Preventing damages to RFID cards

Stéphane Czeck – Director of marketing – NFC & Wireless Charging
Introduction
Project background

Wireless charging needs to be:

- Safe
- Cost effective
- Environment friendly
- Interoperable
Safety is guaranteed through various mechanisms.

Foreign object detection is one of them.

Upon detection of a metal object, a power transmitter shall immediately stop to transmit power.
Some issues coming from the field report RFID cards (banking card, transportation card) being damaged during a wireless charging process.
Analysis
The voltage of the digital ping may be an issue.
RFID tags are not detected as foreign objects.

► Therefore a charging operation may very well take place if the tag is present

► The RFID tag will receive all the power generated by the Tx, and may burn if the power is too high (during Ping and/or charging operation)
Types of possible counter measures
Approach 0: measuring the Digital Ping signals

The amplitude of the analog and the digital ping shall be under a reasonable value, in order not to damage the tag.

How to assess the « reasonable » value?
Approach 0: measuring the Digital Ping signals

The ISO 10373-6 specification defines test methods for RFID readers and smartcards, to aim at interoperability.

It specifies different test accessories, such as the test apparatus and the reference PICC.

A few test items:

For tags/smartcards:
- Measure their load modulation amplitude
- Check their ability to receive different reader waveshapes
- Measure their loading effect
- Check their ability to resist to a powerful field strength

For readers:
- Measure their field strength
- Measure the power transfer
- Measure the waveform parameters
- Detect a destructive field strength
Approach 0: measuring the Digital Ping signals

The ISO 10373-6 specification defines test methods for RFID readers and smartcards, to aim at interoperability.

It specifies different test accessories, such as the test apparatus and the reference PICC.

A few test items:

For tags/smartcards:
- Measure their load modulation amplitude
- Check their ability to receive different reader waveshapes
- Measure their loading effect
- Check their ability to resist to a powerful field strength

For readers:
- Measure their field strength
- Measure the power transfert
- Measure the waveform parameters
- Detect a destructive field strength
Approach 0: measuring the Digital Ping signals

Can emulate the presence of a PICC (load), adjustable with R2. Envelop detector, transformation of a magnetic field in a DC voltage. The resonance frequency of the Reference PICC can be adjusted.
Approach 0 : measuring the Digital Ping signals

Destructive field strength detection test:

By choosing R1, the Reference PICC emulates the presence of a standard PICC. It is possible to calibrate this Reference PICC so that the DC voltage indicates a field over the destructive field strength. Move the reference PICC in the proximity of the reader under test.
Approach 0: measuring the Digital Ping signals

Destructive field strength detection test:

If the DC voltage is higher than 3V, the reader generates a dangerous field that may damage RFID/NFC tags => fail according to RFID/NFC standards.

Experiments show that it is difficult to use this antenna as is for Qi Tx.
Approach 0: measuring the Digital Ping signals

Destructive field strength detection test:

The ISO 10373-6 reference PICC is designed to test readers that operate at 13.56MHz (RFID/NFC operating frequency).

Qi operates in the range of 150kHz.
Approach 0: measuring the Digital Ping signals

NXP and Micropross designed a specific reference PICC.

- Same circuitry
- Different coil (RFID tag shaped, more turns)
- Identify that chargers should not give ping signals above 3V
Approach 0: measuring the Digital Ping signals

A bit over 3V…It is risky
Approach 1: using the phone’s integrated NFC reader

High end smartphones embed the NFC functionality.

The goal is to use the internal NFC reader of the mobile phone to detect the attached smartcard.

If a smartcard is detected, then the mobile phone shall send an appropriate message to the power transmitter.
Approach 1: using the phone’s integrated NFC reader

- Does not need to modify readers HW and SW

- The phone must embed NFC
- The NFC functionnality must be turned on
- The communication protocol between the mobile phone and the power transmitter must include some flags related to detection of RFID tags
Approach 2: make the power transmitter smarter

Make the power transmitter capable of detecting RFID tags.
If a tag is detected, then no power transmission.

The way to detect RFID tags is to actually enable the transmitter to behave like a RFID reader.

Prototypes are circulating (NXP) and embed an additional antenna for the RFID detection feature.
Approach 2: make the power transmitter smarter

- Analog ping
- NFC reader polling
- Digital ping
Approach 2 : make the power transmitter smarter

Easy approach :

If the reader gets a response to a polling command
- No power shall be transmitted
- Stop performing analog and digital pings
- Try to detect a RFID tag again
- Repeat

Not so easy…

A NFC mobile phone in card mode (example : Apple Pay, contactless transport) is also able to respond to RFID readers polling commands.

Workaround : enhance the algorithm to differentiate RFID tags from a NFC mobile phone.

Reminder : We want to charge the mobile phone, but not if there is a RFID/NFC tag around.
Approach 2: make the power transmitter smarter

- A RFID tag:
  - May not be well protected against exposure to high power (depends on chip and antenna types)
  - Handles
    - ISO 14443 A OR
    - ISO 14443 B OR
    - ISO 15693 OR
    - FeliCa protocols

- A NFC enabled Smartphone:
  - Is robust to exposure to high power
  - Handles
    - ISO 14443 A AND
    - ISO 14434 B AND
    - ISO 15693 AND
    - FeliCa protocols
Approach 2: make the power transmitter smarter

A good way to determine if the object is a RFID tag or a NFC Phone in card mode is to poll different technologies following each other.

If only one technology is supported:
> This is a RFID tag

If several technologies are supported:
> This is a NFC phone
Example of RFID tag vs NFC Phone decision tree
No tag detected. The Tx pings as usual.

A tag is detected. NFC communication is happening. All ping activity is suspended.

The NFC tag is removed. The Tx resumes its ping activity.
Approach 2: make the power transmitter smarter

- May use the NFC support to create value added services (pay for charge, …)
- Does not require changes on NFC enabled mobile phones

- Complexifies power transmitters
Testability considerations

- There are two sides to consider:
  - **The measurement of the pings**
    - This is addressed with Vdc measurement on the Qi ISO reference PICC
  - **The improvement of power 1x**, to make them able to detect RFID tags before starting to ping
    - It requires to test both a tag, and a NFC device behaviour
    - The Qi ISO reference PICC is able to behave as a RFID tag, and can be connected to a programmable RFID tag simulator
Testability consideration

MP500 TCL3

- High end NFC and RFID signal generator
- Support if ISO 14443 A, ISO 14443 B, ISO 15693, FeliCa communications
- Totally customizable (analog + protocol parameters)
- Direct connection to the Qi ISO reference PICC
  - Vdc measurement available directly
  - Programmation of RFID tag simulation scenarii
- Also used in Micropross Qi test solution
Conclusion
The Wireless Charging technology is in a breakthrough phase
- Embedded as a feature in high end mobile phones
- More big announcements may be coming soon

Ensuring a flawless experience to the user is important. We should avoid damaging transportation cards, banking cards, or any of the user’s valuable assets.

The WPC has led an initiative aiming at protecting the user, and helping in reinforcing Qi’s leadership position with the RFID taskforce. Concepts exist, seem viable.

Next steps:
Decide on modifying both Qi system specification and test specification to include specific test cases or leave this as an option.
Micropross has the right offering in order to perform those RFID tag coexistence test cases.

- 18 years of experience in RFID testing
- Availability of Qi conformance test tools
- Usage of an identical hardware platform for Qi and RFID detection testing