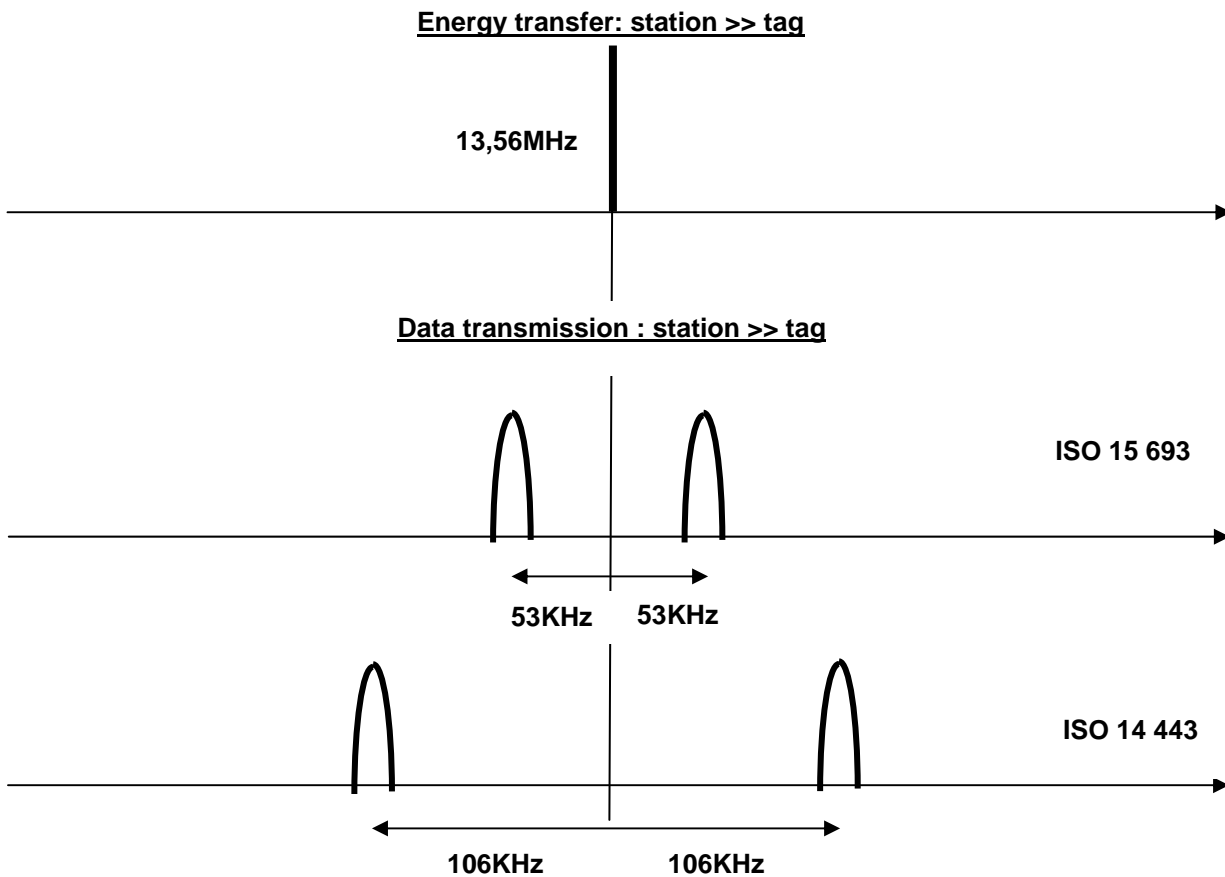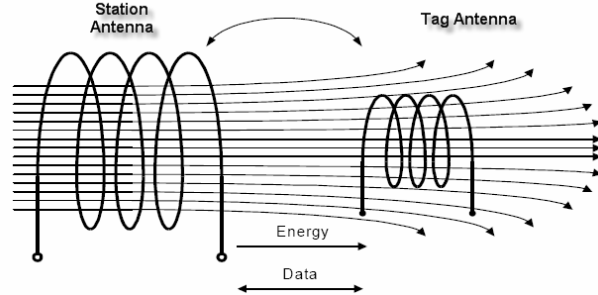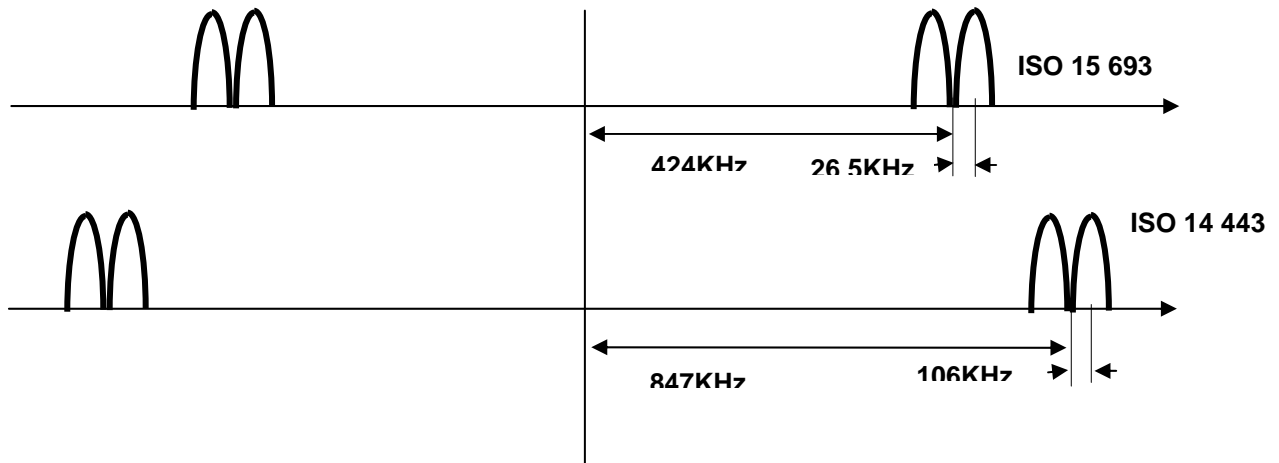# 5- Theory of operations

## 5.1  RFID Controller and antenna :

The three main functions on the RFID side are supported by the RFID IC controller associated to the antenna :

- To generate an electromagnetic field  in a coil antenna in order to provide wireless power supply to the RFID tag in front of the station.
  The frequency of this electromagnetic field is 13.56 MHz.



- To modulate the electromagnetic field in order to send data to the RFID tag in front of the station.
  The shape of this modulation is adapted to RFID standards : ISO 15693 and ISO 14443. Each of these standards is working with different speed and modulation ratios.

- To receive data from the tag in front of the station. This is done by a detection of the power load seen from the reader (the tag is modulating its own power consumption to transmit data)
-

- Spectrum frequency analysis on the antenna :

**Energy transfer: station >> tag**

**13,56MHz**

**Data transmission : station >> tag**

**ISO 15 693**

**53KHz**   **53KHz**

**ISO 14 443**

**106KHz**      **106KHz**

**<u>Data transmission : tag >> station</u>**

**ISO 15 693**

424KHz     26.5KHz

**ISO 14 443**

847KHz     106KHz

Example of modulation generated by the Ositrack stations with ISO 14443A protocol :
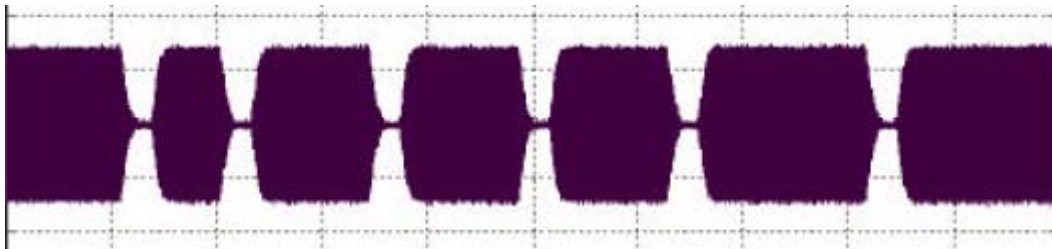
Power limits:
According to ETS 300 330, the maximum value for the radiated electromagnetic field of a RFID 13.56 MHz device is 42 dbµA/m (measuring distance = 10 m).
When it is converted in current in the antenna of a Ositrack station, this limit is giving a maximum current of 58 Aeff for XGCS49xxxxx and 12.9 Aeff for XGCS89xxxxx (Two different size of antennas).
The measured value on a Ositrack stations are :
XGCS49xxxxx : 0.23 Aeff
XGCS89xxxxx : 0.14 Aeff.

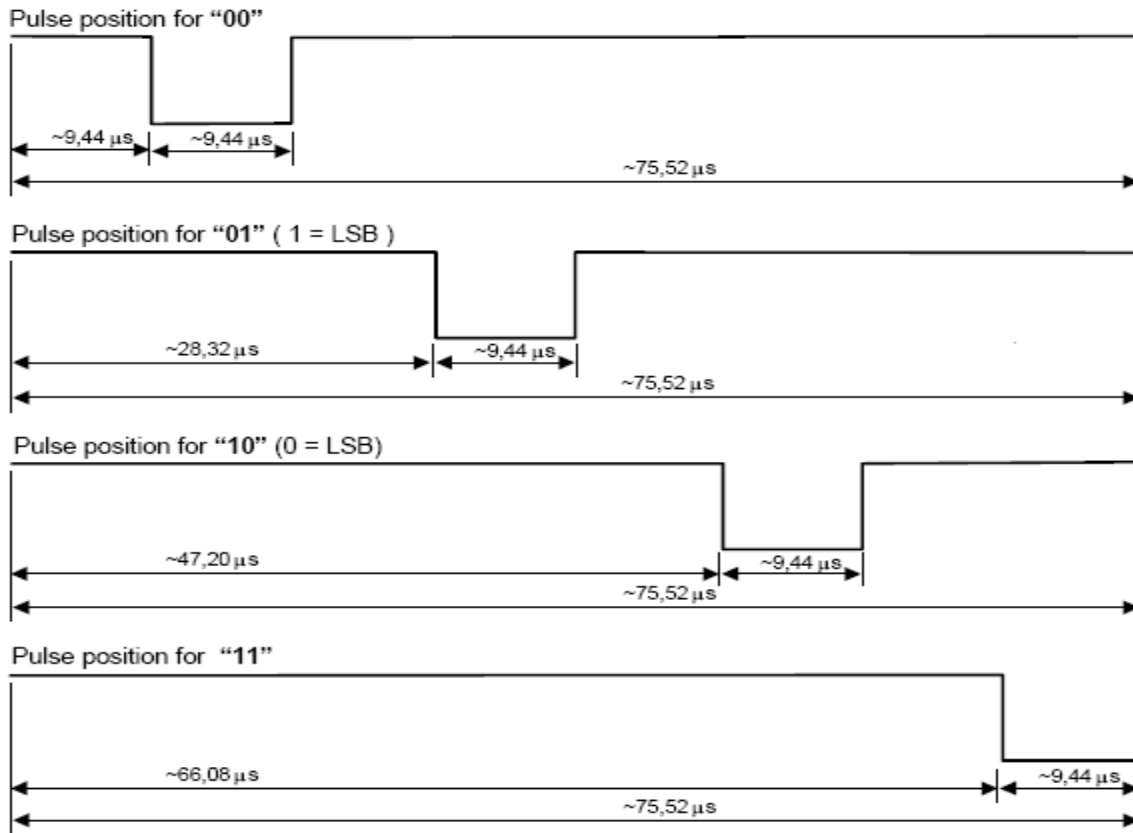Transmission of data from the reader :

Data coding in ISO 15693 mode :
**Data coding mode: 1 out of 4**
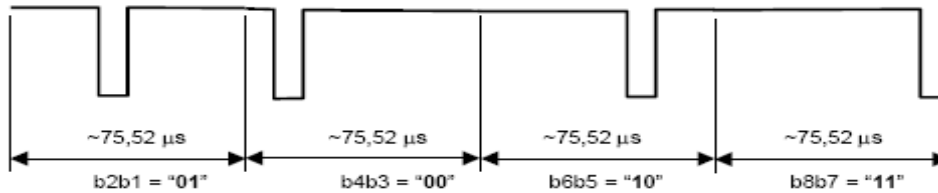The position of a pulse determines two bits at a time.
Four successive pairs of bits form a byte, where the least significant pair of bits is transmitted first.
The resulting data rate is 26,48 kbits/s ($f_c/512$).
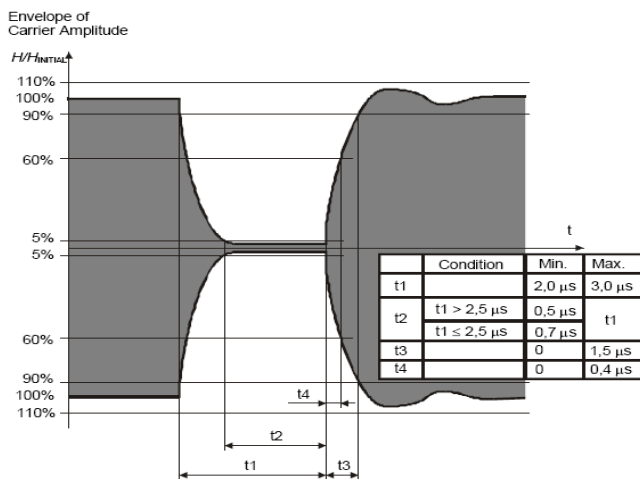Figure 5 illustrates the 1 out of 4 pulse position technique and coding.

Pulse position for **"00"**

~9,44 µs | ~9,44 µs

~75,52 µs

Pulse position for **"01"** ( 1 = LSB )

~28,32 µs | ~9,44 µs

~75,52 µs

Pulse position for **"10"** (0 = LSB)

~47,20 µs | ~9,44 µs

~75,52 µs

Pulse position for **"11"**

~66,08 µs | ~9,44 µs

~75,52 µs

Example : transmission of 'E1' = (11100001)b = 225

| ~75,52 µs | ~75,52 µs | ~75,52 µs | ~75,52 µs |
|---|---|---|---|
| b2b1 = **"01"** | b4b3 = **"00"** | b6b5 = **"10"** | b8b7 = **"11"** |

**data coding in ISO 14443 A mode :**
Communication from PCD to PICC for a bit rate of *fc*/128 shall use the modulation principle of ASK 100% of the RF operating field to create a "Pause" :

Envelope of
Carrier Amplitude

$H/H_{INITIAL}$

| | Condition | Min. | Max. |
|---|---|---|---|
| t1 | | 2,0 µs | 3,0 µs |
| t2 | t1 > 2,5 µs | 0,5 µs | t1 |
| | t1 ≤ 2,5 µs | 0,7 µs | |
| t3 | | 0 | 1,5 µs |
| t4 | | 0 | 0,4 µs |

The following sequences are defined:
_ sequence X: after a time of half the bit duration a "Pause" shall occur.
_ sequence Y: for the full bit duration no modulation shall occur.
_ sequence Z: at the beginning of the bit duration a "Pause" shall occur.
The above sequences shall be used to code the following information:
_ logic "1": sequence X.
_ logic "0": sequence Y with the following two exceptions:
i) If there are two or more contiguous "0"s, sequence Z shall be used from the
second "0" on.
ii) If the first bit after a "start of frame" is "0", sequence Z shall be used to represent
this and any "0"s which follow directly thereafter.
_ start of communication: sequence Z.
_ end of communication: logic "0" followed by sequence Y.
_ no information: at least two sequences Y.


### 5.2 <u>Micro controller</u>
The main functions of this device are :
- To manage the RFID controller :
  - o Configuration of the internal registers for adaptation to different protocols (ISO 15693, ISO 14443) and tags.
  - o Transmission and reception of data
  - o Scanning for tag identification
  - o Power monitoring of the antenna
- To provide an interface between the frames received on the serial RS485 communication port (9600 to 115200 bauds) and the RFID part of the reader :
  - o Frame analysis to identify the protocol and the format (speed, parity,..)
  - o Requests treatment to select the action to do (read data in a tag, write data in a tag, errors,..)
- To give visual informations to the user (LEDs management)
- To memorize  the device configuration ( internal eeprom memory)
-