



TEXAS INSTRUMENTS RFID



TI Technology Day

1





What's RFID?

RFID is a memory chip with a radio:

- **passive**
- **maintenance-free**
- **contactless**



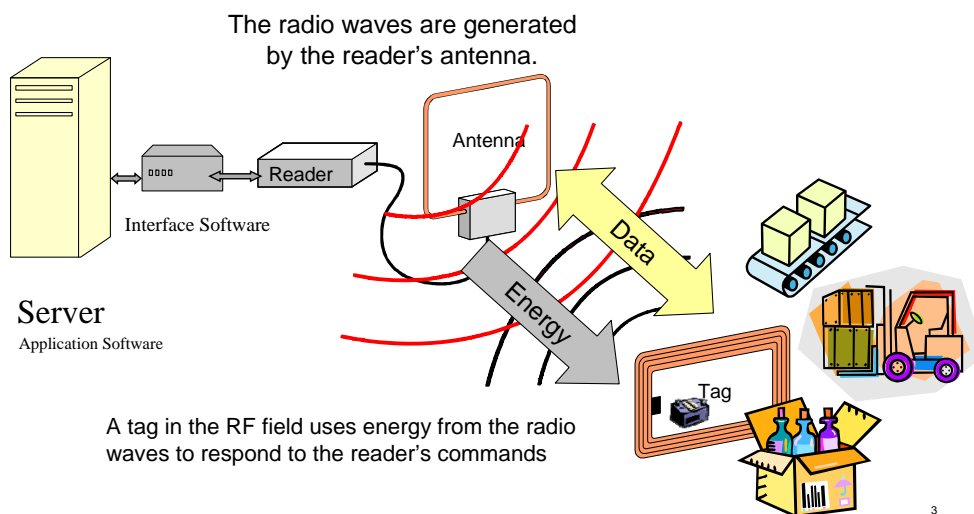
wireless technology for identification and data exchange which turns assets into smart assets



2

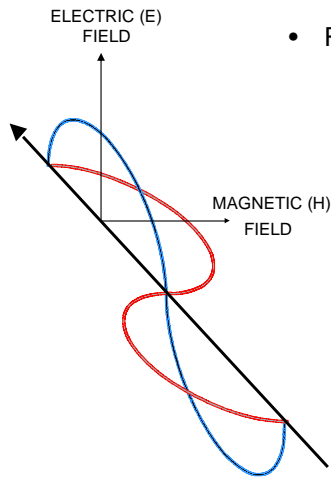


RFID system in action





Quick Physics Lesson



- Radio Waves

- 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

4



All electro-magnetic fields have 2 components: Magnetic (or “H”) field and Electric (or ‘E’) field

HF and LF use magnetic field and work by **INDUCTIVELY** coupling the energy with coil loops. Much like an AM radio.

UHF uses e-field and works by **CAPACITIVELY** coupling the energy with dipole antenna. This is like FM radios.

Any frequency can use either type of field, but the physics behind the wavelengths and the resulting antennas are almost always a the deciding factor.






Choose your flavor of RFID

5





Technology Comparisons

| | LF | HF 15693 only | UHF |
|-------------------------|---|--|---|
| Frequency | 120 to 134kHz | 13.56MHz | 840 to 960MHz |
| Wavelength | 2500m (1.5 miles) | 22m (72ft) | 30cm (1ft) |
| Liquid Immunity | excellent | good | poor |
| Data rates | 12 kb/sec | 27 kb/sec | 640 Kb/sec |
| Read rates | ~28 tags/sec | ~50 tags/sec | +100 tags/sec |
| Anticollision | No | Yes | Yes |
| Read Range (typ) | 0~2m | 0~1m | .1~10m |
| Tags / Inlays |  23-mm 32-mm |  |  |

6



The main take away:

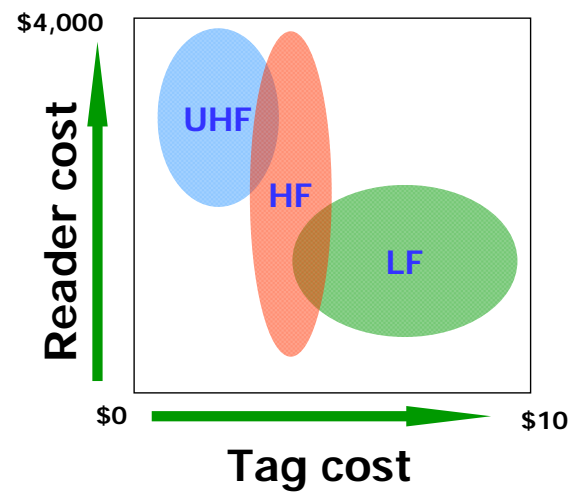
LF has great performance near liquids and metals, but it can only read 1 tag at a time and it is relatively expensive.

UHF has long read range and it is least expensive, but performance around metals and liquids is poor

HF is in between in nearly every category.



Relative Costs



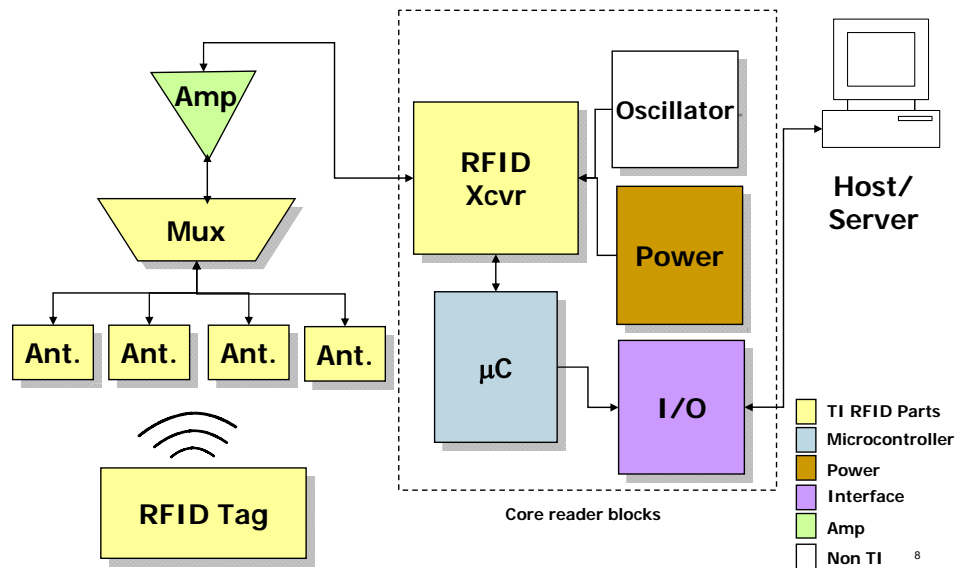
NOTE: Not to scale

7





System Block Diagram





Product offerings by Line

| | LF | HF | UHF |
|---------------|----|----|-----|
| Tag IC | | ✓ | ✓ |
| Inlay/Xpdr | ✓ | ✓ | |
| Readers | ✓ | ✓ | |
| Reader Module | ✓ | | |
| Reader IC | ✓ | ✓ | |
| Power Amps | ✓ | | |
| Mux | ✓ | ✓ | |
| Antenna | ✓ | ✓ | |

9



Low Frequency

For harsh environs

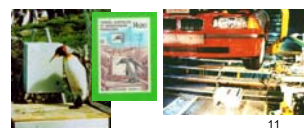
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134kHz - LF Applications

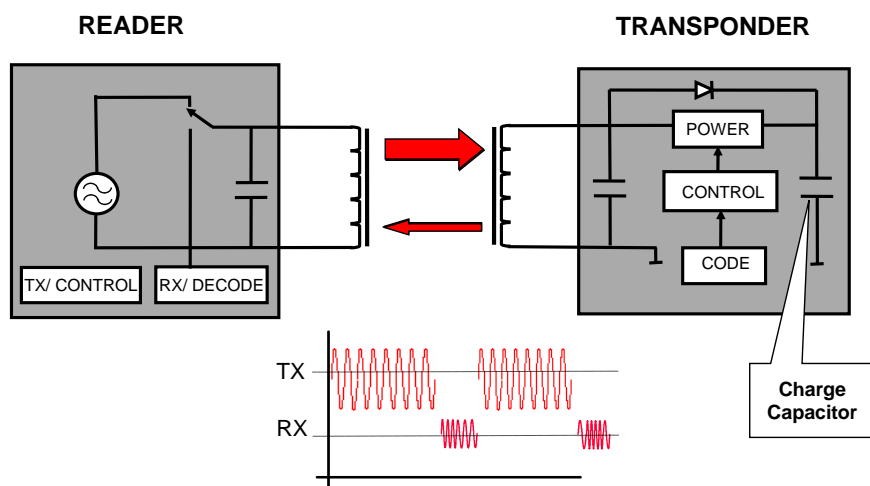
- Waste Management
- Industrial Asset Control
- Livestock
- Vehicle Identification
- Container Tracking
- Access Control
- Sports Management



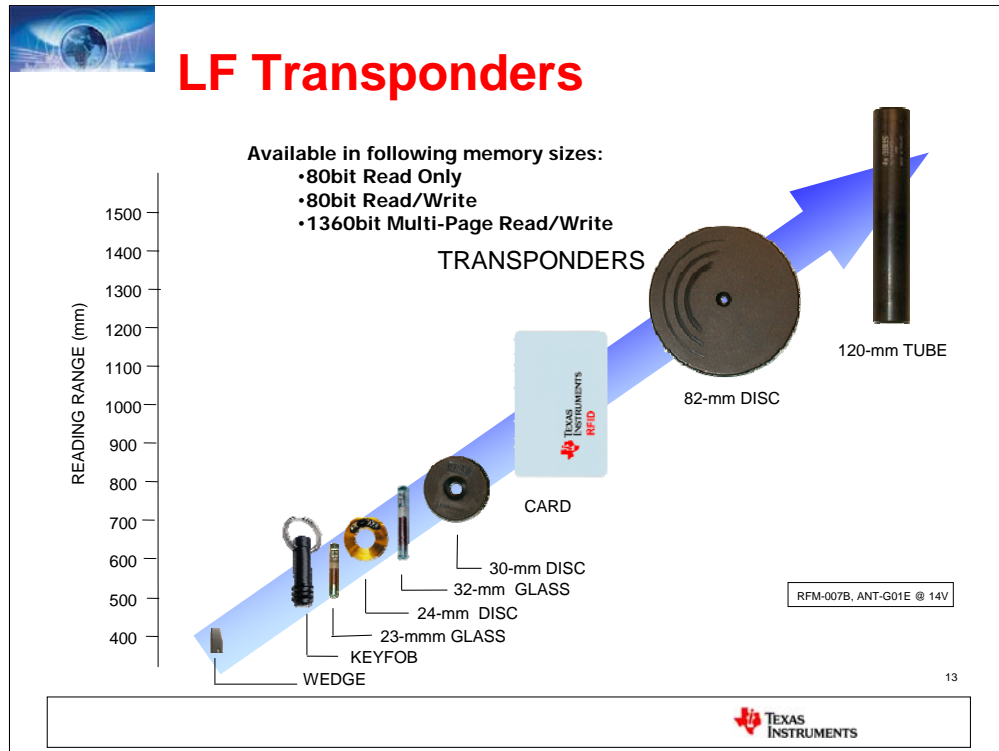
11



TI Differentiator – LF HDX Technology



12



Here is a chart of TI's LF tag line up.

One phenomenon that is true for all forms of RFID is the larger the transponder antenna, the longer the read range.



TI-RFID LF Readers

Easy to implement in your design

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

Reader IC
TMS3705

Microreader
RI-STU-MRD1

Mini RFM
RI-RFM-003B-00

Power RFM +
Control Module
RI-RFM-007B
RI-CTL-MB2B/MB6B



S251 Power
Reader
RI-STU-251B

14





LF Evaluation Kits

- Mid Range – based on MicroReader



RI-K3A-001A



- Long Range – based on S2000 Reader

RI-K2A-001A

15

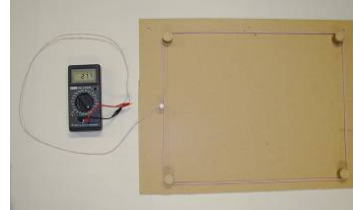




LF Antenna Design

– Easily prototyped with basic tools and materials

- Copper wire
- Copper pipe/tubing
- PCB



- TI has tools to help.
 - Checking the Inductance (Calculated)
 - ADU.exe

16





High Frequency

15693 - The general purpose choice

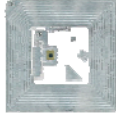
14443 - For security

17



HF Standards

- **ISO 15693** – HF-I Product Line – ***Vicinity cards***



- UID Hard coded at Fab
- License plate + reprogrammable memory
- General Purpose

- **ISO 14443** – Wireless Payment – ***Proximity cards***



- International standard for contact less smart cards
- Encryption
- User memory
- Applications: ticketing and payments
- Catalog product Apollo now available!

18



The 2 main standards in HF ISO15693 and 14443.

15693 is the bulk of the market, this is the standard that our Tag-it inlays use. These are the types of tags that are typically in corporate id badges. These are less sophisticated and less expensive than 14442 based cards.

All 15693 tags on the market have a 64bit unique ID (UID) hard coded into them. Every manufacturer has their own series of numbers that greatly reduces the possibility of cloning tags. In addition to the UID, we also have either 256bit or 2kbit user memory that can be programmed and locked.

ISO 14443 is the standard for contactless smartcards and are the basis for most of our Secure Product line. These cards incorporate encryption and authentication and secure memory and are considerably more sophisticated than 15693 tags. They are also 2-3x higher cost.

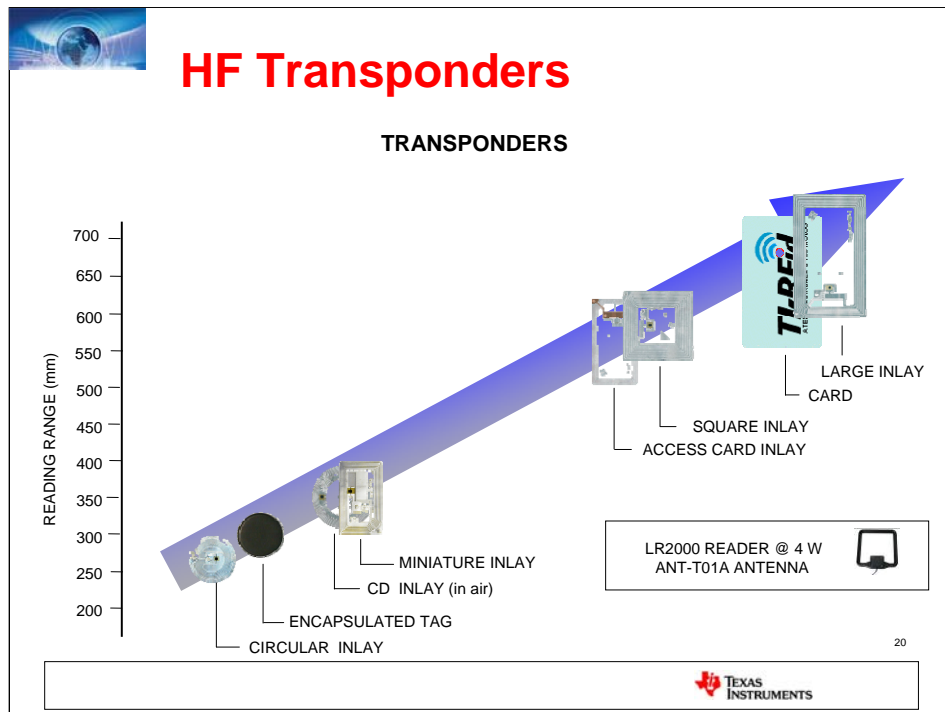


13.56MHz Applications Reader and Tag-it HF-I ICs / Inlays

- Product Authentication
- Ski Ticketing
- Library Management
- Medical Application
- Asset Management
- eMetering
- Access Control
- Point-of-Sales



19



Again just like, LF the larger the tag, the longer the read range. We have several different form factors and we work with partners to develop new tag sizes regularly.

A noteworthy tag in is the encapsulated model. This is a ruggedized button that is intended for the commercial laundry market. It is built to withstand chemicals and steam treatment.

Most of the form factors are available with 3 different IC installed:

HF-I Plus has the highest memory at 2kbit (not Byte). This is fairly large amount of memory and we have special block commands that make block reading and writing data much faster built into this tag. This is the highest value version of each tag.

The HF-I Pro has less memory, 256bit. The lower memory means we could delete the special block commands. So we added extra security in the form of password protected write command and kill command. "Kill" will permanently disable the tag with needing to physically touch the tag. These tags are the mid-priced versions.

HF-I Standard also has 256bit and deletes the security and block commands. It is the lowest priced version.



Tag-it HF-I ICs Options


| Features | Tag-it HF I Chip Version | | |
|--|--------------------------|----------------------|-----------------|
| | Tag-it HF-I Plus | Tag-it HF-I Standard | Tag-it HF-I Pro |
| Protocol: | | | |
| ISO 15693-2,-3; ISO18000-3 | ✓ | ✓ | ✓ |
| Memory: | | | |
| Unique ID read only - 64bit - | ✓ | ✓ | ✓ |
| 2048bit User memory read/write | ✓ | | |
| 256bit User memory read/write | | ✓ | ✓ |
| Application Family Identifier (AFI) | ✓ | | |
| FastSID | | ✓ | ✓ |
| Data Storage Format Identifier (DSFI) | ✓ | | |
| Security: | | | |
| User lock per block | ✓ | ✓ | ✓ |
| Factory pre-programming and Factory lock | ✓ | ✓ | ✓ |
| Password protected write command | | | ✓ |
| Command to disable IC functionality | | | ✓ |

Wafer processing:

- Die thickness (150um / 265um / 710um)
- Bumping (unbumped, AU bumps and Ni-Au bumps)
- Unsawn / sawn and inked / wafer map file
- Packaging: single wafer / multi wafer

21





HF Reader ASIC - TRF796x

Products (all are pin for pin compatible)

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

Low Power/Small size


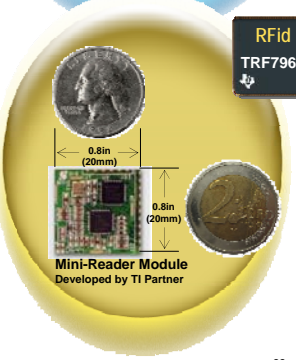
- ✓ 2.7 to 5.5V input supply range
- ✓ 7 user selectable power modes for maximizing battery life
- ✓ 32pin QFN (5mm x 5mm)

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 software license agreement

Rfid
TRF796x

22



The upper right shows our TRF EVM. This is a development board available on our website and through distributors. It includes the board pictured, a GUI program, and access to our source code.

There are 2 versions of this part that differ in the number of protocols supported: the '60' supports all major HF protocols, the '61' only handles the less sophisticated 15693 and Tag-it protocols.

The TRF is an extremely low power part with power modes for maximum flexibility and the voltage is continuously variable between 2.5 and 5.5V, not to certain voltage levels.

Many formerly discrete parts are integrated into this package to reduce overall BOM costs. Besides a few passive components, customers only need a microprocessor, clock oscillator, and antenna. The reader even has a clock output for the microcontroller, so only 1 crystal is needed for the system. And there are 2 output power modes of 100 and 200mW. Higher output power is available with an amplifier circuit.

This part is highly configurable and can be optimized for a variety of applications. Communication can happen over either parallel or SPI busses. When used with an MSP430, there is available source code for firmware development.

This is an example of how small the reader circuit can be made. This is a module from an Asian Company, Jogtek, that integrates an MSP430 and TRF. The only thing required for a reader now is a power source and antenna.



TRF7960 EVM

Part Number : TRF7960EVM

Orderable : Yes, See your distributor

EVM Features Include

- MSP430F2370 with fully-functional firmware
- Supports both Parallel & SPI mode interface
- Supports ISO 15693, ISO 14443A/B, Tag-IT
- JTAG connector for custom FW download
- On-board highly-optimized loop antenna
- Headers for debug and system development
- USB interface with a Virtual COMPORT
- GUI with well-documented API
- Polling Mode for card detection



23





HF Custom Antenna



- Much like LF, antennas are easily prototyped and tuned with basic components
- TI has several documents to help.



24



Ultra High Frequency

Least Expensive Tags, longest read range
Not for harsh environs

25





UHF Applications

- PCB Tracking
- Retail Supply Chain
- Asset Management
- Identification



26



The bulk of the market for UHF today is the Retail supply chain, or Walmart, applications. This segment is very price sensitive and segment that TI is not very competitive in. Most of the main players are either losing money or selling at unacceptably low margins.

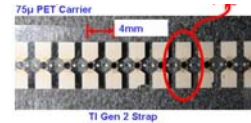
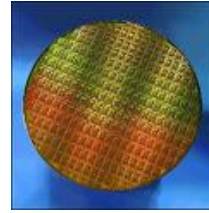
We are trying to find closed loop applications where there is a demonstrable value to using RFID. The best example of this is the PCB tracking application, where we have a solder on part that mounts like any other device and can track board assemblies throughout the manufacturing process.



EPC Gen 2 Products

Packaging options

1. **Wafer-** For inlay makers and flip chip capable customers
2. **Strap-** For printers and low precision, reel-to-reel equipment.
3. **SMT package-** For PCB mounting



27



Wafers are intended for customers that either assembly their own inlays with direct die attach, or customers with flip chip assembly capability.

Straps are intended for customers that assemble inlays or labels with rotary equipment. As of mid-2007, the strap is a Jedec standard package.

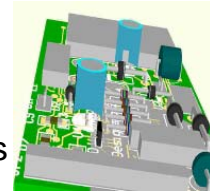
The TLLGA package is a small SMT package meant for PCB mounting. It is approximately the size of an 0603 passive component.



PCB Tracking

Key Benefits of UHF over Bar Codes in Mfg

1. PCB area needed is minimal
2. Rewritable for configuration management
3. “Set and forget” reader placement on line
4. Non Line of sight = reading through most packing
5. Can read 100+ tags per second, no need to stop or slow down line
6. 96-bits of storage = 79×10^{27} combinations



28



Talking points

1. Extremely flexible placement. The RFID chip will harvest energy from the reader RF field through the ground plane. This is extremely attractive to PCB designers, as they can place the chip and antenna where it will fit best for them. Real estate is more efficiently used.
2. Every time a PCB is updated, repaired, or reconfigured, the RFID data can be changed automatically.
3. Basically the reader antenna can be positioned above/beside/under the assembly line in a convenient manner for the mfgr. It won't have to be reconfigured or moved when a new PCB is setup on the line.
4. As long as the PCB isn't shielded, i.e. not inside a metal container or heavy ESD bag, the RFID tags should be readable through many kinds of packaging.
5. Throughput is not affected by the reading process because it is fast.
6. 96-bits may not sound like a lot of storage, but it can be used for a near infinite number of combinations



Board Layout Considerations

- Simple Slot antenna:
 - Need plane layer(s) available (ie. GND)
 - Must repeat pattern on all layers.
 - Size is typically 0.5x35mm
 - Suggested placement is minimum 1mm from edge of plane
 - Does not need to be straight, it can meander around features
 - Recommend to keep in Power, DC or low speed signal areas
 - Possible to route traces across
- Other antenna options:
 - T-slot, dipole, patch



29



Thank You

www.ti.com/rfid

Texas Instruments Product Marketing & Business Development RFID Products

Products

- Wafers and ICs
- Transponders
- Readers
 - HF Reader IC
- Antennas
- Evaluation Kits
- Accessories

Document Center

- Brochures/White Papers
- Datasheets
- Reference Guides
- Technical Notes
- Software Downloads

Third Party Network

- Overview
- Members
- Contact Third Party Networks

More RFID Applications

- Animal Tracking
- Automotive
- Supply Chain

Asset Tracking

[RSS](#) [All](#)



RFID technology raises asset tracking to a new level. End users enjoy faster, seamless transactions that are more secure than currently used systems. Libraries, pharmacies and entertainment venues who adopt RFID can benefit from secure wireless transfer transactions that deliver high return on investment.

- Overview
- Library
- Product Authentication
- Ticketing
- Pharma

Contactless Commerce

[RSS](#) [All](#)



Texas Instruments' RFID is changing the way businesses serve their customers by creating smart, secure solutions for the B2C CRM and payment markets. Now, customers do not even need a wallet because they can use their mobile phone or a special keychain to pay.

- Overview
- ExpressPay™
- PayPass™
- SpeedPass™
- Farm Factors

Contactless technology is also enabling businesses to learn more about their customers through the collection and storage of vital information of buying patterns. And this same type technology can be used for personnel access, ticketing, payTV, gaming, and cellphone applications.

Secure & Government ID

[RSS](#) [All](#)



For almost 20 years, Texas Instruments, with its broad array of mobile processing and memory technologies, has delivered radio frequency innovations that help customers create contactless identification solutions for a host of authentication, tracking and security applications. TI is harnessing this experience to deliver a next generation, smart IC platform for contactless government-issued electronic identification.

- Overview
- Non-flash Version
- RF360 Smart IC Platform
- Milestones and Activities
- Gov ID News and Literature

