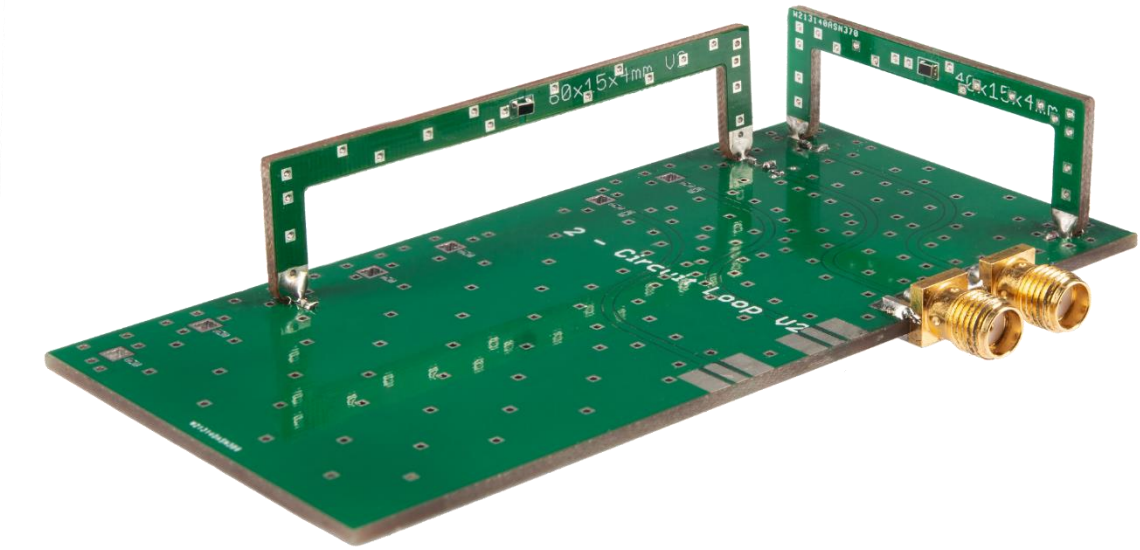
Loop dual-band antenna

Application Note



1. Main features

Antenna type	401 MHz Small grounded loop antenna + 466 MHz Small grounded loop antenna
Antenna size	To be adjusted depending on the available space on the circuit board and inside the casing
Device integration	Free Space (no metallic objects in the vicinity of the device/beacon) Over a metallic board (eg. an a container) – directive radiation pattern On-Body antenna
Other characteristics	No need for a RF switch Low cost RoHs Compliant
Antenna type	401 MHz Small grounded loop antenna + 466 MHz Small grounded loop antenna

2. Typical performances

Frequency [MHz]	Bandwith @ return loss -10dB	Impedance [Ω]
401 MHz (Tx)	5 MHz	50 Ω
466 MHz (Rx)	5.6 MHz	50 Ω

Performances measured on Kineis test board in free space. Size 100x50 mm

3. Layout reference design

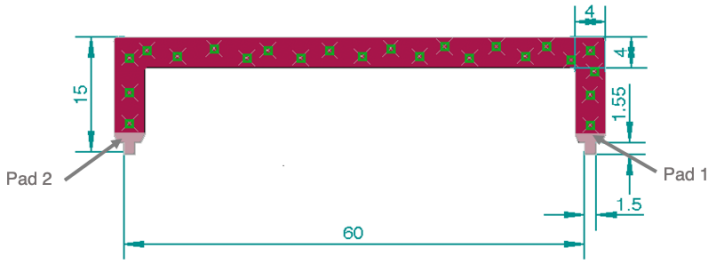
The loop antennas are made of a 1.6 mm 2-layer FR4 substrate.

The antennas are assembled perpendicular to the test board by soldering the antenna pads into plated slots in the test board.

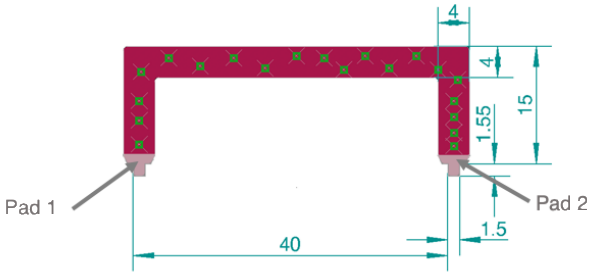
The two layers of the loop boards are filled with copper. They are interconnected with vias.

The antenna Pad 1 is fed by a transmission line on the test board through a matching circuit.

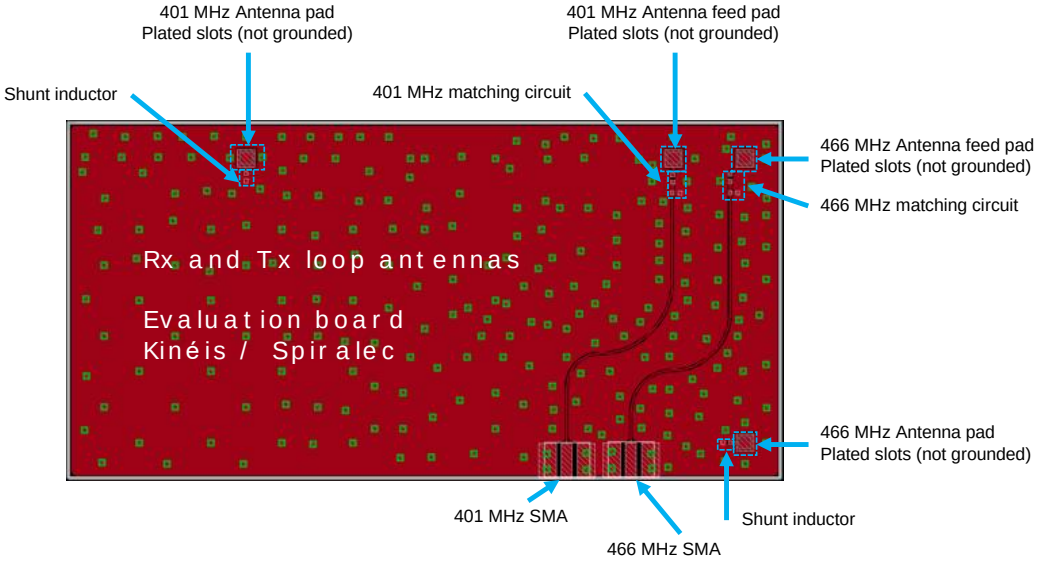
The antenna Pad 2 is connected to a shunt inductor on the test board.



Tx antenna circuit board layout (401 MHz) – Dimensions in mm



Rx antenna circuit board layout (466 MHz) – Dimensions in mm



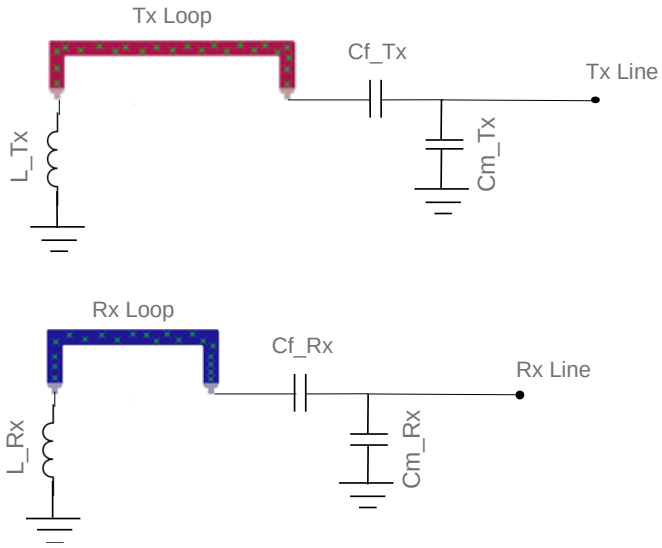
Kinéis test board Layout – Dimensions in mm

4. Typical tuning and matching circuit

The frequency capacitor Cf allows one to tune the resonant frequency of the loop antenna.

The matching capacitor Cm allows one to match the antenna input impedance to 50 Ohms.

The inductor L allows one to fine tune the resonant frequency of the loop antenna.



Tx matching circuit (401 MHz):

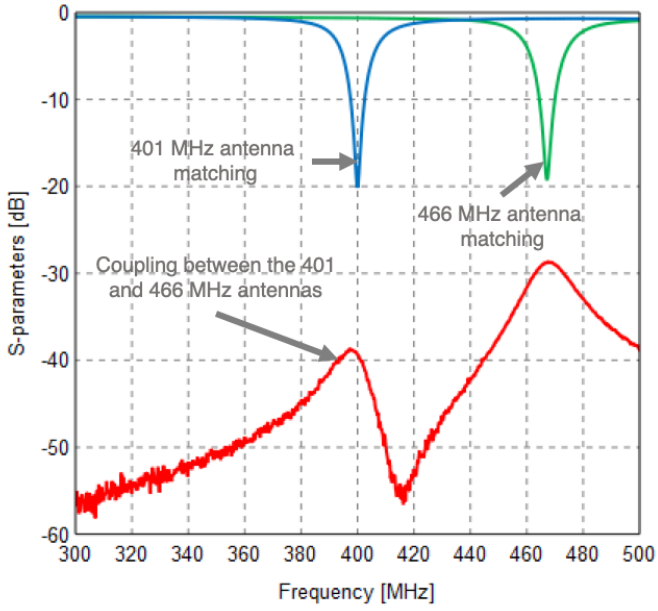
Cf_Tx = 1.5 pF
Cm_Tx = 12 pF
L_Tx = 0 Ohm

Rx matching circuit (466 MHz):

Cf_Tx = 1.2 pF
Cm_Tx = 8.2 pF
L_Tx = 2.7 nH

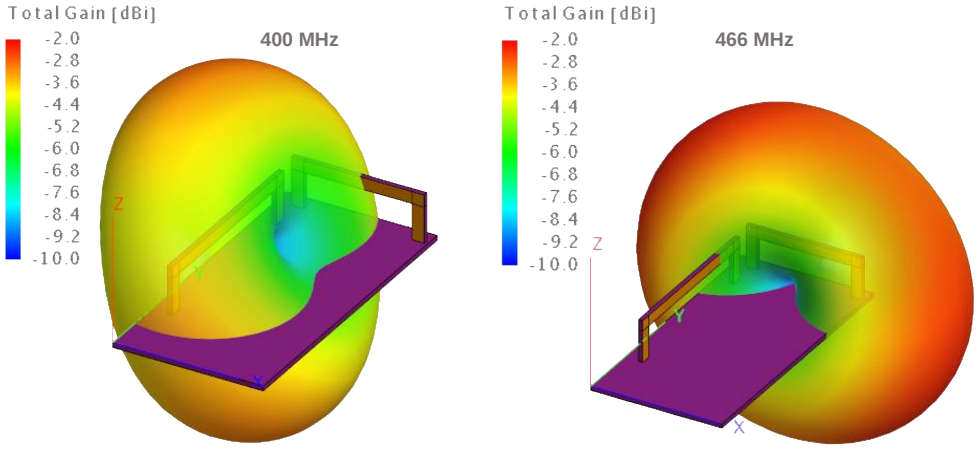
50 Ohms matching circuits in free space.

5. Typical Return Loss S11

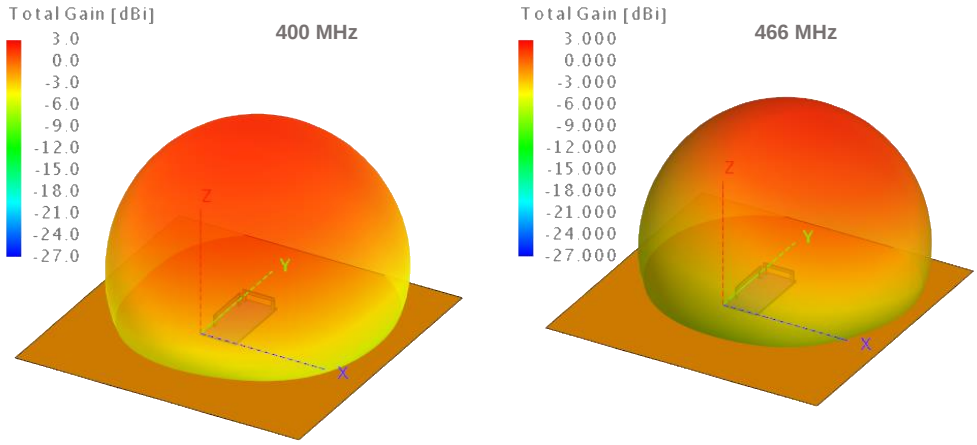


Measured on the 50x100mm test board with matching circuits.

6. Typical Free space Radiation Patterns



Simulated test board in free space (without matching circuits loss)



Simulated test board 100mm over a 40x40 cm metallic board (without matching circuit loss)

7. General integration guidelines

a. Antennas dimensions

The loop antenna dimensions can be adjusted to use at best the available space in the device. An increase in the loop surface induces an increase of its radiation efficiency.

The perimeter of the loop antenna should be kept smaller than a quarter wavelength. The antenna is therefore equivalent to an inductor in series with a resistor (losses). It can be tuned to 50 Ohms as a RLC resonator.

b. Antennas position

The antennas should be placed at two adjacent edges of the circuit board. The antennas pads with the shunt inductor (Pad 2) should be as far away as possible from each other to get a high decoupling between the two antennas.

c. Ground plane

Every available space on the circuit board shall be filled with ground plane. If the circuit board is made of several layers, the ground plane areas should be interconnected with many vias.

d. Matching circuit

The loop antennas are equivalent to a lossy inductor if the antenna perimeter is lower than a quarter wavelength. They are tuned as a RLC resonator (see paragraph 4).

The matching circuit components should be specified for high frequencies and have a low tolerance.

All the components on the board and inside the casing (cables, battery…) must be taken into account while tuning the antenna.

Make sure the antenna tuning is consistent with all chosen device environments.

The evaluation board can lie 10 mm or more above a metallic board without detuning.

If the device is worn on a body, make sure that there is no direct contact between the board's ground plane and the body.

e. Transmission line

The recommended transmission line is a grounded coplanar waveguide on a thin substrate to minimize radiation loss. (50 Ohms).

The length of the transmission line should be as small as possible to minimize transmission loss.

f. PCB population

Small SMD components can be placed under the antenna on the top layer of the circuit board.

A rule of thumb is to place the bulkiest components the far away as possible from the antenna, preferably on the bottom layer.

g. EMI filter

When the board's size is too small compared with the wavelength, RF currents generated by the antenna might travel through the cables connected to the circuit board (battery cables for eg.). That might cause a detuning of the antenna and a deterioration of the radiation pattern. Appropriate filters (ferrite beads and decoupling capacitors) should be routed on the circuit board to be able to prevent RF currents to flow through the cables.

8. Additional information

a. Contact and support

Technical support and commercial contacts are available from Kinéis at the following link: https://www.kineis.com/contact/

b. Custom integration

This reference design was written for Kinéis by Spiralec (www.spiralec.com).

Spirelec provides Radio Frequency expertise with a specialist antenna design and integration service.

They can assist with the following milestones:

- Antenna topology selection according to device dimensions and environment
- Antenna routing
- Antenna tuning
- Coupling between multiple antennas on one device

You can Spiralec with any enquiries by email: contact@spiralec.com

c. Legal notices

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