ISO/IEC 14443 Contactless Interface
Introduction

CAS – 2006
• International Card Standards
• ISO/IEC 14443 Standard
  • Abbreviations
  • Parts 1 – 4
  • PICC States
  • Type A & B
  • Coding & Modulation
• ISO Card Activation Sequence
• Comparison ISO7816 & ISO14443 Standards
• Regulations
Part 1: Physical characteristics
• Physical size of the ISO14443 card

Part 2: RF signal & power interface
• RF-interface (13.56 MHz, modulation, min. field-strength)
  ▪ Type A: 100% modulation, Miller bit-coding
  ▪ Type B: 10% modulation, NRZ bit-coding

Part 3: Initialization & anti-collision
• Start of communication (request, anti-collision, select card)
  ▪ Type A: Bit-wise arbitration
  ▪ Type B: Time-slot Method

Part 4: Transmission protocols
• Describes data exchange between reader and cards

The ISO14443 does not specify any specific application, security or encryption.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATQA</td>
<td>Answer to Request</td>
</tr>
<tr>
<td>BCC</td>
<td>Block Check Character</td>
</tr>
<tr>
<td>CRC_A</td>
<td>Cyclic Redundancy Check</td>
</tr>
<tr>
<td>HLTA</td>
<td>Halt command, type A</td>
</tr>
<tr>
<td>ID</td>
<td>Identification number</td>
</tr>
<tr>
<td>PCD</td>
<td>Proximity Coupling Device (reader/writer device)</td>
</tr>
<tr>
<td>PICC</td>
<td>Proximity Card</td>
</tr>
<tr>
<td>REQA</td>
<td>Request command</td>
</tr>
<tr>
<td>SAK</td>
<td>Select Acknowledge</td>
</tr>
<tr>
<td>SELECT</td>
<td>Select command</td>
</tr>
<tr>
<td>UID</td>
<td>Unique card Identifier</td>
</tr>
<tr>
<td>WUPA</td>
<td>Wake-up command</td>
</tr>
<tr>
<td>ADC</td>
<td>Application Data Coding</td>
</tr>
<tr>
<td>AFI</td>
<td>Application Family Identifier</td>
</tr>
<tr>
<td>ATQB</td>
<td>Answer to Request</td>
</tr>
<tr>
<td>ATTRIB</td>
<td>PICC selection command</td>
</tr>
<tr>
<td>CRC_B</td>
<td>Cyclic Redundancy Check</td>
</tr>
<tr>
<td>EGT</td>
<td>Extra Guard Time</td>
</tr>
<tr>
<td>EOF</td>
<td>End Of Frame</td>
</tr>
<tr>
<td>HLTB</td>
<td>Halt command</td>
</tr>
<tr>
<td>INF</td>
<td>INFormation field belonging to higher layer</td>
</tr>
<tr>
<td>N</td>
<td>Number of anti-collision slots</td>
</tr>
<tr>
<td>PUPI</td>
<td>Pseudo-Unique PICC Identifier</td>
</tr>
<tr>
<td>R</td>
<td>Slot number chosen by PICC</td>
</tr>
<tr>
<td>REQB</td>
<td>Request command</td>
</tr>
<tr>
<td>SOF</td>
<td>Start Of Frame</td>
</tr>
<tr>
<td>TR0</td>
<td>Guard Time</td>
</tr>
<tr>
<td>TRI</td>
<td>Synchronization Time</td>
</tr>
<tr>
<td>WUPB</td>
<td>Wake-up command</td>
</tr>
</tbody>
</table>

To purchase ISO14443 standard documents please go to: [http://www.ISO.ch](http://www.ISO.ch)
This part of the ISO/IEC 14443 specifies the PICC physical characteristics.

- Physical Dimensions
- Ultra-violet light, X-rays
- Dynamic bending and torsion stress
- Alternating magnetic and electric field
- Static electricity and Static magnetic field
- Operating temperature
This part of the ISO/IEC 14443 specifies the RF power and signal interface for Type A and Type B cards.

- **Electrical Dimensions**
- Initial dialogue for proximity card – Reader Talk First
- Frequency (13.56MHz ± 7kHz)
- Operating magnetic field strength range: \( H_{\text{min}} \) and \( H_{\text{max}} \)
- Communication signal for Type A and Type B
ISO/IEC 14443 Part 2 Coding & Modulation

Type A
- Load Modulation
  - Subcarrier fc/16, 106kbit/s
  - ASK-Manchester

 Type B
- Load Modulation
  - Subcarrier fc/16, 106kbit/s
  - BPSK-NRZ

PICC → PCD (Uplink)
- ASK 100%
  - Modified Miller, 106kbit/s
  - Fieldgap 40 cycles

PCD → PICC (Downlink)
- ASK 10%
  - NRZ, 106kbit/s

PCD … Proximity Coupling Device (Reader)
PICC … Proximity Integrated Circuit Card
# Technical aspects of interface

<table>
<thead>
<tr>
<th></th>
<th>Type A</th>
<th>Type B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Downlink Modulation</strong></td>
<td>100% ASK modified Miller code</td>
<td>10% ASK NRZ code</td>
</tr>
<tr>
<td>(PCD to PICC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Signal/noise ratio</strong></td>
<td>Very high (30% noise tol.)</td>
<td>Low (3% noise tolerance)</td>
</tr>
<tr>
<td><strong>Uplink Modulation</strong></td>
<td>Load modulation, ASK Manchester code</td>
<td>Load modulation, BPSK NRZ code</td>
</tr>
<tr>
<td>(PICC to PCD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Anti Collision</strong></td>
<td>Binary Search method</td>
<td>Time slot method</td>
</tr>
<tr>
<td><strong>Product Portfolio</strong></td>
<td>μC and hardwired logic</td>
<td>μC</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>no difference between Type A and Type B</td>
<td></td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>no difference between Type A and Type B</td>
<td></td>
</tr>
<tr>
<td><strong>Power (energy eff.)</strong></td>
<td>no difference between Type A and Type B</td>
<td></td>
</tr>
<tr>
<td><strong>Large scale experience</strong></td>
<td>Extensive; 500M cards, 5M readers components</td>
<td>Limited &lt;30M cards, 20K readers</td>
</tr>
<tr>
<td><strong>Interoperability experience</strong></td>
<td>Extensive, multi suppliers for cards and readers</td>
<td>Limited, no multiple vendors known</td>
</tr>
</tbody>
</table>
**Principle of Bit Wise Anticollision**

Manchester Coding
- data "1" "0"

**PCD**
- Anticollision

**Synchronous answer of all PICCs in the field**
- UID form PICC 1: 1 0 1 0
- UID form PICC 2: 1 0 0 0

![Graphical representation of Manchester Coding and PCD anticollision](image)

- PICC 1: "1" "0" "1" "0"
- PICC 2: "1" "0" "0" "0"
- PCD: "1" "0" "?" "0"

SFG #hwhfw#froqvrq
Unique identifier / serial number (UID) is basis for bitwise arbitration ...

Single remaining (selected) card can be authenticated for R/W operation ...
Type A Card State Diagram

- Request
- Anti-Collision
- Select
Card Activation Sequence 2

PCD

Start

Bit frame anticollision supported?

NO

Proprietary frames and protocol

YES

Anticollision Loop *

UID + SAK

ISO 14443-4 (T=CL)

MIFARE® Classic

SAK bit 6 = 1?

NO

YES

* see next slide

PICC

REQA

ATQA

ISO 14443-3 A

Proprietary frames and protocol

* see next slide
* The CT (= Cascade Tag, Type A) byte indicates that the UID is not received completely yet. It indicates that another anticollision loop on the next higher cascade level is required to get the complete UID.
ISO 7816

- **Smart Card Contact Interface**
- 7816 - 3: Electronic Signals and Transmission Protocols
  - Protocols: T = “0” or T = “1”, ....
  - Manually Insert Card Answer to Reset
  - 5V / 200 mA Logic "0" = 0 to 0,6V

ISO 14443

- **Smart Card Contactless Interface**
- 14443 - 4 Transmission Protocols
- 14443 - 3 Initialisation and Anti-collision
- 14443 - 2 Radio Frequency Power and Signal

3 Parts