

# PCB Printed Antenna Specification

|              |                                       |               |                                                 |
|--------------|---------------------------------------|---------------|-------------------------------------------------|
| Document No. | ANT-NFC-PCB-001                       | Version       | V1.0                                            |
| Product Name | PCB Printed NFC Antenna               | Date          | 2026-04-28                                      |
| Customer     | Changchun Xinhe Electronics Co., Ltd. | Prepared By   | Xiao Yu Creation                                |
| Designer     | Xiao Yu Creation                      | Address       | Mayu Town, Ruian City, Wenzhou, Zhejiang, China |
| Frequency    | 13.56MHz,125KHz                       | Maxinmum Gain | 0dBi                                            |

## 1. Overview

This specification defines the electrical, mechanical, and manufacturing requirements for a differential PCB-printed Near Field Communication (NFC) antenna with center tap, operating at 13.56 MHz. The antenna is implemented as a rectangular spiral coil on a 6-layer FR-4 PCB, utilizing both the top layer and inner layer 1 to achieve the required differential inductance and coupling performance for NFC Forum-compliant applications. The center tap provides a common-mode reference point for balanced differential drive and impedance matching.

2. Antenna Structure & Dimensions

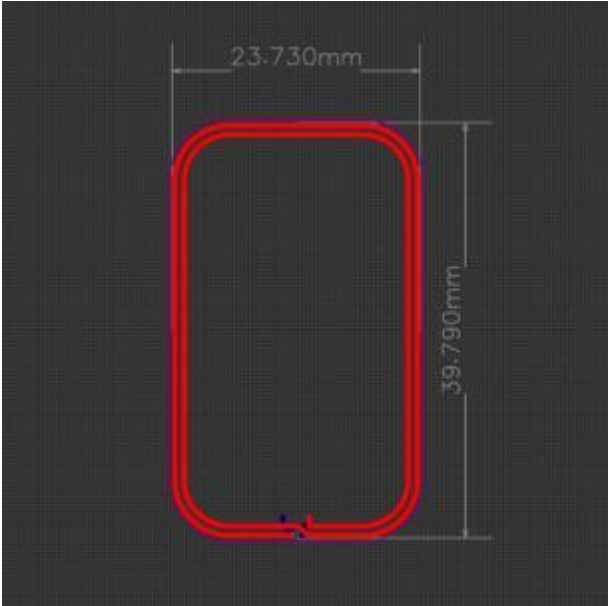


Figure 1. Antenna Design Drawing



Figure 2. PCB Rendering

2.1 Structural Parameters

| Parameter    | Value                             | Unit |
|--------------|-----------------------------------|------|
| Antenna Type | Rectangular Spiral (Differential) | —    |

|                       |                                   |       |
|-----------------------|-----------------------------------|-------|
| Overall Width         | 23.73                             | mm    |
| Overall Height        | 39.79                             | mm    |
| Trace Width           | 0.50                              | mm    |
| Trace Spacing         | 0.90                              | mm    |
| Turns (Top Layer)     | 2                                 | turns |
| Turns (Inner Layer 1) | 2                                 | turns |
| Feed Point            | Bottom Center (Differential Pair) | —     |
| Center Tap            | Mid-point of coil winding         | —     |

## 2.2 PCB Stack-up Parameters

| Parameter                | Value                        | Unit |
|--------------------------|------------------------------|------|
| PCB Layers               | 6                            | —    |
| Board Thickness          | 1.0                          | mm   |
| Antenna Layers           | Top Layer + Inner Layer 1    | —    |
| Top Layer Finish         | Solder Mask Opening (Window) | —    |
| Copper Thickness (Outer) | 1                            | oz   |
| Copper Thickness (Inner) | 0.5                          | oz   |

### 3. Electrical Performance

The following electrical characteristics are based on verified measurement data. The top layer and inner layer 1 are connected in series. The inductance of 1.2  $\mu\text{H}$  and DC resistance of 10.5  $\text{m}\Omega$  were measured directly across the antenna terminals (differential end-to-end) on actual PCB samples using a network analyzer. The antenna is designed for differential drive with a center tap.

| Parameter                | Typical            | Tolerance                   | Conditions                    |
|--------------------------|--------------------|-----------------------------|-------------------------------|
| Operating Frequency      | 13.56MHz<br>125KHz | $\pm 0.5 \text{ MHz}$       | Resonant                      |
| Total Inductance (L)     | 1.2                | $\pm 0.1 \mu\text{H}$       | Measured, @ 13.56 MHz         |
| Arm Inductance (L_arm)   | 0.3                | $\pm 0.03 \mu\text{H}$      | Each side, @ 13.56 MHz        |
| Quality Factor (Q)       | 20 – 40            | —                           | @ 13.56 MHz                   |
| DC Resistance (Total)    | 10.5               | $\text{m}\Omega$ (measured) | @ 25 °C                       |
| DC Resistance (Per Arm)  | ~ 5.25             | $\text{m}\Omega$ (est.)     | @ 25 °C                       |
| Resonant Capacitance     | ~ 115              | $\text{pF}$ (typ.)          | Differential match to L_total |
| Arm Resonant Capacitance | ~ 460              | $\text{pF}$ (typ.)          | Per arm, match to L_arm       |
| Differential Impedance   | 50 – 200           | $\Omega$ (target)           | Via external matching network |

*Note: The top layer and inner layer 1 are connected in series. The measured end-to-end inductance is 1.2  $\mu\text{H}$  and the measured DC resistance is 10.5  $\text{m}\Omega$ , both measured across the antenna terminals. Because the center tap is located at the physical mid-point of the coil winding (half the turns), each arm exhibits  $L_{\text{arm}} \approx L_{\text{total}} / 4 = 0.3 \mu\text{H}$  and  $R_{\text{arm}} \approx R_{\text{total}} / 2 = 5.25 \text{ m}\Omega$ . For differential drive at 13.56 MHz, the total end-to-end capacitance required is approximately 115 pF, while each arm typically requires ~460 pF for individual resonance. Because the DC resistance is exceptionally low, the unloaded Q-factor will be very high; an external damping resistor may be required in the matching network to limit Q to the recommended 20–40 range for stable RFID communication.*

## 4. Material Specification

| Item                                 | Specification          | Remark                  |
|--------------------------------------|------------------------|-------------------------|
| Substrate Material                   | FR-4                   | Standard Tg 130-140 °C  |
| Dielectric Constant ( $\epsilon_r$ ) | 4.3 – 4.7              | @ 1 MHz                 |
| Loss Tangent ( $\tan \delta$ )       | $\leq 0.025$           | @ 1 MHz                 |
| Copper Foil                          | Electro-deposited (ED) | —                       |
| Surface Finish                       | ENIG or OSP            | For top antenna area    |
| Solder Mask                          | Green (standard)       | Opened on antenna trace |

## 5. Manufacturing & Process Requirements

The following process controls shall be observed during PCB fabrication and assembly to ensure antenna performance consistency.

| Process             | Requirement                                   | Tolerance     | Inspection         |
|---------------------|-----------------------------------------------|---------------|--------------------|
| Trace Width         | 0.50 mm                                       | $\pm 0.03$ mm | AOI                |
| Trace Spacing       | 0.90 mm                                       | $\pm 0.05$ mm | AOI                |
| Board Thickness     | 1.0 mm                                        | $\pm 0.1$ mm  | Micrometer         |
| Layer Registration  | $\leq 0.075$ mm                               | —             | X-ray              |
| Solder Mask Opening | Expose copper on top antenna                  | $\pm 0.05$ mm | Visual / AOI       |
| Via Connection      | Top $\leftrightarrow$ Inner 1 interconnection | —             | X-section / E-test |

## 6. Reliability & Environmental Requirements

| Test Item             | Condition                                   | Criterion                  |
|-----------------------|---------------------------------------------|----------------------------|
| Operating Temperature | -25 °C ~ +85 °C                             | No performance degradation |
| Storage Temperature   | -40 °C ~ +125 °C                            | No delamination / crack    |
| Humidity Resistance   | 85 °C / 85% RH, 168 h                       | $\Delta L \leq \pm 5\%$    |
| Thermal Shock         | -40 °C $\leftrightarrow$ +85 °C, 100 cycles | No open / short            |
| ESD (HBM)             | $\pm 2$ kV                                  | No damage                  |

## 7. Application & Integration Notes

This differential antenna with center tap is suitable for the following application scenarios:

- . Tag / Reader modules with differential RF front-end (ISO/IEC 14443 Type A/B)
- . Forum Device Type 1/2/3/4/5 compatible systems
- . Contactless payment and access control terminals
- . IoT devices requiring 13.56 MHz / 125KHz near-field communication with balanced antenna drive

### Integration Recommendations:

1. A differential matching network is required between the antenna feed points (ANT1 / ANT2) and the RFID transceiver IC. The center tap (CT) should be connected to the common-mode voltage reference (VMID) or RF ground as specified by the transceiver datasheet.

2. For resonance at 13.56 MHz with  $L_{total} = 1.2 \mu H$ , the required total end-to-end capacitance is approximately 115 pF. Each arm ( $L_{arm} \approx 0.3 \mu H$ ) will typically require ~460 pF for individual arm resonance. Account for PCB parasitic capacitance (typically 5–15 pF) when selecting external matching capacitors.

3. The measured DC resistance of 10.5 mΩ is extremely low, resulting in a very high unloaded Q-factor. A series or parallel damping resistor (typically 1–5 Ω) should be included in the matching network to reduce the loaded Q to 20–40, ensuring adequate bandwidth for data transmission.

Keep the antenna area free from large copper planes, metal shields, or ferrite plates on the opposite side to avoid Q-factor degradation and frequency shift.

5. If metal backing is unavoidable, place a ferrite sheet ( $\mu' \geq 100$ , thickness  $\geq 0.3$  mm) between the PCB and the metal surface.

6. Top-layer solder mask opening is recommended to reduce dielectric losses and improve coupling efficiency.

## 8. Revision History

| Version | Date       | Description     | Author           |
|---------|------------|-----------------|------------------|
| V1.0    | 2026-04-28 | Initial release | Xiao Yu Creation |

— End of Document —