ICMA Workshop, Munich, October 2015

Update RFID technology in ISO Cards

By Thomas Decker
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RF Frequencies in ISO Cards

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<th>frequency (Hz)</th>
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<tbody>
<tr>
<td>LF 125 KHz</td>
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<tr>
<td>MF 13.56 MHz</td>
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<td>HF 860-960 MHz</td>
</tr>
<tr>
<td>VHF 10M</td>
</tr>
<tr>
<td>UHF 1G</td>
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<tr>
<td>10G</td>
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<table>
<thead>
<tr>
<th>card operating frequencies</th>
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<tbody>
<tr>
<td>1980 200m</td>
</tr>
<tr>
<td>1990 2000m</td>
</tr>
<tr>
<td>2007 50m</td>
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<table>
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<th>commercial market launch</th>
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<tr>
<td>1980 200m</td>
</tr>
<tr>
<td>1990 2000m</td>
</tr>
<tr>
<td>2007 50m</td>
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<table>
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<th>units per year</th>
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<tr>
<td>200m</td>
</tr>
<tr>
<td>2000m</td>
</tr>
<tr>
<td>50m</td>
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volume trend
125 KHz – Low Frequency (LF)

- basics about LF antennas
  - inductive coupling
  - 200-300 turn coil

- common application
  - enterprise Access Control
antenna & inlay technology

- only wire wound antenna / air-coil
- inlays mainly PVC
- Typical inlay thickness 400 micron (allowing 60/40 PVC/PET card structure)
125 KHz – Low Frequency

- common IC supplier
  - Atmel (Temic)
    (T5577 – read write)
  - EM Microelectronics
    (EM 4200 – read only)
  - NXP (Hitag 1 & 2)

- challenges in the card manufacturing process
  - high contend of copper in the card body
    (→ warped cards; traces in the print)
  - final card structure often with PET (60% PVC / 40% PET)
    (→ adhesion in lamination; matching of bipolar orientated PET)
  - typically configuration, formatting and encoding required
    (modulation: ASK, FSK, PSK; format: 26, 35, … bit; encoding: site-code, card ident.)
basics about HF antennas

inductive coupling

4 – 7 turn coil

common application

- transit / automatic fare collection (AFC)
- payment, open & closed loop
- corporate access control
- government ID
- hotel, leisure & entertainment
antenna & inlay technology

- **wire wound antenna / air-coil**
  - high durability (++)
  - limited possibilities for antenna tuning (--) 

- **wire embedded antenna**
  - high durability (Cu wire / no bridge) (++)
  - precise antenna tuning via length & pitch (++)
  - high flexibility design / format changes (++)
  - low impact on card surface (++)
  - available on most substrates (++)
  - Typical inlay thickness (module) 400 micro with migration towards 310 micron
13.56 MHz – High Frequency

- etched antenna (subtractive technology)
  - only on PET substrate → adhesion challenges (--)
  - “bridge” as potential failure cause (--)
  - antenna tuning on batch level complicate (--)
  - antenna traces in print (--)
  - no module visibility (++)
  - lead time & set-up cost for custom. formats (--)
  - low cost in high volume (++)
  - very thin inlay possible (direct die attach) (++)

“bridge”, required for etched, printed & additive HF antennas
13.56 MHz – High Frequency

- **printed antenna**
  - high flexibility on substrate type (++)
  - very thin prelam possible (direct die attach) (++)
  - no module visibility (++)
  - high cost due to silver paste (++)
  - antenna tuning on batch level complicate (--)
  - “bridge” as potential failure cause (--) 
  - durability of antenna tracks (--) 

- **additive antenna (galvanic)**
  - high investment & set-up cost (--)
  - high flexibility on substrate type (++)
  - good RF-performance = low production UPH (--) 
  - “bridge” as potential failure cause (--) 
  - antenna tuning on batch level complicate (--) 
  - no module visibility (++)
  - theoretically low cost per unit in high volume (++)
  - very thin prelam possible (direct die attach) (++)
13.56 MHz – High Frequency (HF)

- common IC suppliers
  - **payment “closed loop”**: Sony (Felica), NXP (Mifare & SmartMX)
    Infineon (SLE 77&78)
  - **payment “open loop”**: Infineon (SLE 77&78), NXP (SmartMX)
    Samsung (S3), ST (ST 23,31), Inside (MicroPass)
  - **transit / automatic fare collection**: NXP (Mifare & SmartMX), Sony (Felica), ST (Calypso), Infineon (SLE 66, SLE 77&78, CIPURSE)
  - **corporate access control**: NXP (Mifare), Inside (PicoPass), Legic (MIM 256,1024)
  - **eID (ISO card)**: NXP (Mifare & SmartMX); Infineon (SLE 77 & 78)
    ST (ST 23,31)
challenges in the card manufacturing process

- lamination adhesion in case of etched inlays
  (PET substrate → hot lamination only with adhesives)

- yield loss control in case of etched & printed antennas
  (typically no protective module around IC)

- trend to higher value ICs → yield loss control becomes more crucial

- module visibility in print
  (improving by migration trend to smaller modules like MOA8, MCS8)
basics about UHF antennas

common application
- government ID
- toll collection
- parking
- access in leisure & entertainment
- crowd control
- future: secure access??
antenna & inlay technology

- etched Al antenna - “solid” PET inlay
  - low cost (++)
  - only on PET substrate (––)
  - lamination challenges due to PET substrate (––)
  - logistics / lead times for customized formats (––)
  - antenna traces in print (––)

- etched Al antenna - PET inlets
  - low cost (++)
  - fair lamination properties with small antennas (++)
  - easier logistics compared to “solid” PET inlay (++)
  - antenna traces in print (––)

- printed antenna
  - flexible on substrates (PVC, PC, PET-G)
    → mono-block structure (++)
  - high cost due to silver paste (––)
  - no antenna traces in print (++)
860–960 MHz – Ultra High Frequency

- additive antenna
  - High set-up cost (++)
  - different substrates (++)
  - logistics / lead times for customized formats (--)
  - in high volume competitive to etched antennas (++)
  - antenna traces in print (--) 

- wire embedded antenna
  - relatively high cost (--)
  - design limitation (--)
  - different substrates (PVC, PC, Teslin, PET-G) (++)
  - no traces in print (++)
  - short lead times for customized formats (++)
860–960 MHz – Ultra High Frequency

- common IC suppliers
  - Impinj (Monza family)
  - NXP (UCODE family; UCODE DNA → secure UHF!)
  - Alien (Higgs family)

- challenges in the card manufacturing process
  - Adhesion issues with “full face” PET-inlays
  - Testing! (challenging in sheet format – cross reads)
Migration of legacy access control systems from LF to HF

Common inlay technologies:
- HF wire embedding / LF coil-winding
- HF coil winding / LF coil winding
Future market for hotel, leisure & entertainment
(i.e. tracking & payment; tracking & access; gated-access & building access)

Common inlay technologies:
- HF wire embedding / UHF printed or etched
- HF “air-coil” / UHF printed or etched

HF / UHF “combo-card” (today)

HF / UHF dual-frequency IC (tomorrow)
Thank you very much

For Questions:

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