PCB Printed NFC Antenna Specification

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Product Name	PCB Printed NFC Antenna	**Date**	2026-04-28
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Designer	Xiao Yu Creation	**Address**	Mayu Town, Ruian City, Wenzhou, Zhejiang, China
Bandwidth	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

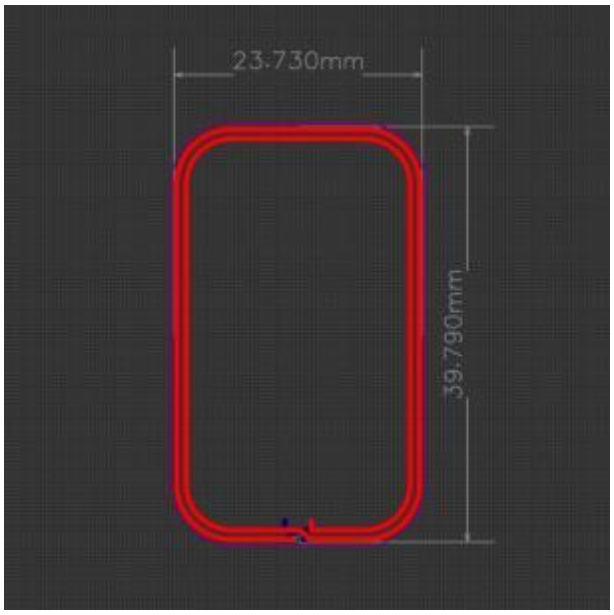

Figure 1. Antenna Design Drawing

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 µH and DC resistance of 10.5 mΩ 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	13.56	± 0.5 MHz	Resonant
Total Inductance (L)	1.2	± 0.1 µH	Measured, @ 13.56 MHz
Arm Inductance (L_arm)	0.3	± 0.03 µH	Each side, @ 13.56 MHz
Quality Factor (Q)	20 – 40	—	@ 13.56 MHz
DC Resistance (Total)	10.5	mΩ (measured)	@ 25 °C
DC Resistance (Per Arm)	~ 5.25	mΩ (est.)	@ 25 °C
Resonant Capacitance	~ 115	pF (typ.)	Differential match to L_total
Arm Resonant Capacitance	~ 460	pF (typ.)	Per arm, match to L_arm
Differential Impedance	50 – 200	Ω (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 µH and the measured DC resistance is 10.5 mΩ, 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_arm ≈ L_total / 4 = 0.3 µH and R_arm ≈ R_total / 2 = 5.25 mΩ. 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 NFC communication.

4. Material Specification

Item	Specification	Remark
Substrate Material	FR-4	Standard Tg 130-140 °C
Dielectric Constant (εr)	4.3 – 4.7	@ 1 MHz
Loss Tangent (tan δ)	≤ 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	± 0.03 mm	AOI
Trace Spacing	0.90 mm	± 0.05 mm	AOI
Board Thickness	1.0 mm	± 0.1 mm	Micrometer
Layer Registration	≤ 0.075 mm	—	X-ray
Solder Mask Opening	Expose copper on top antenna	± 0.05 mm	Visual / AOI
Via Connection	Top ↔ 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	ΔL ≤ ±5%
Thermal Shock	-40 °C ↔ +85 °C, 100 cycles	No open / short
ESD (HBM)	± 2 kV	No damage

7. Application & Integration Notes

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

. NFC Tag / Reader modules with differential RF front-end (ISO/IEC 14443 Type A/B)

. NFC Forum Device Type 1/2/3/4/5 compatible systems

. Contactless payment and access control terminals

. IoT devices requiring 13.56 MHz 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 NFC 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 μH, the required total end-to-end capacitance is approximately 115 pF. Each arm (L_arm ≈ 0.3 μH) 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 NFC data transmission.

4. 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 (μ' ≥ 100, thickness ≥ 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

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