

Chip versus chipless for RFID applications

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Technology overview

Increasing cost & sophistication

- EAS (Electronic Article Surveillance 1 to 4 cents)
AC, LC or EM
- Chipless RFID (0.1 to 50 cents)
Distinct technologies: Microwave reflector, electronic circuits, thin film circuits.
- Passive chip RFID (10 to 800 cents)
Ticket, label, card. Chip powered by the reader.
- Active chip RFID (with battery from \$1 to \$100)
Long range (m), real time location, sensors.
Emits continuous signal for positioning.

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IDTechEx is an independent strategic analyst on RFID, smart labels, smart packaging and printed electronics. Our core services provide:

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Clients include: Shell Oil Resam Whirlpool Europe Guinness UDV Thin Film Electronics PolyTechnica Schiphol Airport...	<ul style="list-style-type: none"> Independent market and technology research reports covering RFID, printed electronics & smart packaging topics. Two monthly journals, Printed Electronics Review and the world's largest RFID case study knowledgebase. 	Global Conferences USA, Europe and Asia Smart Labels Smart Packaging Printed Electronics Food & Livestock Traceability Active RFID

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Tag Price Comparisons

Tag price*

Chipless 32c
Chip 10-20c
Range 1m 4c

Anti-theft 1 bit ID 96 bits More Data N bit

Target to sell trillions a year

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RFID in Packaging

HIGH COST

Crates and expensive products \$2-5 tag Today

Apparel packaging and other moderately expensive products \$0.50 to \$1 tag Today (5 cents in 2007-07)

Fast-moving consumer goods 1 cent tag or less Probably 0.1 cent needed to replace most barcodes 2010 or later? Low cost

*One cent tag price needed to tag items
Unilever, Procter & Gamble

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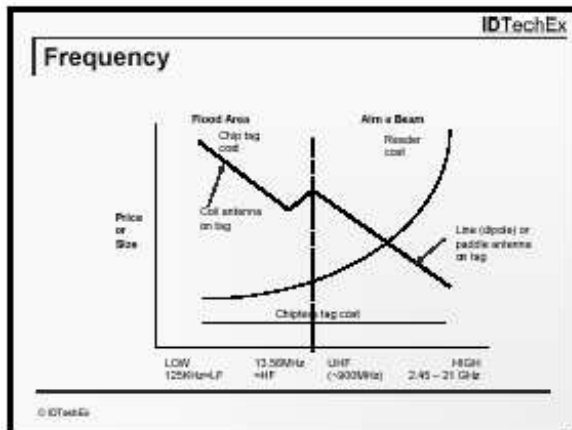
Passive RFID: Main operating frequencies

125KHz=LF 13.56MHz=HF UHF 2.45GHz

Inductive antenna - flooding

Electric antenna - beaming

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Achieving the 5 cent tag

RFID tag component	Tag Cost: MT Auto ID Center/EPC global (cents)	Tag Cost: Rafsec (cents)	Auto ID Center, and Rafsec's 5 cent tag aim (cents)
Chip	20	24	1
Antenna	5	7*	1
Chip placement	5	5	1
Chip connection	5	5	1
Conversion to package	Over 10*	5	1
Total	Over 45	41	< 5

* Includes substrate cost

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Chip Smart Labels

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Ultra-small Chips are Very Important

- e.g. eventually 0.1mm across, 20µm thick
- No supply famines?
- No brittleness problems
- Can go in paper etc.
- Thin chips double as pressure sensors
- Very low cost

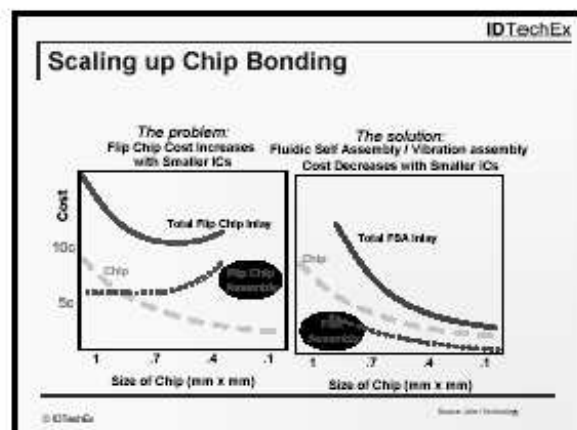
The flex-chip is built using a conventional CMOS process.

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CHOICE OF CHIP RFID SOPHISTICATION

COST	Features
HIGH COST	Encryption Radiolocation Read-write (write ~70% of read range EEPROM) Read only & read write Large memory Long range Well protected
LOW COST	Read only Small memory Short range Naked

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Chipless Smart Labels

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TWO GENERATIONS OF CHIPLESS RFID

FIRST GENERATION: Closed systems i.e. single service provider, no standards, usually little memory - anticounterfeiting, antitamper, secure access, product diversion, in house- track and trace, automated error prevention. Acoustomagnetic, electromagnetic, LC Array

SECOND GENERATION: Open systems i.e. multiple service provider, global standards e.g. EPC. Barcode replacement and more - SAW and later polymer TFTCs and maybe thin film silicon TFTCs and maybe the secret VTT/Panipol printed pyridene label which has 96 bits read only but only at a few mm range.

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Digital Chipless Tags – potential benefits

Remote magnetics	<ul style="list-style-type: none"> Magnetostrictive Simple Electromagnetic Barkhausen effect 	35 million sold Radiation hard. Thinest option 10 million sold. Very secure
Transistorless circuits	<ul style="list-style-type: none"> Surface Acoustic Wave (SAW) Diode based Coil-capacitor (LC) 	Millions sold. Meets standards. Radiation hard. Suitable for track marking. Hundreds of thousands sold. Thin and robust
Transistor circuits	<ul style="list-style-type: none"> Polymer Electronics Silicon film 	Portable onto products. Meets standards. High frequencies possible

VTT/ Panipol/ Mreal pyridene tag – secret technology

Portable onto products. 96 bits EPC

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Electromagnetic Chipless Technology

Confirm Technologies Israel

Link-Sure UK

Flying Null UK

MIT US

Example: Flying Null thread in a blister pack

- Range few centimetres (up to ~0.4m)
- World's thinnest and lowest cost tag

Flying Null can be used for machine readable

- Authentication
- Tamper Evidence
- Track and Trace



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Digital Chipless Tags – limitations

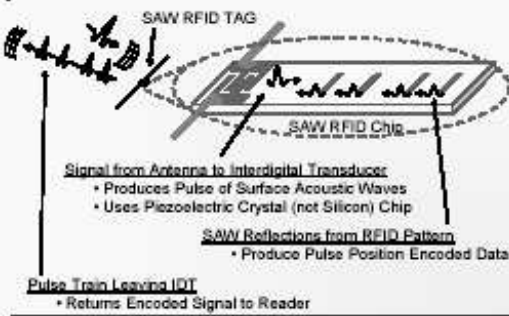
Remote magnetics	<ul style="list-style-type: none"> Magnetostrictive Simple Electromagnetic Barkhausen effect 	Thick. Under 30 bits. Read only Under 30 bits. Read only Expensive. Read only. Few bits
Transistorless circuits	<ul style="list-style-type: none"> Surface Acoustic Wave Diode based Coil-capacitor (LC) 	Thick. Read only Analog. Read only Large footprint. Under 30 bits
Transistor circuits	<ul style="list-style-type: none"> Polymer Electronics Silicon film 	Not in production or isolation Not at UHF or above Production process more expensive than polymer

VTT/ Panipol/ Mreal pyridene tag – secret technology

Range only a few mm

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Surface Acoustic Wave (SAW) RFID Technology



Signal from Antenna to Interdigital Transducer

- Produces Pulse of Surface Acoustic Waves
- Uses Piezoelectric Crystal (not Silicon) Chip

SAW Reflections from RFID Pattern

- Produce Pulse Position Encoded Data

Pulse Train Leaving IDT

- Returns Encoded Signal to Reader

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Reading on Metal

SAW Tag with dipole antenna on coke can



Reading tags on metal, metal foil or containers of liquids is not a great problem

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Global Potential Billion/Year		RFID Leadership
Library	0.1	Singapore
Museums, art galleries	0.1	Europe
National ID cards	0.1	China
Laundry	1	Europe
Animals	1	Thailand, S America, US, Eur.
Tires	1	Europe
Military items	2	US
Blood	2	Europe/US
Test tubes	2	Europe/US
Archiving paperwork	2	US
Air baggage	2	US, China
Air freight	2	US
Drugs	30	US
Pallets, cases	40	US, Europe
Books	50	Japan
Postal	650	Europe
Retail items	10,000	Europe/Japan/US

ITEM LEVEL IN RED

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Chipless smart labels

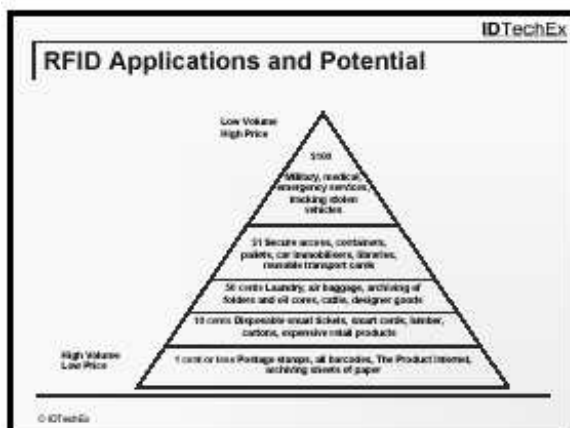
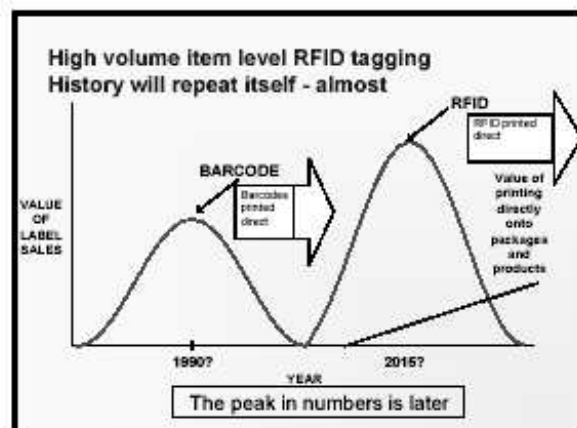
2nd generation chipless tags meet EPC data requirements (96 to 256 bits): e.g. SAW tags (RFSAW and AirGATE Technologies)

Printed Electronics TFTCs: 40+ companies

Chipless RFID tags are only about 2% of the RFID market today by value. They have the potential to reach the lowest cost and therefore highest volume markets – barcode replacement and more. 2014 market share may be as high as 30% as these technologies emerge.



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For further information read:

Item Level RFID

Progress and activities towards tagging each item. This will lead to billions of items being RFID tagged every year. We discuss why, where, what next and give detailed forecasts, winners and losers. IDTechEx

The RFID Knowledgebase

Over 1600 case studies listed and growing by over 50 a month. Covering more than 1700 companies, learn from the successes and failures of others. www.rfidbase.com

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