



RFID in Medical Applications

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Agenda

- **RFID Basics**
- **RFID Portfolio**
 - Readers, Tags, ICs
- **Typical Applications**
 - High frequency applications
 - Low frequency applications
- **RFID Low Power Solutions**
 - TRF7960 + MSP430
 - TMS37157 + MSP430
- **Conclusions**



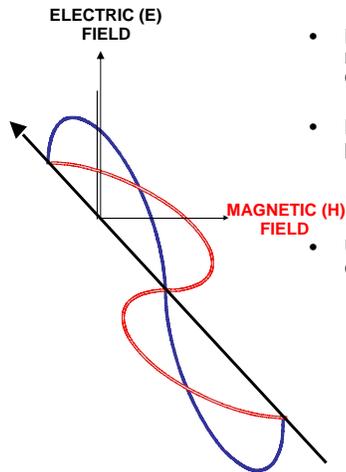
RFID Basics

- **RFID is an automatic way to collect information or data on:**
 - **People**
 - **Products**
 - **Places**
 - **Times**
 - **Transactions**
- **Identification is performed in milliseconds**
 - **No Line-of-sight is required**
 - **It is contact-less**
 - **It works in harsh environments**
 - **Multiple tags can be read simultaneously**

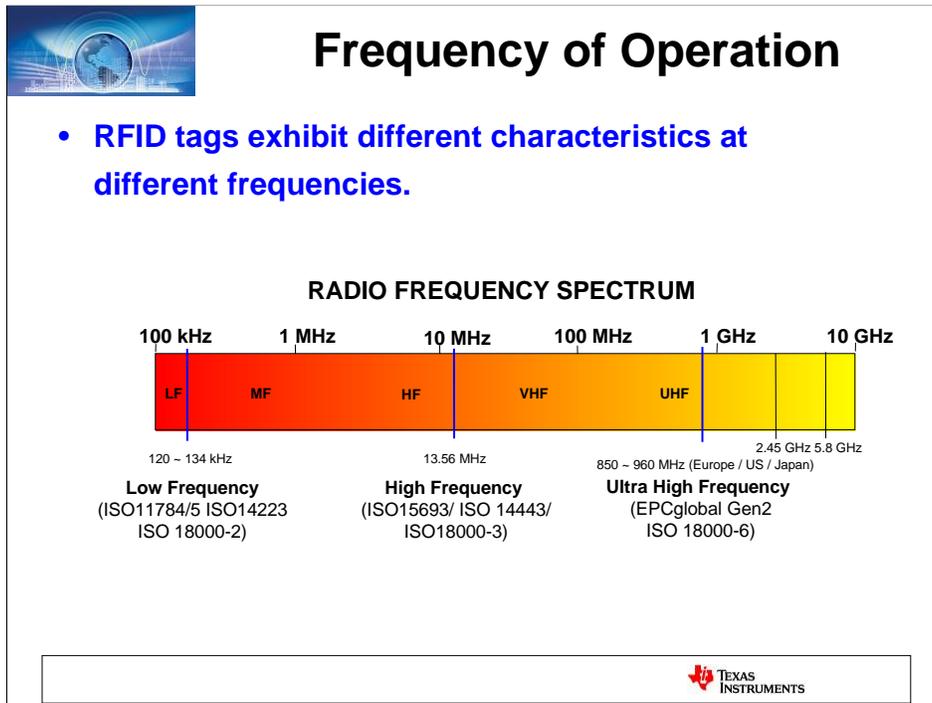




Quick Physics Lesson (Reminder)



- Radio signals are electromagnetic waves, having a magnetic component (H-Field) and an electric component (E-Field)
- LF & HF systems use the **Magnetic field** to transfer power by induction
 - Strength of this field falls off quickly
 - Liquids have less of an effect on H-Field
- UHF systems use the **Electric field** to transfer power by capacitive coupling
 - Strength of this field doesn't fall off as quickly which provides for a potentially longer read distances
 - Liquids absorb E-field and reduce performance
 - Metals either shield signals or detune the inlays
 - Special metal mount tags are typically required



Slide 8

There are only certain frequencies in the radio spectrum where tags are allowed to operate and, depending on the frequency chosen, tags can have quite different operating characteristics.



Here we see part of the radio frequency spectrum - unfortunately, most of this finite resource was allocated long before RFID came along so that RFID is limited to 3 main bands ...



... in the Low Frequency (or LF) band between 120 and 134 kHz



... in the High Frequency (or HF) band at 13.56 MHz



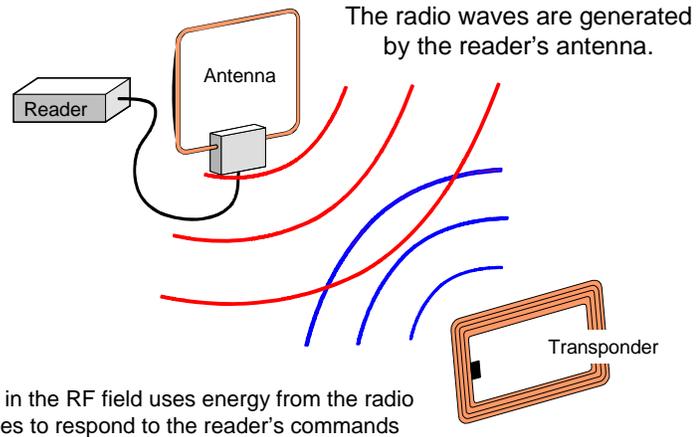
... and in the Ultra High Frequency (or UHF) band between 850 and 960 MHz

Associated with each band are International standards which we will be reviewing later.



Mode of operation

- A battery-less transponder gets its energy from the antenna's signal





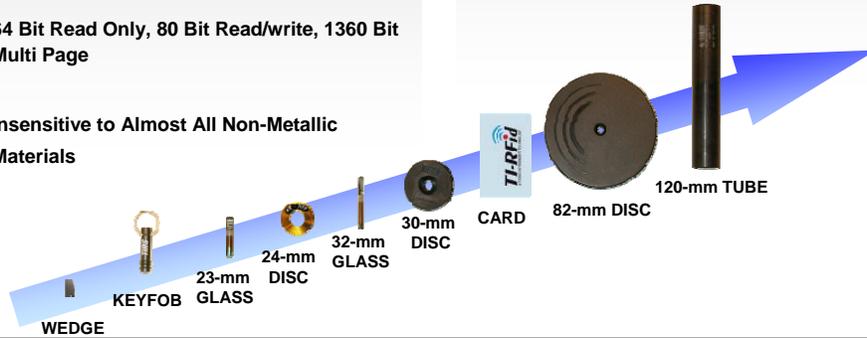
TI – RFID LF - Transponders

Features

- ISO 11784/11785 Compliant
- Best in Class Performance Through Patented HDX Technology
- Patented Transponder Tuning Provides Stable and High Read/Write Performance
- 64 Bit Read Only, 80 Bit Read/write, 1360 Bit Multi Page
- Insensitive to Almost All Non-Metallic Materials

Transponder Processing

- Packaged in Glass
- Plastic Compound
- Several protection classes available, IP 68; IP67; IP53





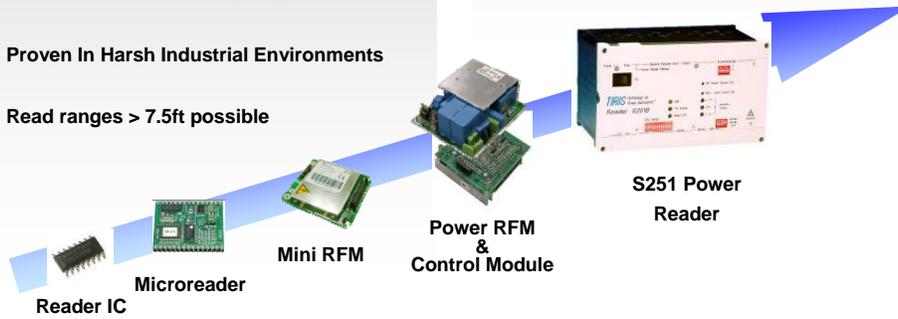
TI – RFID LF Readers

Features

- ❑ Best In Class Performance Through Patented HDX Technology
- ❑ Available as IC and reader modules
- ❑ Reduced Power Output For Handheld And Medium Read/Write Range Applications
- ❑ Proven In Harsh Industrial Environments
- ❑ Read ranges > 7.5ft possible

Easy to implement

- ❑ Full Portfolio of Readers & Antennas
- ❑ Autotuning
- ❑ RS232, RS422/485, and USB Interface
- ❑ Highly Integrated Transceiver IC's
- ❑ Compatible with all TI Transponders





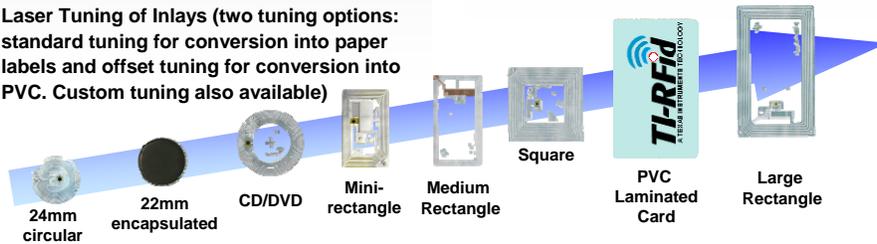
TI – RFID HF - Transponders

Features

- ❑ ISO 15693 / ISO18000-3 (Mode 1) Compliant
- ❑ Highest Quality Inlay Manufacturing Process yields consistent read/write performance
- ❑ 8 standard inlay/tag form factors
- ❑ 256 bit, 256 bit with Password Write Protect and Kill Feature, and 2k bit silicon parts
- ❑ Laser Tuning of Inlays (two tuning options: standard tuning for conversion into paper labels and offset tuning for conversion into PVC. Custom tuning also available)

Transponder Processing

- ❑ Reel form (5k good per reel)
- ❑ Laminated ID-1 cards and overmolded for harsh environments
- ❑ Worldwide third party relationships for custom application tags using our HF die.





TI – RFID HF Readers

Features

- ❑ Best In Class Performance
- ❑ Available as IC and reader modules
- ❑ Reduced Power Output For Handheld And Medium Read/Write Range Applications
- ❑ Proven In Harsh Industrial Environments
- ❑ Read ranges >4.5 ft. possible

Easy to implement

- ❑ Full Portfolio of IC's, Readers & Antennas
- ❑ USB, Ethernet, RS232 and RS422/485 Interfaces Available
- ❑ Highly Integrated Transceiver IC's
- ❑ Compatible with all TI Transponders





Use of RFID in medical application

Product Identification

RFID used to identify the product

→ Avoid mix up



Product authentication

RFID used to prevent product counterfeiting



Product adjustment

RFID used to change and adjustment calibrating data

→ Avoid manually mistakes





Use of RFID in medical application

Flexible asset management

RFID used to track products over a value chain

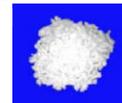
→ **Process optimization**



Secure asset control

RFID used to identify the status of the products

→ **Prevent to re-use without sterilization**





Requirements for Medical RFID

- Containers
 - Product size and shape
 - Flat and flexible antennas for container
 - Compact antennas for seal
 - Reading Performance
 - Short reading distance
 - Read and of multiple tags in field
 - Environmental requirements
 - Insensitive regarding moisture
 - No negative influence of container and content





Requirements for Medical RFID

- **Patients**
 - **Product size and shape**
 - Flat and flexible antennas
 - **Reading Performance**
 - Short and medium reading distance
 - Read and of multiple tags in field
 - **Environmental requirements**
 - Insensitive regarding moisture
 - Robust regarding deformation
 - Easy to mount





Requirements for Medical RFID

- **Inside body measurements/ function control**
 - **Product size and shape**
 - Small antennas
 - Non-angular
 - **Reading Performance**
 - Medium and large reading and writing distance
 - Read and write of multiple sensors and signals in body
 - **Environmental requirements**
 - Insensitive regarding moisture
 - Antiseptic and body friendly





Comparison of Frequency Ranges

	LF (125/134.2kHz)	HF (13.56Mhz)	UHF (433, 868,...MHz)
Field Characteristic	Near field Magnetic field	Near field Magnetic field	Far field Electromagnetic field
Allowed field strength	High	Medium	Low
Energy transfer	Very Good	Good	Weak
Moisture	No damping	No damping	Significant damping
Separation	Very Good, no reflections	Very good, no reflections	Very weak, high reflections
Data Transfer Rate	low	high	very high





High Frequency Applications

- Frequency and RFID protocol is common world wide
- Tags are generally in a flexible form factor
- Dedicated read and write Range
- Multiple Tag reading and writing
- Each RFID tag has a world wide unique ID number
- RFID products can be integrated (embedded) either in the packaging or the medical product
- Multiple sources of reader available



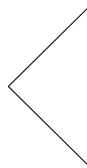


Pharmaceutical Authentication

- Human Readable
- Bar Code
- Security Marker



Human Interaction



RFID: *Electronic Security Marker*

Automated Communication and Security

- without line-of-sight
- difficult to counterfeit





Authentication/Calibration in handheld devices

- Battery operated Handheld Medical devices:
 - Medical metering
 - High value supply tracking
 - Product authentication & calibration
 - Medication authentication and lockout after usage



Medical Demo

RFID in Metering		Benefit
ease in calibration	->	Eliminate user errors & increase accuracy
product authentication	->	Ensure safety & eliminate counterfeit strips



Yes, MFG code=1234.
CalCode=123456789



Are the strips authentic?
What's the cal info?





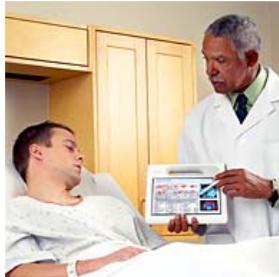
Surgical Sponge Tracking

- Small HF tag inside Sponge
- Antenna in waste bin and storage container keeps count of sponges in and out
- Wand Antenna is also used to scan patient





RFID Enabled Tablet Computer



- Tablet PC incorporates RFID reader utilizing TRF7960 and MSP430
- Allows easy identification of patient and patient history
- Tagged drug bottles/packages and wristbands can be read to ensure correct match with patient





TRF7960/61 HF Reader IC

Products (all are pin for pin compatible)

- TRF7960 supports ISO14443A/B, ISO15693 & Tag-it
- TRF7961 supports ISO15693 & Tag-it

Low Power/Small size

- ✓ 2.7 to 5.5V input supply range
- ✓ 7 user selectable power modes for maximizing battery life
- ✓ 32pin QFN (5mm x 5mm)

Integration

- ✓ Fully integrated protocol handling: encoding, decoding, packetization, and error checking w/ high data rate support (212, 424 & 848kbps)
- ✓ Multiple, Integrated LDO's w/ high PSRR
- ✓ Clock output for microcontroller minimizes total Bill of Materials (BOM)
- ✓ Dual AM & PM (Phase Modulation) receivers and RSSI readings
- ✓ Programmable output power, 100mW and 200mW

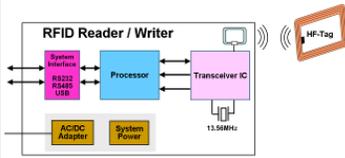
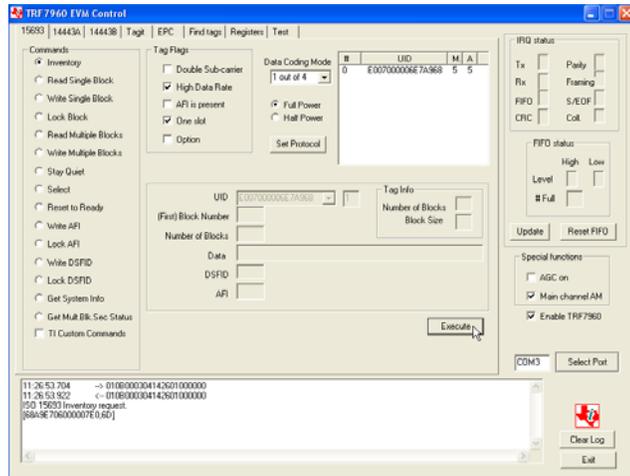
Configurability/flexibility

- ✓ Configurable I/O levels to accommodate multiple uP voltages
- ✓ Selectable receive gain, and AGC
- ✓ 11 User accessible & controllable registers for fine tuning of system
- ✓ Parallel data communication OR Serial 4-pin SPI interface
- ✓ MSP430 source code available free through Extranet Site





Demo Devices and GUI Available with Source Code



MSP430 Source Code: <http://www.ti.com/litv/zip/sloc136>





Example: How Low power?

Ex. Requirement for an access control system

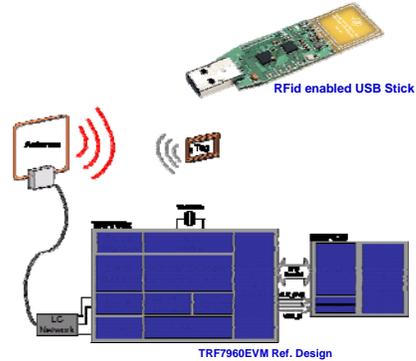
- Number of accesses per day: 4
- Battery Source: 1200mAh
- Duty Cycle: 2sec



Battery Life:

➤ 18 years

Mode	Current (uAsec)	Intervals/Day	Total/Day (uAsec)	Total/Day (mAh)
Polling	14.896	43200	643507.2	0.178752
Inventory	280.5	4	1122	0.0003117
				0.1790637
Battery Capacity (Days)		6,701.5		
Battery Capacity (Years)		18.4		



TRF7960EVM Ref. Design





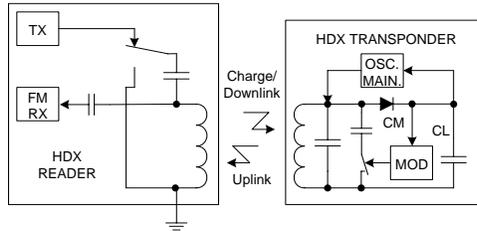
Low Frequency Applications

- **Allows penetration through liquids with no reduction in read range**
- **Small, high efficiency ferrite antenna is suitable for implantable applications**
- **HDX allows for greater read range**
- **Special functions are possible, which require higher supply currents, for example:**
 - in-body temperature and pressure measurement.
 - measurement of other parameter.
 - active transmission for greater response distances (e.g. UHF).
 - trigger of electro-mechanical actuators (e.g. valves).
 - Conversion and transmission of camera signals.



System Principle Comparison (HDX)

- Energy Transfer to Transponder chronologically separated from Uplink
 - Transmitter (TX) of HDX Reader continuously activated during Charge cycle.
 - Energy received during Charge cycle is rectified and stored in capacitor (CL).
 - During a data transfer to Transponder (Downlink), energy is kept or only minor consumed due to Amplitude Shift Keying (ASK) modulation, with refresh cycles (Read/ Write Transponder only).
 - During Uplink, the Transmitter (TX) of HDX Transmitter is off and high sensitive FM Receiver (FM RX) is active.
 - Transponder consumes the energy in the capacitor CL, maintaining the oscillation of Resonance Circuit (OSC. MAIN.) and modulating the Uplink data (MOD).

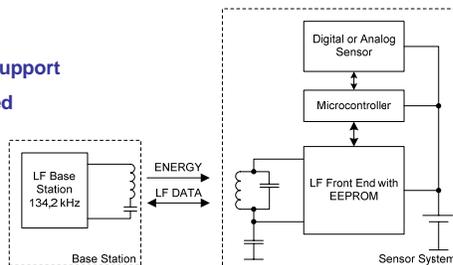




Implantable Battery less Sensors

TMS37157

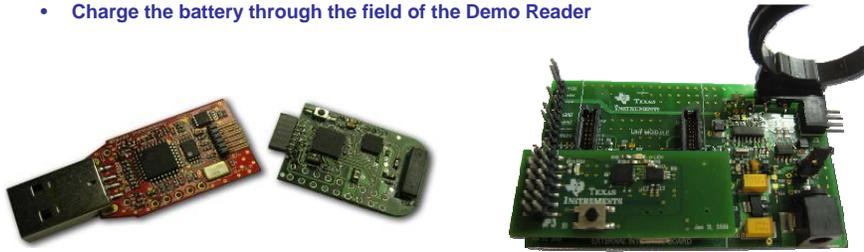
- **Battery-less Configuration Memory**
 - PaLFI memory is written without battery support
 - Memory read by microcontroller if powered
- **Ultra Low Power Data Logger Memory**
 - EEPROM memory extension for existing microcontroller systems
- **Wireless battery-less sensor interface**
 - Microcontroller powered by LF field
 - For capsulated systems without battery availability
- **Multi purpose LF Interface to a Microcontroller**
- **Remote Control Applications**
- **Stand alone LF-Transponder with memory**





eZ430-PaLFI Demo Kit

- **Wireless Batteryless Configuration Memory**
 - Configure how often a certain LED should blink when the MSP430 gets connected to a voltage source
- **SPI Access to MSP430**
 - Send a command to the MSP430 which LED should blink and how often it should blink without using the EEPROM
 - Power the MSP430 out of the field of the Demo Reader
- **Check Battery Level/Battery Charge**
 - The TMS37157 checks the battery level without invoking the MSP430
 - Charge the battery through the field of the Demo Reader





Conclusions

- RFID can help prevent counterfeiting and mix-ups of important medicine and medical devices.
- 13.56Mhz (HF) best for tagging of patients and pharmaceutical containers due to small size, low cost, and flexible form factor.
- 134.2kHz (LF) is best for transponders with measurement tasks due to high energy transfer and HDX operation.
- High integration and low current consumption of TI RFID and MSP430 products make for an attractive reader and microcontroller combination.





Questions?

- **TI-RFID Homepage**
 - <http://www.ti.com/rfid/>
- **RFID PIC Support**
 - 1-800-962-RFID(7343)
 - <http://www-k.ext.ti.com/sc/technical-support/email-tech-support.asp?RFID>
- **Eddie LaCost**
 - eddielacost@ti.com
 - (214) 567-5983

