

RFID standards

ISO14443,ISO15693 and EPCGlobal

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General overview

There are a multitude of standards for contactless ICs:

- ISO14443 for proximity contactless cards
- ISO15693 for vicinity contactless cards
- ISO18000 set of standards for RFIDs
- EPCglobal Class 1 Gen 2 (=18000-6C)

Common terms& definitions

- PCD: Proximity Coupling Device(\approx reader)
- PICC: Proximity IC Card (\approx tag)
- Similarly VCD and VICC for Vicinity reader/tag
- Interrogator: stands for “reader” in EPCglobal standard
- UID: Unique ID
- Carrier: Base signal (e.g. 13.56Mhz). Reader modifies this signal to send data.
- Subcarrier: Signal on top of the base signal. Tag generates this signal to send data.

General background

- Anticollision is needed due to TDMA. Note: FDMA and SDMA are too expensive
- The reader *always* starts all data transfer. So if tag wants to send something, it needs to be queried first. E.g.: “Do you have something to send?” - “Yes, here you go”
- Anticollision is to select one tag. All further commands will be executed by this one tag

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General background

- Proximity card → \approx 10cm max range
- Usually uses the 7810 ID-1 card form factor (i.e. credit card)
- Quite a lot of power on card
- Used in transportation systems, building access, Visa paypass
- Sometimes integrates the 7816-* (i.e. smart card) standards

Radio interface - Type A

PCD→PICC:

- Carrier: 13.56Mhz
- Modulation ASK 100%
- Coding: Modified Miller
- Bandwidth: 106kbit/s→847kbit/s

PICC→PCD:

- Load modulation
- Subcarrier: $f_c/16 \rightarrow f_c/128$
- Coding: OOK, Manchester
- Bandwidth: 106kbit/s→847kbit/s

Radio interface - Type B

PCD→PICC:

- Carrier: 13.56Mhz
- Modulation: ASK 10%
- Coding: NRZ
- Bandwidth: 106kbit/s→847kbit/s

PICC→PCD:

- Load modulation
- Subcarrier: $f_c/16 \rightarrow f_c/128$
- Coding: BPSK, NRZ-L
- Bandwidth: 106kbit/s→847kbit/s

Anticollision - Type A

- 1 Reader issues SELECT command with 0 known bits
- 2 All tags respond with their UID
- 3 Tags clash at bit position C
- 4 Reader decides to explore $C + 1=0$ or $C + 1=1$
- 5 Reader issues SELECT command with $C + 1$ bits
- 6 Goto 3
- 7 If no clash: Issue SELECT with full UID of tag

Anticollision - Type B

- 1 Reader issues REQB with S slots
- 2 All tags pick a slot randomly
- 3 Reader issues SLOT-MARKER commands to mark the slots
- 4 Tag sends ATQB with PUPI inside
- 5 Reader sends ATTRIB (to select it) or HLTB (to halt it)
- 6 If tags clashed, reader starts again with more slots

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General background

- Vicinity card → \approx 1-1.5m max range
- Usually uses the 7810 ID-1 card form factor (i.e. credit card)
- Has much less power so less powerful CPU
- Usually only has some RAM and memory manipulation commands

Radio interface

VCD→VICC:

- Carrier: 13.56Mhz
- Modulation: ASK 10% or 100% (VICC knows both)
- Coding: PPM, “1 out of 4” or “1 out of 256”
- Bandwidth: 26,48 kbits/s or 1.65kbit/s

VICC→VCD:

- Subcarrier: Single: $f_c/32$
 - Single: $f_c/32$
 - Dual: $f_c/28, f_c/32$
- Coding:
 - One subcarrier: (subcarr)(unmodulated time)=0, reverse=1
 - Two subcarrier: (subcarr1)(subcarr2)=0, reverse=1
- Bandwidth:
 - Low: $\approx 6.6\text{kbit/s}$
 - High: $\approx 26\text{kbit/s}$

Anticollison

- 1 Reader issues inventory request with S slots
- 2 Tag sends its inventory response with UID
- 3 Reader issues EOF to signal next slot

Two different modes after anticollison:

- Addressed: 1) Select 2) Issue commands
- Non-addressed : Each command must be individually addressed (i.e. contain the UID)

ISO 15693 physical layer

VICC→VCD:

- Subcarrier:
 - Single: $f_c/32$
 - Dual: $f_c/28, f_c/32$
- Coding:
 - One subcarrier: (subcarr)(unmodulated time)=0, reverse=1
 - Two subcarrier: (subcarr1)(subcarr2)=0, reverse=1
- Bandwidth:
 - Low: $\approx 6.6\text{ kbit/s}$
 - High: $\approx 26\text{ kbit/s}$

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General background

- Most recent standard, to be on all goods
- Works up to a couple of meters
- Very sophisticated inventorying, session management, outlier singulation, etc.
- Multiple physical standards supported (probably to get around IP)

EPC physical layer

Interrogator→tag:

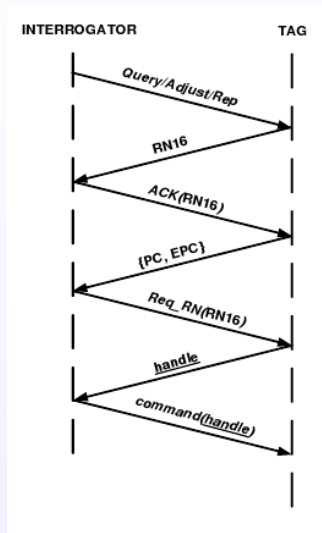
- Carrier: 860-960Mhz (depending on local regulations)
- EU:865.5-867.6Mhz, US: 902-928Mhz , divided into channels (200kHz, 500kHz) – yes, FDMA is possible!
- Modulation: ASK (DSB-ASK,SSB-ASK, PR-ASK – tag understands all)
- Encoding: PIE
- Bandwidth: 26.7-128kbit/s

Tag→interrogator:

- Modulation: ASK or PSK (– reader understands all)
- Encoding: reader decides
 - FM0 baseband (40-640kbit/s)
 - Miller of a subcarrier (5-320kbit/s)
 - Data rate depends on Divide Ratio and TRcal, selected by reader QUERY command

EPC Anticollision

- 1 Reader first SELECTs who will take part in inventorying: session management, mask/truncate EPC, etc.
- 2 Reader issues QUERY to do slotted ALOHA:
 - On picture: tag selected slot 0
 - RN16=random number



Thank you for your time!

Any questions?