

09 Low Frequency Protocols

9th unit in course 451.417, RFID Systems, TU Graz

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Content

- Applications
- FDX (Full Duplex) – HDX (Half Duplex)
- ISO/IEC 11784/85
- ISO 14223
- Read Only Device

Applications

Animal tagging

- Injectable
- Ear tags
- Bolus



Reusable asset tagging

- gas cylinders
- beer kegs

Industrial automation

- automotive parts
- electrical motors

Plastic cards

- club membership
- visitor services
- employee tracking

Casino services

- gaming chips

Waste management

- container tagging

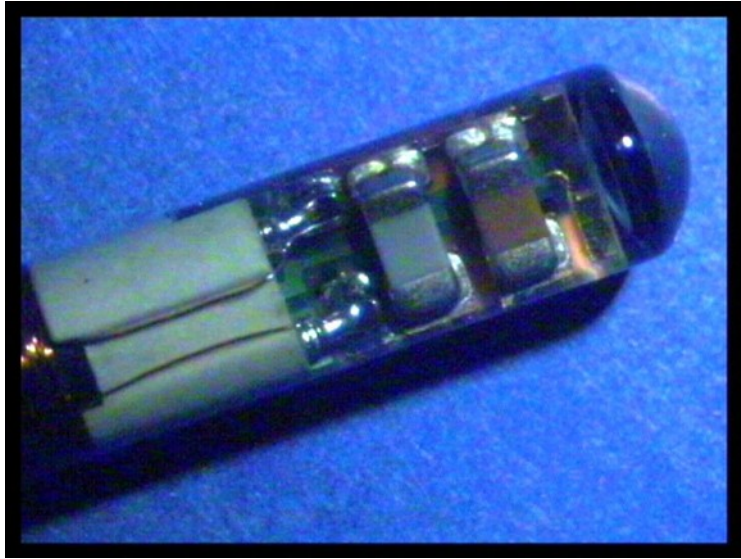
Sports

- marathon timing
- pigeon racing



FDX (Full Duplex) – HDX (Half Duplex)

FDX – HDX Difference



HDX

External capacitor necessary



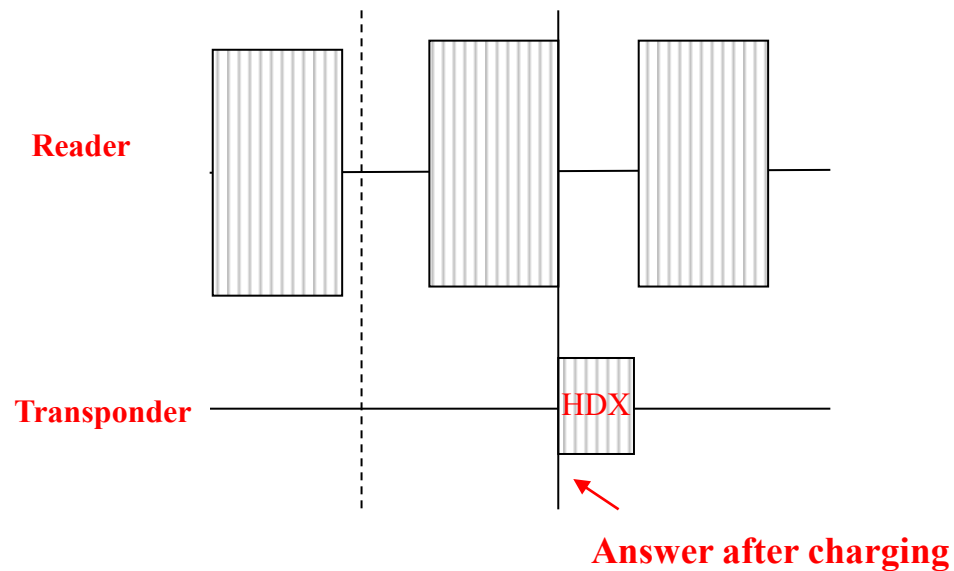
FDX

Only IC and coil

FDX – HDX Difference

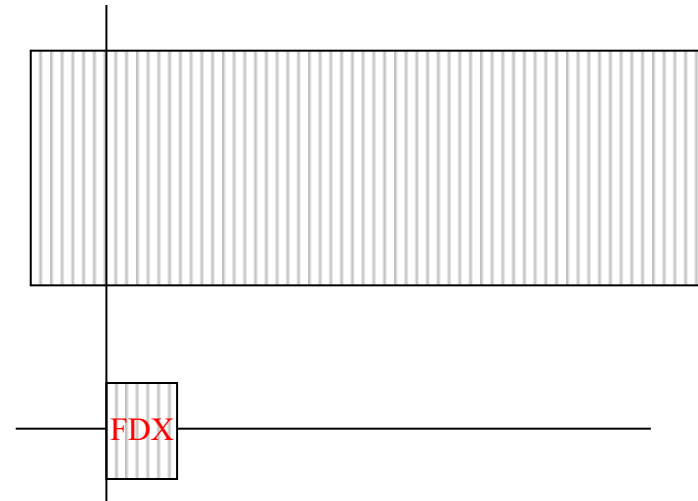
HDX

HDX communication requires that all readers in the surrounding are switched off at the same time.



FDX

FDX modulates the carrier of the reader. The reader field is switched on all the time



ISO/IEC 11784/85

ISO 11784 and ISO 11785 are international standards that regulate the radio-frequency identification (RFID) of animals, which is usually accomplished by implanting, introducing or attaching a transponder containing a microchip to an animal.

ISO 11784/85

- ▶ ISO 11784 specifies the structure of the radio-frequency identification code for animals.
- ▶ ISO 11785 specifies how a transponder is activated and how the stored information is transferred to a transceiver.

- Tag Talks First
- Standard for HDX and FDX transponder
- Frequency 134.2 kHz

Structure of the FDX diagram

The 128bit TTF data consist of the elements as listed below:

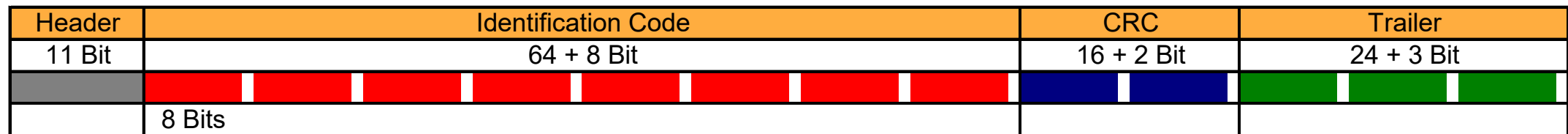
11bit Header ('00000000001')

Part1 → 64bit identification code according to ISO-11784

Part2 → 16bit CRC

Part3 → 24bit trailer

Bit stuffing → every ninth bit beginning with Part1 must be set to '1'



64 bit identification code

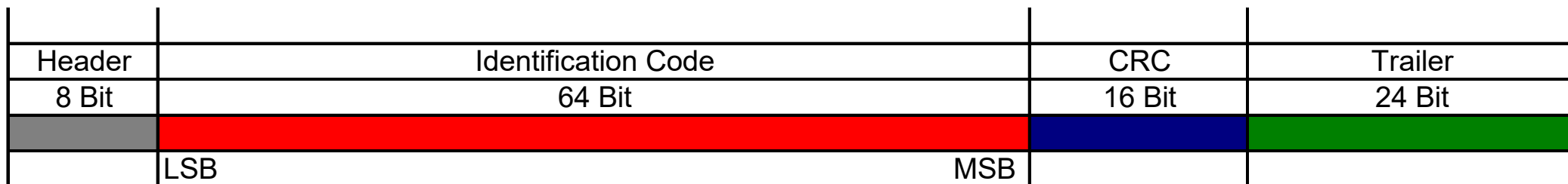
Bit Number	Number of digits	Information	Description
1	1	Flag animal non animal application	set to 1 indicating that it is animal application
2 - 4	1	Retagging Counter , for lost eartags	This counter shall be used only, if a retagging with the same identification number is decided by the specific country (bits 17-26)
5 - 9	2	User Information Field	Information structure decided by the specific country (bits 17-26)
10 - 14	3	Reserved	The meaning of these bits remains unchanged. The value of these bits shall be set to "0"
15	1	Flag indicating advanced transponder	set to 1 indicating that it is an advanced transponder
16	1	Flag indicating data block	set to 1 indicating that the transponder contains additional data
17 - 26	4	ISO 3166 numeric 3 country code	Country codes from 900 to 998 manufacturers Country code 999 test transponder.
27 - 64	12	National identification code	Unique number within a country (274 877 906 944 Combinations)

FDX and HDX Systems

Parameter	FDX system	HDX system
Activation frequency	134.2 kHz	134.2 kHz
Modulation	AM-PSK	FSK
Return frequencies	129.0 kHz to 133.2 kHz	124.2 kHz (1)
	135.2 kHz to 139.4 kHz	134.2 kHz (0)
Encoding	modified DBP	NRZ
Bit rate	4 194 bit/ s	7 762.5 bit/ s (1)
		8 387,5 bit/ s (0)
Telegram structure:		
– Header	11	8
– Identification code	64	64
– Error detection code	16	16
– Trailer	24	24
– Control bits	13	—

Structure of the HDX diagram

- ▶ 4 Parts:
- Part 1: 8 bit Header ('01111110')
- Part 2: 64 bit Identifications code according ISO/IEC11784
- Part 3: 16 bit Cyclic Redundancy Check (CRC),
- Part 4: 24 bit Trailer



ISO 14223

ISO 14223-1 specifies the air interface between the transceiver and the advanced transponder used in the radiofrequency identification of animals under the condition of full upward compatibility according to ISO 11784 and ISO 11785.

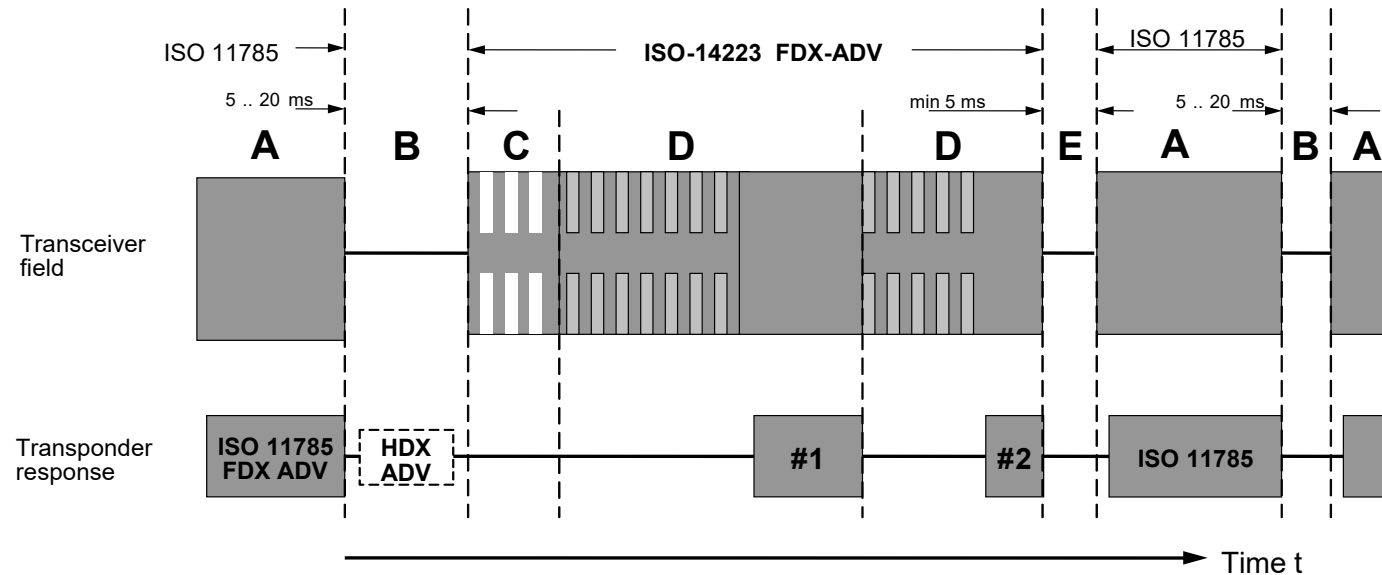
ISO 14223-2 specifies the code and command structure of the radio frequency (RF) system for advanced transponders for animals.

ISO 14223-3 specifies the applications of the radio frequency (RF) system for advanced transponders for animals.

ISO 14223 - Requirements

- Advanced transponders in the interrogation field perform like transponders according to ISO 11785.
- To bring the advanced transponder into the advanced mode, the transceiver shall send a valid request or a SOF.
- Bit 15 of the ISO 11784 frame shall be set to “1” indicating that this is an advanced transponder.
- Bit 16 of the ISO 11784 frame (additional data flag) shall be set to “1”, indicating that the transponder contains additional data.
- To bring the advanced transponder back to the ISO 11785 mode:
 - is no longer in the interrogation field
 - has terminated the advanced operations and the interrogation field was switched off for at least 5ms afterwards
- All communication from transceiver to transponder and vice versa shall be transmitted starting with LSB first.
- In the case that multiple, advanced transponders are in the interrogation field which cause collisions the transceiver has to start the anti-collision procedure.

ISO 14223 - Communication Transponder => Reader



Cycle A: The transceiver reads the ISO 11785 frame. With the bits defined in the reserved field the transceiver detects, that an advanced FDX-ADV transponder is in the interrogation field.

Cycle B: The transceiver switches off the interrogation field for at least 5 ms in order to reset the transponder.

Cycle C: The transceiver sends either the SOF at the start of a valid request or the switch command to the transponder in order to put it into the advanced mode. Any of these has to be issued within the switch window after reset.

Cycle D: Read/Write or Inventory operation in the advanced mode.

Cycle E: After all operations are finished or the transponder left the antenna field, the transceiver switches off the field for at least 5 ms in order to poll for new incoming transponders (compatible with ISO 11785).

Reader to Tag

Data rate and Data Coding(PIE)

Meaning	Symbol	min	max
Carrier off time	T_{F1}	$4 * T_C$	$10 * T_C$
Data "0" time	T_{Fd0}	$18 * T_C$	$22 * T_C$
Data "1" time	T_{Fd1}	$26 * T_C$	$30 * T_C$
Code violation time	T_{Fcv}	$34 * T_C$	$38 * T_C$
Stop condition time	T_{Fsc}	$\geq 42 * T_C$	n/a

Summary of the FDX and HDX systems

Parameter	FDX-ADV	HDX-ADV
Down-link frequency	134.2 kHz	
Modulation (depth)	ASK (90 - 100%)	
Encoding	Pulse Interval Encoding	
Bit rate	Typically 5.5 kbps	2.8 kbps
Switch command or SOF encoding	Binary Pulse Length	

Description of States

RF-Off state

The transponder is in the RF-Off state when it is not activated by the transceiver.

ISO 11785 state

The state where the ISO 11785 protocol is executed.

Wait state

The wait represents a transition phase where the transponder can be switched to the advanced mode.

Ready state

The transponder moves to the ready state after receiving a valid request.

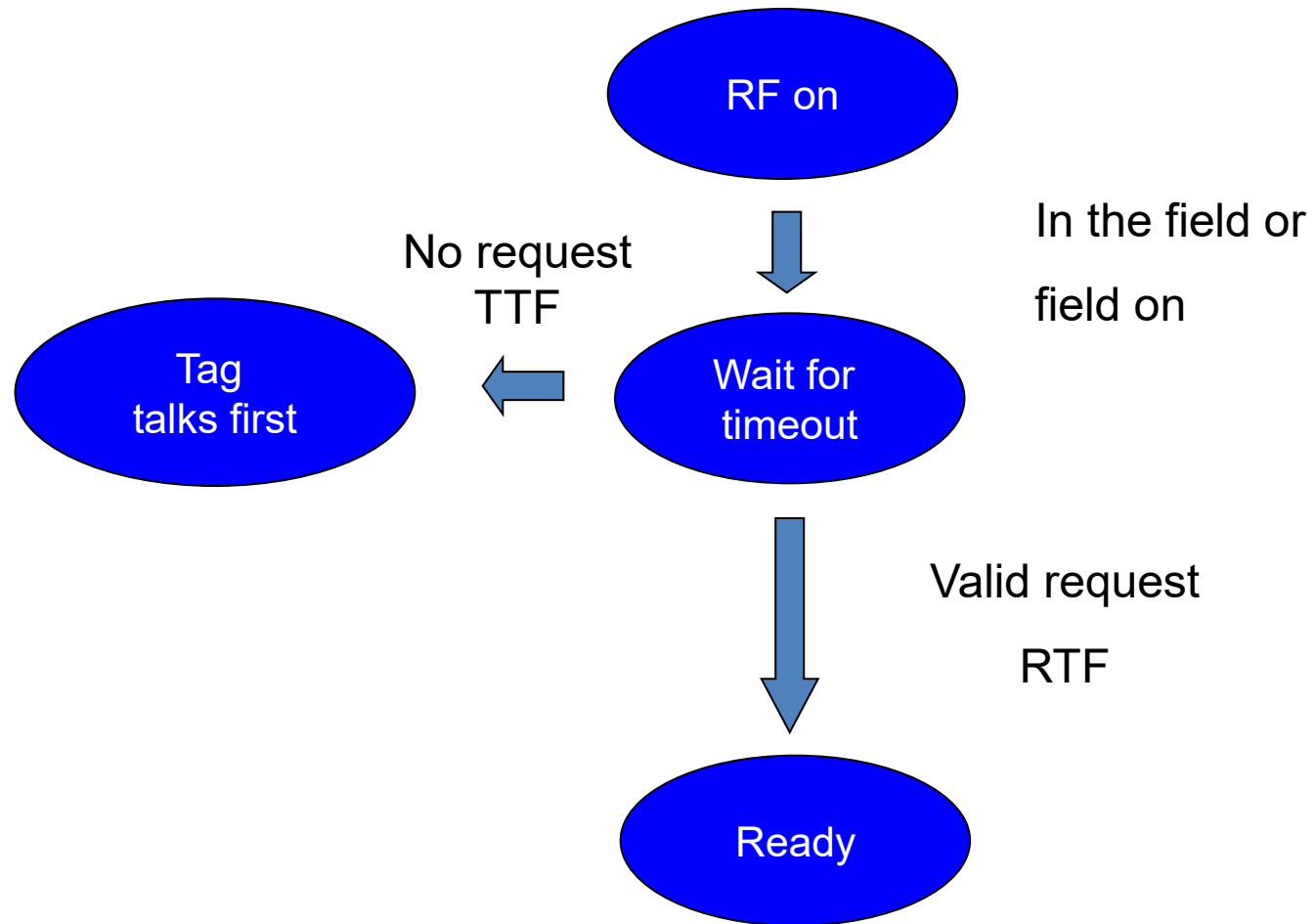
Quiet state

A transponder enters the Quiet state after receiving the STAY QUIET command issued to the transponder. In the Quiet state, the transponder shall process any Request where the ADR flag is set.

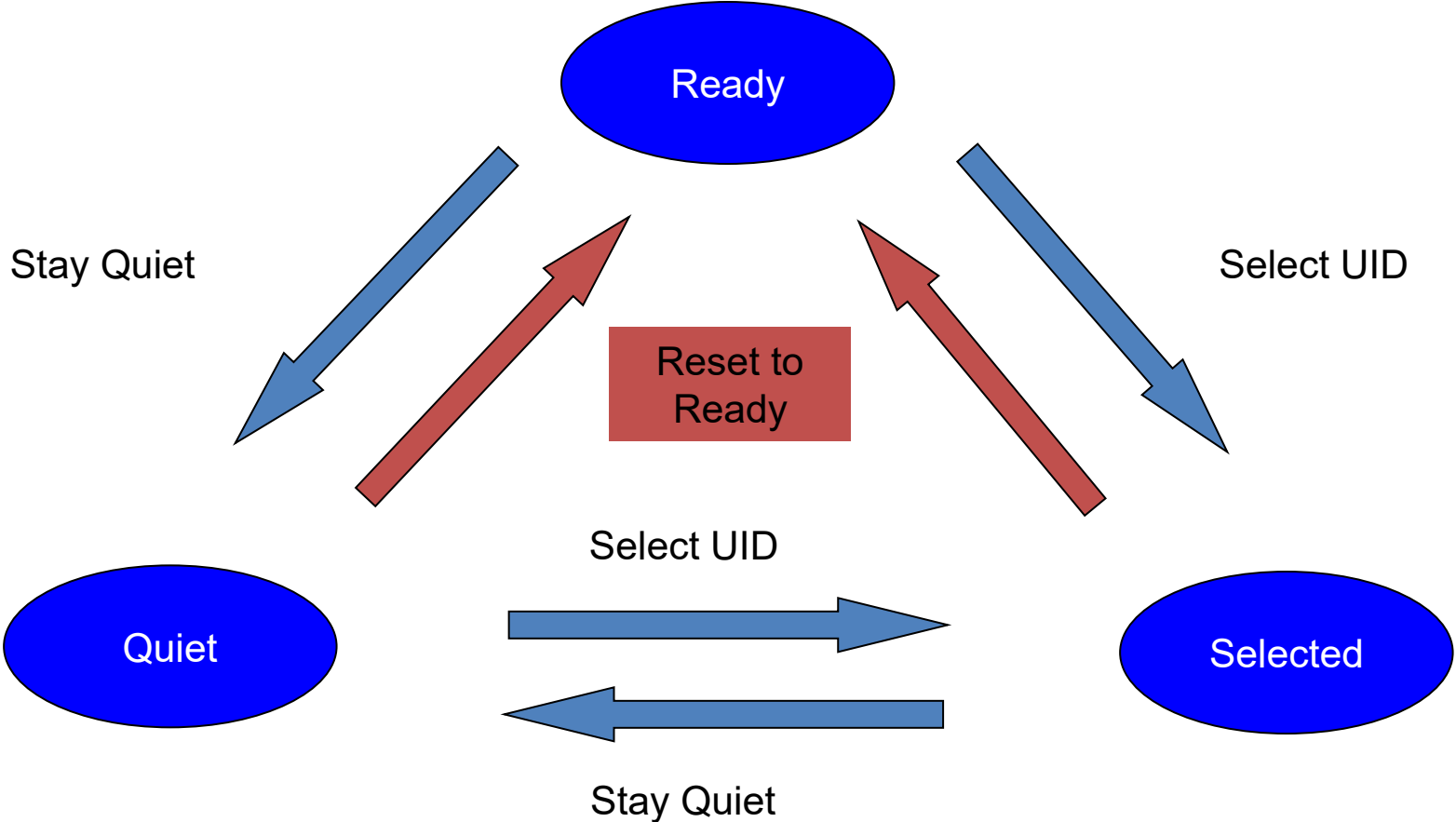
Selected state

A transponder enters the Selected state after receiving the SELECT command with a matching UID.(SEL flag = 1). Only one transponder shall be in the Selected state at any time.

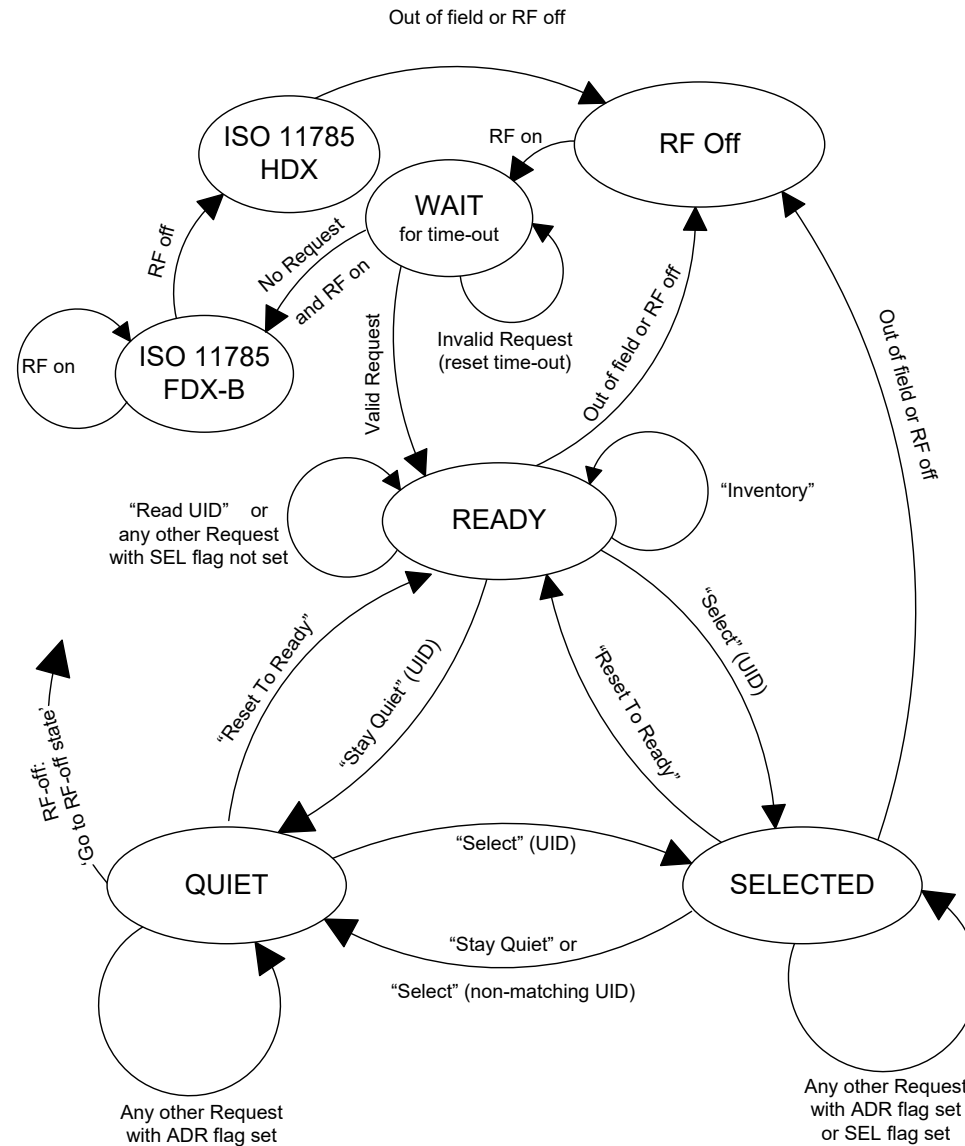
State diagram switch window



Reader talks first



State Diagram

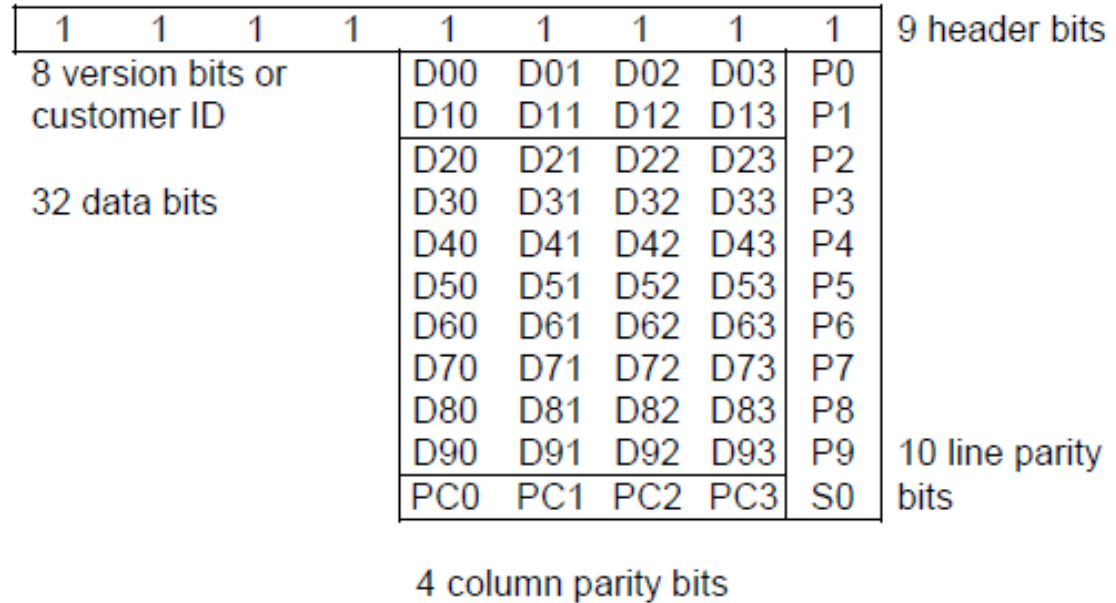


Command List (Mandatory)

Command	Code	Type	Function	Valid in state
Inventory	'00'	<i>Mandatory</i>	Anticollision loop	Ready
Stay quiet	'01'	<i>Mandatory</i>	Forces a transponder into the Quiet state	Ready, Selected
Read UID	'02'	<i>Mandatory</i>	Fast reading of the transponders UID without collision protection	Ready
RFU	'03-0F'			
Read multiple blocks	'12'	<i>Mandatory</i>	Reads multiple user memory blocks	Ready, Quiet, Selected
Write single block	'14'	<i>Mandatory</i>	Writes a single user memory block	Ready, Quiet, Selected
Lock block	'16'	<i>Mandatory</i>	Locks a single user memory block	Ready, Quiet, Selected
Inventory ISO 11785 code	'23'	<i>Mandatory</i>	Inventory command including ISO 11785 code	Ready

Read Only Device Sample

Memory structure Read only



Manchester Code
64 bit Memory
2 kbit Datarate



**Thank you for your
Audience!**

Please feel free to ask questions...

Questions for self-evaluation

- Give an overview of main standards for Low frequency.
- Explain the difference between HDX and FDX.

Additional standards for animal ID

ISO 3166 is an ISO standard published by the International Organization for Standardization (ISO) that defines codes for the names of countries, dependent territories, special areas of geographical interest, and their principal subdivisions (e.g., provinces or states).

ISO 24631 provides the means of evaluating the conformance and performance with ISO 11784 and ISO 11785 of RFID (radiofrequency identification) transponders used in the individual identification of animals.

References (1/2)

- ISO 11784:1996 Radio frequency identification of animals — Code structure
(Published Stage: 90.92 (Confirmed 2021))
Corrigenda / Amendments ISO 11784:1996/Amd 1:2004; ISO 11784:1996/Amd 2:2010
- ISO 11785:1996 Radio frequency identification of animals — Technical concept
(Published Stage: 90.93 (Confirmed 2022))
Corrigenda / Amendments ISO 11785:1996/Cor 1:2008
- ISO 14223-1:2011 Radiofrequency identification of animals — Advanced transponders — Part 1: Air interface
(Published Stage: 90.93 (Confirmed 2022))
- ISO 14223-2:2010 Radiofrequency identification of animals — Advanced transponders — Part 2: Code and command structure
(Published Stage: 90.93 (Confirmed 2021))
- ISO 14223-3:2018 Radiofrequency identification of animals — Advanced transponders — Part 3: Applications
(Published Stage: 90.93 (Confirmed 2023))
- ISO 3166-1:2020 Codes for the representation of names of countries and their subdivisions — Part 1: Country code
(Published Stage: 60.60)
- ISO 3166-2:2020 Codes for the representation of names of countries and their subdivisions — Part 2: Country subdivision code
(Published Stage: 60.60)
- ISO 3166-3:2020 Codes for the representation of names of countries and their subdivisions — Part 3: Code for formerly used names of countries
(Published Stage: 60.60)

References (2/2)

- ISO 24631-1:2017 Radiofrequency identification of animals — Part 1: Evaluation of conformance of RFID transponders with ISO 11784 and ISO 11785 (including granting and use of a manufacturer code)
(Published Stage: 90.93 (Confirmed 2022))
- ISO 24631-2:2017 Radiofrequency identification of animals — Part 2: Evaluation of conformance of RFID transceivers with ISO 11784 and ISO 11785
(Published Stage: 90.93 (Confirmed 2022))
- ISO 24631-3:2017 Radiofrequency identification of animals — Part 3: Evaluation of performance of RFID transponders conforming with ISO 11784 and ISO 11785
(Published Stage: 90.93 (Confirmed 2022))
- ISO 24631-4:2017 Radiofrequency identification of animals — Part 4: Evaluation of performance of RFID transceivers conforming with ISO 11784 and ISO 11785
(Published Stage: 90.93 (Confirmed 2022))
- ISO 24631-5:2014 Radio frequency identification of animals — Part 5: Procedure for testing the capability of RFID transceivers of reading ISO 11784 and ISO 11785 transponders
(Published Stage: 90.93 (Confirmed 2020))
- ISO 24631-6:2011 Radiofrequency identification of animals — Part 6: Representation of animal identification information (visual display/data transfer)
(Published Stage: 90.93 (Confirmed 2022))
- ISO 24631-7:2012 Radiofrequency identification of animals — Part 7: Synchronization of ISO 11785 identification systems
(Published Stage: 90.93 (Confirmed 2022))