# Basic technical information for NeoTAG® HF Transponders, Document 2 of 4

Our product range of NeoTAG® HF RFID transponders/ RFID chips is constantly being expanded and new transponder versions are regularly added. In connection with the use of our transponders, we have compiled a large amount of background information on mounting, function, design, operating behaviour, etc. due to the many applications in which the products are used. As a supplement to our Product Information HF RFID Transponder data sheet, this document contains further technical explanations and application-supporting information.

## 1. Reading ranges


Picture 1: Application example: Reading a NeoTAG® Plug MFG10340 using an NFC-enabled smartphone

All HF RFID transponder variants available in the NEOSID product portfolio in combination with the existing transponder environment (metal/non-metal) as well as the different readers and reader antennas that can be used result in a variety of different reading ranges. For this reason, we have compiled the following table with reference reading ranges to help you select a suitable transponder for your application:

| Application | Metal[*1] | | | Non-Metal | | |
|---|---|---|---|---|---|---|
| Antenna | Loop[*2] | Stub[*3] | NFC[*4] | Loop[*2] | Stub[*3] | NFC[*4] |
| Reader | Industry[*5] 2 W | USB[*6] 200 mW | Mobile Device[*7] | Industry[*5] 2 W | USB[*6] 200 mW | Mobile Device[*7] |
| TAG version | Reading distance *L* | | | | | |
| Inlay F2626 | | | | 110 mm | 8 mm | 5 mm |
| Inlay MF2626 | - | 4 mm | - | | | |
| Inlay F2659 | | | | 210 mm | 16 mm | 25 mm |
| Inlay MF2659 | 45 mm | 8 mm | 6 mm | | | |
| Plug G3326 | | | | 80 mm | 4 mm | 3 mm |
| Plug MG3326 | - | 2 mm | - | | | |
| Plug FG4335 | | | | 100 mm | 8 mm | 5 mm |
| Plug MFG4335 | 110 mm[*8] | 4 mm | - | | | |
| Plug FG/MFG8336 | 50 mm | 6 mm | 5 mm | 110 mm | 8 mm | 8 mm |
| Plug FG10340 | | | | 140 mm | 12 mm | 22 mm |
| Plug MFG10340 | 90 mm | 11 mm | 18 mm | | | |
| Plug FG4670 | | | | 210 mm | 16 mm | 25 mm |
| Flag FG5242[*9] | 40 mm | 7 mm | 5 mm | 110 mm | 8 mm | 8 mm |
| Flag FG7678[*9] | 190 mm | 11 mm | 12 mm | 210 mm | 16 mm | 25 mm |
| SMD FG4530[*9] | 40 mm | 7 mm | 5 mm | 110 mm | 8 mm | 8 mm |

| | |
|---|---|
| | → there is a more suitable TAG for this application (Metal/Non-Metal) |
| - | → there is no reading range in this TAG/Reader combination |

**Important notes:**

[*1]: We test our reading range with RFID TAGs installed in stainless steel, X2CrNi12 (stainless steel according to EN 10088). The use of other materials may result in deviating reading ranges.
[*2]: The loop antenna is a circular antenna made of coiled enamelled copper wire. Ø 125mm
[*3]: The stub antenna is a rod core Z1.2x12 with antenna winding.
[*4]: The NFC antenna is the antenna built inside a mobile device. This varies depending on the device manufacturer and model.
[*5]: We use the model ID ISC.LR1002-E from FEIG as „industrial reader“.
[*6]: We use the model RFID-USB-READER4 from INDUSTRIA as „USB reader“.
[*7]: We use the model EXPERIA XZ1(2018) from SONY as a mobile device with NFC function.
[*8]: RFID TAG inserted into a metallic test piece with a through-hole and radial slot.
[*9]: Measured on metal, stainless steel.

**Reader/Reader antennas:**

For our internal reading range tests, we use the following components, among others:

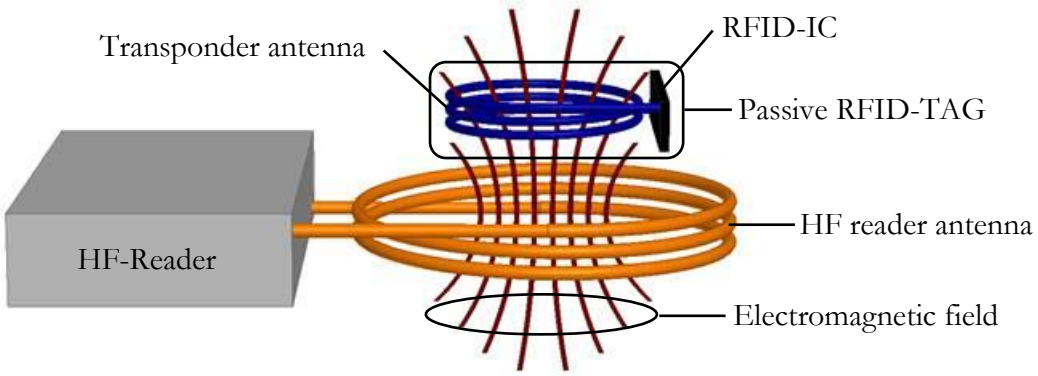
Picture 2:
Loop antenna Ø 125mm
Self made

Picture 3:
USB reader with
stub antenne
type RFID-USB-Reader 4
by INDUSTRIA


Picture 4:
Mobiles device with NFC
function

## 2. Antenna alignment

All NeoTAG® transponders use single-axis transponder antennas. To achieve an optimal reading range, the magnetic fields of the reader antenna and the transponder antenna should be optimally aligned. The magnetic field generated in the reader antenna must produce an electrical voltage when flowing through the transponder antenna. In extreme cases, non-observance can lead to failure of the reading capability.




Picture 5: Components of a HF RFID transmission system

## 3. Antenna orientation in NeoTAG HF transponders

Our various HF-RFID transponders are used in two different orientations:

### 3.1 Rotationally symmetric transponder antenna orientation

In this orientation, the transponders are inserted vertically into an object to be tagged. To read the transponder, the reader antenna is usually brought to the front of the inserted transponder antenna.

Rotationally symmetrical transponder versions:

- NeoTAG® Plug G/MG3326
- NeoTAG® Plug FG/MFG4335
- NeoTAG® Plug FG/MFG8336
- NeoTAG® Plug FG4670
- NeoTAG® Inlay F/MF2659
- NeoTAG® Inlay F/MF2626


Picture 6: Rotationally symmetrical HF RFID transponders

Picture 7: Optimum reading transponder on front side

## 3.2 90° orientation of the transponder antenna

Especially when using mobile devices (smartphones, tablets, ...), it makes sense to offer a larger transponder antenna area. As a rule, the device's internal reader antennas are designed for operation with a credit card. Transponder antennas that are too small thus produce very poor antenna coupling factors. As a solution, we have developed transponders with a 90° rotated antenna orientation for having good NFC reading capability with mobile devices. With these TAGs, the transponder inlays are inserted horizontally into the object to be marked.

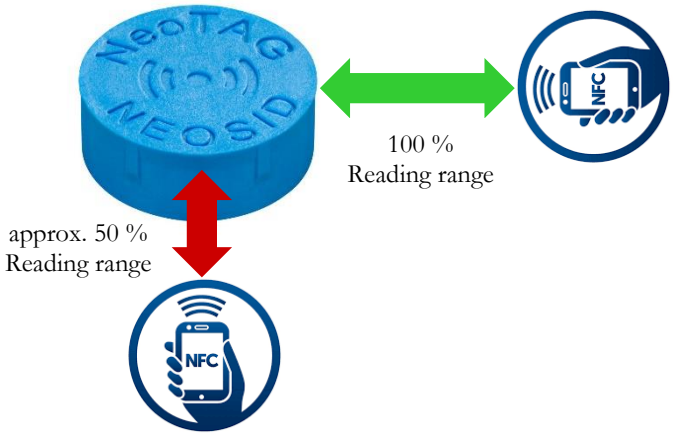
This applies to the following transponder versions:

- NeoTAG® Plug FG/MFG10340
- NeoTAG® Flag FG7678
- NeoTAG® Plug FG4670


Picture 8: HF RFID transponders with 90° antenna alignment

Picture 9: NFC reading process with smartphone

This changed antenna alignment produces different reading ranges depending on the approach direction of the reading antenna to the transponder. These transponders therefore do not have a rotationally symmetrical transponder antenna and require an adapted alignment.



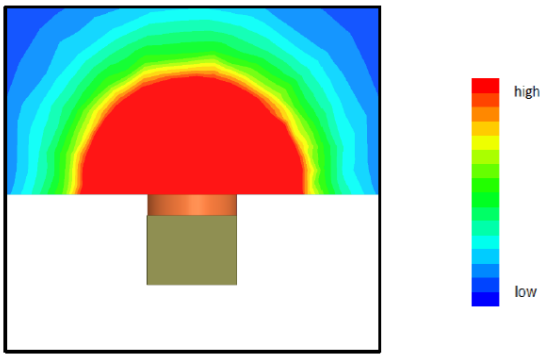

Picture 10: Reading range with different approach directions on NeoTAG® Plug FG/MFG10340

The internal transponder antenna is placed in the housing with 90° antenna alignment in parallel to the radio logo depicted on the top of the housing.

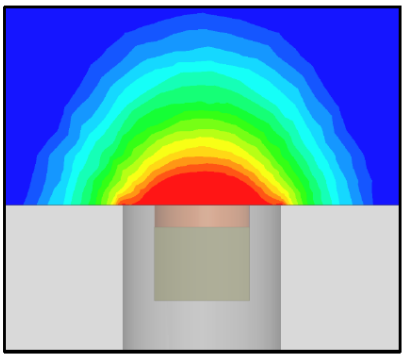
## 4. Transponder characteristics in different materials

Environments other than air influence the inductance of the transponder antenna coil and thus the operating resonance frequency due to altered magnetic conductivity. With plastics or other non-ferromagnetic materials, this is generally not critical.

In a metallic environment, the field strength in the direction of the reading antenna is reduced from 100 % to approx. 20 %! This influence is shown quite well in the following simulation pictures:

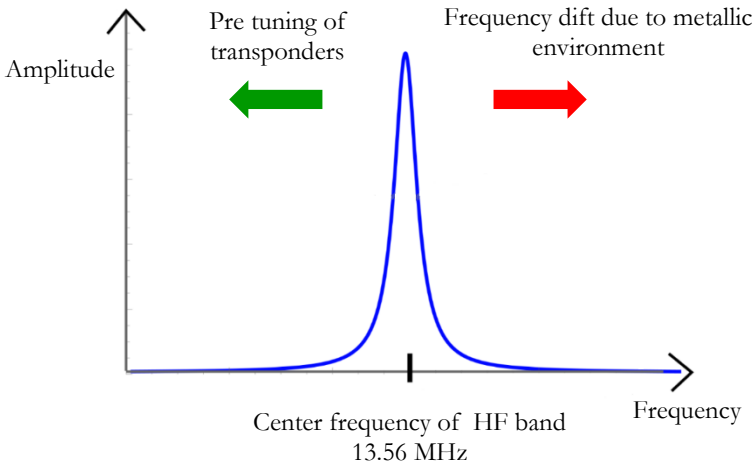



Picture 11: Magnetic field strength of NeoTAG® in air



Picture 12: Magnetic field strength of NeoTAG® in metal

Metallic environments influence the operating resonance frequency differently depending on the material or alloy.




Picture 13: Effect of metallic environments to the resonance frequency of the transponder

## 5. Behaviour of the transponder in certain metals

For common industrial metals and alloys, we have determined the influence to the resonance frequency of the transponder by laboratory tests:

| Material | Chemical symbol/formula | Pre-tuning of Resonance frequency $f_{RES}$ | Resonance frequency $f_{RES}$ before installation | Operating Frequency $f_B$ |
|---|---|---|---|---|
| Aluminium | Al | -2.0 MHz | 11.6 MHz | 13.60 MHz |
| Iron | Fe | -1.0 MHz | 12.6 MHz | 13.60 MHz |
| Brass | CuZn | -1.5 MHz | 12.1 MHz | 13.60 MHz |
| Stainless steel[*1] | e.g. X2CrNi12 | -600 kHz | 13.1 MHz | 13.60 MHz |

Table 1: Frequency behaviour in different metallic environments

[*1] Our NeoTAG® HF RFID transponders are pre-tuned for use in stainless steel!

Due to the broadband design of the transponder and usually also of the reader antennas used, different environmental materials lead in practice to slight deviations in the reading range. In order to achieve an optimal reading range, measurements of the frequency tuning should be carried out in the target application. The resulting application-specific pre-tuning of the transponder will lead to the optimum operating resonance frequency in the application.

## 6. Effects on the RFID reader and its reading antenna

Metallic objects not only influence the electromagnetic behaviour of the TAG, but can also affect the reader's antenna. Any interference must be excluded or taken into account accordingly during range measurements.

## 7. Use of loop antennas

In combination with a loop antenna, the above-mentioned reading ranges are obtained. Investigations have shown that the optimum size of the loop antenna is 125 mm in diameter and that further enlargements do not increase the reading range any further. Loop antennas with smaller diameters achieve smaller reading ranges. Due to their size, loop antennas are generally not used in industrial applications.

## 8. Reading time/power consumption

The time required to read the UID (8 bytes = 64 bits) from the transponder's memory is approx. 10 ms. Reading out other memory areas and quantities leads to longer reading times. Programming/writing the transponder requires more energy in the transponder. This may result in different working ranges than during the reading process.

This product information is one of four documents summarising special features, design notes and mounting information for our HF transponders of the NeoTAG family. The following features are explained with the documents:

| | | |
|---|---|---|
| Product info 1 of 4: | - | Nomenclature |
| | - | Weights and dimensions |
| **Product info 2 of 4:** | **-** | **Reading ranges** |
| | **-** | **Metallic environments** |
| | **-** | **Read duration** |
| | **-** | **TAG alignment** |
| Product info 3 of 4: | - | Mounting |
| | - | Mechanical stress |
| Product info 4 von 4: | - | Environmental tests |
| | - | Temperature resistance |

**Tell us your requirements - we will develop the right solution for you.**

Have we aroused your interest? Then contact us about RFID transponders for different frequency ranges. Customised solutions are our speciality. We will be happy to support you with our know-how to realise your product development.

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