



# UHF Gen 2 for Item-Level Tagging

Dimitri Desmons  
VP, RFID Marketing  
Impinj, inc.

# Gen 2: A Success Story

- **A Better Standard**
  - Vast improvement for case and pallet tagging
    - Higher tag readability
    - Improved quality
    - Lower cost
- **A Single Standard Accepted Worldwide**
  - Transition from Gen 1 to Gen 2 is well underway in various industries
    - Major retailers, DoD, IATA, etc
  - A single ISO standard enabled by worldwide regulations



# Item-Level Tagging

- The natural choice: apply Gen 2 to ILT
- Gen 2 has all the right attributes
  - Fast
  - Great anti-collision algorithm
  - Low Cost
  - Single worldwide standard
  - Here today

**Gen 2 is the right standard for ILT**

- Important benefit: a single infrastructure from items to cases to pallets
  - Reduced implementation costs

# ILT: A Long History

- **Item Level Tagging is as old as RFID**

- Cattle tagging
- Car immobilizers
- Access control
- ...

**LF – Low Frequency  
125 kHz**

- **More recently, HF tags used in new applications**

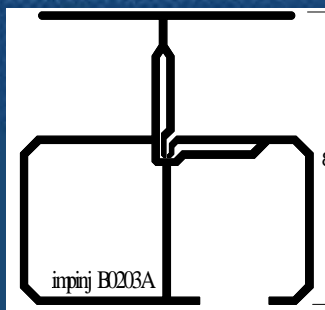
- Library books
- Transportation tickets
- Garments
- Pharmaceuticals
- ...

**HF – High Frequency  
13.56 MHz**

# Conventional Wisdom: "UHF doesn't work for ILT"



It doesn't read !



It doesn't fit !

*"It can't work,  
it's the Physics!"*



It doesn't stick !

# CW, One More Time, Gets It Wrong!

- Our agenda:
  - Why UHF works for ILT – the Physics
  - Why UHF is better than HF for ILT
  - Disprove 7 myths about UHF for ILT

# UHF vs. HF: Typical Comparison

<b>UHF for case and pallet tagging</b>	<b>HF for item tagging</b>
<b>Uses Electromagnetic waves</b> <ul style="list-style-type: none"><li>- Electric field</li><li>- Magnetic field</li><li>- "Far-Field"</li></ul>	<b>Uses Magnetic waves</b> <ul style="list-style-type: none"><li>- Magnetic field</li><li>- "Near-Field"</li></ul>
<b>Long range</b> <ul style="list-style-type: none"><li>- E and H field in FF decrease as 1/distance</li></ul>	<b>Short range</b> <ul style="list-style-type: none"><li>- H field in NF decreases as 1/distance<sup>3</sup></li></ul>
<b>Electric field attenuated in presence of dielectric</b> <ul style="list-style-type: none"><li>- Poor performance on liquids</li></ul>	<b>Magnetic field unaffected by nearby dielectrics</b> <ul style="list-style-type: none"><li>- Good performance on liquids</li></ul>

# UHF For Item Tagging

**Solution: use UHF in the Near-Field**

**Magnetic field coupling only  
Short range**

**Enables small tags unaffected by liquids**

**Benefit of UHF vs. HF:**

**UHF can work in both far-field and near-field  
to cover all from items to pallets**

# Faraday's Law Clearly Favors UHF

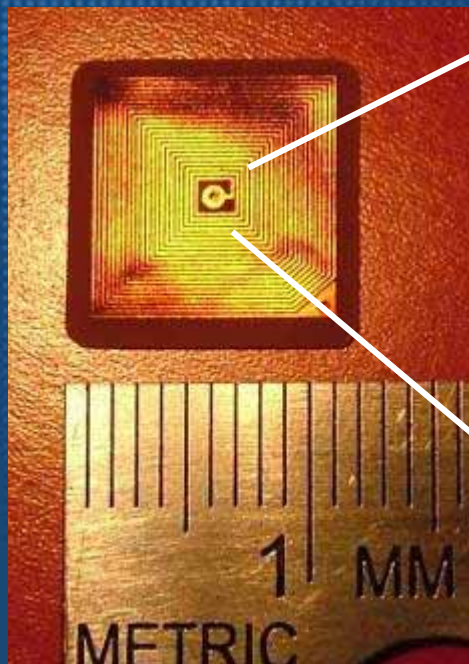
- Maxwell's four equations are the basis of electromagnetic analysis & design
- Faraday's law is one of Maxwell's four equations:
  - "Voltage induced on a coil in a magnetic field is **proportional** to the intensity and **frequency** of the field"

$$\oint_C \mathbf{E} \cdot d\mathbf{l} = - \frac{d}{dt} \int_S \mathbf{B} \cdot d\mathbf{A}$$

- It's simple: Higher frequency = greater efficiency
- UHF is ~**60X** the frequency of HF !
  - Can't argue with Faraday's law: **it's the physics!**

**UHF is 60X more efficient than HF !**

# The Impact of Faraday's Law on HF vs. UHF



Close-up of high manufacturing complexity of HF tag

**HF:** ~20 turns fine resolution etched copper, 2 layers, 12 mm

**VERSUS**



**UHF:** 1 turn conductive ink, 1 layer, 9 mm

# UHF Gen 2 Tags the Item Universe

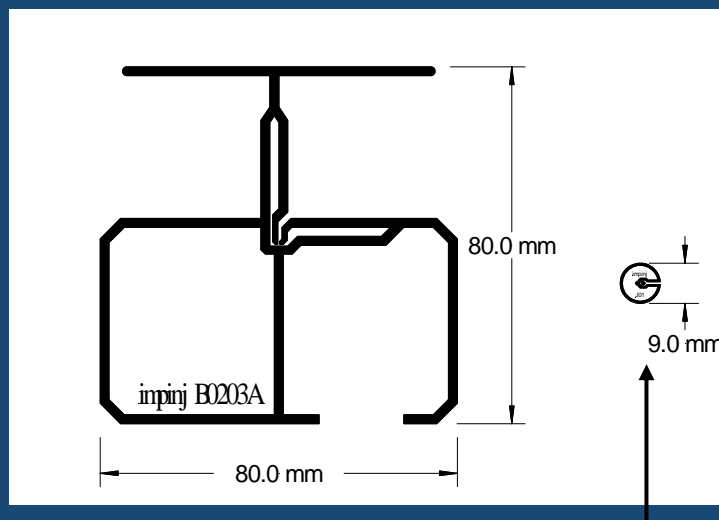


# The Seven Things They Said You Couldn't Do with UHF

- Exposing the myths
  1. UHF tags too big for ILT
  2. 13.56 MHz the only worldwide standard
  3. UHF won't work on liquids
  4. UHF won't work on metals
  5. UHF won't work in close proximity
  6. UHF has too great a range for ILT
  7. UHF more susceptible to noise

# Myth #1: UHF Gen 2 Tags Too Big for ILT

- Fact #1: UHF tags needing long range and orientation insensitivity require large antennas
- Fact #2: UHF tags for *near-field* operation do not!

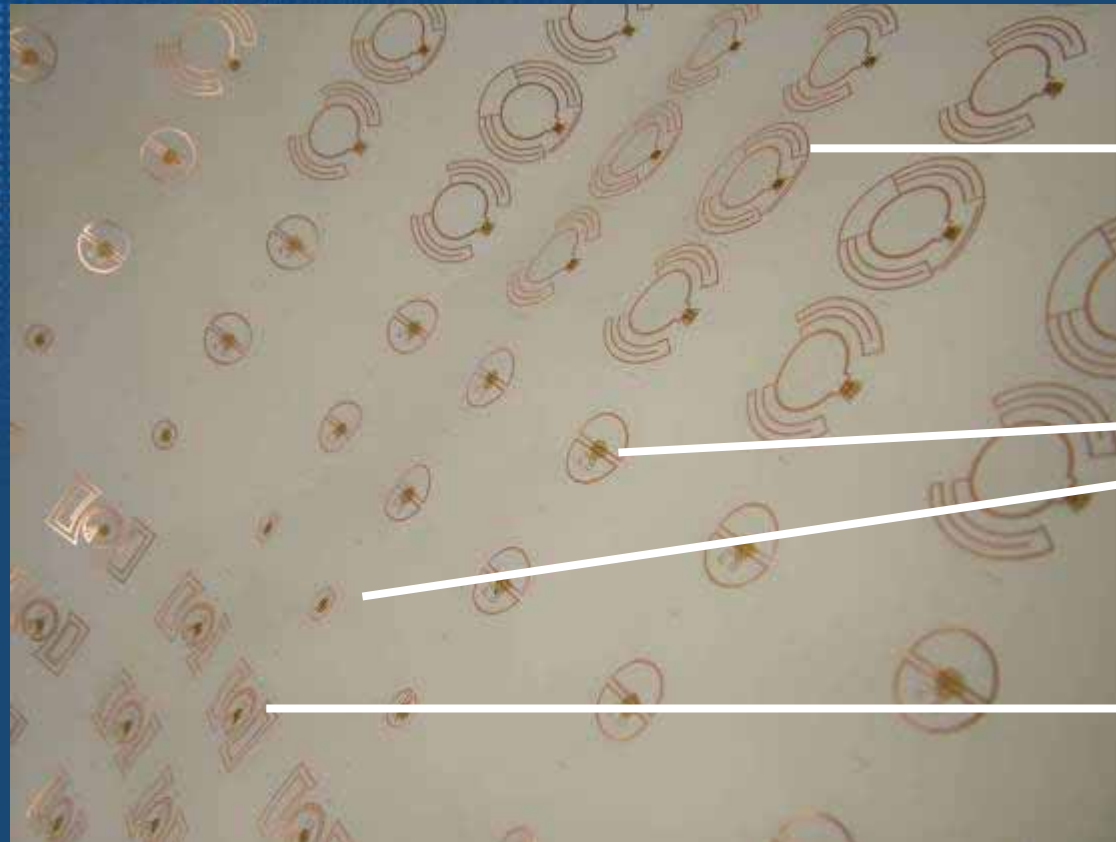


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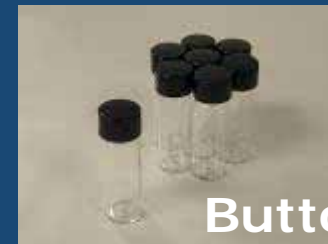
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# UHF Harnesses an Array of Item-level Antenna Designs



Disc™



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# Myth #2: 13.56 MHz is the True Standard

- **Frequency is standard; protocols are not!**
  - HF standards include ISO 14443, ISO 15693, EPCglobal HF Class 1, etc
  - HF cannot be used on cases and pallets
- **UHF Gen 2 is the single universal standard for RFID**
  - UHF bands are open worldwide from 860 to 960 MHz
  - The Gen 2 protocol is approved by EPCglobal today and will be ratified by ISO (18000-6C) in April 2006
  - UHF Gen 2 can handle items, cases and pallets
- **UHF is a more practical, economical band on which to base a standard**
  - UHF tags much easier to manufacture
  - Simple antenna geometries
  - Inexpensive conductive ink process

# Myth #3: UHF Gen 2 Won't Work on Liquids

- UHF's far-field is affected by liquids
- UHF's *near*-field is **not** affected by liquids
- UHF Gen 2 tags not only work *on* water, they work **in** water!



# Myth #4: UHF Gen 2 Won't Work on Metals

- All fields—both near and far, electric and magnetic, HF and UHF—are affected by metals
- BUT, only UHF Gen 2 tags can take advantage of the metal to which it is attached



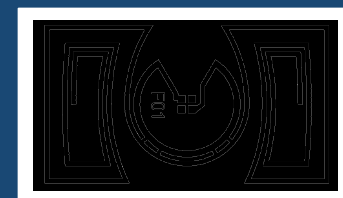
# Myth #5: UHF Gen 2 won't work in close proximity

- **UHF enables simple loop antenna designs that**
  - Result in less magnetic shielding
  - Make stacked tags more visible to reader
- **UHF Gen 2's singulation and anti-collision algorithms superior to HF protocols**
  - > 1,000 tags / second
  - More reliable reads on large tag populations



# Myth #6: UHF Gen 2 Tags Have Too Long a Range

- **Range is a function of antenna design!**
- **UHF Gen 2 tags exhibit outstanding *far*-field performance**
  - Reading at 10 meters!
- **UHF Gen 2 tags also exhibit outstanding *near*-field performance**
  - Can be optimized for ranges of **less than a meter**
  - Reader antenna designed for near-field maximizes the intensity of the near-field response
- **UHF Gen 2 tags are selectively “field sensitive” *depending on the antenna***
  - Near-field, far-field, or *both!*
  - HF tags **ONLY** sensitive to the near-field



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# Myth #7: UHF Gen 2 Tags Susceptible to Noise

- **Noise and interference primarily a far-field concern**
- **Impact of noise in near-field is negligible**
  - Inductive coupling systems less susceptible to noise
  - In near-field, HF offers no noise immunity advantage over UHF
- **In far-field, noise performance determined by chip design**
  - Interference rejection a feature of high-performance chips

# UHF Gen 2: One Size Fits All

- A single open standard, worldwide
- A single infrastructure from items to pallets
- Outstanding performance
- Low manufacturing cost
- Easily tailored via:
  - Application-specific tag antennas
    - Each of which works worldwide
  - Reader accessories (near-field antennas)

**EPCglobal's UHF Gen 2 is the clear choice for ILT**

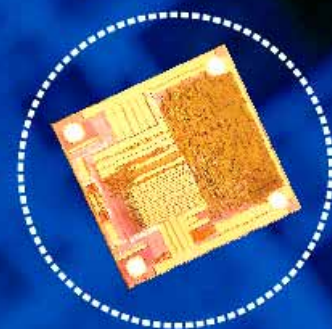
For a demo, visit booth #217



**Impinj**<sup>®</sup>



**GEN 2**



FOLLOW THE LEADER





**Thank you**

**Dimitri Desmons  
VP, RFID Marketing  
Impinj, inc.  
[dimitri.desmons@impinj.com](mailto:dimitri.desmons@impinj.com)**