RFID Technology

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Introduction to RFID

- RFiD (Radio Frequency iDentification) is the most promising technology for automatic identification.
- RFiD is based on Radio Frequency communications to exchange data between a remote memory device (tag) and a PLC or a computer.



Auto-ID Technologies

Barcode















Bubble codes

Vision



Magnet Strip

Zigbee

Biometric

Comparison of Bar Codes and RFID

Bar codes are predominately used today for identifying and tracking products throughout the supply chain. Even though they can achieve efficiencies in the order of 90%, there are still a number of deficiencies in the technology, for which RFID, is able to provide a better solution and further optimization.

Bar code deficiency	RFID improved solution
Line of Sight Technology	Able to Scan and read from different angles and through certain materials
Unable to withstand harsh conditions (dust, corrosive), must be clean and not deformed	able to function in much harsher environments
No potential for further Technology advancement	Technology advancement possible due to new chip and packaging techniques
Can only identify items generically and not as unique objects	EPC code will be able to identify uniquely typically up-to 2 ⁹⁶ items
Poor tracking technology, labor intensive and slow	Potential to track items in real time a they move through the supply chain

RFiD: reliability and robustness

- RFiD provides a high level of reliability and robustness of data, compared to optical (bar code) magnetic (badges) or contact (credit cards) auto ID technologies :
 - Non-metal materials such as paper, wood, plastic, etc. do not obstruct communications between antenna and tags, even though these materials are not transparent
 - The tag and the reader are environment resistants, including water, oils, chemicals and reflected lights
 - The tag has an extremely long span of life. It can be read and written at any time and re used many times.

The origin of RFID Technology

 RFiD is a 40 years old technology



One of the first uses was automatic feeding by reading an RFID tag attached to cows. Because of harsh environment, optical bar code is badly adapted to such applications.

RFID = Evolutive Technology











- Today, RFiD has gone out of exclusive industrial applications with a very large range of tags adapted to each need :
 - Access control badges for skiing, subway,..
 - Paper tags for tracking of books, luggages,...
 - Active tags for cars identification (car parks).
 - Glass tags for pets identification (injected under the skin)

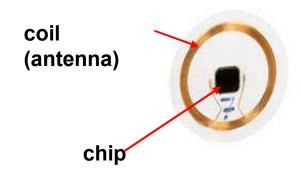
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How RFID works



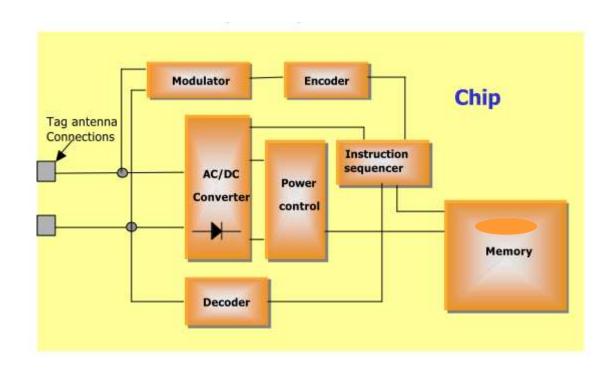
RFID Technology: basics





- An RFID system consists of an electronic tag containing data and a reader to communicate with the tag.
- The tag provides a remote database, that travels with the product itself. It contains an antenna and a silicon chip including a memory. The tag can be powered by the electromagnetic or electrical field generated by the reader (passive tag) or by an internal battery (active tag)
- The reader (or station) consists of an antenna and a controller for communication on serial link or network.

RFiD building blocks: Tags



Active and Passive Tags

	Advantages	Disadvantages	Remarks
Passive	 Longer life time Wider range of form factors Tags are more mechanically flexible Lowest cost 	 Distance limited to 4 - 5m (UHF) Strictly controlled by local regulations 	Most widely used in RFID applications. Tags are LF, HF or UHF
Semi- Passive	 Greater communication distance Can be used to manage other devices like sensors (Temp°, pressure etc) 	 Expensive - due to battery, and tag packaging Reliability - impossible to determine whether a battery is good or bad, particularly in multiple transponder 	Used mainly in real time systems to track high value materials or equipment throughout a factory.
Active	Do not fall under the same strict power regulations imposed on passive devices	environments. Widespread proliferation of active transponders presents an environmental hazard from potentially toxic chemicals in batteries.	

Tag Classes

- One of the main ways of categorizing RFID tags is by their capability to read and write
 - CLASS 0 READ ONLY. Factory programmed

These are the simplest type of tags, where the data, which is usually a simple ID number (EPC) is written only once into the tag during manufacture. The memory is then disabled from any further updates. Class 0 is also used to define a category of tags called EAS (electronic article surveillance) or anti-theft devices, which have no ID, and only announce their presence when passing through an antenna field.

 CLASS 1 – WRITE ONCE READ ONLY (WORM) – Factory or User programmed

In this case the tag is manufactured with no data written into the memory . Data can then either be written by the tag manufacturer or by the user – one time. Following this no further writes are allowed and the tag can only be read. Tags of this type usually act as simple Identifiers

CLASS 2 - READ WRITE

This is the most flexible type of tag, where users have access to read and write data into the tags memory. They are typically used as data loggers, and therefore contain more memory space than what is needed for just a simple ID number.

CLASS 3 – READ WRITE – with on board sensors

These tags contain on-board sensors for recording parameters like temperature, pressure, and motion, which can be recorded by writing into the tags memory. As sensor readings must be taken in the absence of a reader, the tags are either semi-passive or active.

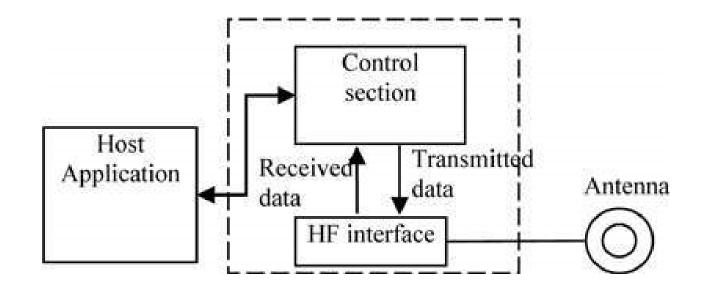
Memory of the RFID tags

Туре	Advantages	Disadvantages
ROM	Good resistance to high temperaturesLow cost	- Read only
EEPROM	- No battery or backup battery	Relatively long read/write access timeNumber of write operations limited to 100000 cycles per byte
RAM	Rapid access to dataHigh capacityUnlimited number of read/write operations	- Back up battery needed in tag
FeRAM (ferroelectric)	Rapid access to dataNo battery or backup batteryHigh capacity	- Number of read/write operations limited to 10 ¹² cycles per byte

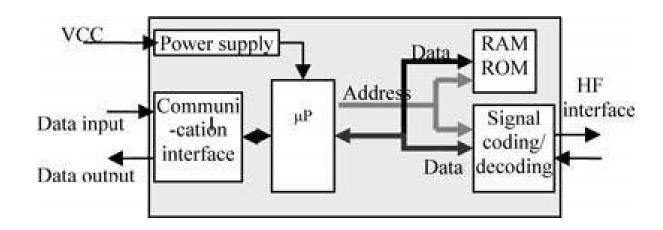
Tags adapted to each application



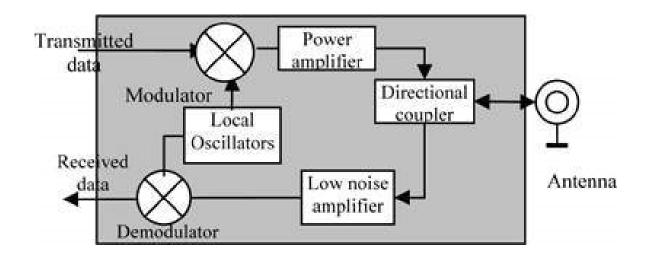
 The main role of a RFiD reader is to transmit and to encode a radio signal to interrogate a tag



- The control section of the RFID reader performs digital signal processing and procedures over the received data from the RFID transponder.
- Also, the control section enables the reader to communicate with the transponders wirelessly by performing modulation, anti-collision procedures and decoding the received data from the transponders.
- This section usually consists of a microprocessor, a memory block, a few analog-to digital converters and a communication block for the software application.



- The high frequency interface of the reader is used for RF signal transmission and reception.
- HF interfaces are consisted of two separate signal paths to correspond with the two directional data flows from and to the tag.



Industrial readers
 OEM readers





Portable readers



Office readers







RFID building blocks : antennas

Access control (gate)









Oem antenna

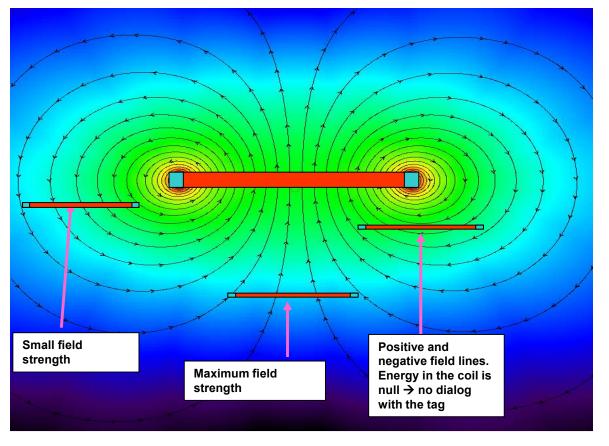


LF and HF antennas : coupling conditions

The dialog area is defined from several parameters:

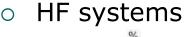
- ☐ Shape of each antennas
- □ Sensitivity of the reader
- ☐ Sensitivity of the tag (power consumption)
- ☐ Influence of metal presence in the RF field (metal is considered as a short circuit)
- Additional ferrite pieces in the RF field

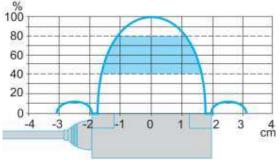
Air solenoid configuration of LF and HF antennas

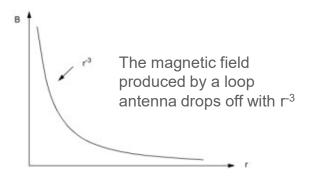


Communication fields

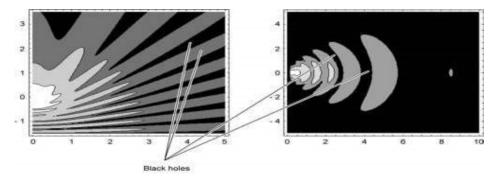
 Environment around RFID systems creates multiple effects which disturb the electrical behaviors of devices. The electromagnetic waves can be reflected, refracted, diffracted and absorbed by materials.







UHF systems



Communication protocols

Three main layers

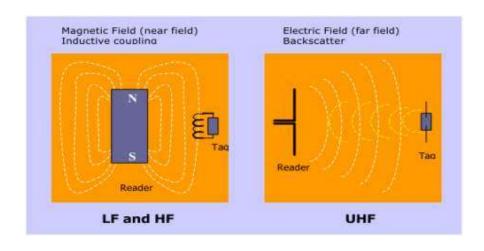
Application → user's data

Communication → 'Language' between tags and readers (read and write commands, Id of the tag, data integrity management,..)

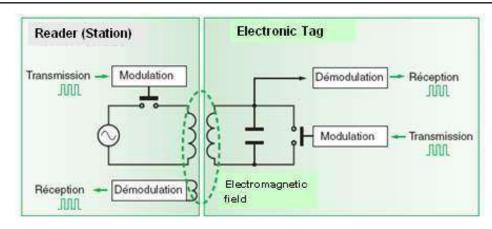
Transport → air interface between tag and reader (Frequency, Modulation, Waveform, Baudrate)

Wireless energization

- In order to receive energy and communicate with a reader, passive tags use one of the two following methods shown bellow.
- near field communication which employs inductive coupling of the tag to the magnetic field circulating around the reader antenna (like a transformer)
- Far field communication which uses similar techniques to radar (backscatter reflection) by coupling with the electric field.
- The near field is generally used by RFID systems operating in the LF and HF frequency bands, and the far field for longer read range UHF and microwave RFID systems.



Wireless communication



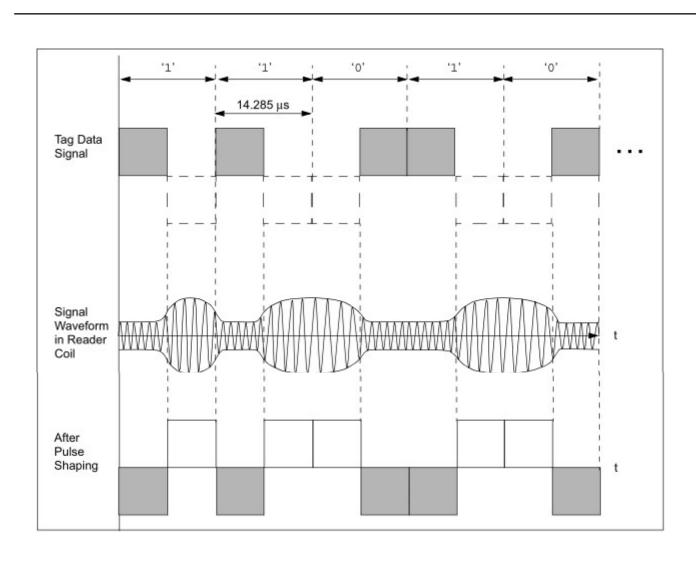
Reader to tag

 The RF signal amplitude is modulated by the reader. The tags receiver circuit is able to detect the modulated field, and decode the original information from it

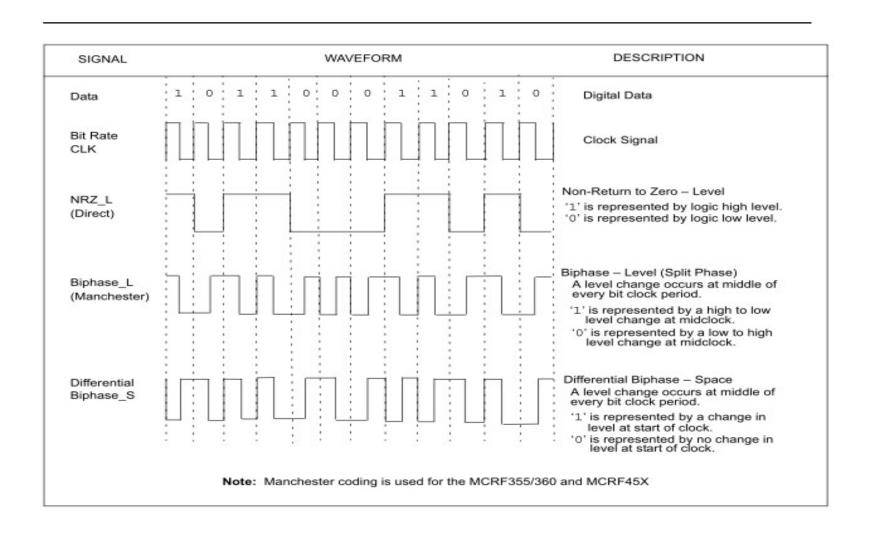
Tag to Reader

- The principle is similar to a transformer where the secondary coil (tag antenna) changes the load and the result is seen in the Primary (reader antenna).
- The tag chip accomplishes this same effect by modulating its antenna impedance via an internal circuit. The reader receiver is able to detect this modulation, and decode the orginal information from it

Data signal waveforms



Data coding waveforms



Standardization

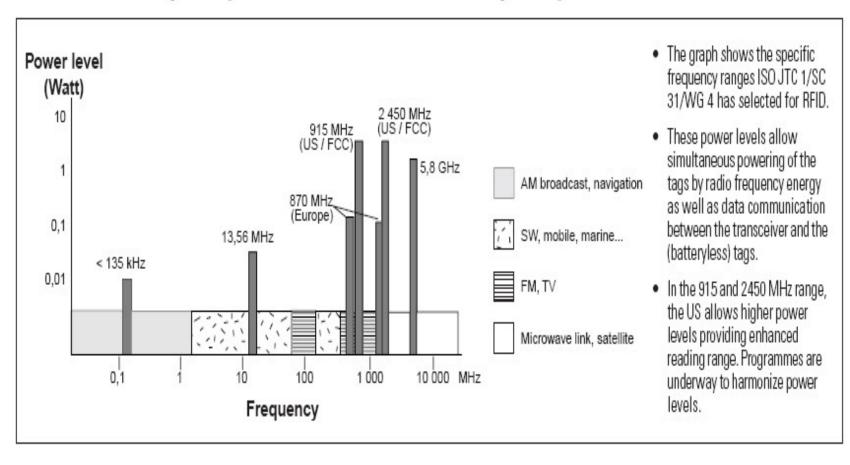


Standardization

- A very important aspect of RFID technology are the associated standards and regulations. They are designed to ensure safe operation with respect to other electrical and radio equipment, and guarantee interoperability between different manufacturers readers and tags.
- Regulations are mainly concerned with reader power emissions and allocation of frequency bands, whilst standards like the ISO (International Standards Organization) define the Air interface communication between Reader->Tag and Tag->Reader, and include parameters such as;
 - Communication protocol
 - Signal Modulation types
 - Data coding and frames
 - Data Transmission rates
 - Anti-collision (detection and sorting of many tags in the Reader field at the same time)

RFiD Frequencies

Worldwide frequency allocations for radio frequency identification



RFiD Frequencies

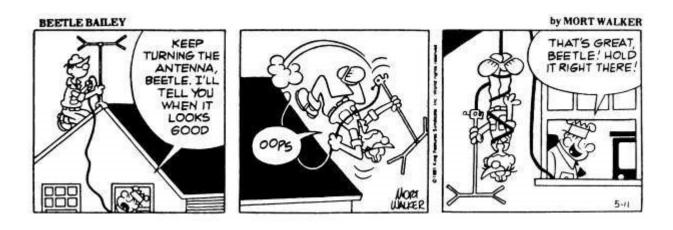
Operating frequency	Most common applications	Advantages	Disadvantages
100 KHz – 2MHz (low frequency)	Animal identificationCar securityAutomotive industry	Low impact of water and metal on read/write distances	Low speed access to data. Short read/write range (< 500 mm) Closed systems (no standard)
13.56 MHz (high frequency)	-Access control -Payment (smart card)	Standardization of data transfer protocols (ISO 15693 – ISO 14443 A/B)	Short read/write range (<500 mm)
850 – 950 MHz (UHF)	- Warehousing -Supply Chain	Very low cost of tags Medium read/write range (< 5 m)	Highly sensitive to metal and liquids Frequency reserved for mobile phones (Europe and Asia) Low memory size
2.45 GHz (micro-wave)	- Car monitoring (toll motorway, car park)	High data transfer speed Long read/write range (<30 m)	Active tags (needs battery replacement)

RFID standards

Communication layer	Air interface layer	Applications	Frequency
ISO 11784/85	ISO 18000-2	Animals	LF
ISO 14443A/B	ISO 18000-3	Badges	HF
ISO 15693	ISO 18000-3	Items	HF
NFC	ISO 18000-3	Items	HF
EPC	ISO 18000-6	Retail / logistic	UHF / HF
ISO 18185	ISO 18000-4 ISO 18000-7	Freight Containers	UHF - Microwave

RFID in applications

 The choice of the RFID elements (tags, antennas, frequencies) is linked to the environment of each application



Applications: Industry

Chemical treatment process



Batch process



Assembly process



Tool identification



Positionning



Conveying / sorting



Applications : Security

- Electronic Passport
- Access control
- Container tracking
- Car immobilizer





Applications: Traceability

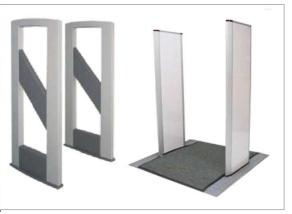
Animals



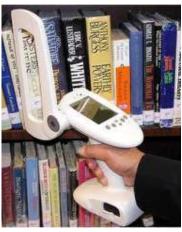
Patient tracking



Anti theft detection



Books in libraries



Cold Chain tracking



Equipments



Applications : Services

- Access control of vehicules in pedestrian streets / areas
- Rent of bicycles
- Access to public facilities /services
 - Battery charging spots for electric vehicules
 - Services (pre-payment) for trucks
 / camper-van on parks (electricity
 / water / network)



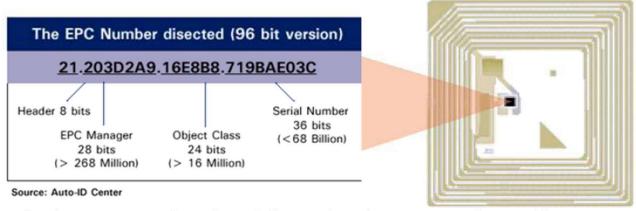
Applications : EPC

Electronic Product Code

Based on UHF frequencies (850-950 MHz) and passive tags

Low cost tags (<10 cents) – High-Tech readers (ERP interfaces,...)

Long range (up to 10 meters)



- Promoted by retail market (Walmart, Metro, Carrefour, Gillette,..) and majors in software (SAP, IBM, Microsoft, HP,...)
- Lack of harmonization in frequencies and radio power around the world
- Still some technical issues with sensitivity to water and metal environment
- o Today: used for packaging ID in logistic applications
- o Tomorrow: will replace barcodes in retail segment

Applications: NFC (Near Field Communication)









Card Emulation Mode Make contactless transactions:

Mobile payment, Ticketing, Access control, Transit with Mifare4 Mobile, Top-ups, Toll-Gate

Peer-to-Peer Communication Connectivity:

Data transfer: Fast, easy & convenient device association, setup & configuration

Reader Mode Access information on the move:

Content distribution, Information access, Smart advertising

Integration of RFID technology

RFID is based on communication.
 The readers are always connected to something...

Application

Position control of a mobile crane for coke loading :

-Identification of the position of the crane on the rail



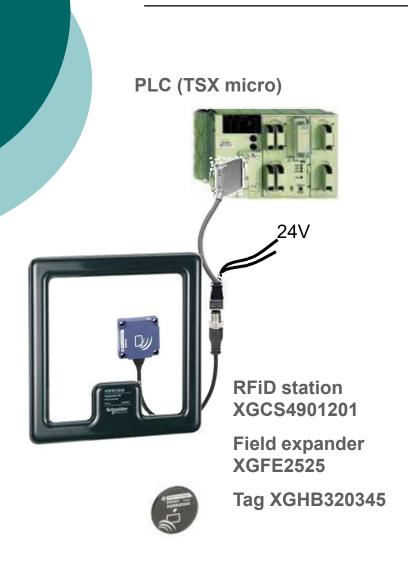
Functions

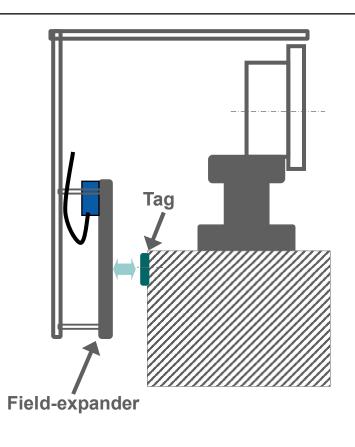
Position ID:

The positions of tags mounted on the rail are used as references for the position of the crane..

Benefits

- •Reliable position control whatever environment conditions
- •Unexpensive position control for long distances





Application

Access control to pump stations (water distribution):



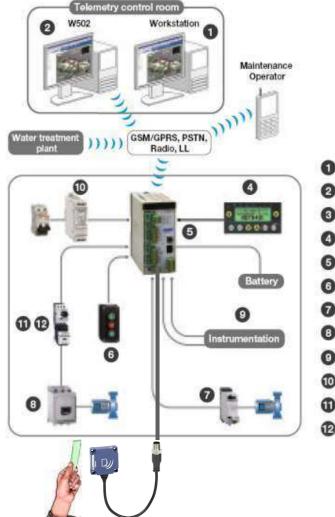
Functions

Management of maintenance operations:

- Each operator has a RFiD badge A RFiD reader is fixed near the door of the pump station
- -When a badge is passed in front of the reader, the UID is sended to a central system which remotely opened the door if the access to this pump station is scheduled.
- -The history is stored in a central database

Benefits

- •To reduce risks of terrorist action
- •Better management of the maintenance operations



- Vijeo Citect SCADA
- 2 W@de portal W502
- Operator SMS alarming
- Magelis XBT RT
- 6 W@de W320i
- 6 HMI push buttons: Harmony XALD
- Motor starter TeSys U
- Altistart 48
- Instrumentation 4-20 mA
- Power supply ABL7
- Circuit breaker
- (2) Contactor

- •The RFID station is connected on existing Modbus communication.
- •ID data are managed as automation data.
- •The reader is mounted in a hole in the wall near the door.
- •Read/write of the badges through the concrete (protection against external action)

Application

Traceability in a batch process (jammanufacturing) – Link between the loading and the cooking workshops.





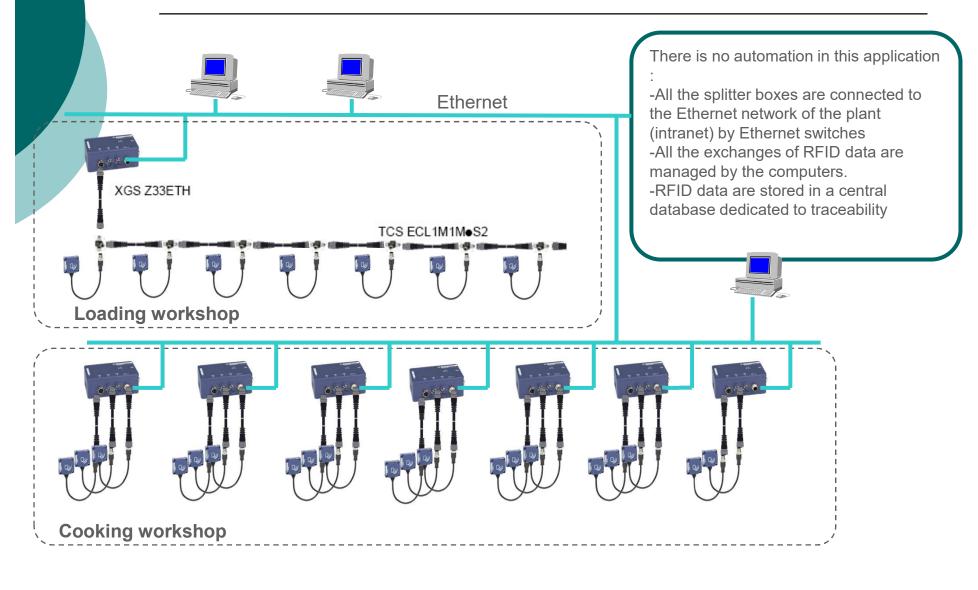
Functions

ID of the trolleys / containers:

- A RFiD badge is fixed on each trolley A code (ID of each trolley) is stored in each badge
- -RFiD readers are mounted on each loading and cooking points
- -Data transmission:
- -All RFID readers are connected to a centralized system and transmits the ID of each trolley

Benefits

- -Adapted to harsch environment (high pressure hot cleaning)
- -Easy integration



Conclusion

RFiD is promised to become a major technology, with a wide impact on our daily life, similar to mobile phoning.



A future 'totally tagged' world?

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- "RFiD Made easy" μEM AppNote 411