# RFID

## Contents and form

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# RFID considerations

Critical performance variables in an RFID system are the following:

- Communication range.
- Size of the information space reserved on the tag.
- Communication rate between tag and reader.
- Anti-collision and the ability of the system to communicate simultaneously with multiple tags.
- Robustness of the communication with respect to interference due to material in the path between the reader and the tag.

# RFID considerations

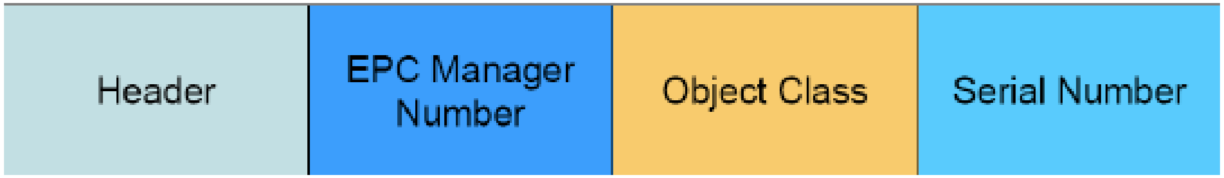
The level of performance that can be achieved in these variables is determined by several factors:

- Legal/regulatory emission levels allowed in the country of use
- Type of tag (with or without a battery included in the tag to assist its communication back to the reader)
- Air interface
  - Frequency of the RF carrier used to carry the information between the tag and the reader.
  - Modulation,
  - Bit encoding
- Commands and responses that address memory in terms of blocks (or words, or pages)

# Contents of RFID

- **Identification of RFID chips (**EPCglobal Tag Data Standard Version 1.6)
- RFID chips contains 96 or 64 bit unique number

  -> **EPC** = Electronic Product Code




| 01. | 0000A89. | 00016F. | 000247DC0 |
|---|---|---|---|
| Header | EPC Manager | Object Class | Serial Number |
| 8 bits | 28 bits | 24 bits | 36 bits |

# Form of RFID – a TAG

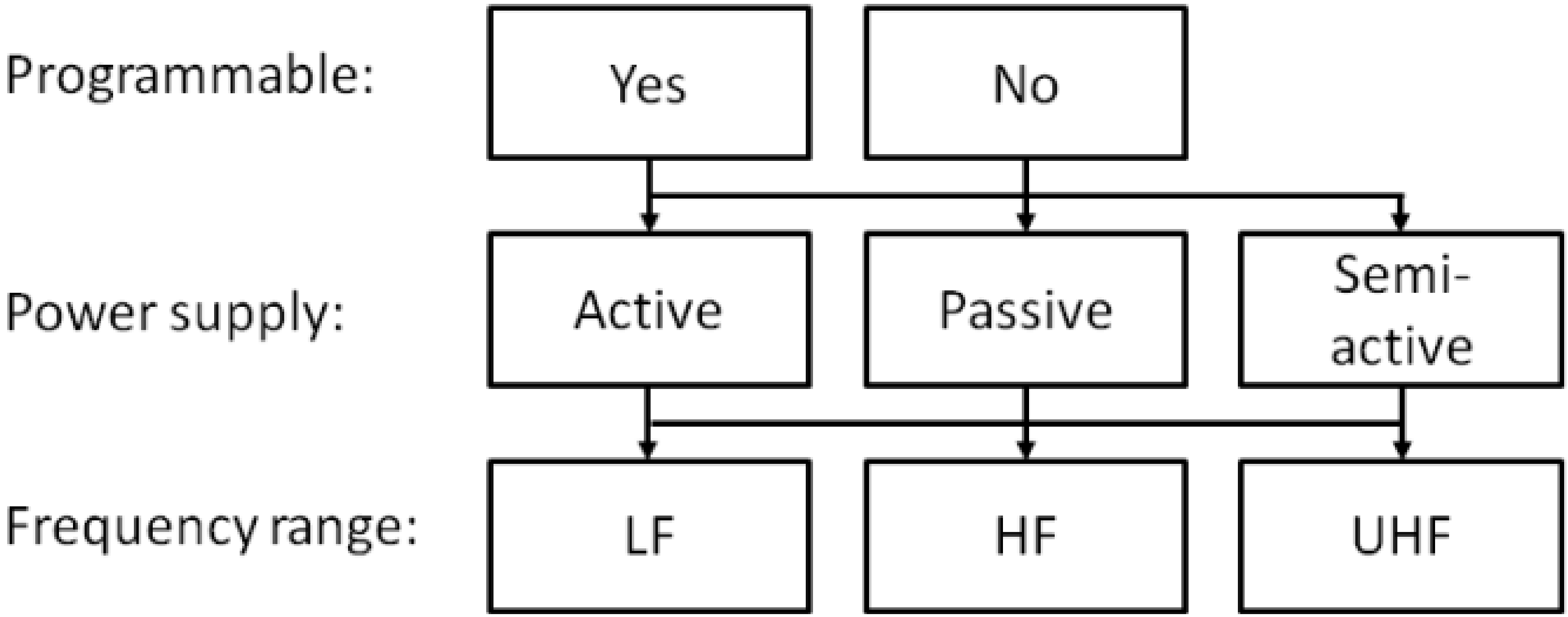



**Figure 5. The features of RFID systems**

# Discussion

- May I add other data to a TAG?
- How big it is?
- What frequencies shall I use?
- What read ranges do the RFID have?

# Communication over the air interface

**Frequency choice affects**

- Reading range and reading speed
- Tag size (lower frequency = bigger antenna)
- Antenna type, solenoid vs. dipole
- Environmental ruggedness (lower frequency = better)
- Price (higher frequency = higher price)

**Table 2.3** Band Frequency, Wavelength, and Classical Usage

| Band | Unlicensed Frequency | Wavelength | Classical Use |
|---|---|---|---|
| LF | 125–134.2KHz | 2,400 meters | Animal tagging and keyless entry |
| HF | 13.56MHz | 22 meters | |
| UHF | 865.5–867.6MHz (Europe)<br>915MHz (U.S.)<br>950–956MHz (Japan) | 32.8 centimeters | Smart cards, logistics, and item management |
| ISM | 2.4GHz | 12.5 centimeters | Item management |

# Communication over the air interface

**Low-and middle frequency ("LF, MF") tags**,

- operate in range 30 kHz to 3 MHz. Typically **125 kHz or 134,2 kHz.**
- Wide spread, can be used in bad environmental conditions.
- for short-range uses, like animal identification and anti-theft systems, such as RFID-embedded automobile keys.
- large antenna (solenoid) = cost and size problem

**High frequency ("HF") tags.**

- operate in range 3 MHz to 30 MHz. Typically at **13.56 MHz.**
- Have higher communication speed (data rate).
- Can be used in bad environmental conditions, but water affects reading range. Read range to 1m
- Used in smart cards in libraries (books), luggage tagging,

# Communication over the air interface

## Ultra-High Frequency ("UHF") tags

- operate in range 300 MHz to 3 GHz. Typically at **915 MHz (USA) / 868 MHz (Europe) for passive tags. For active also 2,4 GHz**
- Have higher communication speed (data rate)
- High reading range of 3m / 10m (in case of 2.4 GHz)
- Susceptible for metal presence, can not be used in humid / water environments.

## Microwave Frequency ("SHF, EHF") tags

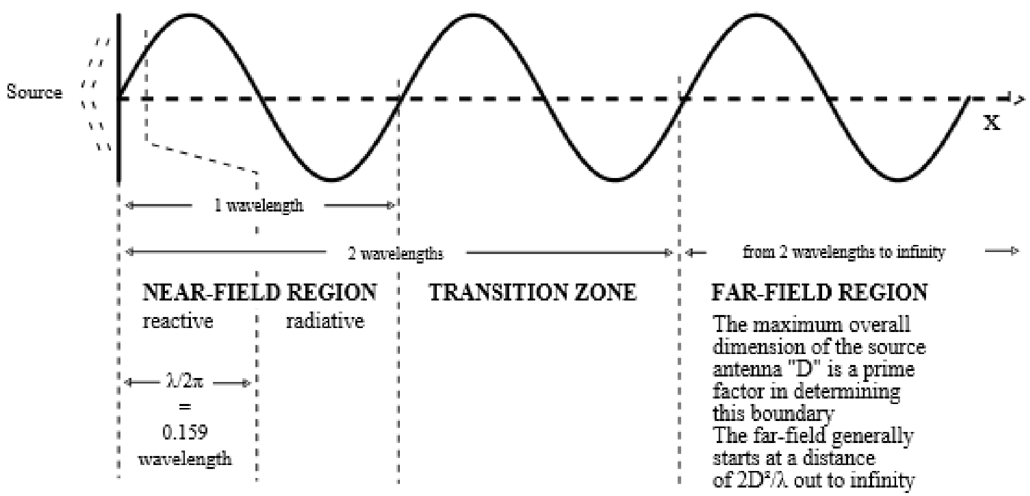
- operate in range 3 GHz to 300 GHz. Typically at **5,9 GHz (USA) / 5,8 GHz (Europe)**
- Have advantages and disadvantages of the above but with greater effect

# Read range

- Frequency vs. power vs. antenna (principle)
- **Example 1 (900 MHz)**
  - At 900 MHz, the wavelength is: $\lambda = 300/f_{MHz} = 0.333$ m
- **Example 2 (13.56 MHz)**
  - At 13.56 MHz, wavelength of $\lambda = 300/f_{MHz} = 22.1$ m,
- Media used
  - Magnetic field (up to $\lambda/2\pi$, near field) - inductive coupling
  - Electric field (from 2 $\lambda$, far field) – back scatter

# Far versus near field

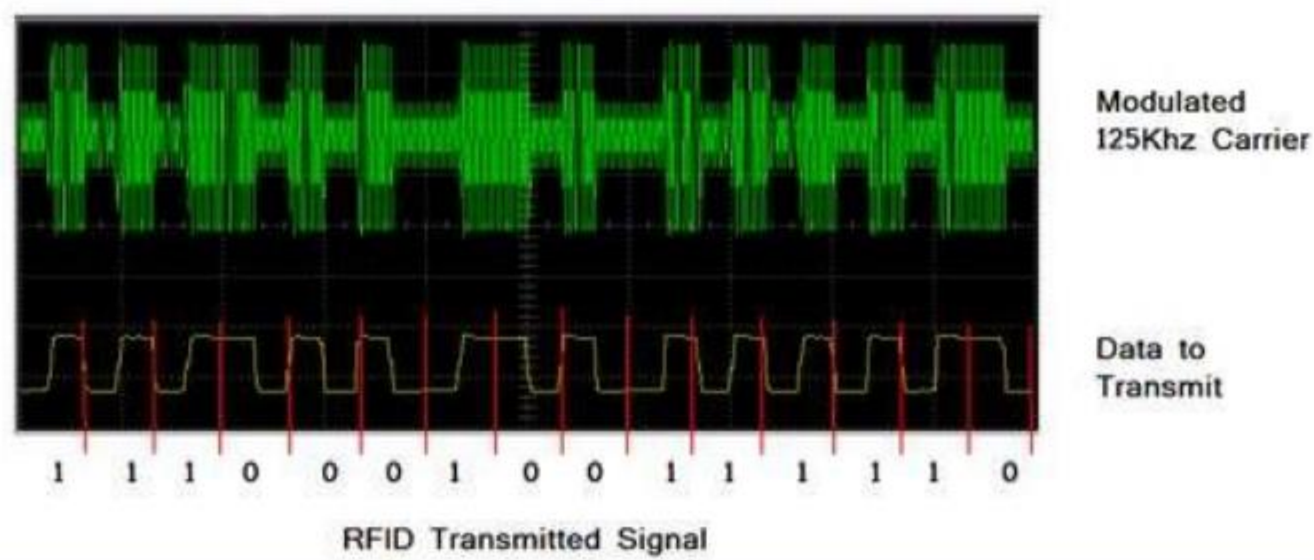
- **far-field** = "normal" electromagnetic radiation. The power of this radiation decreases as the square of distance from the antenna.
- **near-field**, Absorption of radiation in the reactive part affect the load on the transmitter. Magnetic induction can be seen as a very simple model of this type of near-field electromagnetic interaction.




Wiki, and: http://www.drillingcontractor.org/the-abcs-of-rfid-physics-oilfield-usage-14030

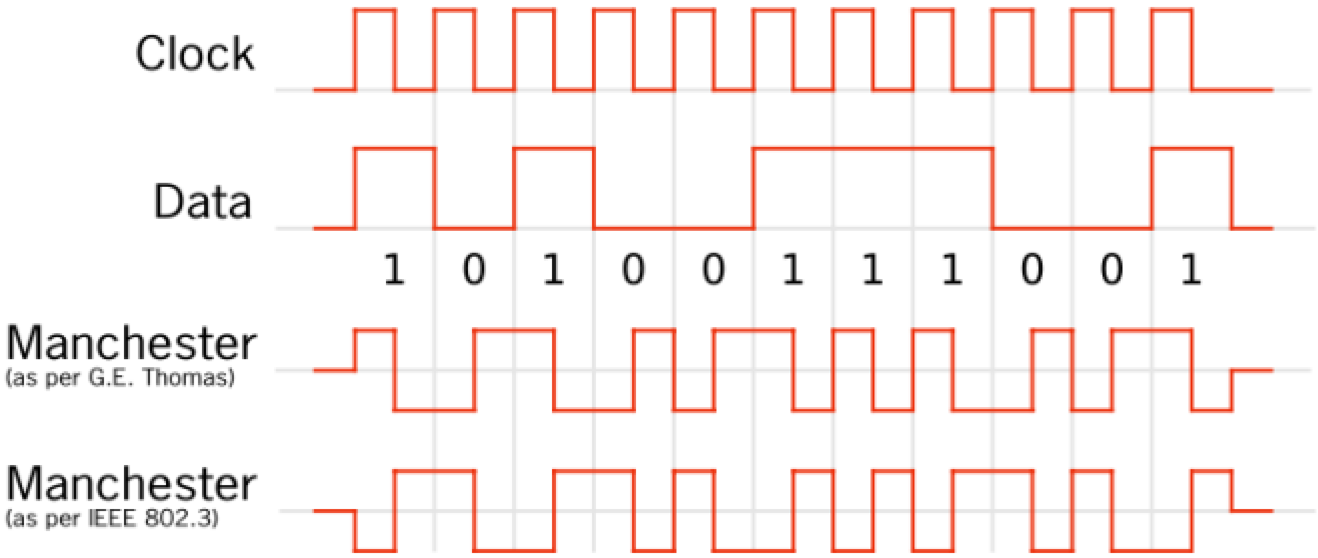
# Modulation and coding

- Uses binary modulation techniques: ASK, PSK and FSK



# Modulation and coding

- Uses different line coding schemes: NRZ, RZ, Manchaster



# Data encoding

- ID: 0007820706 119,21922 to binary 111111111 0010**1** 1100**0** 0000**0** 0000**0** 0111**1** 0111**1** 0101**0** 0101**0** 1010**0** 0010**1** 0110 0
- START + 10 x (5 bits) + CHCK+ STOP
- 3 groups, we have 2c, followed by 0077(HEX = 119 in decimal), 55A2 (HEX = 21922 in decimal) this corresponds to the 119,21922.


0010 **1** = 2

1100 **0** = C

0000 **0** = 0

0000 **0** = 0

0111 **1** = 7

0111 **1** = 7

0101 **0** = 5

0101 **0** = 5

1010 **0** = A

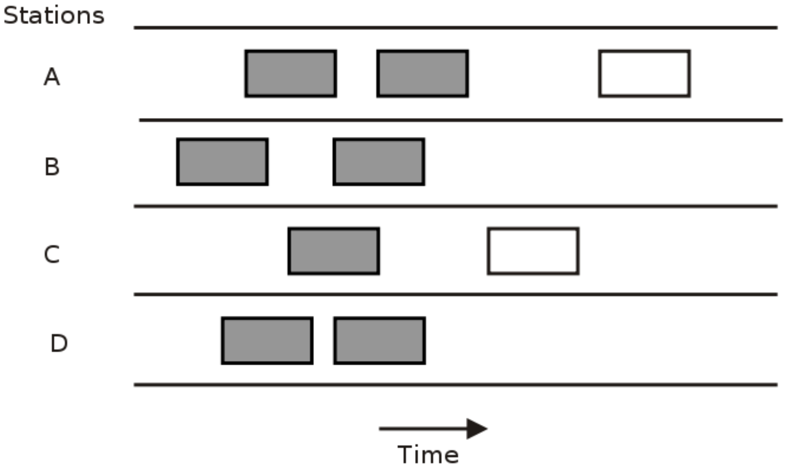
0010 **1** = 2

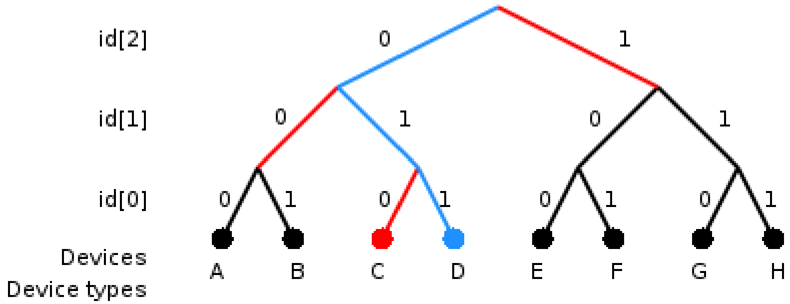
0110 checksum

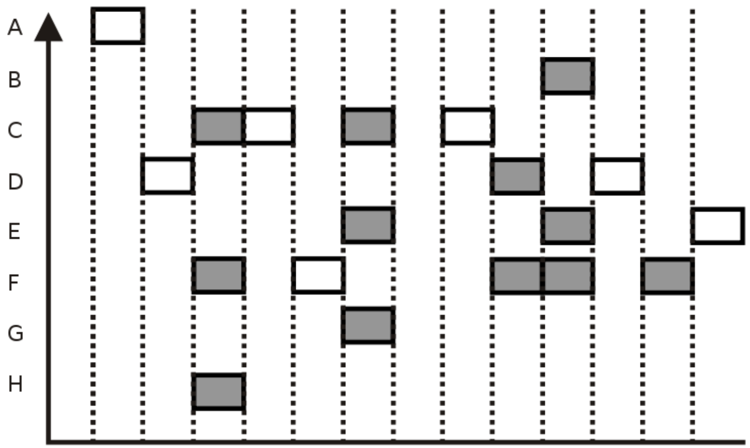
+ 0 stop bit

# Collision mechanisms

- Detection
- Resolve:
  - ALOHA (200 tags/s)
  - TREE WALKING (1000 tags/s)




Slotted ALOHA protocol (shaded slots indicate collision)

# Discussion?

- http://www.simonsothcott.com/2011/11/what-is-rfid-10-examples-of-rfid.html