Product Introduction Manual

IPH2331 NFC Passive Padlock PCBA

Battery-free NFC energy harvesting · Secure communication · Motor unlock controller

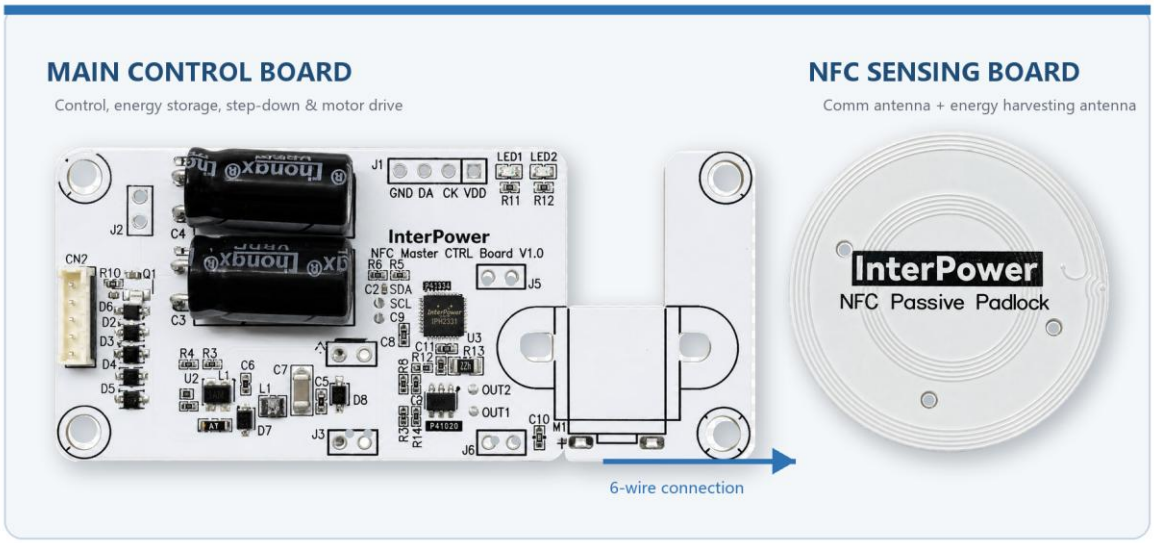


Figure 1 NFC passive padlock main control board and sensing board

Core positioning

This is a complete NFC passive PCBA for smart padlocks and compact electronic locks. The boards integrate energy harvesting, storage management, secure communication, status sensing and bidirectional motor control so they can drive unlock and reset with the lock mechanism. The companion app supports Android, iOS and HarmonyOS, plus multiple languages and customer-logo customization.

1. Product Overview

The IPH2331 NFC Passive Padlock PCBA consists of a main control board and an NFC sensing board. It provides a complete control chain from phone-side NFC powering, identity verification, energy storage and action decisions through to motor unlock / reset. Customers only need to match the lock body, motor and harness to build a smart padlock that does not require a conventional battery in the lock.

The PCBA product model is IPH2331. Component configuration may change with product optimization, supply chain or customer customization. Mass production shall follow the mutually confirmed BOM, drawings, firmware and acceptance specification.

1.1 PCBA Function Specifications

Item	Specification / description
Architecture	Main control board + NFC sensing board; PCB thickness 1.0 mm, copper 1 oz
Power & storage	Phone NFC reverse powering; the boards harvest, rectify, store and regulate the supply
Communication & authorization	Bidirectional NFC, ISO/IEC 14443A compatible; device identification, binding and secure command exchange
Actuation	Drives a 1.5-4.5 V geared motor forward and reverse for unlock, reset and fault recovery
On-board interfaces	Sensing-board connector, motor connector, programming, debug and status-test interfaces
Target unlock time	Target specification < 3 s; 1.8 s measured on an OPPO Find N6 prototype at the best coupling position
Security	Device UID check + 64-bit rolling code (32-bit rolling code + 32-bit fixed code)
App & customization	Android, iOS, HarmonyOS, multiple languages, and customer logo / UI customization

1.2 Typical Operation

1. Select bind, unlock, reset or unbind in the app; the app actively wakes the phone NFC radio.
2. Hold the phone NFC antenna area against the padlock sensing face and keep the relative position stable.
3. The system first verifies the UID and rolling code, then harvests energy. The motor is driven after the storage voltage reaches the threshold.
4. The app shows progress and the result. To lock, push the shackle back in; run reset if needed.

2. Mobile App and Brand Customization

NFC Padlock is the companion mobile app for this PCBA. Besides bind, unlock, reset and unbind, it provides device renaming, UID display and operation-record lookup. The app checks the device UID before every sensitive action and does not send unlock, reset or unbind commands to a non-target device.

Capability	Delivery scope
OS support	Android、iOS、HarmonyOS
Languages	Chinese, English and other languages; additional locales can be added by project assessment
Brand customization	Customer logo, app name and UI visual customization; scope follows the delivery requirements
Core functions	Bind / unbind, unlock, lock (reset), rename, operation records

2.1 Chinese / English UI Comparison

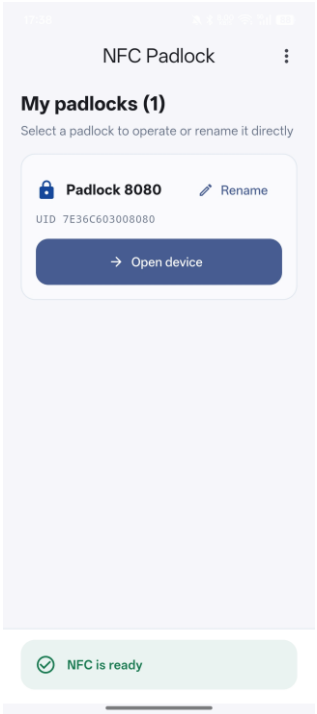
Chinese UI	English UI
	
Device list	*Device list*

Figure 2 NFC Padlock app Chinese / English device list

2.2 Device Controls and Customization Scope

The device detail page groups unlock, lock (reset), operation records and unbind. Chinese and English builds share the same information architecture so training and after-sales materials can be reused across markets.

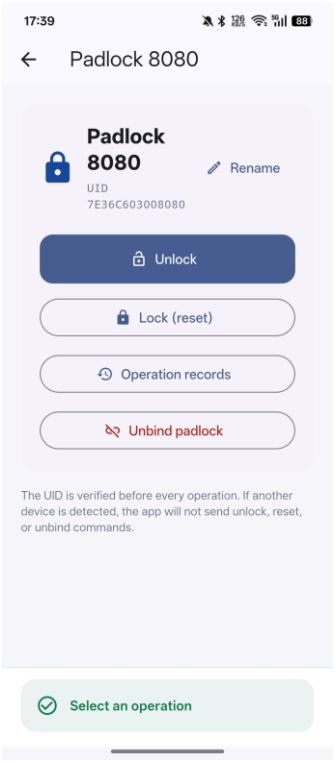
Chinese UI	English UI
 *Device controls*	 *Device controls*

Figure 3 NFC Padlock app Chinese / English device controls

Customization item	Available options
Brand identity	Customer logo, app icon and app name; subject to project assessment and store-review requirements
Visual design	Brand primary color, splash screen and key UI elements can be adjusted by project assessment
Language versions	Chinese, English and target-market languages; translation and terminology to be confirmed by both parties
OS versions	Android, iOS, HarmonyOS; supported OS versions and handset range follow the delivery test list

3. App Operating Instructions

Each NFC tap runs only one flow. After it finishes, move the phone away and wake NFC again for the next action. The steps below apply to the standard app; button names and visuals may differ in a customized build.

3.1 Bind

Binding is required before first use. Tap Add Device on the home screen, wake NFC, then hold the phone to the padlock. After a successful bind, the device name can be edited, and the UID and bind time are shown.

3.2 Unlock

Tap Unlock on the device list or device detail page, hold the phone steadily over the sensing area, and watch the progress prompt. The shackle pops out after the motor completes the motion.

3.3 Reset / Lock

If unlock energy was insufficient or the shackle does not push back smoothly, run Lock (Reset) on the device detail page. The system harvests energy again and drives the motor in reverse.

3.4 Unbind

Select Unbind Padlock on the device detail page. Binding is cleared after NFC identity verification completes again.

3.5 Name and Records

The device name distinguishes multiple padlocks. Operation records store unlock and reset results with timestamps for later tracing.

3.6 Coupling Success Tips

- Align the NFC antenna area on the back of the phone (often near the camera module) with the product sensing mark.
- Keep the sensing face close to and parallel with the phone. Avoid large tilt angles or frequent movement during charging.
- Phone cases, metal brackets and magnetic accessories can reduce coupling efficiency. Tests should cover accessories commonly used by the customer.
- If progress stalls, move the phone slowly to find the best position instead of rapidly tapping on and off.

Security logic

The app verifies the device UID before sending a command. The boards also use a rolling code and a sync counter to reduce cloning and replay risk. The complete-lock customer must still perform threat modeling and application-level verification.

4. Operating Principle

The system splits the phone NFC field into an energy path and a data path: the energy path charges the storage capacitors and drives the motor; the data path handles device identification, encrypted command exchange and action control.

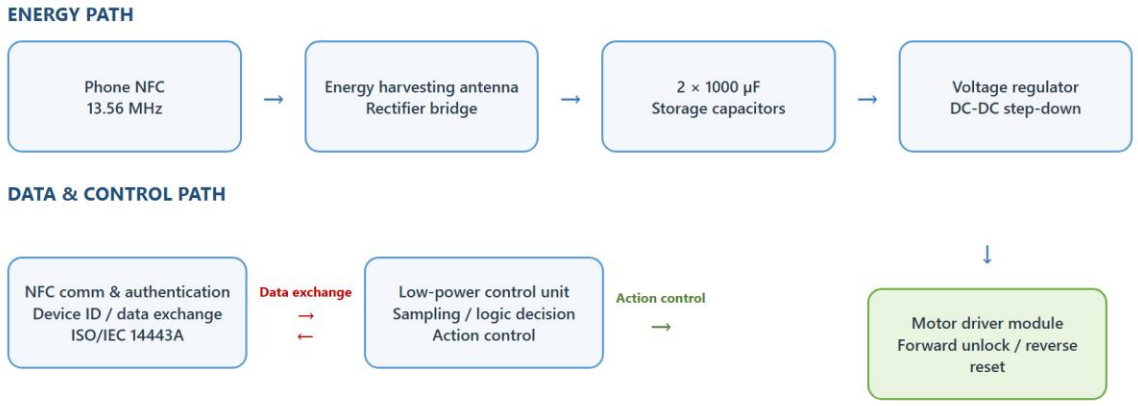


Figure 4 NFC passive padlock PCBA block diagram

Stage	Function	Design focus
Energy harvesting	The harvesting antenna charges 2 × 1000 µF / 16 V capacitors through a rectifier bridge	The antenna and resonant capacitors must be tuned to 13.56 MHz on the complete lock
Communication & authorization	Performs bidirectional NFC, device identification, binding and secure command reception	Exchanges identity, status and operation data with the control unit
Energy management	Monitors storage status in real time and decides when to act for unlock or reset	Action thresholds must be confirmed with the motor and lock under load
Regulated supply	Enables the regulated supply after storage reaches the condition, powering control and motor action	Input range, efficiency and minimum operating voltage follow the final hardware specification
Actuation	The motor-driver module runs the geared motor forward to unlock and reverse to reset	Confirms shackle motion from voltage change and stall detection

5. PCBA Features

Feature	Description
Battery-free, low maintenance	No battery is required in the lock. The phone NFC field supplies energy in use, reducing battery replacement and leakage maintenance.
Full function integration	The main control board and sensing board together handle harvesting, storage, communication, authorization, status decisions and motor control, reducing customer-side peripheral development.
Closed-loop energy management	Unlock timing is gated by storage voltage, temperature and action conditions so the motor is not driven when energy is insufficient.
Bidirectional actuation	Supports forward unlock and reverse reset, with motion-state detection to improve mechanism reliability.
Secure authorization	Uses the device UID, rolling code and sync counter for identification and command checks, reducing cloning and replay risk.
Visible operation feedback	The app shows coupling, harvesting and unlock progress so users can quickly find a good NFC position.
Platform and brand fit	The app supports multiple OS platforms, languages and customer logo / UI customization for multi-market delivery.

5.1 Positioning vs. Conventional Battery Padlocks

Item	NFC passive PCBA	Conventional battery design
Lock-side power	Powered by the phone NFC field in use	Depends on a battery inside the lock
Maintenance	No periodic battery replacement	Requires charge management and battery replacement
User feedback	App can show coupling / unlock progress	Depends on the product
Security	UID + rolling code + sync counter	Depends on the product design

Note

“Battery-free” means the padlock PCBA has no conventional battery. Unlock performance still depends on phone NFC power, antenna coupling, storage, the motor and lock load. Unlock time and success rate under different phones and mechanics must be verified separately.

6. PCBA Appearance and Interfaces

The PCBA comprises a rectangular main control board and a circular NFC sensing board. The main board integrates rectification, storage, regulated supply, low-power control, motor drive and debug interfaces. The sensing board integrates the NFC communication antenna, energy-harvesting antenna and matching network. The two boards connect through a 6-wire interface so they can be placed flexibly inside the lock body.

6.1 Main Control Board

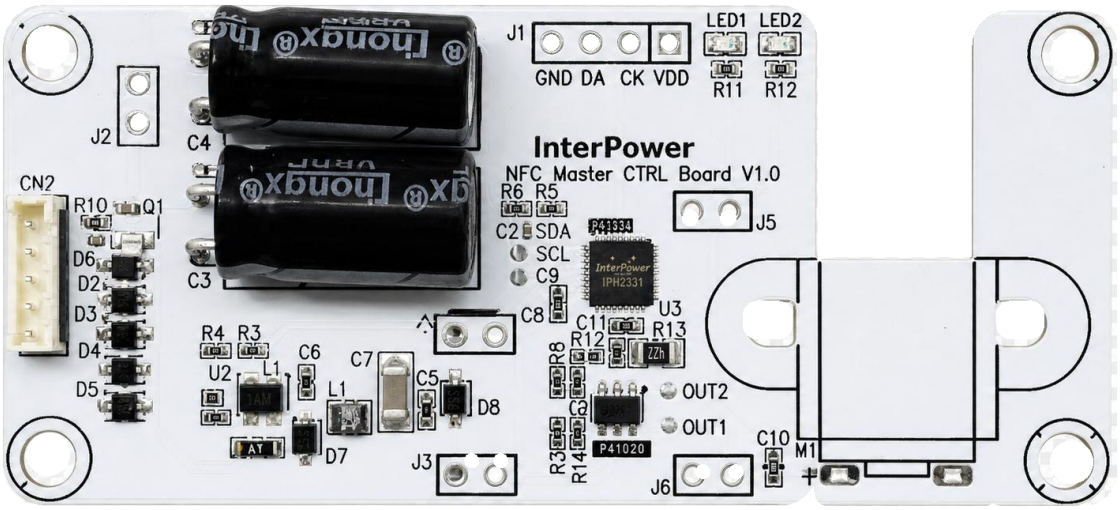


Figure 5 Main control board front: storage, power conversion, control and motor drive

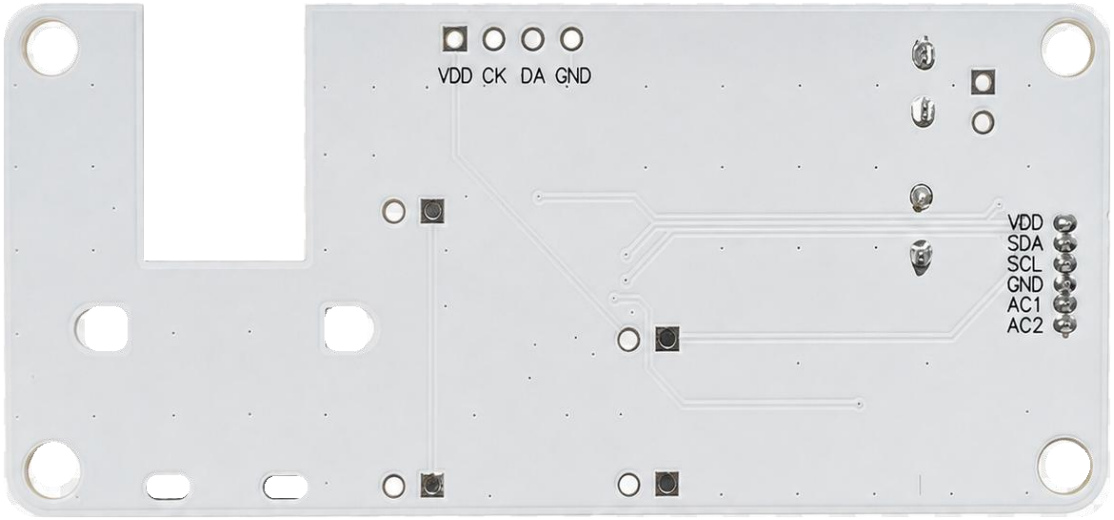


Figure 6 Main control board back: programming pads and sensing-board connector

6.2 NFC Sensing Board and Key Interfaces

Front: communication antenna + energy-harvesting antenna

Back: communication, authentication and matching components

Figure 7 NFC sensing board, front and back

Connector / part	Purpose	Usage notes
J1：GND / DA / CK / VDD	Firmware programming and debug	Powered separately by e-Link during programming; connect per the mass-production test procedure
CN2 / 6-wire pads	Main control board to sensing board	VDD / SDA / SCL / GND / AC1 / AC2; confirm no shorts or cold solder joints
C4 / C5：1000 µF / 16 V ×2	Stores harvested NFC energy	Observe polarity; action thresholds must be verified with the motor under load
M1 / J3 / J6	Geared-motor interface	Reference motor 1.5-4.5 V; confirm wire order and mechanism direction
J5 / LED1 / LED2	Status indicators and test jumpers	Connect per the functional-test procedure; mass-production builds may be configured by project
Q1 / R10	NFC communication-unit power control	Part of the board power-up sequence; reference designators follow the final hardware revision

7. Antenna and System Integration Guidelines

Success of an NFC passive design is jointly determined by the phone NFC field, communication antenna, harvesting antenna, resonant matching, storage, geared motor and lock load. The parameters below are for initial design and complete-lock debug. Confirm them on the real mechanics and target phone set before mass production.

Item	Initial parameters	Description
NFC communication antenna	Diameter about 19.5 mm; 5 turns; measured about 806 nH	Reference matching capacitor about 120 pF; final value follows tuning after board assembly
Energy-harvesting antenna	Two-layer, diameter about 32 mm; measured about 4.68 µH	Resonant capacitor about 30 pF
Resonant frequency	13.56 MHz	Final capacitors must be re-matched to the PCB, assembly and measured inductance
Storage capacitors	2 × 1000 µF / 16 V	Capacitance, ESR and low-temperature behavior affect charging and motor action
Action thresholds	Unlock ≥ 11.76 V; reset ≥ 7.65 V	Do not use these as mass-production thresholds for every lock; reconfirm on the complete lock

7.1 Mechanical and Layout Notes

- Place the sensing board close to the housing surface and align it with a location the phone can contact easily. Mark the NFC sensing area clearly on the product exterior.
- Avoid large metal areas, magnetic materials and closed conductive loops near the sensing face. If needed, validate spacing, cutouts or magnetic isolation materials.
- Matching of the communication and harvesting antennas must be re-measured on the assembled lock, not from bare-board inductance alone.
- Keep the AC1 / AC2 energy path, rectifier and storage loop short and low-impedance. Route low-voltage communication and sensitive sense signals away from the motor and high-current loops.
- Pay attention to storage-capacitor polarity, ESR, voltage rating and low-temperature capacitance. Motor, gear and lock stall loads must cover tolerance and lifetime drift.
- Phone coverage tests should include representative Android, iOS and HarmonyOS models, plus common cases, magnetic rings and metal accessories.

Mass-production validation

At minimum complete antenna tuning, multi-phone compatibility, low / high temperature, weak-field unlock, lock-body tolerance, stall, cycle life, EMC, ESD and fault-recovery tests. Parameters in this manual do not replace the complete-lock specification.

8. PCBA Control Logic and Customer Integration

After the phone is presented, the PCBA performs device identification, bind-state check, secure-command verification, energy judgment and actuation, then enters the bind, unbind, unlock or reset flow. Each NFC tap executes only one action; the board then waits for the phone to move away to avoid repeated false triggers.

Process	PCBA behavior	Result
Bind	Runs the bind action and sends confirmation; the phone stores the bind state after it acknowledges	Creates a device entry that can be renamed
Unlock	Verifies UID / sync counter, reads temperature, sets the threshold and reports charging progress	Runs forward after the unlock voltage is reached; after stall is confirmed, reverses to the re-lock position
Reset	Recharges to the reset threshold and drives the motor in reverse	Ensures the shackle can be pushed back in
Unbind	Verifies the sync counter and unbind command, then waits for phone confirmation	Clears the binding
Fault recovery	Re-receives the packet if the sync counter can be resynchronized; rejects the action if it is out of range	Reduces replay and wrong-device operation risk

8.1 Mass-Production Configuration and Validation

1. Confirm correct soldering of the main control board, sensing board, storage capacitors, motor interface and harness before connecting the programming and test interfaces.
2. Configure unlock / reset thresholds, motion direction, wait times and fault-recovery parameters for the customer lock body, motor and transmission.
3. Complete mass-production programming and traceability of security data such as device UID, keys, binding and the sync counter.
4. Validate antenna matching, multi-phone compatibility, weak-field powering, temperature variation and maximum mechanism load on the assembled lock.
5. Outgoing tests should cover bind, unlock, reset, unbind, stall protection and fault recovery, and record key motion data.

Customization and delivery support

Interface and harness, motion parameters, firmware logic, test procedures and board-shape optimization can be assessed by project. The app can also be customized for languages, customer logo and UI visuals.

9. Prototype Test Data and Applications

The following are PCBA prototype test data for design evaluation only. Phone, coupling position, lock body, motor, temperature and PCB revision all affect the results.

Test item	Test data	Conditions / notes
Product form	Main control board + NFC sensing board	Complete PCBA function module
Lock-side power	Phone NFC reverse powering	PCBA has no conventional battery
Target unlock time	< 3 s	PCBA target specification
Prototype unlock time	1.8 s	OPPO Find N6, best NFC coupling position
Prototype peak operating current	217 mA	Measured under unlock conditions; design upper limit 250 mA
Communication protocol	ISO/IEC 14443A	NFC communication
Motor compatibility	1.5-4.5 V; no-load start <110 mA; 60±10 rpm	Loaded capability and motion direction must be measured on the lock
Storage configuration	2 × 1000 µF / 16 V	Capacitance, ESR and low-temperature performance affect actuation capability
Action thresholds	Unlock ≥11.76 V; reset ≥7.65 V	Must be reconfirmed on the complete lock for mass production

9.1 Application Scenarios

- Home and security padlocks: gates, warehouses, toolboxes and other low-maintenance uses.
- Luggage and bag locks: no in-lock battery replacement; present the phone to authorize and unlock.
- Lockers and storage cabinets: schools, offices and gyms, with the motor and transmission matched to the lock body.
- Electronic-lock PCBA platform: for rapid validation of NFC reverse powering, secure communication, storage management and geared-motor control.

Selection boundary

Do not write the 1.8 s prototype result from a single phone at the best coupling position into an end-product guarantee. Mass-production specifications should be set from a representative phone set, worst antenna position, temperature extremes and maximum lock load.

10. Contact and Disclaimer

10.1 Contact

For samples, design evaluation, PCBA customization, app localization or customer-logo support, contact us as follows.

WhatsApp **+86 138 2963 2935** WeChat: scan the QR code on the right	*WeChat QR code*

10.2 Disclaimer

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